PARSONS

HYDROGEOLOGICAL ASSESSMENT REPORT

Williams Parkway from Dixie Road to Torbram Road

Brampton, Ontario

November 2024

Prepared For: City of Brampton

PARSONS

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1 Introduction

The City of Brampton (City) has retained Parsons Inc. (Parsons) to complete a Schedule “A+” Municipal Class Environmental Assessment (MCEA) and Preliminary Design for improvements to Williams Parkway from Dixie Road to Torbram Road (study area). The MCEA study will review the need for improvements to Williams Parkway from Dixie Road to Torbram Road through evaluating the needs for active transportation, existing infrastructure conditions, safety and the overall growth of the City. The proposed road improvements consist of implementing a multi-use trail on both sides of Williams Parkway to provide better connectivity with the existing trail system and pedestrian-friendly routes within the City. As part of the MCEA, Parsons completed a hydrogeological assessment to document and characterize the current hydrogeological conditions within the study area to provide the necessary hydrogeological information to support the MCEA.

The study area shown in Figure 1 (Site Location Map and Site Plan) is approximately 2.8 km in length and includes the Williams Parkway roadway and lands within 100 metres surrounding Williams Parkway. Williams Parkway is an east-west minor arterial road and generally consists of a 4-lane urban cross-section. The topography of the study area is shown on Figure 2 (Topographic Map).

1.1 Objectives

The objectives for this Hydrogeological Assessment were as follows:

- Determine and document the physical, geologic and hydrogeologic conditions within the study area;
- Evaluate potential impacts the Williams Parkway project may have to groundwater quantity and quality within the study area;
- Develop a short-list of wells from the desktop water well survey completed for the above evaluation that may require abandonment prior to construction in accordance with amended Ontario Regulation 903 (O.Reg. 903), if required;
- Identify any locations within the study area that may require construction dewatering and approvals from the Ministry of the Environment, Conservation and Parks (MECP); and
- Recommend potential mitigation measures that could address potential interferences or impacts to groundwater in the study area.

1.2 Scope of Work

The scope of work completed for this hydrogeological assessment included the following tasks:

- Reviewed available municipal, topographic and geologic maps, source water protection information, and selected water well records for the study area;
- Completed a search of the MECP water well records database to identify and map wells potentially within the study area;
- Installed two groundwater monitoring wells during the concurrent geotechnical investigation undertaken by Terraprobe Inc. (now Englobe);
- Completed a groundwater monitoring and sampling event and compared the laboratory analytical results to the applicable municipal storm and sanitary sewer by-law limits;
- Completed rising and falling head hydraulic conductivity (slug) tests at each monitoring well to estimate hydraulic conductivity;
- Installed groundwater level loggers in the monitoring wells to assess the groundwater elevation variations over approximately one year;
- Developed a short-list of the above water well records that are likely to be impacted by the project’s study area and, therefore, may require abandonment in accordance with O. Reg. 903 (as amended) prior to the proposed construction activities;
- Determined where the depth of construction and hydrogeological conditions would likely require construction dewatering and associated approvals; and

- Prepared this report, including mitigation measures and, if required, recommendations

1.3 Background Information

The Williams Parkway project involves mostly shallow construction. Areas of deeper excavation may be required to facilitate foundations for structural culverts and storm sewer system replacements/upgrades. These deeper excavations are of particular importance to this hydrogeological assessment because MECP approvals for construction dewatering may be required prior to construction phase, and there is a greater potential to interfere with and/or impact the quantity and quality of groundwater in the study area. Two locations were identified where construction dewatering may be required, specifically at the existing culverts as shown on Figures 1a to 1c and 2, namely: Spring Creek Culvert at Chinguacousy Trail and Williams Parkway intersection; and Mimico Creek Culvert at Williams Parkway and Torbram Road intersection.

2 Study Area Description

2.1 Study Area Location, Groundwater Study Area and Current Land Use

The study area as shown on Figures 1a to 1c is approximately 2.8 km in length and includes the Williams Parkway from Dixie Road to Torbram Road and includes “buffer” lands within 100 metres surrounding Williams Parkway roadway. Williams Parkway is an east to west minor arterial road and generally consists of a 4-lane urban cross-section. The topography of the site is shown on Figure 2 (Topographic Map). Etobicoke Creek and Mimico Creek are the major drainage features in the study area. Spring Creek (tributary of Etobicoke Creek) crosses Williams Parkway between Dixie Road and Bramalea Road. Mimico Creek crosses at the intersection of Williams Parkway and Torbram Road.

The study area includes lands within 100 m from the center of the Williams Parkway alignment. The rationale for the adequacy of a 100 m step-out distance from Williams Parkway are as follows:

- The study area is long (i.e., 2.8km) and narrow and in an urbanized area. Greater step-out distances would yield an unnecessarily larger and complex study area for this project, considering the project details below:
    - The proposed construction is mostly shallow and unlikely to affect groundwater quantity or quality over most of the project area;
    - The subsurface soils are primarily fine textured and, therefore, the areas of influence in response to construction dewatering would be relatively small; and
    - The project is located within an urbanized area with municipal water supplies that draw exclusively from Lake Ontario, therefore, interference with public or private groundwater supply wells would be very unlikely.

It was determined that within the study area there are two older private water wells (well ID 4901322 and 4901437); however, these wells are recorded as being in the middle of Williams Parkway and are likely destroyed. Although groundwater is not typically used as a source of drinking water in the study area, it is recommended to confirm the absence of private drinking water wells during detailed design through a water well survey.

Land use in the study area is predominantly residential with open space (Chinguacousy Trail and walking and cycling paths) and institutional (schools and recreational centres), the latter being located on the south side of Williams Parkway west of Bramalea Road, and the north side of Williams Parkway east of Bramalea Road. Land use to the east of Torbram Road is commercial/industrial.

2.2 Topography and Drainage

As indicated by Figure 2 (Topographic Map), the topography of the study area is generally flat to rolling hills and sloping downward regionally to the south, towards Lake Ontario. The exception being near the water courses that cross the study that are incised due to post-glacial isostatic rebound. Ground elevations in the study area range from greater than 210 m in deepest valley in northeast study to approximately 230 to 235 masl along Williams Parkway.

As discussed in Section 2.1, there are creeks that cross the study area and flow southward to Lake Ontario. Based on topography and surface water flow patterns, the regional direction of groundwater flow would be southeasterly toward Lake Ontario, however, shallow groundwater flow could be diverted towards water courses that cross the study area. Shallow and more permeable fills may also be expected to affect local shallow groundwater flow patterns.

2.3 Physiography

The site is in the physiographic region in southern Ontario known as the Peel Plain (Chapman and Putnam, 1984: Map P.2715), as shown on Figure 3, the study area is comprised of the following:

- Till plains (Drumlinized) in the west portion of the study area;
- Beveled Till Plains in the east portion of the study area; and
- Eskers in the southwest portion of the study area.

2.4 Quaternary Geology

According to the Ontario Geological Survey Quaternary Geology of Ontario (OGS, 1992) as shown on Figure 4, the surficial geology within the study area consists of the Halton Till, which predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor (i.e., the Halton Till), with a glaciolacustrine deposit southeast of the northeast end of the study area that is comprised of silt and clay, minor sand, basin and quiet water deposits, which would be stratigraphy overlying the till (i.e., a post-glacial lake deposit overlying the Halton Till)

Seventeen select water well records from the study area were reviewed to provide information regarding the deeper geology. Only select records were reviewed because the geology of the study area has a generally horizontal stratigraphy, therefore, extrapolating between individual records is reasonable. The records reviewed are listed in Appendix A. The geology documented by the well records include sand and silt that extend to depths of 20 to 30 m, followed by fine sand and clay to a maximum depth of 37 m, followed by till to 60 m overlying grey shale, as well as modern alluvial deposits consisting of clay, silt, sand, gravel. Based on the above, the project may expect to encounter mostly tills comprised of relatively fine textured low permeable soil.

