Additional Subsurface Investigation Report

Arva Pumping Station to Huron St Water Transmission Main Municipal Class Environmental Assessment Master Plan

City of London

Project reference: Additional Subsurface Investigation
Project number: 60619503

September 30, 2020

Statement of Qualifications and Limitations

The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“AECOM”) for the benefit of the Client (“Client”) in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the “Agreement”).

The information, data, recommendations and conclusions contained in the Report (collectively, the “Information”):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the “Limitations”);
- represents AECOM’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time..

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM’s professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information (“improper use of the Report”), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

Quality information

Prepared by	Checked by	Approved by
William Hanson Geotechnical EIT	Taesang Ahn, Ph.D., P.Eng.	John Haasen, PMP, CET, Senior Vice President

Prepared for:

City of London
The Corporation of the City of London
300 Dufferin Ave
London, ON
N6B 1Z2, Canada
T +1-519-661-2489

Prepared by:

William Hanson
Geotechnical EIT
T: 519.673.0510
E: william.hanson@aecom.com

AECOM Canada Ltd.
250 York Street
Suite 410, Citi Plaza
London, ON N6A 6K2
Canada

T: 519.673.0510
F: 519.673.5975
aecom.com

Table of Contents

Tables

1. Introduction

AECOM Canada Limited (ACL) was requested to conduct an additional subsurface investigation as part of an Environmental Assessment (EA) level of evaluation for the existing Water Main transmission line (water-main) between the Arva Pumping Station (Arva P.S.) and Huron Street in the City of London (the City). The additional subsurface investigation was conducted in general conformance with the proposal letter entitled '*Arva to Huron – Proposed Subsurface Investigation*' provided on April 15, 2020.

The purpose of this report is to confirm the existing subsurface soil conditions and to summarize the existing soil corrosivity potential and its impact on the water-main for use in the EA level of evaluation.

2. Geological Setting

The City of London is located at the confluence of three physiographic regions: the Stratford till plain to the North, the Caradoc sand plains, and the Mount Elgin Ridges to the South (Chapman and Putnam, 1984). The study area is not in conflict with any of the Wellhead Protection Areas. The study area does live within highly vulnerable aquifers and significant groundwater recharge areas. Further information on the study areas geological setting was provided under the separate cover entitled '*Geotechnical and Hydrogeological Data Report – EA – Arva Pumping Station to Huron Street Water Main (the Report)*' dated April 21, 2020.

3. Investigation Procedures

3.1 Borehole Marking and Utility Locating

The borehole locations were established in the field on July 16, 2020 by AECOM staff. Borehole locations were established in consultation with the City's Water Operations representatives. The public utility infrastructure owners were contracted through the Ontario One Call (On1Call) system to request marking of subsurface utilities in the investigation area. The water-main was located in the field by City Water Operations personnel utilizing winching and opening up manhole covers, where available.

3.2 Borehole Investigation and Sampling Methods

The borehole drilling program was carried out between August 11 and 15, 2020 under the full-time supervision of AECOM staff. To carry out the drilling program, AECOM retained the services of Altech Drilling and Investigative Services Inc., located in Cambridge, Ontario, a Ministry of the Environment, Conservation, and Parks licensed drilling contractor. The boreholes were advanced using a 1.52 m long, metal-clad direct push casing from a Geoprobe 7822 drill mounted on a rubber track. An inner tube 200 mm outside diameter casing collected soil samples for laboratory analysis. Two (2) monitoring wells were drilled utilizing continuous flight hollow stem augers and installed in conformance with Ontario Regulation 903 (O. Reg 903). Upon completion of the drilling and monitoring well construction, the boreholes were surveyed with a hand-held GPS unit, and backfilled in accordance with O.Reg 903. The borehole location plan is presented in **Appendix B**.

In general, the field sampling was carried out using ASTM standards that may have been modified based on site conditions. The borings consisted of attempting to drill boreholes to 4.6 or 6.1 mbgs, dependent on the cohesiveness or compactness of the ground conditions. The soil conditions as encountered during the subsurface investigation are presented in the Record of Borehole Logs in **Appendix C**.

Several prospective boreholes were cancelled due to inadequate utility clearances or access requirements closer to the Thames River. Borehole BH-E3 was cancelled because a right of way access agreement was never granted from Enbridge, who owned high pressure gas mains in the area. Boreholes BH-E5 and BH-E9 were cancelled because the located areas were unable to maintain adequate clearance from the Water-main. Boreholes BH-E10 through to BH-E13 were cancelled as site access for boreholes BH-E10 through BH-E10 was only provided for one day of the investigation.

3.3 Laboratory Testing

All soil samples were reviewed by experienced AECOM geotechnical staff to confirm field logging details, and to assign the proposed laboratory testing. Selected soil samples were collected for analytical chemical testing and stored in laboratory supplied sample containers. Soil samples were tested for natural moisture contents (ASTM D2216), and soil corrosivity. Samples were submitted to the AGAT Laboratories (AGAT) in Mississauga, Ontario under their chain-of-custody procedures. AGAT is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. and Standard Council of Canada for specific tests listed on their scope of accreditation. The results of the soil corrosivity testing and natural moisture contents are provided in **Appendix D**.

4. Field and Laboratory Investigation

4.1 Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes are summarized in the following sections. The stratigraphic layers were inferred from non-continuous sampling and observation of drilling resistance and typically represent a transition from one soil type to another. These boundaries should not be interpreted to represent actual planes of geological change. The subsurface conditions have been confirmed at the borehole locations only, and they may vary between and beyond the borehole locations. In total, 17 boreholes were advanced and two (2) monitoring wells were installed. Refer to **Appendix C** for the Borehole Logs. Refer to **Appendix B** for the location of the boreholes drilled.

Generally, the soil stratigraphic profile is consistent with previous geotechnical data reviewed and summarized in the the Report. The overlying pavement structure or topsoil is underlain by cohesive materials consisting of silty clays or clayey silts overlying cohesionless materials consisting of sands, sandy silts, gravelly sands, or sandy gravels increasing in thicknesses closer to the Thames River. The cohesionless materials generally overly a cohesive silty clay..

4.1.1 Topsoil

Topsoil was encountered at the ground surface in boreholes BH-E1, BH-E4, BH-E17 through BH-E19, and BH-E21 through BH-E24. The topsoil was 80 to 300 mm thick. Materials classified as topsoil was based solely on textural and visual observations.

4.1.2 Pavements

4.1.2.1 Asphalt

Asphalt was encountered at the ground surface in boreholes BH-E6, BH-E7, and BH-E8. The asphalt was 60 to 80 millimetres thick. The existing asphalt condition was inspected to be in fair to good condition.

4.1.2.2 Pavement Base Fill

Pavement base fill was explored underlying the asphalt in boreholes BH-E6, BH-E7, and BH-E8 and at the ground surface in boreholes BH-E2, BH-E14 through BH-E16, and BH-E20. The base fill consisted of a sand and gravel with some silt and crushed granular. The fill thickness ranged from 0.15 to 0.8 metres.

4.1.3 Fill

Fill materials were encountered either below the topsoil or pavement base. The fill materials were variable consisting of gravelly sands, silty clay, sandy silt and sands. Fill materials were classified based on appearance during sample retrieval, the inclusion of buried organics, or the appearance of quarried materials. Fill materials were encountered in boreholes, BH-E1, BH-E2, BH-E6, BH-E8, BH-E16, BH-E18, and BH-E21 through BH-E24. The fill thickness ranged from

4.1.4 Cohesive Materials (Silty Clay, Sandy Silt, Clayey Silt)

Cohesive materials were encountered below the above fill materials. The cohesive materials consisted of silty clays, sandy silts, and clayey silts. Cohesive materials were explored in all boreholes advanced as part of the investigation.

A layer of silty clay soil was encountered in boreholes BH-E1, BH-E2, and BH-E4. The layer of silty clay had trace gravel, some to trace sands and ranged in thickness from 0.7 to 0.9 metres.

A layer of sandy silt to silty sand soil was encountered in boreholes BH-E1, BH-E2, BH-E6 through BH-E8, BH-E15, BH-E20, and BH-E22 through BH-E24. The layer of sandy silt to silty sand had some to trace clay with trace gravel and ranged in thickness from 0.3 to 2.8 metres. Water contents conducted on this layer had values ranging from 9.4 to 21%.

A layer of clayey silt soil was encountered in boreholes BH-E2, BH-E14, BH-E21, and BH-E22. The clayey silt had some to trace sand and ranged in thickness from 0.8 to 1.7 metres. A water content conducted on this layer had a value of 9.1%.

4.1.5 Cohesionless Materials (Sand, Sandy Gravel/Gravelly Sand)

Cohesionless materials were encountered below, or intersected with, the above cohesive materials. The cohesionless materials consisted of sand, sandy gravels, and gravelly sands. Cohesionless materials were explored in al boreholes advanced as part of the investigation.

A layer of sand soil was encountered in boreholes BH-E15, BH-E17 through BH-E21, and BH-E24. The layer of sand had some to trace silt, trace gravel and ranged in thickness from 0.3 to 1.8 metres. A water content conducted on this layer had a value of 16.5%.

A layer of sandy gravel to gravelly sand soil was encountered in boreholes BH-E17 through BH-E20, and BH-E22 through BH-E24. The sandy gravel to gravelly sand had some to trace silt and ranged in thickness from 0.3 to 2.9 metres. Water contents conducted on this layer had values ranging from 11.4 to 17.4%.

4.1.6 Silty Clay Till

A layer of silty clay till was encountered below, or intersected with, the above cohesive and cohesionless materials. This layer of till was encountered in boreholes BH-E1, BH-E2, BH-E4, BH-E7, BH-E8, and BH-E14 through BH-E23. The layer of silty clay till had some to trace gravel, some to trace sand and ranged in thickness from 0.3 to 3.8 metres. Water contents conducted on this layer had values ranging from 9.2 to 22.3%.

4.2 Groundwater Conditions

Two (2) monitoring wells were installed in boreholes BH-E18 and BH-E19. The following **Table 1** presents the groundwater depth data collected as of the date of the preparation of this report. Details regarding the installation of the monitoring wells are presented in the Record of Borehole sheets in **Appendix C**.

Table 1 – Observed Site Groundwater Levels

Monitoring Well Location	Depth to Water (mbgs)	Groundwater Elevation (mASL)	Date Measured*
BH-18	1.1	256.2	Sept. 11/2020
BH-19	1.3	251.9	Sept. 11/2020

4.3 Soil Corrosivity Conditions

A total of 19 representative soil samples were selected and submitted for corrosivity testing. The following **Table 2** presents the soil corrosivity analytical results. The soil samples were taken from approximate depths to account for corrosivity testing at the approximate depth in which the water-main soil backfill would reside.

