Hydrogeological Investigation

PRELIMINARY REPORT

Royal Premier Homes

Project Name:
Hydrogeological Investigation
1350 Wharncliffe Road South
London, Ontario

Project Number:
KCH-22022007-A0

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Date Submitted:
February 1, 2023

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Type of Document:

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Date Submitted:

February 1, 2023

Executive Summary

EXP Services Inc. (EXP) was retained by **Royal Premier Homes** to conduct a hydrogeological assessment in support of a proposed development located at 1350 Wharncliffe Road South in London, Ontario (herein referred to as the 'Site'). The proposed development consists of medium and low density residential blocks and roadways, and will be serviced via municipal water and sewers.

The objective of the hydrogeological investigation was to assess 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, and collecting groundwater elevations over the course of multiple months. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site resulting from the proposed development and provides recommendations and design/construction measures, where applicable, to mitigate potential impacts.

There are no Upper Thames Region Conservation Authority (UTRCA) Regulated Lands within the limits of the Site. It is understood that the hydrogeological assessment report will be submitted for review and approval by the City of London. The study design and report have been compiled in general accordance with the standard Hydrogeological requirements as outlined in the City of London Design Specification & Requirements Manual (2019) as well as the Conservation Authority Guidelines for Hydrogeological Assessments (2013).

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

- A total of ten (10) boreholes were advanced at the Site on October 13 and 14, 2022. A total of four (4) boreholes were completed as groundwater monitoring wells.
- Based on the encountered geologies and groundwater elevations observed at the Site, it is interpreted that the investigated subsurface comprises one hydrostratigraphic unit consisting of clayey silt till with intermittent lenses of coarser-grained sediments.
- Based on the current monitoring period (October 2022 to January 2023) groundwater levels at the Site ranged between 0.24 and 6.71 mbgs with elevations ranging between 264.88 and 273.38 mamsl. It is noted that static conditions were not reached until the January monitoring event, and the water level within monitoring location BH7/MW has not reached the static condition at the time of writing. It is acknowledged that the current monitoring period has not captured the seasonal high groundwater table. Groundwater monitoring is ongoing and is slated to cease in April 2023 following the spring freshet.
- Since the clayey silt till unit is interpreted to represent an aquitard unit beneath the Site, the predominant groundwater flow direction is anticipated to be downward. The horizontal component of the groundwater flow direction is interpreted to be to the south/southeast, following topography.
- There were no exceedances of the ODWQS MAC in the two (2) groundwater samples collected. However, there were exceedances of the ODWQS A/O for calculated total dissolved solids, hardness (as $CaCO_3$), and/or dissolved aluminum in one or both groundwater samples collected. Since the proposed development will be serviced via municipal water supply, the elevated concentrations above the ODWQS A/O are not considered a concern.
- Particle size distribution analysis of shallow native soils and in-situ infiltration testing were not completed as part of the hydrogeological investigation. Based on our experience conducting in-situ infiltration testing on

similar soils in the area, typical infiltration rates within similar soils range between 4 to 8 mm/hr which includes a safety factor of 2.

- A monthly water balance was completed by Stantec and is included in their 2023 FPR. The Stantec water balance calculations indicate that the proposed development will maintain 45% of the pre-development infiltration. Applying a minimum thickness of 300 mm of topsoil throughout the pervious areas under post-development increases the infiltration volume maintained to 60%. In order to achieve post-development infiltration maintenance greater than 60%, secondary infiltration measures (i.e. LIDs) would be required.
- Private water users are present within 500 m of the Site. A door-to-door private well survey was outside the scope of the hydrogeological assessment and can be undertaken at a future time once the design details are finalized.
- Based on the observed shallow groundwater condition, it is anticipated that the shallow water table located within the clayey silt till unit will be encountered during construction of building foundations and services within the Site. However, the low hydraulic conductivity of this unit indicates groundwater inflow to excavations would occur slowly and could likely be managed via conventional methods (i.e. sumps).

<u>Recommendations</u>

- The Stantec pre- to post-development Site-wide water balance calculations indicate that post-development condition will maintain 60% of the pre-development infiltration if a minimum topsoil thickness of 300 mm is applied to all pervious areas under the post-development condition. LIDs could be considered in order to attain post-development infiltration targets greater than 60%, given that the infiltration facilities are designed appropriately.
- If LIDs are proposed, in-situ infiltration testing will be necessary to assess the infiltration rates in the vicinity of the proposed LID locations.
- A dewatering assessment, including a door-to-door private well survey, is outside the scope of this hydrogeological study. The requirement for a dewatering assessment should be reviewed upon finalizing the Site design. In the event any water supply wells fall within the predicted radius of influence, a monitoring program that includes contingencies would be required.
- Monitoring stations to assess during and post-development changes to water quality and quantity may be considered; however, the specific purpose and long-term responsibility for servicing and maintenance of the monitoring stations would need to be established.

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Appendices

Tables (in text)

Drawings (Appendix A)

1. Introduction and Background

1.1 Background

EXP Services Inc. (EXP) was retained by **Royal Premier Homes** to conduct a hydrogeological assessment in support of a proposed development located at 1350 Wharncliffe Road South in London, Ontario (herein referred to as the 'Site'). The proposed development consists of medium and low density residential blocks and roadways, and will be serviced via municipal water and sewers. The Site Location Plan is provided on **Drawing 1** in **Appendix A**.

This hydrogeological assessment is being completed to support Draft Plan Approval. It is noted that groundwater monitoring was initiated at the Site in October 2023 and is slated to cease in April 2023, following seven (7) months of monitoring. It is anticipated that the seasonal high groundwater will be captured during this monitoring period. This preliminary hydrogeological report will be updated once the groundwater monitoring program is completed.

A scoping meeting was held with Mr. Jeff Hachey, the City of London Hydrogeologist, on September 20, 2022, where the hydrogeological scope of work was discussed and approved, as shown in the correspondence with Mr. Hachey provided in **Appendix B**.

The objective of the hydrogeological investigation was to assess 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, and collecting groundwater elevations over the course of multiple months. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site resulting from the proposed development and provides recommendations and design/construction measures, where applicable, to mitigate potential impacts.

There are no Upper Thames Region Conservation Authority (UTRCA) Regulated Lands within the limits of the Site. It is understood that the hydrogeological assessment report will be submitted for review and approval by the City of London. The study scope and report have been compiled in general accordance with the standard Hydrogeological requirements as outlined in the City of London Design Specification & Requirements Manual (2019) as well as the Conservation Authority Guidelines for Hydrogeological Assessments (2013).

1.2 Development Plans and Stormwater Management Plan

A Draft Plan of Subdivision has been prepared by Stantec, dated September 26, 2022, provided in **Appendix C**. As shown, the development is proposed to consist of the following:

- Low Density Residential (Lots 1-29);
- Medium Density Residential (Lots 29-39, Block 40);
- Future Road (Block 41);
- Future Development (Block 42);
- 0.3 m Reserve (Block 43-44); and
- Roadways

It is noted that a heritage house is located with the Site that is intended to remain post-development (residential Lot 28).

The Final Proposal Report (FPR) prepared by Stantec, dated January 12, 2023, outlines the existing and proposed services and stormwater management at the Site. As outlined in the FPR, stormwater for the proposed development will continue to be directed to the White Oaks Drain and Pincombe Drain. These two drains are tributaries to the Dingman Creek.

Proposed on-Site controls include an Oil-Grit Separator (OGS) for treatment of minor flows within the medium density block and 860 m^3 of on-Site storage for the medium density block. No Low Impact Development (LID) strategies, including infiltration trenches, are proposed at this time.

The reader is directed to the FPR prepared by Stantec for additional details.

1.3 Terms of Reference and Scope of Work

A scoping meeting was held with the Hydrogeologist from the City of London, Jeff Hachey, on September 20, 2022, to review the hydrogeological investigation requirements.

The City-approved scope of work for the Hydrogeological Assessment consisted of the following:

1. Desktop Study: This task consisted of a review of existing information including Site plans, previous reports (where available), geological maps, geological cross sections, groundwater level information, borehole logs, and MECP WWR.

2. Field Program: The drilling program was completed on October 13 and 14, 2022, and included the advancement of ten (10) boreholes across the Site to facilitate the geotechnical investigation also being completed for the Site. A total of four (4) boreholes were completed as groundwater monitoring wells to facilitate the hydrogeological investigation. Manual groundwater measurements have been collected on a monthly basis between October 2022 and January 2023 and is slated to continue until April 2023, following the 2023 spring freshet. Single well response tests (SWRT) were completed on two (2) selected monitoring wells to assist in characterizing the geological units the wells are screened within. Groundwater samples were collected from two (2) monitoring wells on January 17, 2023, that were analyzed for general chemistry parameters to document the current groundwater chemistry prior to construction and development of the Site.

3. Data Evaluation: Compilation and evaluation of the collected field and laboratory data.

4. 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).

2. Methodology

2.1 Borehole Drilling and Monitoring Well Installations

Borehole drilling and monitoring well installations were completed on October 13 and 14, 2022. The drilling program consisted of the advancement of ten (10) boreholes with four (4) completed as groundwater monitoring wells at the locations shown on **Drawing 2**.

The borehole and monitoring well installations were completed by a specialized drilling subcontractor under the supervision of EXP staff. The boreholes were advanced using a track-mounted drill rig equipped with continuous flight solid and hollow stem augers, soil sampling and soil testing equipment. Disturbed soil samples were recovered from each borehole, at depth intervals of 0.75 m and 1.5 m using conventional split spoon sampling equipment.

The stratigraphy in the boreholes was examined during the drilling and logged in the field by EXP technical personnel. Copies of the borehole logs are provided in **Appendix D**.

The location of each borehole was established in the field based on information provided by the Client.

Groundwater monitoring wells were constructed from 51 mm (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. Well screens consisted of 1.5 m long lengths of PVC pipe with 0.010-inch factory-generated slots. 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 boring, was used as a seal above the filter pack. A summary of the well installation details is provided in **Table 1**.

The monitoring wells were constructed in accordance with Ontario Regulation 903 (as amended) as administered by the MECP.

When no longer required, the monitoring wells installed at the Site should be properly decommissioned in accordance with Ontario Regulation 903, under the Ontario Water Resources Act. This regulation identifies minimum standards and proper abandonment/decommissioning of existing domestic wells, as well as regulations for licensing well contractors and well technicians. Further, the decommissioning work must be undertaken by a licensed contractor.

Table 1 – Monitoring Well Construction Details

Well ID	Ground Surface Elevation[1] (mamsl)	Top of Standpipe Elevation (mamsl)	Borehole Completion Depth (mbgs)	Screened Interval (m)	Soil Description[2]
BH1/MW	274.00	274.73	5.2	3.4-4.9	Clayey Silt, some Sand
BH3/MW-A	271.59	272.36	8.2	5.8-7.3	Clayey Silt, some Sand, trace Gravel
BH3/MW-B	271.69	272.47	4.6	3.0-4.6	Clayey Silt, some Sand, trace Gravel
BH7/MW	270.52	271.15	5.2	3.7-5.2	Clayey Silt, some Sand, trace Gravel

[1] Ground surface elevations were extracted from the topographical survey provided by the Client. Geodetically surveyed elevations will be utilized in the final hydrogeological report.
[2] Soil descriptions are based on grain size analysis results for soil samples collected from the screened interval of the monitoring well.

2.2 Well Development and Groundwater Sampling

Monitoring well development was completed on December 14, 2022. Due to the slow recovery of water within the wells, well development consisted of purging the well dry, or adding clean water and surging the well with a Waterra™ surge block to remove fine sediments within the well screen. Water was immediately removed from the well following surging.

Monitoring wells were developed to:

- remove fine soil particles adjacent to the well screen;
- 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.

Groundwater samples were collected on January 17, 2023, from monitoring well locations BH1/MW and BH7/MW. Prior to sampling, the wells were purged dry, and the samples were collected once the water level had recovered to a sufficient level to allow for sample recovery.

Groundwater samples were submitted to an accredited laboratory for analysis of general chemistry parameters (i.e. pH, total dissolved solids, conductivity), nutrients, and dissolved metals.

2.3 Long-Term Groundwater Elevation Monitoring

Site-wide manual water levels have been measured monthly between October 25, 2022, and January 17, 2023, using a battery-signal water level tape. Groundwater monitoring is on-going and is slated to cease in April 2023 following the 2023 spring freshet.

No electronic pressure transducers (data loggers) were installed as part of the monitoring program.

2.4 Hydraulic Conductivity Testing

Single well response tests (SWRTs) were completed on monitoring locations BH1/MW and BH7/MW to evaluate the hydraulic characteristics of the screened overburden. The test method consisted of a recovery test (i.e. rising head test) whereby the well was purged dry, and the water level recovery was monitored using a data logger until it was observed to reach the static or near-static level.

The recovery test at BH7/MW was initiated on January 17, 2023. The well was revisited nine (9) days later (January 26, 2023) to assess the progress of the test. It was observed that the water level had reached 62% recovery after approximately nine (9) days indicating very slow hydraulic conductivity. Therefore, the data logger was removed, and the test was terminated prior to attaining 90% recovery.

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.

Hvorslev (1951) was selected as the analytical method since research has shown that the Hvorslev analysis typically results in higher K estimates compared to several other analytical methods, including Bouwer and Rice (1976), and Dagan (1978) (Ismael, 2016). Ismael (2016) also states:

> *Larger K values typical of pump tests are generally known to be superior to smaller values from slug tests, largely due to inadequate development of wells that are slugged (Butler and Healy, 1998). Butler (1998) says that "the hydraulic-conductivity estimate obtained from a slug test should virtually always be viewed as a lower bound on the hydraulic conductivity of the formation in the vicinity of the well." That is why larger K values are considered to be inherently better or more potentially true than smaller values*.

Assumptions in the Hvorslev method for estimating K are:

- The aquifer has infinite aerial extent;
- The aquifer is homogeneous and of uniform thickness;
- The tested well is fully or partially penetrating;
- Flow to the well is quasi-steady-state (storage is negligible); and
- Water is injected into or discharged from the well instantaneously.

3. Regional Hydrogeological Setting

In addition to the shallow groundwater information collected from the boreholes completed 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. Thames River Basin Water Management Study Technical Report. Ontario Ministry of the Environment, Water Resources Report 14;
- MECP Well Records within 500 m of the Site boundary; and,
- Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August.

3.1 Regional Geology

3.1.1 Bedrock Geology

The Site is underlain by limestone, dolostone and shale of the Dundee Formation (OGS, 2011). Bedrock topography mapping (**Drawing 3**) indicates the bedrock surface is likely at an elevation of about 200 mamsl beneath the Site. The bedrock surface generally slopes to the west-southwest in this area. Drift thickness mapping in the area indicates the overburden is approximately 72 m thick in the vicinity of the Site (OGS, 2011). Bedrock was not encountered during this investigation.

3.1.2 Physiography and 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 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. The physiography of the Site was influenced by the Huron Lobe.

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.

The surficial deposits were mapped and categorized into several physiographic regions by Chapman and Putnam (1984). The physiographic mapping for the area indicates the site is situated within the Mount Elgin Ridges, as shown on **Drawing 4**. This physiographic region consists of a series of ridges and vales. The ridges are comprised of calcareous clay to silty clay while the vales generally consist of alluvium of gravel, sand, or silt (Chapman and Putnam, 1984).

Physiographic landform mapping (**Drawing 5**) indicates that the Site is located within an area characterized by undrumlinized till plains. Till moraines are mapped to the north and spillways are mapped to the south of the Site.

Surficial geology mapping (OGS, 2010; **Drawing 6**) indicates the Site is underlain by clay to silt-textured till (Port Stanley Till).

3.2 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.

3.2.1 Overburden Aquifers

The uppermost shallow and unconfined overburden aquifer was described by Goff and Brown (1981) as consisting of lacustrine or glacio-fluvial sands that may, in some locations, be overlain by lower permeability silts and clays. 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 mbgs) and deep overburden aquifers (>30 mbgs) aquifers are reported by Goff and Brown (1981) to generally consist of saturated sand and gravel deposits and are very discontinuous in nature due to the heterogeneous nature of glacial deposits. 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.

Shallow groundwater flow is expected to follow the local topography. On a regional scale, the deep overburden aquifer flow direction is reported to be towards the south-southwest (Dillon and Golder, 2004).

3.2.2 Bedrock Aquifer

The bedrock aquifer consists of limestone from the Dundee Formation (OGS, 2011). As with the intermediate depth and deep overburden aquifers, the bedrock aquifer is confined by the overlying soils, which is indicated to be approximately 72 m thick in the vicinity of the site (OGS, 2011). Wells extending into the shallow fractured bedrock (up to about 3m) 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 was generally in a south-southwest direction towards Lake Erie.

3.3 Local Water Use

A search of the online Ontario MECP Water Well Records database identified 31 water supply well records within 500 m of the Site boundaries. The following provides a summary of the well records identified:

- 13 records were listed a water supply wells. Of these:
    - 8 records were listed with the primary use as domestic; and
    - 5 records were listed with the primary use as commercial;

- 5 records were listed as test holes or observations wells;
- 8 records were listed as abandoned; and
- 2 records did not identify a final status.

One of the domestic water supply wells is mapped as being located within the limits of the Site (Well ID 4110013). This well record states the well was installed on July 12, 1983, and was installed to a depth of 15.2 mbgs. The lithology is described as brown to grey dense clay from ground surface to 10.7 mbgs underlain by sand and clay to 12.2 mbgs. Loose sand is reported from 12.2 to 15.2 mbgs.

It is understood that this water supply well continues to supply the heritage house located on the Site. However, this well, in addition to the septic bed on Site, will be decommissioned during construction and the heritage house will be serviced via municipal services once available through development of the Site.

Other water supply wells within 500 m of the Site were installed to depths ranging between 11.9 and 24.4 mbgs and were installed between August 1949 and July 1983.

The approximate locations of identified wells, as provided by the MECP WWIS, are shown on **Drawing 7**, with a summary provided in **Appendix E**.

4. Site Description and Geologic Setting

4.1 Site Location and Description

The Site is located within the City of London, south of the Wharncliffe Road South and Bradley Avenue West intersection (**Drawing 1**). The Site is roughly rectangular in shape and comprises an area of approximately 4.05 hectares (10.01 acres). The Site currently consists of a heritage house and farmstead with associated outbuildings, a paved and tree-lined driveway, and gravel-surfaced parking area. Access to the Site is provided via Wharncliffe Road South to the north.

Wharncliffe Road South is located immediately north of the Site with vacant undeveloped properties present beyond. Cultivated agricultural land is present to the east and south. Lands to the west are currently undergoing development as a residential subdivision.

4.2 Topography and Drainage

Topography at the Site generally slopes to the south/southwest. As outlined in the FPR (Stantec, 2023) under the existing conditions, runoff in the north portion of the Site is directed easterly to a tributary of the White Oaks Drain while runoff in the south portion of the Site is directed to the south and ultimately discharges to the Pincombe stormwater management facility (SWMF) #3.

4.3 Site Specific Surficial Geology

Generally, the Site consists of topsoil underlain by clayey silt till. Sequences of fill were observed at ground surface at borehole locations BH6 and BH7/MW, located in the southern portion of the Site, to depths ranging between 0.5 and 0.9 mbgs. The fill consisted of granular fill or a mix of topsoil, gravel, and asphalt.

A layer of sandy silt till with some gravel was observed below the fill at borehole BH6, and a thin layer of silty sand was observed at BH8 at approximately 2.6 mbgs. All boreholes were terminated within the native clayey silt till unit with the exception of BH3/MW-A where a silty sand unit was encountered beneath the clayey silt till to the maximum depth investigated at this location (8.2 mbgs).

The detailed soil profiles encountered in each borehole are provided on the borehole logs in **Appendix D**. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous soil sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the hydrogeological investigation and shall not be interpreted as exact planes of geological change.

4.4 Site Specific Groundwater Elevations

The monthly water levels and groundwater elevations measured between October 25, 2022, and January 17, 2023, are included in **Appendix G**.

Groundwater levels at the Site ranged between 0.24 and 6.71 mbgs during the monitoring period, with elevations ranging between 264.88 and 273.38 mamsl. It is noted that static conditions were not reached in monitoring locations BH1/MW, BH3A/MW, and BH3B/MW until the January monitoring event, and the water level within monitoring location BH7/MW has not reached the static condition at the time of writing.

It is acknowledged that the current monitoring period has not captured the seasonal high groundwater table. Groundwater monitoring is ongoing and is slated to cease in April 2023 following the spring freshet.

4.5 Hydrostratigraphic Interpretation

Based on the encountered geologies and groundwater elevations observed at the Site, it is interpreted that the investigated subsurface comprises one hydrostratigraphic unit consisting of the clayey silt till with intermittent lenses of coarser-grained sediments (sandy silt till, silty sand). It is noted that a silty sand unit was encountered beneath the clayey silt till at borehole location BH3A/MW that the borehole was terminated within. Therefore, the thickness and presence of groundwater of this unit is unknown and this unit may represent a separate hydrostratigraphic unit beneath the Site.

The clayey silt till unit present beneath the Site is interpreted to represent an aquitard which is defined as a less-permeable bed within a stratigraphic sequence (Freeze and Cherry, 1979). Aquitards can store water and slowly transmit water from one aquifer to another (Fetter, 2001).