Terraprobe advanced two boreholes each completed with a monitoring well in the study area during the concurrent geotechnical investigation that were utilized for this hydrogeologic assessment, namely monitoring wells TC3 and EC1 (see Figure 1 and borehole logs in Appendix D). The general stratigraphy encountered in these boreholes, with increasing depth, included topsoil, silt fill, and silt till to depths ranging from approximately 3.8 or 4.6 m. In addition, both logs indicate shallow bedrock at depths of approximately 3.8 m.

2.5 Bedrock Geology

According to the OGS bedrock map (OGS, 1992), bedrock beneath the study area is comprised of shale, specifically the northeastern portion of the study area is along the contact between the reddish shale of the Queenston formation and the bluish-grayish shale of the Georgian Bay formation, and the southwestern portion entirely in the Queenston formation. Both formations are described by the OGS map as being shale, limestone, dolostone, siltstone. Based on review of the Draft Pavement Design Report (Terraprobe, 2023), weathered bedrock was encountered at depths ranging from 3.8 m and 9.1 m below ground surface (mbgs) during the geotechnical investigations discussed under Section 2.4 and is inferred to be fractured, weathered shale, based on the auger cuttings and split spoon samples to a maximum depth of investigation of 10.7 mbgs.

2.6 Surface Water

As previously discussed under Section 2.1, there are two watercourses that cross the study area generally flowing from northwest to southeast towards Lake Ontario. As shown on Figure 2, these watercourses include:

- Spring Creek, adjacent to Chinguacousy Trail (OGF ID 127, 168, 565)
- Mimico Creek flowing generally southeast, but obviously redirected in the study area by previous construction at the adjacent trail and/or Williams Parkway-Torbram Road intersection. The creek flows from Professor's Lake in Brampton and drains to Lake Ontario. Within the study area, Mimico Creek flows northeast from North Park Drive towards Williams Parkway, then turns southeast at Williams Parkway and flows southerly adjacent to Torbram Road. along the Don Doan Trail adjacent to Williams Parkway, then southeast along Torbram Road, and continues to meander southeast beyond the study area.

Given the shallow depth to groundwater in the study area (see Section 3), it is possible that the base flow for the above watercourses is from groundwater and, therefore, they would be categorized as groundwater discharge areas. As a result, these watercourses could be susceptible to impact from construction dewatering. Additional discussions and recommendations regarding potential impacts to surface watercourses before and after construction are presented in Section 4 to 6.

3 Groundwater

3.1 Site Conditions

Shallow groundwater or indications of such were encountered at the site as follows:

- An unstable groundwater level was measured at 5.6 mbgs in borehole TC3; however, EC1 was dry after drilling.

No information reviewed provided a direction of shallow groundwater flow from monitoring wells or its quality (i.e., chemistry).

3.1.1 HYDRAULIC CONDUCTIVITY

Hydraulic conductivity testing was conducted on January 26, 2023, at two monitoring wells within the boulevard adjacent to Williams Parkway. Specifically, at EC1 installed in the silt and sand overlying the bedrock (screened from approximately 2.5 to 5 mbgs; elevations 217.0 to 215.5 masl), and TC3 installed in the shale bedrock (screened from approximately 4.6 to 6.1 mbgs; elevations 208.7 to 206.2 masl). The results were 6.7×10^{-9} m/s and 2.1×10^{-6} m/s, respectively, which is typical of a shale and glacial till (Freeze and Cherry, 1979). Note the groundwater level in these monitoring wells had stabilized between 3 to 4 mbgs. In EC1 the groundwater table was within the well screen, and in TC3 the well screen was submerged below it. For construction dewatering estimates, using the higher conductivity for the shale bedrock is recommended.

3.1.2 LONG TERM GROUNDWATER MONITORING

EC1 was installed near a segment of the Spring Creek (OGF ID 127, 168, 565) that crosses the study area between Maitland Park and Hilldale Park along Williams Parkway near the intersection with the Chinguacousy Trail (see Figure 1). The monitoring well was installed by Terraprobe on October 19, 2022, to an approximate depth of 4.1 mbgs. A groundwater level logger (Solinst) was placed in the well from December 14, 2022, to January 16, 2024, to record the groundwater levels in the well for approximately a year. The results and graphical analysis are presented in Appendix C. Graph 2 shows that barometric pressure apparently has no effect on groundwater levels. Barometric pressure data was not available after July 2023, therefore, groundwater levels presented thereafter are in meters of H_2O (Graph 1).

Two major decreases in groundwater levels observed on December 14, 2022, and January 5, 2023, are artifacts of groundwater sampling and monitoring activities. Except for those events, the overall groundwater levels did not show significant variations during the approximately one-year period. Based on the barometrically corrected groundwater level data presented in Graph 2, there is an approximately 4 m of groundwater column in EC1, and the groundwater elevation at EC1 ranged from 219.993 to 219.751 masl given the elevation at bottom of the hole is 215.500 m surveyed to geodetic (Terraprobe, 2022). Maximum groundwater elevation was observed on February 9, 2023, at 219.751 masl, and the minimum groundwater elevation was observed on June 11, 2023, at 218.993 m.

Monitoring well TC3 was installed near the intersection of Torbram Road and Williams Parkway. The well was installed by Terraprobe on September 14, 2022, to an approximate depth of 6.1 metres below ground surface (mbgs). A groundwater level logger was placed in the well to record groundwater levels twice daily for approximately a year from March 24 to July 25, 2023. During this period, daily and seasonal fluctuations of groundwater elevations were recorded. Groundwater elevation was higher in March and the beginning of May and then a decreasing trend until approximately mid-July (Graph 5). Overall, groundwater elevations were relatively stable and ranged from 209.440 m to 209.060 m during the monitoring period given a bottom of hole a 205.900 masl (Terraprobe, 2022). The maximum groundwater elevation was observed on April 1, 2023, and minimum on June 21, 2023. As previously mentioned, the effect of barometric pressure on groundwater levels appears to be minimal (see Graph 4).

Groundwater elevation is higher at EC1 than TC3 during the monitoring period, likely due to the depth of screen in the monitoring well. However, the groundwater level at TC3, which was installed deeper from ground surface, has less fluctuations compared to EC1. Daily rainfall data is from the weather station at Toronto Pearson Airport. The peaks in groundwater level at EC1 appear to correlate to the major precipitation events.

3.1.1 GROUNDWATER ANALYTICAL RESULTS

Samples were collected from monitoring wells TC3 and EC1 on January 5, 2023, and analyzed for parameters applicable to the Region of Peel's storm (Table 2) and sanitary (Table 1) sewer use by-laws and dissolved metals to evaluate potential treatment required during future construction dewatering. Metals samples were field filtered to determine if filtering by 0.45 microns would eliminate metals exceedances if discharging to the sewer. All parameters met the Peel Region By-law Number 53-2010 guidelines for sanitary sewer. All parameters met the Peel Region By-law Number 53-2010 guidelines for storm sewer discharge except for total Kjeldahl nitrogen, total suspended solids, total manganese, total zinc, and di-n-butyle phthalate. Therefore, filtering would not eliminate the need for water treatment of metals prior to discharging to the storm sewer. Di-n-butyle phthalate is a manufactured chemical that does not occur naturally. It is used as a plasticizer and solvent. The source of this contaminant was not determined in the scope of this assessment, however a second round of groundwater sampling from TC1 and EC3 is recommended to confirm the exceedance.