Table 2 - Soil Corrosivity Analytical Results

Sample	Depth (mbgs)	Sulfide (%)	Chloride (µg/g)	Sulphate (µg/g)	pH	Electrical Conductivity (mS/cm)	Resistivity (ohm.cm)	Redox Potential (mV)
BH-1 TW-3	3.1 – 4.6	<0.05	690	68	8.98	0.366	2730	121
BH-2 TW-3	3.1 – 4.6	<0.05	5760	246	8.82	2.42	413	81
BH-2 TW-4	4.6 – 6.1	<0.05	5740	153	8.67	2.30	435	74
BH-4 TW-3	3.1 – 4.6	<0.05	61	32	8.35	0.127	7870	178
BH-6 TW-3	3.1 – 4.6	0.11	51	405	8.4	0.209	4780	132
BH-7 TW-3	3.1 – 4.6	0.16	43	672	8.3	0.238	4200	51
BH-8 TW-3	3.1 – 4.6	<0.05	284	559	8.54	0.268	3730	67
BH-14 TW-2	1.5 – 3.1	<0.05	119	287	8.35	0.191	5240	99
BH-15 TW-2	1.5 – 3.1	<0.05	79	125	8.16	0.165	6060	92
BH-16 TW-2	1.5 – 3.1	<0.05	42	122	7.96	0.15	6670	190
BH-17 TW-3	3.1 – 4.6	0.25	122	769	8.33	0.273	3660	52
BH-18 TW-2	1.5 – 3.1	0.55	42	2340	7.91	0.529	1890	116
BH-18 TW-3	3.1 – 4.6	0.45	60	1990	8.10	0.453	2210	105
BH-19 TW-3	3.1 – 4.6	<0.05	110	356	8.59	0.182	5490	80
BH-20 TW-3	3.1 – 4.6	<0.05	124	178	8.66	0.160	6250	117
BH-21 TW-3	3.1 – 4.6	<0.05	109	58	9.16	0.109	9170	142
BH-22 TW-3	3.1 – 4.6	0.63	159	1280	8.16	0.382	2620	160
BH-23 TW-3	3.1 – 4.6	0.13	35	581	8.30	0.231	4330	171
BH-24 TW-3	3.1 – 4.6	<0.05	360	53	9.02	0.200	5000	86

6. Soil Corrosion Potential

The American National Standards Institute/American Water Works Association (ANSI/AWWA) rating for soil-test corrosion evaluation was used for reference. According to the ANSI/AWWA, a score of 10 points or greater indicates that the soil is corrosive to ductile-iron pipe and that protection is required. **Table 3** presents the score rating for the soil samples obtained during the current investigation.

The concertation of sulphate is an indicator of potential sulphate attack on buried concrete; Table 3 of the Canadian Standards Association (CSA) Standard CAN/CSA-A23.1-14 is used for reference. **Table 3** presents the results indicating sulphate exposure for concrete in contact with soil and groundwater at the site.

Table 3 - Soil Corrosion Potential

Sample	Depth (mbgs)	ANSI/AWWA Soil Score	Sulphate Exposure
BH-1 TW-3	3.1 – 4.6	5	Low
BH-2 TW-3	3.1 – 4.6	18.5	Moderate
BH-2 TW-4	4.6 – 6.1	18.5	Moderate
BH-4 TW-3	3.1 – 4.6	3	Low
BH-6 TW-3	3.1 – 4.6	3	Moderate
BH-7 TW-3	3.1 – 4.6	6.5	Moderate
BH-8 TW-3	3.1 – 4.6	8.5	Moderate
BH-14 TW-2	1.5 – 3.1	6.5	Moderate
BH-15 TW-2	1.5 – 3.1	6.5	Low
BH-16 TW-2	1.5 – 3.1	3	Low
BH-17 TW-3	3.1 – 4.6	6.5	Moderate
BH-18 TW-2	1.5 – 3.1	8	Severe
BH-18 TW-3	3.1 – 4.6	5	Severe
BH-19 TW-3	3.1 – 4.6	9.5	Moderate
BH-20 TW-3	3.1 – 4.6	6.5	Moderate
BH-21 TW-3	3.1 – 4.6	6	Low
BH-22 TW-3	3.1 – 4.6	4	Moderate
BH-23 TW-3	3.1 – 4.6	3	Moderate
BH-24 TW-3	3.1 – 4.6	8.5	Low

Table 3 illustrates that the highest potential degree of sulphate exposure to the water-main would occur in the soils near to BH-18 and BH-2. It should be noted that these samples were wet when retrieved from the drill rig; indicating that the more saturated soils are, generally the more corrosive potential they carry.

It is assumed that the construction of the watermain consisted of the excavation of soils through open and cut trench methods. The corrosivity and saturation of the trench backfill soils located near to the water-main may impact the longevity of the concrete structure. The corrosivity of the local soils should not be used as the only indicator of the water-main condition.

Appendix A – Photographic Log

Figure 1 - Drill Rig Set-up on BH-E2

Figure 2 - Drill rig set-up at BH-E18

Figure 3 - Sample condition, BH-E18 TW-3

Appendix B – Borehole Location Plan

LEGEND

Historical Boreholes

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

2020 Investigation Boreholes

- 2020 Environmental Borehole

NOTES:

- Boreholes were surveyed with a hand-held GPS unit with an approximate 3m accuracy

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME:
CITY OF LONDON

PROJECT LOCATION:
Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

PROPOSED BOREHOLE LOCATION PLAN

DRAWN BY: CS	SCALE: N/A	DRAWING No. 1
CHECKED: WH	DATE: Sep. 2020	REVISION 0

C:\Users\curtis.simpson\AppData\Local\Temp\AcPublish_26852\60619503 - Existing BH and BH As Built.dwg

LEGEND

Historical Boreholes

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

2020 Investigation Boreholes

- 2020 Environmental Borehole

NOTES:

- Boreholes were surveyed with a hand-held GPS unit with an approximate 3m accuracy

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION
1	2020.01.20	Existing Transmission Main and Easments

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME: CITY OF LONDON

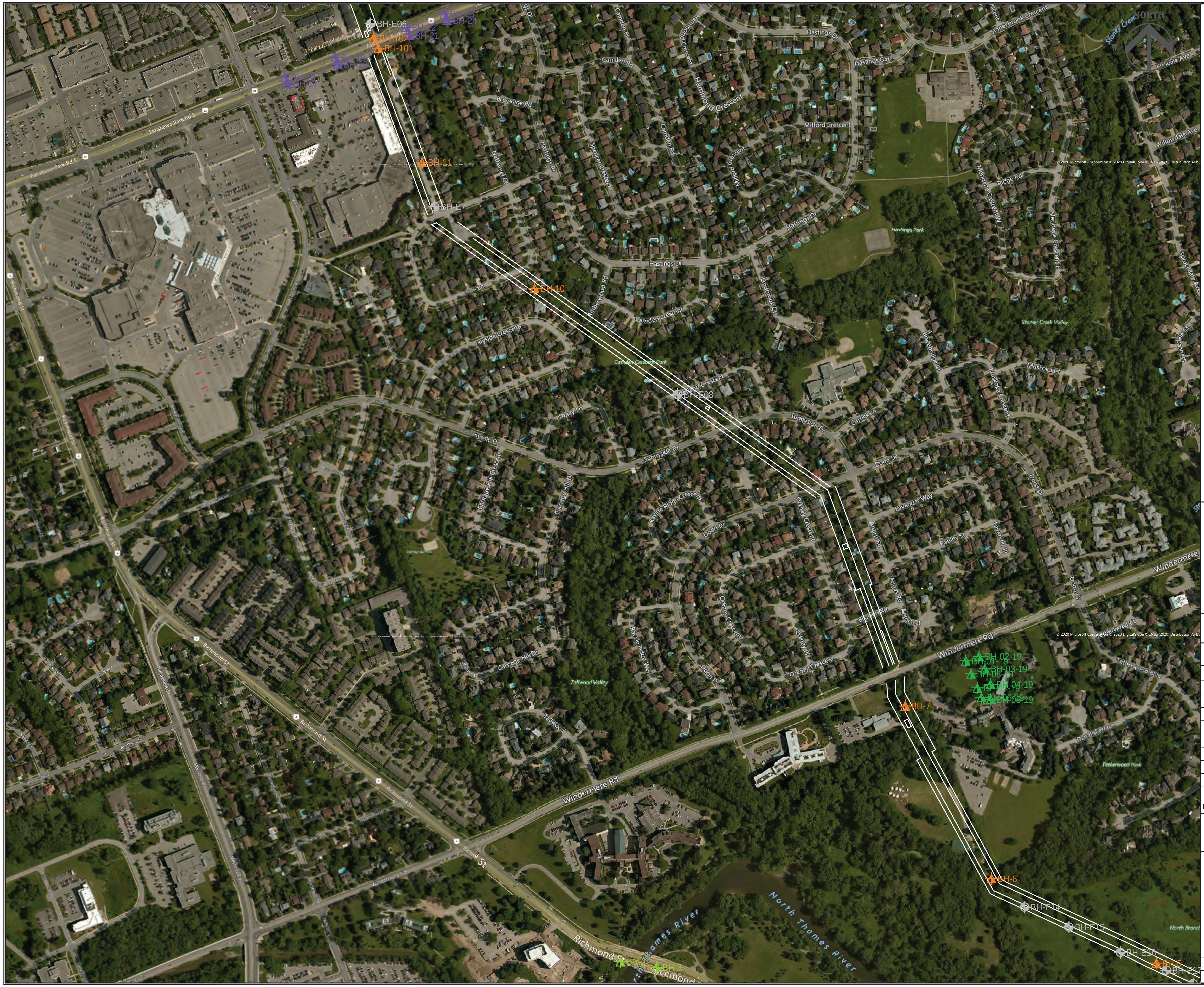
PROJECT LOCATION: Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

PROPOSED BOREHOLE LOCATION PLAN

DRAWN BY: CS	SCALE: N/A	DRAWING No. 2
CHECKED: WH	DATE: Sep. 2020	REVISION 0

C:\Users\curtis.simpson\AppData\Local\Temp\AcPublish_26852\60619503 - Existing BH and BH As Built.dwg



LEGEND

Historical Boreholes

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

2020 Investigation Boreholes

- 2020 Environmental Borehole

NOTES:

- Boreholes were surveyed with a hand-held GPS unit with an approximate 3m accuracy

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION
1	2020.01.20	Existing Transmission Main and Easments

