AECOM CANADA LTD.
250 York Street, Suite 410,
London, ON, Canada N6A 6K2

519 963 5930 tel
519 673 5975 fax

Technical Memorandum

To:	Stephen Romano, P.Eng. Environmental Services Engineer	Page 1
CC	Aaron Rozentals, Jake Helm, John Haasen	
	City of London: Arva Pumping Station to Huron Street Water Transmission Main Municipal Class Environmental Assessment Master Plan	
Subject	**Technical Memorandum – Long Term Alternative Conceptual Design**	
From	Bander Abou Taka, P.Eng.	
Date	March 30, 2021	Project Number 60619503

1. Background

The City of London (City) retained AECOM to perform a Municipal Class Environmental Assessment Master Plan (MCEAMP) of a twinned 1,050 mm dia. Prestressed Concrete Cylinder Pipe (PCCP) transmission main from the Arva Pumping Station to Fanshawe Park Road, and a single 1,050 mm dia. PCCP transmission main between Fanshawe Park Road and Huron Street. Refer to **Figure 1.1.**

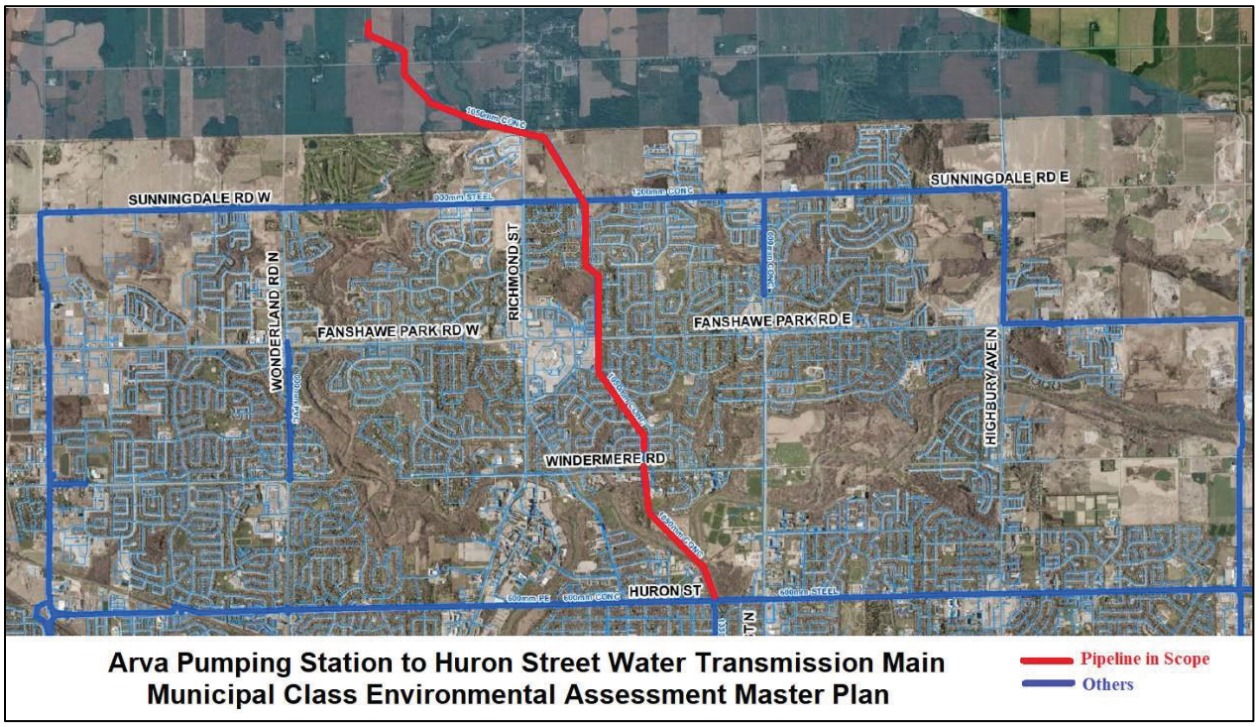


Figure 1.1 Arva PS to Huron Street Transmission Main

The existing single transmission main and a number of associated valve chambers are located on several privately owned properties between Fanshawe Park Road and Huron Street, which makes it difficult to access, maintain, repair, and twin in the future. Several alternatives to twin the single main were reviewed and analyzed including:

1- Alternative 1: Do nothing, where no twinning is considered from Fanshawe Park Road to Huron Street;
2- Alternative 2: Twin the transmission main along Adelaide Street with connections to the existing transmission main(s) via Medway Road, Sunningdale Road, or Fanshawe Park Road and ending at the new relocated Chamber 13 on Regent Street; and
3- Alternative 3: Twin the transmission main along Richmond Street ending at the new relocated Chamber 13 on Regent Street. Several options for connections to Richmond Street included:
    a. 3A: Twin the transmission main along Richmond Street with a connection via Medway Road or Fanshawe Park Road;
    b. 3B: Twin the transmission main along Richmond Street via Windermere Road and the existing easement between Windermere Road and Huron Street or via Huron Street.

Figure 1.2 illustrates the twinning alternatives evaluated and considered by the City.

Alternative 2, Option C twinning along Adelaide Street, and connecting to the existing transmission mains via Fanshawe Park Road and Regent Street, was identified as the preferred alternative, and is the basis for the conceptual design discussed in this technical memorandum. Future modeling and master planning for the City as whole to better serve Northeast London may modify or add connection points to one of the other options on Medway Road or Sunningdale Road.

Option A

MEDWAY ROAD

Option B

SUNNINGDALE RD E

SUNNINGDALE RD W

RICHMOND ST

ADELAIDE ST N

Option C

FANSHAWE PARK RD E

FANSHAWE PARK RD W

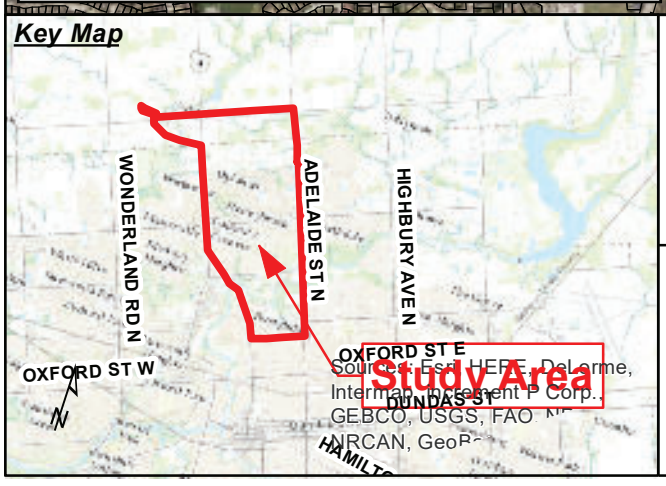
WINDERMERE RD

HURON ST

0 300 600 1,200 Metres

Source: Esri, Maxar, GeoEye, Earthstar and the GIS User Community

Key Map



City of London
Arva to Huron Transmission Main
Municipal Class Environmental Assessment

Figure 1.2: Alternatives

Date:	PN:	Datum: NAD83 UTM17
December 2020	60619503	Source: City of London

Legend

- Existing Transmission Main
- Alternative 2: Adelaide Street Twinning Routes
- Alternative 3A: Richmond Street North Twinning Routes
- Alternative 3B: Richmond Street South Twinning Routes

AECOM

2. Transmission Main Routing

For the Adelaide Street preferred option, transmission main construction will be within existing roadway right-of-way's (ROW) on roadway portions for the most part, with some sections in boulevard areas wherever possible along the preferred route. Existing utilities on Fanshawe Park Road, Adelaide Street and Regent Street including water, sanitary and storm were evaluated to generate a transmission main route that limits disruption to existing utilities, reduces bends and abrupt change in direction, and limits the need to purchase or obtain additional land or easements outside of City owned property. Other shallow utilities such as gas, and communication lines were only evaluated where available and may affect the location and/or construction method. This should be confirmed as part of preliminary/detailed design. Drawings for Alternative 2 Option C are provided in **Appendix A**. **Table 2.1** shows the transmission main routing, estimated pipe length, number of chambers, and major road and/or waterway crossings. The values are based on a single transmission main installation. For twinned mains the values would be doubled. **Figure 2.1** illustrates the profile for the proposed transmission mains from the Fanshawe Park Road connection to Chamber 13 on Regent Street. There are several high and low points along the route including two water crossings and several road crossings that may require air and drain valve chambers to accommodate elevation changes associated with deeper installation methods. **Appendix A** provides more details on locations of these chambers and the proposed routing. Section 3 provides general information on the types of construction methods that will be used for construction of the transmission mains. **Section 3.4** provides additional information on valve chambers.

Table 2.1: Transmission Main Options (Single Main)

Connection Option	Total Pipe Length (m)	Total Pipe in Roadway (m)	Total Pipe in Boulevard (m)	Total Pipe Using Trenchless Methods (m)	Number of Chambers *	Number of Road Crossings	Number of Water Crossings
Option C – Fanshawe Park Road Connection	5,165	3,995	920	250	10-12	4	2

*To be confirmed during design phase.

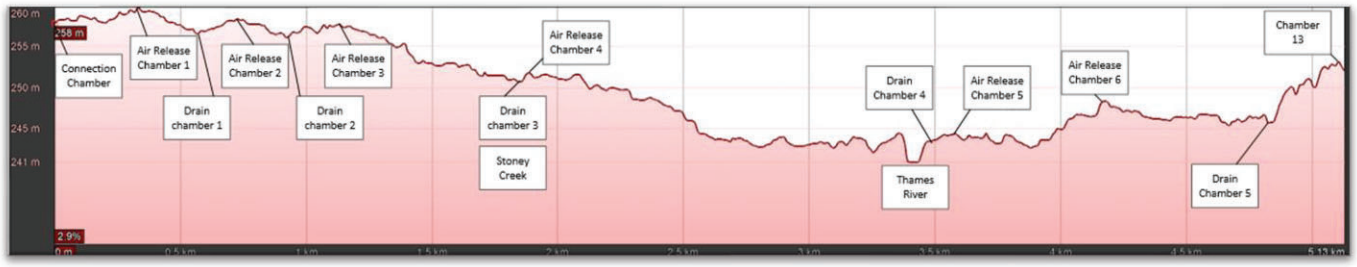


Figure 2.1: Transmission Main Proposed Profile and Chamber Locations.

3. Transmission Main Construction

3.1 *Installation*

Where the transmission main is installed within a roadway or boulevard area, it can be installed in two traditional manners:

Method 1 - Open trench/cut installation: This method is the most common construction method for transmission main installations. It consists of excavating to the required depth, preparing bedding, installing new pipe sections, and then backfilling the trench.

The work includes but is not limited to the following steps:

Sawcut pavement, if in roadway, or strip the surface of vegetation and remove trees as required, and excavate a trench to the required depth;

Install new transmission main, including the required bedding, valving, chambers, etc.;

Secure areas where trench is located while work is in progress;

Conduct quality control inspections including pressure and leak testing, and disinfection;

Repair any curb, roadway, and sidewalk panels damaged during construction;

Restore any vegetation disturbed during construction with topsoil and grass seed; and

Restore fences and gates to previous conditions if removed or destroyed during construction.

Open cut method may not be suitable for some sections of pipe installation because of the following:

Congested area with many shallow and deep utilities;

Difficultly to manage traffic in a busy intersection;

Transmission mains under railways or watercourses;

Sensitive environmental areas where open cut method is not preferred by the MECP; and

High costs to restore nontraditional type of pavement such as decorative bricks or stamped concrete.

In these cases, **Method 2** – Horizontal Directional Drilling (HDD), or Jack and Bore method, would be more appropriate. HDD enables precise boring techniques enabling the contractor to bypass underground obstacles such as other pipes, train tracks or watercourses. This method involves the following steps:

Creating pilot hole that is drilled and steered along a chosen pathway;

Drilling bore would continue under all obstacles at the preferred elevation and then resurface at the precise final location above grade;

A back reamer (cutting tool) is then drawn back through the tunnel;

The back reamer will drill backwards, increasing the diameter of the tunnel to match the new transmission main size, 1,050mm in our case;

Attached to the reamer would be the new 1,050mm transmission main which would be made of different materials such as PVC or High-Density polyethylene (HDPE) depending on pressure rating required, chemical resistivity, flexibility, or bends required for installation;

Pipe is pulled back with the back reamer and used as the new transmission main for this section;

The HDD installed transmission main would then be connected to the remaining transmission main using open cut method or continues by HDD where appropriate.

Jacking and boring is a trenchless method for constructing piping in short runs, where open trench method is not suitable or desired such as piping under river beds or across busy intersections. The work involves the following steps:

Digging and preparing the sending and receiving pits to the required depth;

Installing the jack and bore machine in the sending pit;

Coring a new hole in the ground and push the piping through to the receiving pit;

Removing the jack and bore machine from the sending pit;

Backfilling the pits;

Restoring surfaces as required.

Figure 3.1 illustrates the open cut method while **Figure 3.2** illustrates what is involved with the HDD method. **Figures 3.3** and **3.4** provides an example of recent projects where Jack and Bore construction methods were utilized under major roadways and/or a watercourse. As a minimum, these approaches would be required for the Thames River and Stoney Creek crossings.

Figure 3.1: Open Cut Construction example with support to existing utilities

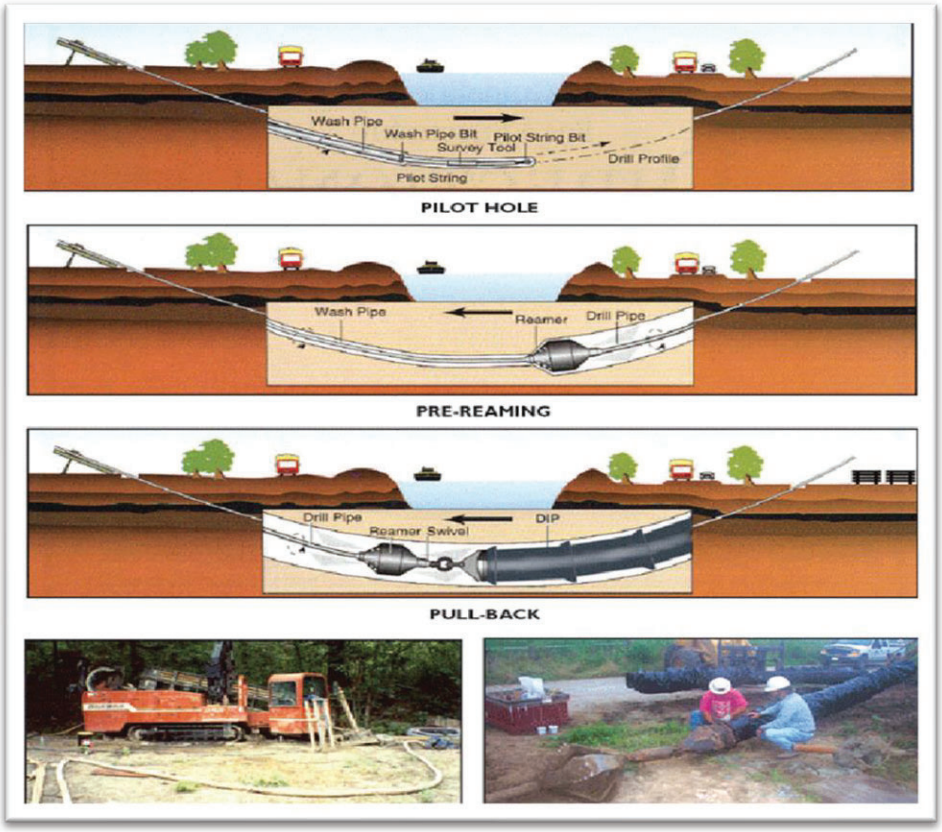


Figure 3.2: Directional Drilling Construction (1)

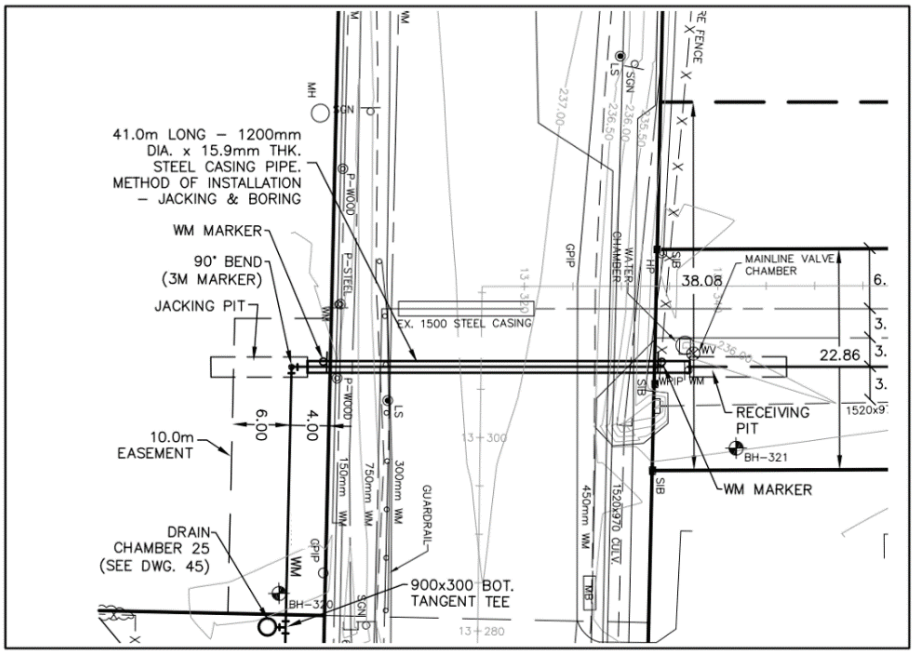


Figure 3.3: Example of installing a watermain under a major roadway or watercourse using Jack and Bore, or HDD construction method.

(1) Image taken from the Journal of Applied Sciences article “Introducing Bentonite into the Environment in the Construction Stage of Linear Underground Investment Using the HDD Method” by Urszula Kwast-Kotlarek , Maria Heldak , and Jakub Szczepa ´nski, Published on November 10, 2018.

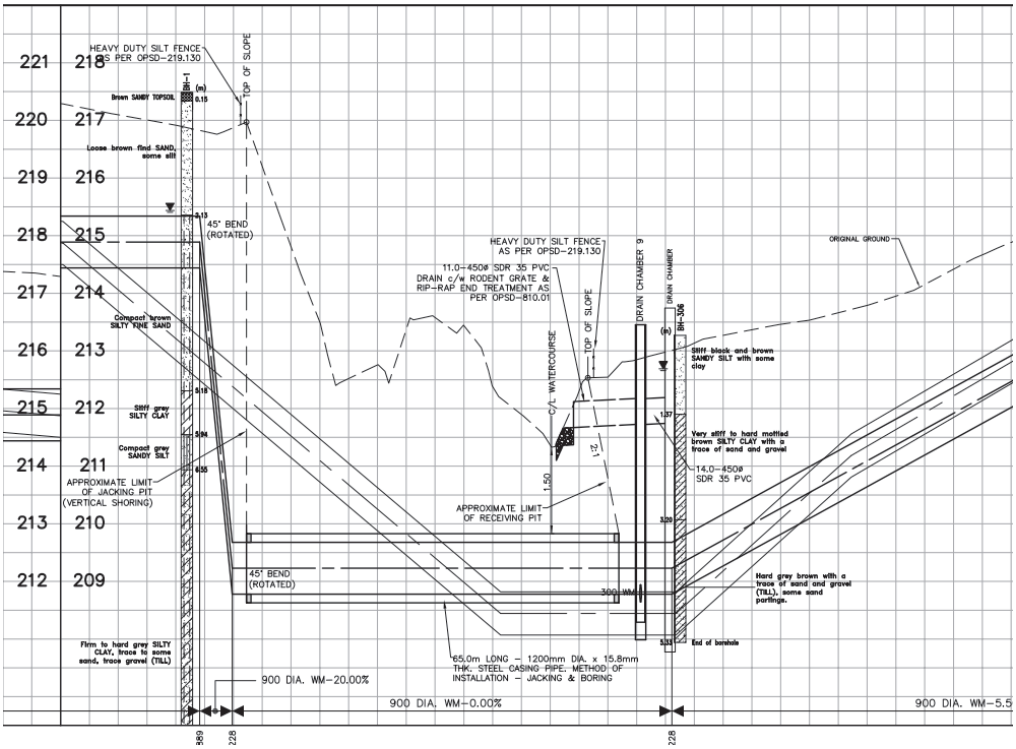


Figure 3.4: Example of a profile view of a watermain under a watercourse using HDD or Jack and Bore construction method.

3.2 *Clearances Between Mains and Utilities*

The Ministry of Environment Conservation and Parks (MECP) requires under normal conditions that watermains be laid with at least 2.5 meters of horizontal separation from any non-potable water source such as sewers, storm pipes, and manholes, preferably in separate trenches. If separate trenches cannot be constructed, or 2.5 meters cannot be accommodated due to conflicts with other existing utilities, bedrock, dewatering issues, etc., a watermain may be laid closer to non-potable piping and manholes, provided that the elevation of the crown of the non-potable piping is at least 0.5 meters below the invert of the transmission main. This protects the watermain in case there is a break or leakage of the non-potable line and it comes in contact with the potable water transmission main. If vertical separation cannot be achieved, the non-potable water pipeline is recommended to be relocated or replaced with piping material equivalent to watermain standards of construction, and be pressure tested, in accordance with Division 701 of the Ontario Provincial Standards Specification (OPSS), published by the Ontario Ministry of Transportation at a pressure of 350 kPa, with no leakage.

If the transmission main route requires it to cross other utilities, then the main will be laid above non-potable pipelines with sufficient vertical separation to allow for proper bedding and structural support of the watermain and sewer. If this vertical separation cannot be achieved, then the transmission main can cross under non-potable utilities with the following requirements as per the MECP:

a. A vertical separation of at least 0.5 meters between the invert of the sewer and the crown of the watermain.

b. Sewer lines shall be adequately supported to prevent deflection of joints and settling.

c. Ensure the section of transmission main crossing under the non-potable water lines be installed at the centre of the transmission main where the joints of the transmission main are equidistant and as far as possible from the sewer.

3.3 *Construction Allowance and Easement Requirements*

For most of the transmission main routing, the installation will be within an existing roadway or boulevard where appropriate, to avoid other utilities in the ROW or to be near or within City owned property to allow more room for construction equipment. For the open cut construction method, soil type will dictate the width of the open trench required to minimize cave in and rolling of material down the slope. Soils are identified by geotechnical engineers based on borehole or test pit inspections. Soils are categorized into four types. For Type 1 and 2 soils, or relatively good soils, the trench can be cut back at an angle of 1 to 1, or one meter back for each meter up. Walls should be sloped to within 1.2 meters of the trench bottom. For Type 3 soils, the trench walls should be cut back to the bottom of the pipe elevation in a 1 to 1 slope. For Type 4 soils, or bad soils, the slope should be cut back in a 1 to 3 slope, or 3 meters back for every 1 meter up from the trench bottom. **Figure 3.5** illustrates the various trench slopes for each soil type. Based on the Geotechnical work completed as part of the project, along the existing transmission main north of Fanshawe Park Road, the soil type is classified as Type 2 or 3, and a 1 to 1 slope ratio is assumed for all open cut construction work along Fanshawe Park Road, Adelaide Street and Regent Street. Additional geotechnical investigation will be required to confirm soil types at all locations during preliminary/detailed design. Therefore, for a single 1,050mm main, and assuming 2 meters of depth, a 7-meter width is required for clearance and sloping. An additional 3 meters of space is required for construction equipment allowance for a total width of 10 meters. If two transmission mains are to be installed, then an additional 3 meters would be required for a minimum width of 13 meters.

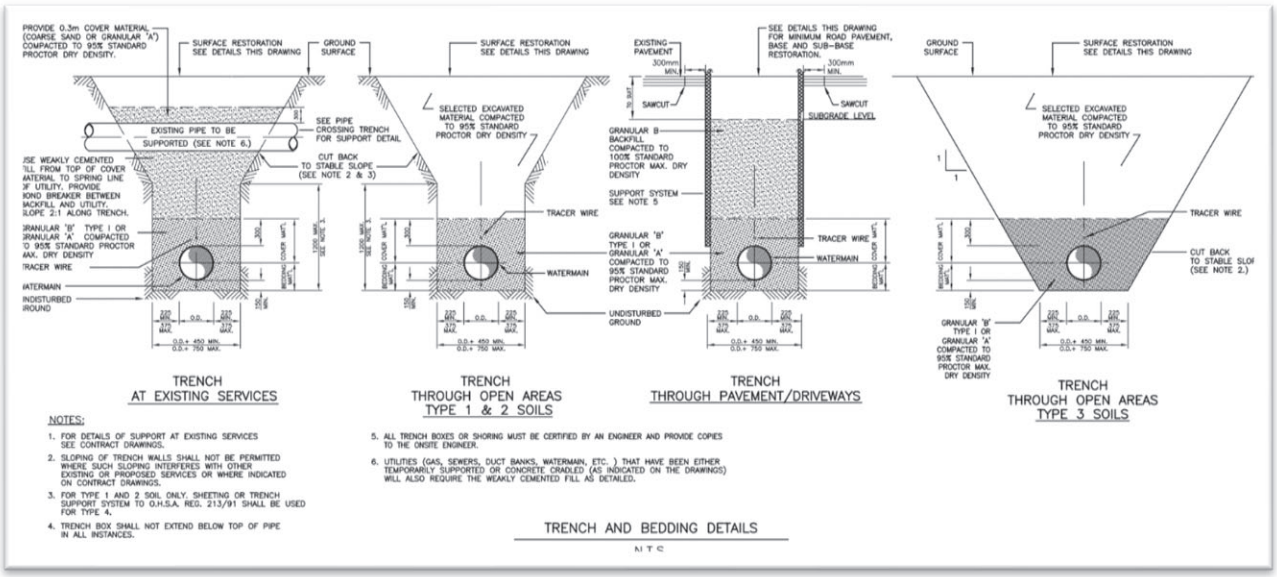


Figure 3.5: Typical Trench & Bedding Details

For two transmission mains in the same trench, **Figure 3.6** provides a typical installation from a similar project in the City of London using two mains in the same trench. The details shown in the figures are typical for under pavement construction and shows clearances from other utilities in the ground.