3.2 Source Water

The Approved Source Water Protection Plan for the Toronto and Region Source Protection Regions (CTC Source Protection Region, 2015) was reviewed to identify potential threats in the study area and associated specific policies that may apply to the project. In summary:

- There are no Well Head Protection Areas (WHPAs) or Significant Groundwater Recharge Areas (SGRAs) within the study area.
- There are no intake protection zones (IPZs) associated with municipal supply intakes in Lake Ontario near the study area.

The CTC Source Protection Plan was reviewed to determine if the project would potentially effect source water in the study area. The project is within the Toronto & Region Source Protection Area (TRSPA), all relevant findings are summarized as follows:

- Most drinking water with in the TRSPA is from Lake Ontario, with a small percentage being from groundwater; however, all drinking water within the study area is from Lake Ontario.
- Locally shallow sodium and chloride concentrations can increase in urbanized areas due to road salting, but groundwater quality is generally of good quality. There are naturally elevated concentrations of iron, manganese, and hardness.
- There were no long-term Permits for groundwater (or surface water) takings identified within the study area.
- The overburden thickness was in the "Low" range presented on the applicable map.
- There were no WHPAs within or near the study area.
- There are no SGRAs within or near the study area.

- There are Highly Vulnerable Aquifers (HVAs) throughout the study area, but this is common and not necessarily and concern.
- There are no policies that would affect the project.

The on-line interactive Source Water Protection Information Atlas (MECP, 2018) was subsequently reviewed for the study area and the relevant results are summarized as follows:

- It was confirmed there are no WHPAs, SGRAs, or IPZs in the study area.
- The nearest SGRA is 6 km northwest of the study area.
- There are numerous shallow HVAs throughout the study area.

Based on the above information, there are no source water concerns related to groundwater with respect to the proposed project.

The most significant threat the project would pose to drinking source water would be if it were to cause a major sanitary sewer main break that released substantial sewage to one of the water courses crossing the study area and from there potentially to water treatment plant intakes in Lake Ontario. There is no specific policy that would apply to the project because the developed policy applies to the MECP's Spills Action Centre (SAC), specifically the SAC would be required to notify the applicable water treatment plant operators of such an event. Additionally, the threat of contaminating the HVAs within the study area (an aquifer with very little natural protection from sewage, chemicals, and other substances), therefore, typical mitigation measures should be implemented.

3.3 Municipal Use

Parsons did not contact the municipality regarding municipal water supply in the study area. Due to information reviewed under Section 3.2, it evident that the study area is highly urbanized with most properties connected to municipal drinking water systems that are supplied from Lake Ontario.

3.4 PTTWs and EASRs

A search of MECP's PTTWs database was completed in October 2023 (see https://www.ontario.ca/environment-and-energy/map-permits-take-water). There were no active or inactive permits identified within 1 km of the study area.

The MECPs Environmental Activity and Sector Registry (EASR) was searched (see https://www.ontario.ca/page/list-environmental-approvals-and-registrations) for EASRs and PTTWs within 1 km of the study area in February 2024. As indicated by Figures 1 and 2, two EASRs and one PTTW was identified in the study area, details are outlined below:

Approval Type	Business	Date	Status
PTTW	The Regional Municipality of Peel	May 2017	Expired
EASR	Premium Body Shop Inc.	December 2019	Registered
EASR	Zora Transport Ltd.	August 28, 2015	Registered

Due to the nature of the registrations (expired or for auto repair) and the distance from the project extent, they are not relevant to this project.

3.5 Water Wells

A search of the MECP water well records database was completed for the study area. The locations of wells identified by the search are presented in Figures 5. In summary, a total of 9 wells were identified within the study area, two water supply wells and 7 other well records. Details of the water well records search are presented in Appendix A.

The following table summarizes relevant information from the water well records.

Average Well Depth (m)	Average Depth to Bedrock (m)	Minimum Depth to Groundwater (m)	Maximum Depth to Groundwater (m)	Average Depth to Groundwater (m)
12.0	Not Encountered	3.0	3.0	3.0

It is noteworthy that:

- Bedrock appears relatively deep throughout the study area (i.e., not included in any of the well records), however, was intersected in the monitoring wells installed in the watercourse valleys during this assessment.
- Only two well records had a recorded depth to water level.

Fifteen of the water well records were recent (2014 to 2018) and did not include static groundwater levels indicating these were unlikely to be water supply wells. These wells are more likely test holes where no wells were installed (i.e., holes abandoned upon completion). Two of the water well records dated back to 1956 ad 1958, respectively, indicating that some older water wells may still exist in the study area and such wells may still be in use by their owners. Any further evaluations would require field verification activities. The list of water well records in the study area is presented in Appendix A.

4 Construction Dewatering

Based on the findings of the hydrogeological assessment, construction dewatering may be required within the project area at culverts in watercourse valleys.

The MECP requires a PTTW and/or EASR for groundwater takings exceeding 50,000 liters per day (L/day). For construction dewatering, a PTTW is required for dewatering rates that exceed 400,000 L/day or if the project does not qualify for an EASR. An EASR is required for a rate between 50,000 and 400,000 L/day unless a Category two PTTW is applicable. An EASR or PTTW are not required for taking less than 50,000 L/day.

Groundwater control or dewatering should be designed and implemented by a specialist contractor and with target draw-down of the groundwater table to a depth of at least one metre below the applicable excavation’s base, or as necessary to ensure stable conditions during excavation. Surface water should be diverted away from the excavation areas. Pumping discharge should comply with any requirements from the local municipalities and/or MECP and/or conservation authorities, if/as applicable.

It was not within the preliminary design scope for this hydrogeological assessment to complete dewatering calculations or obtain water taking permits.

5 Impact Assessment

Potential impacts to groundwater posed by the project identified by this hydrogeological study are provided in the following Sections 5.1 through 5.4.

5.1 Water Wells

There are two water wells in the study area that may be affected by the project and, more specifically, by construction dewatering that may be required. Additional mapping of water wells in these specific areas and desktop review would be required to develop a short list of wells that could be affected by the project, followed by mail surveys and/or field verification visits to mitigate potential impacts to these wells. It is unlikely that the two older private water wells are still being used based on their locations in the middle of Williams Parkway, and being in an area that is serviced by municipal distribution systems that are supplied from Lake Ontario.

5.2 Municipal Water Supply

Groundwater is not used by municipalities in or near the study area and, therefore, the project would not threaten such municipal drinking water supplies. However, the study area does include HVAs which are highly susceptible to contamination due to their geology and permeability. Therefore, any spill of chemicals or dewatering over land could impact the aquifer, so preventative measures should be established during construction to prevent any such incidents. The HVAs may have old shallow private water wells that are in use and, therefore, susceptible to impacts by the project due to potential construction dewatering.

5.3 Aquifers

Aquifers identified in the study area include numerous shallow HVAs and such HVAs are common in Source Water Protection Plans. The project in unlikely to result in impacts to these HVAs given the municipal water supply system discussed in Section 5.2 and the water quality results from this hydrogeological assessment, which indicate that groundwater in the study area where construction dewatering may be required does not appear to be contaminated and generally of good quality as discussed in Section 3.1.1.

5.4 Surface Water Bodies

As discussed in Section 2.6, two watercourses cross the study area:

- Spring Creek adjacent to the Chinguacousy Trail (OGF ID 127, 168, 565)
- Mimico Creek flows generally south and east from Professor's Lake in Brampton and feeds into Lake Ontario. Within the study area, Mimico Creek flows east from North Park Drive towards Williams Parkway, turns northeast at Williams Parkway along the Don Doan Trail adjacent to Williams Parkway, then southeast along Torbram Road, and continues to meander southeast beyond the study area.

