Hydrogeological Assessment

FINAL REPORT

Western Prestige Village

Project Name:
Proposed Apartment Complex
735 Southdale Road West
London, Ontario

Project Number:
KCH-00257251-A0

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Date Submitted:
April 25, 2022

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Executive Summary

EXP Services Inc. (EXP) was retained by **Western Prestige Village** to conduct a hydrogeological assessment relating to the proposed development of an apartment complex to be located at 735 Southdale Road West in London, Ontario, hereinafter referred to as the 'Site'.

The objective of the hydrogeological assessment was to examine the hydrogeological characteristics of the Site by reviewing the Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (WWR), reviewing the soils and groundwater information provided from a series of sampled boreholes and monitoring wells at the Site, compiling a site wide water balance, collecting a full year of groundwater elevations to identify any seasonal variations, and assess the natural heritage features on the property. It is understood that the hydrogeological assessment will be submitted for review and approval by the City of London and the Upper Thames River Conservation Authority (UTRCA).

Based on the results of the hydrogeological assessment, the following findings are presented:

- The Site is situated within the Dingman Creek sub-watershed;
- A Provincially Significant Wetland (PSW) as designated by the MECP is located at the southern border of the Site. Unevaluated Wetlands (UWs) are also present at the east and west side of the Site, as classified by the City of London in Natural Heritage Map 5. An area encompassing both the PSW and west UW is considered regulated lands of the UTRCA;
- An EIS Report completed by MTE consultants identified the PSW on the Site as part of the North Talbot Wetlands. The western UW is classified as a Mineral Meadow Marsh Ecosite Inclusion (MAM2) and the eastern UW is classified as a Submerged Shallow Aquatic Ecosite (SAS1);
- The Site is covered with a low-permeability silty clay till with occasional wet sand and silt pockets. The till unit thins out towards the west part of the Site. Underlying the till in this area is an extensive sand stratum. The sand stratum was found to be dry and is likely connected to a fluvial terrace extending west of the Site;
- Overall, groundwater elevations within the shallow till wells installed on Site (MW3, MW8B) ranged from seasonal lows of roughly 3.2 mbgs (November 2020) to seasonal highs of 0.5 mbgs (April 2020). The saturated conditions of the shallow soils will need to be considered for construction and design;
- The PSW shows surface water fluctuations with seasonal ponding up to 1m of water and dry surface conditions occurring throughout summer into fall, 2020;
- A total of two (2) domestic groundwater supply wells are located within a 500 m radius of the Site. These wells were installed into overburden sand aquifers encountered at depths of 39 m and 49 mbgs;
- The domestic water supply well for the original farmhouse will need to be properly decommissioned prior to development of the property;

- Single Well Response Tests (SWRT) were completed on three (3) of the monitoring wells. Three (3) grain size analyses were carried out on samples of the silty clay till. The average estimated hydraulic conductivity of the dominant silty clay till soils at the Site was 5.0×10^{-9} cm/s based on the test results;

- During construction, short term dewatering may be required where excavations extend into the shallow groundwater table. Based on the water levels and hydraulic conductivity of the shallow soils on Site, it is not expected that a dewatering permit from the MECP will be required;

- Surface drainage follows Site topography and generally drains towards the PSW and both UWs. Due to the low permeability surficial soils across the Site, the surface water ponds at these locations during periods of rainfall;

- The monitoring wells on Site have been maintained for ongoing study past the completion of this report. When the wells are no longer required, they should be decommissioned in accordance with O. Reg. 903;

- Water balance calculations are provided and indicate secondary infiltration opportunities will be required to provide appropriate infiltration volumes to the wetland feature in the post-development environment. The current stormwater management plans for the Site include routing clean rooftop runoff to the wetland feature which will assist in providing these necessary volumes;

- It is recommended that prior to construction, additional monitoring wells be installed to the depths of construction in order to confirm the dry sand conditions at the appropriate excavation depths.

Groundwater and surface water elevations were collected for 1 year from November 2019 to December 2020. Pre-consultation meetings were held with the UTRCA and City and the results of the scoped study requirements are included in the following report.

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1. Introduction

1.1 Background

EXP Services Inc. (EXP) was retained by **Western Prestige Village** to conduct a hydrogeological study and water balance assessment relating to the proposed development of an apartment building complex to be located at 735 Southdale Road West in London, Ontario, hereinafter referred to as the 'Site' (**Appendix A, Drawing 1**).

The objective of the hydrogeological study was to examine the hydrogeological characteristics of the Site by reviewing the Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (WWR), reviewing the soil and groundwater information provided from a series of sampled boreholes and monitoring wells at the Site, compiling a Site wide water balance, collecting a full year of groundwater elevations to identify any seasonal variations; and assess the natural heritage features on the property. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site and provides recommendations and design/construction measures, where applicable, to mitigate this potential for impact.

It is understood that the hydrogeological study and water balance assessment will be submitted for review and approval by the City of London and the Upper Thames River Conservation Authority (UTRCA) as part of the Draft Plan Approval for the proposed development. The study design and report have been compiled in accordance with the City of London Design Specification & Requirements Manual (2019) as well as the Conservation Authority Guidelines for Hydrogeological Assessments (2013).

A Provincially Significant Wetland (PSW) is located along the south boundary of the Site and primarily resides on the adjacent property to the south. Two (2) Unevaluated Wetlands (UW) are located at the east and west limits of the Site. Refer to **Drawing 2** for locations. These natural features have been assessed based on their impact to, and dependence on, groundwater resources on the Site.

The UTRCA administers a regulation made under Section 28 of the Conservation Authorities Act, known as Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (O.Reg. 157/06). The regulation was approved by the Minister of Natural Resources and Forestry on May 4, 2006. This regulation allows the UTRCA to ensure that proposed development and other activities have regard for natural hazard features. The UTRCA implements the regulation by issuing Section 28 permits for works in or near watercourses, valleys, wetlands, or shorelines, when required.

Property owners must obtain permission and/or a letter of clearance from the local Conservation Authority before beginning any development, site alteration, construction, or placement of fill within the regulated area. Permits are also required for any wetland interference, or for altering, straightening, diverting or interfering in any way with the existing channel of a creek, stream or river. It is EXP's understanding that the Site is subject to this regulation, and required a Section 28 permit, as the Site contains wetland features.

1.2 Development Plan and Stormwater Management Strategies

The development plan for the Site is currently proposed to include four (4) apartment buildings ranging in height from 9 to 12 storeys containing 560 units, with 656 parking spaces. Underground parking structures will accommodate 470 parking areas with the remainder above surface parking. The current development plan is included in **Appendix B**.

Stormwater management on Site will include catch basins directing impervious flows (surface parking area, rooftops, walkways, patios) offsite to an existing stormwater management (SWM) pond. Open space areas and green spaces will allow for infiltration into the subsurface soils on Site.

Low Impact Development (LID) strategies proposed for implementation include directing clean rooftop runoff from Building A towards the wetland feature. Additional runoff from landscaped areas surrounding Building A will also be directed towards the wetland to aid in achieving development infiltration targets.

1.3 Terms of Reference and Scope of Work

The hydrogeological assessment was generally completed in accordance with the scope of work outlined in EXP's Proposal 999-25001656-PP dated October 22, 2019. Authorization to proceed with this investigation was received from Mr. Farhad Noory, President of Royal Premier Homes, in an email dated November 12, 2019. In person consultation was held with the UTRCA at the Watershed Conservation Centre on January 24, 2020. Comments received from the UTRCA Hydrogeologist, Linda Nicks, included a request for an additional monitoring station within the UW in the southwest of the Site to monitor surface water and shallow groundwater interaction within this feature. This additional monitoring station was installed and is labelled Station 3 on **Drawing 2**.

The purpose of the assessment was to examine the subsoil and groundwater conditions at the Site by advancing a series of boreholes at the locations chosen by EXP and illustrated on the attached Borehole Location Plan (**Drawing 2**). Subsoil and groundwater information from the Geotechnical Investigation prepared by EXP in December 2019 was used to assist in the preparation of this report.

The scope of work for the Hydrogeological Assessment consisted of the following tasks:

1. <u>Desktop Study</u>: This task consisted of a review of existing information including Site plans, previous reports, geological maps, geological cross sections, groundwater level information, borehole logs, and MECP WWR.

   EXP completed a Preliminary Geotechnical Investigation at the Site (EXP, 2019) in conjunction with this investigation as well as a Hydrogeological Assessment of the neighbouring property to the south (EXP, 2020), owned by Southside Construction and called Toppings Lands or Talbot Village Phase 7. Relevant details from these investigations are provided in this report, where applicable. In addition, EXP has completed several Geotechnical Investigations and Hydrogeological Assessments for the surrounding properties and relevant details from those studies have been incorporated, where appropriate.

2. <u>Field Program</u>: Drilling of ten (10) boreholes was carried out as part of the field program in collaboration with the Geotechnical Investigation, with monitoring wells installed in three (3) of the boreholes (BH3/MW, BH7/MW, and BH8/MW). One (1) additional 'nested' monitoring well was installed adjacent to the PSW (BH8/MW – A/B). In addition, a total of three (3) surface water monitoring stations were installed within wetland features on Site. Water levels were measured, groundwater samples were collected, and single well response tests (SWRT) were completed for the purposes of characterizing the hydrogeological conditions at

the Site. Water levels were collected from the monitoring wells and wetlands for a period of 14 months (November 2019 to December 2020) to identify seasonal fluctuations in the groundwater elevations and the hydroperiod of the wetlands.

3. Data Evaluation: Evaluation of the available field and laboratory data, assessment of the dewatering requirements and potential dewatering effects on the surrounding environment, as applicable.

4. Water Balance: Preparation of a water balance assessment of the subject Site evaluating pre- and post-development conditions will be completed in the final report, once a development plan has been finalized.

5. Reporting: This task consisted of preparing this hydrogeological assessment report. In preparing this report, EXP has considered the guidance material available in the Conservation Ontario Guidelines for Hydrogeological Assessments (Conservation Ontario, 2013) and City of London Design Specification & Requirements Manual (2019).

Reference is made to **Appendix J** of this report, which contains further information necessary for the proper interpretation and use of this report.

2. Methodology

Prior to conducting the field work, it was not anticipated that significant amounts of shallow, near surface groundwater would be present at the Site. EXP has had a great deal of experience with the soil and shallow groundwater in the area of the Site, having carried out several hydrogeological and geotechnical investigations and providing inspection and testing services for much of the nearby residential developments in the area.

However, based on that experience, it was anticipated that discontinuous sand and silt lenses may be present within the till soils, and that those pockets may contain shallow groundwater which has infiltrated through weathered zones in the near-surface soils. Given that much of the servicing and potential underground parking depths at the Site are expected to be at conventional depths (some 2 to 5 m below final grades), it was determined that where wet sand and silt seams were encountered, it would be reasonable to install shallow wells to characterize any shallow groundwater which may be present. Additional wells were installed at greater depths within the aquitard layers to assist in developing a conceptual model for the groundwater flow system at the Site.

The monitoring wells were also installed for the purpose of providing insight on potential impacts of development on local natural heritage features and how groundwater conditions may impact the progress of construction activities such as excavations for basement construction and site servicing.

2.1 Borehole Drilling and Monitoring Well Installations

The borehole drilling program for the Site was completed in conjunction with the Geotechnical Investigation. The drilling program included completion of ten (10) boreholes across the Site with installation of monitoring wells in three (3) boreholes (BH3/MW, BH7/MW, and BH8/MW), with one (1) additional 'nested' well adjacent to the Provincially Significant Wetland (PSW), to allow for hydrogeological evaluation (BH8/MW – A/B). Borehole drilling and monitoring well installation was completed from November 21st to November 23rd, 2019 under the technical supervision of EXP. The location and depth of the boreholes was based on the proposed development plan which was provided to EXP and locations of significant natural features. Boreholes were advanced to depths ranging from 3.5 and 11.1 m below grade.

The boreholes were completed using a track-mounted drill rig and standard 21 cm (8") OD hollow stem auger drilling techniques with split spoon sampling. During the drilling, the stratigraphy in the boreholes was examined and logged in the field by EXP technical personnel. Representative samples of the soils found in the boreholes were submitted for laboratory testing that included moisture content and gradation. Copies of the field borehole logs are provided in **Appendix C**. Copies of the soil gradation analyses are included in **Appendix D**. Monitoring well data and a gradation analysis completed as part of the Hydrogeological Assessment on the neighbouring property to the south (EXP, 2020) have also been included in **Appendices C** and **D**.

Four (4) groundwater monitoring wells were installed within the clayey silt till. All wells were constructed from 5.1 cm (2") diameter, schedule 40, polyvinyl chloride (PVC), flush-threaded casing. The appropriate number of risers were coupled with screen sections via threaded joints to construct the well. The well screens consisted of PVC pipe with 0.010-inch factory-generated slots. A summary of the well installation details is provided in **Table 1**, with the well locations shown in **Drawing 2**. In addition to the four (4) monitoring wells installed on the Site, **Table 1** also includes the five (5) monitoring wells installed within the property immediately to the south, owned by Southside Construction, called Topping Lands or Talbot Village Phase 7.

A primary filter pack consisting of Silica Sand was placed around the well screen in the borehole and extended above the top of the well screen. Hole Plug, a swelling Bentonite clay that forms an effective barrier to the vertical movement of fluids when installed in a borehole, was used as a seal above the filter pack.

Table 1 – Monitoring Well Construction Details

Well ID	Ground Surface Elevation (m AMSL)	Top of Standpipe Elevation (m AMSL)	Completion Depth (m bgs)	Screen Length (m)	Screened Strata
BH3/MW	281.85	282.64	3.05	1.52	Silty Clay Till
BH7/MW	277.96	278.83	9.14	3.05	Silty Clay Till
BH8/MW-A	278.15	279.09	7.62	1.52	Silty Clay Till
BH8/MW-B	277.88	279.06	4.88	1.52	Silty Clay Till
BH2/MW (EXP, 2020)*	*274.51*	*275.27*	*12.19*	*1.52*	*Sandy Silt*
BH6/MW (EXP, 2020)*	*277.29*	*277.99*	*8.38*	*1.52*	*Silty Clay Till/Sand and Gravel*
BH7/MW (EXP, 2020)*	*274.81*	*275.47*	*9.75*	*1.52*	*Silt*
BH9/MW (EXP, 2020)*	*279.19*	*280.25*	*15.24*	*3.05*	*Sand*
BH11/MW (EXP, 2020)*	*277.82*	*278.70*	*15.24*	*3.05*	*Sand*

Notes: 1. m AMSL denotes metres above mean sea level.
2. m bgs denotes metres below ground surface.
* Indicates monitoring wells installed within the property immediately to the south, Southside Construction Talbot Village Phase 7.

2.2 Piezometer and Staff Gauge Installation

A total of two (2) shallow groundwater piezometers and two (2) staff gauges were installed on December 13, 2019 in the PSW and eastern Unevaluated Wetland (UW) area of the Site where surface water was present (Station 1 and Station 2). Following consultation with the Upper Thames River Conservation Authority, an additional shallow groundwater piezometer was installed in the UW at the west end of the Site on February 17, 2020 (Station 3). The locations are shown on **Drawing 2**. The following **Table 2** outlines the piezometer construction details.

The piezometers were installed with a 6-inch Solinst drive point end (6-inch screen length). The Solinst drive point piezometer ends have a stainless steel, 50 mesh cylindrical filter screen, within a ¾" (20mm) stainless steel drive-point body.

Staff gauges were installed at Stations 1 and 2 within the surface water body in order to capture monthly surface water elevations. These staff gauges are referred to as SG1 (Station 1) and SG2 (Station 2).

Table 2 – Surface Water Station Details

Station ID	Piezometer ID	Ground Surface Elevation (m AMSL)	Top of Piezometer Elevation (m AMSL)	Completion Depth (m bgs)	Screen Length (m)	Screened Strata	Staff Gauge Installed
Station 1	**P-1**	277.51	279.29	1.08	0.15	Silty Clay Till	Yes (SG1)
Station 2	**P-2**	273.35	274.58	1.20	0.15	Silty Clay Till	Yes (SG2)
Station 3	**P-3**	278.73	279.69	1.24	0.15	Silty Clay Till	No

Notes: 1. m AMSL denotes metres above mean sea level.
2. m bgs denotes metres below ground surface.

2.3 Well Development and Groundwater Sampling

Monitoring wells were developed after installation. The wells were developed to:

- remove fine soil particles adjacent to the well screen that may otherwise interfere with water quality analyses;
- restore the groundwater properties that may have been disturbed during the drilling process;
- improve the hydraulic communication between the well and the geologic materials; and,
- remove water, if any, added during the drilling process.

Wells were generally developed by removing a minimum of ten times the volume of water contained in the well casing (casing volume) where possible using rigid high-density polyethylene (HDPE) tubing fitted with Waterra™ inertial pumps.

After appropriate well development, groundwater samples were collected for analysis of groundwater quality. Samples were collected from monitoring wells on February 17th and April 27th, 2020 to establish baseline water quality.

Prior to collecting groundwater samples for chemical analysis during each sampling event, the stagnant water in the well was purged to allow groundwater representative of the aquifer to enter the well. A minimum of three casing volumes of water was removed ("purged") from each well immediately prior to sampling.

Monitoring wells were purged using either a peristaltic pump or rigid high-density polyethylene (HDPE) tubing fitted with Waterra™ inertial pumps that are dedicated to each monitoring well. Water samples were collected by direct transfer of groundwater from the Waterra™ pumping system to appropriate pre-labelled containers, with filtering and preservation as appropriate, before submission to Bureau Veritas Laboratories in London, ON for chemical analysis. The samples were submitted for laboratory analysis of dissolved metals, cations and anions, nitrogen species (nitrate, nitrite, and ammonia), phosphate and chloride.

2.4 Surface Water Sampling

Surface water sampling has occurred at Station 1 and Station 2 in order to establish baseline surface water quality. Surface water samples were collected on two (2) occasions on February 17th and April 27th, 2020. The samples were submitted for laboratory analysis of total and dissolved metals, cations and anions, nitrogen species (nitrate, nitrite, and ammonia), phosphate and chloride.

2.5 Long-Term Groundwater Elevation Monitoring

Water level monitoring in all monitoring wells and piezometers installed on Site was completed on a monthly basis since installation. Measurements are manually collected using a battery-signal water level tape.

Water level dataloggers were installed in monitoring wells BH7/MW, BH8/MW-A and BH8/MW-B, as well as in piezometers P-1 and P-2 to assist in the evaluation of groundwater elevations and influence of precipitation on groundwater levels. An additional logger was placed at surface and used for barometric compensation. The water level dataloggers were installed on December 13, 2019 and remained in place for continued monitoring for a total monitoring period of 12 months. Water level measurements were logged every 24 hours.

2.6 Hydraulic Conductivity Testing

Hydraulic conductivity estimates for the soils were determined using two methods. The first method is applicable to saturated soils at depth and involves single well recovery tests (SWRT) within the installed monitoring wells.

The second method involves a calculated estimation of hydraulic conductivity based on soil sample particle size analysis using the Puckett method. The two methods used for this study area are described in the following subsections.

2.6.1 Single Well Response Tests (SWRTs)

Single well response tests (SWRTs) were completed on BH7/MW, BH8/MW-A and BH8/MW-B to evaluate the hydraulic characteristics of the screened overburden. The test method consisted of an initial purging of the well and subsequently monitoring the rise in the water level in the well over time.

The mathematical solution by Hvorslev (1951) was used to interpret the data and involved matching a straight-line solution to water-level displacement data collected during the recovery test. The time required for the water level in the well to reach 37% of the initial change (T_o) is determined from the plot, and used in the following equation to estimate the hydraulic conductivity (K);

$$\mathbf{K\ (m/s) = [r^2 \ln(L/R)] / [2\ L\ T_o]}$$

where: r is the radius of the well casing;
R is the radius of the well screen; and,
L is the length of the well screen.

2.6.2 Grain Size Analyses

A total of three (3) soil samples were selected for grain size distribution analysis testing. Due to the nature of the Site soils, estimated hydraulic conductivity (K) values were determined using the methodology derived by Puckett et al. The Puckett method of correlating the grain size distribution analysis to the soil hydraulic conductivity is based on the following relationship:

$$\mathbf{K\ (cm/s) = 4.36\ (10^{-5})\ e^{[-0.1975\ (\%\ clay)]}}$$

3. Site Description and Geologic Setting

3.1 Site Location and Description

The Site is located south of Southdale Road West, west of Bostwick Road and east of Colonel Talbot Road. The municipal address is 735 Southdale Road in London Ontario. The Site is triangular in shape and approximately 3.85 ha in size (**Drawing 1**). The Site is generally bounded by residential development to the north and west and agricultural land to the south and east.

A Provincially Significant Wetland (PSW) is located on the southern edge of the Site (**Drawing 2**) which is primarily within the adjacent property to the south. The part of the wetland that borders the Site contains mature trees and shrubs. Two (2) Unevaluated Wetlands (UW) are located at the east and west side of the Site, as shown on **Drawing 2**. A small, wooded area is located on the west side of the Site and along the south adjacent to the PSW. The Site contains a residential house and barn.

The development plan for the Site is currently proposed to include four (4) apartment buildings ranging in height from 9 to 12 storeys containing 560 units, with 656 parking spaces. Underground parking structures will accommodate 470 parking areas with the remainder above surface parking. The Site will be serviced with municipal water and sewer services set at conventional depths. The proposed development plan is included in **Appendix B**.

3.2 Topography and Drainage

The existing topography at the Site is generally sloped towards the southeast with the eastern section draining east towards an UW and the western section draining south towards a PSW. The Site ground elevations range between 282 and 274 metres (m).

Drainage from the Site is primarily through surface infiltration and overland flow. Runoff generally follows topography. The Ministry of Agriculture, Food and Rural Affairs (OMAFRA) mapping used in **Drawing 3** does not have drainage information for the Site but suggests the agricultural fields of surrounding properties to be randomly tile drained. The OMAFRA drainage mapping further supports this, as no municipal drains are noted in the area.

Ponding of water was noted in the low-lying area near the east side of the Site, designated as the Unevaluated Wetland (UW) mapped in the City of London’s Natural Heritage Map 5. The ponded water is generally responsive to rainfall events, as evidenced through site observations throughout the seasons. This eastern UW is also fed from surface flows originating from the pond north of Southdale Road, through a culvert.

Ponding of water has also been observed within the PSW on the south edge of the Site.

The Site is located in the subwatershed of Dingman Creek. The majority of the west half of the Site surrounding the PSW is regulated by the Upper Thames River Conservation Authority (UTRCA) as shown on **Drawing 4**.

3.3 Wetlands and Ecology

The ecology of the Site has been studied by MTE Consultants (MTE), and a detailed study is completed under separate cover. The Ecological Land Classification (ELC) as completed by MTE, defines the PSW on Site as part of the North Talbot Wetlands. The western Unevaluated Wetland (UW) is classified as a Mineral Meadow Marsh Ecosite inclusion (MAM2), and the eastern UW is classified as a Submerged Shallow Aquatic Ecosite (SAS1).

3.4 Site Geology

3.4.1 Bedrock Geology

The Site is underlain by limestone, dolostone and shale of the Dundee Formation (OGS, 2011). This formation consists of 60 to 160 feet (18 to 49 m) of light brown, medium-grained with some minor chert (Hewitt, 1972), and is part of the Algonquin Arch, which forms a ridge along the southwestern Ontario peninsula between the Michigan Basin (to the northwest) and the Appalachian Basin (to the southwest). Bedrock is generally not exposed in the area.

Review of bedrock topography mapping (**Drawing 5**; OGS, 1978) indicates the bedrock surface at an elevation in the range of 198 to 206 m at the Site. The bedrock surface generally slopes to the south or southwest in this area. Review of MECP Well records for the area (**Appendix F**) indicates that there are no wells within 500 m of the Site that were drilled to bedrock. Bedrock was not encountered during the drilling program completed as part of this investigation.

3.4.2 Overburden Geology

The physiography of Southwestern Ontario was altered significantly by the glacial and interglacial periods that took place throughout the Quaternary period. The overburden deposits which are present in the study area were formed by numerous glacial events during the late Wisconsinan glacial stage approximately 10,000 to 23,000 years before present. There were two distinct glacial lobes present in Southwestern Ontario during this period. The Huron Lobe advanced from Lake Huron southwards, and the Erie Lobe advanced from the northeast, receding to the east.

During the advancement of the glacial ice sheets, bedrock and unconsolidated sediments were eroded. During the recession of the glaciers, the eroded materials were deposited in lakes, rivers and along spillways, contributing to the present configuration of moraines, abandoned spillways, drumlins, eskers, abandoned shorelines, and various still-water sediment deposits.

Deposits in the area can be contributed to the Port Bruce Stadial period. In the London area, a series of east-west recessional and end moraines were formed, along with the Port Stanley Till Plain. Deposition of the basal portion of the Port Stanley Till was formed during the initial advance of the Erie Lobe. Overlying till was deposited during subsequent cycles of advance and retreat, resulting in silt and sand layering within the till plain.

The surficial deposits were mapped and categorized into a number of physiographic regions by Chapman and Putnam (1984). The Site is part of the physiographic region known as the Mount Elgin Ridges (**Drawing 6**). The Site is located on the Ingersoll Till Moraine (**Drawing 7**).

Quaternary mapping completed by Barnett et. al. (1981) indicates that the quaternary geology at the Site consists of glaciofluvial outwash deposits: gravel and sand including proglacial river and deltaic deposits (**Drawing 8**).

Surficial geology has also been described by Ontario Geological Survey MRD128 (OGS, 2010) as being glaciolacustrine deposits consisting of clay to silt-textured till (Ingersoll Till Moraine) across the entire Site. A fluvial terrace is mapped to be present west of the Site (**Drawing 9**).

3.4.3 Site Specific Surficial Geology

In conjunction with the Preliminary Geotechnical Investigation for the Site (EXP, 2019), ten (10) boreholes were completed by EXP, with installation of monitoring wells in three (3) boreholes, with one (1) additional 'nested' well adjacent to the Provincially Significant Wetland (PSW), to allow for hydrogeological evaluation. The locations of the boreholes are provided in **Drawing 2**. The boreholes were terminated at a maximum depth of between 3.5 and 11.1 m below existing grade. Borehole logs are provided in **Appendix C**.

Generalized stratigraphic cross sections through the Site, as shown in **Drawing 10**, are provided as **Drawings 11** and **12**. The cross sections include wells from EXP's Hydrogeological Assessment of the neighbouring property to the south (EXP, 2020) and Ministry of Environment, Conservation and Parks (MECP) Water Well Records (WWR), and generally shows a low permeability clayey silt/silty clay till layer overlying the Site, with fill noted at surface of some boreholes. Permeable sand and silt layering is noted within the till layer and an extensive sand unit is noted beneath the till at the west end of the Site. The detailed stratigraphy encountered in the boreholes is summarized below.

Generally, the Site is overlain by a layer of topsoil. Fill material was encountered beneath the topsoil at Boreholes BH7/MW and BH10, extended to depths of 2.0 to 3.3 m bgs and consisted of loose clayey silt with some sand and some topsoil inclusions. All other boreholes encountered clayey silt till or clayey silt beneath the topsoil. Sandy silt till was encountered under the clayey silt till in Borehole BH3/MW. Beneath the till, sand was encountered in Boreholes BH1 and BH3/MW. A sand and gravel lens within the till was noted in Borehole BH4. Review of MECP Well Records for the area suggests that an extensive sand to sand and gravel stratum is located below the clayey silt till at elevations ranging between 253 m and 272 m. The layer was noted as dry in the upper levels, with static water levels at approximate depths of 234 m to 236 m.

A total of three (3) grain size analyses were completed from samples collected during drilling at various locations across the Site. The grain size results, and the results of gradations carried out on samples collected from the neighbouring property to the south (EXP, 2020) are discussed in Section 4.5 *Hydraulic Conductivity*. Laboratory results and graphs are provided in **Appendix D**.

4. Hydrogeologic Setting

In addition to the groundwater information collected from the monitoring wells installed at the Site, the following documents were reviewed to gain an understanding of the hydrogeological conditions in the area:

- Dillon Consulting Limited and Golder Associates Ltd. Middlesex-Elgin Groundwater Study, Final Report, submitted to Middlesex and Elgin Counties, dated July 2004, henceforth referred to as the Middlesex-Elgin Groundwater Study;
- Goff, K and D.R. Brown, 1981. Ground-Water Resources – Summary. Thames River Basin Water Management Study Technical Report. Ontario Ministry of the Environment, Water Resources Report 14;
- Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August; and,
- MECP Water Well Records (WWR) within 500 m of the perimeter of the Site.

4.1 Regional Aquifer

Goff and Brown (1981) described the potential for four regional aquifers in the study area; shallow unconfined overburden aquifer, intermediate and deep confined aquifers and a bedrock aquifer.

4.1.1 Overburden Aquifers

The uppermost shallow and unconfined overburden aquifer was described as consisting of lacustrine or glacio-fluvial sands that may, in some locations, be overlain by lower permeability silts and clays. Regionally, the shallow aquifer is generally associated with the Caradoc Sand Plain and glacial deposits and are typically less than 15 m in thickness. Shallow overburden aquifers are discontinuous in nature and are expected to be linked more directly to precipitation and recharge compared to the intermediate and deep overburden aquifers.

Intermediate depth (15 to 30 m below ground surface (bgs)) and deep overburden (>30 m bgs) aquifers generally consist of saturated sand and gravel deposits in the overburden and are very discontinuous in nature due to the heterogeneous nature of glacial deposits. Sand and gravel layers are present in the Port Stanley and Catfish Creek glacial till sheets. The intermediate depth and deep overburden aquifers are generally confined by overlying silt, clay and glacial till deposits which limit vertical migration of shallow groundwater.

Locally, shallow groundwater flow is expected to follow the local topography, and generally drain towards Dingman Creek, to the southwest of the Site. On a regional scale, the deep overburden aquifer flow direction is reported to be towards the south-southwest (Dillon and Golder, 2004).

Based on the well record information reviewed for this investigation (discussed below), the occurrence of shallow overburden water supply wells in the immediate vicinity of the Site is low.

4.1.2 Bedrock Aquifer

The bedrock aquifer is contained within limestone of the Dundee Formation. The water quality is generally good with elevated levels of iron, sodium and chloride in some wells. As with the intermediate and deep overburden aquifers, the bedrock aquifer is confined by the overlying till material, which generally ranges in thickness up to 17 m in the vicinity of the Site. Wells extending into the shallow fractured bedrock (up to about 3 m) are typically considered to be hydraulically connected to the overlying sand and gravel deposits that are present at the bedrock-overburden interface.

Flow direction in the deeper confined aquifer(s) and regional groundwater system has not been assessed as part of this investigation. However, as part of the Middlesex-Elgin Groundwater Study (Dillon and Golder, 2004), groundwater flow within the deeper aquifer is generally in a south-southwest direction towards Lake Erie.

4.2 MECP Water Well Records

A search of the Ontario Ministry of Environment, Conservation and Parks (MECP) Water Well Records (WWR) database resulted in the identification of nine (9) records for an area within approximately 500 m of the Site boundary. Identified wells are generally situated to the south of the Site (**Drawing 13**), with no well records found within 500 m of the Site to the north.

Water uses in the area include the following:

- domestic water supply (2 wells);
- monitoring or test holes (6 wells); and
- 1 abandoned well.

The approximate locations of identified wells are shown on **Drawing 13**, with the MECP WWR Summary provided in **Appendix F**.

Domestic water supply in the local area wells are drawing from the confined deep sand/sand and gravel aquifer, with static water levels ranging between 35 m and 43 m bgs. The one (1) domestic water supply well listed as being on the Site is for the original farmhouse and will be decommissioned during development of the property.

The monitoring/test holes range in depth between 6.1 m and 15.2 m and typically are terminated in the surficial glacial till deposit.

4.3 Well Survey

Municipal services are available along Southdale Road and in the residential subdivisions north, south and west of the Site. Based on the results obtained during the MECP WWR database search, there is a low likelihood for shallow wells to be presently used or to be impacted by construction activities at the Site. Therefore, a door to door well survey was not completed by EXP.

4.4 Site Specific Groundwater Elevations

4.4.1 Monitoring Well Hydrographs

Manual water levels in the monitoring wells have been collected monthly since November 2019. Details of the monthly water levels are summarized in **Appendix G**. Overall, groundwater elevations within the shallow till wells installed on Site (MW3, MW8B) ranged from seasonal lows of roughly 3.2 mbgs (November 2020) to seasonal highs of 0.5 mbgs (April 2020). Wells installed deeper in the till (MW7, MW8A) ranged from seasonal lows of roughly 5.6 mbgs (November 2020) to seasonal highs of 0.93 mbgs (March 2020).

Dataloggers were installed in three (3) selected monitoring wells (monitoring wells BH7/MW, BH8/MW-A and BH8/MW-B) to provide continuous groundwater elevation monitoring. Results are presented in **Appendix G**. Manual measurements generally correlate well with datalogger results, indicating reliable results.

The hydrographs from monitoring wells BH7/MW, BH8/MW-A and BH8/MW-B, which are each screened across the shallow glacial till, do not indicate a notable response to rain events. The groundwater sampling events on February 17th and April 27th, 2020 were captured in the graphs and illustrate the low permeability of the screened stratum, with some of the wells requiring months to recharge to static levels.

Monitoring well BH7/MW recovered the fastest of the wells with dataloggers following the sampling events, taking approximately one week for groundwater to return to static levels. Groundwater elevations in this well increased from logger installation in December 2019 to mid January 2020, and then remained fairly consistent until June 2020, apart from the large decreases following groundwater sampling events. Beginning in June 2020 a decreasing trend is noted through the summer months, eventually levelling off through September and early November. Beginning in the middle of November 2020 an increasing trend is noted in this well. The groundwater temperature remained consistent throughout the monitoring period in this well.

Monitoring well BH8/MW-A had the slowest recovery following the SWRT and sampling event on April 27, 2020, taking nearly two months to return to static levels. The sampling event in February 2020 produced a much less significant response in this well. This monitoring well showed an increasing trend from datalogger installation in December 2019 until the SWRT and sampling event in April 2020. Following the April 2020 event water levels steadily increased again until June 2020. Beginning in July 2020 a decreasing trend is noted at this well, continuing until early December 2020 when groundwater elevations began to increase again. The groundwater temperature in this well also remained consistent throughout the monitoring period.

Monitoring well BH8/MW-B took approximately two weeks to recover from the February 2020 sampling event and approximately one month to recover from the April 2020 SWRT and sampling event. This well showed a similar pattern to BH8/MW-A, showing increasing groundwater elevations from December 2020 until March 2020 when they began to level off until the April 2020 monitoring event. Following the April 2020 event groundwater elevations increased steadily until early June 2020 when they then began to decrease. This decrease in groundwater elevations continued until late November 2020, at which point groundwater elevations again began to increase. The temperature in this well showed the most variation of the three monitoring wells with dataloggers, showing a decrease from datalogger installation in December 2019 to May 2020, at which point the temperature began a slow increase until December 2020.