4.6 Groundwater Flow

As outlined above, the clayey silt till unit is interpreted to represent an aquitard unit beneath the Site. In general, the groundwater flow direction across an aquifer is horizontal while groundwater flow across aquitards is primarily vertical (Cherry, et. al., 2006). Therefore, the predominant groundwater flow direction in the clayey silt till unit is anticipated to be downward with the horizontal component likely following topography to the south/southeast, as shown on **Drawing 8**.

4.7 Hydraulic Conductivity (k), Horizontal Hydraulic Gradient (i), and Average Linear Groundwater Velocity (V_x)

As stated in **Section 2.4**, SWRTs were completed on monitoring locations BH1/MW and BH7/MW to evaluate the hydraulic characteristics of the screened overburden. It is noted that the water level within BH7/MW was observed to have only 62% recovery after approximately nine days. The data logger was removed from this location prior to attaining 90% recovery, and the hydraulic conductivity at this location is estimated to be less than 1×10^{-10} m/s.

The hydraulic conductivity estimates for the tested monitoring wells are summarized below:

Table 2 – Hydraulic Conductivity Testing Results Summary

Well ID	Soil Description[1]	Hydraulic Conductivity (m/s)	Screened Unit
BH1/MW	Clayey Silt, some Sand	1.3×10^{-8}	Aquitard
BH7/MW	Clayey Silt, some Sand, trace Gravel	1.0×10^{-10}*	Aquitard
	Geomean	1.1×10^{-9}	

[1] Soil descriptions are based on grain size analysis results for soil samples collected from the screened interval of the monitoring well.
*The hydraulic conductivity estimate for BH7/MW is based on the very slow recovery (62% in nine days) and the observed recoveries within the other monitoring locations.

These results are generally consistent with the estimated range of hydraulic conductivity values for their respective lithologies reported by Freeze and Cherry (1979). The semi-log plots for normalized drawdown versus time are provided in **Appendix H**.

Horizontal hydraulic gradient and groundwater velocity calculations were not completed since an aquifer unit was not encountered within the investigated depths at the Site.

4.8 Groundwater Chemistry

Groundwater samples were collected from monitoring locations BH1/MW and BH7/MW on January 17, 2023. The groundwater samples were submitted for analysis of general chemistry parameters to document the current groundwater chemistry prior to construction and development of the Site. The groundwater samples were compared to the Ontario Drinking Water Quality Standards (ODWQS) Maximum Acceptable Concentrations (MAC) and Aesthetic/Operational Guidelines (A/O). The Groundwater Analytical Results Summary and Laboratory Certificates of Analysis are provided in **Appendix F**.

4.8.1 General Chemistry & Dissolved Metals

Both groundwater samples reportedly contained concentrations of calculated total dissolved solids and hardness (as $CaCO_3$) above the ODWQS A/O. Dissolved aluminum in the groundwater sample collected from BH7/MW was also above it's respective ODWQS A/O. There were no reported concentrations above the ODWQS MAC.

Since the proposed development will be serviced via municipal water supply, the elevated concentrations above the ODWQS A/O are not considered a concern.

4.8.2 Anions and Nutrients

Nitrite was reported as below the detectable limit for both samples collected while nitrate concentrations ranged between 0.11 and 0.72 mg/L which are below the ODWQS MAC of 10 mg/L. Due to the presence of cultivated agricultural fields immediately east of the Site, it is anticipated that these concentration may fluctuate annually if nitrate-containing fertilizers are applied to these agricultural properties; however the highest concentrations would be likely encountered along the eastern Site boundary and are anticipated to reduce to the west.

4.8.3 Schoeller Diagrams

Schoeller Diagrams were also prepared for the groundwater samples for major and minor ions, included in **Appendix F**. The groundwater chemistry between BH1/MW and BH7/MW is generally consistent with the exception of chloride, sulphate, and nitrate plus nitrite.

BH1/MW is located in the north portion of the Site, near the Wharncliffe Road South municipal roadway. Therefore, it is anticipated that this location is influenced to a higher degree from surface runoff and salting of this roadway.

4.8.4 Piper Diagram

A Piper Diagram was prepared for the groundwater quality samples, provided in **Appendix F**. Both groundwater samples plot within the magnesium bicarbonate alkaline zone of the Piper Diagram.

4.9 Preliminary Infiltration Rates

Particle size distribution analysis from the shallow native soils and in-situ infiltration testing were not completed as part of the hydrogeological investigation. Based on our experience conducting in-situ infiltration testing on similar soils in the area, typical infiltration rates range between 4 to 8 mm/hr which includes a design safety factor of 2.

It is acknowledged that if LIDs are proposed, in-situ infiltration testing will be required to assess the infiltration rates of the soils within the proposed LID locations.

5. Water Balance Assessment

A pre-to-post development monthly water balance was completed by Stantec as part of the FPR (2023).

A summary of the water balance calculation findings are summarized in **Table 3**, below.

Table 3: Summary of Stantec Water Balance Estimates – No Additional Measures

	Pre-Development	Post-Development	Difference	% Maintained
Estimated Runoff (m^3/year)	9,731	27,764	18,033	285%
Estimated Infiltration (m^3/year)	9,539	4,323	-5,216	45%

Based on the above, the proposed development maintains 45% of the pre-development infiltration. Therefore, the use of supplemental/secondary infiltration (LIDs) would need to be designed and constructed in order to achieve a post-development infiltration maintenance greater than 45%.

The Stantec water balance also included calculations considering increased topsoil thicknesses of at least 300 mm in pervious areas. The results of these calculations findings are summarized in **Table 4**, below.

Table 4: Summary of Stantec Water Balance Estimates – Increased Topsoil Thickness of at Least 300 mm in Pervious Areas

	Pre-Development	Post-Development	Difference	% Maintained
Estimated Runoff (m^3/year)	9,731	26,375	16,644	271%
Estimated Infiltration (m^3/year)	9,539	5,711	-3,828	60%

As shown above, having topsoil thicknesses of at least 300 mm in pervious areas increases the post-development infiltration maintenance to 60%. In order to achieve post-development infiltration maintenance greater than 60%, secondary infiltration measures (i.e. LIDs) would be required.

5.1 LID Design Considerations

The subsurface investigations completed at the Site have identified the shallow native soils to consist of fine-grained clayey silt till. Although the infiltration rates of this material are low, studies completed in Southern Ontario have shown that infiltration chambers installed in clayey glacial till are an effective means of promoting post-development infiltration and maintaining the infiltration water balance (Young, 2015).

The Sustainable Technologies Evaluation Program (STEP) of the Toronto and Region Conservation Authority has completed field monitoring programs for evaluating the effectiveness of infiltration practices within fine-textured till soils. The evaluation program included monitoring infiltration trenches and chambers that were installed in glacial till soils for rainfall depth, outflow, and water levels within the chambers for a period of two to three years (Young, 2015). The monitoring program found that, although the drainage rates are slow, "substantial reductions in runoff volume can be achieved through thoughtful design" (Young, 2015).

Through the evaluation of the infiltration facilities, it was observed that the drainage rates decline exponentially as the water level in the chamber declines, and is about 2.5 higher when then chamber is full versus when half full. When the water level in the chamber is less than 1 m deep, the drainage is very slow (less than 1mm/hr), indicating that infiltration strategies with shallow water storage reservoirs will not drain well within these tight till soils (Young, 2015). This observation indicates that the drainage performance would be increased by ensuring the infiltration facility is designed to "maintain hydraulic head in the water storage reservoir for longer than the typical target of 48 to 72 hours" (Young, 2015). Designing the infiltration facility in this way would help to maximize the drainage rate and increase the volume of infiltration water. Therefore, for low permeability soils, the infiltration facility may be designed such that it never fully drains (Young, 2015).

The study concluded that "for developments on fine-textured soils, where roof area makes up at least 50 percent of the lot, underground infiltration practices can fully compensate for the loss of groundwater recharge caused by site development through infiltration of roof runoff alone." (Young, 2015).

Based on the above, it is anticipated that LIDs may be considered to achieve the desired pre- to post-development infiltration water balance given that the infiltration facilities are designed appropriately.

6. Impact Assessment

6.1 Source Water Protection Considerations

6.1.1 Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge is largely controlled by soil conditions, and typically occurs in upland areas.

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.

The Source Water Protection Information Atlas (SWPIA) online mapping indicates the Site is not located within a SGRA.

6.1.2 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:

- Intrinsic susceptibility index (ISI).
- Aquifer vulnerability index (AVI).
- Surface to aquifer advection time (SAAT).
- 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 MOECC'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 MOECC'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 Source Water Protection Information Atlas (SWPIA) online mapping indicates the Site is not located within a HVA.

6.1.3 Wellhead Protection Areas (WHPAs)

Wellhead Protection Areas are located surrounding municipal supply wells and delineate travel times to the well using both qualitative and quantitative assessments of geology and groundwater flow. There are four WHPA zones, defined as:

- WHPA A: 100 m radius around the municipal supply well
- WHPA B: time of travel to the well is 2 years or less
- WHPA C: time of travel to the well is greater than 2 years and equal to or less than 5 years, and
- WHPA D: time of travel to the well is greater than 5 years and equal to or less than 25 years.

The SWPIA online mapping indicates the Site is not located within a WHPA.

6.1.4 Intrinsic Vulnerability

The assessment of an aquifers intrinsic vulnerability takes into consideration the land uses in the area and the ability of surface or near-surface sources of contamination to infiltrate to the ground surface and reach the aquifer through various transport pathways (e.g. wells, septic systems, stormwater infiltration, etc.). The presence of transport pathways increases the likelihood of contamination of an aquifer as they facilitate the downward movement of contaminants. The intrinsic vulnerability scores range from low, medium, and high.

Map 4-3-1 (Aquifer Vulnerability) of the Upper Thames River Source Protection Area Approved Assessment Report (dated August 18, 2010) indicates the Site is located within an area with medium to low aquifer vulnerability.

6.1.5 Issue Contributing Areas (ICAs)

Issue contributing areas are delineated around municipal supply well intake areas where issues have been identified that may negatively impact drinking water supplies. Issues include various types of parameters (pathogens, chemical parameters, aesthetic parameters, etc.).

The SWPIA online mapping indicates the Site is not located within an ICA.

6.2 Private Water Well Users

6.2.1 Private Well Survey

Shallow wells interpreted to be located hydraulically up-gradient of the Site have a higher likelihood of being impacted by dewatering activities at the Site. As described in **Section 4.6**, the clayey silt till present at ground surface beneath the Site represents an aquitard unit where the predominant groundwater flow direction is downward.

A dewatering assessment including a door-to-door private well survey, is outside the scope of this hydrogeological study and can be completed, if required. In the event any water supply wells fall within the predicted radius of influence, a monitoring program that includes contingencies would be required.

6.3 Surface Water Features

The Site is located within the Dingman Creek Subwatershed. Land Information Ontario (LIO) mapping indicates a constructed municipal drain is located east of the Site boundary, in the vicinity of BH3A-B/MW, running west to east that is intermittently wet. This municipal drain was not observed during the course of this investigation.

The nearest surface water feature is a municipal drain located approximately 110 m east of the Site, running to the south, discharging to the White Oaks Drain approximately 1.5 km south of the Site. The White Oaks Drain discharges to the Dingman Creek, approximately 2 km south of the Site.

The following comments are provided with recommendations to help minimize impact to surface water features in the vicinity of the Study Area during construction:

- 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; and,
- Limit the use of salts or other additives for ice and snow control on the roadways.

6.4 Groundwater Separation Distances and Preliminary Construction Dewatering Considerations

Groundwater elevations at the Site during the monitoring period ranged between 0.24 and 6.71 mbgs during the monitoring period, with elevations ranging between 264.88 and 273.38 mamsl. It is noted that static conditions were not reached until the January monitoring event, and the water level within monitoring location BH7/MW has not reached the static condition at the time of writing.

It is acknowledged that the current monitoring period has not captured the seasonal high groundwater table. Groundwater monitoring is ongoing and is slated to cease in April 2023 following the spring freshet.

Based on the observed shallow groundwater condition, it is anticipated that the shallow water table located within the clayey silt till unit will be encountered during construction of building foundations and services within the Site. However, the low hydraulic conductivity of this unit indicates that the groundwater inflow to excavations would occur slowly and could likely be managed via conventional methods (i.e. sumps).

A dewatering assessment can be completed at the detailed design stage once the installation details of the services and the finished floor elevations are determined. It is noted that construction dewatering water takings between 50, 000 and 400, 000 litres per day (LPD) require registration on the online Environmental Activity and Sector Registry (EASR). Construction dewatering water takings exceeding 400,000 LPD require a Category 3 Permit to Take Water (PTTW). The dewatering assessment report is reviewed by the MECP that involves a review period of up to 4 months.

6.5 Water Quality Monitoring Considerations

It is typical for groundwater monitoring to be recommended during the construction and post-construction phases of development projects to assess potential impacts of the development on groundwater levels and quality. There are several items that can be considered to reduce the likelihood of negative impacts to the groundwater during construction, outlined below. These 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 support the proposed development, analytical testing of the imported material will be required as per the Ontario On-Site and Excess Soil Management Regulation (O. Reg. 406/19);

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

- 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.

Monitoring stations to assess during and 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. Recommendations

Based on the findings of the preliminary Hydrogeological Investigation, the following summary of recommendations is provided:

- The Stantec pre- to post-development Site-wide water balance calculations indicate that post-development condition will maintain 60% of the pre-development infiltration if a minimum topsoil thickness of 300 mm is applied to all pervious areas under the post-development condition. LIDs could be considered in order to attain post-development infiltration targets greater than 60%, given that the infiltration facilities are designed appropriately.

- If LIDs are proposed, in-situ infiltration testing will be necessary to assess the infiltration rates in the vicinity of the proposed LID locations.

- A dewatering assessment including a door-to-door private well survey, is outside the scope of this hydrogeological investigation. The requirement for a dewatering assessment should be reviewed upon finalizing the Site design. In the event any water supply wells fall within the predicted radius of influence, a monitoring program that includes contingencies may be necessary.

- Monitoring stations to assess during and 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.

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 prepared by Ms. Kassandra Wallace, B.B.R.M. Ms. Wallace has more than 5 years' experience in the environmental consulting industry that includes conducting hydrogeological assessments for various types of development projects, Phase One and Phase Two Environmental Site Assessments, and remediation projects. She obtained her bachelor's degree in Bio-Resource Management (Environmental Management Major) from the University of Guelph and obtained her Ontario College Graduate Certificate in Environmental Engineering Applications from Conestoga College.

This report was reviewed by Ms. Heather Jaggard, M.Sc., P. Geo. Ms. Jaggard is a hydrogeologist and environmental geoscientist with more than 10 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 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 PTTW have been part of her routine assignments.

9. References

Barnett, P.J., Cowan, W.R. and Henry, A.P. 1981. Quaternary geology of Ontario, southern sheet; Ontario Geological Survey, Map 2556.

Barnett, P.J. 1982. Quaternary geology of the Tillsonburg Area, southern Ontario; Ontario Geological Survey, Report 220, 87p.

Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2, 270p.

Cherry, J. A., Parker, B. L., Bradbury, K. R., Eaton, T. T., Gotowitz, M. B., Hart, D. J., & Borchardt, M. A. (2006). Contaminant Transport Through Aquitards: A State-of-the-Science Review. Awwa Research Foundation.

Conservation Ontario. 2013. Hydrogeological Assessment Submissions - Conservation Ontario Guidelines to Support Development Applications. June.

Corporation of the City of London. 2019. Design Specifications & Requirements Manual. Updated August 2019.

Dillon Consulting Limited and Golder Associates Ltd. (Dillon and Golder). 2004. Middlesex-Elgin Groundwater Study, Final Report, submitted to Middlesex and Elgin Counties.

Freeze, R. A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall Inc. New Jersey. 604 pp

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.

Lake Erie Source Protection Committee (LESPC). 2021. Grand River Source Protection Area Approved Assessment Report.

Ismael, R. I. 2016. Slug Tests in Unconfined Aquifers. Master's Theses. 699.
https://scholarworks.wmich.edu/masters_theses/699

Ministry of the Environment: Water Well Records. https://www.ontario.ca/environment-and-energy/map-well-records.

Ministry of the Environment (MOE). 2001. Groundwater Studies 2001/2002, Technical Terms of Reference

Ontario Geological Survey (OGS). 2010. Surficial geology of Southern Ontario, Miscellaneous Release--Data 128-REV.

Ontario Geological Survey (OGS). 2011. Bedrock Geology of Ontario, 1:250 000 scale, Miscellaneous Release Data 126-Revision 1.

Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August.

Young, D. (n.d.). Go Deep - Making Stormwater Infiltration Work on Tight Soils. *Environmental Connection*, 37-39.

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.

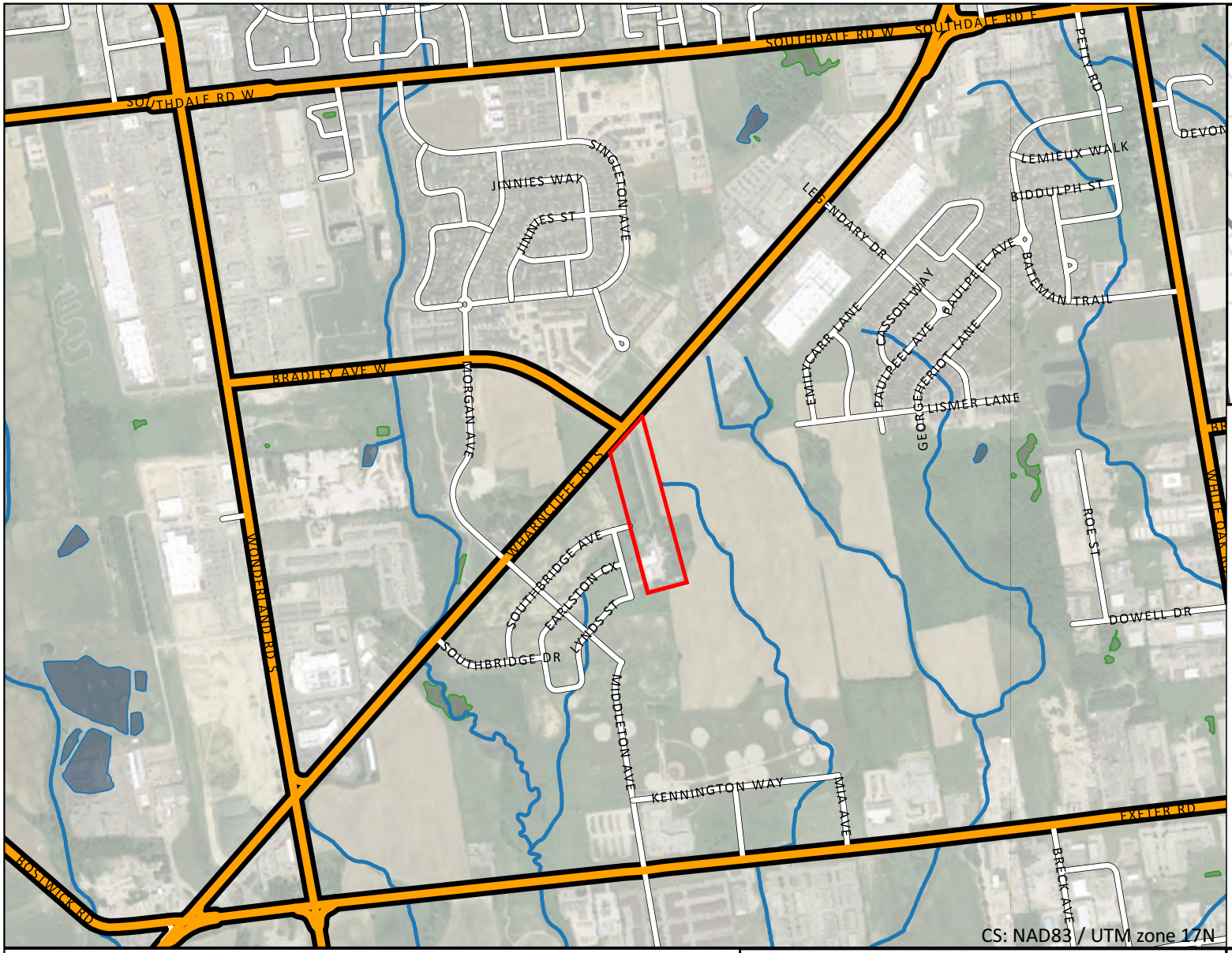
The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than 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 **Royal Premier Homes** 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-

- Site Boundary
- Watercourse (OHN)
- Waterbody (OHN)
- Marshes (City of London Open Data)

Notes:
OHN - Ontario Hydro Network

Data Sources:
Contains information licensed under the Open Government License - Ontario
Google Earth Imagery (c) 2022 City of London, First Base Solutions, Maxar Technologies

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Site Location Plan
Prepared By: K.W.	Reviewed By: H.J.