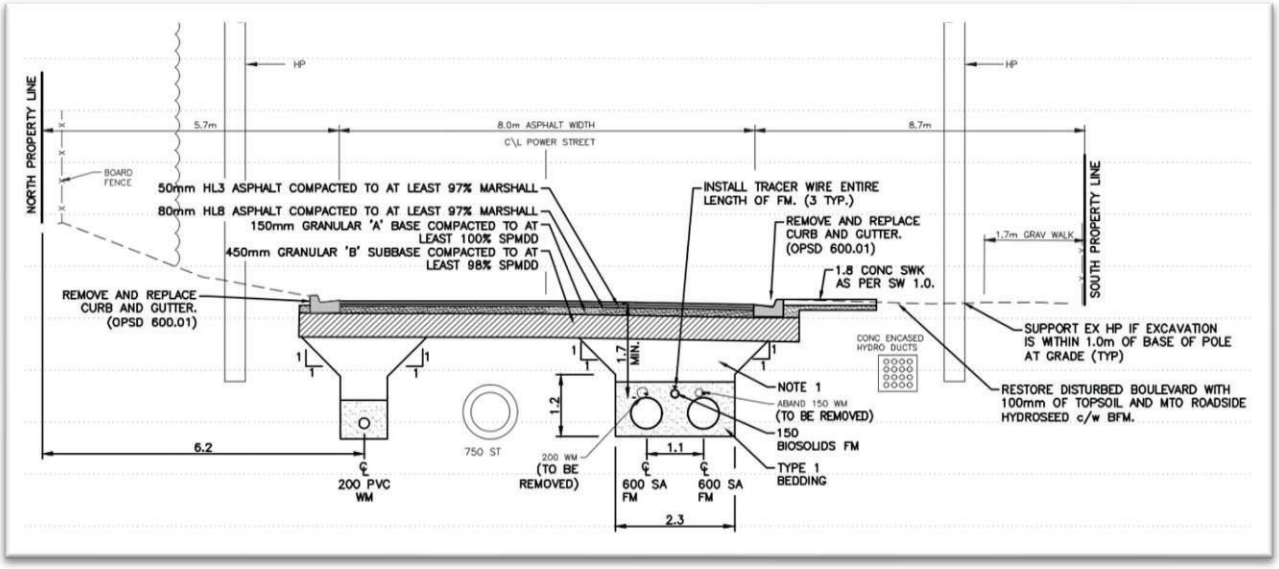


Figure 3.6: Typical Trench & Bedding Details for multiple mains in a road

Where the required 10-13 meters of spacing cannot be achieved, the contractor can utilize removable trench boxes that provide engineered support to the trench walls at a 90° angle without the need to slope the trench. This system is meant to protect the workers in case of cave-ins. In some cases, additional shoring or support of the trench box would also be required to prevent movement of the trench box walls. This is usually used to prevent the movement of soils, protect underground utilities nearby, and protect nearby roads and building foundations. Refer to **Figure 3.7**.

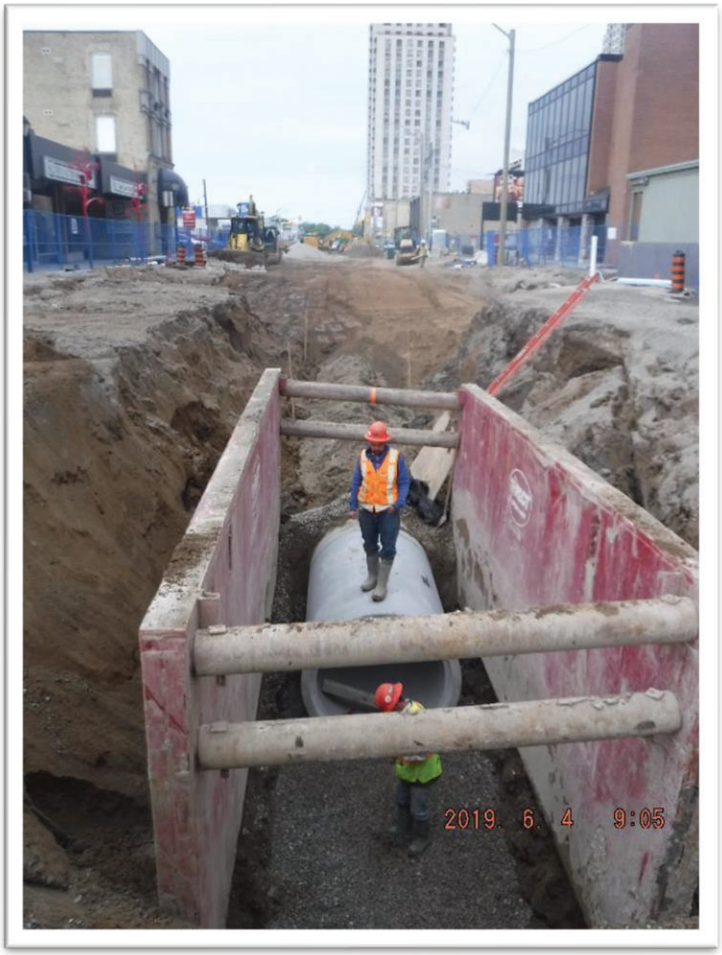


Figure 3.7: Trench Box and Shoring

Depending on the location of the transmission main, additional land may be required to allow for traditional type construction and access to chambers for maintenance and repairs. Based on the preliminary drawings in **Appendix A**, no additional easements are required at this point of conceptual design. It is recommended to review property/easement conditions and transmission main needs during preliminary/detailed design to confirm any additional land needs and obtain any required approvals from the various ministries to work near watercourse, heritage, natural, and/or protected lands prior to construction of the new main(s).

3.4 *Chamber Installations*

Where air release valves, vacuum valves, isolation/diversion valves, or drain valves are required as shown on the drawings in **Appendix A**, a new chamber would be constructed that allows for continuous operation of the transmission main while providing the required servicing, bypassing and protection for the main(s) and surrounding properties. Air release or vacuum valves provide the means to expel trapped air in a pipeline or allow air into a pipeline when required. These valves reduce inefficiencies and serious operating issues such as preventing vacuum conditions and air-related surges in pipelines that could cause line breaks and forced release of high-pressure water in the area. The location of these air valves is determined using sophisticated hydraulic models and an analysis would be recommended during preliminary/detailed design. For this technical memo, it is assumed that air release valves are installed at key high points in the pipeline to allow for trapped air to be expelled. Drain chambers are added to the pipeline to allow the City to drain problematic sections of the pipeline for repairs or inspections by draining the water out at a key low point in the pipeline to avoid pumping the water out. Locations of drain valve chambers are also strategically placed to allow water to flow downhill towards storm sewers or nearby watercourse and avoid pooling or ponding near homes or in nearby roads.

These chambers can range from single manholes with one or two valves to a multi-valve complex structure where various valves and instruments are required to connect to the existing transmission main(s). **Figures 3.8** and **3.9** are examples of typical chambers that would be used for this transmission main. **Figure 3.10** provides an example of multiple transmission mains interconnecting inside a single chamber to control flow direction. The chamber for this project would be much larger to allow for the installation of five isolation valves in addition to any other air or drain valves required.

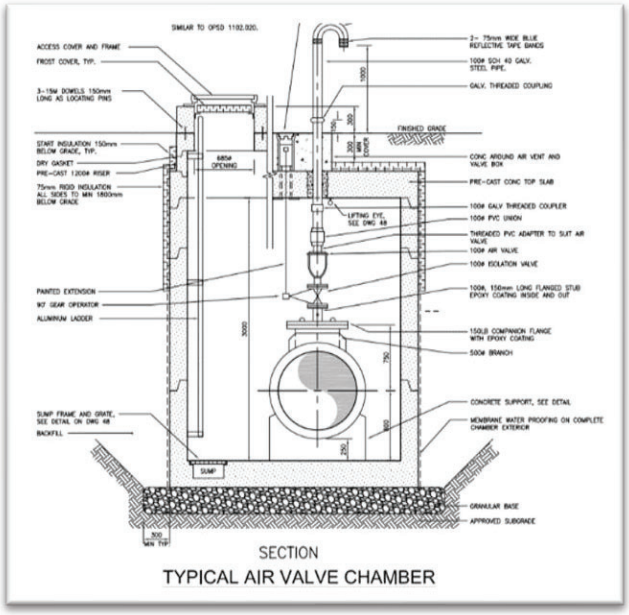


Figure 3.8: Typical Air Valve Chamber

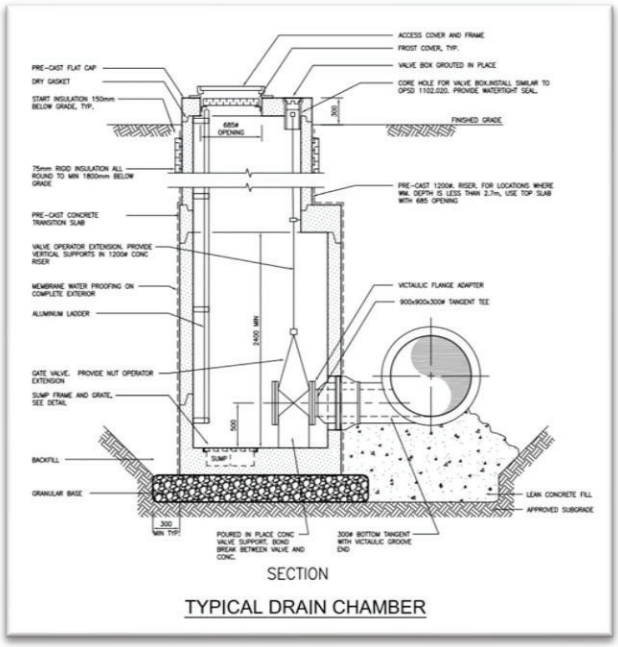


Figure 3.9: Typical Drain Valve Chamber

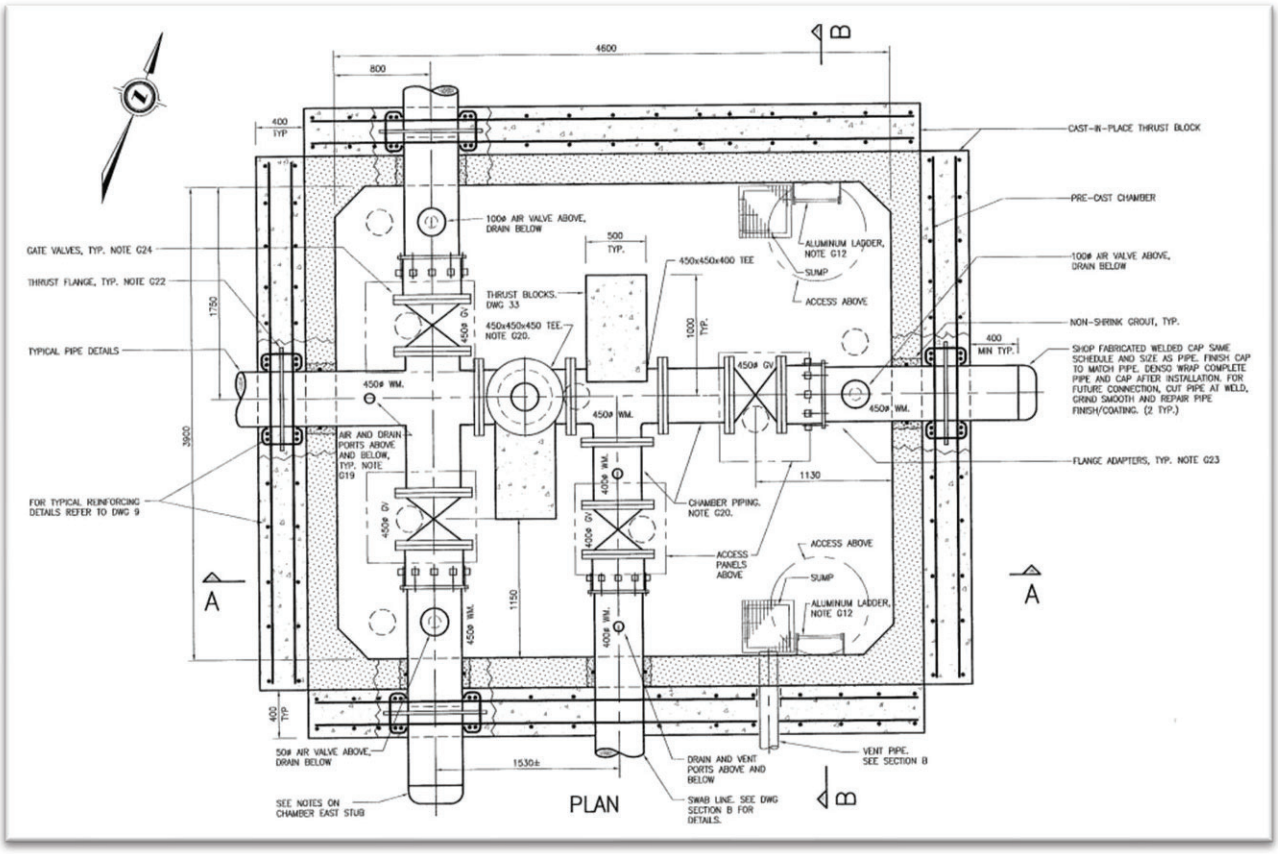


Figure 3.10: Example of multiple mains interconnecting in a single valve chamber

4. Phasing of Construction

Since the proposed transmission main and future twinning will be within existing right of ways and developed areas of the City, the work may be initiated ahead of schedule when several factors are encountered including:

1- Changing condition of the existing transmission main. This will expedite or delay the start of the upgrades. If the single main between Fanshawe Park Road and Windermere Road starts to show increasing signs of deterioration, such as increased wire break reports, and more unscheduled repair work before the lifespan of the PCCP is reached, then it may be necessary to accelerate the twinning schedule, or start installing portions of the transmission main before the theoretical end of life of PCCP is reached.
2- Road work and repairs: Reconstruction of roads in the City is a major undertaking and usually accompanies other infrastructure upgrades and modifications such as rerouting or replacing underground utilities, new concrete curbs, new storm catch basins, and storm and sanitary sewer and manholes upgrades. When certain road portions along the proposed transmission main route are scheduled to be replaced along with major underground utilities work, it is recommended to evaluate the opportunity to install portions of this new transmission main(s) now, or at least rearrange the utilities to take into consideration the location of the proposed main(s) in that portion of the roadway, to allow for future installation of the main(s) as shown on the proposed routing in **Appendix A.**
3- Requirements for urban development. In certain areas along the transmission main, undeveloped lands may be developed in the future, and servicing these new developments will require utilities and road works to be completed. The City will have an opportunity to install portions of the transmission main(s) near these developments when service connections are added. The City may also have an opportunity to acquire new easements for the transmission main(s) and reduce portions under roadways.

As will be discussed in Section 5, Capital Costs, the cost to twin the transmission main for Alternative 2 is high, and constructing the work in several phases over many years may be necessary to reduce the financial burden to the City, and to reduce traffic congestion and long road closures in major developed areas. The following phasing strategy is suggested and can be modified in the future during preliminary/detailed design:

Phase 1 – Within 0-5 years: The new relocated Chamber 13 will be installed on Regent Street. Capped stubs are recommended to be installed at this time as part of the Chamber 13 relocation project, and a corridor for future piping will be provided on Regent Street for the future twin mains.

Phase 2 – Within 5-15 years: It is recommended that portions of the transmission main be installed when 20 to 30% of the life expectancy of the PCCP is remaining, or when an opportunity or a requirement to upgrade portions of roadways along the route is required. The Fanshawe Park Road portion of the work is considered critical as it requires major interconnections to the existing transmission main(s). Having this connection ready, and most of the transmission main on Fanshawe Park Road to Adelaide Street in place would facilitate rapid installation of the transmission main when required on Adelaide Street. Fanshawe Park Road is in relatively good condition and does not require reconstruction for 10 to 15 years.

Phase 3 – Within 15-25 years: All major road and watercourse crossings are on the north to south portion of the transmission main(s) on Adelaide Street. It is preferred that all works on Adelaide Street be completed in one phase to reduce multiple closures of the roadway in the future. Adelaide Street is also relatively new, and reconstruction of the roadway is not required for 15-25 years. At this time all remaining mains on Regent Street would be installed to complete the connection from the Arva Pumping Station to Chamber 13.

5. Capital Costs

Table 5.1 presents a summary of estimated costs for placing the transmission main along Adelaide Street with connections on Fanshawe Park Road and Regent Street. Costs include the costs for new single or twinned portions (in the same trench), of a 1,050mm main(s) installed via the open cut method, and some sections by trenchless methods at Thames River crossing and Stoney Creek crossing. At this stage of the review, it is assumed that the remaining transmission main construction work will be completed using open cut construction methods. However, this should be verified during preliminary/detailed design. The costs also include the supply and installation of air and drain chambers, interconnecting chambers to connect to the existing transmission main, pavement and surface restoration, engineering, and an estimating contingency of 25%. These costs do not include taxes, or the costs to purchase additional lands or easements if required. All costs are in 2020 dollars. **Appendix B** provides more detailed calculations for the estimated costs.

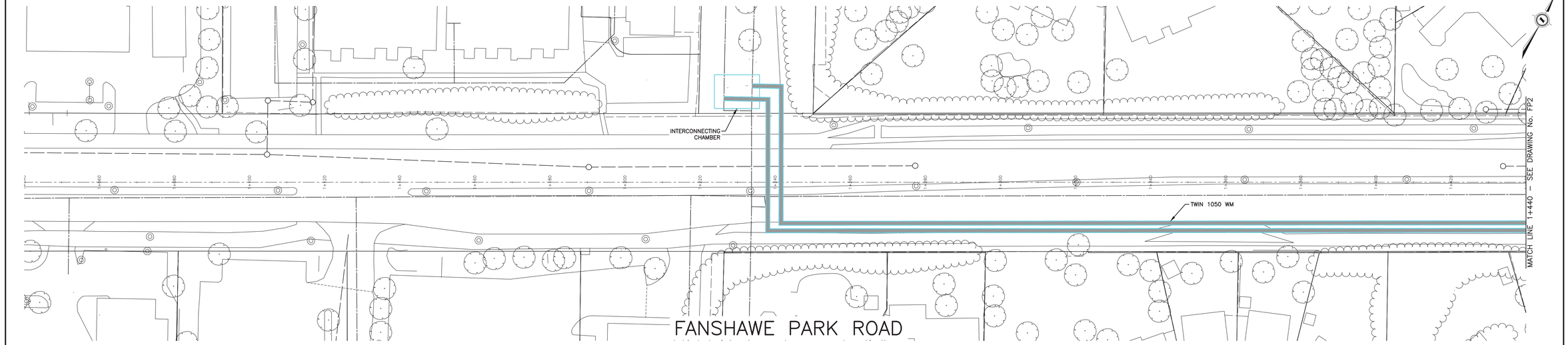
Table 5.1: Summary of Estimated Costs

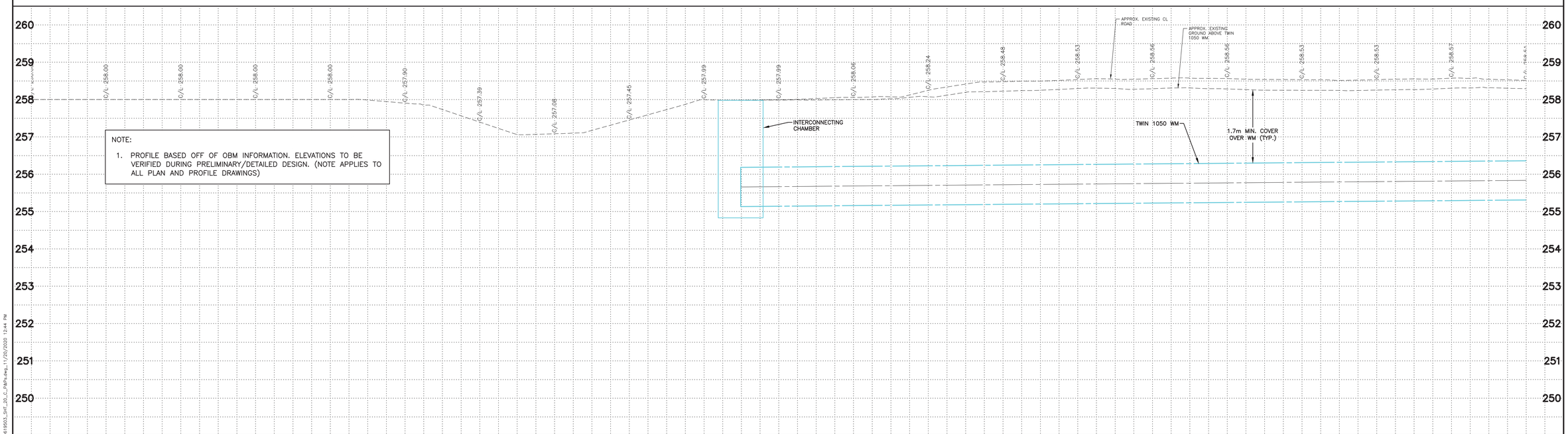
Alternative	Single Line	Twinned Lines
Alternative 2 – Option C: Connection on Fanshawe Park Road	$ 20,000,000	$ 32,000,000

The City may want to consider connecting to the existing main(s) at other locations in the future based on changes in demands in the northeast portion of the City or if other factors render the connection on Fanshawe Park Road less desirable. The costs to connect via Medway Road are estimated at $34 and $53 Million for single and twinned mains respectively, and the costs to connect via Sunningdale Road is estimated at $25 and $40 Million for single and twin mains respectively.

APPENDIX A

Proposed Transmission Main(s) Twinning Drawings





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

DRAFT

STATION: 1+060 | 1+080 | 1+100 | 1+120 | 1+140 | 1+160 | 1+180 | 1+200 | 1+220 | 1+240 | 1+260 | 1+280 | 1+300 | 1+320 | 1+340 | 1+360 | 1+380 | 1+400 | 1+420 | 1+440

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

London CANADA
CORPORATION OF THE CITY OF LONDON

SCALE
HORIZONTAL SCALE – 1 : 500
5 0 10m
VERTICAL SCALE – 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

FANSHAWE PARK ROAD

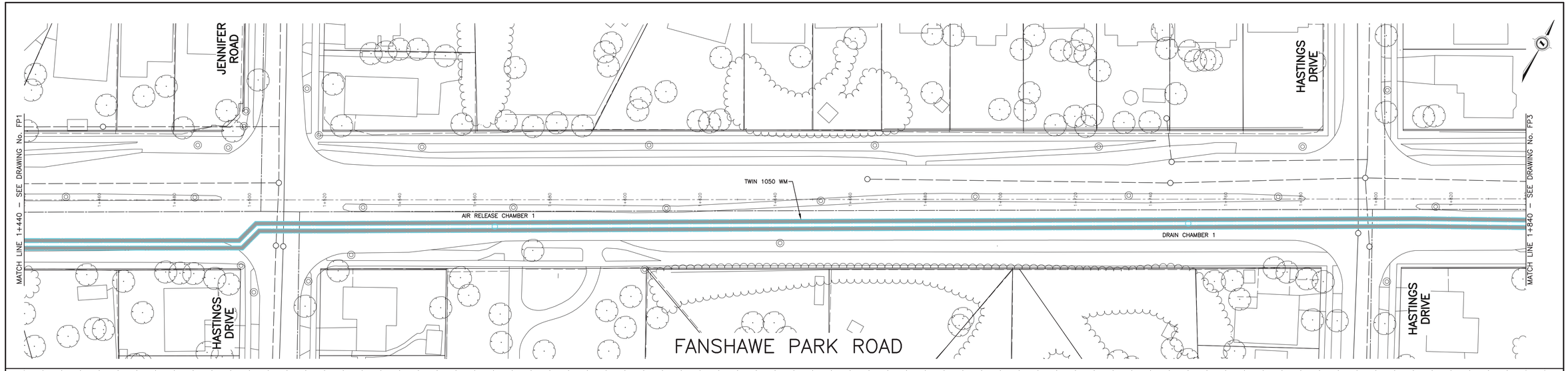
FROM 1+040 TO 1+440

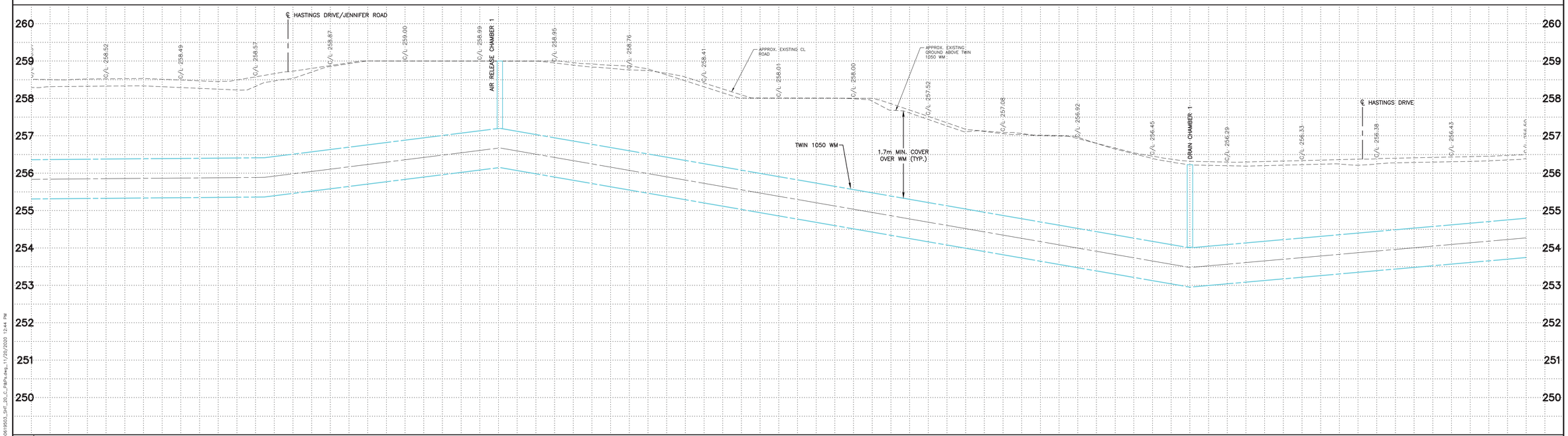
PROJECT No. 60619503

SHEET No. FP1

PLAN FILE No.