4.4.1 Surface Water Station Hydrographs

Dataloggers were installed in the piezometer (P-1) as well as surface water staff gauge (SG1) at Station 1, located within the PSW. The piezometer was installed into the underlying silty clay soils, adjacent to the surface water body. The hydrograph of Station 1 is located in **Appendix G**. From the point of installation of P-1, it took approximately 2 weeks for the water level to reach static levels within the piezometer. The winter rainstorm on January 11, 2020 is seen on the hydrograph and both the surface water and shallow groundwater elevations rose approximately 20-30 cm due to this weather event. The datalogger and manual measurements show the surface water readings are consistently higher than the piezometer readings, indicating downward recharging conditions.

The datalogger installed at SG1 no longer collected reliable information after the July 2020 monitoring event, which was also followed by dry surface conditions within the PSW from August to November 2020. The datalogger installed in P-1 was noted as stolen during the field visit in October 2020.

The Station 2 hydrograph includes datalogger information from piezometer P-2 as well as manual water levels collected from P-2 and from staff gauge SG2. The hydrograph is included in **Appendix G**. The water levels collected in piezometer P-2 and SG2 show similar patterns throughout the monitoring period with the surface water readings showing consistently higher elevations compared to the piezometer readings. This water body was frozen over for most of the winter and receives runoff from Southdale Road as well as from the pond to the north of the road, through a culvert. The groundwater elevation in P-2 showed some variation at the beginning of the monitoring period but remained consistent throughout the monitoring period. The groundwater temperature in this piezometer has fluctuated throughout the monitoring period with a general increasing trend from March 2020 to late July 2020, and then a decreasing trend form July 2020 to December 2020.

4.5 Groundwater Flow and Hydraulic Gradients

Shallow groundwater flow across the Site is affected by hydraulic conductivity, topography, drainage, and geology. A groundwater elevation map was created based on groundwater measurements collected from monitoring wells on May 23, 2020. Based on the shallow groundwater elevations collected from monitoring wells across the Site, combined with groundwater elevation information from the site to the south (EXP, 2020), it is determined that groundwater is generally flowing in a southeasterly direction. Groundwater elevations and flow direction is presented in **Drawing 14**.

The nested groundwater wells, BH8/MW-A and BH8/MW-B, were both installed in the till and the measurements collected from both locations allow us to identify the hydraulic gradient within the till. The following table presents the groundwater elevations collected from both wells during the monitoring period thus far.

Table 3 – Hydraulic Gradient

	Completion Depth (m AMSL)	Groundwater Elevation (m AMSL)											
		Jan 28/20	Feb 17/20	Mar 14/20	Apr 27/20	May 23/20	Jun 10/20	Jul 11/20	Aug 26/20	Sep 17/20	Oct 28/20	Nov 14/20	Dec 17/20
BH8/MW-A (Deep)	270.53	271.58	272.30	273.14	274.15	271.93	273.99	273.79	273.51	273.31	272.82	272.54	2272.86
BH8/MW-B (Shallow)	273.08	276.04	276.87	277.22	277.38	277.00	277.22	276.83	276.03	275.78	275.06	274.61	276.43
Hydraulic Gradient		Down	Down	Down	Down	Down	Down	Down	Down	Down	Down	Down	Down

Notes: 1. m AMSL denotes metres above mean sea level.

The groundwater elevations collected in the nested well set indicate that the hydraulic gradient is consistently downwards during each of the monitoring events, due to the shallow well having higher groundwater elevations than the deeper well.

4.6 Hydraulic Conductivity

Single Well Recovery Tests (SWRT) were carried out on monitoring wells BH7/MW, BH8/MW-A and BH8/MW-B with results shown graphically in **Appendix E**. The mathematical solution by Hvorslev (1951) was used to interpret the SWRT data and involved matching a straight-line solution to water-level displacement data collected during the recovery test. The time required for the water level in the well to reach 37% of the initial change (T_o) is determined from the plot, and used in the following equation to estimate the hydraulic conductivity (K);

$$\mathbf{K\ (m/s) = [r^2 \ln(L/R)] / [2\ L\ T_o]}$$

where: r is the radius of the well casing;
R is the radius of the well screen; and,
L is the length of the well screen.

The results from the SWRT of BH7/MW and BH8/MW-B indicate the estimated hydraulic conductivity of the silty clay till ranges from approximately 1.7×10^{-9} m/s to 4.5×10^{-10} m/s respectively (**Table 4**). Monitoring well BH8/MW-A took over two months to recover fully following the SWRT. These results are within the estimated range of hydraulic conductivity values reported by Freeze and Cherry (1979) for similar soils.

Grain size analyses were carried out on select soil samples collected from the boreholes, with results summarized in **Table 4**, and shown graphically in **Appendix D**.

A total of three (3) soil samples from Site were selected for grain size distribution analysis testing. Due to the nature of the Site soils, estimated hydraulic conductivity (K) values were determined using the methodology derived by Puckett et al. The Puckett method of correlating the grain size distribution analysis to the soil hydraulic conductivity is based on the following relationship:

$$\mathbf{K\ (cm/s) = 4.36\ (10^{-5})\ e^{[-0.1975\ (\%\ clay)]}}$$

Based on the grain size analyses, the hydraulic conductivities for the silty clay till soils range from 2.2 x 10^{-7} m/s to 7.3 x 10^{-7} m/s. The results of all hydraulic conductivity testing are compiled in the table below.

Table 4 – Hydraulic Conductivity Testing Results

Sample ID	Lithology	Hydraulic Conductivity (m/s)
Grain Size Analyses		
BH7/MW	Silty Clay Till	6.0 x 10^{-7}
BH8/MW-A	Silty Clay Till	2.2 x 10^{-7}
BH8/MW-B	Silty Clay Till	7.3 x 10^{-7}
Single Well Response Tests		
BH7/MW	Silty Clay Till	1.7 x 10^{-9}
BH8/MW-B	Silty Clay Till	4.5 x 10^{-10}

4.7 Groundwater and Surface Water Quality

Groundwater samples were collected from three (3) selected monitoring wells (BH7/MW, BH8/MW-A, and BH8/MW-B) on February 17th and April 27th, 2020 to establish baseline water quality. Surface water samples were also collected from two locations (Stations 1 and 2; **Drawing 2**) on February 17th and April 27th, 2020 to establish baseline water quality of the Provincially Significant Wetland (PSW) and east Unevaluated Wetland (UW) prior to development. The Bureau Veritas laboratory results and chain of custodies are included in **Appendix H**.

Groundwater quality was compared to the Ontario Drinking Water Standards, Objectives and Guidelines (ODWQS) (O.Reg. 169/03) maximum allowable concentrations (MAC). Although the groundwater on site is not planned for use as drinking water, the MAC guidelines are used for comparison's sake only. In comparison to these guidelines, groundwater was found to meet all of the ODWQS. The groundwater results are tabulated in **Appendix H**.

Surface water quality was compared to Ontario Provincial Water Quality Objectives (PWQO). Surface water quality was found to exceed the PWQO guidelines for a number of parameters in both sampling events. The following table summarizes the detected exceedances. Total phosphorus was found to exceed PWQO guidelines at both stations during both events, indicating impacts from fertilizers.

Table 5 – Surface Water Quality Exceedances

Parameter	PWQO Guideline	Station 1		Station 2	
		17-Feb-20	27-Apr-20	17-Feb-20	27-Apr-20
pH	6.5 – 8.5	*	*	*	8.94
Total Phosphorus	0.01 mg/L	0.041	0.11	0.028	0.062
Total Aluminum	75 ug/L	*	89	*	120
Total Iron	300 ug/L	*	*	*	720
Total Zinc	20 ug/L	*	*	60	*

Note: * meets PWQO

The water quality results were plotted on a Piper Diagram and Schoeller Diagram and are presented in **Drawings 15 and 16,** respectively. The chemical results show that the water quality within the monitoring wells are generally consistent and relatively similar. The surface water quality at Station 1 (the PSW) and Station 2 (the UW) show somewhat different results, indicating variability in their sources and/or impacts. Station 1 plots closer to the groundwater results whereas Station 2 shows quite the variability from the groundwater results. These results suggest that Station 1 may have some groundwater influence on the PSW whereas Station 2 is likely influenced more by surface flows.

5. Sourcewater Protection Considerations

5.1 Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge is largely controlled by soil conditions, and typically occurs in upland areas. The groundwater flow direction has been previously identified as flowing in a southeastern direction.

As defined in the Clean Water Act (2006), an area is a significant groundwater recharge area if,

1. the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or

2. the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.

An assessment report for the Upper Thames River Source Protection Area was completed by the Thames-Sydenham and Region Source Protection Committee. As defined by the Clean Water Act (2006) and identified by the Thames-Sydenham and Region Source Protection Committee, the Site is located outside of a SGRA (**Drawing 17**). This is consistent with the observed low permeable surficial soils observed at Site.

5.2 Highly Vulnerable Aquifers (HVA)

The susceptibility of an aquifer to contamination is a function of the susceptibility of its recharge area to the infiltration of contaminants. As defined in the *Clean Water Act (2006)*, the vulnerability of groundwater within a source protection area shall be assessed using one or more of the following groundwater vulnerability assessment methods:

1. Intrinsic susceptibility index (ISI).

2. Aquifer vulnerability index (AVI).

3. Surface to aquifer advection time (SAAT).

4. Surface to well advection time (SWAT).

In the Thames-Sydenham and Region, HVAs were mapped using the ISI method. The ISI method is an indexing approach using existing provincial Water Well Information System (WWIS) database. The ISI method is described in detail in the MECP’s Technical Terms of Reference (2001). However, in short, the ISI method is a scoring system that takes into consideration the unique hydrogeologic conditions at a particular location. The scores are determined using a combination of the saturated thickness of each unit and an index number related to the soil type, and as such, the scores reflect the susceptibility of the aquifer to contamination.

As defined in the MECP's 2001 Technical Rules,

- an area having an ISI score of less than 30 is considered to be an area of high vulnerability;
- an area having an ISI score greater than or equal to 30, but less than or equal to 80, is considered to be an area of medium vulnerability; and,
- an area having an ISI score of greater than 80 is considered to be an area of low vulnerability.

The Thames-Sydenham and Region Source Protection Committee has determined, using the ISI method, that the Site is not located within HVA areas (**Drawing 18**).

6. Monthly Water Balance Assessment

The monthly water balance assessments for the Site were completed in accordance with the recommendations indicated in the guidance document "Hydrogeological Assessment Submissions: Conservation Authority Guidelines to Support Development Applications" (Conservation Ontario, 2013), and using appropriate site condition values obtained from Table 3.1 of the MOE Stormwater Management Planning and Design Manual (MOE, 2003). The results of the water balance are provided in **Appendix M**.

The water balance accounts for all water in and out-flows in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can then run off towards wetlands, ponds, lakes, and streams (R), infiltrate into the ground (I), or evaporate from surface water and vegetation (ET). When long-term average values of P, R, I, and ET are used, then minimal or no net change to groundwater storage (ΔS) is assumed.

The annual water balance can be stated as follows:

$$\mathbf{P = ET + R + I + \Delta S}$$

Where:

P = precipitation (mm/year)

ET = evapotranspiration (mm/year)

R = runoff (mm/year)

I = Infiltration (mm/year)
ΔS = change in groundwater storage (taken as zero) (mm/year).

6.1 Precipitation and Evapotranspiration

The annual total precipitation used for this water balance (1011.5 mm/yr) is based on data provided by Environment Canada, based on the 30 year average data for climate normals, using the nearest local weather station information (London, ON). In this detailed monthly water balance, precipitation as rain and snow are both considered. Snow storage and resulting snow melt in the winter and early spring months is considered as part of the evapotranspiration volumes.

Evapotranspiration combines evaporation and transpiration and refers to the water lost to the atmosphere. The rate of evapotranspiration is a function of the water holding capacity of the soil and varies with soil and vegetation type and amount of impermeable surface cover.

Monthly evapotranspiration volumes were calculated using the monthly water balance graphical interface created by the U.S. Geological Survey (USGS), Open-File report 2007-1088 (McCabe and Markstrom, 2007). This interface uses the principles outlined by Thornthwaite and Mather (1957) and permits the user to easily modify water balance parameters and provide useful estimates of water balance components for a specified location.

The difference between the annual precipitation and the annual evapotranspiration represents the surplus water which is available for infiltration and surface run-off. Distribution of the surplus water to infiltration is based on an infiltration factor based on site conditions for topography, cover vegetation and soil.

6.2 Infiltration and Runoff

The soil water holding capacities and infiltration rate were determined using values presented in Table 3.1 of the MOE Stormwater Management Planning and Design Manual (MOE, 2003) based on the vegetative cover and the hydrologic soil group. The weighted values based on the Site conditions are presented in the calculation sheets provided in **Appendix M**.

Localized infiltration rates will vary based on factors such as the saturated hydraulic conductivity of surface soils, land slope, rainfall intensity, relative soil moisture at the start of a rainfall event, and type of cover on the ground surface.

Based on soil mapping by the Ministry of Agriculture, Food and Rural Affairs the surficial soils at the Site are predominantly C and B-type soils (silt and sand loam). Based on borehole logs from the Site, the soil cover ranges from sandy silt till to clayey silt till (CD-type soil). For the water balance analysis, soil moisture capacity for B and CD-type soils was utilized. CD-type soils have a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.

6.3 Pre-development and Post-development Calculations

Pre-development and Post-development water balance calculations have been carried out and are based on preliminary and available design data. The development consists of four (4) apartment buildings with associated roadway, underground parking and above ground parking, as presented in **Appendix B**.

In general, the Site comprises a land area of about 3.85 hectares and currently contains a residential property and driveways. A forested area is present in the west portion of the Site. Post-development will consist of apartment buildings with non-impervious areas consisting of a vegetative cover classification of urban lawns and landscaping. Low Impact Development (LID) strategies proposed for implementation include directing clean rooftop runoff from a portion of Building A towards the wetland feature. Additional runoff from landscaped areas surrounding Building A will also be directed towards the wetland to aid in achieving development infiltration targets.

The Site was divided into 2 areas representing drainage to separate regions, as shown in **Drawing 19**. Area A (2.26 ha) consists of lands in the western portion of the Site and drains to the south towards the PSW and Area B (1.59 ha) includes the eastern portion of the property which drains east toward the UW. As no grading plans have been finalized, the drainage patterns between pre and post development have been assumed to be similar.

For pre-development conditions, Area A currently contains roughly 0.07 ha of impermeable surfaces (existing driveway), and Area B currently contains 0.02 ha of rooftop area from the existing residential property. Post development pervious and impervious cover is presented in **Table 6**.

Under post-development conditions, it is assumed at this time that the total rooftop area from Building A contributing runoff volume to the wetland feature is 0.18 ha. In addition, the landscaped area surrounding Building A will direct runoff towards the wetland feature. This landscaped area contribution is estimated to be 0.54 ha.

Table 6: Summary of Post-Development Cover

	Drainage Area A (Ha)	Drainage Area B (Ha)
Rooftop runoff to wetland	0.18	n/a
Landscaped Area – runoff contribution to wetland	0.54	n/a
Open Space	0.45	0.61
Impervious cover (rooftops, surface parking, roads, sidewalks, patios)	1.09	0.98
TOTAL AREA	**2.26**	**1.59**

Table 7 provides a summary of the pre and post development water balance calculations. Calculation worksheets are provided in **Appendix I**. Calculations have been completed for the additional volume of runoff from the landscaped areas surrounding Building A (0.54 ha) as well as the rooftop area of a portion of Building A (0.18 ha). The added runoff from the landscaped area will provide 74% of existing conditions infiltration to the wetland feature. The additional rooftop volume will provide an added 1,269 m^3/year of secondary infiltration into the wetland, resulting in roughly 116% of pre-development infiltration volumes to the wetland feature.

Table 7: Summary of Water Balance Estimates

	Pre-Development	Post-Development with Landscaped Area (0.54 ha)	% Difference	Post-Development with Added Rooftop Flows (0.18 ha)	% Difference With Rooftop Mitigation
Drainage Area A					
Estimated Runoff (m^3/year)	8,343	10,635	127%	-	-
Estimated Infiltration (m^3/year)	3,030	2,249	74%	3,518	116%
Drainage Area B					
Estimated Runoff (m^3/year)	5,965	10,290	173%	-	-
Estimated Infiltration (m^3/year)	1,933	844	44%	-	-

Conservation Ontario Guidelines (Conservation Ontario, 2013) suggest a target of 80% of the pre-development infiltration be maintained in the post-development conditions. Calculations for the Site are indicative of the post-development infiltration being at approximately 74% of the pre-development infiltration in Area A with just the landscaped area contributing infiltration volumes to the wetland feature. As discussed above, the addition of rooftop runoff volumes to the wetland feature on Site will increase the infiltration volumes to exceed the recommended infiltration guidelines.

7. Impact Assessment

7.1 Water Well Users

Potable wells in the area are typically sourced from deep sand and gravel aquifers which are confined below low permeability silty clay overburden. Domestic water supply in the local area wells is sourced from the deep aquifer sand and gravel wells extending to depths between 41 and 71 m. Site development is not expected to impact any local potable wells. In addition, municipal water servicing is available along Southdale Road, in the subdivisions north, south and west of the Site.

Wells set at depths greater than 10 m are not expected to be impacted by the construction of site services or typical excavations associated with the residential development of the site. The silty clay strata noted in the boreholes will limit both the vertical and horizontal zone of influence impacting the wells due to the lower permeability of the founding soils. No significant long-term impact is anticipated on the deep wells, either quantitatively or qualitatively since the inverts of the sewers are not expected to be deep enough to penetrate into the underlying aquifers. Any temporary dewatering operations which may be required to deal with groundwater seepage from the overburden soils are not expected to cause any long-term impacts to the intermediate and deep overburden and bedrock aquifers supplying the water supply wells near the Site.

Monitoring wells have been installed at the Site as part of the Site investigations to document stabilized groundwater conditions. Prior to the Site grading work, and when the monitoring wells are determined to be no longer required, the wells should be properly decommissioned in accordance with Ontario Regulation 903. Decommissioning a well which is no longer in use helps to ensure the safety of those in the vicinity of the well, prevents surface water infiltration into an aquifer via the well, prevents the vertical movement of water within a well, conserves aquifer yield and hydraulic head and can potentially remove a physical hazard.

7.2 Surface Water Features

7.2.1 Provincially Significant Wetland (PSW)

As evidenced through previous Site investigations on the neighbouring property to the south (EXP, 2020), the Provincially Significant Wetland (PSW) has standing water seasonally with dry conditions occurring through summer into fall. Near surface soils across the Site and in the area of the PSW generally consist of silty clay till over sand. The sand was encountered at approximate depths ranging between 5.0 m and 8.6 m bgs in the area of the PSW. Groundwater elevations in the nested well set directly beside the PSW recorded consistent downward gradients throughout the monitoring period, suggesting the shallow groundwater is recharged from precipitation and surface runoff.

7.2.2 Unevaluated Wetlands (UW)

Two (2) unevaluated wetlands (UW) are documented in the City of London’s Natural Heritage Map 5 and are depicted in **Drawing 2**. The eastern UW has ponded water year-round and is fed by surface runoff from Southdale Road West as well as from flows originating from the pond north of Southdale Road West, and directed through the culvert. The western UW was noted to be seasonally dry through Site monitoring carried out by EXP.

7.2.3 General Comments

Preliminary water balance calculations have been completed for the Site based on the current development plan and the results suggest that storm water management designs will need to include assessment of runoff to Site features to maintain similar conditions as those observed under pre-development.

The PSW and UWs are considered as being vulnerable to contamination from surface sources. During construction, short term impacts to the surface water may be anticipated, particularly where vegetation on nearby land is stripped and area grading works are underway.

The following comments are provided with recommendations to help minimize impact to surface water features observed at the site:

- During the site grading work, suitable sedimentation controls will be required to help control and reduce the turbidity of run-off water which may flow towards the surface water features;
- A Best Management Practice (BMP) and spill contingency plan (including a spill action response plan) should be in place for fuel handling, storage and onsite equipment maintenance activities to minimize the risk of contaminant releases as a result of the proposed construction activities;
- Re-establishing vegetative cover in disturbed areas following the completion of the construction work;
- Limit the use of commercial fertilizers in landscaped areas which border a habitat feature; and,

Limit the use of salts or other additives for ice and snow control on the roadways and parking areas.

7.3 Water Quality Monitoring Considerations

A monitoring program to assess the characteristics of the shallow groundwater collected in the monitoring wells and the surface water at the Site has been carried out. Baseline water quality testing was carried out on samples of the shallow groundwater collected from selected monitoring wells, the surface water in the PSW and surface water from the eastern UW.

In comparison with ODWQS and the PWQO, which is considered appropriate for assessing potential impacts of groundwater discharge to surface or nearby surface water features (which may occur during construction dewatering activities associated with site servicing), the test results for the water samples do not indicate a high potential for adverse effects for aquatic receptors which may be present in nearby surface water features.

There are a number of items which can be considered during construction and for the future residential development which can assist in maintaining groundwater and surface water quality. The following comments are provided for consideration, but are not intended as an exhaustive list in this regard:

- In the event that imported materials are required to restore onsite excavations, or to raise grades in portions of the Site, analytical testing of the imported material may be considered to ensure that any material brought to the Site meets the applicable standards under Ontario Regulation 153 for residential lands.

- Contractors working at the Site should ensure that construction equipment is in good working order. Equipment operators should have spill-prevention kits, where appropriate.

- Chemical application in landscaped and grassed areas should be limited. Consideration may be given to using grass varieties which are heartier and require less extensive watering or fertilizers.

Consideration may be given to carrying out additional water quality testing during construction, where construction activities are in close proximity to surface water features, where a concern for potential impact is identified.

Monitoring stations to assess post-development changes to water quality may be considered; however, the specific purpose and long-term responsibility for servicing and maintenance of the monitoring stations would need to be established.

7.4 Construction Dewatering Considerations

The proposed construction at the Site is expected to involve excavations for the installation of underground parking garages as well as servicing across the Site (typically to a maximum depth of 3 m bgs). According to Sections 34 and 98 of the Ontario Water Resources Act R.S.O. 1990 and the Water Taking and Transfer Regulation O. Reg. 387/04, groundwater construction dewatering in excess of 50,000 litres per day requires either an Environmental Activity and Sector Registry (EASR) or a Permit to Take Water (PTTW). EASR's are required for dewatering volumes up to 400,000 litres per day. For volumes of 400,000 litres per day or more, Category 3 PTTW applications will need to be approved by the MECP.

Based on the information collected during this study, the soils at the Site are predominantly characterized by clayey silt till overlying dry sand. Hydraulic conductivities based on SWRTs and grain size analyses was 5.0 x 10^{-9} cm/s for the till soils. Water levels across the Site were relatively shallow and within a meter of ground surface in several locations (BH7/MW and BH8B/MW). Due to the low hydraulic conductivities of the soils on Site, it is not anticipated that a PTTW will be required for construction. However, detailed dewatering calculations should be completed once detailed designs are provided for the proposed underground parking structures in order to confirm this assumption.

Any collected water from service trenches and temporary excavations should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Sediment control measures should be provided at the discharge point of the dewatering system.

7.5 Secondary Infiltration Opportunities

Due to the increased impermeable surfaces (such as roof-tops, roadways, sidewalks), the proposed development is expected to result in a reduction in the post-development infiltration level, and a corresponding increase in the estimated run-off. The use of Low Impact Development (LID) strategies on Site are recommended to assist in maintaining the pre-development infiltration volumes across the Site, in particular the volumes which currently feed the wetland.

These recommendations and water balance calculations should be provided to the Stormwater and Civil Engineers in order to present the benefits of designing LID features, in addition to the volumes required to obtain water balance.

8. Qualifications of Assessors

EXP Services Inc. provides a full range of environmental services through a full-time Earth and Environmental Services Group. EXP's Environmental Services Group has developed a strong working relationship with clients in both the private and public sectors and has developed a positive relationship with the Ontario Ministry of the Environment, Conservation and Parks (MECP). Personnel in the numerous branch offices form part of a large network of full-time dedicated environmental professionals in the EXP organization.

This report was authored by Mr. Eric Buchanan, P.Eng. Mr. Buchanan works in the Earth and Environment Discipline and has been thoroughly trained in conducting geotechnical and hydrogeological assessments. He obtained a Bachelor of Engineering Degree from Lakehead University and has been working in the geo-science field for 9 years. He has authored and reviewed reports for numerous projects including residential and commercial developments that require geotechnical and hydrogeological input, Level 2 hydrogeological assessments for underwater aggregate extraction, groundwater impact assessments and calculated groundwater removal quantities for short- and long-term construction. Mr. Buchanan oversees coordinating all of EXP’s hydrogeological field operations for London and surrounding area. His responsibilities include designing work plans and hydrogeological modelling.

This report was reviewed by Ms. Heather Jaggard, M.Sc., P.Geo. Ms. Jaggard is a hydrogeologist and environmental geoscientist with more than 9 years in the environmental field and is a licensed Professional Geoscientist (P.Geo.) in Ontario. She obtained a Master’s of Science (M.Sc.) in 2012 from Queen’s University in Kingston, and is a Qualified Person (QP) registered with the Ontario Ministry of Environment, Conservation and Parks (MECP). She has worked in the Hydrogeological and Environmental fields since that time. In her professional career for the past few years, Ms. Jaggard has completed numerous hydrogeological assessments and modelling works for land development sites. Environmental site assessments and preparation of submissions for Permit to Take Water (PTTW) have been part of her routine assignments.

9. References

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10. General Limitations

The information presented in this report is based on a limited investigation designed to provide information to support an assessment of the current environmental conditions within the subject property. The conclusions and recommendations presented in this report reflect Site conditions existing at the time of the investigation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, EXP Services Inc. should be contacted to assess the situation, and the need for additional testing and reporting. EXP has qualified personnel to provide assistance in regards to any future geotechnical and environmental issues related to this property.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the engineering profession. It is intended that the outcome of this investigation assist in reducing the client's risk associated with environmental impairment. Our work should not be considered 'risk mitigation'. No other warranty or representation, either expressed or implied, is included or intended in this report.

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

EXP Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, EXP Services Inc. will assume no responsibility for interpretation of the recommendations in this report

This report was prepared for the exclusive use of **Western Prestige Village** and may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Appendix A - Drawings

-LEGEND-

━ Approximate Site Boundary

Image Source: Google Earth Pro (July 2018)

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Site Location Plan

Prepared By: E.B.

Reviewed By: H.J.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:10,000	KCH-00257251-A0	1

-LEGEND-

⊕ BH1	Approximate Borehole Location
+ Station 1	Approximate Surface Water Station Location
—	Approximate Site Boundary
⊕ BH9/MW	Approximate Monitoring Well Location (Project 16262)
⊕ SW Station 1	Approximate Surface Water Location (Project 16262)
▨	Unevaluated Wetland
▨	Provincially Significant Wetland

Image Source: Google Earth Pro (July 2018)
Note: Natural Hertiage Feature boundaries obtained from City of London's Natural Heritage Map 5.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT
Western Prestige Village

TITLE
Borehole Location Plan and Natural Heritage Features

Prepared By: K.D.
Reviewed By: H.J.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
NOVEMBER 2020	1:3,500	KCH-00257251-A0	2

OMAF - Artificial Drainage System Map

Scale: 1:30,000

-LEGEND-

—	Approximate Site Boundary
—	Department of Fisheries and Oceans Class 'F' Drain
▨	Tile Drain Random
● ● ●	Pipeline/Main

Image Source 1: OMAFRA Mapping; www.gisapplication.lrc.gov.on.ca
Image Source 2: Ontario Ministry of Agriculture and Food. Artificial Drainage System, County of Middlesex, Township of Westminster. Drawing No. 19-220. July 23, 1981.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

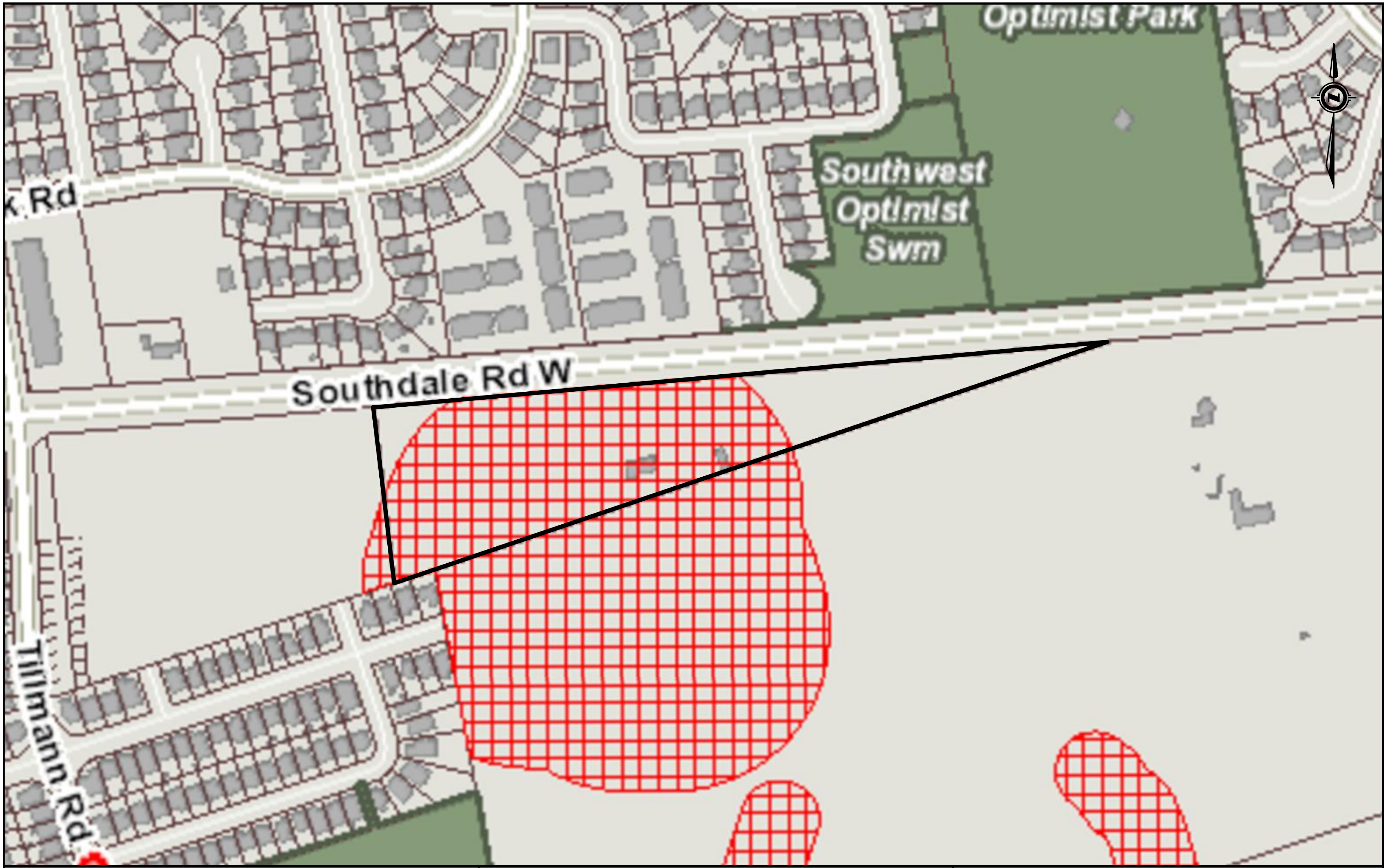
CLIENT
Western Prestige Village

TITLE
Site Area Drainage

Prepared By: E.B.
Reviewed By: H.J.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:4,000	KCH-00257251-A0	3



-LEGEND-

—	Approximate Site Boundary
▦	Regulated Lands of the Upper Thames River Conservation Authority

Image Source: City of London Mapping Software; www.london.ca/maps

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Regulated Lands of the UTRCA

Prepared By: E.B.

Reviewed By: H.J.

exp. EXP Services Inc.

15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
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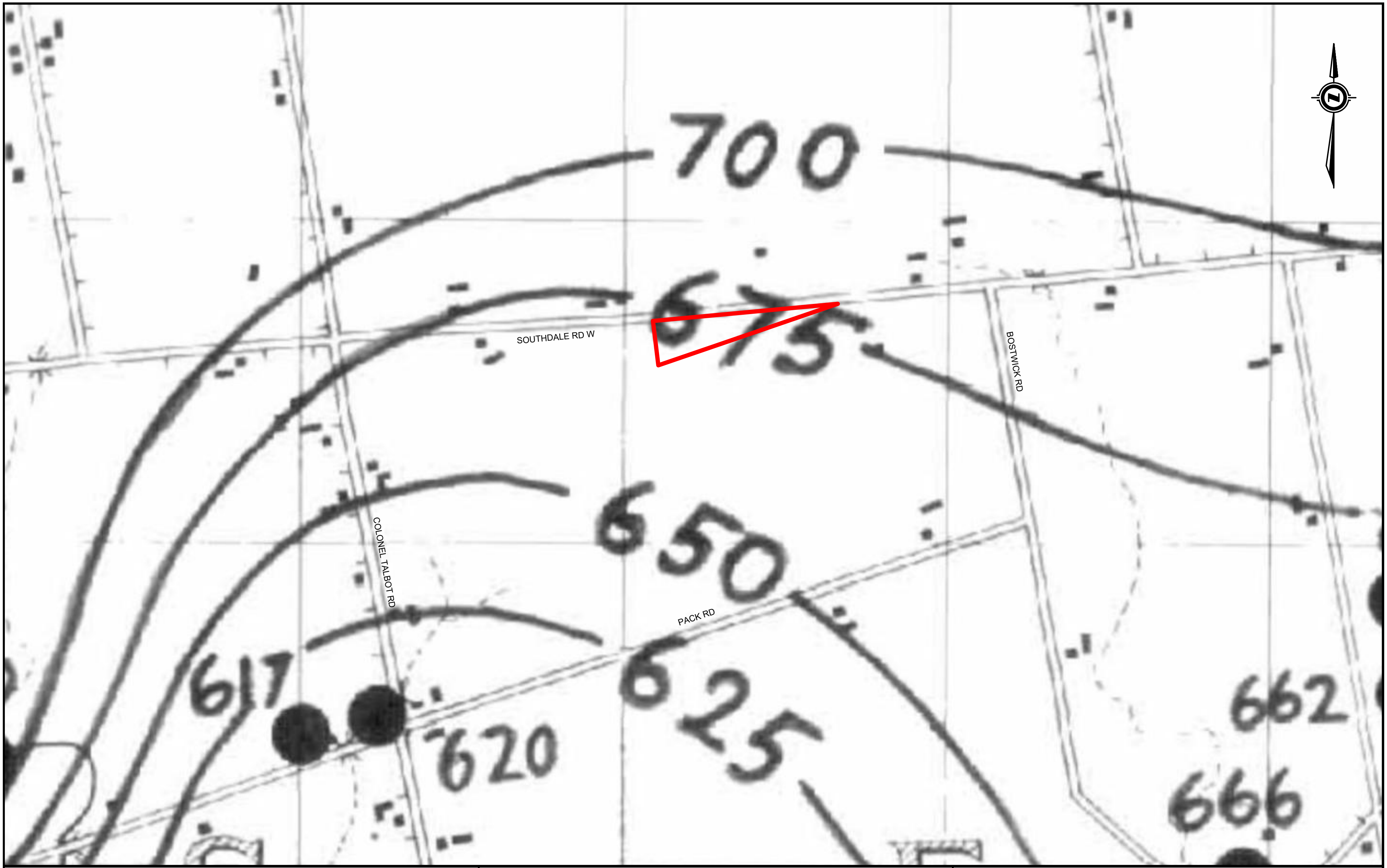

-LEGEND-

—	Approximate Site Boundary
● 617	Bedrock Surface Elevation (feet) in a Well or Test Hole
─675─	Contours on Bedrock Surface (feet)

Image Source: Ontario Geological Survey. 1968. Bedrock Topography Series, St. Thomas Sheet, Southern Ontario, Preliminary Map P.482.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Bedrock Topography

Prepared By: E.B.