Given the shallow depth to groundwater in the study area (see Section 3), it is possible that the base flow for the above watercourses is from groundwater and, therefore, they would be categorized as groundwater discharge areas. There is a potential for construction dewatering to interfere with surface water levels in these creeks or the discharge could impact the creeks and streams in the event of a direct or overland discharge. Such interferences and/or impacts are typically mitigated by conditions of PTTWs or the EASR water taking and discharge plans.

6 Impact Mitigation

If construction dewatering is anticipated within the project extent where deeper excavation will be required, the applicable approvals should be obtained well before construction activities commence. Construction dewatering may interfere with surface water levels in watercourses that cross the study area, and the dewatering discharge has the potential to impact the watercourses if not properly managed. These impacts and interferences would be mitigated by adhering to the requirements of the water taking approvals (PTTW/EASR).

Based on a search of MECP water well records, 12 wells were identified within the study area of the project that may require abandonment before or during construction in accordance with O.Reg. 903 (as amended). These wells need to be properly identified and locations provided to the construction contractor such that they are not inadvertently destroyed before they can be properly abandoned. Only an MECP licensed Well Contractor can abandon these wells. It may be preferable to abandon these under a single program.

Erosion and Sediment Control measures should be implemented and maintained during construction dewatering and construction zones should be isolated using standard perimeter silt fencing and additional erosion and sediment controls if required.

The combined dewatering rate from all sources should be considered when assessing the dewatering approval requirements for the project because some may be relatively close to others and dewatering activities may be concurrent. A more detailed understanding of the construction activities that may require dewatering is required to evaluate the need for construction dewatering and develop the dewatering estimates required to obtain PTTWs/EASRs.

Post-construction, the project has the potential to impact groundwater by infiltration drainage of melted snow during the deicing season and run-off from Williams Parkway that may result in salt related or other impacts to soil, groundwater, and surface water. Such drainage needs be controlled through the municipal storm sewer system that would be designed to mitigate impacts to groundwater and surface water.

Potential impacts to shallow HVAs are possible where construction dewatering discharge is directed to land surface greater than 30 m from a waterbody where it might infiltrate to an HVA. These impacts are typically addressed by the water taking approvals that require estimating the radius of influence and monitoring of the discharge quality and any private water wells within the ROI. This requires a better understanding of water wells that are in use within the study area proximal to the proposed dewatering locations. Discharging to the sanitary sewer would also mitigate such impacts, however, would not address interference with the quantity of groundwater in any private wells.

It is possible that permanent impermeable subsurface infrastructure installed for the project could affect groundwater flow patterns and levels up-gradient and down-gradient post construction. Such potential affects would be limited to areas of deeper infrastructure that are impermeable, and long and deep enough to result in such affects. These likely only exist where construction dewatering is anticipated because the remainder of the project involves only shallow construction activities. Currently these locations do not appear to include infrastructure that would be either deep and long enough to cause such effects, but current construction design information is very limited, and it appears that groundwater could flow around or under the currently proposed deeper infrastructure with only very localized effects on groundwater flow patterns.

7 Conclusions and Recommendations

The key findings of this study are as follows:

- Two watercourses flow across the study area incised into relatively deep valleys with the shale bedrock being only marginally deeper than the valleys' floors. The surface water courses could be affected by construction dewatering during any culvert work and the discharge could impact the water courses if not effectively managed. Obtaining and complying with the water taking approvals is typically sufficient to address such impacts.
- There are numerous HVAs in the study area; however, these are not used for municipal water supply and may only need consideration where there is a potential for construction dewatering. Specifically, there may be old private water wells that are still being used where either or both of quantity or quality of groundwater might be affected; however, such interferences/impacts are also typically addressed by the complying with the terms and conditions of applicable water taking approvals.
- The project is not likely to affect groundwater flow patterns in the study area post-construction as no deep foundations are involved.

The following is recommended:

- When more detailed construction information is available, where applicable, complete dewatering calculations to estimate the rate of construction dewatering and ROIs to support water taking approvals.
- If applicable, obtain the necessary water taking approvals for construction dewatering.
- When more detailed construction design information is available for review, confirm there is no sufficiently deep impermeable proposed infrastructure that has the potential to permanently effect groundwater elevations and flow patterns down and up gradient.
- The areas where construction dewatering is required may be located near contaminated sites. Once determined, the estimated ROIs for construction dewatering should assessed for historical and current property uses that have potential to contaminate soil and groundwater.

8 References

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Source Water Protection Information Atlas, MECP, 2018

Ontario Hydro Network (OHN) – Watercourse, Ontario Ministry of Natural Resources and Forestry, October 10, 2019.

9 Statement of Limitations

This report has been prepared and the work referred to in this report has been undertaken by Parsons Inc. (Parsons) for The City of Brampton. It is intended for the sole and exclusive use of The City of Brampton, its affiliated companies and partners and their respective insurers, agents, employees and advisors (collectively, "The City of Brampton"). Any use, reliance on or decision made by any person other than The City of Brampton based on this report is the sole responsibility of such other person. The City of Brampton and Parsons make no representation or warranty to any other person with regard to this report and the work referred to in this report and they accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

The investigations undertaken by Parsons with respect to this report and any conclusions or recommendations made in this report reflect Parsons' judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information examined at the time of preparation of this report. This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by this investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

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TABLE 1

GROUNDWATER ANALYTICAL RESULTS
PEEL REGION SANITARY SEWER DISCHARGE

SAMPLE LOCATIONS	**TC3**	**EC1**	**TABLE 1 LIMITS[a]**
Paracel Certificate of Analysis No.	**2301303**	**2301303**	
Paracel Sample ID	**2301303-01**	**2301303-02**	
Date Sampled (yyyy/mm/dd)	**2023/01/05**	**2023/01/05**	
PARAMETERS			
Biochemical Oxygen Demand	<2	<2	300
Total Cyanide	<0.01	<0.01	2
Fluoride	0.4	0.3	10
Total Kjeldahl Nitrogen	1.1	2.9	100
Phenolics	<0.001	<0.001	1.0
Total Phosphorus	0.20	0.31	10
Solvent Extractable Matter - Mineral/Synthetic	<0.5	<0.5	15
Solvent Extractable Matter - Animal/Vegetable	<1.00	<1.00	150
Total Suspended Solids	83	40	350
Total Aluminium*	0.02	8.21	50
Total Antimony*	<0.001	<0.001	5
Total Arsenic*	<0.01	<0.01	1
Total Cadmium*	<0.001	<0.001	0.7
Total Chromium*	<0.05	<0.05	5
Total Cobalt*	<0.001	0.007	5
Total Copper*	<0.005	<0.005	3
Total Lead*	<0.001	0.006	3
Total Manganese*	0.06	1.26	5
Total Mercury*	<0.0001	<0.0001	0.01
Total Molybdenum*	<0.005	0.007	5
Total Nickel*	<0.005	<0.005	3
Total Selenium*	<0.005	<0.005	1
Sulphate	160	920	1500
Chloroform	<0.0005	<0.0005	0.04
1,2-Dichlorobenzene	<0.0005	<0.0005	0.05
1,4-Dichlorobenzene	<0.0005	<0.0005	0.08
Cis-1,2-Dichloroethylene	<0.0005	<0.0005	4
Trans-1,3-Dichloropropylene	<0.0005	<0.0005	0.14
Ethyle Benzene	<0.0005	<0.0005	0.16
Total Silver	<0.001	<0.001	5
Total Tin	<0.01	<0.01	5
Total Titanium	<0.01	0.25	5
Total Zinc	0.62	2.45	3
Benzene	<0.0005	<0.0005	0.01
Mythylene Chloride	<0.0050	<0.0050	2
1,1,2,2-Tetrachloroethane	<0.0005	<0.0005	1.4
Tetrachloroethylene	<0.0005	<0.0005	1
Toluene	<0.0005	<0.0005	0.27
Trichloroethylene	<0.0005	<0.0005	0.4
Xylenes	<0.0005	<0.0005	1.4
Di-n-butyle phthalate	0.040	0.035	0.08
Bis (2-ethylhexyl) phthalate	<0.001	0.002	0.012
Polychlorinated Biphenyls	<0.05	<0.05	0.001
Methyl Ethyl Ketone	<0.0050	<0.0050	8.0
Styrene	<0.0005	<0.0005	0.2
Nonylphenols	-	-	0.02
Nonylphenol Ethoxylates	-	-	0.2

a - Peel Region By-law Number 53-2010

"-" - Not analyzed

<u>BOLD</u> - Exceeds applicable limit

Results for all parameters are reported in milligrams per litre (mg/L)

The specific date each sample was analyzed is presented in the laboratory Certificates of Analysis.

