HYDROGEOLOGICAL ASSESSMENT

PROPOSED MIXED USE DEVELOPMENT
952 SOUTHDALE ROAD WEST, LONDON

LDS PROJECT NO. GE-00085

REPORT DATE: AUGUST 18, 2021

Submitted to:

1739626 ONTARIO LTD.

Distribution (via email):
Mr. David Traher, Vice President, Planning/Development
Mr. Iyman Meddoui, President

Table of Contents

Appendices

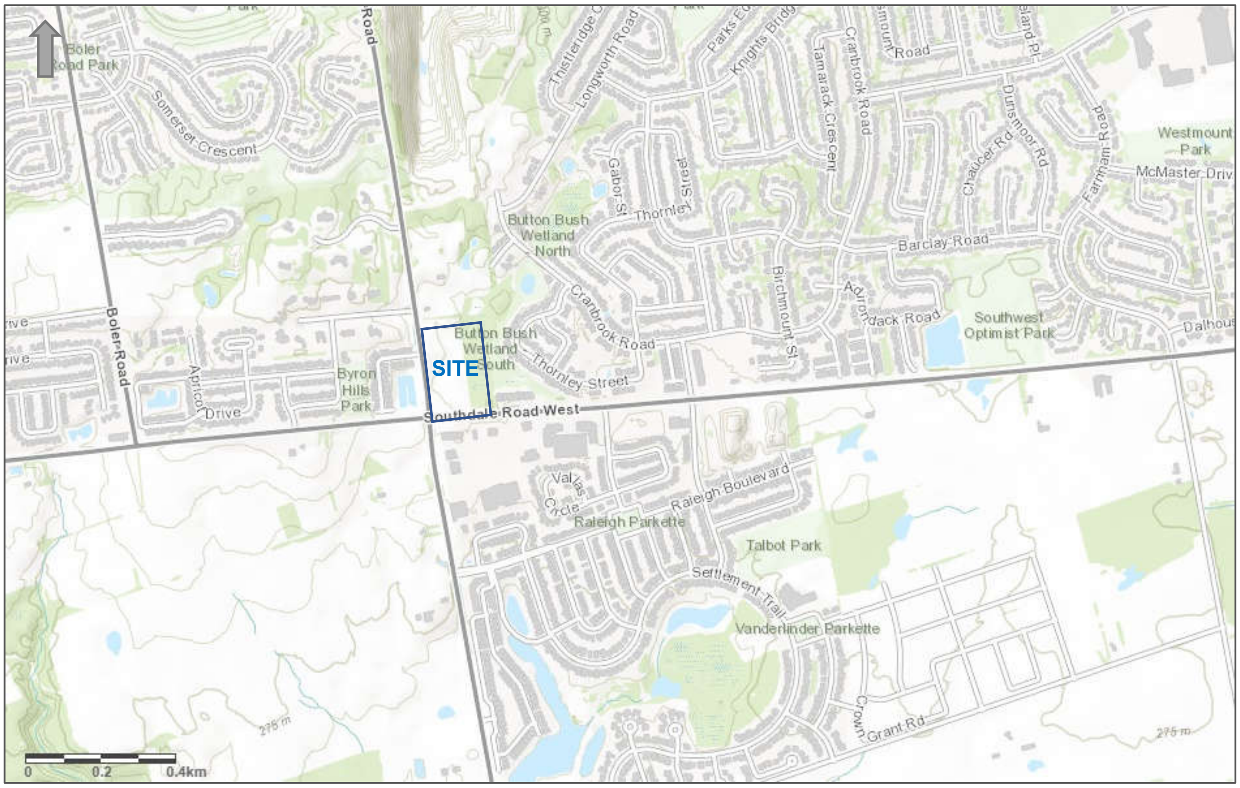
1.0 INTRODUCTION

LDS Consultants Inc. (LDS) has been retained by 1739626 Ontario Ltd. c/o Westdell Development Corp. to carry out a Preliminary Hydrogeological Assessment for a proposed commercial development in London, Ontario. The subject property is located at 952 Southdale Road, which is on the north-east junction of Colonel Talbot Road and Southdale Road in West London. The Legal description for the site is as follows:

- Concession 1, Part Lot 42 RP 33R8507, Part 1, City of London.

A key plan showing the site location is provided below as Figure 1, for reference.

Figure 1: Key Plan



The City of London zoning designation for this parcel of land is Urban Reserve, UR2. UR2 designation is applied to undeveloped areas within the former City boundaries and to areas which have been reviewed through the Community Plan Process. Under Schedule B1 of the City of London Official Plan, the site does not contain a natural heritage feature overlay over the property. However, Schedule B1 does identify the Buttonbush Wetland (to the east) as a Provincially Significant Wetland, along with unevaluated wetland patches north and northeast of the site.

The site is also located within the North Talbot Community Plan (prepared in December 1999) area. Of particular significance within the Community Plan, are the stormwater management objectives which have been established, for the purposes of maintaining and protecting the natural wetlands and natural heritage features in the area, to encourage the use of at-source and conveyance stormwater controls, encourage infiltration and groundwater recharge where possible, and provide at-source sedimentation and erosion control measures during construction. The Community Plan also identified that post-development runoff from the area north of Southdale Road (which includes the subject lands) will be intercepted at Southdale Road by a storm sewer, which directs stormwater flows to the Talbot Village stormwater management facility located to the south.

The site is located within the Dingman Creek watershed. The broader watershed area drains an area of approximately 170 km2, and includes approximately 30 tributaries, most of which have been altered from their natural state as a result of urbanization.

Surface water run-off at the site collects into a pair of existing swales which cross the property in an east-west configuration, and drain towards the wetland area on the east side of the property. The wetland feature next to the site is the southerly limit of the Buttonbush Wetland.

The proposed development plans at the site include a mix of commercial and residential uses. The west end of the site is expected to have a series of 3-storey townhouse blocks, with surface parking. The central part of the site is expected to have a large grocery store, oriented towards Southdale Road West, with a central parking lot area. At the east end of the site, two smaller commercial buildings are planned, potentially housing restaurants, coffee shops, and/or office space.

This report contains the findings of the Hydrogeological Assessment for the proposed development on the subject lands.

1.1 Terms of Reference

This Report has been prepared for the purposes of examining hydrogeologic (groundwater) and hydrologic (surface water) characteristics of the site, and determining if the proposed commercial site development could result in adverse / negative impacts to natural features in the area. Of critical importance, is the Buttonbush Swamp/North Talbot Wetland, located along the eastern side of the property and beyond the eastern and north-eastern site boundaries, and providing recommendations to minimize potential negative impacts to the nearby natural features.

This hydrogeological report includes the following scoped elements:

- Site location and description;
- Summarised conditions, including topography, physiography, geology and borehole findings;
- Review of aerial photographs;
- Ministry of Environment, Conservation and Parks (MECP) well record review;
- Description of surface water features, drainage and functions;
- Discussion regarding shallow groundwater conditions;
- Water Quality testing on shallow groundwater and wetland samples;
- Preliminary Feature Based Water Balance Assessment (including a monthly breakdown) for baseflows to existing wetland;
- Impact assessment for potential impacts to the adjacent wetland and shallow groundwater, including considerations for groundwater recharge and discharge; and,
- A discussion for mitigation measures to be incorporated into the design and construction of the commercial development to prevent and / or limit negative impacts to the adjacent wetland, and shallow groundwater conditions at the site.

Prior to the issuance of this report, LDS undertook a pre-consultation discussion with City of London Hydrogeologist, Jeff Hachey on February 7, 2019. From that discussion, the following items were identified for inclusion in the Hydrogeological Report:

- Water quality data for the groundwater and surface water in the wetland.
- Details of the planned stormwater discharge, since a municipal storm sewer outlet is not available.
- Discussion outlining LID measures and soil / groundwater suitable to accommodate whatever LID measures are being considered.
- Discussion of mitigation measures to ensure that stormwater from the development will not cause further degradation to the water quality in the wetland.
- Construction dewatering discussion – identify estimated volumes and associated zone of influence, discuss how will impacts of dewatering be minimized/mitigated on the wetland, and outline requirements for treatment which will be part of the discharge plan for any pumped water.
- Outline recommendations for an environmental monitoring program to characterize water quality in the wetland during and post construction.

On September 17, 2020, a formal pre-consultation (Zoom) meeting was held to review the scoping of the Hydrogeological Report and Environmental Impact Study (EIS) being prepared in support of the proposed development. The following items were identified during meeting discussion to supplement the preliminary consultation noted above with City of London in February 2020:

- UTRCA advised that additional monitoring wells located away from the swales are recommended, along with multi-level piezometers should be considered for the wetland area. At least 3 wells required for each aquifer being assessed. Additional dataloggers and monitoring should be conducted.
- UTRCA advised that if water quality discussion relies on inferred presence of contaminants associated with SWM facilities up gradient, that additional water quality sampling would be required to support any such assumptions.
- City suggested use of the Hydrogeological Checklist table outlined in Section 6 of the current City Design Standards.
- City advised that a monitoring well should be located in LID areas (if known) to confirm stabilized and high groundwater conditions which may limit effectiveness.
- Construction dewatering recommendations required to address the need for EASR or PTTW, confirm zone of influence, and include recommendations to minimize amount of groundwater pumping required.

This report is provided on the basis of the terms noted above. The site investigation and recommendations provided in this report follow generally accepted practice for professional consultants carrying out geoscience and geotechnical work in Ontario. The format and content of this report has been guided to address specific client needs.

It is important to note that this report has been prepared to support the planning applications at the site, and that recommendations are provided to assist in the design of the proposed development. Ongoing fieldwork, data collection and monitoring is planned at the site, to provide additional data to support the preparation of a final Hydrogeological Report for the proposed development.

1.2 Coordination with Supporting Studies

LDS has been involved with site characterization work at this property since 2017, primarily for the purposes of preparing a Hydrogeological background study to support the proposed Official Plan amendment and Zoning change for the site development to proceed. In conjunction with the preparation of this Hydrogeological Report, LDS has also prepared the Geotechnical Report (October 2020) outlining geotechnical comments and recommendations related to the proposed site development.

LDS has coordinated with Stantec Consulting, with regards to site grading and stormwater management design aspects for the proposed development, to ensure that the Hydrogeological Report provides the information required to support their design efforts.

In addition, LDS has coordinated with MTE Consultants (formerly Biologic) with regards to the EIS work being completed by their staff, to ensure that this report provides the required information to complement and inform the EIS from a hydrogeologic and hydrologic standpoint.

LDS has also had regard for previous EIS work which was completed (by others) in the vicinity of the site, for the lands immediately east of the site. Previous reports which have been reviewed are outlined below:

- Environmental Impact Statement, Norquay Developments Limited, Dillon Consulting Limited, Project Reference 03-1844, report date February 2004.
- Phase II Crestwood Subdivision, Environmental Impact Study, Dillon Consulting Limited, Project Reference 05-5223, report date August 8, 2006.
- Phase II Highland Ridge Corp Property, Addendum Environmental Impact Study Letter Report, report date November 7, 2007.

As work continues through the planning and approvals process, it is anticipated that ongoing coordination will be required with the design team to ensure that the design of the proposed development is updated in a manner which addresses hydrogeological and ecological issues and concerns, to ensure that the approved development does not cause ‘adverse effects’ to the form and function of the Buttonbush Wetland feature, as defined in the Environmental Protection Act..

2.0 EXISTING CONDITIONS

2.1 Site Location and Description

2.1.1 Site Description

The subject site is located in the south-west portion of the City of London, on the northeast corner of Colonel Talbot Road and Southdale Road. The site occupies 6.37 acres (25.8 ha), and is roughly rectangular shaped. The property was historically occupied by agricultural cropland and is currently vacant. For an overview of the project area and general site features, refer to Drawing 1, in Appendix A

A portion of the Buttonbush Wetland (South) is located along the easterly extent of the property, and extends northeast and east of the property. It is understood that the Buttonbush Wetland was designated as a Provincially Significant Wetland in 2006. This natural feature is discussed further in Section 2.2.

Beyond the wetland area, the site is bordered by single family residential homes to the east, by a small-holding farm and house to the north, Southdale Road and commercial plaza to the south, and a stormwater pond and residential subdivision to the west, across Colonel Talbot Road.

Select site photographs are provided in Appendix D.

2.1.2 Site Topography

The site slopes to the east and south-east with significant drop in grade (approximately 4m) from Colonel Talbot Road at the western boundary of the property. The most significant change in grade at the site occurs along a 3 to 4 m high slope along the western site boundary, and then the site follows a general slope to the east towards the wetland area.

2.1.3 Surface Water Features

Surface drainage is generally from west to east and from north-west to south-east following the general area topography. Under existing conditions, stormwater which accumulates at the site generally follows overland swales which discharge to the east into the wetland, due to the low permeability shallow silty subgrade soils at the site.

Under existing conditions, stormwater which accumulates at the site generally follows overland swales which discharge to the east into the wetland. A series of auger probes which were advanced along the drainage swales contacted very little topsoil at surface. It is anticipated that over the years, the surficial topsoil has been conveyed towards the wetland with overland flows.

An aerial photograph (2018) is provided on Drawing 1 in Appendix A, shows the nearby site features and current surface drainage patterns.

A review of historical aerial photographs has been carried out - refer to select photographs provided on Drawings 2A and 2B, in Appendix A. Drawing 2A shows the development of the overland drains at the site, with the southerly of the two drains appearing in the aerial photograph from the mid 1950's, and the northerly swale appearing in the late 1960's. It is interesting to note that the Buttonbush Wetland in these photos appears to have maintained a linear westerly edge, and appears to be wooded in the earlier photos, and becomes more of a pronounced wetland feature with upland drainage paths which develop through the 1960s.

In more recent years (since 2000), urbanization of the lands to the northeast and east of the wetland, west of Colonel Talbot Road and south of Southdale Road West are shown at 5 year intervals on Drawing 2B. A wetland pocket (immediately south of Cranbrook Road) was converted into a SWM facility for the lands immediately east of the wetland feature. This pond was part of the broader linear wetland feature shown in the earlier aerial photographs. Urbanization of the upgradient area next to the wetland has resulted in some localized modifications to the physical limits of the wetland, where the development encroaches into the natural feature in sections which appear to have been straightened to accommodate residential lots and road alignments.

2.1.4 Systematic Drainage

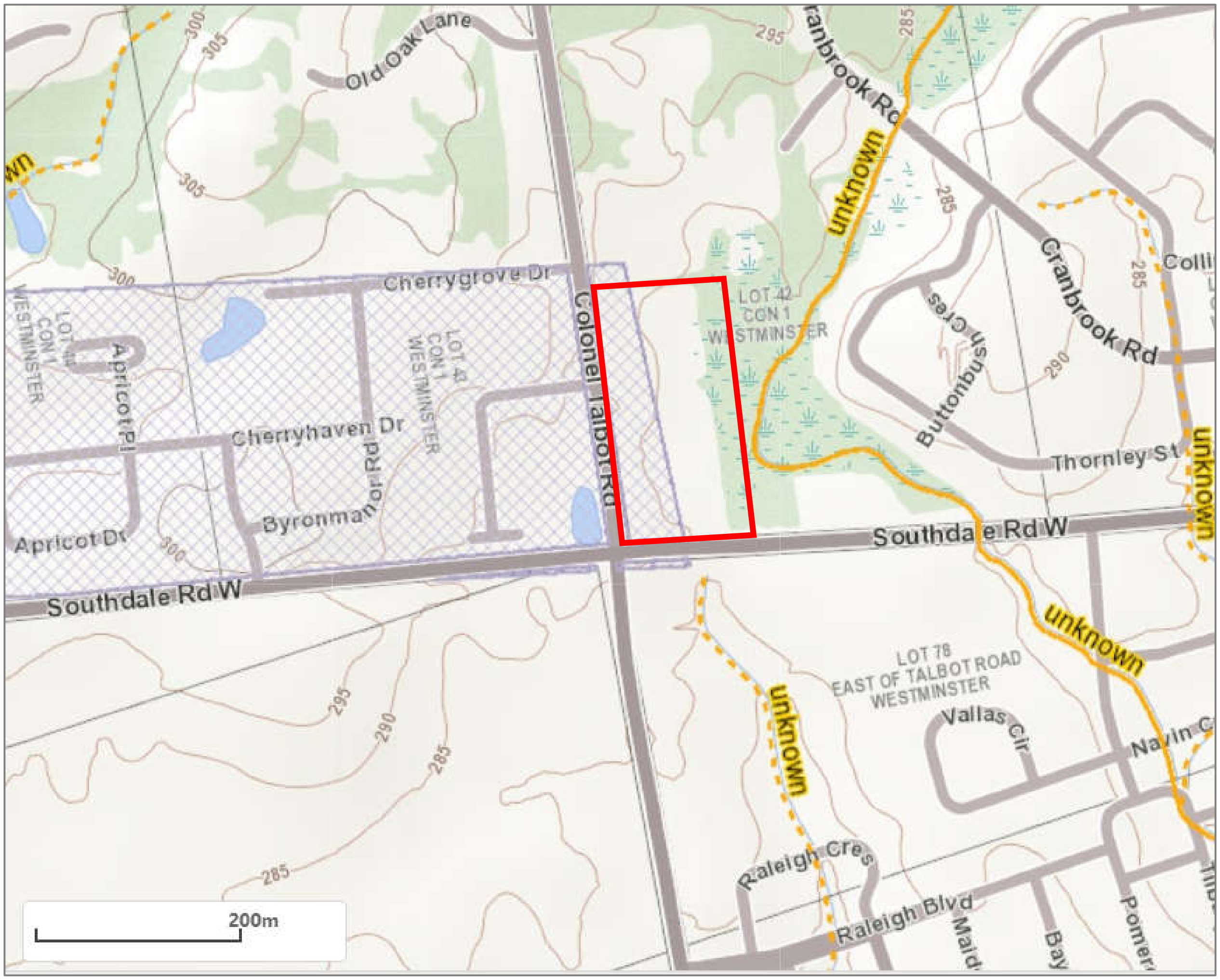
Systematic subsurface tile drainage was present on the western side of the subject property. Tile drains were not encountered in the boreholes drilled at the site, and outlets for a tile drainage system has not been identified during LDS' visits to the site. Drainage mapping (available online from the Ontario Ministry of Agriculture, GIS mapping) identifies that

A closed pipe/tiled drain is identified on the south side of the Southdale Road, immediately south of the site which appears to convey flows in a south and westerly direction, as a tributary to the Dingman Creek. The alignment of this drain can be seen on the aerial photos (pre-

2010) on Drawings 2A and 2B. Since 2010, much of the land on the south side of Southdale Road has been developed, and the ultimate routing of the closed pipe/tile drain south of the site has been altered with the extent of commercial and residential development which has occurred along its former alignment.

The drainage mapping also identifies a drain alignment through the Buttonbush Wetland on the east side of the subject property, as shown on Figure 2, below. The alignment of the easterly drain follows the length of the Buttonbush wetland, and the alignment of the upgradient stormwater management ponds at Cranbrook Road. Similarly to the closed pipe/tile drain noted above, the portion of this drain alignment which extends south of Southdale Road West has been diverted or re-routed as a result of developments which have occurred since 2010. This can be seen on the aerial photographs, as noted above.

Figure 2 – Drainage Mapping Excerpt

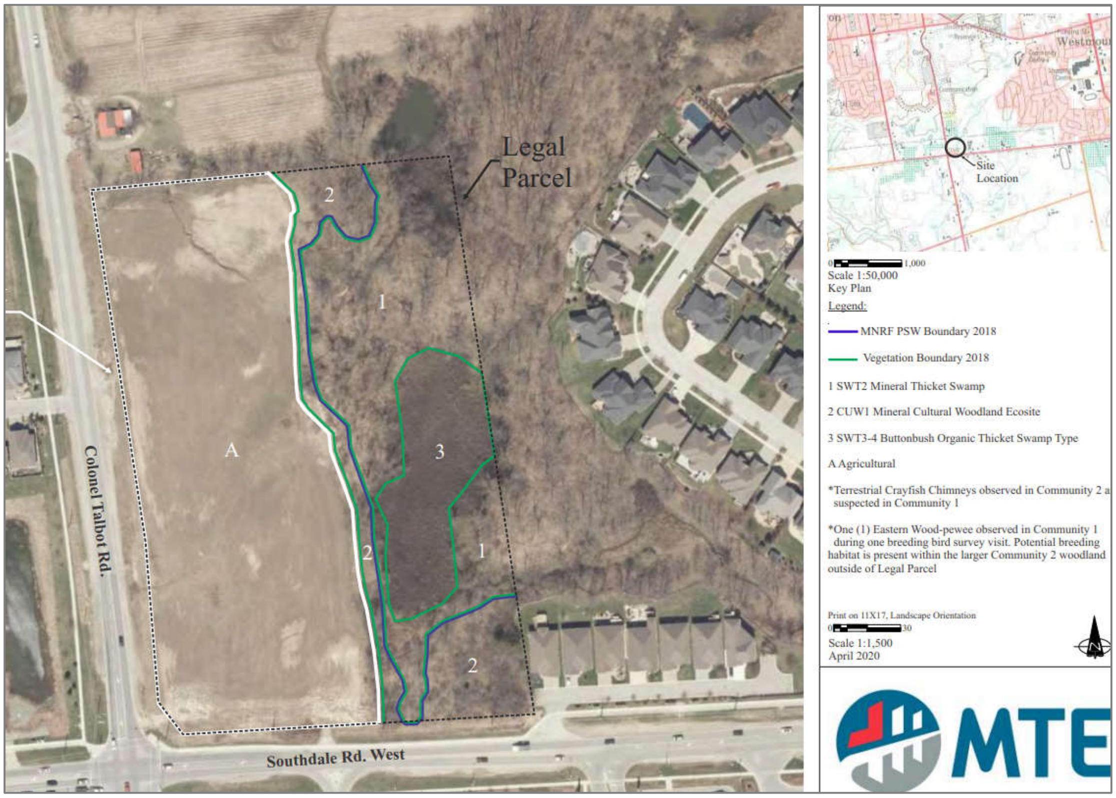


2.2 Natural Heritage Features

As noted previously, under Schedule B1 of the City of London Official Plan, the site does not contain a natural heritage feature overlay over the property. However, Schedule B1 does identify the Buttonbush Wetland (to the east) as a Provincially Significant Wetland, along with unevaluated wetland patches north and northeast of the site. An excerpt of Schedule B1 is provided on Drawing 3, in Appendix A.

The Buttonbush Wetland (South) is located east and north-east of the site, with a drain connection which flows in a southerly direction, crossing Southdale Road. Much of the vegetated area within the Buttonbush Swamp (aka North Talbot Wetland) is also classified as a significant Natural Heritage Feature on the 2014 Middlesex County Natural Heritage study mapping. It is understood that the Buttonbush Wetland has been designated as a Provincially Significant Wetland since July 2006. This wetland area borders the eastern edge of the property, and plant species observed during various LDS visits to the site in the autumn of 2017 and throughout 2018, 2019, 2020 and 2021 have included buttonbush, cat-tails, phragmites, and red maple trees. During various periods, much of the wetland had surface water throughout. The ecological characteristics of the wetland are being further assessed by MTE (formerly Biologic); however, it is understood that the central part of the feature is identified as a Buttonbush mineral thicket swamp, with cultural thickets and woodlands around the perimeter of the swamp area. Figure 3 (refer to the following page) provides an excerpt of the Vegetation Communities mapping which has been prepared by MTE. Within the wetland feature, visual observations of the wetland since 2017 indicate that the wetland swamp has a long hydroperiod, with water being present at least 10 months of the year under typical conditions.

Figure 3: Vegetation Communities Mapping (Excerpt)



The head of the wetland feature is immediately downstream of two stormwater management ponds, accessed from Longworth Road and Gabor Street. The Buttonbush Wetland falls within the Upper Thames River Conservation Authority (UTRCA) Regulated Lands. The UTRCA has Regulated Lands along the eastern boundary and to the north-east of the site. The requirements for development within UTRCA Regulated Lands are discussed further in Section 2.3

The wetland has undergone extensive pressures from urbanization of the area which has occurred in the immediate area over the past 20 years. Development pressures have included residential subdivision developments bordering the wetland feature, as well as road and servicing crossings along the linear stream corridor to the northeast of the site, including the introduction of a culvert at Cranbrook Road which has altered the water levels in the wetland feature from upgradient sources. Various development applications for the general area around the wetland have been submitted in the past 20 years. In various documents available through the City of London published Planning Applications and Reports, it is noted on various occasions that development upgradient of the site has resulted in stormwater management ponds being breached and sending sediment and turbid discharge into the wetland feature.

As such, the development pressures in the area have not just impacted the boundary of the wetland feature, but also the quality of the surface water which provides base flows into the wetland.

Within the tableland of the site, there are two shallow swales which drain towards the wetland feature, the central swale drains flows from Colonel Talbot Road, and historical ecological studies conducted at the site have identified portions of this drainage feature as a meadow marsh feature. However, under the current ecological assessment work completed by MTE, the entirety of the tableland area is identified as agricultural, since it has been actively farmed in recent years.

2.3 UTRCA Considerations

In accordance with the Conservation Authorities Act, the UTRCA regulates development within its Regulation Limit as defined in its Development, Interference with Wetlands and Alteration to Shoreline Regulation. This regulation is intended to ensure public safety, prevent property damage and social disruption due to natural hazards such as flooding and erosion. Ontario Regulation 157/06 is implemented by the local Conservation Authority, by means of permit issuance for works in or near watercourses, valleys, and wetlands.

The Adjacent Lands identified in the UTRCA Environmental Planning Policy Manual (2006) is 120 m for Provincially Significant Wetlands. Since the site is located adjacent to the Buttonbush Wetland, which has been identified as a Provincially Significant Wetland development at the site must have regard for the UTRCA Wetland Policies, which require an Environmental Impact Study (EIS) or an Environmental Assessment to be completed to the satisfaction of the UTRCA to demonstrate no negative impact on the feature or its ecological function. Similarly, studies are required to confirm that proposed development has no impact on the hydrological function of the wetland. An EIS (prepared by others) is also being conducted for the site.

The limits of the UTRCA Regulated lands are shown on Drawing 3, in Appendix A. The Regulation Limit encompasses the site, and extends beyond the site to the north and east. Proposed development within the study area will be subject to the above referenced Regulation. Property owners must obtain permission from UTRCA before beginning any development, site alteration, construction, or placement of fill within the regulated area. Consultation with the local Conservation Authority for review of site-specific development plans is required in this regard.

2.4 Source Water Protection Mapping

LDS has reviewed the MECP Source Water Protection Information Atlas and Thames-Sydenham and Region mapping to determine whether the site is located in any identified areas of source water concern, as they relate to local groundwater quality (current to March 2018).

The following observations were recorded by LDS:

- The Property is located within the Upper Thames River Source Protection Area.
- The Property is not located in any of the following designated areas listed in the MECP Source Protection mapping:
    - Wellhead Protection Area, Wellhead Protection Area E (GUDI), Wellhead Protection Area Q1 or Wellhead Protection Area Q2;
    - Intake Protection Zone or Intake Protection Zone Q;
    - Highly Vulnerable Aquifer;
    - Issue Contributing Area;
    - Event Based Area.
- The southeast corner of the site which is occupied in part by the Buttonbush Wetland is located within an area denoted as a Significant Groundwater Recharge Area, with the scoring of 2 (considered low).

Additional discussion is provided in Section 6 of this report.

2.5 Proposed Development Plans

The site is currently occupied by cultivated land, and is bordered by a mix of commercial and residential lands, with the Buttonbush Wetland to the east. The proposed development at the site is expected to include a mix of commercial and residential land.

The west end of the site is expected to have a series of 3-storey townhouse blocks, with surface parking. The central part of the site is expected to have a large grocery store (approximately 3095 m2), oriented towards Southdale Road West, with a central parking lot area. At the east end of the site, two smaller buildings are planned, potentially housing restaurants, coffee shops, and office space.

A concept plan is provided on Drawing 4, in Appendix A.

3.0 GEOLOGIC SETTING

3.1 Regional Physiography and Geology

Select geological mapping and publications were reviewed for the purposes of reviewing regional characteristics for soil conditions in the area. Findings are summarized below, for reference.

Physiography

Physiographic mapping for Southwestern Ontario (Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228), indicates that the site is located in the northwest part of the physiographic region known as the Mount Elgin Ridges. The Mount Elgin Ridges consist of the Ingersoll Moraine to the north and the Westminster, St. Thomas, Sparta and Tillsonburg Moraines to the south. The moraines are separated by till plains, and the rolling topography resulting from this configuration controls surface water drainage patterns. The ridges are typically well drained, while the hollows are poorly drained. As a result, the areas between the ridges act as a source of groundwater recharged, where surface water infiltrations into the surficial soils as shallow groundwater.

The site location is near the confluence of a Till Plain, Till Moraine and glacial spillway (to the north). Soils in this area is typically characterised by clayey silt, clay, and occasional silty sand and gravel deposits, with low to moderate relief.

Quaternary Geology

The Quaternary Geology was created by glacial movement approximately 10,000 to 23,000 years ago. The overburden material deposited by the movement and eroding action of the glaciers contributed to the creation of moraines, eskers, drumlins and other topographic features in the Southern Ontario area.

Based on the Quaternary Geology mapping (Ontario Geological Survey 2000. Quaternary geology, seamless coverage of the Province of Ontario; Ontario Geological Survey, Data Set 14---Revised (Google© Earth)), the site is located in an area which transitions from moraine to till plain; which is consistent with the silty soils and occasional sandy layers encountered in the drilling onsite.

The predominant soil in the area is Port Stanley Till, which is described as silty clay till and clayey silt till, with some areas having thin patches of lacustrine silt. The Port Stanley Till includes the Ingersoll and Westminster Moraines. The Port Stanley Till is underlain by Catfish Creek Till, which directly overlies the bedrock surface. The Catfish Creek till contains layers of lacustrine sediments which were deposited between ice sheet advances. These depositional processes result in a mixture of fine-grained layers within the tills that are characterized by low permeability (aquitards) and sandy layers containing aquifers.

Pleistocene Geology Mapping for the area identifies a 'stream trench' which crosses the area, roughly in the same alignment of the Buttonbush Wetland - North and Buttonbush Wetland – South feature which is north-east and east of the site. This stream feature is shown to extend south of Southdale Road, and continuing in a southerly direction. Soils within this feature are described as alluvial soils, comprised of silt, sand and gravel, with organics. An excerpt from the Pleistocene Geology mapping showing the trench alignment is provided on Drawing 5, in Appendix A.

Bedrock Geology

Bedrock geology mapping for Southwestern Ontario (Ontario Geological Survey. 1:250 000 scale, Bedrock Geology of Ontario. Ontario Geological Survey, Miscellaneous Release Data 126, Revised 2006) indicates that the bedrock in the general area consists of limestone of the Dundee Formation. The limestone bedrock is part of the Algonquin Arch, which forms a ridge along the southwestern Ontario peninsula between the Michigan Basin (to the northwest) and the Appalachian Basin (to the southwest). The limestone is generally light brown, medium-grained with some minor chert. Based on the Ontario Department of Mines Preliminary Map No. P.482 titled "Bedrock Topography Series, St. Thomas Sheet, Southern Ontario", the bedrock surface in the vicinity of the site is generally at approximate Elevation 182 to 200 m asl. The typical depth to bedrock within proximity to the study area was confirmed through a review of MECP well records.

3.2 Borehole Findings

A series of boreholes and piezometers have been advanced at the site to assess the soil and groundwater conditions onsite.

Borehole locations were determined by LDS to characterize soil and groundwater conditions across the site, and monitoring well locations were determined as being in proximity to existing surface water features (swales and overland flow paths) and with regard to existing agricultural activities, to help limit disturbance and damage from farm equipment.

Information regarding the borehole, monitoring well and piezometer installations by LDS Consulting Inc. are described in the following sections.

3.2.1 Borehole Field Program

Ten (10) boreholes, and six (6) shallow auger hole were advanced throughout the site by LDS on September 25, 2017, with four (4) of the boreholes being equipped with monitoring wells including a second well at MW5 (one shallow and one deep). On February 10 and 11, 2021, an additional set of boreholes (denoted with 300-series borehole numbering) were advanced at the site. In addition, damaged well casings at BH5 (deep) and BH6 were decommissioned, and the wells were replaced with new well installations within 1 m of the original well installations.

Borehole locations are shown on Drawing 6 in Appendix A, and borehole logs are provided in Appendix B, for reference.

Ground surface elevations at the borehole and auger probe locations were surveyed by LDS using a Trimble© R10 GPS rover and are summarised in the following table.

Table 1: Borehole Locations

ID	Northing	Easting	Ground Surface Elevation, m asl
BH1	4754025.17	474118.77	286.60
BH2	4753908.06	474136.32	284.01
BH3	4753858.53	474135.84	285.99
BH4	4754080.31	474167.12	286.62
BH5 (MW)	4754035.25	474175.45	282.06
BH5 (MW) - Deep	4754034.96	474173.98	282.35
BH6 (MW)	4753959.92	474168.88	282.67
BH7	4753887.32	474209.93	282.56
BH8	4753956.21	474214.69	281.65
BH9 (MW)	4753920.31	474142.64	283.93
BH10 (MW)	4754065.93	474105.43	285.98
AP101	4754056.11	474147.08	283.44
AP102	4754069.47	474134.27	284.60
AP103	4754041.91	474167.78	282.10
AP104	4753924.23	474151.42	283.62
AP105	4753939.80	474158.54	283.36
AP106	4753947.62	474163.13	282.96
BH301 (MW)	4754084.90	474154.91	287.09
BH302 (MW)	4754011.40	474149.52	284.54
BH303 (MW) - Shallow	4753981.82	474118.80	288.70
BH303 (MW) - Deep	4753981.82	474118.80	288.70
BH304 (MW) - Shallow	4753919.66	474211.91	282.26
BH304 (MW) - Deep	4753919.66	474211.91	282.26
BH305 (MW)	4753845.98	474176.36	284.77

Monitoring wells were installed in the boreholes noted above with the ‘MW’ notation. The wells were installed to allow for monitoring the stabilized groundwater level at the site. The Monitoring Wells were constructed of 2-inch (50.8 mm) diameter CPVC screens and riser pipes fitted with an end cap at bottom. The screens on each well are mill-slotted, with a slot spacing of 0.5 mm, and were backfilled with Type 2 Silica Sand. Above the screened depth, the annular space was backfilled with a bentonite slurry, up to ground surface to prevent a hydraulic connection from occurring with the ground surface. The wells and have been equipped with lockable caps. Details of the monitoring well construction are summarized in Table 2, below.

Table 2: Monitoring Well Construction

Borehole	Ground Surface Elevation, m asl	Top of Screened Interval, m asl	Bottom of Screened Interval, m asl	Screened Length, m	Screened Strata
Shallow Wells					
BH5 (MW) - Shallow	282.06	281.14	279.62	1.52	Sandy Silt
BH6 (MW)	282.67	281.75	279.89	1.52	Sandy Silt
BH9 (MW)	283.93	283.02	279.97	3.05	Silt Till, wet sand seams
BH10 (MW)	285.98	284.46	281.41	3.05	Silty Sand, silt inclusions
BH302 (MW)	284.54	281.49	279.97	1.52	Silt Till, wet sand seams
BH303 (MW) - Shallow	288.70	286.41	284.89	1.52	Silt Till, wet sand seams
BH304 (MW) - Shallow	282.26	279.97	278.45	1.52	Silt, wet sandy silt seams
BH305 (MW)	284.77	282.48	280.96	1.52	Silt Till, wet sand seams
Deep Wells					
BH5 (MW) - Deep	282.35	277.78	279.89	3.05	Fine Sand
BH301 (MW)	287.09	280.99	279.47	1.52	Fine Sand
BH303 (MW) – Deep	288.70	281.08	279.56	1.52	Fine Sand
BH304 (MW) – Deep	282.26	273.11	271.59	1.52	Fine Sand

The monitoring wells have been registered with MECP, in accordance with Ontario Regulation (O.Reg.) 903.

The depth to groundwater seepage and short-term water level measurements were obtained prior to backfilling the remaining boreholes. Boreholes were backfilled with a mixture of bentonite chips and cuttings, to restore holes back to level conditions with the ground surface.

A series of shallow piezometers (PZ 201 and PZ 202)were also installed on the site by LDS on October 20, 2017 in the wetland area. An additional piezometer (PZ 203) was installed at the site on February 10, 2021. Surface water was present in the wetland at the time of piezometer installation. The piezometers were installed to depths between 0.55 to 1.2 m bgs. The piezometer installations are comprised of 50 mm (2-inch) inner diameter (ID) schedule

40 polyvinyl chloride (PVC) risers coupled with No. 10 slot PVC screens. Each well screen was sealed at the bottom using a PVC friction fit cap and each riser was sealed at the top with a lockable J-plug cap. Bentonite was placed in the bottom of the auger hole, to ensure that the screen was set within the water-bearing sand layer.

Ground surface elevations at the LDS monitoring well and piezometer locations were surveyed by LDS using a Trimble R10 GPS rover, and are summarised below.

Table 3: Piezometer Coordinates

ID	Northing	Easting	Ground Surface Elevation, m asl
PZ201 (shallow)	4753940.88	474223.22	281.01
PZ201 (deep)	4753939.81	474220.10	281.09
PZ202A	4754008.53	474252.62	280.96
PZ202B	4754009.85	474254.31	281.19
PZ203 (shallow)	4754047.30	474203.69	281.69
PZ203 (deep)	4754047.22	474203.59	281.66

3.2.2 Observed Soil Conditions

Tableland

As shown on the borehole logs provided in Appendix B, the predominant soil conditions encountered in the boreholes which were drilled through the site comprise of natural sandy silt/silty sand and silt till. The soils encountered near ground surface are described as being mottled in colour, and in a weathered condition in the upper 1.2 to 1.5 m. The silt and silt till soils are described as containing discontinuous sand layers, and/or intermittent fine sand layering. Below the weathered zone, the soils are predominantly brown in colour, becoming grey at variable depths below 3.0 m.

The soil boundaries identified on the borehole logs have been inferred from non-continuous samples and observations of drilling resistance. They may represent a transition from one soil type to another and should not be interpreted to represent exact planes of geological change. Further, the subsurface conditions may vary between and beyond the borehole locations.

Groundwater observations in the open boreholes and a review of soil moisture contents are indicative of the shallow groundwater generally being contained within the sandy soils or weathered silt soils near surface, perched above the less permeable silt and silt till soils. As such, the assessment includes an analysis to estimate the hydraulic conductivity of these water-bearing soils, as presented in the following section.

Wetland

In the wetland area along the east side of the site, the surficial deposits encountered within the wetland piezometers are comprised of topsoil and organics (typically in the range of 0.3 to 1.0 m thick), overlying alluvial (unconsolidated) deposits of sandy silt which contain organic inclusions. The deep piezometers were terminated in compact silt till soils, similar to that observed within the tableland areas of the site.

3.2.3 Estimate of Hydraulic Conductivity / Permeability

The hydraulic conductivity of a soil depends on a number of factors, including particle size distribution, degree of saturation, compactness, adsorbed water (which depends on clay content). The heterogeneous nature of glacial deposits can also contribute to variations in soil permeability where the soil composition may include localised areas with increased fine material or sandy material which can influence soil permeability at different points within the soil strata. Determining soil permeability for subgrade soils at the site has included a review of published data, correlation with laboratory testing, and single well response tests, as outlined below.

Published Data Review

The Groundwater Information Network (online at www.gin.gw-info.net) provides the following table which summarises the porosity and hydraulic conductivities for the soil strata encountered within its well record database for Southwestern Ontario. It is understood that these values are based on published literature.

Table 4: Hydraulic Conductivity based on soil types

Lithology	Porosity (%)	Hydraulic Conductivity (m/s)
Clay	34 to 57	1×10^{-11} to 4×10^{-9}
Silt	34 to 61	1×10^{-9} to 2×10^{-5}
Sand	26 to 53	2×10^{-7} to 6×10^{-3}
Gravel (containing > 30% gravel)	24 to 44	3×10^{-4} to 3×10^{-2}

Correlation with Gradation Analyses

Grain Size analysis was carried out on a sample of silty sand collected from Borehole BH10. The results of the testing are provided below for reference, and shown graphically in Appendix B. To further refine the hydraulic conductivity specifically encountered at the site, the results of the grain size analyses were used to correlate the gradation results to the hydraulic conductivity, using Hazen's method. This correlation is based on the following relationship:

$$k\ (cm/s) = C(d_{10})^2$$

where, d_{10} is the diameter (size measured in mm) at which 10% of the sample passes; and,

C is an empirical coefficient (average value of 1.0).

Table 5: Gradation Results – Silty Sand

Sample ID	% Clay	% Silt	% Sand	% Gravel	k (m/s)
Silty Sand, BH10, Sample 3	0.0	39.9	57.9	2.2	3.24×10^{-6}
Silty Sand, BH5, Sample 7	0.0	20.4	79.6	0.0	2.92×10^{-5}
Silty Sand, BH301, Sample 6	0.0	10.8	65.3	23.9	4.62×10^{-5}
Silty Sand, BH303, Sample 9	0.0	36.2	63.08	0.0	2.21×10^{-5}

Grain Size analysis was also carried out on a sample of silt collected from Borehole BH4. The results of the testing are provided below for reference, and shown graphically in Appendix B. Based on the gradation results, a value for saturated hydraulic conductivity and infiltration rate has been calculated for the collected sample of silt till, using the Puckett Method and the following expression:

$$k = 4.36 \times 10^{-5} \times e^{-0.1975 \times C}$$

where: k = hydraulic conductivity (m/s)
C = clay content (%)

Table 6: Gradation Results – Sandy Silt

Sample ID	% Clay	% Silt	% Sand	% Gravel	k (m/s)
Sandy Silt, BH4, Sample 1	13.0	52.4	31.6	5.9	3.35×10^{-6}

Both approaches which are presented above yield results which are within a similar range.