Reviewed By: H.J.

exp.

EXP Services Inc.

15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
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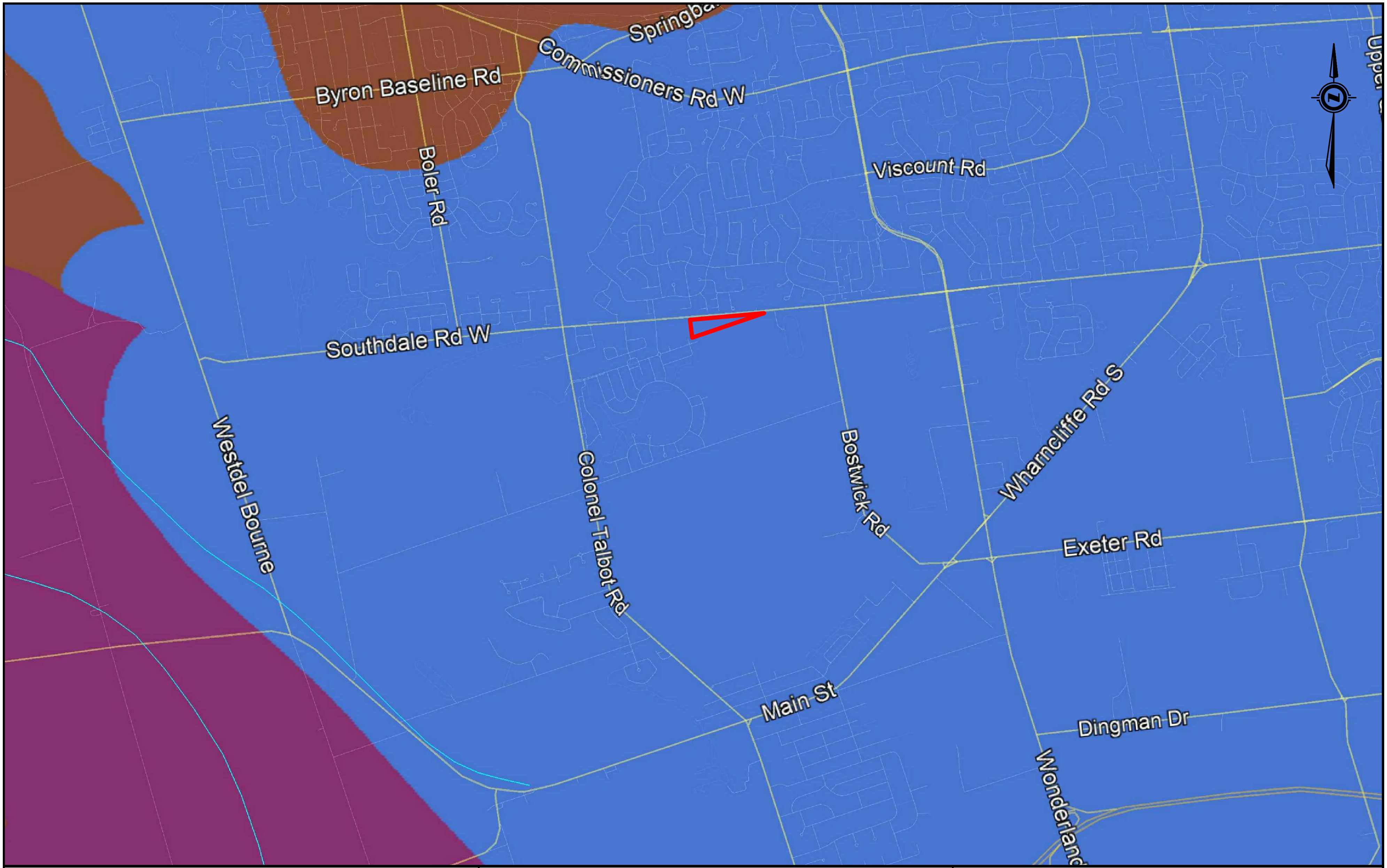


-LEGEND-

— Approximate Site Boundary

🟦 Mount Elgin Ridges

🟫 Caradoc Sand Plains and London Annex

🟪 Ekfrid Cly Plain

Image Source: Chapman, L.J. and Putnam, D.F. 2007 The Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Physiographic Regions

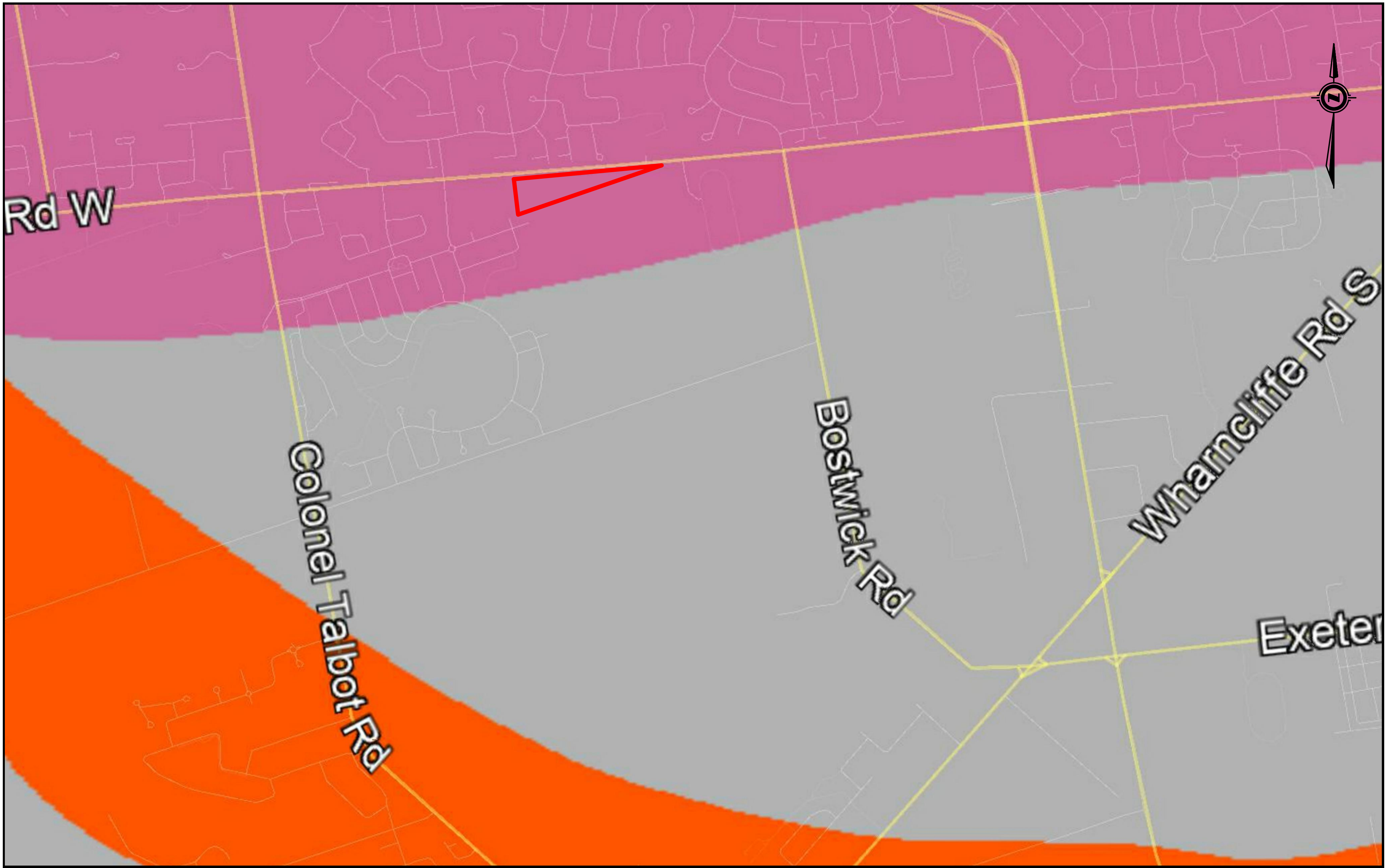
Prepared By: E.B.

Reviewed By: H.J.

exp.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:40,000	KCH-00257251-A0	6



-LEGEND-

— Approximate Site Boundary

🟪 Till Morains

🟧 Spillways

⬜ Till Plains (Undrumlinized)

Image Source: Chapman, L.J. and Putnam, D.F. 2007 The Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Physiographic Landforms

Prepared By: E.B.

Reviewed By: H.J.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
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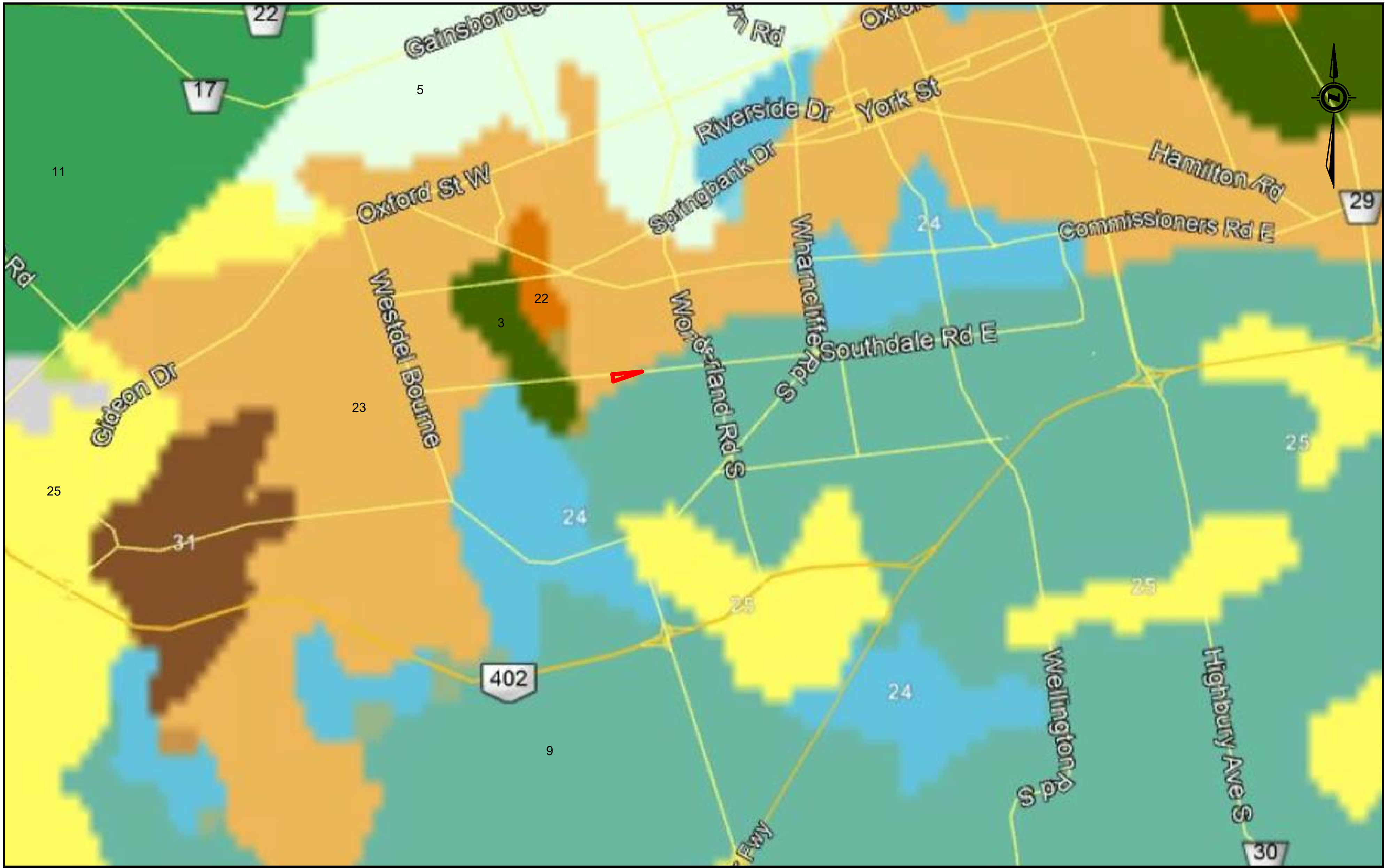


-LEGEND-

— Approximate Site Boundary

🟩 3 Catfish Creek Till

⬜ 5 Tavistock Till

🟩 9 Port Stanley Till

🟩 11 Rannoch Till

🟧 22 Glaciofluvial Ice

🟧 23 Glaciofluvial Outwash deposits

🟦 24 Glaciolacustrine deposits- silt and clay

🟨 25 Glaciolacustrine deposits- sand and gravel

🟫 31 Fluvial deposits

Image Source: Barnett, P.J., Cowan, W.R. and Henry, A.P. 1991. Quaternary geology of Ontario, southern sheet; Ontario Geological Survey, Map 2556.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT
Western Prestige Village

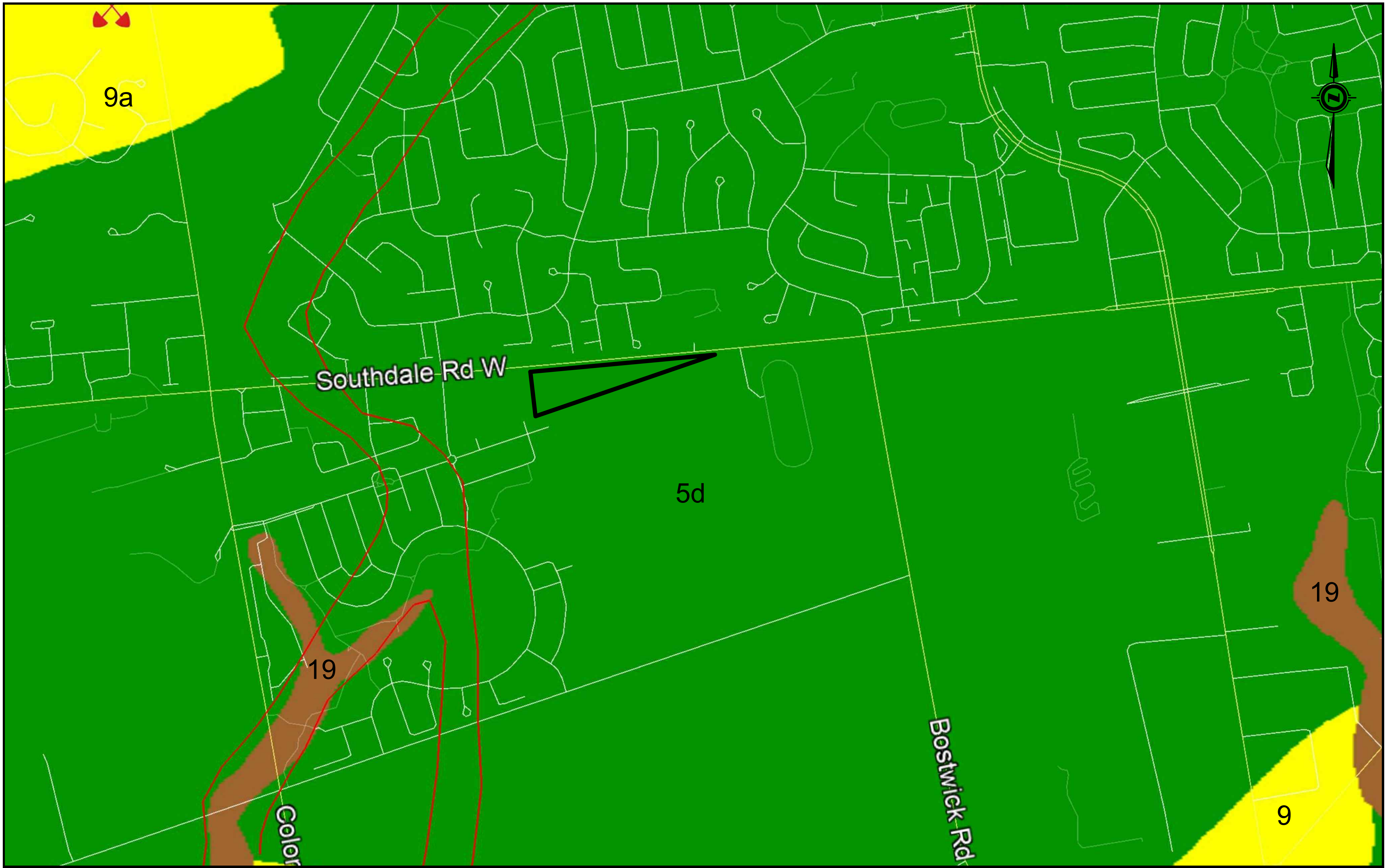
TITLE
Quaternary Geology

Prepared By: E.B.

Reviewed By: H.J.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:100,000	KCH-00257251-A0	8



-LEGEND-

▬	Approximate Site Boundary
5d	Till: Clay to silt-textured till
9	Coarse-textured glaciolacustrine deposits
19	Modern alluvial deposits
▬	Fluvial Terrace

Image Source: The Ontario Geological Survey. 2003. Surficial Geology of Southern Ontario

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

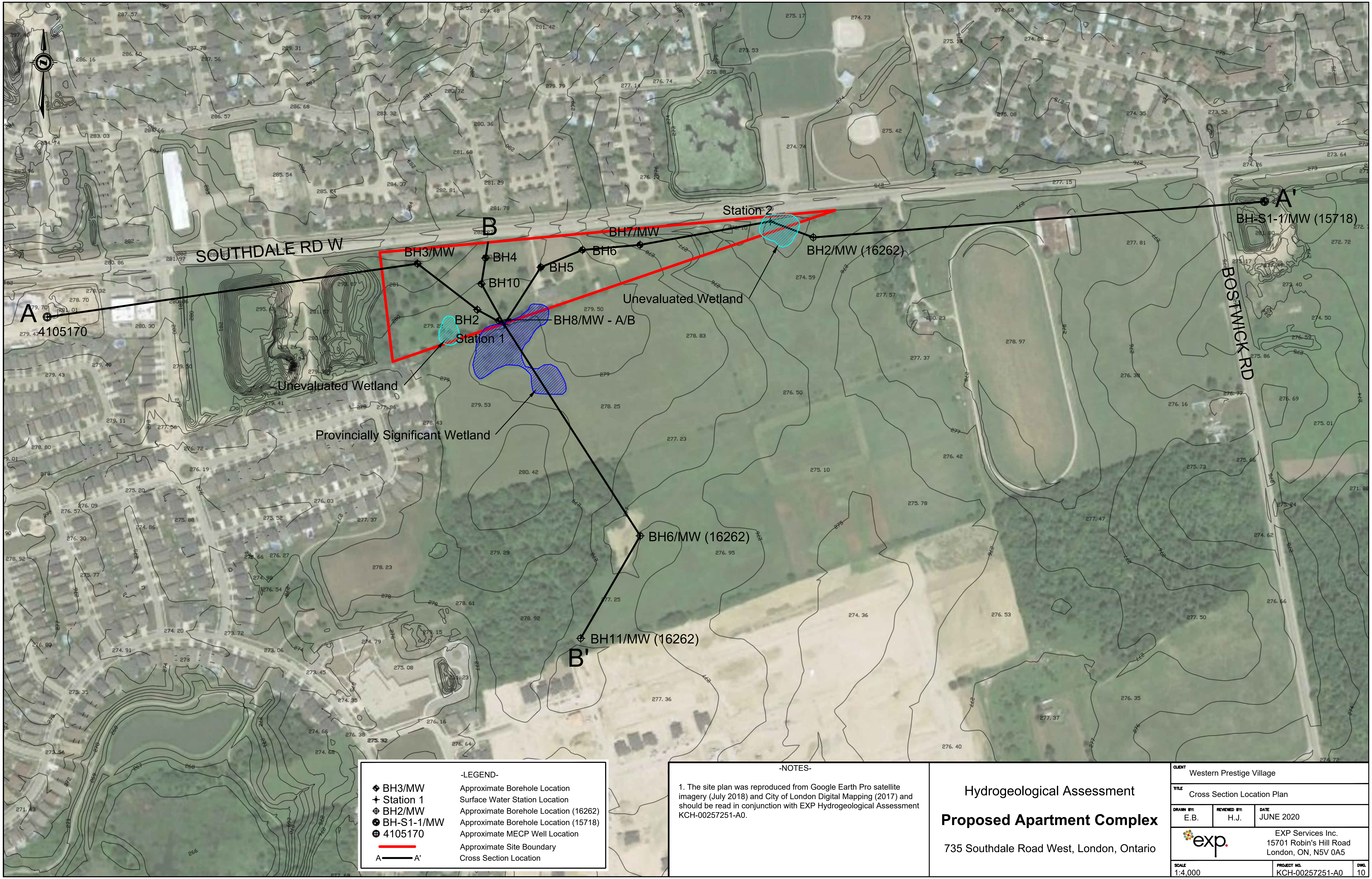
TITLE Surficial Geology

Prepared By: E.B.

Reviewed By: H.J.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:16,000	KCH-00257251-A0	9



-LEGEND-

⊕ BH3/MW	Approximate Borehole Location
+ Station 1	Surface Water Station Location
⊕ BH2/MW	Approximate Borehole Location (16262)
⊕ BH-S1-1/MW	Approximate Borehole Location (15718)
⊕ 4105170	Approximate MECP Well Location
🟥	Approximate Site Boundary
A——A'	Cross Section Location

-NOTES-

1. The site plan was reproduced from Google Earth Pro satellite imagery (July 2018) and City of London Digital Mapping (2017) and should be read in conjunction with EXP Hydrogeological Assessment KCH-00257251-A0.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

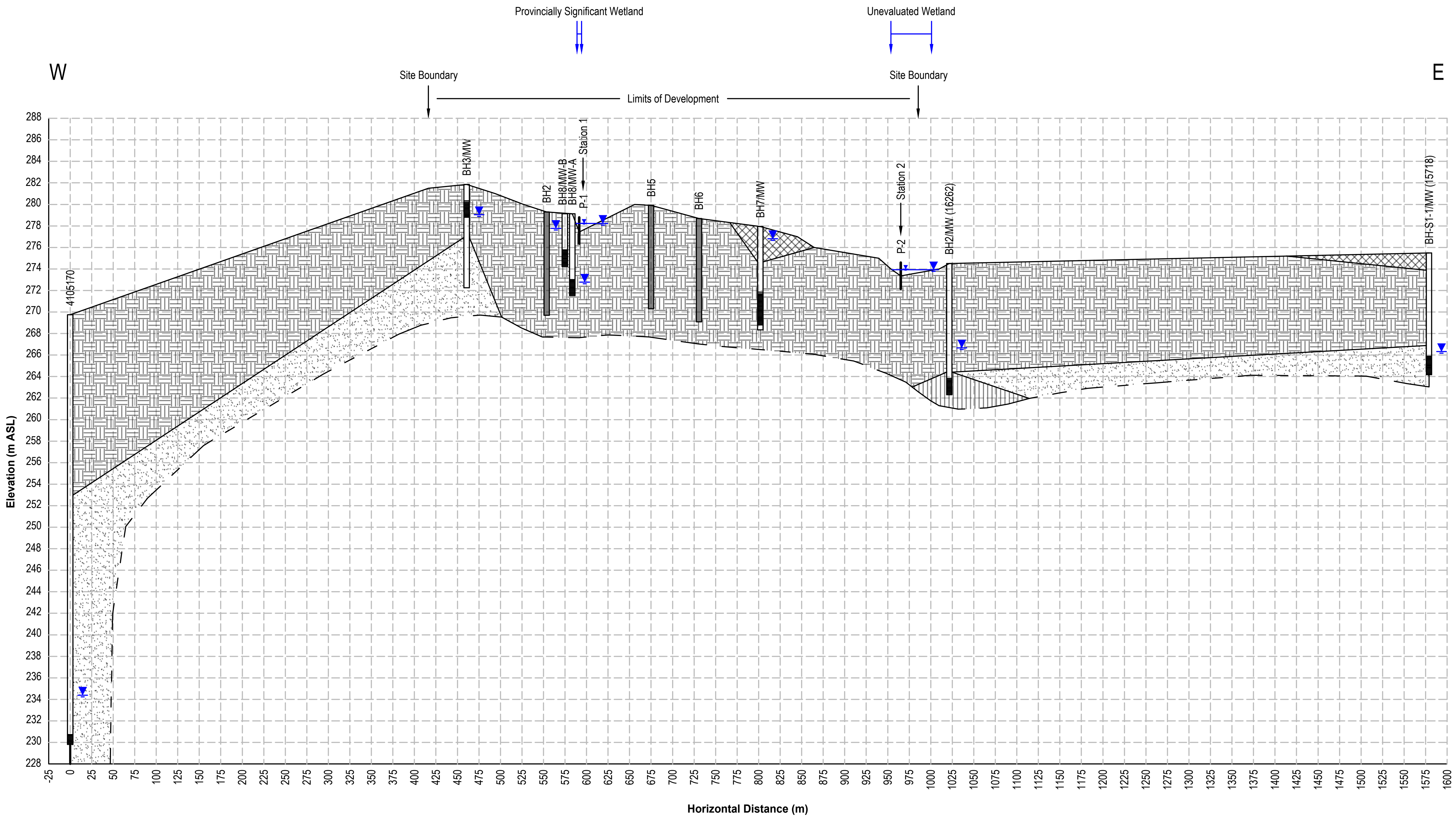
TITLE Cross Section Location Plan

DRAWN BY: E.B.
REVIEWED BY: H.J.
DATE JUNE 2020

exp.
EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

SCALE 1:4,000
PROJECT NO. KCH-00257251-A0
DWG. 10

Generalized Cross Section A - A'



-LEGEND-

▼	Groundwater Measurement
▩	Fill
▦	Clayey Silt/Silty Clay/Glacial Till
▥	Sand and Silt
░	Sand

-NOTES-

1. The cross section should be read in conjunction with EXP Hydrogeological Assessment KCH-00257251-A0.
2. The water levels in the MECP Wells displayed in the cross section are based on static water levels recorded in the well records.
3. The water levels in the EXP boreholes were measured in May 2020.
4. The water level in BH-S1-1/MW was measured in May 2019.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

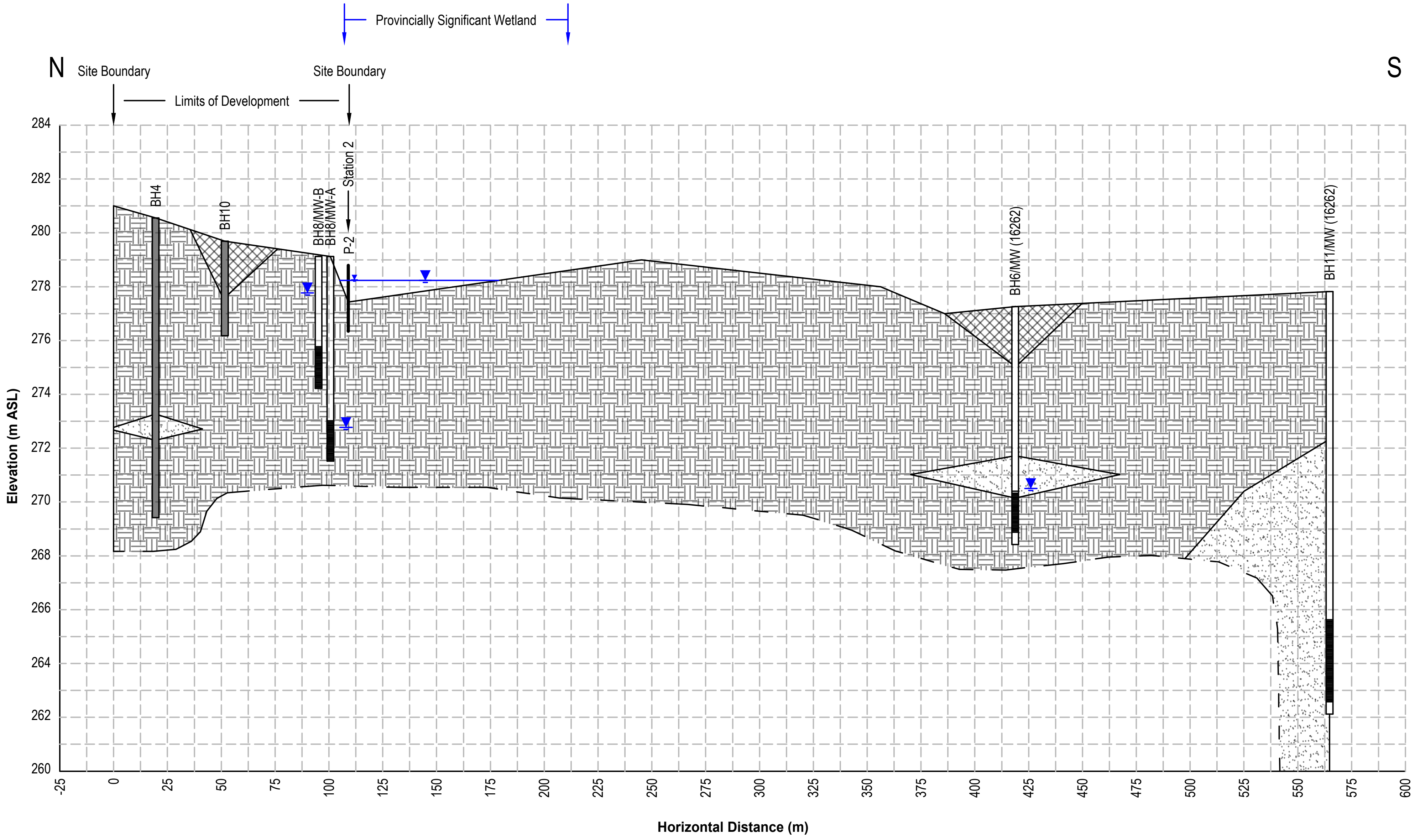
TITLE Generalized Cross Section A - A'

DRAWN BY:	REVIEWED BY:	DATE
E.B.	H.J.	JUNE 2020

EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

SCALE	PROJECT NO.	DWG.
H=1:5000, V=1:400	KCH-00257251-A0	11

Generalized Cross Section B - B'



-LEGEND-

- ▼ Groundwater Measurement
- ▩ Fill
- ▦ Clayey Silt/Silty Clay/Glacial Till
- ▥ Sand and Silt
- ⬚ Sand

-NOTES-

1. The cross section should be read in conjunction with EXP Hydrogeological Assessment KCH-00257251-A0.
2. The water levels in the MECP Wells displayed in the cross section are based on static water levels recorded in the well records.
3. The water levels in the EXP boreholes were measured in May 2020.