* - Samples were field filtered and analyzed as total

TABLE 2

GROUNDWATER ANALYTICAL RESULTS
PEEL REGION STORM SEWER DISCHARGE

SAMPLE LOCATIONS	TC3	EC1	TABLE 2 LIMITS[a]
Paracel Certificate of Analysis No.	**2301303**	**2301303**	
Paracel Sample ID	**2301303-01**	**2301303-02**	
Date Sampled (yyyy/mm/dd)	**2023/01/05**	**2023/01/05**	
PARAMETERS			
Biochemical Oxygen Demand (BOD5)	<2	<2	15
Total Cyanide	<0.01	<0.01	0.02
Total Kjeldahl Nitrogen	**1.1**	**2.9**	1
Phenolics (4AAP)	<0.001	<0.001	0.008
Total Phosphorus	0.20	0.31	0.4
Total Suspended Solids	**83**	**40**	15
Total Arsenic*	<0.01	<0.01	0.02
Total Cadmium*	<0.001	<0.001	0.008
Total Chromium*	<0.05	<0.05	0.08
Total Copper*	<0.005	<0.005	0.050
Total Lead*	<0.001	0.006	0.120
Total Manganese*	**0.06**	**1.26**	0.05
Total Mercury*	<0.0001	<0.0001	0.0004
Total Nickel*	<0.005	<0.005	0.08
Total Selenium*	<0.005	<0.005	0.02
Total Silver*	<0.001	<0.001	0.12
Total Zinc*	**0.62**	**2.45**	0.04
Benzene	<0.0005	<0.0005	0.002
Chloroform	<0.0005	<0.0005	0.002
1,2-Dichlorobenzene	<0.0005	<0.0005	0.0056
1,4-Dichlorobenzene	<0.0005	<0.0005	0.0068
Cis-1,2-Dichloroethylene	<0.0005	<0.0005	0.0056
Trans-1,3-Dichloropropylene	<0.0005	<0.0005	0.0056
Ethyle Benzene	<0.0005	<0.0005	0.002
Mythylene Chloride	<0.0050	<0.0050	0.0052
1,1,2,2-Tetrachloroethane	<0.0005	<0.0005	0.017
Tetrachloroethylene	<0.0005	<0.0005	0.0044
Toluene	<0.0005	<0.0005	0.002
Trichloroethylene	<0.0005	<0.0005	0.008
Xylenes	<0.0005	<0.0005	0.0044
Di-n-butyle phthalate	**0.040**	**0.035**	0.015
Bis (2-ethylhexyl) phthalate	<0.001	0.002	0.0088
PCBs	<0.05	<0.05	0.0004

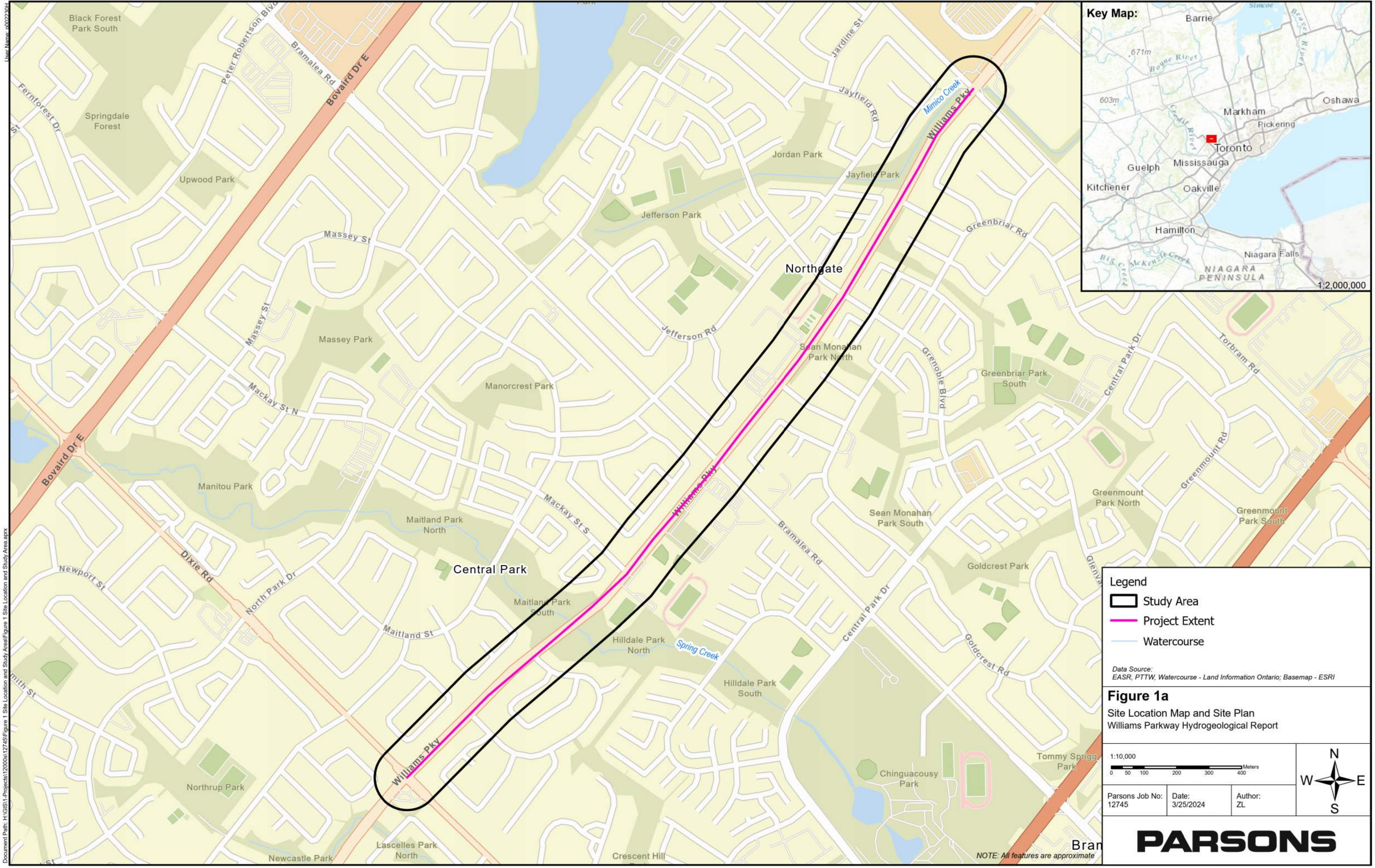
a - Peel Region By-law Number 53-2010
BOLD - Exceeds applicable limit

Results for all parameters are reported in milligrams per litre (mg/L)

The specific date each sample was analyzed is presented in the laboratory Certificates of Analysis.

