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A REPORT TO
BREMONT HOMES CORPORATION

HYDROGEOLOGICAL STUDY

PROPOSED 4-STOREY APARTMENT BUILDING WITH 1-LEVEL UNDERGROUND PARKING GROUND
60-90 RIVER ROAD EAST
TOWN OF WASAGA BEACH

REFERENCE No. 1707-W036

SEPTEMBER 2017

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1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. (SEL) has completed a Hydrogeological Assessment for a proposed development site located at 60-90 River Park East in the Town of Wasaga Beach.

The subject site is located on top of a bluff within the Nottawasaga basin. The surface soil comprises lacustrine deposits, consisting, predominantly of sand, gravelly sand and gravel which are considered as, nearshore and beaches deposits.

The records review indicates that the subject site is located within the Marl Creek sub-watershed of the Nottawasaga Valley Watershed. There are records for natural features, including water bodies, watercourses and provincial parks within close proximity of the subject site. The ground surface is relatively flat; however it exhibits a gentle decline towards the west/northwest limits of the subject property.

The study has disclosed that beneath a layer of topsoil and sand fill the subsoil underlying the subject site consists of fine sand having trace silt.

The findings of this study confirms that the groundwater elevations levels range from 177.70 to 177.91 meters above sea level (masl), or in the range of 3.09 to 3.80 m below the prevailing ground surface where shallow groundwater flows, in general, in a northwesterly direction, towards the Nottawasaga River, located at the north and west limits of the property.

The hydraulic conductivity (K) estimates ranges from 2.5×10^{-6} to 7.3×10^{-6} m/sec for the fine sand units at the depths of the well screens. The K estimates for the water-bearing soil layers beneath the subject sites suggest low to moderate groundwater seepage rates within excavations below the water table. Given the prevalence of sand subsoils in the general area low to moderate seepage rates and unstable soil conditions below the water table can be anticipated within open excavation for construction.

The highest shallow ground water level was measured at El. 177.91, which is below the proposed elevation for the base of the underground parking stucture. As such, there are no concerns pertaining to potential impacts to shallow or deep groundwater beneath the subject site with regard to construction dewatering. The estimated construction dewatering flow rate could reach a maximum of 27,365.4 L/ for construction of underground services. By considering a 3x safety factor, the estimated dewatering flow rate could reach an approximate daily maximum of 82, 096.2 L/day.

The estimated dewatering flow rate exceeds 50,000 L/day for installation of the underground services and is expected to reach a maximum daily rates of 82,096.2 L/day. As such, the registering of the proposed water-taking for construction is through an EASR, and its filing with the MOECC, which is recommended prior to proposed earthworks.

The subject site is located within the Wellhead Protection Area-B (WHPA-B), indicating 2 years travel time to the Jenetta Street Well Nos. 1, 2 and 3 having a vulnerability score of 6. As such, minimal threats and mitigation measures should be considered pertaining to potential impacts from the proposed development to the groundwater quality relative to nearby municipal wells.

Optimizing road salt application efficiency, implementing road design that minimizes, de-icing, salt application, and snow storage requirements, monitoring and maintaining storm water management structures, applying of road salt alternatives are recommended to minimize the potential impacts on groundwater quality.

Handling and storage Dense Non-Aqueous Phase Liquids (DNAPL), organic solvents and Vinyl chloride have a high potential risk score for entire subject site and they have significant vulnerability score for WHPA B areas. However, subject site is proposed for residential development where industrial chemical will not be used. As such, there is no concern regarding the handling and storage of DNAPL, organic solvents and Vinyl chloride within the subject site following site development.

2.0 INTRODUCTION

2.1 Project Description

In accordance with the written authorization, dated July 7, 2017, from Mr. Matthew Marsili of Bremont Homes corporation, SEL has performed a hydrogeological study for a proposed 4-storey apartment bulling having a1-level underground parking garage structure. The current study was carried out for 60-90 River Road East, Wasaga Beach, located northeast of the intersection of Beck Street and River Road East, in the Town of Wasaga Beach. The location plan for the site is shown on Drawing No. 1.

The subject is situated on a bluff within the Nottawasaga basin where the previous glacial Lake Nipissing extended. The site's currently consists of vacant lot and the surrounding lands uses consist of residential properties. The subject site is rectangular in shape and currently consists of a vacant lot which is weed coveredhaving scattered trees.

Nottawasaga River runs adjacent the north part of the site. The ground surface is slightly undulated and generally descends to the northwest, extending to a valley bank at the northwest limits of the property.

It is understood that the property will be used for proposed apartment/condominium building. The proposed development will be provided with full municipal water sewage and storm water services meeting urban standards.

The purpose of this Hydrogeological Study is to summarize the findings of the field study and the associated groundwater monitoring and testing, to provide a description and characterization of the interpreted hydrogeological setting for the site. The current study provides preliminary recommendations for construction dewatering needs, including an estimation of construction dewatering flow rates and the associated zones of influence, prior to the detailed design.

Since the subject site is located within a source protection area for municipal well No’s. 13, 14 and 15, servicing the Town of Wasaga Beach. The recommendation for any need to complete is included as part of this report along with any applicable recommendations for land use activities for the site being within a WHPA, Source Water Impact Assessment Mitigation Plan (SWIAMP).

2.2 Project Objectives

The major objectives of this Hydrogeological Study report are to:

1. Establish the local hydrogeological setting for the site in support of a proposed residential development;
2. Interpretation of the shallow groundwater flow patterns;
3. Preparation of interpreted hydro-stratigraphic cross-sections across the subject site;
4. Assess the hydraulic conductivity (K) for groundwater-bearing subsoil strata;
5. Identify zones of higher groundwater yield to assess potential groundwater seepage into excavations used for construction;
6. Estimate the anticipated dewatering flows that may be required to lower the water table to facilitate earthworks and construction;
7. Evaluate potential impacts to groundwater receptors within the anticipated zones of influence associated with construction dewatering program;

8. Comment on the need to complete a source water impact assessment mitigation plan (SWIAMP) to address planning policies for the site being within a municipal wellhead protection area.
9. Provide any applicable land use recommendations given that the site is within a WHPA related to the nearby municipal wells.

2.3 **Scope of Work**

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

1. Review of concurrent reports;
2. Clearance of underground services, drilling of three (3) boreholes and installation of monitoring wells at each of the borehole locations within the site's development footprint;
3. Reviewing and plotting of Ministry of Environment and Climate Change (MOECC) water well records within 500 m of the proposed residential and commercial development site;
4. Groundwater level monitoring and measurements at the three (3) installed monitoring wells;
5. Describing the geological and hydrogeological setting for the subject site and nearby surrounding areas;
6. Estimating groundwater flow rates and the zones of influence associated with construction dewatering to facilitate earth works and underground servicing;
7. Providing mitigation recommendations and an impact assessment for groundwater receptors, natural heritages and nearby structures located within the conceptual zones of influence for construction dewatering, if required;

8. Providing application recommendations regarding proposed land use activities to safeguard the nearby municipal wells and a recommendations to complete an groundwater impact assessment and mitigation plan given that the site is within a WHPA.

3.0 METHODOLOGY

3.1 Borehole Advancement and Monitoring Well Installation

The borehole drilling and monitoring well construction were performed on July 20, 2017. The program consisted of three (3) drilled boreholes and installation of a monitoring well one in each of three (3) drilled boreholes. The locations of the boreholes and monitoring wells are shown on Drawing No. 2.

The drilling and monitoring well installations were completed by DBW Drilling, a licensed contractor. The boreholes were drilled using hollow-stem flight-augers, with the field work being supervised and the findings recorded by a hydrogeological technician who logged the soil strata changes and collected representative soil samples for classification. Detailed descriptions of the encountered subsurface soil strata and groundwater conditions are presented on the Borehole and Monitoring Well Logs, enclosed as Figures 1 to 3.

The monitoring wells were constructed using 50-mm diameter PVC riser pipe and screen sections, and installed in accordance with Ontario Regulation (O. Reg.) 903. The monitoring wells were provided with monument-type steel protective casings.

The ground surface elevations at the boreholes and monitoring wells locations were adopted from the associated previous Soils Report (Reference No. 1306-S162). The UTM coordinates and ground surface elevations at the borehole and monitoring well locations, together with the well details, are provided in Table 3-1.

Table 3-1 - Monitoring Well Installation Details

Well ID	Installation Date	East (m)	North (m)	Ground Elevation (masl)	Borehole Depth (mbgs)	Screen Interval (mbgs)	Casing Dia.(mm)
BH/MW 101	July 20, 2017	578298.6	4930661	181.0	6.10	3.05-6.10	50
BH/MW 102	July 20, 2017	578315.8	4930703	181.5	6.10	3.05-6.10	50
BH/MW 103	July 20, 2017	578337.7	4930739	181.1	6.10	3.05-6.10	50

mbgs - metres below ground surface masl – metres above sea level

3.2 <u>Groundwater Monitoring</u>

The monitoring wells underwent development on August 4, 2017. The groundwater levels were recorded manually at all the monitoring wells on August 4, 28 and September 7, 2017.

3.3 <u>Mapping of Ontario Water Well Records</u>

Soil Engineers Ltd. (SEL) reviewed the MOECC Water Well Records (WWRs) for registered wells, located on the subject site and within 500 m from the site boundaries (study area). The records indicate that eighty-five (85) wells are located within the study area. Drawing No. 3 shows the location of the water well records within the study area and a summary of the Ontario WWRs reviewed for this study are listed in Appendix ‘A’.

3.4 Monitoring Well Development and Single Well Response Tests

The monitoring wells underwent development in preparation for single well response tests (SWRT) to estimate hydraulic conductivity (K) for soil strata at the depths of the well screens. Well development involves the purging and removal of several casing volumes of groundwater from each well to remove remnants of clay, silt and other debris introduced into the wells during construction, and to induce the flow of fresh formation groundwater through the well screens, thereby improving the transmissivity of the water bearing soil formation at the well screen depths.

An SWRT is used to estimate the hydraulic conductivity value (K) for the groundwater-bearing soil strata at the depth of the well screen. The K estimates provide an indication of the groundwater yield capacity for the groundwater-bearing soil strata and can be used to estimate the flow of groundwater through the water-bearing soil 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 water 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 water table recovers to static conditions is used to estimate the K value for the water-bearing formation at the well screen depth. SWRTs were performed at BH/MW 1, 2 and 3 monitoring wells on August 23, 2017. The test results with the estimates are provided in Appendix ‘B’ with a summary of results provided in table 6-2.

3.5 Previous and Current Report Review

The following report was reviewed in preparation of this hydrogeological study:

“A Report to 2323918 Ontario Limited., A Soil Investigation for Proposed Residential Development, River Road East and Beck Street, Town of Wasaga Beach, Reference No. 1306-S162, dated August 2013.

4.0 GEOLOGICAL SETTING

4.1 Regional Geology

The subject site lies within the physiographic region of Southern Ontario known as the Simcoe Lowlands where bevelled sand plain is the dominated surficial physiographic feature. The area is referred to as the Nottawasaga basin. In addition clay plains underline the area about 2 km to the east and beaches underline the area about 1.75 km northeast of the subject site.

A surface geology map of Ontario shows that the subject site is located on the lacustrine deposits, consisting predominantly of sand, gravely sand and gravel, representing nearshore and beach deposits. Drawing No. 4, reproduced from Ontario Geology Survey (OGS) mapping, illustrates the quaternary surface soil geology for the area.

The bedrock elevation is at approximately 120 masl, about 60 m below the prevailing ground surface (Bedrock Topography of the Collingwood-Nottawasaga Area, Southern Ontario). The bedrock beneath the site consists of Middle Ordovician aged shale, limestone, dolodtone, shale , arkose and sandstone of the Verulam Formation.

4.2 Physical Topography

A review of the topography shows that the subject site exhibits a gentle decline in relief to the west, towards the Nottawasaga River. Runoff from the site is expected to be drain towards the northwest portion of the property. Based on review of a topographic map for the area, the area declines towards the northwest. Drawing No. 5 shows the mapped topographic contours for the subject site and surrounding area.

4.3 Watershed Setting

The subject site is located in the boundary area of the Marl Creek sub-watershed of the Nottawasaga Valley Watershed. The associated rivers and creeks originate on the Niagara Escarpment, Simcoe Uplands, Oak Ridges Moraine and Oro Moraine. The Nottawasaga Valley Watershed lies within the Counties of Simcoe, Dufferin, and Grey. The Nottawasaga River is approximately 122 km in length and has a drainage area of approximately 3,200 km^2. The Nottawasaga Valley has 9 subwatersheds the largest subwatershed being the Lower Nottawasaga River (www.nvca.on.ca). Drawing No. 6 shows the location of the subject site within the Nottawasaga Valley Watershed.

4.4 Local Surface Water and Natural Features

The subject site is located adjacent the Nottawasaga River, which flows into Georgian Bay which is the closest water body relative to the subject site. Based on review of the available records, there are no parts of the site which are classified as an Areas of Natural and Scientific Interest (ANSI).

Watercourses, wood lots, wetlands and a provincial park area are scattered around the subject site. The closest record for a wetland which is classified as provincially significant wetland feature (PSW) is located about 350 m east/northeast of the site. The closest wooded area is located, approximately 150 m east of the site and the closest provincial park is located approximately 75 m west of the subject site.

Drawing No. 7 shows the locations of the mentioned natural features around the subject site.

5.0 SOIL LITHOLOGY

This study has disclosed that beneath a layer at topsoil in one location, or a layer of sand fill, the native soil underlying the subject site consists of fine sand to the investigated depth of 6.5 m below the prevailing grade. A Key Plan and the interpreted geological cross-sections along southwest-to-northeast transect are shown on Drawing Nos. 8-1 to 8-2.