Table 7: Saturated Hydraulic Conductivity & Factored Infiltration Rates

Test Method	Sample ID	Saturated Hydraulic Conductivity	Factored Infiltration Rate
Gradation Analysis	Silty Sand, BH10, Sample 3	3.24×10^{-6} m/s	25 mm/hr
Gradation Analysis	Sandy Silt, BH4, Sample 1	3.35×10^{-6} m/s	25 mm/hr

The above factored infiltration rates were calculated using correlation from TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide protocol which references Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario. A Factor of Safety of 2.5 has been applied, in accordance with TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide protocol.

Single Well Response Test

A Single Well Response Test (rising head test) was conducted in the deep monitoring well installed at Borehole BH5 on January 25, 2019 to estimate the hydraulic conductivity of the lower water-bearing fine sand layer encountered below 5.8 m depth.

Groundwater level measurements were taken prior to the start of the test. A submersible pressure transducer with a water level logger was inserted into the monitoring well to measure the change in water level for the duration of the test. Use of the data logger allows for high frequency data collection and increased accuracy, compared to manual measurements during the testing.

The Hydraulic conductivity values were estimated from field SWRT data as per the Hvorslev's method (refer to worksheets provided in Appendix C). A summary of the hydraulic conductivity values estimated from the field SWRT is provided in the table below.

Table 8: Saturated Hydraulic Conductivity & Factored Infiltration Rates

Well ID	Well Depth, m bgs	Screen Length, m	Formation Screened	Estimated Hydraulic Conductivity, m/s	Factored Infiltration Rate mm/hr
BH5	7.65	3.05	Fine Sand	1.48×10^{-8}	6

Similar to the approach noted above, the above factored infiltration rate was calculated using correlation from TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide protocol, utilizing a Factor of Safety of 2.5.

Onsite Verification During Construction

A number of factors can influence the actual soil permeability and infiltration rate onsite during the site grading activities, including cut-fill activities, and the use of onsite or imported materials to achieve design grades. It is recommended that geotechnical inspection of materials which are used onsite and field testing during the construction phase of the project be carried out to confirm that infiltration rates which have been used for design purposes are appropriate to the actual site conditions.

3.3 Shallow Groundwater Observations

The wells installed into the LDS boreholes were advanced using 6-inch (152.4 mm) outer diameter hollow stem augers. The monitoring wells were constructed with 2-inch (50.8 mm) diameter CPVC pipe. The screens on each well are mill-slotted, with a slot spacing of 0.5 mm, and were backfilled with Type 2 Silica Sand. Above the screened depth, the annular space was backfilled with a Bentonite slurry, up to ground surface.

The Piezometers which were installed at the site are also constructed of 2-inch (50.8 mm) diameter CPVC screens and riser pipes (similar to those used for the monitoring wells) fitted with a drive-point end cap at bottom. Water was present in both wetland piezometers upon completion of installation. The wells and piezometers are equipped with lockable caps.

3.3.1 Manual Groundwater Measurements

Manual water level measurements using a Heron© Level Logger (calibration dates February 10, 2017, February 15, 2018, February 4, 2019, and January 12, 2021), were taken to establish a record of stabilised groundwater levels. The meters are equipped with an electrode connected to a graduated polyethylene tape, where the depth to water can be obtained by slowly lowering the electrode into the well until the buzzer sounds. Water level measurements were recorded in metres to the nearest 0.01 m and converted to elevations above mean sea level (m, asl) using surveyed elevation data. The manual water level data was also used to calibrate and check the accuracy of the data recorded by the dataloggers. A summary of the manual readings taken at the site from 2017 to 2019 are summarized in Table 9 (refer to page 25).

In February 2021, a series of additional monitoring wells and piezometers were installed at the site, and the wells installed at Boreholes BH5 (deep) and BH6 were replaced with new installations. Table 10 (refer to page 26) outlines the water level measurements which have been taken at the site in 2021.

From the initial set of water level measurements collected at the site from 2017 through to 2019, general trends in the water levels generally indicate that the groundwater flow direction generally follows existing topography towards the east, with flows being in the direction of the Buttonbush Swamp/North Talbot Wetland to the east of the site. This was further validated through the water level measurements which have been collected at the site from the existing and newly installed wells in 2021, for both the shallow wells and deep wells at the site.

With the addition of multi-level piezometers at the site, it has been observed that water levels within the wetland area fluctuate seasonally (for longer duration at higher magnitudes) and following significant rain events (for shorter duration at lower magnitudes). The piezometers are located along the perimeter of the wetland, and in that position they document periods of flooding when the water level is at or above the ground surface, and periods when water levels fall approximately 0.3 m below the ground surface. Within the 2021 monitoring period, that fluctuation in the water level has ranged upwards of 0.5 m.

Within the tableland area, which makes up much of the site, the perched groundwater within the near surface sandy soils and weathered silt till soils has similarly varied up to about 0.5 m with the 2021 readings measured to date. This shallow groundwater condition closely corresponds to that observed in the wetland area, regardless of the wells being located within the existing swales which conduct overland flows towards the wetland, or other parts of the site which are set further away from the swales and wetland area. The horizontal groundwater gradient indicated from the water levels recorded within the shallow wells indicate groundwater flow towards the wetland.

The deeper wells are generally set into wet sandy layers within the silt till. The horizontal groundwater gradient indicated from the water levels recorded within the deeper wells similarly indicate groundwater flow towards the wetland. The groundwater levels within the deep wells have been recorded within the screened interval within the water-bearing soils at each of the respective wells, and no significant vertical upward gradient has been noted.

As additional groundwater measurements are collected at the site, this will continue to be monitored to identify if under seasonal conditions, an upward gradient occurs from this water table.

A Shallow Groundwater Contour Plan during Spring 2018 conditions is provided on Drawing 7; a Shallow Groundwater Contour Plan during Spring 2019 conditions) is provided on Drawing 8, and a Shallow Groundwater Contour Plan during Spring 2021 is provided on Drawings 9A and 9B, differentiating the flows in the shallow and deep wells respectively.

Table 9: 2017-2019 Manual Water Level Measurements

Well Location	**Ground Surface Elev. (m)**	**Depth to Groundwater (m, bgs)** ***Groundwater Elevation (m, asl)***																
		13-Oct-2017	**20-Oct-2017**	**23-Oct-2017**	**08-Nov-2017**	**01-Dec-2017**	**10-Jan-2018**	**06-Feb-2018**	**27-Feb-2018**	**21-Mar-2018**	**23-Apr-2018**	**16-May-2018**	**06-Jun-2018**	**06-Jul-2018**	**08-Aug-2018**	**09-Sep-2018**	**20-Nov-2018**	**10-Dec-2018**
BH5 - shallow	282.06	2.15 *279.91*		0.30 *281.76*	0.55 *281.51*	0.30 *281.76*	0.22 *281.84*	0.05 *282.01*	0.00 *282.06*	0.05 *282.01*	0.20 *281.86*	0.30 *281.76*	0.48 *281.58*	1.03 *281.03*	0.84 *281.22*	0.86 *281.20*	0.00 *282.06*	0.05 *282.01*
BH5 - deep	282.06	7.50 *274.56*		7.50 *274.56*	7.22 *274.84*	7.32 *274.74*	7.44 *274.62*	7.16 *274.90*	6.67 *275.39*	6.74 *275.32*	6.17 *275.89*	6.30 *275.76*	6.46 *275.60*	6.65 *275.41*	7.09 *274.97*	6.97 *275.09*	7.21 *274.85*	7.33 *274.73*
BH6	282.67	1.11 *281.56*		1.01 *281.66*	0.15 *282.52*	0.20 *282.47*	0.22 *282.45*	0.23 *282.44*	0.16 *282.51*	0.22 *282.45*	0.28 *282.39*	0.26 *282.41*	0.25 *282.42*	0.42 *282.25*	0.84 *281.83*	0.84 *281.83*	0.17 *282.50*	0.18 *282.49*
BH9	283.93	0.92 *283.01*		0.69 *283.24*	0.28 *283.65*	0.22 *283.71*	0.26 *283.67*	0.38 *283.55*	0.22 *283.71*	0.28 *283.65*	0.34 *283.59*	0.20 *283.73*	0.50 *283.43*	0.80 *283.13*	0.68 *283.25*	0.71 *283.22*	0.28 *283.65*	0.27 *283.66*
BH10	285.98	1.21 *284.77*		1.20 *284.78*	0.58 *285.40*	0.70 *285.28*	0.74 *285.24*	0.71 *285.27*	0.52 *285.46*	0.56 *285.42*	0.60 *285.38*	0.66 *285.32*	0.85 *285.13*	1.18 *284.80*	0.90 *285.08*	0.96 *285.02*	0.58 *285.40*	0.57 *285.41*
PZ201	281.01		0.05 *280.96*	0.17 *280.84*	-0.10 *281.11*	0.00 *281.01*	*frozen*	0.24 *280.77*	0.00 *281.01*	-0.15 *281.16*	-0.23 *281.24*	-0.15 *281.16*	0.07 *280.94*	0.06 *280.95*	-0.18 *281.19*	-0.16 *281.17*	-0.01 *281.02*	0.00 *281.01*
PZ202	280.96		0.04 *280.92*	0.18 *280.78*	-0.03 *280.99*	0.01 *280.95*	*frozen*	0.31 *280.65*	-0.05 *281.01*	0.00 *280.96*	-0.04 *281.00*	-0.17 *281.13*	0.04 *280.92*	0.05 *280.91*	-0.05 *281.01*	-0.06 *281.02*	-0.05 *281.01*	-0.02 *280.98*

Well Location	**Ground Surface Elev. (m)**	**Depth to Groundwater (m, bgs)** ***Groundwater Elevation (m, asl)***					
		16-Jan-2019	**14-Mar-2019**	**10-Apr-2019**	**28-May-2019**	**25-Jun-2019**	**08-Nov-2019**
BH5 - shallow	282.06	0.00 *282.06*	0.00 *282.06*	0.04 *282.02*	0.00 *282.06*	0.54 *281.52*	0.00 *282.06*
BH5 - deep	282.06	7.61 *274.45*	6.33 *275.73*	6.00 *276.06*	5.63 *276.43*	6.30 *275.76*	3.05 *279.01*
BH6	282.67	0.21 *282.46*	0.26 *282.41*	0.19 *282.48*	0.22 *282.45*	0.63 *282.04*	0.19 *282.48*
BH9	283.93	0.13 *283.80*	0.23 *283.70*	0.49 *283.44*	0.30 *283.63*	0.50 *283.43*	0.32 *283.63*
BH10	285.98	0.61 *285.37*	0.45 *285.53*	0.65 *285.33*	0.54 *285.44*	0.72 *285.26*	0.50 *285.48*
PZ201 (Shallow)	281.01	*frozen*	0.00 *281.01*	0.00 *281.01*	-0.30 *281.31*	-0.02 *281.03*	-0.04 *281.05*
PZ202 (Shallow)	280.96	*frozen*	-0.05 *281.01*	0.00 *280.96*	-0.30 *281.26*	-0.20 *281.16*	-0.10 *281.06*

Summary of Water Level Measurements

Location	*Minimum Water Level*	*Maximum Water Level*	*Net Change*
BH5 shallow	*279.91 m*	*282.06 m*	*2.15 m*
BH5 deep	*274.45 m*	*275.89 m*	*1.44 m*
BH6	*281.56 m*	*282.52 m*	*0.96 m*
BH9	*283.01 m*	*283.80 m*	*0.79 m*
BH10	*284.77 m*	*285.53 m*	*0.76 m*
PZ201	*280.77 m*	*281.24 m*	*0.47 m*
PZ202	*280.65 m*	*281.13 m*	*0.48 m*

Notes

1. Negative values in the wetland piezometers are water levels measured up from ground surface.
2. m, bgs denotes metres below ground surface
3. m, asl denotes metres above sea level
4. Grey shading denotes no measurements taken

Table 10: 2021 Manual Water Level Measurements

Well Location	**Ground Surface Elev. (m, asl)**	**22-Jan-2021**	**18-Feb-2021**	**01-Mar-2021**	**25-Mar-2021**	**27-Apr-2021**	**30-May-2021**	**21-Jun 2021**	**28-Jun-2021**
Shallow Wells									
BH5 – shallow	282.06	0.00 *282.06*	0.00 *282.06*	0.00 *282.06*	0.03 *282.03*	0.32 *281.74*	0.50 *281.56*	0.54 *281.52*	0.56 *281.50*
BH6	282.67	Damaged	0.34 *282.60*	0.28 *282.66*	0.33 *282.61*	0.62 *282.32*	0.72 *282.22*	0.34 *282.60*	0.43 *282.51*
BH9	283.93	0.23 *283.70*	0.25 *283.68*	0.21 *283.72*	0.25 *283.68*	0.44 *283.49*	0.80 *283.13*	0.84 *283.09*	0.66 *283.27*
BH10	285.98	0.49 *285.49*	0.51 *285.47*	0.30 *285.68*	0.48 *285.50*	0.74 *285.24*	0.83 *285.15*	0.74 *285.24*	0.53 *285.45*
MW302	284.54	- -	1.33 *283.21*	0.31 *284.23*	0.56 *283.98*	1.30 *283.24*	2.87 *281.67*	3.51 *281.03*	3.45 *281.09*
MW303 – shallow	288.70	- -	2.84 *285.86*	1.80 *286.90*	1.82 *286.88*	1.95 *286.75*	2.63 *286.07*	3.02 *285.68*	2.91 *285.79*
MW304 – shallow	282.26	- -	2.41 *279.85*	0.52 *281.74*	0.58 *281.68*	0.71 *281.55*	1.04 *281.22*	1.34 *280.92*	1.18 *281.08*
MW305	284.77	- -	1.53 *283.24*	0.31 *284.46*	0.54 *284.23*	0.70 *284.07*	1.02 *283.75*	1.28 *283.49*	1.00 *283.77*
Deep Wells									
BH5 – deep	282.06	Damaged	7.05 *275.30*	7.06 *275.29*	6.43 *275.92*	5.38 *276.97*	6.68 *275.67*	6.95 *275.40*	6.79 *275.56*
MW301	287.09	- -	Dry to *279.47*	Dry to *279.47*	Dry to *279.47*	Dry to *279.47*	Dry to *279.47*	Dry to *279.47*	Dry to *279.47*
MW303 – deep	288.70	- -	Dry to *279.56*	Dry to *279.56*	9.08 *279.62*	9.03 *279.67*	9.10 *279.60*	6.03 *282.67*	Dry to *279.56*
MW304 – deep	282.26	- -	10.32 *271.94*	10.17 *272.09*	10.54 *271.72*	10.66 *271.60*	Dry to *271.59*	Dry to *271.59*	Dry to *271.59*
Piezometers									
PZ201 – shallow	281.01	-0.50 *281.51*	0.00 *281.01*	-0.06 *281.07*	-0.22 *281.23*	-0.15 *281.16*	-0.30 *281.31*	-0.15 *281.16*	-0.21 *281.22*
PZ201 – deep	281.09	- -	Installed (frozen)	N/R	-0.11 *281.20*	*0.00* *281.09*	*-0.05* *281.14*	0.11 *280.98*	0.02 *281.07*
PZ202 A	280.96	Frozen	Snow cover	Frozen	-0.03 *280.99*	-0.10 *281.06*	-0.20 *281.16*	-0.15 *281.11*	0.04 *280.92*
PZ202 B	281.19	- -	Installed (frozen)	Frozen	-0.03 *281.22*	0.00 *281.19*	*-0.10* *281.29*	-0.10 *281.29*	-0.10 *281.29*
PZ203 – shallow	281.69	- -	0.36 *281.33*	Frozen	-0.02 *281.71*	0.00 *281.69*	0.06 *281.63*	0.25 *281.44*	0.12 *281.57*
PZ203 – deep	281.66	- -	0.30 *281.36*	0.06 *281.60*	-0.05 *281.71*	-0.10 *281.76*	0.00 *281.66*	0.27 *281.39*	0.12 *281.54*

Notes:

Depth to Groundwater (m, bgs) provided for each date and location. Groundwater Elevation (m, asl) is denoted in *italics*.

Negative values indicate groundwater level above ground surface.

3.3.2 Continuous Groundwater Measurements – LDS Datalogger Installations

Dataloggers were installed in wetland piezometer PZ202, and monitoring wells MW6, and MW10 following installation, to allow for regular temperature and water level readings. After approximately three months, the data loggers were downloaded, and then on a regular basis thereafter, with manual groundwater measurements collected to confirm the accuracy of the data collected by the dataloggers. Groundwater hydrographs are provided in Appendix C, for reference.

To obtain an accurate measurement of the groundwater level at each well, the water level data obtained from the dataloggers is corrected for atmospheric pressure. Prior to February 6, 2018, this was done using published weather data from the Environment Canada Weather Station from London Airport. After February 6, 2018, an additional datalogger was installed in one of the monitoring wells onsite (suspended above the water table) for the purposes of recording atmospheric pressure for use in correlating the water levels.

Hydrographs also include water temperatures recorded in the monitoring wells with the dataloggers. The temperature range typically sits between 5 and 15 degrees Celsius, with the warmest temperatures recorded in the late summer-early fall months, and lowest temperatures in late winter-early spring months.

The direct comparison of the water levels reported between MW6, MW10, and PZ202 show a typical drop in elevation of approximately 4 m, which supports the opinion that the shallow groundwater flows towards and discharges to the wetland.

When the new monitoring wells were installed at the site in 2021, the following wells were instrumented with dataloggers: MW5 (deep), PZ201 (shallow), MW303 (deep), PZ203 (shallow), MW6, MW304 (shallow). Due to the unseasonably dry spring condition experienced in the spring of 2021, continuous groundwater data is still being collected at the site. As this additional information becomes available, LDS will review the impacts of that data on the current analysis which has been carried out for the site, and will incorporate the additional continuous groundwater monitoring data into the Hydrogeological Report which supports detailed design.

3.3.3 Water Quality - Analytical Testing

Water Samples taken 2017 & 2019

Laboratory testing was carried out on groundwater samples, collected from the monitoring well at BH6, and the piezometer PZ202 on November 13, 2017. A second set of samples were collected from the same locations on February 11, 2019.

The monitoring wells were developed 24 hours in advance of the testing, including the removal of the equivalent of three water-columns of water. Samples were collected by a technician wearing disposable nitrile gloves, and were collected using designated bailer tubes. Water samples were placed in laboratory-supplied sample bottles, labelled with a unique sample number, dated, and recorded on the laboratory chain of custody form. Groundwater samples for metals analyses were field-filtered prior to preservation using dedicated 0.45 micron in-line filters. Samples were immediately placed in a cooler with ice for delivery to an accredited laboratory (Maxxam Analytics depot in London, Ontario) under a Chain of Custody.

The water samples were submitted for testing to assess the general chemistry (RCAp analysis package) of the groundwater. The results of the analyses are provided in Appendix E, for reference and are discussed further in Section 4.3 of this report.

Water Samples taken June 2021

An additional round of groundwater and surface water sampling and testing was carried out in late June 2021. The samples were collected from the following locations: Surface water sample within wetland, PZ202A, BH301, BH302, and BH6.

The monitoring wells were developed 24 hours in advance of the testing, including the removal of the equivalent of three water-columns of water. Samples were collected by a technician wearing disposable nitrile gloves, and were collected using designated bailer tubes. Water samples were placed in laboratory-supplied sample bottles, labelled with a unique sample number, dated, and recorded on the laboratory chain of custody form. Water samples were field-filtered prior to preservation using dedicated 0.45 micron in-line filters. Samples were immediately placed in a cooler with ice for delivery to an accredited laboratory (Paracel depot in London, Ontario) under a Chain of Custody.

The water samples were submitted for testing to assess the general chemistry parameters, including the following:

- Dissolved Metals: Standard Metals Package for General Chemistry;
- Cation and Anion Parameters;
- Nutrients: Nitrate, Nitrite; and,
- General Inorganic Parameters: pH, Total Suspended Solids, Electrical Conductivity, Hardness.

The results of the analyses are provided in Appendix E, for reference and are discussed further in Section 4.3 of this report.

3.4 MECP Well Record Review

A review of MECP well records for this area was carried out to review the water levels recorded in the nearby wells. The location of the water supply wells and observation / test wells (with Well Registration No.) which are approximately 500 m from the site boundaries are shown on a Drawing 10 in Appendix B. Appendix F includes a copy of the well records, which are summarised in the following section of this report.

The following table summarises the well records for water supply wells in proximity to the site. The wells are generally 40 to 135 m deep, set into deep overburden silt till or sand and gravel layer deposits. Static water levels are reported at depths which range 48 - 60 m depth, and pump rates are in the range of 4 to 10 gpm (gallons per minute), with higher pump rates of 18 - 20 gpm for Irrigation wells.

Table 11 - MECP Water Supply Well Summary

Well ID	Type	Well Depth (m)	Date of Completion	Depth Water Found, m	Static Water Level, m	Pump Rate, gpm
4103401	Livestock	70.1	08/07/1966	57	48	4
4103403	Domestic	66.4	06/08/1959	65	60	8
4105170	Domestic	41.5	04/09/1970	39	35	10
7118093	Irrigation	68.9	09/05/2008	56	55	18
7276717	Irrigation	68.3	30/11/2016	62	55	20

Additional wells are identified in the MECP well records as monitoring / observation wells, test holes and abandoned well records. These are included in the MECP well record summary provided in Appendix F.

3.5 Wetland Hydroperiod

As noted previously, a series of piezometers installed along the perimeter of the wetland area, within the site limits. The piezometers include instrumentation to document continuous water levels, to assist in determining the wetland hydroperiod. Based on the information collected to date, the perimeter of the wetland fluctuates between flooding periods where water levels are above ground level, and when water levels fall to a level of up to about 0.3 m below ground level. Where fine sandy soils and organic soils are present near surface, capillary rise effects within these soils results in soil moisture being present near surface to help sustain vegetation within the wetland, even when water levels are below the ground surface. Within the broader wetland feature, visual observations of the wetland since 2017 indicate that the wetland feature has a long hydroperiod, with water being present at least 10 months of the year under typical conditions.

During drier periods, the duration of water being present may be reduced. Continuous data being collected through 2021 may be able to provide additional insight into this, as the spring of 2021 was a relatively dry period. As additional monitoring is being carried out at the site, additional information is expected to be available to supplement the current data when the detailed design work proceeds.

4.0 HYDROGEOLOGICAL SETTING

4.1 Regional Setting

For the purposes of this study, the Middlesex-Elgin Groundwater Study (2004), and the Dingman Creek Subwatershed Study (2005) were reviewed to provide context for the regional setting within the study area. Within the study area and surrounding lands, four aquifers have been identified:

- Shallow unconfined overburden aquifer, typically encountered within 0 to 15 m depth;
- Intermediate confined overburden aquifer, typically encountered at 15 to 30 m depth;
- Deep confined overburden aquifer, typically encountered at 30 to 60 m depth; and,
- Bedrock aquifer.

The shallow groundwater encountered in the shallow monitoring wells installed at the site contact the shallow unconfined overburden aquifer. The shallow unconfined groundwater table follows the local topography, with groundwater flow towards the existing wetland to the east of the site. Regional groundwater flow information for the shallow aquifer is indicative of water levels within the range of Elevation 230 - 260 m, with a groundwater flow direction towards the south-east.

The deeper wells which have been installed at the site, are still within the 15 m depth below ground surface noted above, and is contained within water-bearing sandy soils, which are separated from the near-surface unconfined aquifer by silt and silt till soils which are present at the site. This is consistent with the intermediate overburden aquifer described in the Groundwater Study, which is described as being comprised of silt till deposits, which are generally contained within the Moraine and till plain of the site area. A review of hydrogeological studies and groundwater assessments for the area indicate that the intermediate and deep overburden aquifer (located within the Catfish Creek Till) consists of differentiated sand and gravel layers within the till. This aquifer is generally discontinuous in nature due to the glaciated erosional and depositional conditions.

According to the Groundwater Study mapping, the site is in an area of moderate to low aquifer intrinsic susceptibility. The intermediate Aquifer is less vulnerable to impact from surface contaminants, due to the relative low permeability of clayey silt soils. However, there may be some potential for horizontal infiltration and migration of contaminants in sand and gravel layers nearer to surface in areas of higher relief.

In regional terms, wells that penetrate a few metres into the bedrock are generally interconnected to overlying sand, sand and gravel or fractured bedrock wells, and are referred to as basal aquifers. Wells that penetrate deeper into the bedrock tap into formations with cracks, where water accumulates. the bedrock surface in the vicinity of the site is generally at approximate Elevation 182 to 200 m asl. As such, the potential impact to the aquifer from proposed development at the site is not anticipated to be significant, and no further discussion is provided regarding the bedrock aquifer.

4.2 Shallow Groundwater Conditions

Short term water level observations were recorded in the open boreholes which were advanced at the site by LDS. Five monitoring wells and two piezometers are currently present onsite. The predominant soils encountered in the boreholes are comprised of clayey silt, with intermittent sandy silt or silty sand layers near surface.

Continuous groundwater level measurements and manual groundwater measurements have been collected at the site from the monitoring wells and piezometers for the period between October 2017 and June 2019, by LDS. Ongoing data collection is continuing at the site. The following table summarises the maximum and minimum water levels recorded manually using the Heron water level meter in the monitoring wells at the site.

Table 12 - Groundwater Elevation Fluctuations

Parameter recorded between October 2017 and January 2019	MW 5 shallow	MW 5 deep	MW 6	MW 9	MW10	PZ201	PZ202
Highest Elevation, m	282.06	275.89	282.52	283.80	285.53	281.24	281.13
Lowest Elevation, m	279.91	274.45	281.56	283.01	284.77	280.77	280.65
Difference, m	2.15	1.44	0.96	0.79	0.76	0.47	0.48

Notes: Groundwater Elevation is provided in m, asl.

The shallow groundwater flow direction is in an easterly direction, towards the wetland. It is anticipated that the existing drains and surface water features (swales) contribute to localised variations in the shallow groundwater levels. Groundwater Contour Plans are provided on Drawings 7, 8 and 9, in Appendix A.

Within the area of the proposed development (outside of the wetland area), the average groundwater gradient ranges from about 0.041 m/m under spring conditions, to 0.036 m/m under summer conditions. Within the wetland area, the average gradient is greatly reduced, ranging from about 0.017 m/m in spring conditions to 0.013 m/m under summer conditions.

Water levels were re-established at the site in February 2021, along with the addition of some new monitoring wells which were installed at the site. Regular water level measurements taken since February 2021 show similar ranges in the manual water level readings, with more significant fluctuations in the shallow unconfined aquifer within the site limits, compared to the water levels within the perimeter of the wetland or compared to the deeper aquifer.

4.3 Groundwater Quality

Discreet water samples were obtained on November 13, 2017 and February 11, 2019 from PZ202 and MW6. In June 2021, a set of water samples were collected from BH5 (deep), BH6, PZ202 (shallow), BH303 (shallow), and a surface water sample from the wetland, near PZ202.

Samples obtained were sent for Laboratory analysis to document the general chemistry of the groundwater encountered in the wetland surface water and groundwater samples collected from the site. The analytical testing included the following sampling parameters.

- Dissolved Metals: Standard Metals Package for General Chemistry;
- Cation and Anion Parameters;
- Nutrients: Nitrate, Nitrite
- General Inorganic Parameters: pH, Total Suspended Solids, Electrical Conductivity, Hardness.

Each well was fitted with a dedicated bailer to allow purging and sampling of the well and avoid cross-contamination. The monitoring well and piezometer were purged of at least 3 times the volume of water prior to sampling. For the samples taken in June 2021, the wells were developed 24 hours in advance of the water sampling. Water samples were collected by a technician wearing disposable Nitrile gloves, and samples were placed in laboratory-supplied sample bottles, labelled with a unique sample number, dated, and recorded on the laboratory chain of custody form. Samples were immediately placed in a cooler with ice for delivery to an accredited laboratory (2017 and 2019 samples were taken to Maxxam Analytics, and 2021 samples were taken to Paracel Laboratories) under the chain of custody.

Copies of the Certificate of Analysis for each round of testing are provided in Appendix E.

The water samples collected from Borehole BH6 have consistently demonstrated some outlier parameters, with elevated chloride and sodium levels. Chloride is widely distributed in nature, generally as the sodium (NaCl) and potassium (KCl) salts. Sodium chloride and, to a lesser extent, calcium chloride (CaCl2) are also used for snow and ice control in Canada. Elevated concentrations of calcium, magnesium, sodium were noted in samples taken from both locations. Based on the adjacent main roads and the historical agricultural use of the property, this result is unsurprising. The positioning of Borehole BH6 within the surface drainage swale which extends to the site limits along Colonel Talbot Road towards the downstream end of the swale alongside of the drain, shows a significant influence from surface water run-off which has been impacted by the urbanization of the area.

The general chemistry generally results in the other collected water samples illustrate more dilute levels of the various chemical parameters within the wetland piezometer, which suggests a certain amount of water contained therein is surface water or rainfall from within the broader catchment area, which is not influenced by background conditions within the groundwater.

The water samples from the wetland piezometer (PZ202) indicate elevated iron levels, compared to the concentrations observed in the other monitoring wells. The surface water sample collected in 2021 does not show a correlating iron concentration.

The water quality results indicate that the groundwater is considered very hard, with values reported in excess of 750 mg/L.

Overall, there remains good correlation between the water samples obtained within the wetland area and the shallow groundwater observed within the site limits, which supports the opinion that the shallow groundwater discharges to the wetland, and that shallow groundwater also migrates down to the lower aquifer.

4.4 Groundwater and Surface Water Interaction

Groundwater conditions encountered at the site is generally contained within a shallow unconfined groundwater aquifer, based on the variable thickness and permeability of the weathered silt and sandy soils which were encountered at shallow depths within the boreholes. The groundwater is perched near surface above the less permeable silt and silt till soils, and within sandy layers within the silt till soil.

Similar to most shallow aquifer systems, groundwater and surface water at the site have been found to have a close interaction, with consideration of the local topography and the shallow groundwater observed within the boreholes, and the surface water documented in the wetland area. Surface water run-off follows existing ground surface through swales and through infiltration into shallow sandy and weathered subgrade soils, and flows towards the Buttonbush Wetland to the east.

Groundwater contributions to the wetland area arrives from the site from the more permeable surficial soils which are upgradient of the wetland area. The groundwater contours generally follow the trend established by the topography of the site. It was observed at the piezometer locations along the edge of the wetland area, that during the dry summer months, the groundwater table generally lies below the wetland substrate, except in those instances where localized recharge from high volume rainfall events causes groundwater elevations to rise close to, or above, the ground surface. Further into the wetland area (beyond the piezometer locations), limited site observations are indicative of surface water conditions being more persistent under seasonal conditions, which may be indicative of the broader catchment area contributing to base flows within the wetland, and the possibility of upwelling or groundwater contributions within the wetland feature.

Due to the surface water flows that occur under current conditions, and the base flow contributions from upgradient areas around the wetland feature, it is anticipated that both surface water and groundwater contributions help to sustain the form and function, and recharges the wetland feature. Development at the site which alters surface water or groundwater contributions to the wetland could have long term impacts to the nearby portion of the wetland feature which borders the site. The site makes up a small subcatchment area for the Buttonbush Wetland, and is located at the downgradient end of the feature. The broader catchment area on lands to the north and east of the site also contribute flows to the wetland. However, it is important to ensure that proposed development at the site has consideration for providing clean stormwater run-off, and utilizes opportunities to promote groundwater infiltration.

Further, there is a risk that surface water run-off from the site could be responsible for increased salt loading during late winter and early spring periods. As such, consideration should be given to identifying appropriate mitigation measures to reduce potential salt loading associated with the development and control / maintenance during the winter months under post-development conditions.

The deeper monitoring wells which are installed at the site do not demonstrate a significant upward gradient, based on the water level readings recorded to date. As such, the lower water table does not appear to have a significant impact on the surface water conditions. However, it is noted that this lower aquifer is contained within localized sandy soils, and may receive surface and shallow groundwater which slowly migrates down through weathered soils and through sandy seams within the silt till strata.

4.5 Additional Groundwater Monitoring

Ongoing groundwater monitoring is recommended at the site, to collect additional seasonal data from the monitoring wells and piezometers which have been installed at the site. The complete set of wells have been monitored over the period of February to June 2021 and indicate similar trends and characteristics of water levels recorded in the earlier period of data collection (2017 to 2019), however additional monitoring during summer and fall conditions is expected to continue to further validate the conclusions which have been presented based on the information collected to date.

The shallow groundwater is most susceptible to potential impacts from the proposed development, and as such, priority has been given to addressing potential concerns with the stormwater run-off within the existing surface water features onsite, the shallow groundwater conditions present within the unconfined aquifer, and mitigating potential impacts on the Buttonbush Wetland feature which borders the proposed development area, having regard for both water quality and water quantities.

5.0 SOURCEWATER PROTECTION CONSIDERATIONS

Where proposed developments are being planned, it is important to determine the presence of Significant Groundwater Recharge Areas and High Vulnerability Aquifers in the area. These areas are protected under the Clean Water Act (2006).

In general, Significant Groundwater Recharge Areas are defined as areas where water seeps into an aquifer from rain and melting snow, supplying water to the underlying aquifer. A highly vulnerable aquifer occurs where the subsurface material offers limited protection from contamination resulting from surface activities.

The Thames-Sydenham and Region Source Protection Plan (approved September 2015) presents the framework for assessing lands within the City of London and surrounding area. The Source Protection Plan also presents the assessment work which has been done by the Thames-Sydenham and Region Source Protection Committee.

A more detailed discussion is provided below.

5.1 Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge is largely controlled by soil conditions, and typically occurs in upland areas. As discussed previously, regional groundwater flow directions identified in the Middlesex-Elgin Groundwater Study for overburden and bedrock aquifers are typically indicated to be in a southerly or westerly direction.

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

- 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,
- 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.

As defined by the Clean Water Act (2006) and identified by the Thames-Sydenham and Region Source Protection Committee, the south-eastern portion of site is located within a

Significant Groundwater Recharge Area (SGRA) with a Vulnerability rating of 2, as demonstrated on Drawing 11 in Appendix A. Vulnerability of SGRA's is determined by cross referencing aquifer vulnerability maps with SGRA mapping. Those areas which have high intrinsic vulnerability are classified as 6, and those with low vulnerability as 4 and 2. The location of this significant groundwater recharge area corresponds with a glacial stream trench identified on the Pleistocene geology mapping, with soils described as alluvial silt, sand, and gravel with organics.

It should be noted that the majority of the site is not included in the SGRA. The low permeability soils onsite are not conducive to significant groundwater recharge. Typically, these lower permeability silty soils result in a higher contribution to runoff rather than infiltration.

5.2 High Vulnerability Aquifers

The susceptibility of an aquifer to contamination is a function of the susceptibility of its recharge area to the infiltration of contaminants.

In the Thames-Sydenham and Region, HVA’s were mapped using the Intrinsic susceptibility index (ISI) method, which is an indexing approach using existing provincial Water Well Information System (WWIS) database. The ISI method is described in detail in the MOE’s Technical Terms of Reference (2001), and is an empirical 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 MOE’s 2008 Technical Rules:

- Low Vulnerability – ISI score greater than 80
- Medium Vulnerability – ISI score of 30 to 80
- High Vulnerability – ISI score less than 30

Using the method described above, the Thames-Sydenham and Region Source Protection Committee has determined, that the Site is not within highly vulnerable aquifer zone.

5.3 Wellhead Protection Area

The Thames-Sydenham and Region Source Protection Report outlines that Wellhead Protection Areas (WHPA's) are defined as the vulnerable areas around groundwater sources that have been delineated using three-dimensional groundwater flow models. The WHPA for each well field (or well) is based on an estimate of the groundwater travel time to the well, with defined zones extending out to a period of 25-years for groundwater travel to the well.

Based on the aforementioned Report, the subject lands are not within or near a WHPA. The nearest WHPA is located in the in the north-west part of the city north of the River Thames approximately 2.7 km north of the site.

5.4 Summary Comments

As noted in the previous discussion, the site is not identified to be within a High Vulnerability Aquifer or Well Head Protection Area. The Site is however identified as having Significant Groundwater Recharge Areas (SGRAs) with a Vulnerability Rating of 2 located on the eastern portion of the Site. As such, development at the site must have regard for the sensitivity of the shallow aquifer, and the design of the proposed development should incorporate suitable measures and design aspects to minimize negative effects to the shallow groundwater aquifer. This can be addressed through strategic stormwater management design, the use of contingency and mitigation measures to limit development impacts.

6.0 WATER BALANCE CONSIDERATIONS

A preliminary water balance assessment has been completed for the site, based on available information. The water balance analysis is based on onsite infiltration and run-off contributions which make up base-flow contributions to the wetland feature along the east side of the site.

Based on information from Stantec, it is understood that Buttonbush Wetland has a contributing drainage area of 77.4 hectares, much of which has been subject to urbanization, and has an approximate impervious level of about 63 percent. It is important to note that this assessment does not consider the broader catchment area for the wetland area, which extends beyond the subject lands. This water balance is based on the onsite contributions, through surface water (stormwater run-off) and onsite infiltration which contribute to the adjacent wetland features. The following table summarizes the recommended elements of the assessment, and provides a reference to the corresponding material within this report.

Table 13: Water Balance Overview

Conservation Authority Recommended Element of the Water Balance Assessment	Reference
Obtain precipitation values from a reliable source such as Environment Canada Meteorological Services for the area (utilize closest station with adequate data)	Environment Canada Climate Normals 1981 – 2010 London Airport Weather Station, Ontario
Estimate of local values for major water balance components (evapotranspiration, surplus, runoff, and infiltration) for pre-development, post-development and post-development with mitigation conditions	Estimated pre and post-development values of evapotranspiration, surplus, runoff, and infiltration are summarized in the following paragraphs. Calculation Work Sheets are provided in Appendix G, which reference values which are based on Table 3.1 of the MECP Stormwater Management Planning and Design Manual, and modified to reflect site conditions, as described.
Calculations of impervious areas that reflect actual conditions based on the proposed site plan or a reasonable range of impervious areas used in those cases where only a conceptual development plan is provided	Total impervious area used for the pre and post-development water balance calculations are based on existing conditions, and the concept plan provided by the client.

Conservation Authority Recommended Element of the Water Balance Assessment	Reference
The water balance is required to take into account the changes to grading / topography and land cover	Variables such as elevation, surficial soils, hydrologic soil group, vegetation, root zone, impervious areas, grading and topography are taken into account when estimating the pre and post-development water balance components, and are presented on the Water Balance Calculation Worksheets in Appendix G.
Grain size analysis for both the fill material and on-site soils to confirm fill material is similar to existing soil conditions (maybe recommended)	Soil permeability values are based on correlation with collected sample gradation results.
Appropriate catchments should be used within the analysis (i.e. delineate catchments based on drainage, grades, vegetation, soils and show how infiltration and runoff will change within these zones for both pre and post-development)	The rationale used to delineate catchment areas, and to estimate infiltration / runoff values within the zones for both pre and post-development areas are summarized in the following paragraphs.
Figure of catchments used within the pre and post-development water balance	Pre and post development water balance catchment areas are provided on the Plans provided in Appendix G.
All calculations should be provided in a table format which clearly demonstrates that inputs (precipitation, additional runoff, water from municipal well, etc.) are equal to outputs (i.e. infiltration runoff, water use)	Calculations are summarized in table format in the following sections of this report.

It is also noted that the analysis presented in the following sections is based on the proposed layout and design information which has been provided by the developer and their civil design team. As detailed design occurs, updates to this analysis may be required to reflect specific changes to the proposed site grading, LID features and other design aspects of the site.

6.1 Catchment Areas

Under existing site conditions, two catchment areas have been identified. These are denoted as Catchment 101 and 102. The limits of these Catchment Areas are shown on Pre-Development Drawing, in Appendix G, and described in the following table.

Table 14: Predevelopment Catchment Areas

Catchment	Area	Description
101	2.59 ha	Comprises of the open field and future development area outside of the wetland area.
102	1.47 ha	Comprises of the wetland area.

Under the proposed development plans, the area is subdivided into four catchment areas, denoted as Catchment 201 through 204. At this time, it is understood that the site does not have a storm sewer outlet, and that it is anticipated that the stormwater generated from the site will be accommodated onsite. A description of the catchment areas, and the specific stormwater management features associated with each catchment are described in the following table.

Table 15: Post Development Catchment Areas

Catchment	Area	Description
201	1.77 ha	Contains the future parking lot and small commercial buildings in the southwest quadrant of the site. It has been assumed that stormwater run-off in this area will be directed to storm sewers for water quality treatment.
202	1.47 ha	Contains the wetland / open space area along the east side of the site.
203	0.27 ha	Contains the future development block in the southeast corner of the site. May be used for future townhouse block, however details for this area are not currently confirmed.
204	0.55 ha	Contains the rooftops of the proposed residential buildings, large grocery store, and commercial building closest to the wetland. It is recommended that stormwater run-off in this area be directed towards an infiltration feature which outlets at the wetland.

The limits of these Catchment Areas are shown on the Post-Development Drawing, in Appendix G. However, since this analysis is preliminary in nature, water directed to the storm sewer system has been identified separately from water which will be directed towards the wetland area, to provide flexibility in the design of the stormwater strategy.

6.2 Water Balance Calculations

For each Catchment Area within the Site; precipitation, evapotranspiration, total runoff, and infiltration was reviewed utilizing a method authored by C. W. Thornthwaite and J. R. Mather in their 1957 paper titled Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance. The methodology can be found in the MECP SWM Planning and Design Manual, Section 3.2.