C:\Users\Vpixley\Documents\TEMPORARY – 60619503 Arva WW\01_CAD\20–SHEETS\C\60619503_Sht_20_C_PAPs.dwg, 11/20/2020 12:44 PM





DRAFT

	1+460	1+480	1+500	1+520	1+540	1+560	1+580	1+600	1+620	1+640	1+660	1+680	1+700	1+720	1+740	1+760	1+780	1+800	1+820	1+840
STATION																				
SANITARY SEWER INVERT																				
STORM SEWER INVERT																				
C/L WATERMAIN ELEVATION																				

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0.5 0 1m

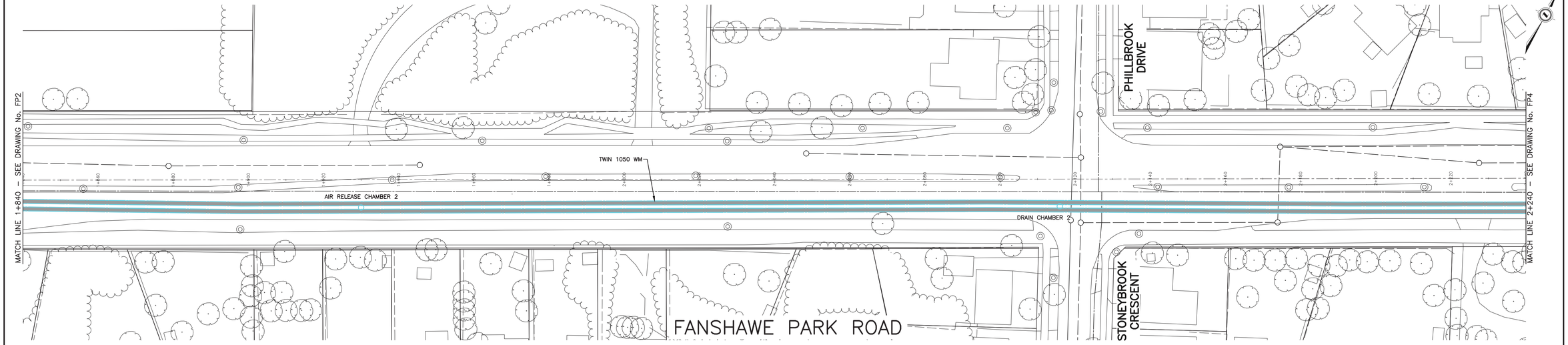
ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

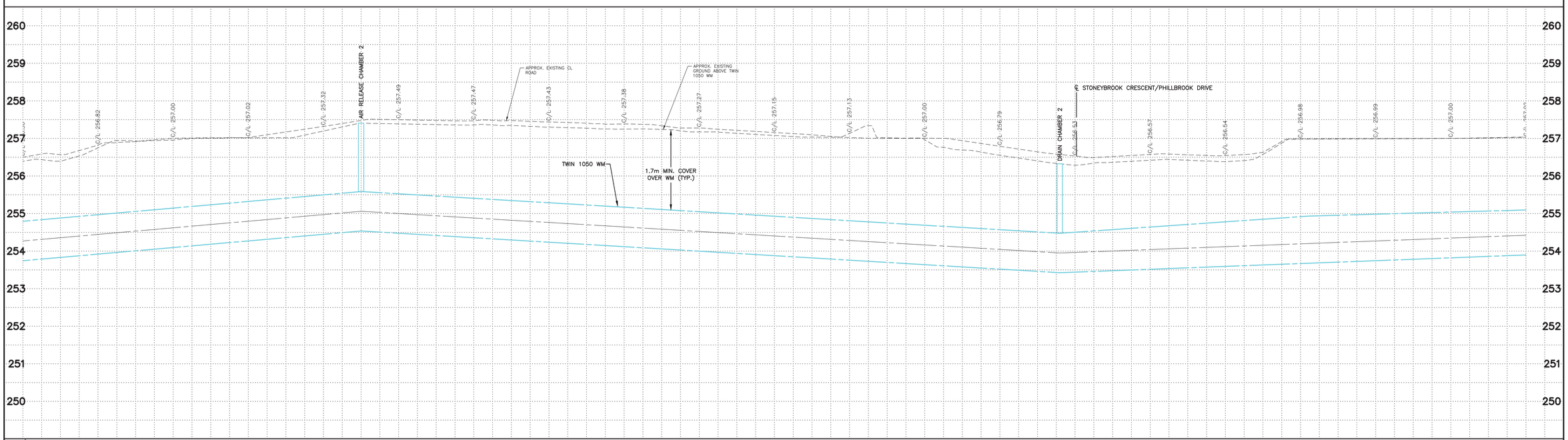
FANSHAWE PARK ROAD

FROM 1+440 TO 1+840

PROJECT No. 60619503
SHEET No. FP2
PLAN FILE No.

C:\Users\Vpixley\Documents\TEMPORARY – 60619503 Arva WM\01_CAD\20–SHEETS\C\60619503_Sht_20_C_FAPk.dwg, 11/20/2020 12:44 PM





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION 1+860 1+880 1+900 1+920 1+940 1+960 1+980 2+000 2+020 2+040 2+060 2+080 2+100 2+120 2+140 2+160 2+180 2+200 2+220 2+240

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

FANSHAWE PARK ROAD

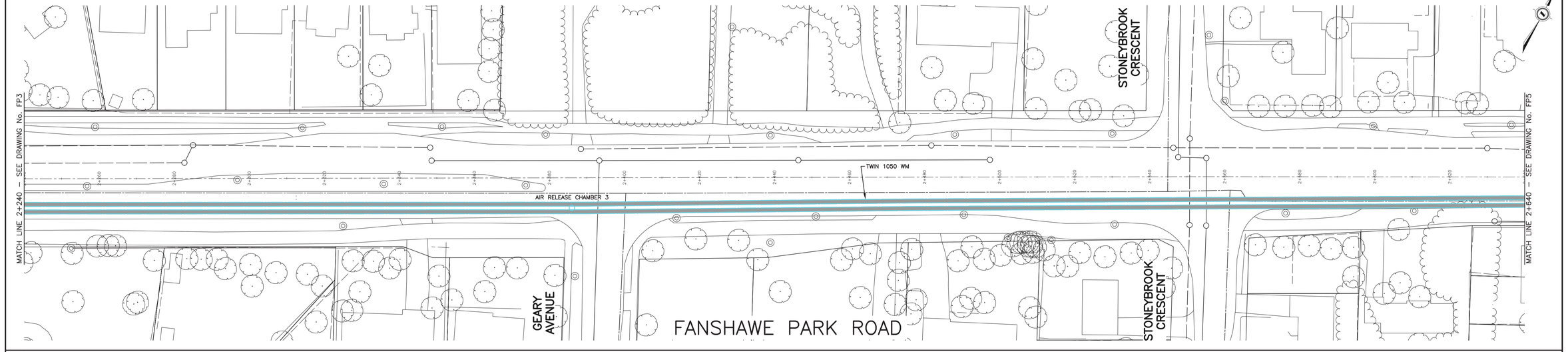
FROM 1+840 TO 2+240

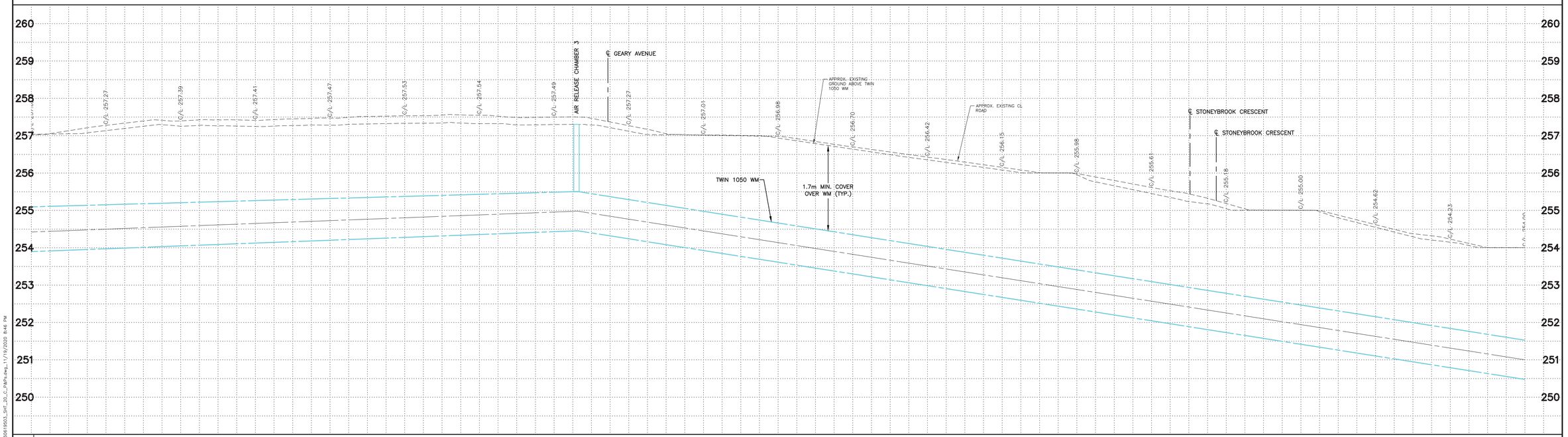
PROJECT No. 60619503

SHEET No. FP3

PLAN FILE No.

C:\Users\tayloryk\Documents\TEMPORARY – 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_P&Ps.dwg, 11/20/2020 12:44 PM





	2+260	2+280	2+300	2+320	2+340	2+360	2+380	2+400	2+420	2+440	2+460	2+480	2+500	2+520	2+540	2+560	2+580	2+600	2+620	2+640
STATION																				
SANITARY SEWER INVERT																				
STORM SEWER INVERT																				
C/L WATERMAIN ELEVATION																				

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0,5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

FANSHAWE PARK ROAD

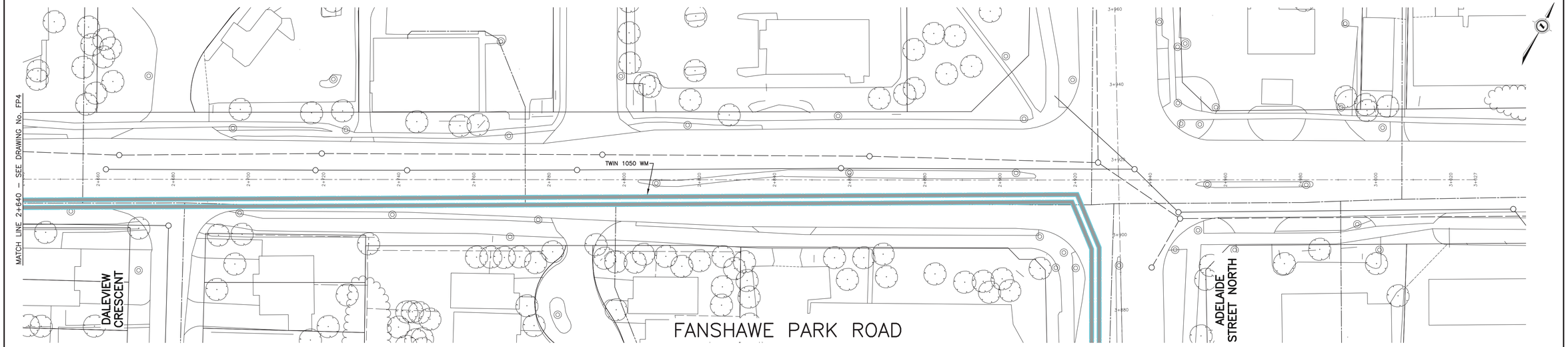
FROM 2+240 TO 2+640

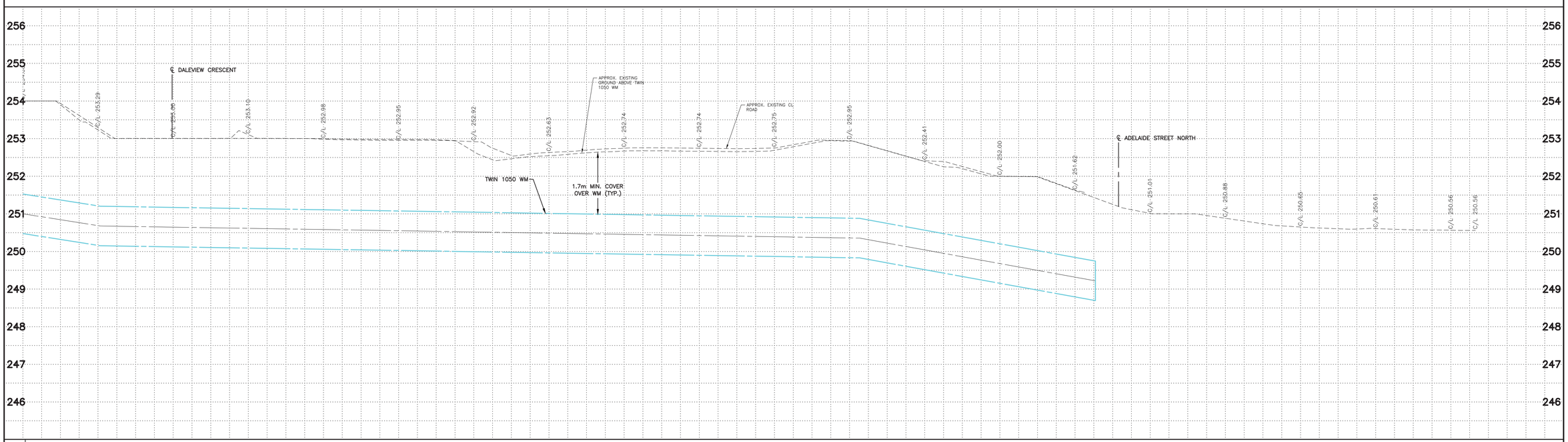
PROJECT No. 60619503

SHEET No. FP4

PLAN FILE No.

C:\Users\taylorA\Documents\TEMPORARY – 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_PlnPrf.dwg_11/19/2020 8:46 PM





C/L WATERMAIN ELEVATION																					
STORM SEWER INVERT																					
SANITARY SEWER INVERT																					
STATION	2+660	2+680	2+700	2+720	2+740	2+760	2+780	2+800	2+820	2+840	2+860	2+880	2+900	2+920	2+940	2+960	2+980	3+000	3+020	3+040	

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0,5 0 1m

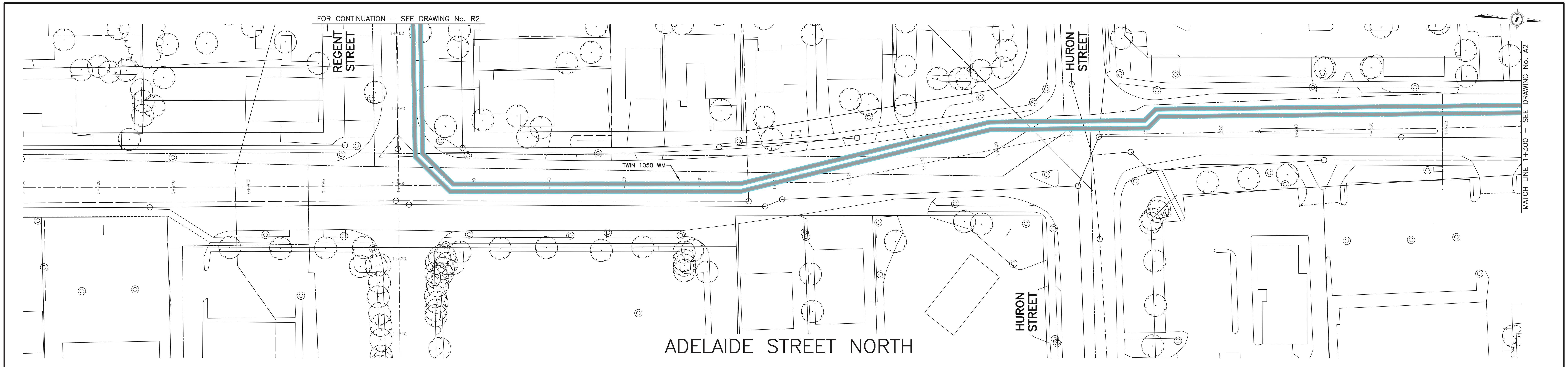
ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

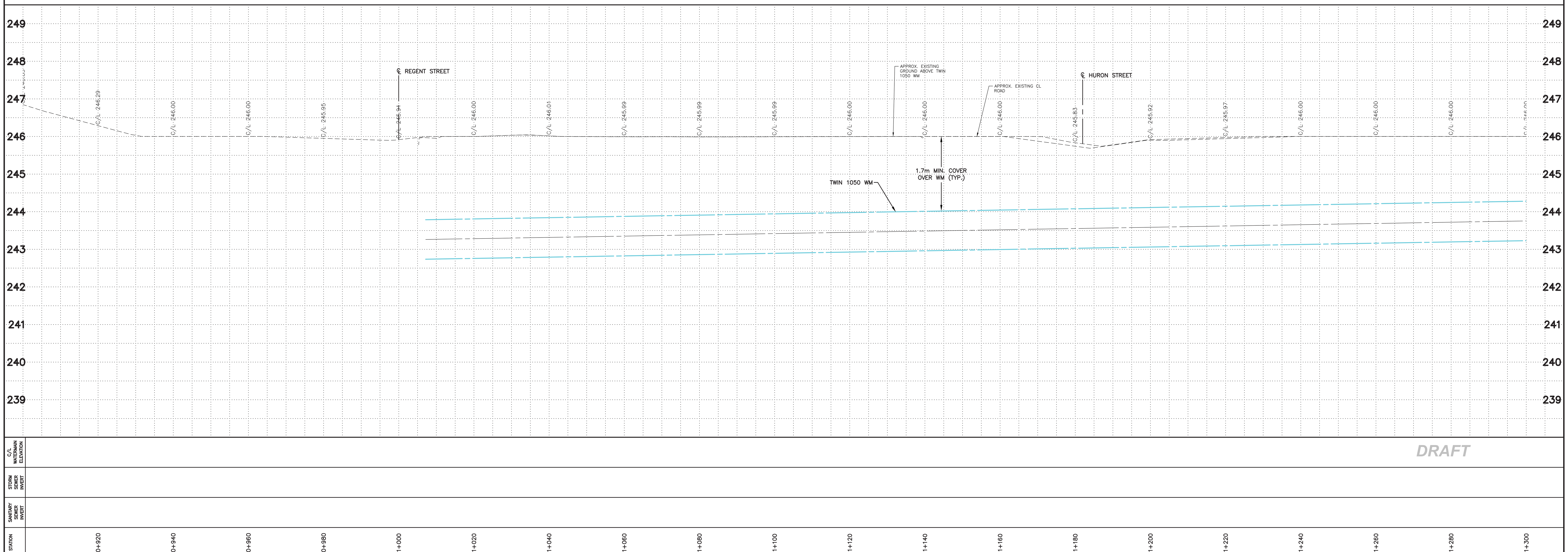
FANSHAWE PARK ROAD

FROM 2+640 TO ADELAIDE STREET NORTH

PROJECT No. 60619503
SHEET No. FP5
PLAN FILE No.

C:\Users\taylera\Documents\TEMPORARY – 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_P&Pfs.dwg_11/20/2020 12:44 PM





EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION	DETAILS		No.	REVISIONS	DATE	CONSULTANT
					DESIGN		1.	#	#	#
					DRAWN BY					
					CHECKED					
					APPROVED					
					DATE	JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

London CANADA
CORPORATION OF THE CITY OF LONDON

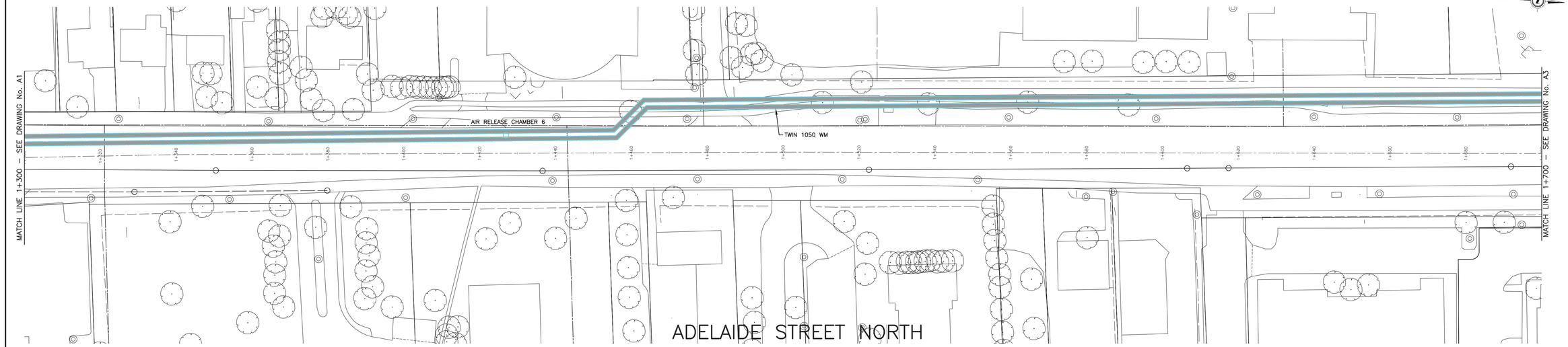
SCALE
HORIZONTAL SCALE – 1 : 500
5 0 10m
VERTICAL SCALE – 1 : 50
0.5 0 1m

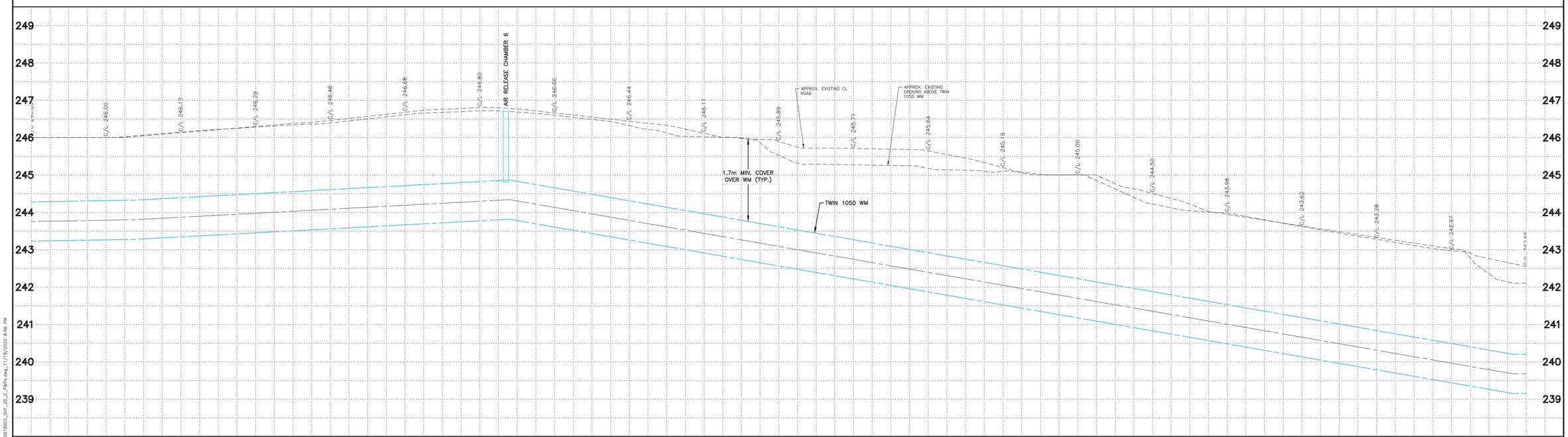
ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

ADELAIDE STREET NORTH

FROM REGENT STREET TO 1+300

PROJECT No. 60619503
SHEET No. A1
PLAN FILE No.