5.1 **Topsoil** (BH/MWs 1)

The topsoil horizon, 18 cm thick, was contacted at west portion of the site where the BH/MW 1 is located.

5.2 **Sand Fill** (All BH/MWs)

The fill consists of fine sand at west portion and sand fill at cerntral and east portion of the site, having topsoil inclusions. The thickness of the layer ranges from 0.3 to 1.5± m. It is brown in colour and the moisture content for retrieved samples ranges from 4% to 9%, indicating moist to saturated conditions.

5.3 **Fine Sand** (All BH/MWs)

Fine sand was encountered beneath the sand fill which extend to maximum depth of investigation at 6.5 mbgs. The fine sand contains some silt. This unit is brown to grey in colour and the moisture content ranges from 5% to 27%, indicating that it is in moist to saturated conditions. Grain size analysis was performed on two (2) samples and the estimated permeability for these samples is 10^{-2} cm/sec. The gradation plots are provided on Figure 4.

6.0 GROUNDWATER STUDY

6.1 Review Summary of previous and Current Reports

A concurrent geotechnical investigation, performed at the site by SEL has revealed that beneath the topsoil and sand fill, the site is generally underlain by fine sand having traces of silt in all the boreholes.

Based on the report, the groundwater was generally recorded, at El. 178.50± m. The soil colour changes from brown to grey at a depth of 6.0 m below the prevailing ground surface. The groundwater levels generally correspond to the water levels of Nottawasaga River. The brown colour indicates that the soils in the upper soil horizons have oxidized and are generally above the prevailing groundwater levels beneath the site.

The groundwater is subject to seasonal fluctuation and will be impacted by the Nottawasaga River.

Perched groundwater derived from infiltrated precipitation will occur at shallow depths during the wet seasons. In excavations, the groundwater yield from the fine sands will be appreciable and is expected to be high due to site being within close proximity of the Nottawasaga River.

6.2 Review of Ontario Water Well Records

The MOECC WWRs for the subject site area and for the properties within a 500 m radius of the boundaries of the subject site (study area) were reviewed.

The records indicate that eighty-five (85) wells are located within the study area. The locations of these wells, based on the UTM coordinates provided by the records, are shown on Drawing No 3. A detailed summary of the MOECC WWRs reviewed is provided in Appendix ‘A’.

A review of the final status of the wells within the study area reveals that seventy-three (73) wells are registered as water supply wells, three (3) are registered as observation wells, two (2) are registered as test holes wells, five (5) are abandoned-supply wells, and two (2) wells have unknown status.

A review of the first status of the wells shows that one (1) well is monitoring well, twenty-two (22) are commercial wells, four (4) are listed as not being used, forty-five (45) as registered as domestic wells, five (5) are listed as public supply wells, one (1) is listed as a livestock well, three (3) are listed as municipal wells and four (4) wells are identifies as have unknown status,

The records indicate that there is one domestic water supply well within the subject site, but during our visit we did not find any supply well on the property.

6.3 Groundwater Monitoring

The groundwater levels were measured in the monitoring wells on August 4, 23 and September 7, 2017, to record the fluctuation of the groundwater table beneath the site over the study period. The measured groundwater levels are presented in Table 6-1.

Table 6-1 - Water Level Measurements

Well ID		August 4, 2017	August 23, 2017	September 7, 2017	Average (m)
BH/MW 101	mbgs	3.09	3.15	3.18	3.14
	masl	177.91	177.85	177.82	177.86
BH/MW 102	mbgs	3.75	3.77	3.80	3.77
	masl	177.75	177.73	177.70	177.73
BH/MW 103	mbgs	3.28	3.3	3.34	3.31
	masl	177.82	177.80	177.76	177.79

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

As shown above, the shallow groundwater exhibited a descending trend over the monitoring period at BH/MWs 101, 102 and 103 which were installed within the east portion of the subject site. The highest shallow groundwater level was recorded at BH/MW 1 on August 4, 2017. Groundwater at this monitoring well exhibited a 9.0 cm decline between August 4 and September 7 2017, which corresponds with a drop in precipitation levels received over the late summer period.

6.4 Single Well Response Test Analysis

Single Well Response Tests (SWRTs) were performed at BH/MWs 101, 102 and 103. The results are presented in Appendix 'B' and summarized in Table 6-2.

Table 6-2 - Summary of SWRT Results

Well ID	Ground El. (masl)	Borehole Depth (mbgs)	Screen Depth (mbgs)	Screen Interval (mbgs)	Screened Soil Strata	Hydraulic Conductivity (K) (m/sec)
BH/MW 101	181.0	6.1	3.0	3.1-6.1	Fine sand trace of silt	7.9×10^{-6}
BH/MW 102	181.5	6.1	3.0	3.1-6.1	Fine sand trace of silt	5.1×10^{-6}
BH/MW 103	181.10	6.1	3.0	3.1-6.1	Fine sand trace of silt	7.9×10^{-6}

The results of the SWRTs provide an indication of the groundwater yield capacity for the groundwater-bearing soil strata at the depths of the well screens. Based on the moderate estimates for hydraulic conductivity (K), correspondingly moderate groundwater seepage rates can be anticipated for these soils at the depths of the well screens, or for similar soils, or if encountered in excavations within the same depth interval below the prevailing groundwater table. Moderate seepage rates can be expected in open excavation below the water table. Given the prevalence of fine sand beneath the site, open excavations below the water table are likely to be unstable.

6.5 **Shallow Groundwater Flow Pattern**

The average groundwater levels measured at the boreholes/monitoring wells were used to interpret the shallow ground flow pattern beneath the subject site. A review of the data indicates that it flows in general towards the northeast, towards the Nottawassaga River, located north of the subject site. However, the water table in relatively flat across the site and locally flows towards the centre of the site from west and east, indicating the possibility of existence of an old channel beneath the central portion of the subject site. The interpreted shallow groundwater flow pattern for the site is illustrated on Drawing No. 9.

7.0 GROUNDWATER CONTROL DURING CONSTRUCTION

The estimated hydraulic conductivity (K) values suggest that if groundwater is encountered during excavation, the seepage rates within the groundwater bearing soil units below the groundwater table will be moderate.

7.1 Groundwater Construction Dewatering Rates

The conceptual development plans, prepared by ISM Architects, dated February 24, 2017 were reviewed for this assessment. The proposed development will involve construction of a residential apartment building having a 1-level underground parking structures.

The highest shallow groundwater was measured at El. 177.91 masl. A review of the development plan indicates that the base of the proposed underground structure will be at El. 179.5. Since the highest shallow groundwater was measured about 1.6 m below the proposed base for the underground structure, no dewatering is anticipated for the proposed development. However, it should be noted that the shallow groundwater was monitored over the low precipitation season where low groundwater levels would be expected. The shallow groundwater could be higher over the spring season. As such, it is recommended that the earth work be completed over the low precipitation season (late summer and fall) to avoid any construction dewatering.

The underground servicing installation plan was not available for review. As such, it is assumed that the underground services will be installed at a depth of 5.0± m (El. 177.70 masl) below the proposed finished grade El. 182.70 masl. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the water table be lowered to El. 176.70 masl, which is about 1.0 m below the lowest proposed excavation depths for underground servicing. The highest shallow groundwater was measured at El. 177.91 masl. As such, the estimated dewatering flow rate is anticipated to reach a maximum rate of 27,365.4 L/day; by considering a 3x safety factor, the estimated dewatering flow rate could reach an approximate daily maximum of 82,096.2 L/day. It should be noted that an open trench excavation length of 30.0 m was considered for this assessment.

In accordance with the current policy of the Ministry of Environment and climate Change (MOECC), where the dewatering flow rate is between 50,000 L/day and 4000,000 L/D, registering of the proposed water-taking for construction is by means of the filing an Environmental Activity and Sector Registry (EASR) with the MOECC. Since the estimated dewatering flow rate exceeds 50,000 L/day for the installation of the underground services and is expected to reach a maximum daily rate of 82,096.2 L/day, registering any proposed water-taking for construction is through an EASR, with its filing with the MOECC, being recommended.

7.2 Groundwater Control Methodology

Groundwater seepage in open excavations below the water table may be controllable by occasional pumping from sumps when needed during earthworks. However due to the unstable nature of fine sand below the water table, the water table should be lowered in advanced of excavations. The final design for the dewatering system will be the responsibility of the construction contractors.

7.3 Mitigation of Potential Impacts Associated with Dewatering

The zone of influence for construction dewatering could reach a maximum of 10.2 m from the conceptual dewatering array considered for construction of underground services. Based on the records review and site visits, there are no natural features, or groundwater receptors, including water supply wells within, in close proximity of the site, or within the estimated zone of influence for any construction dewatering. However, River Road East is located at the east limit of the property which may be located within the zone on influence for construction dewatering. As such, it is recommended that an assessment of potential ground settlement to the roadway and the adjacent structures, adjacent the site be completed by geotechnical engineer.

7.4 **Groundwater Function for the Subject Site**

The proposed development consists of a residential apartment building, having a 1-level underground parking structure and associated underground services.

This study shows that the shallow groundwater is below the proposed base for the underground structure. However, shallow groundwater should be temporary lowered to install the underground services if they will be installed at or below El. 177.20 masl. There are no natural features or groundwater receptors within or in close proximity of the site. Furthermore, the monitoring program was completed during the late summer period where low precipitation amounts were received at the site. As such, if the construction is completed over the summer or fall, dewatering will not likely be required for construction of the proposed 1- level underground structure. However, temporary dewatering is anticipated for installation of underground services.

8.0 Source Water Protection Impact Assessment

The subject site is located within the wellhead protection area due to its relatively close proximity to three (3) municipal wells that service the Town of Wasaga Beach. It is located within the WHPA-B zone which comprises areas where groundwater travels slowly and will take 2 years to reach the well. Drawing No. 10 shows the location of the subject site relative to the mapped wellhead protection area for municipal wells. Details of the municipal wells, screen interval and aquifer classification which have been provided for Town of Wasaga Beach are summarized in Table 8-1 (Town of Wasaga Beach, Source Water Protection Threat Assessment, Golder Associates, July 2010) .

Table 8-1 - Municipal Wells Details based on Town of Wasaga Beach, Source Water Protection Threat Assessment, Golder Associates, July 2010)

Municipal Well ID/Well Tag No.	MOECC ID	Aquifer ID	Aquifer Type
(Jenetta Street Well No. 1)	5731664	A3/A4	Confined
(Jenetta Street Well No. 2)	5731668	A3/A4	Confined
(Jenetta Street Well No. 3)	5731666	A3/A4	Confined

It should be mentioned that MOECC well record website was reviewed for the Jenetta Street water wells based on the MOECC ID is provided by the above mentioned report. However, detailed information for the municipal wells having the above mentioned IDs were not available for review.

A review of MOECC website indicate that there are three (3) cluster municipal wells having MOECC ID 5738794 located at north of the Nottawasaga River within the Wasaga Prudential Park Area, where Jenetta Street Wells are located. Details for above mentioned wells are summarized as in Table 8-2:

Table 8-2 – Water Supply Wells Details (MOECC Records)

WELL ID	MOECC ID	East (m)	North (m)	Well Depth (m)	Screen Interval (m)	Well Use
13	5738794	578105.0	4930724.0	68.00	57.30-64.90	Municipal
14	5738794	578105.0	4930724.0	68.00	57.30-64.90	Municipal
15	5738794	578105.0	4930724.0	68.00	57.30-64.90	Municipal

The Wasaga Beach area is underlain by four overburden soil aquifer systems. The upper unconfined aquifer (Aquifer A1) is located within a few metres of the ground surface and is made up of the sand that is present at the ground surface across at Wasaga Beach. The sand is up to approximately 20 m thick, depending on the below elevation, and can have a saturated thickness of up to approximately 15 m. Most of the wells constructed in this aquifer are sand points or dug wells; however shallow drilled wells are also present. The second aquifer in the sequence is Aquifer A2. This unit is present predominantly in the western part of Wasaga Beach near the McIntyre Estates area, and as a thin sand zone at an elevation range of 135 to 155 metres above sea level (masl) along River Road West, but is absent at Powerline Road area. Between Aquifer A2 and Aquifer A1 there is a confining layer described as silt and clay in most drillers records. This confining unit is recognized in many areas as deep water varved lacustrine silts and clay of Lake Algonquin origin. The lower aquifers (A3) and (A4) host the municipal water supply wells. In most areas of Wasaga Beach this aquifer is separated from Aquifer A2 by a 10 to 15 m thick silt and clay confining layer; however in some areas it may be absent. It is expected that Aquifers A3 and A4 are connected, however testing at the two well fields at rates of up to 15,725 m^3/day (182 L/s) has failed to result in measurable interference between the well fields. The coarse-grained portion of the aquifer is at the base of this unit and is approximately 10 m thick. The upper portion of the aquifer at Wells 2 and 3 is described as fine sand or sand with the odd streak of gravel,whereas the lower portion is composed of fine to coarse gravel and boulders (Town of Wasaga Beach, Source Water Protection Threat Assessment, Golder Associates, July 2010) .

Site plan and site section plan, provided by ISM Architects dated March 17, 2017, having Drawing Nos. 100 and 101 were reviewed for this assessment. Based on the development plans the proposed development includes a 1- level underground parking structure. The Ground surface elevation has been proposed at El. 182.70 masl. and the base of the underground parking has been considered at a depth of 3.0 m below the proposed ground surface. As such, base of the proposed 1-level underground parking has been considered at El. 179.70 masl.