The basic water balance for a region can be expressed as:

$$P = RO + ET + I + \Delta S$$

Where, P = Precipitation (rain and snow)
RO = Runoff
ET = Evapotranspiration
I = Infiltration (Groundwater Recharge)
ΔS = Change in Storage (assumed to be zero under steady state conditions)

Precipitation is a measured value, with the averages (1981 to 2010) used in this assessment being obtained from the Environment Canada operated London International Airport Climate Station. Evapotranspiration is calculated based on measured air temperatures. Infiltration and runoff are calculated based on precipitation and evapotranspiration, where the difference between these components is the water surplus available for infiltration and recharge.

Within the monthly breakdown portion of the analysis, it was assumed that no infiltration occurs in the months of January through March and in December, because of frozen ground conditions and average daily temperatures which occur through that period. The winter run-off volumes have been applied under spring conditions (50 percent in each of April and May), and winter infiltration volumes are applied under spring conditions with 75 percent occurring in April and 25 percent occurring in May. This is detailed in the calculation worksheets provided in Appendix G.

Table 16 summarizes the existing water balance volumes under existing (pre-development) and post-development conditions, as it relates to base flow contributions to the Buttonbush wetland feature located on the east end of the site.

Table 16: Water Balance Calculation Summary

Receiver	**Catchment**	**Adjusted Evapo-transpiration (mm/year)**	**Infiltration (m^3/year)**	**Runoff (m^3/year)**
Predevelopment catchment areas contributing to wetland area	101, 102	558.0	7,757	12,635
Post development catchment areas contributing to wetland area	201, 202, 203, 204	548.8	9,891	10,117
Net Change			⇧ 2,134	⇩ 2,518

Under the post-development conditions, the analysis indicates that there is a deficit for water being directed towards the wetland under post development conditions, since the decrease in the run-off volumes are not completely offset by the increased infiltration. To help offset the deficit of infiltration contributing to the wetland, ‘clean’ water from the rooftops which make up catchment 204 could be captured and directed towards the wetland in a dedicated stormwater piped system set into infiltration galleries in the greenspace area adjacent to the wetland, or using LID features located in the greenspace area along the east side of the site, between the parking lot and wetland area. The use of an in-ground infiltration-based system would also be helpful to attenuate thermal impacts associated with introducing stormwater run-off towards the natural feature.

When additional information regarding the stormwater management strategy is available for the site, the water balance should be updated to reflect stormwater catchments used in the design. Additional discussion is provided in the following section to assist in the design of the stormwater management strategy.

6.3 Stormwater Management Strategy – Design Considerations

It is understood that the site does not have a municipal stormwater outlet, or access to an external storm sewer connection. As such, stormwater run-off generated from the site is expected to be handled and treated onsite. The following discussion is provided to assist in the design of the stormwater system.

It is anticipated that the wetland feature on the east side of the site is influenced by upstream stormwater facilities; however, it is anticipated that the development will need to have suitable measures in place to help prevent further water quality degradation for water leaving the subject lands which makes its way into the wetland feature.

Drainage mapping (as discussed in Section 2.1.4) identifies that a systematic drainage system is/was in place in the westerly extents of the site. Although field tiles (or drainage outlets) were not encountered or observed during the field program, and existing infrastructure along Col. Talbot Road has likely intersected any formal drainage features from the lands on the west side of the road allowance, there may still be tile drains (or portions thereof) present onsite, unless the overland swales which have been discussed previously provided an outlet conveying flows towards the wetland. Regardless, the systematic drainage of the area has historically provided some base flow contributions to the wetland, whether through overland flow routes or tile drains. Alterations to the site grading, disturbance to subsurface tile drains and introduction of impermeable hard surfaces will alter those base flow contributions, as demonstrated in the water balance calculations noted above. As such, it is important that clean stormwater run-off (such as that collected from roof-tops or landscaped areas), be directed towards features which direct flows towards the wetland area.

To increase post development infiltration and evapotranspiration volumes, low impact development (LID) measures may be incorporated into the stormwater design plan/strategy for the proposed development. From a quantitative standpoint, incorporating effective at-source infiltration structures into final land development design as part of a storm water management strategy is primarily dependent on (but not limited to), native soil infiltration rates and depth to seasonal high groundwater table.

The silty sand and sandy silt soils encountered near ground surface have a factored infiltration rate in the range of 25 mm/hr, as identified in Section 3.2.2. Although sandy soils are generally present near surface, they are generally in a wet to saturated state. The shallow unconfined aquifer being present at shallow depths limit the ability to effectively use LID strategies which require separation from the high groundwater table.

The site grades are generally well below the surrounding roads, and based on preliminary site grading information provided by Stantec, it is anticipated that some significant grading work will be done to raise grades throughout much of the site. In this regard, consideration should be given to using imported soils which have a sandy texture and consistency, to broaden the possible types of LIDs which may be suitable for use at the site.

As noted in the previous section of the report, based on existing grading information and the concept plan for the proposed development, the water balance for maintaining base flow contributions to the wetland area appears to have a deficit. To help offset the deficit of infiltration contributing to the wetland, 'clean' water from the rooftops of the larger commercial buildings could be captured and directed towards the wetland in a dedicated stormwater piped system set into infiltration galleries in proximity to the wetland, or using LID features located in the greenspace area along the east side of the site, between the parking lot and wetland area. The use of an in-ground infiltration-based system would be helpful to attenuate thermal impacts associated with introducing stormwater run-off towards the natural feature.

Stantec has proposed the use of two sets of stormwater storage chambers/features at the site (one for the residential area and one for the commercial area), to receive runoff from the paved parking lot areas. To provide water quality of the parking lot run-off, oil grit separator stormceptors are planned, and would be positioned inline ahead of reaching the stormwater chambers. Stormwater chambers should be designed to provide adequate storage capacity, with infiltration capacity provided along an overflow/outlet pipe, directed to the wetland. Preliminary design drawings indicate an outlet adjacent to the edge of the wetland feature with a rip-rap pad. Similarly, a rip-rap pad for roof water conveyed off of the larger commercial building, and discharged towards the wetland. Roof flows are expected to be controlled, as to not overwhelm the outlet.

Table 17 – Proposed Stormwater Storage Features

Parameter	Town Home Storage Facility	Commercial Storage Facility
Minimum Footprint	300 m^3	1000 m^3
Minimum Storage Volume	175 m^3	550 m^3

Based on these volumes, and the water balance discussed in the previous section of this report, the proposed storage features will capture the entirety of a 25 mm storm event (less than design 2 year storm) from approximately 83 percent of the development area. This is suitable to offset the previously described deficit resulting from the introduction of impermeable surfaces at the site. The water balance analysis assumed that 20% of the run-off would be captured from building rooftops, and this design exceeds that requirement.

The interface between the bottom of the storage system, and the natural soils should be reviewed to ensure that soils are suitable to provide infiltration capacity to supplement the storage system.

The use of the stormwater storage features provides an opportunity to help minimize thermal impacts to the wetland, by providing time to stabilize stormwater runoff temperatures to the ground temperature, prior to discharge towards the wetland.

The use of grassed swales and reduced lot grading in the residential area may also be considered to provide some further benefits in greenspace areas, to extend the amount of time that stormwater is detained on the surface, helping to moderate run-off and provide additional infiltration and evapotranspiration opportunities.

7.0 IMPACT ASSESSMENT FOR POTENTIAL RECEPTORS

It is anticipated that the proposed commercial and residential development which is planned for the site can proceed without construction activities or changes in the land-use from causing any adverse effects on the characteristics of the surface and groundwater at the site, and the form and function of the Buttonbush wetland feature which borders the site. To this end, the following discussion is provided to identify potential impacts, and to discuss mitigation measures which can be implemented through the design and construction to avoid adverse impacts.

7.1 Surface Water and Wetland Features

Under existing conditions, stormwater run-off follows the surface topography and is generally directed towards the wetland to the east of the site, with swales directing to both the north-east and the south-east corners of the site directing flows more quickly overland towards the wetland.

Drainage mapping (as discussed in Section 2.1.4) identifies that a systematic drainage system is/was in place in the westerly extents of the site. The systematic drainage of the area has historically provided some base flow contributions to the wetland, whether through overland flow routes or tile drains. As such, it is important that clean stormwater run-off (such as that collected from roof-tops or landscaped areas), be directed towards the wetland area. This was discussed as part of the stormwater management strategy recommendations in Section 6.3,

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. As construction work progresses at the site, regular maintenance and additional sedimentation measures will be required to limit the effect of siltation of run-off water in localized areas. If deficiencies are identified in the performance of the sediment and erosion control measures through regular inspection, enhancements beyond the recommended design may be required.

Based on the findings of this report, it is anticipated that the development can proceed with no net negative impact to the Buttonbush Wetland which (located on the east side of the site), provided that clean stormwater run-off is directed into areas where it can be infiltrated or otherwise directed towards the natural feature. Stormwater run-off containing contaminants (from site pavements) are expected to be captured and directed into a storm sewer system for treatment.

7.2 Wetland Flooding Considerations

Based on the site grading information prepared by Stantec, it is understood that a 3 metre high retaining wall will be required along the easterly limit of the development, next to the Wetland feature. Under current site conditions, when a flood event occurs within the wetland area, flood waters are able to extend into the site, with backwater flows into the existing swales, and into the open field area. Under the proposed development plans, the proposed change in grades at the site and the introduction of the retaining wall will prevent the free flow of water to extend into the site. As such, flood waters in the wetland which extend into the property under current conditions may be diverted/displaced into adjacent lands. It is understood that Stantec is responsible to confirm the applicable flooding elevation and assess the potential for offsite impacts.

Based on information in the EIS Report prepared by MTE, it is understood that Buttonbush Swamp ecology and sensitivity is such that this type of feature is “tolerant to a wide variety of hydrologic changes, including prolonged flooding, and is well adapted to flood events characteristic of disturbed ecosystems”. It is anticipated that flooding associated with frequent storm events (such as the 2 or 5 year storm event) will not yield significant changes to the flooding frequency or duration which would have a significant adverse effect on the wetland features. Small seasonal floods typically contribute a source of nutrients to aquatic ecosystems, and when the nominal increase in the volume of water is assessed over the broad extent of the wetland feature, changes in the flood duration and frequency are not expected to be significant.

For flooding associated with more significant storm events, the volume of flood water which is retained in the wetland may be more likely to have an impact to the ecological features within the wetland. If the ecological assessment indicates that there is a need to attenuate the effects of flooding in the wetland, this could be addressed (in part) through temporarily controls to limit stormwater run-off from the development being directed into the wetland by utilizing onsite storage capability in temporary holding chambers, and/or providing an alternative outlet such as a road crossing / culvert which connects into the stormwater infrastructure which services the lands south of Southdale Road, and/or west of Colonel Talbot Road. In the latter case, there may be an opportunity to incorporate the creation of a storm overflow/outlet as part of the future road expansion works which are planned along Southdale Road.

7.3 Impacts to Shallow Groundwater

Shallow groundwater and surface water interactions have been described previously. As such, maintaining shallow groundwater contributions to the wetland feature to the east is an important consideration for the proposed development. Limited green-space and buffer areas adjacent to the wetland will continue to provide opportunities for infiltrated surface water (sourced from sheet flow at the site) to travel in the shallow subsurface; however, the introduction of impermeable surfaces which will limit natural infiltration of surface water at the site will directly result in changes to the shallow groundwater contributions from the site. As such, consideration has been given to identifying alterative means to direct stormwater runoff towards the wetland, in lieu of the run-off and infiltration which occurs under current conditions. This is important, since the EIS report prepared by MTE identifies that Buttonbush Swamps are generally less tolerant to drought or other conditions which lower the water table.

7.3.1 Post-Construction Removal of Swales and Reduced Infiltration

The near surface silty sand/sandy silt soils are described as being in a moist to wet state, and contain shallow groundwater. The topsoil and composition of the silty sand/sandy silt soils are conducive to surface water infiltration, and the presence of shallow swales at the site facilitate surface water being conveyed into these soils and towards the wetland feature. Under the proposed post-development conditions, much of the surface will be covered with hard surfaces, comprised of buildings and paved parking, and the swales are expected to be removed as part of the site grading work. The shallow groundwater which exists near surface is expected to be influenced by the restrictions which will exist for surface water to infiltrate directly into the near surface soils.

The shallow groundwater currently contributes base flows to the wetland, and with the presence of hard surfaces, it will be required to direct clean water which can be captured at the site towards the wetland, to help minimize the impact to the shallow groundwater which exists under current conditions. Stormwater run-off from site pavements and parking areas can also be directed into temporary storage and infiltration features which can serve to provide enhanced infiltration of the stormwater run-off, and overflow capacity to support the wetland feature. Filtration and treatment of any stormwater runoff from the site pavements is recommended, to prevent the introduction of contaminants into the subsurface.

7.3.2 Construction Dewatering Considerations

The shallow groundwater is contained within weathered soils and sandy silt typically encountered near surface, and perched above the less permeable silt till. Seasonal high groundwater levels were measured throughout the site at Elevation 282.0 to 285.5 m depth. As noted previously, the deepest excavations are expected to located at the sanitary sewer connection at Southdale Road, at about Elevation 280.0 m, asl.

Conventional groundwater control methods are expected to be suitable for shallow excavations which remain above the groundwater table at the site; however, excavations which extend below the groundwater table will require positive groundwater control and a comprehensive groundwater dewatering plan.

For substantial excavations which extend below the groundwater table, consideration may be given to utilizing a system of well points for temporary groundwater control. It is generally accepted that the height to which water can be drawn down using a single stage well point system is approximately 6 metres. The close proximity of the Buttonbush Wetland is sensitive to changes in the shallow groundwater table; therefore, it is recommended (where possible) that servicing depths be set as high as possible and work be carried out in seasonally drier periods to limit the amount of construction dewatering which is required. In addition, the use of trench liners and cut-off systems can also assist in reducing the amount of construction dewatering which may be required.

However, given the sensitive nature of the wetland to the east of the site, design of the site grading and servicing should consider ways to limit excavations below the stabilized groundwater table, where possible.

Additional discussion is provided in Section 8.1.

7.4 Impacts to Potable Wells

The proposed development is expected to be provided with full municipal services, including water supply, sanitary and storm sewer services. The development will not be reliant on potable aquifers in the area, as the municipal water supply is sourced from Lake Huron.

Similarly, neighbouring residential and commercial developments are also equipped with municipal water supply. The water supply wells which are identified in the area are typically set into the intermediate and deep overburden aquifers (at depths generally more than 40m below existing grade). Any wells which are still in use are not expected to be impacted by construction dewatering for site services or typical depth excavations associated with the buildings of the site.

No significant long-term impact is anticipated on the wells, either quantitatively and qualitatively.

Based on the information provided in the MECP water well records, and supplemented by our understanding of the municipal water supply available in the area, a door to door well survey was not completed as part of our assessment.

7.5 Water Quality Considerations

Given the naturally low permeability of the silt till soils which underlie the site, the intermediate and deep overburden aquifers and deep bedrock aquifer is not considered to be vulnerable to contamination from surface sources. However, the shallow groundwater which provides base flow contributions to the wetland area to the east does not have the benefit of a low-permeability protective soil layer above it, and it therefore more susceptible to potential impacts resulting surface activities during construction.

7.5.1 Baseline Conditions

Most pollutants in urban runoff are well retained by infiltration practices and soils and therefore, have a low to moderate potential for groundwater contamination. Two sets of water quality samples have been obtained from the site, to collect baseline water quality data. The results of the testing are discussed in Section 4.4.

The general chemistry of the shallow groundwater indicates elevated levels of sodium and chloride. Given the use of salt-application for road de-icing, the relatively shallow depth to the shallow groundwater, and the location of the site at Southdale Road and Colonel Talbot Road, elevated salt levels are not unexpected.

7.5.2 Snow Removal and Salt Management

Further to the comments above, chloride and sodium from de-icing salts applied to roads and parking areas during winter are not well attenuated in soil and can easily travel to the shallow unconfined groundwater aquifer. Given the importance of mitigating potential impacts to the wetland area, and in an effort to ensure that the proposed development has no net negative impacts to the wetland, consideration should be given to utilizing a Salt-Management Plan for the proposed development. Contractors used to carry out salting activities should be familiar with best practices to ensure that salt is used only during conditions when it will be effective, and should able to produce equipment inspection or calibration records to ensure that spreader controls are not over-applying salt.

The introduction of hard surfaces, namely paved parking areas in proximity to the wetland area creates the potential for impacts to the wetland from snow accumulation/storage onsite resulting from parking lot clearing. Snow can be impacted by salts and other ice control chemicals; oil, grease and heavy metals from vehicles; litter and debris; and, dirt, dust and airborne pollutants. If snow is cleared from parking areas and remains onsite, it should be managed to prevent contaminants from reaching the wetland. Further, if snow is pushed into LID areas (such as rain-gardens or grassed swales intended to promote infiltration), snowmelt may result in a release of contaminants, debris and litter into such areas, which can directly impact their effectiveness and have a negative impact to local water quality.

In warm weather conditions, maintenance may be required to remove physical debris and litter. A program of water quality testing in snow storage areas, and/or in the buffer area between the parking lot and wetland feature. Monitoring can be expensive and should be scoped to address specific goals. If after monitoring some parameters it becomes clear that they are not relevant, then they should be discontinued, subject to review by an environmental engineer.

Alternatively, snow accumulation could be removed from the site and taken to a snow disposal area where a snow management plan and treatment (if required) is in place.

7.5.3 Potential Impact from Construction Equipment

Construction activities at the site are not expected to impact the general chemistry or bacteriological properties of the unconfined shallow aquifer. However, the possibility exists that a spill or uncontrolled release of fuel or associated material could occur during construction, which could have a direct impact to the unconfined shallow groundwater aquifer.

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. It is recommended that there be a designated equipment fuelling areas located away from the wetland, and implementing a spill contingency plan (including a spill action response plan) for fuel handling, storage and onsite equipment maintenance activities to minimize the risk of contaminant releases as a result of the proposed construction activities.

It is important to note that if a spill (possible incident) is related to the contractor’s activities, the contractor is responsible to report the incident to the Spills Action Centre, and/or notify the local MECP office. Depending on the type of incident, water sampling and quality testing may be warranted to document the extent of the impact. Scoping for the required testing will depend on the incident report.

7.5.4 Thermal Considerations

Numerous studies indicate that urbanisation (and by extension, the increase of imperious surfaces) typically causes temperature increases in stormwater runoff. Asphalt and other impervious surfaces absorb heat energy and during rainfall events the stored heat is transferred to the runoff.

For the stormwater run-off generated from the parking lot areas, the water is expected to be collected and directed into a stormwater storage facility within the respective residential and commercial areas. These features are expected to promote infiltration into the natural subgrade soils, with overflows set to direct discharge towards the wetland feature. As such, the temporary storage of surface water below grade will help to moderate temperatures before discharge. Water which naturally infiltrates into the subgrade soils, is expected to match ground temperatures, mimicking the typical range of temperatures which occur in the shallow groundwater under current conditions.

It is anticipated that stormwater run-off from the large grocery store building will be directed towards the wetland, with roof water being discharged at a controlled rate. To help mitigate thermal impacts before reaching the wetland limits, the use of a partially buried conveyance system and vegetive cover or shading at the rip-rap outlet may be considered.

7.5.5 Potential Impact from Uncontrolled Erosion / Sediment Discharge

Surface water quality can be detrimentally impacted by uncontrolled erosion and sediment discharge from the site. As such, it is imperative that an adequate Sediment and Erosion Control Strategy be established for the site. In addition to implementing sediment and erosion controls during construction, regular inspection and maintenance will also be necessary to ensure that sensitive receptors are not negatively impacted during construction.

Mitigation measures and best management practices are outlined in the Geotechnical Report (LDS, 2020) to limit foreseeable events where contamination or negative impacts to natural features at the site. These are also reiterated (in part), in Table 18 (refer to next page), for those measures which relate to groundwater and surface water quality.

7.6 Monitoring Plan

Development plans are currently at a conceptual stage, and as such, insufficient details are available to prepare a detailed monitoring plan at this time. However, due to the sensitive nature of the wetland area next to the site, it is anticipated that as detailed design information becomes available, that an environmental monitoring program will be prepared, to help ensure that site activities during construction, and in post-development conditions do not have a detrimental impact to the wetland area, from an ecological perspective, and hydrologic perspective. The main objectives of the Environmental Monitoring Plan are expected to include:

- Providing an early indication should any environmental control measures (such as sediment and erosion control measures) or practices fail to achieve prescribed standards;
- Monitoring the performance and effectiveness of mitigation measures;
- Determining project compliance with regulatory requirements and standards and outlining reporting requirements, including timing and distribution;
- Identifying an emergency contact list and response protocol to respond to any issues or concerns identified during construction; and,
- Taking remedial actions if unexpected problems or unacceptable interference or negative impacts arise.

Table 18: Best Management Practices, ESC Controls

Practice / Task	During Site Grading	During Site Servicing	Building Construction & Partial Pavements	Following Construction
Delineate work areas to limit construction activities encroaching into the natural heritage features and setback areas, to prevent unnecessary vegetation removal.	✓	✓	✓	
Monitoring of discharge water (for water quality – turbidity) from stormwater run-off and construction dewatering activities.	✓	✓	✓	
Installing perimeter ESC measures such as silt fence and/or silt sock around temporary soil stockpiles, with dedicated points of access clearly marked onsite.	✓	✓		
Dedicated fuel storage and equipment fuelling areas located away from natural features. Contractors should have an emergency spills management plan.	✓	✓		
Incorporate trench plugs/clay collars in servicing trenches to minimize groundwater migration through granular pipe bedding and disturbed backfill material. The location of such features should be reviewed in the field to confirm that they are placed at appropriate locations where groundwater migration may be expected to occur.		✓		
Re-establishing vegetative cover in disturbed areas. In areas which are susceptible to erosion, additional measures may include the use of sod, mulch, etc.	✓	✓	✓	✓
Maintain perimeter silt fence (and other perimeter ESC measures) in place until disturbed areas and lots are sodded/seeded, and vegetative cover has become established.			✓	✓
Build-up boulevard areas to help limit sediment-laden stormwater run-off from discharging into catchbasins and stormwater infrastructure, and regular inspection and maintenance of silt bags/geotextile filters installed in catchbasins.			✓	
Limit the use of commercial fertilizers in landscaped areas which border the natural areas.				✓
Limit the use of salts or other additives for ice and snow control for site pavements and entrances.				✓

Preliminary recommendations for inspections and monitoring are provided in Section 9.0 of this report. From a preliminary standpoint, the following comments are provided regarding monitoring efforts which are expected to be confirmed and refined as detailed design information becomes available. The Monitoring Plan should be prepared by a Qualified Person (QP) and periodically reassessed and updated by the QP, as appropriate, to ensure that the objectives stated above are effectively and efficiently achieved.

The Contractor and Contract Administrator should endeavour to preserve all monitoring points, where reasonable.

During construction dewatering, weekly water level monitoring of the existing monitoring wells and wetland piezometers should be implemented prior to the start of construction, and continue for at least two months following construction, or until water levels return to 90 percent of the pre-construction water level, or return to typical groundwater levels recorded under similar seasonal conditions. Thermal profiling of the groundwater column in select wells should also be carried out over the same period.

Inspection of sediment and erosion control measures at the site during construction will be incorporated into the environmental monitoring program for the site. The frequency of inspections will depend on weather conditions (such as periods with rainfall or snowmelt). At a minimum, inspections are expected to include checks on siltation barrier installations to confirm that it is properly installed and secured, including inspection for evidence of damage or tears, and overtopping or undermining; checking condition of surface water ponding areas and storm drain inlets, and documenting areas where seeding / sodding / mulching is implemented to re-establish vegetative cover.

While active construction dewatering occurs at the site, a program which includes turbidity monitoring is may be appropriate to confirm that the quality of discharge water will not have adverse impacts to sensitive receptors. In the event that water discharged from the site is considered to have an elevated turbidity level, associated construction activities should be halted until remedial measures can be implemented. Such measures may include enhanced or more robust sediment and erosion control measures, incorporating pooling areas and measures that will reduce suspended solids, temporary storage measures to prevent off-site discharge.

In the event that there is an incident or perceived impact to groundwater quality identified through monitoring at the site, interim water quality testing should be carried out within 24 hours of the reported incident, to document conditions which may have been impacted. Scoping for the required testing will depend on the incident reported.

For general guidance, the following parameters are suggested, however it is important to note that some parameters may be added or removed depending on the site activities and incident reporting.

- General inorganic parameters, such as pH, electrical conductivity, total dissolved and suspended solids, turbidity;
- Major anions and cations;
- Nutrients (including ammonia and nitrogen species);
- A limited selection of dissolved and total metals; and,
- Petroleum hydrocarbons.

Groundwater field parameters, including pH, temperature and EC should also be measured. All monitoring activities and groundwater/surface water sample collection should be conducted by qualified environmental field staff.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Construction Dewatering

Shallow groundwater encountered at the site is contained within weathered soils and sandy silt typically encountered near surface, and perched above less permeable silt till soils. Seasonal high groundwater levels were measured throughout the site at Elevation 282.0 to 285.5 m depth. The deepest excavations are expected to located at the sanitary sewer connection at Southdale Road, at about Elevation 280.0 m, asl.

Depending on final design grades, and the amount of fill placement which is carried out to raise grades in low areas, building foundations may be expected to remain above the shallow groundwater level; however, servicing excavations may be expected to encounter the shallow groundwater table.

Conventional groundwater control methods are expected to be suitable for shallow excavations which remain above the groundwater table at the site; however, excavations which extend below the groundwater table will require positive groundwater control and a comprehensive groundwater dewatering plan.

Where possible, construction during the drier summer months is preferred to carry out excavations when stabilized groundwater levels are not elevated under seasonal conditions. If construction occurs during wet-weather conditions or when seasonal water levels are elevated, monitoring the water levels within the monitoring wells during construction can be used to confirm the zone of influence, and to identify changes in the water level while construction dewatering is actively occurring.

The Geotechnical Report (LDS, 2020) provides preliminary zone of influence calculations which are also summarized below, and indicate that the westerly extent of the Buttonbush Wetland could be within the zone of influence associated with construction dewatering. Since this natural feature is sensitive to changes in the shallow groundwater, it is recommended that servicing depths be designed to minimize the need for construction dewatering where possible. In addition, it is recommended that construction staging utilize measures to limit the amount of dewatering required, to keep water taking volumes within 400,000 litres per day, such that the construction dewatering can be carried out under an EASR submission.

EASR Requirements

The EASR requires preparation of a Construction Dewatering and Discharge Plan, which requires information from the contractor carrying out the excavation work, and the contractor responsible for providing groundwater control. The construction methodology, including details for the typical length and depth of service trenches, information about excavation support or cut-off systems (such as trench liner boxes) which may be utilized, and the method of groundwater control which will be utilized. This information is included, to inform the discussion which is provided in the Dewatering Plan, which identifies potential impacts to soil settlement, impact to existing groundwater users and surface water features, along with consideration for extreme weather events.

The Discharge Plan identifies the discharge location for pumped water, including sediment and erosion control measures which will be utilized where water is contained onsite in surface water features, or where filtering of discharge water is planned, for water being outletted to municipal infrastructure. Construction dewatering effluent which is directed to the City's stormwater infrastructure must meet the water quality standards outlined in the City of London Sewer Discharge By-Law. Monitoring and inspection requirements, and contingency plans for treating pumped water to reduce turbidity levels should also be incorporated into the Discharge Plan.

Zone of Influence Calculations

As a preliminary assessment of the zone of influence for potential construction dewatering activities, the Sischart and Kryieleis method has been utilized, which is based on an empirical relationship with the amount of groundwater lowering and the soil permeability. The zone of influence is calculated using the following equation:

$$Ro = 3000 (H-h)(k)^{1/2}$$

where, H = high water level, m
h = lowered water level, m
k = soil permeability, m/s

For the purposes of this preliminary analyses, a soil permeability of 3.0 x 10-6 m/s has been used, based on correlations with the gradation analyses, and the water levels have been measured relative to the lower grey silt till layer, typically encountered below 8.5 m depth.

The following table summarizes the range of distances applicable to various depths of the groundwater lowering.

Table 19: Zone of Influence Distances

Effective Lowering	1.0 m	2.0 m	4.0 m	6.0 m
Zone of Influence, m Based on average k = 3 x10^{-6} m/s	5	10	21	31

Variability in the overall zone of influence should be expected, depending on the composition of the soil, and the overall depth of effective lowering of the water table. The use of cut-off walls or similar type systems may be considered for the purposes of minimizing impacts to the stable shallow groundwater table during construction, if a need is identified to limit the zone of influence from open excavations. Confirmation of detailed design information, including site grading information is imperative to have to accurately determine the zone of influence. Field testing can be conducted to confirm design parameters, so that actual site conditions are accurately reflected.

Excavations should be dewatered using appropriately sized pumps placed in properly constructed

and filtered sumps located within or near the excavations. Water from sump pumps should be discharged through filter bag(s), rock check dams and/or settlement tanks towards strategically located sediment control measures.

The use of cut-off walls or similar type systems may be considered for the purposes of minimizing impacts to the stable shallow groundwater table during construction.

8.2 Site Grading near the Wetland

Site grading work at the north end of the site, along the east side of the site (next to the wetland), is expected to tie into existing grades. Through the central and southern part of the site, it is anticipated that grades will be raised throughout the site, and the transition area towards the wetland is expected to incorporate a retaining wall structure. In both cases, it is imperative that site grading activities do not extend into the wetland feature, and that the ecological buffer identified by MTE is adhered to. In addition, robust sediment and erosion control measures will be required to prevent sediment discharge towards the wetland feature.

The positioning of the retaining wall will need to allow for sufficient room to ensure that foundations can be properly constructed on natural mineral soils, without excavated materials being stockpiled in proximity to the wetland. The retaining wall structure will require a subdrain system and granular backfill for long-term stability. As such, it is anticipated that the retaining wall will have a positive outlet, to provide drainage of the subdrain system. The positioning of the outlet will be located on the downgradient / wetland-side of the wall, and suitable measures will need to be incorporated into the design to prevent scouring at the outlet, or blockage from icing of the surface water in the wetland. Under flooding conditions within the wetland, it is important to ensure that flooding does not create a backwater effect in the retaining wall subdrainage system. This will need to be assessed as part of the retaining wall design.

A program of environmental monitoring while site grading and construction work is recommended. A detailed Sediment and Erosion Control Plan should be prepared to delineate the extent of sediment and erosion control measures which will be in place during the interim construction period when site grading works are underway. It is important to ensure that the sediment control measures are installed properly, and in accordance with approved design drawings. If deficiencies are identified in its performance through regular inspection, enhancements beyond the recommended design may be required.

8.3 Building Foundations

As noted previously, shallow groundwater conditions are present at the site, and engineered fill placement is expected throughout much of the site to raise grades.

Building foundations for slab-on-grade buildings (set at conventional depths – design frost depths) are expected to be set in the engineered fill, above the shallow groundwater level. The Geotechnical Report (LDS, 2020) provides recommendations for moisture barriers below slab-on-grade floors.

Residential buildings are currently proposed in the north end of the site. It is anticipated that some fill placement will also occur within this area to raise existing grades, particularly along the west side of the residential block. The underside of footing levels for new residences (if constructed with full basements) may extend down into the stabilized groundwater level, particularly during the seasonal high spring conditions. It is recommended that building design be considered to allow for basement levels and residential foundations to remain above the seasonal high groundwater conditions. Foundations (which are set above the high groundwater table) should be provided with damp-proofing and foundation drainage tiles, in accordance with standard Ontario Building Code (OBC) requirements. Consideration may be given to enhanced damp-proofing measures (such as subfloor drains), where there is reasonable concern that the basement level may encounter the high groundwater level on an intermittent basis.

8.4 Pipe Infiltration/Exfiltration Testing

In general terms, OPSS 410 and OPSS 407 specify that infiltration tests shall be conducted where the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section, and exfiltration testing is appropriate where the groundwater level is 600 mm or more above crown of the pipe or the highest point of the highest service connection included in the test section.

Stabilized water levels measured at the site under spring conditions have been measured at variable depths across the site. It is anticipated that the deepest sections of the storm and sanitary sewers along Apricot Drive will extend below the stabilized groundwater levels measured at the site. The remainder of the servicing excavations are expected to generally remain above the stabilized groundwater level.

As noted in the Geotechnical Report (LDS, 2020), suitable water-tight gaskets to prevent infiltration and exfiltration of groundwater and pipe effluent are required at joints and at manhole connections.

When testing is required (in accordance with OPSS 407 and OPSS 410), the test sections are expected to be defined between maintenance access / manhole locations. Infiltration tests shall be conducted where the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. Exfiltration testing is appropriate where the groundwater level is 600 mm or more above crown of the pipe or the highest point of the highest service connection included in the test section.

8.5 Monitoring Well Maintenance & Decommissioning

The information contained within this report is based on LDS’ data collection from Autumn 2017 through to November 2019.

The monitoring wells at the site have been maintained for additional and ongoing data collection, which can be used to verify and validate the information and assumptions used to prepare this report.

Wells which are maintained onsite during construction can be used to assess the impacts of construction dewatering activities, if required. In this regard, they can be equipped with data loggers to monitor changes in water level and the lateral extent of the zone of influence of the construction activities, and/or used to collect water quality samples.

Monitoring wells and piezometers which are in proximity to the Wetland may be maintained (where possible) to allow for post-development monitoring, to assess the operation and impact of the completed development condition in proximity to the wetland. Specific regard to thermal impacts can be assessed with continuous groundwater temperature data collection.

A site plan showing any monitoring wells to be maintained and protected at the site should be provided to the contractors working at the site.

When the monitoring wells which are present on the site are determined to be no longer required, they should be properly decommissioned in accordance with Ontario Regulation 903. This regulation identifies that only certified and qualified well drilling technicians are permitted to direct the decommissioning work for existing wells. Decommissioning a well which is no longer in use helps to ensure the safety of those in the vicinity of the well, prevents surface water infiltration into an aquifer via the well, prevents the vertical movement of water within a well, conserves aquifer yield and hydraulic head and can potentially remove a physical hazard.

8.6 Environmental Considerations for Imported Fill

It is important to note that Ontario Regulation 153 provides applicable standards for any fill material which will be brought to site. For the purpose of importing and stockpiling materials at the site, consideration should be given to accepting material which has concentrations consistent with, or less than the standard concentrations identified in O. Reg. 153 (last amended April 15, 2011) for Table 1 (residential land-use) for any fill placed at the site, due to the proximity of the Buttonbush Wetland.

9.0 QUALIFICATIONS OF ASSESSORS

This report was prepared by Ms. P.E. 'Tara' Sieg, BA Env. MA, Geo-Environmental Scientist. Ms. Sieg has over 15 years of experience in conducing Environmental, Geotechnical and Ecological studies under the supervision of Professional Engineers and/or Geoscience QPs, and is routinely engaged in Environmental and Hydrogeological field work.

This assessment was supervised and reviewed by Mrs. Rebecca Walker, P. Eng., QPESA, who has been thoroughly trained in conducting geotechnical and hydrogeological assessments. Mrs. Walker is a licensed professional engineer in the Province of Ontario. She obtained a Bachelor of Applied Science in Geological Engineering from Queen’s University in 1998 and is a Qualified Person (QPESA) registered with MECP, under the requirements of Ontario Regulation 153. Rebecca provides geotechnical and geoscience services under the Guideline of Professional Engineers Providing Geotechnical Engineering Services under the Professional Engineers Act in Ontario. Rebecca is qualified to provide geoscience (hydrogeological) services under the Professional Geoscientists Act as an exempted engineer, by virtue of her training and experience, as prescribed by the Professional Engineers Act.

Mrs. Walker has over 20 years of direct experience in the geotechnical and hydrogeological consulting industry. Over 3,800 projects have been completed under her supervision. Mrs. Walker is also a recognized expert in the industry and has testified as an expert witness in Ontario Municipal Board and Local Planning Appeals Tribunal hearings and Municipal Councils related to groundwater hydrogeology and geotechnical matters for land development and construction. She has been retained for many projects, both directly and indirectly by local municipalities as a hydrogeological and geotechnical consultant.

10.0 CLOSING

The information presented in this report is based on a limited investigation designed to provide information to support a preliminary assessment of the hydrogeological setting at the subject property, for the project described in the text of the report.

It is important to note that this assessment involves a limited sampling of the subsurface conditions at specific borehole locations. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation and a review of available information which has been presented in the report. Should subsurface conditions be encountered which vary materially from those observed in the boreholes, we recommend that LDS be consulted to review the additional information and verify if there are any changes to the recommendations and discussion provided in this report.

No portion of this report may be used as a separate entity. It is intended to be read in its entirety. LDS should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented.

We trust this satisfies your present requirements. If you have any questions or require anything further, please feel free to contact our office.

Respectfully submitted,

LDS CONSULTANTS INC.