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

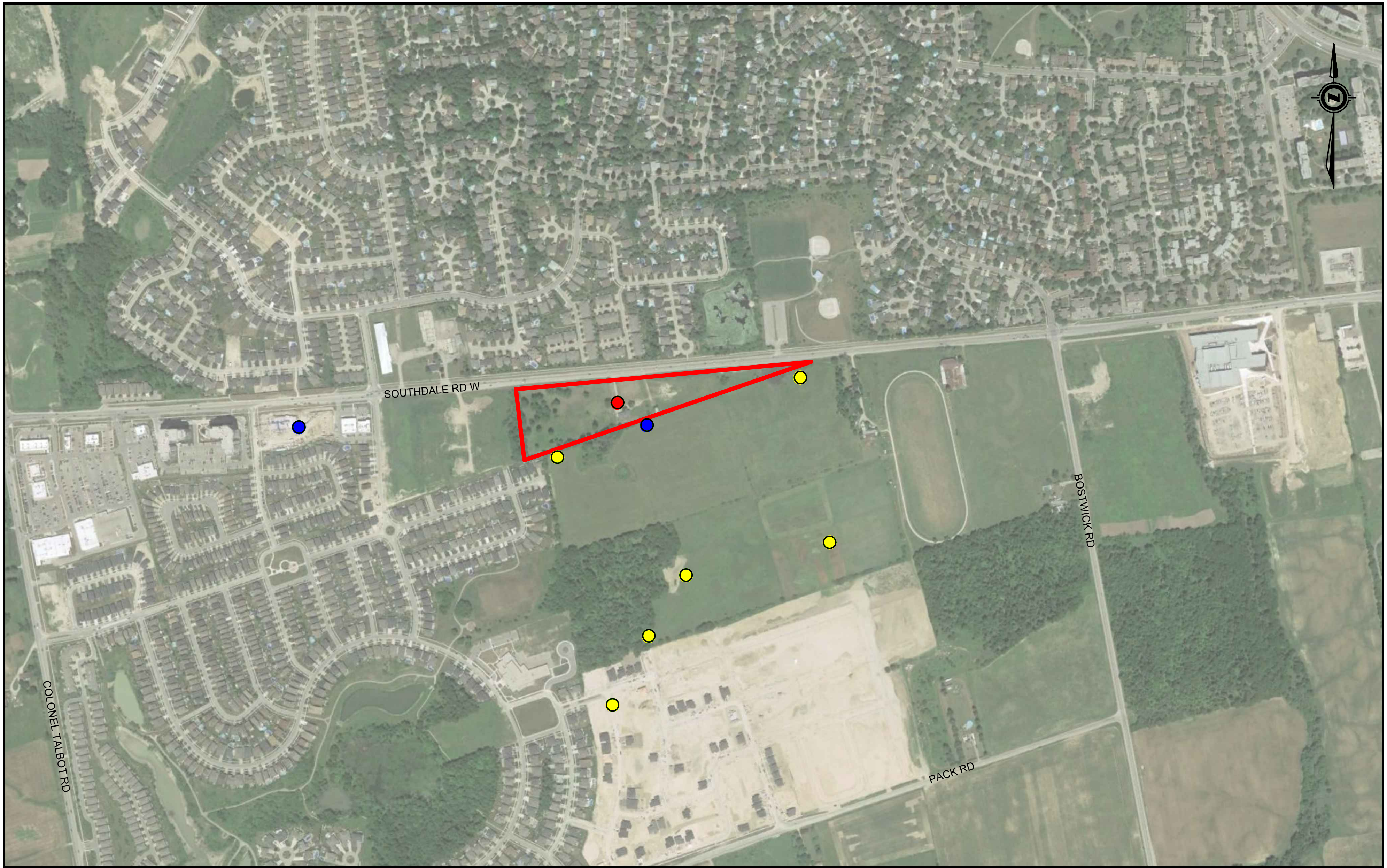
CLIENT
Western Prestige Village

TITLE
Generalized Cross Section B - B'

DRAWN BY: E.B.
REVIEWED BY: H.J.
DATE JUNE 2020

EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

SCALE H=1:2,500; V=1:200
PROJECT NO. KCH-00257251-A0
DWG. 12



-LEGEND-

— Approximate Site Boundary
🔵 Water Supply - Domestic
🟡 Monitoring/Test Hole
🔴 Abandoned

Image Source: Google Earth Pro (July 2018)

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT	Western Prestige Village
TITLE	Approximate Location of MECP Registered Wells
Prepared By: E.B.	Reviewed By: H.J.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:10,000	KCH-00257251-A0	13

-LEGEND-

🟥	Approximate Site Boundary
⌖ BH3/MW	Approximate Borehole Location
⌖ BH6/MW	Approximate Borehole Location (16262)
279.04	Groundwater Measurement (May 23, 2020)
—	Groundwater Equipotential Line
→	Groundwater Flow Direction

Image Source: Google Earth Pro (July 2018)

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

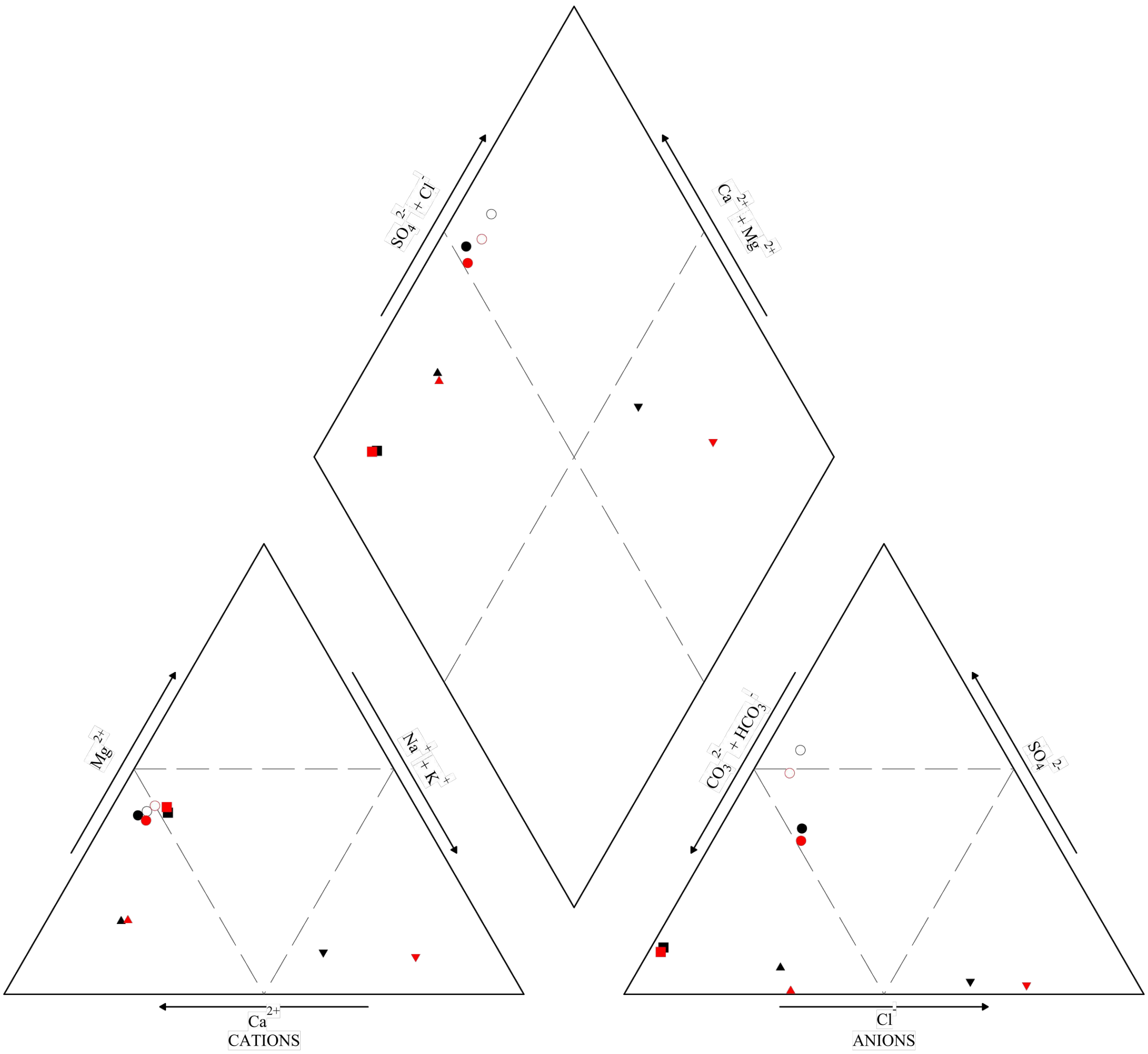
CLIENT
Western Prestige Village

TITLE
Groundwater Flow Direction

Prepared By: E.B.
Reviewed By: H.J.

exp.
EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:5,000	KCH-00257251-A0	14



-LEGEND-

■ BH7/MW (February 2020)
○ BH8A/MW (February 2020)
● BH8B/MW (February 2020)
▲ SW Station 1 (February 2020)
▼ SW Station 2 (February 2020)

🟥 BH7/MW (April 2020)
○ BH8A/MW (April 2020)
🔴 BH8B/MW (April 2020)
🔺 SW Station 1 (April 2020)
🔻 SW Station 2 (April 2020)

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT
Western Prestige Village

TITLE
Piper Diagram

DRAWN BY:
M.B.

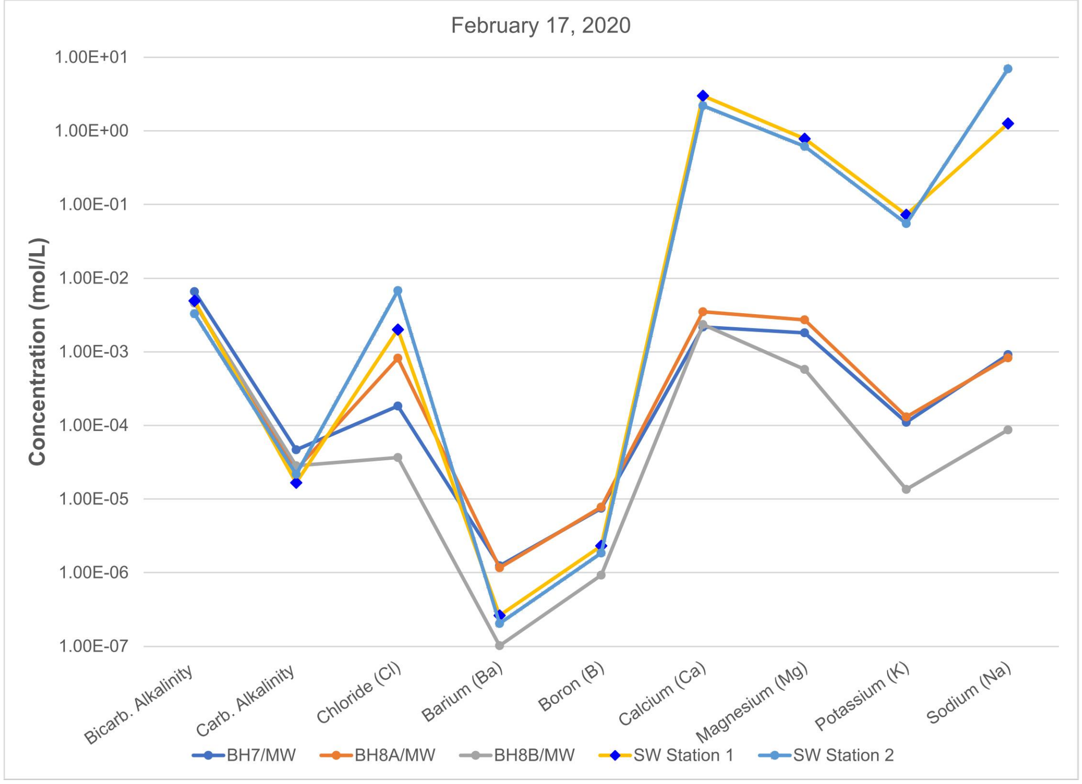
REVIEWED BY:
E.B.

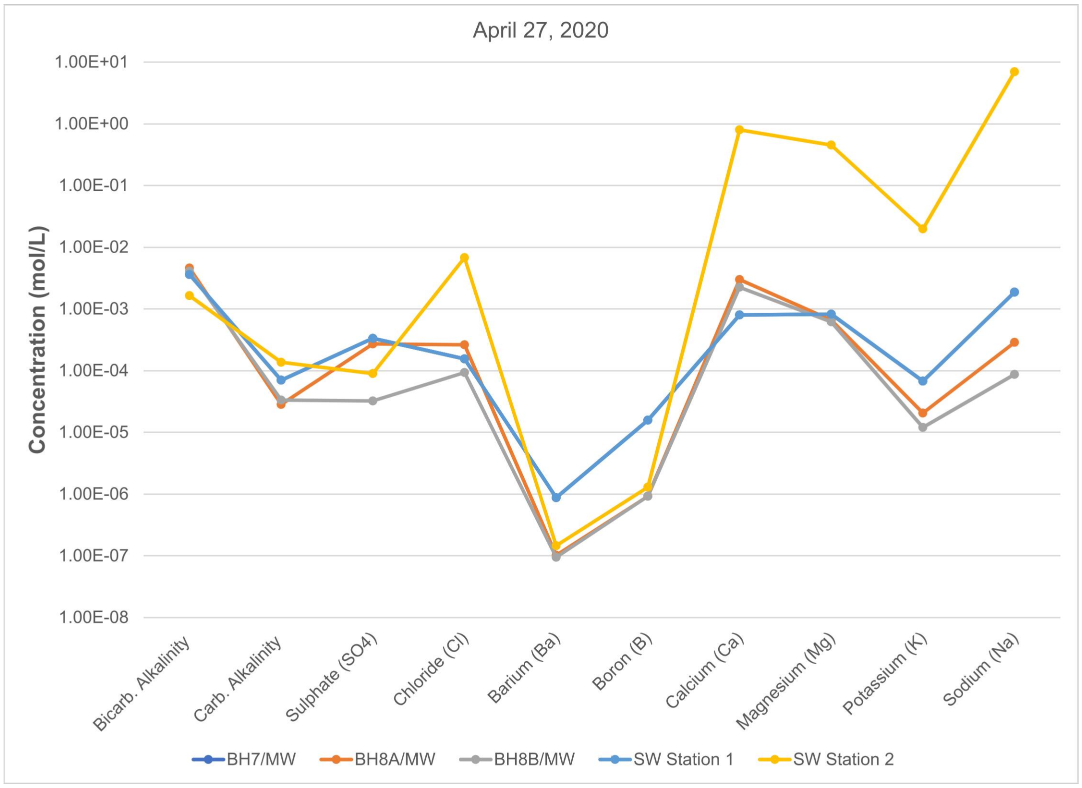
EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

DATE
JUNE 2020

PROJECT NO.
KCH-00257251-A0

DWG.
15





Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT
Western Prestige Village

TITLE
Schoeller Diagrams for Water Quality

DRAWN BY:
E.B.

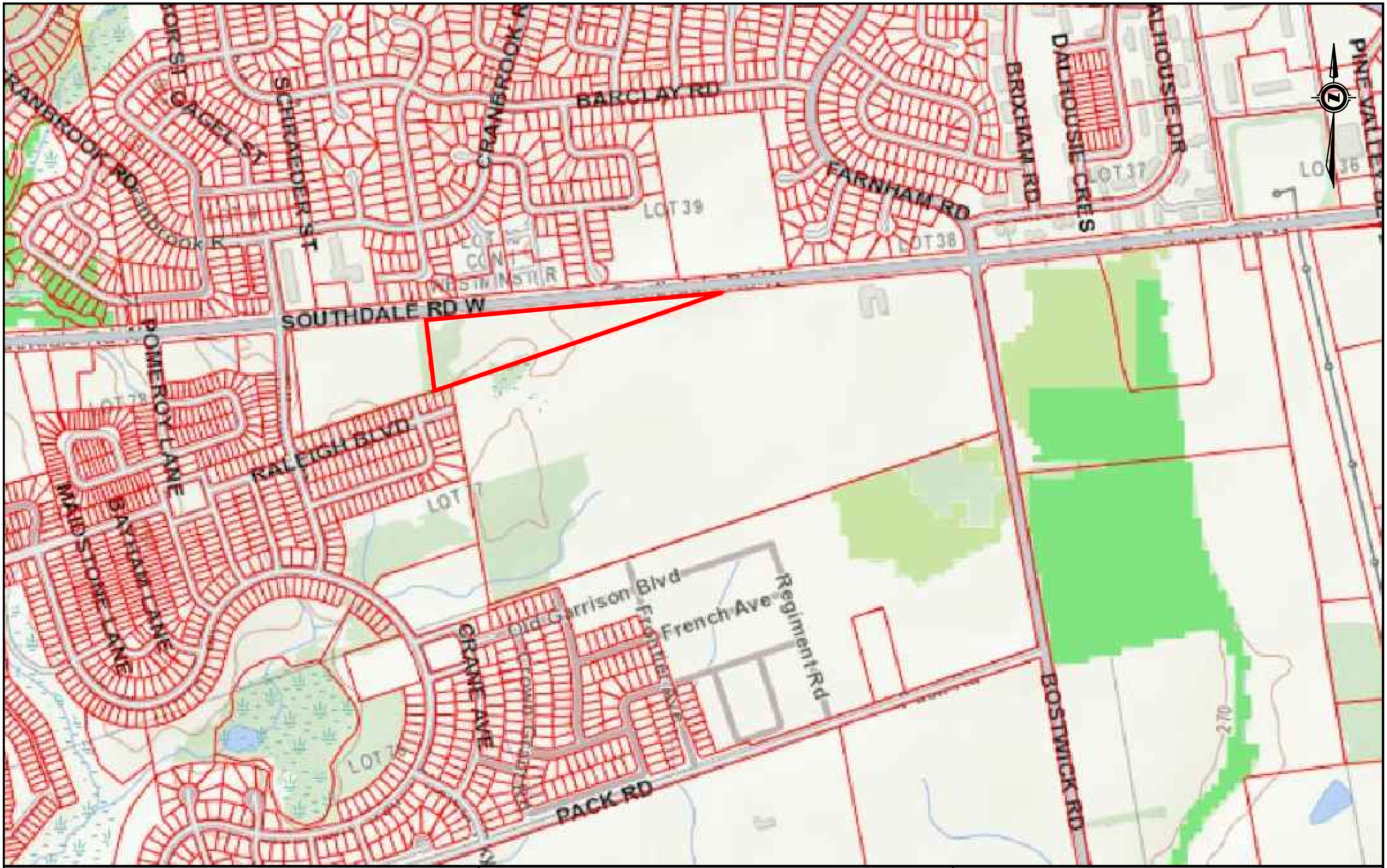
REVIEWED BY:
H.J.

EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

DATE
JUNE 2020

PROJECT NO.
KCH-00257251-A0

DWG.
16



-LEGEND-

▬	Approximate Site Boundary
🟩	Vulnerability = 2
🟩	Vulnerability = 4
🟨	Vulnerability = 6

Image Source: UTRCA online mapping software; maps.thamesriver.on.ca

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

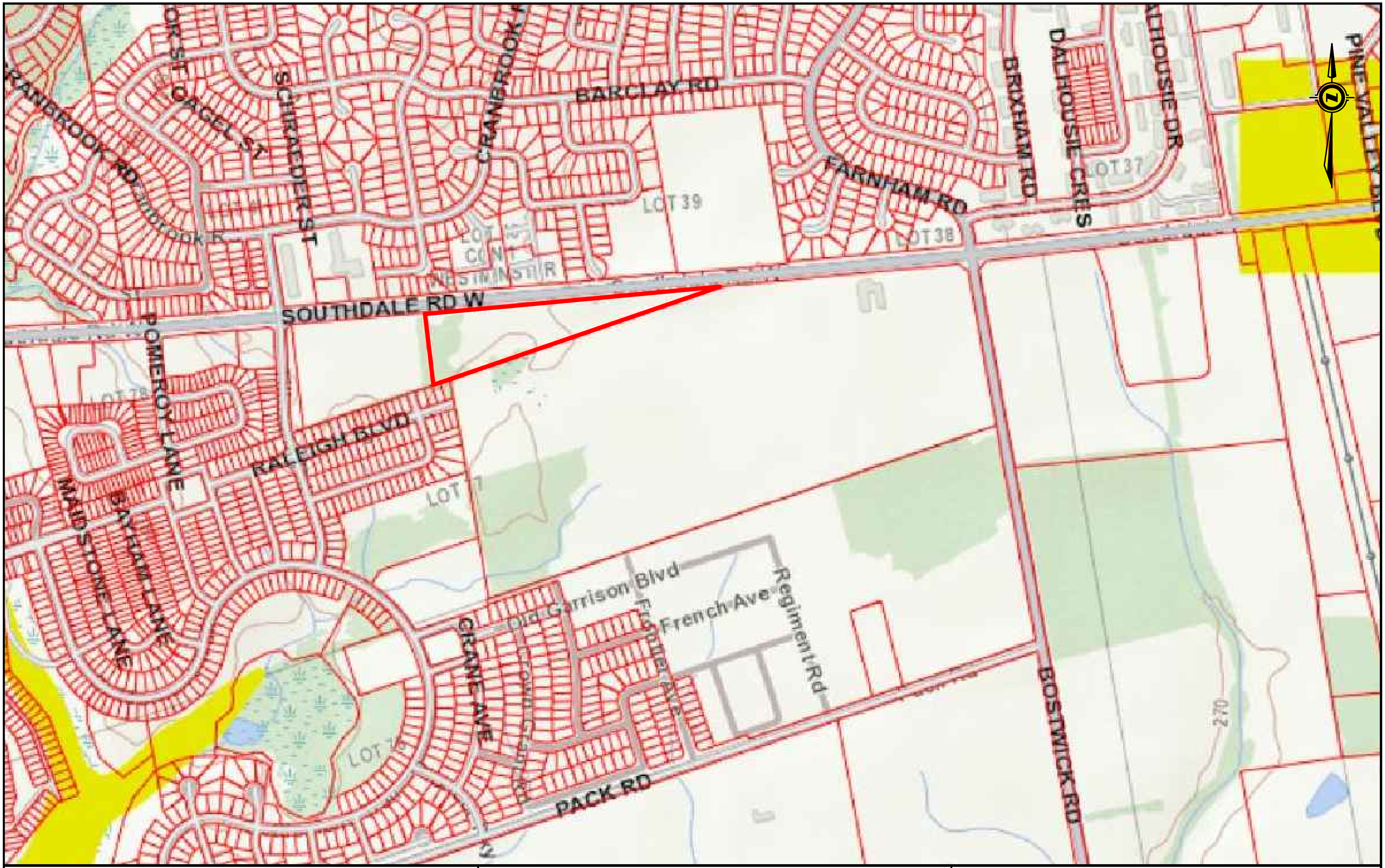
TITLE Significant Groundwater Recharge Areas

Prepared By: E.B.

Reviewed By: H.J.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:10,000	KCH-00257251-A0	17



-LEGEND-

— Approximate Site Boundary

🟨 Highly Vulnerable Aquifer - Approved

Image Source: UTRCA online mapping software; maps.thamesriver.on.ca

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Western Prestige Village

TITLE Highly Vulnerable Aquifers

Prepared By: E.B.

Reviewed By: H.J.

exp.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
JUNE 2020	1:10,000	KCH-00257251-A0	18

-LEGEND-

🟥 Approximate Site Boundary

Image Source: Google Earth Pro (July 2018)

Hydrogeological Assessment

Proposed Apartment Complex

735 Southdale Road West, London, Ontario

CLIENT Royal Premier Homes

TITLE Site Drainage Areas

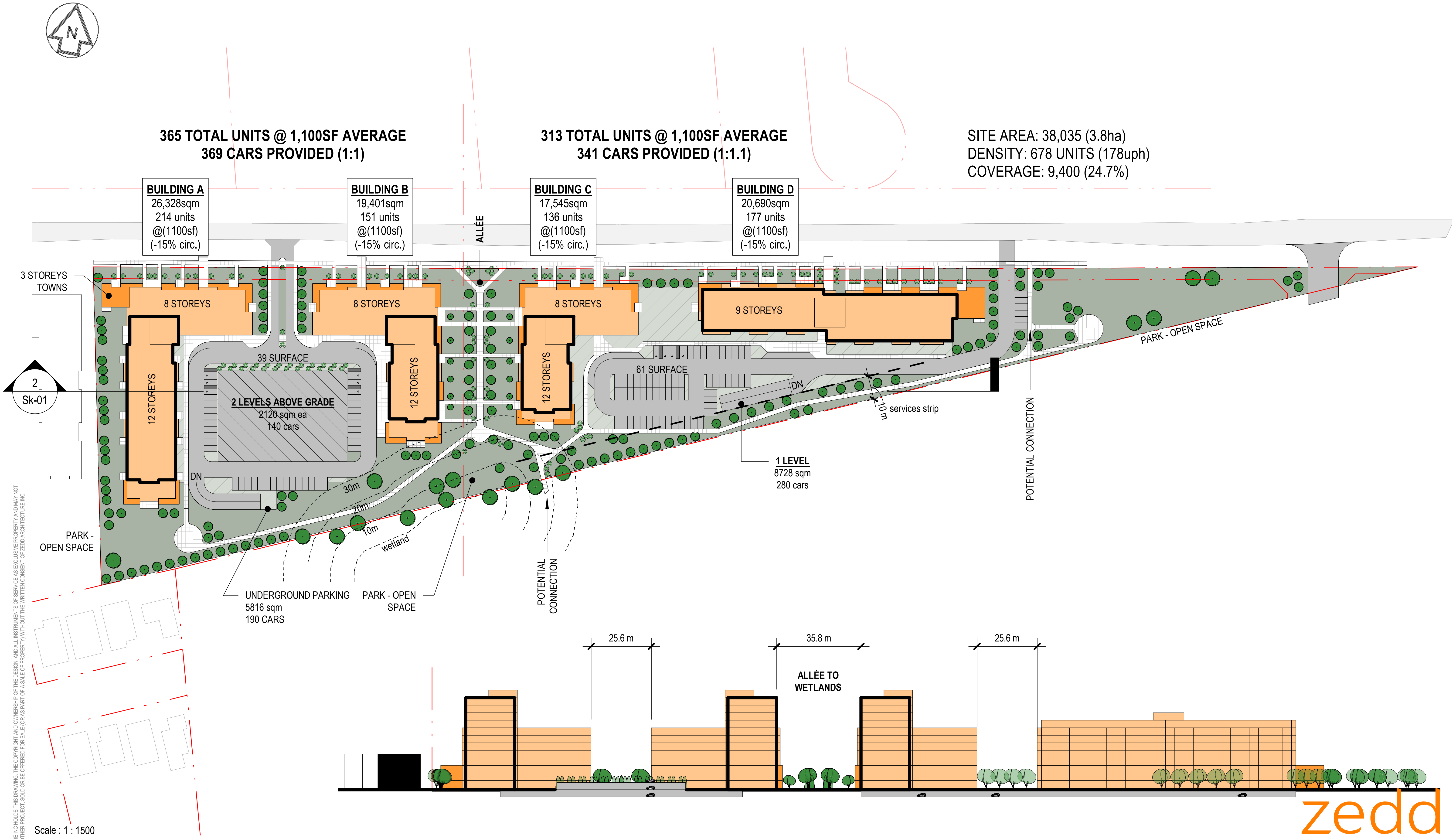
Prepared By: K.D.

Reviewed By: H.J.

EXP Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	APPROXIMATE SCALE	PROJECT NO.	DWG.
NOVEMBER 2020	1:4,000	KCH-00257251-A0	19

Appendix B – Development Plan



Scale : 1 : 1500

20-002 | Feasibility Study | Royal Premier Homes | Site Plan_v11 | 2021-12-13 | Sk-01

zedd
ARCHITECTURE
Z-627 maitland street london ontario N5Y 2V7 519 518 9333
www.zeddarchitecture.com info@zeddarchitecture.com

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File: Z:\Projects\2020\20-002 - Southdale - Royal Premier Homes\02 Drawings\20-002 - Royal Premier Homes_V11.rvt

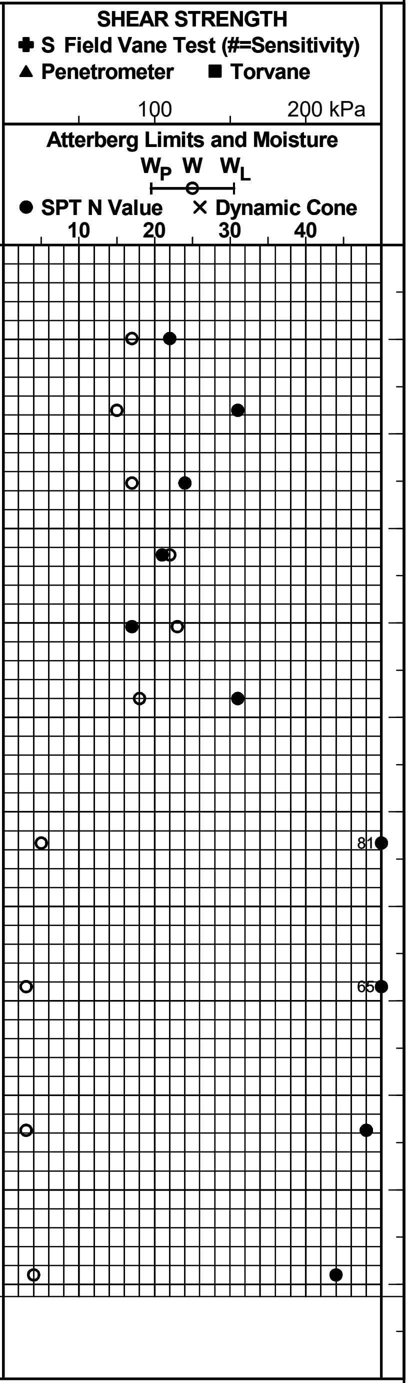
Appendix C – Borehole Logs

BOREHOLE LOG

BH1
Sheet 1 of 1

CLIENT **Western Prestige Village** PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex** DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON** DATES: Boring **November 21, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
	279.3						
0	279.0	**TOPSOIL** - 300 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff to hard, moist					
1			SS	S1	300	22	17
			SS	S2	350	31	15
2							
			SS	S3	400	24	17
3		- becoming grey near 2.9 m bgs					
			SS	S4	200	21	22
4			SS	S5	400	17	23
			SS	S6	300	31	18
5							
	273.8						
		SAND - brown, fine to medium grained, trace silt, trace gravel, dense to very dense, damp to moist - silty in upper level					
6			SS	S7	450	81	5
7							
8			SS	S8	300	65	3
9			SS	S9	300	48	3
10							
11	268.2		SS	S10	300	44	4
		End of Borehole at 11.1 m bgs.					
12							



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 9.8 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH2
Sheet 1 of 1

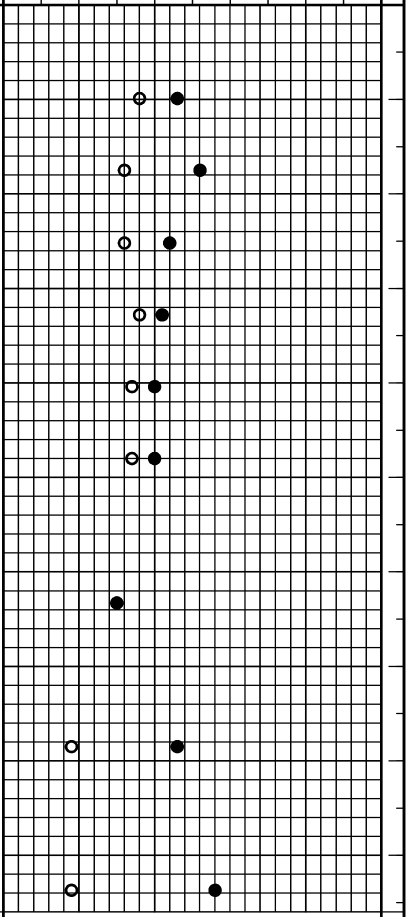
CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 21, 2019**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	279.3						
	279.1	**TOPSOIL** - 250 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff, moist					
1			SS	S1	350	23	18
			SS	S2	450	26	16
2							
			SS	S3	400	22	16
3			SS	S4	0	21	18
		- becoming grey near 3.7 m bgs					
4			SS	S5	450	20	17
			SS	S6	0	20	17
5							
6			SS	S7	400	15	15
7		- becoming damp near 7.1 m bgs					
		- moist sand layer encountered near 7.6 m bgs	SS	S8	450	23	9
8							
9			SS	S9	300	28	9
	269.7	**End of Borehole at 9.6 m bgs.**					
10							
11							
12							

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa

Atterberg Limits and Moisture
W_P W W_L

● SPT N Value × Dynamic Cone
10 20 30 40



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 8.8 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS
G Specific Gravity
H Hydrometer
S Sieve Analysis
γ Unit Weight
P Field Permeability
K Lab Permeability
C Consolidation
CD Consolidated Drained Triaxial
CU Consolidated Undrained Triaxial
UU Unconsolidated Undrained Triaxial
UC Unconfined Compression
DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

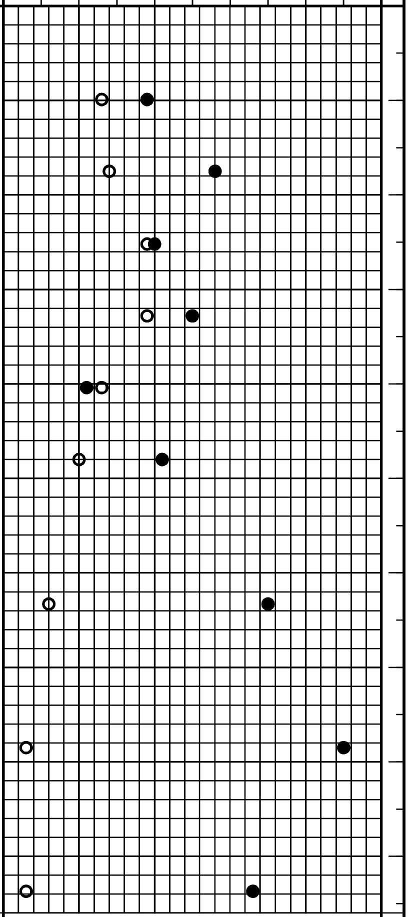
BH3/MW
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 22, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	281.9						
	281.5	**TOPSOIL** - 350 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff, moist	SS	S1	300	19	13
			SS	S2	300	28	14
			SS	S3	350	20	19
			SS	S4	200	25	19
	277.8	**SANDY SILT TILL** - brown, trace clay, trace gravel, compact, moist	SS	S5	300	11	13
			SS	S6	300	21	10
	276.9	**SAND** - brown, fine to medium grained, trace silt, trace gravel, dense, damp to moist					
			SS	S7	400	35	6
		- some gravel near 7.6 m bgs	SS	S8	400	45	3
			SS	S9	450	33	3
	272.3	**End of Borehole at 9.6 m bgs.**					

STRATA PLOT / WELL LOG

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

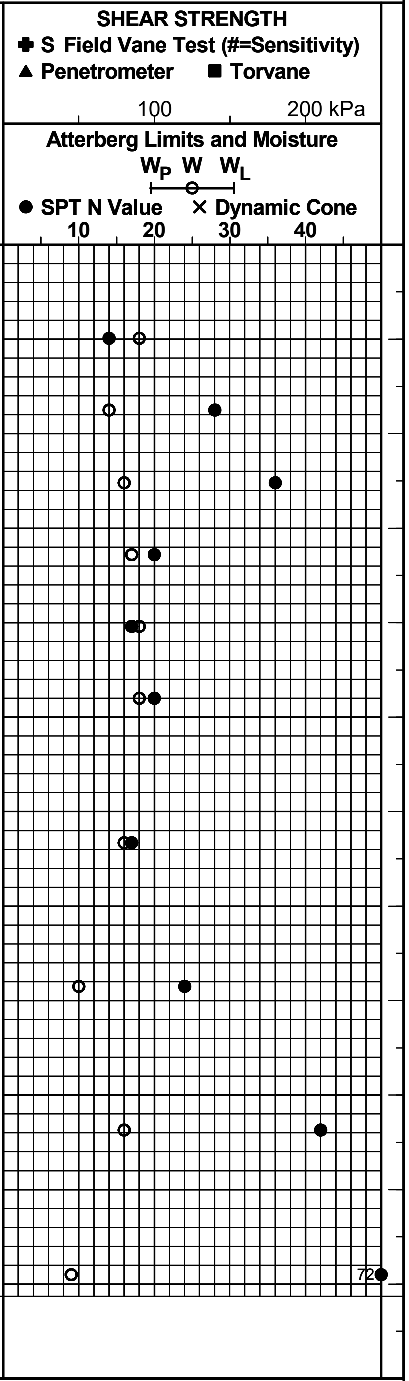
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH4
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 21, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	280.6								
	280.2	**TOPSOIL** - 350 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to hard, moist			SS	S1	250	14	18
					SS	S2	400	28	14
		- possible cobble encountered near 2.4 m bgs			SS	S3	300	36	16
					SS	S4	400	20	17
					SS	S5	300	17	18
					SS	S6	400	20	18
		- becoming grey near 5.6 m bgs							
					SS	S7	400	17	16
	273.2	SAND AND GRAVEL - grey, trace silt, compact, moist			SS	S8	300	24	10
	272.3	**SILTY CLAY TILL** - grey, trace sand, trace gravel, hard, damp to moist			SS	S9	400	42	16
11	269.4				SS	S10	300	72	9
		End of Borehole at 11.1 m bgs.							