Based on the findings for current hydrogeological assessment, the entire site is covered by a thick stratum of sand which extends to the termination depth of investigation, at 6.5 m below the prevailing ground surface (174.5 masl). Considering the proposed grading elevation, it is estimated that the bottom for the underground basement level will be within the sand unit which has moderate to high permeability.

Since the maximum excavation depth is considerably very above the tops of the intake screens for the municipal wells installed within a deep confined aquifer there are no concerns regarding potential interference drawdown from any temporary dewatering program that may be required in connection with construction for the proposed development.

8.1 **Risk Assessment Analysis**

- ***Previous or Current Environmental Risk Assessment Report***

Soil Engineers Ltd. is not aware of any Environmental Risk assessment completed for the subject site.

- ***Anthropogenic Transport Pathways***

Wells and underground services represent potential transport pathways for contamination. The proposed residential building will be provided with full municipal underground services. Record review shows a water supply well within the subject site. However, there was no evidence of water well at the time of site inspection.

- ***Identification of Vulnerable Areas***

According to the Source Water Protection database, the subject site is located within the 2 year travel time (WHPA- B) and vulnerability score of 6 has been considered for this area. Drawing No. 11 shows the location of the subject site within the provided vulnerability score plan area provided for by the Town of Wasaga Beach (Town of Wasaga Beach, Source Water Protection Threat Assessment, Golder Associates, July 2010) .

- ***Threat Assessment Analysis on the Subject Site***

A threat assessment analysis review was conducted for the subject site and the proposed development. Subject site is not located within the significant, moderate and low threat-chemicals planning policy area for the Jenetta Street Wells Nos. 1, 2 and 3 based on Table C-6 of the Source Water Protection Threat Assessment report provided by Golder Associates, dated July 2010. As such, minimal threat is anticipated from potential impacts of the proposed development to the Jenetta Street municipal wells.

The proposed development consists of residential building with a 1- level underground parking structure. The proposed residential building will be provided with underground services. In addition, the highest shallow ground water level was measured at El. 177.90, which is below the proposed elevation for the base of the underground parking level. As such, there are no concerns pertaining to potential impact to shallow or deep groundwater beneath the subject site with minimal or no anticipated long term foundation drainage needs following development. However, minor dewateing is anticipated for installation of the underground services. Since the proposed base for the 1-level undergeround parking is very above the municipal wells screens, no concerns are anticipated with regards to potential impact to groundwater beneath the subject site.

Handling and storage Dense Non-Aqueous Phase Liquids (DNAPL), organic solvents and Vinyl chloride have high risk score for entire subject site and they have significant vulnerability score for WHPA B areas. However, subject site is proposed for residential development. As such, there is no concern regarding the handling and storage of DNAPL, organic solvents and Vinyl chloriden within the subject site. In addition, Handling and storage of road salt for de-icing over the winter time could increase the concentration of the sodium chloride recharging to the municipal aquifer; however using alternative de-icing methods such as Magnesium Acetate which has a low environmental impact, or implementing road design that minimizes salt application, could be considered for the development. Given that the site will be paved there will be minimal recharge to the aquifer. Therefore potential impacts from de-icing salt are expected to be low to negligible. This assessment was conducted based on the available Table of Drinking Water Threats (Clean Water Act, 2006). Furthermore, handling and storage of household hazardous waste, maintaining fuel oil tanks and septic systems, maintaining or decommissioning a supply well increases the risk for contaminating to the aquifer for this zone (drinking

Water Source Protection, February 2013); however, the proposed development will be serviced by the Town of Wasaga Beach water supply and sanitary sewer systems. Therefore, none of above mentioned concerns applies to the subject site for the proposed development. Furthermore, since the proposed development will consist of a residential apartment building, there is no concern pertaining to potential use of commercial, industrial or agricultural hazardous materials, which are restricted and from usage within the WHPA B zone.

8.2 **Risk Management Analysis and Mitigation Plan**

The subject site is located within the "WHPA B zone from the mapped wellhead protection areas associated with the Jenetta Street Wells Nos. 1, 2 and 3. In order to prepare risk management and mitigation plan and to conduct a risk management analysis, the MOECC's Risk Management Measures Catalogue for applying, handling and storage of road salt was reviewed (http://www.trcagauging.ca/RmmCatalogue/QualityThreat.aspx). Findings of the review are summarized as below:

- Handling and storage Dense Non-Aqueous Phase Liquids (DNAPL), organic solvents and Vinyl chloride is not allowed at WHPA-B having vulnerability score of 6. Since subject site will be developed for residential land use, no risk is anticipated.

- Optimizing road salt application efficiency: This measure reduces the negative environmental impacts of salt applications by delivering the correct amount of road salt at the right place and at the right time.

- Implementing road design that minimizes salt application, de-icing, and snow storage requirements: An increase in the roadway and bridge designers' awareness of techniques, configurations, and design parameters will reduce the amount of snow and ice accumulation, which can lead to reduced salt application.

- Monitoring and maintaining storm water management structures: Storm water management structures are commonly used for controlling storm water runoff, removing contaminants, and to facilitate recharging of the groundwater table.
- Application of a Road Salt Alternative - Calcium Magnesium Acetate: Calcium Magnesium Acetate has a low environmental impact but can contribute to biochemical oxygen demand (BOD). It also has a high purchase cost relative to NaCl. In addition, Potassium acetate (KA) is often used as a base for commercial chloride-free liquid deicer formulations as a road salt alternative, having low corrosion, relatively high performance, and a low environmental impact. The above risk management and risk mitigation measures should be considered for the proposed development.

9.0 **CONCLUSION**

1. The subject site is located on top of a bluff within the Nottawasaga basin. The surface soil comprises lacustrine deposits, consisting, predominantly of sand, gravelly sand and gravel, considered as nearshore and beaches deposits.
2. The records review indicates that the subject site is located within the Marl Creek sub-watershed of the Nottawasaga Valley Watershed. There are records for natural features, including water bodies, watercourses and Provincial Parks within close proximity of the subject site. The ground surface is relatively flat; however. it exhibits a decline towards the west/northwest limits of the subject property.
3. The study has disclosed that beneath a layer of topsoil and sand fill the subsoil underlying the subject site consists of fine sand.
4. The findings of this study confirms that the groundwater elevations levels range from 177.70 to 177.91 meters above sea level (masl), or in the range of 3.09 to 3.80 m below the prevailing ground surface with shallow groundwater generally flowing in a northwesterly direction, towards the Nottawasaga River, located at the north/ northwest limits of the property.
5. The hydraulic conductivity (K) estimates ranges from 2.5×10^{-6} to 7.3×10^{-6} m/sec for the fine sand units at the depths of the well screens. The K estimates for the water bearing soil layers beneath the subject sites suggest low to moderate groundwater seepage rates within excavations below the water table. Given the prevalence of sand subsoils in the general area low to moderate seepage rates and unstable soil conditions below the water table can be anticipated within open excavations below the water table for construction.
6. The highest shallow ground water level was measured at El. 177.91 masl, which is below the proposed elevation for the base of the proposed underground parking structure. As such, there are no concerns pertaining to potential impacts to the

shallow or deep aquifer system beneath the subject site with regard to construction dewatering. The estimated construction dewatering flow rate could reach a maximum of 27,365.4 L/ for construction of underground services. By considering a 3x safety factor, the estimated dewatering flow rate could reach an approximate daily maximum of 82, 096.2 L/day.

7. Since the estimated dewatering flow rate exceeds 50,000 L/day for installation of the underground services and is expected to reach a maximum daily rate of 82,096.2 L/day. The registering of the proposed water-taking for construction through an EASR, and its filing with the MOECC, is recommended.

8. The subject site is located within the Wellhead Protection Area-B (WHPA-B), indicating 2 years travel time to the Jenetta Street Well Nos. 1, 2 and 3 having a vulnerability score of 6. As such, minimal threats and mitigation should be considered pertaining to potential impacts of the proposed development to the groundwater quality relative to nearby municipal wells.

9. Optimizing road salt application efficiency, implementing road design that minimizes, de-icing, salt application, and snow storage requirements, monitoring and maintaining storm water management structures, applying of road salt alternatives are recommended to minimize the potential impacts on local groundwater quality.

10. Handling and storage Dense Non-Aqueous Phase Liquids (DNAPL), organic solvents and Vinyl chloride having a high risk score for entire subject site and they have significant vulnerability score for WHPA B areas. However, subject site is proposed for residential development where associated chemicals will not be used. As such, there is no concern regarding the handling and storage of DNAPL, organic solvents and Vinyl chloriden within the subject site following site development.

Yours truly,

SOIL ENGINEERS LTD.

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10.0 REFERENCES

1. The Physiography of Southern Ontario (Third Edition), L. J. Chapman and D. F. Putnam, 1984.
2. Lake Simcoe Region Conservation Authority, 2015.
3. Bedrock Topography of the Newmarket Area, Southern Ontario, 1993, Open File Map P. 3214, Mines and Minerals Division, Ontario Geological Survey.
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5. Approved Updated Assessment Report, Toronto and Region Source Water Protection Area, January 2012, 61 p.
6. Don River Watershed Plan, Geology and Groundwater Resource Report on Current Conditions, Toronto and Region Conservation Authority, 2009, 71 P.

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FIGURES 1 to 4

BOREHOLE LOGS AND GRAIN SIZE DISTRIBUTION GRAPHS

REFERENCE NO. 1707-W036

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—•—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0	Field vane test in borehole; the number denotes the sensitivity to remoulding
△	Laboratory vane test
□	Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 1707-W036

LOG OF BOREHOLE NO.: BH/MW 101

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed 4-Storey Apartment Building with 1-Level Underground Parking Garage

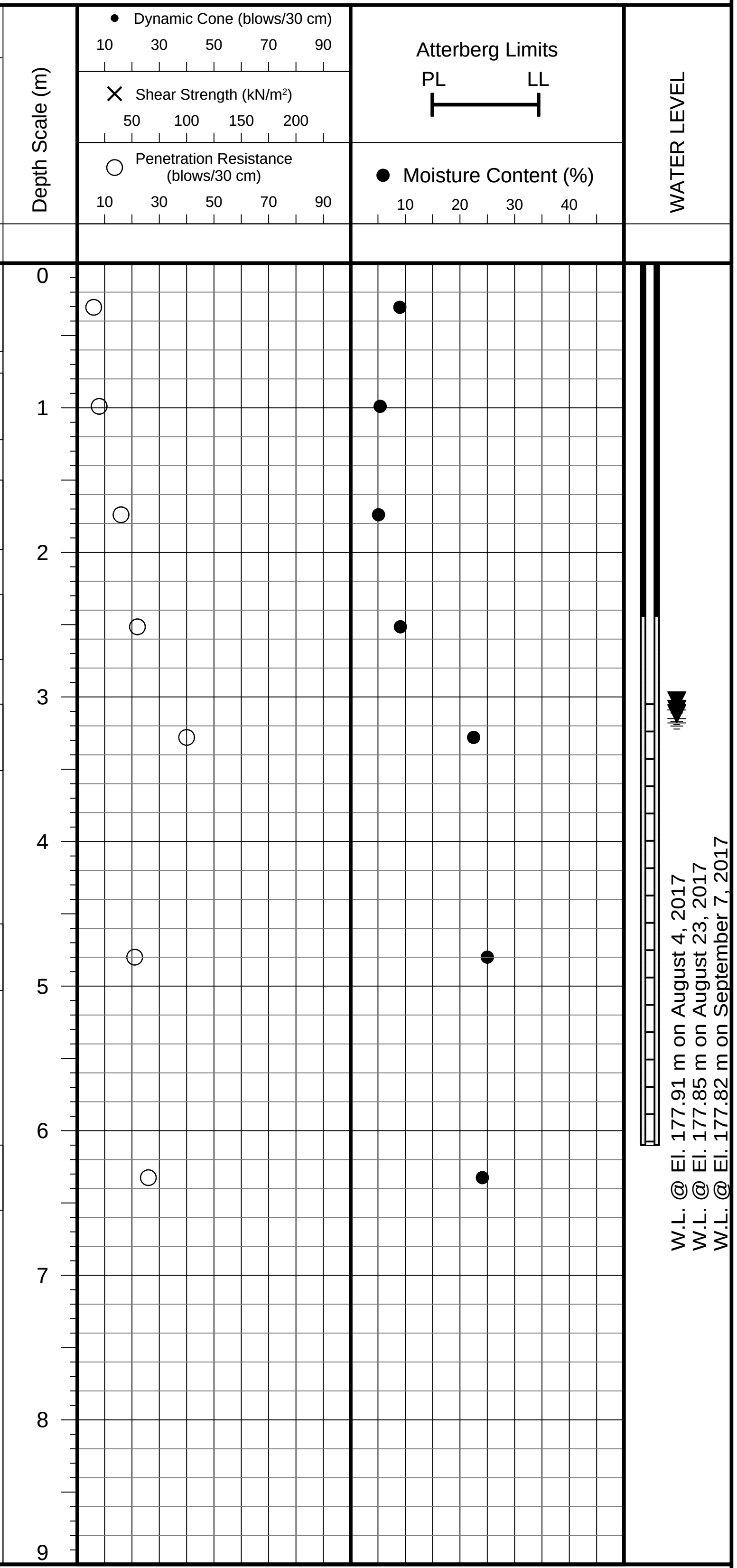
METHOD OF BORING: Hollow-Stem Auger

PROJECT LOCATION: 60-69 River Road East - Town of Wasaga Beach

DRILLING DATE: July 20, 2017

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
181.0	Ground Surface			
180.8 0.2	**18 cm TOPSOIL**			
	Brown **FINE SAND FILL**	1	DO	6
180.2 0.8		2	DO	8
		3	DO	16
		4	DO	22
	Loose to dense **FINE SAND**	5	DO	40
	wet			
		6	DO	21
	Brown Grey	7	DO	26
174.5 6.5	**END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 6.10m
3.05 m screen from 3.05 to 6.10 m
Sand backfill from 2.44 to 6.1 m
Bentonite seal from 0.00 to 2.44 m
provided with a steel monument casing