* - Samples were field filtered and analyzed as total

Service Layer Credits: World Topographic Map: Esri, © OpenStreetMap contributors, HERE, Garmin, FAO, USGS, NGA, EPA, NPS, AAFC, NRCan



Legend

- ▭ Study Area
- Project Extent
- Watercourse

Data Source:
EASR, PTTW, Watercourse - Land Information Ontario; Basemap - ESRI

Figure 1a

Site Location Map and Site Plan
Williams Parkway Hydrogeological Report

1:10,000

0 50 100 200 300 400 Meters

N W E S

Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

User Name: p002230H

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 1 Site Location and Study Area\Figure 1 Site Location and Study Area.aprx

Service Layer Credits: World Topographic Map: Esri, © OpenStreetMap contributors, HERE, Garmin, FAO, USGS, NGA, EPA, NPS, AAFC, NRCan

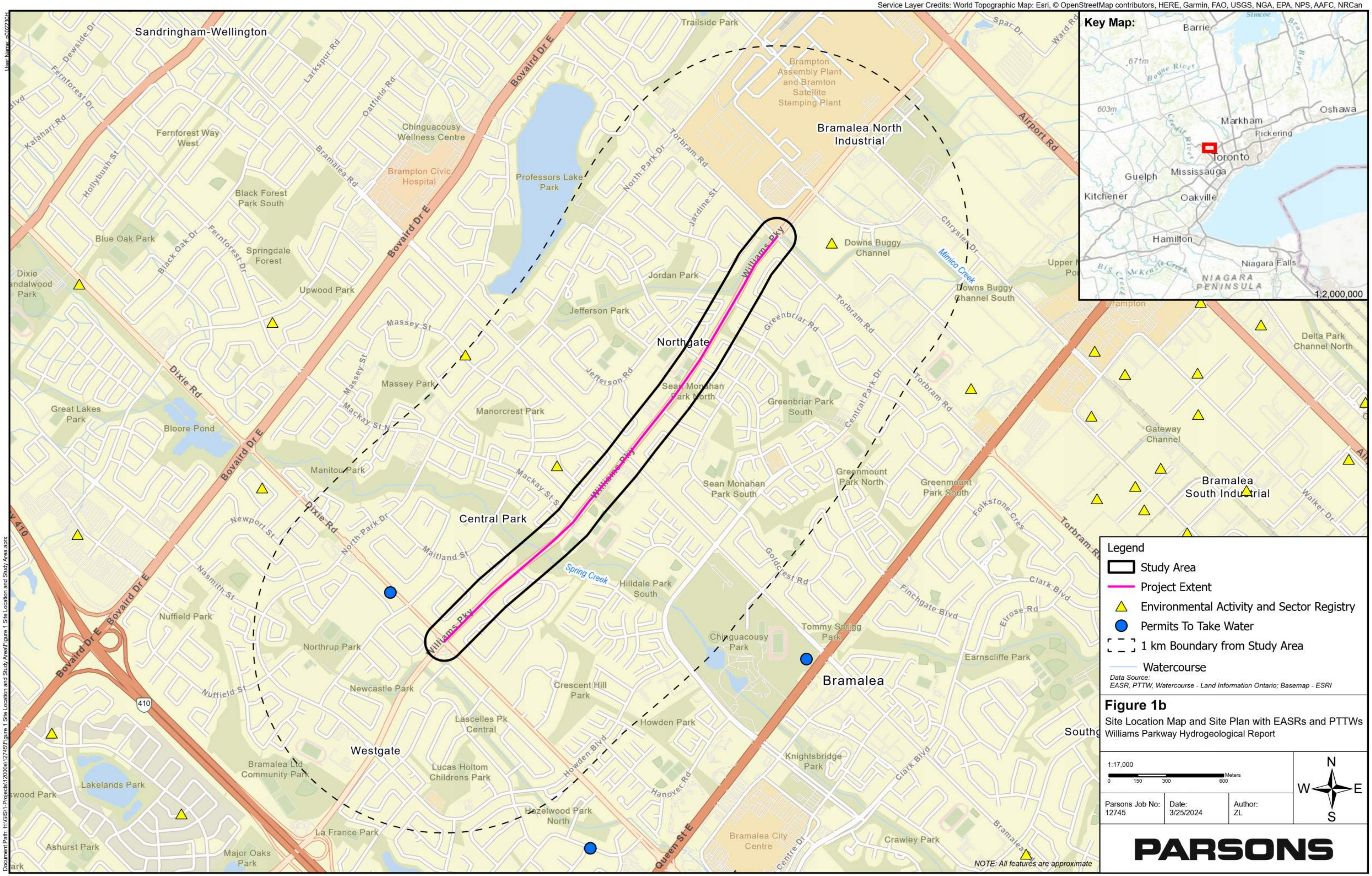


Figure 1b

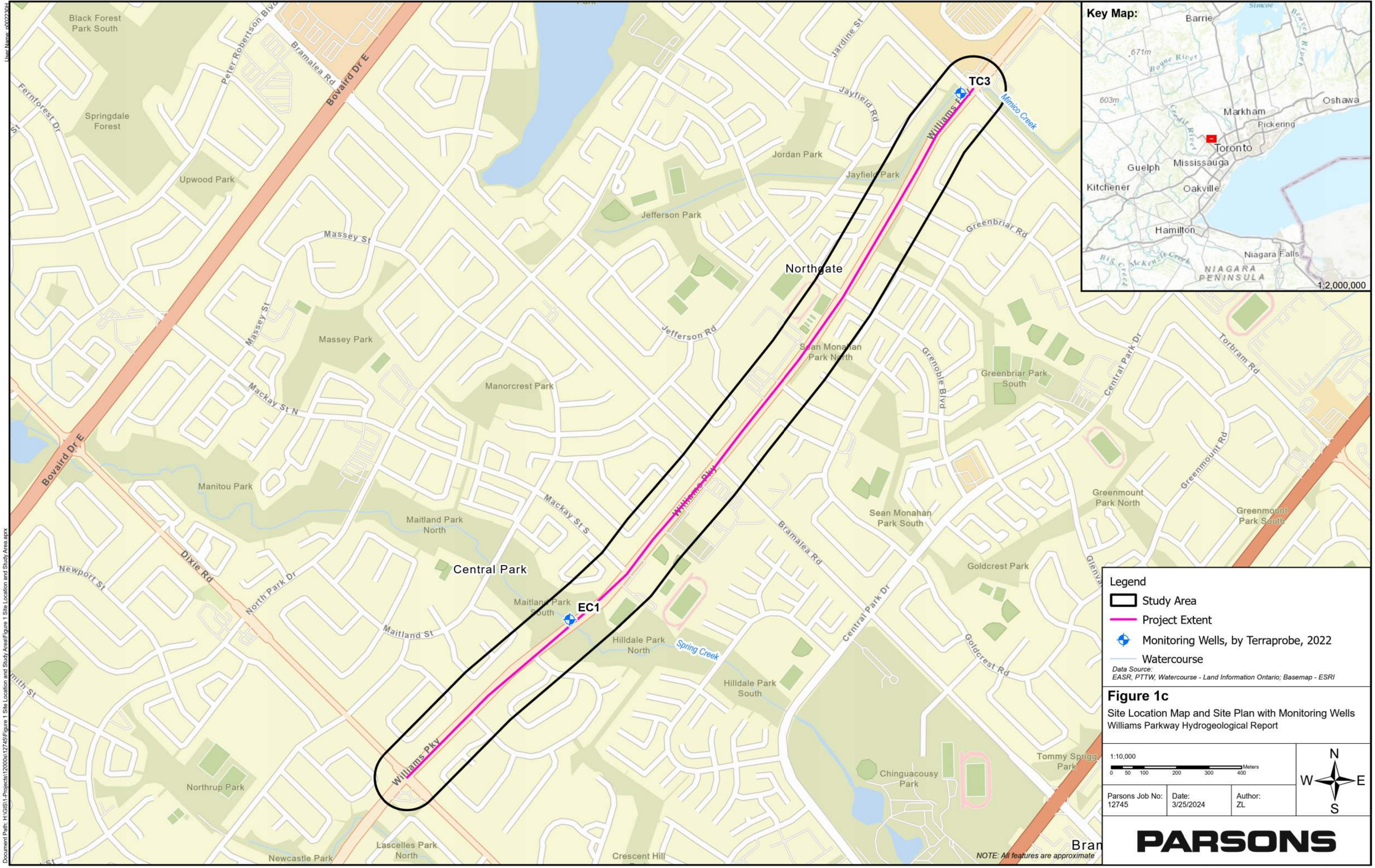
Site Location Map and Site Plan with EASRs and PTTWs
Williams Parkway Hydrogeological Report

Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

Service Layer Credits: World Topographic Map: Esri, © OpenStreetMap contributors, HERE, Garmin, FAO, USGS, NGA, EPA, NPS, AAFC, NRCan

User Name: p002230H



Legend

- ▭ Study Area
- ━ Project Extent
- ⊕ Monitoring Wells, by Terraprobe, 2022
- ─ Watercourse

Data Source:
EASR, PTTW, Watercourse - Land Information Ontario; Basemap - ESRI

Figure 1c

Site Location Map and Site Plan with Monitoring Wells
Williams Parkway Hydrogeological Report

1:10,000

0 50 100 200 300 400 Meters

N W E S

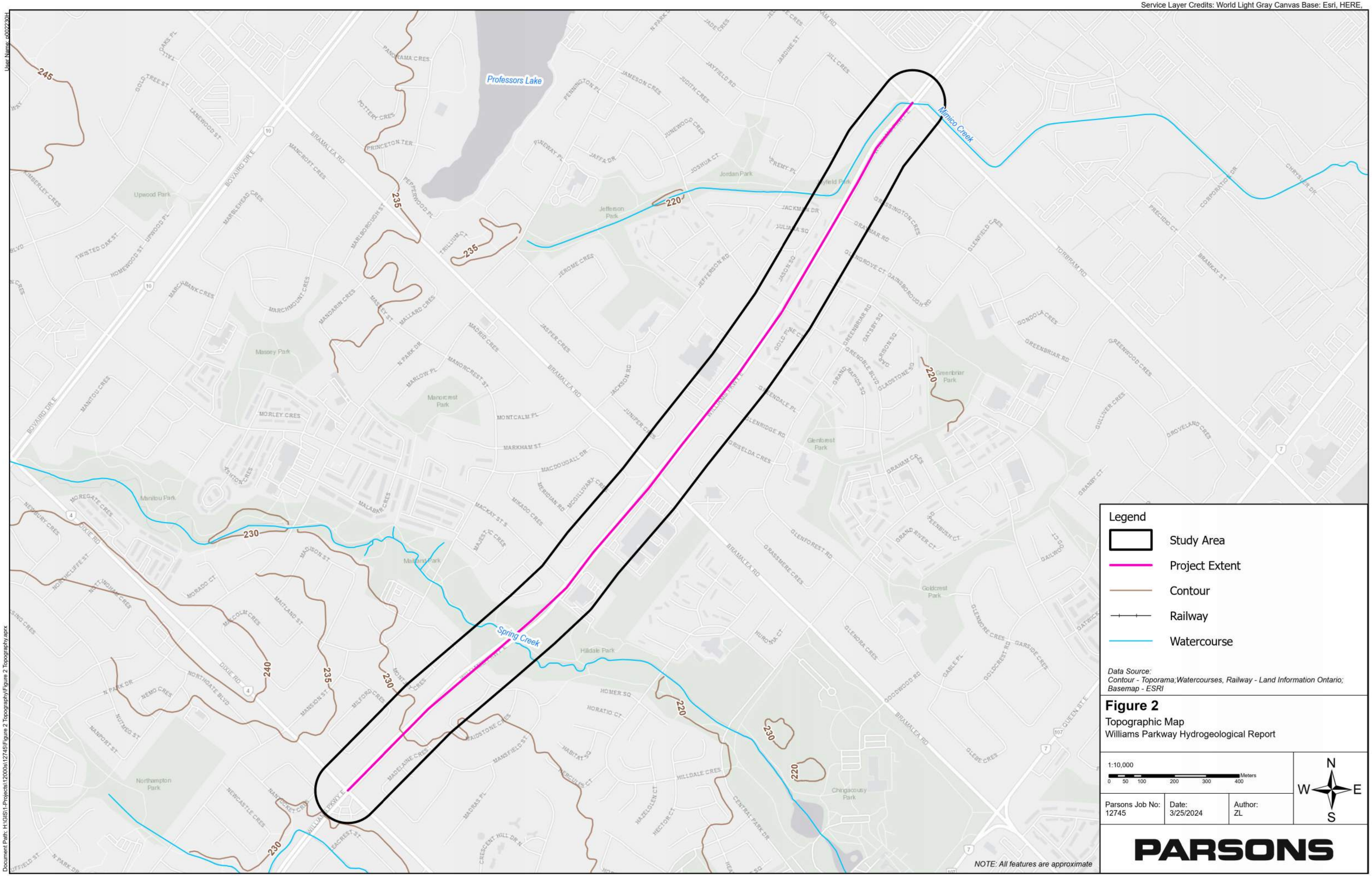
Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 1 Site Location and Study Area\Figure 1 Site Location and Study Area.aprx

Service Layer Credits: World Light Gray Canvas Base: Esri, HERE,

User Name: p002230H



NOTE: All features are approximate

Legend

- ▭ Study Area
- Project Extent
- Contour
- Railway
- Watercourse

Data Source:
Contour - Toporama;Watercourses, Railway - Land Information Ontario;
Basemap - ESRI

