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A REPORT TO

SPHERE DEVELOPMENTS (KINGSTON) LP
HYDROGEOLOGICAL ASSESSMENT

PROPOSED MIXED-USE DEVELOPMENT

875 KINGSTON ROAD,

CITY OF PICKERING

REFERENCE NO. 2204-W019

MAY 2023

DISTRIBUTION

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1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. has conducted a hydrogeological assessment for a proposed residential development site, located at 875 Kingston Road, in the City of Pickering. The surrounding land use, includes; Highway 401, along with both commercial and residential properties situated to the south, Kingston Road and commercial properties to the west, along with both commercial and residential properties to the north.

The subject site is currently an unoccupied, vacant lot with weed and tree growth. The proposed development will have two (2), 17-storey mixed-use building towers, having four levels of underground parking structure.

The subject site lies within the Physiographic Region of Southern Ontario known as the Iroquois Sand Plain. The mapped native surface geological soil units consist of undifferentiated till materials, consisting, predominantly of sandy silt to silt matrix, being high in calcium carbonate content.

The subject site is located within the Frenchman's Bay Watershed.

A review of the ground surface elevations at borehole and monitoring well locations, the total elevation elevation relief across the subject site is about 4.5 m.

This study has disclosed that beneath a layer topsoil, and a layer of earth fill at BH/MW 1, the sub-soils underlying the subject site consists of silty clay till, silty clay, and shale bedrock.

The findings of this study confirm that the groundwater level elevations range from 92.25 to 85.74 masl, (i.e., 1.33 to 12.06 mbgl), and that the interpreted shallow groundwater flow pattern beneath the site is in a northerly direction, towards the low relief portion of the property.

The single well response test yielded estimated hydraulic conductivity (K) values that range from between 8.3×10^{-8} m/sec and 5.6×10^{-7} m/sec and, for the silty clay till and silty clay subsoils, at the depths of the monitoring well screens. These findings suggest that low groundwater seepage rates can be anticipated into open excavations below the groundwater table.

The estimated temporary dewatering flow estimates for construction of the proposed 4-level underground parking structure could reach an estimated daily rate of about of

117,271.10 L/day. By applying a safety factor of three (3), it could reach a maximum of 351,813.3 L/day.

For the construction dewatering flow rate estimates to build the four (4) level underground basement/parking structures, the accumulation of runoff volume, associated with storm events within the excavation footprint area is estimated at 422,800 L/day.

The estimated long-term seepage drainage rate for a conventional Mira drainage network for a shored excavation is 11,930.1 L/day. The long-term seepage drainage drainage rate to the under basement-slab floor drainage networks is estimated at 883.01 L/day. The combined long-term seepage rate to both the Mira drainage and the under-basement slab floor drainage networks is estimated at 12,813.02 L/day. Applying a safety factor of three (3), the combined drainage flow rate is estimated at 38,439.07 L/day for the 4-levels shared underground parking structure.

2.0 INTRODUCTION

2.1 Project Description

In accordance with authorization from Mr. Rohan Gawri of Sphere Developments (Kingston) LP, Soil Engineers Ltd., (SEL) has conducted a hydrogeological assessment for a proposed mixed-use, residential building development site, located at 875 Kingston Road, Pickering. The location of the subject site is shown on Drawing No. 1.

The subject site is located within an existing, mixed-use residential and commercial area in the City of Pickering, where the surrounding land use, includes; Highway 401, and both commercial and residential properties to the south, Kingston Road and commercial properties to the west, Kingston Road and both commercial and residential properties to the north, and to the east. At the time of investigation, the subject site was vacant covered by weed and tree growth. It is proposed that the subject property will be developed with two (2), 17-storey mixed-use building towers, having four levels of underground parking structure. The development will be provided with full municipal services and roadways meeting the current municipal standards.

This report summarizes findings of the field study and associated groundwater monitoring and hydraulic testing. The current study provides preliminary recommendations for any temporary construction dewatering needs, including any long-term foundation drainage needs, prior to detailed design. A description and characterization of the hydro-geo-stratigraphy for the subject site and the local surrounding area, is provided, together with an assessment of the site's groundwater function relative to the maintenance for any on-site, or nearby groundwater receptors.

2.2 Project Objectives

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

1. Establish the local hydrogeological setting for the subject site and the local surrounding areas in support of a proposed mixed-use development;
2. Interpret shallow groundwater flow and runoff patterns;
3. Identify zones of higher groundwater yield as potential sources for ongoing shallow groundwater seepage;

4. Estimation of the hydraulic conductivity (K) for the groundwater-bearing sub-soil strata;
5. Prepare an interpreted hydro-geo-stratigraphic cross-section across the subject site, and the proposed development footprint;
6. Estimate the anticipated dewatering flows that may be required to lower the groundwater table to facilitate construction, or to facilitate any permanent, long-term foundation drainage needs, following construction;
7. Evaluate potential impacts to any nearby groundwater receptors within the anticipated zone of influence for any temporary construction dewatering; along with preliminary estimates for any temporary construction dewatering flow rates that may be required to facilitate earthwork excavations
   for construction, or from any long-term foundation drainage needs, following construction.
8. Provide comments regarding any need to file for an Environment Activity and Sector registry (EASR), or to acquire a Permit-To-Take Water (PTTW) as an approval to facilitate groundwater taking for a temporary construction dewatering program.
9. Comment on the feasibility for implementing of LID stormwater management infrastructure at the developed site to address future storm water management planning and design.

2.3 <u>**Scope of Work**</u>

The scope of work for the hydrogeological assessment is summarized below:

1. Clearance of underground services, drilling of seven (7) boreholes, and the installation of monitoring wells, one within five (5) selected boreholes advance beneath the subject site within the proposed development footprint;
2. Monitoring well development and groundwater level measurements at the five (5) installed monitoring wells;
3. Performance of Single Well Response Tests (SWRTs) at the five (5) installed monitoring wells to estimate the hydraulic conductivity (K) for the groundwater-bearing subsoil strata at the depths of the monitoring well screens;
4. Describing the geological and hydrogeological setting for the subject site and local surrounding areas;
5. Estimating the hydraulic conductivity (K) for the groundwater bearing subsoil strata, based on the SWRT results, and from a review of the grain size analyses from the collected soil samples.
6. Review of the findings of the concurrent geotechnical study; review of available

engineering development plans and profiles for the proposed residential development; assessing the preliminary construction dewatering needs, and estimation of any anticipated dewatering flows to lower the groundwater levels for construction, or for any anticipated long-term foundation drainage needs following construction.

7. Providing preliminary recommendations for monitoring and mitigation to address potential impacts to nearby groundwater receptors, i.e., private wells and groundwater-dependent natural heritage features (creeks, wetlands).
8. Comment on the feasibility of the subject site for implementing of LID stormwater management infrastructure to address future storm water management planning and design.

3.0 METHODOLOGY

3.1 Borehole Advancement and Monitoring Well Installation

Borehole drilling and monitoring well construction were performed, between May 3 and May 6, 2022. The program consisted of the drilling of seven (7) boreholes (BH) and the installation of five (5) monitoring wells (MW), one within each five (5) selected boreholes advance beneath the subject site at the time of the borehole drilling program. The locations of the boreholes/monitoring wells are shown on Drawing No. 2.

The borehole drilling and monitoring well construction were completed by licensed water well contractor, DBW Drilling, under the full-time supervision of a field technician from SEL, who also logged the subsoil strata, encountered during borehole advancement, collected representative subsoil samples for textural classification, and supervised the monitoring well installations. The boreholes were drilled, using a continuous-flight, power auger machine, equipped with solid-stem augers. Selected subsoil samples, retrieved during the borehole drilling program underwent laboratory, grain size analysis to confirm the subsoil textures. Detailed descriptions of the encountered subsurface soil and groundwater conditions are presented on the borehole and monitoring well logs, on Figures 1 to 7, inclusive.

The monitoring wells were constructed, using 50-mm diameter PVC riser pipes and screens, which were installed in each of the boreholes in accordance with Ontario Regulation (O. Reg.) 903. All of the monitoring wells were provided with monument-type, steel protective casings at and above the ground surface. Details for the monitoring well construction are provided on the enclosed Borehole Logs (Figures 1 to 7, inclusive).

The ground surface elevations and horizontal coordinates at the monitoring well locations were determined at the time of the investigation, using a handheld Global Navigation Satellite System survey equipment (Trimble Geoexplorer unit TSC3) which has an accuracy of ±0.05 m. The UTM coordinates and ground surface elevations at the borehole/monitoring well locations, together with the summary of the monitoring well construction and installation details, are provided in Table 3-1.

Table 3-1 - Monitoring Well Installation Details

Well ID	Installation Date	UTM Coordinates		Ground El. (masl)	Borehole Depth (mbgs)	Screen Interval (mbgs)	Casing Dia. (mm)
		East	North				
BH/MW 1	May 3, 2022	652161	4853937	95.2	13.8	10.8-13.8	50
BH/MW 2	May 3, 2022	652187	4853968	97.6	15.6	12.6-15.6	50
BH/MW 4	May 5, 2022	652206	4853963	96.9	14.7	11.7-14.7	50
BH/MW 5	May 4, 2022	652227	4853951	93.7	12.3	9.3-12.3	50
BH/MW 7	May 5, 2022	652244	4853975	93.1	7.7	4.7-7.7	50

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

3.2 Groundwater Monitoring

The groundwater levels in the monitoring wells were measured, manually on May 7, May 12, June 16, July 18 and August 10 2022 to record the fluctuation of the shallow groundwater table beneath the subject site, with the details discussed in the section 6.2 of this report.

3.3 Mapping of Ontario Water Well Records

SEL received the Ministry of the Environment, Conservation and Park (MECP) Water Well Records (WWRs) for the registered wells, located on the subject site, and within 500 m of the site boundaries (study area). The well records indicate that thirty-four (34) registered well records are located within the 500 m zone of influence study area relative to the subject site boundaries. The WWR well locations are shown on Drawing No. 3, and a summary of the WWRs reviewed for this study are listed in Appendix 'A', with a discussion of the findings from the review being provided in Section 6.1.

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 the hydraulic conductivity (K) for saturated subsoil strata at the depths of the monitoring well screens. Well development involved the purging and removal of several well casing volumes of groundwater from each monitoring well to remove remnants of clay, silt and other debris introduced into the monitoring wells during construction, and to induce the flow of formation groundwater through the monitoring well screens, thereby improving the transmissivity of the subsoil strata formation at the monitoring well screen depths.

The test results from SWRT's are used to estimate the hydraulic conductivity (K) for groundwater-bearing subsoil strata at the depths of the monitoring well screens. The K values, estimated from the SWRTs provide an indication of the yield capacity for the groundwater-bearing subsoil strata, and can be used to estimate the flow of groundwater through the groundwater-bearing subsoil strata.

The SWRT involves the placement of a slug of known volume into the monitoring well, below the groundwater table, to displace the groundwater level upward. The rate at which the groundwater level recovers to static conditions (falling head) is tracked, using a data logger/ pressure transducer, and/or manually, using an electric water level tape.

The rate at which the groundwater table recovers to static conditions is used to estimate the K values for the groundwater-bearing subsoil strata at the monitoring well screen depth intervals. All the monitoring wells underwent a SWRT on July 18, 2022. The SWRT test results are provided in Appendix 'B', with a summary of the findings, being provided in Table 6-2.

3.5 Review Summary of Concurrent Report

The following, concurrent geotechnical soil investigation report, prepared by SEL was also reviewed in preparation of this hydrogeological study:

A Report to Sphere Development (Kingston) LP., a Geotechnical Investigation for Proposed Mixed-Use Development, 875 Kingston Road, City of Pickering, Reference No. 2204-S019 dated March 2023.

4.0 REGIONAL AND LOCAL SETTING

4.1 Regional Geology

The subject site lies within the Physiographic Region of Southern Ontario, known as the Iroquois Plain, where Sand Plain is the predominant shallow physiographic feature mapped for the area. The Lake Iroquois Plain occupies the lowland areas around the western part of Lake Ontario, covering a distance of about 300 km, extending from the Niagara River to the Trent River. It has a width, varying from about 100 m to over 10 km. When the last glacier (Wisconsinan) was receding from Southern Ontario, the area was inundated by a body of water known as Lake Iroquois which emptied/drained eastward at Rome, New York State (Chapman and Putnam, 1984). Sand was deposited along the former lake shoreline areas, forming the present-day sand plain.

Based on a review of a surface geological map for Southern Ontario, the subject site is underlain by undifferentiated native, glacial till subsoil material, consisting, predominantly of sandy silt to stilt matrix, commonly rich in clasts, where the soil matrix is high in calcium carbonate content. Drawing No. 4, as reproduced from Ontario Geological Survey (OGS) mapping, illustrates the Quaternary surface soil geology for the subject site and surrounding areas.

The bedrock underlying the site is comprised, mainly of the Upper Ordovician, aged shale, limestone, dolostone, and siltstone of the Georgian Bay Formation, the Blue Mountain Formation, the Billings Formation, the Collingwood Member, and the Eastview Member (Ontario Ministry of Northern Department and Mines, 1991). The approximate elevation for the top of bedrock, beneath the subject site is at about 81.6 masl (Oak Ridges Moraine Groundwater Program, https://www.oakridgeswater.ca/).

4.2 Physical Topography

A review of the topography shows that the subject site is relatively flat, exhibiting a gradual decline in elevation relief, towards the tributary of the Amberlea Creek (Vistula Ravine), which traverses the property form a northwesterly to southeasterly direction. Runoff from the site is expected to drain towards the tributary of the Amberlea Creek, based on review of the topographic map, eventually flowing into Lake Ontario which is located, approximately 1 km southeast from the subject site. Based on review of the ground surface elevations at borehole and monitoring well locations, the total elevation relief across the subject site is about 4.5 m. Drawing No. 5 shows the mapped topographical contours for the subject site, and the local surrounding area.

4.3 Watershed Setting

The subject site is located within the Frenchman's Bay Watershed. The Frenchman's Bay Watershed is heavily urbanized with more than 75% of its area being occupied by residential and non-residential developments, along with utility and transportation infrastructure and land uses. Extensive paved parking areas are associated with the large commercial developments in the area (e.g., Pickering Town Centre Mall), located between Highway 401 and Kingston Road. Tributary streams, that arise from cedar swamps and from local groundwater springs at the base of the shoreline for the former glacial Lake Iroquois area are conveyed in eroded channels which discharge fine suspended sediment to the Bay during "flashy" and substantial wet-weather events (Eyles et al. 2003). Erosion is particularly severe in certain areas of Amberlea Creek & Pine Creek.

Many of these observed problems have been linked to the effects of uncontrolled stormwater runoff from the 2,260 ha. drainage area, which discharges into Lake Ontario through Frenchman's Bay. The City of Pickering, and the Toronto Region Conservation Authority have jointly initiated a project to include a stormwater management strategy to maintain the environmental sustainability for Frenchman's Bay.

Drawing No. 6 shows the location of the subject site within the Frenchman's Bay Watershed area.

4.4 Local Surface Water and Natural Features

A tributary of Amberlea Creek, which traverses the west boundary of the property, flows in a northwesterly to southeasterly direction. It flows in a southeasterly direction, before draining into Lake Ontario. Lake Ontario is situated, approximately 1 km south east of the site.

A northwest portion of the subject site is occupied by wooded areas. Wooded areas were also observed along the banks and adjacent to the Amberlea Creek, and its associated tributaries.

The locations of the site and and all the mentioned, nearby and associated water courses, water bodies, wetlands, and wooded areas are shown on Drawing No. 7.