EXP Services Inc.
405 Maple Grove Road, Cambridge, ON N3E 1B6

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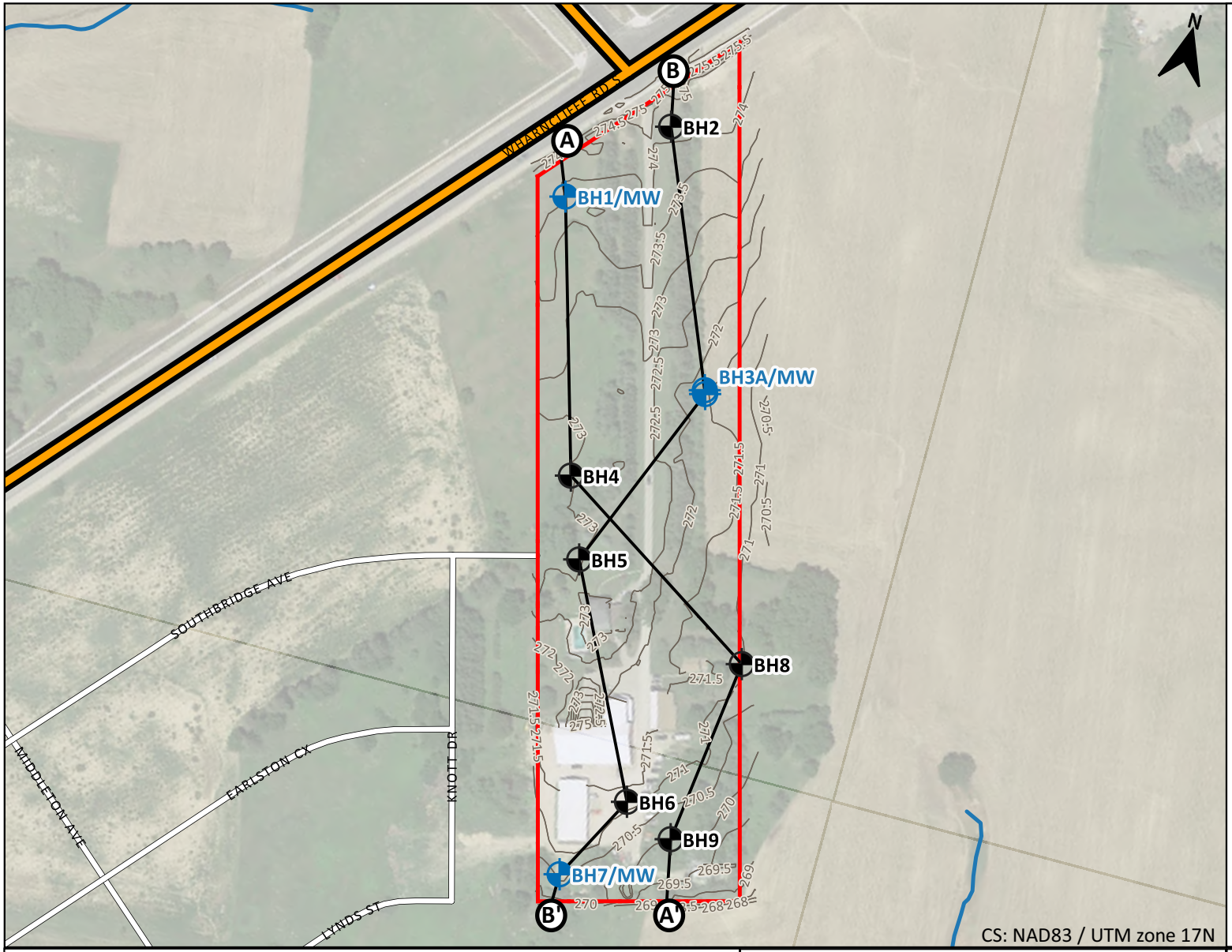

-LEGEND-

- Site Boundary
- Ground Surface Elevation Contour (mamsl)
- Watercourses (City of London Open Data)
- Geological Cross-Section

Investigative Locations

- Monitoring Well
- Borehole

Notes:
Ground surface elevation contours provided by topographical mapping from the Client.

Data Sources:
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Google Earth Imagery (c) 2022 City of London, First Base Solutions, Maxar Technologies

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Site Features & Borehole Location Plan
Prepared By: K.W.	Reviewed By: H.J.

EXP Services Inc.
405 Maple Grove Road, Cambridge, ON N3E 1B6

DATE	SCALE	PROJECT NO.	DWG.
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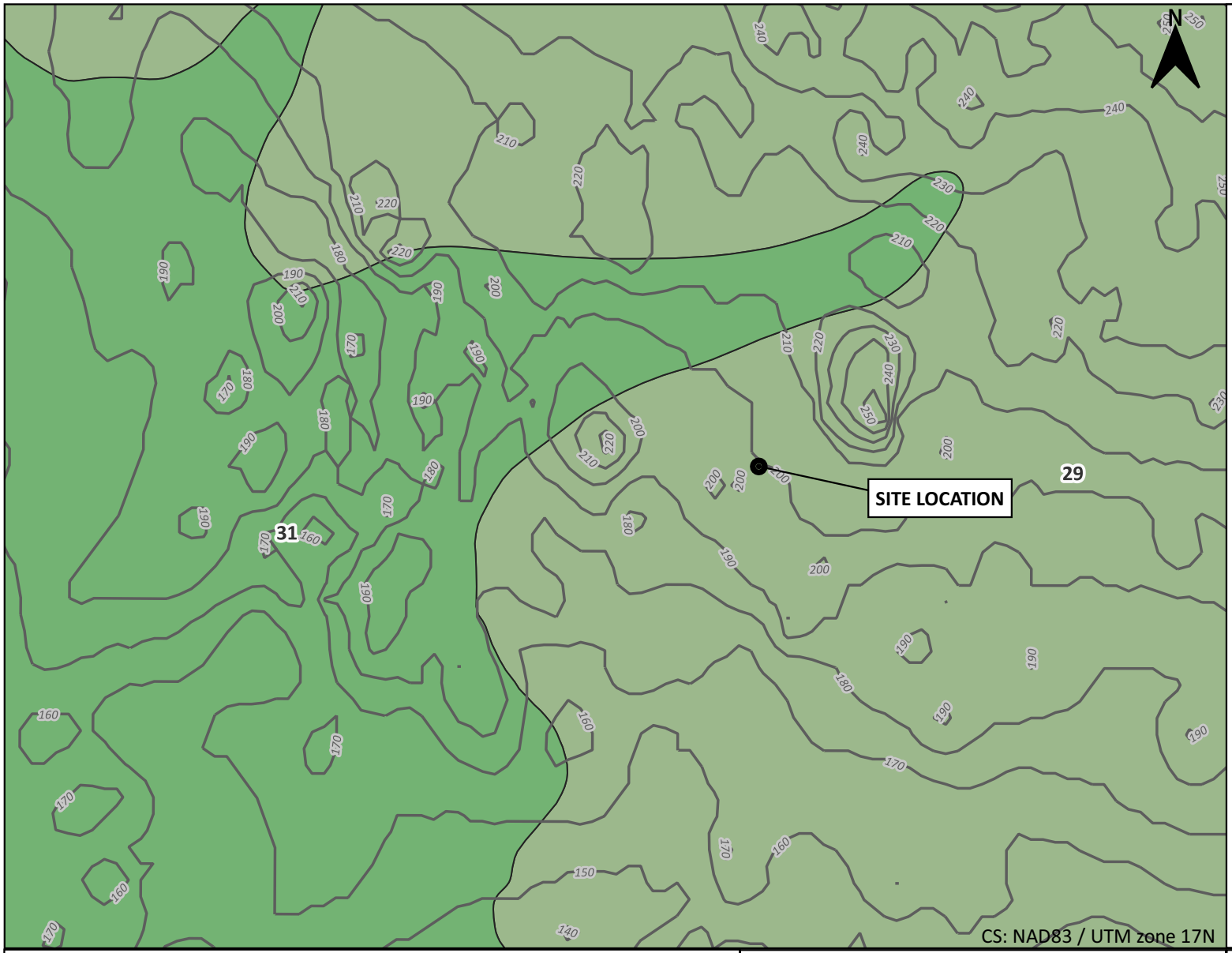

-LEGEND-

- Bedrock Topography Contours (10m)
- 29 Dundee Formation
- 31 Hamilton Group

Notes:

Data Sources:
Bedrock topography contours extrapolated from Paleozoic Geology data provided by the Ministry of Northern Development, Mines, Natural Resources and Forestry OGSEarth Mapping.
Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release - Data 219.

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT: Royal Premier Homes

TITLE: Bedrock Geology & Topography

Prepared By: K.W.

Reviewed By: H.J.

EXP Services Inc.
405 Maple Grove Road, Cambridge, ON N3E 1B6

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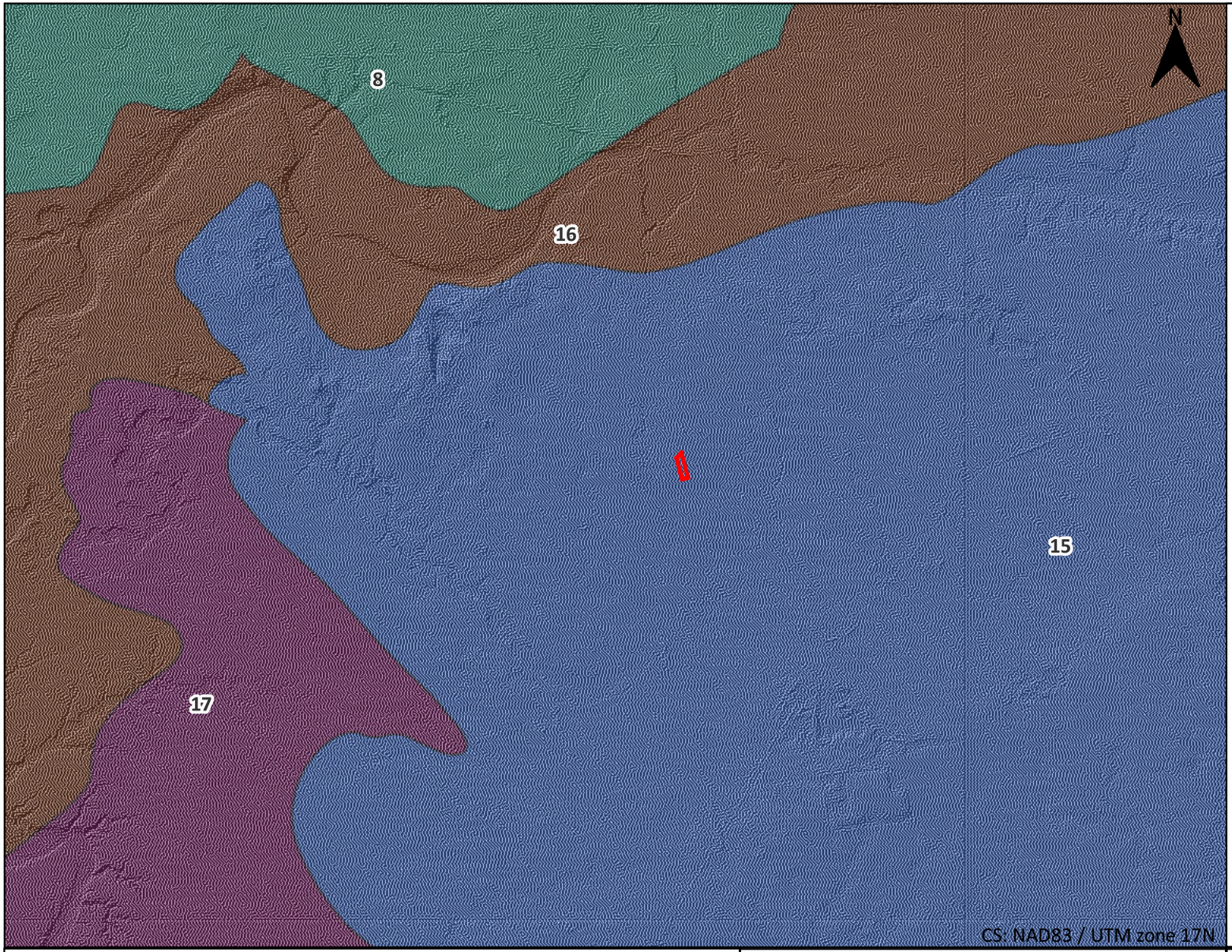

-LEGEND-

Site Boundary

Physiographic Regions

- 8 Stratford Till Plain
- 15 Mount Elgin Ridges
- 16 Caradoc Sand Plains and London Annex
- 17 Ekfrid Clay Plain

Notes:

Data Sources:
Contains information licensed under the Open Government Licence – Ontario.
Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 228.

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT: Royal Premier Homes

TITLE: Physiographic Regions

Prepared By: K.W. | Reviewed By: H.J.

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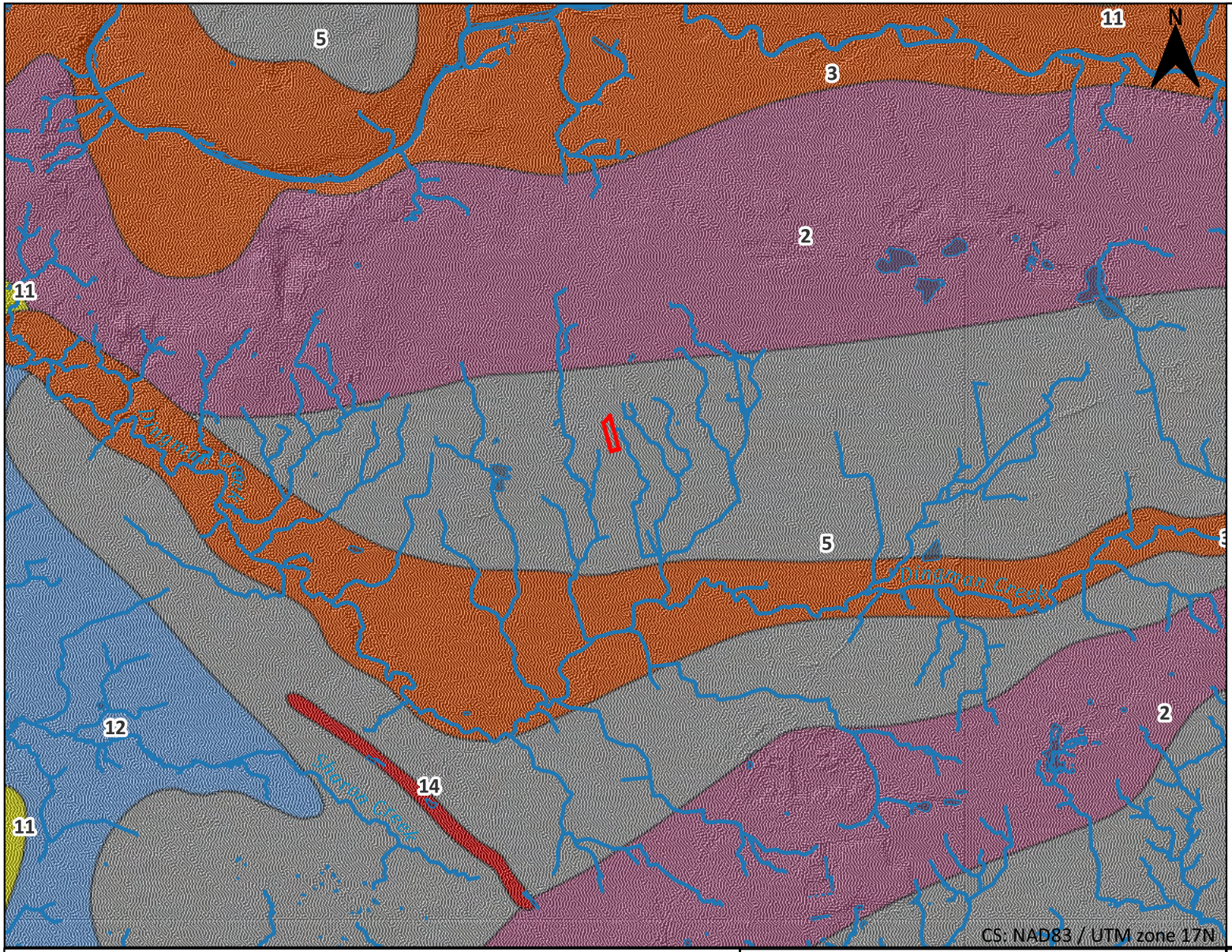

-LEGEND-

- Site Boundary
- Watercourse (OHN)
- Waterbody (OHN)

Physiographic Landforms

- 2 Till Moraines
- 3 Spillways
- 5 Till Plains (Undrumlinized)
- 11 Sand Plains
- 12 Clay Plains
- 14 Beaches

Notes:

Data Sources:
Contains information licensed under the Open Government Licence – Ontario.
Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 228.

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Physiographic Landforms
Prepared By: K.W.	Reviewed By: H.J.

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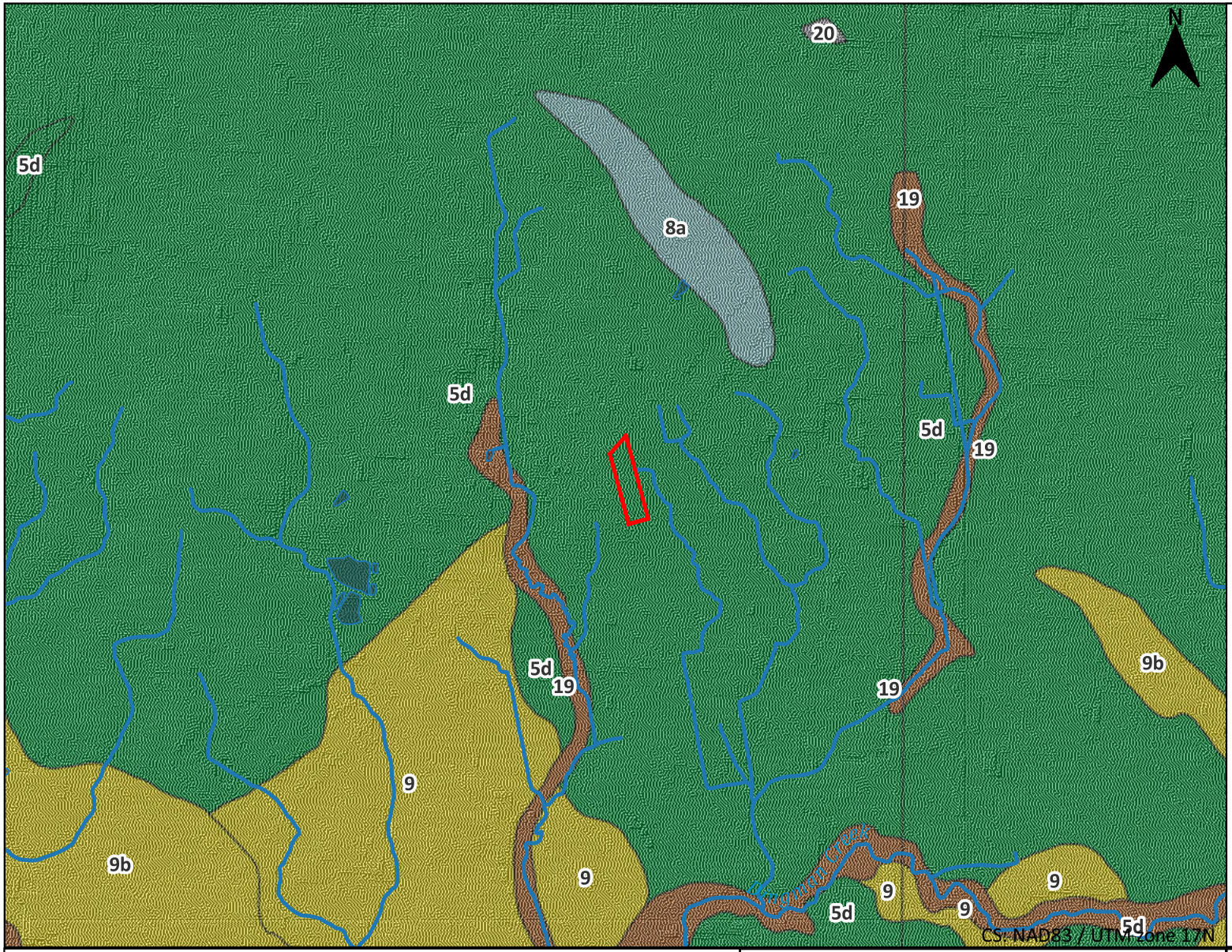

-LEGEND-

- Site Boundary
- Watercourse (OHN)
- Waterbody (OHN)

Surficial Geology

- 20 Organic Deposits: peat, muck, marl
- 19 Modern Alluvial Deposits: clay, silt, sand, gravel, may contain organic remains
- 9 Coarse-textured Glaciolacustrine Deposits: sand, gravel, minor silt and clay
- 9b Littoral Deposits
- 8 Fine-textured Glaciolacustrine Deposits: silt and clay, minor sand and gravel
- 8a Massive to well laminated
- 7 Glaciofluvial Deposits: river deposits and delta top facies
- 5d Clay to silt-textured till (derived from glaciolacustrine deposits or shale)

Notes:

Data Sources:
Contains information licensed under the Open Government Licence – Ontario.
Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised.

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT: Royal Premier Homes

TITLE: Surficial Geology

Prepared By: K.W. | Reviewed By: H.J.