LICENSED PROFESSIONAL ENGINEER
Aug 18, 2021
R.A. WALKER
PROVINCE OF ONTARIO

R. Walker

Tara Sieg, BA Env.MA
Geo-Environmental Scientist
Office: 226-289-2952
Cell: 519-933-2686
tara.sieg@LDSconsultants.ca

Rebecca A. Walker, P. Eng., QPESA
Principal, Geotechnical Services
Office: 226-289-2952
Cell: 519-200-3742
rebecca.walker@LDSconsultants.ca

APPENDIX A

Drawings

LEGEND

➡ Surface Water Flow (based on site topography)

SOURCE

Google Earth Pro, Version 7.3.2.5491,
17T, 474190.38 m E, 4753946.39 m N,
Imagery Date 7/2/2018

PROJECT NAME

Proposed Residential &
Commercial Development

PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Site Features

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
July 2021	1

1942 Aerial Photo (Dept. of Land and Forests, 1:12,000)

1955 Aerial Photo (Dept. of Land and Forests, 1:15,700)

1967 Aerial Photo (Lockwood Survey Corp, 1:12,000)

1999 Aerial Photo (City of London, database)

SOURCE:

University of Western Ontario, Aerial Photography Database, City of London Air Photo Collection

PROJECT NAME

1739626 Ontario Ltd
Proposed Commercial Development

PROJECT LOCATION

952 Southdale Road West
London, Ontario

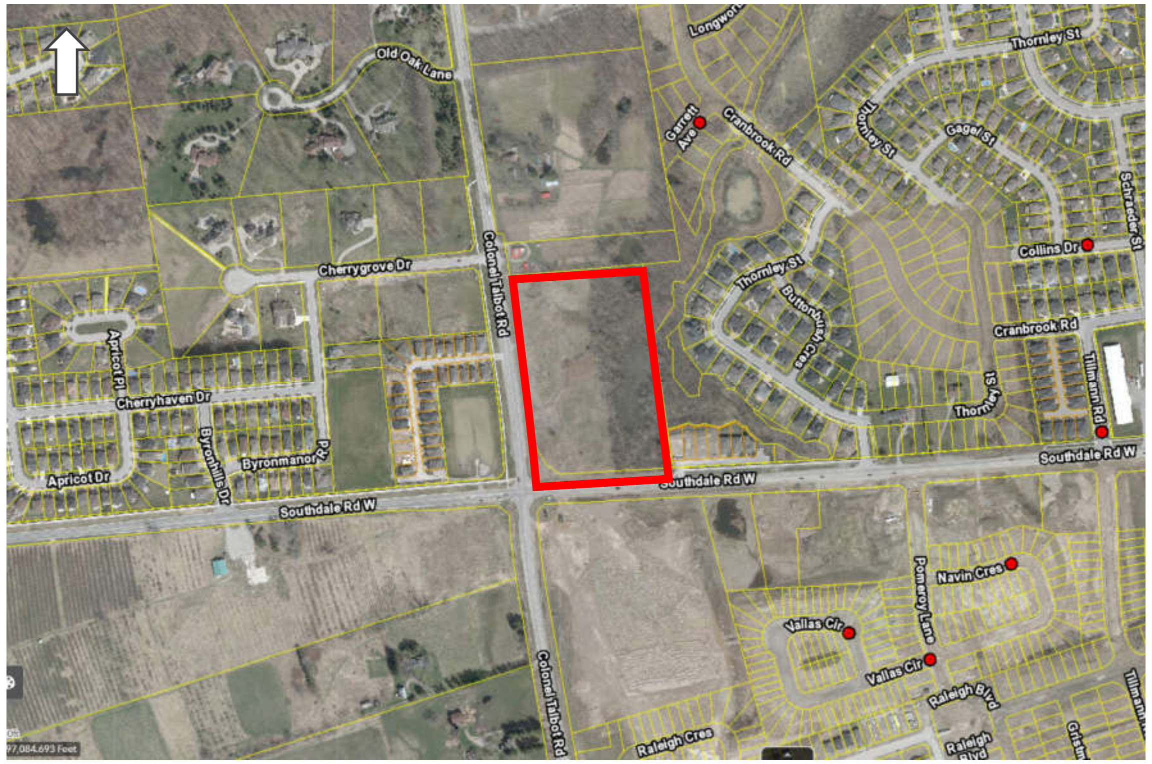
DRAWING NAME

Historical Aerial Photographs

SCALE	**PROJECT NO.**
NTS	GE-00085
DATE	**DRAWING NO.**
July 2021	2A

2005 Aerial Photo (City of London, database)

2010 Aerial Photograph (City of London, database)



2015 Aerial Photo (City of London, database

2020 Aerial Photo (City of London, database)

SOURCE:

City of London Air Photo Collection

LDS

PROJECT NAME

1739626 Ontario Ltd
Proposed Commercial Development

PROJECT LOCATION

952 Southdale Road West
London, Ontario

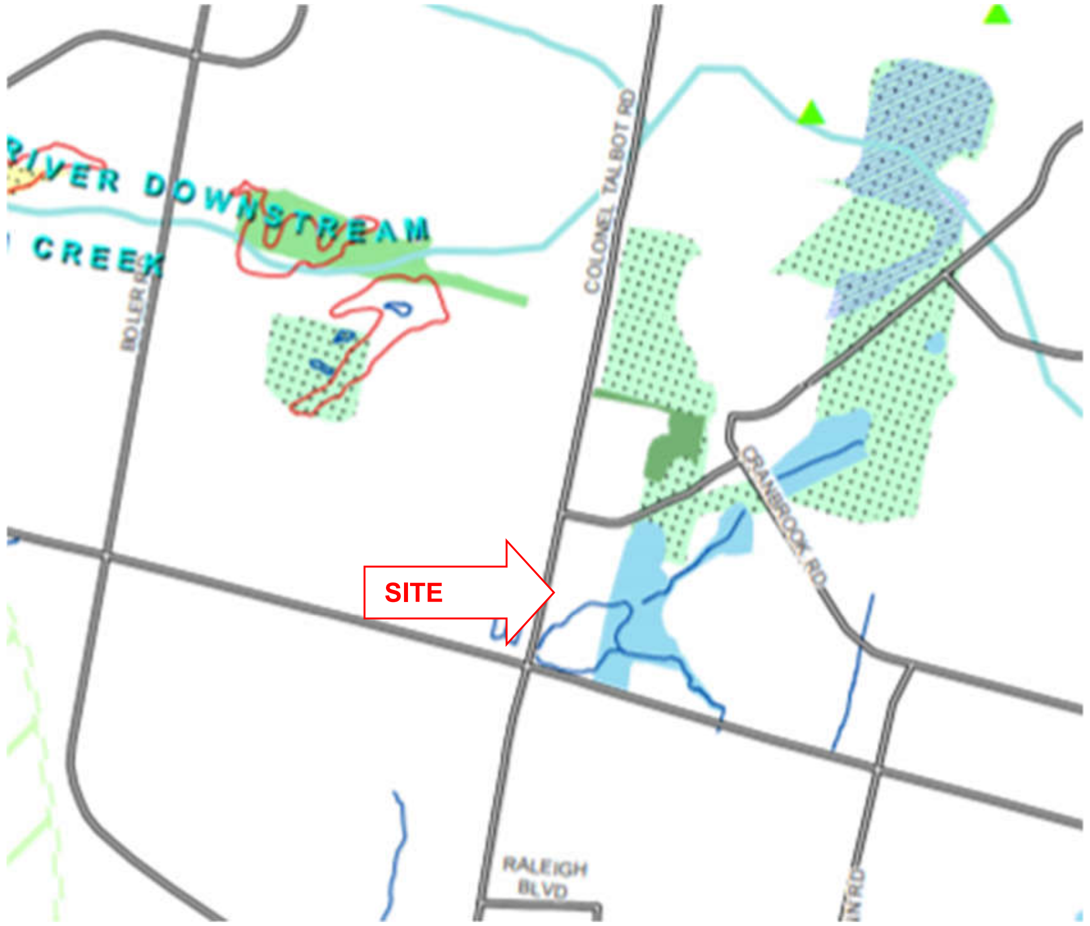
DRAWING NAME

Historical Aerial Photographs

SCALE	**PROJECT NO.**
NTS	GE-00085
DATE	**DRAWING NO.**
August 2021	2B

City of London Official Plan (1989) Schedule B1 – Map 6

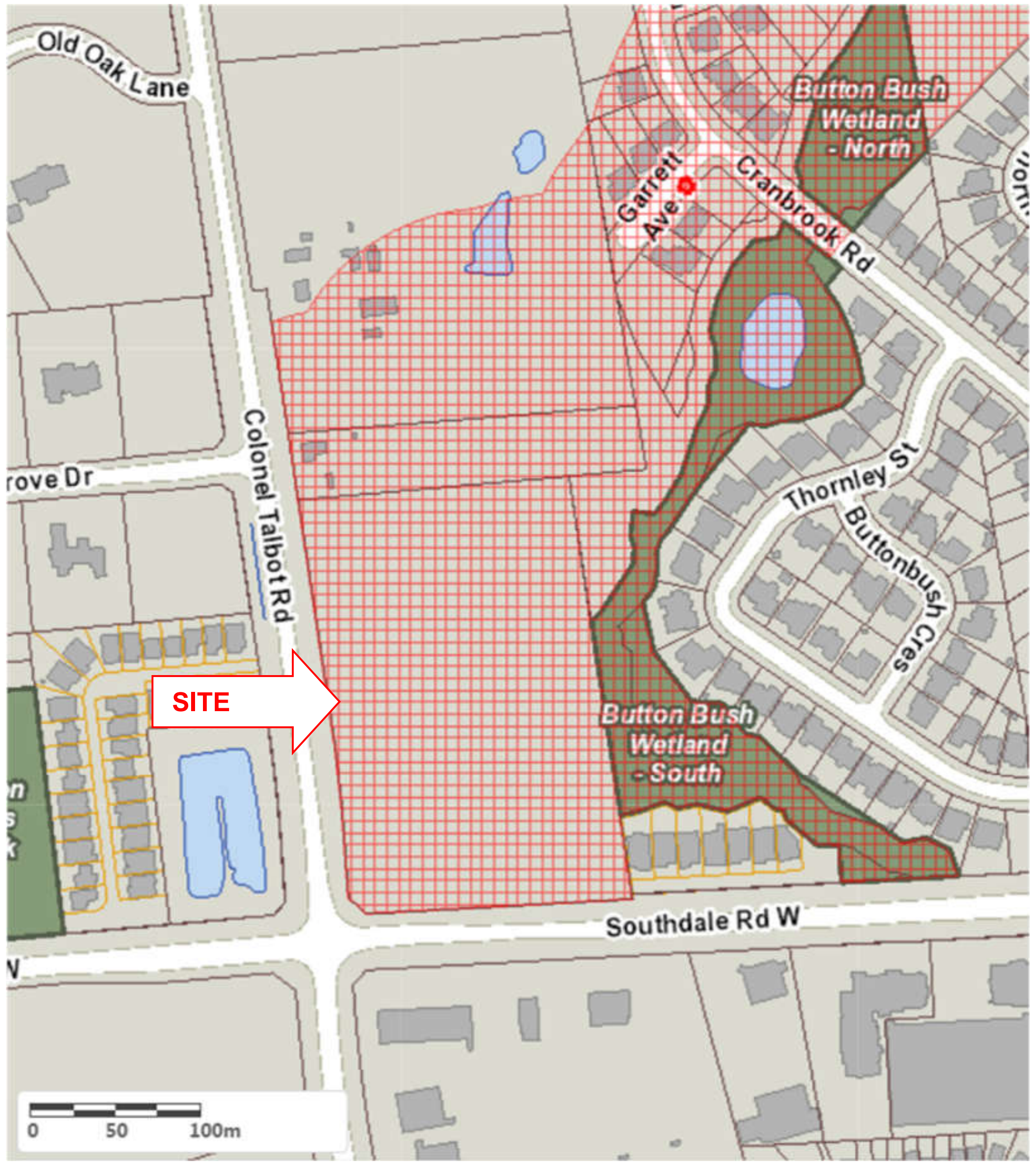
Natural Heritage Features Overlay



LEGEND

- 🟨 ESAs
- ▦ Potential ESAs
- 🟩 Significant Woodlands
- ☐ Unevaluated Corridors
- 🟦 Prov Significant Wetlands
- ▨ Locally Significant Wetlands
- ▒ Ground Water Recharge
- ⋀ Max Hazard Line
- ⋀ Cons. Authority Bndry
- 🟩 Woodlands
- ▦ Unevaluated Vegetation Patches
- 🟧 Significant Corridors
- ▨ Unevaluated Wetlands
- ▲ Pot Naturalization Area
- ▲ Pot Upland Corridor
- ⋀ SWS Bndry
- ▨ Big Picture Meta-Cores and Meta-Corridors

UTRCA Regulated Lands



LEGEND

▦ UTRCA Regulated Lands

SOURCE:

City of London Online Mapping, www.maps.london.ca/CityMap/Index.html?viewer= zoning

Note: Borehole/monitoring well locations are approximate.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Natural Heritage Features and
UTRCA Regulated Lands

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	3

SOURCE:

Site Plan, prepared by SRM Architects Inc., dated 08 18 2021.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

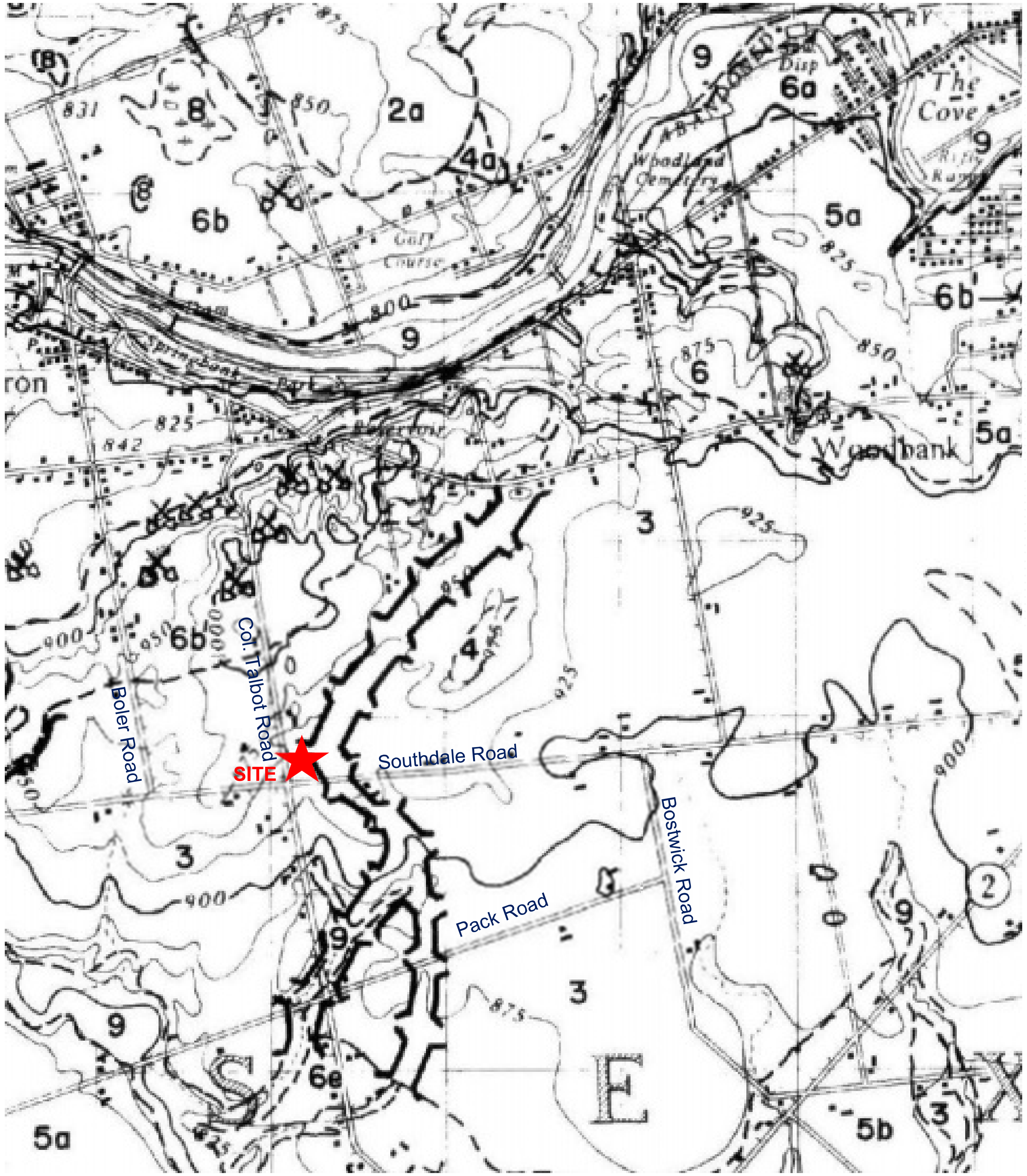
PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Concept Plan

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	4



LEGEND

Recent

9	Modern alluvium: Gravel, sand, and silt, containing organic remains
8	Swamps and bogs: Peat, muck, marl

Recent and Late Wisconsin

7	Aeolian: Fine sand; low dunes and sand plains, mostly in areas of former sandy deltaic, lacustrine and beach deposits, and eastward of them

Late Wisconsin

Glacio-lacustrine and Glacio-fluvial

6	Gravel and gravelly sand 6e Beach deposits L.Wa.: Lake Warren L.Wh.: Lake Whittlesey L.A.: Lake Arkona L.M.III: Lake Maumee III L.M.II. Lake Maumee II 6d Deltaic deposits in Lake Warren and Lake Arkona 6c Deltaic deposits in Lake Whittlesey 6b Deltaic deposits in Lake Maumee II, covered by a veneer of silty sand of Lake Maumee III; 6b′-older than L. Maur 6a Valley trains
5	Silt, silty sand, and clay; lacustrine deposits; level or slightly hummocky topography (in stagnant ice areas): 5b Silty sand and very fine to fine sand predominates 5a Clay and clayey silt predominates

Glacio-lacustrine and glacial, undifferentiated

4	Stagnant ice moraine: hills and ridges of lacustrine silt and sand, or silty clay till, deposited in crevasses and pits in stagnant ice area, inundated by lake 4a Silt and sand predominates

Glacial. Erie lobe

3	Port Stanley silty clay till and clayey silt till, in places covered by thin patches of lacustrine silt; ground moraine plains and end moraine ridges; slightly undulating topography, except for the more hilly slopes of the Ingersoll end moraine

SYMBOLS

Raised shoreline: Well developed

Raised shoreline: Poorly developed

Raised shoreline: Modified by associated stagnant ice and lacustrine deposits, particularly silt knolls

Stream trench

Direction of glacial movement, concluded from alignment of pebbles in till

SOURCE

Ontario Department of Mines, Preliminary Geological Map No. 238, Pleistocene Geology of the St. Thomas Area (West Half), Southern Ontario, issued 1964.

PROJECT NAME

Proposed Residential &
Commercial Development

PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Pleistocene Geology

SCALE	PROJECT NO.
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	5

SOURCE

Google Earth Pro, Version 7.3.2.5491, 17T, 474190.38 m E, 4753946.39 m N, Imagery Date 7/2/2018

NOTES

Borehole locations surveyed by LDS.

PROJECT NAME

Proposed Residential & Commercial Development

PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

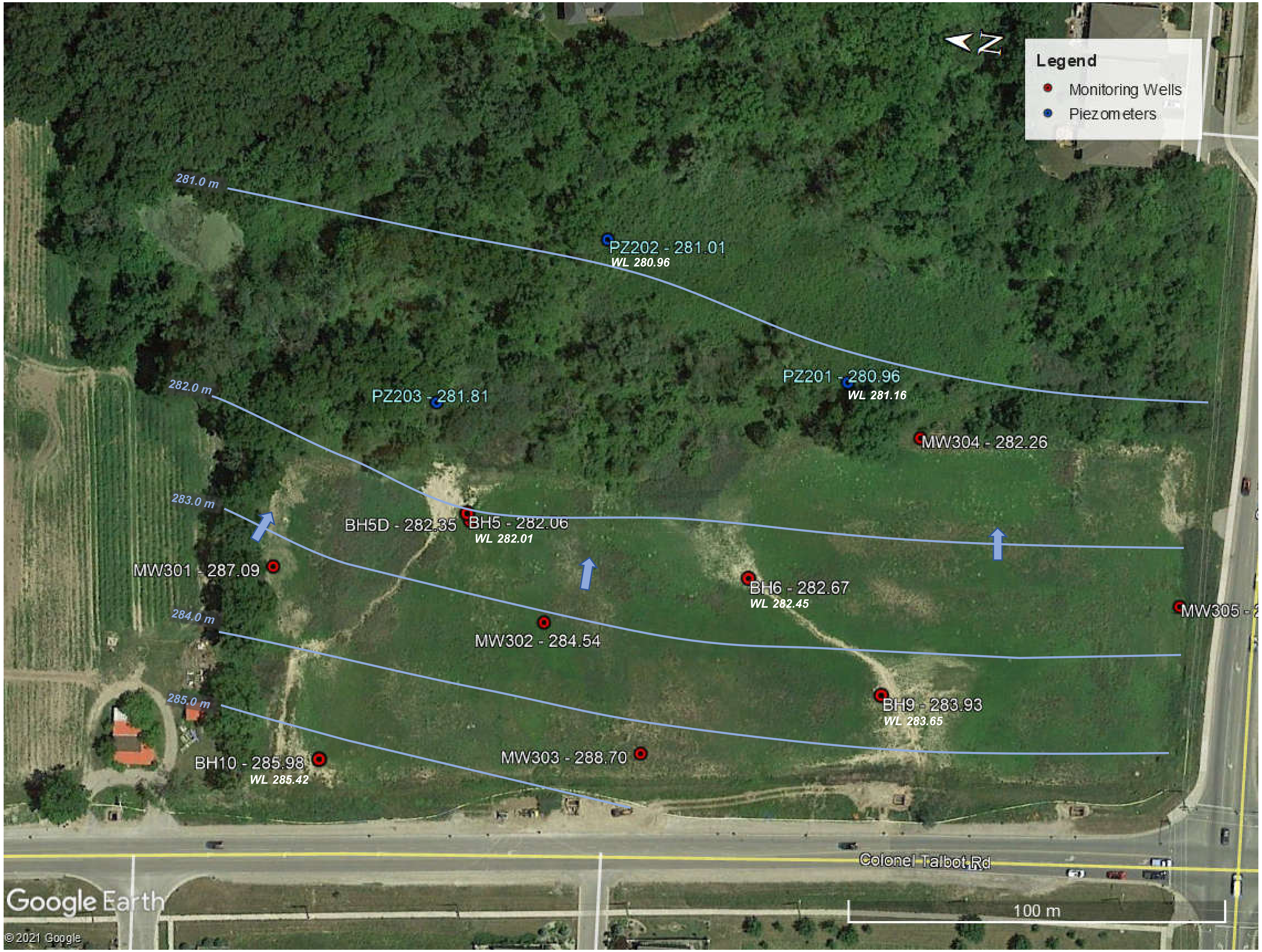
Borehole Location Plan

SCALE
As Shown

PROJECT NO.
GE-00085

DATE
August 2021

DRAWING NO.
6



LEGEND

— Groundwater Piezometric Contour, m

⇨ Inferred Groundwater Flow Direction

SOURCE

Google Earth Pro, Version 7.3.2.5491,
17T, 474190.38 m E, 4753946.39 m N,
Imagery Date 7/2/2018

NOTES

Borehole locations surveyed by LDS. Water levels measured March 21, 2018.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Groundwater Contour Plan
Spring 2018

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	7

LEGEND

Groundwater Piezometric Contour, m

Inferred Groundwater Flow Direction

SOURCE

Google Earth Pro, Version 7.3.2.5491,
17T, 474190.38 m E, 4753946.39 m N,
Imagery Date 7/2/2018

NOTES

Borehole locations surveyed by LDS. Water levels measured May 28, 2019.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

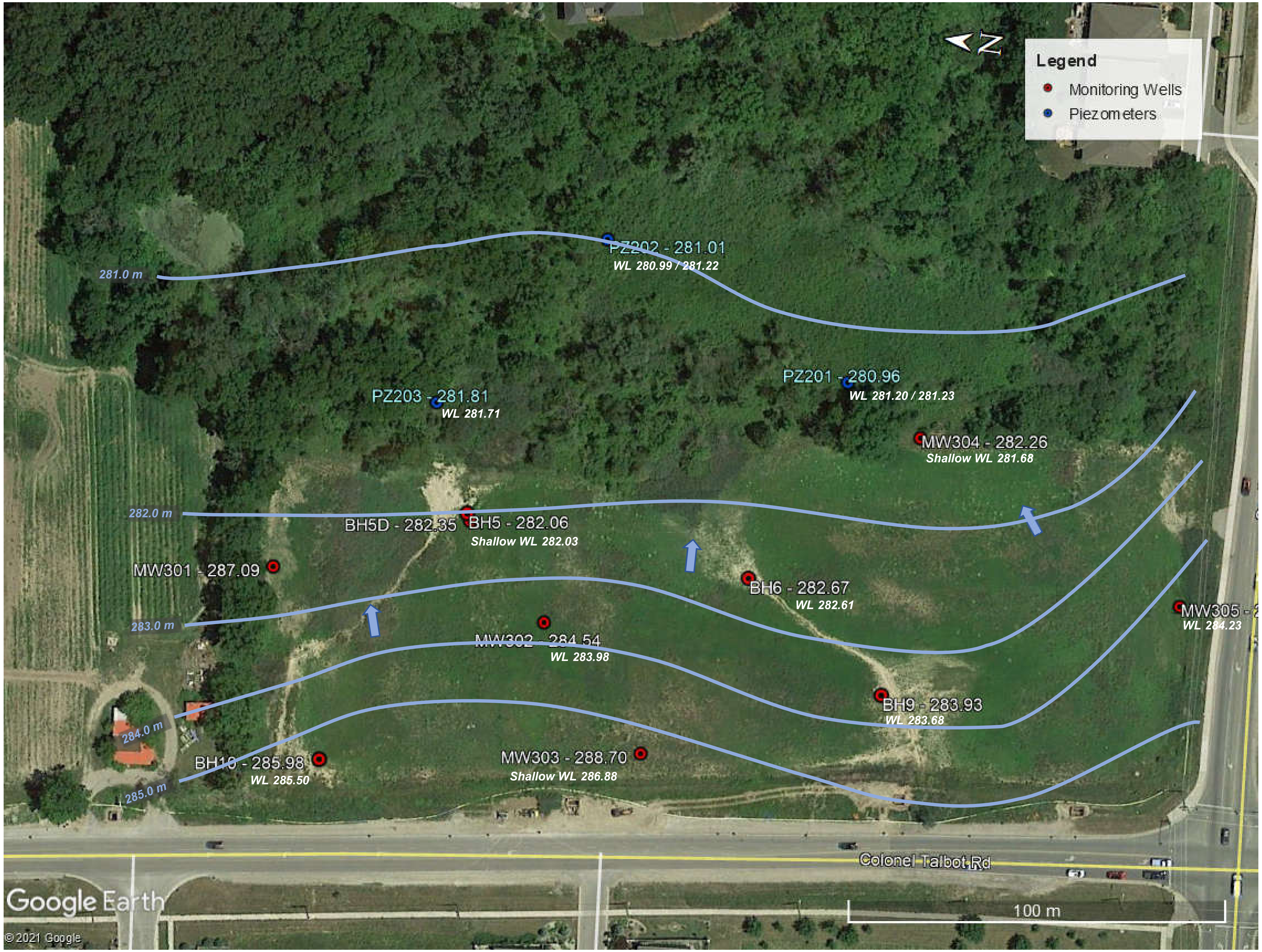
PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Groundwater Contour Plan
Spring 2019

SCALE	PROJECT NO.
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	8



LEGEND

Groundwater Piezometric Contour, m

Inferred Groundwater Flow Direction

SOURCE

Google Earth Pro, Version 7.3.2.5491,
17T, 474190.38 m E, 4753946.39 m N,
Imagery Date 7/2/2018

NOTES

Borehole locations surveyed by LDS. Water levels measured March 25, 2021.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

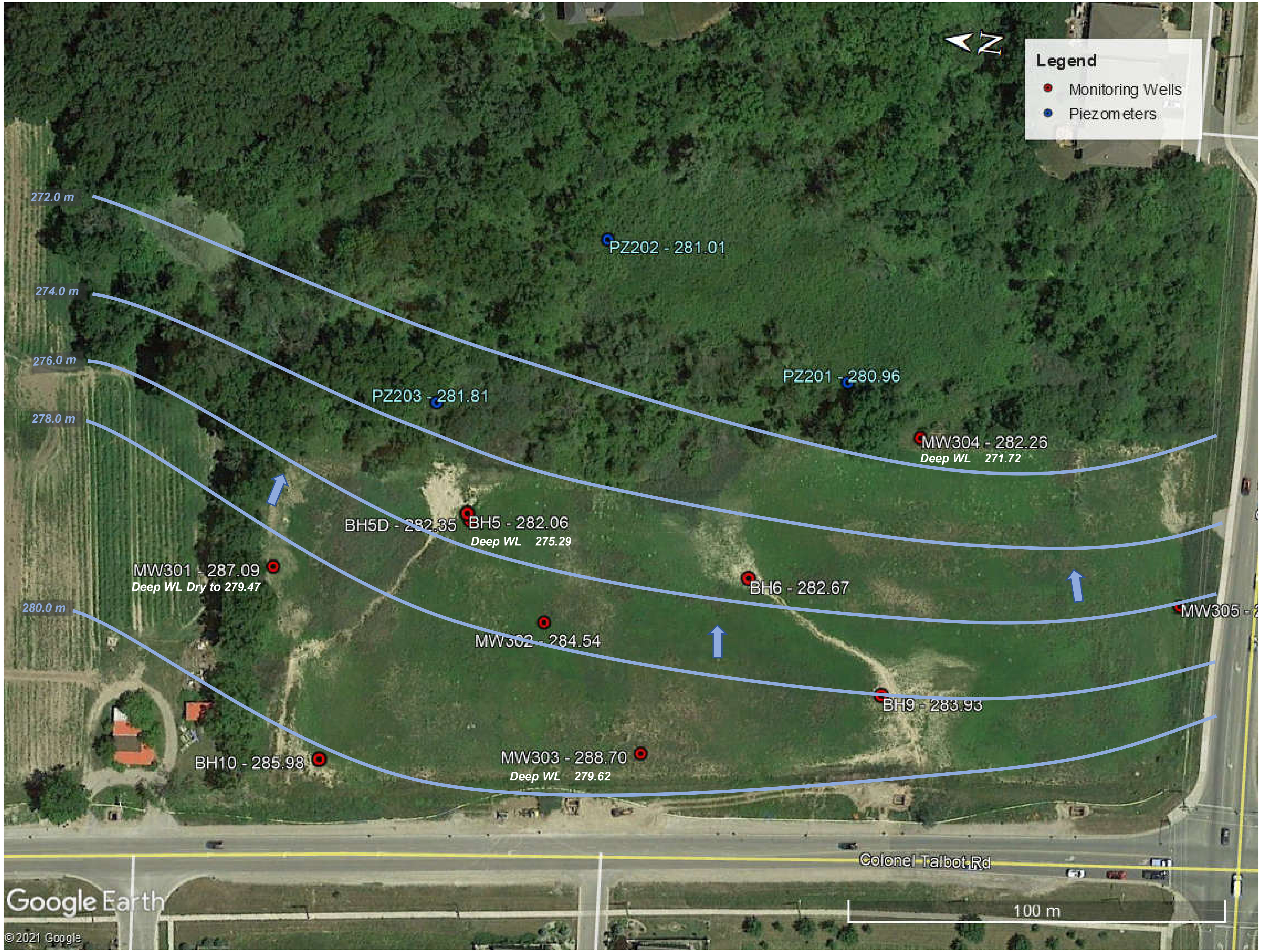
PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Groundwater Contour Plan
Spring 2021 – Shallow Wells

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	9A



LEGEND

— Groundwater Piezometric Contour, m

⇨ Inferred Groundwater Flow Direction

SOURCE

Google Earth Pro, Version 7.3.2.5491,
17T, 474190.38 m E, 4753946.39 m N,
Imagery Date 7/2/2018

NOTES

Borehole locations surveyed by LDS. Water levels measured March 25, 2021.

LDS

PROJECT NAME

Proposed Residential &
Commercial Development

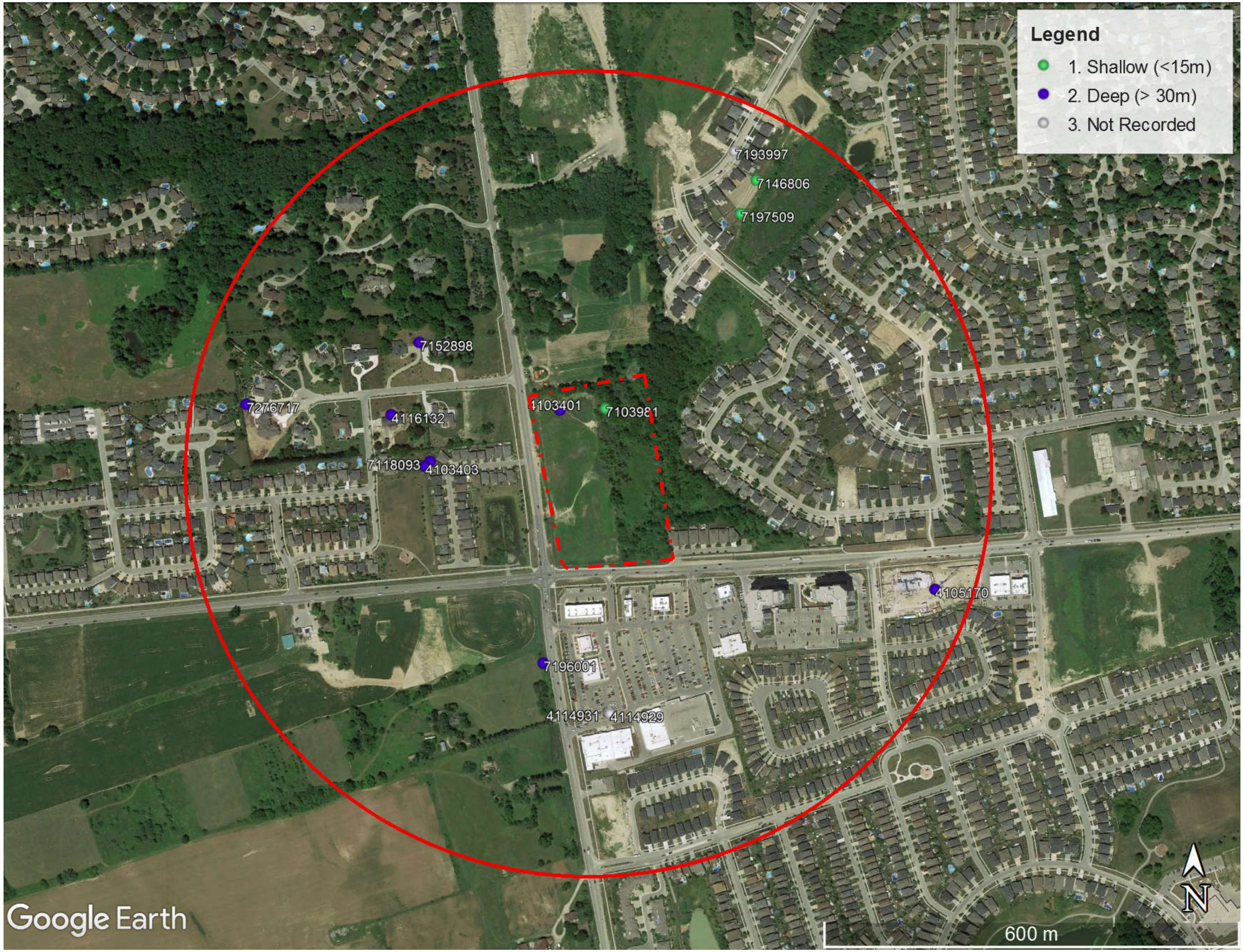
PROJECT LOCATION

952 Southdale Road
London, Ontario

DRAWING NAME

Groundwater Contour Plan
Spring 2021 – Deep Wells

SCALE As Shown	**PROJECT NO.** GE-00085
DATE August 2021	**DRAWING NO.** 9B



LEGEND

● MECP Well Locations &
Well Registration No.

NOTE: Water Supply Wells
4103401, 4103403, 4105170,
718093, 7276717

All other wells are identified as observation or monitoring wells, or well abandonment records.

PROJECT NAME

1739626 Ontario Ltd
Proposed Commercial Development

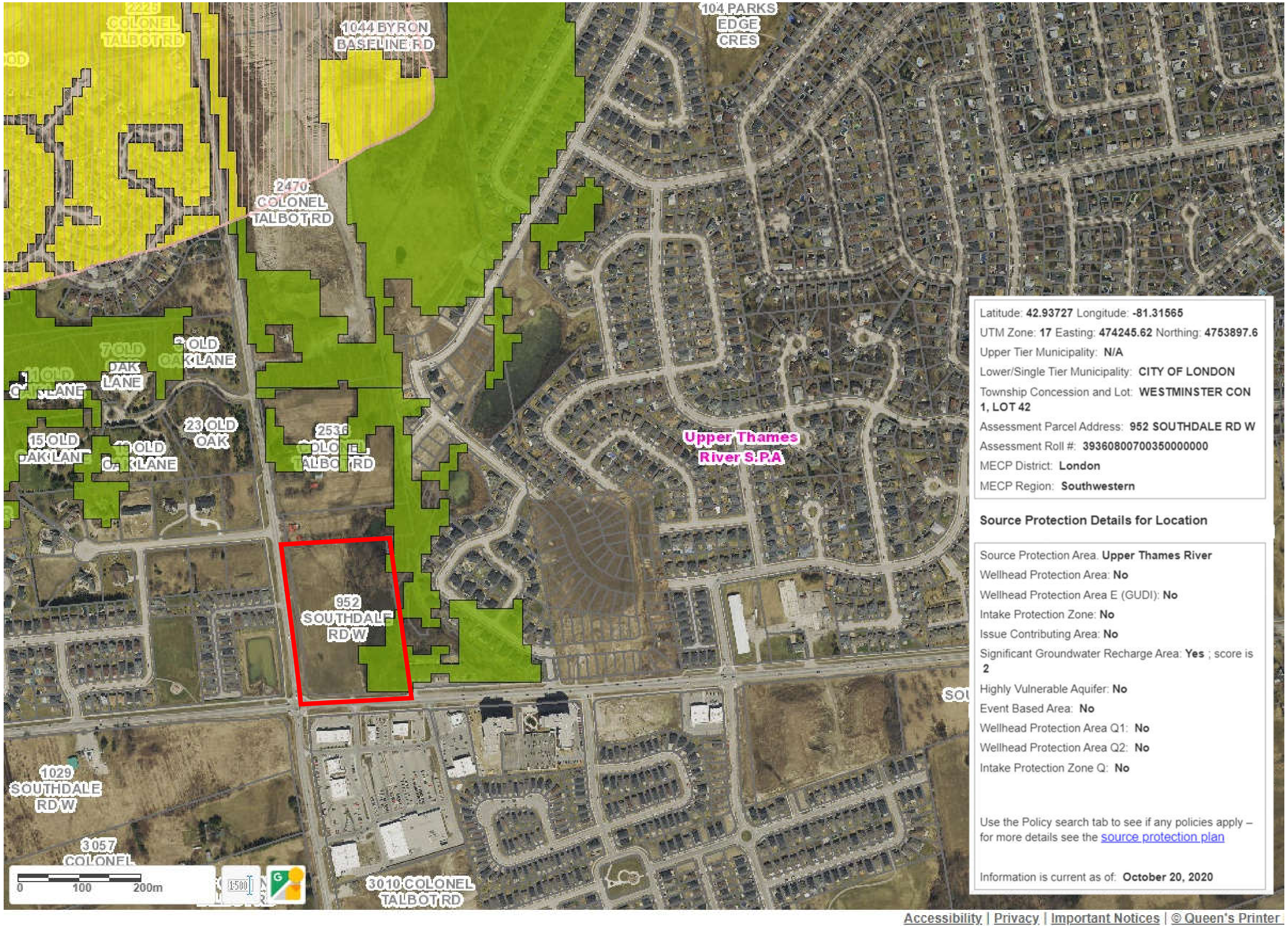
PROJECT LOCATION

952 Southdale Road West
London, Ontario

DRAWING NAME

MECP Well Record
Location Plan

SCALE	**PROJECT NO.**
As Shown	GE-00085
DATE	**DRAWING NO.**
August 2021	10



Latitude: **42.93727** Longitude: **-81.31565**
UTM Zone: **17** Easting: **474245.62** Northing: **4753897.6**
Upper Tier Municipality: **N/A**
Lower/Single Tier Municipality: **CITY OF LONDON**
Township Concession and Lot: **WESTMINSTER CON 1, LOT 42**
Assessment Parcel Address: **952 SOUTHDALE RD W**
Assessment Roll #: **393608007003500000000**
MECP District: **London**
MECP Region: **Southwestern**

Source Protection Details for Location

Source Protection Area: **Upper Thames River**
Wellhead Protection Area: **No**
Wellhead Protection Area E (GUDI): **No**
Intake Protection Zone: **No**
Issue Contributing Area: **No**
Significant Groundwater Recharge Area: **Yes** ; score is **2**
Highly Vulnerable Aquifer: **No**
Event Based Area: **No**
Wellhead Protection Area Q1: **No**
Wellhead Protection Area Q2: **No**
Intake Protection Zone Q: **No**

Use the Policy search tab to see if any policies apply – for more details see the source protection plan

Information is current as of: **October 20, 2020**

LEGEND:

☑ Significant Groundwater Recharge Area
- 🟩 0
- 🟩 2
- 🟩 4
- 🟨 6

☑ ▨ Highly Vulnerable Aquifers

SOURCE:

Source Protection Information Atlas, MECP
www.gisapplication.lrc.gov.on.ca/
SourceWaterProtection/
Current to October 20, 2020.

PROJECT NAME

1739626 Ontario Ltd
Proposed Commercial Development

PROJECT LOCATION

952 Southdale Road West
London, Ontario

DRAWING NAME

Source Water Protection Mapping

SCALE	**PROJECT NO.**
As Shown	GE-00009
DATE	**DRAWING NO.**
August 2021	11

APPENDIX B

Borehole Logs & Grain Size Analyses

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the Canadian Foundation Engineering Manual soil classification system, based on visual and tactile examination which are consistent with field identification procedures. Soil descriptions and classifications are based on Unified Soil Classification System (USCS), based on visual and tactile observations. Where grain size analyses have been specified, mechanical grain size distribution has been used to confirm soil classification.

Soil Classification
Clay: < 0.002 mm
Silt: 0.002 – 0.075 mm
Sand: 0.075 – 4.75 mm
Gravel: 4.75 mm – 75 mm
Cobbles: 75 – 200 mm
Boulders: > 200 mm

Terminology & Proportion
Trace: < 10%
Some: 10-20%
Adjective, sandy, gravelly, etc.: 20-35%
And, and gravel, and silt, etc.: > 35%
Noun, Sand, Gravel, Silt, etc.: > 35% and main fraction

2. The compactness of cohesionless soils is based on excavator / drilling resistance, and Standard Penetration Test (SPT) N-values where available. The Canadian Foundation Engineering Manual provides the following summary for reference.

Compactness of Cohesionless Soils	SPT N-Value (# blows per 0.3 m penetration of split-spoon sampler)
Very Loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	50+

3. Topsoil Thickness - It should be noted that topsoil quantities should not be established from information provided at test hole locations only. If required, a more detailed analysis with additional test holes may be recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

4. Fill material is heterogeneous in nature, and may vary significantly in composition, density and overall condition. Where uncontrolled fill is contacted, it is possible that large obstructions or pockets of otherwise unsuitable or unstable soils may be present beyond test hole locations.

5. Where glacial till is referenced, this is indicative of material which originates from a geological process associated with glaciation. Because of this geological process, till must be considered heterogeneous in composition and as such, may contain pockets and / or seams of material such as sand, gravel, silt or clay. Till often contains cobbles or boulders and therefore, contractors may encounter them during excavation, even if they are not indicated on the logs. Where soil samples have been collected using borehole sampling equipment, it should be understood that normal sampling equipment can not differentiate size or type of obstruction. Horizontal and vertical variability occurs in till, therefore the sample description may be applicable to a very limited area.

6. Consistency of cohesive soils is based on tactile examination and undrained shear strength where available. The Canadian Foundation Engineering Manual provides the following summary for field identification methods and classification by corresponding undrained shear strength.