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 10.4 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

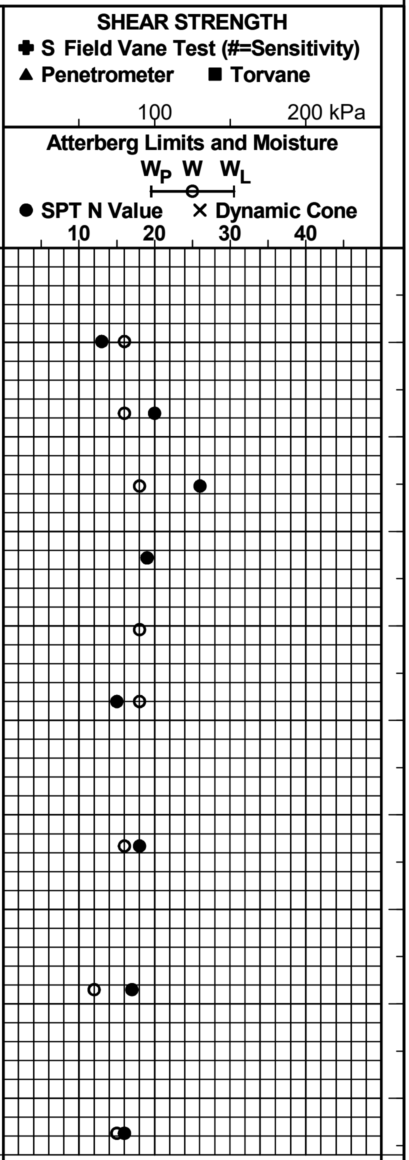
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH5
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 22, 2019**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	279.9						
	279.6	**TOPSOIL** - 300 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to very stiff, moist					
1			SS	S1	300	13	16
			SS	S2	400	20	16
2							
			SS	S3	400	26	18
3			SS	S4	450	19	19
4		- becoming grey near 4.0 m bgs	AS	S5			18
			SS	S6	450	15	18
5							
6			SS	S7	450	18	16
7							
			SS	S8	450	17	12
8							
9							
	270.3		SS	S9	450	16	15
10		**End of Borehole at 9.6 m bgs.**					
11							
12							



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 9.1 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

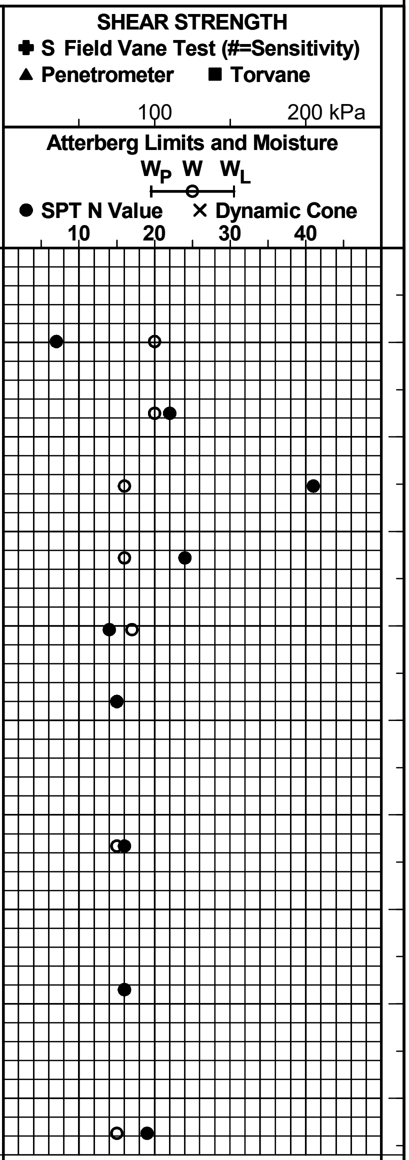
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH6
Sheet 1 of 1

CLIENT **Western Prestige Village** PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex** DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON** DATES: Boring **November 22, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	278.7						
	278.4	**TOPSOIL** - 300 mm					
1	277.3	**CLAYEY SILT** - brown, weathered, some sand, firm, very moist	SS	S1	300	7	20
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to hard, moist	SS	S2	400	22	20
2			SS	S3	450	41	16
3		- becoming grey near 2.9 m bgs	SS	S4	450	24	16
4			SS	S5	450	14	17
5			SS	S6	450	15	15
6			SS	S7	450	16	15
7							
8			SS	S8	0	16	16
9	269.1		SS	S9	350	19	15
10		**End of Borehole at 9.6 m bgs.**					
11							
12							



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 9.1 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

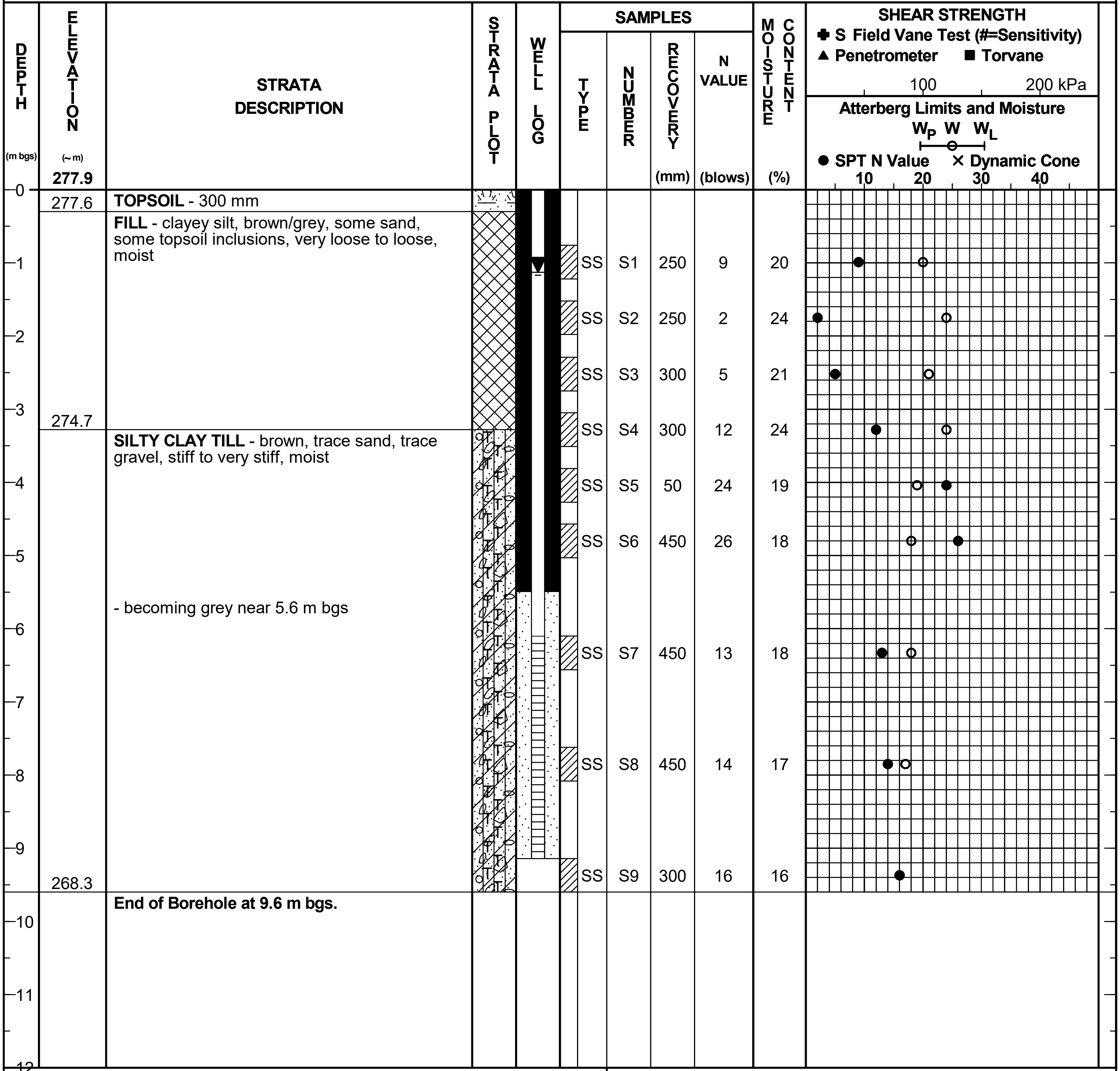
G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH7/MW
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 22, 2019**
Water Level



DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION
0	277.9	
	277.6	**TOPSOIL** - 300 mm
		FILL - clayey silt, brown/grey, some sand, some topsoil inclusions, very loose to loose, moist
	274.7	**SILTY CLAY TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist
		- becoming grey near 5.6 m bgs
	268.3	**End of Borehole at 9.6 m bgs.**

TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
SS	S1	250	9	20
SS	S2	250	2	24
SS	S3	300	5	21
SS	S4	300	12	24
SS	S5	50	24	19
SS	S6	450	26	18
SS	S7	450	13	18
SS	S8	450	14	17
SS	S9	300	16	16

NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

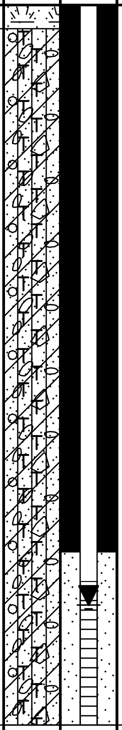
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH8A/MW
Sheet 1 of 1

CLIENT **Western Prestige Village** PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex** DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON** DATES: Boring **November 23, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	SHEAR STRENGTH
0	279.1									
	278.9	**TOPSOIL** - 250 mm								
		SILTY CLAY TILL - brown, trace sand, trace gravel, moist								
		- becoming grey near 3.7 m bgs								
	271.5									
		End of Borehole at 7.6 m bgs.								



SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

Depth scale (m bgs): 0 1 2 3 4 5 6 7 8 9 10 11 12

NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

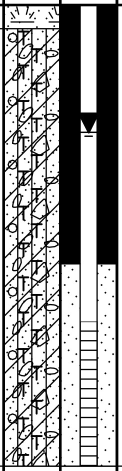
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH8B/MW
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 23, 2019**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	279.1						
	278.9	**TOPSOIL** - 250 mm					
		SILTY CLAY TILL - brown, trace sand, trace gravel, moist					
		- becoming grey near 3.7 m bgs					
	274.2						
5		**End of Borehole at 4.9 m bgs.**					



SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40

NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

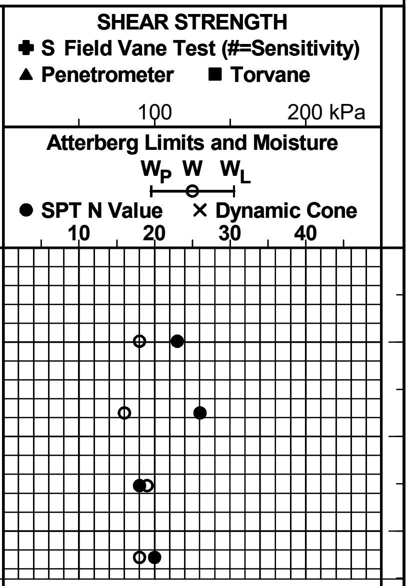
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH9
Sheet 1 of 1

CLIENT **Western Prestige Village** PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex** DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON** DATES: Boring **November 22, 2019** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	278.8								
	278.5	**TOPSOIL** - 300 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff, moist							
1					▨ SS	S1	300	23	18
					▨ SS	S2	400	26	16
2									
					▨ SS	S3	450	18	19
3									
	275.3				▨ SS	S4	450	20	18
		End of Borehole at 3.5 m bgs.							
4									
5									
6									
7									
8									
9									
10									
11									
12									



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 3.1 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

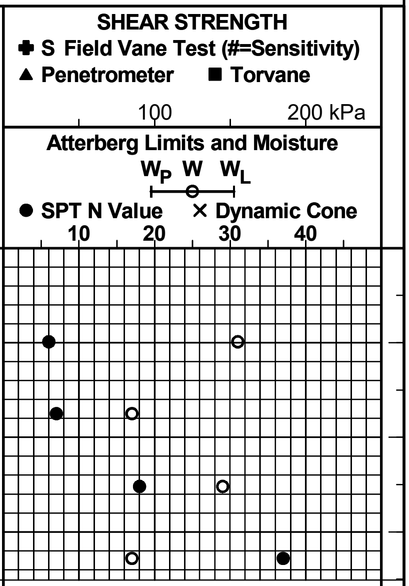
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH10
Sheet 1 of 1

CLIENT **Western Prestige Village**
PROJECT NO. **KCH-00257251-A0**
PROJECT **Proposed Apartment Complex**
DATUM **Geodetic**
LOCATION **735 Southdale Road West, London, ON**
DATES: Boring **November 21, 2019**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	279.7						
	279.4	**TOPSOIL** - 300 mm					
		FILL - clayey silt, brown/grey, some sand, some topsoil inclusions, loose, moist					
1			SS	S1	300	6	31
			SS	S2	200	7	17
	277.7						
2		**SILTY CLAY TILL** - brown, trace sand, trace gravel, very stiff to hard, moist					
			SS	S3	450	18	29
3			SS	S4	400	37	17
	276.2						
		End of Borehole at 3.5 m bgs.					
4							
5							
6							
7							
8							
9							
10							
11							
12							



NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Log must be read in conjunction with EXP Report KCH-00257251-A0.
2) Borehole was open to 3.1 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

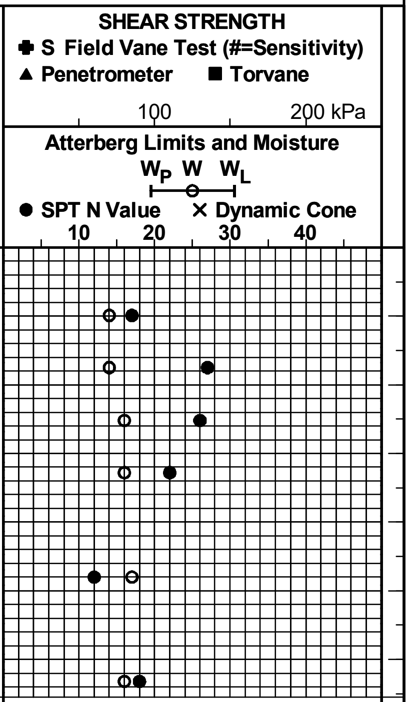
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH1
Sheet 1 of 1

CLIENT **Southside Group**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	279.0								
	278.6	**TOPSOIL** - 400 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to very stiff, moist							
1					SS	S1	400	17	14
					SS	S2	450	27	14
2		- becoming grey near 2.1 m bgs			SS	S3	450	26	16
3					SS	S4	300	22	16
4									
5					SS	S5	400	12	17
6									
	272.5				SS	S6	450	18	16
7		**End of Borehole at 6.6 m bgs.**							
8									
9									
10									
11									
12									
13									
14									
15									
16									



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH2/MW
Sheet 1 of 1

Client Southside Construction Management Limited
Project No. LON-00016262-GE
Project Name Talbot Village - Phase 7
Datum Geodetic
Site Location 3095 Bostwick Road, LOndon, ON
Boring Date May 29, 2018

DEPTH (ft bgs)	DEPTH (m bgs)	ELEVATION (m) 274.5	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	REMARKS
0.0	0.0	274.1	**TOPSOIL** - 400 mm								Well Stickup: 0.72 m
1.3	0.4		**SILTY CLAY TILL** - brown, trace gravel, trace sand, stiff to very stiff, moist								Auger Hole Diameter: 200 mm
						SS	S1	400	18	16	
						SS	S2	400	24	16	Standpipe Diamter: 50 mm
						SS	S3	450	19	16	
9.5	2.9		- becoming grey near 2.9 m bgs			SS	S4	450	13	18	
						SS	S5	450	12		
						SS	S6	450	13	15	
						SS	S7	400	20	13	
29.9	9.1		- sandy silt layering encountered near 9.1 m bgs			SS	S8	450	25	16	
33.2	10.1	264.4									Top of Sand Pack Elev: 264.5 m
			SANDY SILT - grey, trace clay, very dense, wet								Top of Screen Elev: 263.9 m
						SS	S9	450	53	18	
											Bottom of Screen Elev: 262.3 m
40.0	12.2	262.3				AS	S10			17	
			End of Borehole at 12.2 m bgs.								

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

exp.

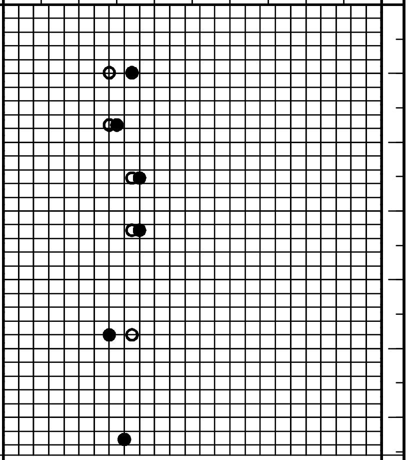
BOREHOLE LOG

BH3
Sheet 1 of 1

CLIENT **Southside Group**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 31, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	277.3								
	277.0	**TOPSOIL** - 250 mm							
		SILTY CLAY TILL - brown, trace sand, trace gravel, stiff to very stiff, moist							
1					SS	S1	400	17	14
					SS	S2	450	15	14
2					SS	S3	450	18	17
3					SS	S4	450	18	17
		- becoming grey near 3.5 m bgs							
4									
5					SS	S5	450	14	17
6	270.7				SS	S6	450	16	16
		End of Borehole at 6.6 m bgs.							
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

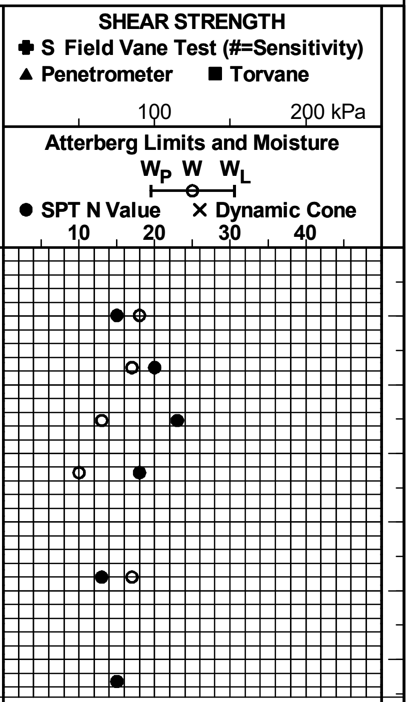
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH4
Sheet 1 of 1

CLIENT **Southside Group** PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7** DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON** DATES: Boring **May 31, 2018** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	276.2						
	275.9	**TOPSOIL** - 300 mm					
		FILL - sand to silty clay, brown, trace gravel, compact, very moist					
1	274.9		SS	S1	400	15	18
		SILTY CLAY TILL - brown, trace gravel, trace sand, stiff to very stiff, moist - occasional silt lenses encountered from 2.3 m to 3.4 m bgs - becoming grey near 2.9 m bgs	SS	S2	450	20	17
			SS	S3	450	23	13
3			SS	S4	400	18	10
5			SS	S5	450	13	17
6	269.7		SS	S6	450	15	15
		End of Borehole at 6.6 m bgs.					



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH5
Sheet 1 of 1

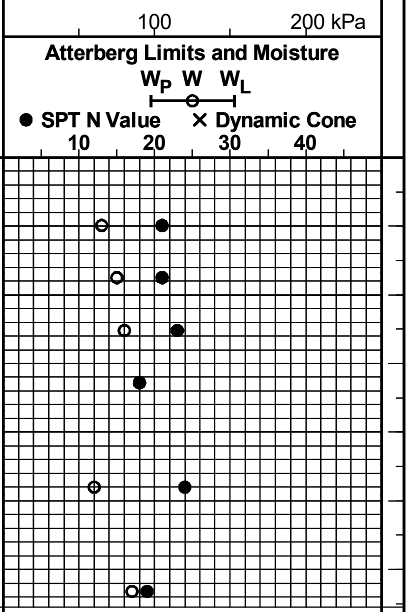
CLIENT **Southside Group**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	277.4							
	277.1	**TOPSOIL** - 300 mm						
		SILTY CLAY TILL - brown, trace sand, trace gravel, very stiff, moist						
1				SS	S1	400	21	13
				SS	S2	450	21	15
2								
				SS	S3	450	23	16
3								
				SS	S4	400	18	18
		- becoming grey near 3.5 m bgs						
4								
				SS	S5	450	24	12
5								
		- wet sand and gravel seam encountered near 5.2 m bgs	⊻					
6								
	270.9			SS	S6	450	19	17
		End of Borehole at 6.6 m bgs.						
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane

Atterberg Limits and Moisture
W_P W W_L

● SPT N Value ✕ Dynamic Cone



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open to 6.1 m bgs and groundwater measured near 5.8 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

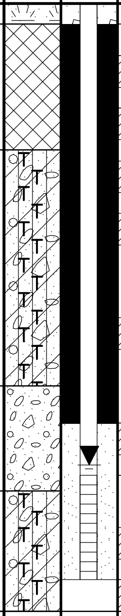
G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
⊻ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH6/MW
Sheet 1 of 1

Client Southside Construction Management Limited
Project No. LON-00016262-GE
Project Name Talbot Village - Phase 7
Datum Geodetic
Site Location 3095 Bostwick Road, LOndon, ON
Boring Date May 30, 2018



DEPTH (ft bgs)	DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	REMARKS
		277.3							
0.0	0.0	277.0	**TOPSOIL** - 300 mm						Well Stickup: 0.67 m
1.0	0.3		**FILL** - sandy silt, brown, some clay, trace gravel, compact, moist to very moist	SS	S1	400	13	14	Auger Hole Diameter: 200 mm
				SS	S2	400	14	19	Standpipe Diamter: 50 mm
7.0	2.1	275.2	**SILTY CLAY TILL** - grey, trace sand, trace gravel, stiff to very stiff, moist	SS	S3	450	11	19	
10.0	3.1			SS	S4	450	11	12	
				SS	S5	450	17	15	
18.2	5.6	271.8	**SAND AND GRAVEL** - brown, trace silt, compact, very moist to wet	SS	S6	400	24	9	Top of Sand Pack Elev: 271.2 m
									Top of Screen Elev: 270.5 m
23.3	7.1	270.2	**SILTY CLAY TILL** - brown, some sand, trace gravel, hard, moist - occasional sand lenses	SS	S7	450	46	11	
									Bottom of Screen Elev: 268.9 m
29.0	8.8	268.5		SS	S8	375	59	10	
			End of Borehole at 8.8 m bgs.						

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

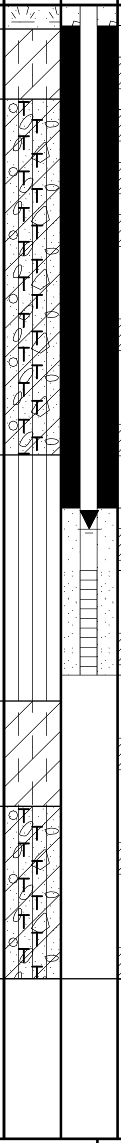
G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH7/MW
Sheet 1 of 1

Client Southside Construction Management Limited
Project Name Talbot Village - Phase 7
Site Location 3095 Bostwick Road, LOndon, ON
Project No. LON-00016262-GE
Datum Geodetic
Boring Date May 29, 2018



DEPTH (ft bgs)	DEPTH (m bgs)	ELEVATION (m) 274.8	STRATA DESCRIPTION	SAMPLES				MOISTURE CONTENT (%)	REMARKS
				TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		
0.0	0.0	274.4	**TOPSOIL** - 350 mm						Well Stickup: 0.78 m
1.1	0.4		**SILTY CLAY** - brown/grey, weathered, trace sand, trace gravel, firm, moist						Auger Hole Diameter: 200 mm
				SS	S1	400	5	26	
4.5	1.4	273.4	**SILTY CLAY TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist	SS	S2	450	13	16	Standpipe Diamter: 50 mm
				SS	S3	400	22	14	
11.5	3.5		- becoming grey near 3.5 m bgs	SS	S4	450	24	14	
				SS	S5	450	15	14	
21.5	6.6	268.2		SS	S6	400	30	15	
			SILT - grey, trace clay, some sand, dilatant, dense to very dense, very moist to wet						Top of Sand Pack Elev: 267.5 m
				SS	S7	400	50*	17	Top of Screen Elev: 266.6 m
				SS	S8	400	31	24	Bottom of Screen Elev: 265.0 m
33.2	10.1	264.7	**SILTY CLAY** - grey, trace sand, stiff, moist						
				SS	S9	450	9	19	
38.3	11.7	263.1	**SILTY CLAY TILL** - grey, trace sand, trace gravel, very stiff to hard, moist - possible cobble encountered near 12.2 m bgs						
40.0	12.2			SS	S10	400	38	10	
46.5	14.2	260.6		SS	S11	400	23	10	
			End of Borehole at 14.2 m bgs.						

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

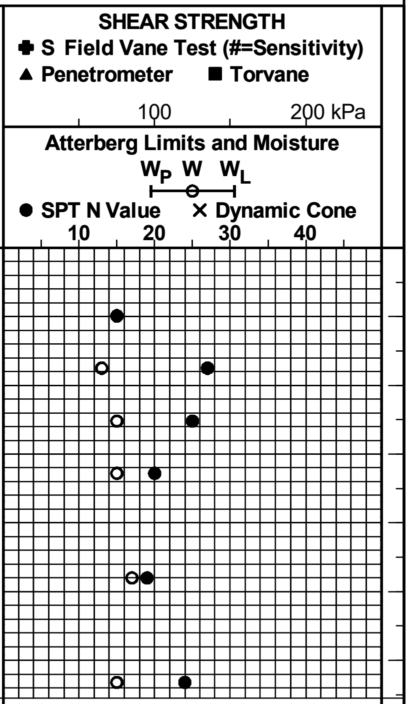
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH8
Sheet 1 of 1

CLIENT **Southside Group** PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7** DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON** DATES: Boring **May 31, 2018** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	275.4						
	275.1	**TOPSOIL** - 350 mm					
1		**SILTY CLAY TILL** - brown, trace sand, trace gravel, very stiff, moist	SS	S1	400	15	15
2			SS	S2	450	27	13
		- sandy silt layering encountered near 2.3 m bgs	SS	S3	450	25	15
3			SS	S4	450	20	15
5		- becoming grey near 4.9 m bgs	SS	S5	450	19	17
6	268.9	- dilatant silt lens encountered near 6.4 m bgs	SS	S6	450	24	15
7		**End of Borehole at 6.6 m bgs.**					



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH9/MW
Sheet 1 of 1

Client Southside Construction Management Limited
Project No. LON-00016262-GE
Project Name Talbot Village - Phase 7
Datum Geodetic
Site Location 3095 Bostwick Road, LOndon, ON
Boring Date May 28, 2018

DEPTH (ft bgs)	DEPTH (m bgs)	ELEVATION (m) 279.2	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	REMARKS
0.0	0.0		**TOPSOIL** - 450 mm								Well Stickup: 0.98 m
1.5	0.5	278.7	**SILTY CLAY TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist			SS	S1	400	14	17	Auger Hole Diameter: 200 mm
						SS	S2	450	21	14	Standpipe Diamter: 50 mm
						SS	S3	450	20	16	
						SS	S4	450	21	16	
12.5	3.8		- becoming grey near 3.8 m bgs								
						SS	S5	450	30	14	
20.0	6.1		- 100 mm thick wet sand and gravel seam encountered near 6.1 m bgs			SS	S6	450	36	11	
23.3	7.1	272.1	**SILT TILL** - brown, trace clay, some sand, trace gravel, very dense, moist			SS	S7	450	50*	13	
28.2	8.6	270.6	**SAND** - brown, fine to medium grained, trace silt, trace gravel, dense to very dense, damp to moist			SS	S8	400	44	2	
						SS	S9	400	59	1	
											Top of Sand Pack Elev: 267.6 m
						SS	S10	400	61	2	Top of Screen Elev: 267.0 m
						SS	S11	400	75	4	
48.3	14.7	264.5	**SILT** - brown, trace clay, some sand, dilatant lenses, moist to very moist								
51.5	15.7	263.5				SS	S12	450	85	17	Bottom of Screen Elev: 264.0 m
			End of Borehole at 15.7 m bgs.								

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

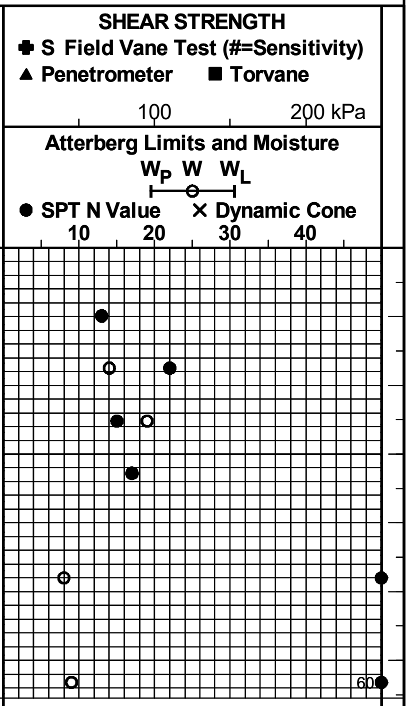
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH10
Sheet 1 of 1

CLIENT **Southside Group**
PROJECT NO. **LON-00016262-GE**
PROJECT **Proposed Talbot Village Phase 7**
DATUM **Geodetic**
LOCATION **3095 Bostwick Road, London, ON**
DATES: Boring **May 28, 2018**
Water Level

ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
279.6						
279.3	**TOPSOIL** - 300 mm					
278.2	**FILL** - silty clay, brown, trace sand, trace gravel, stiff, moist	SS	S1	400	13	13
275.6	**SILTY CLAY TILL** - brown, trace sand, trace gravel, very stiff, moist	SS SS SS	S2 S3 S4	450 425 450	22 15 17	14 19 17
273.0	**SILT TILL** - brown, trace clay, some sand, trace gravel, very dense, moist - occasional sand seams encountered near 6.0 m bgs	SS SS	S5 S6	350 450	50* 60	8 9
	End of Borehole at 6.6 m bgs.					



NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) Borehole open and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.
5) * denotes 50 blows per 75 mm split spoon sampler penetration.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH11/MW
Sheet 1 of 1

Client Southside Construction Management Limited
Project Name Talbot Village - Phase 7
Site Location 3095 Bostwick Road, LOndon, ON
Project No. LON-00016262-GE
Datum Geodetic
Boring Date May 30, 2018

DEPTH (ft bgs)	DEPTH (m bgs)	ELEVATION (m) 277.8	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)	REMARKS
0.0	0.0	277.5	**TOPSOIL** - 350 mm								Well Stickup: 0.88 m
1.1	0.4		**SILTY CLAY TILL** - brown, trace sand, trace gravel, very stiff to hard, moist			▨ SS	S1	400	22	23	Auger Hole Diameter: 200 mm
						▨ SS	S2	450	26	16	Standpipe Diamter: 50 mm
						▨ SS	S3	450	21	16	
10.2	3.1		- possible cobble encountered near 3.1 m bgs			▨ SS	S4	400	31	17	
						▨ SS	S5	400	40	11	
18.2	5.6	272.3	**SAND** - brown, fine to medium grained, trace silt, compact to very dense, damp to moist - gravelly near 6.1 m bgs			▨ SS	S6	400	32	3	
						▨ SS	S7	400	44	4	
						▨ SS	S8	450	49	4	
						▨ SS	S9	450	31	4	Top of Sand Pack Elev: 266.2 m
						▨ SS	S10	450	28	2	Top of Screen Elev: 265.6 m
						▨ SS	S11	450	48	2	
51.5	15.7	262.1				▨ SS	S12	450	85	2	Bottom of Screen Elev: 262.6 m
			End of Borehole at 15.7 m bgs.								