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405 Maple Grove Road, Cambridge, ON N3E 1B6

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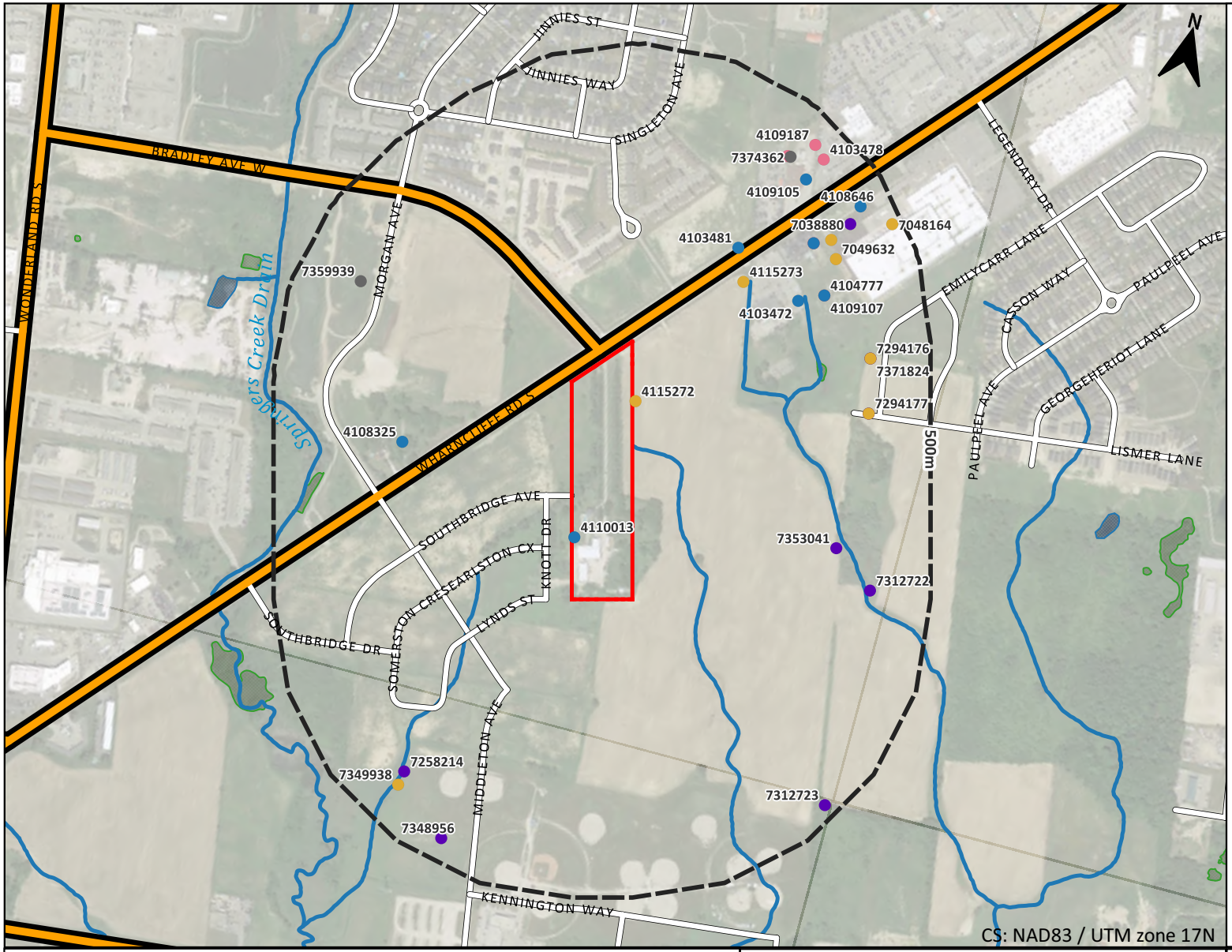

-LEGEND-

- Site Boundary
- 500m Buffer
- Watercourse (OHN)

MECP WWR within 500m

- Water Supply - Domestic
- Water Supply - Commercial
- Observation Wells and Test Holes
- Final Status Not Provided
- Abandoned-Other

Notes:
MECP well locations are provided by the MECP Water Well Information System (WWIS) online database. Actual locations may differ.
Additional information provided in Appendix D - MECP Water Well Records Summary.

Data Sources:
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Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	MECP WWR within 500m
Prepared By: K.W.	Reviewed By: H.J.

EXP Services Inc.
405 Maple Grove Road, Cambridge, ON N3E 1B6

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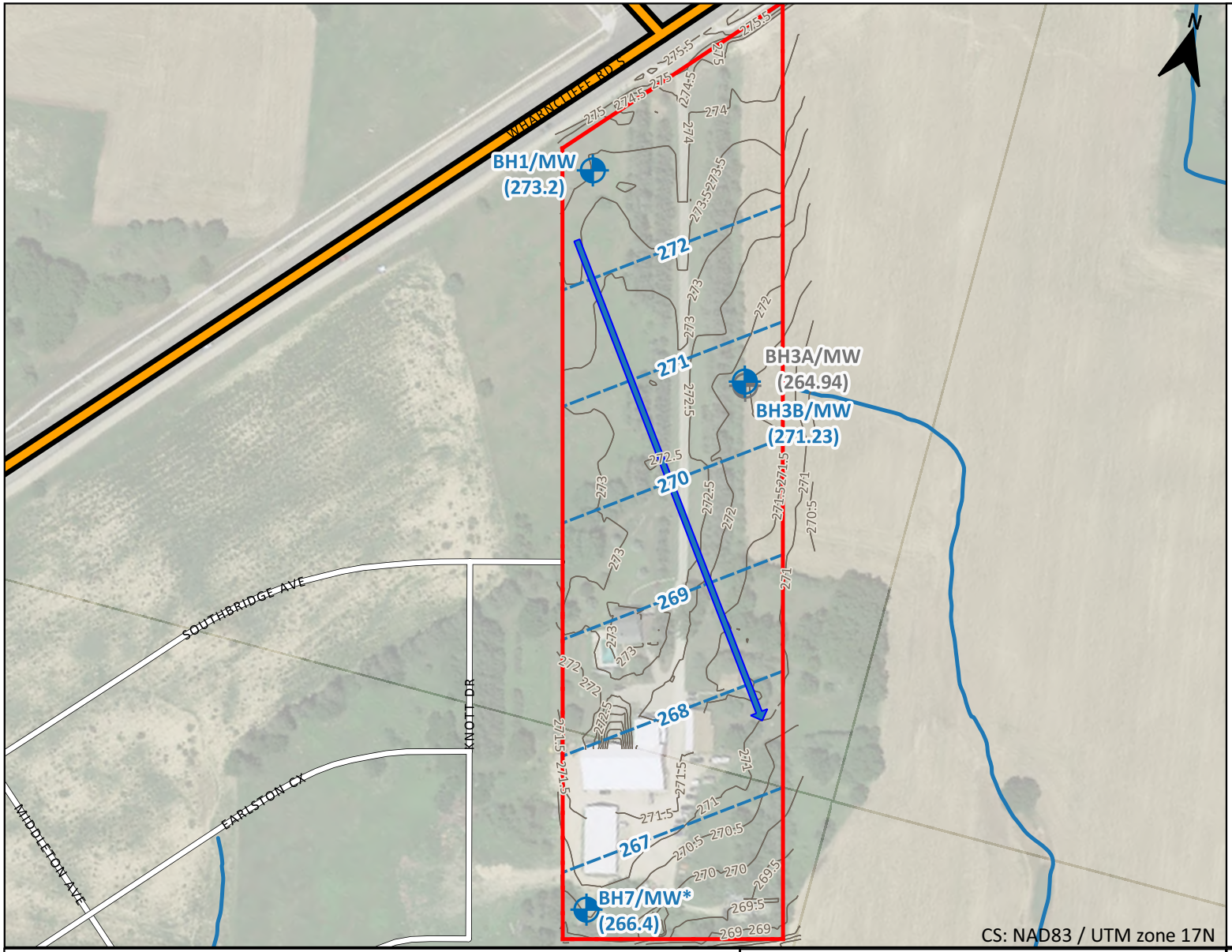

-LEGEND-

- Site Boundary
- Ground Surface Elevation Contour (mamsl)
- Watercourse (OHN)
- Monitoring Well (Groundwater Elevation, mamsl)
- Monitoring Well Not Used in Flow Interpretation (Groundwater Elevation, mamsl)
- Shallow Groundwater Elevation Contour (mamsl)
- Interpreted Shallow Horizontal Groundwater Flow Direction

Notes:
The shallow groundwater flow interpretation is based on Site-wide manual groundwater level meaurements collected January 17, 2023, and with consideration given to the ground surface topography.
*The groundwater elevation at BH7/MW does not represent a static condition as the water level was still undergoing recovery at the time of measurement.
Ground surface elevation contours provided by topographical mapping from the Client.
Data Sources:
Contains information licensed under the Open Government License - Ontario
Google Earth Imagery (c) 2022 City of London, First Base Solutions, Maxar Technologies

Hydrogeological Investigation

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Interpreted Shallow Horizontal Groundwater Flow Direction
Prepared By: K.W.	Reviewed By: H.J.

EXP Services Inc.
405 Maple Grove Road, Cambridge, ON N3E 1B6

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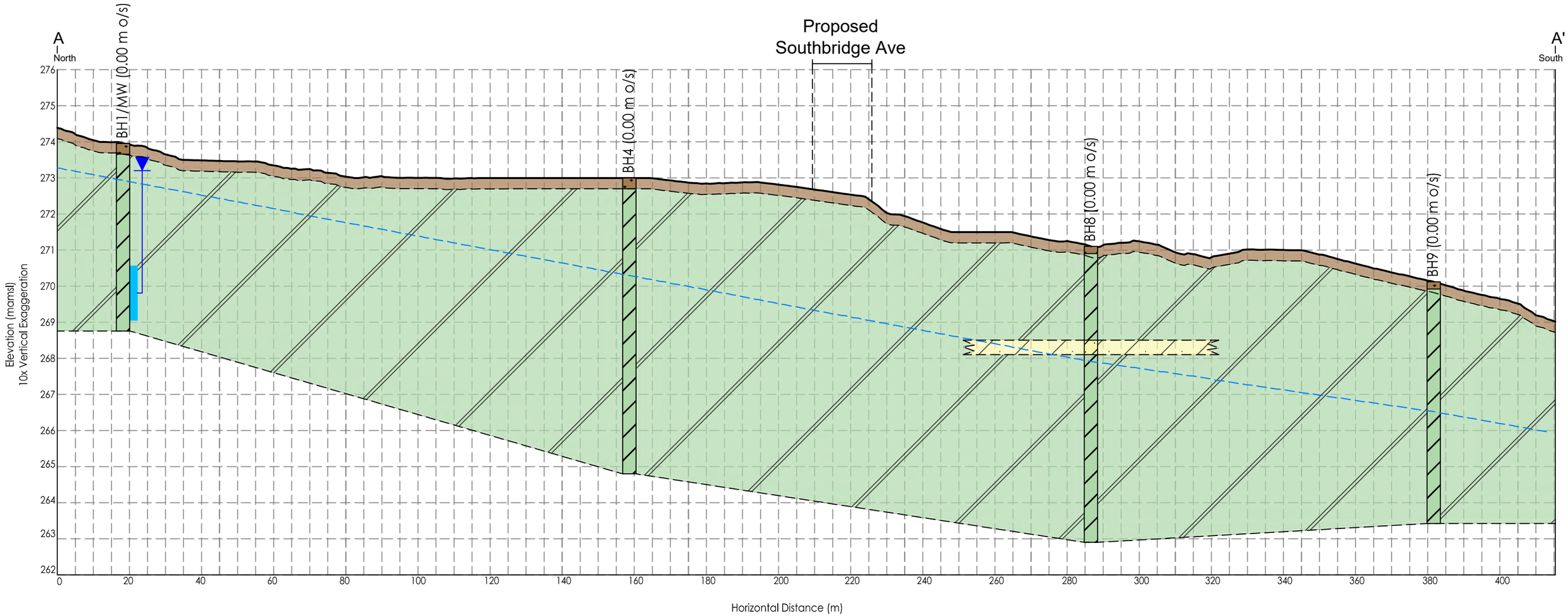


-LEGEND-

- Ground Surface (See Notes)
- Interpreted Water Table* (See Notes)

Lithologies

- Topsoil
- Fill
- Silty Sand
- Silt Till
- Sandy Silt Till

Borehole
Manual Water Level
Well Screen

-NOTES-

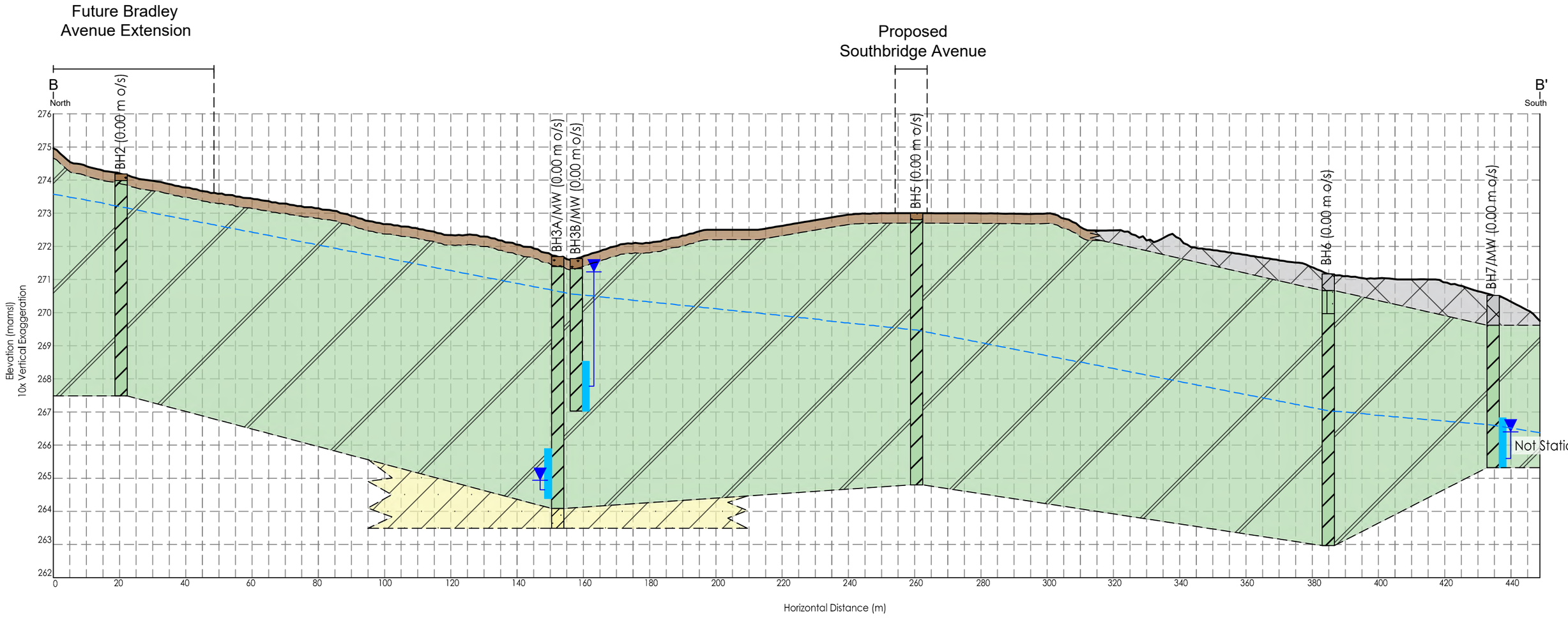
1. The cross section should be read in conjunction with EXP's Hydrogeological Report.
2. The geological interpretation is based on subsurface observations made at each borehole location. Subsurface conditions between and beyond boreholes may vary.
3. The projected ground surface is from the topographical mapping provided by the Client.
4. Manual groundwater measurements collected January 17, 2023. The groundwater elevation at BH7/MW does not represent a static condition as the water level was still undergoing recovery at the time of measurement.
5. Illustrated extents are approximate.

Hydrogeological Assessment

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Geological Cross Section A - A'
DRAWN BY: K.W.	REVIEWED BY: H.J.
DATE: January 2023	
EXP Services Inc. 405 Maple Grove Road, Cambridge, ON, N3E 1B6	
SCALE: As Shown	PROJECT NO.: KCH-22022007-A0
DWG.: 9	



-LEGEND-

- Ground Surface (See Notes)
- Interpreted Water Table* (See Notes)

Lithologies

- Topsoil
- Fill
- Silty Sand
- Silt Till
- Sandy Silt Till

- Borehole
- Manual Water Level
- Well Screen

-NOTES-

1. The cross section should be read in conjunction with EXP's Hydrogeological Report.
2. The geological interpretation is based on subsurface observations made at each borehole location. Subsurface conditions between and beyond boreholes may vary.
3. The projected ground surface is from the topographical mapping provided by the Client.
4. Manual groundwater measurements collected January 17, 2023. The groundwater elevation at BH7/MW does not represent a static condition as the water level was still undergoing recovery at the time of measurement.
5. Illustrated extents are approximate.

Hydrogeological Assessment

Proposed Development

1350 Wharncliffe Road South, London

CLIENT	Royal Premier Homes
TITLE	Geological Cross Section B - B'
DRAWN BY: K.W. / REVIEWED BY: H.J. / DATE: January 2023	
	EXP Services Inc. 405 Maple Grove Road, Cambridge, ON, N3E 1B6
SCALE: As Shown / PROJECT NO.: KCH-22022007-A0 / DWG.: 10	

Appendix B - Correspondence

Kassandra Wallace

From: Hachey, Jeff <jhachey@london.ca>
Sent: Tuesday, September 20, 2022 3:07 PM
To: Kassandra Wallace
Cc: Heather Jaggard; Jerzy Smolarek
Subject: RE: Pre-Consultation RE: 1350 Wharncliffe Rd. S., London

Thanks Kassandra – Please proceed as discussed.

Regards,

Jeff

Jeff Hachey, M.Sc.E., P.Eng.
Hydrogeologist/Environmental Engineer
Stormwater Engineering Division
City of London

300 Dufferin Avenue, London, ON, N6A 4L9
P: 519.661.CITY(2489) x 7359 | Fax: 519.661.2355
jhachey@london.ca | www.london.ca

From: Kassandra Wallace <Kassandra.Wallace@exp.com>
Sent: Tuesday, September 20, 2022 2:48 PM
To: Hachey, Jeff <jhachey@london.ca>
Cc: Heather Jaggard <Heather.Jaggard@exp.com>; Jerzy Smolarek <jsmolarek@siv-ik.ca>
Subject: [EXTERNAL] RE: Pre-Consultation RE: 1350 Wharncliffe Rd. S., London

Hi Jeff,

Thanks for meeting with us.

As discussed, we understand that the scope of work outlined below is acceptable.

We will look into whether a private well / septic bed are present on-Site and if so, what the plans are for those moving forward.

Thanks again,

Kassandra

Kassandra Wallace
EXP | Project Manager
t : +1.226.616.0742 | m : +1.519.573.9210 | e : kassandra.wallace@exp.com
exp.com | legal disclaimer
keep it green, read from the screen

From: Kassandra Wallace
Sent: Thursday, September 8, 2022 9:34 AM
To: Hachey, Jeff <jhachey@london.ca>
Cc: Heather Jaggard <Heather.Jaggard@exp.com>; Jerzy Smolarek <jsmolarek@siv-ik.ca>
Subject: RE: Pre-Consultation RE: 1350 Wharncliffe Rd. S., London

Thanks Jeff. I will send a meeting invite for next Thursday between 2:30-3:30.

Kassandra Wallace
EXP | Project Manager
t : +1.226.616.0742 | m : +1.519.573.9210 | e : kassandra.wallace@exp.com
exp.com | legal disclaimer
keep it green, read from the screen

From: Hachey, Jeff <jhachey@london.ca>
Sent: Thursday, September 8, 2022 9:29 AM
To: Kassandra Wallace <Kassandra.Wallace@exp.com>
Cc: Heather Jaggard <Heather.Jaggard@exp.com>; Jerzy Smolarek <jsmolarek@siv-ik.ca>
Subject: RE: Pre-Consultation RE: 1350 Wharncliffe Rd. S., London

Hi Kassandra,

At this point, the only time I have available next week is next Thursday afternoon (between 1:30 pm and 4 pm). If that time block doesn't work, then we'd have to look at the week of September 19th.

Let me know if that time block works, or if we need some alternative dates and times.

Thanks,

Jeff

Jeff Hachey, M.Sc.E., P.Eng.
Hydrogeologist/Environmental Engineer
Stormwater Engineering Division
City of London

300 Dufferin Avenue, London, ON, N6A 4L9
P: 519.661.CITY(2489) x 7359 | Fax: 519.661.2355
jhachey@london.ca | www.london.ca

From: Kassandra Wallace <Kassandra.Wallace@exp.com>
Sent: Wednesday, September 7, 2022 12:27 PM
To: Hachey, Jeff <jhachey@london.ca>
Cc: Heather Jaggard <Heather.Jaggard@exp.com>; Jerzy Smolarek <jsmolarek@siv-ik.ca>
Subject: [EXTERNAL] Pre-Consultation RE: 1350 Wharncliffe Rd. S., London

Good afternoon Jeff,

We have been retained to complete a Hydrogeological Investigation for the property located at 1350 Wharncliffe Road South in London. The Hydrogeological Investigation will be completed concurrent with the geotechnical investigation also being completed for the Site.