W.L. @ El. 177.91 m on August 4, 2017
W.L. @ El. 177.85 m on August 23, 2017
W.L. @ El. 177.82 m on September 7, 2017

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JOB NO.: 1707-W036

LOG OF BOREHOLE NO.: BH/MW 102

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed 4-Storey Apartment Building with 1-Level Underground Parking Garage

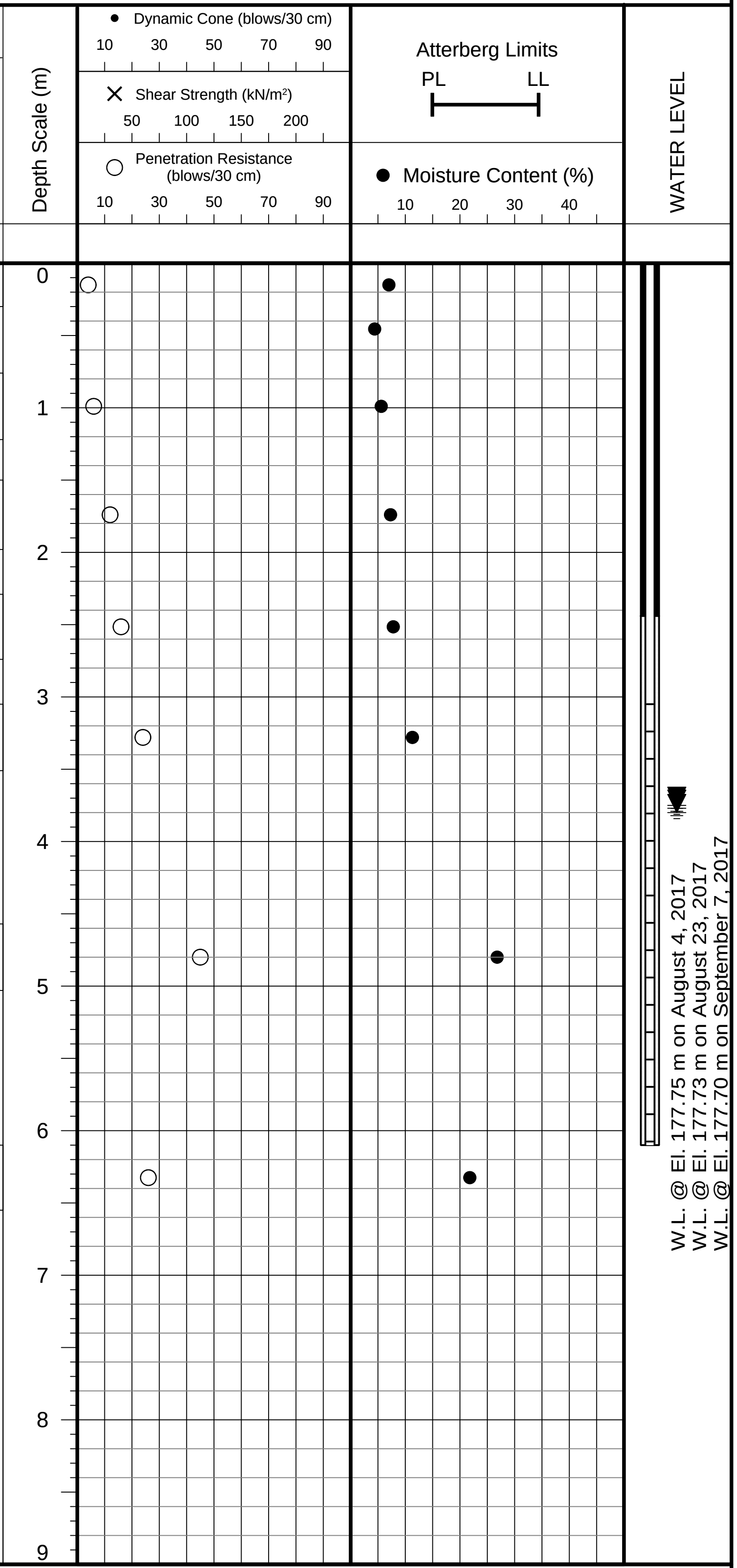
METHOD OF BORING: Hollow-Stem Auger

PROJECT LOCATION: 60-69 River Road East - Town of Wasaga Beach

DRILLING DATE: July 20, 2017

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
181.5	Ground Surface			
0.0 181.2	Grey **SAND FILL**	1A	DO	4
0.3	very loose to dense **FINE SAND**	1B	DO	
		2	DO	6
		3	DO	12
		4	DO	16
		5	DO	24
	trace of shells	6	DO	45
	Brown Grey	7	DO	26
175.0 6.5	**END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 6.10m
3.05 m screen from 3.05 to 6.10 m
Sand backfill from 2.44 to 6.1 m
Bentonite seal from 0.00 to 2.44 m
provided with a steel monument casing



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JOB NO.: 1707-W036

LOG OF BOREHOLE NO.: BH/MW 103

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed 4-Storey Apartment Building with 1-Level Underground Parking Garage

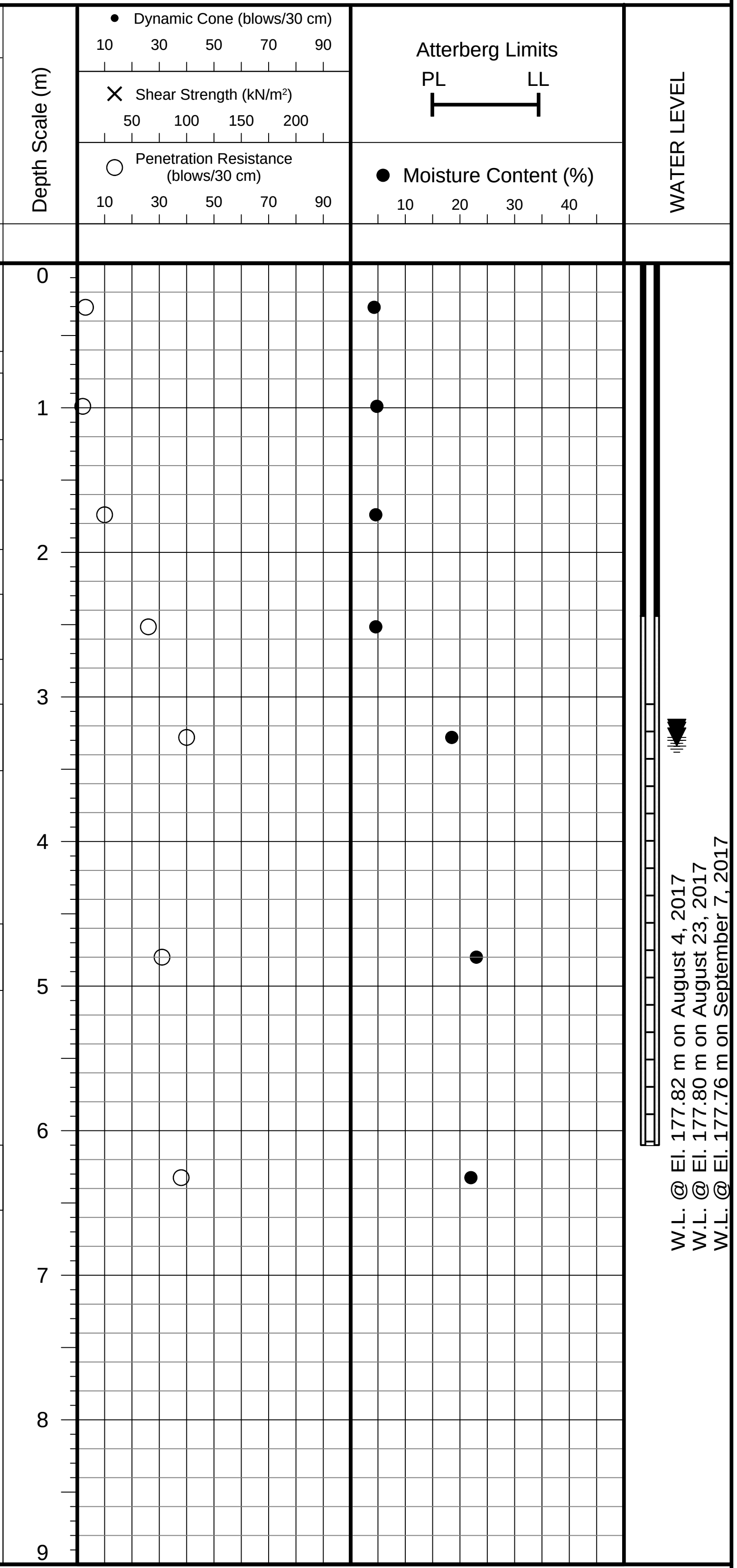
METHOD OF BORING: Hollow-Stem Auger

PROJECT LOCATION: 60-69 River Road East - Town of Wasaga Beach

DRILLING DATE: July 20, 2017

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
181.1 0.0	Ground Surface			
	Brown **SAND FILL**	1	DO	3
		2	DO	2
179.6 1.5	very loose to dense **FINE SAND**	3	DO	10
		4	DO	26
		5	DO	40
	wet	6	DO	31
	Brown Grey	7	DO	38
174.6 6.5	**END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 6.10m
3.05 m screen from 3.05 to 6.10 m
Sand backfill from 2.44 to 6.1 m
Bentonite seal from 0.00 to 2.44 m
provided with a steel monument casing



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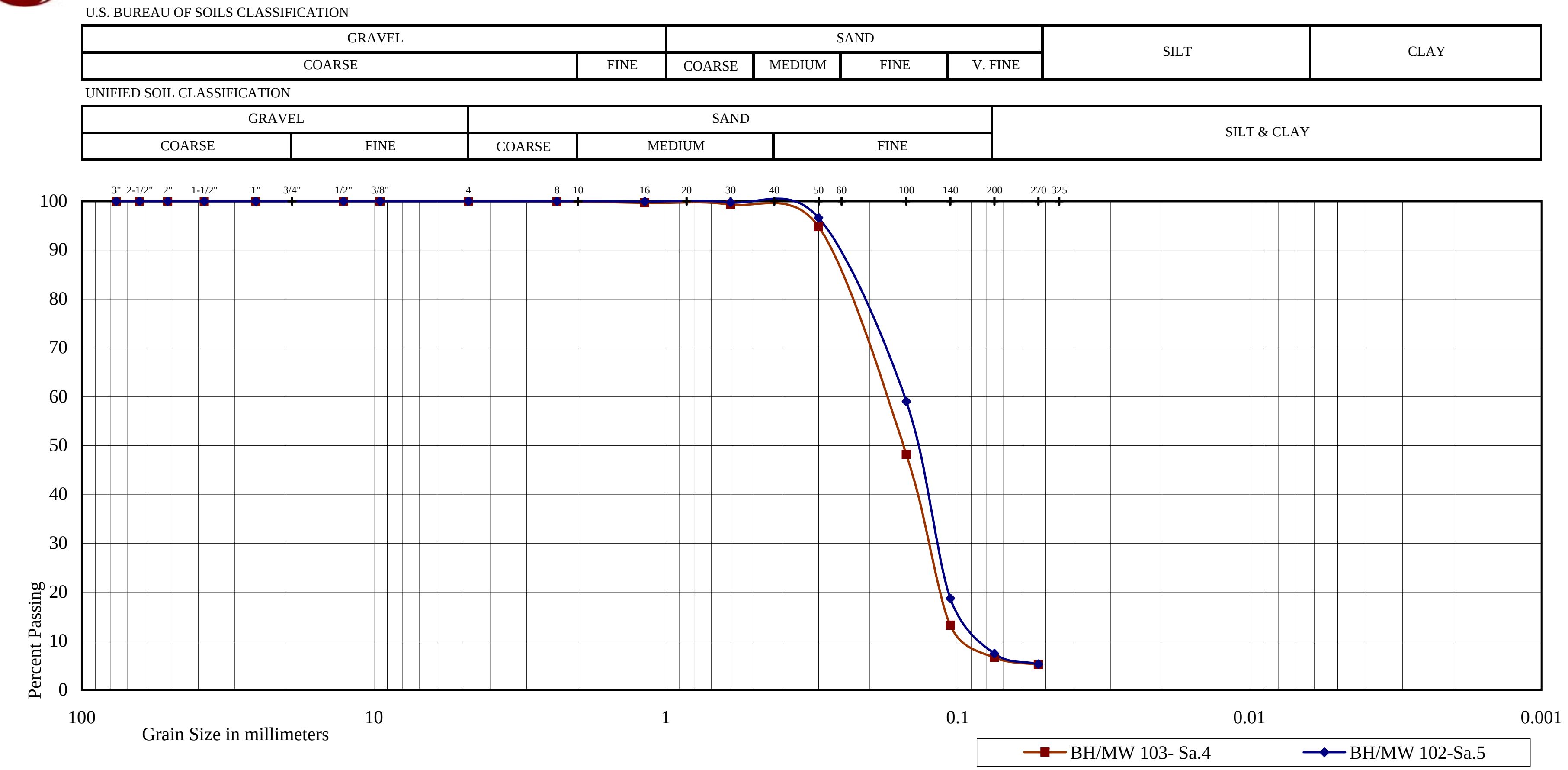
GRAIN SIZE DISTRIBUTION

Reference No: 1707-W036



Project: Proposed 4-Story Apartment Building with 1-Level Underground Parking

Location: 60-90 River Road East, Town of Wasaga Beach

Borehole No:	103	102
Sample No:	4	5
Depth (m):	2.5	3.3
Elevation (m):	178.6	178.2

BH/MW 102- Sa. 5Estimated Permeability (cm./sec.) = 10^{-2}

BH/MW 103- Sa. 4 Estimated Permeability (cm./sec.) = 10^{-2}

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

Figure 4

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DRAWINGS 1 to 11

REFERENCE NO. 1707-W036

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

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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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Title: Site Location Plan

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:

Drawing No. 1

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

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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N

🟥	Subject Site
▨	Proposed Building Footprint
⌖	Borehole with Monitoring Well
🟦	Waterbody
→	Watercourse
—	Major Road

Soil Engineers Ltd.