5.0 SOIL LITHOLOGY

This subsurface study has disclosed that beneath a layer of topsoil and layers of earth fill, the native subsoils, underlying the subject site consists of silty clay till/silty clay, overlaying probable bedrock or boulders. A Key Plan and the interpreted geological cross-sections along delineated northwest to northeast and northwest to southeast, transects are presented on Drawing Nos. 8-1 and 8-2.

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

Topsoil, approximately 20 to 60 mm thick, was observed at the ground surface at all of the BH/MWs locations.

5.2 **Earth Fill** (BH/MW 1)

A layer of earth fill, extending to a depth of 1.5 m was encountered at BH/MW 1 location. The earth fill layer is comprised, mainly of silty clay and has topsoil inclusions.

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

Silty clay till and silty clay subsoil was encountered at all boreholes locations. It was encountered, at depths, ranging between 0.2 to 1.5 mbgs at the all BH/MW locations, extending to auger refusal depths of the advanced boreholes. The unit is brown/grey in colour, and is stiff to hard in consistency, having some sand to sandy, a trace of gravel, with occasional silt seams and layers, and cobbles and boulders. The moisture contents range from 7% to 27%, indicating generally moist to saturated conditions. the estimated permeability for silty clay till/silty clay units, encountered at depths, ranging from below 3.0 to 13.7 mbgs, is approximately 10^{-7} m/sec. Grain size analyses were performed on eight (8) subsoil samples and the gradation curved are plotted on Figures 8 and 9.

5.4 **Auger Refusal Shale**(All BH/MWs)

Shale fragments and refusal to borehole augering was encountered in all of the boreholes, at depths ranging from 7.7 to 15.6 m (or El. 81.0 to 85.4 m).

6.0 GROUNDWATER STUDY

6.1 Review Summary of Current Geotechnical Report

A review of the findings from the concurrent, geotechnical soil investigation report (SEL, Reference No. 2204-S019) indicates that investigation has revealed that beneath topsoil and layer of earth fill layers encountered in Borehole 1, the subject area is underlain by stiff to hard silty clay and silty clay till, overlying weathered shale.

6.2 Review of Ontario Water Well Records

The Ministry of Environment, Conservation, and Parks (MECP) water well records 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 thirty-four (34) well records are located within the study area. The locations of these well records, based on the UTM coordinates provided by the well records, are shown on Drawing No. 3. Details of the MECP water well records that were reviewed for this study are provided in Appendix ‘A’.

A review of the final status of the well records within the study area reveals that nine (9) are registered as water supply wells, three (3) are registered as monitoring and test hole wells, three (3) are registered as test hole wells, nine (9) are registered as observation wells, four (4) are registered as abandoned-other wells, and there are six (6) wells, having unknown statuses.

A review of the first use of the well records within the study area reveals that three (3) are registered as a monitoring and test hole wells, seven (7) are registered as monitoring wells, nine (9) are registered as domestic wells, two (2) wells are registered as not being used, three (3) are registered as test hole wells, and there are ten (10) wells having unknown statuses.

6.3 Groundwater Monitoring

The groundwater levels within the monitoring wells were manually measured, on three occasions over the study period, on the following dates; May 7, 12, June 16, July 18 and on August 10, 2022, to record the fluctuation of the shallow groundwater table beneath the site. The groundwater levels and their corresponding elevations are given in Table 6-1.

Table 6-1 - Groundwater Level Measurements

Well ID		May 7, 2022	May 12, 2022	June 16, 2022	July 18, 2022	August 10, 2022	Average	Fluctuation (m)
BH/MW 1	mbgs	3.14	3.34	2.97	3.02	3.09	3.14	0.37
	masl	92.07	91.87	92.24	92.19	92.12	92.10	
BH/MW 2	mbgs	12.06	11.90	10.79	9.84	9.46	10.81	2.60
	masl	85.74	85.90	87.01	87.96	88.34	86.99	
BH/MW 4	mbgs	Dry	12.18	10.59	9.0	7.7	9.86	6.88
	masl	<82.2	84.60	86.19	87.78	89.08	86.91	
BH/MW 5	mbgs	1.44	1.50	1.54	1.61	1.64	1.55	0.2
	masl	92.25	92.19	92.15	92.08	92.05	92.15	
BH/MW 7	mbgs	1.34	1.38	1.44	1.56	1.58	1.46	0.24
	masl	91.69	91.65	91.59	91.47	91.45	91.69	

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

As shown above, in Table 6-1, the groundwater levels at BH/MWs 2 and 4 showed a consistent rising trend throughout the monitoring period. BH/MWs 5 and 7 displayed a decreasing trend over the monitoring period, while the water levels at BH/MW 1 initially decreased, between May 7 and May 12, it then increased, between May 12 and June 16 and then exhibited a decrease, between June 16 to August 10, 2022.

The greatest fluctuation was observed at BH/MW 4, where the groundwater level increased by 6.88 m during the spring summer season monitoring period.

6.4 Shallow Groundwater Flow Pattern

The shallow groundwater flow pattern beneath the subject site was interpreted, based on the highest shallow groundwater levels, measured at all the BH/MWs, suggesting that it flows in a northerly direction, towards the low relief portion of the property. The interpreted shallow groundwater flow pattern was completed for the proposed development footprint area. The interpreted shallow groundwater flow pattern beneath the subject site is illustrated on Drawing No. 9.

6.5 Single Well Response Test Analysis

All of the BH/MWs, underwent single well response testing (SWRT), to estimate the hydraulic conductivity (K) for saturated shallow aquifer sub-soils at the depths of the monitoring 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 SWRTs Results

Well ID	**Ground El. (masl)**	**Monitoring Well Depth (mbgs)**	**Borehole Depth (mbgs)**	**Well Screen Interval (mbgs)**	**Screened Subsoil Strata**	**Hydraulic Conductivity (K) (m/sec)**
BH/MW 1	95.2	12.2	13.8	9.2-12.2	Silty Clay Till/ Silty Clay	8.3×10^{-8}
BH/MW 2	97.6	12.2	15.6	9.2-12.2	Silty Clay Till/ Silty Clay	1.6×10^{-7}
BH/MW 4	96.9	12.2	14.7	9.2-12.2	Silty Clay Till/ Silty Clay	8.3×10^{-8}
BH/MW 5	93.7	12.3	12.3	9.2-12.2	Silty Clay	5.6×10^{-7}
BH/MW 7	93.1	12.2	12.3	9.2-12.2	Silty Clay	3.5×10^{-7}

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

As shown in Table 6-2, the K estimates for the underlying sub-soil units ranges from between 8.3×10^{-8} m/sec and 5.6×10^{-7} m/sec. The above estimates indicate that the hydraulic conductivity estimates for the groundwater-bearing subsoils at the depths of the monitoring well screens is moderate, with corresponding moderate anticipated groundwater seepage rates being anticipated into open excavations, below the ground water table.

7.0 GROUNDWATER CONTROL

The hydraulic conductivity (K) estimates for the silty clay till, silty clay and shale bedrock, suggest that groundwater seepage rates into open excavations below the groundwater table will be low, and most likely un-sustained given that the underlying shale is considered to be a poor aquifer. To provide safe, dry and stable conditions for earthworks excavations for construction of the proposed 4-levels underground parking structures, the groundwater table should be lowered in advance of, or during construction. The preliminary estimates for temporary 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 development plan, prepared by ICON Architects, Project No. 21124, dated April 4, 2023, was reviewed for the preparation of the dewatering needs assessment. Based on the review of the plans, the proposed development will involve construction of a mixed-use building comprised of two (2) towers, being 17-stories high, having 4-levels of underground parking structure. Based on the measured shallow groundwater level elevations, temporary construction dewatering is anticipated to facilitate earthworks and construction for the proposed 4-level underground parking structure(s). The construction dewatering flow rate estimates are discussed below:

Dewatering Flow Rate Estimates for 4-Levels of Underground Parking Structure, with an at grade elevation @ 80.39 masl.

Based on review of the site plan, provided by ICON Architects, Project No. 21124, Drawing No. 02, dated April 4, 2023, the finished floor base elevation for the proposed 4-level underground structure is at 80.39 masl. The subject site is almost rectangular in shape, comprising an approximate area of 3,500.00 m², being approximate 100 m long by 35 m wide, and having an estimated perimeter length of about 270 m. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the groundwater table be lowered to an elevation of 79.4 masl, which is about 1.0 m below the lowest proposed excavation depth. The subsoil profile consists of silty clay till, silty clay and shale bedrock extending to the maximum anticipated excavation depth. The highest groundwater level, as recorded at BH/MW 5 was at an elevation of 92.25 masl. Based on the assessment, the temporary construction dewatering flows are anticipated to a reach daily rate of 117,271.1 L/day for the proposed 4-level, underground parking structure; by considering a 3x safety factor, this rate could reach an approximate daily maximum of 351,813.3 L/day. In accordance with the current policy of the Ministry of the Environment, Conservation and

Parks (MECP), where the dewatering flow rate is between 50,000 L/day and 400,000 L/day, the approval for temporary groundwater taking for construction is by means of the registering for proposed groundwater-taking for construction by means of the filing an Environmental Activity and Sector Registry (EASR) with the MECP. Since the estimated temporary construction dewatering flow rate exceeds 50,000 L/day, the registering for any proposed groundwater-taking for construction would be through an EASR, and its filing with the MECP. It is recommended that the EASR be filed for the maximum allowable construction dewatering flow rate of 400,000 L/day to also account for the management and removal of any accumulated runoff within the construction excavation footprint areas following high rainfall events.

Higher construction dewatering flow rates may occur at the beginning of the dewatering process, which may include any rapid removal of accumulated runoff within the excavation footprint areas, following a high intensity storm event. It is anticipated that, following the lowering of the localized groundwater table, groundwater seepage volumes removed via dewatering from the open excavation are likely to be low and any groundwater seepage from the weathered shale beneath the site is expected dissipate following exposure within the open excavation.

7.2 **Management of Runoff Accumulation During Construction**

The anticipated storm event, rainfall related runoff volume that could accumulate within the proposed excavated areas, was calculated by using the Intensity-Duration Frequency (IDF) curve for the year 2010. By considering a 100-yr return period 24-hour event for the IDF coordinates of 43.820833, -79.104167 a rainfall depth estimate of 120.8 mm was determined from the curve. The modelled rainfall data was taken from the Ministry of Transportation (MTO) website. The runoff volume which could accumulated within the proposed underground parking structure excavation footprint area, being approximately 3,500 square meters (length of 100 m and width of 35 m), was calculated using the maximum storm event rainfall depth, multiplied by the estimated area for the construction footprint excavation i.e.

Maximum rainfall depth; 120.8 mm (0.1208 m)
Surface area for proposed excavation; 3,500 m^2
Accumulated rainfall for a 100-year return period = (0.1208 m *3,500 square meters) = 422.8 m^3 /day (422,800 litres/day).

The anticipated runoff volume was calculated at 422,800 liters per day. The dewatering system should be designed for the maximum expected runoff accumulation rate.

The total anticipated runoff accumulation volume within the anticipated excavations for the development were calculated at 422,800 liters per day. As such, any temporary dewatering system should be designed for the maximum expected runoff accumulation rate.

7.3 Groundwater Control Methodology

Given that low groundwater seepage is anticipated into open excavations below the groundwater table, any construction dewatering can likely be controlled by pumping from sumps when and where required during construction. The final design for the temporary dewatering system will be the responsibility of the construction contractors.

7.4 Mitigation of Potential Impacts Associated with Dewatering

The maximum zone of influence for any temporary construction dewatering could reach a maximum of 28.9 m any from the conceptual dewatering array or sump pit wells for the proposed excavation. Based on the records review, there are no records for any private water supply wells, bodies of water, water courses or wetlands present within the conceptual zone of influence for any temporary construction dewatering. Also, the subject site is located within an existing, developed urbanized area, which is bordered by existing commercial developments, a Church, Highway 407, and Kingston Road and existing infrastructure which could potentially be affected by ground settlement associated with the conceptual zone of influence for any temporary construction dewatering. A geotechnical engineer should also be consulted to review potential ground settlement concerns to nearby structures prior to construction.

7.5 Long-Term Foundation Drainage Estimation

The proposed development plans, prepared by ICON Architects, Project No. 21124, dated April 4, 2023, were reviewed for the preparation of this assessment. Based on the review of the plans, the proposed development is expected to be completed as a mixed-use building having two building towers, each being 17-stories high, having 4-levels of common underground parking structure.

Given the low groundwater seepage rate estimates for any long-term foundation drainage, a conventionally shored excavation, completed using pile and lagging methods can be designed for construction of the proposed 4-levels underground parking structure. A conventional Mira drainage network can be included with the design of a conventionally shored excavation, along with a simple under, basement slab drainage network to address any long-term seepage to the excavation and the completed underground parking structure.

These systems can be drained to separate sump pits. The drainage network should be designed by a qualified mechanical engineer, having experience with the designs for under-slab and Mira drainage networks.

The foundation drainage networks should have separate connections to proposed sump pits, with one pit connected to the shore wall, mira drainage network for a conventionally shored excavation, and a second pit connected to the under-basement floor slab floor drainage network.

In order to estimate the long-term foundation drainage needs for the shored excavations, for the associated mira-foundation drainage network, and for the under, basement slab floor drainage network at the subject site, Darcy's expression and equation was used. The estimates are provided as follows:

The base elevation for the 4-levels underground parking structure was considered to be at depth elevation of approximately 80.39 masl, which was used for the long-term foundation drainage needs estimation. Review of the measured groundwater levels indicates that the shallow groundwater levels are above the base for the proposed 4-level underground parking structure. As such, it is anticipated that that some long-term foundation drainage needs will be required for the proposed common underground parking structure. Darcy's Expression below, was used to assess the long-term foundation seepage flow estimates:

$$Q = KiA$$

Where:

- Q = Estimated seepage drainage rate (m^3/day)
- K = 5.6×10^{-7} m/sec (hydraulic conductivity (K) assessed for the shale bedrock aquifer encountered during the study)
- A = 3,202.2 m^2 for the saturated Mira drain foundation walls and 219.91 m^2 for the under-slab floor drainage network which is the approximate surface area of weeper drains to intercept groundwater seepage below the ground surface (cross-sectional area of flow)
- iv = 0.0829 [unitless], Vertical Hydraulic Gradient for groundwater considered for the under-slab basement floor drainage system
- ih = 0.0770 [unitless], Horizontal Hydraulic Gradient for groundwater considered for the perimeter, footing drainage system.

Based on the plans for the proposed 4-levels underground parking structure, the estimated long-term seepage drainage rate associated with the Mira drainage network for the shored excavation is 11,930.1 L/day. The long-term seepage drainage rate for the under, basement slab floor drainage networks is 883.01 L/day. The combined long-term seepage rate from both the shore wall, Mira, and the under-basement floor slab drainage networks is estimated at 12,813.02 L/day. Applying a safety factor of three (3), the combined drainage flow rate is estimated at 38,439.07 L/day for the 4-levels underground parking structure.

The pumping facility and sump systems should be designed for the maximum expected seepage drainage rates. The systems should be designed by a qualified mechanical engineer having experience in design for foundation drainage systems. The drainage piping should be properly constructed using weeper tiles surrounded by filter cloth, in turn surrounded by bedding stone or concrete sand to minimize potential losses of fines and to prevent silt from clogging of weeper tiles. Over time, the foundation drainage flows for the underground structures may diminish to a lower, or possibly negligible rate, but more likely to a lower, steady-state rate that will remain relatively constant over time. During the expected dry season, minimal or negligible long-term foundation seepage drainage rates may be experienced. The drainage networks should have separate connections to the proposed sump pits, with one pit connected to the shored wall/mira drainage network, and a second pit connected to the basement, under slab drainage network.