NOTES

1) Borehole interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00016262-GE.
2) bgs denotes below ground surface.
3) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ⊡ VN Vane Sample

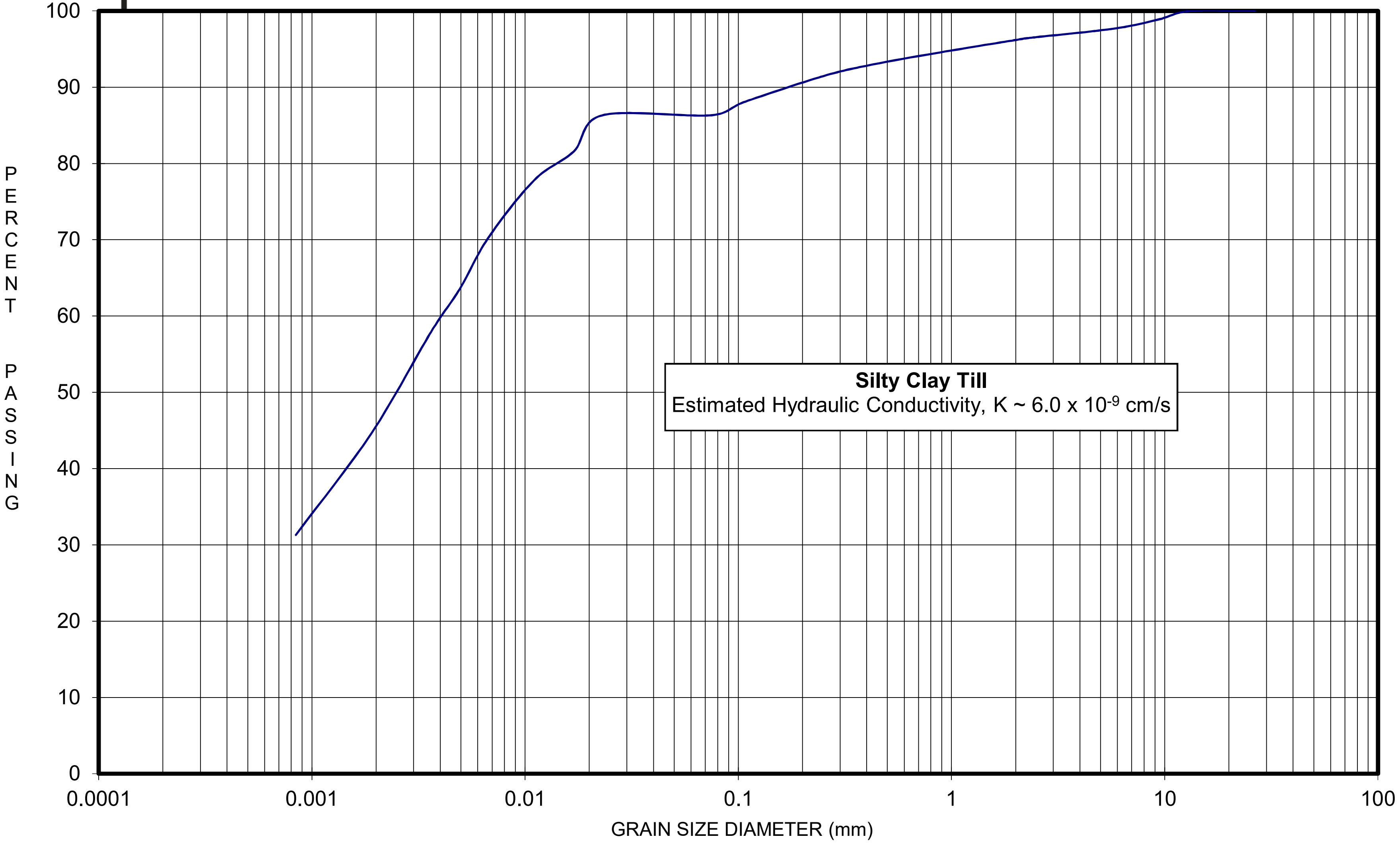
OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
∇ Apparent ▼ Measured ▲ Artesian (see Notes)

Appendix D – Grain Size Analyses

MECHANICAL GRAIN SIZE ANALYSIS



Silty Clay Till
Estimated Hydraulic Conductivity, K ~ 6.0 x 10^{-9} cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

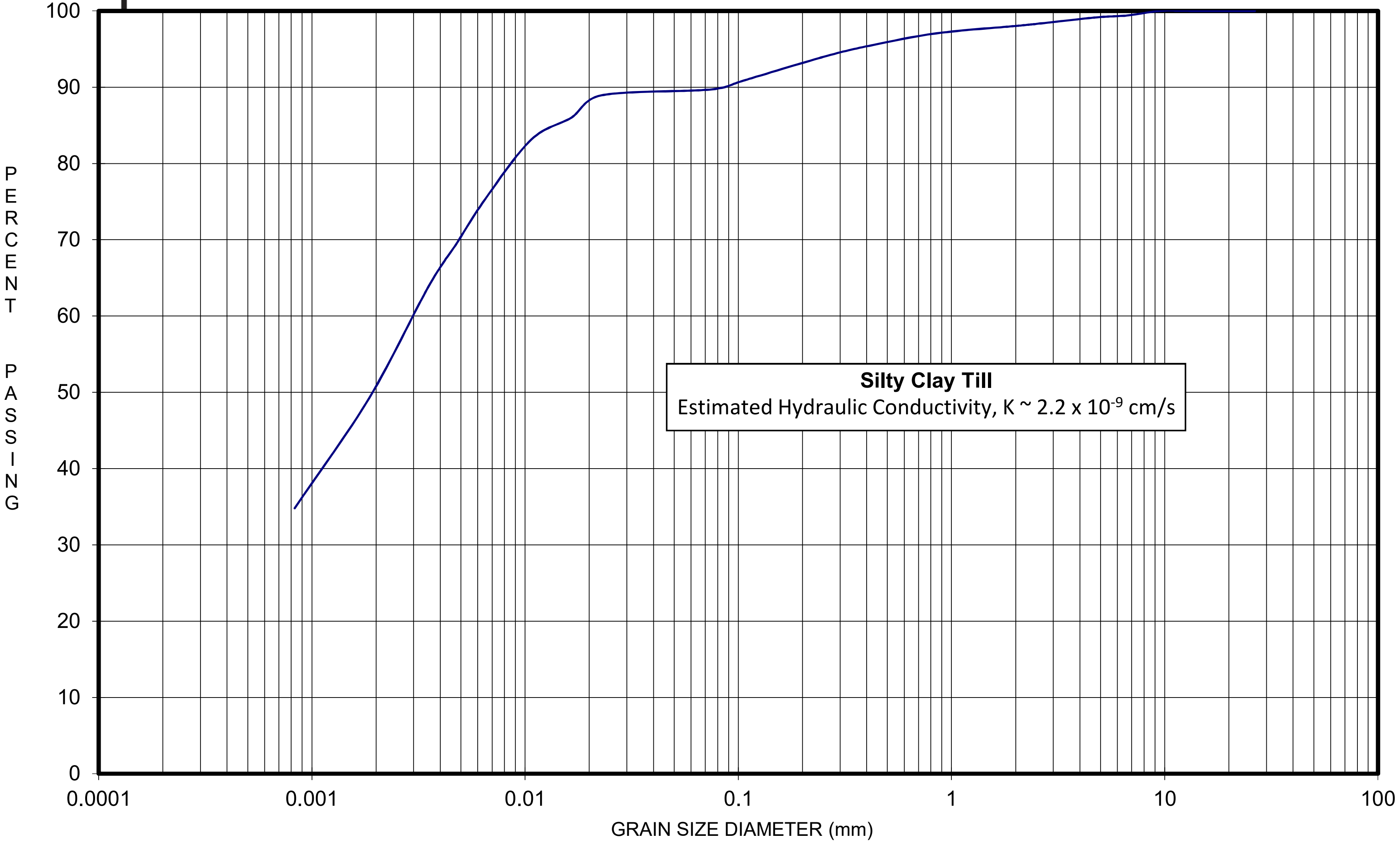
MODIFIED M.I.T. CLASSIFICATION

Sample Description:
Silty Clay Till (BH2 S5, 3.8 to 4.3 m depth)

735 Southdale Rd W, London
Project: KCH00257251-A0

Figure 1

MECHANICAL GRAIN SIZE ANALYSIS

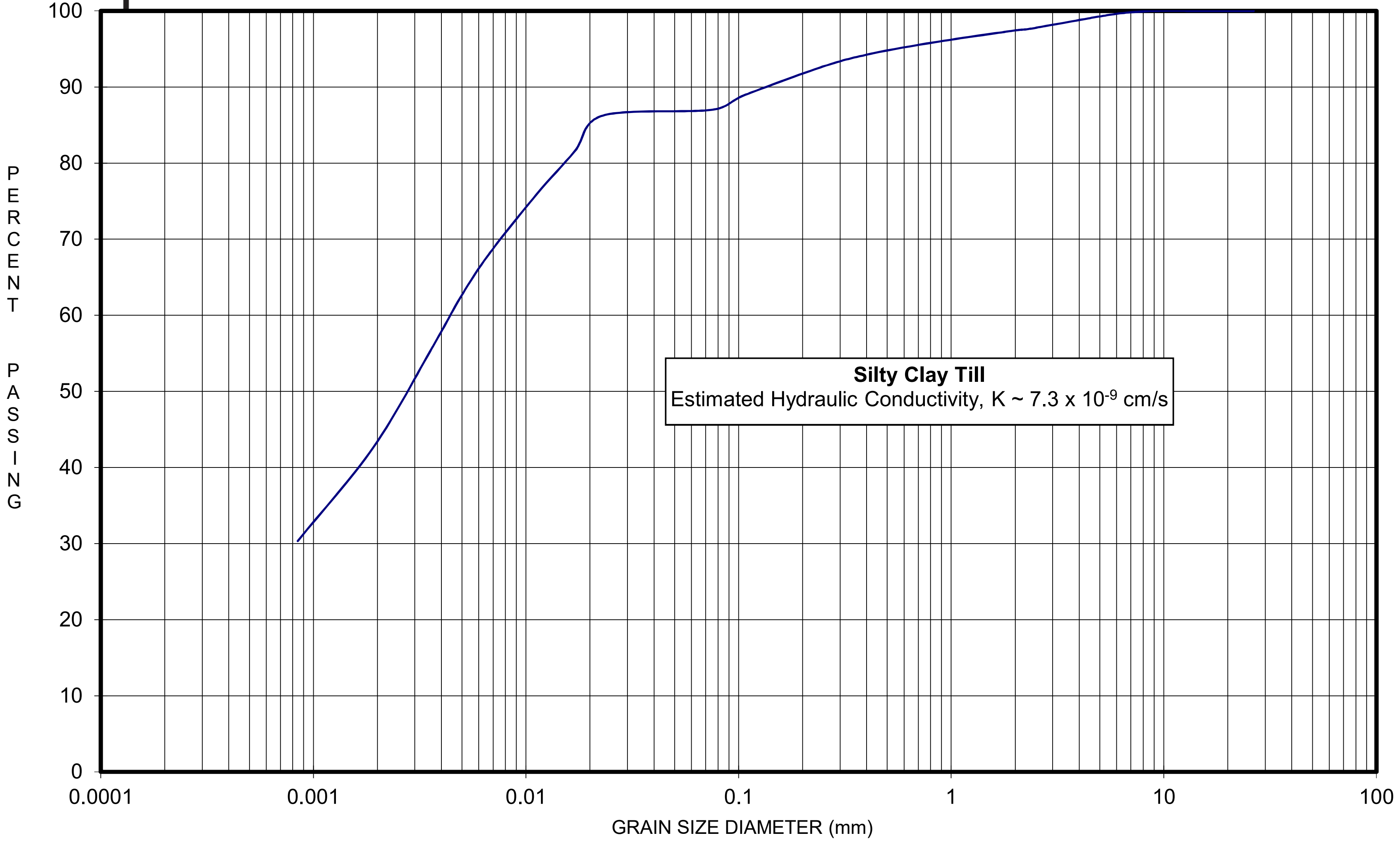


Silty Clay Till
Estimated Hydraulic Conductivity, K ~ 2.2 x 10^{-9} cm/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

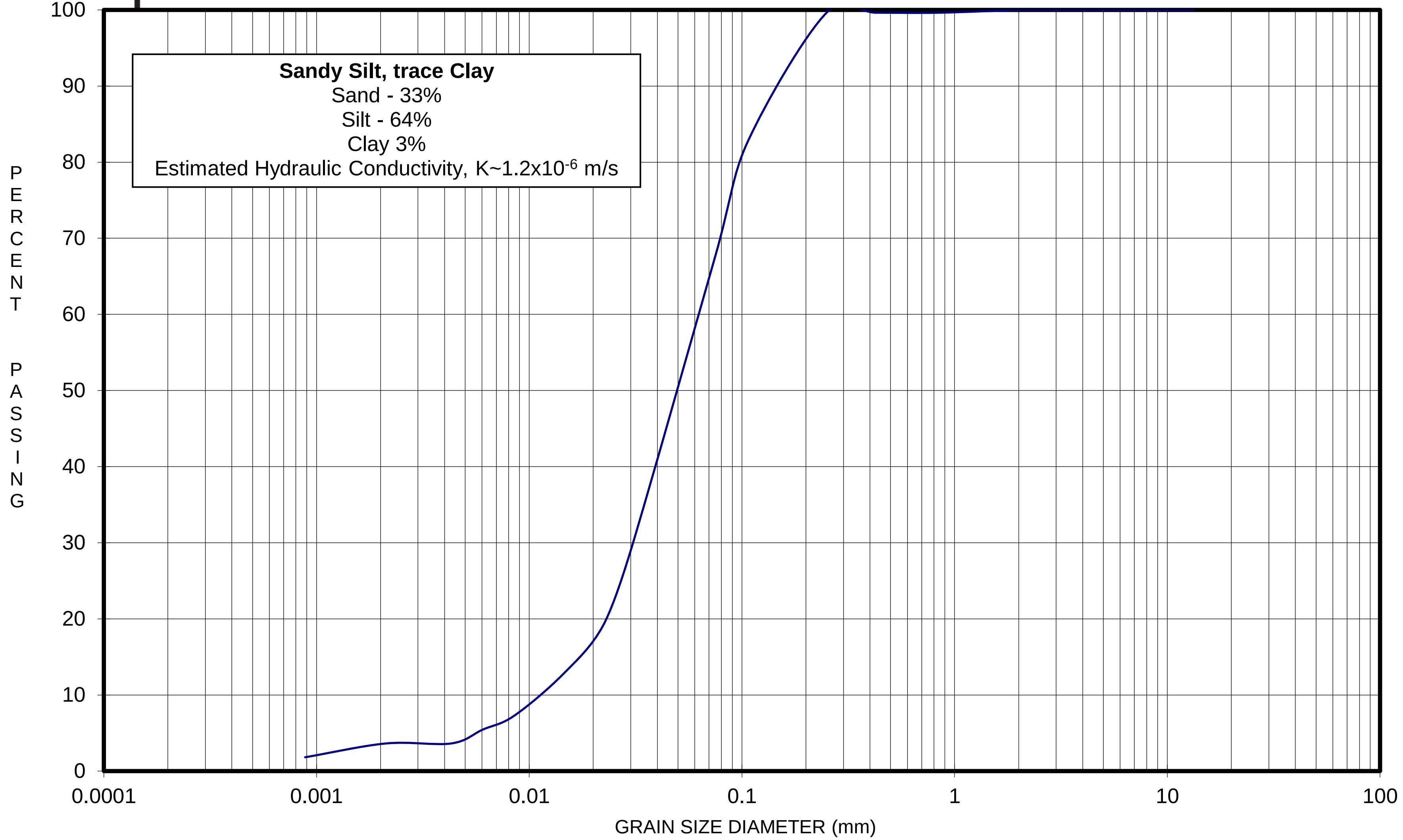
MODIFIED M.I.T. CLASSIFICATION	**Sample Description:** **Silty Clay Till (BH3 S3, 2.3 to 2.7 m depth)**	**735 Southdale Rd W, London** **Project: KCH00257251-A0**	**Figure 2**

MECHANICAL GRAIN SIZE ANALYSIS



<table>
<tr><td rowspan="2">CLAY</td><td>FINE</td><td>MEDIUM</td><td>COARSE</td><td>FINE</td><td>MEDIUM</td><td>COARSE</td><td>FINE</td><td>MEDIUM</td><td>COARSE</td><td rowspan="2"></td></tr>
<tr><td colspan="3">SILT</td><td colspan="3">SAND</td><td colspan="3">GRAVEL</td></tr>
<tr><td>MODIFIED M.I.T. CLASSIFICATION</td><td colspan="5">Sample Description:
Silty Clay Till (BH7 S8, 7.6 to 8.1 m depth)</td><td colspan="3">735 Southdale Rd W, London
Project: KCH00257251-A0</td><td colspan="2">Figure 3</td></tr>
</table>

MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

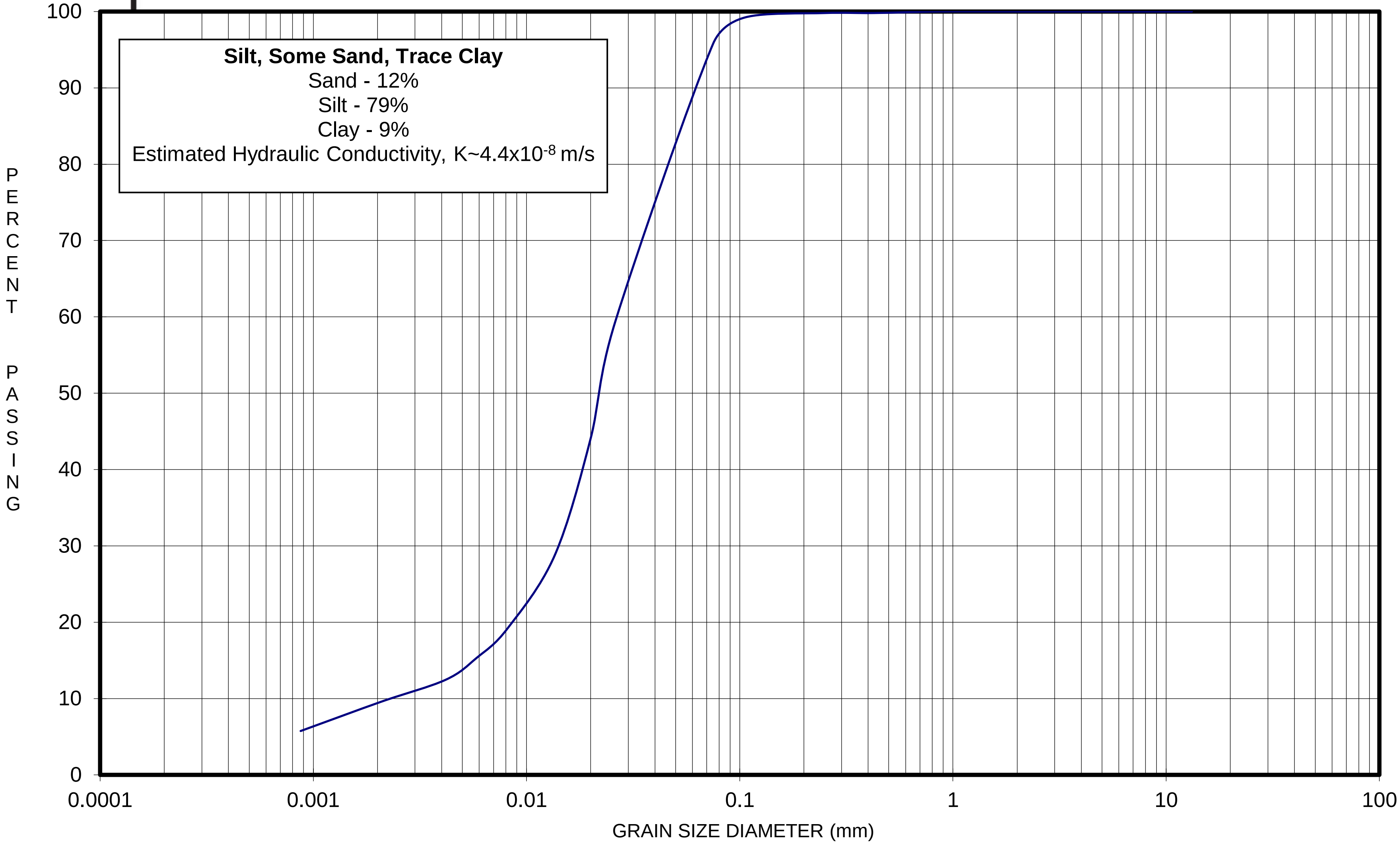
MODIFIED M.I.T. CLASSIFICATION

Sample Description:
BH2/MW S9 - 10.7 m bgs

Project: LON-00016262-HG

Figure 1

MECHANICAL GRAIN SIZE ANALYSIS



Silt, Some Sand, Trace Clay
Sand - 12%
Silt - 79%
Clay - 9%
Estimated Hydraulic Conductivity, K~4.4x10^{-8} m/s

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

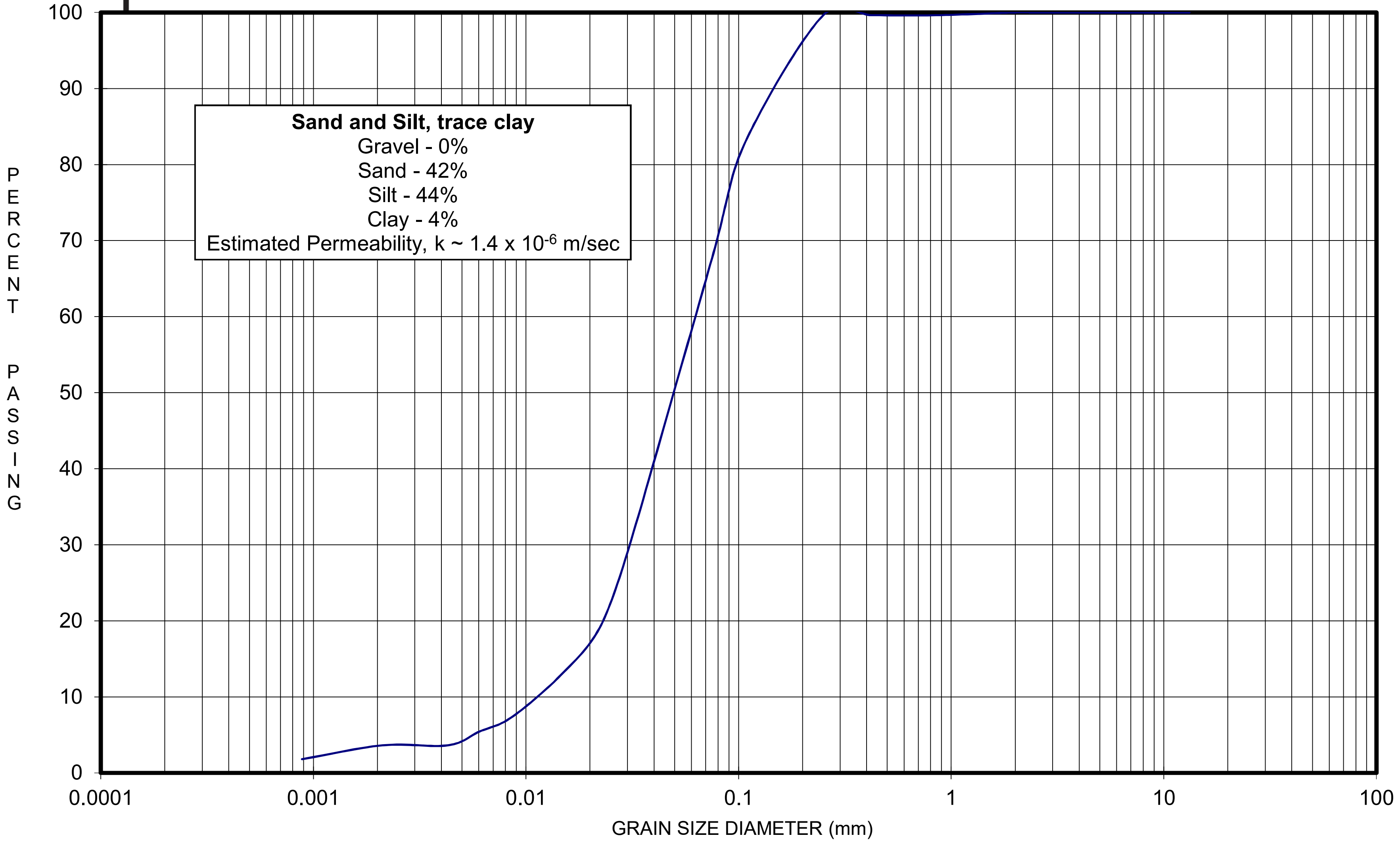
MODIFIED M.I.T. CLASSIFICATION

Sample Description:
BH7/MW S8 - Depth 9.1 m bgs

Project: LON-00016262-HG

Figure 2

MECHANICAL GRAIN SIZE ANALYSIS



Sand and Silt, trace clay
Gravel - 0%
Sand - 42%
Silt - 44%
Clay - 4%
Estimated Permeability, k ~ 1.4 x 10^{-6} m/sec

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

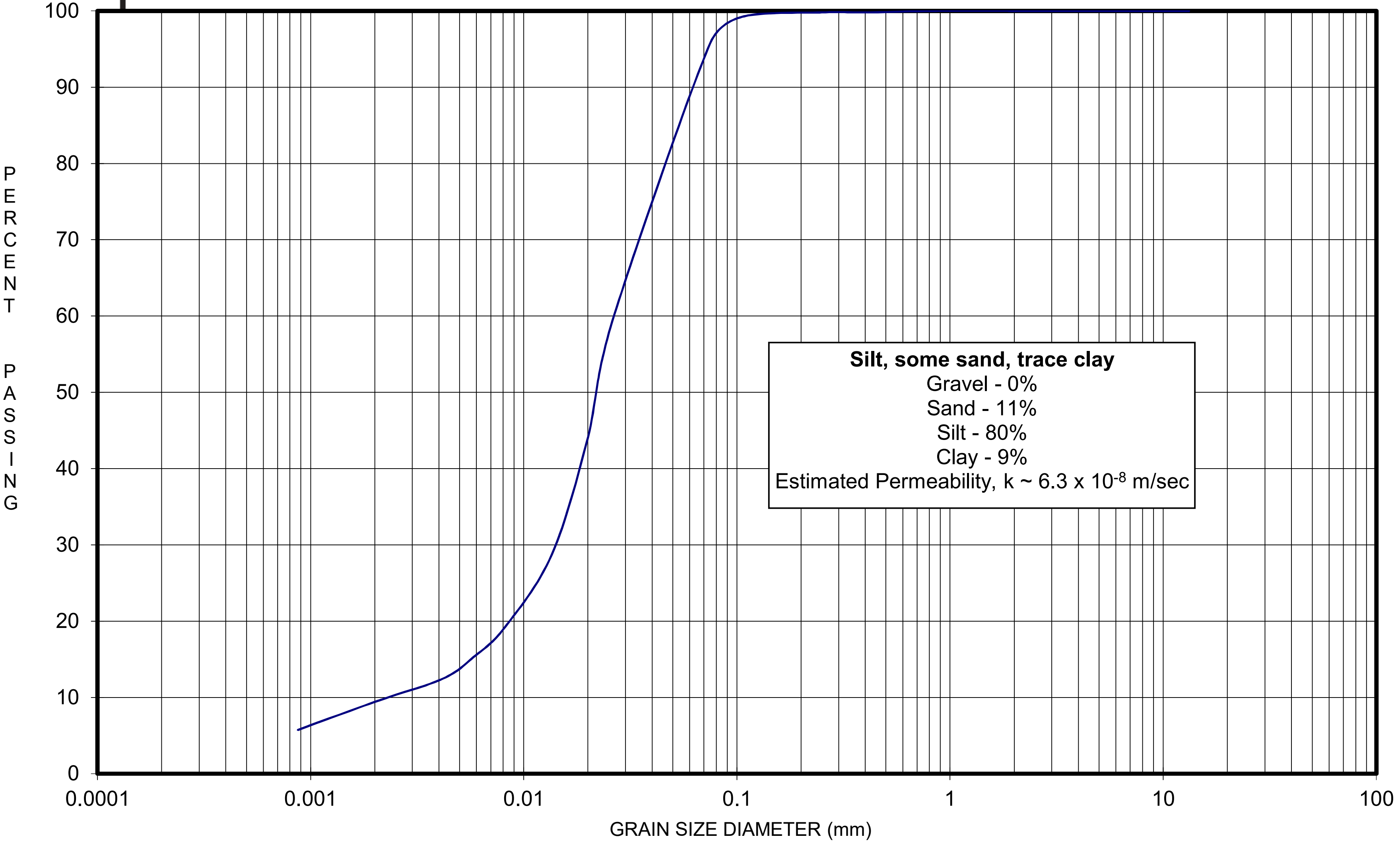
MODIFIED M.I.T. CLASSIFICATION

Sample Description:
Sand and Silt (BH2/MW S9 (10.7 - 11.1 m bgs)

Talbot Village Phase 7
Project: LON-00016262-GE

Figure 1

MECHANICAL GRAIN SIZE ANALYSIS



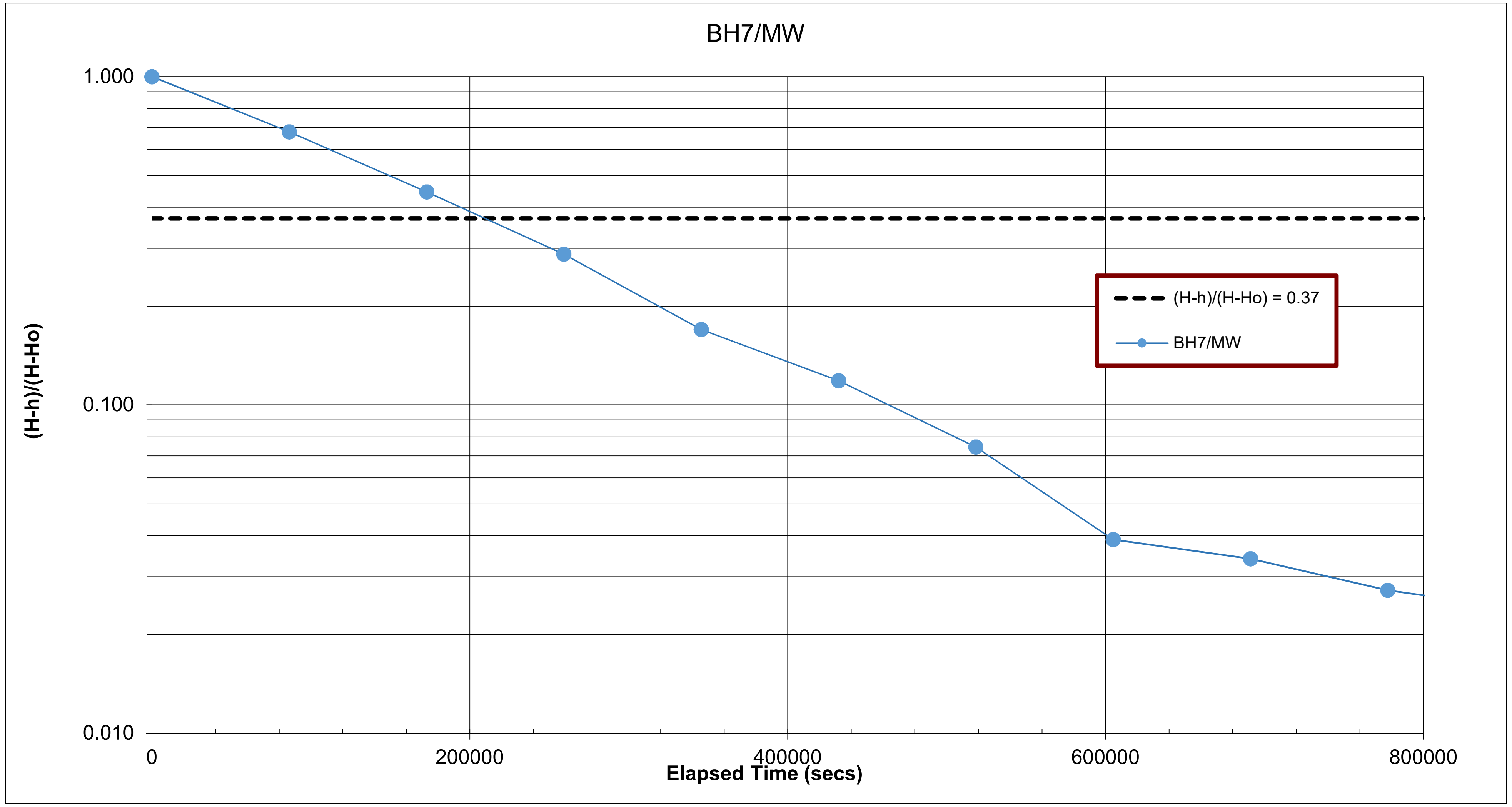
Silt, some sand, trace clay
Gravel - 0%
Sand - 11%
Silt - 80%
Clay - 9%
Estimated Permeability, k ~ 6.3 x 10^{-8} m/sec

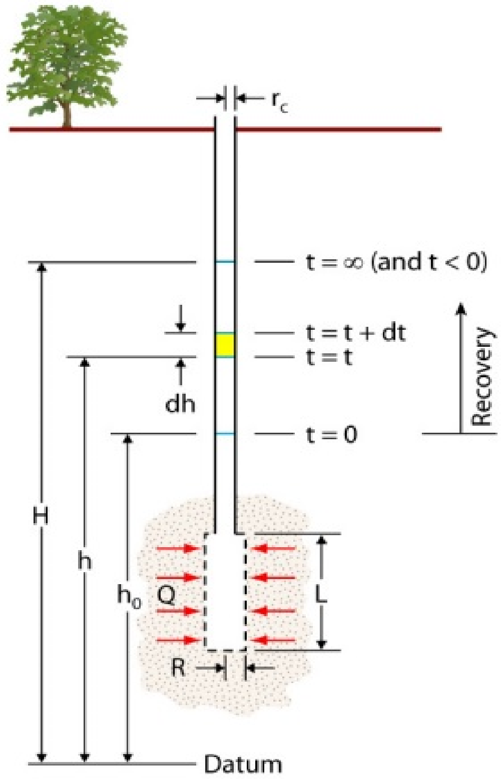
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION	**Sample Description:** **Silt (BH7/MW S8, 9.1 - 9.6 m bgs)**						**Talbot Village Phase 7** **Project: LON-00016262-GE**		**Figure 3**	

Appendix E – Single Well Response Tests

Recovery Testing - Hvorslev Method (1951)

Project Number: KCH-00257251-A0
Date ot Test: 27-Apr-20
Completed by: MB





Initial Water Level 3.07 m bgs
Maximum Drawdown 6.66 m

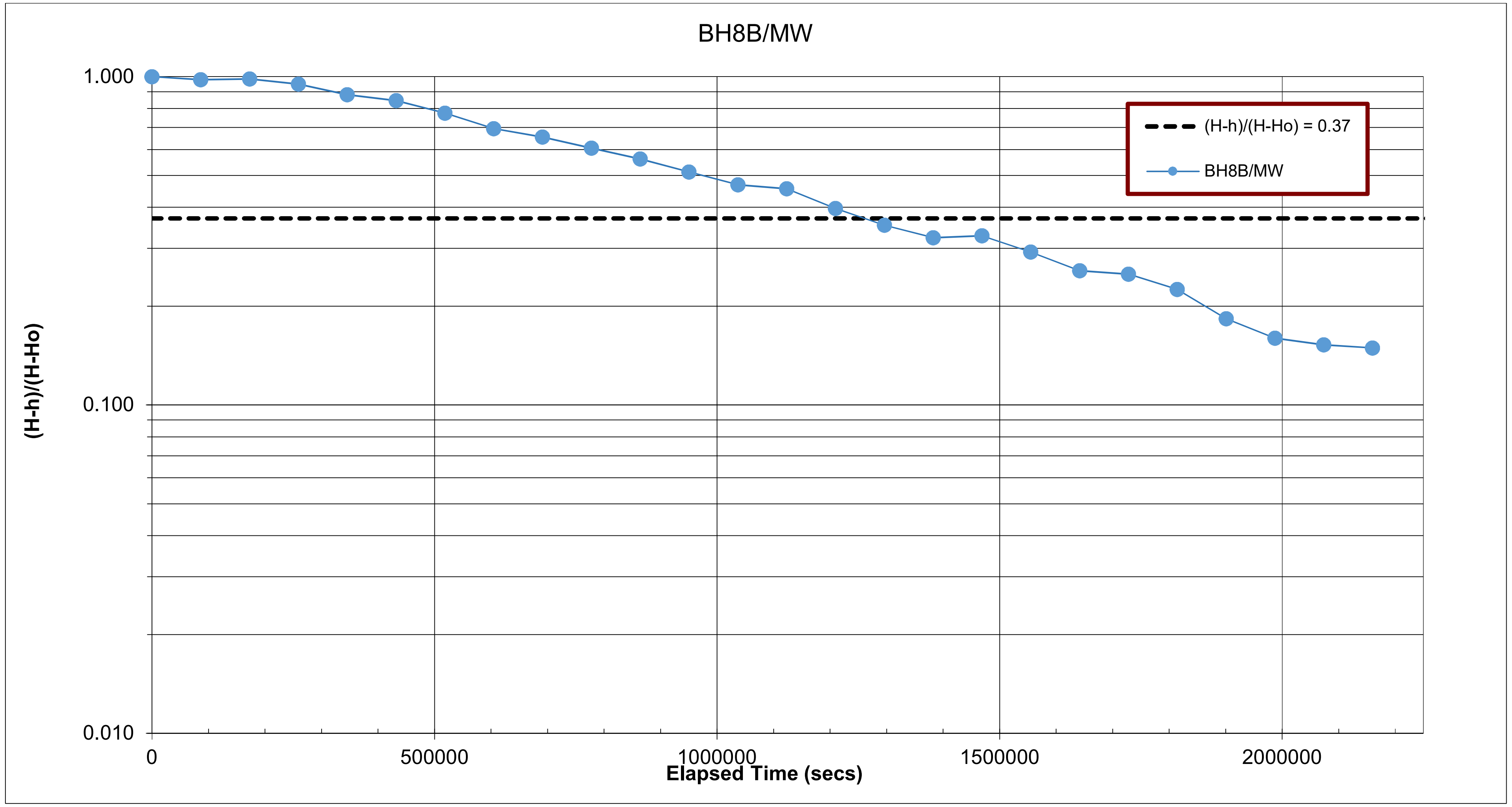
r (m) =	0.0254
L (m) =	3.05
R (m) =	0.1048
T_o (sec) =	205,000
K (m/s) =	1.7E-09