Title: Borehole and Monitoring
Well Location Plan

Project:

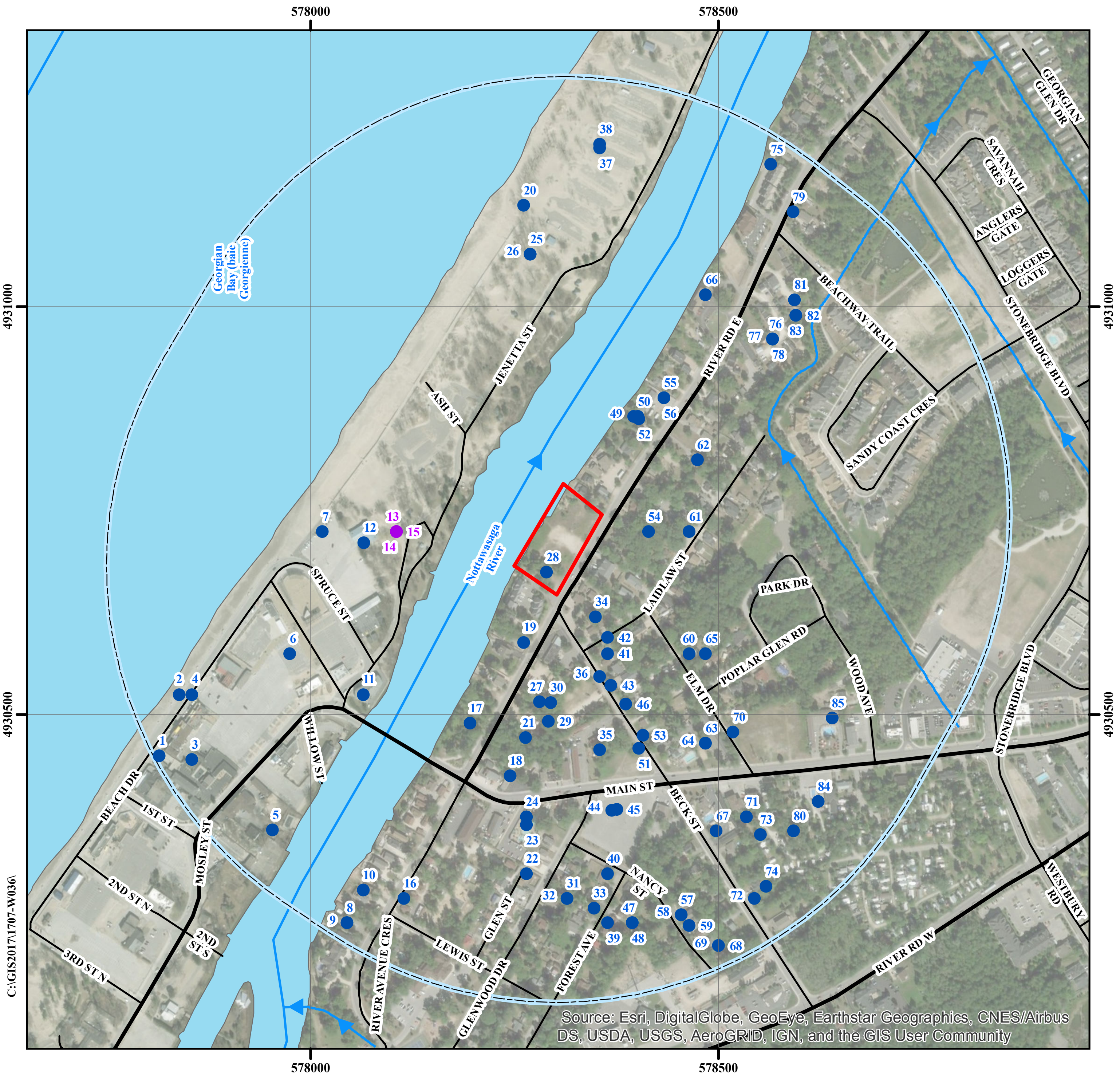
Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:
0 4.25 8.5 17 25.5 34 42.5
Metres

Drawing No. 2



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

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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□	Subject Site
●	Well Locations from MOECC Well Records
●	Municipal Well Locations
▨	Waterbody
→	Watercourse
━	Major Road
─	Local Road

Soil Engineers Ltd.

Title: MOECC Well Location Plan

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

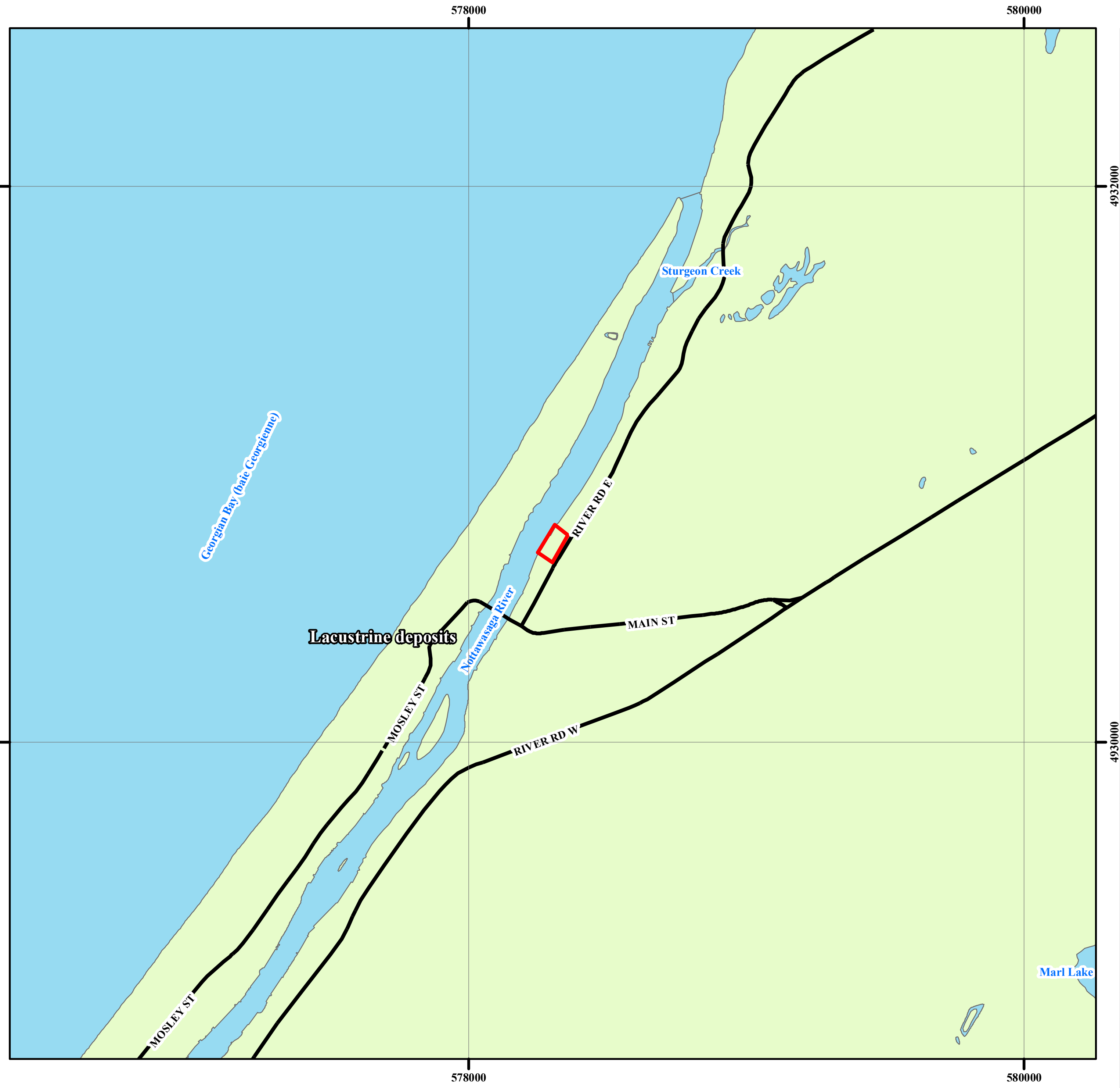
Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 35 70 140 210 280 350
Metres

Drawing No. 3



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N

🟥 Subject Site

🟩 Lacustrine deposits;
Material: sand, gravelly sand and
gravel, nearshore and beach deposits

🟦 Waterbody

— Major Road

Soil Engineers Ltd.

Title: Quarternary and Surface
Geology Map

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

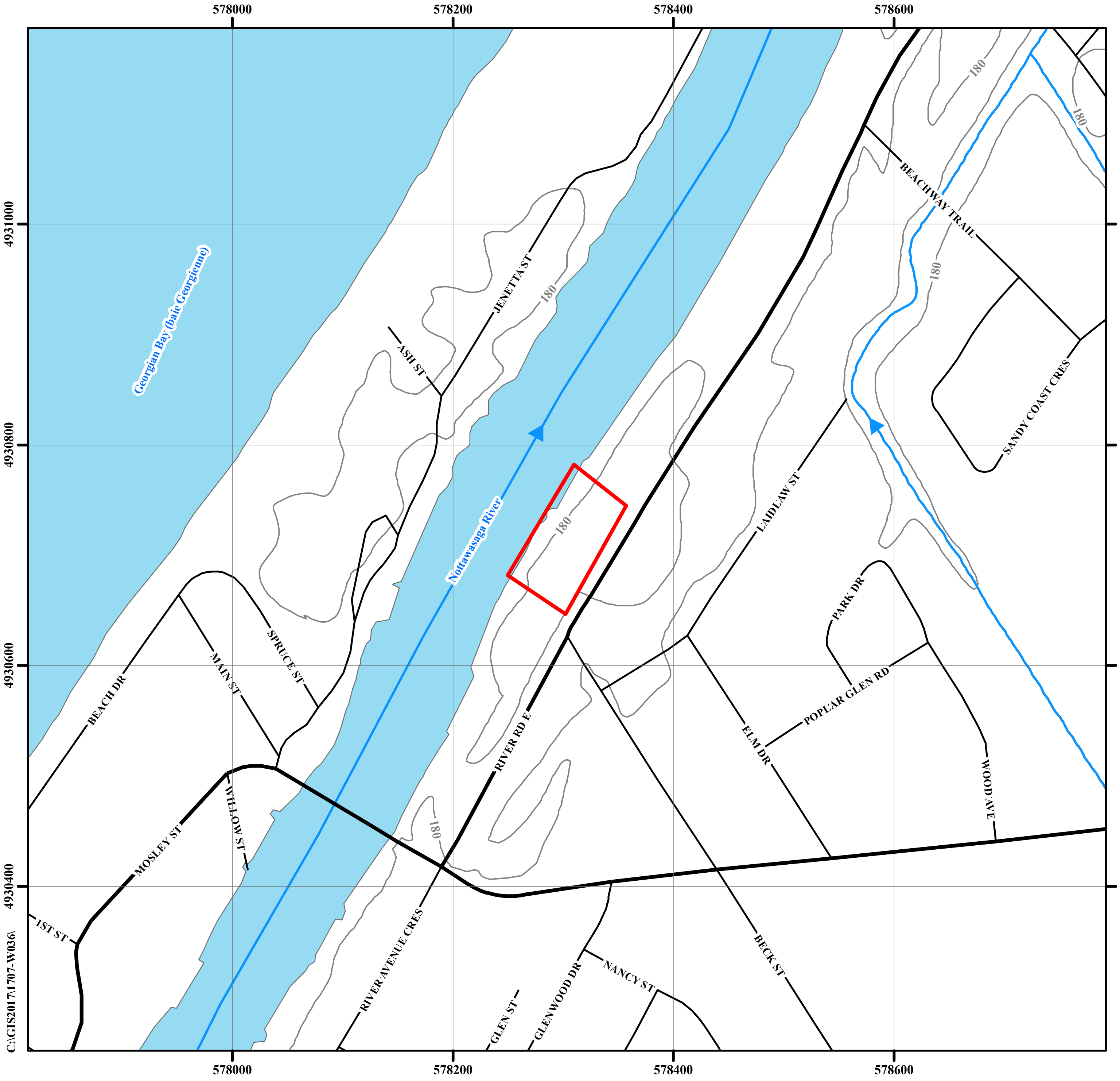
Reference No. 1707-W036

Date: July 7, 2017

Scale:
0 100 200 400 600 800 1,000
Metres

Drawing No. 4

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



🟥 Subject Site

▨ Waterbody

→ Watercourse

━ Major Road

— Local Road

—180— Topographic Contour (masl)

Soil Engineers Ltd.