Considering the estimated long term foundation drainage rates, in order to completely cut off groundwater seepage to the excavation and to affect waterproofing of the proposed underground structure, a caisson, along with a raft slab that could be installed around the perimeter of the excavation and at the base of the excavation respectively. However, the additional costs for water proofing of the underground structures are substantial and may not be cost effective given the minimal long-term foundation drainage rates being anticipated for the completed underground structure.

Given that permanent foundation drainage for the proposed development is anticipated, a discharge approval may be required from the City of Pickering and/or Region of Durham to convey and dispose of any generated long term foundation drainage effluent to the local sewer systems.

7.6 Recommendations for Permanent Foundation Drainage Design

Implications for final design for the proposed underground structure include:

1. Need to design a perimeter, Mira drainage, and under-basement floor slab drainage networks with two independent connections to two sump-pit systems.

2. Alternatively, it is recommended that a watertight design can be considered to waterproof the underground parking structure and/or any elevator pits to avoid the need for disposal management for any long-term groundwater seepage generated for the completed underground structures and for its disposal to the local sewer system.

Typically, the mechanical engineer is tasked with the design for the foundation drainage network and sump pit systems. The final designs for any drainage networks should mitigate against the potential losses of soil fines to the systems, to prevent weeper tile/pipe clogging, to mitigate against potential ground settlement attributed to potential losses of soil fines to the drainage networks, and to maintain a longer lifespan for these drainage networks.

For the final design for any shore wall Mira drainage network, consideration should be given to mitigate against potential storm-related flood event runoff entering the Mira drainage network, where surface water runoff related drainage could potentially overwhelm a sump pit if the system if the system is not designed to mitigate against storm event flooding.

7.7 <u>**Ground Settlement**</u>

The subject site is located within an existing developed urbanized area, supplied by municipal water and associated storm and sanitary services. The area is surrounded by existing commercial buildings, a church building and roads which could potentially be affected by ground settlement associated with the conceptual zone of influence for any temporary construction dewatering. A geotechnical engineer should be consulted to review potential ground settlement concerns to nearby structures, prior to construction.

7.8 <u>**Groundwater Function of the Subject Site**</u>

A tributary of Amberlea Creek traverses the west boundary of the subject property where it flows in a northwest to southeasterly direction. It joins another tributary of the Amberlea Creek, south of the site where it flows in a southeast direction, before draining southward into Lake Ontario.

The upstream area that is conveyed through the site via Amberlea Creek will not be altered by the proposed development.

7.9 <u>**Low Impact Development**</u>

The surficial subsoil beneath the site consists mainly of silty clay till and silty clay which will limit infiltration of precipitation to the subsurface to recharge. In this case, passive LID measures, such as implementation of bioswales, permeable pavements, green roofs and thickening of topsoil within the landscape areas to an approximate maximum thickness of 400 mm within landscaped areas should be considered to divert storm runoff away from municipal storm sewer catch basins, and could be implemented to address future stormwater management planning and design for the proposed development.

Any proposed LID infrastructure should be designed by the stormwater engineer for the project. Furthermore, any proposed LID infiltration infrastructure should be offset sufficiently form the proposed building foundation to avoid or minimize the capturing of re-directed runoff meant for infiltration to the subsurface from being intercepted by the new building’s foundation drainage network.

8.0 CONCLUSIONS

1. The subject site lies within the Physiographic Region of Southern Ontario, known as the as the Iroquois Sand Plain. The mapped native surface geological soil units consist of undifferentiated till material, comprised, predominantly of sandy silt to silt matrix, where the subsoil matrix is high in calcium carbonate content.
2. The subject site is located within the within the Frenchman's Bay Watershed.
3. Based on the review of the ground surface elevations at borehole and monitoring well locations, the total elevation relief across the subject site is about 4.5 m.
4. This study has disclosed that beneath the topsoil horizon, and a layer of earth fill at BH/MW 1, the sub-soils underlying the site consists of silty clay till, silty clay, and shale bedrock.
5. The findings of this study confirm that the groundwater level elevations range from 92.25 to 85.74 masl, (i.e., 1.33 to 12.06 mbgl), and that the interpreted shallow groundwater flow pattern beneath the site is in a south easterly direction, towards the low relief portion of the property.
6. The single well response tests yielded estimated hydraulic conductivity (K) values for the silty clay till and silty clay unit, that range from between 8.3 x 10^{-8} m/sec and 5.6 x 10^{-7} m/sec, at the depths of the monitoring well screens. These results suggest that low groundwater seepage rates can be anticipated into open excavations below the groundwater table.
7. The estimated temporary dewatering flow estimates for construction of the proposed 4-level underground parking structure could reach a daily rate of about of 117,271.10L/day. By applying a safety factor of three (3), it could reach a maximum of 351,813.3 L/day. This anticipated dewatering flow rate is below the PTTW threshold limit requirement of 400,000 L/day. In accordance with the current policy of the Ministry of the Environment, Conservation and Parks (MECP), where the dewatering flow rate is between 50,000 L/day and 400,000 L/day the approval to facilitate the temporary groundwater taking for a construction dewatering program is by means of the filing an Environmental Activity and Sector Registry (EASR) with the MECP.
8. The construction dewatering flow rate estimates for the proposed 4-level underground basement/parking structures also suggests that the anticipated runoff volume accumulation within the excavation footprint area associated with storm events is estimated at 422,800 L/day.
9. The estimated long-term seepage drainage rate for a conventional Mira drainage network for shored excavation is 11,930.1 L/day. The long-term drainage seepage drainage rate for the under-slab floor drainage networks is 883.01 L/day. The combined long-term seepage drainage rate from both the Mira drainage network

foundation and the under, basement floor slab drainage network is estimated at 12,813.02 L/day. Applying a safety factor of three (3), the combined drainage rate is estimated at 38,439.07 L/day for the proposed 4-level shared underground parking structure.

10. The underlying shallow silty clay till and silty clay will limit infiltration of precipitation to the subsurface to recharge the groundwater table. In this case, passive LID measures such as; implementation of bioswales, rain gardens, the thickening topsoil within landscaped areas, the implantation of soak away pits along with green roof, and the use of permeable fill material at the developed site, during the grading stages are all recommend to be considered to address future stormwater management planning and design for the proposed development.

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9.0 REFERENCES

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4. Oakridges Moraine Groundwater Program (https://www.oakridgeswater.ca/)

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FIGURES 1 to 9

BOREHOLE LOGS/MONITORING WELL LOGS

REFERENCE NO. 2204-W019

JOB NO.: 2204-W019

LOG OF BOREHOLE: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

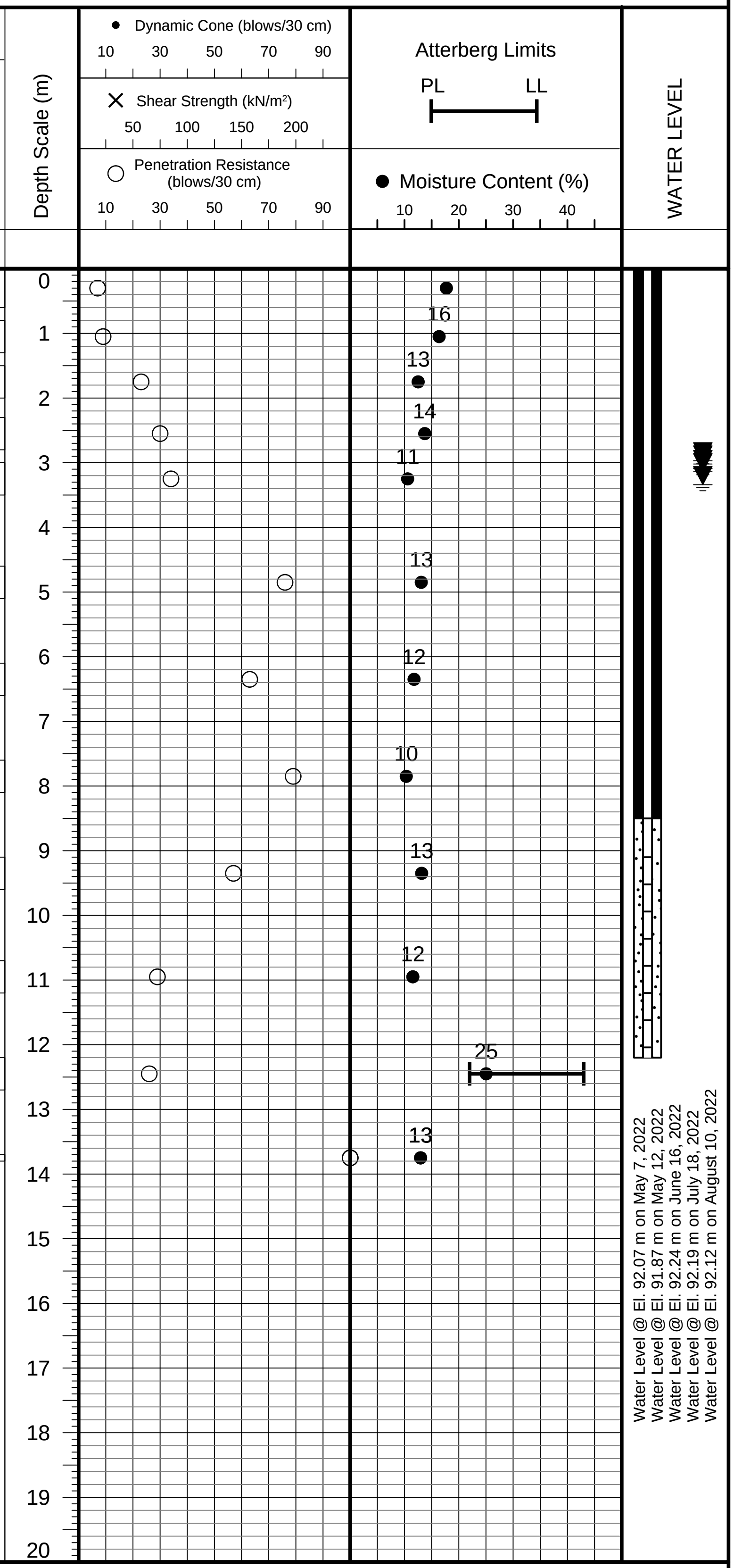
PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 3, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
95.2	Ground Surface			
0.0	**20 cm Topsoil** **EARTH FILL** Brown to dark brown silty clay occ. topsoil inclusions	1	DO	7
		2	DO	9
93.7 / 1.5	Very stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers	3	DO	23
		4	DO	30
		5	DO	34
	brown grey			
		6	DO	76
		7	DO	63
		8	DO	79
		9	DO	57
		10	DO	29
83.5 / 11.7	Grey, very stiff **SILTY CLAY** a trace to some sand medium plasticity	11	DO	26
81.4 / 13.8	occ. shale fragments	12	DO	50/13

END OF BOREHOLE
due to auger refusal on probable bedrock

Straight augered and installed 50 mm Ø monitoring well to 12.2 m
completed with 3.1 m screen
Sand backfill from 8.5 to 12.2 m
Bentonite seal from 0.0 m to 8.5 m
Provided with a monument steel casing



Soil Engineers Ltd.

JOB NO.: 2204-W019

LOG OF BOREHOLE: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 3, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION
97.6	Ground Surface
0.0	**20 cm Topsoil**
	Stiff to hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered; brown / grey)
85.9 / 11.7	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity (occ. shale fragments)
82.0 / 15.6	**END OF BOREHOLE due to auger refusal on probable bedrock**

Straight augered and installed 50 mm Ø monitoring well to 12.2 m
completed with 3.1 m screen
Sand backfill from 8.5 to 12.2 m
Bentonite seal from 0.0 m to 8.5 m
Provided with a monument steel casing

SAMPLES

Number	Type	N-Value	Moisture Content (%)
1	DO	8	
2	DO	26	10
3	DO	49	10
4	DO	69	8
5	DO	50/23	9
6	DO	50/28	11
7	DO	89	10
8	DO	79	11
9	DO	50/28	9
10	DO	77	15
11	DO	77	22
12	DO	47	21
13	DO	50/23	23

Depth Scale (m): 0–20

● Dynamic Cone (blows/30 cm): 10 30 50 70 90
× Shear Strength (kN/m²): 50 100 150 200
○ Penetration Resistance (blows/30 cm): 10 30 50 70 90
Atterberg Limits: PL LL
● Moisture Content (%): 10 20 30 40

WATER LEVEL

Water Level @ El. 85.74 m on May 7, 2022
Water Level @ El. 85.90 m on May 12, 2022
Water Level @ El. 87.01 m on June 16, 2022
Water Level @ El. 87.96 m on July 18, 2022
Water Level @ El. 88.34 m on August 10, 2022

Soil Engineers Ltd.

JOB NO.: 2204-W019

LOG OF BOREHOLE: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Mixed-Use Development

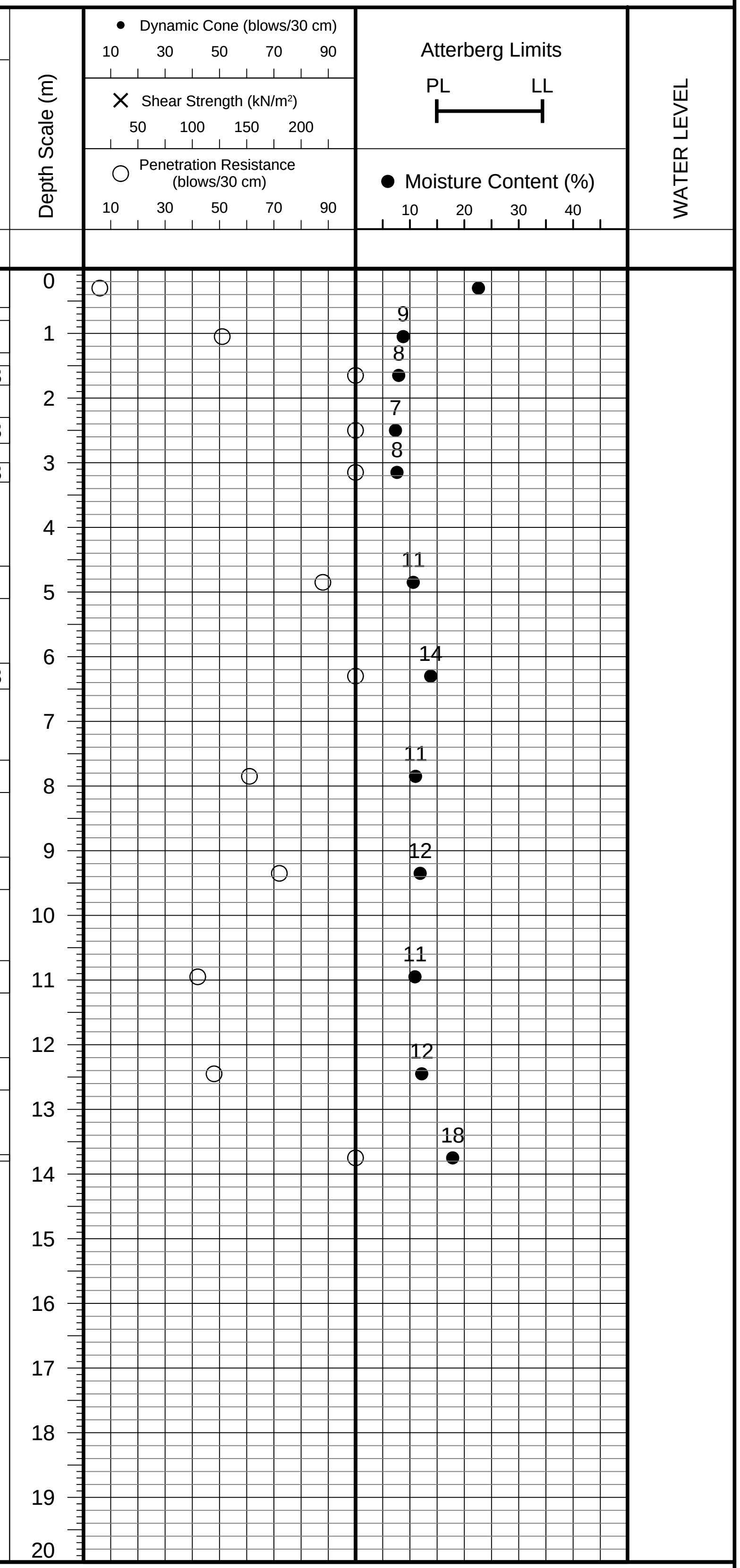
METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 4, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION
94.8	Ground Surface
0.0	**60 cm Topsoil**
	Hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered; brown / grey)
81.6 / 13.2	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity (occ. shale fragments)
81.0 / 13.8	**END OF BOREHOLE due to auger refusal on probable bedrock**