The development is a proposed subdivision consisting of medium density blocks, low density freehold dwellings, and two roadways. The existing Heritage House located on the property is also proposed to be retained post-development.

The currently proposed scope of work includes:

Fieldwork:

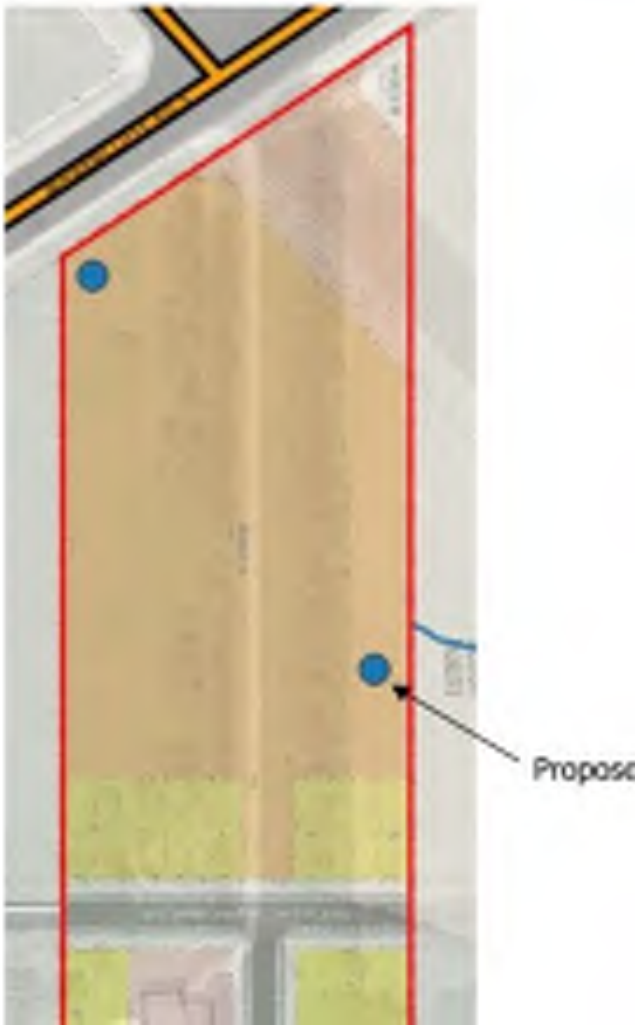
- Advancing 9 boreholes across the Site to facilitate both the geotechnical and hydrogeological investigations
- Completing 4 boreholes as groundwater monitoring wells (includes 1 set of nested wells)
- Monthly groundwater level monitoring for 7 months, anticipated to be between October 2022 and April 2023, to capture the seasonal high water table. Data loggers are not proposed at this time.
- 1 round of groundwater sampling, samples to be collected from 2 selected wells
- Single well response tests on selected wells
- In-Situ infiltration testing is not proposed at this time

Reporting:

- Final report to be completed in May 2023
- Hydrogeological Investigation report will be compiled that will include:
    - Description of Site and regional geology
    - Laboratory testing results
    - MECP water well records within 500 m of the Site boundary
    - Thornthwaite-Mather water balance (Site-based) and LID recommendations
    - Discussion of potential impacts to natural features in the vicinity of the Site from the proposed development
    - Discussion of groundwater separation distances based on observed groundwater elevations and development design information
    - A minimum of 2 geological cross-sections illustrating the interpreted soil stratigraphy and water table across the Site
    - A discussion of Source Water Protection information including the presence of highly vulnerable aquifers and significant groundwater recharge areas

A dewatering assessment is not proposed at this time.

The proposed locations of the monitoring wells are shown below:



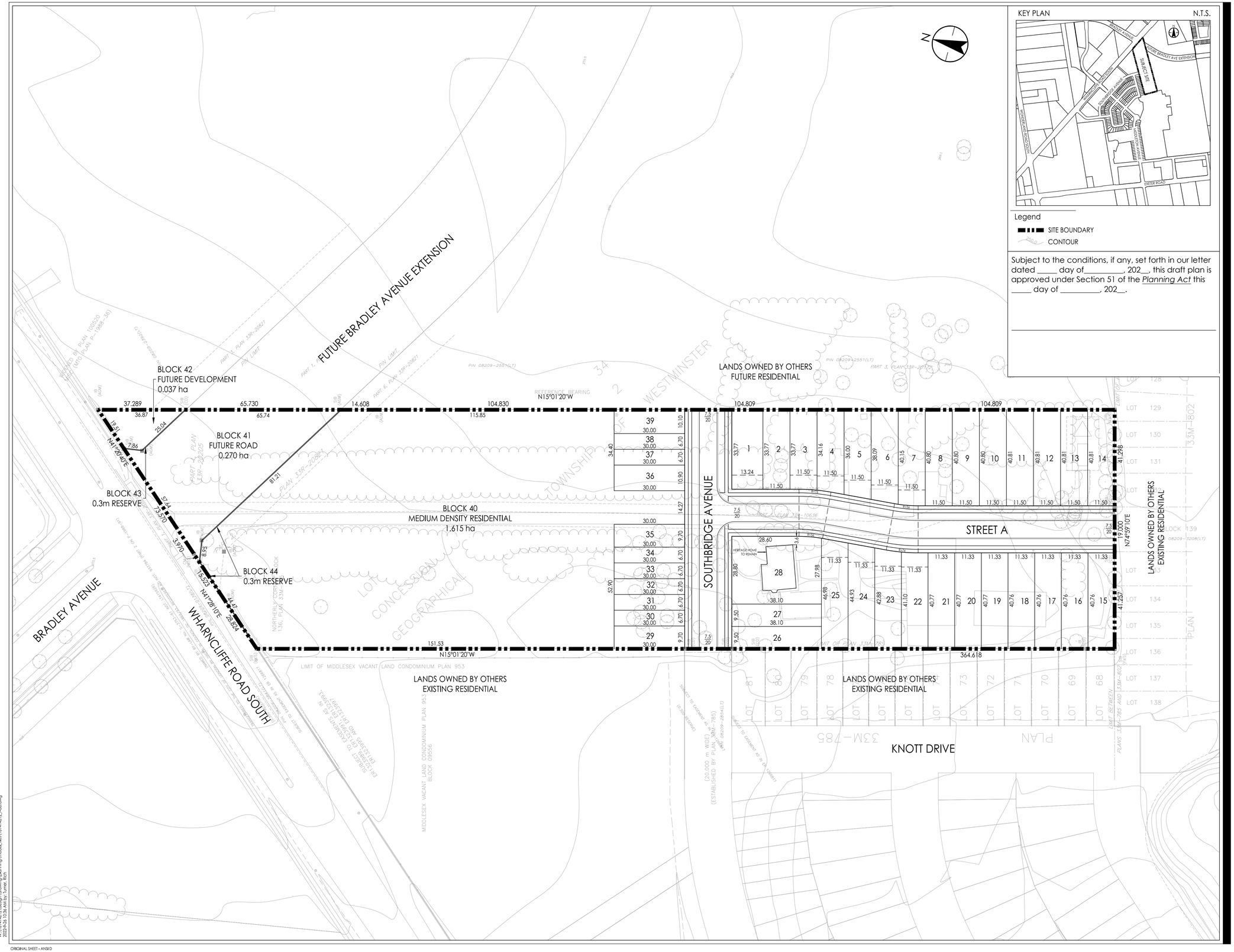
Please let us know when you would be available to meet to discuss the above.

Thank you,

Kassandra

Kassandra Wallace
EXP | Project Manager
t : +1.226.616.0742 | m : +1.519.573.9210 | e : kassandra.wallace@exp.com
405 Maple Grove Road
Unit 6
Cambridge, ON N3E 1B6
CANADA
exp.com | legal disclaimer
keep it green, read from the screen

Appendix C -
Development Plans



KEY PLAN N.T.S.

Legend

SITE BOUNDARY

CONTOUR

Subject to the conditions, if any, set forth in our letter dated _____ day of_____, 202__, this draft plan is approved under Section 51 of the *Planning Act* this _____ day of _____, 202__.

_____

INFORMATION REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT

A: AS SHOWN ON DRAFT PLAN
B: AS SHOWN ON DRAFT AND KEY PLAN
C: AS SHOWN ON DRAFT AND KEY PLAN
D: ACCORDING TO LAND USE SCHEDULE
E: RESIDENTIAL, AGRICULTURAL
F: AS SHOWN ON DRAFT PLAN
G: AS SHOWN ON DRAFT AND KEY PLAN
H: MUNICIPAL PIPED WATER TO BE INSTALLED
I : T.B.D.
J: AS SHOWN ON DRAFT PLAN
K: MUNICIPAL SANITARY AND STORM SEWERS TO BE INSTALLED
L: AS SHOWN ON PLAN

SCHEDULE OF LAND USE

LOW DENSITY RESIDENTIAL	- LOTS 1 - 28	1.326 ha
MEDIUM DENSITY RESIDENTIAL	- LOTS 29 - 39	0.262 ha
MEDIUM DENSITY RESIDENTIAL	- BLOCK 40	1.615 ha
FUTURE ROAD	- BLOCK 41	0.270 ha
FUTURE DEVELOPMENT	- BLOCK 42	0.037 ha
0.3m RESERVE	- BLOCK 43 - 44	0.005 ha
ROADS		0.530 ha
	TOTAL	4.045 ha

OWNER'S AUTHORIZATION

THE UNDERSIGNED AUTHORIZES THE PREPARATION AND SUBMISSION OF THIS DRAFT PLAN OF SUBDIVISION.

FARHAD NOORY
2847012 ONTARIO INCORPORATED
AUTHORIZING AGENT

DATE

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED, AS SHOWN ON THIS PLAN, AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

JEREMY C.E. MATTHEWS O.L.S.
STANTEC GEOMATICS

DATE

Stantec
600-171 Queens Avenue
London ON N6A 5J7
Tel. 519-645-2007
www.stantec.com

Liability Note

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay.

DRAFT PLAN OF SUBDIVISION

OF PART OF
LOT 34
CONCESSION 2
(GEOGRAPHIC TOWNSHIP OF WESTMINSTER)
CITY OF LONDON
COUNTY OF MIDDLESEX

File Name: 161414212_r-db	RT Dwn.	DV Chkd.	RT Dsgn.	22.09.26 YY.MM.DD

Client/Project
2847012 ONTARIO INCORPORATED

1350 WHARNCLIFFE ROAD SOUTH

London, ON Canada

Title
DRAFT PLAN OF SUBDIVISION

Project No.	Scale	Revision
161414212	HORZ – 1 : 750 (7.5 0 15m)	
Drawing No.	Sheet	
1	1 of 1	

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2022-09-26 10:56 AM by Turner, Rich

ORIGINAL SHEET - ANSI D

Appendix D -
Borehole Logs & Particle Size Distribution Curves

BOREHOLE LOG

BH1/MW
Sheet 1 of 1

CLIENT **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** Water Level **Oct 25, 2022**

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	274.0						
	273.8	**TOPSOIL** ~ 230 mm					
		CLAYEY SILT TILL - brown, weathered, trace to some sand, trace gravel, stiff to very stiff, moist					
1			SS	S1	500	26	11
2			SS	S2	450	19	13
			SS	S3	650	21	15
3			SS	S4	450	14	16
4							
		- grey near 4.6 m bgs CLAY SILT SAND 38% 47% 15%	SS	S5	450	12	18
5	268.8						
		End of Borehole at 5.2 m bgs.					
6							
7							
8							
9							

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Groundwater was measured near 4.5 m bgs (Elevation: 269.45 m) on Oct 25, 2022.
4) No significant methane gas concentration was detected upon completion.

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

BH2
Sheet 1 of 1

CLIENT **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** 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	274.2								
	274.0	**TOPSOIL** ~ 230 mm							
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist							
1					SS	S1	370	10	15
2					SS	S2	520	21	16
					SS	S3	550	19	17
3					SS	S4	540	12	13
		- grey near 3.5 m bgs							
4									
		- some sand lenses near 4.6 bgs							
5					SS	S5	470	8	14
6									
	267.5				SS	S6	520	10	19
7		**End of Borehole at 6.7 m bgs.**							
8									
9									

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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

BH3A/MW
Sheet 1 of 1

CLIENT **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** Water Level **Oct 25, 2022**

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	271.6						
	271.3	**TOPSOIL** ~ 300 mm					
1		**CLAYEY SILT TILL** - brown, trace to some sand, trace gravel, stiff to very stiff, moist	AS	S1	200	9	17
2			SS	S2	430	11	18
			SS	S3	490	17	13
3		-grey near 3.0 m bgs	SS	S4	450	13	15
4							
5			SS	S5	520	14	19
6		CLAY SILT SAND GRAVEL 40% 46% 13% 1%	SS	S6	540	18	18
7	264.0						
		SILTY SAND - grey, very dense, very moist	SS	S7	50	74	
8	263.4						
		End of Borehole at 8.2 m bgs.					
9							

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

74

NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Groundwater was measured near 6.55 m bgs (Elevation: 265.1 m) on Oct 25, 2022.
4) No significant methane gas concentration was detected upon completion.

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

BH3B/MW
Sheet 1 of 1

CLIENT **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** Water Level **Oct 25, 2022**

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 / Atterberg Limits and Moisture
0	271.7									S Field Vane Test (#=Sensitivity); Penetrometer; Torvane; 100 200 kPa; W_P W W_L; SPT N Value; Dynamic Cone; 10 20 30 40
0	271.4	**TOPSOIL** ~ 300 mm								
1		**CLAYEY SILT TILL** - brown, trace to some sand, trace gravel, very stiff to stiff, moist								
2										
3		- grey near 3.0 m bgs CLAY SILT SAND GRAVEL 31% 47% 18% 4%			SS	S1	520	13	17	
4	267.1									
5		**End of Borehole at 4.6 m bgs.**								
6										
7										
8										
9										

NOTES

1) Borehole Log interpretation requires assistance by EXP before use by others and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Groundwater was measured near 3.6 m bgs (Elevation: 268.05 m) on Oct 25, 2022.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	273.0						
	272.7	**TOPSOIL** ~ 300 mm					
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist					
1			SS	S1	420	27	12
2			SS	S2	440	25	15
			SS	S3	540	20	17
3			AS	S4	200	15	18
4							
		- grey near 4.6 m bgs					
5			SS	S5	490	8	19
6			AS	S6	200	13	18
7							
			SS	S7	570	17	18
8	264.8						
		End of Borehole at 8.2 m bgs.					
9							

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** 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	273.0								
	272.8	**TOPSOIL** ~ 230 mm							
		CLAYEY SILT TILL - brown, trace sand, trace gravel, trace cobbles, very stiff to hard, moist							
1					SS	S1	350	27	11
2					SS	S2	400	31	14
					SS	S3	230	23	
3					SS	S4	620	18	13
4									
		- grey near 4.6 m bgs			SS	S5	520	12	20
5									
6					SS	S6	490	17	19
		- occasional cobbles observed near 6.7 m bgs							
7									
8					SS	S7	580	16	19
	264.8								
		End of Borehole at 8.2 m bgs.							
9									

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	271.2						
	270.7	**GRANULAR FILL** ~ 450 mm					
1	270.0	**SANDY SILT TILL** - brown/black, mottled, some gravel, compact, moist	SS	S1	420	13	20
2		**CLAYEY SILT TILL** - brown, trace to some sand, trace gravel, stiff to very stiff, moist	SS	S2	490	12	30
3			SS	S3	470	19	17
4			SS	S4	540	20	19
5		- grey near 4.6 m bgs	SS	S5	450	10	19
6			SS	S6	590	9	20
7							
8	262.9		SS	S7	630	11	21
9		**End of Borehole at 8.2 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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 14, 2022** Water Level **Oct 25, 2022**

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	270.5	**FILL** brown, mix of topsoil, gravel and asphalt, loose, moist					
	269.6						
1		**CLAYEY SILT TILL** - brown, trace to some sand, trace gravel, stiff to very stiff, moist	SS	S1	370	10	
2			SS	S2	390	18	
3			SS	S3	550	27	
		- grey near 3.3 m bgs	SS	S4	530	24	
4							
5	265.3	CLAY 31% SILT 51% SAND 17% GRAVEL 1%	SS	S5	540	14	
		End of Borehole at 5.2 m bgs.					
6							
7							
8							
9							

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Groundwater was measured near 5.12 m bgs (Elevation: 265.44 m) on Oct 25, 2022.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 13, 2022** 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	271.0								
	270.8	**TOPSOIL** ~ 230 mm							
		CLAYEY SILT TILL - brown, trace sand, trace gravel, very stiff, moist							
1					SS	S1	320	22	10
2					SS	S2	360	21	11
	268.4				SS	S3	560	26	13
	268.0	**SILTY SAND** - brown, some clay, compact, moist							
3		**CLAYEY SILT TILL** - grey, trace sand, trace gravel, very stiff to stiff, moist			SS	S4	540	17	15
4									
5					SS	S5	540	14	13
6									
					SS	S6	570	13	18
7									
8					SS	S7	530	16	18
	262.8								
		End of Borehole at 8.2 m bgs.							
9									

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 and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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 **2847012 Ontario Inc. (Royal Premier Developments)** PROJECT NO. **LON-22022009-A0**
PROJECT **Subdivision Development** DATUM **Geodetic**
LOCATION **1350 Wharncliffe Rd, London, ON** DATES: Boring **Oct 14, 2022** Water Level

DEPTH (m bgs)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	270.0								
	269.8	**TOPSOIL** ~ 250 mm							
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist							
1					SS	S1	450	12	
2					SS	S2	530	25	
					SS	S3	480	24	
3		- grey near 3.0 m bgs							
					SS	S4	530	13	
4									
5					SS	S5	570	16	
6		-sand layerings observed near 6.1 m bgs							
	263.3				SS	S6	570	18	
7		**End of Borehole at 6.7 m bgs.**							
8									
9									

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

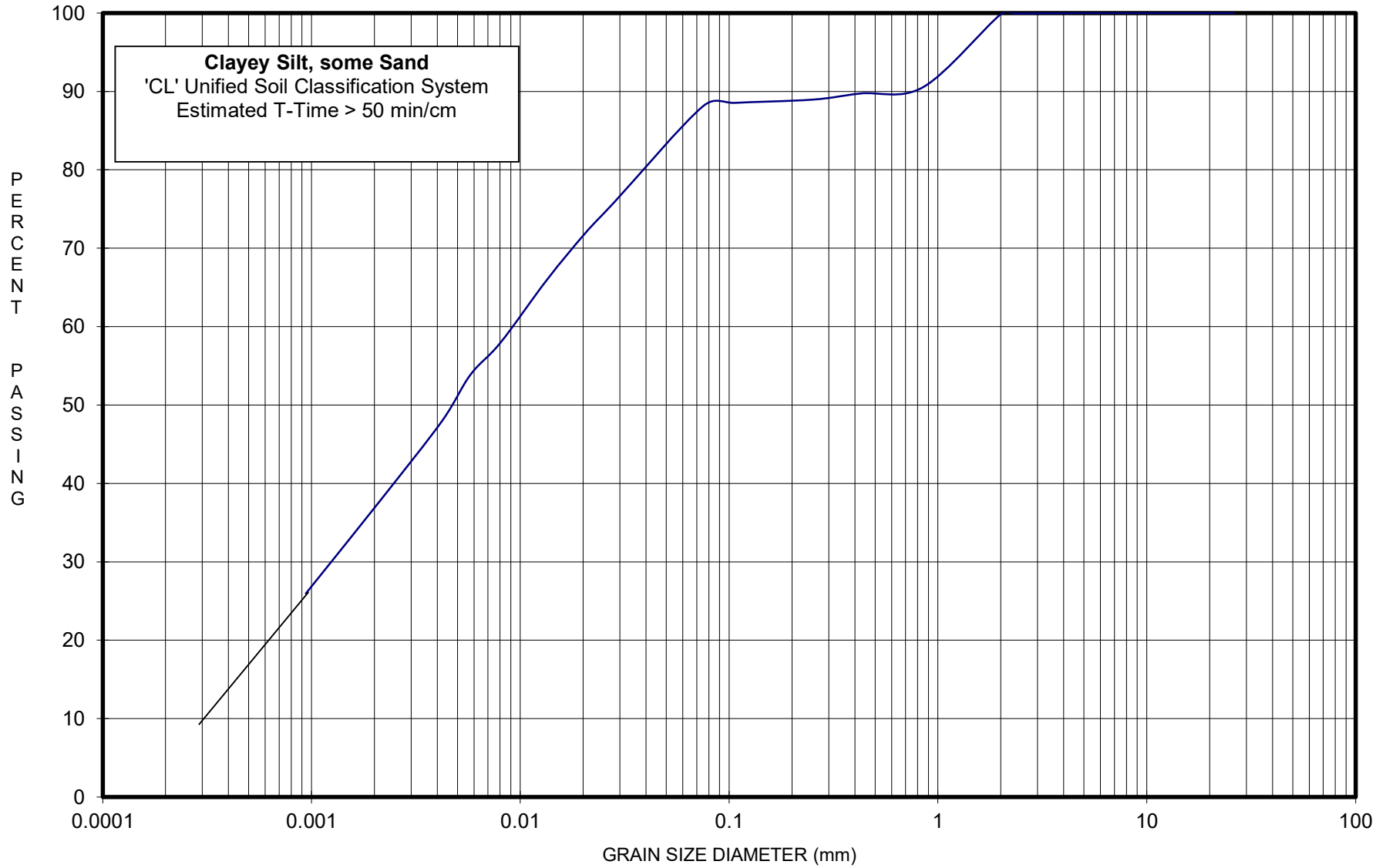
1) Borehole Log interpretation requires assistance by EXP before use by others and must be read in conjunction with EXP Report LON-22022009-A0. For definition of terms used on logs, see sheets prior to logs.
2) bgs denotes below ground surface
3) Upon completion of drilling, borehole was open and dry.
4) No significant methane gas concentration was detected upon completion.