Title: Topographic Map

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 25 50 100 150 200 250
Metres

Drawing No. 5

Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
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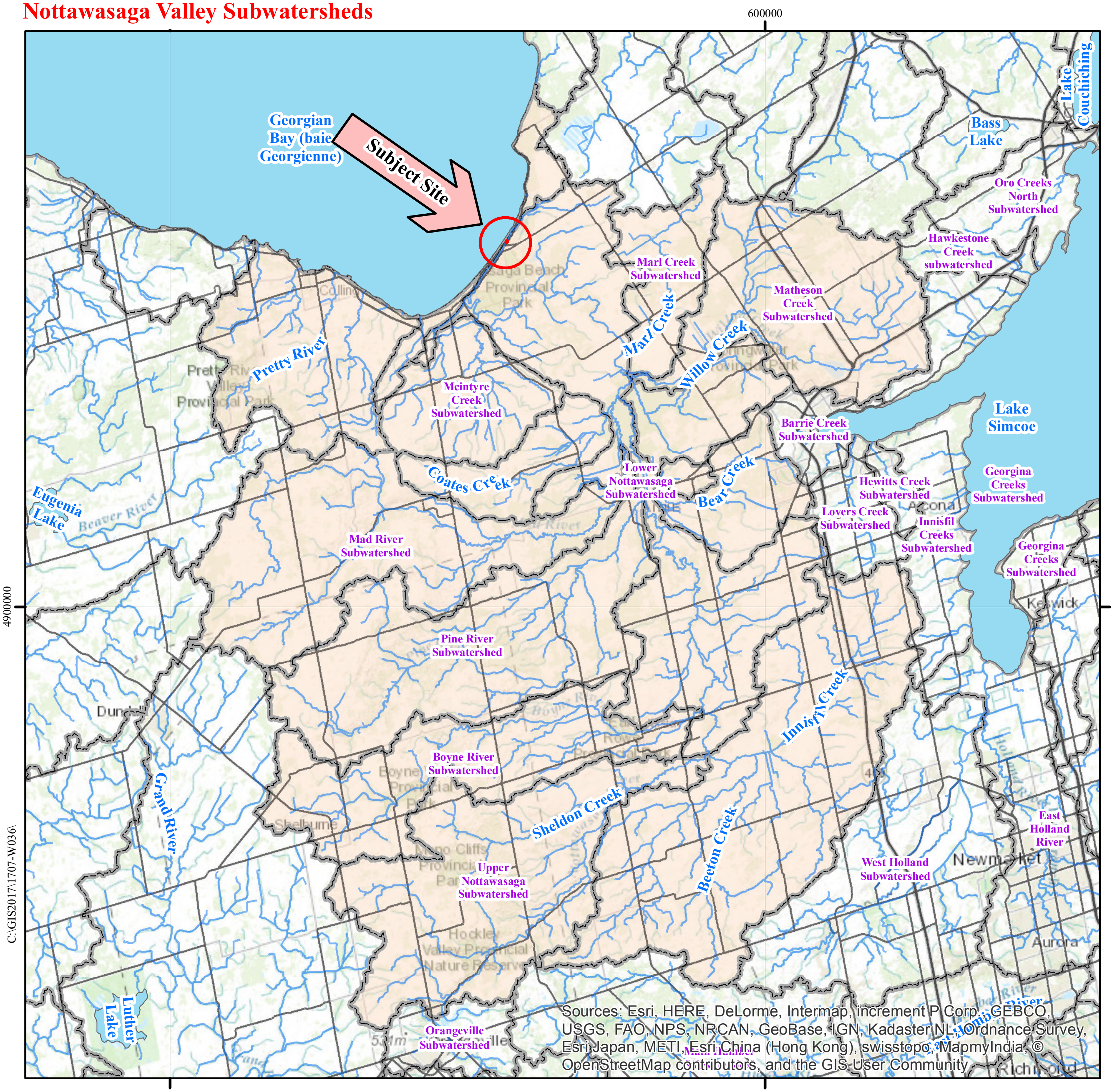
Nottawasaga Valley Subwatersheds



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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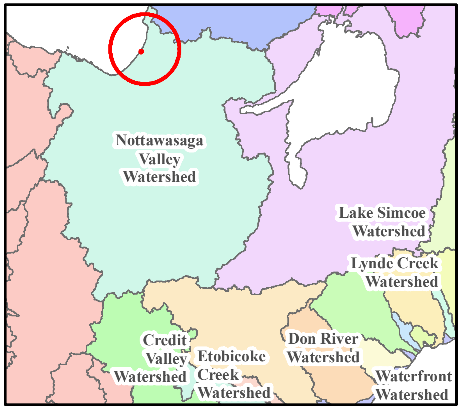
Data sources used in its production are of varying quality and accuracy and all boundaries should be considered approximate.

Watershed:



🟥	Approximate Boundary of the Subject Site
▨	Watershed Boundaries
🟦	Water Body
—	Watercourse
—	Expressway/Major Road

Soil Engineers Ltd.

Title: Watershed and Subwatershed Map

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

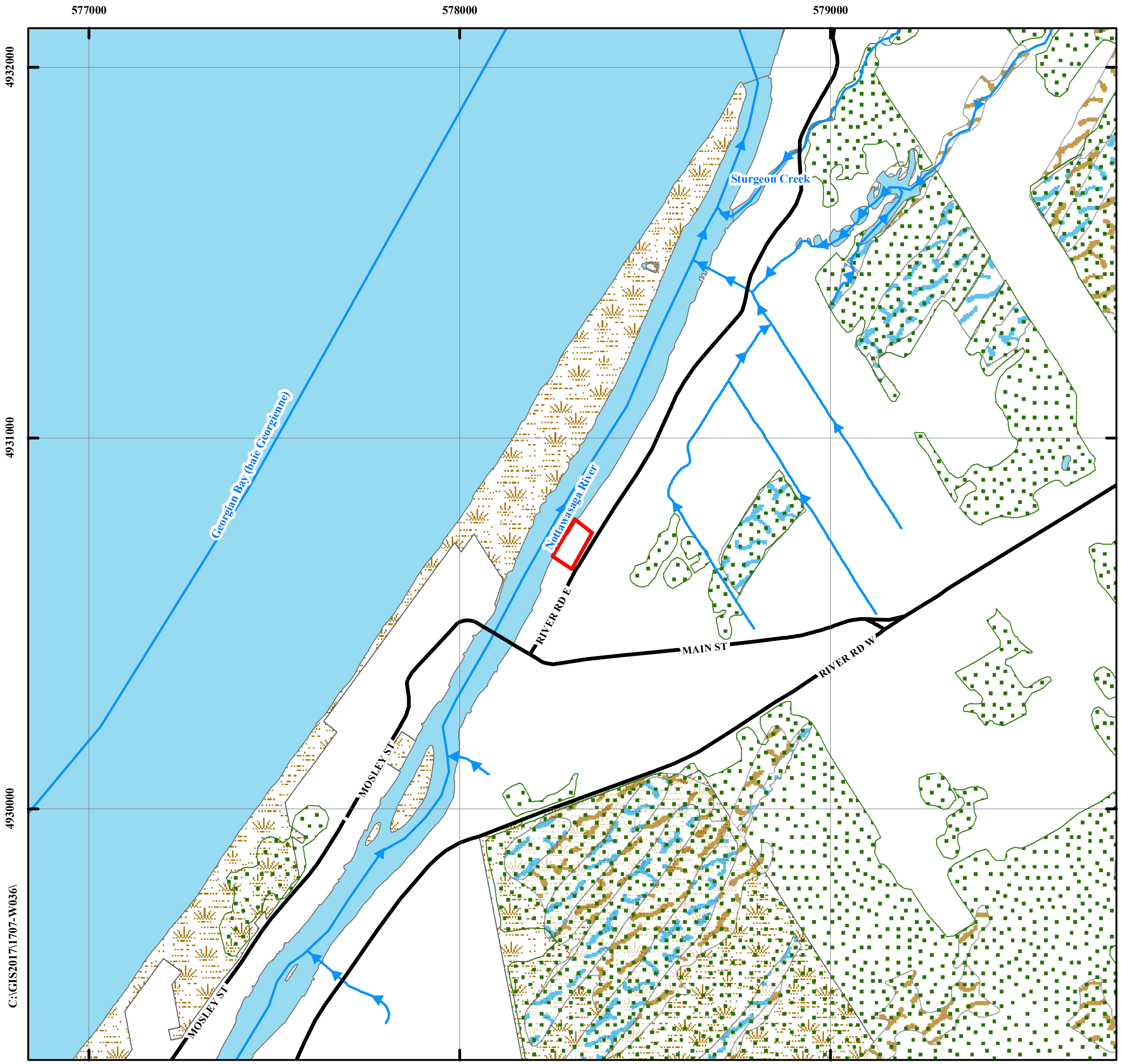
Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 10,000 20,000 40,000 60,000 80,000 100,000
Metres

Drawing No. 6



N

▭ Subject Site

▨ Wetland (classified as Provincial)

▨ Wetland (Not Evaluated per OWES)

▨ Provincial Park Area

▨ Wooded Area

▨ Water Body

→ Watercourse

━ Major Road

Soil Engineers Ltd.

Title: Natural Features and
Protection Area Plan

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 75 150 300 450 600 750
Metres

Drawing No. 7

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
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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:\GIS2017\1707-W036\

N

🟥 Subject Site

⊕ Borehole with Monitoring Well

🟦 Waterbody

→ Watercourse

— Major Road

A — A' Cross-Section Direction

—180— Topographic Contour (masl)

Soil Engineers Ltd.

Title: Cross-Section Key Plan

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 4 8 16 24 32 40
Metres

Drawing No. 8-1

Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
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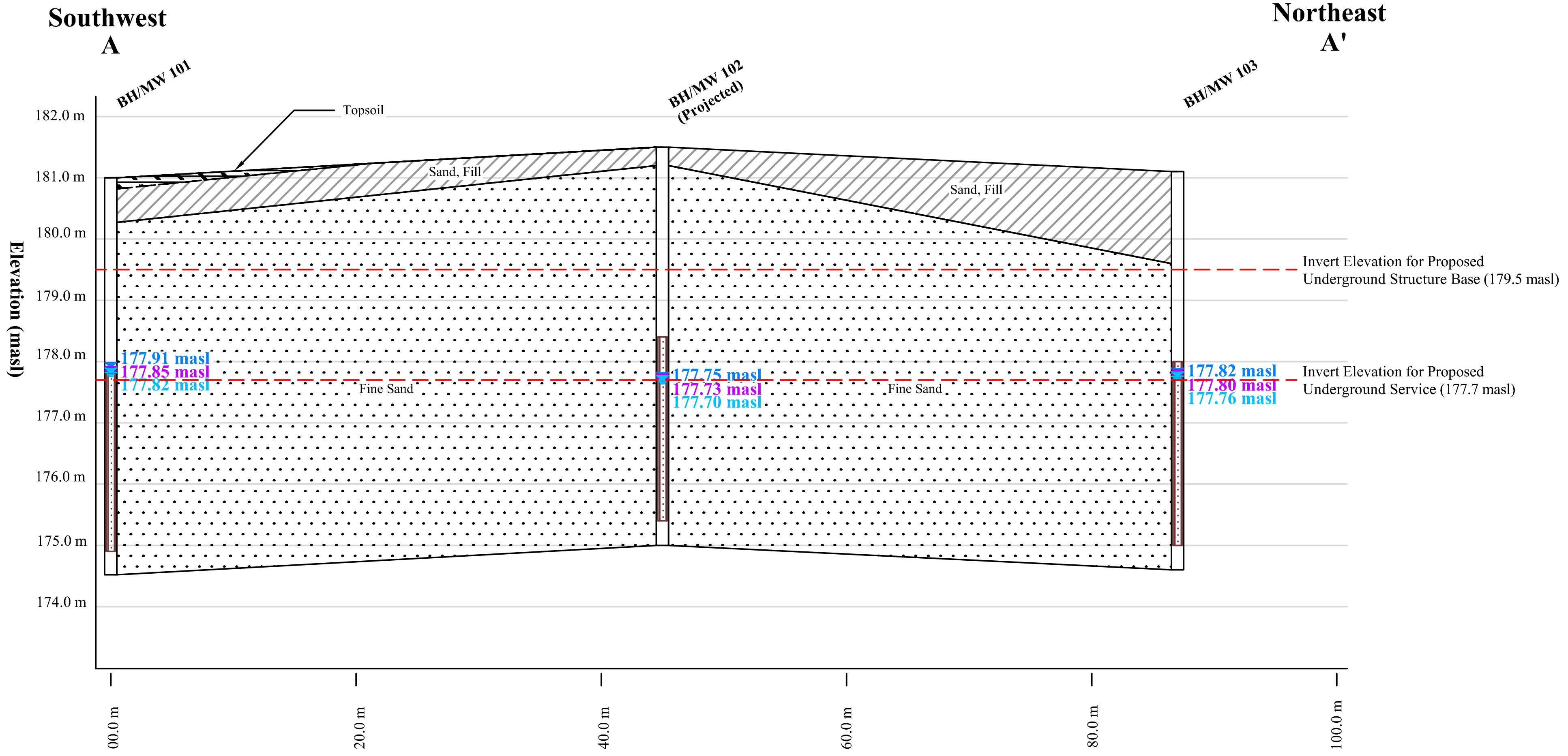

Section A-A'

▤ **Topsoil**

▨ **Sand Fill**

⋯ **Fine Sand**

▯ **3.0 m Screen**

▼ **Water Table on August 4, 2017**

▼ **Water Table on August 23, 2017**

▼ **Water Table on September 7, 2017**

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Title: Geological Cross-Sections (A-A')

Project: Hydrogeological Assessment
Proposed 4-Storey Apartment Building with 1-Level Underground Parking Ground
60-90 River Road East, Town of Wasaga Beach

Reference No:	Date:	Scale: V	Scale: H	Drawing No.
1707-W036	September, 2017	1:100	1:500	8-2

C:\Projects\2017 Jobs\1707-W036

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

C:\GIS2017\1707-W036\

N

🟥 Subject Site

→ General Shallow Groundwater Flow Direction

→ Local Shallow Groundwater Flow Direction

— Interpreted Shallow Groundwater Level Elevation (masl)

- - Inferred Shallow Groundwater Level Elevation (masl)

🟦 Waterbody

→ Watercourse

— Major Road

—180— Topographic Contour (masl)

177.79 Average Shallow Groundwater Level Elevation (masl)

Soil Engineers Ltd.