SAMPLES Number	Type	N-Value	Moisture Content (%)
1	DO	6	
2	DO	51	9
3	DO	50/13	8
4	DO	50/23	7
5	DO	50/13	8
6	DO	88	11
7	DO	50/28	14
8	DO	61	11
9	DO	72	12
10	DO	42	11
11	DO	48	12
12	DO	50/5	18



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JOB NO.: 2204-W019

LOG OF BOREHOLE: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 5, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION	Number	Type	N-Value	Moisture Content (%)
96.9	Ground Surface				
0.0	**36 cm Topsoil**	1	DO	8	
	Brown, very stiff to hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered)	2	DO	30	10
		3	DO	51	10
94.7 / 2.2	Hard **SILTY CLAY** a trace to some sand, medium plasticity (brown / grey)	4	DO	36	20
		5	DO	63	19
		6	DO	50	20
91.3 / 5.6	Grey, hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers	7	DO	63	13
		8	DO	68	10
		9	DO	68	11
		10	DO	46	12
85.2 / 11.7	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity	11	DO	32	21
		12	DO	35	26
82.2 / 14.7	occ. shale fragments	13	DO	50/8	15

END OF BOREHOLE due to auger refusal on probable bedrock

Straight augered and installed 50 mm Ø monitoring well to 12.2 m
completed with 3.1 m screen
Sand backfill from 8.5 to 12.2 m
Bentonite seal from 0.0 m to 8.5 m
Provided with a monument steel casing

WATER LEVEL

Water Level @ El. <96.77 m on May 7, 2022
Water Level @ El. 84.60 m on May 12, 2022
Water Level @ El. 86.19 m on June 16, 2022
Water Level @ El. 87.78 m on July 18, 2022
Water Level @ El. 89.08 m on August 10, 2022

Dynamic Cone (blows/30 cm): 10 30 50 70 90
Shear Strength (kN/m^2): 50 100 150 200
Penetration Resistance (blows/30 cm): 10 30 50 70 90
Atterberg Limits: PL, LL
Moisture Content (%): 10 20 30 40

Depth Scale (m): 0–20

Soil Engineers Ltd.

JOB NO.: 2204-W019

LOG OF BOREHOLE: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

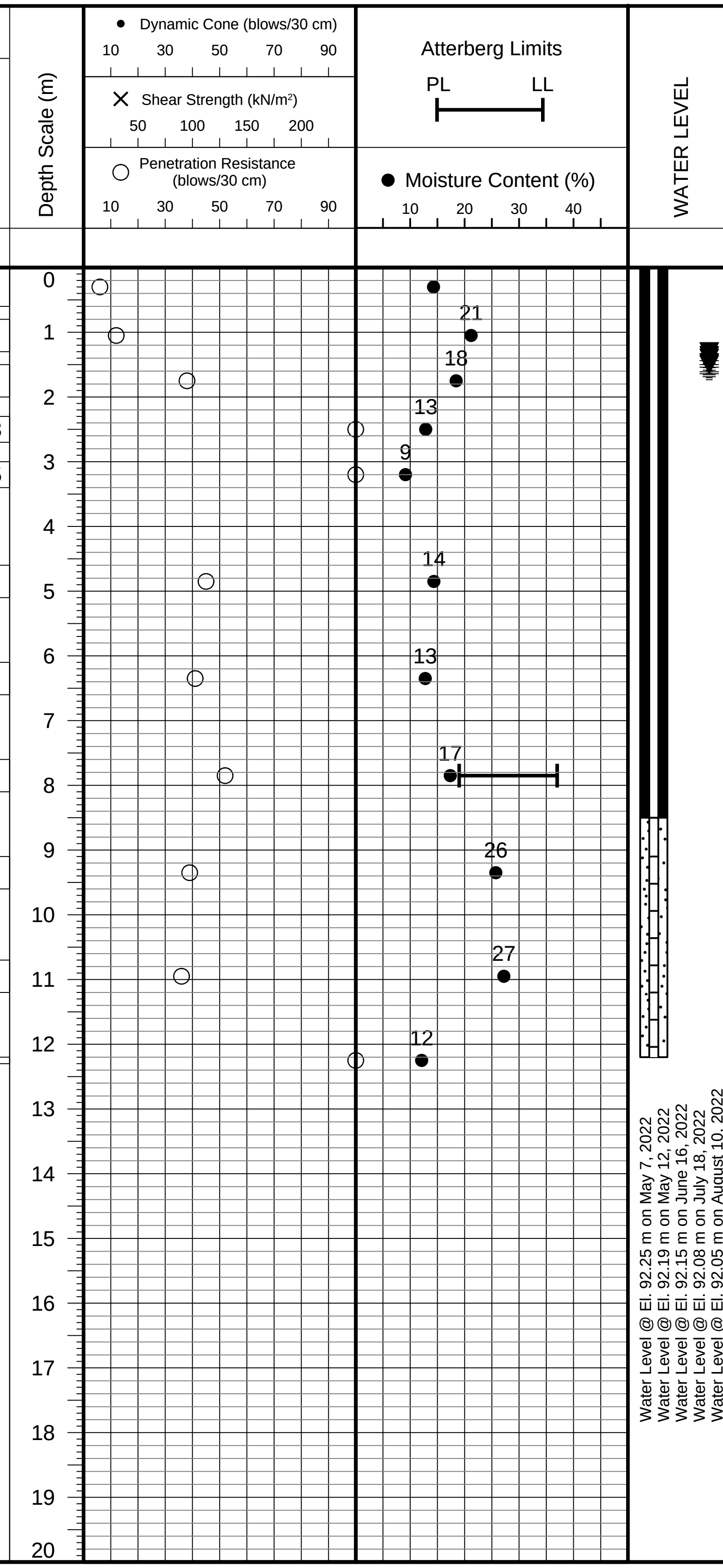
PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 4, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION
93.7	Ground Surface
0.0	**60 cm Topsoil**
	Stiff to hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered; brown / grey)
85.1 / 8.6	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity (occ. shale fragments)
81.4 / 12.3	**END OF BOREHOLE due to auger refusal on probable bedrock**

Straight augered and installed 50 mm Ø monitoring well to 12.2 m
completed with 3.1 m screen
Sand backfill from 8.5 to 12.2 m
Bentonite seal from 0.0 m to 8.5 m
Provided with a monument steel casing

SAMPLES Number	Type	N-Value	Moisture Content (%)
1	DO	6	
2	DO	12	21
3	DO	38	18
4	DO	50/23	13
5	DO	50/25	9
6	DO	45	14
7	DO	41	13
8	DO	52	17
9	DO	39	26
10	DO	36	27
11	DO	50/8	12



Water Level @ El. 92.25 m on May 7, 2022
Water Level @ El. 92.19 m on May 12, 2022
Water Level @ El. 92.15 m on June 16, 2022
Water Level @ El. 92.08 m on July 18, 2022
Water Level @ El. 92.05 m on August 10, 2022

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JOB NO.: 2204-W019

LOG OF BOREHOLE: 6

FIGURE NO.: 6

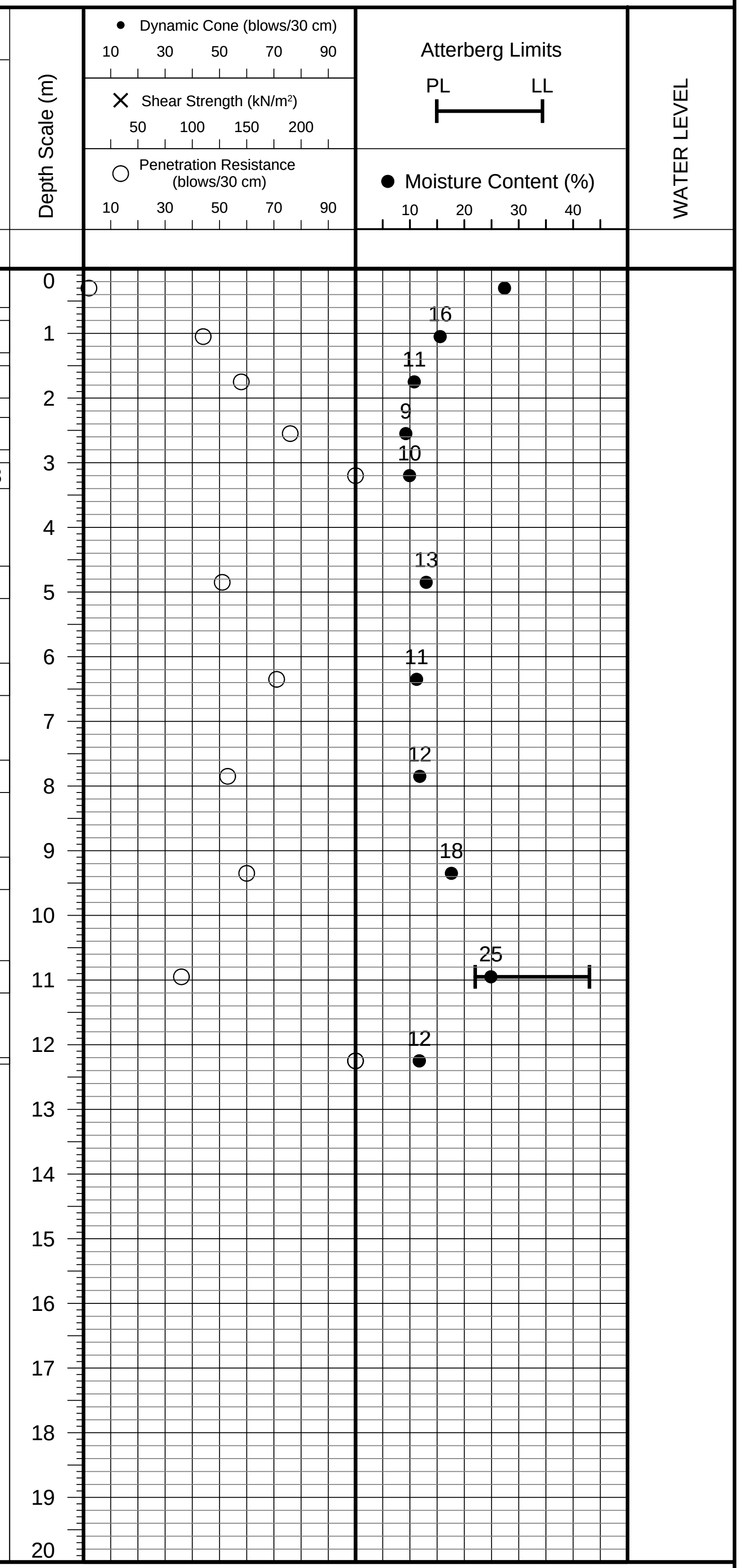
PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 6, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value	Moisture Content (%)
94.0 / 0.0	Ground Surface				
	45 cm Topsoil	1	DO	2	
	Hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered)	2	DO	44	16
		3	DO	58	11
		4	DO	76	9
		5	DO	50/28	10
	brown / grey	6	DO	51	13
		7	DO	71	11
		8	DO	53	12
		9	DO	60	18
83.9 / 10.1	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity	10	DO	36	25
	occ. shale fragments	11	DO	50/8	12
81.7 / 12.3	**END OF BOREHOLE due to auger refusal on probable bedrock**				



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JOB NO.: 2204-W019

LOG OF BOREHOLE: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Mixed-Use Development

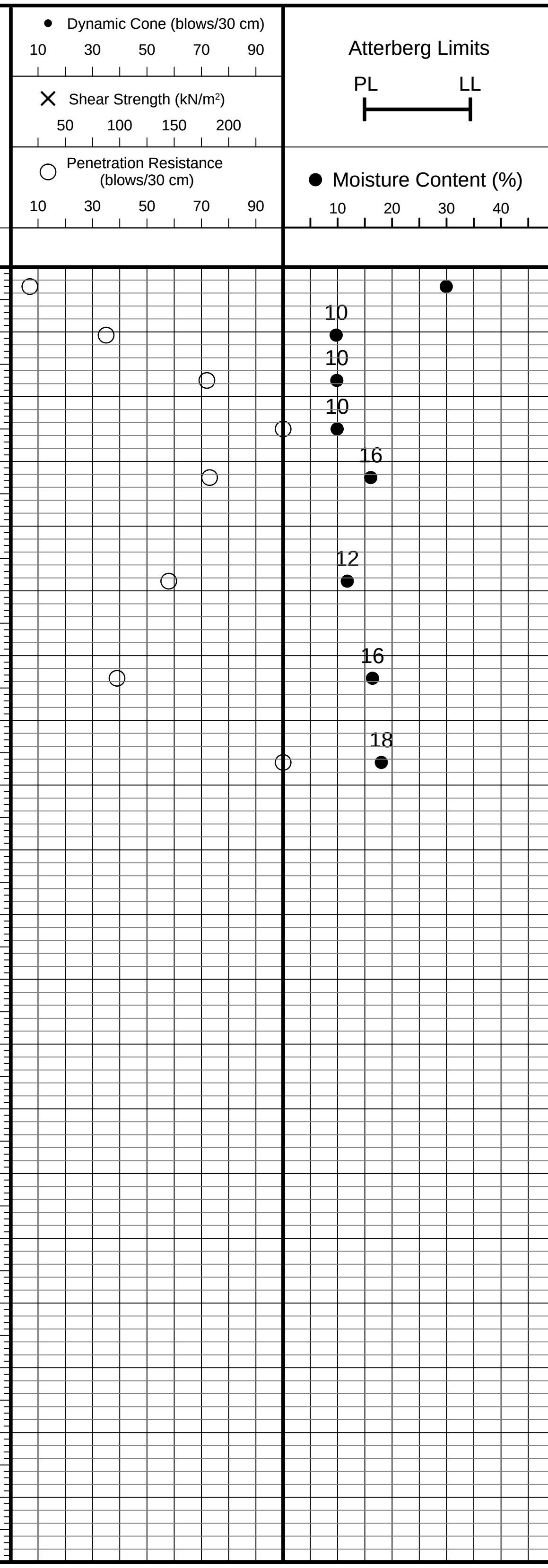
METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 5, 2022

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
93.1	Ground Surface				
0.0	**60 cm Topsoil**	1	DO	7	0
	Hard **SILTY CLAY TILL** some sand to sandy, a trace of gravel, occ. cobbles and boulders, occ. sand and silt seams and layers (weathered)	2	DO	35	1
		3	DO	72	2
		4	DO	50/28	
		5	DO	73	3
	brown / grey				4
		6	DO	58	5
87.5 / 5.6	Grey, hard **SILTY CLAY** a trace to some sand, medium plasticity				6
		7	DO	39	7
	occ. rock fragments	8	DO	50/5	8
80.8 / 12.3	**END OF BOREHOLE due to auger refusal on probable boulder**				12

Straight augered and installed 50 mm Ø monitoring well to 12.2 m
completed with 3.1 m screen
Sand backfill from 8.5 to 12.2 m
Bentonite seal from 0.0 m to 8.5 m
Provided with a monument steel casing



WATER LEVEL

Water Level @ El. 92.69 m on May 7, 2022
Water Level @ El. 91.65 m on May 12, 2022
Water Level @ El. 91.59 m on June 16, 2022
Water Level @ El. 91.47 m on July 18, 2022
Water Level @ El. 91.45 m on August 10, 2022

Soil Engineers Ltd.