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION: 1+320 | 1+340 | 1+360 | 1+380 | 1+400 | 1+420 | 1+440 | 1+460 | 1+480 | 1+500 | 1+520 | 1+540 | 1+560 | 1+580 | 1+600 | 1+620 | 1+640 | 1+660 | 1+680 | 1+700

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE — 1 : 500
5 0 10m
VERTICAL
SCALE — 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

ADELAIDE STREET NORTH

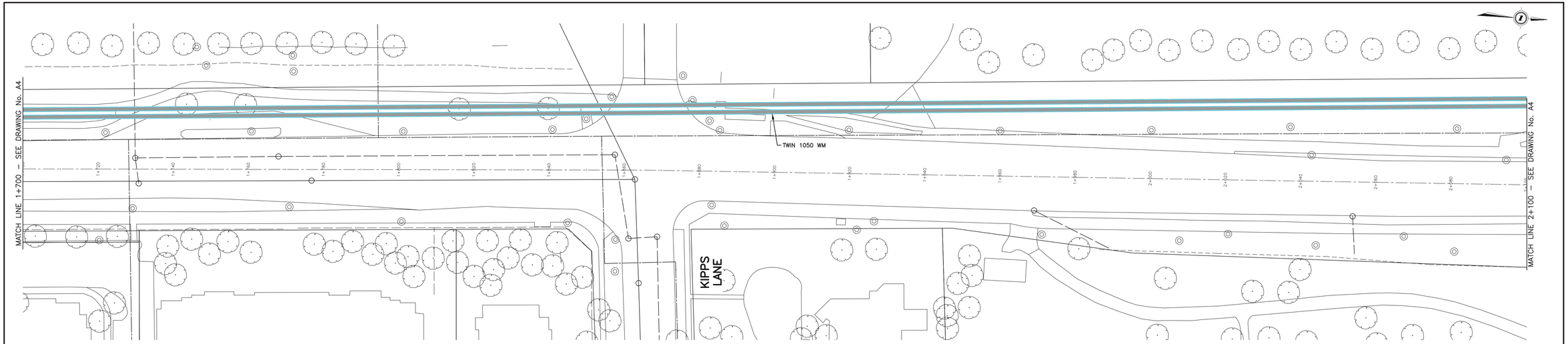
FROM 1+300 TO 1+700

PROJECT No. 60619503

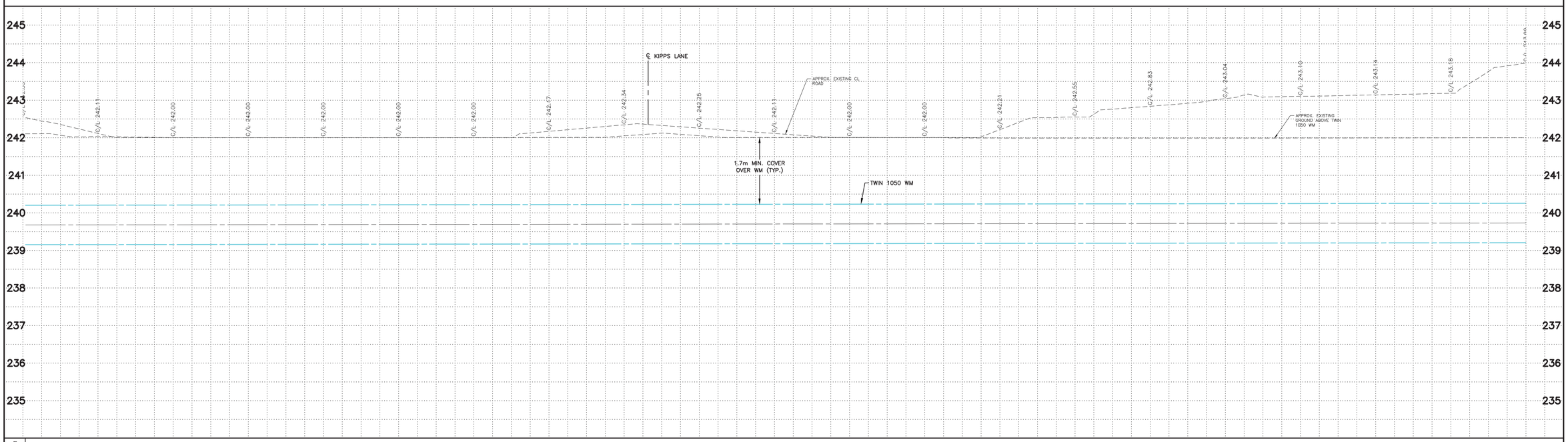
SHEET No. A2

PLAN FILE No.

C:\Users\tayloryk\Documents\TEMPORARY - 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_P&Ps.dwg, 11/19/2020 8:46 PM



ADELAIDE STREET NORTH



C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION	1+720	1+740	1+760	1+780	1+800	1+820	1+840	1+860	1+880	1+900	1+920	1+940	1+960	1+980	2+000	2+020	2+040	2+060	2+080	2+100

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

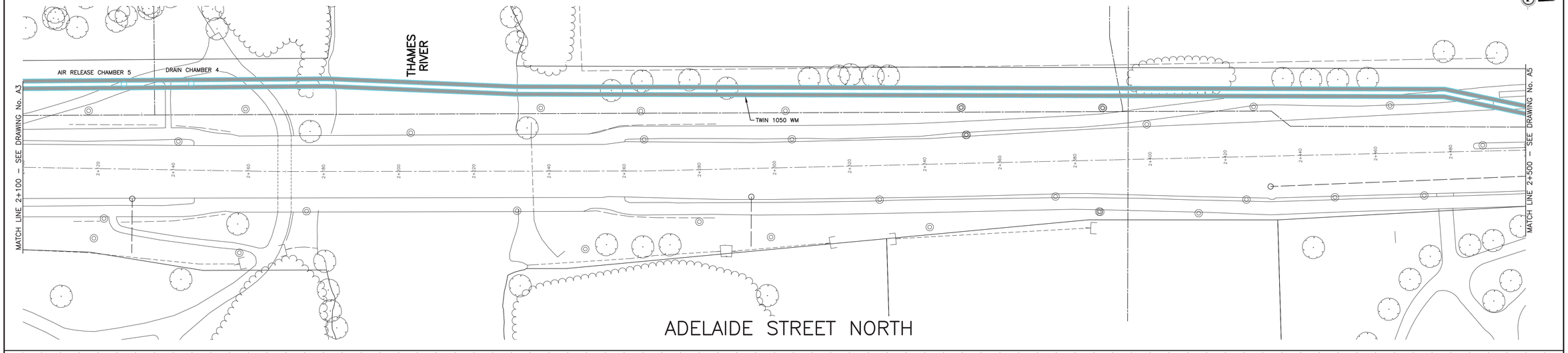
ADELAIDE STREET NORTH

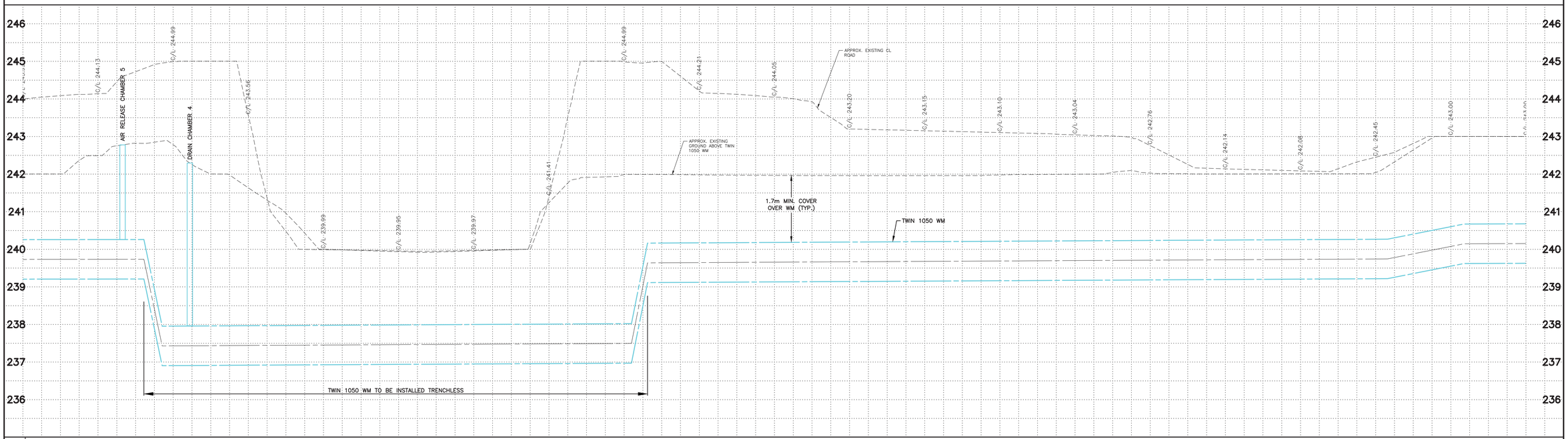
FROM 1+700 TO 2+100

PROJECT No. 60619503

SHEET No. A3

PLAN FILE No.





DRAFT

	2+120	2+140	2+160	2+180	2+200	2+220	2+240	2+260	2+280	2+300	2+320	2+340	2+360	2+380	2+400	2+420	2+440	2+460	2+480	2+500
STATION																				
SANITARY SEWER INVERT																				
STORM SEWER INVERT																				
C/L WATERMAIN ELEVATION																				

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0.5 0 1m

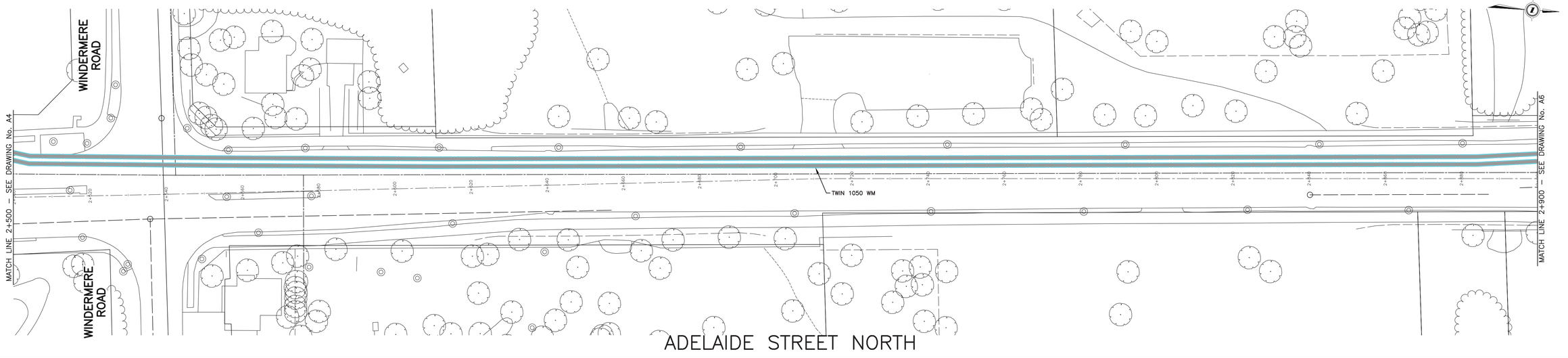
ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

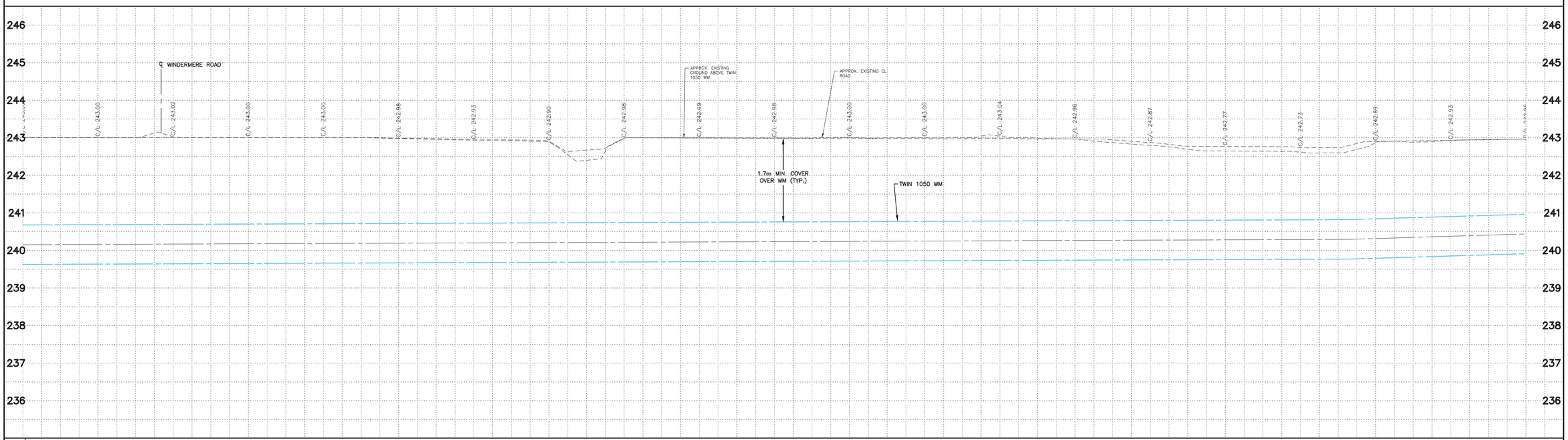
ADELAIDE STREET NORTH

FROM 2+100 TO 2+500

PROJECT No. 60619503
SHEET No. A4
PLAN FILE No.

C:\Users\tayloryA\Documents\TEMPORARY – 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_P&Pa.dwg, 11/26/2020 12:44 PM





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION: 2+520 2+540 2+560 2+580 2+600 2+620 2+640 2+660 2+680 2+700 2+720 2+740 2+760 2+780 2+800 2+820 2+840 2+860 2+880 2+900

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL SCALE — 1 : 500
5 0 10m
VERTICAL SCALE — 1 : 50
0,5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

ADELAIDE STREET NORTH

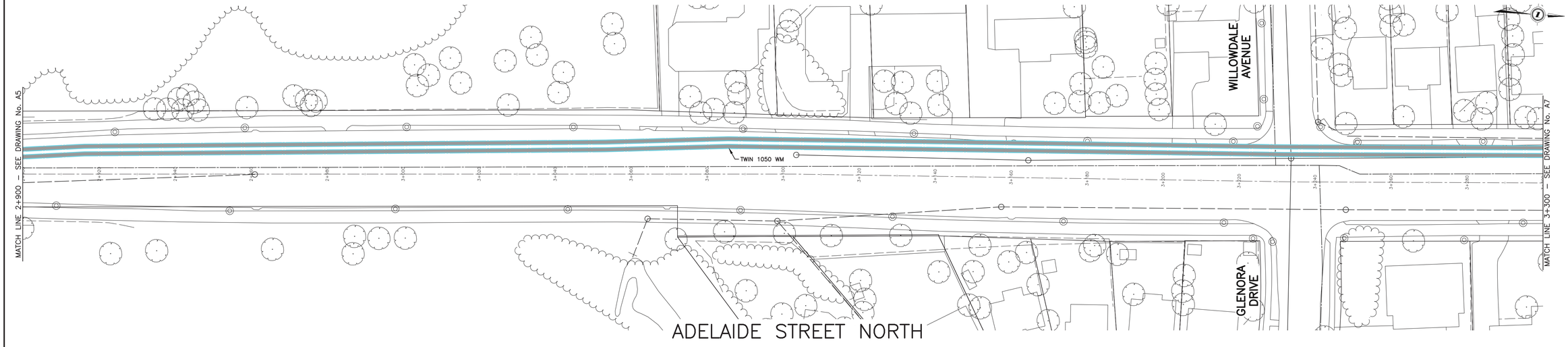
FROM 2+500 TO 2+900

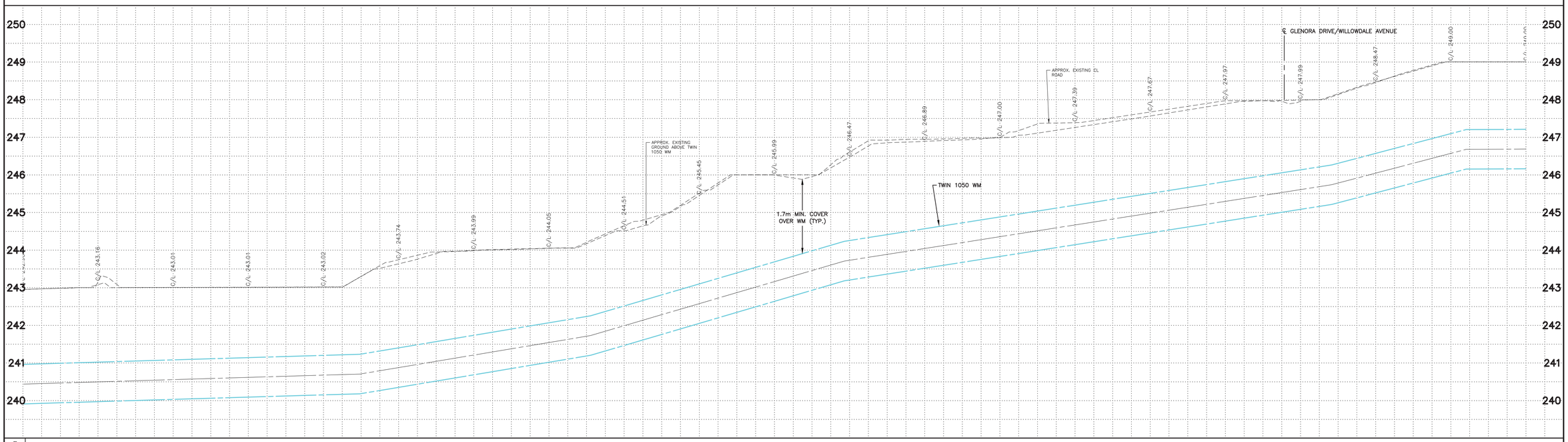
PROJECT No. 60619503

SHEET No. A5

PLAN FILE No.

C:\Users\taylorj4\Documents\TEMPORARY - 60619503 Arva WM\d10_CAD\20-SHEETS\C\60619503_SHT_20_C_PlanProfs.dwg, 11/19/2020 8:46 PM





DRAFT

	2+920	2+940	2+960	2+980	3+000	3+020	3+040	3+060	3+080	3+100	3+120	3+140	3+160	3+180	3+200	3+220	3+240	3+260	3+280	3+300
C/L WATERMAIN ELEVATION																				
STORM SEWER INVERT																				
SANITARY SEWER INVERT																				
STATION																				

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

ADELAIDE STREET NORTH

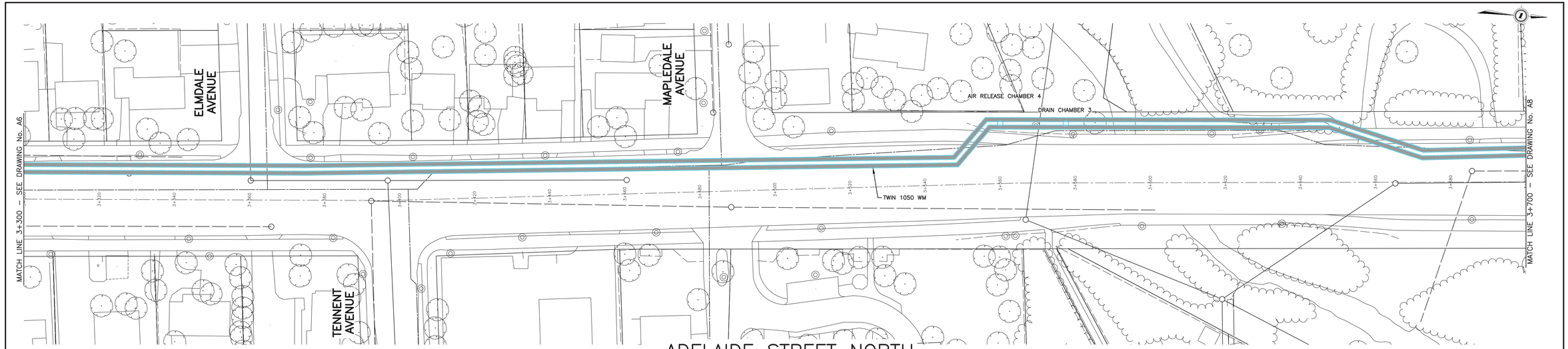
FROM 2+900 TO 3+300

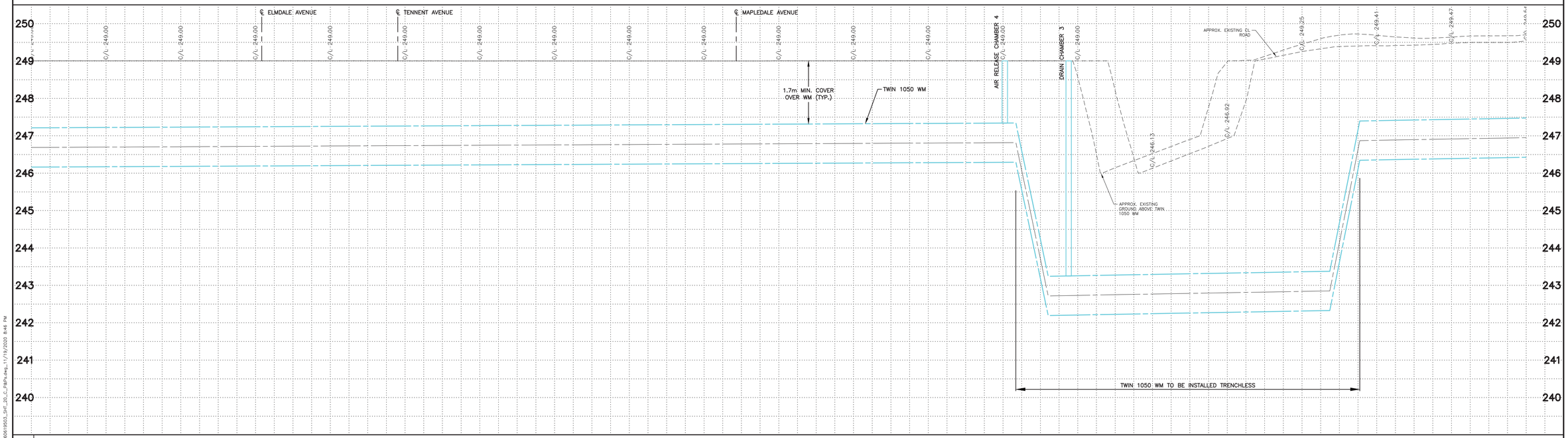
PROJECT No. 60619503

SHEET No. A6

PLAN FILE No.

C:\Users\toyoryr\Documents\TEMPORARY - 60619503 Arva WM\910_CAD\20-SHEETS\C\60619503_SHT_20_C_P&Ps.dwg, 11/19/2020 8:46 PM





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION 3+320 3+340 3+360 3+380 3+400 3+420 3+440 3+460 3+480 3+500 3+520 3+540 3+560 3+580 3+600 3+620 3+640 3+660 3+680 3+700

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE — 1 : 500
5 0 10m
VERTICAL
SCALE — 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

ADELAIDE STREET NORTH

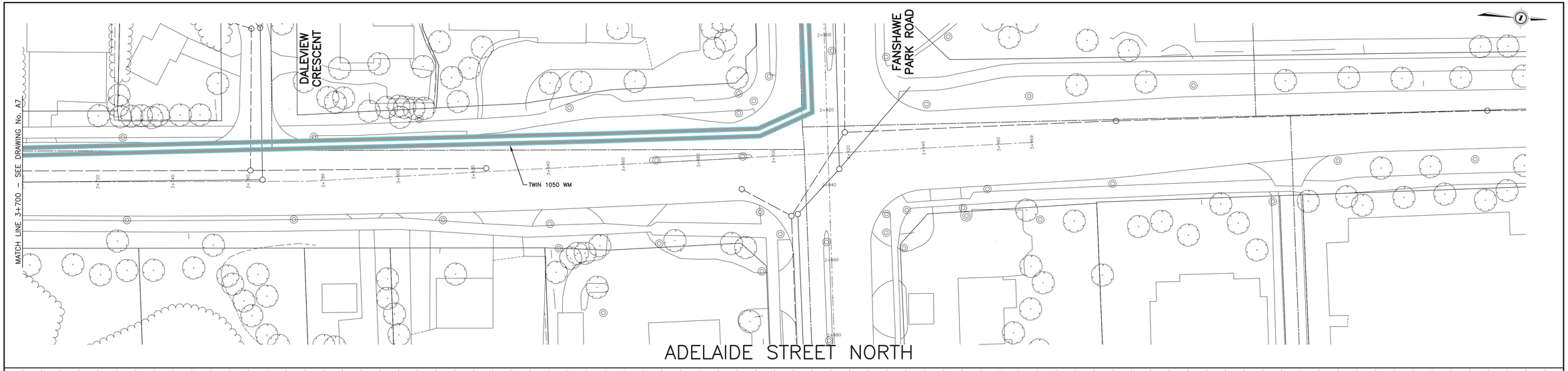
FROM 3+300 TO 3+700

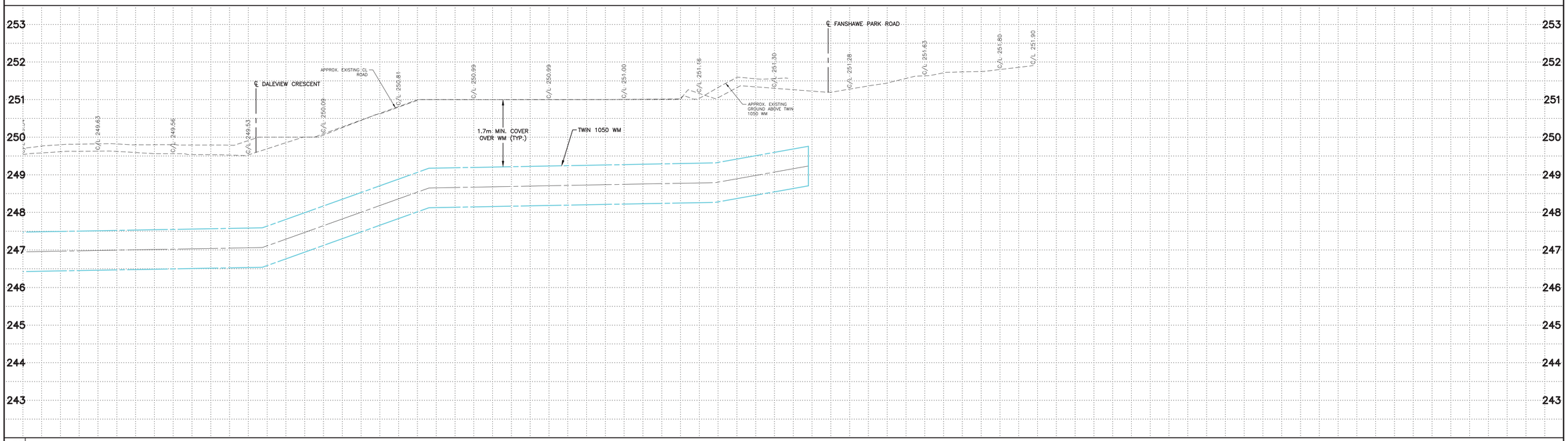
PROJECT No. 60619503

SHEET No. A7

PLAN FILE No.