Title: Shallow Groundwater Flow Pattern Plan

Project:

Proposed 4-Storey Apartment Building with
1-Level Underground Parking Ground
60-90 River Road East
Town of Wasaga Beach

Reference No. 1707-W036

Date: July 7, 2017

Scale:

0 4 8 16 24 32 40
Metres

Drawing No. 9

Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
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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
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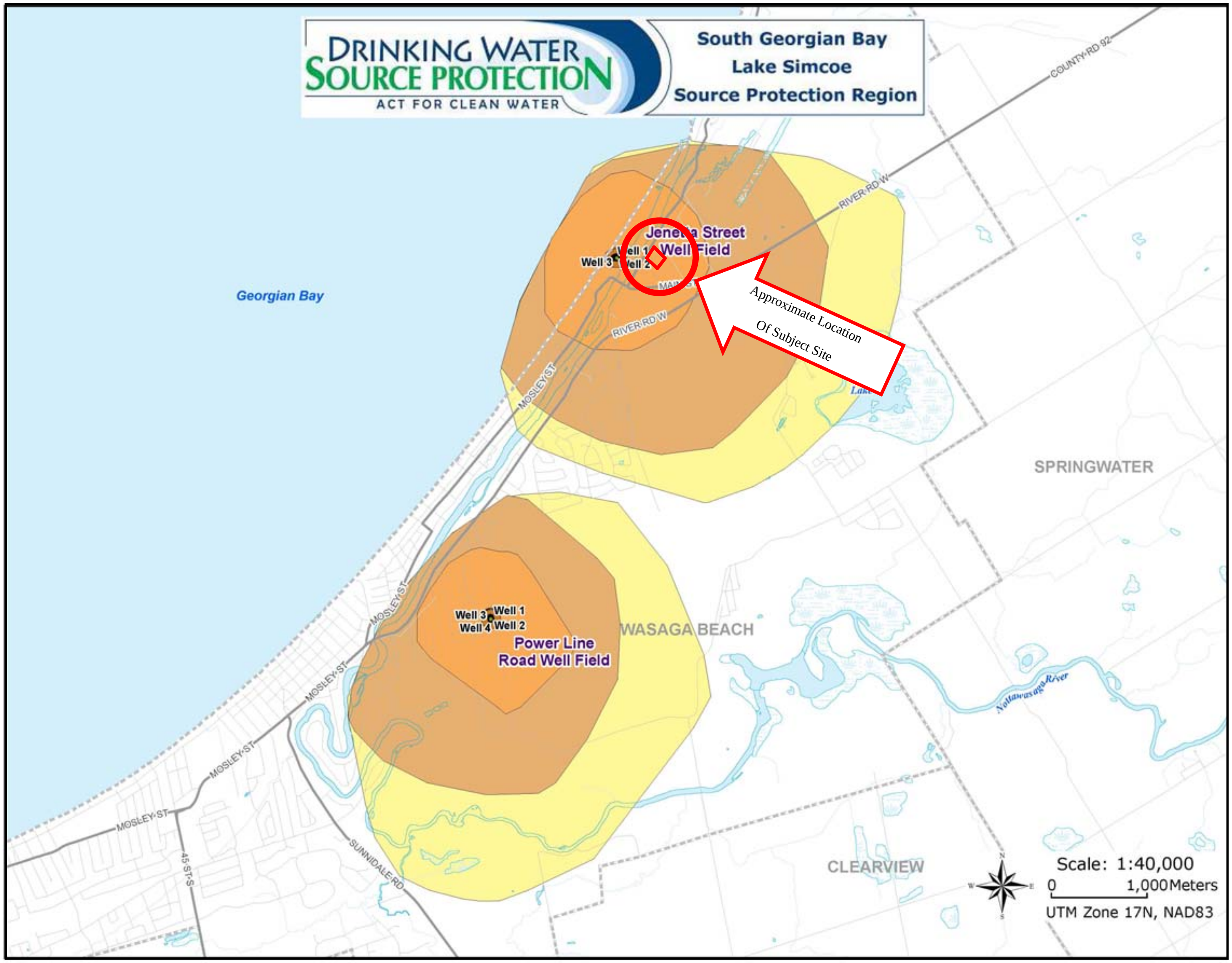


N

● Municipal Wells

Major Road

Local Road

Watercourse

Water Area, Permanent

Wetland, Permanent

WHPA TOT

WHPA-A (100 m radius)

WHPA-B (2yr TOT)

WHPA-C1 (10 yr TOT)

WHPA-D (25 yr TOT)

Municipal Boundary

☐ Approximate Location of Subject Site

Golder Associates
Barrie, Ontario

Created by: Golder Associates Ltd.
Project #: 07-1170-0014
File Number:
WasagaBeach_CaptureZones.mxd
Date: 2009-10-21

This map was produced for the Town of Wasaga Beach, for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

Soil Engineers Ltd.

Title:

Source Water Protection Area Map

Project:

Proposed 4-Story Apartment
Building with 1-Level
Underground Parking
60-90 River Road East
Town of Wasaga Beach

Date

September 6, 2017

Reference No.

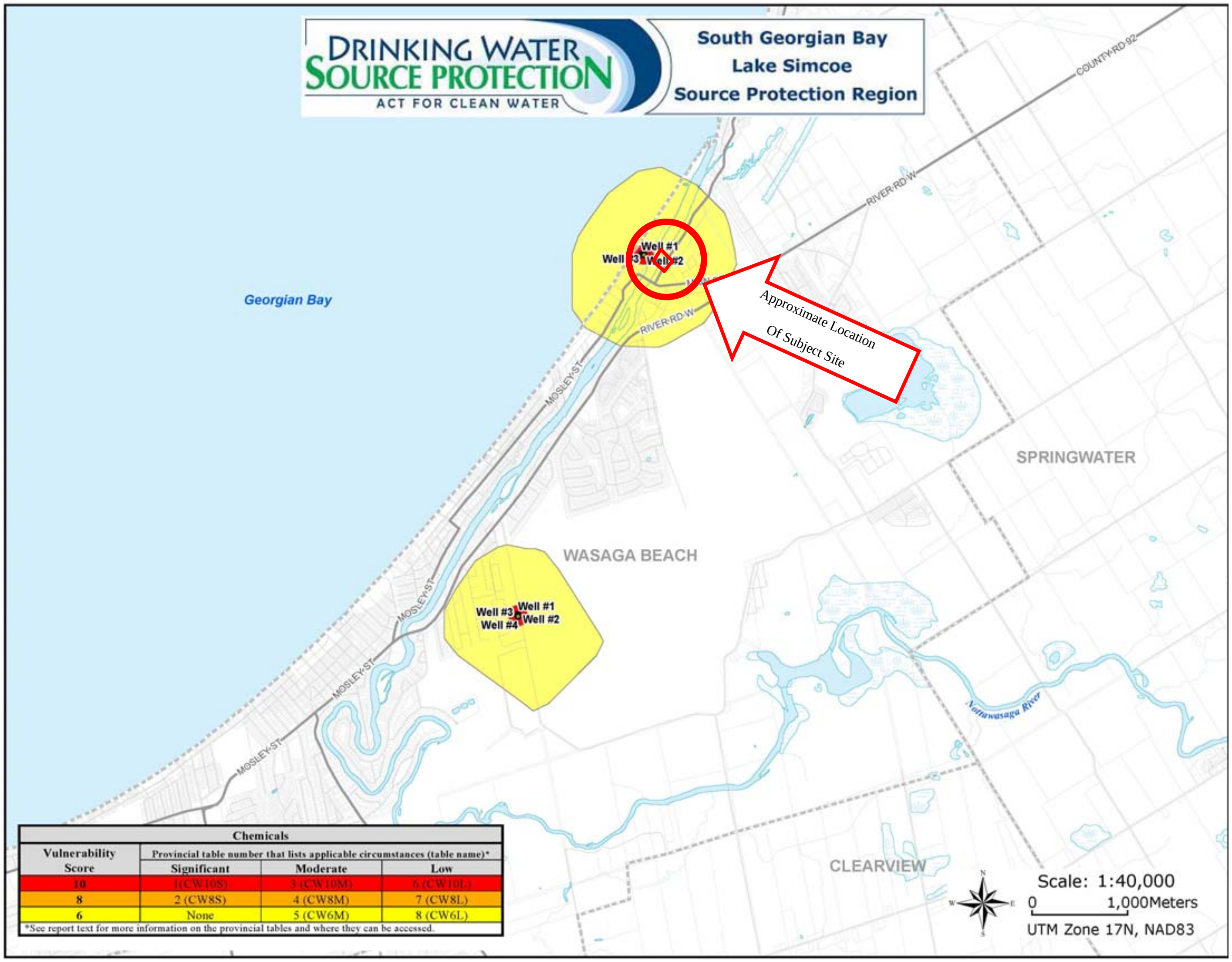
1707-W036

Scale

See Map

Drawing No.

10



Chemicals			
Vulnerability Score	Provincial table number that lists applicable circumstances (table name)*		
	Significant	Moderate	Low
10	1(CW10S)	3 (CW10M)	6 (CW10L)
8	2 (CW8S)	4 (CW8M)	7 (CW8L)
6	None	5 (CW6M)	8 (CW6L)

*See report text for more information on the provincial tables and where they can be accessed.

N

● Municipal Well

Vulnerability Score

🟥 10

🟧 8

🟨 6

Major Road

Local Road

Watercourse

Water Area, Permanent

Wetland, Permanent

Parcel Fabric

Municipal Boundary

☐ Approximate Location of Subject Site

Soil Engineers Ltd.

Title:

Vulnerability Score Map

Project:

Proposed 4-Story Apartment
Building with 1-Level
Underground Parking
60-90 River Road East
Town of Wasaga Beach

Date

September 6, 2017

Reference No.

1707-W036

Scale

See Map

Drawing No.

11

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APPENDIX ‘A’

MOECC WATER WELL RECORDS SUMMARY

REFERENCE NO. 1707-W036

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	5705499	Cable Tool	29.26	Water Supply	Commerical	28.06	0.00	28.36	29.28
2	5705039	Cable Tool	3.6576	Water Supply	Commerical	3.66	1.53	3.05	3.66
3	5705058	Cable Tool	8.5344	Water Supply	Commerical	3.66	3.66	7.63	8.54
4	5706491	Cable Tool	31.3944	Water Supply	Commerical	30.50	0.00	30.50	31.41
5	5705053	Jetting	31.0896	Water Supply	Commerical	29.59	-1.53	29.89	31.11
6	5706267	Cable Tool	34.7472	Water Supply	Domestic	33.24	1.53	32.02	34.77
7	5705707	Cable Tool	54.864	Water Supply	Public	53.38	2.44	53.68	54.90
8	5707521	Cable Tool	37.4904	Water Supply	Public	35.08	2.44	35.69	36.60
9	5707521	Cable Tool	-	Water Supply	Public	35.08	2.44	36.60	37.52
10	5707375	Jetting	34.1376	Water Supply	Domestic	34.16	1.83	-	-
11	5711116	Cable Tool	11.8872	Water Supply	Domestic	10.07	2.75	-	-
12	5705044	Cable Tool	8.5344	Water Supply	Domestic	6.10	6.10	7.93	8.54
13	5738794	Rotary (Reverse)	69.2	Water Supply	Municipal	55.00	4.18	57.30	64.90
14	5738794	Rotary (Reverse)	-	Water Supply	Municipal	55.00	4.18	57.30	64.90
15	5738794	Rotary (Reverse)	-	Water Supply	Municipal	55.00	4.18	57.30	64.90
16	5712930	Cable Tool	58.5216	Water Supply	Domestic	58.56	1.53	-	-
17	5705037	Cable Tool	55.1688	Water Supply	Commerical	55.20	1.22	53.38	54.59
18	5714069	Cable Tool	30.1752	Water Supply	Domestic	27.75	2.14	28.98	29.89
19	5705043	Cable Tool	6.4008	Water Supply	Domestic	2.75	2.75	5.80	6.41
20	5705033	Cable Tool	34.1376	Water Supply	Commerical	34.16	2.14	29.28	34.16
21	5705045	Cable Tool	7.9248	Water Supply	Domestic	3.66	3.66	7.32	7.93
22	5706780	Jetting	30.48	Water Supply	Domestic	27.75	2.44	29.28	30.50
23	5709596	Jetting	29.8704	Water Supply	Domestic	28.67	3.05	28.67	29.89
24	5714516	Cable Tool	40.2336	Water Supply	Domestic	39.04	1.83	39.34	40.26
25	5709215	Rotary (Convent.)	60.96	Observation Wells	Not Used	57.95	3.66	51.85	57.95
26	5709215	Rotary (Convent.)	-	Observation Wells	Not Used	50.33	3.66	51.85	57.95
27	5705054	Jetting	8.2296	Water Supply	Domestic	3.05	2.44	7.32	7.93
28	5705031	Jetting	26.5176	Water Supply	Domestic	26.54	3.36	22.57	26.54
29	5705022	Cable Tool	26.5176	Water Supply	Domestic	22.88	1.83	24.09	26.54
30	5707873	Jetting	17.6784	Water Supply	Domestic	16.16	1.83	16.47	17.69
31	5709567	Jetting	36.2712	Water Supply	Domestic	36.30	2.14	35.08	36.30
32	5709567	Jetting	-	Water Supply	Domestic	35.08	2.14	35.08	36.30
33	5705103	Jetting	30.1752	Water Supply	Domestic	29.28	2.44	-	-
34	5708698	Jetting	25.6032	Water Supply	Domestic	23.79	2.44	24.40	25.62