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME: CITY OF LONDON

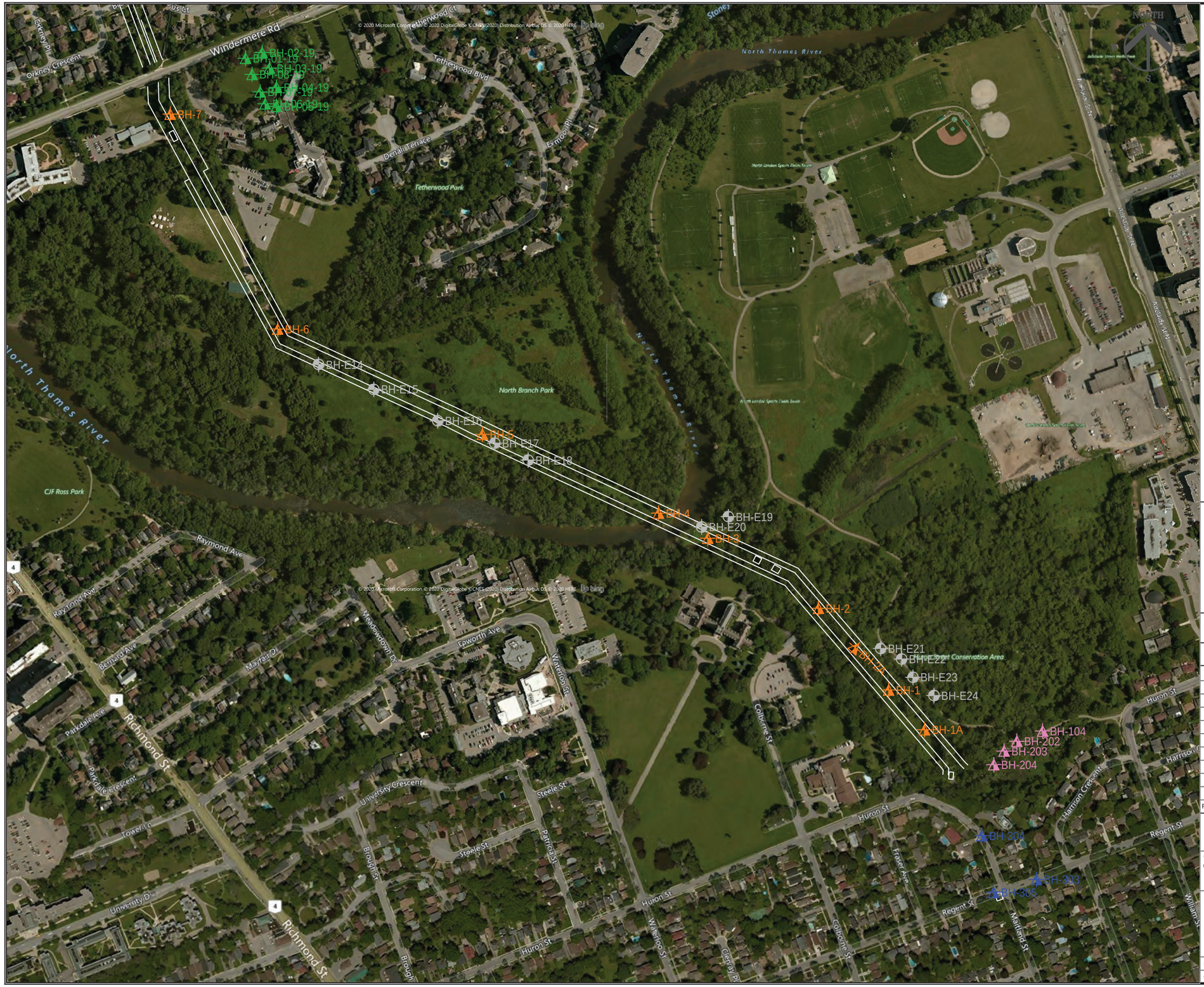
PROJECT LOCATION: Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

PROPOSED BOREHOLE LOCATION PLAN

DRAWN BY: CS	SCALE: N/A	DRAWING No. 3
CHECKED: WH	DATE: Sep. 2020	REVISION 0

C:\Users\curtis.simpson\AppData\Local\Temp\AcPublish_26852\60619503 - Existing BH and BH As Built.dwg



LEGEND

Historical Boreholes

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

2020 Investigation Boreholes

- 2020 Environmental Borehole

NOTES:

- Boreholes were surveyed with a hand-held GPS unit with an approximate 3m accuracy

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME: CITY OF LONDON	PROJECT LOCATION: Arva Pump Station to Huron Street, London
	PROJECT NUMBER: 60619503

PROPOSED BOREHOLE LOCATION PLAN

DRAWN BY: CS	SCALE: N/A	DRAWING No. 4
CHECKED: WH	DATE: Sep. 2020	REVISION 0

C:\Users\curtis.simpson\AppData\Local\Temp\AcPublish_26852\60619503 - Existing BH and BH As Built.dwg

Appendix C – Record of Borehole and Drillhole Logs

AECOM

TERMINOLOGY USED IN BOREHOLE LOGS

Topsoil: Mixture of soil and humus capable of supporting good vegetative growth.

Peat: A mass of organic matter usually fibrous in texture in various stages of decomposition, generally dark brown to black in colour and of spongy consistency.

Fill: The term fill has been used to describe materials which have been placed by non-natural processes. Fills can often be heterogeneous in nature and those relying on this report should expect them to contain deleterious materials. Such materials can include wood, bricks, slag, porcelain, organics, and obstructions such as scrap metal, storage tanks, and abandoned concrete/steel structures.

Due to the uncertainty of the placement method of the material, the boring samples obtained for this report are not expected to represent other materials at any horizontal or vertical distance from where the sample was obtained.

Fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill site. Unless specifically stated, the fill on this site has not been tested for contaminants that can be considered toxic or hazardous. Testing to determine the toxicity of fill materials can be conducted, if requested.

Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Till must be considered heterogeneous in composition and containing pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) and boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the logs. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Due to the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone. Caution is essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

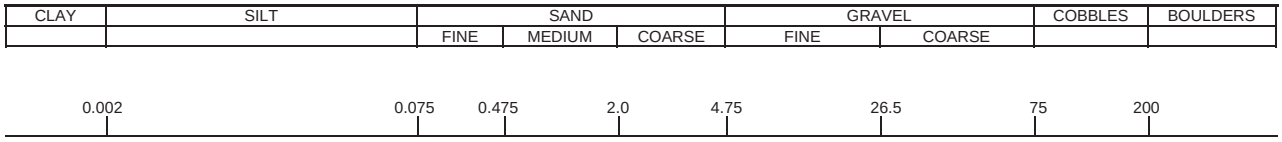
Uniformly Graded: predominantly on grain size.

Residual: completed weathered sedimentary rock mixed with native soils.

AECOM

All soil sample descriptions included in this report generally follow the Canadian Foundations Engineering Manual and the Unified Soil Classification System. These systems follow the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by AECOM follow the same system. Note that, with exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact gain sizing.

ISSMFE / USCS SOIL CLASSIFICATION



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis. Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils.

The standard terminology to describe cohesionless soils includes the compactness condition as determined by the Standard Penetration Test 'N' value.

Cohesionless Soils		Cohesive Soils			Composition	
Compactness Condition	**SPT N-Index (blows per 0.3 m)**	**Consistency**	**Undrained Shear Strength (kPa)**	**SPT N-Index (blows per 0.3 m)**	**Term**	**Criteria**
Very loose	0 – 4	Very soft	< 12	< 2	Trace	1% - 10%
Loose	4 – 10	Soft	12 - 25	2 – 4	Some	10% - 20%
Compact	10 – 30	Firm	25 – 50	4 – 8	Adjective	20% - 35%
Dense	30 – 50	Stiff	50 – 100	8 – 15	And	> 35%
Very Dense	> 50	Very Stiff	100 - 200	15 – 30	Noun	> 35% & largest fraction
		Hard	> 200	> 30		

Standard Penetration Test (SPT):

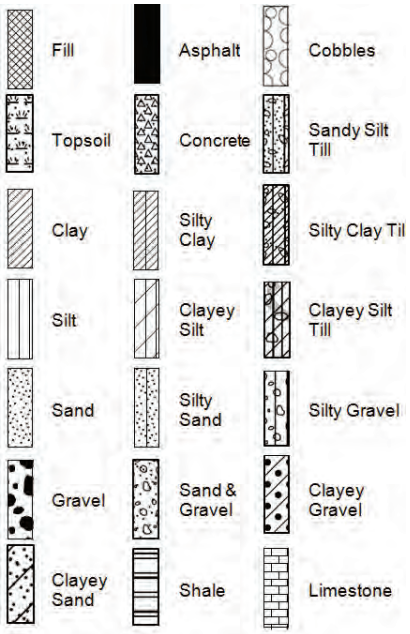
The number of blows required to drive a 50 mm (2 in.) open split spoon sampler from a depth of 150 mm (6 in.) to 450 mm (18 in.) in undisturbed soil. Each blow is driven by a 63.6 kg (140 lb.) hammer free falling a distance of 0.76 m (30 in.).

Sample & Soil Abbreviations	
CORE	Rock core sample
AS	Auger sample
FV	Field vane
PP	Pocket penetrometer
SG	Specific Gravity
GS	Grab sample
TW	Thin-walled open sample
DCPT	Dynamic cone penetration test
GR	Gravel
SA	Sand
SI	Silt
CL	Clay

Contaminant Abbreviations	
BNAE	base/neutral/acid extractables
BTEX	benzene, toluene, ethylbenzene, xylenes
OCP	organochlorine pesticides
MI	metals & inorganics
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PHC	petroleum hydrocarbons hydrocarbons (fractions 1 – 4)
VOC	volatile organic compounds (includes BTEX)

Plasticity Description	**Liquid Limit (w_l)**
Low	$w_l < 30$
Medium	$30 < w_l < 50$
High	$50 < w_l$

Strata/Graphic Plot



Appendix D – Laboratory Soil Analytical Results

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: AECOM CANADA LTD
250 YORK STREET, SUITE 410
LONDON, ON N6A6K2
(519) 673-0510
ATTENTION TO: William Hanson
PROJECT: Arva-Huron EA
AGAT WORK ORDER: 20L640861
SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer
TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist
DATE REPORTED: Aug 31, 2020
PAGES (INCLUDING COVER): 8
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20L640861