C:\Users\vjoyce\Documents\TEMPORARY — 60619503 Arva WM\10_CAD\20-SHEETS\C\60619503_Shf_20_C_PAP4.dwg, 11/19/2020 8:46 PM





DRAFT

STATION	3+720	3+740	3+760	3+780	3+800	3+820	3+840	3+860	3+880	3+900	3+920	3+940	3+960	3+980
SANITARY SEWER INVERT														
STORM SEWER INVERT														
C/L WATERMAIN ELEVATION														

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL
SCALE – 1 : 500
5 0 10m
VERTICAL
SCALE – 1 : 50
0,5 0 1m

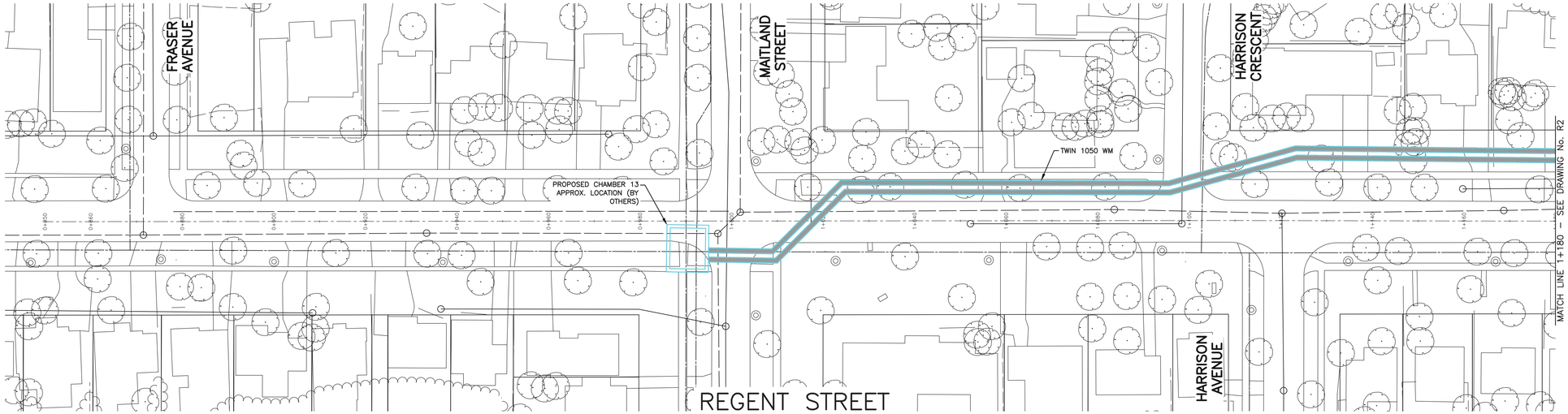
ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

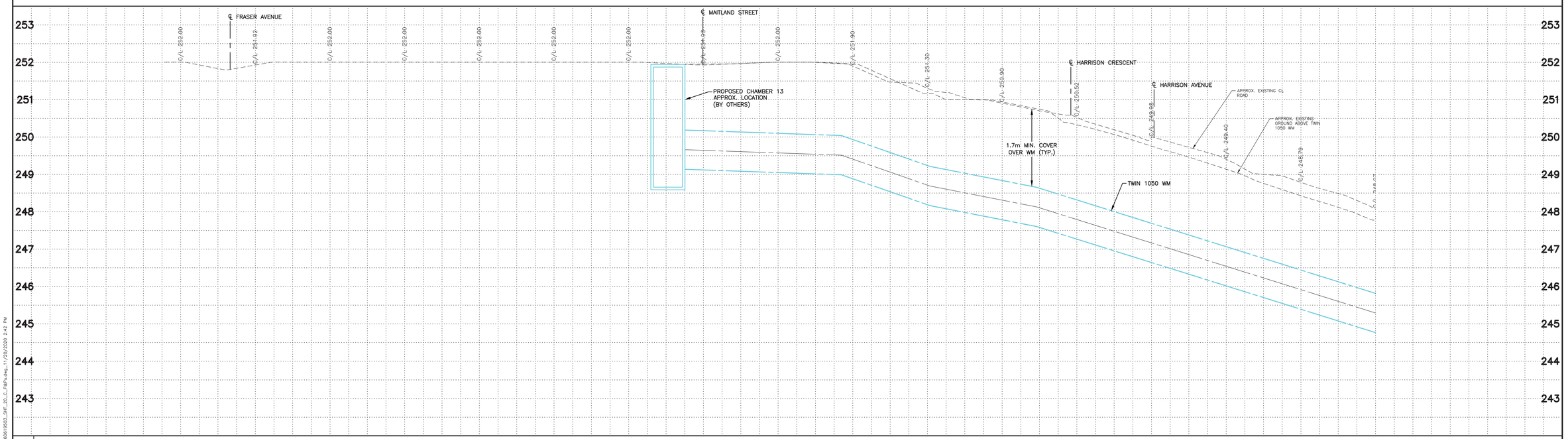
ADELAIDE STREET NORTH

FROM 3+700 TO FANSHAWE PARK ROAD

PROJECT No. 60619503
SHEET No. A8
PLAN FILE No.

C:\Users\taylorA\Documents\TEMPORARY - 60619503 Arva WM V10_CAD\20-SHEETS\C\60619503_SHT_20_C_PMH.dwg, 11/20/2020 12:44 PM





C/L WATERMAIN ELEVATION

STORM SEWER INVERT

SANITARY SEWER INVERT

STATION: 0+860 | 0+880 | 0+900 | 0+920 | 0+940 | 0+960 | 0+980 | 1+000 | 1+020 | 1+040 | 1+060 | 1+080 | 1+100 | 1+120 | 1+140 | 1+160 | 1+180

DRAFT

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL SCALE – 1 : 500
5 0 10m
VERTICAL SCALE – 1 : 50
0,5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

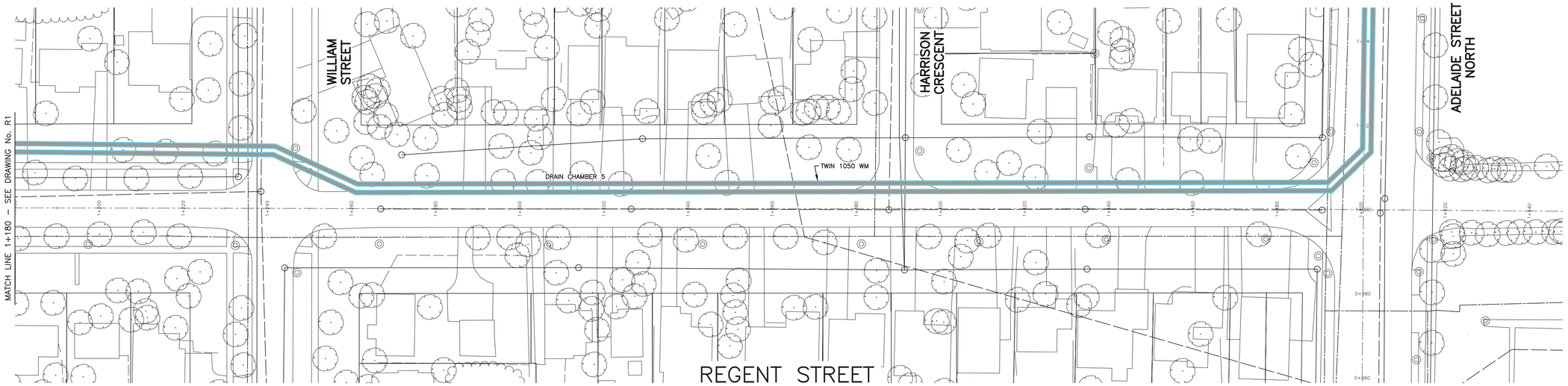
REGENT STREET

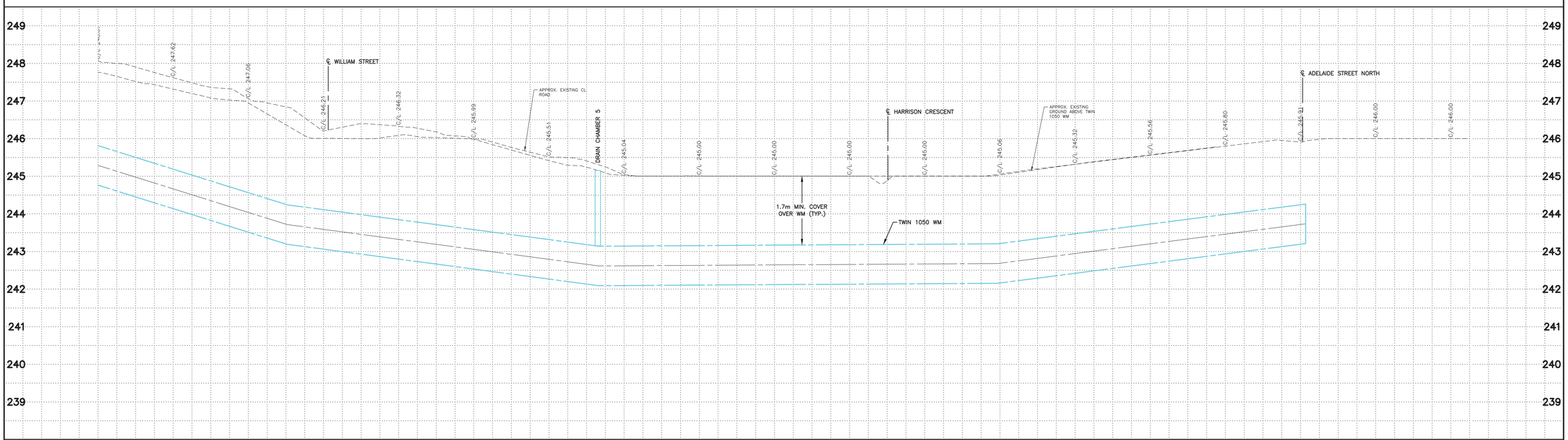
FROM FRASER AVENUE TO 1+180

PROJECT No. 60619503

SHEET No. R1

PLAN FILE No.





C/L WATERMAIN ELEVATION	DRAFT
STORM SEWER INVERT	
SANITARY SEWER INVERT	
STATION	1+180 1+200 1+220 1+240 1+260 1+280 1+300 1+320 1+340 1+360 1+380 1+400 1+420 1+440 1+460 1+480 1+500 1+520 1+540

EXISTING SERVICES	DRAWING #, SOURCE	DATE	AS CONSTRUCTED SERVICES	COMPLETION

DETAILS	No.	REVISIONS	DATE	CONSULTANT
DESIGN	1.	#	#	#
DRAWN BY				
CHECKED				
APPROVED				
DATE JAN. 2020				

CONSULTANT OR DIVISION

AECOM
London, Ontario
519.673.0510

ENGINEER'S STAMP

CORPORATION OF THE CITY OF LONDON
London CANADA

SCALE
HORIZONTAL SCALE – 1 : 500
5 0 10m
VERTICAL SCALE – 1 : 50
0.5 0 1m

ARVA PUMPING STATION TO HURON STREET WATER TRANSMISSION MAIN MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT MASTER PLAN

REGENT STREET

FROM 1+180 TO ADELAIDE STREET NORTH

PROJECT No. 60619503
SHEET No. R2
PLAN FILE No.

APPENDIX B

Costs Calculations

Probable Costs for a Single 1,050mm Trasnmission Main

Alternative 2 - Option A (Medway Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	4,525	$ 2,200	$ 9,955,000
1050 mm Transmission Main - Greenfield	m	5,375	$ 1,800	$ 9,675,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	18	$ 100,000	$ 1,800,000
Water Crossings - HDD - 1050	m	250	$ 10,000	$ 2,500,000
Construction Requirements	10%			$ 2,410,000
Engineering and Construction Contract Contingency	30%			$ 7,230,000
TOTAL ESTIMATED CONTRACT COST				**$ 34,000,000**

Alternative 2 - Option B (Sunningdale Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	4,540	$ 2,200	$ 9,988,000
1050 mm Transmission Main - Greenfield	m	2,100	$ 1,800	$ 3,780,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	14	$ 100,000	$ 1,400,000
Water Crossings - HDD - 1050	m	250	$ 10,000	$ 2,500,000
Construction Requirements	10%			$ 1,783,800
Engineering and Construction Contract Contingency	30%			$ 5,351,400
TOTAL ESTIMATED CONTRACT COST				**$ 25,000,000**

Alternative 2 - Option C (Fanshawe Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	3,995	$ 2,200	$ 8,789,000
1050 mm Transmission Main - Greenfield	m	920	$ 1,800	$ 1,656,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	10	$ 100,000	$ 1,000,000
Water Crossings - HDD - 1050	m	250	$ 10,000	$ 2,500,000
Construction Requirements	10%			$ 1,411,500
Engineering and Construction Contract Contingency	30%			$ 4,234,500
TOTAL ESTIMATED CONTRACT COST				**$ 20,000,000**

Probable Costs for Twin 1,050mm Trasnmission Mains

Alternative 2 - Option A (Medway Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	4,525	$ 2,200	$ 9,955,000
1050 mm Transmission Main Twin in same trench - with road restoration (paved)	m	4,525	$ 800	$ 3,620,000
1050 mm Transmission Main - Greenfield	m	5,375	$ 1,800	$ 9,675,000
1050 mm Transmission Main - Greenfield - Twin	m	5,375	$ 800	$ 4,300,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	36	$ 100,000	$ 3,600,000
Water Crossings - HDD - 1050	m	310	$ 10,000	$ 3,100,000
Water Crossings - HDD - 1050 - Twin	m	310	$ 10,000	$ 3,100,000
Construction Requirements	10%			$ 3,752,000
Engineering and Construction Contract Contingency	30%			$ 11,256,000
TOTAL ESTIMATED CONTRACT COST				**$ 53,000,000**

Alternative 2 - Option B (Sunningdale Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	4,540	$ 2,200	$ 9,988,000
1050 mm Transmission Main Twin in same trench - with road restoration (pave	m	4,540	$ 800	$ 3,632,000
1050 mm Transmission Main - Greenfield	m	2,100	$ 1,800	$ 3,780,000
1050 mm Transmission Main - Greenfield - Twin	m	2,100	$ 800	$ 1,680,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	28	$ 100,000	$ 2,800,000
Water Crossings - HDD - 1050	m	310	$ 10,000	$ 3,100,000
Water Crossings - HDD - 1050 - Twin	m	310	$ 10,000	$ 3,100,000
Construction Requirements	10%			$ 2,825,000
Engineering and Construction Contract Contingency	30%			$ 8,475,000
TOTAL ESTIMATED CONTRACT COST				**$ 40,000,000**

Alternative 2 - Option C (Fanshawe Connection)

Item	Units	Quantity	Unit Price	Total Price
1050 mm Transmission Main - with road restoration (paved)	m	3,995	$ 2,200	$ 8,789,000
1050 mm Transmission Main Twin in same trench - with road restoration (paved)	m	3,995	$ 800	$ 3,196,000
1050 mm Transmission Main - Greenfield	m	920	$ 1,800	$ 1,656,000
1050 mm Transmission Main - Greenfield - Twin	m	920	$ 800	$ 736,000
Connect to existing Twin lines	ls	2	$ 35,000	$ 70,000
Interconnecting Valve Chamber	ls	1	$ 100,000	$ 100,000
Air and Drain Valve Chambers	ea.	20	$ 100,000	$ 2,000,000
Water Crossings - HDD - 1050	m	250	$ 10,000	$ 2,500,000
Water Crossings - HDD - 1050 - Twin	m	310	$ 10,000	$ 3,100,000
Construction Requirements	10%			$ 2,214,700
Engineering and Construction Contract Contingency	30%			$ 6,644,100
TOTAL ESTIMATED CONTRACT COST				**$ 32,000,000**

AECOM CANADA LTD.
250 York Street, Suite 410,
London, ON, Canada N6A 6K2

519 963 5930 tel
519 673 5975 fax

Technical Memorandum

To:	Stephen Romano, P.Eng. Environmental Services Engineer	Page 1
CC	Aaron Rozentals, Jake Helm, John Haasen	
Subject	**City of London: Arva to Huron EA** **Technical Memorandum – Short Term Conceptual Design**	
From	Bander Abou Taka, P.Eng.	
Date	March 30, 2021	Project Number 60619503

1. Background

The City of London (City) retained AECOM to perform a Municipal Class Environmental Assessment Master Plan (MCEAMP) of a twinned 1,050 mm dia. Prestressed Concrete Cylinder Pipe (PCCP) transmission main from the Arva Pumping Station to Fanshawe Park Road, and a single 1,050 mm dia. PCCP transmission main between Fanshawe Park Road and Huron Street (Figure 1.1).

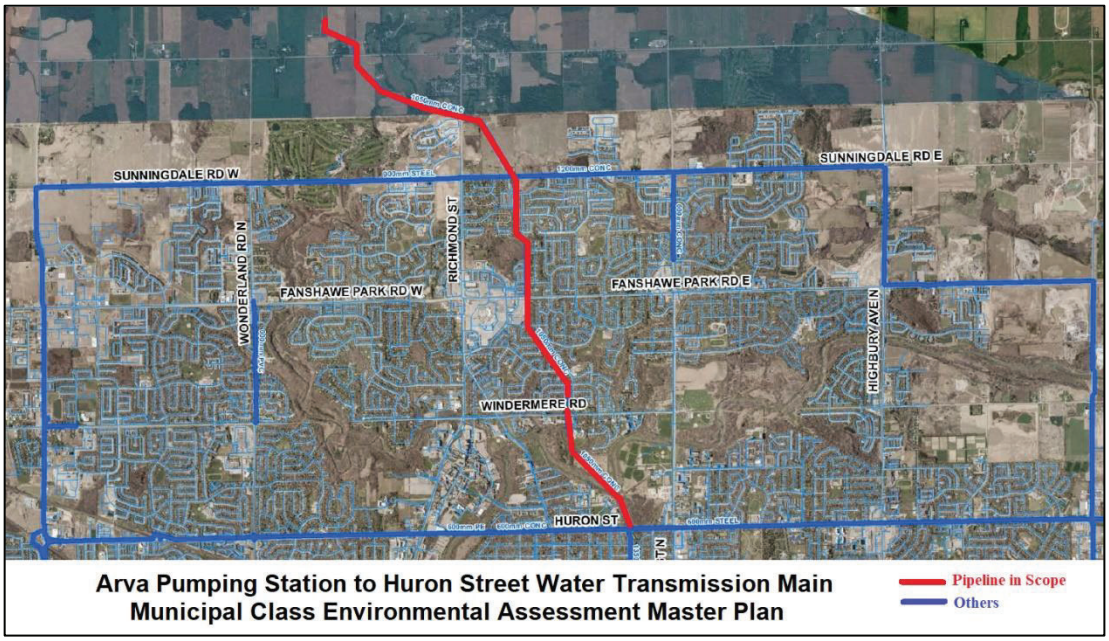


Figure 1.1 Arva to Huron Transmission Main

Several short-term maintenance and/or upgrade alternatives were included as part of the Environmental Assessment review including:

1- Alternative 1: Do Nothing, where the City would maintain current operations, monitoring, and spot repairs with no planned improvements;

2- Alternative 2: Maintain the current legal easements and ensure access is maintained for ongoing maintenance and monitoring, and proactive and/or emergency repairs when needed. Widening of the easements was not considered as part of this alternative. However, the City would acquire land to increase easement width, where appropriate, and when an opportunity arises; and
3- Alternative 3: Widen the existing easement to greater than 15m up to 30m, where possible to allow for easier maintenance, monitoring and repair access using conventional construction methods.

Alternative 2 was identified as the preferred alternative and is the basis for the conceptual design discussed in this technical memorandum.

2. Short Term Strategies

2.1 *Required Actions*

The regular inspection and maintenance of transmission main chambers, valves and associated appurtenances are essential components of transmission main management. The strategic closure of one or more transmission main valves in the event of a transmission main failure is necessary to ensure an efficient response to stop the flow of water. Therefore, valve condition and operation is critical. Regular clearing of access routes and the interior clearing of accumulated debris associated with each chamber can improve response times during a failure. Routine inspection and maintenance of transmission main chambers are proactive measures to ensure peak performance and the level of service of the transmission main and its associated components.

It is recommended that the City continue to, or implement the regular inspection and maintenance programs listed in **Table 2.1**.

Table 2.1: Inspection, Maintenance and Monitoring Activities

Action	Frequency	Comment
Inspection and Maintenance of Valves and Chambers	Annual	From a Levels of Service (LoS) measure, inspection and maintenance of valves and valve chambers is required to avoid impacts to the loss of physical integrity of the chamber and valves. This includes replacing damaged valves, chamber cleaning where required, missing air vents, minor rehabilitation of chambers, etc. 100% of the valves and chambers should be inspected/maintained annually.
Soil Sampling and Testing of ground near transmission mains, including coring into ground, sample collection, and laboratory testing.	Every 15 Years	Reduced resistivity of soil is one of the contributing factors to increased deterioration of PCCP. Due to de-icing, chloride levels may elevate and would further decrease the resistivity levels. Therefore, understanding the soil characteristics on a frequent basis would provide additional insights for interventions.
Test Pits to inspect the surface of the transmission main, and excavating to the transmission main and inspecting the surface of the concrete pipe for signs of pitting, cracking or damage.	Every 15 Years	Test pits would offer direct information about the condition of the pipe, depending on the type of examination. Joints in corrosive soils should be monitored at a certain frequency to understand the level of intervention.
Free-Swimming EM tool or Pipe Diver tool to inspect the inside of the transmission main for damage while the line is in service	Every 15 Years	The City currently monitors the pipeline using Acoustic Fiber Optics (AFO) technology that provides an estimated location for wire breaks in the concrete piping. It is recommended to deploy a Free-Swimming EM or Pipe Diver tool to inspect the inside of the pipeline and provide a baseline of the state of the pipeline.

Action	Frequency	Comment
Repair of Joints	Based on Assessment	Joints are mostly assessed based on the above internal or external examinations. The deterioration of joints is hardly captured by EM technologies. The impact of soil envelope may increase the degradation level of joints.

To be able to conduct the above inspections and maintenance activities, access to the transmission main and valve chambers, along the transmission mains route, would need to be provided by all property owners, as per the rights and privileges granted to the City and as stated in the Easement Agreements attached to each property.

2.2 *Access Requirements & City Rights*

The easement agreements for the transmission main entitle the City to the following rights on each property:

At any time and from time to time, to lay, install, construct, reconstruct, operate, maintain, open, inspect, pair and keep in good condition, remove, replace, relocate and supplement not more than one water main including all accessories, equipment and appurtenances necessary or incidental thereto, any of which shall be located underground at a depth of not less than four feet below grade level, and valve chambers, vent pipes and marker posts on the surface and/or underground, the valve chambers to be located on that part of the said easement lying south of Fanshawe Park Road at the locations indicated in yellow on the said attached plan of survey, and which said chambers shall not extend above the surface of the ground more than two feet nor have a surface area in excess of twenty-five square feet.

To keep the said lands, clear of brush, trees and other obstructions of any nature whatsoever as may be necessary to the exercise and for the enjoyment of the said rights and easements.

To enter upon the said lands and pass and repass from time to time and at all times with the servants, agents, contractors, workmen of and other persons duly authorized by The Corporation of the City of London with all plant, machinery, material, vehicles and equipment as may be necessary for the purposes necessary or incidental to the exercise and for the enjoyment of the said rights and easements.

To erect such gates as the said Corporation may from time to time consider necessary.

The owner of the property has the following right:

The owner of the said lands otherwise to have the right fully to use and enjoy the said lands except as may be necessary for the said rights and easements provided no person shall excavate, drill, install or erect thereon, any pit, well, foundation, pavement, building or other structure or installation without the consent in writing of the said Corporation.

2.3 *Strategies to Access Private Properties*

Depending on the site conditions, access will be necessary to maintain valve chambers, and for rapid repairs on piping, chambers, and other infrastructure along the transmission mains in the event of a failure. This requirement will necessitate coordination with property owners to allow City crews and/or their representatives immediate access when required. It is recommended that the City issue notifications to property owners where the existing easement is located to allow them time to make changes to their property to accommodate the City's needs and requirements per the easement rights. Three levels of notifications are proposed:

1- **Level 1 - Low risk**: For property owners with a low risk designation, a notice should be sent advise property owners that City owned infrastructure is located on their property, that is not critical at this stage but may require City to inspect or access, if required. The notice should also recommend

changes to properties to facilitate access to City owned infrastructure, within reason. Low level risk means that a failure of the main on the property would likely cause minimal damage. These sites also provide rapid access to City crews for repairs or inspections. Refer to **Figures 2.1 to 2.4** for locations of Level 1 properties within the existing easement. An example of Level 1 properties include a property with no valve chambers, non-fenced areas with little to no obstacles within the City's easement, property on City owned land, or property that the City's crews can access immediately with minimal obstacle removal to excavate and repair damaged transmission mains. The City is not obligated to repair or compensate owners for any damages caused by removing obstacles within the City's easement, if any. **Appendix A** provide a sample letter that could be provided to Level 1 property owners.

2- **Level 2 - Medium risk**: For property owners with a medium risk designation, a notice should be sent advising property owners that city owned infrastructure is located on their properties, that are important for the City to have access to for inspections and/or repairs. The notice should advise them to relocate or remove obstacles to facilitate access to City owned infrastructure. The letter would include a warning that damage to property may occur if City infrastructure malfunctions and requires immediate repair, and if repairs and emergency work are required, the City has the right to remove obstacles to repair infrastructure. The City is not obligated to repair or compensate owners for any damages caused by these actions. Refer to **Figures 2.1 to 2.4** for locations of Medium risk or Level 2 properties. An example of a Level 2 property is one that has an air valve chamber on it with access required for City crews to inspect or repair. **Appendix A** provide a sample letter that could be provided to Level 2 property owners.