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				
36	5705064	Cable Tool	6.7056	Water Supply	Commerical	2.44	2.44	5.795	6.71
37	5709051	Rotary (Convent.)	65.532	Test Hole	-	-	1.83	53.07	59.17
38	5709050	Rotary (Convent.)	71.628	Test Hole	Not Used	49.715	1.22	53.07	59.17
39	5707372	Jetting	31.0896	Water Supply	Domestic	31.11	3.05	-	-
40	5706036	Cable Tool	36.576	Water Supply	Domestic	35.38	3.05	33.55	36.6
41	5712191	Cable Tool	16.764	Water Supply	Domestic	15.25	1.83	15.86	16.775
42	5705946	Cable Tool	37.4904	Water Supply	Domestic	36.6	2.44	36.6	37.515
43	5705102	Jetting	28.956	Water Supply	Domestic	25.925	2.44	24.095	28.975
44	5705123	Jetting	31.6992	Water Supply	Domestic	28.06	1.22	28.06	31.72
45	5705023	Jetting	26.2128	Water Supply	Commerical	26.23	2.44	23.18	26.23
46	5705024	Jetting	26.2128	Water Supply	Commerical	26.23	2.745	23.18	26.23
47	5709578	Jetting	38.4048	Water Supply	Domestic	36.6	3.05	37.21	38.43
48	5709578	Jetting	-	Water Supply	Domestic	38.43	3.05	37.21	38.43
49	5705021	Cable Tool	33.2232	Water Supply	Domestic	33.245	2.44	30.195	33.245
50	5705121	Jetting	37.1856	Water Supply	Domestic	34.16	1.22	31.72	37.21
51	5705040	Cable Tool	25.6032	Water Supply	Commerical	3.355	3.05	24.4	25.62
52	5705055	Cable Tool	35.052	Water Supply	Domestic	32.33	2.44	32.94	35.075
53	5705029	Jetting	26.2128	Water Supply	Commerical	23.485	2.745	23.485	26.23
54	5712464	Cable Tool	34.7472	Water Supply	Domestic	33.855	5.795	33.855	34.77
55	5705096	Cable Tool	38.4048	Abandoned-Supply	-	-	-	-	-
56	5705095	Cable Tool	62.1792	Abandoned-Supply	Not Used	62.22	-	-	-
57	5709597	Jetting	37.1856	Water Supply	Domestic	35.99	2.44	35.99	37.21
58	5709597	Jetting	-	Water Supply	Domestic	37.21	2.44	35.99	37.21
59	5705041	Cable Tool	7.3152	Water Supply	Commerical	1.22	0.915	6.71	7.32
60	5705754	Cable Tool	18.5928	Water Supply	Livestock	17.385	2.44	17.69	18.605
61	5706017	Cable Tool	29.8704	Water Supply	Domestic	28.975	1.525	28.975	29.89
62	5705063	Cable Tool	6.096	Water Supply	Commerical	3.355	3.355	4.88	5.795
63	5707221	Cable Tool	22.2504	Water Supply	Domestic	19.825	2.135	20.435	21.35
64	5707221	Cable Tool	-	Water Supply	Domestic	19.825	2.135	21.35	22.265
65	5707547	Cable Tool	22.504	Water Supply	Domestic	19.825	3.05	20.435	22.265
66	5707246	Cable Tool	33.528	Water Supply	Commerical	31.72	-	31.72	33.55
67	5700822	Cable Tool	32.9184	Water Supply	Domestic	30.5	1.22	30.5	32.94
68	5705071	Jetting	37.1856	Water Supply	Domestic	25.01	-	25.62	26.84
69	5705071	Jetting	-	Water Supply	Domestic	0.915	-	25.62	26.84
70	7240558	Rotary (Convent.)	4.572	Observation Wells	Monitoring	-	-	3.05	4.575
71	5706003	Cable Tool	25.6032	Water Supply	Commerical	25.62	-	23.79	25.62
72	5706032	Cable Tool	34.1376	Water Supply	Domestic	32.33	3.05	30.805	34.16

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**				
73	5700823	Cable Tool	6.7056	Water Supply	Commerical	0.61	0.61	6.1	6.71
74	5700818	Jetting	32.3088	Water Supply	Domestic	29.28	0.61	29.89	32.33
75	5713196	Cable Tool	40.8432	Water Supply	Domestic	38.125	1.525	39.04	40.87
76	5705049	Cable Tool	35.568	Abandoned-Supply	Commerical	34.16	3.05	34.16	35.38
77	5705049	Cable Tool	-	Abandoned-Supply	Commerical	5.49	3.05	34.16	35.38
78	5705049	Cable Tool	-	Abandoned-Supply	Commerical	28.06	3.05	34.16	35.38
79	5705057	Cable Tool	6.4008	Water Supply	Commerical	3.05	3.05	5.795	6.405
80	5700825	Rotary (Convent.)	37.1856	Water Supply	Public	25.01	2.44	25.315	26.535
81	5710769	Jetting	38.7096	Water Supply	Domestic	34.77	2.745	32.94	38.735
82	7287688	-	-	-	-	-	-	-	-
83	7281695	-	-	-	-	-	-	-	-
84	5700826	Cable Tool	27.432	Water Supply	Public	26.535	3.66	26.535	27.45
85	5700824	Jetting	38.4048	Water Supply	Domestic	36.295	3.05	37.21	38.43

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APPENDIX ‘B’

RESULTS OF
SINGLE HEAD RESPONSE TESTS

REFERENCE NO. 1707-W036

Falling Head Test (Slug Test)

Test Date:		23-Aug-17	
Piezometer/Well No.:		BH/MW 101	
Ground level:		181.00	m
Screen top level:		177.90	m
Screen bottom level:		174.90	m
Test El. (at midpoint of screen):		176.40	m
Test depth (at midpoint of screen):		4.6	m
Screen length	L=	3	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.221	m
Initial water depth		3.18	m
Aquifer material:		**Fine Sand**	

Shape factor

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

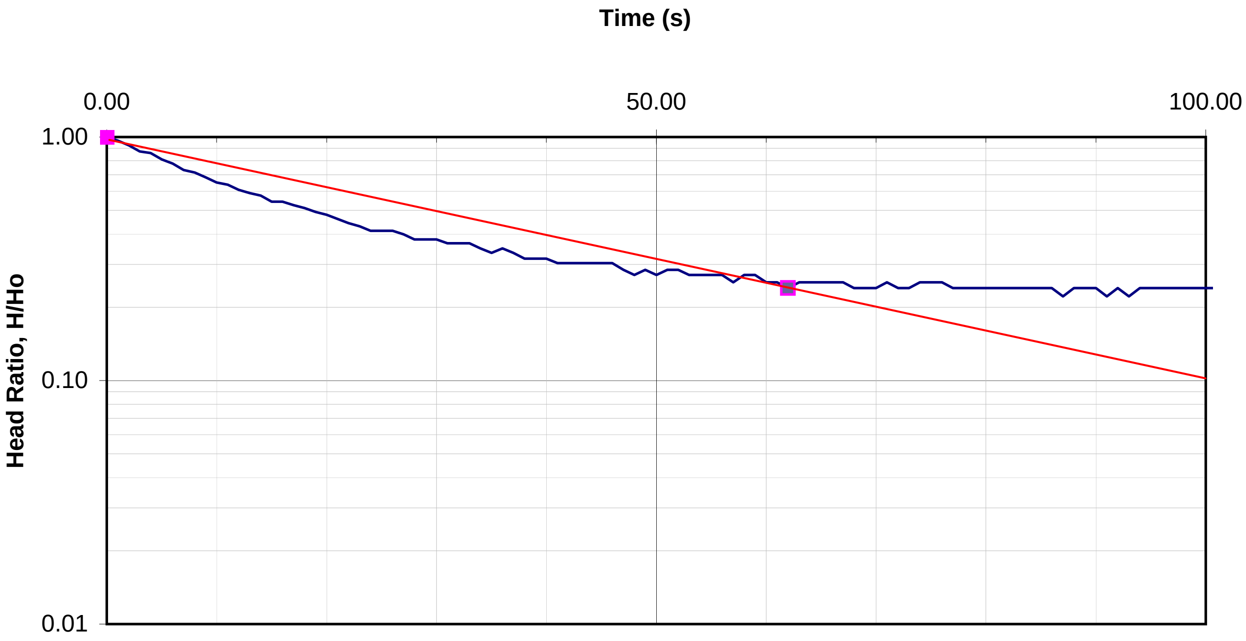
Permeability

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

(Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.023030174$$

K= **7.9E-04** cm/s
7.9E-06 m/s



Falling Head Test (Slug Test)

Test Date: 23-Aug-17
Piezometer/Well No.: BH/MW 102
Ground level: 181.50 m
Screen top level: 178.40 m
Screen bottom level: 175.40 m
Test El. (at midpoint of screen): 176.90 m
Test depth (at midpoint of screen): 4.6 m
Screen length below GW level L= 2.3 m

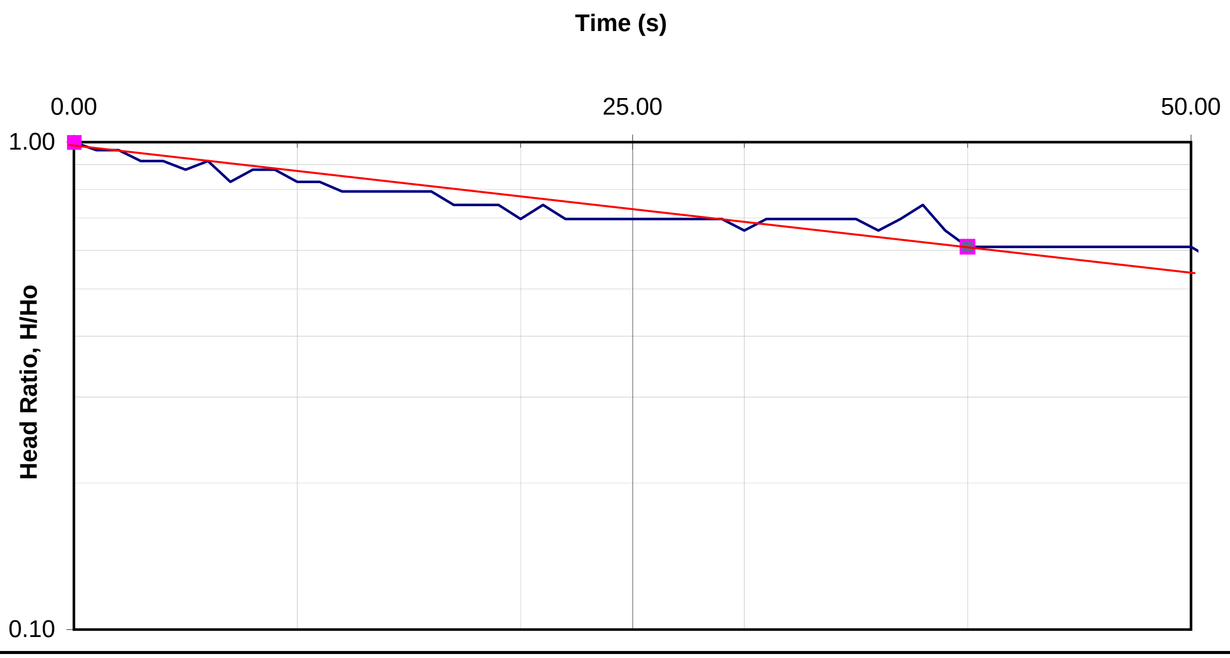
Diameter of undisturbed portion 2R= 0.22 m
Standpipe diameter 2r= 0.05 m
Initial unbalanced head Ho= -0.082 m
Initial water depth 3.77 m
Aquifer material: **Fine Sand**

Shape factor F= $\frac{2 \times 3.14 \times L}{\ln(L/R)}$ = 4.753438 m

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

$\frac{\ln(H1/H2)}{(t2 - t1)}$ = 0.012367406

K= **5.1E-04** cm/s
5.1E-06 m/s



Falling Head Test (Slug Test)

Test Date:		23-Aug-17	
Piezometer/Well No.:		BH/MW 103	
Ground level:		181.10	m
Screen top level:		178.00	m
Screen bottom level:		175.00	m
Test El. (at midpoint of screen):		176.50	m
Test depth (at midpoint of screen):		4.6	m
Screen length	L=	3	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.066	m
Initial water depth		3.3	m
Aquifer material:		**Fine Sand**	

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

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

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

ln (H1/H2)
------------ = 0.022916533
(t2 - t1)

K= **7.9E-04** cm/s
7.9E-06 m/s