PROJECT: Arva-Huron EA

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

SAMPLING SITE:London

SAMPLED BY:WHanson

Corrosivity Package

DATE RECEIVED: 2020-08-21

DATE REPORTED: 2020-08-31

SAMPLE DESCRIPTION:				S-BH1-TW3		S-BH2-TW3	S-BH2-TW4		S-BH4-TW3	S-BH6-TW3	S-BH7-TW3
SAMPLE TYPE:				Soil		Soil	Soil		Soil	Soil	Soil
DATE SAMPLED:				2020-08-21 09:00		2020-08-21 09:00	2020-08-21 09:00		2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383752	RDL	1383762	1383763	RDL	1383764	1383765	1383766
Chloride (2:1)	µg/g		2	690	8	5760	5740	2	61	51	43
Sulphate (2:1)	µg/g		2	68	8	246	153	2	32	405	672
pH (2:1)	pH Units		NA	8.98	NA	8.82	8.67	NA	8.35	8.40	8.30
Electrical Conductivity (2:1)	mS/cm		0.005	0.366	0.005	2.42	2.30	0.005	0.127	0.209	0.238
Resistivity (2:1) (Calculated)	ohm.cm		1	2730	1	413	435	1	7870	4780	4200
Redox Potential 1	mV		NA	118	NA	81	72	NA	182	132	51
Redox Potential 2	mV		NA	121	NA	85	74	NA	178	130	54
Redox Potential 3	mV		NA	123	NA	77	76	NA	168	133	48

SAMPLE DESCRIPTION:				S-BH8-TW3	S-BH14-TW2	S-BH15-TW2	S-BH16-TW2	S-BH17-TW3	S-BH18-TW2	S-BH18-TW3	S-BH19-TW3
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383767	1383768	1383769	1383770	1383771	1383773	1383774	1383775
Chloride (2:1)	µg/g		2	284	119	79	42	122	42	60	110
Sulphate (2:1)	µg/g		2	559	287	125	122	769	2340	1990	356
pH (2:1)	pH Units		NA	8.54	8.35	8.16	7.96	8.33	7.91	8.10	8.59
Electrical Conductivity (2:1)	mS/cm		0.005	0.268	0.191	0.165	0.150	0.273	0.529	0.453	0.182
Resistivity (2:1) (Calculated)	ohm.cm		1	3730	5240	6060	6670	3660	1890	2210	5490
Redox Potential 1	mV		NA	67	99	86	191	52	111	100	92
Redox Potential 2	mV		NA	69	102	92	190	47	116	101	80
Redox Potential 3	mV		NA	62	97	114	189	61	120	113	78

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20L640861

PROJECT: Arva-Huron EA

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

SAMPLING SITE:London

SAMPLED BY:WHanson

Corrosivity Package

DATE RECEIVED: 2020-08-21

DATE REPORTED: 2020-08-31

SAMPLE DESCRIPTION:				S-BH20-TW3	S-BH21-TW3	S-BH22-TW3	S-BH23-TW3	S-BH24-TW3
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383776	1383777	1383778	1383779	1383780
Chloride (2:1)	µg/g		2	124	109	159	35	360
Sulphate (2:1)	µg/g		2	178	58	1280	581	53
pH (2:1)	pH Units		NA	8.66	9.16	8.16	8.30	9.02
Electrical Conductivity (2:1)	mS/cm		0.005	0.160	0.109	0.382	0.231	0.200
Resistivity (2:1) (Calculated)	ohm.cm		1	6250	9170	2620	4330	5000
Redox Potential 1	mV		NA	105	137	156	171	88
Redox Potential 2	mV		NA	117	142	168	175	93
Redox Potential 3	mV		NA	120	145	160	168	86

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1383752 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

1383762-1383763 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Dilution required, RDL has been increased accordingly.

1383764-1383780 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20L640861

PROJECT: Arva-Huron EA

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

SAMPLING SITE:London

SAMPLED BY:WHanson

Moisture content (Soil)

DATE RECEIVED: 2020-08-21

DATE REPORTED: 2020-08-31

		SAMPLE DESCRIPTION:		S-BH1-TW3	S-BH2-TW3	S-BH2-TW4	S-BH4-TW3	S-BH6-TW3	S-BH7-TW3	S-BH8-TW3	S-BH14-TW2
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383752	1383762	1383763	1383764	1383765	1383766	1383767	1383768
Moisture Content	%		0.1	9.4	9.1	10.9	15.5	21.0	9.2	14.1	12.6

		SAMPLE DESCRIPTION:		S-BH15-TW2	S-BH16-TW2	S-BH17-TW3	S-BH18-TW2	S-BH18-TW3	S-BH19-TW3	S-BH20-TW3	S-BH21-TW3
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383769	1383770	1383771	1383773	1383774	1383775	1383776	1383777
Moisture Content	%		0.1	13.3	22.3	11.4	12.7	12.5	15.0	10.3	16.5

		SAMPLE DESCRIPTION:		S-BH22-TW3	S-BH23-TW3	S-BH24-TW3
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		2020-08-21 09:00	2020-08-21 09:00	2020-08-21 09:00
Parameter	Unit	G / S	RDL	1383778	1383779	1383780
Moisture Content	%		0.1	17.4	12.0	13.1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: NPopowich

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: AECOM CANADA LTD
AGAT WORK ORDER: 20L640861

PROJECT: Arva-Huron EA
ATTENTION TO: William Hanson

SAMPLING SITE:London
SAMPLED BY:WHanson

Soil Analysis

RPT Date: Aug 31, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Chloride (2:1)	1383752	1383752	690	756	9.1%	< 2	90%	70%	130%	93%	80%	120%	96%	70%	130%
Sulphate (2:1)	1383752	1383752	68	65	4.2%	< 2	87%	70%	130%	95%	80%	120%	115%	70%	130%
pH (2:1)	1383752	1383752	8.98	8.84	1.6%	NA	98%	90%	110%						
Electrical Conductivity (2:1)	1383752	1383752	0.366	0.368	0.5%	< 0.005	101%	80%	120%						
Redox Potential 1	1						100%	90%	110%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: AECOM CANADA LTD

AGAT WORK ORDER: 20L640861

PROJECT: Arva-Huron EA

ATTENTION TO: William Hanson

SAMPLING SITE:London

SAMPLED BY:WHanson

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Trace Organics Analysis			
Moisture Content	VOL-91-5009	CCME Tier 1 Method, SW846 5035,8015	BALANCE

AGAT Laboratories

1 large bk

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: AECOM CANADA LIMITED
Contact: William Hanson
Address: 250 York St, Suite 410
London, ON
Phone: 519-281-2749 Fax:
Reports to be sent to:
1. Email: william.hanson@aecom.com
2. Email:

Project Information:

Project: Arva-Huron EA
Site Location: London
Sampled By: WHanson
AGAT Quote #: per MSA PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table ____ *Indicate One*
☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture *(Check One)* ☐ Coarse ☐ Fine

☐ Excess Soils R406
Table ____ *Indicate One*
Sample from APEC? ☐ Yes ☐ No
☐ Stockpile ☐ In-situ

☐ Regulation 558

☐ Sewer Use ☐ Sanitary ☐ Storm
____ *Region*
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
____ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☒ No

Report Guideline on *Certificate of Analysis* ☑ Yes ☐ No

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Laboratory Use Only

Work Order #: 20L640861
Cooler Quantity: 1 large
Arrival Temperatures: 2.8 2.9 3.1
LT- 1ob 2.2 2.0
Custody Seal Intact: ☐Yes ☐No ☐N/A
Notes:

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153	Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	Excess Soils Characterization Package ☐ ICP MS Metals, BTEX, F1-F4	Salt - EC/SAR	Corrosivity	H_2O content	Potentially Hazardous or High Concentration (Y/N)
S-BH1-TW3	Aug 21	900 AM/PM	1	S								X	X	
S-BH2-TW3			1	S								X	X	
S-BH2-TW4			1	S								X	X	
S-BH4-TW3			1	S								X	X	
S-BH6-TW3			1	S								X	X	
S-BH7-TW3			1	S								X	X	
S-BH8-TW3			1	S								X	X	
S-BH14-TW2			1	S								X	X	
S-BH15-TW2			1	S								X	X	
S-BH16-TW2			1	S								X	X	
S-BH17-TW3			1	S								X	X	

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
William Hanson	Aug 21/20	1:15pm	J. Smith	20/8/21	1:20
			Shanmr	Aug 25/2020	9:10

Page 1 of 2

No: T 105605

Document ID: DIV 78 1511 017

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

Date Issued: April 23, 2020

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: AECOM Canada Limited
Contact: William Hanson
Address: 250 York St, Suite 410
London, ON,
Phone: 519-281-2749 Fax:
Reports to be sent to:
1. Email: william.hanson@aecom.com
2. Email:

Project Information:

Project: Arva-Huron EA
Site Location: London
Sampled By: WHanson
AGAT Quote #: per MSA PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐

Company:
Contact:
Address:
Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table ____ *Indicate One*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☐ Coarse
☐ Fine

☐ Excess Soils R406
Table ____ *Indicate One*
Sample from APEC?
☐ Yes
☐ No
☐ Stockpile ☐ In-situ

☐ Regulation 558

☐ Sewer Use
☐ Sanitary ☐ Storm
____ *Region*
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
____ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☒ No

Report Guideline on *Certificate of Analysis* ☒ Yes ☐ No

Laboratory Use Only

Work Order #: 20L640861

Cooler Quantity: 1 ~~three~~ large
Arrival Temperatures: 2.8 | 2.9 | 3.1
LT- 1.6 | 2.2 | 2.0
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: (on ice)

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC Y/N	O. Reg 153	PAHs	PCBs	VOC	Landfill Disposal Characterization TCLP: ☐ H&P ☐ VOC ☐ ABNs ☐ B(a)P ☐ PCBs	Excess Soils SPLP Rainwater Leach ☐ Metals ☐ VOCs ☐ SVOCs	Excess Soils Characterization Package ☐ ICPMS Metals, BTEX, F1-F4	Sat - EC/SAR	Corrosivity	pH Content	Potentially Hazardous or High Concentration (Y/N)
S-BH17-TW3	Aug 21	900 AM/PM	1	S											X	X	
S-BH18-TW2			1	S											X	X	
S-BH18-TW3			1	S											X	X	
S-BH19-TW3			1	S											X	X	
S-BH20-TW3			1	S	N/A										X	X	
S-BH21-TW3			1	S											X	X	
S-BH22-TW3			1	S											X	X	
S-BH23-TW3			1	S											X	X	
S-BH24-TW3			1	S											X	X	

Samples Relinquished By (Print Name and Sign): William Hansen	Date: Aug 21/20	Time: 120 pm	Samples Received By (Print Name and Sign): J. Smith	Date: 20/8/21 Time: 1:20
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date: Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign): Sharmin S	Date: Aug 25/2020 Time: 9:00am

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: AECOM CANADA LTD
250 YORK STREET, SUITE 410
LONDON, ON N6A6K2
(519) 673-0510

ATTENTION TO: William Hanson

PROJECT: 20L640861

AGAT WORK ORDER: 20T643715

SOLID ANALYSIS REVIEWED BY: Sherin Moussa, Senior Technician

DATE REPORTED: Sep 01, 2020

PAGES (INCLUDING COVER): 5

Should you require any information regarding this analysis please contact your client services representative at (905) 501-9998