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)

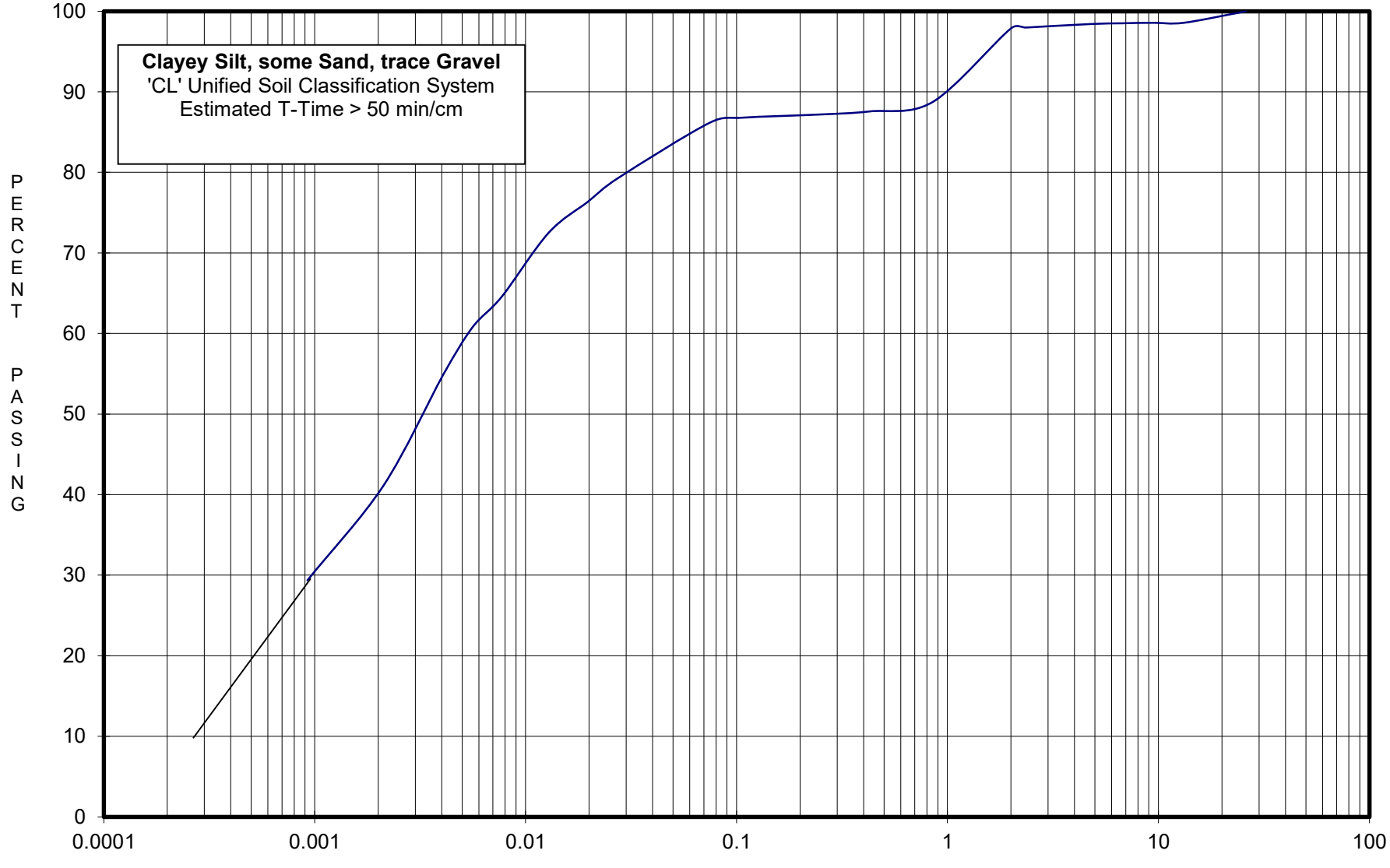
MECHANICAL GRAIN SIZE ANALYSIS



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

MODIFIED M.I.T. CLASSIFICATION	**Sample Description: BH/MW 1 SA 5 15 -17ft**	**Project: 2202009 22022007-104**	**Figure 1**

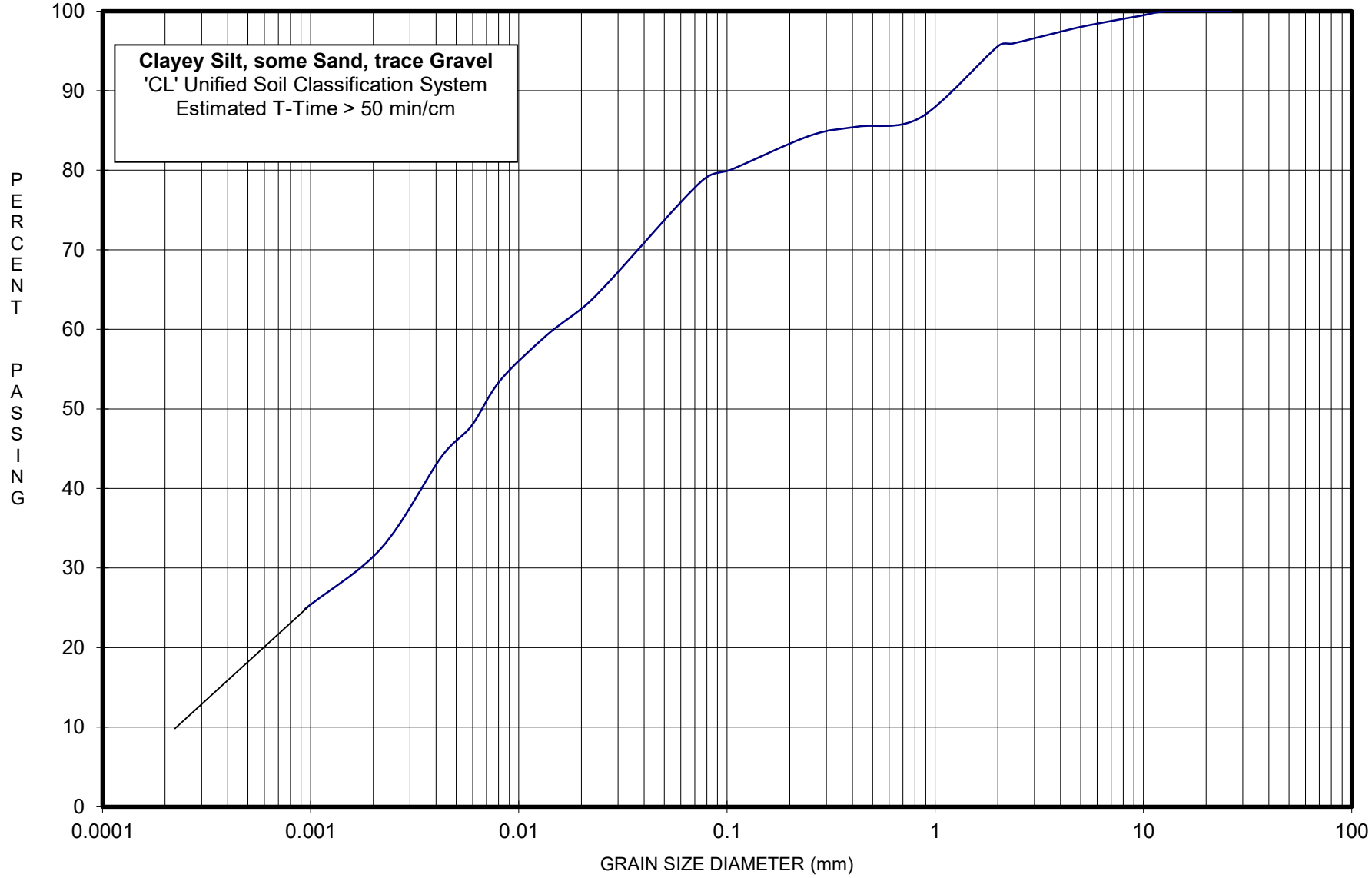
MECHANICAL GRAIN SIZE ANALYSIS



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

MODIFIED M.I.T. CLASSIFICATION	Sample Description: BH/MW 3A SA 6 20-22 ft	Project: 2202009 22022007-104	Figure 1

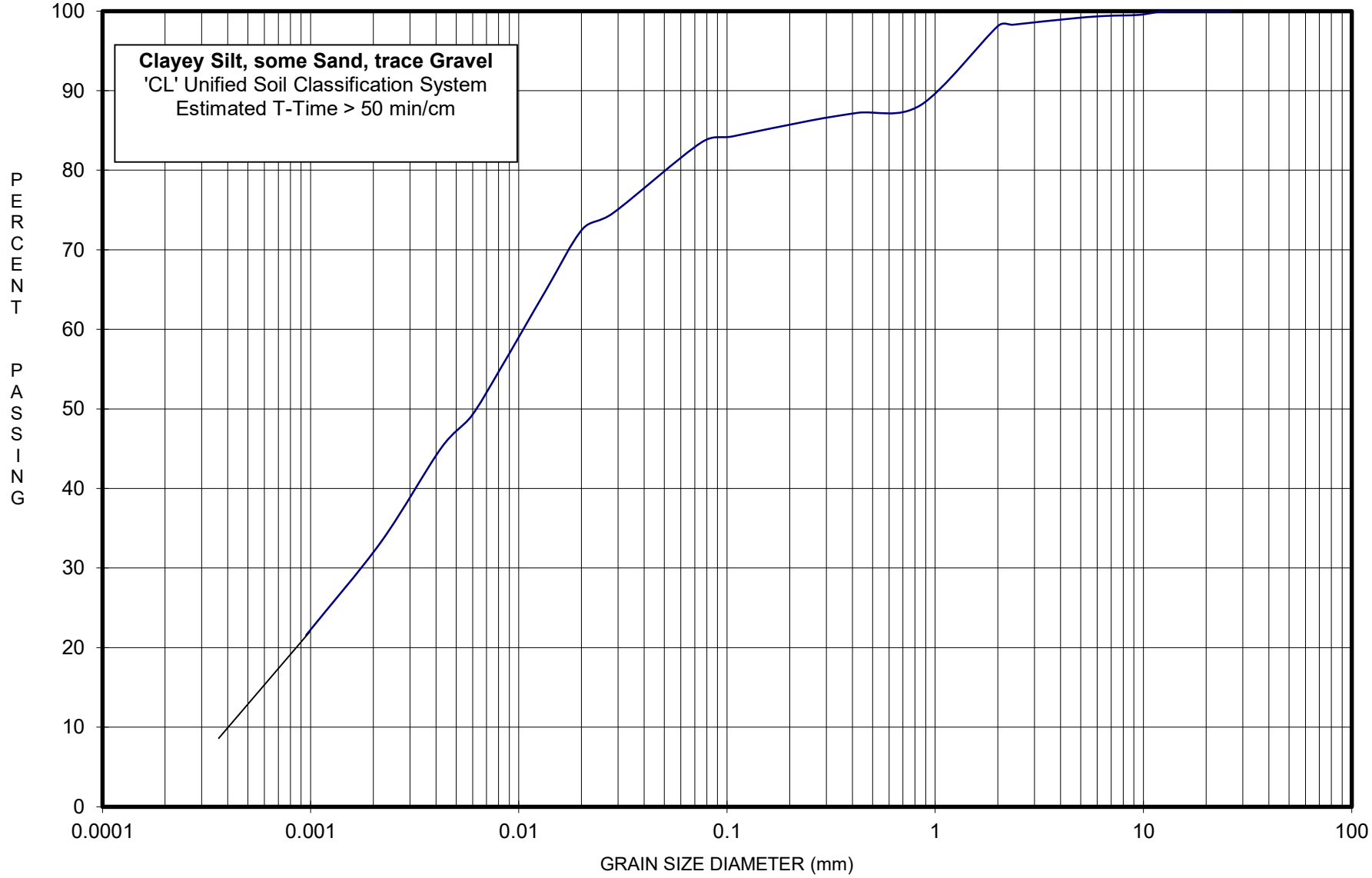
MECHANICAL GRAIN SIZE ANALYSIS



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

MODIFIED M.I.T. CLASSIFICATION	Sample Description: BH/MWB 3 SA 1 10-12 ft	Project: 2202009 22022007-104	Figure 1

MECHANICAL GRAIN SIZE ANALYSIS



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

MODIFIED M.I.T. CLASSIFICATION	**Sample Description: BH/MW 7 SA 5 15-17ft**	**Project: 2202009 22022007-104**	**Figure 1**

Appendix E -
MECP Water Well Records Summary

Well ID	Easting (m)	Northing (m)	Date Completed	Depth (m)	Final Status	Primary Use	Secondary Use	Distance from Site (m)	Location Relative to Site
4110013	478194	4752943	12-Jul-83	15.2	Water Supply	Domestic	N.A.	0	On-Site
4115272	478234	4753190	2-Jun-03	18.3	Abandoned-Other	N.A.	N.A.	5	Hydraulically Cross-Gradient
4115273	478357	4753430	2-Jun-03	0.0	Abandoned-Other	N.A.	N.A.	211	Hydraulically Cross-Gradient
4103481	478334	4753483	15-Aug-49	18.3	Water Supply	Domestic	N.A.	237	Hydraulically Cross-Gradient
4108325	477874	4753023	31-Aug-77	12.8	Water Supply	Domestic	N.A.	284	Hydraulically Cross-Gradient
4103472	478454	4753423	4-Mar-65	11.9	Water Supply	Domestic	N.A.	286	Hydraulically Cross-Gradient
4104777	478494	4753443	4-Sep-69	14.0	Water Supply	Commerical	Domestic	331	Hydraulically Cross-Gradient
4109107	478494	4753443	14-May-79	18.3	Water Supply	Domestic	N.A.	331	Hydraulically Cross-Gradient
7353041	478623	4753039	17-Oct-19	10.7	Observation Wells	Monitoring	N.A.	341	Hydraulically Cross-Gradient
4103479	478454	4753523	5-Sep-67	13.1	Water Supply	Commerical	N.A.	345	Hydraulically Cross-Gradient
4108791	478454	4753523	11-Jul-78	24.4	Water Supply	Domestic	N.A.	345	Hydraulically Cross-Gradient
7049632	478497	4753507	31-Aug-07	7.3	Abandoned-Other	Not Used	N.A.	368	Hydraulically Cross-Gradient
7048165	478481	4753536	18-Jul-07	15.4	Abandoned-Other	N.A.	N.A.	374	Hydraulically Cross-Gradient
7359939	477737	4753265	1-May-20	0.0	N.A.	N.A.	N.A.	391	Hydraulically Cross-Gradient
7294177	478617	4753271	4-Aug-17	10.7	Test Hole	Test Hole	Monitoring	396	Hydraulically Cross-Gradient
7371822	478617	4753271	9-Oct-20	0.0	Abandoned-Other	N.A.	N.A.	396	Hydraulically Cross-Gradient
4109105	478414	4753623	7-Aug-79	17.4	Water Supply	Domestic	N.A.	398	Hydraulically Cross-Gradient
7312722	478696	4752985	10-May-18	9.1	Observation Wells	Monitoring	N.A.	398	Hydraulically Cross-Gradient
7294176	478596	4753361	4-Aug-17	10.7	Test Hole	Test Hole	Monitoring	399	Hydraulically Cross-Gradient
7371824	478596	4753361	9-Oct-20	0.0	Abandoned-Other	N.A.	N.A.	399	Hydraulically Cross-Gradient
7258214	478020	4752490	8-Feb-16	6.8	Test Hole	Test Hole	N.A.	402	Hydraulically Cross-Gradient
4107852	478374	4753653	9-Nov-76	15.8	Water Supply	Commerical	N.A.	405	Hydraulically Cross-Gradient
7374362	478379	4753653	17-Nov-20	0.0	N.A.	N.A.	N.A.	407	Hydraulically Cross-Gradient
7038880	478505	4753570	30-Nov-06	7.6	Observation Wells	N.A.	N.A.	415	Hydraulically Cross-Gradient
7349938	478016	4752466	6-Nov-19	0.0	Abandoned-Other	Monitoring	N.A.	425	Hydraulically Cross-Gradient
4103478	478434	4753663	22-Sep-65	12.8	Water Supply	Commerical	N.A.	442	Hydraulically Cross-Gradient
4108646	478514	4753603	21-Sep-78	14.0	Water Supply	Domestic	N.A.	444	Hydraulically Cross-Gradient
4109187	478414	4753683	18-Jun-79	20.4	Water Supply	Commerical	N.A.	450	Hydraulically Cross-Gradient
7348956	478109	4752398	16-Oct-19	7.6	Observation Wells	N.A.	N.A.	456	Hydraulically Cross-Gradient
7312723	478716	4752618	10-May-18	13.7	Observation Wells	Monitoring	N.A.	472	Hydraulically Down-Gradient
7048164	478573	4753588	18-Jul-07	18.4	Abandoned-Other	N.A.	N.A.	478	Hydraulically Cross-Gradient

Notes:

Information is as provided by the MECP WWIS Online Database. Actual locations may differ.

N.A. - Information not provided in the MECP WWIS Database

Appendix F -
Groundwater Chemistry, Piper & Schoeller Diagrams, Laboratory Certificates of Analysis

Parameter Name	ODWS - MAC	ODWS - A/O	Sample Location		BH1/MW	BH7/MW
			Sample ID		MW1	MW7
			Bureau Veritas ID		UVD781	UVD921
			Sampling Date		2023/01/17	2023/01/17
			Investigated Unit		Clayey Silt Till (Aquitard)	Clayey Silt Till (Aquitard)
			UNITS	RDL	Result	Result
Calculated Parameters						
Anion Sum			me/L	N/A	11.2	10.9
Bicarb. Alkalinity (calc. as CaCO3)			mg/L	1	320	300
Calculated TDS		500	mg/L	1	**610**	**620**
Carb. Alkalinity (calc. as CaCO3)			mg/L	1	2.2	2.1
Cation Sum			me/L	N/A	12.4	11.7
Hardness (CaCO3)		80:100	mg/L	1	**540**	**510**
Ion Balance (% Difference)			%	N/A	4.88	3.83
Langelier Index (@ 20C)			N/A		0.964	0.849
Langelier Index (@ 4C)			N/A		0.716	0.602
Saturation pH (@ 20C)			N/A		6.91	7.01
Saturation pH (@ 4C)			N/A		7.16	7.25
Inorganics						
Total Ammonia-N			mg/L	0.05	0.16	0.057
Conductivity			umho/cm	1	1100	940
Dissolved Organic Carbon		5	mg/L	0.4	1.2	1.7
Orthophosphate (P)			mg/L	0.01	<0.010	0.014
pH		6.5:8.5	pH		7.87	7.85
Dissolved Sulphate (SO4)		500	mg/L	1	52	190
Alkalinity (Total as CaCO3)		30:500	mg/L	1	320	310
Dissolved Chloride (Cl-)		250	mg/L	1	130	23
Nitrite (N)	1		mg/L	0.01	<0.010	<0.010
Nitrate (N)	10		mg/L	0.1	0.11	0.72
Nitrate + Nitrite (N)	10		mg/L	0.1	0.11	0.72
Metals						
Dissolved Aluminum (Al)		100	ug/L	4.9	7.4	**210**
Dissolved Antimony (Sb)	6		ug/L	0.5	<0.50	0.52
Dissolved Arsenic (As)	10		ug/L	1	<1.0	<1.0
Dissolved Barium (Ba)	1000		ug/L	2	180	130
Dissolved Beryllium (Be)			ug/L	0.4	<0.40	<0.40
Dissolved Boron (B)	5000		ug/L	10	43	110
Dissolved Cadmium (Cd)	5		ug/L	0.09	<0.090	<0.090
Dissolved Calcium (Ca)			ug/L	200	120000	100000
Dissolved Chromium (Cr)	50		ug/L	5	<5.0	<5.0
Dissolved Cobalt (Co)			ug/L	0.5	<0.50	<0.50
Dissolved Copper (Cu)		1000	ug/L	0.9	2.9	3
Dissolved Iron (Fe)		300	ug/L	100	<100	190
Dissolved Lead (Pb)	10		ug/L	0.5	<0.50	<0.50
Dissolved Magnesium (Mg)			ug/L	50	59000	64000
Dissolved Manganese (Mn)		50	ug/L	2	9.1	20
Dissolved Molybdenum (Mo)			ug/L	0.5	4.8	11
Dissolved Nickel (Ni)			ug/L	1	<1.0	<1.0
Dissolved Phosphorus (P)			ug/L	100	<100	100
Dissolved Potassium (K)			ug/L	200	3500	4100
Dissolved Selenium (Se)	50		ug/L	2	<2.0	5.3
Dissolved Silicon (Si)			ug/L	50	6600	6100
Dissolved Silver (Ag)			ug/L	0.09	<0.090	<0.090
Dissolved Sodium (Na)	20000*	200000	ug/L	100	34000	32000
Dissolved Strontium (Sr)			ug/L	1	1200	1800
Dissolved Thallium (Tl)			ug/L	0.05	<0.050	<0.050
Dissolved Titanium (Ti)			ug/L	5	<5.0	7.5
Dissolved Uranium (U)	20		ug/L	0.1	3.7	5.2
Dissolved Vanadium (V)			ug/L	0.5	1.1	1.5
Dissolved Zinc (Zn)		5000	ug/L	5	<5.0	<5.0