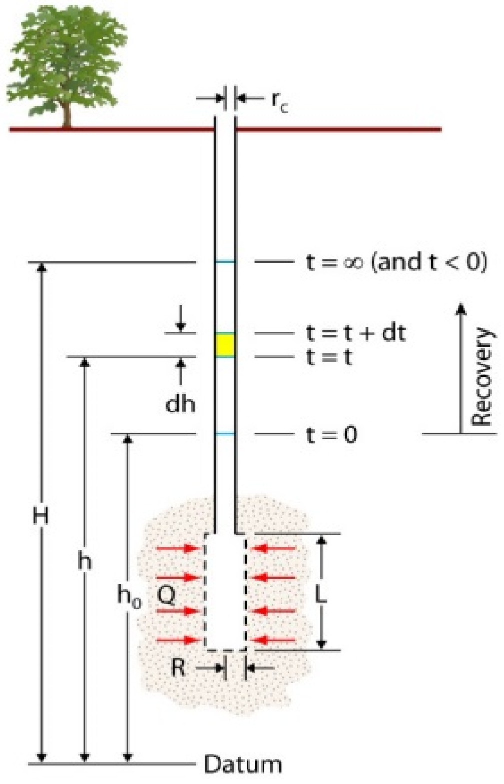
Note:
1 - T_o is determined from plots where (H-h)/(H-Ho) = 0.37

K = Hydraulic Conductivity
r = radius of well casing
R = Radius of well screen or filter pack
L = Length of the well screen (in Slug Test) or the length of submerged portion of the well screen (in Rising Head)
T_0 = time for water level to rise or fall to 37% of the initial change

Recovery Testing - Hvorslev Method (1951)

Project Number	KCH-00257251-A0
Date ot Test	27-Apr-20
Completed by	MB





Initial Water Level	0.97 m bgs
Maximum Drawdown	3.66 m
Total Depth	5.03 m bgs
r (m) =	0.0254
L (m) =	1.53
R (m) =	0.1048
T_o (sec) =	1,252,800
K (m/s) =	4.5E-10

Note:
1 - T_o is determined from plots where (H-h)/(H-Ho) = 0.37

K = Hydraulic Conductivity
r = radius of well casing
R = Radius of well screen or filter pack
L = Length of the well screen (in Slug Test) or the length of the submerged portion of the well screen (in Rising Head)
T_0 = time for water level to rise or fall to 37% of the initial change

Appendix F – MECP Water Well Record Summary

TABLE F1 - MECP Water Well Record Summary

Well ID	Well Type	Date Completed	Depth (m)	Water Use	Water Status	Screened/Bottom Lithology	Water Found at Depth (m)	Static Water Level (m)
4104496	Overburden	13-Aug-68	70.7	Domestic	Water Supply	Sand	70.7	43.0
4104620	Overburden	17-Feb-69	7.6	Abandoned	---	Clay	---	---
4105170	Overburden	4-Sep-70	41.5	Domestic	Water Supply	Sand	39.0	35.4
7251801	Overburden	11-Aug-15	6.1	Monitoring	Test Hole	Clayey Silt	---	---
7312747	Overburden	31-May-18	15.2	Monitoring	Test Hole	Sand	---	---
7312748	Overburden	31-May-18	12.2	Monitoring	Test Hole	Sandy Silt	10.1	9.1
7312749	Overburden	31-May-18	13.7	Monitoring	Test Hole	Sand	7.0	---
7312750	Overburden	31-May-18	15.2	Monitoring	Test Hole	Sand	---	---
7312751	Overburden	31-May-18	8.4	Monitoring	Test Hole	Silty Sand	7.9	---

Appendix G – Water Levels and Hydrographs

KCH-00257251
735 Southdale Road West, London, Ontario
Groundwater Level Monitoring

Water Elevation Monitoring

Well ID	BH3/MW	BH7/MW	BH8A/MW	BH8B/MW	BH2/MW (16262)	BH6/MW (16262)	BH7/MW (16262)	BH9/MW (16262)	BH11/MW (16262)
Ground Surface Elevation (masl)	281.85	277.96	278.15	277.88	274.51	277.29	274.81	279.19	277.82
Top of Pipe Elevation (masl)	282.64	278.83	279.09	279.06	275.27	277.99	275.47	280.25	278.70
Groundwater Elevation									
29-Nov-19	Dry	271.58	Dry	Dry	-	-	-	-	-
13-Dec-19	Dry	276.36	Dry	273.62	-	-	-	Dry	-
28-Jan-20	280.00	276.92	271.58	276.04	266.47	-	-	Dry	-
17-Feb-20	Dry	276.67	272.30	276.87	266.55	-	-	Dry	-
14-Mar-20	279.11	277.03	273.14	277.22	266.56	-	-	Dry	-
27-Apr-20	Dry	276.67	274.15	277.38	266.60	-	-	Dry	-
23-May-20	279.04	276.89	271.93	277.00	266.66	270.50	267.91	Dry	Dry
10-Jun-20	Dry	276.24	273.99	277.22	266.61	270.74	267.01	Dry	Dry
11-Jul-20	Dry	275.74	273.79	276.83	266.52	270.31	266.72	Dry	Dry
26-Aug-20	Dry	275.45	273.51	276.03	266.40	269.99	266.55	Dry	Dry
17-Sep-20	Dry	275.74	273.31	275.78	266.39	269.91	267.21	Dry	Dry
28-Oct-20	Dry	275.59	272.82	275.06	266.43	269.80	267.23	Dry	Dry
14-Nov-20	Dry	275.72	272.54	274.61	266.47	269.66	267.37	Dry	Dry
17-Dec-20	Dry	276.80	272.86	276.43	266.43	269.54	268.02	Dry	Dry

Water Level Monitoring

Well ID	BH3/MW	BH7/MW	BH8A/MW	BH8B/MW	BH2/MW (16262)	BH6/MW (16262)	BH7/MW (16262)	BH9/MW (16262)	BH11/MW (16262)
Ground Surface Elevation (masl)	281.85	277.96	278.15	277.88	274.51	277.29	274.81	279.19	277.82
Top of Pipe Elevation (masl)	282.64	278.83	279.09	279.06	275.27	277.99	275.47	280.25	278.70
Groundwater Level (mbgs)									
29-Nov-19	Dry	6.38	Dry	Dry	-	-	-	-	-
13-Dec-19	Dry	1.60	Dry	4.26	-	-	-	Dry	-
28-Jan-20	1.85	1.04	6.57	1.84	8.04	-	-	Dry	-
17-Feb-20	Dry	1.29	5.85	1.01	7.96	-	-	Dry	-
14-Mar-20	2.74	0.93	5.01	0.66	7.95	-	-	Dry	-
27-Apr-20	Dry	1.29	4.00	0.50	7.91	-	-	Dry	-
23-May-20	2.81	1.07	6.21	0.88	7.85	6.80	6.90	Dry	Dry
10-Jun-20	Dry	1.72	4.16	0.66	7.90	6.56	7.80	Dry	Dry
11-Jul-20	Dry	2.22	4.36	1.05	8.00	6.99	8.09	Dry	Dry
26-Aug-20	Dry	2.51	4.64	1.85	8.12	7.31	8.26	Dry	Dry
17-Sep-20	Dry	2.22	4.84	2.10	8.13	7.39	7.60	Dry	Dry
28-Oct-20	Dry	2.37	5.33	2.82	8.09	7.50	7.58	Dry	Dry
14-Nov-20	Dry	2.24	5.61	3.27	8.05	7.64	7.44	Dry	Dry
17-Dec-20	Dry	1.16	5.29	1.45	8.09	7.76	6.79	Dry	Dry

Notes:
- indicates not measured

KCH-00257251
735 Southdale Road West, London, Ontario
Surface Water Level Monitoring

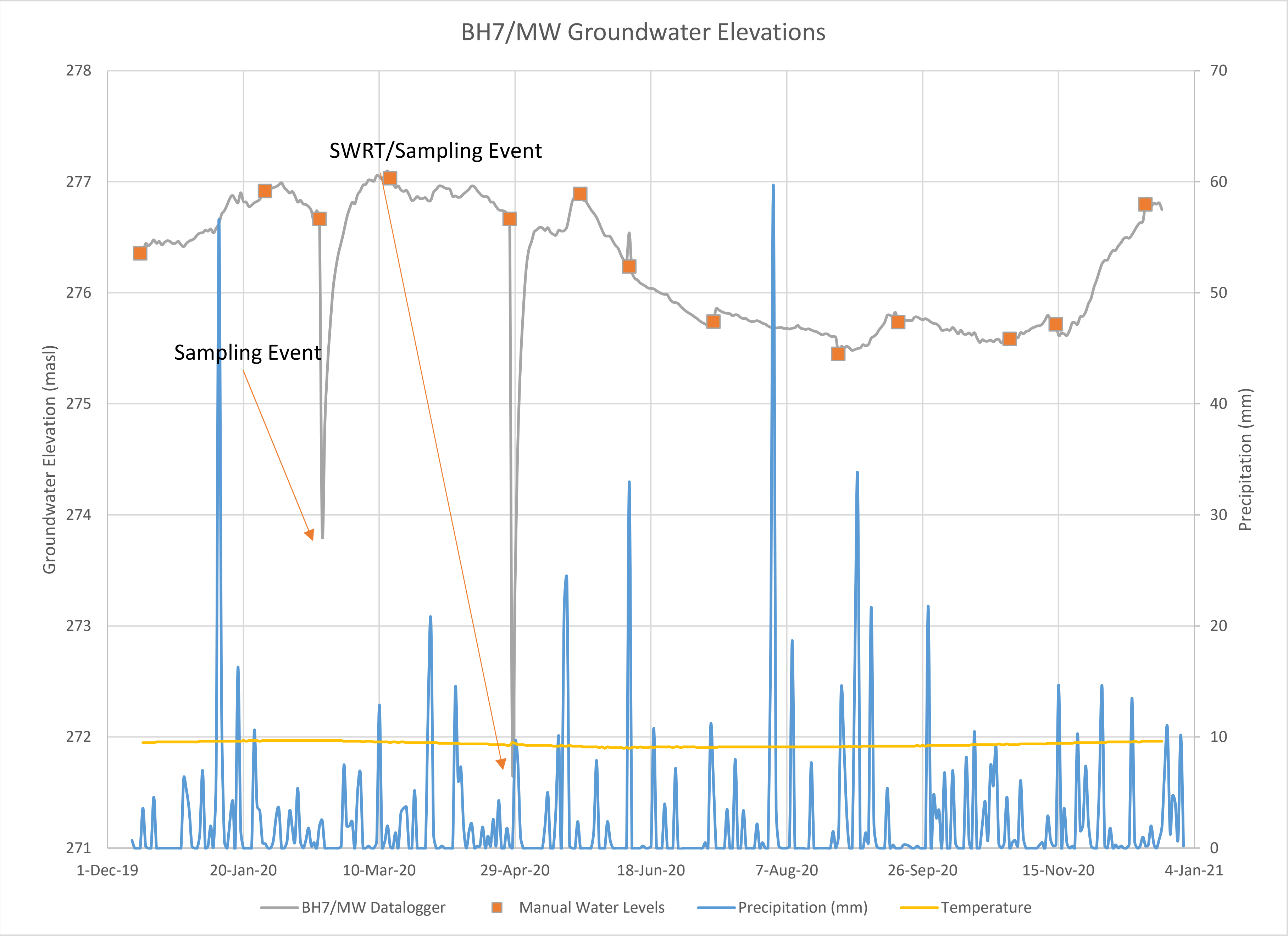
Water Elevation Monitoring

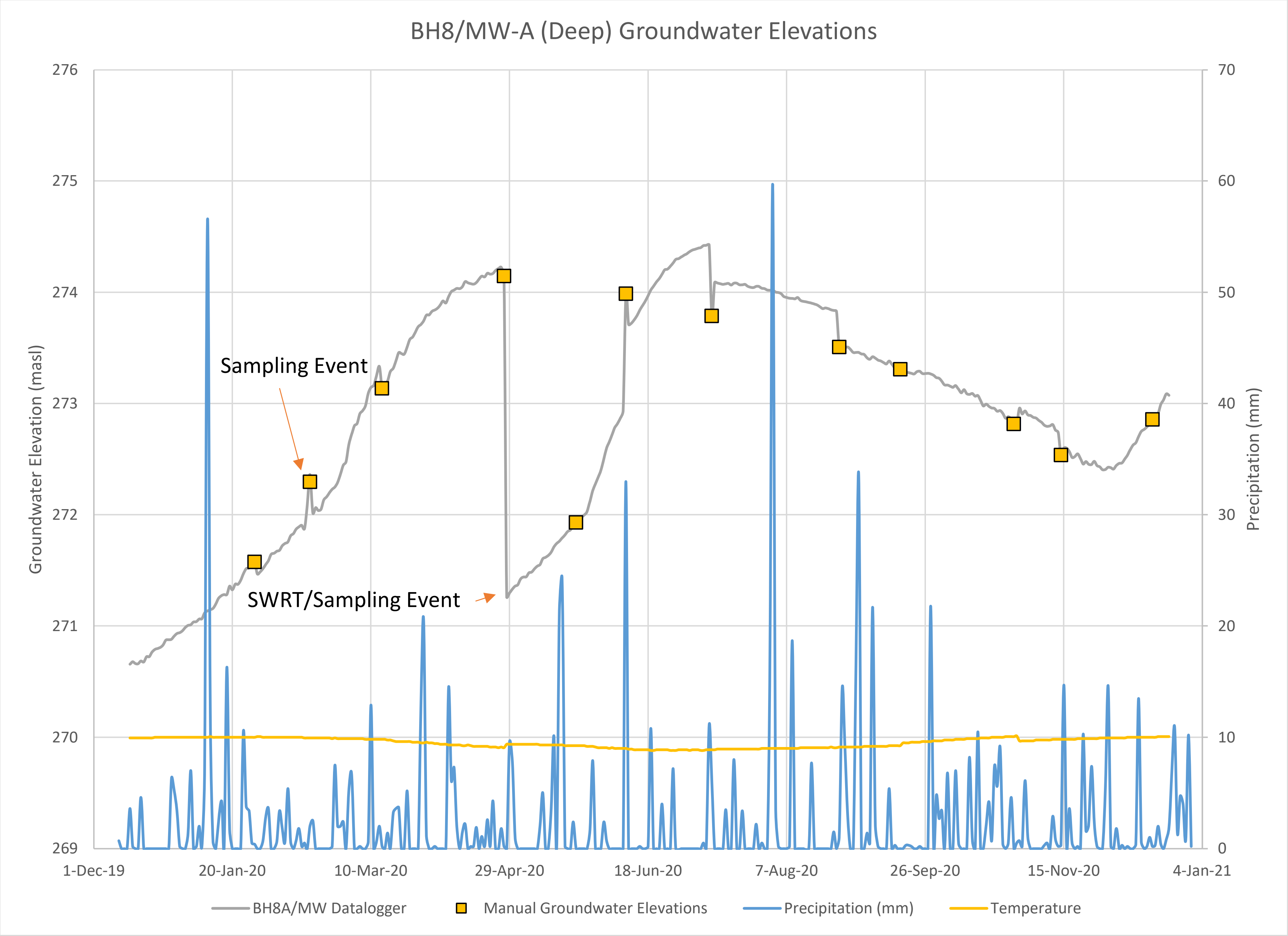
Station ID	P1	P2	SG1	SG2	P3
Ground Surface Elevation (masl)	277.51	273.35	277.53	273.35	278.73
	278.78	274.58	---	---	279.69
Groundwater Elevation					
13-Dec-19	Installed	Installed	278.03	273.94	-
28-Jan-20	Frozen	Frozen	Frozen	274.05	-
17-Feb-20	Frozen	Frozen	Frozen	Frozen	Installed
14-Mar-20	278.27	274.00	278.45	274.09	279.21
27-Apr-20	278.24	273.98	278.42	274.03	279.14
23-May-20	278.24	273.97	278.43	274.02	279.07
10-Jun-20	278.09	273.94	278.30	273.96	278.67
11-Jul-20	277.77	273.79	277.93	274.05	Dry
26-Aug-20	277.43	273.83	Dry	273.95	Dry
17-Sep-20	277.28	273.92	Dry	274.01	Dry
28-Oct-20	277.16	273.87	Dry	273.96	Dry
14-Nov-20	277.15	273.80	Dry	273.98	Dry
17-Dec-20	277.75	273.77	278.10	NM	Frozen

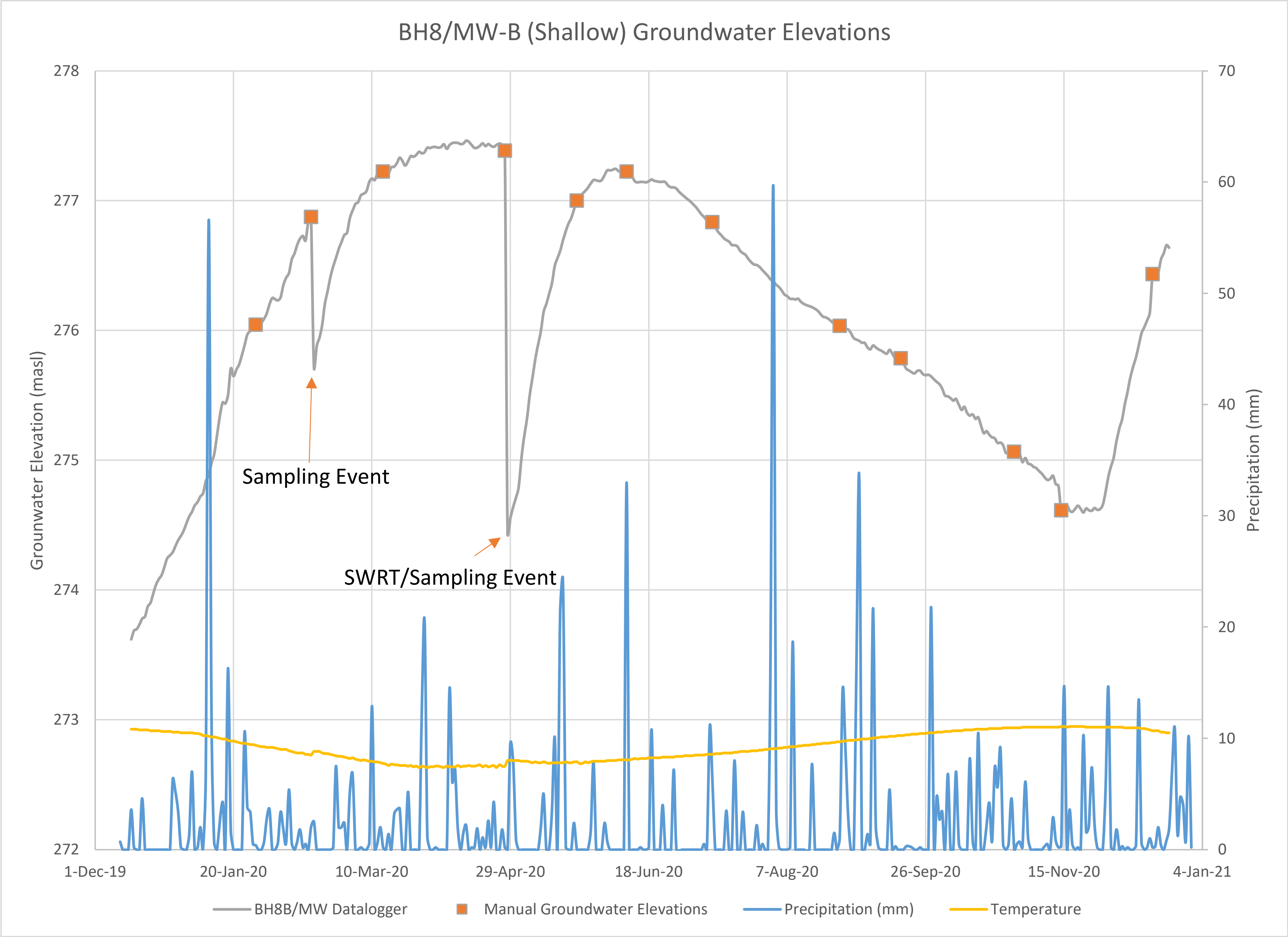
Water Level Monitoring

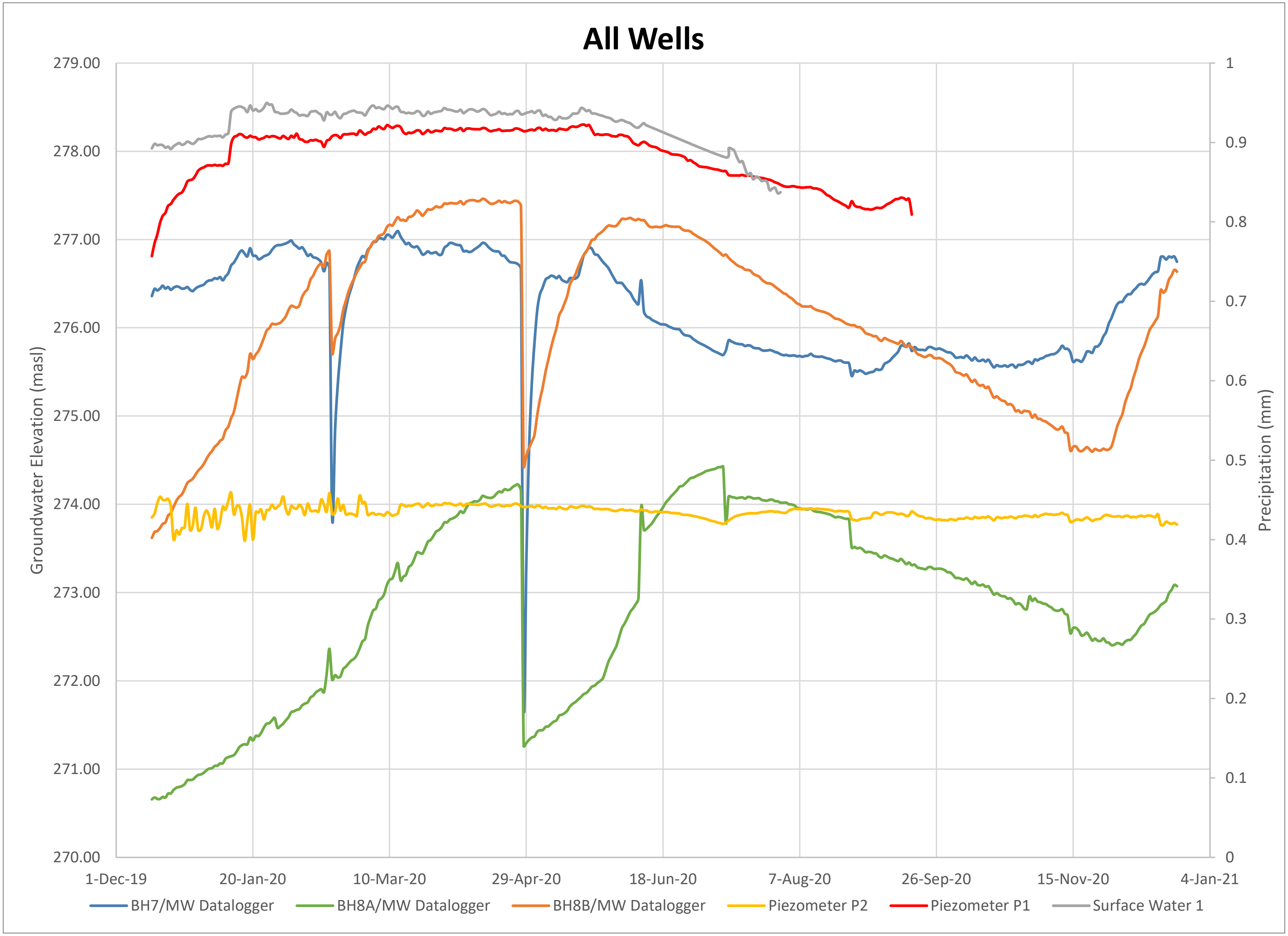
Well ID	P1	P2	SG1	SG2	P3
Ground Surface Elevation (masl)	277.51	273.35	277.53	273.35	278.73
Top of Pipe Elevation (masl)	278.78	274.58	---	---	279.69
Groundwater Level (mbgs)					
13-Dec-19	Installed	Installed	-0.51	-0.59	-
28-Jan-20	Frozen	Frozen	Frozen	-0.69	-
17-Feb-20	Frozen	Frozen	Frozen	Frozen	Installed
14-Mar-20	-0.77	-0.64	-0.92	-0.73	-0.48
27-Apr-20	-0.74	-0.63	-0.89	-0.68	-0.41
23-May-20	-0.74	-0.61	-0.90	-0.66	-0.34
10-Jun-20	-0.59	-0.59	-0.77	-0.61	0.06
11-Jul-20	-0.27	-0.44	-0.40	-0.69	Dry
26-Aug-20	0.07	-0.48	Dry	-0.60	Dry
17-Sep-20	0.22	-0.57	Dry	-0.66	Dry
28-Oct-20	0.34	-0.52	Dry	-0.61	Dry
14-Nov-20	0.35	-0.45	Dry	-0.63	Dry
17-Dec-20	-0.25	-0.42	-0.57	-	Frozen

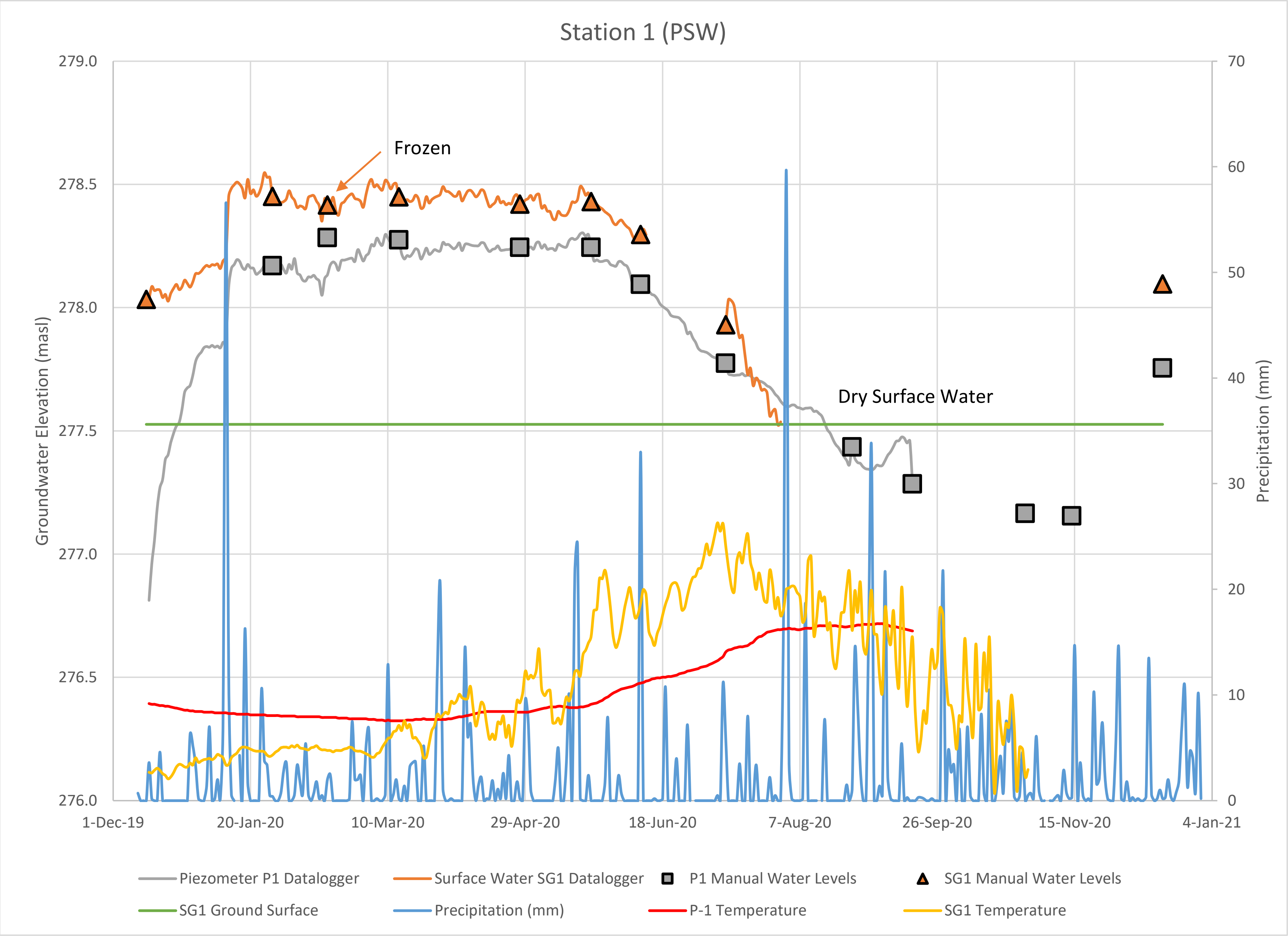
Notes:
- indicates not measured
Negative values indicate water level above ground surface

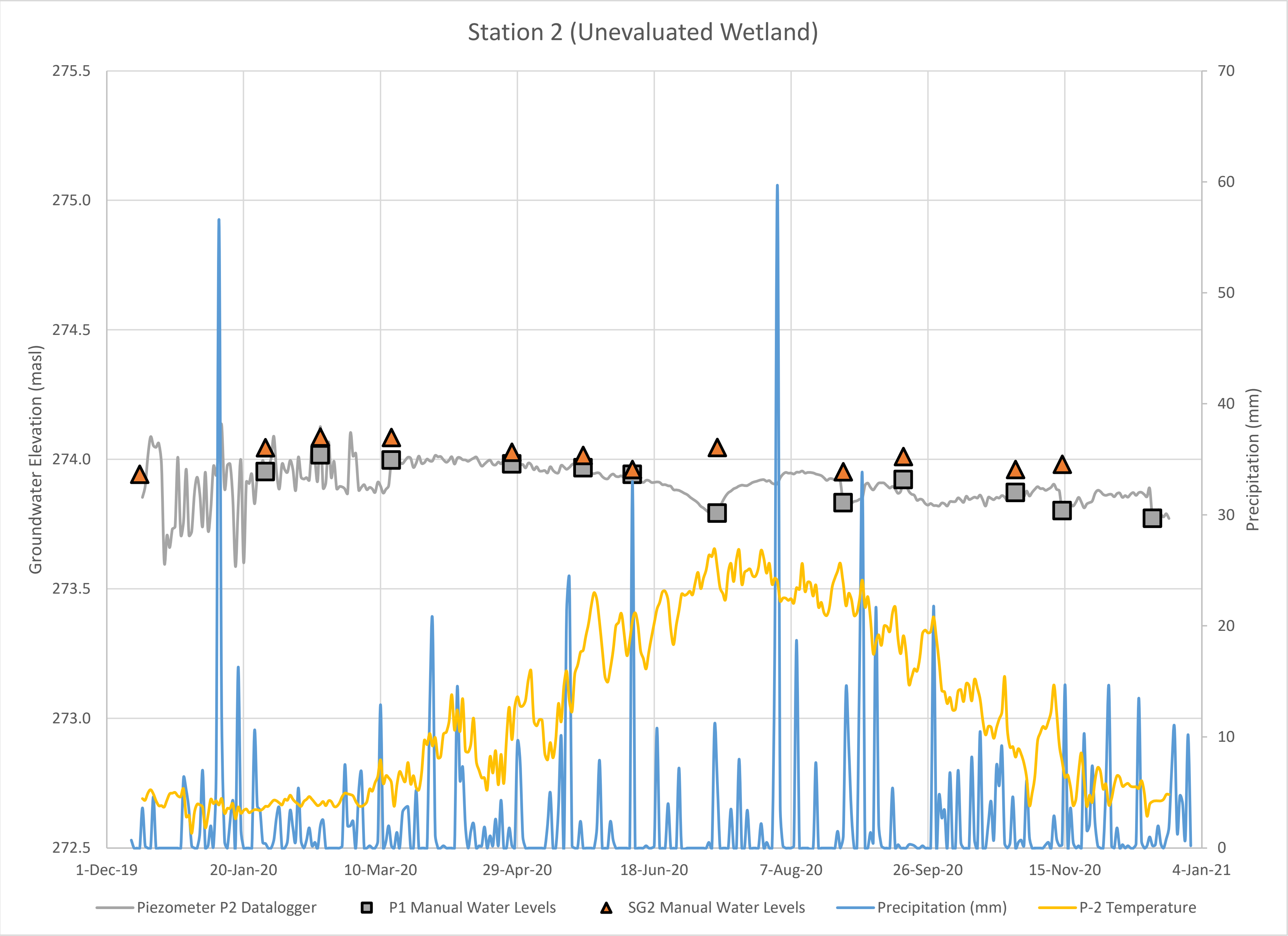

BH7/MW Groundwater Elevations
SWRT/Sampling Event
Sampling Event
Groundwater Elevation (masl)
Precipitation (mm)
278
277
276
275
274
273
272
271
70
60
50
40
30
20
10
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
BH7/MW Datalogger
Manual Water Levels
Precipitation (mm)
Temperature


BH8/MW-A (Deep) Groundwater Elevations
Groundwater Elevation (masl)
Precipitation (mm)
276
275
274
273
272
271
270
269
70
60
50
40
30
20
10
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
Sampling Event
SWRT/Sampling Event
BH8A/MW Datalogger
Manual Groundwater Elevations
Precipitation (mm)
Temperature


BH8/MW-B (Shallow) Groundwater Elevations
Grounwater Elevation (masl)
278
277
276
275
274
273
272
Precipitation (mm)
70
60
50
40
30
20
10
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
Sampling Event
SWRT/Sampling Event
BH8B/MW Datalogger
Manual Groundwater Elevations
Precipitation (mm)
Temperature


All Wells
Groundwater Elevation (masl)
Precipitation (mm)
279.00
278.00
277.00
276.00
275.00
274.00
273.00
272.00
271.00
270.00
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
BH7/MW Datalogger
BH8A/MW Datalogger
BH8B/MW Datalogger
Piezometer P2
Piezometer P1
Surface Water 1


Station 1 (PSW)
Groundwater Elevation (masl)
Precipitation (mm)
279.0
278.5
278.0
277.5
277.0
276.5
276.0
70
60
50
40
30
20
10
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
Frozen
Dry Surface Water
Piezometer P1 Datalogger
Surface Water SG1 Datalogger
P1 Manual Water Levels
SG1 Manual Water Levels
SG1 Ground Surface
Precipitation (mm)
P-1 Temperature
SG1 Temperature


Station 2 (Unevaluated Wetland)
Groundwater Elevation (masl)
275.5
275.0
274.5
274.0
273.5
273.0
272.5
Precipitation (mm)
70
60
50
40
30
20
10
0
1-Dec-19
20-Jan-20
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
Piezometer P2 Datalogger
P1 Manual Water Levels
SG2 Manual Water Levels
Precipitation (mm)
P-2 Temperature