*NOTES

All samples are stored at no charge for 90 days. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20T643715

PROJECT: 20L640861

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

(201-042) Sulfide

DATE SAMPLED: Aug 27, 2020 | DATE RECEIVED: Aug 28, 2020 | DATE REPORTED: Sep 01, 2020 | SAMPLE TYPE: Other

Analyte:	Sulfide
Unit:	%
Sample ID (AGAT ID) RDL:	0.05
S-BH1-TW3-1383752 (1397887)	<0.05
S-BH1-TW3-1383752-DUP (1397888)	<0.05
S-BH2-TW3-1383762 (1397889)	<0.05
S-BH2-TW4-1383763 (1397890)	<0.05
S-BH4-TW3-1383764 (1397891)	<0.05
S-BH6-TW3-1383765 (1397892)	0.11
S-BH7-TW3-1383766 (1397893)	0.16
S-BH8-TW3-1383767 (1397894)	<0.05
S-BH14-TW2-1383768 (1397895)	<0.05
S-BH15-TW2-1383769 (1397896)	<0.05
S-BH16-TW2-1383770 (1397897)	<0.05
S-BH17-TW3-1383771 (1397898)	0.25
S-BH18-TW2-1383773 (1397899)	0.55
S-BH18-TW3-1383774 (1397900)	0.45
S-BH19-TW3-1383775 (1397901)	<0.05
S-BH20-TW3-1383776 (1397902)	<0.05
S-BH21-TW3-1383777 (1397903)	<0.05
S-BH22-TW3-1383778 (1397904)	0.63
S-BH23-TW3-1383779 (1397905)	0.13
S-BH24-TW3-1383780 (1397906)	<0.05

Comments: RDL - Reported Detection Limit

Analysis performed at AGAT 5623 McAdam Rd., Mississauga, ON (unless marked by *)

Certified By: Sherin Moussa

AGAT Laboratories

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Quality Assurance - Replicate

AGAT WORK ORDER: 20T643715

PROJECT: 20L640861

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

(201-042) Sulfide

	REPLICATE #1				REPLICATE #2				REPLICATE #3							
Parameter	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD				
S	1397887	0.011	0.016	37.0%	1397904	0.682	0.678	0.6%	1397906	0.006	0.007	15.4%				
Sulfate	1397887	< 0.01	< 0.01	0.0%	1397904	0.05	0.05	0.0%	1397906	< 0.01	< 0.01	0.0%				
Sulfide	1397887	< 0.05	< 0.05	0.0%	1397904	0.63	0.63	0.0%	1397906	< 0.05	< 0.05	0.0%				

AGAT Laboratories

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Quality Assurance - Certified Reference materials

AGAT WORK ORDER: 20T643715

PROJECT: 20L640861

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: William Hanson

(201-042) Sulfide

	CRM #1				CRM #2				CRM #3							
Parameter	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits				
S	0.80	0.80	100%	90% - 110%	0.80	0.81	101%	90% - 110%	0.80	0.82	102%	90% - 110%				
Sulfate	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%				
Sulfide	0.80	0.79	98%	90% - 110%	0.80	0.80	100%	90% - 110%	0.80	0.81	101%	90% - 110%				

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

Method Summary

CLIENT NAME: AECOM CANADA LTD

AGAT WORK ORDER: 20T643715

PROJECT: 20L640861

ATTENTION TO: William Hanson

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Solid Analysis			
Sulfide	MIN-200-12037		LECO

aecom.com

DRAFT

AECOM Imagine it. Delivered.

City of London

Geotechnical and Hydrogeological Data Review

Arva Pumping Station to Huron Street Water Transmission Main

Municipal Class Environmental Assessment Master Plan

London, Ontario

Quality information

Prepared by	Checked by	Approved by
William Hanson B.A.Sc, Geotechnical EIT	**Taesang Ahn** Ph.D., P.Eng Senior Geotechnical Engineer	**John Haasen** PMP, CET Senior Vice President

Revision History

Revision	Revision date	Details
0	February 14, 2020	Initial Draft

Prepared for:

The Corporation of the City of London
300 Dufferin Ave
London, ON
N6B 1Z2, Canada
T +1-519-661-2489

Prepared by:

William Hanson
B.A.Sc,
Geotechnical EIT

AECOM Canada Ltd.
250 York Street
Suite 410, Citi Plaza
London, ON N6A 6K2
Canada

T: 519.673.0510
F: 519.673.5975
aecom.com

Statement of Qualifications and Limitations

The attached Geotechnical Investigation Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

Table of Contents

Tables

1. Introduction

AECOM Canada Limited (ACL) was requested to complete a geotechnical and hydrogeological data review as part of an Environmental Assessment (EA) level of evaluation for the existing Water Main transmission line (water-main) between Arva Pumping Station (Arva P.S.) and Huron Street in the City of London (the City). The geotechnical and hydrogeological data review was conducted as part of the agreement between the City and AECOM's agreement #EW3553 signed on December 5, 2019.

Due to the significant variation in the soil conditions along the existing watermain transmission line, the route has been separated into four (4) divisions for the convenience of discussion. The divisions are as follows:

Division One – Arva P.S. to Sunningdale Avenue
Division Two – Sunningdale Avenue to Fanshawe Park Road
Division Three – Fanshawe Park Road to Windermere Road
Division Four – Windermere Road to Huron Street

The purpose of this submittal is to summarize the historical geotechnical and hydrogeological data obtained during various field investigations completed by other consultants through, or near, the existing water main transmission line right of way (ROW) to determine their relevance and suitability for use in the EA level of evaluation.

2. Geological Setting

The City of London is located at the confluence of three physiographic regions: the Stratford till plain to the North, the Caradoc sand plains, and the Mount Elgin Ridges to the South (Chapman and Putnam, 1984).

The Stratford till plain is a broad clay plain interrupted by several terminal, closely spaced, moraines drained by the Thames River. This till is fairly uniform, being a brown calcareous silty clay with variation in the stone (gravel, cobbles & boulders) content. Shallow surface deposits of silt cover sizable tracts with sand and gravel present in the closely spaced intermorainal valleys.

The Caradoc sand plain consists of an old glacial spillway in which beds of silt and fine sand were deposited. As glaciation retreated, gravelly alluvium was spread over the lower elevation areas of the plain. Generally, the soil conditions in the area consist of sands over fine tills or clay; thereby having wet subsoils. Locally, high perched groundwater conditions are known to exist near to the Thames River Valley.

The Mount Elgin Ridges are moraines of pale brown calcareous clay or silty clay while in the morainal valleys it is common to find alluvium of gravel, sand, or silt. For the areas draining into the Thames River, deep loams (organic deposits such as peats), sand, and gravels occupy the valleys; indicating the much larger streams occupying them during the last glaciation retreat. Due to the variation in soil stratigraphy, topography generally dictates local drainage. There are considerable areas of sandy deposits with varying degrees of drainage as well as several undrained basins with peat and other organic, low strength, soils.

According to the Bedrock Geology of Ontario, Southern Sheet (Map 2544, Ministry of Northern Development and Mines), the bedrock of the London area consists of limestones, dolostones and shales of the Dundee Formation and Hamilton Group. The Dundee Formation consists of grey to tan to brown, fossiliferous, medium to thick bedded limestones and minor dolostones (Armstrong and Carter 2010). Calcareous shales with limestone interbeds of the Hamilton Group disconformably overlie the Dundee Formation.

3. Geotechnical & Hydrogeological Data Review

The following geotechnical and hydrogeological data review was based on a literature review of publicly available data and reports provided by the City. The geotechnical and hydrogeological data obtained from this review, may have been changed by subsequent construction activities since data acquisition.

Standard Penetration Tests (SPTs) were assumed to be completed in general accordance with ASTM D1586 which consists of freely dropping a 63.5 kilogram weight using a hammer over a vertical distance of 0.76 m to a drive a 51 mm outside diameter split-spoon sampler into the ground. The number of hammer blows required to drive the sampler into the relatively undisturbed ground over a vertical depth of 0.3 m is recorded as the N-value of soil. Water content determinations were assumed to be completed in general accordance with ASTM D2216, soil grain size distributions were assumed to be completed in general accordance with ASTM D7928, and Atterberg limit tests were assumed to be completed in general accordance with ASTM D4318.

3.1 Division One – Arva P.S. to Sunningdale Avenue

The following reports were used in the geotechnical and hydrogeological data review for Division One:

> Proposed Arva to London Waterline, Arva Reservoir to Huron Street, London, Ontario by Golder & Associates Limited, dated November 1965;
>
> Geotechnical Investigation, Proposed Arva Reservoir Expansion, Lake Huron Water Supply System, Ministry of the Environment Project No. 5-0001-06, Arva, Ontario by Golder Associates Limited, dated May 1990;
>
> Site Investigation, Proposed Arva Medway Bridge, London Township, Ontario by H. Q. Golder & Associates Limited, dated September 1962; and
>
> Hydrogeological Assessment, Proposed Apartment Buildings, 2300 Richmond Street, London, Ontario by exp Services Inc., dated May 12, 2015.

A total of twenty-one (21) boreholes, five (5) test pits, two (2) dynamic cone penetration test (DCPT) holes, and ten (10) monitoring wells were advanced in Division One. The test pits were advanced as part of the Arva Pumping Station reservoir upgrades project. The DCPT holes and monitoring well installations were conducted as part of a hydrogeological assessment. The boreholes were advanced in conjunction with the construction of the watermain nearby a bridge construction over the Medway River, and as part of a hydrogeological assessment. **Drawing 1** in **Appendix A** presents the approximate locations of the existing subsurface borings referenced in Division One.

3.1.1 Subsurface Soil Conditions

Eight (8) boreholes were advanced by Golder Associates (Golder) as part of the geotechnical investigation associated with the installation of the watermain. BH-25 and BH-26 were drilled north of Medway Road, BH-24 was drilled through Medway Road, BH-22 and BH-21 were drilled on both sides of the Medway River, BHs 20 and 20A were advanced through Highway 4 (Richmond St), and BH-19 was advanced in-between Richmond St and Sunningdale Road. The geotechnical investigation was undertaken before the construction of the watermain to provide factual information of subsurface conditions along the proposed route at the time of the report. It was difficult to decipher some of the geotechnical information from the report. Table 1 provides details of the subsurface soil conditions. **Drawing 1** in **Appendix A** presents borehole locations as interpreted from the report provided.