Consistency of Cohesive Soils	Field Identification	Undrained Shear Strength (kPa)
Very Soft	Easily penetrated several cm by the fist	0 – 12
Soft	Easily penetrated several cm by the thumb	12 – 25
Firm	Can be penetrated several cm by the thumb with moderate effort	25 – 50
Stiff	Readily indented by the thumb, but penetrated only with great effort	50 – 100
Very Stiff	Readily indented by the thumb nail	100 – 200
Hard	Indented with difficulty by the thumbnail	200+

	Project	**Hydrogeological Assessment**	Borehole ID
	Project Location	**952 Southdale Road West, London**	**1**
	Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**September 25, 2017**	Ground Surface Elevation	**286.60 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Hollow Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						<u>TOPSOIL</u> - brown sandy loam (75 mm)	
0.5						**<u>SILT TILL</u>** - brown, some clay, trace sand and fine gravel, very stiff, damp	
1.0	◪	1	70	17			*MC = 16.8*
1.5							
	◪	2	60	16			
2.0							
2.5	◪	3	90	18		- some fine sand layering (~50 mm) at 2.5 m depth	*MC = 19.1*
3.0							
	◪	4	80	16			
3.5							
4.0							
4.5							
	◪	5	80	12			
5.0							
5.5					*5.50m*		
						<u>SANDY SILT TILL</u> - brown, trace fine gravel, trace clay, very dense, moist	
6.0							
	◪	6	80	79			*MC = 21.2*
6.5							
7.0							
7.5							
	◪	7	70	87	*8.08m*		
8.0						BH Terminated at 8.08 m depth	
						Open and dry upon completion	

<u>Legend</u>

- ◪ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

<u>Well Construction Details</u>

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

<u>Additional Notes</u>

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**2**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**September 25, 2017**	Ground Surface Elevation	**284.01 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Hollow Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
					▨	**TOPSOIL** - brown sandy loam (75 mm)	
0.5					▨	**SANDY SILT** - brown, intermittent topsoil inclusions to 1.4 m depth, loose, moist	
1.0	◩	1	70	5	▨		*MC = 16.5*
1.5					▨		
	◩	2	80	4	▨		
2.0					*2.15m*		
2.5	◩	3	90	19	🟩	**SILT TILL** - brown to grey, trace clay, trace gravel, very	*MC = 18.9*
3.0					🟩		
	◩	4	90	18	🟩	- becoming grey below 3.0 m depth	
3.5					🟩		
4.0					🟩		
4.5					🟩		
	◩	5	90	13	🟩		
5.0					🟩		
5.5					🟩		
6.0					🟩		
	◩	6	80	12	🟩		*MC = 17.4*
6.5					🟩		
7.0					🟩		
7.5					🟩		
	◩	7	70	15	*8.08m*		
8.0						BH Terminated at 8.08 m depth Open and dry upon completion	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**3**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**September 25, 2017**	Ground Surface Elevation	**285.99 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Hollow Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown sandy loam (100 mm)	
0.5						**SILT** - brown, trace sand, dense, damp	
1.0	◩	1	60	40	*1.42m*		*MC = 11.5*
1.5	◩	2	75	22		**SILT TILL** - brown, some clay, trace sand, trace fine gravel, very stiff, moist	*MC = 22.4*
2.0							
2.5	◩	3	70	18		- contains some fine sand layering at 2.3 m depth	
3.0	◩	4	90	22			*MC = 18.7*
3.5							
4.0							
4.5	◩	5	80	14		- brown / grey mottled, and stiff below 4.5 m depth	
5.0							
5.5							
6.0	◩	6	70	12		- grey below 6.0 m depth	*MC = 19.6*
6.5							
7.0							
7.5	◩	7	70	14	*8.08m*		
8.0						BH Terminated at 8.08 m depth Open and dry upon completion	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC denotes moisture content

			Borehole ID
LDS	Project	**Hydrogeological Assessment**	**4**
	Project Location	**952 Southdale Road West, London**	
	Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**286.62 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown sandy loam (50 mm)	
						SANDY SILT - brown, trace to some gravel, loose, damp	
0.5							
1.0							Sample 1 *Gravel - 5.9%* *Sand - 31.6%* *Fines - 62.5%* *MC = 8.3*
1.5	☒	1					
2.0					*2.42m*		
2.5						**SILT TILL** - brown, some clay, trace sand and fine gravel, firm to stiff, moist	
3.0	☒	2					
3.5							
4.0							
4.5	☒	3					*MC = 15.9*
5.0							
5.5							
6.0	☒	4				- some sand present below 6.0 m depth	
6.5							
7.0							
7.5	☒	5				- becoming grey below 7.5 m depth	*MC = 17.6*
8.0					*8.08m*	BH Terminated at 8.08 m depth Open and dry upon completion	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC denotes moisture content

LDS

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**5/MW Shallow**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**September 25, 2017**	Ground Surface Elevation	**282.06 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**DRY**
Drilling Method	**Hollow Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						SANDY SILT - brown, trace gravel, loose, moist	
0.5							
1.0		1	60	4			*MC = 8.9*
1.5							
		2	70	4		- very moist to wet near 1.8 m depth	*MC = 14.1*
2.0					*2.24m*		
2.5		3	80	5		**SILT TILL** - grey, some clay, trace sand and gravel, firm, moist	
3.0							
		4	70	9		- stiff below 3.1 m depth	*MC = 16.2*
3.5							
4.0							
4.5							
		5	90	17		- very stiff, and moist to very moist below 4.5 m depth	
5.0							
5.5					*5.80m*		
6.0						**SAND** - brown, fine to medium grained, trace gravel, trace silt, compact to dense, moist to very moist - wet at 6.4 m depth	
		6	80	34			*MC = 14.9*
6.5							
7.0							
7.5							
		7	70	16	*8.08m*	- contains some silt at 7.6 m bgs	*MC = 12.9*
8.0						BH Terminated at 8.08 m depth Open and dry upon completion	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well 1 - Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**2.44 m**
Screen Length	**1.52 m**
Depth of Bentonite Seal	**0-0.6 m**

Well Equipped with lockable cap.

Screen length backfilled with Type 2 filter sand.

Well 2 - Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**7.65 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0-4.3m**

Well Equipped with lockable cap.

Screen backfilled with Type 2 filter sand.

Note:
Deep well reported as damaged in Jan 2021. Refer to reinstallation details (Feb 2021) noted on following page.

Project	**Proposed Residential & Commercial Development**	Borehole ID	
Project Location	**952 Southdale Road, London, ON**		**5/MW Deep**
Project Number	**GE-00085**		*Sheet 1 of 1*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**282.35 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						TOPSOIL - brown, sandy loam, 152 mm	
0.5						**SILTY SAND** - brown, fine grained, wet	
1.0	◪	1	-	-			
1.5							
	◪	2	-	-			
2.0					*2.24 m*		
2.5	◪	3	-	-		**SILT TILL** - brown, some clay, trace sand, trace fine gravel, moist	
3.0							
	◪	4	-	-			
3.5							
4.0							
4.5							
	◪	5	-	-			
5.0							
5.5					*5.80 m*		
6.0						**SAND** - brown, fine to medium grained, trace gravel, trace silt, very moist	
	◪	6	-	-			
6.5							▼ May 30/21 WL - 6.68 m
7.0						- some silt observed below 7.1 m depth	
7.5							
	☐	7	-	-		Gradation: 0% Gravel, 90% Sand, 20% Fines (Silt/Clay)	*MC - 13.2%*
8.0					*8.08 m*	BH Terminated at 8.08 m MW Installed at 7.62 m - refer to details below	

Legend

◪ SPT Sample
☐ Bulk Sample
☐ Shelby Tube
▼ Stabilized Groundwater
▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	7.62 m
Screen Length	3.05 m w/ No. 2 filter sand
Depth of Bentonite Seal	2.44 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 5.38 m bgs
May 30, 2021 - WL, 6.68 m bgs

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**6 / MW**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**September 25, 2017**	Ground Surface Elevation	**282.67 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**8.0 m**
Drilling Method	**Hollow Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						SANDY SILT - brown, trace gravel, loose, moist	
0.5							
1.0		1	75	7			
1.5							
		2	70	5		- very moist to wet near 1.8 m depth	
2.0					*2.13m*		
						SILT TILL - mottled brown to grey to 2.4 m depth, some clay, trace gravel, very stiff, moist	
2.5		3	60	20			
3.0							
		4	60	22			
3.5							
4.0							
4.5							
		5	70	26			
5.0							
5.5							
6.0							
		6	80	15			
6.5							
7.0							
7.5							
		7	70	19	*8.08m*		
8.0						BH Terminated at 8.08 m depth	
						Open with 50-75mm of water at base	

Legend

◩	SPT Sample
☒	Bulk Sample
▥	Shelby Tube
▼	Stabilized Groundwater
▽	Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**2.44 m**
Screen Length	**1.52 m**
Depth of Bentonite Seal	**0 to 0.6 m**

Well Equipped with lockable cap.

Screen length backfilled with Type 2 filter sand.

Additional Notes

MC denotes moisture content

Note:
Well reported as damaged in Jan 2021. Refer to reinstallation details (Feb 2021) noted on following page.

LDS

Project	**Proposed Residential & Commercial Development**	Borehole ID	**6/MW**
Project Location	**952 Southdale Road, London, ON**		
Project Number	**GE-00085**		*Sheet 1 of 1*

Date Drilled	**February 11, 2021**	Ground Surface Elevation	**282.94 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown, sandy loam, 152 mm	
0.5						**SILTY SAND** - brown, fine grained, saturated	
1.0	◩	1	-	-			▼ May 30/21 WL - 0.72 m
1.5							
	◩	2	-	-			*MC - 27.8%*
2.0							
					2.44 m		
2.5	◩	3	-	-		**SILT TILL** - brown, some clay, trace sand, trace fine gravel, moist	
3.0							
	◩	4	-	-	*3.51 m*		*MC - 25.4%*
3.5						BH Terminated at 3.51 m MW Installed at 3.05 m - refer to details below	
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
				-			
8.0							

Legend

- ◩ SPT Sample
- ⊠ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	3.05 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	1.53 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 0.62 m bgs
May 30, 2021 - WL, 0.72 m bgs

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**7**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**282.56 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						SANDY SILT - brown, trace clay, trace gravel, loose, moist	
0.5							
1.0					*1.36m*		
1.5	☒	1				**SILT TILL** - brown, some clay, trace sand and fine gravel, stiff, moist	*MC = 16.8*
2.0							
2.5							
3.0	☒	2					
3.5						- becoming grey below 3.5 m depth	
4.0							
4.5	☒	3				- stiff to very stiff below 4.5 m depth	*MC = 18.4*
5.0							
5.5							
6.0	☒	4					
6.5							
7.0							
7.5	☒	5			*8.08m*		
8.0						BH Terminated at 8.08 m depth Open and dry upon completion	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

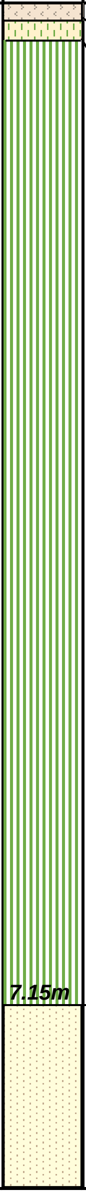
Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID	**8**
Project Location	**952 Southdale Road West, London**		
Project Number	**GE-00085**		*Sheet 1 of 2*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**281.65 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**



Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Material Description**	**Remarks and Other Tests**
					TOPSOIL - brown sandy loam (100 mm)	
					SANDY SILT - brown, loose, moist (150 mm)	
0.5					**SILT TILL** - brown, some clay, trace fine gravel, trace sand, firm to stiff, moist	
1.0	☒	1				*MC = 20.1*
1.5						
	◩	2	90	21		
2.0						
2.5	☒	3			- becoming grey and stiff below 2.5 m depth	*MC = 18.7*
3.0						
	◩	4	80	28		
3.5						
4.0						
4.5						
	◩	5	80	24		
5.0						
5.5						
6.0						
	☒	6				
6.5						
7.0						
					SILTY SAND - brown, fine grained, trace gravel, compact, damp to moist	
7.5						
	☒	7				*MC = 7.3*
8.0						

BH continued on following page

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**No well installation**
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

Additional Notes

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID	
Project Location	**952 Southdale Road West, London**	**8**	
Project Number	**GE-00085**	*Sheet 2 of 2*	

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**281.65 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**None observed**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						<u>SILTY SAND</u> - brown, trace gravel, trace clay, compact, damp to moist	
8.5					*8.52m*		
	☒	8				**<u>SILT TILL</u>** - grey, some clay, trace sand, very stiff, moist	
9.0							
9.5							
10.0							
	☒	9					
10.5					*10.67m*		
						BH Terminated at 10.67 m depth Open and dry upon completion	
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

<u>Legend</u>

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

<u>Well Construction Details</u>

Pipe Diameter	--
Installation Depth	--
Screen Length	--
Depth of Bentonite Seal	--

<u>Additional Notes</u>

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**9 / MW**
Project Number	**GE-00085**	*Sheet 1 of 2*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**283.93 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**DRY**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.5					0.76m	**SANDY SILT** - brown, trace gravel, trace clay, loose, moist	
1.0						**SILT TILL** - grey, some clay, trace sand and gravel, firm, moist to very moist	
1.5	☐	1					
2.0							
2.5						- moist, stiff below 2.5 m depth	
3.0	☐	2					
3.5							
4.0							
4.5	☐	3					
5.0							
5.5							
6.0	☐	4				- very stiff below 6.0 m depth	
6.5							
7.0							
7.5	☐	5					
8.0							

BH continued on following page

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**3.96 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 to 0.6 m**

Well Equipped with lockable cap.

Screen length backfilled with Type 2 filter sand.

Additional Notes

MC denotes moisture content

Project	**Hydrogeological Assessment**	Borehole ID
Project Location	**952 Southdale Road West, London**	**9 / MW**
Project Number	**GE-00085**	*Sheet 2 of 2*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**283.93 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**DRY**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					▥	**SILT TILL** - grey, some clay, trace sand and gravel, very stiff, moist	
8.5	☐	8			▥		
9.0					▥		
9.5					▥		
10.0	☐	9			▥		
10.5					10.67m		
11.0						BH Terminated at 10.67 m depth Open and dry upon completion	
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**3.96 m**
Screen Length	**3.05 m w/ Type 2 sand**
Depth of Bentonite Seal	**0 to 0.6 m**

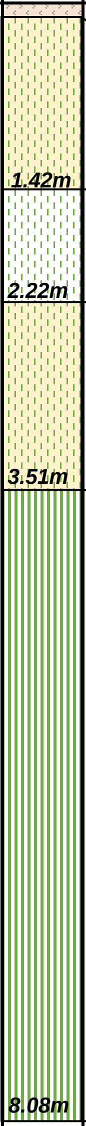
Note: Well equipped with lockable cap

Additional Notes

MC denotes moisture content

Project	**Hydrogeological Assessment**		Borehole ID
Project Location	**952 Southdale Road West, London**		**10 / MW**
Project Number	**GE-00085**		*Sheet 1 of 1*

Date Drilled	**October 2, 2017**	Ground Surface Elevation	**285.98 m**
Drill Rig	**LST - Track**	Groundwater Level at Completion	**4.5 m**
Drilling Method	**Solid Stem Augers**	Technician	**Nick Houlton**
Drilling Contractor	**London Soil Test Ltd**	Checked By	**R. Walker, P.Eng.**



Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown sandy loam (75 mm)	
0.5						**SANDY SILT** - brown, trace gravel, trace clay, loose, moist	
1.0	☐	1					*MC = 12.6*
1.5	☐	2			1.42m	**SILT** - brown / grey mottled, some clay, some sandy silt layering, moist, firm	
2.0					2.22m		
2.5	☐	3				**SILTY SAND** - brown, fine to medium grained, trace clay, loose, moist	Sample 3 *Gravel - 2.2%* *Sand - 57.9%* *Fines - 39.9%*
3.0	☐	4					*MC = 11.0*
3.5					3.51m	**SILT TILL** - grey, some clay, trace sand, stiff to very stiff,	
4.0							
4.5	☐	5					*MC = 20.3*
5.0							
5.5							
6.0	☐	6					*MC = 17.7*
6.5							
7.0							
7.5	☐	7					
8.0					8.08m	BH Terminated at 8.08 m depth Open to 4.5 m, water at 4.5 m	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**4.57 m**
Screen Length	**3.05 m**
Depth of Bentonite Seal	**0 to 1.2 m**

Well Equipped with lockable cap.

Screen length backfilled with Type 2 filter sand.

Additional Notes

MC denotes moisture content

Project **Hydrogeological Assessment**
Project Location **952 Southdale Road West, London**
Project Number **GE-00085**

Auger Probe
101
Sheet 1 of 1

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						SANDY SILT- brown, some topsoil and organic inclusions, wet	
0.25							
0.50							
0.75	☒	1					
1.00					*1.06m*		
1.25	☒	2				**SILT TILL** - brown, some clay, moist	
1.50					*1.52m*		
1.75						Hole Terminated at 1.52 m bgs.	
2.00							☒ Bulk Sample

Project **Hydrogeological Assessment**
Project Location **952 Southdale Road West, London**
Project Number **GE-00085**

Auger Probe
102
Sheet 1 of 1

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						SANDY SILT- brown, some topsoil and organic inclusions, wet	
0.25							
0.50							
0.75	☒	1					
1.00							
1.25							
1.50					*1.52m*		
1.75	☒	2			*1.82m*	**SILT TILL** - mottled brown-grey, some clay, moist	
2.00						Hole Terminated at 1.82 m bgs.	☒ Bulk Sample

LDS

Project **Hydrogeological Assessment**
Project Location **952 Southdale Road West, London**
Project Number **GE-00085**

Auger Probe
103
Sheet 1 of 1

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
0.25	☒	1				**SANDY SILT**- brown, some topsoil and organic inclusions, wet	
0.50					*0.61m*		
0.75						**SILT TILL** - mottled brown-grey, some clay, moist	
1.00							
1.25	☒						
1.50		2			*1.52m*		
1.75						Hole Terminated at 1.52 m bgs.	
2.00							☒ Bulk Sample

LDS

Project **Hydrogeological Assessment**
Project Location **952 Southdale Road West, London**
Project Number **GE-00085**

Auger Probe
104
Sheet 1 of 1

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
0.25						**SANDY SILT**- brown, some topsoil and organic inclusions, wet	
0.50	☒	1					
0.75					*0.91m*		
1.00						**SILT TILL** - mottled brown-grey, some clay, moist	
1.25	☒						
1.50		2			*1.52m*		
1.75						Hole Terminated at 1.52 m bgs.	
2.00							☒ Bulk Sample

Project	**Hydrogeological Assessment**	Auger Probe
Project Location	**952 Southdale Road West, London**	**105**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
0.25	☒	1				**SANDY SILT**- brown, some topsoil and organic inclusions, wet	
0.50							
0.75							
1.00					*1.07m*		
1.25	☒	2				**SILT TILL** - mottled brown-grey, some clay, moist	
1.50					*1.52m*		
1.75						Hole Terminated at 1.52 m bgs.	
2.00							☒ Bulk Sample

Project	**Hydrogeological Assessment**	Auger Probe
Project Location	**952 Southdale Road West, London**	**106**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**October 2, 2017**	Drilling Contractor	**London Soil Test Ltd**
Drill Rig	**LST - Track**	Technician	**Nick Houlton**
Drilling Method	**Solid Stem Augers**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
0.25						**SANDY SILT**- brown, some topsoil and organic inclusions, wet	
0.50	☒	1			*0.61m*		
0.75						**SILT TILL** - mottled brown-grey, some clay, moist	
1.00							
1.25							
1.50	☒	2			*1.52m*		
1.75						Hole Terminated at 1.52 m bgs.	
2.00							☒ Bulk Sample

	Project	**Hydrogeological Assessment**	Piezometer **201** **Shallow** *Sheet 1 of 1*
	Project Location	**952 Southdale Road West, London**	
	Project Number	**GE-00085**	

Date Drilled	**October 20, 2017**	Ground Surface Elevation	**281.01 m**
Drill Rig		Groundwater Level at Completion	**0.05 m**
Drilling Method	**Hand-held Auger**	Technician	**Rob Walker**
Drilling Contractor	**LDS Consultants**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
	☒	1			▼ ▨	**TOPSOIL & ORGANICS** - (300 mm)	
0.25					▨		
	☒	2			▥	**SANDY SILT**- brown, some topsoil and organic inclusions, saturated	
0.50					▥		
						Hole Terminated at 0.55 m bgs.	
0.75							
1.00							
1.25							
1.50							
1.75							
2.00							

Legend

- ◩ SPT Sample
- ☐ Bulk Sample
- ☐ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**0.55 m**
Screen Length	**0.35 m**
Depth of Bentonite Seal	**none**

Piezometer equipped with lockable cap.

Additional Notes

Water Levels
Oct 20 2017 - 0.05 m depth
Oct 23 2017 - 0.17 m depth
Nov 08 2017 - 0.10 m above ground
Dec 01 2017 - at ground surface
Jan 10 2018 - frozen

		Piezometer **201** **Deep** *Sheet 1 of 1*
Project	**Hydrogeological Assessment**	
Project Location	**952 Southdale Road West, London**	
Project Number	**GE-00085**	

Date Drilled	**February 18, 2021**	Ground Surface Elevation	**281.09 m**
Drill Rig		Groundwater Level at Completion	**frozen at surface**
Drilling Method	**Hand-held Auger**	Technician	**Rob Walker**
Drilling Contractor	**LDS Consultants**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
					▨	**TOPSOIL & ORGANICS** - (300 mm), frozen	
0.25					▨		
0.50	☒	1			▥	**SANDY SILT**- brown, some topsoil and organic inclusions, wet	
0.75	☒	2			🟩	**SILT TILL** - mottled, brown-grey, trace sand and fine gravel, wet	
1.00						Hole Terminated at 0.91 m bgs.	
1.25							
1.50							
1.75							
2.00							

Legend

◩	SPT Sample
☐	Bulk Sample
☐	Shelby Tube
▼	Stabilized Groundwater
▽	Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**0.76 m**
Screen Length	**0.45 m**
Depth of Bentonite Seal	**none**

Piezometer equipped with lockable cap.

Additional Notes

LDS	Project	**Hydrogeological Assessment**	Piezometer
	Project Location	**952 Southdale Road West, London**	**PZ202A**
	Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**October 20, 2017**	Ground Surface Elevation	**280.96 m**
Drill Rig		Groundwater Level at Completion	**0.04 m**
Drilling Method	**Hand-held Auger**	Technician	**Rob Walker**
Drilling Contractor	**LDS Consultants**	Checked By	**R. Walker, P.Eng.**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
	☒	1			▼	**TOPSOIL & ORGANICS** - (1.0 m)	
0.25							
0.50							
	☒	2					
0.75							
1.00	☒	3				**SANDY SILT** - brown, some topsoil and organic inclusions, saturated	
						Hole Terminated at 1.21 m bgs.	
1.25							
1.50							
1.75							
2.00							

Legend

- ◩ SPT Sample
- ☐ Bulk Sample
- ☐ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**1.21 m**
Screen Length	**1.06 m**
Depth of Bentonite Seal	**none**

Piezometer equipped with lockable cap.

Project	**Hydrogeological Assessment**	Piezometer	
Project Location	**952 Southdale Road West, London**	**PZ202B**	
Project Number	**GE-00085**	*Sheet 1 of 1*	

Date Drilled	**October 20, 2017**	Ground Surface Elevation	**284.19 m**
Drill Rig		Groundwater Level at Completion	**frozen at surface**
Drilling Method	**Hand-held Auger**	Technician	**Rob Walker**
Drilling Contractor	**LDS Consultants**	Checked By	**R. Walker, P.Eng.**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					▨	**TOPSOIL & ORGANICS** - (0.28 m)	
0.25					▨	**SANDY SILT** - brown, some topsoil and organic inclusions, saturated	
0.50	☒	1			▨		
0.75					▨		
1.00					▨		
1.25	☒	2			▨	**SILT** - grey, some sand, damp, compact, wet	
						Hole Terminated at 1.35 m bgs.	
1.50							
1.75							
2.00							

Legend

- ◩ SPT Sample
- ☐ Bulk Sample
- ☐ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	**50 mm CPVC**
Installation Depth	**1.35 m**
Screen Length	**1.06 m**
Depth of Bentonite Seal	**none**

Piezometer equipped with lockable cap.

	Project	**Proposed Residential & Commercial Development**	Borehole ID
	Project Location	**952 Southdale Road, London, ON**	**PZ203**
	Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**Shallow - 281.69 m asl** **Deep - 281.66 m asl**
Drill Rig	**GeoProbe**		
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						TOPSOIL - brown, silty loam, 25 mm	
0.5						**SILTY SAND** - brown, fine grained, saturated	*MC - 18.6%*
1.0							
1.5	◩	1	-	-			*MC - 22.0%*
2.0							
					2.44 m		
2.5						**SILT TILL** - grey, trace clay, trace sand, trace fine gravel, damp	
3.0	◩	2	-	-	***3.51 m***		
3.5						BH Terminated at 3.51 m MW Installed at 3.05 m - refer to details below MC - denotes moisture content	
4.0							
4.5							
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details (Shallow)

Pipe Diameter	50 mm CPVC pipe
Installation Depth	1.21 m
Screen Length	0.45 m w/ No. 2 filter sand

Well equipped with locking J-Plug cap.

Well Construction Details (Deep)

Pipe Diameter	50 mm CPVC pipe
Installation Depth	3.51 m
Screen Length	1.52 m w/ sand
Depth of Bentonite Seal	1.22 m

Well equipped with locking J-Plug cap.

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**301/MW**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**287.09 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown, sandy loam, 152 mm	
0.5						**SILT TILL** - brown, some clay, trace sand, trace fine gravel, moist	
1.0							
1.5	◩	1	-	-			*MC - 15.0%*
2.0							
2.5	◩	2	-	-			*MC - 15.5%*
3.0	◩	3	-	-			*MC - 17.4%*
3.5							
4.0							
4.5	◩	4	-	-			*MC - 18.4%*
5.0							
5.5					*5.48 m*	**SAND** - brown, fine grained, trace to some grave, trace silt, damp	
6.0	◩	5	-	-		- damp gravelly sand seam encountered at 6.6 m depth	*MC - 2.9%*
6.5	◩	6	-	-		Gradation: 24% Gravel, 65% Sand, 11% Fines (Silt/Clay)	*MC - 1.9%*
7.0							
7.5	◩	7	-	-		- some silt observed below 8.0 m depth	*MC - 19.3%*
8.0					*8.08 m*		
						BH Terminated at 8.08 m MW Installed at 7.62 m - refer to details below	

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	7.62 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	4.88 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, Dry
May 30, 2021 - WL, Dry

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**302/MW**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**284.54 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	**Seepage at 4.3 m depth**
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown, sandy loam, 203 mm	
0.5						**SILT TILL** - brown/grey, mottled, weathered, trace sand, trace fine gravel, moist	
1.0	◩	1	-	-			*MC - 19.7%*
1.5						- becoming brown and less weathered below 1.4 m depth	
	◩	2	-	-			*MC - 16.1%*
2.0							
2.5	◩	3	-	-		- silt with trace to some fine sand below 2.4 m depth	*MC - 18.6%* ▼ **May 30/21 WL - 2.87 m**
3.0	◩	4	-	-			*MC - 18.9%*
3.5							
4.0						- becoming grey, contains some fine wet sand layering below 4.0 m depth	
4.5					▽ **4.3 m**		
5.0	◩	5	-	-	***5.03 m***		*MC - 19.0%*
						BH Terminated at 5.03 m MW Installed at 4.57 m - refer to details below	
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

◩ SPT Sample
☒ Bulk Sample
▥ Shelby Tube
▼ Stabilized Groundwater
▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	4.57 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	2.44 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 1.30 m bgs
May 30, 2021 - WL, 2.87 m bgs

Project	**Proposed Residential & Commercial Development**	Borehole ID	
Project Location	**952 Southdale Road, London, ON**	**303/MW - Shallow**	
Project Number	**GE-00085**	*Sheet 1 of 1*	

Date Drilled	**February 11, 2021**	Ground Surface Elevation	**288.70 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	**Seepage at 3.2 m depth**
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						TOPSOIL - brown, sandy loam, 152 mm	
0.5						**SILT TILL** - brown/grey, mottled, weathered, some clay, trace sand, trace fine gravel, moist	
1.0	◪	1	-	-			*MC - 17.9%*
1.5							
2.0	◪	2	-	-			*MC - 19.5%*
2.5	◪	3	-	-			▼ **May 30/21** **WL - 2.63 m**
3.0	◪	4	-	-	▽ 3.2 m	- becoming brown and less weathered below 2.9 m depth, with intermittent fine wet sand seams throughout	
3.5							
4.0	◪	5	-	-	*4.27 m*		*MC - 20.3%*
4.5						BH Terminated at 4.27 m MW Installed at 3.81 m - refer to details below	
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- ◪ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	3.81 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	1.98 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 1.95 m bgs
May 30, 2021 - WL, 2.63 m bgs

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**303/MW - Deep**
Project Number	**GE-00085**	*Sheet 1 of 2*

Date Drilled	**February 11, 2021**	Ground Surface Elevation	**288.70 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	**8.65 m depth at completion**
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
						TOPSOIL - brown, sandy loam, 152 mm	
0.5						**SILT TILL** - brown/grey, mottled, weathered, some clay, trace sand, trace fine gravel, moist	
1.0	◪	1	-	-			*MC - 17.9%*
1.5							
	◪	2	-	-			*MC - 19.5%*
2.0							
2.5	◪	3	-	-			*MC - 18.0%*
3.0						- becoming brown and less weathered below 2.9 m depth, with intermittent fine wet sand seams throughout	
	◪	4	-	-			
3.5							
4.0	◪	5	-	-			*MC - 20.3%*
4.5							
	◪	6	-	-			
5.0							
5.5							
6.0							
	◪	7	-	-			
6.5							
7.0					*7.09 m*		
						SAND - brown, fine grained, trace gravel, trace silt, very moist	
7.5							
	◪	8	-	-			*MC - 4.2%*
8.0							

continued on the following page

Legend

- ◪ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	9.14 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	7.32 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 9.03 m bgs
May 30, 2021 - WL, 9.10 m bgs

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**303/MW - Deep**
Project Number	**GE-00085**	*Sheet 2 of 2*

Date Drilled	**February 11, 2021**	Ground Surface Elevation	**288.70 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						continued from previous page	
8.5					▽ 8.65m	- becoming saturated, silty sand below 8.6 m depth	
9.0							▼ May 30/21 WL - 9.10 m
9.5	◩	9	-	-	*9.60 m*	Gradation: 0% Gravel, 64% Sand, 36% Fines (Silt/Clay)	
						BH Terminated at 9.60 m MW Installed at 9.14 m - refer to details below	
10.0							
10.5							
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	9.14 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	7.32 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 9.03 m bgs
May 30, 2021 - WL, 9.10 m bgs

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**304/MW - Shallow**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**282.26 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					▨	**TOPSOIL** - brown, silty loam, 152 mm	
0.5					▥	**SILT** - brown, weathered, some sand, damp	
1.0	◩	1	-	-	▥	-wet sandy silt seams below 1.1 m depth	▼ May 30/21 WL - 1.04 m
					1.37 m		
1.5					🟩		
	◩	2	-	-	🟩	**SILT TILL** - brown/grey, mottled, weathered, trace to some fine sand, trace fine gravel, damp	*MC - 17.3%*
2.0					🟩		
2.5	◩	3	-	-	🟩		*MC - 20.5%*
3.0	◩	4	-	-	🟩		*MC - 20.6%*
3.5					🟩	- becoming brown and less weathered below 3.7 m depth	
4.0	◩	5	-	-	🟩		*MC - 20.1%*
					4.27 m		
4.5						BH Terminated at 4.27 m MW Installed at 3.81 m - refer to details below	
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

- ◩ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	3.81 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	1.98 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 0.71 m bgs
May 30, 2021 - WL, 1.04 m bgs

LDS	Project	**Proposed Residential & Commercial Development**	Borehole ID
	Project Location	**952 Southdale Road, London, ON**	**304/MW - Deep**
	Project Number	**GE-00085**	*Sheet 1 of 2*

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**282.26 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					▒	**TOPSOIL** - brown, silty loam, 152 mm	
0.5					▥	**SILT** - brown, weathered, some sand, damp	
1.0	◪	1	-	-	▥ 1.37 m	-wet sandy silt seams below 1.1 m depth	*MC - 24.0%*
1.5	◪	2	-	-	🟩	**SILT TILL** - brown/grey, mottled, weathered, trace to some fine sand, trace fine gravel, damp	*MC - 19.5%*
2.0					🟩		
2.5	◪	3	-	-	🟩		*MC - 19.9%*
3.0	◪	4	-	-	🟩		
3.5					🟩	- becoming brown and less weathered below 3.7 m depth	
4.0	◪	5	-	-	🟩		
4.5	◪	6	-	-	🟩		*MC - 27.8%*
5.0					🟩		
5.5					🟩	- becoming grey below 5.6 m depth	
6.0	◪	7	-	-	🟩		*MC - 26.6%*
6.5					🟩		
7.0					🟩		
7.5	◪	8	-	-	🟩		*MC - 19.9%*
8.0					🟩		

continued on the following page

Legend

- ◪ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	10.67 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	8.53 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, Dry
May 30, 2021 - WL, Dry

LDS			Borehole ID
	Project	**Proposed Residential & Commercial Development**	**304/MW - Deep**
	Project Location	**952 Southdale Road, London, ON**	*Sheet 2 of 2*
	Project Number	**GE-00085**	

Date Drilled	**February 10, 2021**	Ground Surface Elevation	**282.26 m asl**
Drill Rig	**GeoProbe**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
					🟩	*continued from previous page*	
8.5					🟩		
9.0					🟩		
9.5	◪	9	-	-	🟩 *9.60 m*		*MC - 7.2%*
10.0					▨	**SAND** - brown, fine grained, trace gravel, trace silt, damp	
10.5					*10.51 m*		
11.0	◪	10	-	-	🟩 *11.13 m*	**SILT TILL** - grey, some clay, trace sand, trace fine gravel, damp	*MC - 20.4%*
11.5						BH Terminated at 11.13 m MW Installed at 10.67 m - refer to details below	
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							

Legend

- ◪ SPT Sample
- ☒ Bulk Sample
- ▥ Shelby Tube
- ▼ Stabilized Groundwater
- ▽ Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	10.67 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	8.53 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, Dry
May 30, 2021 - WL, Dry

Project	**Proposed Residential & Commercial Development**	Borehole ID
Project Location	**952 Southdale Road, London, ON**	**305/MW**
Project Number	**GE-00085**	*Sheet 1 of 1*

Date Drilled	**February 11, 2021**	Ground Surface Elevation	**284.77 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	
Drilling Method	**Hollow Stem Auger**	Technician	**Rob Walker**
Drilling Contractor	**London Soil Test**	Checked By	**S. Hadden, EIT**

Depth (m)	**Sample Type**	**Sample Number**	**Recovery (%)**	**SPT N-value (blows/0.3 m)**	**Graphic Log**	**Material Description**	**Remarks and Other Tests**
						TOPSOIL - brown, silty loam, 152 mm	
0.5						**SILT** - brown, weathered, some sand, moist	
1.0	◪	1	-	-			▼ May 30/21 WL - 1.02 m
1.5							
2.0	◪	2	-	-	*2.13 m*	- intermittent wet sand seams below 1.8 m depth	*MC - 11.7%*
2.5	◪	3	-	-		**SILT TILL** - brown/grey, mottled, weathered, some clay, some sand, trace fine gravel, damp - wet sand seams observed in Sample 3	*MC - 22.4%*
3.0							
3.5	◪	4	-	-			*MC - 21.0%*
4.0	◪	5	-	-	*4.27 m*	- becoming brown and less weathered below 4.0 m depth	*MC - 19.4%*
4.5						BH Terminated at 4.27 m MW Installed at 3.81 m - refer to details below	
5.0							
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							

Legend

◪	SPT Sample
☒	Bulk Sample
▥	Shelby Tube
▼	Stabilized Groundwater
▽	Inferred Groundwater

Well Construction Details

Pipe Diameter	50 mm CPVC pipe
Installation Depth	3.81 m
Screen Length	1.52 m w/ No. 2 filter sand
Depth of Bentonite Seal	1.98 m

Well equipped with locking J-Plug cap.

Additional Notes

MC - denotes moisture content

April 27, 2021 - WL, 0.70 m bgs
May 30, 2021 - WL, 1.02 m bgs

Particle Size Distribution
Results of Sieve Analysis

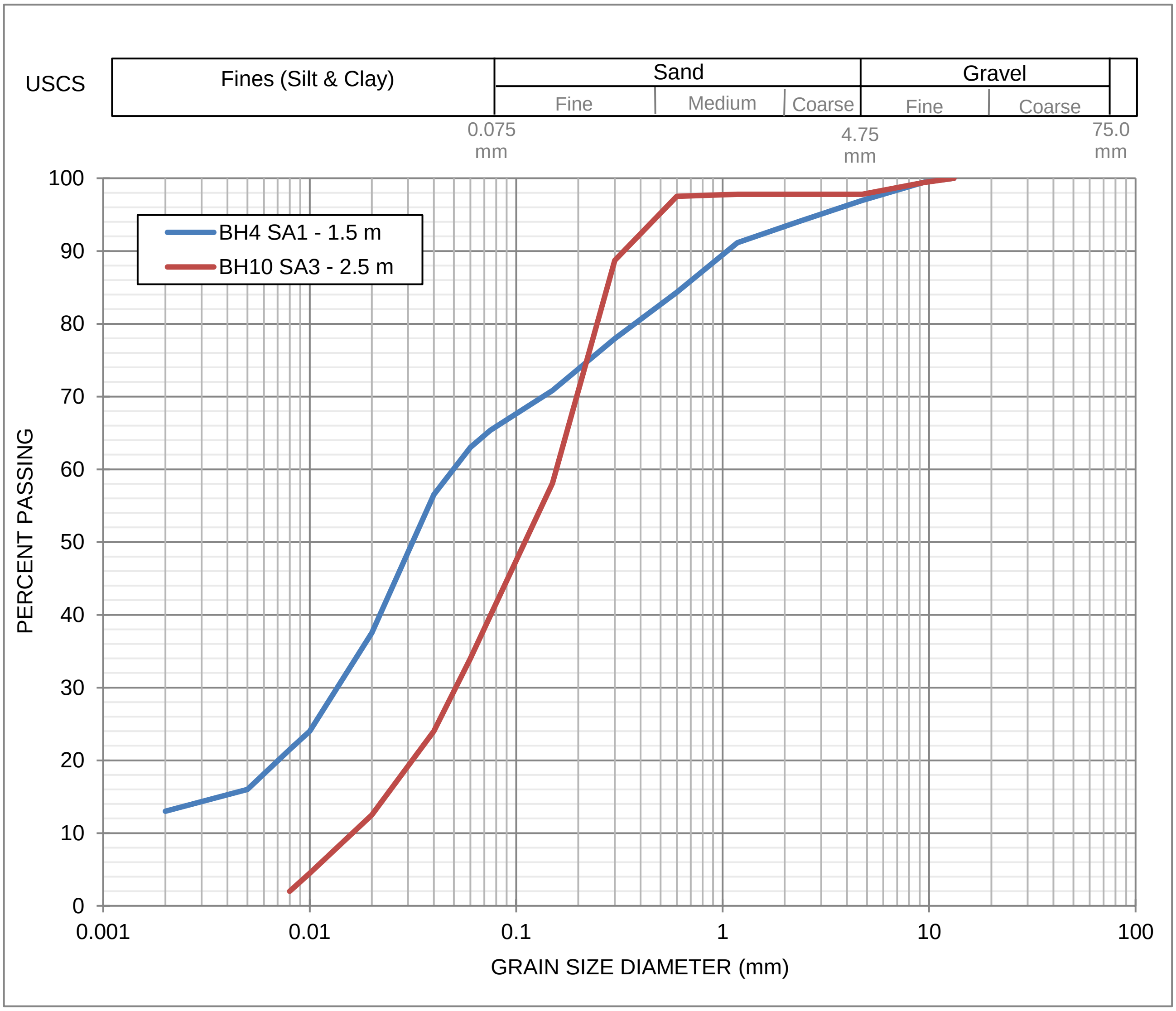
Project Name: 952 Southdale Road

Date: 25-Jan-18

Project Location: London, Ontario

Project No.: GE-00085

Sample ID	**Unified Soil Classification**				**Moisture Content**
	% Clay	**% Silt**	**% Sand**	**% Gravel**	
BH4 SA1 - 1.5 m	13.0%	52.4%	31.6%	3.1%	13.8%
BH10 SA3 - 2.5 m		39.9%	57.9%	2.2%	16.9%