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

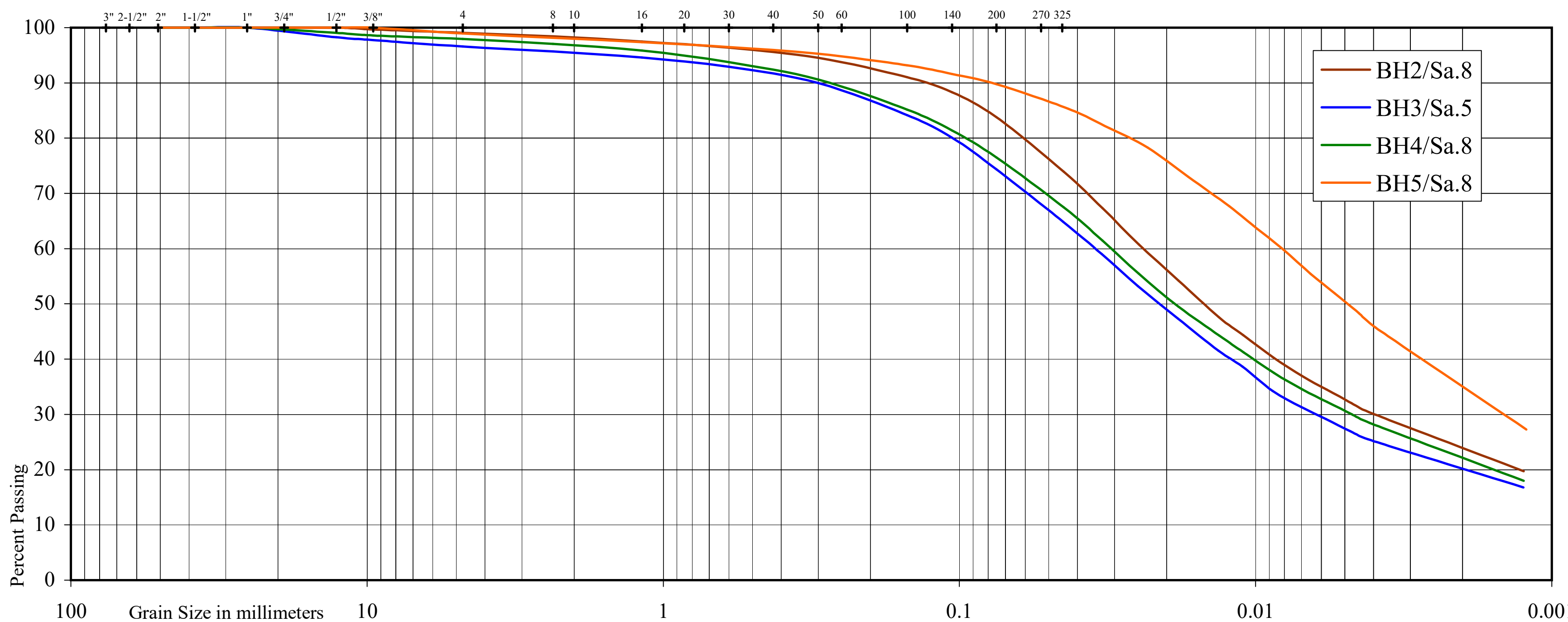
Reference No: 2204-W019

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project:	Proposed Mixed-Use Development			
Location:	875 Kingston Road, City of Pickering			
Borehole No:	2	3	4	5
Sample No:	8	5	8	8
Depth (m):	7.6	3.0	7.6	7.6
Elevation (m):	90.0	91.8	89.3	86.1

BH/Sa.:	2/8	3/5	4/8	5/8
Liquid Limit (%) =	-	-	-	37
Plastic Limit (%) =	-	-	-	19
Plasticity Index (%) =	-	-	-	18
Moisture Content (%) =	11	8	10	17
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

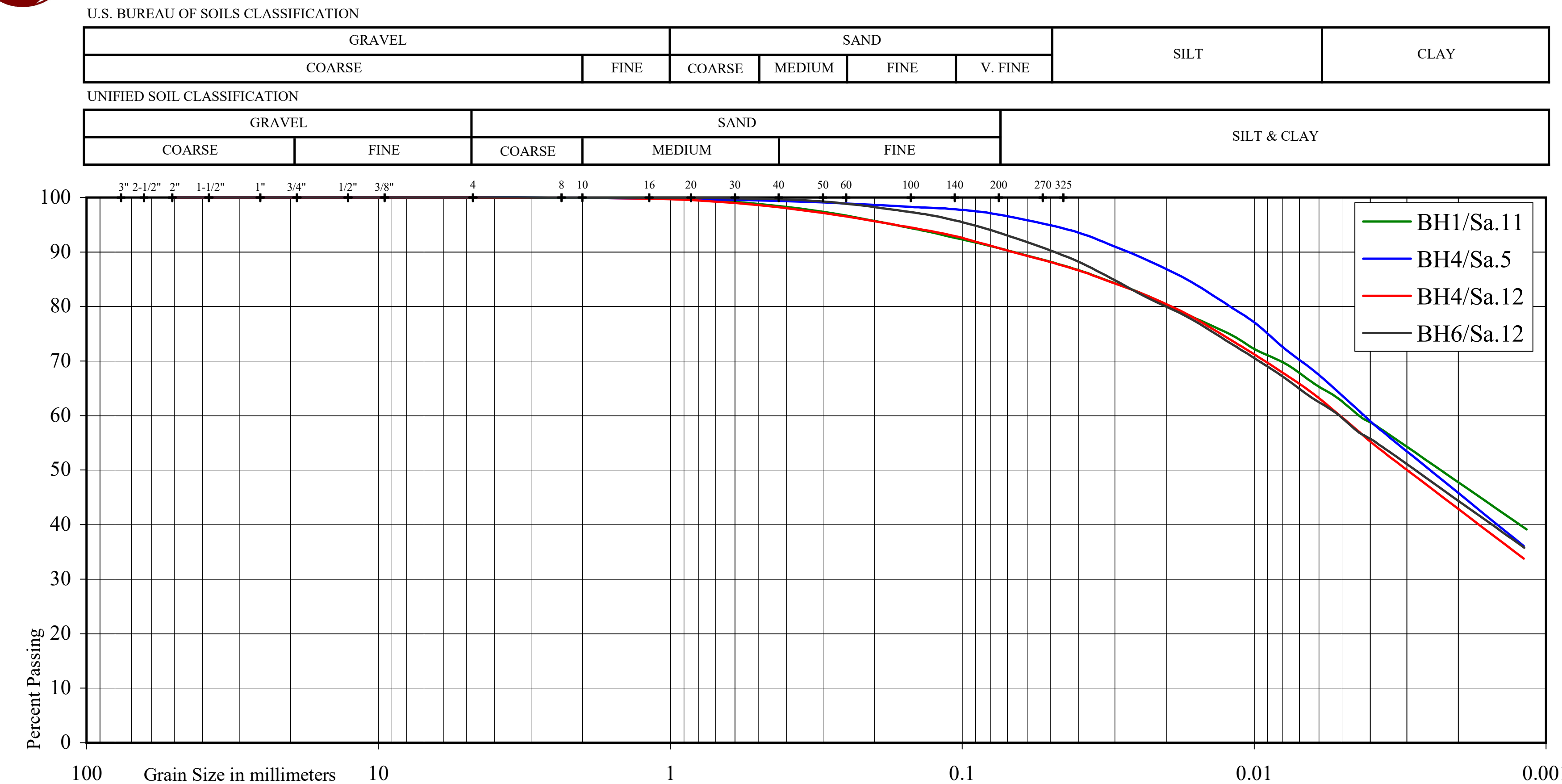
Classification of Sample [& Group Symbol]: SILTY CLAY TILL
some sand to sandy, a trace of gravel

Figure 8

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2204-W019



Project: Proposed Mixed-Use Development

Location: 875 Kingston Road, City of Pickering

Borehole No:	1	4	4	6
Sample No:	11	5	12	10
Depth (m):	12.2	3.0	13.7	10.7
Elevation (m):	83	93.9	83.2	83.3

BH/Sa.:	1/11	4/5	4/12	6/10
Liquid Limit (%) =	43	-	43	42
Plastic Limit (%) =	22	-	22	22
Plasticity Index (%) =	21	-	21	20
Moisture Content (%) =	25	19	26	25
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY
a trace to some sand

Figure 9

DRAWINGS 1 to 9

REFERENCE NO. 2204-W019

N

Legend

- Approximate Boundary of Subject Site
- Expressway/Freeway
- Major Road
- Local Road
- Watercourse_Main_2016

Soil Engineers Ltd.

Title: Site Location Plan

Project:
Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 20 40 80 120 160 200
Metres

Drawing No. 1

Source: Ontario Ministry of Natural Resources and Forestry

N

Legend

- Approximate Boundary of Subject Site
- Borehole with Monitoring Well
- Borehole
- Watercourse
- Expressway/Freeway
- Major Road
- Local Road

Soil Engineers Ltd.

Title: Borehole and Monitoring Well Location Plan

Project:

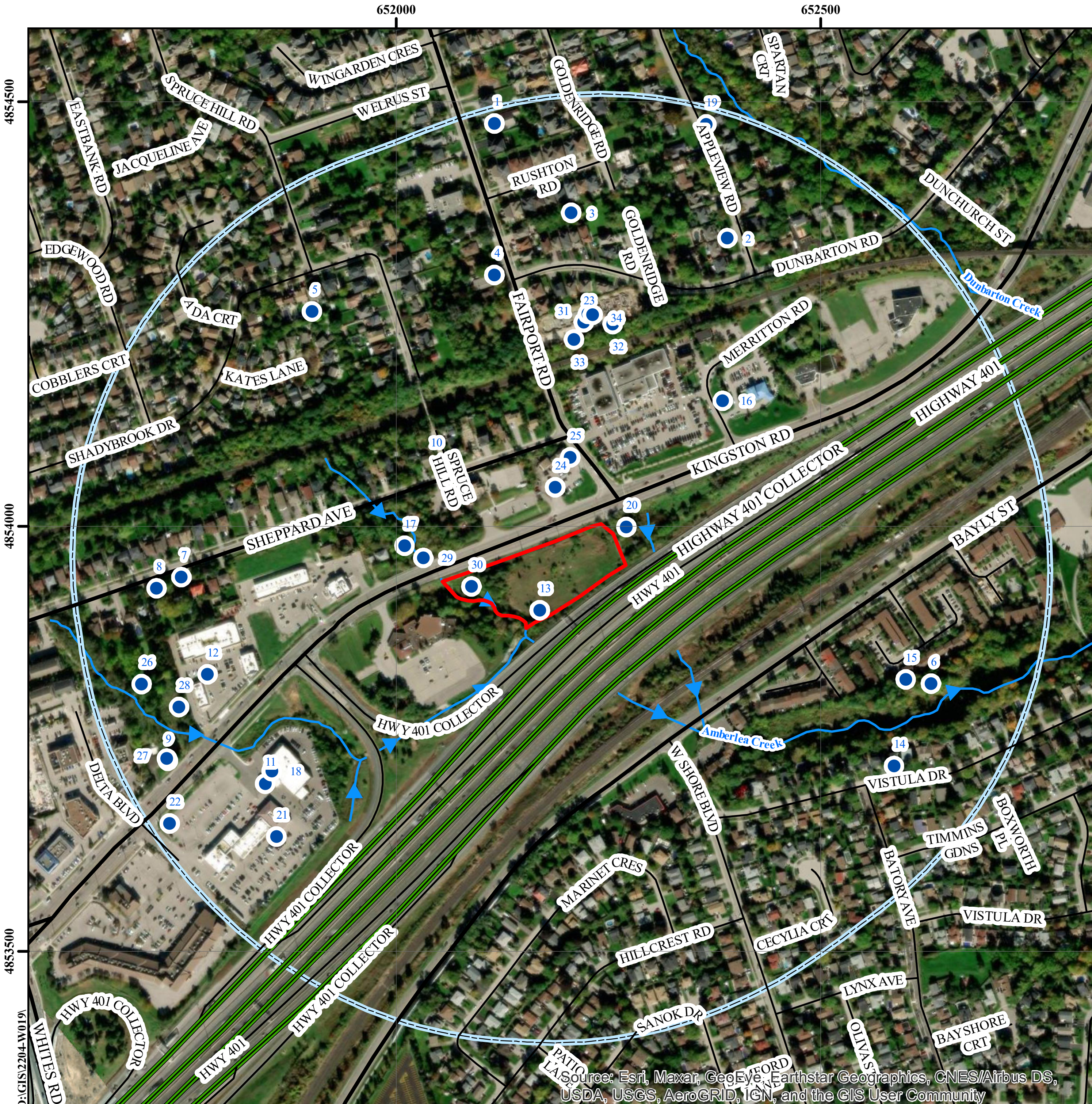
Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 5 10 20 30 40 50
Metres

Drawing No. 2



N

Legend

- Approximate Boundary of Subject Site
- 500 metres from Subject Site Boundary
- Well Location from MECP Well Records (see Appendix 'A')
- Watercourse
- Expressway/Freeway
- Major Road
- Local Road

Soil Engineers Ltd.

Title: MECP Well Location Plan

Project:
Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 30 60 120 180 240 300
Metres

Drawing No. 3

Source: Ontario Ministry of Natural Resources and Forestry

N

Legend

Glaciolacustrine deposits (Sandy)
Material: sand, gravelly sand and gravel, nearshore and beach deposits

Till
Material: undifferentiated, predominantly sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonate content

Glaciolacustrine deposits (Silty)
Material: silt and clay, minor sand, basin and quiet water deposits

Expressway/Freeway

Major Road

Soil Engineers Ltd.