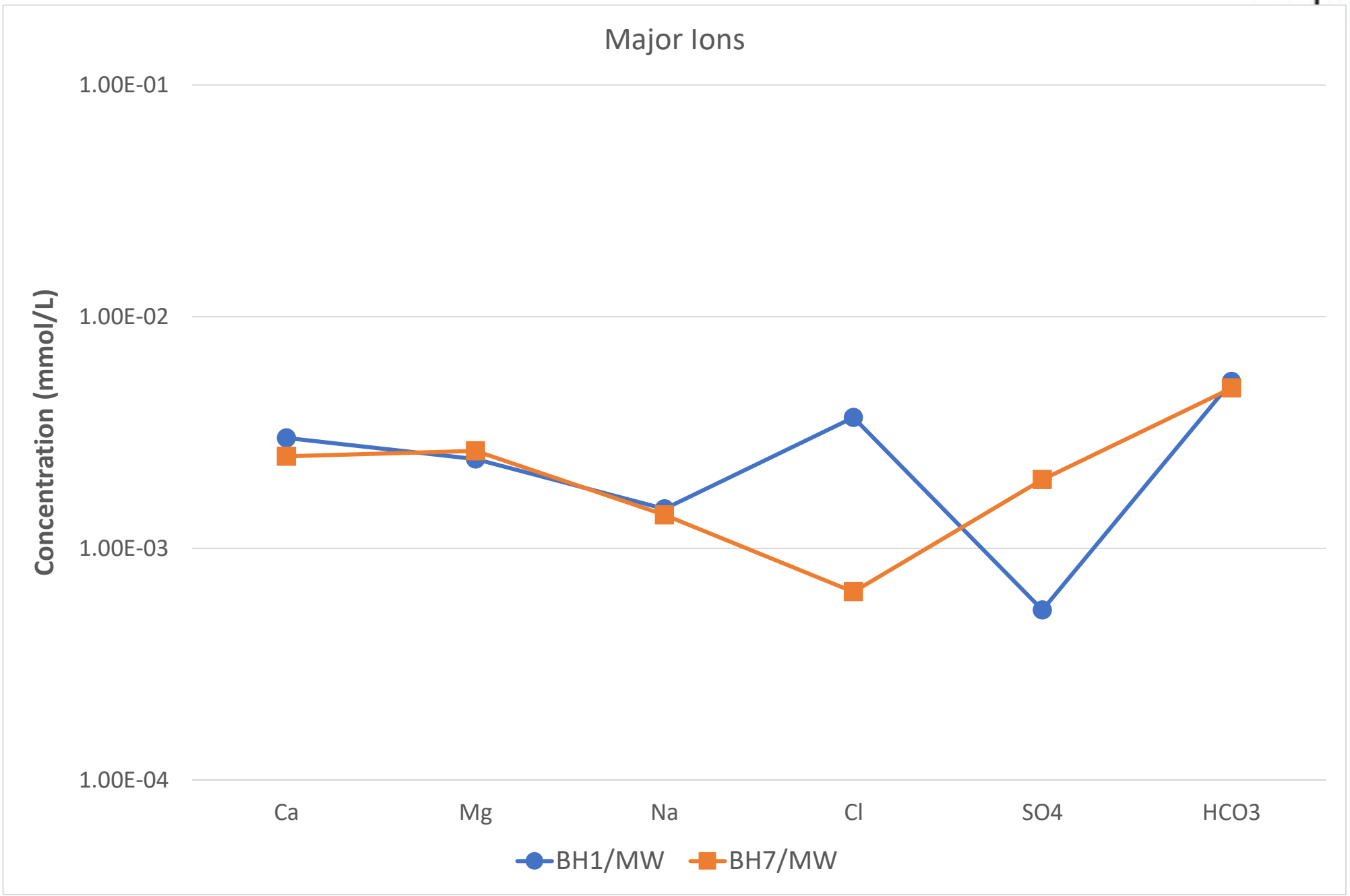
LEGEND

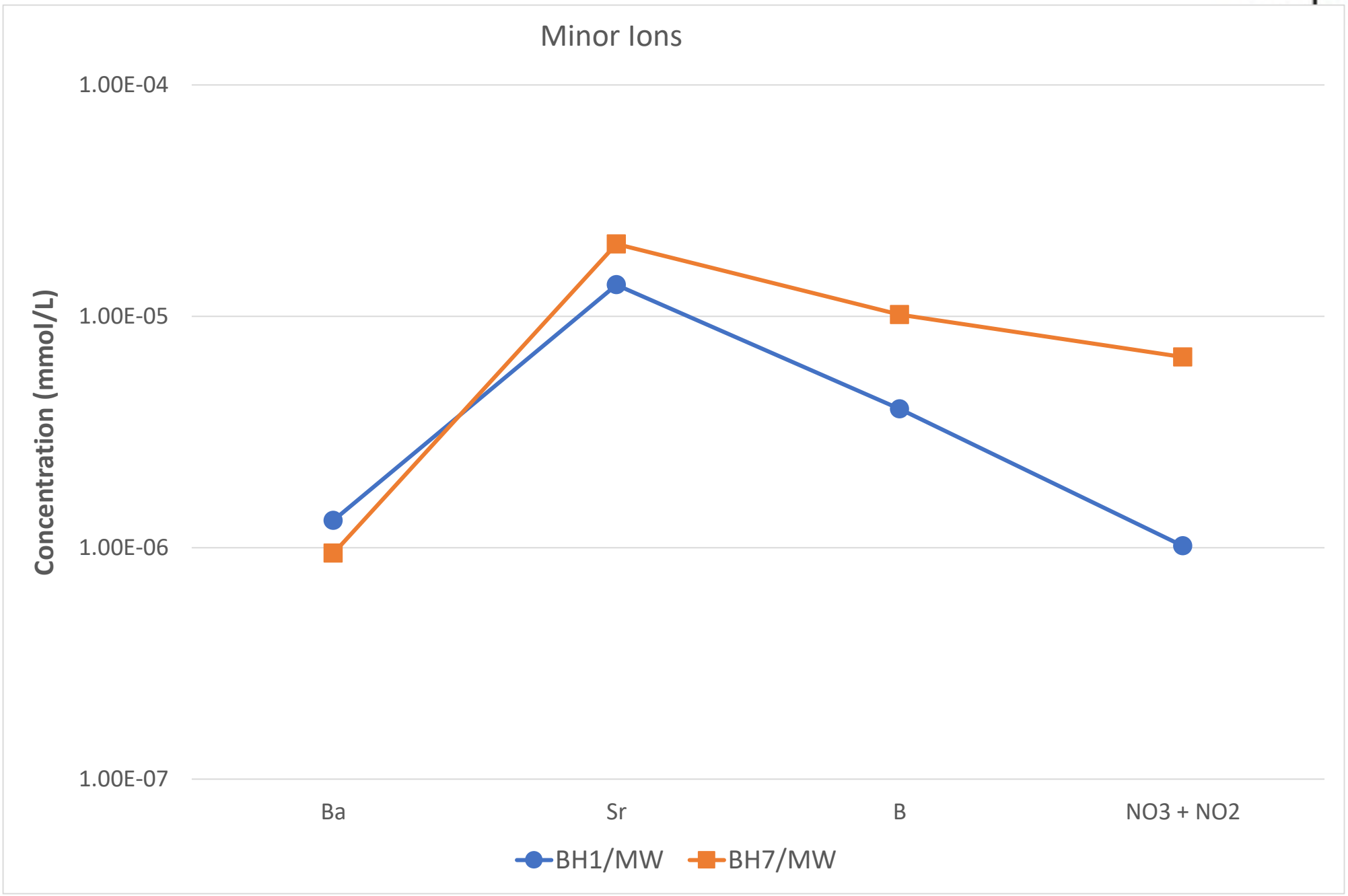
* The MAC limit for dissolved sodium represents the concentration where exceedances should be reported to the local Medical Officer of Health so the information can be provided to local physicians for patients on sodium-restricted diets.

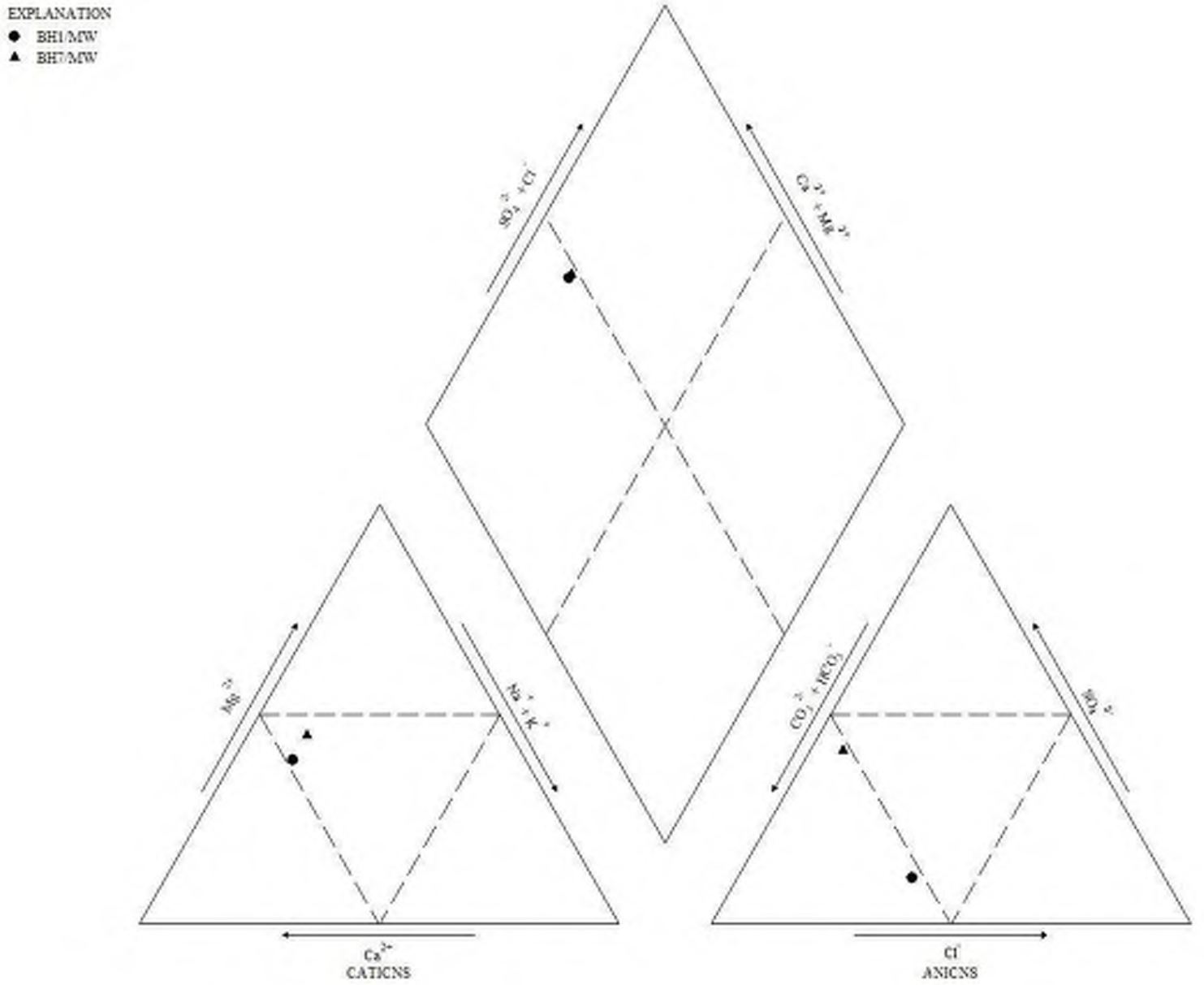
ODWS - MAC: Ontario Drinking Water Quality Standard - Maximum Acceptable Concentration

ODWS - A/O: Ontario Drinking Water Quality Standard - Aesthetic/Operational Objective

Bold	Exceedance of Aesthetic Objective
Bold & Red	Exceedance of Maximum Acceptable Concentration


Major Ions
1.00E-01
1.00E-02
1.00E-03
1.00E-04
Concentration (mmol/L)
Ca
Mg
Na
Cl
SO4
HCO3
BH1/MW
BH7/MW


Minor Ions
1.00E-04
1.00E-05
1.00E-06
1.00E-07
Concentration (mmol/L)
Ba
Sr
B
NO3 + NO2
BH1/MW
BH7/MW


EXPLANATION
BH1/MW
BH7/MW
$SO_4^{2-} + Cl^-$
$Ca^{2+} + Mg^{2+}$
Mg^{2+}
$Na^+ + K^+$
Ca^{2+}
CATIONS
$CO_3^{2-} + HCO_3^-$
SO_4^{2-}
Cl^-
ANIONS

Your Project #: KCH-22022007
Your C.O.C. #: 915214-01-01

Attention: Kassandra Wallace

exp Services Inc
London Branch
15701 Robin's Hill Rd
Unit 2
London, ON
CANADA N5V 0A5

Report Date: 2023/01/23
Report #: R7481156
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C315322
Received: 2023/01/17, 13:02

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity	2	N/A	2023/01/19	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2023/01/20	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2023/01/19	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	N/A	2023/01/19	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2023/01/18	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2023/01/20	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	2	N/A	2023/01/19	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2023/01/20		
Anion and Cation Sum	2	N/A	2023/01/20		
Total Ammonia-N	2	N/A	2023/01/19	CAM SOP-00441	USGS I-2522-90 m
Nitrate & Nitrite as Nitrogen in Water (2)	2	N/A	2023/01/19	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	2	2023/01/18	2023/01/19	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2023/01/19	CAM SOP-00461	SM 23 4500-P E m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2023/01/20		Auto Calc
Sat. pH and Langelier Index (@ 4C)	2	N/A	2023/01/20		Auto Calc
Sulphate by Automated Colourimetry	2	N/A	2023/01/19	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2023/01/20		Auto Calc

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or

Your Project #: KCH-22022007
Your C.O.C. #: 915214-01-01

Attention: Kassandra Wallace

exp Services Inc
London Branch
15701 Robin's Hill Rd
Unit 2
London, ON
CANADA N5V 0A5

Report Date: 2023/01/23
Report #: R7481156
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C315322
Received: 2023/01/17, 13:02

implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Christine Gripton, Senior Project Manager
Email: Christine.Gripton@bureauveritas.com
Phone# (519)652-9444

==========

This report has been generated and distributed using a secure automated process.
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Bureau Veritas Job #: C315322
Report Date: 2023/01/23

exp Services Inc
Client Project #: KCH-22022007
Sampler Initials: JS

RCAP - COMPREHENSIVE (WATER)

Bureau Veritas ID				UVD781		UVD921		
Sampling Date				2023/01/17 11:15		2023/01/17 11:55		
COC Number				915214-01-01		915214-01-01		
	UNITS	MAC	A/O	MW1	QC Batch	MW7	RDL	QC Batch
Calculated Parameters								
Anion Sum	me/L	-	-	11.2	8454861	10.9	N/A	8454861
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	-	320	8453331	300	1.0	8453331
Calculated TDS	mg/L	-	500	**610**	8454864	**620**	1.0	8454864
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	-	2.2	8453331	2.1	1.0	8453331
Cation Sum	me/L	-	-	12.4	8454861	11.7	N/A	8454861
Hardness (CaCO3)	mg/L	-	80:100	**540**	8453330	**510**	1.0	8453330
Ion Balance (% Difference)	%	-	-	4.88	8454800	3.83	N/A	8454800
Langelier Index (@ 20C)	N/A	-	-	0.964	8454862	0.849		8454862
Langelier Index (@ 4C)	N/A	-	-	0.716	8454863	0.602		8454863
Saturation pH (@ 20C)	N/A	-	-	6.91	8454862	7.01		8454862
Saturation pH (@ 4C)	N/A	-	-	7.16	8454863	7.25		8454863
Inorganics								
Total Ammonia-N	mg/L	-	-	0.16	8454667	0.057	0.050	8454667
Conductivity	umho/cm	-	-	1100	8456727	940	1.0	8456727
Dissolved Organic Carbon	mg/L	-	5	1.2	8455979	1.7	0.40	8455979
Orthophosphate (P)	mg/L	-	-	<0.010	8457031	0.014	0.010	8457031
pH	pH	-	6.5:8.5	7.87	8456716	7.85		8456716
Dissolved Sulphate (SO4)	mg/L	-	500	52	8453911	190	1.0	8453911
Alkalinity (Total as CaCO3)	mg/L	-	30:500	320	8456735	310	1.0	8456735
Dissolved Chloride (Cl-)	mg/L	-	250	130	8456165	23	1.0	8456165
Nitrite (N)	mg/L	1	-	<0.010	8456213	<0.010	0.010	8456018
Nitrate (N)	mg/L	10	-	0.11	8456213	0.72	0.10	8456018
Nitrate + Nitrite (N)	mg/L	10	-	0.11	8456213	0.72	0.10	8456018
Metals								
Dissolved Aluminum (Al)	ug/L	-	100	7.4	8456390	**210**	4.9	8456390
Dissolved Antimony (Sb)	ug/L	6	-	<0.50	8456390	0.52	0.50	8456390
Dissolved Arsenic (As)	ug/L	10	-	<1.0	8456390	<1.0	1.0	8456390
Dissolved Barium (Ba)	ug/L	1000	-	180	8456390	130	2.0	8456390

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
MAC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [MAC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)
N/A = Not Applicable

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Bureau Veritas Job #: C315322
Report Date: 2023/01/23

exp Services Inc
Client Project #: KCH-22022007
Sampler Initials: JS

RCAP - COMPREHENSIVE (WATER)

Bureau Veritas ID				UVD781		UVD921		
Sampling Date				2023/01/17 11:15		2023/01/17 11:55		
COC Number				915214-01-01		915214-01-01		
	UNITS	MAC	A/O	MW1	QC Batch	MW7	RDL	QC Batch
Dissolved Beryllium (Be)	ug/L	-	-	<0.40	8456390	<0.40	0.40	8456390
Dissolved Boron (B)	ug/L	5000	-	43	8456390	110	10	8456390
Dissolved Cadmium (Cd)	ug/L	5	-	<0.090	8456390	<0.090	0.090	8456390
Dissolved Calcium (Ca)	ug/L	-	-	120000	8456390	100000	200	8456390
Dissolved Chromium (Cr)	ug/L	50	-	<5.0	8456390	<5.0	5.0	8456390
Dissolved Cobalt (Co)	ug/L	-	-	<0.50	8456390	<0.50	0.50	8456390
Dissolved Copper (Cu)	ug/L	-	1000	2.9	8456390	3.0	0.90	8456390
Dissolved Iron (Fe)	ug/L	-	300	<100	8456390	190	100	8456390
Dissolved Lead (Pb)	ug/L	10	-	<0.50	8456390	<0.50	0.50	8456390
Dissolved Magnesium (Mg)	ug/L	-	-	59000	8456390	64000	50	8456390
Dissolved Manganese (Mn)	ug/L	-	50	9.1	8456390	20	2.0	8456390
Dissolved Molybdenum (Mo)	ug/L	-	-	4.8	8456390	11	0.50	8456390
Dissolved Nickel (Ni)	ug/L	-	-	<1.0	8456390	<1.0	1.0	8456390
Dissolved Phosphorus (P)	ug/L	-	-	<100	8456390	100	100	8456390
Dissolved Potassium (K)	ug/L	-	-	3500	8456390	4100	200	8456390
Dissolved Selenium (Se)	ug/L	50	-	<2.0	8456390	5.3	2.0	8456390
Dissolved Silicon (Si)	ug/L	-	-	6600	8456390	6100	50	8456390
Dissolved Silver (Ag)	ug/L	-	-	<0.090	8456390	<0.090	0.090	8456390
Dissolved Sodium (Na)	ug/L	-	200000	34000	8456390	32000	100	8456390
Dissolved Strontium (Sr)	ug/L	-	-	1200	8456390	1800	1.0	8456390
Dissolved Thallium (Tl)	ug/L	-	-	<0.050	8456390	<0.050	0.050	8456390
Dissolved Titanium (Ti)	ug/L	-	-	<5.0	8456390	7.5	5.0	8456390
Dissolved Uranium (U)	ug/L	20	-	3.7	8456390	5.2	0.10	8456390
Dissolved Vanadium (V)	ug/L	-	-	1.1	8456390	1.5	0.50	8456390
Dissolved Zinc (Zn)	ug/L	-	5000	<5.0	8456390	<5.0	5.0	8456390