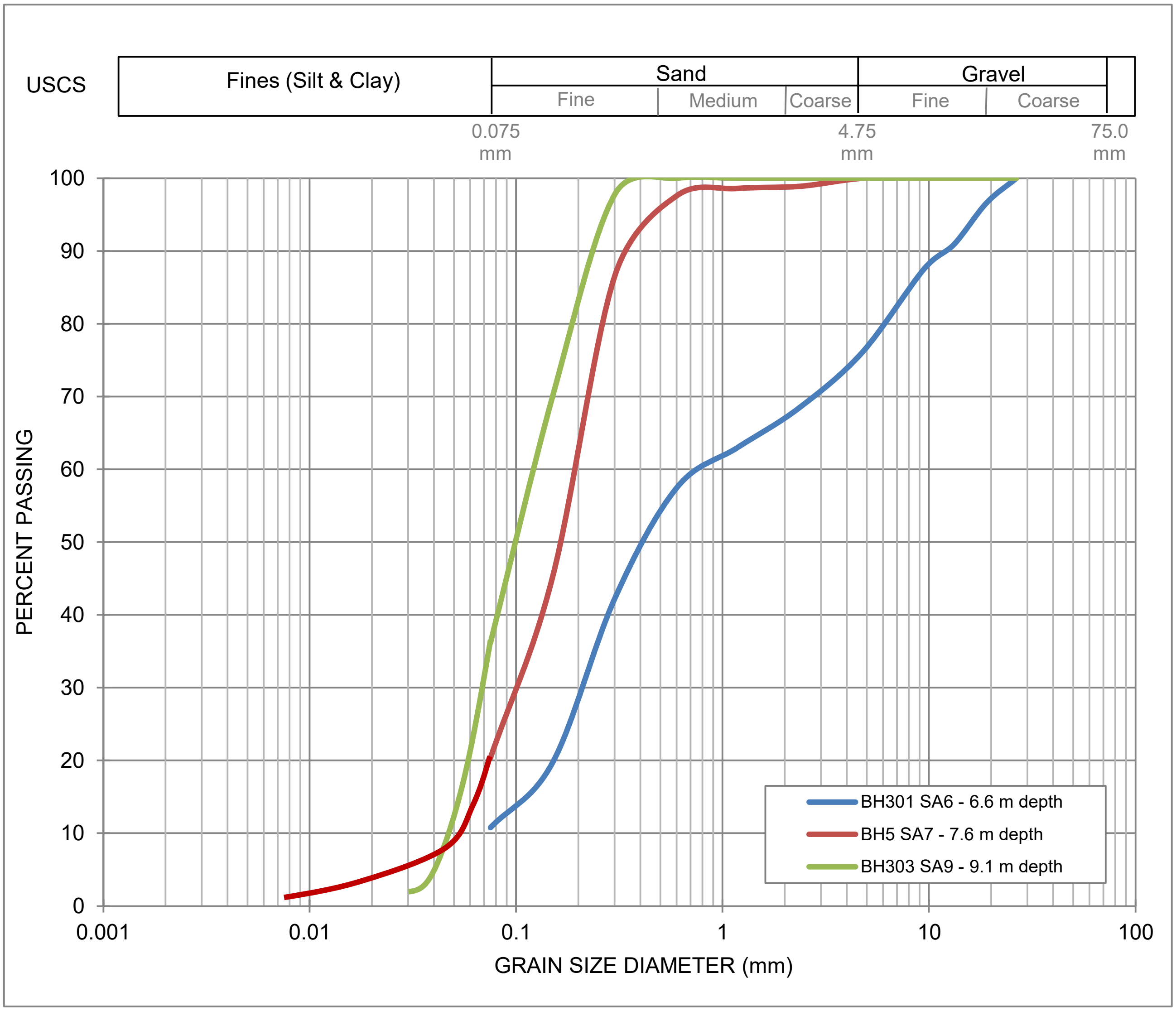


Particle Size Distribution
Results of Sieve Analysis

Project Name: Proposed Residential & Commercial Development **Date:** 4-Jun-21

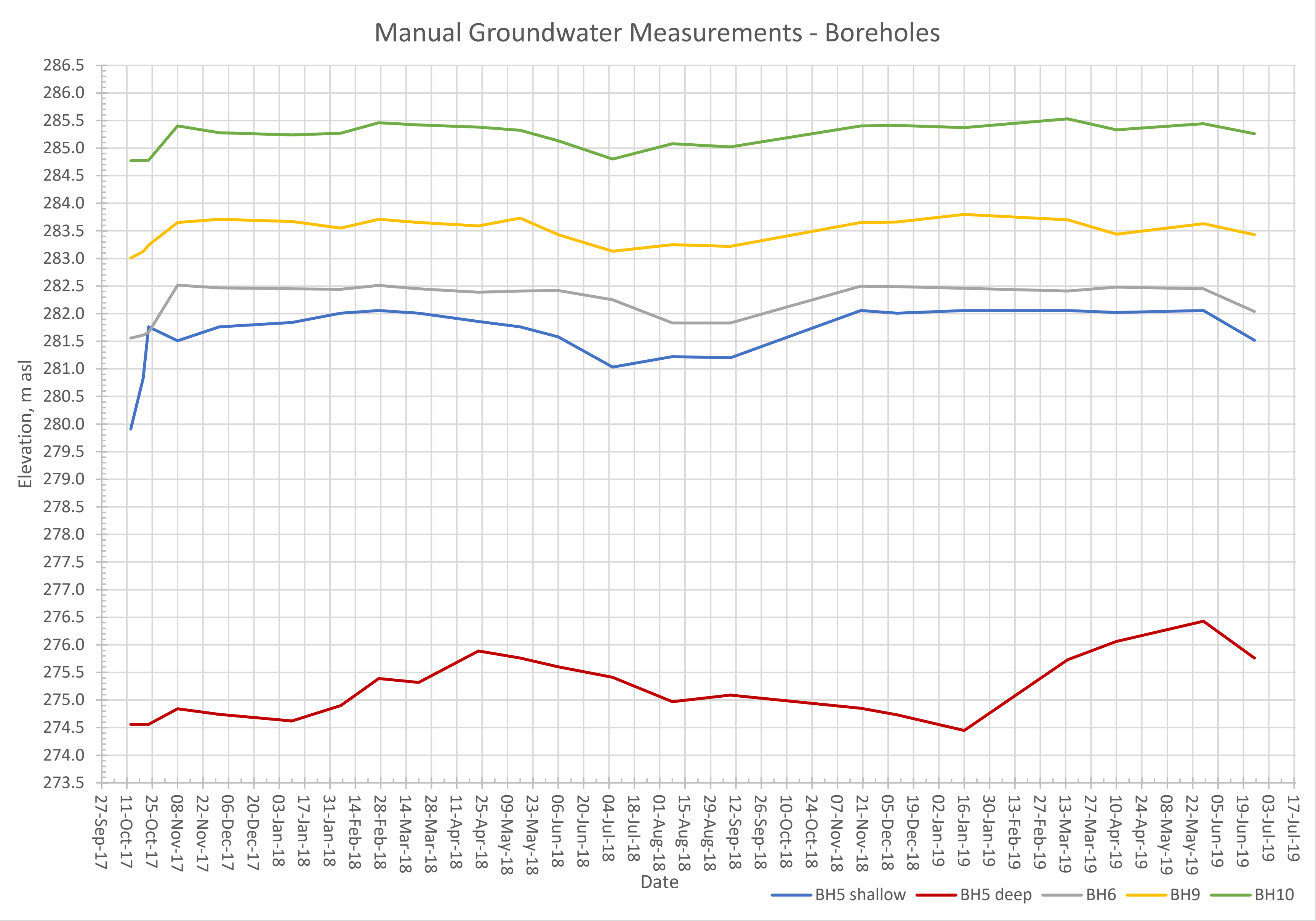
Project Location: 952 Southdale Rd, London, Ontario **Project No.:** GE-00085

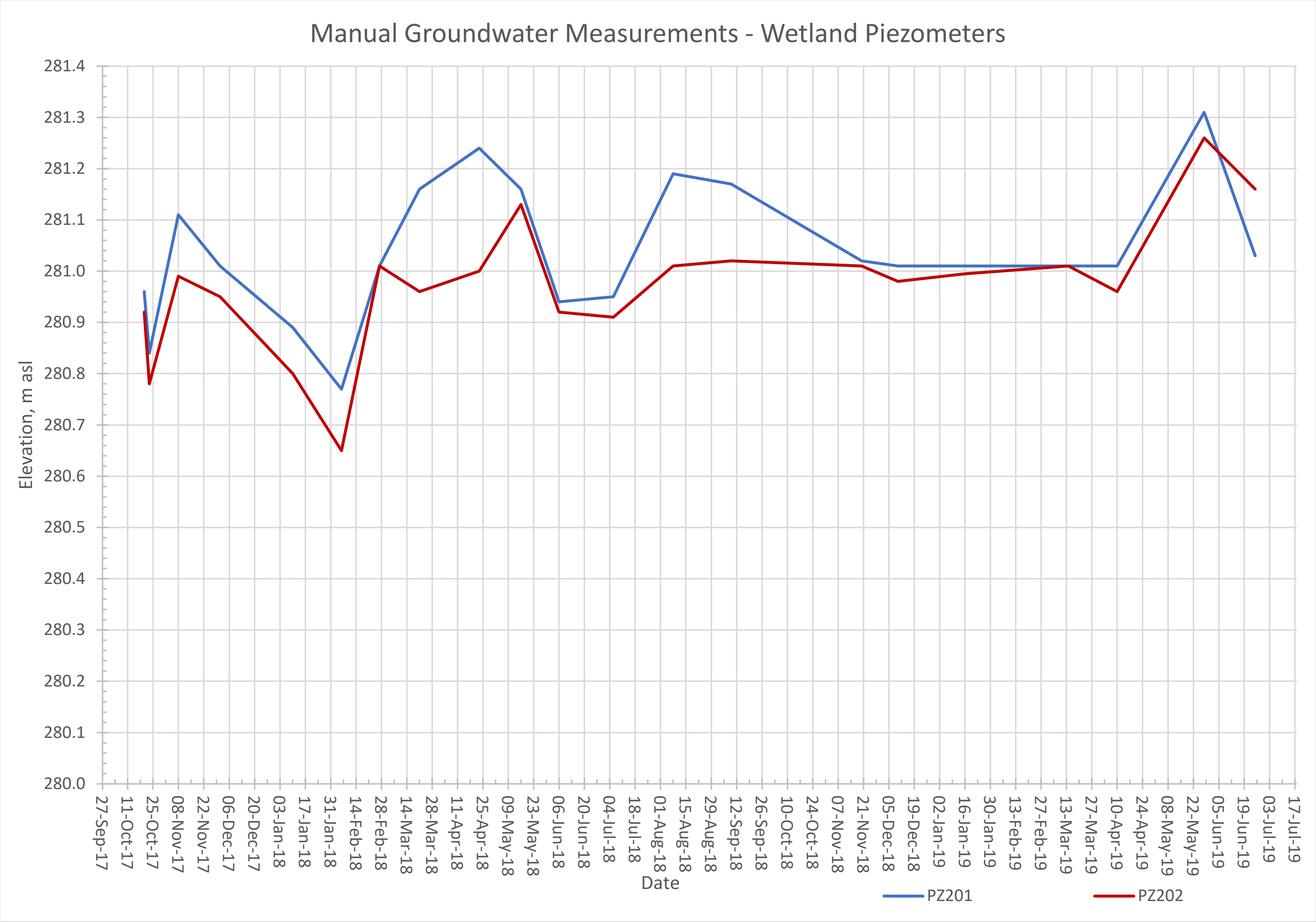
Sample ID	**Unified Soil Classification**				**Moisture Content (%)**
	Fines (Silt & Clay)	**% Sand**	**% Gravel**	**% Cobbles**	
BH301 SA6 - 6.6 m depth	10.8%	65.3%	23.9%	0.0%	2.4%
BH5 SA7 - 7.6 m depth	20.4%	79.6%	0.0%	0.0%	12.3%
BH303SA9 - 9.1 m depth	36.2%	63.8%	0.0%	0.0%	5.1%

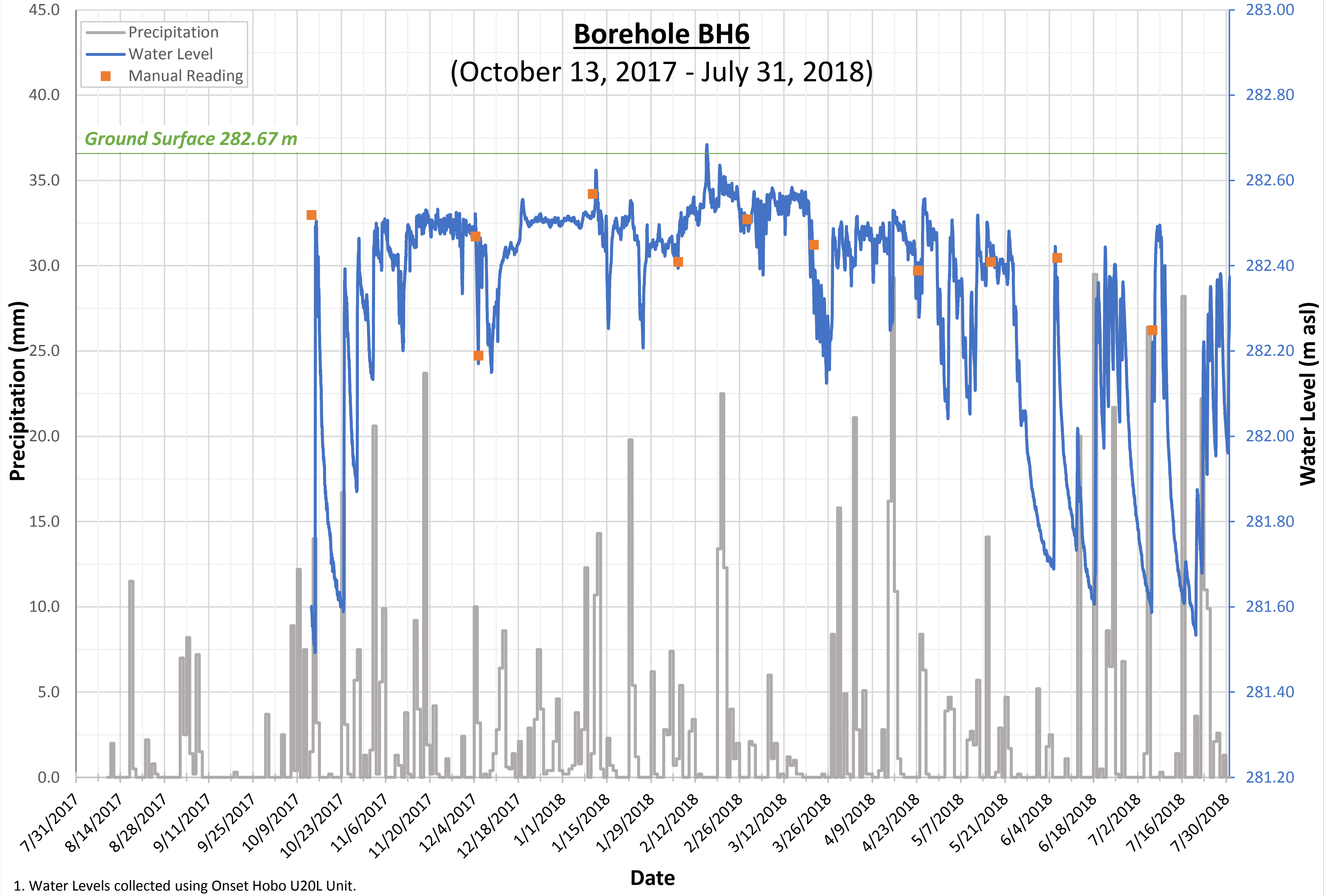


APPENDIX C

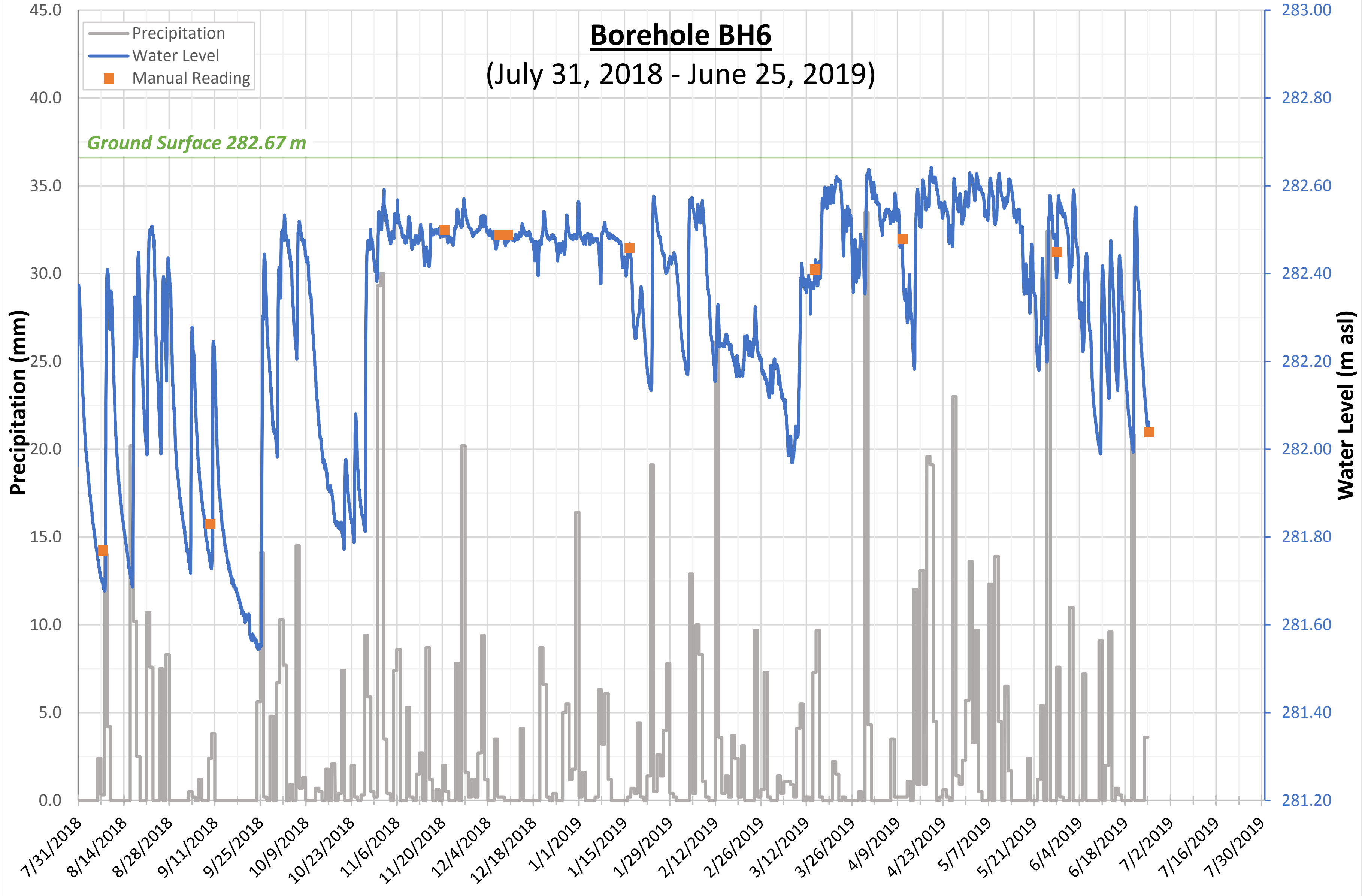
Groundwater Hydrographs


Manual Groundwater Measurements - Boreholes
Elevation, m asl
286.5
286.0
285.5
285.0
284.5
284.0
283.5
283.0
282.5
282.0
281.5
281.0
280.5
280.0
279.5
279.0
278.5
278.0
277.5
277.0
276.5
276.0
275.5
275.0
274.5
274.0
273.5
27-Sep-17
11-Oct-17
25-Oct-17
08-Nov-17
22-Nov-17
06-Dec-17
20-Dec-17
03-Jan-18
17-Jan-18
31-Jan-18
14-Feb-18
28-Feb-18
14-Mar-18
28-Mar-18
11-Apr-18
25-Apr-18
09-May-18
23-May-18
06-Jun-18
20-Jun-18
04-Jul-18
18-Jul-18
01-Aug-18
15-Aug-18
29-Aug-18
12-Sep-18
26-Sep-18
10-Oct-18
24-Oct-18
07-Nov-18
21-Nov-18
05-Dec-18
19-Dec-18
02-Jan-19
16-Jan-19
30-Jan-19
13-Feb-19
27-Feb-19
13-Mar-19
27-Mar-19
10-Apr-19
24-Apr-19
08-May-19
22-May-19
05-Jun-19
19-Jun-19
03-Jul-19
17-Jul-19
Date
BH5 shallow
BH5 deep
BH6
BH9
BH10

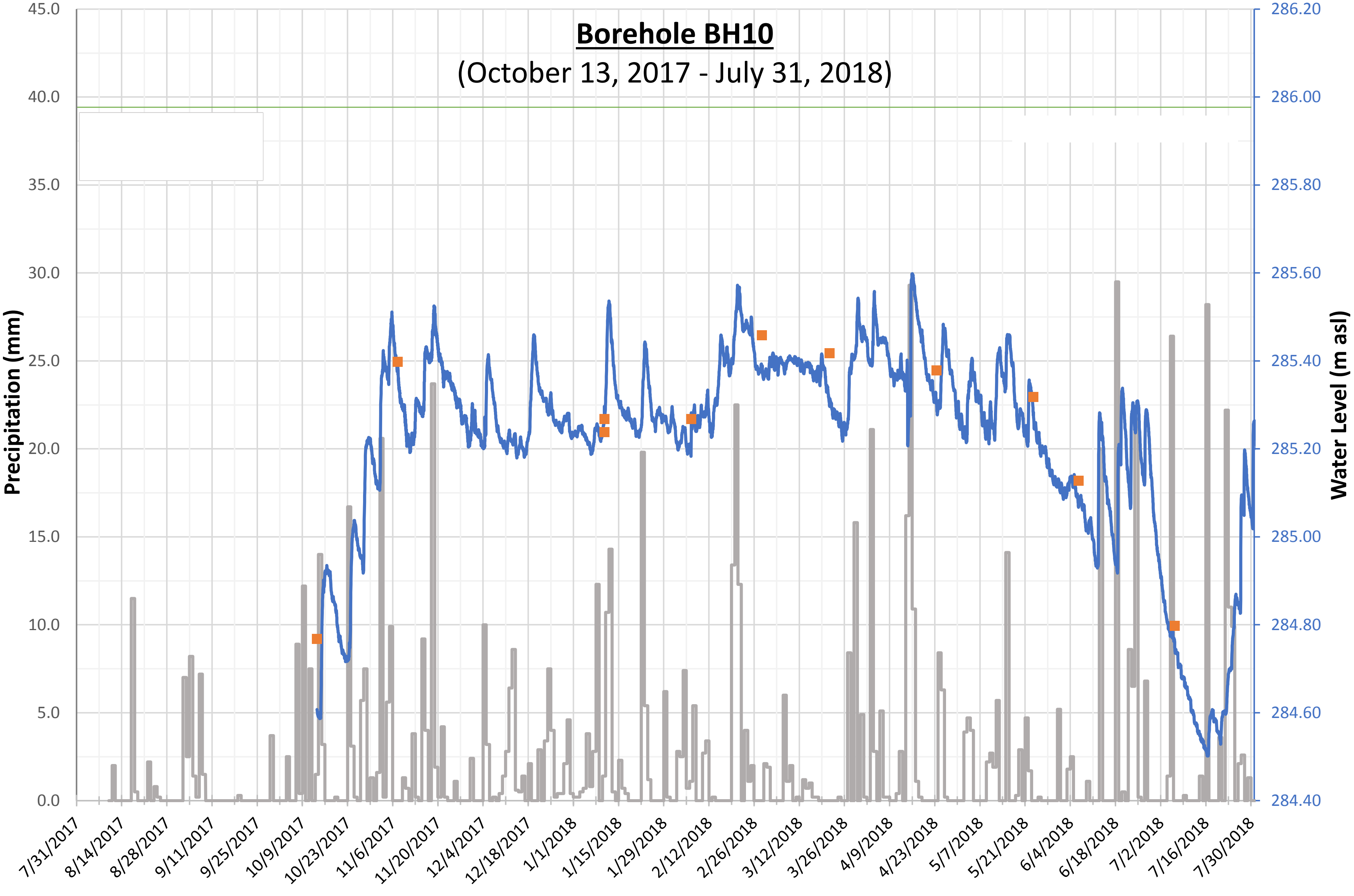

Manual Groundwater Measurements - Wetland Piezometers
Elevation, m asl
281.4
281.3
281.2
281.1
281.0
280.9
280.8
280.7
280.6
280.5
280.4
280.3
280.2
280.1
280.0
27-Sep-17
11-Oct-17
25-Oct-17
08-Nov-17
22-Nov-17
06-Dec-17
20-Dec-17
03-Jan-18
17-Jan-18
31-Jan-18
14-Feb-18
28-Feb-18
14-Mar-18
28-Mar-18
11-Apr-18
25-Apr-18
09-May-18
23-May-18
06-Jun-18
20-Jun-18
04-Jul-18
18-Jul-18
01-Aug-18
15-Aug-18
29-Aug-18
12-Sep-18
26-Sep-18
10-Oct-18
24-Oct-18
07-Nov-18
21-Nov-18
05-Dec-18
19-Dec-18
02-Jan-19
16-Jan-19
30-Jan-19
13-Feb-19
27-Feb-19
13-Mar-19
27-Mar-19
10-Apr-19
24-Apr-19
08-May-19
22-May-19
05-Jun-19
19-Jun-19
03-Jul-19
17-Jul-19
Date
PZ201
PZ202



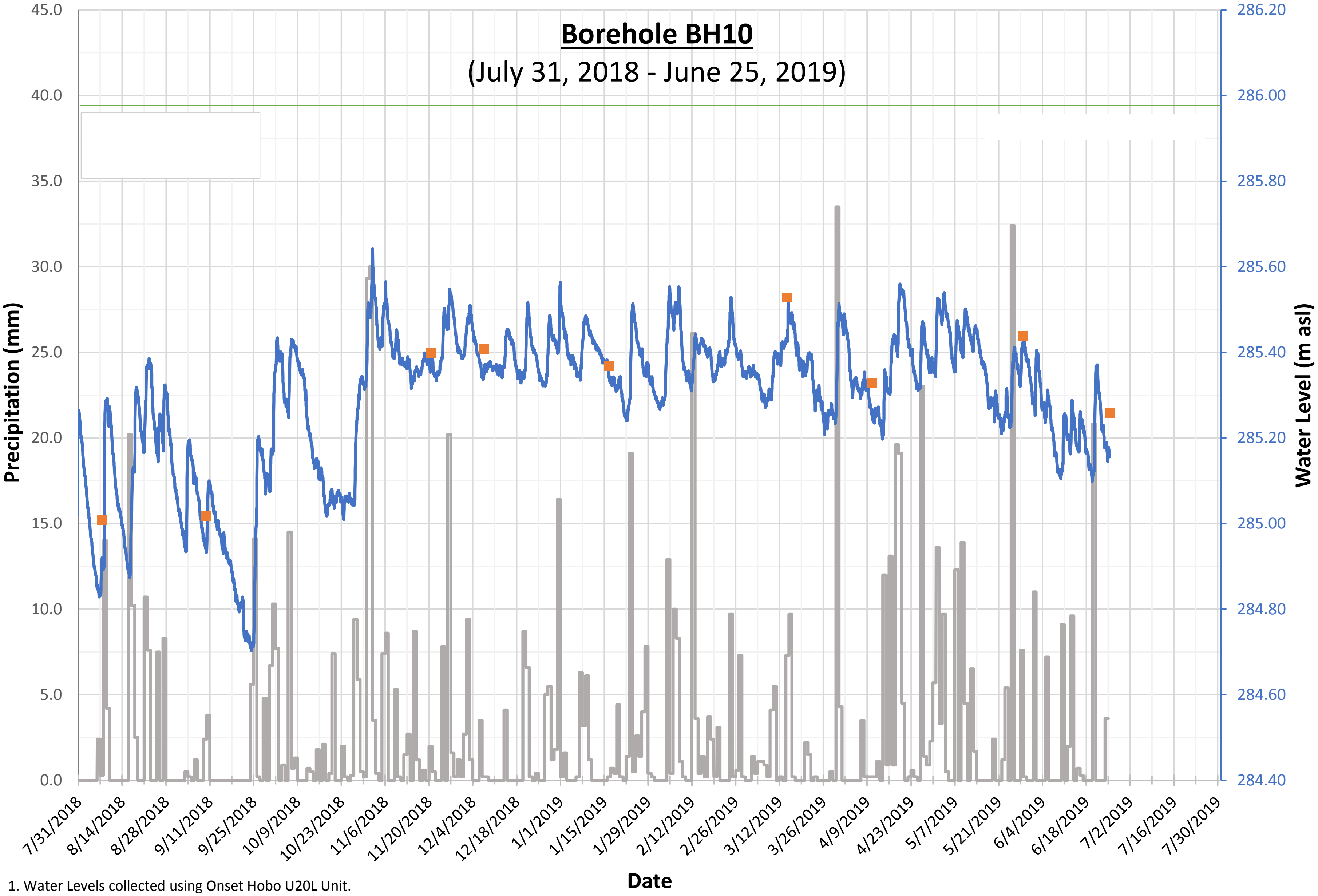
1. Water Levels collected using Onset Hobo U20L Unit.
2. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London Airport to February 6, 2018.
3. Pressure Corrections based on hourly atmospheric data collected from onsite datalogger from February 6, 2018 to current.
4. Precipitation data sourced from Environment Canada London International Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit.
2. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London Airport to February 6, 2018.
3. Pressure Corrections based on hourly atmospheric data collected from onsite datalogger from February 6, 2018 to current.
4. Precipitation data sourced from Environment Canada London International Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit.
2. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London Airport to February 6, 2018.
3. Pressure Corrections based on hourly atmospheric data collected from onsite datalogger from February 6, 2018 to current.
4. Precipitation data sourced from Environment Canada London International Airport Weather Station.



1. Water Levels collected using Onset Hobo U20L Unit.
2. Pressure Corrections based on hourly atmospheric data from Environment Canada Station at London Airport to February 6, 2018.
3. Pressure Corrections based on hourly atmospheric data collected from onsite datalogger from February 6, 2018 to current.
4. Precipitation data sourced from Environment Canada London International Airport Weather Station.

APPENDIX D

Site Photographs

Photographic Log

Wetland onsite

Swamp willow, buckthorn, and dogwood vegetation
East view

	Installation of PZ201
	Installation of PZ202

APPENDIX E

Analytical Lab Results

Your C.O.C. #: 101758

Attention:Rebecca Walker

LDS Consultants Inc
2070 Huron Street East
Suite A
London, ON
CANADA N5V 5A7

Report Date: 2017/11/21
Report #: R4869501
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7P5025
Received: 2017/11/13, 14:32

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	2	N/A	2017/11/15	CAM SOP-00448	SM 22 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2017/11/16	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2017/11/15	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2017/11/15	CAM SOP-00414	SM 22 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2017/11/15	CAM SOP-00446	SM 22 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2017/11/17	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	1	N/A	2017/11/17	CAM SOP-00447	EPA 6020B m
Dissolved Metals by ICPMS	1	N/A	2017/11/20	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2017/11/17		
Anion and Cation Sum	2	N/A	2017/11/17		
Total Ammonia-N	2	N/A	2017/11/17	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	2	N/A	2017/11/15	CAM SOP-00440	SM 22 4500-NO3I/NO2B
pH	2	N/A	2017/11/15	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2017/11/15	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2017/11/17		
Sat. pH and Langelier Index (@ 4C)	2	N/A	2017/11/17		
Sulphate by Automated Colourimetry	2	N/A	2017/11/15	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2017/11/17		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam’s profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam 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.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report.

Your C.O.C. #: 101758

Attention:Rebecca Walker

LDS Consultants Inc
2070 Huron Street East
Suite A
London, ON
CANADA N5V 5A7

Report Date: 2017/11/21
Report #: R4869501
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7P5025
Received: 2017/11/13, 14:32

provide analysis samples provided by using testing methodology report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

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.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
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 your Project Manager.
Christine Gripton, Senior Project Manager
Email: CGripton@maxxam.ca
Phone# (800)268-7396 Ext:250
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

RCAP - COMPREHENSIVE (WATER)

Maxxam ID			FNU365			FNU366		
Sampling Date			2017/11/13 13:30			2017/11/13 14:00		
COC Number			101758			101758		
	UNITS	**Criteria**	**PZ 202**	**RDL**	**QC Batch**	**MW6**	**RDL**	**QC Batch**
Calculated Parameters								
Anion Sum	me/L	-	3.94	N/A	5264149	33.8	N/A	5264149
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	130	1.0	5264146	270	1.0	5264146
Calculated TDS	mg/L	-	610	1.0	5264152	1800	1.0	5264152
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1.0	1.0	5264146	1.3	1.0	5264146
Cation Sum	me/L	-	23.3	N/A	5264149	31.5	N/A	5264149
Hardness (CaCO3)	mg/L	-	850	1.0	5264147	750	1.0	5264147
Ion Balance (% Difference)	%	-	71.1	N/A	5264148	3.49	N/A	5264148
Langelier Index (@ 20C)	N/A	-	0.923		5264150	0.841		5264150
Langelier Index (@ 4C)	N/A	-	0.675		5264151	0.597		5264151
Saturation pH (@ 20C)	N/A	-	6.92		5264150	6.86		5264150
Saturation pH (@ 4C)	N/A	-	7.16		5264151	7.10		5264151
Inorganics								
Total Ammonia-N	mg/L	-	1.2	0.050	5267791	0.064	0.050	5267791
Conductivity	umho/cm	-	410	1.0	5266401	3700	1.0	5266401
Dissolved Organic Carbon	mg/L	-	31	0.50	5266387	2.4	0.50	5266387
Orthophosphate (P)	mg/L	-	0.031	0.010	5265719	0.014	0.010	5265719
pH	pH	-	7.84		5266402	7.70		5266402
Dissolved Sulphate (SO4)	mg/L	-	11	1.0	5265717	44	1.0	5265717
Alkalinity (Total as CaCO3)	mg/L	-	130	1.0	5266391	270	1.0	5266391
Dissolved Chloride (Cl)	mg/L	**790**	40	1.0	5265711	**970**	10	5265711
Nitrite (N)	mg/L	**-**	<0.010	0.010	5265698	0.020	0.010	5265701
Nitrate (N)	mg/L	**-**	<0.10	0.10	5265698	0.64	0.10	5265701
Nitrate + Nitrite (N)	mg/L	**-**	<0.10	0.10	5265698	0.66	0.10	5265701
Metals								
Dissolved Aluminum (Al)	ug/L	**-**	27	5.0	5273282	9.6	5.0	5266207
Dissolved Antimony (Sb)	ug/L	**6.0**	<0.50	0.50	5273282	<0.50	0.50	5266207
Dissolved Arsenic (As)	ug/L	**25**	3.6	1.0	5273282	1.2	1.0	5266207
Dissolved Barium (Ba)	ug/L	**1000**	100	2.0	5273282	290	2.0	5266207
Dissolved Beryllium (Be)	ug/L	**4.0**	<0.50	0.50	5273282	<0.50	0.50	5266207
Dissolved Boron (B)	ug/L	**5000**	28	10	5273282	69	10	5266207
Dissolved Cadmium (Cd)	ug/L	**2.7**	<0.10	0.10	5273282	<0.10	0.10	5266207
Dissolved Calcium (Ca)	ug/L	**-**	290000	200	5273282	220000	200	5266207

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria: Ontario Reg. 153/04 (Amended April 15, 2011)
Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition
Potable Ground Water- All Types of Property Uses - Coarse Texture Soil

N/A = Not Applicable

Maxxam Job #: B7P5025
Report Date: 2017/11/21

LDS Consultants Inc
Sampler Initials: TS

RCAP - COMPREHENSIVE (WATER)

Maxxam ID			FNU365			FNU366		
Sampling Date			2017/11/13 13:30			2017/11/13 14:00		
COC Number			101758			101758		
	UNITS	**Criteria**	**PZ 202**	**RDL**	**QC Batch**	**MW6**	**RDL**	**QC Batch**
Dissolved Chromium (Cr)	ug/L	**50**	<5.0	5.0	5273282	<5.0	5.0	5266207
Dissolved Cobalt (Co)	ug/L	**3.8**	2.0	0.50	5273282	<0.50	0.50	5266207
Dissolved Copper (Cu)	ug/L	**87**	2.0	1.0	5273282	1.5	1.0	5266207
Dissolved Iron (Fe)	ug/L	-	6500	100	5273282	240	100	5266207
Dissolved Lead (Pb)	ug/L	**10**	<0.50	0.50	5273282	<0.50	0.50	5266207
Dissolved Magnesium (Mg)	ug/L	-	30000	50	5273282	49000	50	5266207
Dissolved Manganese (Mn)	ug/L	-	1300	2.0	5273282	320	2.0	5266207
Dissolved Molybdenum (Mo)	ug/L	**70**	1.5	0.50	5273282	3.1	0.50	5266207
Dissolved Nickel (Ni)	ug/L	**100**	4.1	1.0	5273282	2.1	1.0	5266207
Dissolved Phosphorus (P)	ug/L	-	120	100	5273282	<100	100	5266207
Dissolved Potassium (K)	ug/L	-	1200	200	5273282	8000	200	5266207
Dissolved Selenium (Se)	ug/L	**10**	<2.0	2.0	5273282	<2.0	2.0	5266207
Dissolved Silicon (Si)	ug/L	-	7800	50	5273282	6700	50	5266207
Dissolved Silver (Ag)	ug/L	**1.5**	<0.10	0.10	5273282	<0.10	0.10	5266207
Dissolved Sodium (Na)	ug/L	**490000**	140000	100	5273282	380000	100	5266207
Dissolved Strontium (Sr)	ug/L	-	460	1.0	5273282	1600	1.0	5266207
Dissolved Thallium (Tl)	ug/L	**2.0**	<0.050	0.050	5273282	<0.050	0.050	5266207
Dissolved Titanium (Ti)	ug/L	-	<5.0	5.0	5273282	<5.0	5.0	5266207
Dissolved Uranium (U)	ug/L	**20**	13	0.10	5273282	7.7	0.10	5266207
Dissolved Vanadium (V)	ug/L	**6.2**	1.8	0.50	5273282	1.6	0.50	5266207
Dissolved Zinc (Zn)	ug/L	**1100**	5.3	5.0	5273282	<5.0	5.0	5266207

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria: Ontario Reg. 153/04 (Amended April 15, 2011)
Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition
Potable Ground Water- All Types of Property Uses - Coarse Texture Soil

GENERAL COMMENTS

Sample FNU365 [PZ 202] : All samples, except the dissolved metals, were received with Trace Settled Sediment (just cover bottom of container).
Ion balance out of acceptance. Results confirmed by re-analysis of original container. Cations suspected to be biased high.