Title: Quarternary and Surface Geology Map

Project:

Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

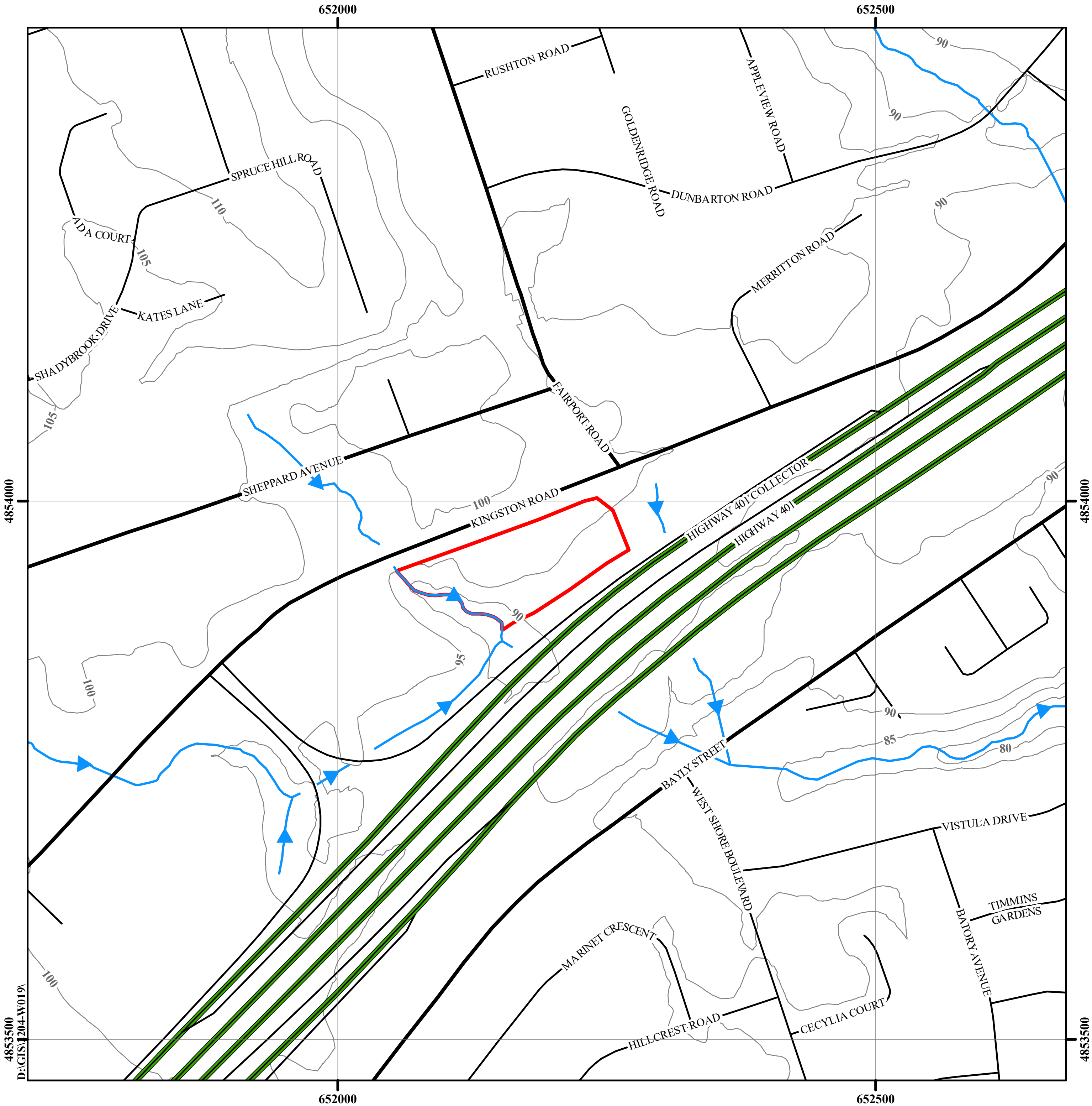
Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 100 200 300 400 500
Metres

Drawing No. 4

Source: Ontario Geological Survey, 1997, Miscellaneous Release---Data 0014



N

Legend

- Approximate Boundary of Subject Site
- Expressway/Freeway
- Major Road
- Local Road
- Watercourse
- 100 Topographic Contour (masl)

Soil Engineers Ltd.

Title: Topographic Map

Project:
Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

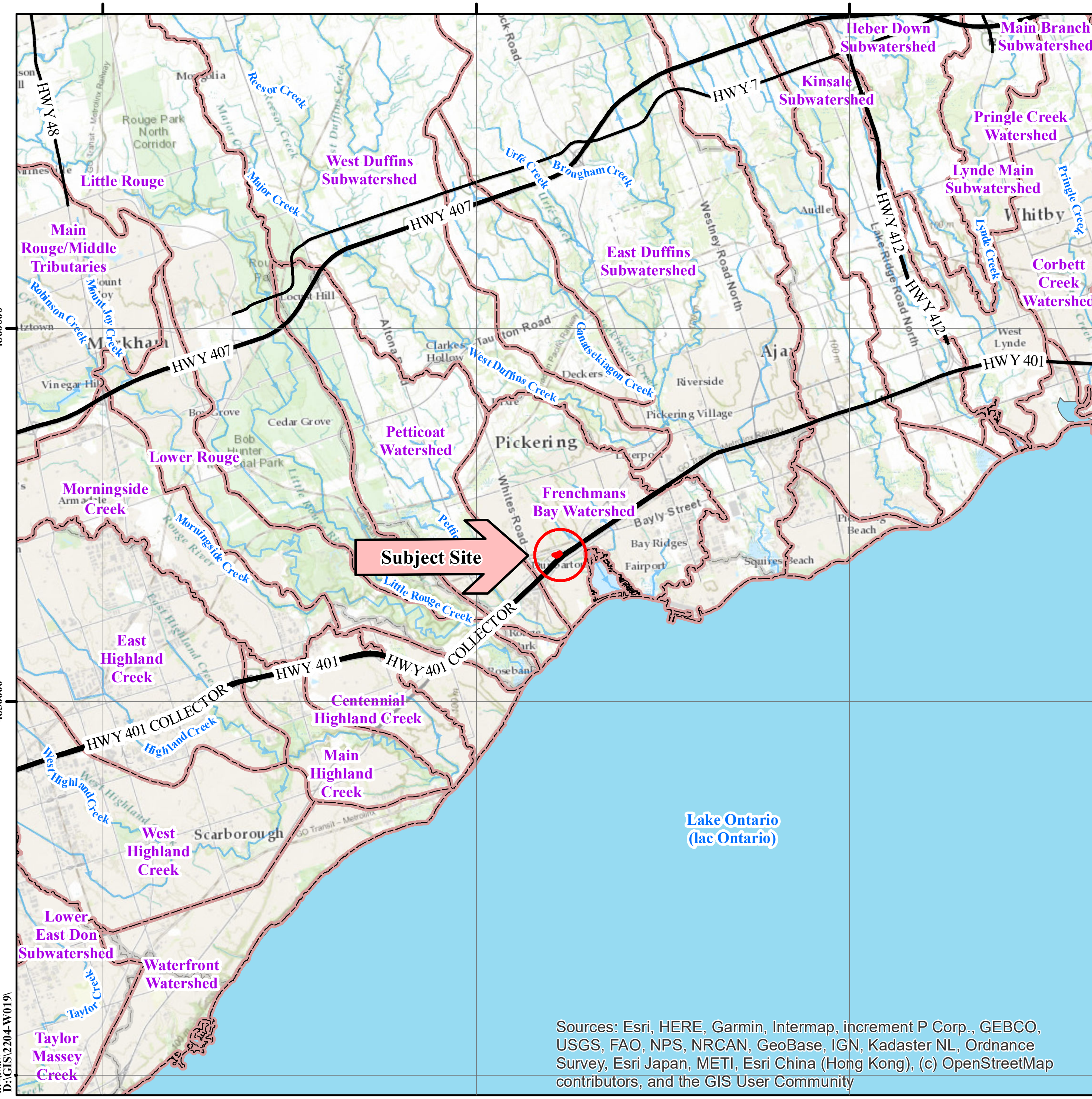
Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 25 50 100 150 200 250
Metres

Drawing No. 5

Source: Ontario Ministry of Natural Resources and Forestry

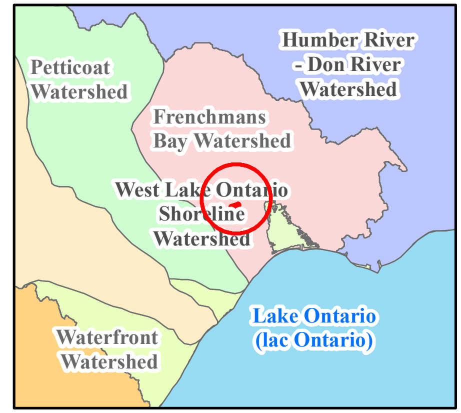


D:\GIS\2204-W019\

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.

N

Watershed:



Legend

- Approximate Boundary of the Subject Site
- Watershed Boundaries
- Waterbody
- Watercourse
- Expressway/Major Road

Soil Engineers Ltd.

Title: Watershed and Subwatershed Map

Project:

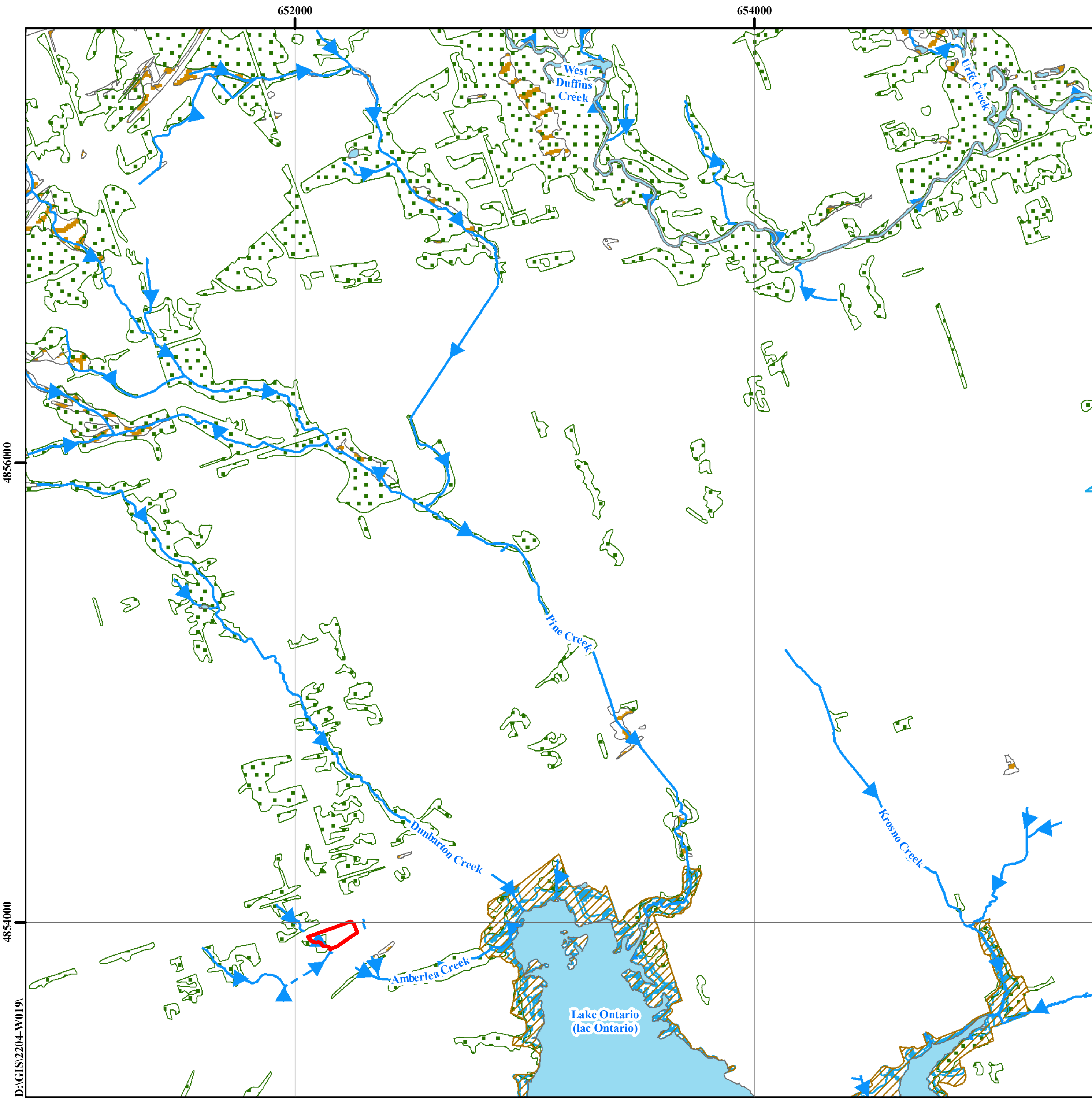
Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 1,600 3,200 4,800 6,400 8,000
Metres

Drawing No. 6



Contains information licensed under the Open Government Licence – Ontario, 2022.
Includes information: Provincial Park, Conservation Reserve, Area of Natural and Scientific Interest, Wetland, Niagara Escarpment Protection Area, Oak Ridges Moraine Conservation and Wilderness Areas

Legend

- Approximate Boundary of Subject Site
- Wetland (classified as Provincial)
- Wetland (Not evaluated per OWES)
- Wooded Area
- Area of Natural and Scientific Interest (ANSI)
- Waterbody
- Watercourse
- Expressway/Freeway
- Major Road
- Local Road

Soil Engineers Ltd.

Title: Natural Features and Protection Area Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: July 3, 2022

Scale:
0 160 320 480 640 800
Metres

Drawing No. 7

Source: Ontario Ministry of Natural Resources and Forestry
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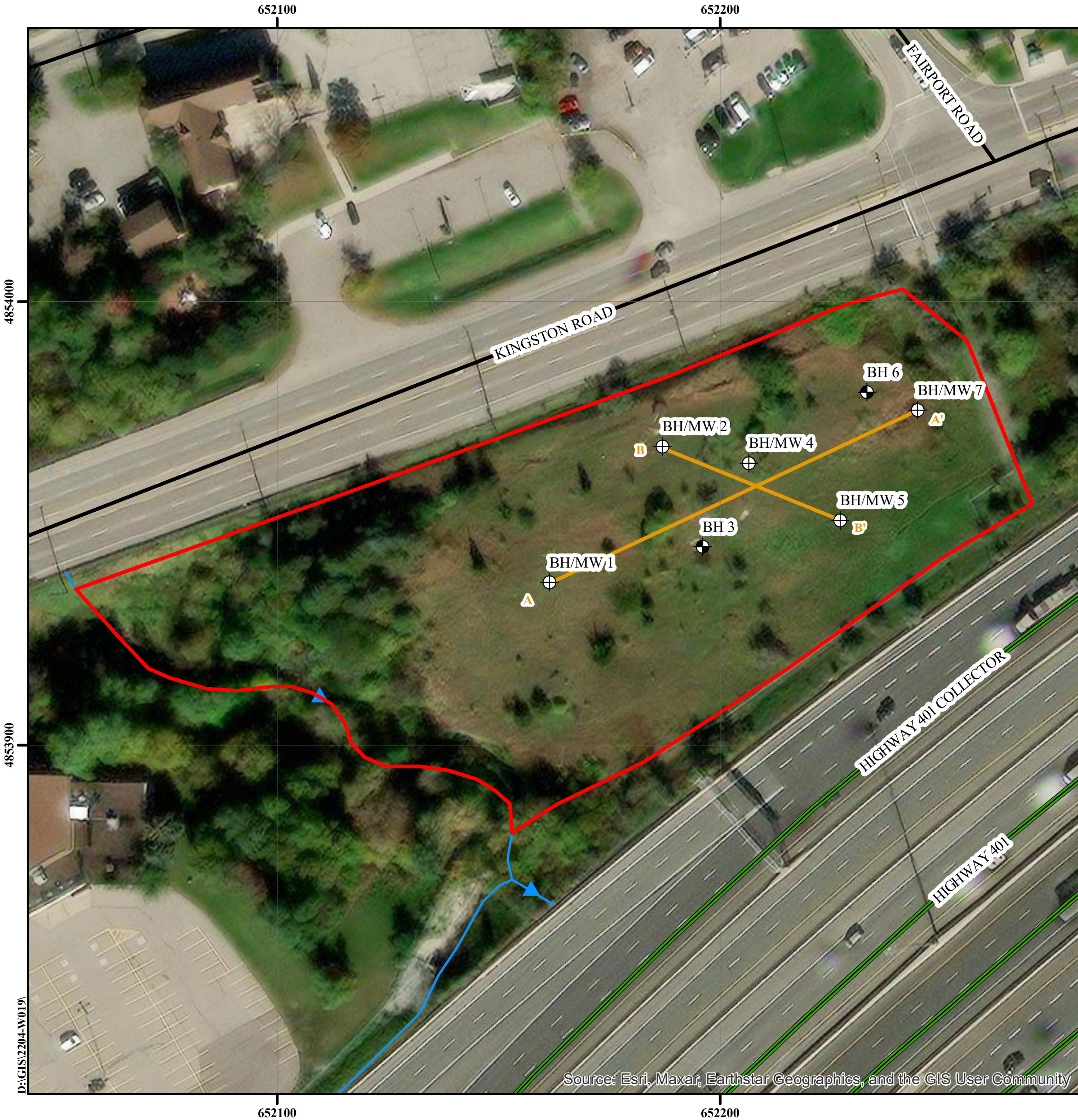
OWES: Ontario Wetland Evaluation System



N

Legend

- Proposed Development Area
- Borehole with Monitoring Well
- Borehole
- Expressway/Freeway
- Major Road
- Watercourse
- A A' Cross-Section Direction

Soil Engineers Ltd.