Table 1 - Subsurface Soil Conditions – Golder & Associates Report, November 1965 – Division One

Soil Type	Thickness (m)	Consistency/Compactness	Additional Information
Topsoil	0.5 – 0.9	Loose	Silty to sandy, black
Fill	0.2 - 4.1	N/A	Road base for Medway Road & Highway 4
Sand to Sand and Gravel	1.5 – 4.1	Very loose to compact	Fine grained to coarse grained
Silt	1.5 – 3.8*	Loose to compact	Sandy, with some buried organics
Sandy to Clayey Silt Till	1.7 - 4.6*	Very stiff to hard	Sandy to clayey, N blows 17 to 39 (very stiff to hard), 9% to 15% water contents

* - where indicated, borehole was terminated in the soil type

Five (5) test pits were advanced by Golder as part of the Arva P.S. reservoir expansion. Table 2 provides details of the subsurface soil conditions. The approximate test pit locations are presented in **Drawing 1** in **Appendix A**.

Table 2 - Subsurface Soil Conditions – Golder Associates Limited Report, May 1990 – Division One

Topsoil	0.1 – 0.3	N/A	Brown, silty
Fill	0.2 – 0.4	N/A	Clayey silt, some topsoil, buried debris
Silty Sand	1.0	13	Some gravel & cobbles
Clayey Silt Till**	2.9* – 5.6*	10 – 14	Some to trace sand. Atterberg Limits (PL = 15% & LL = 26%)

* - where indicated, borehole was terminated in the soil type

** - Clayey Silt Till had a grain size distribution analysis completed - 5% gravel, 20% sand, 55% silt and 20% clay

Three (3) boreholes were advanced by Golder as part of a geotechnical investigation associated with construction of a new bridge structure over the Medway River. Table 3 provides details of the subsurface soil conditions. The approximate borehole locations are presented in **Drawing 1** in **Appendix A**.

Table 3 – Subsurface Soil Conditions – Golder & Associates Report, 1962 – Division One

Soil Type	Thickness (m)	SPT N blows	Grain Size Distribution			Additional Information
			Gravel (%)	Sand (%)	Silt/Clay (%)	
Topsoil	0.3	N/A	-	-	-	
Sandy Silt	2.1	8 – 18	8	67	25	Some gravel
Sand/Sand & Gravel	2.0 - 2.7	2 – 40	5 – 65	30 - 87	5 – 8	Trace silt
Sandy Silt Till	6.1* - 8.2*	23 – 87	5 – 52	17 – 42	18 – 75	Gravelly to some gravel. Water contents ranged from 8% to 14%. Plastic limits ranged from 12% to 13% and liquid limits ranged from 17% to 18%

* - where indicated, borehole was terminated in the soil type

Ten (10) boreholes and ten (10) monitoring wells were advanced by exp Services Inc. as part of a hydrogeological assessment for a property in which the Water-Main traverses. Table 4 provides details of the subsurface soil conditions. The approximate borehole locations are presented in **Drawing 1** in **Appendix A**.

Table 4 – Subsurface Soil Conditions – exp Services Inc., 2015 – Division One

Soil Type	Thickness (m)	SPT N blows	Water Content (%)	Additional Information
Topsoil	0.15 – 4.0	N/A	N/A	Silty and sandy, black
Clayey Silt Till	0.8 – 7.9*	8 – 35	9 – 23	Some sand, trace gravel
Sand	1.1 – 5.4*	10 – 33	4 – 24	Some to trace silt, trace gravel, fine to coarse grained
Silty Sand	3.6 – 4.5	10 – 26	15 – 22	Trace gravel, some clayey silt layering
Silt	6.5* – 9.8*	11 – 28	18 – 22	Some sand, dilatant

* - where indicated, borehole was terminated in the soil type

In addition to sampled boreholes and monitoring well installations, DCPT was carried out in two boreholes during the exp Services Inc. investigation. N blows ranged from 4 to 41 blows per 0.3 metres.

3.1.2 Groundwater Conditions

The groundwater generally flows locally towards the Medway River. Relatively high, perched, groundwater tables were encountered in Division One as a result of the inter-layering of cohesive and cohesionless deposits. Artesian conditions were encountered during the exp Services Inc., 2015 investigation. The groundwater observations for boreholes located in Division One are summarized in Table 5. No groundwater samples were collected for water quality analysis.

Table 5 – Groundwater Conditions – Division One

Borehole ID	Groundwater Level (mbgs; masl*)	Report	Date Measured
BH-25	3.4	Golder & Associates Report, November 1965	December 1964
BH-24	1.7	Golder & Associates Report, November 1965	December 1964

BH-22	1.5	Golder & Associates Report, November 1965	December 1964
BH-21	0.6	Golder & Associates Report, November 1965	December 1964
BH-20A	2.7	Golder & Associates Report, November 1965	November 1965
TP-1	0.6; 284.04	Golder Associates Limited, May 1990	May 1990
BH-1	1.0	H. Q. Golder & Associates Limited, Sept 1962	Aug, 1962
BH-2	1.4	H. Q. Golder & Associates Limited, Sept 1962	Aug 1962
BH/MW 101	2.07; 271.68	exp Services Inc., May 2015	July 2014
BH/MW 102	0.30**; 271.69	exp Services Inc., May 2015	July 2014
BH/MW 103	0.97; 270.67	exp Services Inc., May 2015	July 2014
BH/MW 104	1.65; 269.87	exp Services Inc., May 2015	July 2014
BH/MW 105	0.30**; 268.19	exp Services Inc., May 2015	July 2014
BH/MW 106	1.49; 267.15	exp Services Inc., May 2015	July 2014
BH/MW 107	2.91; 271.89	exp Services Inc., May 2015	July 2014

* - metres above mean sea level
** - groundwater level observed above ground surface level (artesian conditions)

3.2 Division Two – Sunningdale Avenue to Fanshawe Park Road

The following reports were used in the geotechnical and hydrogeological data review for the Division Two of the EA:

Proposed Arva to London Waterline, Arva Reservoir to Huron Street, London, Ontario by Golder & Associates Limited, dated November 1965;

Geotechnical Investigation – Final Report, Proposed Reconstruction – Sunningdale Road, London, Ontario by exp Services Inc., dated June 22, 2011; and

Geotechnical Investigation – Final Report, City of London 2012 Arterial Roads Program, London, Ontario by exp Services Inc., dated December 2011.

A total of twenty (20) boreholes were advanced in Division Two. The boreholes were advanced to gather subsurface information relating to Sunningdale Road and Fanshawe Road and to gather subsurface information prior to construction of the watermain. **Drawing 2** in **Appendix A** presents the approximate locations of the existing subsurface borings undertaken in Division Two.

3.2.1 Subsurface Conditions

Eight (8) boreholes were advanced by Golder & Associates as part of the geotechnical investigation associated with the installation of the watermain. Boreholes BH-16 to BH-12/BH12A were drilled in-between Sunningdale Road and Fanshawe Park Road. Boreholes BH-102 and BH-101 were drilled through Fanshawe Park Road. The geotechnical investigation was undertaken before the construction of the watermain to provide factual information of subsurface conditions along the proposed route. It was difficult to decipher some of the geotechnical information from the report. Table 6 provides details of the subsurface soil conditions. **Drawing 2** in **Appendix A** presents the approximate locations of the boreholes.

Table 6 - Subsurface Soil Conditions - Golder & Associates Report, November 1965 – Division Two

	Thickness (m)	
Silt	N/A	Stiff to very stiff
Silty Sand	3.5	Very loose to compact
Sandy Silt	2.9 – 5.8*	Loose to compact, brown
Sandy Silt Till	1.4*	Hard, grey

* - where indicated, borehole was terminated in the soil type

Four (4) boreholes were advanced by exp Services Inc. as part of the Sunningdale Road Reconstruction. Boreholes 14 through 17 were drilled through the existing pavement surfaces on Sunningdale Road. The purpose of the boreholes was to obtain subsurface information to assist with the pavement re-design. Table 7 provides the details of the subsurface soil conditions. **Drawing 2** in **Appendix A** presents borehole locations as interpreted from the report provided.

Table 7 – Subsurface Soil Conditions – exp Services Inc., June 2011 – Division Two

Soil Type	Thickness (m)	Consistency/Compactness	Additional Information
Asphalt	0.06 – 0.12		Asphaltic concrete
Granular Base	0.5 – 1.42*	N/A	Road base granulars
Topsoil	0.10	N/A	
Sandy Silt/Silty Sand	0.53* – 0.84*	Loose to dense	Trace gravel, brown, moist

* - where indicated, borehole was terminated in the soil type

Eight (8) boreholes were advanced by exp Services Inc. as part of the geotechnical investigation associated with the reconstruction of Fanshawe Park Road. Boreholes BH-18 to BH-24 were drilled through the existing pavement surface on Fanshawe Park Road. The purpose of the boreholes was to obtain subsurface information to assist with the pavement re-design. Table 8 provides the details of the subsurface soil conditions. **Drawing 2** in **Appendix A** presents borehole locations as interpreted from the report provided.

Table 8 – Subsurface Soil Conditions – exp Services Inc., December 2011 – Division Two

Soil Type	Thickness (m)	Additional Information
Asphalt	0.15 – 0.18	Asphaltic Concrete
Granular Base	0.6 – 1.35*	Road Base
Sand/Sandy Silt	0.52* - 0.73*	Trace gravel, trace to some silt, brown, wet, Water Content = 2.7%

* - where indicated, borehole was terminated in the soil type

3.2.2 Groundwater Conditions

No stabilized groundwater level measurements were obtained as no monitoring wells were installed in Division Two. The encountered groundwater observations for boreholes located in Division One are summarized in Table 9.

Table 9 - Groundwater Conditions - Division Two

Borehole ID	Groundwater Level (mbgs)	Report	Date Measured
BH-15	7.3	Golder & Associates Report, November 1965	December 1964
BH-14	4.3	Golder & Associates Report, November 1965	December 1964
BH-13	2.6	Golder & Associates Report, November 1965	December 1964
BH-12A	0.9	Golder & Associates Report, November 1965	December 1964
BH-12	0.6	Golder & Associates Report, November 1965	December 1964

3.3 Division Three – Fanshawe Park Road to Windermere Road

The following reports were used in the geotechnical and hydrogeological data review for the Division Three of the EA:

Proposed Arva to London Waterline, Arva Reservoir to Huron Street, London, Ontario by Golder & Associates Limited, dated November 1965;

Geotechnical Report – Ivey Spencer Leadership Centre Addition, 551 Windermere Road, London, Ontario by Englobe Inc., dated March 2019; and

Report on Foundation Investigation for the Proposed Thames river Bridge on Highway 4, North of London, Ontario by Racey, MacCallum and Associates, dated March 21, 1957.

A total of twelve (12) boreholes and one (1) monitoring well were advanced in Division Three. The monitoring well and boreholes were advanced in conjunction with the construction of the watermain, a nearby bridge construction over the Thames River, and a building addition. **Drawing 3** from **Appendix A** presents the approximate locations of the existing subsurface borings undertaken in Division One.