Sample FNU366 [MW6] : ortho-Phosphate > Total Phosphorus: Both values fall within the method uncertainty for duplicates and are likely equivalent.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5265698	C_N	Matrix Spike	Nitrite (N)	2017/11/15		99	%	80 - 120
			Nitrate (N)	2017/11/15		82	%	80 - 120
5265698	C_N	Spiked Blank	Nitrite (N)	2017/11/15		99	%	80 - 120
			Nitrate (N)	2017/11/15		101	%	80 - 120
5265698	C_N	Method Blank	Nitrite (N)	2017/11/15	<0.010		mg/L	
			Nitrate (N)	2017/11/15	<0.10		mg/L	
5265698	C_N	RPD	Nitrite (N)	2017/11/15	0.75		%	20
			Nitrate (N)	2017/11/15	0.86		%	20
5265701	C_N	Matrix Spike	Nitrite (N)	2017/11/15		102	%	80 - 120
			Nitrate (N)	2017/11/15		99	%	80 - 120
5265701	C_N	Spiked Blank	Nitrite (N)	2017/11/15		102	%	80 - 120
			Nitrate (N)	2017/11/15		104	%	80 - 120
5265701	C_N	Method Blank	Nitrite (N)	2017/11/15	<0.010		mg/L	
			Nitrate (N)	2017/11/15	<0.10		mg/L	
5265701	C_N	RPD	Nitrite (N)	2017/11/15	NC		%	20
			Nitrate (N)	2017/11/15	NC		%	20
5265711	ADB	Matrix Spike	Dissolved Chloride (Cl)	2017/11/15		100	%	80 - 120
5265711	ADB	Spiked Blank	Dissolved Chloride (Cl)	2017/11/15		105	%	80 - 120
5265711	ADB	Method Blank	Dissolved Chloride (Cl)	2017/11/15	<1.0		mg/L	
5265711	ADB	RPD	Dissolved Chloride (Cl)	2017/11/15	6.5		%	20
5265717	ADB	Matrix Spike	Dissolved Sulphate (SO4)	2017/11/15		NC	%	75 - 125
5265717	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2017/11/15		103	%	80 - 120
5265717	ADB	Method Blank	Dissolved Sulphate (SO4)	2017/11/15	<1.0		mg/L	
5265717	ADB	RPD	Dissolved Sulphate (SO4)	2017/11/15	0.19		%	20
5265719	ADB	Matrix Spike	Orthophosphate (P)	2017/11/15		104	%	75 - 125
5265719	ADB	Spiked Blank	Orthophosphate (P)	2017/11/15		100	%	80 - 120
5265719	ADB	Method Blank	Orthophosphate (P)	2017/11/15	<0.010		mg/L	
5265719	ADB	RPD	Orthophosphate (P)	2017/11/15	NC		%	25
5266207	PBA	Matrix Spike	Dissolved Aluminum (Al)	2017/11/17		101	%	80 - 120
			Dissolved Antimony (Sb)	2017/11/17		114	%	80 - 120
			Dissolved Arsenic (As)	2017/11/17		103	%	80 - 120
			Dissolved Barium (Ba)	2017/11/17		102	%	80 - 120
			Dissolved Beryllium (Be)	2017/11/17		101	%	80 - 120
			Dissolved Boron (B)	2017/11/17		93	%	80 - 120
			Dissolved Cadmium (Cd)	2017/11/17		106	%	80 - 120
			Dissolved Calcium (Ca)	2017/11/17		NC	%	80 - 120
			Dissolved Chromium (Cr)	2017/11/17		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/11/17		99	%	80 - 120
			Dissolved Copper (Cu)	2017/11/17		99	%	80 - 120
			Dissolved Iron (Fe)	2017/11/17		101	%	80 - 120
			Dissolved Lead (Pb)	2017/11/17		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/11/17		99	%	80 - 120
			Dissolved Manganese (Mn)	2017/11/17		103	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/11/17		107	%	80 - 120
			Dissolved Nickel (Ni)	2017/11/17		98	%	80 - 120
			Dissolved Phosphorus (P)	2017/11/17		100	%	80 - 120
			Dissolved Potassium (K)	2017/11/17		103	%	80 - 120
			Dissolved Selenium (Se)	2017/11/17		101	%	80 - 120
			Dissolved Silicon (Si)	2017/11/17		100	%	80 - 120
			Dissolved Silver (Ag)	2017/11/17		82	%	80 - 120
			Dissolved Sodium (Na)	2017/11/17		NC	%	80 - 120
			Dissolved Strontium (Sr)	2017/11/17		NC	%	80 - 120
			Dissolved Thallium (Tl)	2017/11/17		101	%	80 - 120
			Dissolved Titanium (Ti)	2017/11/17		103	%	80 - 120
			Dissolved Uranium (U)	2017/11/17		103	%	80 - 120

Maxxam Job #: B7P5025
Report Date: 2017/11/21

LDS Consultants Inc
Sampler Initials: TS

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Vanadium (V)	2017/11/17		99	%	80 - 120
			Dissolved Zinc (Zn)	2017/11/17		101	%	80 - 120
5266207	PBA	Spiked Blank	Dissolved Aluminum (Al)	2017/11/17		100	%	80 - 120
			Dissolved Antimony (Sb)	2017/11/17		107	%	80 - 120
			Dissolved Arsenic (As)	2017/11/17		97	%	80 - 120
			Dissolved Barium (Ba)	2017/11/17		97	%	80 - 120
			Dissolved Beryllium (Be)	2017/11/17		97	%	80 - 120
			Dissolved Boron (B)	2017/11/17		94	%	80 - 120
			Dissolved Cadmium (Cd)	2017/11/17		103	%	80 - 120
			Dissolved Calcium (Ca)	2017/11/17		95	%	80 - 120
			Dissolved Chromium (Cr)	2017/11/17		93	%	80 - 120
			Dissolved Cobalt (Co)	2017/11/17		98	%	80 - 120
			Dissolved Copper (Cu)	2017/11/17		99	%	80 - 120
			Dissolved Iron (Fe)	2017/11/17		98	%	80 - 120
			Dissolved Lead (Pb)	2017/11/17		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/11/17		98	%	80 - 120
			Dissolved Manganese (Mn)	2017/11/17		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/11/17		99	%	80 - 120
			Dissolved Nickel (Ni)	2017/11/17		95	%	80 - 120
			Dissolved Phosphorus (P)	2017/11/17		100	%	80 - 120
			Dissolved Potassium (K)	2017/11/17		99	%	80 - 120
			Dissolved Selenium (Se)	2017/11/17		99	%	80 - 120
			Dissolved Silicon (Si)	2017/11/17		97	%	80 - 120
			Dissolved Silver (Ag)	2017/11/17		102	%	80 - 120
			Dissolved Sodium (Na)	2017/11/17		96	%	80 - 120
			Dissolved Strontium (Sr)	2017/11/17		101	%	80 - 120
			Dissolved Thallium (Tl)	2017/11/17		101	%	80 - 120
			Dissolved Titanium (Ti)	2017/11/17		101	%	80 - 120
			Dissolved Uranium (U)	2017/11/17		98	%	80 - 120
			Dissolved Vanadium (V)	2017/11/17		93	%	80 - 120
			Dissolved Zinc (Zn)	2017/11/17		98	%	80 - 120
5266207	PBA	Method Blank	Dissolved Aluminum (Al)	2017/11/17	<5.0		ug/L	
			Dissolved Antimony (Sb)	2017/11/17	<0.50		ug/L	
			Dissolved Arsenic (As)	2017/11/17	<1.0		ug/L	
			Dissolved Barium (Ba)	2017/11/17	<2.0		ug/L	
			Dissolved Beryllium (Be)	2017/11/17	<0.50		ug/L	
			Dissolved Boron (B)	2017/11/17	<10		ug/L	
			Dissolved Cadmium (Cd)	2017/11/17	<0.10		ug/L	
			Dissolved Calcium (Ca)	2017/11/17	<200		ug/L	
			Dissolved Chromium (Cr)	2017/11/17	<5.0		ug/L	
			Dissolved Cobalt (Co)	2017/11/17	<0.50		ug/L	
			Dissolved Copper (Cu)	2017/11/17	<1.0		ug/L	
			Dissolved Iron (Fe)	2017/11/17	<100		ug/L	
			Dissolved Lead (Pb)	2017/11/17	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2017/11/17	<50		ug/L	
			Dissolved Manganese (Mn)	2017/11/17	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2017/11/17	<0.50		ug/L	
			Dissolved Nickel (Ni)	2017/11/17	<1.0		ug/L	
			Dissolved Phosphorus (P)	2017/11/17	<100		ug/L	
			Dissolved Potassium (K)	2017/11/17	<200		ug/L	
			Dissolved Selenium (Se)	2017/11/17	<2.0		ug/L	
			Dissolved Silicon (Si)	2017/11/17	<50		ug/L	
			Dissolved Silver (Ag)	2017/11/17	<0.10		ug/L	
			Dissolved Sodium (Na)	2017/11/17	<100		ug/L	
			Dissolved Strontium (Sr)	2017/11/17	<1.0		ug/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Thallium (Tl)	2017/11/17	<0.050		ug/L	
			Dissolved Titanium (Ti)	2017/11/17	<5.0		ug/L	
			Dissolved Uranium (U)	2017/11/17	<0.10		ug/L	
			Dissolved Vanadium (V)	2017/11/17	<0.50		ug/L	
			Dissolved Zinc (Zn)	2017/11/17	<5.0		ug/L	
5266207	PBA	RPD	Dissolved Antimony (Sb)	2017/11/17	NC		%	20
			Dissolved Arsenic (As)	2017/11/17	NC		%	20
			Dissolved Barium (Ba)	2017/11/17	0.56		%	20
			Dissolved Beryllium (Be)	2017/11/17	NC		%	20
			Dissolved Boron (B)	2017/11/17	5.2		%	20
			Dissolved Cadmium (Cd)	2017/11/17	NC		%	20
			Dissolved Chromium (Cr)	2017/11/17	NC		%	20
			Dissolved Cobalt (Co)	2017/11/17	2.7		%	20
			Dissolved Copper (Cu)	2017/11/17	NC		%	20
			Dissolved Iron (Fe)	2017/11/17	1.9		%	20
			Dissolved Lead (Pb)	2017/11/17	NC		%	20
			Dissolved Molybdenum (Mo)	2017/11/17	NC		%	20
			Dissolved Nickel (Ni)	2017/11/17	NC		%	20
			Dissolved Potassium (K)	2017/11/17	1.1		%	20
			Dissolved Selenium (Se)	2017/11/17	NC		%	20
			Dissolved Silver (Ag)	2017/11/17	NC		%	20
			Dissolved Sodium (Na)	2017/11/17	3.0		%	20
			Dissolved Thallium (Tl)	2017/11/17	NC		%	20
			Dissolved Uranium (U)	2017/11/17	0.92		%	20
			Dissolved Vanadium (V)	2017/11/17	NC		%	20
			Dissolved Zinc (Zn)	2017/11/17	NC		%	20
5266387	AHA	Matrix Spike	Dissolved Organic Carbon	2017/11/15		92	%	80 - 120
5266387	AHA	Spiked Blank	Dissolved Organic Carbon	2017/11/15		101	%	80 - 120
5266387	AHA	Method Blank	Dissolved Organic Carbon	2017/11/15	<0.50		mg/L	
5266387	AHA	RPD	Dissolved Organic Carbon	2017/11/15	5.9		%	20
5266391	SAU	Spiked Blank	Alkalinity (Total as CaCO3)	2017/11/15		95	%	85 - 115
5266391	SAU	Method Blank	Alkalinity (Total as CaCO3)	2017/11/15	<1.0		mg/L	
5266391	SAU	RPD	Alkalinity (Total as CaCO3)	2017/11/15	0.66		%	20
5266401	SAU	Spiked Blank	Conductivity	2017/11/15		101	%	85 - 115
5266401	SAU	Method Blank	Conductivity	2017/11/15	<1.0		umho/cm	
5266401	SAU	RPD	Conductivity	2017/11/15	0.39		%	25
5266402	SAU	Spiked Blank	pH	2017/11/15		101	%	98 - 103
5266402	SAU	RPD	pH	2017/11/15	0.53		%	N/A
5267791	COP	Matrix Spike	Total Ammonia-N	2017/11/17		103	%	80 - 120
5267791	COP	Spiked Blank	Total Ammonia-N	2017/11/17		98	%	85 - 115
5267791	COP	Method Blank	Total Ammonia-N	2017/11/17	<0.050		mg/L	
5267791	COP	RPD	Total Ammonia-N	2017/11/17	11		%	20
5273282	PBA	Matrix Spike	Dissolved Aluminum (Al)	2017/11/20		107	%	80 - 120
			Dissolved Antimony (Sb)	2017/11/20		112	%	80 - 120
			Dissolved Arsenic (As)	2017/11/20		104	%	80 - 120
			Dissolved Barium (Ba)	2017/11/20		102	%	80 - 120
			Dissolved Beryllium (Be)	2017/11/20		104	%	80 - 120
			Dissolved Boron (B)	2017/11/20		102	%	80 - 120
			Dissolved Cadmium (Cd)	2017/11/20		106	%	80 - 120
			Dissolved Calcium (Ca)	2017/11/20		NC	%	80 - 120
			Dissolved Chromium (Cr)	2017/11/20		97	%	80 - 120
			Dissolved Cobalt (Co)	2017/11/20		101	%	80 - 120
			Dissolved Copper (Cu)	2017/11/20		103	%	80 - 120
			Dissolved Iron (Fe)	2017/11/20		103	%	80 - 120
			Dissolved Lead (Pb)	2017/11/20		95	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Magnesium (Mg)	2017/11/20		NC	%	80 - 120
			Dissolved Manganese (Mn)	2017/11/20		NC	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/11/20		106	%	80 - 120
			Dissolved Nickel (Ni)	2017/11/20		97	%	80 - 120
			Dissolved Phosphorus (P)	2017/11/20		109	%	80 - 120
			Dissolved Potassium (K)	2017/11/20		106	%	80 - 120
			Dissolved Selenium (Se)	2017/11/20		102	%	80 - 120
			Dissolved Silicon (Si)	2017/11/20		108	%	80 - 120
			Dissolved Silver (Ag)	2017/11/20		101	%	80 - 120
			Dissolved Sodium (Na)	2017/11/20		NC	%	80 - 120
			Dissolved Strontium (Sr)	2017/11/20		NC	%	80 - 120
			Dissolved Thallium (Tl)	2017/11/20		102	%	80 - 120
			Dissolved Titanium (Ti)	2017/11/20		107	%	80 - 120
			Dissolved Uranium (U)	2017/11/20		105	%	80 - 120
			Dissolved Vanadium (V)	2017/11/20		103	%	80 - 120
			Dissolved Zinc (Zn)	2017/11/20		99	%	80 - 120
5273282	PBA	Spiked Blank	Dissolved Aluminum (Al)	2017/11/20		100	%	80 - 120
			Dissolved Antimony (Sb)	2017/11/20		105	%	80 - 120
			Dissolved Arsenic (As)	2017/11/20		99	%	80 - 120
			Dissolved Barium (Ba)	2017/11/20		99	%	80 - 120
			Dissolved Beryllium (Be)	2017/11/20		102	%	80 - 120
			Dissolved Boron (B)	2017/11/20		99	%	80 - 120
			Dissolved Cadmium (Cd)	2017/11/20		102	%	80 - 120
			Dissolved Calcium (Ca)	2017/11/20		99	%	80 - 120
			Dissolved Chromium (Cr)	2017/11/20		92	%	80 - 120
			Dissolved Cobalt (Co)	2017/11/20		99	%	80 - 120
			Dissolved Copper (Cu)	2017/11/20		99	%	80 - 120
			Dissolved Iron (Fe)	2017/11/20		99	%	80 - 120
			Dissolved Lead (Pb)	2017/11/20		97	%	80 - 120
			Dissolved Magnesium (Mg)	2017/11/20		102	%	80 - 120
			Dissolved Manganese (Mn)	2017/11/20		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/11/20		98	%	80 - 120
			Dissolved Nickel (Ni)	2017/11/20		95	%	80 - 120
			Dissolved Phosphorus (P)	2017/11/20		110	%	80 - 120
			Dissolved Potassium (K)	2017/11/20		102	%	80 - 120
			Dissolved Selenium (Se)	2017/11/20		99	%	80 - 120
			Dissolved Silicon (Si)	2017/11/20		100	%	80 - 120
			Dissolved Silver (Ag)	2017/11/20		98	%	80 - 120
			Dissolved Sodium (Na)	2017/11/20		97	%	80 - 120
			Dissolved Strontium (Sr)	2017/11/20		98	%	80 - 120
			Dissolved Thallium (Tl)	2017/11/20		102	%	80 - 120
			Dissolved Titanium (Ti)	2017/11/20		99	%	80 - 120
			Dissolved Uranium (U)	2017/11/20		101	%	80 - 120
			Dissolved Vanadium (V)	2017/11/20		96	%	80 - 120
			Dissolved Zinc (Zn)	2017/11/20		98	%	80 - 120
5273282	PBA	Method Blank	Dissolved Aluminum (Al)	2017/11/20	<5.0		ug/L	
			Dissolved Antimony (Sb)	2017/11/20	<0.50		ug/L	
			Dissolved Arsenic (As)	2017/11/20	<1.0		ug/L	
			Dissolved Barium (Ba)	2017/11/20	<2.0		ug/L	
			Dissolved Beryllium (Be)	2017/11/20	<0.50		ug/L	
			Dissolved Boron (B)	2017/11/20	<10		ug/L	
			Dissolved Cadmium (Cd)	2017/11/20	<0.10		ug/L	
			Dissolved Calcium (Ca)	2017/11/20	<200		ug/L	
			Dissolved Chromium (Cr)	2017/11/20	<5.0		ug/L	
			Dissolved Cobalt (Co)	2017/11/20	<0.50		ug/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Copper (Cu)	2017/11/20	<1.0		ug/L	
			Dissolved Iron (Fe)	2017/11/20	<100		ug/L	
			Dissolved Lead (Pb)	2017/11/20	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2017/11/20	<50		ug/L	
			Dissolved Manganese (Mn)	2017/11/20	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2017/11/20	<0.50		ug/L	
			Dissolved Nickel (Ni)	2017/11/20	<1.0		ug/L	
			Dissolved Phosphorus (P)	2017/11/20	<100		ug/L	
			Dissolved Potassium (K)	2017/11/20	<200		ug/L	
			Dissolved Selenium (Se)	2017/11/20	<2.0		ug/L	
			Dissolved Silicon (Si)	2017/11/20	<50		ug/L	
			Dissolved Silver (Ag)	2017/11/20	<0.10		ug/L	
			Dissolved Sodium (Na)	2017/11/20	<100		ug/L	
			Dissolved Strontium (Sr)	2017/11/20	1.2, RDL=1.0		ug/L	
			Dissolved Thallium (Tl)	2017/11/20	<0.050		ug/L	
			Dissolved Titanium (Ti)	2017/11/20	<5.0		ug/L	
			Dissolved Uranium (U)	2017/11/20	<0.10		ug/L	
			Dissolved Vanadium (V)	2017/11/20	<0.50		ug/L	
			Dissolved Zinc (Zn)	2017/11/20	<5.0		ug/L	
5273282	PBA	RPD	Dissolved Antimony (Sb)	2017/11/20	NC		%	20
			Dissolved Arsenic (As)	2017/11/20	1.4		%	20
			Dissolved Barium (Ba)	2017/11/20	2.2		%	20
			Dissolved Beryllium (Be)	2017/11/20	NC		%	20
			Dissolved Boron (B)	2017/11/20	0.82		%	20
			Dissolved Cadmium (Cd)	2017/11/20	NC		%	20
			Dissolved Chromium (Cr)	2017/11/20	NC		%	20
			Dissolved Cobalt (Co)	2017/11/20	4.6		%	20
			Dissolved Copper (Cu)	2017/11/20	4.0		%	20
			Dissolved Lead (Pb)	2017/11/20	NC		%	20
			Dissolved Molybdenum (Mo)	2017/11/20	8.4		%	20
			Dissolved Nickel (Ni)	2017/11/20	8.7		%	20
			Dissolved Selenium (Se)	2017/11/20	NC		%	20
			Dissolved Silver (Ag)	2017/11/20	NC		%	20
			Dissolved Sodium (Na)	2017/11/20	2.4		%	20
			Dissolved Thallium (Tl)	2017/11/20	NC		%	20
			Dissolved Uranium (U)	2017/11/20	2.7		%	20
			Dissolved Vanadium (V)	2017/11/20	5.7		%	20
			Dissolved Zinc (Zn)	2017/11/20	NC		%	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).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brad Newman, Scientific Service Specialist

Your Project #: GE-00085
Site Location: 952 SOUTHDALE ROAD, LONDON
Your C.O.C. #: 119154

Attention: Rebecca Walker

LDS Consultants Inc
15875 Robins Hill Road
Unit 1
London, ON
CANADA N5V 0A5

Report Date: 2019/02/28
Report #: R5610342
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B937254
Received: 2019/02/11, 14:50

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	2	N/A	2019/02/13	CAM SOP-00448	SM 23 2320 B m
Carbonate, Bicarbonate and Hydroxide	2	N/A	2019/02/13	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	2	N/A	2019/02/14	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2019/02/13	CAM SOP-00414	SM 23 2510 m
Dissolved Organic Carbon (DOC) (1)	2	N/A	2019/02/12	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3)	2	N/A	2019/02/13	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	2	N/A	2019/02/13	CAM SOP-00447	EPA 6020B m
Ion Balance (% Difference)	2	N/A	2019/02/14		
Anion and Cation Sum	2	N/A	2019/02/13		
Total Ammonia-N	1	N/A	2019/02/15	CAM SOP-00441	EPA GS I-2522-90 m
Total Ammonia-N	1	N/A	2019/02/19	CAM SOP-00441	EPA GS I-2522-90 m
Nitrate (NO3) and Nitrite (NO2) in Water (2)	2	N/A	2019/02/15	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH	2	N/A	2019/02/13	CAM SOP-00413	SM 4500H+ B m
Orthophosphate	2	N/A	2019/02/14	CAM SOP-00461	EPA 365.1 m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/02/14		
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/02/14		
Sulphate by Automated Colourimetry	2	N/A	2019/02/14	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (TDS calc)	2	N/A	2019/02/14		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam 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.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam 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 Maxxam, unless otherwise

Your Project #: GE-00085
Site Location: 952 SOUTHDALE ROAD, LONDON
Your C.O.C. #: 119154

Attention: Rebecca Walker

LDS Consultants Inc
15875 Robins Hill Road
Unit 1
London, ON
CANADA N5V 0A5

Report Date: 2019/02/28
Report #: R5610342
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B937254
Received: 2019/02/11, 14:50

agreed in writing. Maxxam 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 Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
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 your Project Manager.
Christine Gripton, Senior Project Manager
Email: CGripton@maxxam.ca
Phone# (800)268-7396 Ext:250
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IYR709			IYR710		
Sampling Date		2019/02/11			2019/02/11		
COC Number		119154			119154		
	UNITS	**PZ102**	**RDL**	**QC Batch**	**BH6**	**RDL**	**QC Batch**
Calculated Parameters							
Anion Sum	me/L	25.2	N/A	5969143	48.2	N/A	5969143
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	530	1.0	5969141	300	1.0	5969141
Calculated TDS	mg/L	1500	1.0	5969146	2700	1.0	5969146
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.4	1.0	5969141	<1.0	1.0	5969141
Cation Sum	me/L	31.2	N/A	5969143	46.0	N/A	5969143
Hardness (CaCO3)	mg/L	1100	1.0	5969142	1000	1.0	5969142
Ion Balance (% Difference)	%	10.7	N/A	5969132	2.31	N/A	5969132
Langelier Index (@ 20C)	N/A	1.11		5969144	0.798		5969144
Langelier Index (@ 4C)	N/A	0.868		5969145	0.556		5969145
Saturation pH (@ 20C)	N/A	6.32		5969144	6.73		5969144
Saturation pH (@ 4C)	N/A	6.57		5969145	6.97		5969145
Inorganics							
Total Ammonia-N	mg/L	1.4	0.25	5972927	<0.050	0.050	5974965
Conductivity	umho/cm	2400	1.0	5971310	5100	1.0	5971310
Dissolved Organic Carbon	mg/L	15	0.50	5970986	1.9	0.50	5970986
Orthophosphate (P)	mg/L	0.016	0.010	5973672	<0.010	0.010	5973672
pH	pH	7.44		5971309	7.53		5971309
Dissolved Sulphate (SO4)	mg/L	29	1.0	5973636	36	1.0	5973636
Alkalinity (Total as CaCO3)	mg/L	530	1.0	5971306	300	1.0	5971306
Dissolved Chloride (Cl-)	mg/L	500	5.0	5973633	1500	15	5973633
Nitrite (N)	mg/L	<0.010	0.010	5973400	<0.010	0.010	5973400
Nitrate (N)	mg/L	<0.10	0.10	5973400	0.12	0.10	5973400
Nitrate + Nitrite (N)	mg/L	<0.10	0.10	5973400	0.12	0.10	5973400
Metals							
Dissolved Aluminum (Al)	ug/L	9700	5.0	5972713	<5.0	5.0	5972713
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	5972713	<0.50	0.50	5972713
Dissolved Arsenic (As)	ug/L	11	1.0	5972713	<1.0	1.0	5972713
Dissolved Barium (Ba)	ug/L	450	2.0	5972713	490	2.0	5972713
Dissolved Beryllium (Be)	ug/L	2.3	0.50	5972713	<0.50	0.50	5972713
Dissolved Boron (B)	ug/L	20	10	5972713	43	10	5972713
Dissolved Cadmium (Cd)	ug/L	2.8	0.10	5972713	<0.10	0.10	5972713
Dissolved Calcium (Ca)	ug/L	360000	200	5972713	300000	200	5972713
Dissolved Chromium (Cr)	ug/L	<5.0	5.0	5972713	<5.0	5.0	5972713
Dissolved Cobalt (Co)	ug/L	4.7	0.50	5972713	<0.50	0.50	5972713

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RCAP - COMPREHENSIVE (WATER)

Maxxam ID		IYR709			IYR710		
Sampling Date		2019/02/11			2019/02/11		
COC Number		119154			119154		
	UNITS	**PZ102**	**RDL**	**QC Batch**	**BH6**	**RDL**	**QC Batch**
Dissolved Copper (Cu)	ug/L	62	1.0	5972713	3.6	1.0	5972713
Dissolved Iron (Fe)	ug/L	39000	100	5972713	<100	100	5972713
Dissolved Lead (Pb)	ug/L	46	0.50	5972713	<0.50	0.50	5972713
Dissolved Magnesium (Mg)	ug/L	36000	50	5972713	63000	50	5972713
Dissolved Manganese (Mn)	ug/L	3700	2.0	5972713	220	2.0	5972713
Dissolved Molybdenum (Mo)	ug/L	<0.50	0.50	5972713	0.76	0.50	5972713
Dissolved Nickel (Ni)	ug/L	12	1.0	5972713	27	1.0	5972713
Dissolved Phosphorus (P)	ug/L	1800	100	5972713	<100	100	5972713
Dissolved Potassium (K)	ug/L	700	200	5972713	6400	200	5972713
Dissolved Selenium (Se)	ug/L	<2.0	2.0	5972713	<2.0	2.0	5972713
Dissolved Silicon (Si)	ug/L	9100	50	5972713	5400	50	5972713
Dissolved Silver (Ag)	ug/L	<0.10	0.10	5972713	<0.10	0.10	5972713
Dissolved Sodium (Na)	ug/L	170000	100	5972713	590000	100	5972713
Dissolved Strontium (Sr)	ug/L	560	1.0	5972713	1600	1.0	5972713
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	5972713	<0.050	0.050	5972713
Dissolved Titanium (Ti)	ug/L	88	5.0	5972713	<5.0	5.0	5972713
Dissolved Uranium (U)	ug/L	25	0.10	5972713	3.1	0.10	5972713
Dissolved Vanadium (V)	ug/L	63	0.50	5972713	<0.50	0.50	5972713
Dissolved Zinc (Zn)	ug/L	58	5.0	5972713	59	5.0	5972713

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

GENERAL COMMENTS

Revised report (2019/02/28): Includes project details as requested.

Sample IYR709 [PZ102] : Elevated ion balance was confirmed by re-analysis. The sample bottle submitted for dissolved metals contained sediment covering almost the entire bottom of the bottle.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5970986	KRM	Matrix Spike	Dissolved Organic Carbon	2019/02/12		92	%	80 - 120
5970986	KRM	Spiked Blank	Dissolved Organic Carbon	2019/02/12		100	%	80 - 120
5970986	KRM	Method Blank	Dissolved Organic Carbon	2019/02/12	<0.50		mg/L	
5970986	KRM	RPD	Dissolved Organic Carbon	2019/02/12	2.2		%	20
5971306	SAU	Spiked Blank	Alkalinity (Total as CaCO3)	2019/02/13		97	%	85 - 115
5971306	SAU	Method Blank	Alkalinity (Total as CaCO3)	2019/02/13	<1.0		mg/L	
5971306	SAU	RPD	Alkalinity (Total as CaCO3)	2019/02/13	1.0		%	20
5971309	SAU	Spiked Blank	pH	2019/02/13		102	%	98 - 103
5971309	SAU	RPD	pH	2019/02/13	0.27		%	N/A
5971310	SAU	Spiked Blank	Conductivity	2019/02/13		102	%	85 - 115
5971310	SAU	Method Blank	Conductivity	2019/02/13	<1.0		umho/cm	
5971310	SAU	RPD	Conductivity	2019/02/13	0.22		%	25
5972713	ADA	Matrix Spike	Dissolved Aluminum (Al)	2019/02/13		101	%	80 - 120
			Dissolved Antimony (Sb)	2019/02/13		102	%	80 - 120
			Dissolved Arsenic (As)	2019/02/13		100	%	80 - 120
			Dissolved Barium (Ba)	2019/02/13		96	%	80 - 120
			Dissolved Beryllium (Be)	2019/02/13		102	%	80 - 120
			Dissolved Boron (B)	2019/02/13		97	%	80 - 120
			Dissolved Cadmium (Cd)	2019/02/13		99	%	80 - 120
			Dissolved Calcium (Ca)	2019/02/13		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/02/13		99	%	80 - 120
			Dissolved Cobalt (Co)	2019/02/13		101	%	80 - 120
			Dissolved Copper (Cu)	2019/02/13		102	%	80 - 120
			Dissolved Iron (Fe)	2019/02/13		100	%	80 - 120
			Dissolved Lead (Pb)	2019/02/13		93	%	80 - 120
			Dissolved Magnesium (Mg)	2019/02/13		NC	%	80 - 120
			Dissolved Manganese (Mn)	2019/02/13		98	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/02/13		105	%	80 - 120
			Dissolved Nickel (Ni)	2019/02/13		94	%	80 - 120
			Dissolved Phosphorus (P)	2019/02/13		99	%	80 - 120
			Dissolved Potassium (K)	2019/02/13		103	%	80 - 120
			Dissolved Selenium (Se)	2019/02/13		101	%	80 - 120
			Dissolved Silicon (Si)	2019/02/13		99	%	80 - 120
			Dissolved Silver (Ag)	2019/02/13		71 (1)	%	80 - 120
			Dissolved Sodium (Na)	2019/02/13		NC	%	80 - 120
			Dissolved Strontium (Sr)	2019/02/13		NC	%	80 - 120
			Dissolved Thallium (Tl)	2019/02/13		95	%	80 - 120
			Dissolved Titanium (Ti)	2019/02/13		100	%	80 - 120
			Dissolved Uranium (U)	2019/02/13		91	%	80 - 120
			Dissolved Vanadium (V)	2019/02/13		97	%	80 - 120
			Dissolved Zinc (Zn)	2019/02/13		98	%	80 - 120
5972713	ADA	Spiked Blank	Dissolved Aluminum (Al)	2019/02/13		100	%	80 - 120
			Dissolved Antimony (Sb)	2019/02/13		102	%	80 - 120
			Dissolved Arsenic (As)	2019/02/13		101	%	80 - 120
			Dissolved Barium (Ba)	2019/02/13		100	%	80 - 120
			Dissolved Beryllium (Be)	2019/02/13		97	%	80 - 120
			Dissolved Boron (B)	2019/02/13		97	%	80 - 120
			Dissolved Cadmium (Cd)	2019/02/13		100	%	80 - 120
			Dissolved Calcium (Ca)	2019/02/13		96	%	80 - 120
			Dissolved Chromium (Cr)	2019/02/13		99	%	80 - 120
			Dissolved Cobalt (Co)	2019/02/13		103	%	80 - 120
			Dissolved Copper (Cu)	2019/02/13		101	%	80 - 120
			Dissolved Iron (Fe)	2019/02/13		101	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Lead (Pb)	2019/02/13		98	%	80 - 120
			Dissolved Magnesium (Mg)	2019/02/13		98	%	80 - 120
			Dissolved Manganese (Mn)	2019/02/13		100	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/02/13		103	%	80 - 120
			Dissolved Nickel (Ni)	2019/02/13		96	%	80 - 120
			Dissolved Phosphorus (P)	2019/02/13		105	%	80 - 120
			Dissolved Potassium (K)	2019/02/13		103	%	80 - 120
			Dissolved Selenium (Se)	2019/02/13		99	%	80 - 120
			Dissolved Silicon (Si)	2019/02/13		100	%	80 - 120
			Dissolved Silver (Ag)	2019/02/13		96	%	80 - 120
			Dissolved Sodium (Na)	2019/02/13		97	%	80 - 120
			Dissolved Strontium (Sr)	2019/02/13		101	%	80 - 120
			Dissolved Thallium (Tl)	2019/02/13		100	%	80 - 120
			Dissolved Titanium (Ti)	2019/02/13		101	%	80 - 120
			Dissolved Uranium (U)	2019/02/13		93	%	80 - 120
			Dissolved Vanadium (V)	2019/02/13		96	%	80 - 120
			Dissolved Zinc (Zn)	2019/02/13		98	%	80 - 120
5972713	ADA	Method Blank	Dissolved Aluminum (Al)	2019/02/13	<5.0		ug/L	
			Dissolved Antimony (Sb)	2019/02/13	<0.50		ug/L	
			Dissolved Arsenic (As)	2019/02/13	<1.0		ug/L	
			Dissolved Barium (Ba)	2019/02/13	<2.0		ug/L	
			Dissolved Beryllium (Be)	2019/02/13	<0.50		ug/L	
			Dissolved Boron (B)	2019/02/13	<10		ug/L	
			Dissolved Cadmium (Cd)	2019/02/13	<0.10		ug/L	
			Dissolved Calcium (Ca)	2019/02/13	<200		ug/L	
			Dissolved Chromium (Cr)	2019/02/13	<5.0		ug/L	
			Dissolved Cobalt (Co)	2019/02/13	<0.50		ug/L	
			Dissolved Copper (Cu)	2019/02/13	<1.0		ug/L	
			Dissolved Iron (Fe)	2019/02/13	<100		ug/L	
			Dissolved Lead (Pb)	2019/02/13	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2019/02/13	<50		ug/L	
			Dissolved Manganese (Mn)	2019/02/13	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2019/02/13	<0.50		ug/L	
			Dissolved Nickel (Ni)	2019/02/13	<1.0		ug/L	
			Dissolved Phosphorus (P)	2019/02/13	<100		ug/L	
			Dissolved Potassium (K)	2019/02/13	<200		ug/L	
			Dissolved Selenium (Se)	2019/02/13	<2.0		ug/L	
			Dissolved Silicon (Si)	2019/02/13	<50		ug/L	
			Dissolved Silver (Ag)	2019/02/13	<0.10		ug/L	
			Dissolved Sodium (Na)	2019/02/13	<100		ug/L	
			Dissolved Strontium (Sr)	2019/02/13	<1.0		ug/L	
			Dissolved Thallium (Tl)	2019/02/13	<0.050		ug/L	
			Dissolved Titanium (Ti)	2019/02/13	<5.0		ug/L	
			Dissolved Uranium (U)	2019/02/13	<0.10		ug/L	
			Dissolved Vanadium (V)	2019/02/13	<0.50		ug/L	
			Dissolved Zinc (Zn)	2019/02/13	<5.0		ug/L	
5972713	ADA	RPD	Dissolved Aluminum (Al)	2019/02/13	NC		%	20
			Dissolved Antimony (Sb)	2019/02/13	NC		%	20
			Dissolved Arsenic (As)	2019/02/13	3.2		%	20
			Dissolved Barium (Ba)	2019/02/13	5.2		%	20
			Dissolved Beryllium (Be)	2019/02/13	NC		%	20
			Dissolved Boron (B)	2019/02/13	2.3		%	20
			Dissolved Cadmium (Cd)	2019/02/13	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Calcium (Ca)	2019/02/13	2.3		%	20
			Dissolved Chromium (Cr)	2019/02/13	NC		%	20
			Dissolved Cobalt (Co)	2019/02/13	NC		%	20
			Dissolved Copper (Cu)	2019/02/13	NC		%	20
			Dissolved Iron (Fe)	2019/02/13	2.7		%	20
			Dissolved Lead (Pb)	2019/02/13	NC		%	20
			Dissolved Magnesium (Mg)	2019/02/13	2.7		%	20
			Dissolved Manganese (Mn)	2019/02/13	3.0		%	20
			Dissolved Molybdenum (Mo)	2019/02/13	2.0		%	20
			Dissolved Nickel (Ni)	2019/02/13	7.0		%	20
			Dissolved Phosphorus (P)	2019/02/13	NC		%	20
			Dissolved Potassium (K)	2019/02/13	1.6		%	20
			Dissolved Selenium (Se)	2019/02/13	NC		%	20
			Dissolved Silicon (Si)	2019/02/13	1.8		%	20
			Dissolved Silver (Ag)	2019/02/13	NC		%	20
			Dissolved Sodium (Na)	2019/02/13	1.1		%	20
			Dissolved Strontium (Sr)	2019/02/13	3.2		%	20
			Dissolved Thallium (Tl)	2019/02/13	NC		%	20
			Dissolved Titanium (Ti)	2019/02/13	NC		%	20
			Dissolved Uranium (U)	2019/02/13	0.14		%	20
			Dissolved Vanadium (V)	2019/02/13	NC		%	20
			Dissolved Zinc (Zn)	2019/02/13	NC		%	20
5972927	C_N	Matrix Spike	Total Ammonia-N	2019/02/15		93	%	75 - 125
5972927	C_N	Spiked Blank	Total Ammonia-N	2019/02/15		102	%	80 - 120
5972927	C_N	Method Blank	Total Ammonia-N	2019/02/15	<0.050		mg/L	
5972927	C_N	RPD	Total Ammonia-N	2019/02/15	NC		%	20
5973400	C_N	Matrix Spike	Nitrite (N)	2019/02/15		99	%	80 - 120
			Nitrate (N)	2019/02/15		NC	%	80 - 120
5973400	C_N	Spiked Blank	Nitrite (N)	2019/02/15		101	%	80 - 120
			Nitrate (N)	2019/02/15		95	%	80 - 120
5973400	C_N	Method Blank	Nitrite (N)	2019/02/15	<0.010		mg/L	
			Nitrate (N)	2019/02/15	<0.10		mg/L	
5973400	C_N	RPD	Nitrite (N)	2019/02/15	0.31		%	20
			Nitrate (N)	2019/02/15	8.9		%	20
5973633	DRM	Matrix Spike	Dissolved Chloride (Cl-)	2019/02/14		NC	%	80 - 120
5973633	DRM	Spiked Blank	Dissolved Chloride (Cl-)	2019/02/14		103	%	80 - 120
5973633	DRM	Method Blank	Dissolved Chloride (Cl-)	2019/02/14	<1.0		mg/L	
5973633	DRM	RPD	Dissolved Chloride (Cl-)	2019/02/14	2.9		%	20
5973636	DRM	Matrix Spike	Dissolved Sulphate (SO4)	2019/02/14		NC	%	75 - 125
5973636	DRM	Spiked Blank	Dissolved Sulphate (SO4)	2019/02/14		104	%	80 - 120
5973636	DRM	Method Blank	Dissolved Sulphate (SO4)	2019/02/14	<1.0		mg/L	
5973636	DRM	RPD	Dissolved Sulphate (SO4)	2019/02/14	1.8		%	20
5973672	ADB	Matrix Spike	Orthophosphate (P)	2019/02/14		106	%	75 - 125
5973672	ADB	Spiked Blank	Orthophosphate (P)	2019/02/14		101	%	80 - 120
5973672	ADB	Method Blank	Orthophosphate (P)	2019/02/14	<0.010		mg/L	
5973672	ADB	RPD	Orthophosphate (P)	2019/02/14	NC		%	25
5974965	COP	Matrix Spike	Total Ammonia-N	2019/02/19		94	%	75 - 125
5974965	COP	Spiked Blank	Total Ammonia-N	2019/02/19		104	%	80 - 120
5974965	COP	Method Blank	Total Ammonia-N	2019/02/19	<0.050		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5974965	COP	RPD	Total Ammonia-N	2019/02/19	NC		%	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.

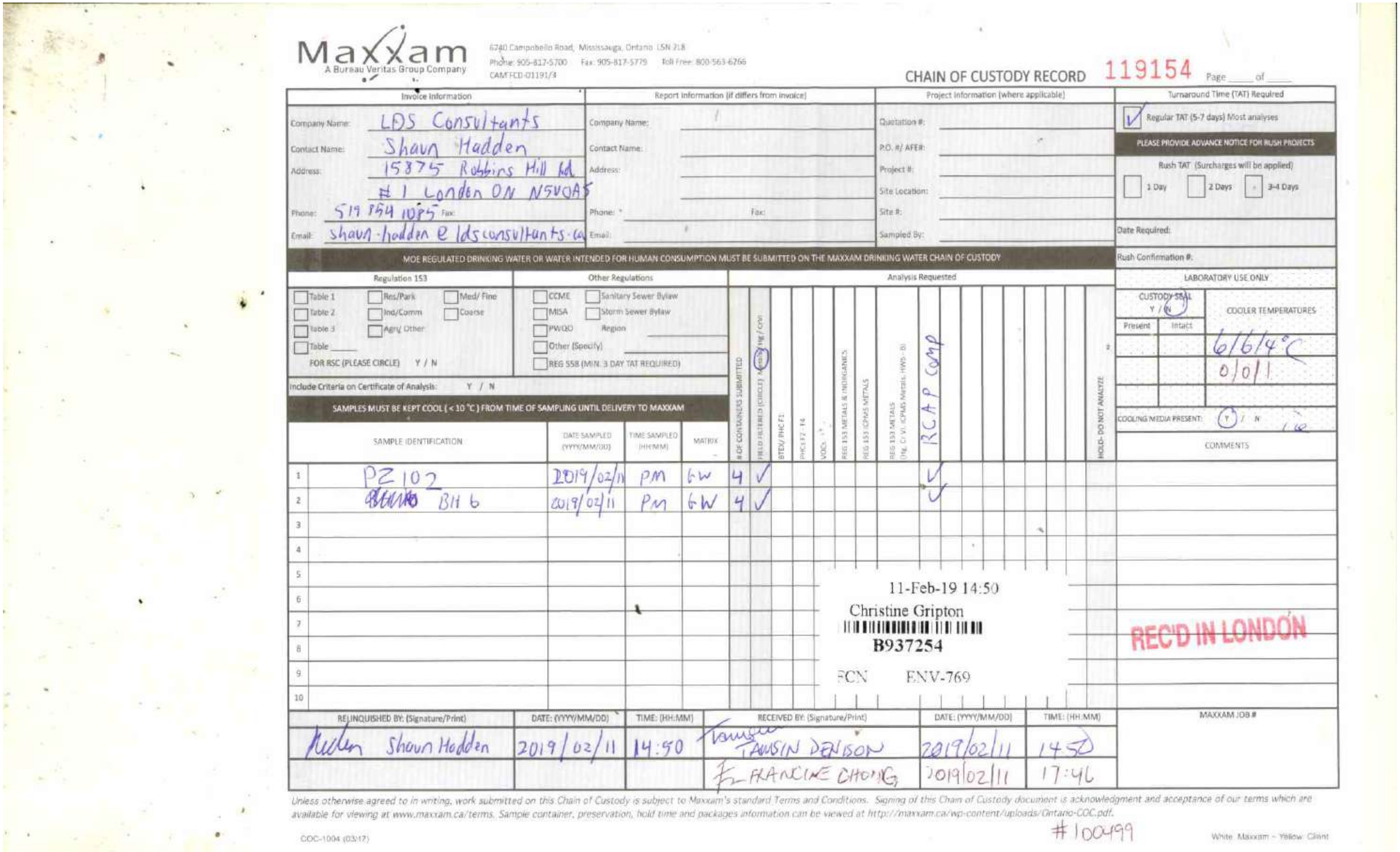
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eva Pranjic

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



Maxxam
A Bureau Veritas Group Company

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/3

CHAIN OF CUSTODY RECORD 119154

Page ____ of ____

Invoice Information

Company Name: LDS Consultants
Contact Name: Shaun Hadden
Address: 15875 Robbins Hill Rd
#1 London ON N5V0A5
Phone: 519 854 1085 Fax:
Email: shaun.hadden@ldsconsultants.ca

Report Information (if differs from invoice)

Company Name:
Contact Name:
Address:
Phone: Fax:
Email:

Project Information (where applicable)

Quotation #:
P.O. #/ AFE#:
Project #:
Site Location:
Site #:
Sampled By:

Turnaround Time (TAT) Required

☑ Regular TAT (5-7 days) Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)
☐ 1 Day ☐ 2 Days ☐ 3-4 Days

Date Required:
Rush Confirmation #:

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

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/ Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/ Other
☐ Table ____
FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region ____
☐ Other (Specify) ____
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

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

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) [✓ Metals] / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	RCAP COMP								HOLD- DO NOT ANALYZE	COMMENTS
1	PZ102	2019/02/11	PM	GW	4	✓							✓									
2	BH 6	2019/02/11	PM	GW	4	✓							✓									
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

11-Feb-19 14:50
Christine Gripton
B937254
FCN ENV-769

LABORATORY USE ONLY

CUSTODY SEAL Y / [✓ N]

Present	Intact	COOLER TEMPERATURES
		6/6/4°C
		0/0/1

COOLING MEDIA PRESENT: [✓ Y] / N

REC'D IN LONDON

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
Shaun Hadden	2019/02/11	14:50	TAMSIN DENISON	2019/02/11	1450	
			F. FRANCINE CHONG	2019/02/11	17:46	

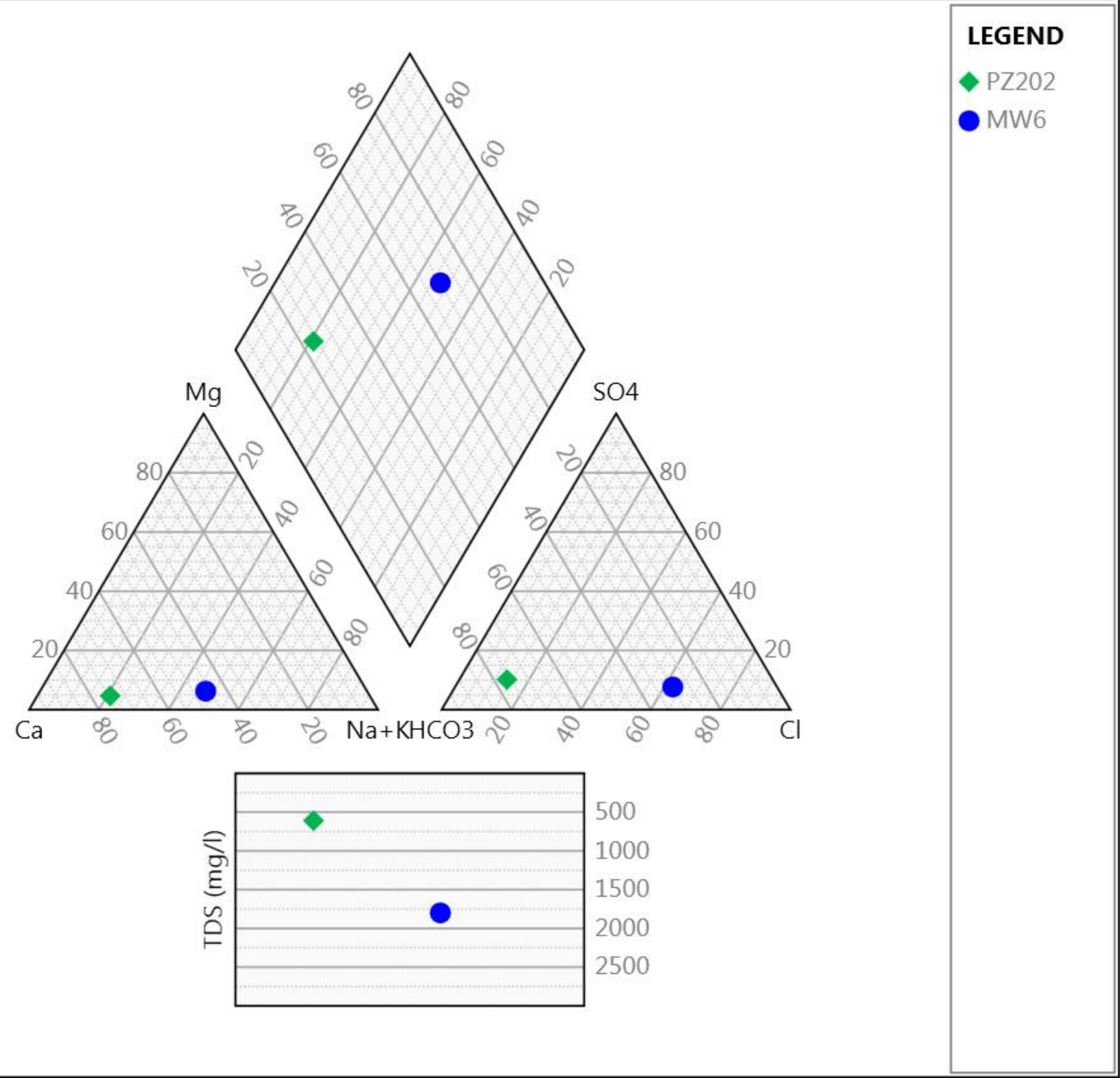
Unless otherwise agreed to in writing, work submitted on this Chain of Custody is subject to Maxxam's standard Terms and Conditions. Signing of this Chain of Custody document is acknowledgment and acceptance of our terms which are available for viewing at www.maxxam.ca/terms. Sample container, preservation, hold time and packages information can be viewed at http://maxxam.ca/wp-content/uploads/Ontario-COC.pdf.