Title: Cross-Section Key Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

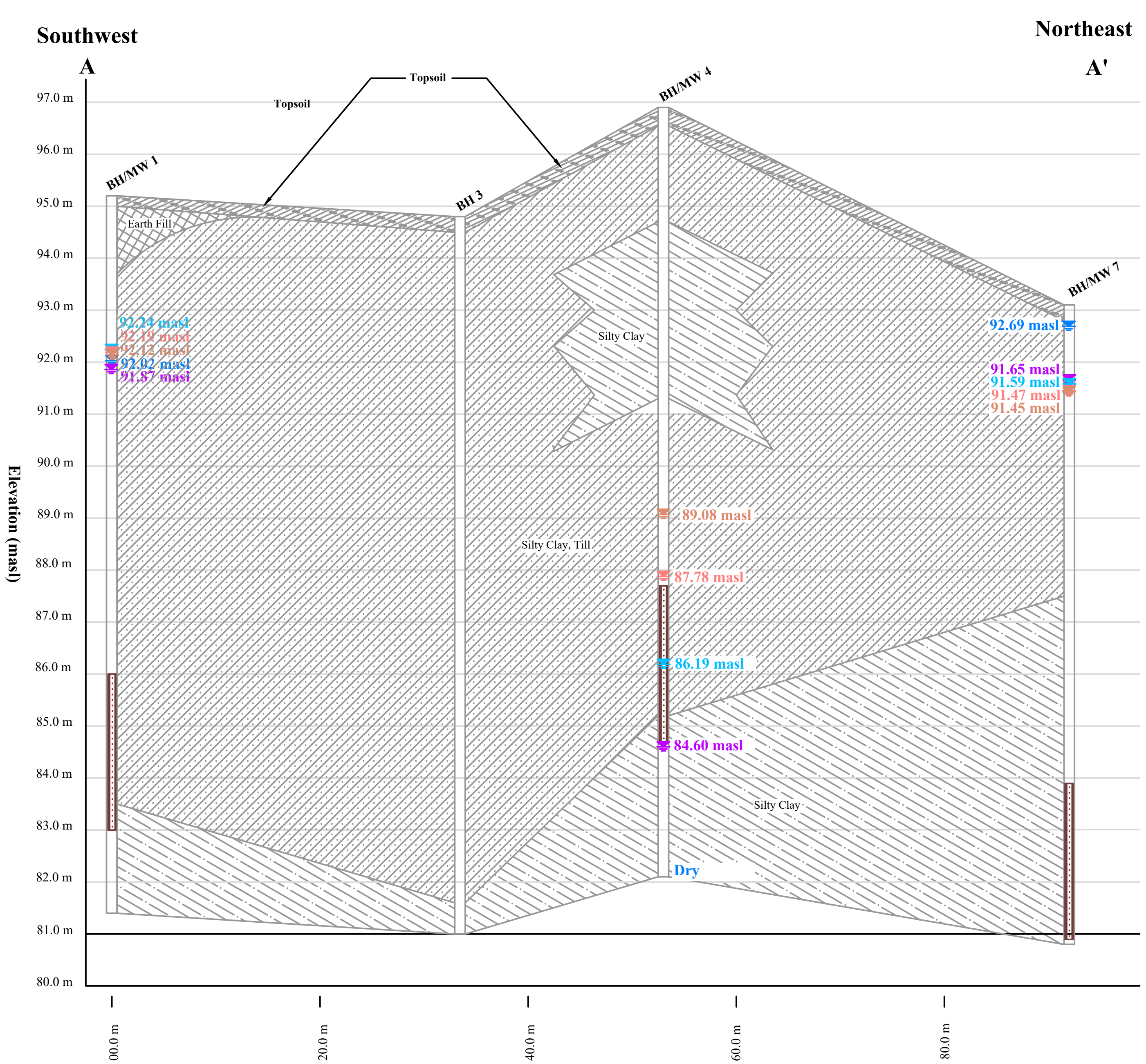
Date: July 3, 2022

Scale:

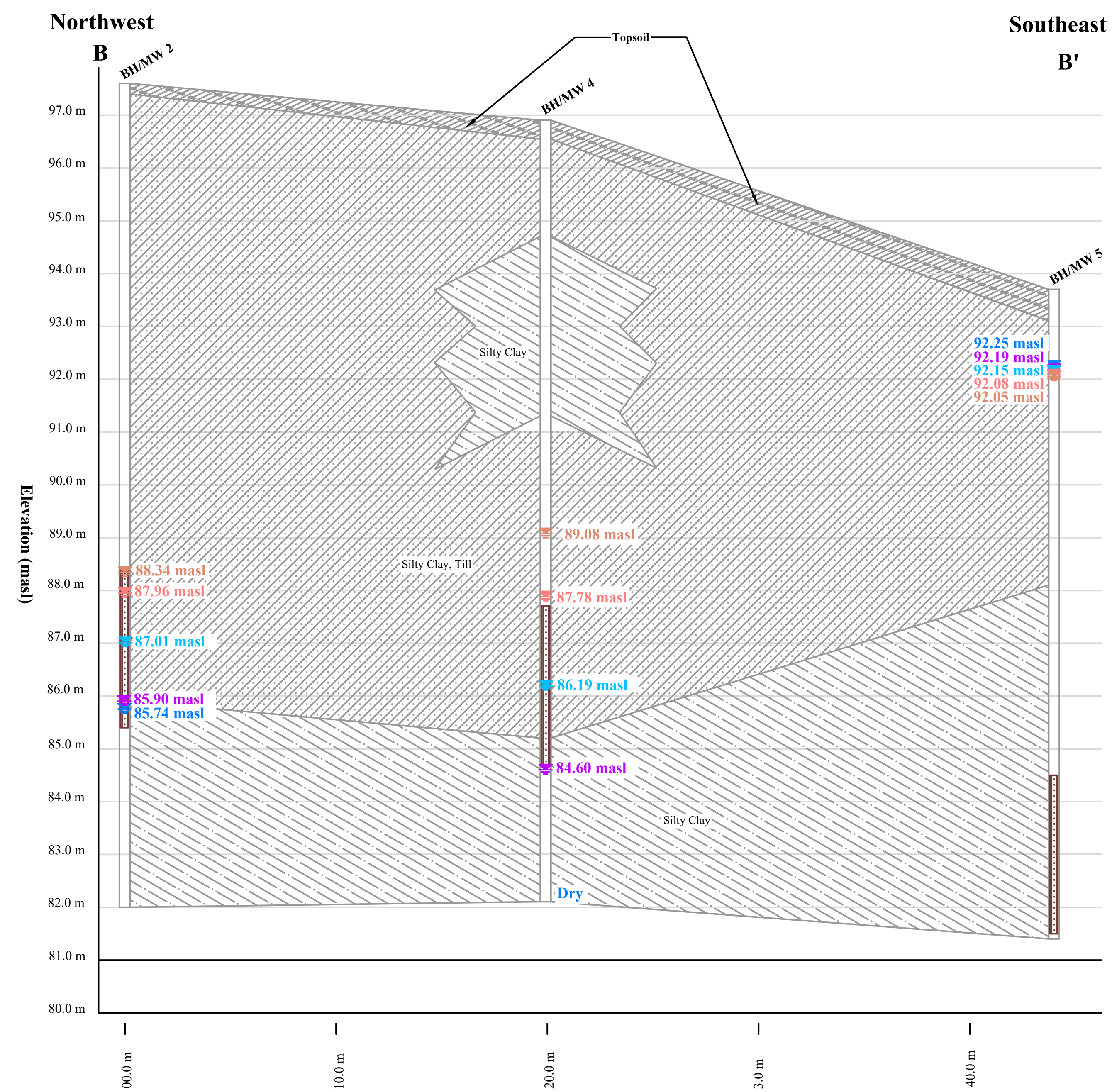
0 5 10 20 30 40 50
Metres

Drawing No. 8-1

Source: Ontario Ministry of Natural Resources and Forestry



Section A-A'



Section B-B'

Topsoil	Silty Clay
Earth, Fill	Silty Clay, Till

3.0 m Screen

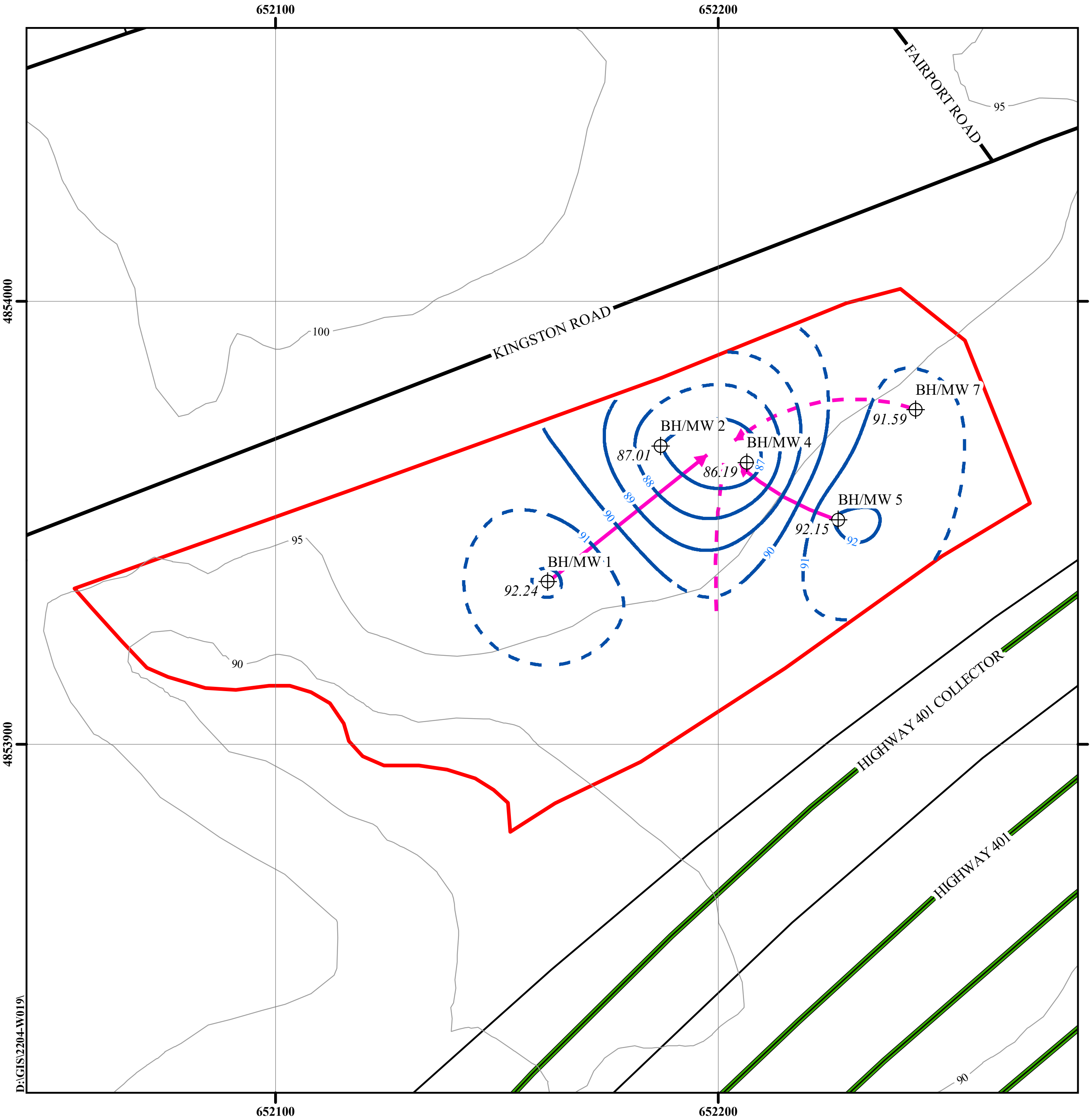
Water Table on May 7, 2022
Water Table on May 12, 2022
Water Table on June 16, 2022
Water Table on July 18, 2022
Water Table on August 10, 2022

Soil Engineers Ltd.
CONSULTING SOIL, FOUNDATION & ENVIRONMENTAL ENGINEERS

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

Project: Hydrogeological Assessment
Proposed Mixed-Use Development
875 Kingston Road, City of Pickering, Ontario

Reference No:	Date:	Scale: V	Scale: H	Drawing No.
2204-W019	May, 2023	1:100	1:2500	8-2



N

Legend

Approximate Boundary of Subject Site

Borehole with Monitoring Well

Interpreted Shallow Groundwater Level Elevation (masl)

Inferred Shallow Groundwater Level Elevation (masl)

Interpreted Shallow Groundwater Flow Direction

Inferred Shallow Groundwater Flow Direction

Expressway/Freeway

Major Road

Local Road

(165.78) Highest Groundwater Level Elevation (masl)

Soil Engineers Ltd.