3.3.1 Subsurface Conditions

Two (2) boreholes were advanced by Golder & Associates as part of a geotechnical investigation associated with the installation of the watermain. Boreholes BH-11 and BH-10 were drilled in-between Fanshawe Park Road and the

Windermere Road. The geotechnical investigation was undertaken before the construction of the watermain to provide factual information of subsurface conditions along the proposed route at the time of the report. It was difficult to decipher some of the geotechnical information from the report. **Drawing 3** in **Appendix A** presents the approximate locations of the boreholes. Based on the available information, the subsurface consisted of topsoil overlying very loose sandy silts over a very stiff to hard sandy silt till.

Eight (8) boreholes were advanced by Englobe Inc. as part of a geotechnical investigation associated with a nearby building addition at 551 Windermere Road. Boreholes BH-01-19 to BH-08-19 were drilled at various locations on the property to provide soil conditions and subsurface information associated with foundation construction. One (1) monitoring well was installed in BH-08-19. Table 10 provides details of the subsurface soil conditions. **Drawing 3** from **Appendix A** presents the borehole locations as interpreted from the report provided.

Table 10 – Subsurface Soil Conditions – Englobe Inc., March 2019 – Division Three

Soil Type	Thickness (m)	N blows (blows/0.3 m)	H2O Content (%)	Additional Information
Topsoil	0.2 – 0.6	N/A	N/A	
Fill	0.9 – 1.6	4 – 21	7 – 18	Sand/silty sand, some gravel, brown
Sand/Sand & Gravel	0.6 – 1.45	12 - 34	3 – 7	Some to trace silt, brown
Silty Sand/Sandy Silt	1.9* - 2.85*	16 - 22	19 - 21	Fine grained, brown
Silt	1.25 - 3.4*	6 – 19	20 – 26	With sand seams, brown

* - where indicated, borehole was terminated in this soil type

Two (2) boreholes were advanced by Racey, MacCallum and Associates as part of a geotechnical investigation associated with the replacement of a bridge structure over the Thames River along Richmond Street (Old Highway 4). Boreholes BH-2 and BH-3 were drilled near the bridge abutments to provide soil conditions and subsurface information associated with foundation construction. Table 11 provides details of the subsurface soil conditions. **Drawing 3** from **Appendix A** presents borehole locations as interpreted from the report provided.

Table 11 – Subsurface Soil Conditions - Racey, MacCallum and Associates, March 1957 – Division Three

Soil Type	Thickness (m)	N blows (blow/0.3 m)	Additional Information
Fill	1.83	12 – 42	Clayey silt, brown with buried organics
Silty Sand	1.83	12 – 42	Some gravel, dense, brown
Clayey Silt Till	10.2*	41 - >100	Some gravel, some sand, mottled to grey

* - where indicated, borehole was terminated in this soil type

3.3.2 Groundwater Conditions

One monitoring well was installed in Division Three. Due to the lack of monitoring well installs, a groundwater flow direction was not determined. The groundwater observations for boreholes located in Division Three are summarized in Table 9.

Table 12 - Groundwater Conditions - Division Three

Borehole ID	Groundwater Level (mbgs; masl)	Report	Date Measured
BH-08-19	2.8; 248.24	Englobe Inc. 2019	March 15, 2019

3.4 Division Four – Windermere Road to Huron Street

The following reports were used in the geotechnical and hydrogeological data review for the Division Four of the EA:

Proposed Arva to London Waterline, Arva Reservoir to Huron Street, London, Ontario by Golder & Associates Limited, dated November 1965;

Geotechnical Exploration, 2017 Infrastructure Lifecycle Renewal Program Contract No. 14 – Assignment B – William Street Storm Trunk Sewer, London, Ontario by Golder Associates, dated February 2018; and

Geotechnical Exploration, 2018 Infrastructure Renewal Program, Contract 6 – William Street and Regent Street, London, Ontario by Golder Associates, dated 2019

A total of twelve (12) boreholes and two (2) monitoring wells were advanced in Division Four. The monitoring well and boreholes were advanced in conjunction with the construction of the water-main and utility upgrading along nearby residential streets. **Drawing 4** in **Appendix A** presents the approximate locations of the existing subsurface borings undertaken in Division One.

3.4.1 Subsurface Conditions

Sixteen (16) boreholes were advanced by Golder as part of a geotechnical investigation associated with the installation of the watermain. Boreholes BH-7 to BH-2, BH-2A, & BH-1A were drilled between Windermere Road and Huron Street. The geotechnical investigation was undertaken before the construction of the watermain to provide factual information of subsurface conditions along the proposed route at the time of the report. It was difficult to decipher some of the geotechnical information from the report. Table 13 provides details of the subsurface soil conditions. **Drawing 4** from **Appendix A** presents the approximate locations of the boreholes drilled.

Table 13 – Subsurface Soil Conditions – Golder & Associates, 1965 – Division Four

Soil Type	Thickness	Additional Information
Topsoil	0.3 – 1.1	Silty, peaty, loose
Sand/Sand & Gravel	0.7 – 0.8*	Loose to compact
Sandy/Clayey Silt	0.9 – 2.2	Some gravel
Clayey Silt/Silty Clay Till	1.5* - 3.6*	Some gravel, hard

* - where indicated, borehole was terminated in this soil type

Four (4) boreholes were advanced by Golder as part of a geotechnical investigation associated with utility work along William Street. Boreholes BH-104, BH-202, BH-203, and BH-204 were drilled near the proposed utility replacement lines to provide soil conditions and subsurface information to aid in utility design. **Drawing 4** from **Appendix A** presents the borehole locations as interpreted from the report provided. Table 14 provides details of the subsurface soil conditions.

Table 14 - Subsurface Soil Conditions – Golder Associates, 2018 – Division Four

Soil Type	Thickness (m)	N blows (blow/0.3 m	H2O Content (%)	Additional Information
Fill	0.4 – 2.59	4 - 14	19 – 43	Silty sand to sand, buried topsoil
Silty Sand	0.61 – 1.14	3 – 49	8 - 21	Some to trace gravel, brown
Sand/Sand and Gravel	0.61* - 2.14*	4 – 38	9 – 22	Fine to coarse grained, trace silt
Sandy Silty Clay Till	0.61 – 0.76*	29 – 62	9 – 21	Some gravel, grey

* - where indicated, borehole was terminated in this soil type

Thr[illegible]ere advanced by Golder as part of a geotechnical investigation associated with proposed sewer a[illegible]atermain insta[illegible]s along portions of Regent Street and Huron Street. Boreholes BH-303 to BH-305 were [illegible]ed near the propose[illegible]wer and watermain lines to provide soil conditions and subsurface information for utility [illegible]tallation. **Drawing 4** fro[illegible]**ppendix A** presents the borehole locations as interpreted from the report provided. [illegible]15 provides details of t[illegible]ubsurface soil conditions.

Table 15 - Subsurface Soil Conditions - Golder Associates, 2019 - Division Four

Soil Type	Thickness (m)	N blows (blow/0.3 m)	H2O Content (%)	Additional Information
Fill	0.2 – 2.65	4	23 - 32	Underlies surface asphalt, variable fill composition
Silt	2.07 – 235	9 – 23	18 - 23	Sandy to trace sand, trace gravel, trace clay, brown
Sand/Silty Sand	0.24 – 1.52*	40 – 49	8 – 10	Fine-grained, trace gravel, brown
Silty Clay Till	1.01* – 2.80*	27 – 59	8 – 14	GSD's - 3%-15% GR, 15%-27% SA, 59%-82% SI&CL. Atterberg Limits - LL = 19.5% – 21.2%, PL = 12.0% – 13.5%
Sandy Silt Till	3.56	35 – 76	8 – 20	Trace gravel, trace clay

* -where indicated, borehole was terminated in this soil type

3.4.2 Groundwater Conditions

The groundwater generally flows towards the Thames River. The interbedded cohesive and cohesionless soil types may result in excessively wet condition as water bearing units may have confined groundwater. The groundwater observations for boreholes located in Division Four are summarized in Table 16.

Table 16 – Groundwater Conditions – Divison Four

Borehole ID	Groundwater Level (mbgs, masl)	Report	Date Measured
BH-104	1.17; 239.72	Golder Associates 2018	Aug. 29, 2016
	1.27; 239.62		Sept. 14, 2016
	1.15; 239.74		Feb. 5, 2018
BH-202	1.51; 239.30	Golder Associates 2018	Jan. 12, 2018
BH-203	2.93; 237.7		Jan. 12, 2018
BH-204	2.06; 238.5		Jan. 12, 2018
BH-304	6.0; 248.0	Golder Associates 2019	Oct. 19, 2018

4. Commentary on Geotechnical & Hydrogeological Review

The following commentary is to highlight existing data gaps for the existing subsurface information that was evaluated as part of the EA process.

Geo-chemistry of the existing soil and groundwater along the watermain: Geo-chemical properties of the existing subsurface will aid in the selection of pipe materials and to quantify the susceptibility of the pipe to corrosion. The possibility of corrosive groundwater and/or soil exists in the project area.

High groundwater tables are known to exist along the watermain. Pipe bedding may be acting as a ‘sink’ and could be conveying groundwater along preferential pathways. If fully-saturated, the pipe bedding would have excessive water pressure build-up that could accelerate pipe degradation or make excavation problematic.

The watermain may not have been constructed with a geotextile separating the existing sub-soil and pipe bedding. The pipe bedding may be migrating into the underlying sub-soil, or vice versa, especially if saturated, and therefore possibly causing excessive differential settlement.

The age of the existing geotechnical and hydrogeological data. The geotechnical report associated with the watermain was completed in 1965, and since 1965, standardization of field and laboratory geotechnical testing has occurred.

5. Recommendations to Improve the Quality of Existing Data

The following recommendations are given to discuss options for improving the quality of the existing subsurface data with respect to possible future constructability and rehabilitation.

The possibility of corrosive groundwater and/or soils and high groundwater tables exist along the watermain. Based on the regional geology review, it is expected that these conditions most likely manifest near to the Thames River. It would be possible to conduct a hydrogeological and geotechnical investigation near the existing Thames River crossing to help quantify the corrosivity potential of the existing soil and groundwater.