3- **Level 3 - High risk**: For property owners with a high-risk designation, a notice should be sent advising property owners that city owned infrastructure is located on their properties, that are critical for the City to have access to for routine inspections and/or repairs. The notice should be sent to require homeowners to make immediate changes to their properties to facilitate access to high risk infrastructure, such as major drain chambers or air valve chambers. The letter should include a warning with a deadline to comply with the required changes. If repairs and emergency work is required, the City has the right to remove obstacles to repair or replace infrastructure. The City is not obligated to repair or compensate owners for any damages caused by these actions. Refer to **Figures 2.1 to 2.4** for locations of Level 3 properties. An example of a Level 3 property includes properties with critical valve chambers that require regular maintenance and inspections to ensure the valves are operating adequately. **Appendix A** provide a sample letter that could be provided to Level 3 property owners.

Following any repairs, the City will reinstate areas to previous condition or better, minus any manmade or natural obstacles within the City's easement. These will not be repaired or replaced. Any obstacle outside the easements where the City required its removal to facilitate access or repairs, would be repaired, replaced or compensated to the owner.

Legend

- Existing Transmission Main
- Existing Watermains
- Existing Valve Chambers
- High Risk Area
- Medium Risk Area
- Low Risk Area

N

0 125 250 500
Metres

City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

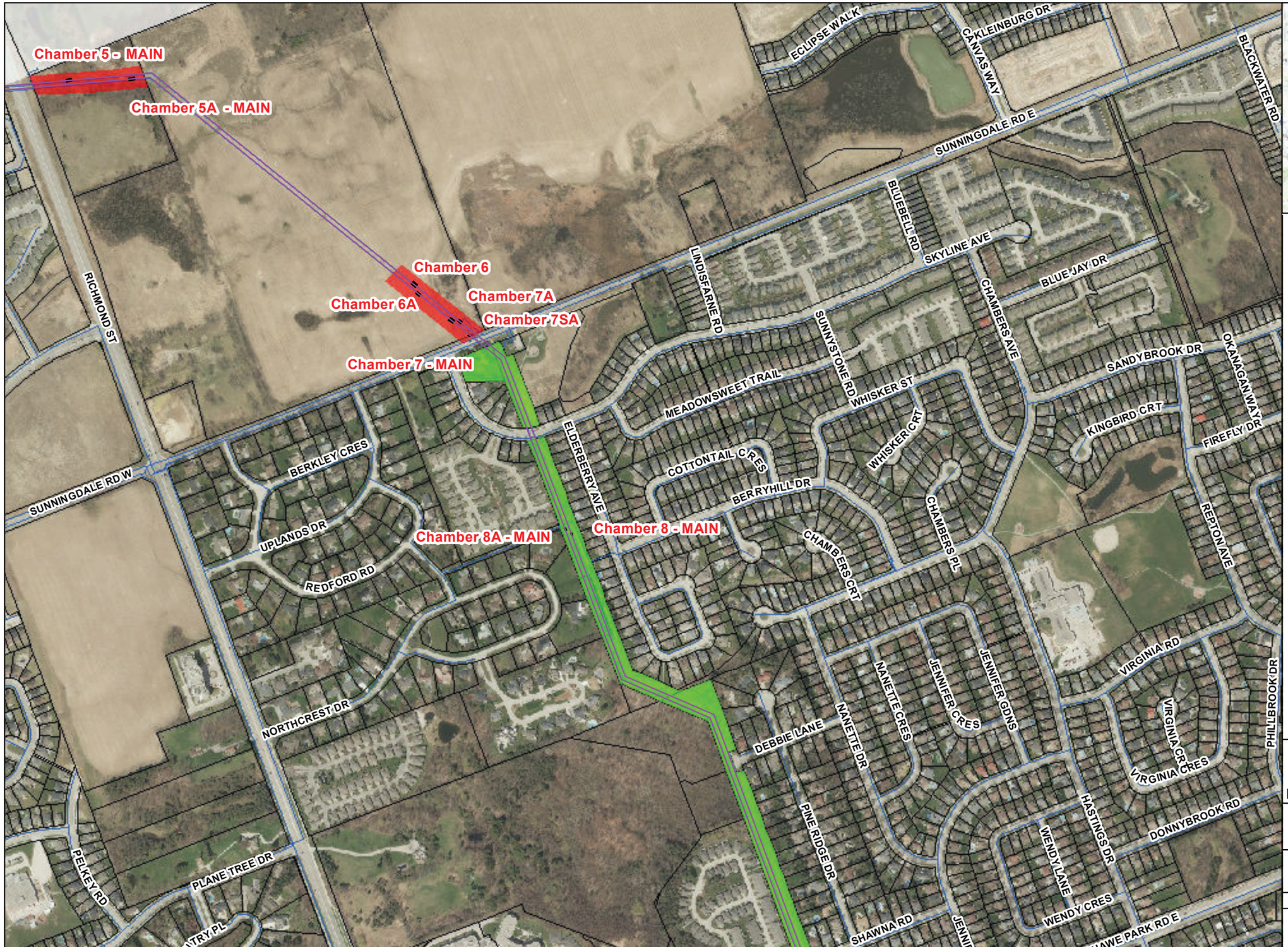
Short Term Alternative Solutions

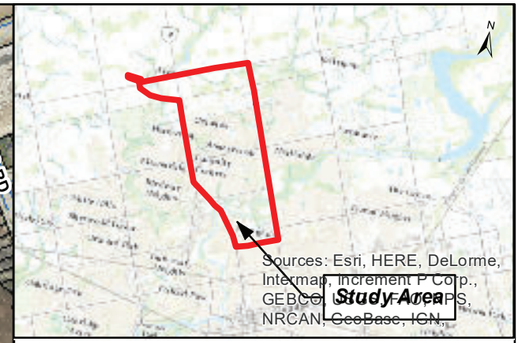
December 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 2.1

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 12/17/2020 11:25:40 AM User Name: Adamsp1





Legend

- Existing Transmission Main
- Existing Watermains
- Existing Valve Chambers
- High Risk Area
- Medium Risk Area
- Low Risk Area

N

0 125 250 500
Metres

City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

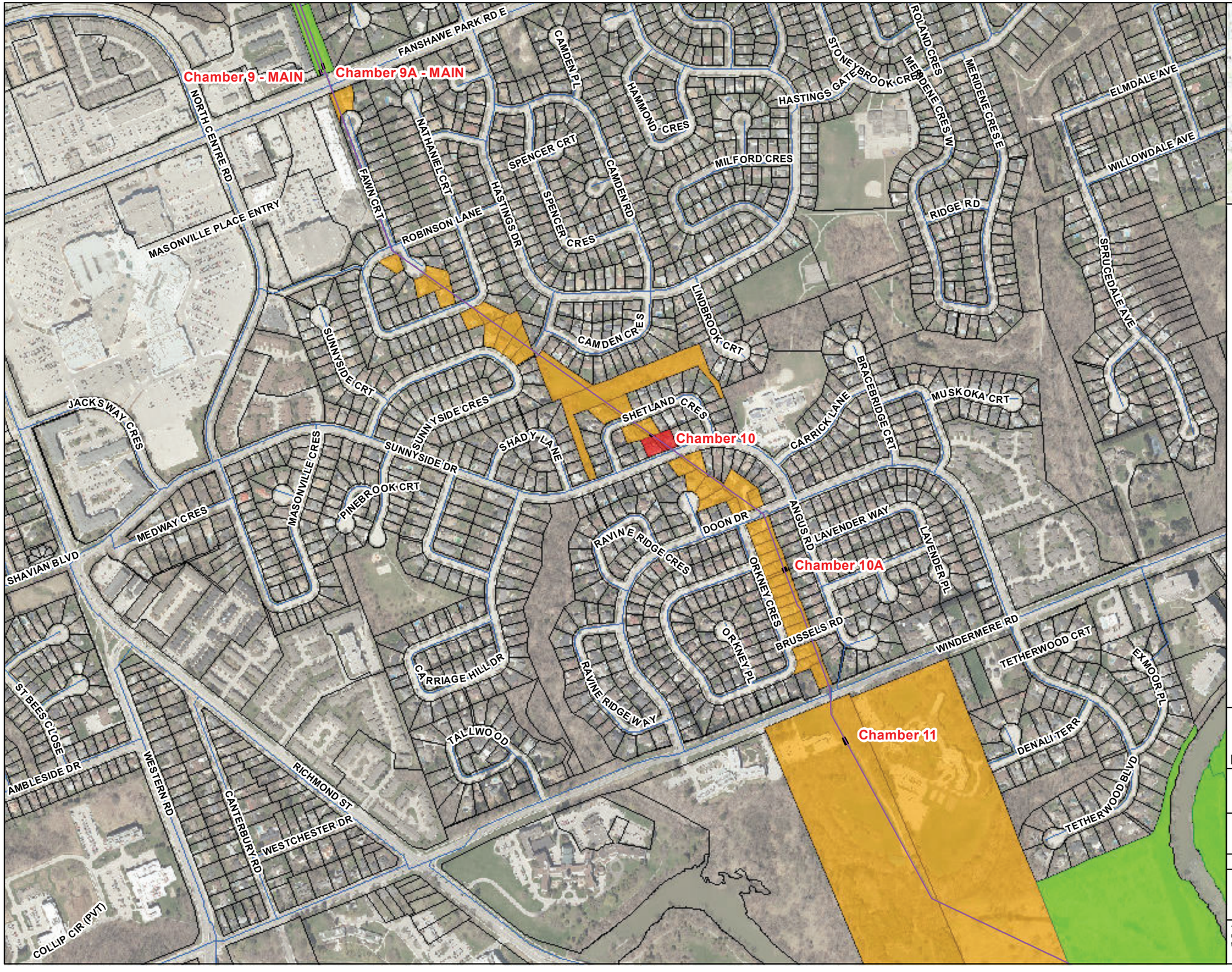
Short Term Alternative Solutions

December 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 2.2

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 12/17/2020 11:23:40 AM User Name: AdamsP



City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

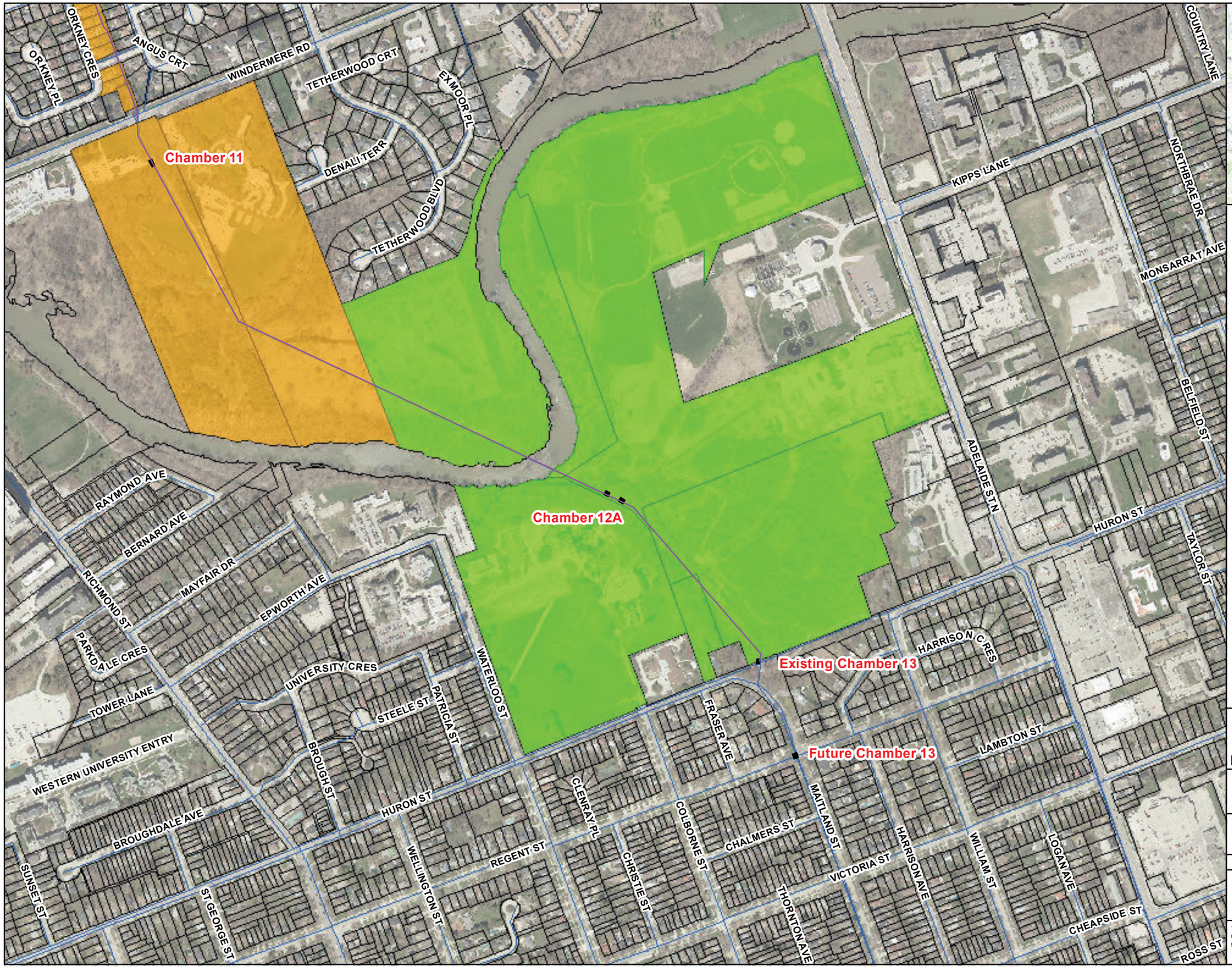
Short Term Alternative Solutions

December 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 2.3

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 12/17/2020 11:25:40 AM User Name: AdamsP1



City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

Short Term Alternative Solutions

December 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 2.4

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 12/17/2020 11:25:40 AM User Name: AdamsP1

3. Easement Review & Recommendation

The easement was reviewed from the Arva Pumping Station to Chamber 13 near Huron Street. The following **Tables 3.1, 3.2 and 3.3** provide an overall review of the infrastructure reviewed, recommended changes on private properties and the level of risk rating assigned to the required or recommended changes. **Figures 3.1 to 3.5** provide mapping to support the tables.

Table 3.1: Arva Pumping Station to Sunningdale

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Twinned transmission mains from Arva Pumping Station to Sunningdale Rd.	The twinned line is located on farmland, county roads, and forested areas. Refer to Figure 3.1 A, B, C, and D: in some areas, the twinned mains appear to be near or under mature trees. The trees are also within the City owned easement.	Low	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chambers 1 and 1A	Chamber 1 and 1A are drain chambers located on farmland. There is access to these two chambers on a dirt access road through the landowner's land.	Low	Maintain access and clear bushes on a regular basis. Inspect chambers and replace valves when required.
Chambers 2 and 2A	Chamber 2 and 2A are air valve chambers. There is no developed access road to the chambers on farmland.	Low	Maintain access and clear bushes on a regular basis. Inspect chambers and replace valves when required. Consider constructing a gravel access road, within the easement with owner approval, to facilitate access by City operators.
Chambers 3 and 3A	Refer to Figure 3.1 B: Chambers 3 and 3A are drain valves chambers. Chamber 3A appears to be near mature trees. The trees are also within the City owned easement. There is no developed access road to the chambers on the farmland.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required. It is difficult to construct a new access road at this location.
Chambers 4 and 4A	Chambers 4 and 4A are air valve chambers, located near a drainage pond on the Sunningdale Gold Course. There is an access road to this site from Richmond Street.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.
Chambers 5 and 5A	Refer to Figure 3.1 C: Chambers 5 and 5A are	Low	Maintain access, and clear bushes as required during specific times of the year to

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	drain chambers in a swampy area. These two chambers are located within a Provincially Significant Wetland (PSW). The trees and brushes are within the City owned easement. There is non paved access to this site from Richmond Street.		minimize disruption to animals and bird habitats. Clearing of trees and brushes should be minimized and limited to where the chambers are located and to provide a vehicle access only. Avoid removal of brushes and trees between the two chambers. Inspect chambers and replace valves when required.
Chambers 6 and 6A	Refer to Figure 3.1 D. Chambers 6 and 6A are critical air valve chambers. There is thick bus near and around the chambers. No developed access road to the chambers on farmland.	High	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required Consider constructing a gravel access road, within the easement with owner approval, to facilitate access by City operators.
Chambers 7 and 7A	Refer to Figure 3.1 D. Chambers 7 and 7A are drain valve chambers There are thick bushes near and around the chambers. There is access to these chambers from Sunningdale Rd.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.
Chamber 7SA	Refer to Figure 3.1 D. Chamber 7SA is an air valve chamber. There are some thick bushes near and around the chamber.	Low	Maintain access and clear bushes on regular basis. Inspect the chamber and replace the valve when required.

Table 3.2: Sunningdale to Fanshawe Park Rd.

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Twinned transmission mains from Sunningdale Rd. to Fanshawe Park Rd	Refer to Figures 3.2 A, B C and D. The twin transmission mains are in a developed area, with several mature trees, hedges and fences within the easement and near the transmission mains. The trees are also within the City owned property	Low.	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chambers 8 and 8A	Refer to Figure 3.2 C. Chambers 8 and 8A are air valve chambers located in a park like setting with mature	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	trees and bushes near the chambers		
Chambers 9 and 9A	Refer to Figure 3.2 F. Chamber 9 is an air and drain valve chamber with a check valve, and chamber 9A is an air valve chamber. Chambers are located at the end of a popular walkway next to Fanshawe Park Rd. This area is accessible to the City and the general public.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required. Consider constructing fencing or adding removable barricade or bollards to protect City infrastructure and prevent the public from parking on top of the chamber covers.

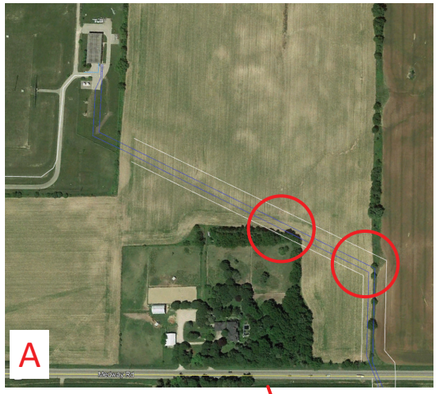
Table 3.3: Fanshawe Park Rd. to Huron Street

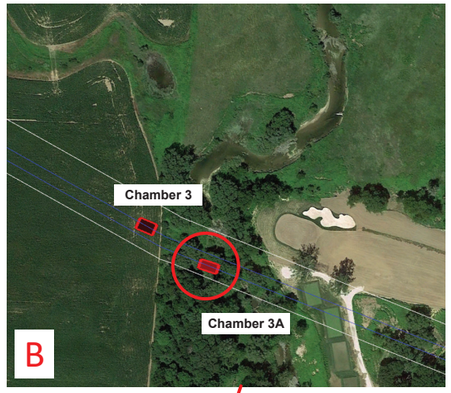
Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Single transmission main from Fanshawe Park Rd. to Huron St.	Refer to Figures 3.3, 3.4 and 3.5. The transmission main is located in a highly developed area, with several mature trees, hedges and fences within the easement and near the transmission main. There are several manmade and natural obstacles near or on top of the transmission main and the valve chambers within the easement. Some areas have limited or no direct access by City crews or their representatives.	Low to High	Depending on the area, it is recommended to review the site and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access. New gates or removable fence sections in existing fencing are required in some areas to allow for chamber access. Refer to figures for locations and examples as to what may be involved to address
	Refer to Figure 3.3 A. The transmission main enters 58 Fawn Crt. property from the north underneath a prefabricated concrete fencing structure and exits south of the property under a wooden fence. The pipeline continues on Fawn Ct. underneath the road right of way to Robinson Ct.	Medium	Recommend installing gates or removable fence sections on both the north and south end of the property to facilitate access to the transmission main in case of repairs. Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
	Refer to Figure 3.3 B. The transmission main enters and exists several properties through Robinson Ct.: 19 Robinson Crt., 79 Robinson	Medium	Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties. Recommend

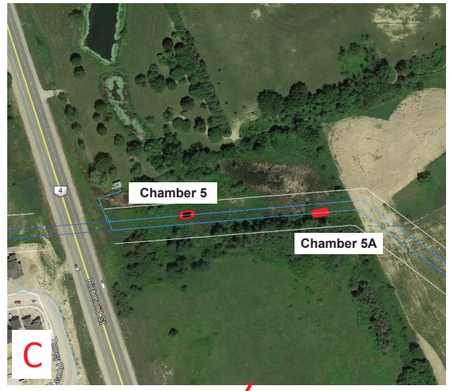
Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	Lane, and 83 Robinson lane. Several manmade and natural obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement.		reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
	Refer to Figure 3.3: Transmission main continues through several properties on Robinson Lane and Sunnyside Cres.: 100 and 104 Robinson Lane, 440, 444, 448, and 452 Sunnyside Cres., then enters Camden Cres. Park towards homes on Shetland Cres.	Medium	Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties. Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chamber 10	Refer to Figure 3.3 C. The transmission main enters and exists several properties: 27 Shetland Cres., 18 Shetland Cres., 186, and 190 Sunnyside Drive. Several manmade and natural obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement. Chamber 10 is a drain chamber located on 186 Sunnyside Drive property. There is access to this chamber for inspections and repairs through the homeowner's fence. There is a large playset and a shed near the chamber and the transmission main. The City owns an easement next to this property as shown on the Figure.	High	The drain chamber is a low spot in the transmission main and would cause major damage to property and infrastructure in case of damage or a break in the line, or the valve in this location. The City is considering abandoning this chamber and constructing an alternative on Shetland Crescent, or Sunnyside Drive. In the meantime, it's highly recommended to remove all obstacles within the easement around the chamber. There is an existing maintenance easement to access the property from Sunnyside Drive, and a small gate into the property. It's recommended to widen the gate to allow for City maintenance trucks to enter the property when required for repairs. Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties
	Refer to Figure 3.4 A. The transmission main enters and exists several properties between Sunnyside Drive and Windermere Rd.: 199, 203 Sunnyside Dr., 27 Caithness Crt., and 126 Doon Dr. Several manmade and natural	Medium	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.

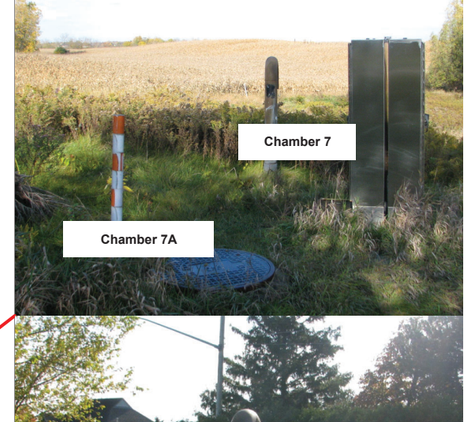
Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement.		
Chamber 10A	Refer to Figure 3.4 Transmission main continues between Doon Dr and Windermere Rd through several properties on Orkney Cres., and Windermere Rd: 127,131,139, 143, 147, 151, 155, 159, 163, 167, 171, 175, 179 Orkney Cres., and 542 Windermere Rd. Refer to Figure 3.4 B. Chamber 10A is an air release chamber located on 163 Orkney Cres. The City owns an easement on the property to access the chamber going through the south end of the property.	Medium	Recommend removing all obstacles around the chamber within the easement and widen the existing gate in the fencing for the 163 Orkney Cres. property, where Chamber 10A is located to allow City maintenance trucks to enter the property when required for repairs.
Chamber 11	Refer to Figure 3.5. Chamber 11 is an air and drain valve chamber with access through Scouts Canada.	Medium	Recommend removing all obstacles around the chamber within the easement and continue to inspect and maintain the valves and chamber.
Chambers 12 and 12A	Refer to Figure 3.5. Chamber 12 is a drain valve chamber, and Chamber 12A is an air valve chamber with access from the trail system behind St. Peter's Seminary through City parks. A short section of the main enters and exists the north end corner of the property on 430 Huron Street. This area is relatively dense with mature trees and close to the City parks.	Low	Chambers are within City owned lands and the easement and can be accessed without the need to access private property. Recommend maintaining access and clear bushes on regular basis. Inspect chambers and replace valves when required. Where the main enters the property on 430 Huron Street, the City should consider obtaining a working easement in that section to facilitate any repairs to the main. The City can access that section of the main from the east through City owned parks.
Chamber 13	Refer to Figure 3.5: Chamber 13 is a drain and a distribution chamber with unobstructed access to City staff.	Low	Chamber is within City ROW and easement and can be accessed without the need to access private property. This chamber will be replaced in 2021

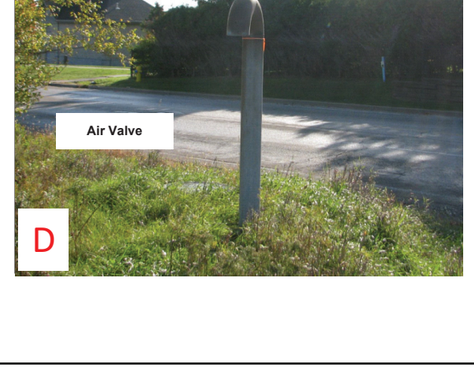
Future developments within and nearby the transmission mains easement should be reviewed in conjunction with this report to ensure short term measures are maintained and incorporated into the development plans of these new developments.