Title: Shallow Groundwater Flow Pattern Plan

Project:

Hydrogeological Assessment
Proposed Mixed-Use Development
Address: 875 Kingston Road
City of Pickering

Reference No. 2204-W019

Date: May 3, 2023

Scale:
0 5 10 20 30 40 50
Metres

Drawing No. 9

APPENDIX ‘A’

MECP WATER WELL RECORDS SUMMARY

REFERENCE NO. 2204-W019

Ontario Water Well Records									
WELL ID	MECP 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	4601200	Cable Tool	33.5	Water Supply	Domestic	32.00	18.3	-	-
2	4601203	Cable Tool	14	Water Supply	Domestic	14.02	7.3	-	-
3	4601204	Boring	12.8	Water Supply	Domestic	7.62	7.6	-	-
4	4601207	Boring	6.4	Water Supply	Domestic	4.27	1.5	-	-
5	4601208	Boring	8.8	Water Supply	Domestic	4.27	3	-	-
6	4601894	Boring	7.6	Water Supply	Domestic	7.01	4.6	-	-
7	4601904	Cable Tool	24.4	Water Supply	Domestic	24.38	14	-	-
8	4601905	Cable Tool	30.5	Water Supply	Domestic	19.20	9.1	-	-
9	4601907	Boring	17.7	Water Supply	Domestic	17.37	14.6	-	-
10	4605199	Not Known	13.4	Observation Wells	Not Used	12.80	1.8	-	-
11	1917749	Rotary (Convent.)	-	Abandoned-Other	-	-	-	-	-
12	1918302	-	-	Abandoned-Other	-	-	-	-	-
13	1918449	Boring	13.4	Observation Wells	Not Used	-	-	9.14	12.19
14	7207909	Rotary (Convent.)	12.2	Monitoring and Test Hole	Monitoring and Test Hole	7.01	-	9.14	12.19
15	7249557	-	-	Abandoned-Other	-	2.77	-	3.17	4.08
16	7263265	-	-	-	-	-	-	-	-
17	7265423	Rotary (Convent.)	12.7	Monitoring and Test Hole	Monitoring and Test Hole	-	-	9.14	12.19
18	7283297	-	-	-	-	-	-	-	-
19	7283419	Boring	10.7	Test Hole	Test Hole	-	-	7.60	10.60
20	7311922	-	-	-	-	-	-	-	-
21	7315925	Rotary (Convent.)	4.6	Test Hole	Test Hole	2.44	-	4.57	1.52
22	7315926	Rotary (Convent.)	4.6	Test Hole	Test Hole	2.44	-	4.57	1.52
23	7329150	Rotary (Convent.)	5.3	Monitoring and Test Hole	Monitoring and Test Hole	3.05	-	2.29	5.33
24	7338562	Auger	6.1	Observation Wells	Monitoring	-	-	3.05	6.10
25	7338563	Auger	4.6	Observation Wells	Monitoring	3.96	-	3.05	4.57
26	7360324	Auger	6.1	Observation Wells	Monitoring	-	-	3.10	6.10
27	7360328	Auger	6.1	Observation Wells	Monitoring	-	-	3.10	6.10

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

**metres below ground surface

Ontario Water Well Records									
WELL ID	MECP 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				
28	7360329	Auger	6.1	Observation Wells	Monitoring	-	-	3.10	6.10
29	7373080	Boring	7.6	Observation Wells	Monitoring	0.61	-	4.57	7.62
30	7373081	Boring	10.7	Observation Wells	Monitoring	-	-	4.57	7.62
31	7380670	-	-	Abandoned-Other	-	1.80	-	-	-
32	7380479	-	-	-	-	-	-	-	-
33	7380480	-	-	-	-	-	-	-	-
34	7380481	-	-	-	-	-	-	-	-

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

**metres below ground surface

APPENDIX ‘B’

RESULTS OF SINGLE WELL RESPONSE TEST

REFERENCE NO. 2204-W019

Falling Head Test (Slug Test)

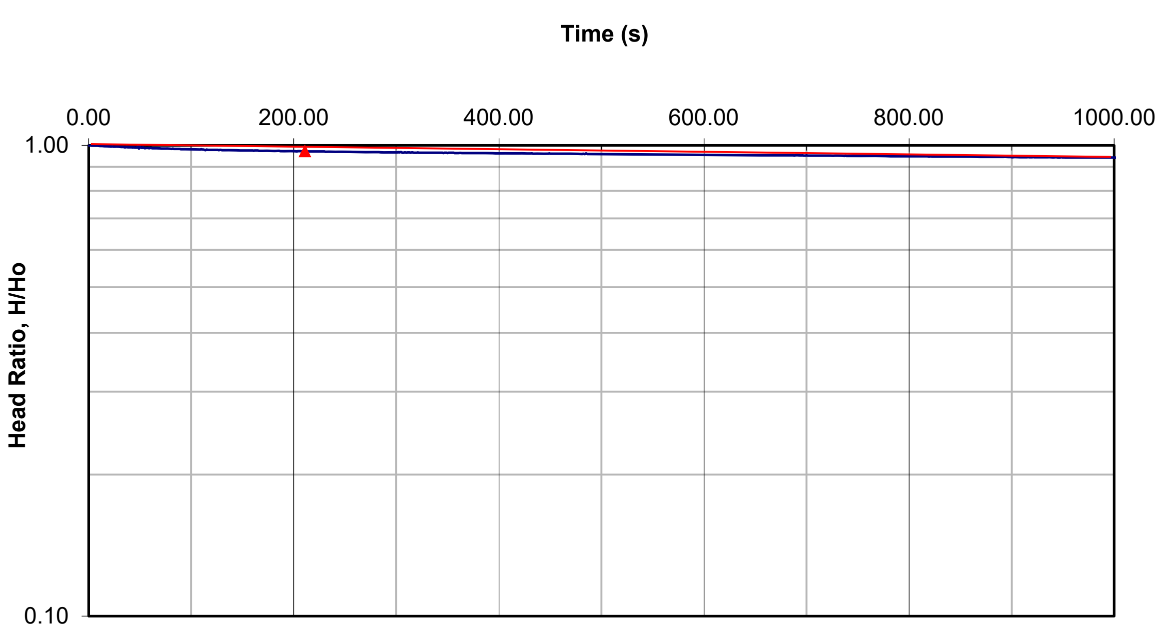
Test Date:		18-Jul-22	
Piezometer/Well No.:		BH/MW 1	
Ground level:		95.20	m
Screen top level:		85.93	m
Screen bottom level:		82.93	m
Test El. (at midpoint of screen):		84.43	m
Test depth (at midpoint of screen):		10.77	m
Screen length	L=	3.0	m
Diameter of undisturbed portion of aquifer	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.5796	m
Initial water depth		3.02	m
Aquifer material:		**Silty Clay Till/Silty Clay**	

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

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

ln (H1/H2) / (t2 - t1) = 0.00024228

K= **8.3E-06** cm/s
8.3E-08 m/s



Falling Head Test (Slug Test)

Test Date:		18-Jul-22	
Piezometer/Well No.:		BH/MW 2	
Ground level:		97.60	m
Screen top level:		88.34	m
Screen bottom level:		85.34	m
Test El. (at midpoint of screen):		86.84	m
Test depth (at midpoint of screen):		10.76	m
Screen length	L=	3.0	m
Diameter of undisturbed portion of aquifer	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.187	m
Initial water depth		9.84	m
Aquifer material:		**Silty Clay Till/Silty Clay**	

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

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

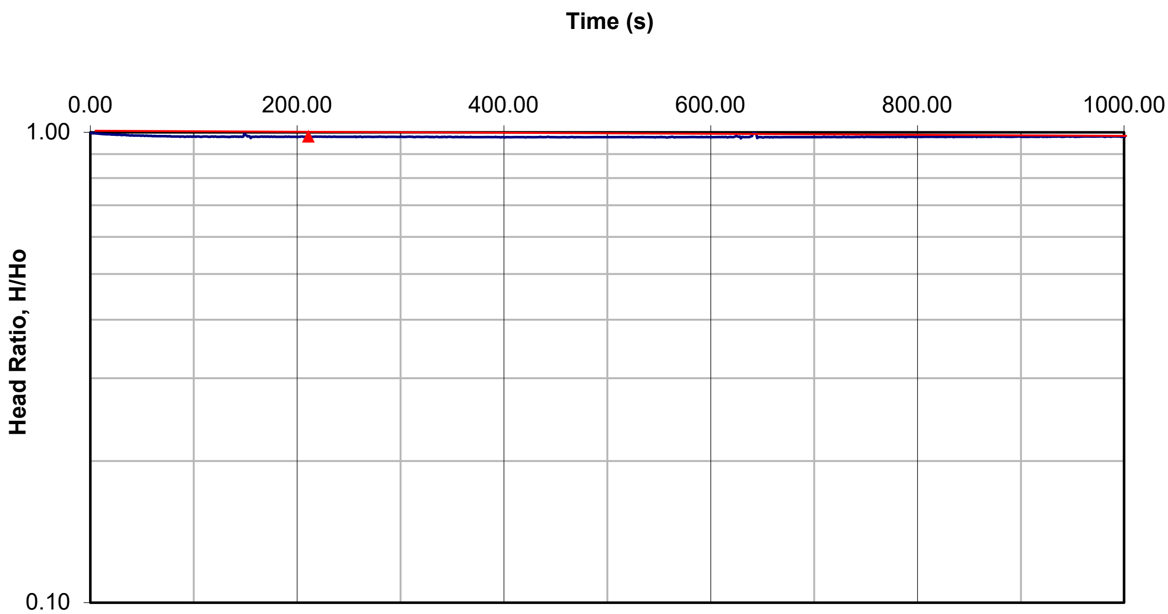
Permeability

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

(Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.00045174$$

K= **1.6E-05** cm/s
1.6E-07 m/s



Falling Head Test (Slug Test)

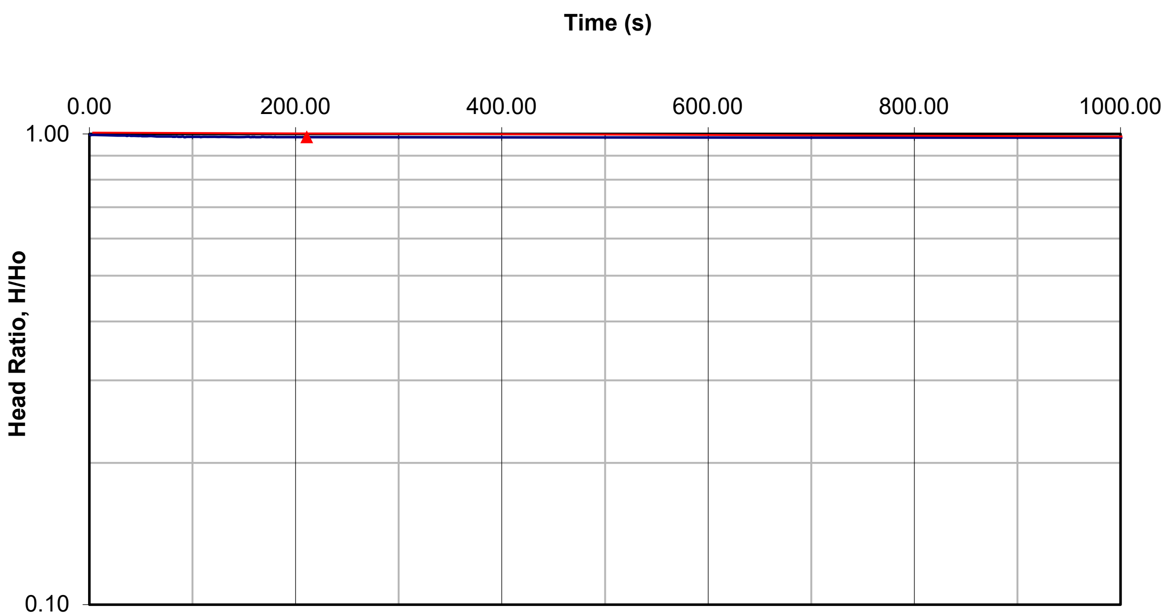
Test Date:		18-Jul-22	
Piezometer/Well No.:		BH/MW 4	
Ground level:		96.90	m
Screen top level:		87.67	m
Screen bottom level:		84.67	m
Test El. (at midpoint of screen):		86.17	m
Test depth (at midpoint of screen):		10.73	m
Screen length	L=	3.0	m
Diameter of undisturbed portion of aquifer	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.5019	m
Initial water depth		9	m
Aquifer material:		**Silty clay till/Silty clay**	

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

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

ln (H1/H2) / (t2 - t1) = 0.00023981

K= **8.3E-06** cm/s
8.3E-08 m/s



Falling Head Test (Slug Test)

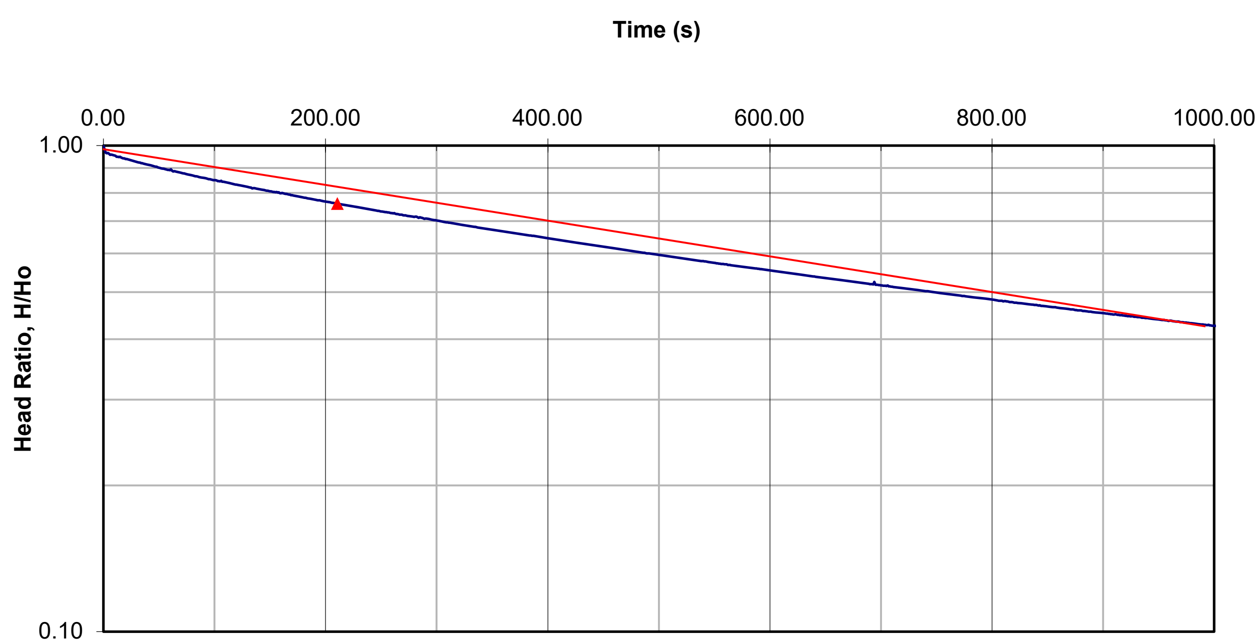
Test Date:		18-Jul-22	
Piezometer/Well No.:		BH/MW 5	
Ground level:		93.70	m
Screen top level:		84.44	m
Screen bottom level:		81.44	m
Test El. (at midpoint of screen):		82.94	m
Test depth (at midpoint of screen):		10.76	m
Screen length	L=	3.0	m
Diameter of undisturbed portion of aquifer	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.5547	m
Initial water depth		1.61	m
Aquifer material:		**Silty Clay**	

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

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

$\frac{\ln(H1/H2)}{(t2 - t1)}$ = 0.00163145

K= **5.6E-05** cm/s
5.6E-07 m/s



Falling Head Test (Slug Test)

Test Date:		18-Jul-22	
Piezometer/Well No.:		BH/MW 7	
Ground level:		93.10	m
Screen top level:		83.76	m
Screen bottom level:		80.76	m
Test El. (at midpoint of screen):		82.26	m
Test depth (at midpoint of screen):		10.84	m
Screen length	L=	3.0	m
Diameter of undisturbed portion of aquifer	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.5927	m
Initial water depth		0.9593	m
Aquifer material:		**Silty Clay**	

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

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

$\dfrac{\ln(H1/H2)}{(t2 - t1)}$ = 0.0010115

K= **3.5E-05** cm/s
3.5E-07 m/s