Appendix A – Existing Borehole Location Plans

A.1 Division 1 – Drawing No.1

A.2 Division 2 – Drawing No.2

A.3 Division 3 – Drawing No.3

A.4 Division 4 – Drawing No.4

LEGEND

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

NOTES:

- Borehole locations were estimated based on the existing drawings where coordinates were not provided

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME:
CITY OF LONDON

PROJECT LOCATION:
Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

EXISTING BOREHOLE LOCATION PLAN DIVISION ONE

DRAWN BY: CS	SCALE: N/A	DRAWING No. 1
CHECKED: WH	DATE: Feburary 2020	REVISION 0

\\CALON1FP001\work\London Geotech\Projects\60619503 - CoL Arva PS to Huron St WTM - EA\900 - Work\930 - CAD, Drawings\60619503 - Existing BH Location.dwg

LEGEND

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

NOTES:

- Borehole locations were estimated based on the existing drawings where coordinates were not provided

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

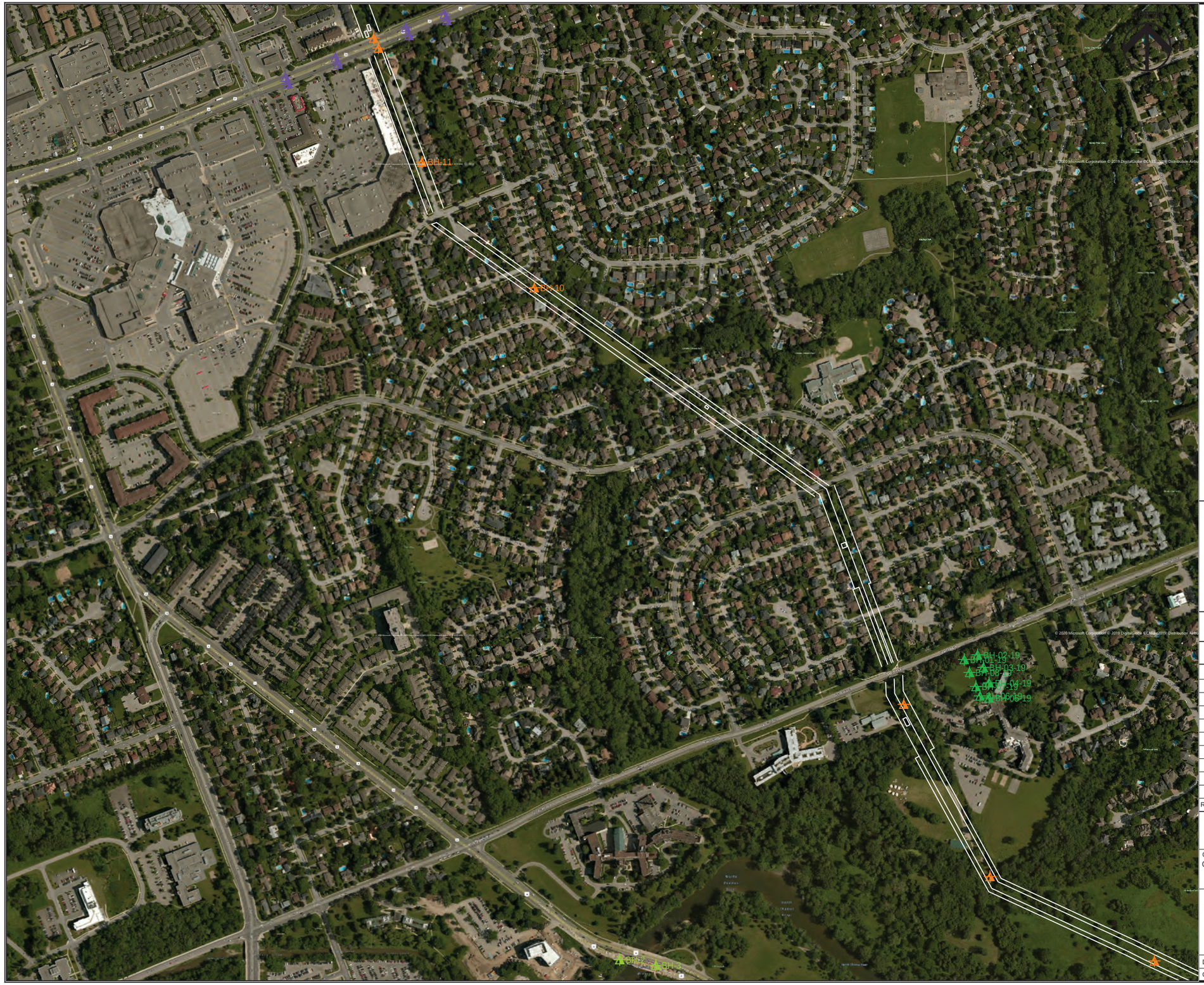
AECOM

CLIENT NAME: CITY OF LONDON	PROJECT LOCATION: Arva Pump Station to Huron Street, London
	PROJECT NUMBER: 60619503

EXISTING BOREHOLE LOCATION PLAN DIVISION TWO

DRAWN BY: CS	SCALE: N/A	DRAWING No. 2
CHECKED: WH	DATE: Feburary 2020	REVISION 0

\\CALON1FP001\work\London Geotech\Projects\60619503 - CoL Arva PS to Huron St WTM - EA\900 - Work\930 - CAD, Drawings\60619503 - Existing BH Location.dwg



LEGEND

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

NOTES:

- Borehole locations were estimated based on the existing drawings where coordinates were not provided

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME:
CITY OF LONDON

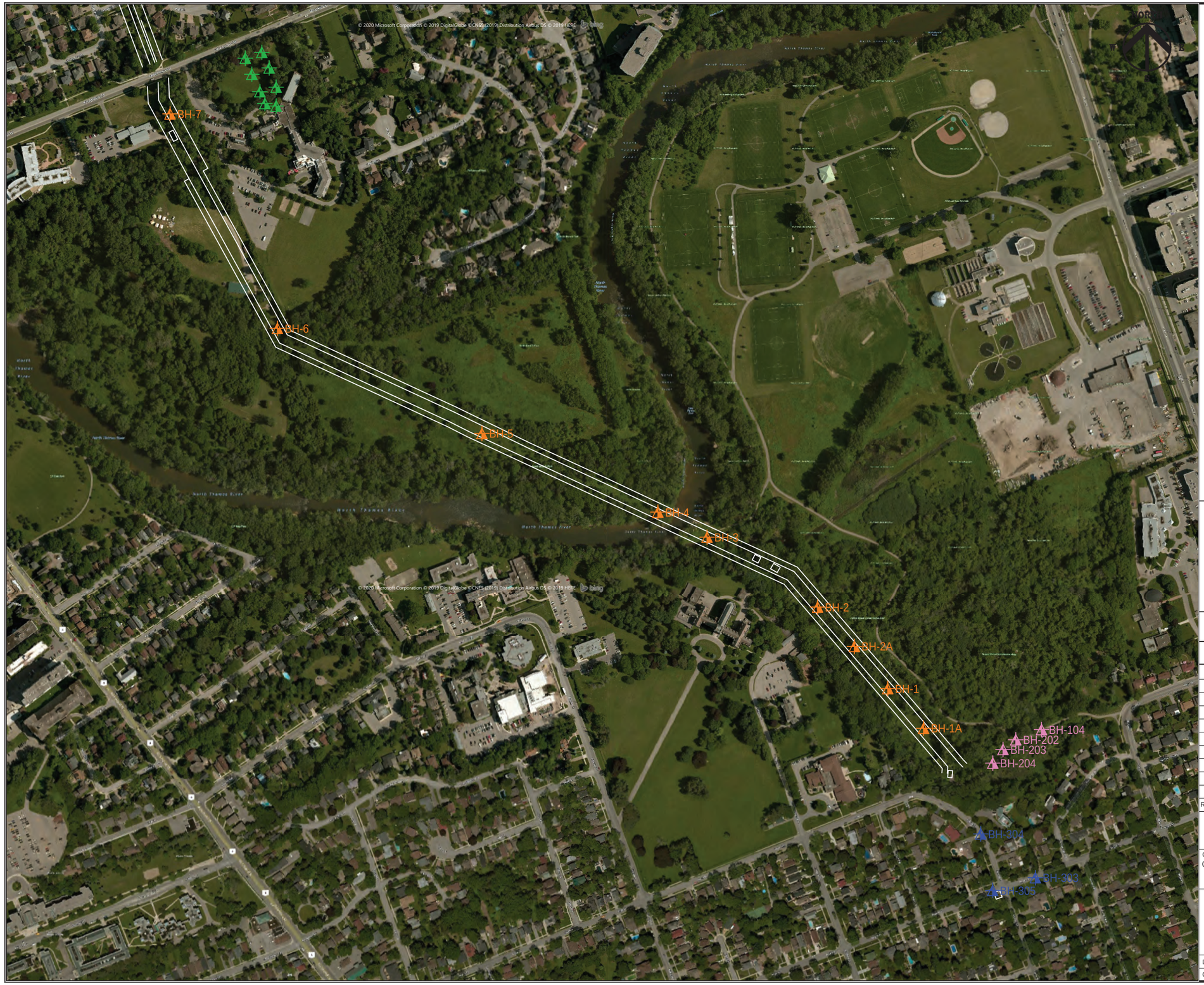
PROJECT LOCATION:
Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

EXISTING BOREHOLE LOCATION PLAN DIVISION THREE

DRAWN BY: CS	SCALE: N/A	DRAWING No. 3
CHECKED: WH	DATE: Feburary 2020	REVISION 0

\\CALON1FP001\work\London Geotech\Projects\60619503 - CoL Arva PS to Huron St WTM - EA\900 - Work\930 - CAD, Drawings\60619503 - Existing BH Location.dwg



LEGEND

- Test Pit (Report #901-3146 by Golder Associates Ltd.)
- Borehole (Report #64150 by Golder Associates Ltd.)
- Borehole (Report #62-F-297M by Golder Associates Ltd.)
- Borehole (Report #LON-00012042-HG by exp Servies Inc.)
- Borehole (Report #LON00011278-GE by exp Services Inc.)
- Borehole (Report #LON00011544-GE by exp Services Inc.)
- Borehole (Report #P-160-B-0020682-1-GE-R-0001-00 by Englobe Corp.)
- Borehole (Report #S-500/T-593 by Racey, MacCallum and Associates Ltd)
- Borehole (Report #18100403-R01 by Golder Associates Ltd.)
- Borehole (Report #1656044-1000-R01 by Golder Associates Ltd.)

NOTES:

- Borehole locations were estimated based on the existing drawings where coordinates were not provided

REFERENCE DRAWINGS

1	2020.01.20	Existing Transmission Main and Easments
NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK

AECOM

CLIENT NAME:
CITY OF LONDON

PROJECT LOCATION:
Arva Pump Station to Huron Street, London

PROJECT NUMBER: 60619503

EXISTING BOREHOLE LOCATION PLAN
DIVISION FOUR

DRAWN BY: CS	SCALE: N/A	DRAWING No. 4
CHECKED: WH	DATE: Feburary 2020	REVISION 0

\\CALON1FP001\work\London Geotech\Projects\60619503 - CoL Arva PS to Huron St WTM - EA\900 - Work\930 - CAD, Drawings\60619503 - Existing BH Location.dwg