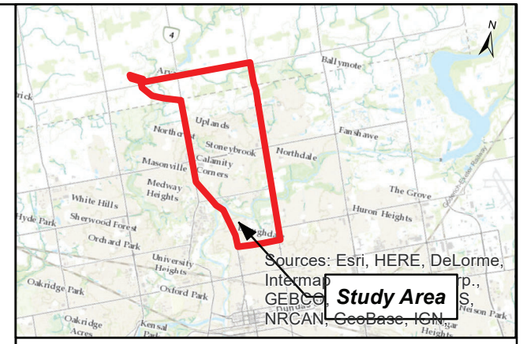












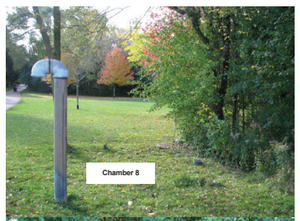
City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

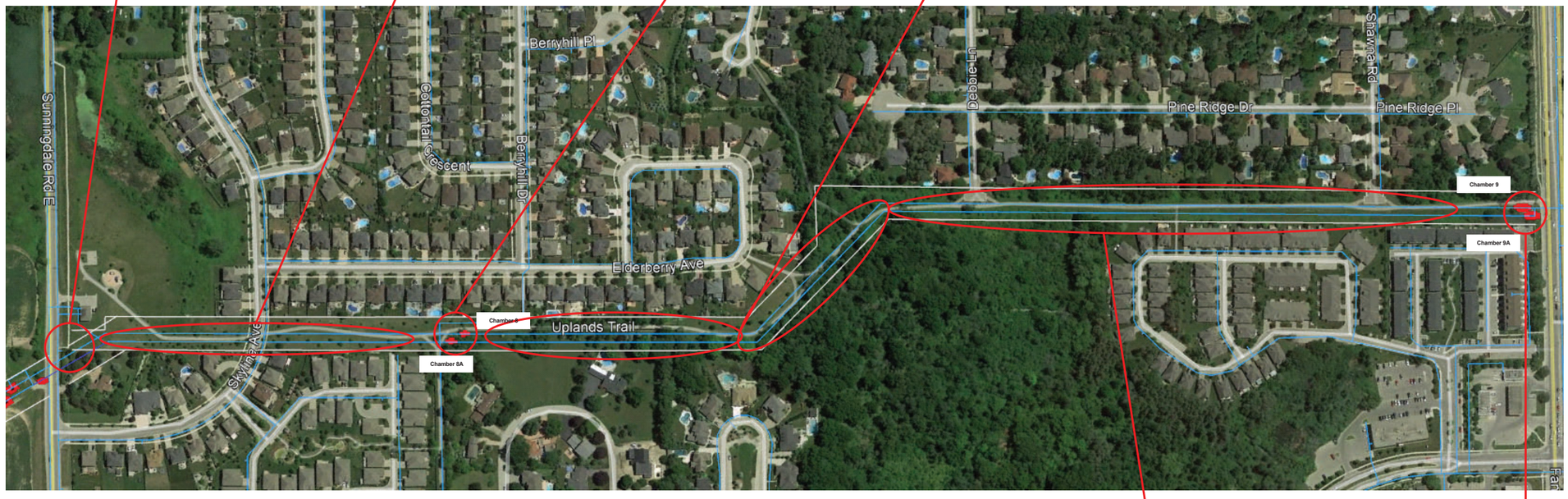
November 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

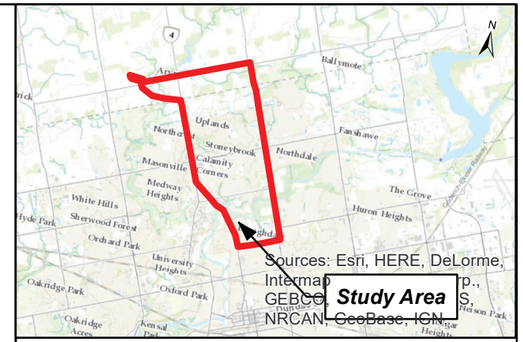
AECOM

Figure 3.1

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 11/5/2020 12:11:11 PM User Name: AdamsP1







City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

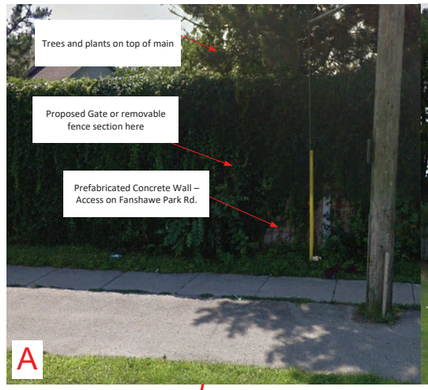
Sunningdale Road to Fanshawe Park Road

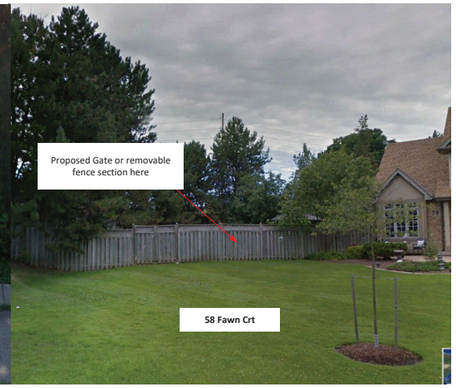
November 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

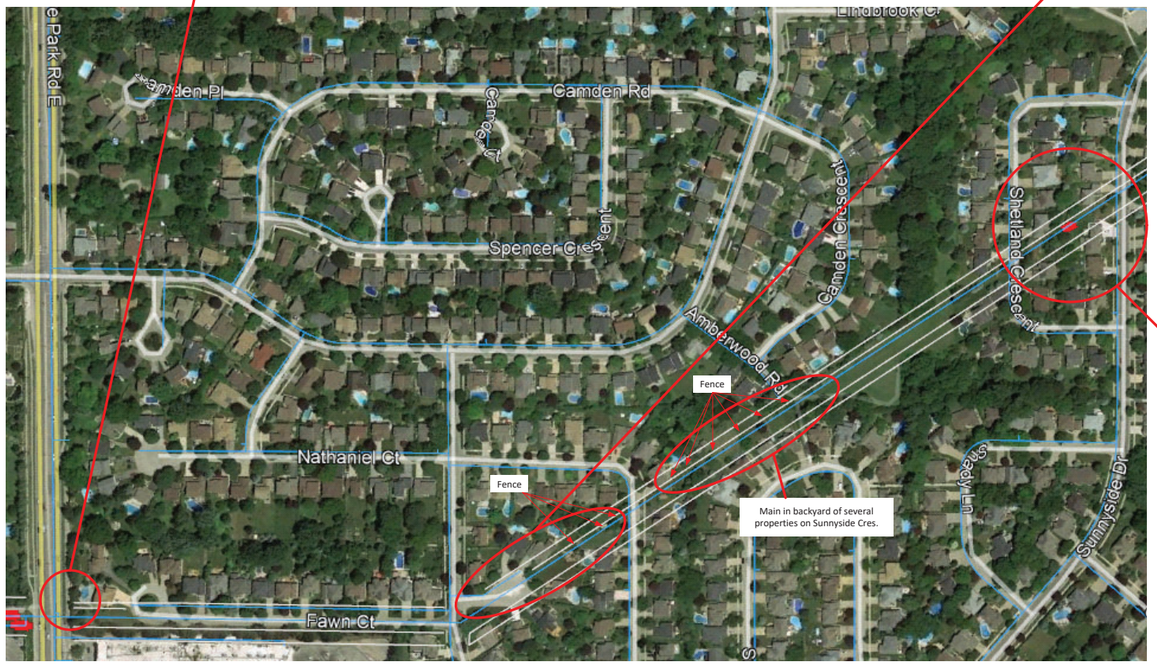
AECOM

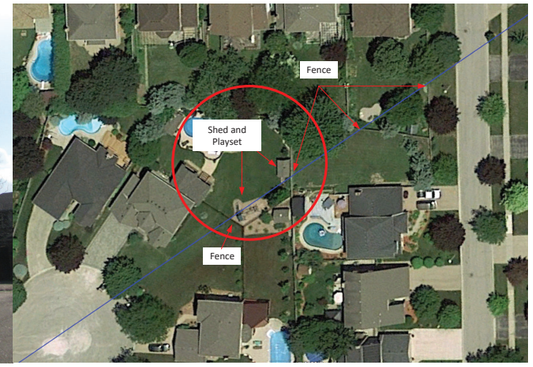
Figure 3.2

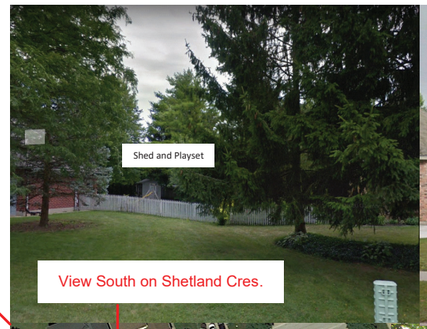
Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 11/5/2020 12:11:11 PM User Name: AdamsP1

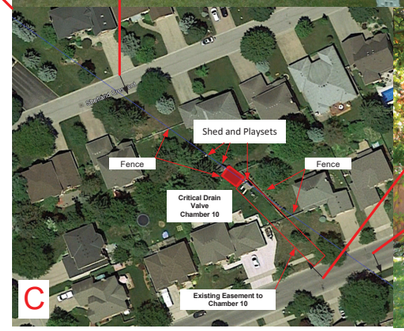


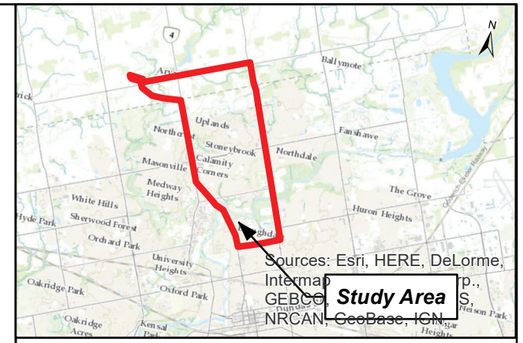












City of London

Arva to Huron Transmission Main

Muncipal Class Environmental Assessment

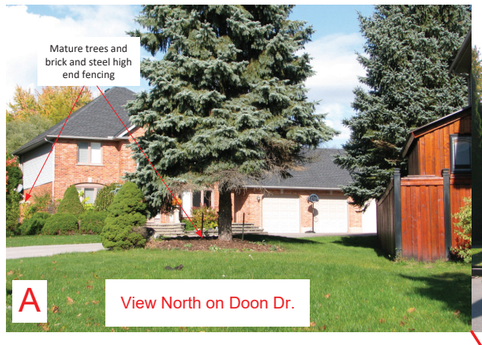
Fanshawe Park Road to Sunnyside Drive

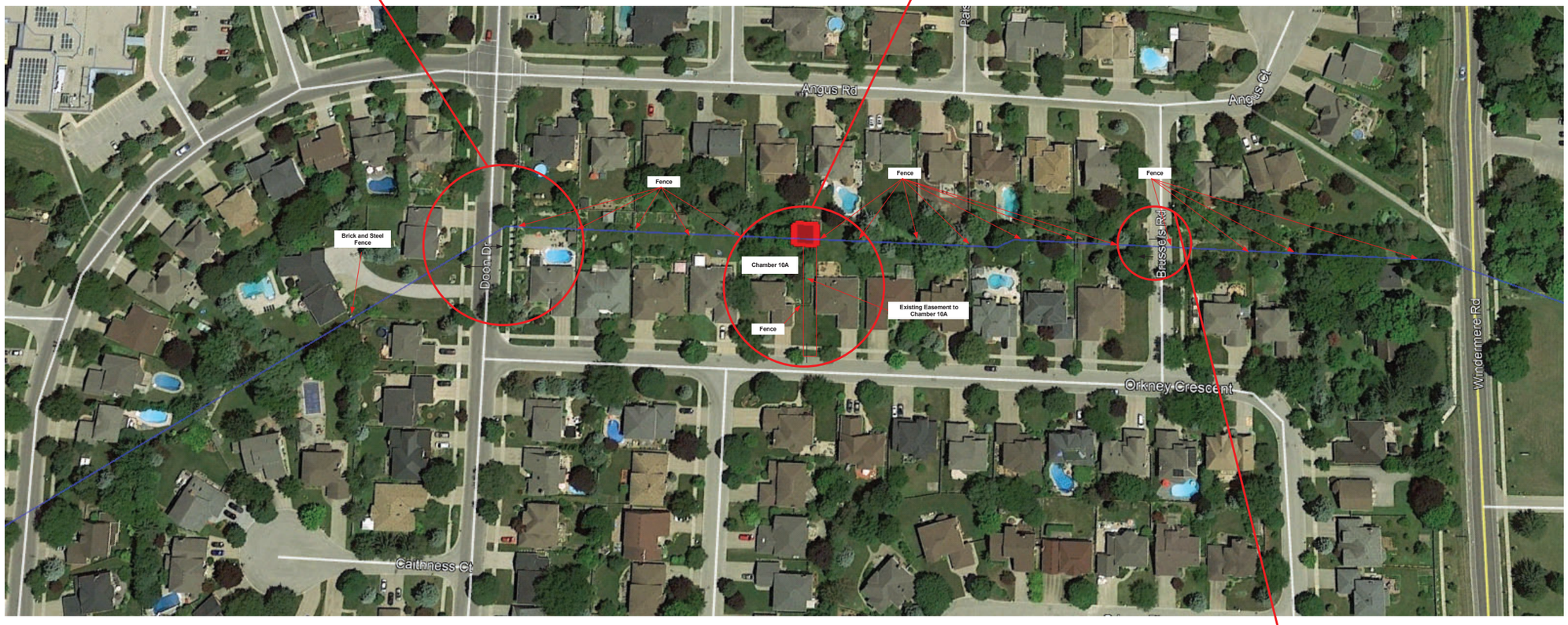
November 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

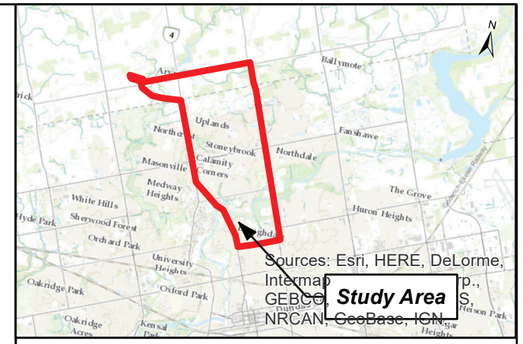
AECOM

Figure 3.3

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 11/5/2020 12:11:11 PM User Name: Adamsp1







City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

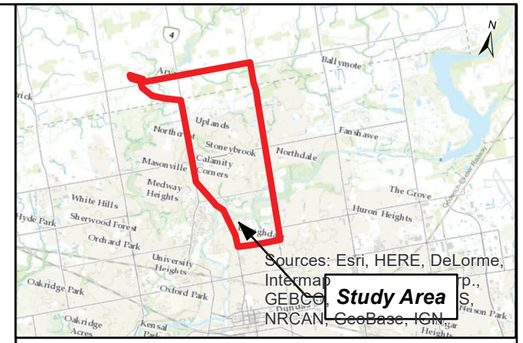
Sunnyside Drive to Windemere Road

November 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 3.4

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 11/3/2020 12:11:11 PM User Name: AdamsP1



City of London
Arva to Huron Transmission Main
Muncipal Class Environmental Assessment

Windermere Road to Huron Street

November 2020	Scale: As Shown	Datum: NAD83 UTM17 Source: City of London
P#: 60619503	V#:	

AECOM

Figure 3.5

Map location: C:\Users\adamsp1\Desktop\Arva\Short Term Memo\Short_Term_Priority.mxd
Date Saved: 11/5/2020 12:11:11 PM User Name: AdamsP1

4. Capital Costs for Recommended and Required Upgrades

Based on the above review and recommendations, **Table 4.1** provides an estimate to complete all maintenance, monitoring and upgrade works from the year 2021 to 2040 (20-year period). The estimated costs do not include removals or relocations of privately owned obstacles within the City's easement, but include the costs for removing mature trees, clearing bushes, and installing gates and removable fence sections on private properties where appropriate. For ongoing maintenance and inspection work, a 2% yearly inflation rate was used along with the 2020 costs for maintenance, inspections and replacements presented in the Asset Management report.

Table 4.1: Capital & O&M costs for 20 years from 2021 to 2040

Item	Year 2021 Costs	Years 2022 to 2040 Costs
Clearing of bushes and trees (including stumps and roots) [1]	$ 200,000	$ 580,000
Removable bollards or barricade for Chambers 9 and 9A	$ 2,500	$ 0,000
Inspection and Maintenance of Valves and Chambers [2]	$ 62,500	$ 1,460,000
New Chamber 10 [3]	$0.00	$170,000
Replacing Valves [4]	$ 40,000	$ 940,000
Soil Sampling and Testing [5]	$ 0.00	$ 20,000
Test Pits [6]	$ 127,500	$ 170,000
Free-Swimming EM [7]	$ 0.00	$ 2,120,000
Joints Repairs [8]	$ 100,000	$2,330,000
Subtotal	$ 532,500	$ 7,590,000
Contingency (25%)	$ 133,125	$ 1,900,000
TOTAL (Rounded)	**$ 700,000**	**$ 9,700,000**

1- Assumed value.
2- Assume four hours for two operators inspecting 25 chambers per year (200hrs per year) at $100 per hour (Material costs included).
3- Abandon existing chamber 10, remove access, concrete encase piping, and install new chamber 10 on Shetland or Sunnyside St in year 2025.
4- Assume replacing 1 valve per year. Valves range in size from 150mm air release and butterfly valves to 600mm main drain gate valves. Costs range from $10,000 to $100,000 for full replacement of the valves including valve costs, removal of old valve(s), installation of new valve(s), testing, and commissioning. An average cost of $40,000 was used in the calculations to replace each valve; however, costs will be based on actual valve condition, location, access, valve type, and replacement value at the time of replacement. Costs do not include costs to replace or modify the chamber itself.
5- No sampling is required in year 2021 as samples were taken in 2020. Assume 10 soil samples are tested in year 15. Cost of each sample is based on the year 2020 cost of $1,200 per soil sample as stated in the Asset Management Report.
6- Assume 5 test pits are to be competed in years 2021 and 2036, using the year 2020 cost of $25,000 per test pit as stated in the Asset Management Report.
7- Assume testing both twin mains for the full length from Arva PS to Chamber 13 – (12.3Km at $60/km + $100,000 fee) in years 2022 and 2037 as stated in the Asset Management Report for the year 2020 costs.
8- Assume repairing 2 joints per year, at $40,000 to $50,000 per joint repair. Costs include the cost to excavate to the damaged joint, drain the pipeline, access inside the main, remove corroded materials, welding by a specialty welder, grouting, testing, and reinstating area and surface to previous condition (green field to paved roads).

Total costs for upgrades, inspections, maintenance, and repairs over a 20 year period is approximately $10,400,000. **Appendix B** provides a breakdown of costs per year based on a 2% inflation rate from the year 2021 to 2040.

AECOM

AECOM CANADA LTD.
250 York Street, Suite 410,
London, ON, Canada N6A 6K2

519 963 5930 tel
519 673 5975 fax

Technical Memorandum

To:	Stephen Romano, P.Eng. Environmental Services Engineer	Page 1
CC	Aaron Rozentals, Jake Helm, John Haasen	
Subject	**City of London: Arva to Huron EA** **Technical Memorandum – Short Term Conceptual Design**	
From	Bander Abou Taka, P.Eng.	
Date	January 22, 2021	Project Number 60619503

1. Background

The City of London (City) retained AECOM to perform a Municipal Class Environmental Assessment Master Plan (MCEAMP) of a twinned 1,050 mm dia. Prestressed Concrete Cylinder Pipe (PCCP) transmission main from the Arva Pumping Station to Fanshawe Park Road, and a single 1,050 mm dia. PCCP transmission main between Fanshawe Park Road and Huron Street (Figure 1.1).

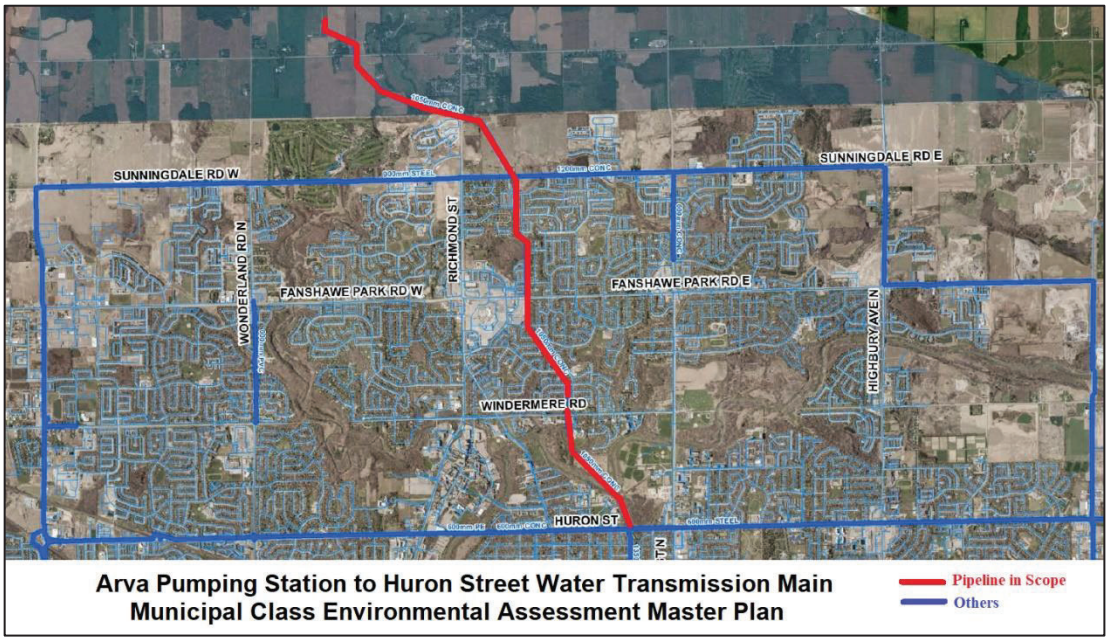


Figure 1.1 Arva to Huron Transmission Main

Several short-term maintenance and/or upgrade alternatives were included as part of the Environmental Assessment review including:

1- Alternative 1: Do Nothing, where the City would maintain current operations, monitoring, and spot repairs with no planned improvements;

2- Alternative 2: Maintain the current legal easements and ensure access is maintained for ongoing maintenance and monitoring, and proactive and/or emergency repairs when needed. Widening of the easements was not considered as part of this alternative. However, the City would acquire land to increase easement width, where appropriate, and when an opportunity arises; and
3- Alternative 3: Widen the existing easement to greater than 15m up to 30m, where possible to allow for easier maintenance, monitoring and repair access using conventional construction methods.

Alternative 2 was identified as the preferred alternative and is the basis for the conceptual design discussed in this technical memorandum.

2. Short Term Strategies

2.1 *Required Actions*

The regular inspection and maintenance of transmission main chambers, valves and associated appurtenances are essential components of transmission main management. The strategic closure of one or more transmission main valves in the event of a transmission main failure is necessary to ensure an efficient response to stop the flow of water. Therefore, valve condition and operation is critical. Regular clearing of access routes and the interior clearing of accumulated debris associated with each chamber can improve response times during a failure. Routine inspection and maintenance of transmission main chambers are proactive measures to ensure peak performance and the level of service of the transmission main and its associated components.

It is recommended that the City continue to, or implement the regular inspection and maintenance programs listed in **Table 2.1**.

Table 2.1: Inspection, Maintenance and Monitoring Activities

Action	Frequency	Comment
Inspection and Maintenance of Valves and Chambers	Annual	From a Levels of Service (LoS) measure, inspection and maintenance of valves and valve chambers is required to avoid impacts to the loss of physical integrity of the chamber and valves. This includes replacing damaged valves, chamber cleaning where required, missing air vents, minor rehabilitation of chambers, etc. 100% of the valves and chambers should be inspected/maintained annually.
Soil Sampling and Testing of ground near transmission mains, including coring into ground, sample collection, and laboratory testing.	Every 15 Years	Reduced resistivity of soil is one of the contributing factors to increased deterioration of PCCP. Due to de-icing, chloride levels may elevate and would further decrease the resistivity levels. Therefore, understanding the soil characteristics on a frequent basis would provide additional insights for interventions.
Test Pits to inspect the surface of the transmission main, and excavating to the transmission main and inspecting the surface of the concrete pipe for signs of pitting, cracking or damage.	Every 15 Years	Test pits would offer direct information about the condition of the pipe, depending on the type of examination. Joints in corrosive soils should be monitored at a certain frequency to understand the level of intervention.
Free-Swimming EM tool or Pipe Diver tool to inspect the inside of the transmission main for damage while the line is in service	Every 15 Years	The City currently monitors the pipeline using Acoustic Fiber Optics (AFO) technology that provides an estimated location for wire breaks in the concrete piping. It is recommended to deploy a Free-Swimming EM or Pipe Diver tool to inspect the inside of the pipeline and provide a baseline of the state of the pipeline.

Action	Frequency	Comment
Repair of Joints	Based on Assessment	Joints are mostly assessed based on the above internal or external examinations. The deterioration of joints is hardly captured by EM technologies. The impact of soil envelope may increase the degradation level of joints.

To be able to conduct the above inspections and maintenance activities, access to the transmission main and valve chambers, along the transmission mains route, would need to be provided by all property owners, as per the rights and privileges granted to the City and as stated in the Easement Agreements attached to each property.

2.2 *Access Requirements & City Rights*

The easement agreements for the transmission main entitle the City to the following rights on each property:

At any time and from time to time, to lay, install, construct, reconstruct, operate, maintain, open, inspect, pair and keep in good condition, remove, replace, relocate and supplement not more than one water main including all accessories, equipment and appurtenances necessary or incidental thereto, any of which shall be located underground at a depth of not less than four feet below grade level, and valve chambers, vent pipes and marker posts on the surface and/or underground, the valve chambers to be located on that part of the said easement lying south of Fanshawe Park Road at the locations indicated in yellow on the said attached plan of survey, and which said chambers shall not extend above the surface of the ground more than two feet nor have a surface area in excess of twenty-five square feet.

To keep the said lands, clear of brush, trees and other obstructions of any nature whatsoever as may be necessary to the exercise and for the enjoyment of the said rights and easements.

To enter upon the said lands and pass and repass from time to time and at all times with the servants, agents, contractors, workmen of and other persons duly authorized by The Corporation of the City of London with all plant, machinery, material, vehicles and equipment as may be necessary for the purposes necessary or incidental to the exercise and for the enjoyment of the said rights and easements.

To erect such gates as the said Corporation may from time to time consider necessary.