COC-1004 (03/17)

#100499

White: Maxxam - Yellow: Client

GE-00085 - 952 Southdale Road
Piper Diagram



PARACEL
LABORATORIES LTD.
TRUSTED. RESPONSIVE. RELIABLE.

351 Nash Road North, unit 9B
Hamilton, ON L8H 7P4
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LDS Consultants Inc. (London)

15875 Robins Hill Road, Unit 1
London, ON N5V 0A5
Attn: Rebecca Walker

Client PO:
Project: GE-00085
Custody: 61751

Report Date: 7-Jul-2021
Order Date: 29-Jun-2021

Order #: 2127383

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2127383-01	BH5 deep
2127383-02	BH6
2127383-03	PZ202 Shallow
2127383-04	BH303 Shallow
2127383-05	Surface

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: LDS Consultants Inc. (London)
Client PO:

Report Date: 07-Jul-2021
Order Date: 29-Jun-2021
Project Description: GE-00085

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, bicarbonate	calculated from EPA 310.1 - Titration to pH 4.5	2-Jul-21	2-Jul-21
Alkalinity, carbonate	calculated from EPA 310.1 - Titration to pH 4.5	2-Jul-21	2-Jul-21
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	2-Jul-21	2-Jul-21
Ammonia, as N	EPA 351.2 - Auto Colour	30-Jun-21	5-Jul-21
Anion Sum	Calculated	7-Jul-21	7-Jul-21
Nitrate + Nitrite as N	calculated from EPA 300.1 - IC	30-Jun-21	1-Jul-21
Anions	EPA 300.1 - IC	30-Jun-21	1-Jul-21
Cation Sum	Calculated	7-Jul-21	7-Jul-21
Conductivity	EPA 9050A- probe @25 °C	2-Jul-21	2-Jul-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	30-Jun-21	30-Jun-21
Hardness	Hardness as CaCO3	2-Jul-21	2-Jul-21
Ion Balance	Calculated	7-Jul-21	7-Jul-21
Langeliers Index	Calculated	7-Jul-21	7-Jul-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	2-Jul-21	2-Jul-21
pH	EPA 150.1 - pH probe @25 °C	2-Jul-21	2-Jul-21
Saturation pH, calculated	Calculated	7-Jul-21	7-Jul-21
Solids total dissolved, calculated	Calculated	7-Jul-21	7-Jul-21

Certificate of Analysis

Client: **LDS Consultants Inc. (London)**

Client PO:

Report Date: 07-Jul-2021

Order Date: 29-Jun-2021

Project Description: GE-00085

Client ID:		BH5 deep	BH6	PZ202 Shallow	BH303 Shallow
Sample Date:		29-Jun-21 12:00	29-Jun-21 12:00	29-Jun-21 12:00	29-Jun-21 12:00
Sample ID:		2127383-01	2127383-02	2127383-03	2127383-04
	MDL/Units	Water	Water	Water	Water
Calculated Parameters					
Anion Sum	0.01 mEq/L	7.54	68.8	3.45	13.3
Cation Sum	0.01 mEq/L	7.12	64.7	3.14	9.21
Ion balance	0.1 %	-2.9	-3.1	-4.6	-18 [2]
Solids, total dissolved - calc.	10.0 mg/L	362	3810	176	607
Langlier Index	0.01 S.I.	0.78	0.47	-0.43	0.69
Saturation pH	0.10 pH Units	6.92	6.70	7.83	6.91
General Inorganics					
Alkalinity, total	5 mg/L	343	344	114	358
Hardness	mg/L	334	1040	102	437
Alkalinity, bicarbonate	5 mg/L	342	343	113	357
Alkalinity, carbonate	5 mg/L	<5	<5	<5	<5
Ammonia as N	0.01 mg/L	0.12	0.23	0.22	0.05
Dissolved Organic Carbon	0.5 mg/L	2.5	5.0	14.1	2.7
Conductivity	5 uS/cm	717	7760	540	1380
pH	0.1 pH Units	7.7	7.2	7.4	7.6
Anions					
Chloride	1 mg/L	13	2170	40	188
Nitrate as N	0.1 mg/L	1.3	<0.1	<0.1	1.3
Nitrite as N	0.05 mg/L	<0.05	<1.00 [1]	<0.05	<0.05
Nitrate + Nitrite as N	0.150 mg/L	1.32	-	<0.150	1.33
Nitrate + Nitrite as N	1.10 mg/L	-	<1.10	-	-
Phosphate as P	0.2 mg/L	<0.2	<0.2	<0.2	<0.2
Sulphate	1 mg/L	11	34	2	37
Metals					
Aluminum	1 ug/L	4	5	259	4
Antimony	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Arsenic	1 ug/L	<1	<1	2	<1
Barium	1 ug/L	41	372	21	102
Beryllium	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Boron	10 ug/L	25	20	26	26
Cadmium	0.1 ug/L	<0.1	0.2	<0.1	<0.1
Calcium	100 ug/L	102000	339000	35400	119000
Chromium	1 ug/L	<1	<1	<1	<1
Cobalt	0.5 ug/L	<0.5	0.8	<0.5	<0.5
Copper	0.5 ug/L	1.2	1.5	1.2	0.8

Certificate of Analysis

Client: **LDS Consultants Inc. (London)**

Client PO:

Report Date: 07-Jul-2021

Order Date: 29-Jun-2021

Project Description: GE-00085

Client ID: **Sample Date:** **Sample ID:**		BH5 deep 29-Jun-21 12:00 2127383-01 Water	BH6 29-Jun-21 12:00 2127383-02 Water	PZ202 Shallow 29-Jun-21 12:00 2127383-03 Water	BH303 Shallow 29-Jun-21 12:00 2127383-04 Water
	MDL/Units				
Iron	100 ug/L	<100	<100	843	<100
Lead	0.1 ug/L	<0.1	<0.1	0.5	<0.1
Magnesium	200 ug/L	19600	47700	3230	33900
Manganese	5 ug/L	<5	760	265	53
Molybdenum	0.5 ug/L	<0.5	<0.5	<0.5	1.2
Nickel	1 ug/L	<1	4	<1	<1
Potassium	100 ug/L	681	5140	3650	2280
Selenium	1 ug/L	<1	<1	<1	<1
Silver	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Sodium	200 ug/L	9560	1000000	23500	9420
Strontium	10 ug/L	169	793	75	223
Thallium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Tin	5 ug/L	<5	<5	<5	<5
Titanium	5 ug/L	<5	<5	6	<5
Tungsten	10 ug/L	<10	<10	<10	<10
Uranium	0.1 ug/L	0.6	2.1	0.2	2.5
Vanadium	0.5 ug/L	<0.5	0.7	1.0	<0.5
Zinc	5 ug/L	<5	6	<5	<5

Certificate of Analysis

Report Date: 07-Jul-2021

Client: **LDS Consultants Inc. (London)**

Order Date: 29-Jun-2021

Client PO:

Project Description: GE-00085

	Client ID:	Surface	-	-	-
	Sample Date:	29-Jun-21 12:00	-	-	-
	Sample ID:	2127383-05	-	-	-
	MDL/Units	Water	-	-	-
Calculated Parameters					
Anion Sum	0.01 mEq/L	3.51	-	-	-
Cation Sum	0.01 mEq/L	3.39	-	-	-
Ion balance	0.1 %	-1.7	-	-	-
Solids, total dissolved - calc.	10.0 mg/L	181	-	-	-
Langlier Index	0.01 S.I.	0.05	-	-	-
Saturation pH	0.10 pH Units	7.75	-	-	-
General Inorganics					
Alkalinity, total	5 mg/L	122	-	-	-
Hardness	mg/L	112	-	-	-
Alkalinity, bicarbonate	5 mg/L	122	-	-	-
Alkalinity, carbonate	5 mg/L	<5	-	-	-
Ammonia as N	0.01 mg/L	0.15	-	-	-
Dissolved Organic Carbon	0.5 mg/L	11.8	-	-	-
Conductivity	5 uS/cm	400	-	-	-
pH	0.1 pH Units	7.8	-	-	-
Anions					
Chloride	1 mg/L	36	-	-	-
Nitrate as N	0.1 mg/L	<0.1	-	-	-
Nitrite as N	0.05 mg/L	<0.05	-	-	-
Nitrate + Nitrite as N	0.150 mg/L	<0.150	-	-	-
Phosphate as P	0.2 mg/L	<0.2	-	-	-
Sulphate	1 mg/L	2	-	-	-
Metals					
Aluminum	1 ug/L	7	-	-	-
Antimony	0.5 ug/L	<0.5	-	-	-
Arsenic	1 ug/L	1	-	-	-
Barium	1 ug/L	22	-	-	-
Beryllium	0.5 ug/L	<0.5	-	-	-
Boron	10 ug/L	27	-	-	-
Cadmium	0.1 ug/L	<0.1	-	-	-
Calcium	100 ug/L	37700	-	-	-
Chromium	1 ug/L	<1	-	-	-
Cobalt	0.5 ug/L	<0.5	-	-	-
Copper	0.5 ug/L	2.1	-	-	-
Iron	100 ug/L	<100	-	-	-

Certificate of Analysis

Report Date: 07-Jul-2021

Client: **LDS Consultants Inc. (London)**

Order Date: 29-Jun-2021

Client PO:

Project Description: GE-00085

Client ID:		Surface	-	-	-
Sample Date:		29-Jun-21 12:00	-	-	-
Sample ID:		2127383-05	-	-	-
	MDL/Units	Water	-	-	-
Lead	0.1 ug/L	<0.1	-	-	-
Magnesium	200 ug/L	4250	-	-	-
Manganese	5 ug/L	128	-	-	-
Molybdenum	0.5 ug/L	<0.5	-	-	-
Nickel	1 ug/L	<1	-	-	-
Potassium	100 ug/L	2560	-	-	-
Selenium	1 ug/L	<1	-	-	-
Silver	0.1 ug/L	<0.1	-	-	-
Sodium	200 ug/L	25300	-	-	-
Strontium	10 ug/L	73	-	-	-
Thallium	0.1 ug/L	<0.1	-	-	-
Tin	5 ug/L	<5	-	-	-
Titanium	5 ug/L	<5	-	-	-
Tungsten	10 ug/L	<10	-	-	-
Uranium	0.1 ug/L	0.1	-	-	-
Vanadium	0.5 ug/L	<0.5	-	-	-
Zinc	5 ug/L	5	-	-	-

Certificate of Analysis
Client: **LDS Consultants Inc. (London)**
Client PO:

Report Date: 07-Jul-2021
Order Date: 29-Jun-2021
Project Description: GE-00085

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Phosphate as P	ND	0.2	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Alkalinity, bicarbonate	ND	5	mg/L						
Alkalinity, carbonate	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Conductivity	ND	5	uS/cm						
Metals									
Aluminum	ND	1	ug/L						
Antimony	ND	0.5	ug/L						
Arsenic	ND	1	ug/L						
Barium	ND	1	ug/L						
Beryllium	ND	0.5	ug/L						
Boron	ND	10	ug/L						
Cadmium	ND	0.1	ug/L						
Calcium	ND	100	ug/L						
Chromium	ND	1	ug/L						
Cobalt	ND	0.5	ug/L						
Copper	ND	0.5	ug/L						
Iron	ND	100	ug/L						
Lead	ND	0.1	ug/L						
Magnesium	ND	200	ug/L						
Manganese	ND	5	ug/L						
Molybdenum	ND	0.5	ug/L						
Nickel	ND	1	ug/L						
Potassium	ND	100	ug/L						
Selenium	ND	1	ug/L						
Silver	ND	0.1	ug/L						
Sodium	ND	200	ug/L						
Strontium	ND	10	ug/L						
Thallium	ND	0.1	ug/L						
Tin	ND	5	ug/L						
Titanium	ND	5	ug/L						
Tungsten	ND	10	ug/L						
Uranium	ND	0.1	ug/L						
Vanadium	ND	0.5	ug/L						
Zinc	ND	5	ug/L						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	516	5	mg/L	504			2.3	10	
Nitrate as N	0.98	0.1	mg/L	0.96			2.2	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Phosphate as P	ND	0.2	mg/L	ND			NC	10	
Sulphate	113	1	mg/L	111			2.2	10	
General Inorganics									
Alkalinity, total	338	5	mg/L	343			1.6	14	
Alkalinity, bicarbonate	336	5	mg/L	342			1.6	14	
Alkalinity, carbonate	ND	5	mg/L	ND			NC	14	
Ammonia as N	0.112	0.01	mg/L	0.113			1.2	18	
Dissolved Organic Carbon	2.6	0.5	mg/L	2.7			1.8	37	
Conductivity	330	5	uS/cm	338			2.4	5	
pH	7.8	0.1	pH Units	7.8			0.3	3.3	
Metals									
Aluminum	564	1	ug/L	600			6.3	20	
Antimony	1.03	0.5	ug/L	0.70			NC	20	
Arsenic	1.4	1	ug/L	1.3			6.1	20	
Barium	18.5	1	ug/L	18.1			2.2	20	
Beryllium	ND	0.5	ug/L	ND			NC	20	
Boron	28	10	ug/L	27			3.3	20	
Cadmium	ND	0.1	ug/L	ND			NC	20	
Calcium	34000	100	ug/L	33100			2.8	20	
Chromium	1.0	1	ug/L	1.0			0.6	20	
Cobalt	ND	0.5	ug/L	ND			NC	20	
Copper	3.83	0.5	ug/L	3.97			3.4	20	
Iron	673	100	ug/L	651			3.3	20	
Lead	0.68	0.1	ug/L	0.59			14.8	20	
Magnesium	6220	200	ug/L	5510			12.0	20	
Manganese	64.5	5	ug/L	62.4			3.2	20	
Molybdenum	8.32	0.5	ug/L	7.82			6.3	20	
Nickel	2.9	1	ug/L	2.0			NC	20	
Potassium	3350	100	ug/L	3250			2.9	20	
Selenium	ND	1	ug/L	ND			NC	20	
Silver	ND	0.1	ug/L	ND			NC	20	
Sodium	10900	200	ug/L	10700			1.7	20	
Strontium	462	10	ug/L	444			4.0	20	
Thallium	ND	0.1	ug/L	ND			NC	20	
Tin	ND	5	ug/L	ND			NC	20	
Titanium	12.4	5	ug/L	14.3			14.1	20	
Tungsten	ND	10	ug/L	ND			NC	20	
Uranium	1.0	0.1	ug/L	0.9			10.3	20	
Vanadium	1.86	0.5	ug/L	2.02			7.9	20	
Zinc	11	5	ug/L	11			0.7	20	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	44.5	1	mg/L	36.3	81.8	77-123			
Nitrate as N	1.90	0.1	mg/L	0.96	94.2	79-120			
Nitrite as N	0.990	0.05	mg/L	ND	99.0	84-117			
Phosphate as P	5.67	0.2	mg/L	ND	113	59-141			
Sulphate	119	1	mg/L	111	76.9	74-126			
General Inorganics									
Ammonia as N	0.355	0.01	mg/L	0.113	96.8	81-124			
Dissolved Organic Carbon	13.4	0.5	mg/L	2.7	108	60-133			
Metals									
Aluminum	53.9	1	ug/L	ND	108	80-120			
Antimony	41.1	0.5	ug/L	0.70	80.7	80-120			
Arsenic	40.2	1	ug/L	ND	80.5	80-120			
Barium	60.6	1	ug/L	18.1	84.9	80-120			
Beryllium	39.7	0.5	ug/L	ND	79.2	80-120			QM-07
Boron	42	10	ug/L	ND	83.1	80-120			
Cadmium	47.9	0.1	ug/L	ND	95.8	80-120			
Calcium	7970	100	ug/L	ND	79.7	80-120			QS-02
Chromium	47.0	1	ug/L	1.0	91.9	80-120			
Cobalt	46.2	0.5	ug/L	ND	91.5	80-120			
Copper	47.7	0.5	ug/L	3.97	87.6	80-120			
Lead	40.8	0.1	ug/L	0.59	80.4	80-120			
Magnesium	8030	200	ug/L	ND	80.3	80-120			
Manganese	105	5	ug/L	62.4	85.6	80-120			
Molybdenum	55.6	0.5	ug/L	7.82	95.5	80-120			
Nickel	46.1	1	ug/L	2.0	88.1	80-120			
Selenium	44.6	1	ug/L	ND	89.2	80-120			
Silver	41.0	0.1	ug/L	ND	81.9	80-120			
Strontium	48	10	ug/L	ND	95.8	80-120			
Thallium	42.1	0.1	ug/L	ND	84.0	80-120			
Tin	43.3	5	ug/L	ND	86.0	80-120			
Titanium	57.1	5	ug/L	14.3	85.6	80-120			
Tungsten	47.7	10	ug/L	ND	95.0	80-120			
Uranium	44.6	0.1	ug/L	0.9	87.5	80-120			
Vanadium	48.3	0.5	ug/L	2.02	92.7	80-120			
Zinc	47	5	ug/L	ND	94.7	80-120			

Qualifier Notes:

1 : Elevated detection limit because of dilution required due to the presence of high levels of non-target analytes.

2 : Ion balance calculation is greater than typically accepted limits. Major cation and ion results have been confirmed by re-analysis. The high result is likely due to matrix effects or elevated compontents not normally included in the calculation.

QC Qualifiers :

QM-07 : The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

QS-02 : Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

PARACEL
LABORATORIES LTD.

TRUSTED.
RESPONSIVE.
RELIABLE.

Paracel ID: 2127383

Chain Of Custody

(Lab Use Only)

Nº 61751

Page 1 of 1

Client Name: LDS Consultants

Contact Name: Rebecca Walker

Address: 15875 Robins Hill Rd

Telephone:

Project Ref: GE-00085

Quote #: LDS Consultants Water Quality Package

PO #:

E-mail:

Turnaround Time

☐ 1 day ☐ 3 day
☐ 2 day ☑ Regular

Date Required:

☐ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table ___
For RSC: ☐ Yes ☐ No

Other Regulation

☐ REG,558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun: ________
☐ Other:

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	general chemistry											
1	BH 5 deep	GW		6	June 29, 2021	PM	✓											
2	BH 6	GW		6	↓	↓	✓											
3	~~202 s~~																	
4	PZ 202 shallow	GW		6			✓											
5	~~PZ~~ BH 303 shallow	GW		6			✓											
6	surface	SW		6			✓											
7																		
8																		
9																		
10																		

Comments: - all bottles were field filtered

Method of Delivery: Walk-in

Relinquished By (Sign): Rob Walker

Relinquished By (Print): Rob Walker

Date/Time: June 29, 2021

Received By Driver/Depot:

Date/Time: 29-JUN-2021 16:00

Temperature: 18 °C

Received at Lab: Sureepor Dohmai

Date/Time: JUN 30, 2021 10.34

Temperature: 7.3 °C

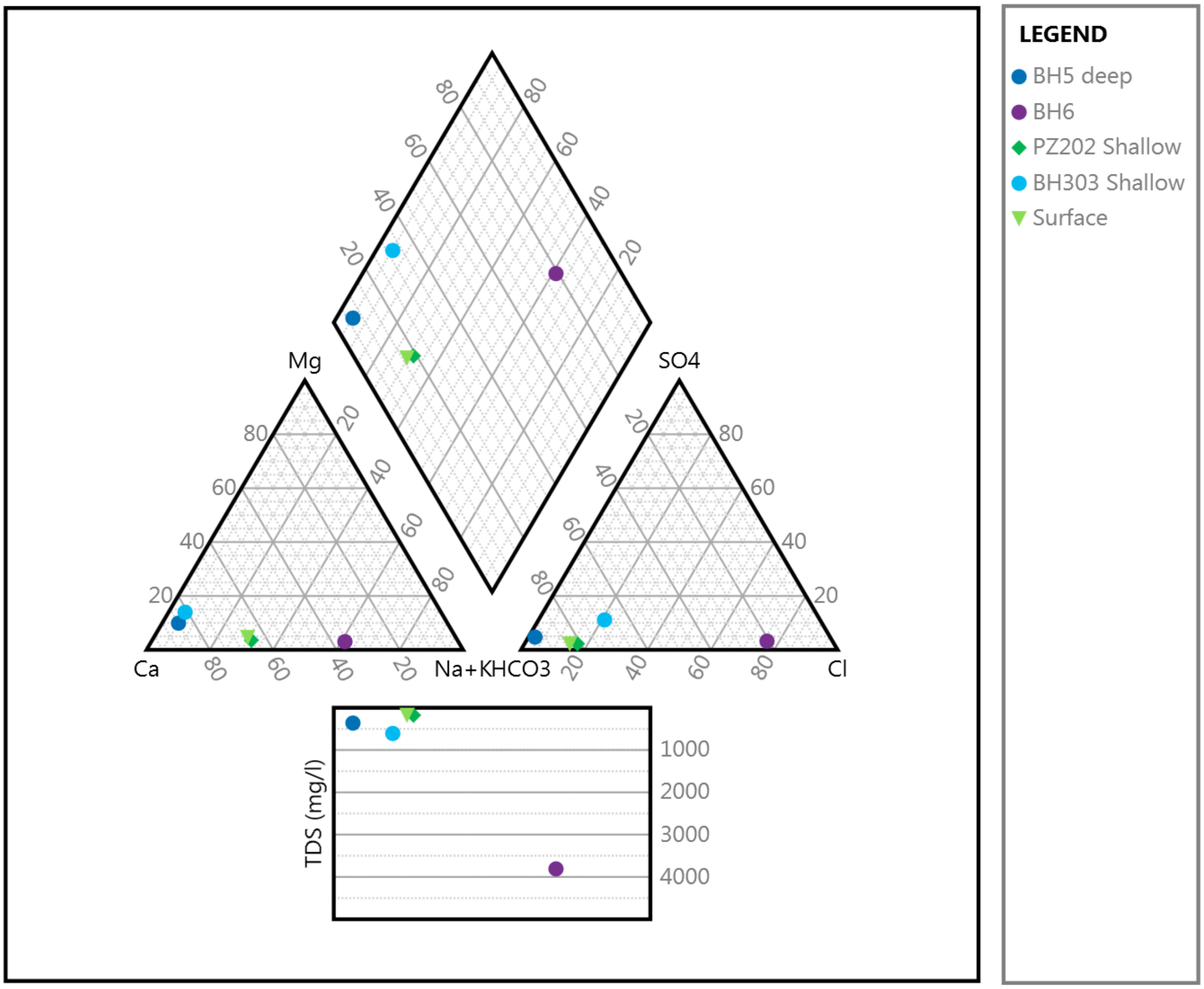
Verified By: ~~11:35~~

Date/Time: 11:35 June 30 2021

pH Verified: ☐ By:

Piper Diagram – 07/07/2021 Water Samples

GE-00085 952 Southdale Road, London
Piper Diagram



APPENDIX F

MECP Well Records

SUMMARY OF MECP WELL RECORDS

MECP Well ID	Completion Date	Type	Depth of Well (m)	Water Found (m)	Static Level (m)	Pump Rate (L/min)	Northing, m N	Easting, m E
4103401	08/07/1966	Water Supply	70.1	56.7	47.5	11.4	4754063.00	474133.50
4103403	06/08/1959	Water Supply	66.4	64.6	59.7	26.6	4753983.00	473938.50
4105170	04/09/1970	Water Supply	41.5	39.0	35.4	38.0	4753803.00	474673.50
7118093	09/05/2008	Water Supply	68.9	55.8	54.9	57.0	4753989.78	473945.97
7276717	30/11/2016	Water Supply	68.3	61.6	55.2	68.4	4754073.00	473681.00
7103981	12/03/2008	Observation Wells	6.5	*NR*	*NR*	*NR*	4754065.00	474199.00
7146806	19/02/2010	Observation Wells	6.1	*NR*	*NR*	*NR*	4754393.00	474418.00
7193997	11/12/2012	Observation Wells	*NR*	*NR*	*NR*	*NR*	4754435.00	474387.00
7197509	09/01/2013	Observation Wells	6.1	*NR*	*NR*	*NR*	4754345.00	474395.00
4116132	29/06/2005	Abandoned-Other	62.8	*NR*	*NR*	*NR*	4754057.00	473890.00
7152898	09/09/2010	Abandoned-Other	56.4	*NR*	*NR*	*NR*	4754161.00	473931.00
7196001	04/01/2013	Abandoned-Other	37.2	*NR*	*NR*	*NR*	4753699.00	474108.00
4114929	21/01/2002		*NR*	*NR*	*NR*	*NR*	4753626.00	474204.00
4114930	21/01/2002		*NR*	*NR*	*NR*	*NR*	4753628.00	474202.00
4114931	21/01/2002		*NR*	*NR*	*NR*	*NR*	4753628.00	474203.00

Refer to Drawing 7, in Appendix A for MECP Well Location Plan

APPENDIX G

Water Balance Worksheets

Z:\GEOTECHNIC-L SERVICES\PROJECTS\GE-00085 952 SOUTHD-LE RD, LONDON\05 - REPORTS\W-TER B-L- CE\20190628\GE-00085 20190628 W-TER B-L- CE.DWG
6/28/2019 12:55:17 PM by: JOE.V- DENBERG

LEGEND:

▬ ▬ ▬ EXISTING CATCHMENT

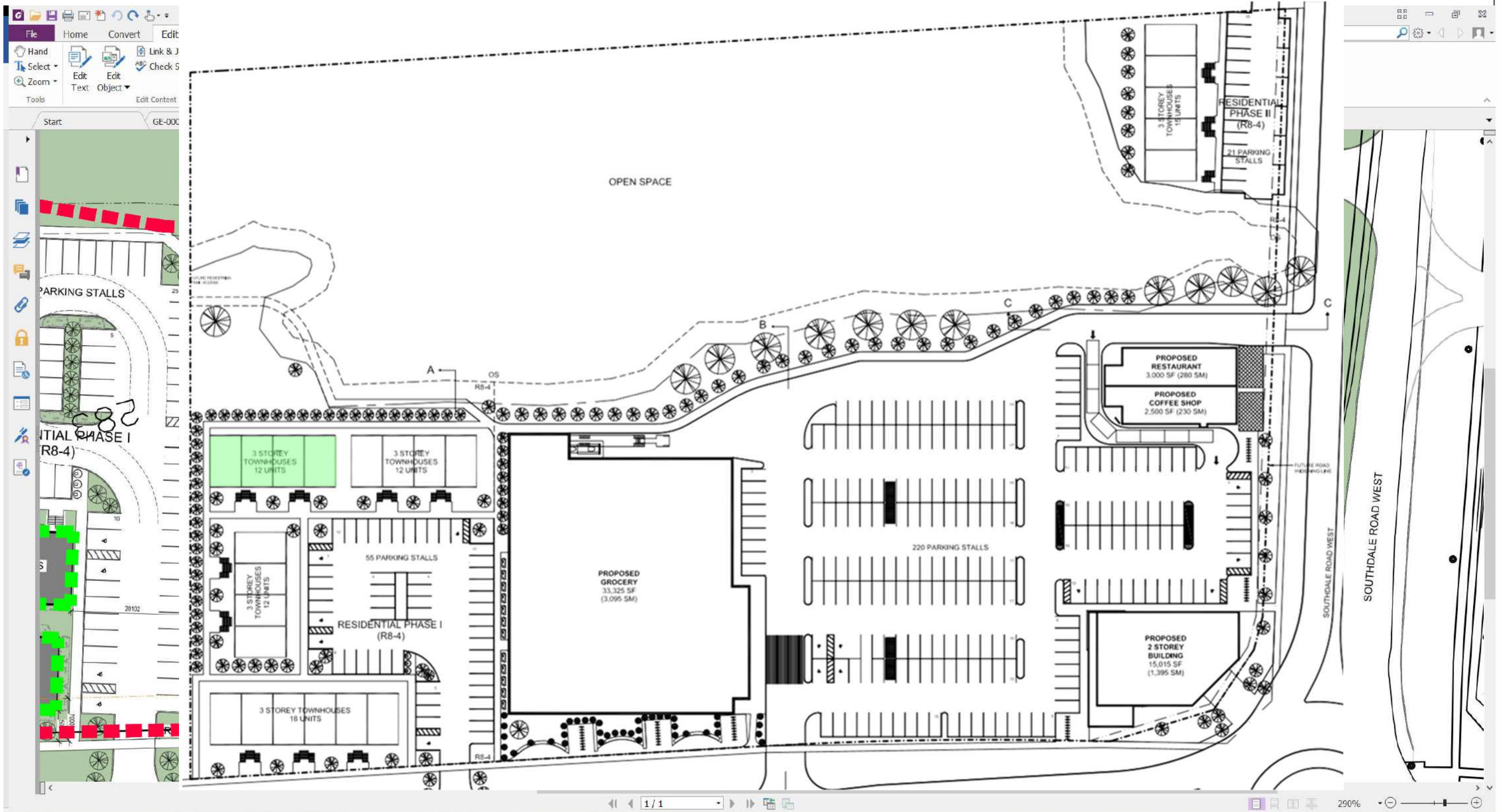
⇨ EXISTING OVERLAND FLOW PATH

101 / 9.9 | 61 CATCHMENT ID
AREA (ha) % IMPERVIOUS

952 SOUTHDALE ROAD
WESTDELL CORPORATION

PRE-DEVELOPMENT CONDITIONS

PROJECT: GE-00085
SCALE: N.T.S.
FIGURE 1



WESTDELL CORPORATION

🟥🟥🟥🟥🟥🟥🟥 PROPOSED CATCHMENT

🟩🟩🟩🟩 ROOFTOPS TO BE INFILTRATED

101 CATCHMENT ID

9.9 AREA (ha)

61 % IMPERVIOUS

POST DEVELOPMENT CONDITIONS

PROJECT: GE-00085

SCALE: N.T.S.

FIGURE 2

Monthly Water Balance Summary
952 Southdale Road
11/13/2020

			Pre Development Condition												
			Temperature	Precipitation	Actual Evapotranspiration	Adjusted ET	Soil Storage	Surplus Water	Potential Infiltration	Actual infiltration		Potential Runoff	Actual Runoff		
										depth	Volume		depth	Volume	
Site Parameters		**Month**	**°C**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(m^3)**	**(mm)**	**(mm)**	**(m^3)**	
Area (ha):	4.1	January	-6.4	72.48	8.72	8.72	390.25	63.76	25.50	0.00	0.00	38.26	0.00	0.00	
Impervious	0%	February	-5.5	59.84	10.44	10.44	392.03	49.39	19.76	0.00	0.00	29.64	0.00	0.00	
Soil Type	C	March	-0.4	76.67	20.14	20.14	393.89	56.52	22.61	0.00	0.00	33.91	0.00	0.00	
Soil Moisture Capacity (mm)	400	April	6.4	81.57	37.43	37.43	396.57	44.14	17.66	91.94	3732.61	26.48	100.76	4091.03	
Total Meadow Area, C101 (ha):	*2.59*	May	13.1	82.73	69.78	69.78	392.18	12.95	5.18	29.94	1215.56	7.77	106.65	4329.99	
Total Wetland/Forest Area, C102(ha):	*1.47*	June	18.0	85.72	98.94	98.94	372.73	-13.23	-5.29	0.00	0.00	-7.94	0.00	0.00	
INFILTRATION FACTOR		July	20.5	80.91	112.12	112.12	335.58	-31.21	-12.48	0.00	0.00	-18.72	0.00	0.00	
Topography factor	0.1	August	19.6	82.25	89.15	89.15	324.38	-6.90	-2.76	0.00	0.00	-4.14	0.00	0.00	
Soils Factor	0.15	September	15.3	97.33	54.17	54.17	342.63	43.16	17.27	17.27	700.96	25.90	25.90	1051.44	
Cover Factor	0.15	October	9.1	81.48	30.74	30.74	368.94	50.73	20.29	20.29	823.88	30.44	30.44	1235.81	
Total INFIL Factor	0.4	November	3.3	95.32	16.23	16.23	392.56	79.08	31.63	31.63	1284.33	47.45	47.45	1926.50	**Check**
		December	-3.0	88.03	10.10	10.10	396.91	77.93	31.17	0.00	0.00	46.76	0.00	0.00	**P=ET+I+R**
		Total:		**984.31**	557.971875	**557.97**			**170.54**	191.07	**7,757.34**	**255.80**	311.20	**12,634.77**	**984.31**

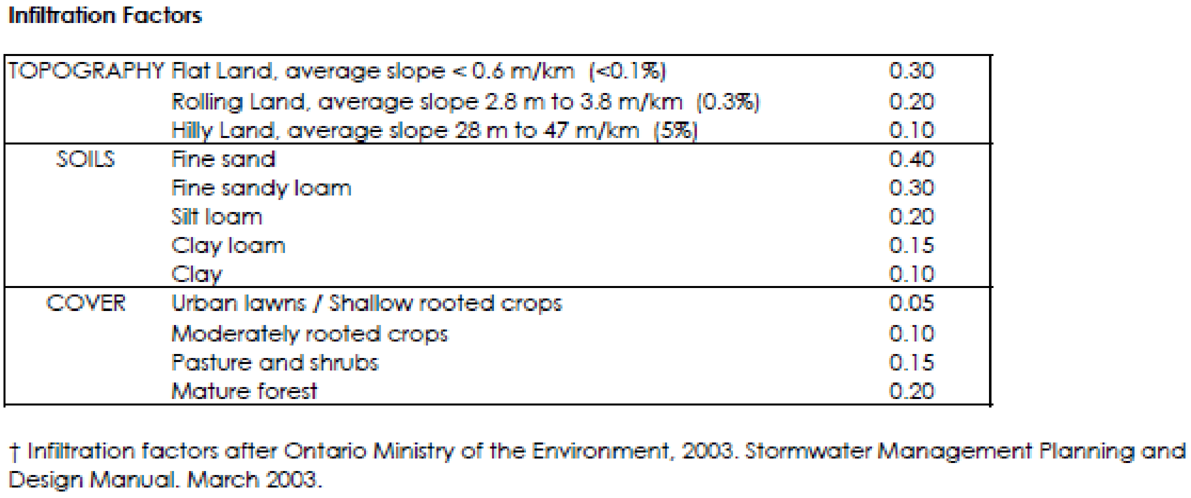
			Post Development Condition												
			Temperature	Precipitation	Actual Evapotranspiration	Adjusted ET	Soil Storage	Surplus Water	Potential Infiltration	Actual infiltration		Potential Runoff	Actual Runoff		
										depth	Volume		depth	Volume	
Site Parameters		**Month**	**°C**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(m^3)**	**(mm)**	**(mm)**	**(m^3)**	
Area (ha):	4.1	January	-6.4	72.48	8.72	8.72	384.26	63.76	30.60	0.00	0.00	33.15	0.00	0.00	
Impervious	0%	February	-5.5	59.84	10.44	10.44	388.88	49.39	23.71	0.00	0.00	25.68	0.00	0.00	
Soil Type	C	March	-0.4	76.67	20.14	20.14	393.24	56.52	27.13	0.00	0.00	29.39	0.00	0.00	
Soil Moisture Capacity (mm)	400	April	6.4	81.57	37.43	37.43	395.78	44.14	21.19	110.33	4479.36	22.95	87.33	3545.73	
Total C201 Area (ha):	*1.77*	May	13.1	82.73	69.66	69.66	386.49	13.06	6.27	35.98	1460.95	6.79	71.17	2889.61	
Total C202 Area (ha):	*1.47*	June	18.0	85.72	98.15	98.15	356.01	-12.43	-5.97	0.00	0.00	-6.47	0.00	0.00	
Total C203 Area (ha):	*0.27*	July	20.5	80.91	108.93	108.93	311.31	-28.02	-13.45	0.00	0.00	-14.57	0.00	0.00	
Total C204 Area (ha):	*0.55*	August	19.6	82.25	85.44	85.44	290.75	-3.19	-1.53	0.00	0.00	-1.66	0.00	0.00	
INFILTRATION FACTOR		September	15.3	97.33	52.97	52.97	306.24	44.36	21.29	21.29	1005.01	23.07	23.07	936.52	
Topography factor	0.1	October	9.1	81.48	30.53	30.53	333.71	50.94	24.45	24.45	1154.11	26.49	26.49	1075.46	
Soils Factor	0.15	November	3.3	95.32	16.23	16.23	370.49	79.08	37.96	37.96	1791.74	41.12	41.12	1669.63	**Check**
Cover Factor	0.1	December	-3.0	88.03	10.09	10.09	386.44	77.94	37.41	0.00	0.00	40.53	0.00	0.00	**P=ET+I+R**
Total INFIL Factor	0.35	Total:		**984.31**	548.75	**548.75**			**209.07**	230.02	**9,891.16**	**226.49**	249.19	**10,116.94**	**984.31**

Summary		Units	Notes
Runoff	**2,517.83**	m^3	Net reduction in run-off from existing to proposed site conditions
Infiltration	**2,133.82**	m^3	Net increase in infiltration (groundwater recharge)

Monthly Water Balance Notes
952 Southdale Road
11/13/2020

General Assumptions

-Infiltration factor is applied to surplus water
-When surplus is negative, moisture is drawn from the soil
-No Infiltration or runoff in winter months (<0°C)
-Winter runoff volumes is runoff in April (50%) and May (50%)
-Winter infiltration volumes infiltrated in April (75%), and May (25%)
-Actual ET is adjusted based on increased evaporation from the pond surface, (pond area noted above)
-25mm event represents 90% of annual runoff.
-To increase flows contributing to the local wetland additional runoff will be redirected
  -20% of Post development runoff will be added to the infiltration total
  -This represents the runoff from select rooftops (C204, area = 0.55ha)



Infiltration Factors

TOPOGRAPHY	Flat Land, average slope < 0.6 m/km (<0.1%)	0.30
	Rolling Land, average slope 2.8 m to 3.8 m/km (0.3%)	0.20
	Hilly Land, average slope 28 m to 47 m/km (5%)	0.10
SOILS	Fine sand	0.40
	Fine sandy loam	0.30
	Silt loam	0.20
	Clay loam	0.15
	Clay	0.10
COVER	Urban lawns / Shallow rooted crops	0.05
	Moderately rooted crops	0.10
	Pasture and shrubs	0.15
	Mature forest	0.20

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.

LDS CONSULTANTS INC.

15875 Robins Hill Road, Unit 1
London, Ontario N5V 0A5

www.ldsconsultants.ca