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
MAC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [MAC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

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Bureau Veritas Job #: C315322
Report Date: 2023/01/23

exp Services Inc
Client Project #: KCH-22022007
Sampler Initials: JS

TEST SUMMARY

Bureau Veritas ID: UVD781
Sample ID: MW1
Matrix: Water

Collected: 2023/01/17
Shipped:
Received: 2023/01/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8456735	N/A	2023/01/19	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	8453331	N/A	2023/01/20	Automated Statchk
Chloride by Automated Colourimetry	KONE	8456165	N/A	2023/01/19	Alina Dobreanu
Conductivity	AT	8456727	N/A	2023/01/19	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	8455979	N/A	2023/01/18	Gyulshen Idriz
Hardness (calculated as CaCO3)		8453330	N/A	2023/01/20	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	8456390	N/A	2023/01/19	Nan Raykha
Ion Balance (% Difference)	CALC	8454800	N/A	2023/01/20	Automated Statchk
Anion and Cation Sum	CALC	8454861	N/A	2023/01/20	Automated Statchk
Total Ammonia-N	LACH/NH4	8454667	N/A	2023/01/19	Shivani Shivani
Nitrate & Nitrite as Nitrogen in Water	LACH	8456213	N/A	2023/01/19	Chandra Nandlal
pH	AT	8456716	2023/01/18	2023/01/19	Surinder Rai
Orthophosphate	KONE	8457031	N/A	2023/01/19	Yogesh Patel
Sat. pH and Langelier Index (@ 20C)	CALC	8454862	N/A	2023/01/20	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	8454863	N/A	2023/01/20	Automated Statchk
Sulphate by Automated Colourimetry	KONE	8453911	N/A	2023/01/19	Samuel Law
Total Dissolved Solids (TDS calc)	CALC	8454864	N/A	2023/01/20	Automated Statchk

Bureau Veritas ID: UVD781 Dup
Sample ID: MW1
Matrix: Water

Collected: 2023/01/17
Shipped:
Received: 2023/01/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8456213	N/A	2023/01/19	Chandra Nandlal

Bureau Veritas ID: UVD921
Sample ID: MW7
Matrix: Water

Collected: 2023/01/17
Shipped:
Received: 2023/01/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8456735	N/A	2023/01/19	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	8453331	N/A	2023/01/20	Automated Statchk
Chloride by Automated Colourimetry	KONE	8456165	N/A	2023/01/19	Alina Dobreanu
Conductivity	AT	8456727	N/A	2023/01/19	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	8455979	N/A	2023/01/18	Gyulshen Idriz
Hardness (calculated as CaCO3)		8453330	N/A	2023/01/20	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	8456390	N/A	2023/01/19	Nan Raykha
Ion Balance (% Difference)	CALC	8454800	N/A	2023/01/20	Automated Statchk
Anion and Cation Sum	CALC	8454861	N/A	2023/01/20	Automated Statchk
Total Ammonia-N	LACH/NH4	8454667	N/A	2023/01/19	Shivani Shivani
Nitrate & Nitrite as Nitrogen in Water	LACH	8456018	N/A	2023/01/19	Chandra Nandlal
pH	AT	8456716	2023/01/18	2023/01/19	Surinder Rai
Orthophosphate	KONE	8457031	N/A	2023/01/19	Yogesh Patel
Sat. pH and Langelier Index (@ 20C)	CALC	8454862	N/A	2023/01/20	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	8454863	N/A	2023/01/20	Automated Statchk

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Bureau Veritas Job #: C315322
Report Date: 2023/01/23

exp Services Inc
Client Project #: KCH-22022007
Sampler Initials: JS

TEST SUMMARY

Bureau Veritas ID: UVD921
Sample ID: MW7
Matrix: Water

Collected: 2023/01/17
Shipped:
Received: 2023/01/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate by Automated Colourimetry	KONE	8453911	N/A	2023/01/19	Samuel Law
Total Dissolved Solids (TDS calc)	CALC	8454864	N/A	2023/01/20	Automated Statchk

Bureau Veritas ID: UVD921 Dup
Sample ID: MW7
Matrix: Water

Collected: 2023/01/17
Shipped:
Received: 2023/01/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	AT	8456735	N/A	2023/01/19	Surinder Rai
Conductivity	AT	8456727	N/A	2023/01/19	Surinder Rai
pH	AT	8456716	2023/01/18	2023/01/19	Surinder Rai
Orthophosphate	KONE	8457031	N/A	2023/01/19	Yogesh Patel

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.3°C

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8453911	Dissolved Sulphate (SO4)	2023/01/19	104	75 - 125	102	80 - 120	<1.0	mg/L	0.92	20
8454667	Total Ammonia-N	2023/01/19	100	75 - 125	97	80 - 120	<0.050	mg/L	NC	20
8455979	Dissolved Organic Carbon	2023/01/18	96	80 - 120	98	80 - 120	<0.40	mg/L	3.3	20
8456018	Nitrate (N)	2023/01/19	97	80 - 120	102	80 - 120	<0.10	mg/L	NC	20
8456018	Nitrite (N)	2023/01/19	107	80 - 120	107	80 - 120	<0.010	mg/L	NC	20
8456165	Dissolved Chloride (Cl-)	2023/01/19	NC	80 - 120	106	80 - 120	<1.0	mg/L	0.076	20
8456213	Nitrate (N)	2023/01/19	115	80 - 120	105	80 - 120	<0.10	mg/L	NC	20
8456213	Nitrite (N)	2023/01/19	112	80 - 120	106	80 - 120	<0.010	mg/L	NC	20
8456390	Dissolved Aluminum (Al)	2023/01/19	110	80 - 120	102	80 - 120	<4.9	ug/L		
8456390	Dissolved Antimony (Sb)	2023/01/19	113	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
8456390	Dissolved Arsenic (As)	2023/01/19	104	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
8456390	Dissolved Barium (Ba)	2023/01/19	104	80 - 120	99	80 - 120	<2.0	ug/L	2.0	20
8456390	Dissolved Beryllium (Be)	2023/01/19	105	80 - 120	100	80 - 120	<0.40	ug/L	NC	20
8456390	Dissolved Boron (B)	2023/01/19	104	80 - 120	98	80 - 120	<10	ug/L	1.5	20
8456390	Dissolved Cadmium (Cd)	2023/01/19	106	80 - 120	101	80 - 120	<0.090	ug/L	NC	20
8456390	Dissolved Calcium (Ca)	2023/01/19	123 (1)	80 - 120	102	80 - 120	<200	ug/L		
8456390	Dissolved Chromium (Cr)	2023/01/19	102	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
8456390	Dissolved Cobalt (Co)	2023/01/19	100	80 - 120	99	80 - 120	<0.50	ug/L	NC	20
8456390	Dissolved Copper (Cu)	2023/01/19	106	80 - 120	102	80 - 120	<0.90	ug/L	9.9	20
8456390	Dissolved Iron (Fe)	2023/01/19	107	80 - 120	102	80 - 120	<100	ug/L		
8456390	Dissolved Lead (Pb)	2023/01/19	99	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
8456390	Dissolved Magnesium (Mg)	2023/01/19	113	80 - 120	101	80 - 120	<50	ug/L		
8456390	Dissolved Manganese (Mn)	2023/01/19	104	80 - 120	100	80 - 120	<2.0	ug/L		
8456390	Dissolved Molybdenum (Mo)	2023/01/19	112	80 - 120	104	80 - 120	<0.50	ug/L	7.4	20
8456390	Dissolved Nickel (Ni)	2023/01/19	97	80 - 120	97	80 - 120	<1.0	ug/L	8.4	20
8456390	Dissolved Phosphorus (P)	2023/01/19	123 (1)	80 - 120	118	80 - 120	<100	ug/L		
8456390	Dissolved Potassium (K)	2023/01/19	115	80 - 120	105	80 - 120	<200	ug/L		
8456390	Dissolved Selenium (Se)	2023/01/19	102	80 - 120	101	80 - 120	<2.0	ug/L	NC	20
8456390	Dissolved Silicon (Si)	2023/01/19	111	80 - 120	106	80 - 120	<50	ug/L		
8456390	Dissolved Silver (Ag)	2023/01/19	71 (2)	80 - 120	104	80 - 120	<0.090	ug/L	NC	20
8456390	Dissolved Sodium (Na)	2023/01/19	137 (1)	80 - 120	102	80 - 120	<100	ug/L	3.6	20

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8456390	Dissolved Strontium (Sr)	2023/01/19	102	80 - 120	101	80 - 120	<1.0	ug/L		
8456390	Dissolved Thallium (Tl)	2023/01/19	102	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
8456390	Dissolved Titanium (Ti)	2023/01/19	112	80 - 120	104	80 - 120	<5.0	ug/L		
8456390	Dissolved Uranium (U)	2023/01/19	102	80 - 120	99	80 - 120	<0.10	ug/L	1.7	20
8456390	Dissolved Vanadium (V)	2023/01/19	103	80 - 120	96	80 - 120	<0.50	ug/L	1.8	20
8456390	Dissolved Zinc (Zn)	2023/01/19	100	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
8456716	pH	2023/01/19			102	98 - 103			0.44	N/A
8456727	Conductivity	2023/01/19			99	85 - 115	<1.0	umho/cm	0.21	25
8456735	Alkalinity (Total as CaCO3)	2023/01/19			99	85 - 115	<1.0	mg/L	1.3	20
8457031	Orthophosphate (P)	2023/01/19	98	75 - 125	101	80 - 120	<0.010	mg/L	5.8	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(2) Matrix Spike exceeds acceptance limits. Probable Matrix interference

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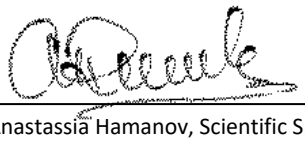
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist

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REC'D IN LONDON

Page 1 of 1

CHAIN OF CUSTODY RECORD

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#28124 exp Services Inc	Company Name:		Quotation #:	C20328	Bureau Veritas Job #:	Bottle Order #: 915214
Attention:	Accounts Payable	Attention:	Kassandra Wallace	P.O. #:			
Address:	15701 Robin's Hill Rd Unit 2	Address:		Project:	KCH-22022007-A0		
	London ON N5V 0A5			Project Name:		COC #: C#915214-01-01	Project Manager: Christine Gripton
Tel:	(519) 963-3000 Fax: (519) 963-1552	Tel:	Fax:	Site #:			
Email:	AP@exp.com, Karen.Burke@exp.com	Email:	kassandra.wallace@exp.com	Sampled By:	Josh S.		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: X
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number: (call lab for #)

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine	☐ CCME ☐ Sanitary Sewer Bylaw	
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ Reg 558 ☐ Storm Sewer Bylaw	
☐ Table 3 ☐ Agri/Other ☐ For RSC	☐ MISA Municipality	
☐ Table	☐ PWQO ☐ Reg 406 Table	
	☒ Other SWS	

Include Criteria on Certificate of Analysis (Y/N)? _____

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ICPMS - Comprehensive	# of Bottles	Comments
1		MW1	Jan 17/23	11:15	GW	X	X	4	Dissolved metals Field Filtered
2		MW7	Jan 17/23	11:55	GW	X	X	4	" "
3									
4									
5									
6									
7									
8									
9									
10									On Ice

17-Jan-23 13:02
Christine Gripton
C315322
RPK ENV-1201

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Rece: 5.6.5	Custody Seal: Present / Intact	Yes	No
Joshua Spitzer	23/01/17	1:00	[illegible]	2023/01/17	13:02						
			ANERS	2023/01/17	17:45						

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL_LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

White: Bureau Veritas Yellow: Client

0110
626266

Bureau Veritas Canada (2019) Inc.

Exceedance Summary Table – ODWS (2002)

Result Exceedances

Sample ID	Bureau Veritas ID	Parameter	Criteria	Result	DL	UNITS
No Exceedances						

The exceedance summary table is for information purposes only and should not be considered a comprehensive listing or statement of conformance to applicable regulatory guidelines.

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Appendix G -
Manual Groundwater Levels & Elevations

Water Level Below Top of Pipe (mbtop)				
Well ID	**BH1/MW**	**BH3A/MW**	**BH3B/MW**	**BH7/MW**
Ground Surface Elevation (mamsl)	274.00	271.59	271.69	270.52
Standpipe Stickup (m)	0.73	0.77	0.78	0.63
Measured Total Depth (mbtop)	5.53	8.11	5.47	6.19
25-Oct-22	5.28	7.30	4.34	5.75
9-Nov-22	3.93	7.31	3.10	5.24
14-Dec-22[1]	2.03	7.41	2.17	3.82
9-Jan-23	1.35	7.45	1.07	5.01
17-Jan-23	1.53	7.42	1.24	4.75

Water Level Below Ground Surface (mbgs)				
Well ID	**BH1/MW**	**BH3A/MW**	**BH3B/MW**	**BH7/MW**
Ground Surface Elevation (mamsl)	274.00	271.59	271.69	270.52
Standpipe Stickup (m)	0.73	0.77	0.78	0.63
25-Oct-22	4.55	6.53	3.56	5.12
9-Nov-22	3.20	6.54	2.32	4.61
14-Dec-22[1]	1.30	6.64	1.39	3.19
9-Jan-23	0.62	6.68	0.29	4.38
17-Jan-23	0.80	6.65	0.46	4.12

Groundwater Elevation (mamsl)				
Well ID	**BH1/MW**	**BH3A/MW**	**BH3B/MW**	**BH7/MW**
Ground Surface Elevation (mamsl)	274.00	271.59	271.69	270.52
Top of Pipe Elevation (mamsl)	274.73	272.36	272.47	271.15
25-Oct-22	269.45	265.06	268.13	265.40
9-Nov-22	270.80	265.05	269.37	265.91
14-Dec-22[1]	272.70	264.95	270.30	267.33
9-Jan-23	273.38	264.91	271.40	266.14
17-Jan-23	273.20	264.94	271.23	266.40

Notes:

[1]Well development occurred Dec 14, 2022, once sufficient water column achieved for development

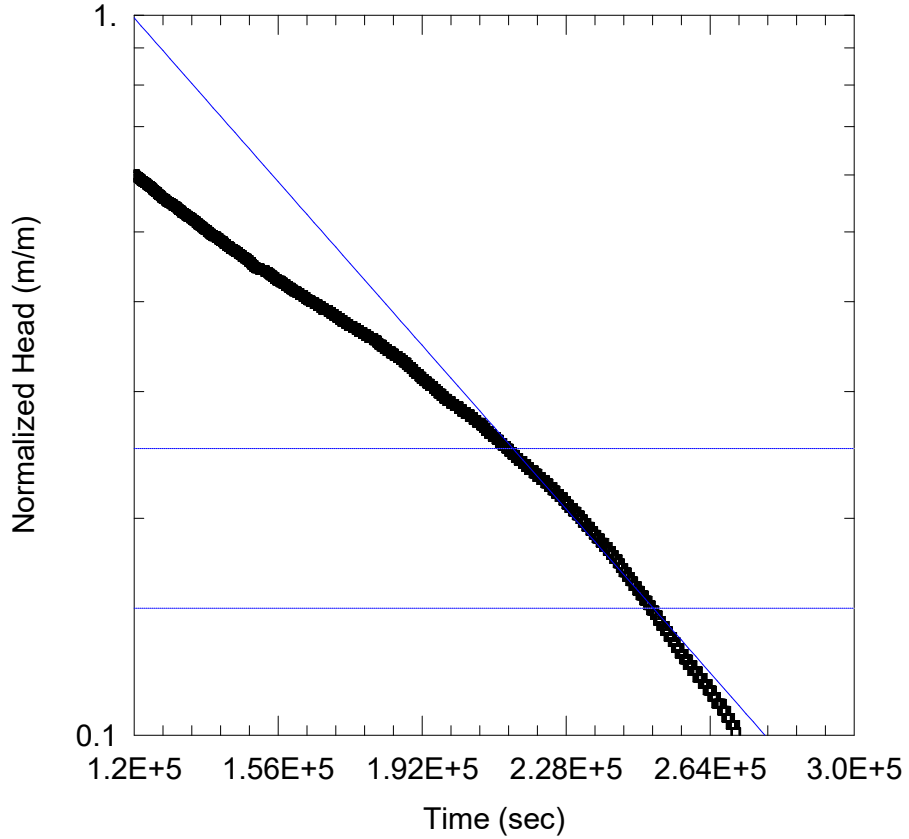
indicates groundwater level not representative of static condition following initial well installation and/or well development

Ground surface elevations exctracted from the topographical mapping provided by the Client

mamsl - metres above mean sea level

mbtop - metres below top of pipe

Appendix H -
Single Well Response Tests



WELL TEST ANALYSIS

Data Set: E:\...\MW1.aqt
Date: 01/30/23 Time: 13:48:25

PROJECT INFORMATION

Company: EXP
Client: Royal Premier Homes
Project: KCH-22022007
Location: 1350 Wharncliffe Rd. S.
Test Well: MW1
Test Date: Jan. 17, 2023

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

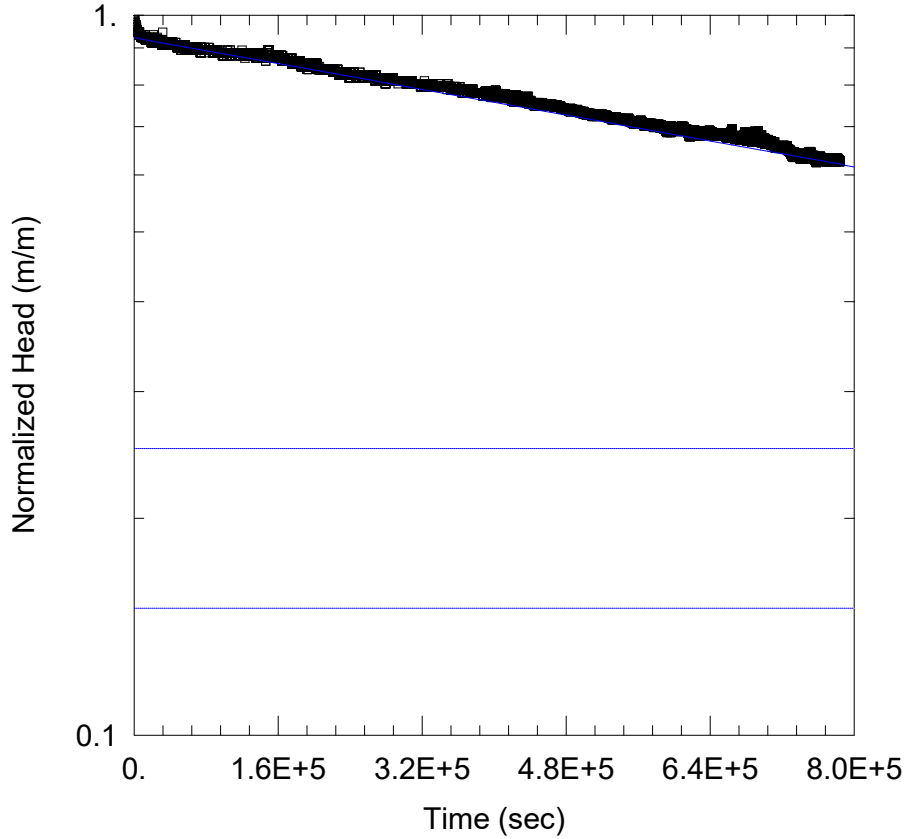
K = 1.288E-8 m/sec
y0 = 23.62 m

AQUIFER DATA

Saturated Thickness: 4.6 m
Anisotropy Ratio (Kz/Kr): 0.2

WELL DATA (MW1)

Initial Displacement: 4.16 m
Total Well Penetration Depth: 4.6 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.6 m
Screen Length: 1.52 m
Well Radius: 0.1048 m



WELL TEST ANALYSIS

Data Set:
Date: 01/30/23 Time: 13:29:34

PROJECT INFORMATION

Company: EXP
Client: Royal Premier Homes
Project: KCH-22022007
Location: 1350 Wharncliffe Rd. S.
Test Well: MW7
Test Date: Jan. 17, 2023

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 6.386E-10 m/sec
y0 = 1.228 m

AQUIFER DATA

Saturated Thickness: 1.38 m
Anisotropy Ratio (Kz/Kr): 0.2

WELL DATA (MW7)

Initial Displacement: 1.32 m
Total Well Penetration Depth: 1.38 m
Casing Radius: 0.0254 m
Static Water Column Height: 1.38 m
Screen Length: 1.38 m
Well Radius: 0.1048 m

Appendix I -
Limitations and Use of Report

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the hydrogeological 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.

COMPLETE REPORT

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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The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of EXP. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. EXP is not responsible for damages suffered by any third party resulting from unauthorized use of the Report.

REPORT FORMAT

Where EXP has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by EXP have utilize specific software and hardware systems. EXP makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are EXP's instruments of professional service and shall not be altered without the written consent of EXP.

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