The owner of the property has the following right:

The owner of the said lands otherwise to have the right fully to use and enjoy the said lands except as may be necessary for the said rights and easements provided no person shall excavate, drill, install or erect thereon, any pit, well, foundation, pavement, building or other structure or installation without the consent in writing of the said Corporation.

2.3 *Strategies to Access Private Properties*

Depending on the site conditions, access will be necessary to maintain valve chambers, and for rapid repairs on piping, chambers, and other infrastructure along the transmission mains in the event of a failure. This requirement will necessitate coordination with property owners to allow City crews and/or their representatives immediate access when required. It is recommended that the City issue notifications to property owners where the existing easement is located to allow them time to make changes to their property to accommodate the City's needs and requirements per the easement rights. Three levels of notifications are proposed:

1- **Level 1 - Low risk**: For property owners with a low risk designation, a notice should be sent advise property owners that City owned infrastructure is located on their property, that is not critical at this stage but may require City to inspect or access, if required. The notice should also recommend

changes to properties to facilitate access to City owned infrastructure, within reason. Low level risk means that a failure of the main on the property would likely cause minimal damage. These sites also provide rapid access to City crews for repairs or inspections. Refer to **Figures 2.1 to 2.4** for locations of Level 1 properties within the existing easement. An example of Level 1 properties include a property with no valve chambers, non-fenced areas with little to no obstacles within the City's easement, property on City owned land, or property that the City's crews can access immediately with minimal obstacle removal to excavate and repair damaged transmission mains. The City is not obligated to repair or compensate owners for any damages caused by removing obstacles within the City's easement, if any. **Appendix A** provide a sample letter that could be provided to Level 1 property owners.

2- **Level 2 - Medium risk**: For property owners with a medium risk designation, a notice should be sent advising property owners that city owned infrastructure is located on their properties, that are important for the City to have access to for inspections and/or repairs. The notice should advise them to relocate or remove obstacles to facilitate access to City owned infrastructure. The letter would include a warning that damage to property may occur if City infrastructure malfunctions and requires immediate repair, and if repairs and emergency work are required, the City has the right to remove obstacles to repair infrastructure. The City is not obligated to repair or compensate owners for any damages caused by these actions. Refer to **Figures 2.1 to 2.4** for locations of Medium risk or Level 2 properties. An example of a Level 2 property is one that has an air valve chamber on it with access required for City crews to inspect or repair. **Appendix A** provide a sample letter that could be provided to Level 2 property owners.

3- **Level 3 - High risk**: For property owners with a high-risk designation, a notice should be sent advising property owners that city owned infrastructure is located on their properties, that are critical for the City to have access to for routine inspections and/or repairs. The notice should be sent to require homeowners to make immediate changes to their properties to facilitate access to high risk infrastructure, such as major drain chambers or air valve chambers. The letter should include a warning with a deadline to comply with the required changes. If repairs and emergency work is required, the City has the right to remove obstacles to repair or replace infrastructure. The City is not obligated to repair or compensate owners for any damages caused by these actions. Refer to **Figures 2.1 to 2.4** for locations of Level 3 properties. An example of a Level 3 property includes properties with critical valve chambers that require regular maintenance and inspections to ensure the valves are operating adequately. **Appendix A** provide a sample letter that could be provided to Level 3 property owners.

Following any repairs, the City will reinstate areas to previous condition or better, minus any manmade or natural obstacles within the City's easement. These will not be repaired or replaced. Any obstacle outside the easements where the City required its removal to facilitate access or repairs, would be repaired, replaced or compensated to the owner.

3. Easement Review & Recommendation

The easement was reviewed from the Arva Pumping Station to Chamber 13 near Huron Street. The following **Tables 3.1, 3.2 and 3.3** provide an overall review of the infrastructure reviewed, recommended changes on private properties and the level of risk rating assigned to the required or recommended changes. **Figures 3.1 to 3.5** provide mapping to support the tables.

Table 3.1: Arva Pumping Station to Sunningdale

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Twinned transmission mains from Arva Pumping Station to Sunningdale Rd.	The twinned line is located on farmland, county roads, and forested areas. Refer to Figure 3.1 A, B, C, and D: in some areas, the twinned mains appear to be near or under mature trees. The trees are also within the City owned easement.	Low	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chambers 1 and 1A	Chamber 1 and 1A are drain chambers located on farmland. There is access to these two chambers on a dirt access road through the landowner's land.	Low	Maintain access and clear bushes on a regular basis. Inspect chambers and replace valves when required.
Chambers 2 and 2A	Chamber 2 and 2A are air valve chambers. There is no developed access road to the chambers on farmland.	Low	Maintain access and clear bushes on a regular basis. Inspect chambers and replace valves when required. Consider constructing a gravel access road, within the easement with owner approval, to facilitate access by City operators.
Chambers 3 and 3A	Refer to Figure 3.1 B: Chambers 3 and 3A are drain valves chambers. Chamber 3A appears to be near mature trees. The trees are also within the City owned easement. There is no developed access road to the chambers on the farmland.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required. It is difficult to construct a new access road at this location.
Chambers 4 and 4A	Chambers 4 and 4A are air valve chambers, located near a drainage pond on the Sunningdale Gold Course. There is an access road to this site from Richmond Street.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.
Chambers 5 and 5A	Refer to Figure 3.1 C: Chambers 5 and 5A are	Low	Maintain access, and clear bushes as required during specific times of the year to

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	drain chambers in a swampy area. These two chambers are located within a Provincially Significant Wetland (PSW). The trees and brushes are within the City owned easement. There is non paved access to this site from Richmond Street.		minimize disruption to animals and bird habitats. Clearing of trees and brushes should be minimized and limited to where the chambers are located and to provide a vehicle access only. Avoid removal of brushes and trees between the two chambers. Inspect chambers and replace valves when required.
Chambers 6 and 6A	Refer to Figure 3.1 D. Chambers 6 and 6A are critical air valve chambers. There is thick bus near and around the chambers. No developed access road to the chambers on farmland.	High	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required Consider constructing a gravel access road, within the easement with owner approval, to facilitate access by City operators.
Chambers 7 and 7A	Refer to Figure 3.1 D. Chambers 7 and 7A are drain valve chambers There are thick bushes near and around the chambers. There is access to these chambers from Sunningdale Rd.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.
Chamber 7SA	Refer to Figure 3.1 D. Chamber 7SA is an air valve chamber. There are some thick bushes near and around the chamber.	Low	Maintain access and clear bushes on regular basis. Inspect the chamber and replace the valve when required.

Table 3.2: Sunningdale to Fanshawe Park Rd.

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Twinned transmission mains from Sunningdale Rd. to Fanshawe Park Rd	Refer to Figures 3.2 A, B C and D. The twin transmission mains are in a developed area, with several mature trees, hedges and fences within the easement and near the transmission mains. The trees are also within the City owned property	Low.	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chambers 8 and 8A	Refer to Figure 3.2 C. Chambers 8 and 8A are air valve chambers located in a park like setting with mature	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required.

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	trees and bushes near the chambers		
Chambers 9 and 9A	Refer to Figure 3.2 F. Chamber 9 is an air and drain valve chamber with a check valve, and chamber 9A is an air valve chamber. Chambers are located at the end of a popular walkway next to Fanshawe Park Rd. This area is accessible to the City and the general public.	Low	Maintain access and clear bushes on regular basis. Inspect chambers and replace valves when required. Consider constructing fencing or adding removable barricade or bollards to protect City infrastructure and prevent the public from parking on top of the chamber covers.

Table 3.3: Fanshawe Park Rd. to Huron Street

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
Single transmission main from Fanshawe Park Rd. to Huron St.	Refer to Figures 3.3, 3.4 and 3.5. The transmission main is located in a highly developed area, with several mature trees, hedges and fences within the easement and near the transmission main. There are several manmade and natural obstacles near or on top of the transmission main and the valve chambers within the easement. Some areas have limited or no direct access by City crews or their representatives.	Low to High	Depending on the area, it is recommended to review the site and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access. New gates or removable fence sections in existing fencing are required in some areas to allow for chamber access. Refer to figures for locations and examples as to what may be involved to address
	Refer to Figure 3.3 A. The transmission main enters 58 Fawn Crt. property from the north underneath a prefabricated concrete fencing structure and exits south of the property under a wooden fence. The pipeline continues on Fawn Ct. underneath the road right of way to Robinson Ct.	Medium	Recommend installing gates or removable fence sections on both the north and south end of the property to facilitate access to the transmission main in case of repairs. Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
	Refer to Figure 3.3 B. The transmission main enters and exists several properties through Robinson Ct.: 19 Robinson Crt., 79 Robinson	Medium	Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties. Recommend

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	Lane, and 83 Robinson lane. Several manmade and natural obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement.		reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
	Refer to Figure 3.3: Transmission main continues through several properties on Robinson Lane and Sunnyside Cres.: 100 and 104 Robinson Lane, 440, 444, 448, and 452 Sunnyside Cres., then enters Camden Cres. Park towards homes on Shetland Cres.	Medium	Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties. Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.
Chamber 10	Refer to Figure 3.3 C. The transmission main enters and exists several properties: 27 Shetland Cres., 18 Shetland Cres., 186, and 190 Sunnyside Drive. Several manmade and natural obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement. Chamber 10 is a drain chamber located on 186 Sunnyside Drive property. There is access to this chamber for inspections and repairs through the homeowner's fence. There is a large playset and a shed near the chamber and the transmission main. The City owns an easement next to this property as shown on the Figure.	High	The drain chamber is a low spot in the transmission main and would cause major damage to property and infrastructure in case of damage or a break in the line, or the valve in this location. The City is considering abandoning this chamber and constructing an alternative on Shetland Crescent, or Sunnyside Drive. In the meantime, it's highly recommended to remove all obstacles within the easement around the chamber. There is an existing maintenance easement to access the property from Sunnyside Drive, and a small gate into the property. It's recommended to widen the gate to allow for City maintenance trucks to enter the property when required for repairs. Recommend installing gates or removable fence sections for rapid access to the easement when required where the pipeline enters and exits these properties
	Refer to Figure 3.4 A. The transmission main enters and exists several properties between Sunnyside Drive and Windermere Rd.: 199, 203 Sunnyside Dr., 27 Caithness Crt., and 126 Doon Dr. Several manmade and natural	Medium	Recommend reviewing the sites and assess the need to remove trees and other obstacles to reduce risk of damage by tree roots, and to allow for maintenance and/or monitoring access.

Pipe / Chamber ID	Site Condition	Risk Level	Recommendations
	obstacles such as playsets, sheds, fencing, concrete pads, trees and shrubs are on top of the transmission main within the City's easement.		
Chamber 10A	Refer to Figure 3.4 Transmission main continues between Doon Dr and Windermere Rd through several properties on Orkney Cres., and Windermere Rd: 127,131,139, 143, 147, 151, 155, 159, 163, 167, 171, 175, 179 Orkney Cres., and 542 Windermere Rd. Refer to Figure 3.4 B. Chamber 10A is an air release chamber located on 163 Orkney Cres. The City owns an easement on the property to access the chamber going through the south end of the property.	Medium	Recommend removing all obstacles around the chamber within the easement and widen the existing gate in the fencing for the 163 Orkney Cres. property, where Chamber 10A is located to allow City maintenance trucks to enter the property when required for repairs.
Chamber 11	Refer to Figure 3.5. Chamber 11 is an air and drain valve chamber with access through Scouts Canada.	Medium	Recommend removing all obstacles around the chamber within the easement and continue to inspect and maintain the valves and chamber.
Chambers 12 and 12A	Refer to Figure 3.5. Chamber 12 is a drain valve chamber, and Chamber 12A is an air valve chamber with access from the trail system behind St. Peter's Seminary through City parks. A short section of the main enters and exists the north end corner of the property on 430 Huron Street. This area is relatively dense with mature trees and close to the City parks.	Low	Chambers are within City owned lands and the easement and can be accessed without the need to access private property. Recommend maintaining access and clear bushes on regular basis. Inspect chambers and replace valves when required. Where the main enters the property on 430 Huron Street, the City should consider obtaining a working easement in that section to facilitate any repairs to the main. The City can access that section of the main from the east through City owned parks.
Chamber 13	Refer to Figure 3.5: Chamber 13 is a drain and a distribution chamber with unobstructed access to City staff.	Low	Chamber is within City ROW and easement and can be accessed without the need to access private property. This chamber will be replaced in 2021

Future developments within and nearby the transmission mains easement should be reviewed in conjunction with this report to ensure short term measures are maintained and incorporated into the development plans of these new developments.

4. Capital Costs for Recommended and Required Upgrades

Based on the above review and recommendations, **Table 4.1** provides an estimate to complete all maintenance, monitoring and upgrade works from the year 2021 to 2040 (20-year period). The estimated costs do not include removals or relocations of privately owned obstacles within the City's easement, but include the costs for removing mature trees, clearing bushes, and installing gates and removable fence sections on private properties where appropriate. For ongoing maintenance and inspection work, a 2% yearly inflation rate was used along with the 2020 costs for maintenance, inspections and replacements presented in the Asset Management report.

Table 4.1: Capital & O&M costs for 20 years from 2021 to 2040

Item	Year 2021 Costs	Years 2022 to 2040 Costs
Clearing of bushes and trees (including stumps and roots) [1]	$ 200,000	$ 580,000
Removable bollards or barricade for Chambers 9 and 9A	$ 2,500	$ 0,000
Inspection and Maintenance of Valves and Chambers [2]	$ 62,500	$ 1,460,000
New Chamber 10 [3]	$0.00	$170,000
Replacing Valves [4]	$ 40,000	$ 940,000
Soil Sampling and Testing [5]	$ 0.00	$ 20,000
Test Pits [6]	$ 127,500	$ 170,000
Free-Swimming EM [7]	$ 0.00	$ 2,120,000
Joints Repairs [8]	$ 100,000	$2,330,000
Subtotal	$ 532,500	$ 7,590,000
Contingency (25%)	$ 133,125	$ 1,900,000
TOTAL (Rounded)	**$ 700,000**	**$ 9,700,000**

1- Assumed value.
2- Assume four hours for two operators inspecting 25 chambers per year (200hrs per year) at $100 per hour (Material costs included).
3- Abandon existing chamber 10, remove access, concrete encase piping, and install new chamber 10 on Shetland or Sunnyside St in year 2025.
4- Assume replacing 1 valve per year. Valves range in size from 150mm air release and butterfly valves to 600mm main drain gate valves. Costs range from $10,000 to $100,000 for full replacement of the valves including valve costs, removal of old valve(s), installation of new valve(s), testing, and commissioning. An average cost of $40,000 was used in the calculations to replace each valve; however, costs will be based on actual valve condition, location, access, valve type, and replacement value at the time of replacement. Costs do not include costs to replace or modify the chamber itself.
5- No sampling is required in year 2021 as samples were taken in 2020. Assume 10 soil samples are tested in year 15. Cost of each sample is based on the year 2020 cost of $1,200 per soil sample as stated in the Asset Management Report.
6- Assume 5 test pits are to be competed in years 2021 and 2036, using the year 2020 cost of $25,000 per test pit as stated in the Asset Management Report.
7- Assume testing both twin mains for the full length from Arva PS to Chamber 13 – (12.3Km at $60/km + $100,000 fee) in years 2022 and 2037 as stated in the Asset Management Report for the year 2020 costs.
8- Assume repairing 2 joints per year, at $40,000 to $50,000 per joint repair. Costs include the cost to excavate to the damaged joint, drain the pipeline, access inside the main, remove corroded materials, welding by a specialty welder, grouting, testing, and reinstating area and surface to previous condition (green field to paved roads).

Total costs for upgrades, inspections, maintenance, and repairs over a 20 year period is approximately $10,400,000. **Appendix B** provides a breakdown of costs per year based on a 2% inflation rate from the year 2021 to 2040.

APPENDIX A

Sample Notice to Property Owners Letters

300 Dufferin Avenue, PO Box 5035, London, ON, N6A 4L9

Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London

Date

Property Owner
Street Address

Dear Property Owner:

The City of London hereby notifies the owner of this property that a vital potable water transmission main and/or other City owned, and operated infrastructure is located on your property as shown on the attached figure. This infrastructure is installed in an existing City of London Easement as attached to your property ownership title. An excerpt of the easement agreement detailing the rights of both the City and the property owner is attached hereto. In the future, the City may require access to this infrastructure for maintenance, monitoring and/or repair, and/or replacement purposes. Failure of this transmission main and any other City owned infrastructure on your property may cause damage to your property and may disrupt water flow to the rest of the City of London. We recommend that you remove any obstacles within this easement including sheds, playgrounds, garden beds, decks, trees, water features, and any other items to allow the City sufficient access to the City owned easement and infrastructure. If the City needs to enter your property to maintain or repair City infrastructure, the City will remove the obstacles and will not compensate or replace any items damaged or destroyed in the process, within the City easement. Grass and existing fencing will be restored to previous condition or better.

The City may also need to install new gates and/or removable fence sections within the City easement to allow unobstructed access to the transmission main and/or City owned chambers on your property. The new fence or gate will be similar in material and design to your existing fencing. Unfortunately, we are unable to confirm exact timing of these improvements but will attempt to work with property owners on a mutually satisfactory approach, where possible.

If you have any questions or concerns, please contact the City at the contact listed below.

Sincerely,Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London

Enclosed

Property Map, Excerpt from Easement Agreement

300 Dufferin Avenue, PO Box 5035, London, ON, N6A 4L9

Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London
Date

Property Owner
Street Address

Dear Property Owner:

The City of London hereby notifies the owner of this property that a vital potable water transmission main and/or other City owned, and operated infrastructure is located on your property as shown on the attached figure. This infrastructure is installed in an existing City of London Easement as attached to your property ownership title. An excerpt of the easement agreement detailing the rights of both the City and the property owner is attached hereto. In the future, the City may require access to this infrastructure for maintenance and repairs. Failure of this transmission main and any other City owned infrastructure on your property may cause damage to your property and may disrupt water flow to the rest of the City of London. Therefore, it is highly recommended that you remove all obstacles within this easement, including sheds, playgrounds, garden beds, decks, trees, water features, and any other item, to allow the City sufficient access to the City owned easement and infrastructure. If the City needs to enter your property to maintain or repair City infrastructure, the City will remove the obstacles and will not compensate or replace any items damaged or destroyed in the process, within the City's easement. Grass and existing fencing will be restored to previous condition or better.

The City may also need to install new gates and/or removable fence sections within the City easement to allow unobstructed access to the pipeline and/or city owned chambers on your property. The new fence or gate will be similar in material and design to your existing fencing. Unfortunately, we are unable to confirm exact timing of these improvements but will attempt to work with property owners on a mutually satisfactory approach, where possible.

If you have any questions or concerns, please contact the City at the contact listed below.

Sincerely,Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London

Enclosed

Property Map, Excerpt from Easement Agreement

300 Dufferin Avenue, PO Box 5035, London, ON, N6A 4L9

Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London

Date

Property Owner
Street Address

Dear Property Owner:

The City of London hereby notifies the owner of this property that a vital potable water transmission main and/or other City owned, and operated infrastructure is located on your property as shown on the attached figure. This infrastructure is installed in an existing City of London Easement as attached to your property ownership title. An excerpt of the easement agreement detailing the rights of both the City and the property owner is attached hereto. In the future, the City may require access to this infrastructure for maintenance and repairs. Failure of this transmission main and any other City owned infrastructure on your property may cause damage to your property and may disrupt water flow to the rest of the City of London. Therefore, all obstacles within this easement should be removed and/or relocated outside the easement within 90 days of receiving this letter. This includes sheds, playgrounds, garden beds, decks, trees, water features, and any other items to allow the City sufficient access to the City owned easement and infrastructure. If the City needs to enter your property to maintain or repair City infrastructure, the City will remove the obstacles and will not compensate or replace any items damaged or destroyed in the process, within the City's easement. Grass and existing fencing will be restored to previous condition or better.

The City may also need to install new gates and/or removable fence sections within the City easement to allow unobstructed access to the pipeline and/or city owned chambers on your property. The new fence or gate will be similar in material and design to your existing fencing. Unfortunately, we are unable to confirm exact timing of these improvements but will attempt to work with property owners on a mutually satisfactory approach, where possible.

If you have any questions or concerns, please contact the City at the contact listed below.

Sincerely,Stephen Romano, M.Eng, P.Eng
Environmental Services Engineer
Water Engineering Division
City of London

Enclosed

Property Map, Excerpt of Easement Agreement

APPENDIX B

Costs Calculations

Capital and O&M Costs - 2021

Item	Units	No. of Units	Cost per unit ($CAD)	Extended Costs ($CAD)
Clearing of bushes and trees (including stumps and roots)	LS	1	$ 200,000.00	$ 200,000.00
Removable bollards or barricade for Chambers 9 and 9A	LS	1	$ 2,500.00	$ 2,500.00
Soil Samples	LS	1	$ -	$ -
Test Pits (3m X 3m X depth varies)	each	5	$ 25,000.00	$ 125,000.00
Inspection and Maintenance of Valves and Chambers	each	25	$ 2,500.00	$ 62,500.00
Free-Swimming EM (12.3 km of piping)	LS	1	$ 838,000.00	$ 838,000.00
Subtotal				$ 1,228,000.00
Contingency (25%)				$ 307,000.00
TOTAL				$ 1,535,000.00

O&M Costs - 2022 to 2041

Item	2020 Costs (Reference from AM report)	Year 1 2021 Costs	Year 2 2022 Costs	Year 3 2023 Costs	Year 4 2024 Costs	Year 5 2025 Costs	Year 6 2026 Costs	Year 7 2027 Costs	Year 8 2028 Costs	Year 9 2029 Costs	Year 10 2030 Costs
Clearing of bushes and maintaining access roads [1]	$ 200,000	$ 200,000	$ 25,000	$ 25,500	$ 26,010	$ 26,530	$ 27,061	$ 27,602	$ 28,154	$ 28,717	$ 29,291
Removable bollards or barricade for Chambers 9 and 9A		$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Inspection and Maintenance of Valves and Chambers	$ -	$ 62,500	$ 63,750	$ 65,025	$ 66,326	$ 67,652	$ 69,005	$ 70,385	$ 71,793	$ 73,229	$ 74,693
Replacing Valves	$ -	$ 40,000	$ 40,800	$ 41,616	$ 42,448	$ 43,297	$ 44,163	$ 45,046	$ 45,947	$ 46,866	$ 47,804
New Chamber 10 - Drain Chamber	$ 150,000	$ -	$ -	$ -	$ -	$ 165,612	$ -	$ -	$ -	$ -	$ -
Soil Sampling and Testing	$ 1,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Test Pits	$ 25,000	$ 127,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Free-Swimming EM	$ 850,000	$ -	$ -	$ 902,027	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Repair of Joints		$ 100,000	$ 102,000	$ 104,040	$ 106,121	$ 108,243	$ 110,408	$ 112,616	$ 114,869	$ 117,166	$ 119,509
Subtotal	$ -	$ 532,500	$ 231,550	$ 1,138,208	$ 240,905	$ 411,335	$ 250,637	$ 255,650	$ 260,763	$ 265,978	$ 271,298
Contingency (25%)	$ -	$ 133,125	$ 57,888	$ 284,552	$ 60,226	$ 102,834	$ 62,659	$ 63,912	$ 65,191	$ 66,495	$ 67,824
TOTAL	$ -	$ 665,625	$ 289,438	$ 1,422,760	$ 301,131	$ 514,169	$ 313,296	$ 319,562	$ 325,954	$ 332,473	$ 339,122

Item	Year 11 2031 Costs	Year 12 2032 Costs	Year 13 2033 Costs	Year 14 2034 Costs	Year 15 2035 Costs	Year 16 2036 Costs	Year 17 2037 Costs	Year 18 2038 Costs	Year 19 2039 Costs	Year 20 2040 Costs	TOTAL 2022 to 2040
Clearing of bushes and maintaining access roads [1]	$ 29,877	$ 30,475	$ 31,084	$ 31,706	$ 32,340	$ 32,987	$ 33,647	$ 34,320	$ 35,006	$ 35,706	$ 580,000
Removable bollards or barricade for Chambers 9 and 9A	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Inspection and Maintenance of Valves and Chambers	$ 76,187	$ 77,711	$ 79,265	$ 80,850	$ 82,467	$ 84,117	$ 85,799	$ 87,515	$ 89,265	$ 91,051	$ 1,460,000
Replacing Valves	$ 48,760	$ 49,735	$ 50,730	$ 51,744	$ 52,779	$ 53,835	$ 54,911	$ 56,010	$ 57,130	$ 58,272	$ 940,000
New Chamber 10 - Drain Chamber	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 170,000
Soil Sampling and Testing	$ -	$ -	$ -	$ -	$ -	$ 16,150	$ -	$ -	$ -	$ -	$ 20,000
Test Pits	$ -	$ -	$ -	$ -	$ -	$ 168,234	$ -	$ -	$ -	$ -	$ 170,000
Free-Swimming EM	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,214,009	$ -	$ -	$ 2,120,000
Repair of Joints	$ 121,899	$ 124,337	$ 126,824	$ 129,361	$ 131,948	$ 134,587	$ 137,279	$ 140,024	$ 142,825	$ 145,681	$ 2,330,000
Subtotal	$ 276,724	$ 282,258	$ 287,903	$ 293,661	$ 299,535	$ 489,909	$ 311,636	$ 1,531,878	$ 324,226	$ 330,710	$ 7,760,000
Contingency (25%)	$ 69,181	$ 70,565	$ 71,976	$ 73,415	$ 74,884	$ 122,477	$ 77,909	$ 382,969	$ 81,056	$ 82,678	$ 1,940,000
TOTAL	$ 345,905	$ 352,823	$ 359,879	$ 367,077	$ 374,418	$ 612,387	$ 389,545	$ 1,914,847	$ 405,282	$ 413,388	$ 9,700,000

TOTAL COSTS for 2021 **$ 700,000**

TOTAL COSTS 2022 to 2040 (Rounded) **$ 9,700,000**

TOTAL from 2021 to 2040 **$ 10,400,000**