Appendix H – Water Quality Data

Groundwater Quality Results
735 Southdale Road W, London, ON
Project No. KCH-00257251-A0

CRITERIA	ODWQS	Units	17-Feb-20	17-Feb-20	17-Feb-20	27-Apr-20	27-Apr-20	27-Apr-20
			BH7/MW	BH8/MW-A	BH8/MW-B	BH7/MW	BH8/MW-A	BH8/MW-B
Calculated Parameters								
Anion Sum	NV	me/L	9.09	13.1	13.1	9.02	12.5	13.6
Bicarb. Alkalinity (calc. as CaCO3)	NV	mg/L	400	280	340	400	300	360
Calculated TDS	NV	mg/L	460	750	730	480	730	770
Carb. Alkalinity (calc. as CaCO3)	NV	mg/L	2.8	1.5	1.8	3.5	2.3	2.6
Cation Sum	NV	me/L	9.02	13.2	13.1	10.1	13.9	14.9
Hardness (CaCO3)	NV	mg/L	400	610	620	450	640	680
Ion Balance (% Difference)	NV	%	0.380	0.510	0.150	5.69	5.58	4.53
Langelier Index (@ 20C)	NV	N/A	0.961	0.823	0.937	1.10	1.03	1.14
Langelier Index (@ 4C)	NV	N/A	0.713	0.577	0.690	0.854	0.780	0.890
Saturation pH (@ 20C)	NV	N/A	6.91	6.92	6.82	6.87	6.89	6.76
Saturation pH (@4C)	NV	N/A	7.16	7.17	7.07	7.12	7.14	7.00
Inorganics								
Total Ammonia-N	NV	mg/L	<0.050	0.066	<0.050	<0.050	<0.050	<0.050
Conductivity	NV	umho/cm	800	1200	1200	810	1100	1200
Dissolved Organic Carbon (DOC)	NV	mg/L	3.4	2.4	2.5	1.9	1.3	1.5
Orthophosphate (P)	NV	mg/L	<0.010	0.010	0.015	<0.010	<0.010	0.011
pH	NV	pH	7.87	7.75	7.76	7.97	7.92	7.89
Dissolved Sulphate (SO4)	NV	mg/L	38	310	210	34	270	200
Alkalinity (Total as CaCO3)	NV	mg/L	410	280	340	410	300	360
Dissolved Chloride (Cl-)	NV	mg/L	6.5	29	67	6.4	30	74
Nitrite (N)	1	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nitrate (N)	10	mg/L	<0.10	0.13	<0.10	<0.10	0.12	<0.10
Nitrate + Nitrite (N)	NV	mg/L	<0.10	0.13	<0.10	<0.10	0.12	<0.10
Metals								
Dissolved Aluminum (Al)	NV	ug/L	<5.0	6.7	<5.0	11	9.3	5.7
Dissolved Antimony (Sb)	6	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dissolved Arsenic (As)	10	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dissolved Barium (Ba)	1000	ug/L	170	160	150	180	110	130
Dissolved Beryllium (Be)	NV	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dissolved Boron (B)	5000	ug/L	81	84	49	89	89	53
Dissolved Cadmium (Cd)	5	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Calcium (Ca)	NV	ug/L	87000	140000	140000	97000	140000	160000
Dissolved Chromium (Cr)	50	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dissolved Cobalt (Co)	NV	ug/L	0.56	<0.50	<0.50	1.9	<0.50	<0.50
Dissolved Copper (Cu)	NV	ug/L	1.2	1.1	1.3	1.3	<1.0	<1.0
Dissolved Iron (Fe)	NV	ug/L	<100	<100	<100	<100	<100	<100
Dissolved Lead (Pb)	10	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dissolved Magnesium (Mg)	NV	ug/L	44000	66000	62000	51000	71000	70000
Dissolved Manganese (Mn)	NV	ug/L	420	93	140	680	45	150
Dissolved Molybdenum (Mo)	NV	ug/L	2.2	3.1	5.3	2.4	4.2	2.5
Dissolved Nickel (Ni)	NV	ug/L	2.5	3.6	2.9	5.3	3.4	2.7
Dissolved Phosphorous (P)	NV	ug/L	<100	<100	<100	<100	<100	<100
Dissolved Potassium (K)	NV	ug/L	4400	5200	4300	4400	5200	4500
Dissolved Selenium (Se)	50	ug/L	<2.0	3.6	<2.0	<2.0	<2.0	<2.0
Dissolved Silicon (Si)	NV	ug/L	7900	5500	6800	8500	6100	7500
Dissolved Silver (Ag)	NV	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Sodium (Na)	NV	ug/L	21000	19000	15000	22000	23000	25000
Dissolved Strontium (Sr)	NV	ug/L	1200	1400	820	1200	1400	770
Dissolved Thallium (Tl)	NV	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Dissolved Titanium (Ti)	NV	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dissolved Uranium (U)	20	ug/L	5.1	10	9.9	4.3	8.5	8.5
Dissolved Vanadium (V)	NV	ug/L	<0.50	<0.50	0.67	1	<0.50	<0.50
Dissolved Zinc (Zn)	NV	ug/L	35	9.3	39	<5.0	<5.0	<5.0

Notes:
Results compared to Reg. 153 Table 1 Site Condition Standards and Ontario Drinking Water Quality Standards (ODWQS)
NV indicates 'No value'
N/A indicates 'Not Applicable'
Exceeds ODWQS

Groundwater Quality Results
735 Southdale Road W, London, ON
Project No. KCH-00257251-A0

CRITERIA	PWQO	Units	17-Feb-20	17-Feb-20	27-Apr-20	27-Apr-20
			Station 1	Station 2	Station 1	Station 2
Calculated Parameters						
Bicarb. Alkalinity (calc. as CaCO3)	NV	mg/L	300	200	310	100
Calculated TDS	NV	mg/L	460	650	460	520
Carb. Alkalinity (calc. as CaCO3)	NV	mg/L	1.0	1.3	4.7	8.2
Hardness (CaCO3)	NV	mg/L	380	280	390	130
Langelier Index (@ 20C)	NV	N/A	0.668	0.588	1.34	1.03
Langelier Index (@ 4C)	NV	N/A	0.420	0.341	1.09	0.780
Saturation pH (@ 20C)	NV	N/A	6.89	7.24	6.86	7.92
Saturation pH (@4C)	NV	N/A	7.14	7.49	7.11	8.16
Inorganics						
Total Ammonia-N	NV	mg/L	0.067	<0.050	<0.050	<0.050
Conductivity	NV	umho/cm	820	1300	850	1100
Total Organic Carbon (TOC)	NV	mg/L	14	6.7	13	10
Orthophosphate (P)	NV	mg/L	<0.010	<0.010	0.032	<0.010
pH	6.5 - 8.5	pH	7.56	7.83	8.20	**8.94**
Total Phosphorus	0.01	mg/L	**0.041**	**0.028**	**0.11**	**0.062**
Dissolved Sulphate (SO4)	NV	mg/L	21	14	2.8	8.6
Turbidity	NV	NTU	1.4	1.7	1.7	3.8
Alkalinity (Total as CaCO3)	NV	mg/L	310	210	320	110
Dissolved Chloride (Cl-)	NV	mg/L	71	240	87	240
Nitrite (N)	NV	mg/L	<0.010	<0.010	<0.010	<0.010
Nitrate (N)	NV	mg/L	0.12	2.00	<0.10	<0.10
Metals						
Dissolved Calcium (Ca)	NV	mg/L	-	-	130	33
Dissolved Magnesium (Mg)	NV	mg/L	-	-	19	10
Dissolved Potassium (K)	NV	mg/L	-	-	2	<1
Dissolved Sodium (Na)	NV	mg/L	-	-	33	170
Total Aluminum (Al)	75	ug/L	38	52	**89**	**120**
Total Antimony (Sb)	20	ug/L	<0.50	<0.50	<0.50	<0.50
Total Arsenic (As)	100	ug/L	<1.0	<1.0	<1.0	<1.0
Total Barium (Ba)	NV	ug/L	36	27	34	22
Total Beryllium (Be)	1100	ug/L	<0.50	<0.50	<0.50	<0.50
Total Boron (B)	200	ug/L	16	<10	16	15
Total Cadmium (Cd)	0.5	ug/L	<0.10	<0.10	<0.10	<0.10
Total Calcium (Ca)	NV	ug/L	120000	84000	120000	32000
Total Chromium (Cr)	8.9	ug/L	<5.0	<5.0	<5.0	<5.0
Total Cobalt (Co)	0.9	ug/L	<0.50	<0.50	<0.50	<0.50
Total Copper (Cu)	5	ug/L	2.2	3.5	1.4	2.0
Total Iron (Fe)	300	ug/L	<100	170	140	**720**
Total Lead (Pb)	5	ug/L	<0.50	<0.50	<0.50	<0.50
Total Magnesium (Mg)	NV	ug/L	17000	14000	20000	11000
Total Manganese (Mn)	NV	ug/L	100	100	21	50
Total Molybdenum (Mo)	40	ug/L	<0.50	<0.50	<0.50	0.65
Total Nickel (Ni)	25	ug/L	<1.0	<1.0	<1.0	<1.0
Total Potassium (K)	NV	ug/L	2800	2200	2000	810
Total Selenium (Se)	100	ug/L	<2.0	<2.0	<2.0	<2.0
Total Silicon (Si)	NV	ug/L	3800	1600	2500	210
Total Silver (Ag)	0.1	ug/L	<0.10	<0.10	<0.10	<0.10
Total Sodium (Na)	NV	ug/L	27000	160000	30000	160000
Total Strontium (Sr)	NV	ug/L	200	200	220	110
Total Thallium (Tl)	0.3	ug/L	<0.050	<0.050	<0.050	<0.050
Total Titanium (Ti)	NV	ug/L	<5.0	<5.0	6.9	5.9
Total Vanadium (V)	6	ug/L	0.61	<0.50	0.69	0.99
Total Zinc (Zn)	20	ug/L	18	**60**	<5.0	<5.0
Dissolved Aluminum (Al)	NV	ug/L	8.7	<5.0	<5.0	19
Dissolved Antimony (Sb)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Arsenic (As)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Barium (Ba)	NV	ug/L	36	28	33	20
Dissolved Beryllium (Be)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Bismuth (Bi)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Boron (B)	NV	ug/L	25	20	14	14
Dissolved Cadmium (Cd)	NV	ug/L	<0.10	<0.10	<0.10	<0.10
Dissolved Calcium (Ca)	NV	ug/L	120000	88000	120000	32000
Dissolved Chromium (Cr)	NV	ug/L	<5.0	<5.0	<5.0	<5.0
Dissolved Cobalt (Co)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Copper (Cu)	NV	ug/L	2.3	2.6	<1.0	1.2
Dissolved Iron (Fe)	NV	ug/L	<100	<100	<100	170
Dissolved Lead (Pb)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Lithium (Li)	NV	ug/L	<5.0	<5.0	<5.0	<5.0
Dissolved Magnesium (Mg)	NV	ug/L	19000	15000	20000	11000
Dissolved Manganese (Mn)	NV	ug/L	110	100	12	8.3
Dissolved Molybdenum (Mo)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Nickel (Ni)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Phosphorus (P)	NV	ug/L	<100	<100	<100	<100
Dissolved Potassium (K)	NV	ug/L	2900	2200	1900	790
Dissolved Selenium (Se)	NV	ug/L	<2.0	<2.0	<2.0	<2.0
Dissolved Silicon (Si)	NV	ug/L	4200	1800	2400	73
Dissolved Silver (Ag)	NV	ug/L	<0.10	<0.10	<0.10	<0.10
Dissolved Sodium (Na)	NV	ug/L	29000	160000	31000	160000
Dissolved Strontium (Sr)	NV	ug/L	210	210	210	110
Dissolved Tellurium (Te)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Thallium (Tl)	NV	ug/L	<0.050	<0.050	<0.050	<0.050
Dissolved Tin (Sn)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Titanium (Ti)	NV	ug/L	<5.0	<5.0	<5.0	<5.0
Dissolved Tungsten (W)	NV	ug/L	<1.0	<1.0	<1.0	<1.0
Dissolved Uranium (U)	NV	ug/L	1.2	0.98	2.5	0.71
Dissolved Vanadium (V)	NV	ug/L	<0.50	<0.50	<0.50	<0.50
Dissolved Zinc (Zn)	NV	ug/L	21	96	<5.0	<5.0
Dissolved Zirconium (Zr)	NV	ug/L	<1.0	<1.0	<1.0	<1.0

Notes:

Results compared to Reg. 153 Table 1 Site Condition Standards and Ontario Provincial Water Quality Objectives (PWQO)

NV indicates 'No value'

N/A indicates ' Not Applicabale'

Exceeds PWQO

Appendix I – Water Balance Assessment

TABLE I-1: PRE-DEVELOPMENT WATER BALANCE CALCULATIONS

Drainage Areas A and B	Impervious Area (m^2)	Pervious Area (m^2)	Total Area (m^2)	Soil Type	Soil Group	Water Holding Capacity (mm)	Infiltration Factor	T_{rain} (°C)	T_{snow} (°C)	Meltmax (%/100)
Drainage Area A	708	21892	38500	Clay to Silt	C	250	0.45	3.3	-10.0	0.92
Drainage Area B	189	15711		Clay to Silt	C	250	0.4			

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Totals
Average Temperature (°C)	-5.6	-4.5	-0.1	6.8	13.1	18.3	20.8	19.7	15.5	9.2	3.4	-2.6	
Total Precipitation (mm/month)	74.2	65.5	71.5	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	87.5	1011.5
Precipitation as rain (mm/month)	24.5	27.1	53.2	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	48.7	
Precipitation as snow (mm/month)	49.7	38.4	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8	
Potential Snow Melt (mm/month)	20.9	32.8	49.1	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Actual Snow Melt (mm/month)	20.9	32.8	49.1	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Snow Storage (mm/month)	47.7	53.4	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	
Drainage Area A (Pervious)													
Estimated Actual Evapotranspiration (mm/month)	8.9	10.8	20.3	38.4	70.3	102.6	116.3	91.4	56.3	30.5	16.0	10.0	571.8
Surplus (mm/month)	36.5	49.1	82.0	67.6	19.5	-10.9	-33.6	-8.5	46.7	50.8	82.0	58.6	439.7
Estimated Runoff (mm/month)	36.5	49.1	63.5	37.2	10.7	0.0	0.0	0.0	25.7	27.9	45.1	58.6	354.3
Estimated Infiltration (mm/month)	0.0	0.0	18.4	30.4	8.8	0.0	0.0	0.0	21.0	22.9	36.9	0.0	138.4
Estimated Actual Evapotranspiration (m^3/month)	**195**	**236**	**444**	**841**	**1539**	**2246**	**2546**	**2001**	**1233**	**668**	**350**	**219**	**12518**
Estimated Runoff (m^3/month)	**800**	**1074**	**1391**	**814**	**235**	**0**	**0**	**0**	**562**	**612**	**987**	**1282**	**7756**
Estimated Infiltration (m^3/month)	**0**	**0**	**404**	**666**	**192**	**0**	**0**	**0**	**460**	**500**	**808**	**0**	**3030**
Drainage Area A (Impervious)													
Initial Actual Evapotranspiration (mm/month)	8.2	10.8	18.4	19.1	16.2	16.5	14.9	14.9	18.5	14.6	17.6	12.3	182.1
Initial Runoff (Surplus) (mm/month)	37.2	49.1	83.9	86.9	73.6	75.2	67.8	68.0	84.5	66.7	80.4	56.2	829.4
Estimated Infiltration (mm/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimated Actual Evapotranspiration (m^3/month)	**6**	**8**	**13**	**14**	**11**	**12**	**11**	**11**	**13**	**10**	**12**	**9**	**129**
Estimated Runoff (m^3/month)	**26**	**35**	**59**	**62**	**52**	**53**	**48**	**48**	**60**	**47**	**57**	**40**	**587**
Estimated Infiltration (m^3/month)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Drainage Area A TOTALS													
Estimated Actual Evapotranspiration (m^3/month)	**201**	**244**	**457**	**854**	**1550**	**2258**	**2557**	**2011**	**1246**	**678**	**363**	**228**	**12647**
Estimated Runoff (m^3/month)	**826**	**1109**	**1450**	**875**	**287**	**53**	**48**	**48**	**622**	**659**	**1044**	**1322**	**8343**
Estimated Infiltration (m^3/month)	**0**	**0**	**404**	**666**	**192**	**0**	**0**	**0**	**460**	**500**	**808**	**0**	**3030**
Drainage Area B (Pervious)													
Estimated Actual Evapotranspiration (mm/month)	8.9	10.8	20.3	38.4	70.3	102.6	116.3	91.4	56.3	30.5	16.0	10.0	571.8
Surplus (mm/month)	36.5	49.1	82.0	67.6	19.5	-10.9	-33.6	-8.5	46.7	50.8	82.0	58.6	439.7
Estimated Runoff (mm/month)	36.5	49.1	65.6	40.5	11.7	0.0	0.0	0.0	28.0	30.5	49.2	58.6	369.7
Estimated Infiltration (mm/month)	0.0	0.0	16.4	27.0	7.8	0.0	0.0	0.0	18.7	20.3	32.8	0.0	123.0
Estimated Actual Evapotranspiration (m^3/month)	**140**	**170**	**319**	**603**	**1104**	**1612**	**1827**	**1436**	**885**	**479**	**251**	**157**	**8984**
Estimated Runoff (m^3/month)	**574**	**771**	**1030**	**637**	**184**	**0**	**0**	**0**	**440**	**479**	**773**	**920**	**5808**
Estimated Infiltration (m^3/month)	**0**	**0**	**258**	**425**	**123**	**0**	**0**	**0**	**293**	**319**	**515**	**0**	**1933**
Drainage Area B (Impervious)													
Initial Actual Evapotranspiration (mm/month)	8.2	10.8	18.4	19.1	16.2	16.5	14.9	14.9	18.5	14.6	17.6	12.3	182.1
Initial Runoff (Surplus) (mm/month)	37.2	49.1	83.9	86.9	73.6	75.2	67.8	68.0	84.5	66.7	80.4	56.2	829.4
Estimated Infiltration (mm/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimated Actual Evapotranspiration (m^3/month)	**2**	**2**	**3**	**4**	**3**	**3**	**3**	**3**	**4**	**3**	**3**	**2**	**34**
Estimated Runoff (m^3/month)	**7**	**9**	**16**	**16**	**14**	**14**	**13**	**13**	**16**	**13**	**15**	**11**	**157**
Estimated Infiltration (m^3/month)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Drainage Area B TOTALS													
Estimated Actual Evapotranspiration (m^3/month)	**141**	**172**	**322**	**607**	**1108**	**1615**	**1830**	**1439**	**888**	**482**	**255**	**159**	**9018**
Estimated Runoff (m^3/month)	**581**	**780**	**1046**	**653**	**198**	**14**	**13**	**13**	**456**	**491**	**788**	**931**	**5965**
Estimated Infiltration (m^3/month)	**0**	**0**	**258**	**425**	**123**	**0**	**0**	**0**	**293**	**319**	**515**	**0**	**1933**

TABLE I-2: POST-DEVELOPMENT WATER BALANCE CALCULATIONS - AREA A

Drainage Area A	Impervious Area (m^2)	Pervious Area (m^2)	Total Area (m^2)	Soil Type	Soil Group	Water Holding Capacity (mm)	Infiltration Factor	T_{rain} (°C)	T_{snow} (°C)	Meltmax (%/100)
Landscaped Areas - Grass and Open Space	-	4500		Clay to Silt	C	125	0.45	3.3	-10.0	0.92
Landscaped Area - Runoff Directed toward Wetland	-	5400	**22,600**							
Impervious - Rooftops, Surface Parking, Roads, Sidewalks, Patios	10900									
Secondary Piped Rooftop Control (calculated on next spreadsheet)	1800									

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Totals**
Average Temperature (°C)	-5.6	-4.5	-0.1	6.8	13.1	18.3	20.8	19.7	15.5	9.2	3.4	-2.6	
Total Precipitation (mm/month)	74.2	65.5	71.5	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	87.5	1011.5
Precipitation as rain (mm/month)	24.5	27.1	53.2	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	48.7	
Precipitation as snow (mm/month)	49.7	38.4	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8	
Potential Snow Melt (mm/month)	20.9	32.8	49.1	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Actual Snow Melt (mm/month)	20.9	32.8	49.1	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Snow Storage (mm/month)	47.7	53.4	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	
DEVELOPMENT AREA - LANDSCAPED OPEN SPACE AND GRASS													
Estimated Evapotranspiration (mm/month)	8.9	10.8	20.3	38.4	70.3	102.6	114.9	89.7	56.3	30.5	16	10	568.7
Surplus (mm/month)	36.5	49.1	82.0	67.6	19.5	-10.9	-32.2	-6.8	46.7	50.8	82.0	58.6	442.8
Estimated Runoff (mm/month)	36.5	49.1	63.5	37.2	10.7	0.0	0.0	0.0	25.7	27.9	45.1	58.6	354.3
Estimated Infiltration (mm/month)	0.0	0.0	18.4	30.4	8.8	0.0	0.0	0.0	21.0	22.9	36.9	0.0	138.4
Estimated Actual Evapotranspiration (m^3/month)	**40**	**49**	**91**	**173**	**316**	**462**	**517**	**404**	**253**	**137**	**72**	**45**	**2559**
Estimated Runoff (m^3/month)	**164**	**221**	**286**	**167**	**48**	**0**	**0**	**0**	**116**	**126**	**203**	**263**	**1594**
Estimated Infiltration (m^3/month)	**0**	**0**	**83**	**137**	**39**	**0**	**0**	**0**	**95**	**103**	**166**	**0**	**623**
DEVELOPMENT AREA - LANDSCAPED RUNOFF DIRECTED TO WETLAND													
Estimated Evapotranspiration (mm/month)	8.9	10.8	20.3	38.4	70.3	102.6	114.9	89.7	56.3	30.5	16	10	568.7
Surplus (mm/month)	36.5	49.1	82.0	67.6	19.5	-10.9	-32.2	-6.8	46.7	50.8	82.0	58.6	442.8
Estimated Runoff (mm/month)	36.5	49.1	63.5	37.2	10.7	0.0	0.0	0.0	25.7	27.9	45.1	58.6	354.3
Estimated Infiltration (mm/month)	0.0	0.0	18.4	30.4	8.8	0.0	0.0	0.0	21.0	22.9	36.9	0.0	138.4
Estimated Initial Evapotranspiration (m^3/month)	**48**	**58**	**110**	**207**	**380**	**554**	**620**	**484**	**304**	**165**	**86**	**54**	**3071**
Estimated Runoff (m^3/month) - To Wetland	**197**	**265**	**343**	**201**	**58**	**0**	**0**	**0**	**139**	**151**	**244**	**316**	**1913**
Estimated Infiltration (m^3/month)	**0**	**0**	**100**	**164**	**47**	**0**	**0**	**0**	**113**	**123**	**199**	**0**	**747**
Estimated Evapotranspiration of Runoff to Wetland (m^3/month)	**30**	**40**	**51**	**30**	**9**	**0**	**0**	**0**	**21**	**23**	**37**	**47**	**287**
Estimated Infiltration of Runoff to Wetland (m^3/month)	**168**	**225**	**292**	**171**	**49**	**0**	**0**	**0**	**118**	**128**	**207**	**269**	**1626**
DEVELOPMENT AREA - IMPERVIOUS COVER													
Inital Actual Evaporation (mm/month)	8.2	10.8	18.4	19.1	16.2	16.5	14.9	14.9	18.5	14.6	17.6	12.3	182.1
Initial Runoff (Surplus) (mm/month)	37.2	49.1	83.9	86.9	73.6	75.2	67.8	68.0	84.5	66.7	80.4	56.2	829.4
Estimated Infiltration (mm/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimated Actual Evapotranspiration (m^3/month)	**89**	**117**	**201**	**208**	**176**	**180**	**162**	**163**	**202**	**160**	**192**	**135**	**1985**
Estimated Runoff (m^3/month)	**406**	**535**	**914**	**947**	**803**	**820**	**739**	**741**	**921**	**727**	**876**	**613**	**9041**
Estimated Infiltration (m^3/month)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTALS - DRAINAGE AREA A													
Estimated Actual Evapotranspiration (m^3/month)	**207**	**264**	**453**	**618**	**881**	**1196**	**1300**	**1051**	**780**	**484**	**387**	**281**	**7902**
Estimated Runoff (m^3/month)	**570**	**756**	**1200**	**1115**	**851**	**820**	**739**	**741**	**1036**	**852**	**1079**	**876**	**10635**
Estimated Infiltration (m^3/month)	**168**	**225**	**375**	**307**	**89**	**0**	**0**	**0**	**212**	**231**	**373**	**269**	**2249**

TABLE I-3: POST-DEVELOPMENT WATER BALANCE CALCULATIONS - AREA B

Drainage Area B	Impervious Area (m^2)	Pervious Area (m^2)	Total Area (m^2)	Soil Type	Soil Group	Water Holding Capacity (mm)	Infiltration Factor	T_{rain} (°C)	T_{snow} (°C)	Meltmax (%/100)
Landscaped Areas - Grass and Open Space	-	6100	15,900	Clay to Silt	C	125	0.45	3.3	-10.0	0.92
Impervious - Rooftops, Surface Parking, Roads, Sidewalks, Patios	9800									

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Totals
Average Temperature (°C)	-5.6	-4.5	-0.1	6.8	13.1	18.3	20.8	19.7	15.5	9.2	3.4	-2.6	
Total Precipitation (mm/month)	74.2	65.5	71.5	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	87.5	1011.5
Precipitation as rain (mm/month)	24.5	27.1	53.2	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	48.7	
Precipitation as snow (mm/month)	49.7	38.4	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8	
Potential Snow Melt (mm/month)	20.9	32.8	49.1	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Actual Snow Melt (mm/month)	20.9	32.8	49.1	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Snow Storage (mm/month)	47.7	53.4	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	
DEVELOPMENT AREA - LANDSCAPED OPEN SPACE AND GRASS													
Estimated Evapotranspiration (mm/month)	8.9	10.8	20.3	38.4	70.3	102.6	114.9	89.7	56.3	30.5	16	10	568.7
Surplus (mm/month)	36.5	49.1	82.0	67.6	19.5	-10.9	-32.2	-6.8	46.7	50.8	82.0	58.6	442.8
Estimated Runoff (mm/month)	36.5	49.1	63.5	37.2	10.7	0.0	0.0	0.0	25.7	27.9	45.1	58.6	354.3
Estimated Infiltration (mm/month)	0.0	0.0	18.4	30.4	8.8	0.0	0.0	0.0	21.0	22.9	36.9	0.0	138.4
Estimated Actual Evapotranspiration (m^3/month)	**54**	**66**	**124**	**234**	**429**	**626**	**701**	**547**	**343**	**186**	**98**	**61**	**3469**
Estimated Runoff (m^3/month)	**223**	**299**	**388**	**227**	**65**	**0**	**0**	**0**	**157**	**170**	**275**	**357**	**2161**
Estimated Infiltration (m^3/month)	**0**	**0**	**113**	**186**	**54**	**0**	**0**	**0**	**128**	**139**	**225**	**0**	**844**
DEVELOPMENT AREA - IMPERVIOUS COVER													
Inital Actual Evaporation (mm/month)	8.2	10.8	18.4	19.1	16.2	16.5	14.9	14.9	18.5	14.6	17.6	12.3	182.1
Initial Runoff (Surplus) (mm/month)	37.2	49.1	83.9	86.9	73.6	75.2	67.8	68.0	84.5	66.7	80.4	56.2	829.4
Estimated Infiltration (mm/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimated Actual Evapotranspiration (m^3/month)	**80**	**106**	**180**	**187**	**158**	**162**	**146**	**146**	**182**	**143**	**173**	**121**	**1784**
Estimated Runoff (m^3/month)	**365**	**481**	**822**	**852**	**722**	**737**	**665**	**666**	**828**	**653**	**788**	**551**	**8128**
Estimated Infiltration (m^3/month)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTALS - DRAINAGE AREA B													
Estimated Actual Evapotranspiration (m^3/month)	**134**	**171**	**304**	**421**	**587**	**788**	**847**	**693**	**525**	**329**	**270**	**182**	**5253**
Estimated Runoff (m^3/month)	**588**	**780**	**1210**	**1078**	**787**	**737**	**665**	**666**	**984**	**824**	**1063**	**908**	**10290**
Estimated Infiltration (m^3/month)	**0**	**0**	**113**	**186**	**54**	**0**	**0**	**0**	**128**	**139**	**225**	**0**	**844**

TABLE I-4: POST-DEVELOPMENT SECONDARY INFILTRATION CALCULATIONS

Building A and Sidewalk Contribution Areas	**Impervious Area (m^2)**	**Pervious Area (m^2)**	**Total Area (m^2)**	**Soil Type**	**Soil Group**	**Water Holding Capacity (mm)**	**Infiltration Factor**	**T_{rain} (°C)**	**T_{snow} (°C)**	**Meltmax (%/100)**
Secondary Piped Rooftop Control (Bld A)	1800	-	**1800**	Clay to Silt	C	125	0.45	3.3	-10.0	0.92

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Totals**
Average Temperature (°C)	-5.6	-4.5	-0.1	6.8	13.1	18.3	20.8	19.7	15.5	9.2	3.4	-2.6	
Total Precipitation (mm/month)	74.2	65.5	71.5	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	87.5	1011.5
Precipitation as rain (mm/month)	24.5	27.1	53.2	83.4	89.8	91.7	82.7	82.9	103.0	81.3	98.0	48.7	
Precipitation as snow (mm/month)	49.7	38.4	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8	
Potential Snow Melt (mm/month)	20.9	32.8	49.1	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Actual Snow Melt (mm/month)	20.9	32.8	49.1	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	
Snow Storage (mm/month)	47.7	53.4	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	
Total Precipitation + Actual Snow Melt (mm/month)	45.4	59.9	102.3	106.0	89.8	91.7	82.7	82.9	103.0	81.3	98.0	68.6	
IMPERVIOUS AREA - BUILDING A ROOFTOP AND SIDEWALKS													
Initial Actual Evaporation (mm/month)	8.2	10.8	18.4	19.1	16.2	16.5	14.9	14.9	18.5	14.6	17.6	12.3	182.1
Initial Runoff (Surplus) (mm/month)	37.2	49.1	83.9	86.9	73.6	75.2	67.8	68.0	84.5	66.7	80.4	56.2	829.4
Estimated Infiltration (mm/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimated Actual Evaporation (m^3/month) (at rooftop)	**15**	**19**	**33**	**34**	**29**	**30**	**27**	**27**	**33**	**26**	**32**	**22**	**328**
Estimated Runoff (m^3/month)	**67**	**88**	**151**	**156**	**133**	**135**	**122**	**122**	**152**	**120**	**145**	**101**	**1493**
Estimated Infiltration (m^3/month)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Estimated Evapotranspiration of Runoff to wetland (m3/month)	**10**	**13**	**23**	**23**	**20**	**20**	**18**	**18**	**23**	**18**	**22**	**15**	**224**
Estimated Infiltration of Runoff to wetland (m3/month)	**57**	**75**	**128**	**133**	**113**	**115**	**104**	**104**	**129**	**102**	**123**	**86**	**1269**

Total Annual Precipitation Volume on Building A Roof and Sidewalks (m^3) **1821**

	otal Annual Evapotranspiration / Evaporation(m3)	**552**	
	Total Annual Runoff (m3)	**1269**	**** Volume directed to wetland**
	Total Annual Infiltration (m3)	**0**	
		1821	**Total**
OR	**otal Annual Evapotranspiration / Evaporation(m3)**	**328**	
	Total Annual Runoff (m3)	**1493**	**** Volume directed to wetland**
	Total Annual Infiltration (m3)	**1269**	

TABLE I-5: SUMMARY CALCULATIONS

DRAINAGE AREA A

Scenario 1 - Contribution from Landscaped Areas (0.54 ha) but NOT rooftops

	Pre-Development	Post-Development	Difference	% Difference
Estimated Runoff (m^3/year)	8,343	10,635	2292	127%
Estimated Infiltration (m^3/year)	3,030	2,249	-781	74%

Scenario 1 provides post-development infiltration volumes for the contribution of the landscaped areas surrounding Building A (0.54 ha). This added landscaped area is estimated to provide 74% of the existing conditions infiltration volumes to the wetland area.

Scenario 2 - WITH Secondary Infiltration (0.18 Ha rooftop contribution)

	Pre-Development	Post-Development	Additional Secondary Infiltration	Total Infiltration with LID	Difference	% Difference
Estimated Infiltration (m^3/year)	3,030	2,249	1269	3518	488	116%

The added volumes provided from the rooftop areas of Building A, 12 story building area only (0.18 ha), will result in the post-development infiltration volumes reaching 116% of existing conditions.

DRAINAGE AREA B

Summary - No Secondary Infiltration

	Pre-Development	Post-Development	Difference	% Difference
Estimated Runoff (m^3/year)	5,965	10,290	4325	173%
Estimated Infiltration (m^3/year)	1,933	844	-1089	44%

The post-development infiltration calculations suggest 44% of infiltration will be achieved in the post-development environment within Drainage Area B.

TABLE I-6: WATER BALANCE ASSUMPTIONS

1. AET occurs year round. Although the average temperature is below 0°C in the winter months, fluctuation above and below the freezing temperature of water occurs. The Thornthwaite model used assumes T_{rain} = 3.3°C and T_{snow} = -10.0°C. When the average monthly temperature falls between these values, the monthly precipitation as rain and snow is derived by assuming a linear interpolation between these values, consistent with the methodology used in the accepted USGS reference material (McCabe, G.J., and Markstrom, S.L., 2007, A monthly water-balance model driven by a graphical use interface: U.S. Geological Survey Open-File report 2007-1088, 6 p.). Values of AET were taken from the Thornthwaite model and are considered to be representative of actual site conditions.

2. Monthly surplus is calculated by summing the precipitation as rain and actual snow melt, less estimated evapotranspiration.

3. Negative surplus values can be achieved during the summer months as water storage in the vadose zone of the soil is subject to evapotranspiration and depleted.

4. Infiltration is assumed not to occur between December and February as frost is typically present throughout those months.

5. Infiltration in March (Average temperature of -0.1°C), is assumed to occur during half of the month.

6. No net infiltration or runoff occur in the summer as the rainfall accumulation is stored on site and infiltration was not assigned a negative value. See Assumption 3.

7. Evapotranspiration in impervious areas is the sum of precipitation as rain and snow melt multiplied by a factor of 0.18.

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of EXP may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by EXP. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and EXP's recommendations. Any reduction in the level of services recommended will result in EXP providing qualified opinions regarding the adequacy of the work. EXP can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the test pit results contained in the Report. The number of test pits necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to EXP to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. EXP has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

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All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to EXP by its client (“Client”), communications between EXP and the Client, other reports, proposals or documents prepared by EXP for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. EXP is not responsible for use by any party of portions of the Report.

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