Figure 2

Topographic Map

Williams Parkway Hydrogeological Report

1:10,000

0 50 100 200 300 400 Meters

N W E S

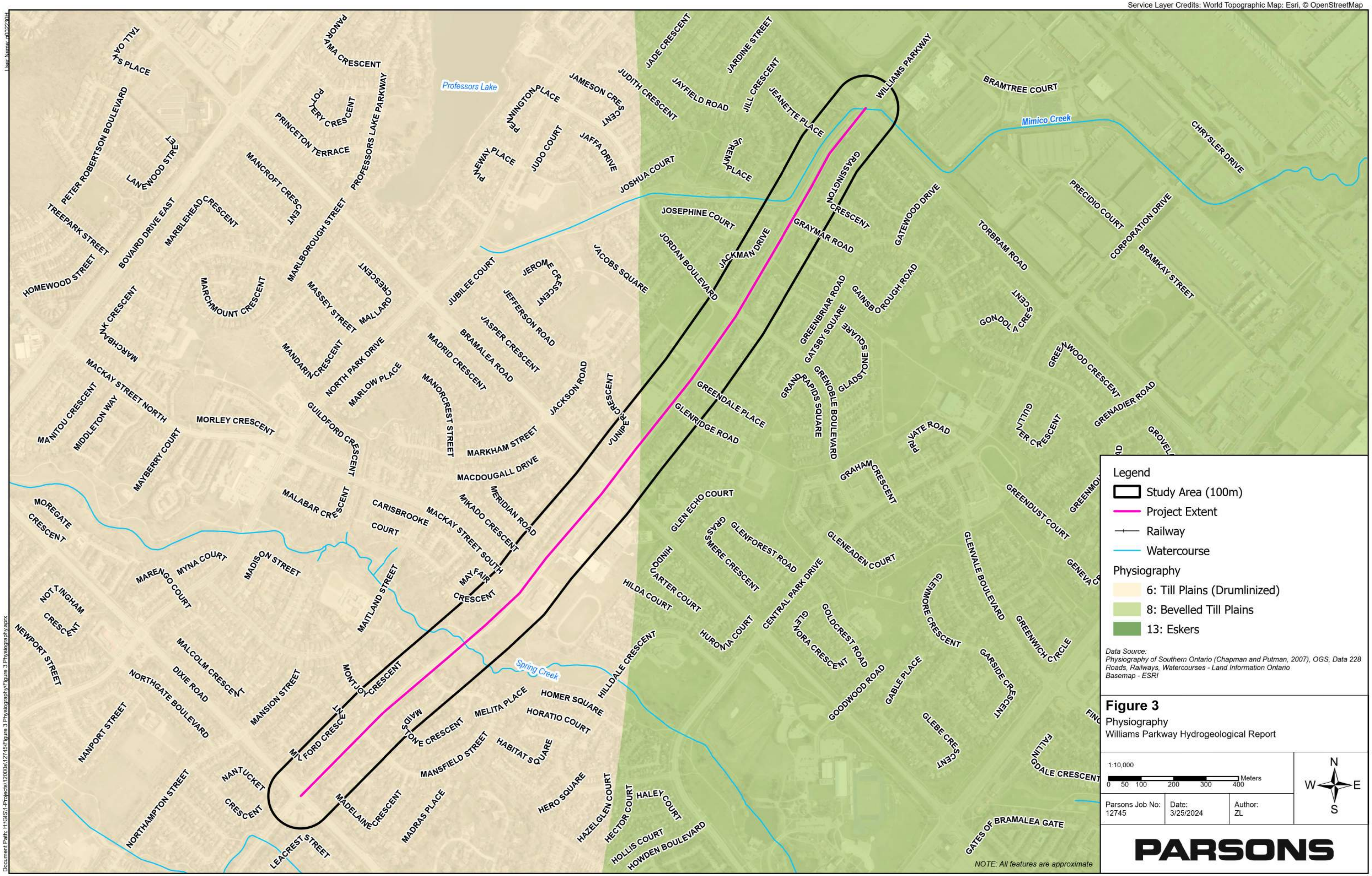
Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 2 Topography\Figure 2 Topography.aprx

Service Layer Credits: World Topographic Map: Esri, © OpenStreetMap

User Name: n0022230H



Data Source:
Physiography of Southern Ontario (Chapman and Putman, 2007), OGS, Data 228
Roads, Railways, Watercourses - Land Information Ontario
Basemap - ESRI

Figure 3
Physiography
Williams Parkway Hydrogeological Report

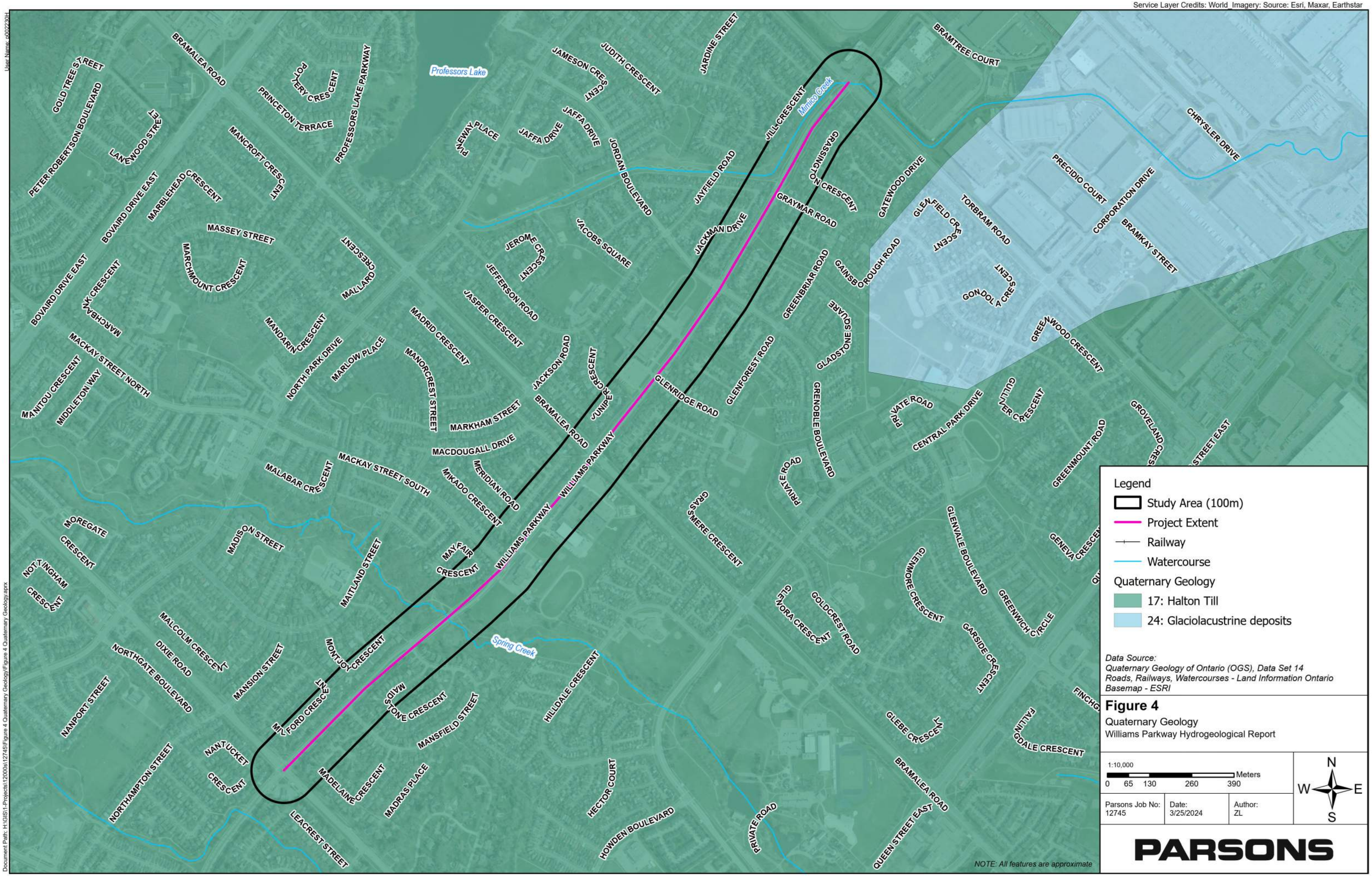
Parsons Job No: 12745
Date: 3/25/2024
Author: ZL

PARSONS

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 3 Physiography\Figure 3 Physiography.aprx

Service Layer Credits: World_Imagery: Source: Esri, Maxar, Earthstar

User Name: p0022230H



Legend

▭ Study Area (100m)

— Project Extent

—+— Railway

— Watercourse

Quaternary Geology

🟩 17: Halton Till

🟦 24: Glaciolacustrine deposits

Data Source:
Quaternary Geology of Ontario (OGS), Data Set 14
Roads, Railways, Watercourses - Land Information Ontario
Basemap - ESRI

Figure 4

Quaternary Geology
Williams Parkway Hydrogeological Report

1:10,000

0 65 130 260 390 Meters

N
W E
S

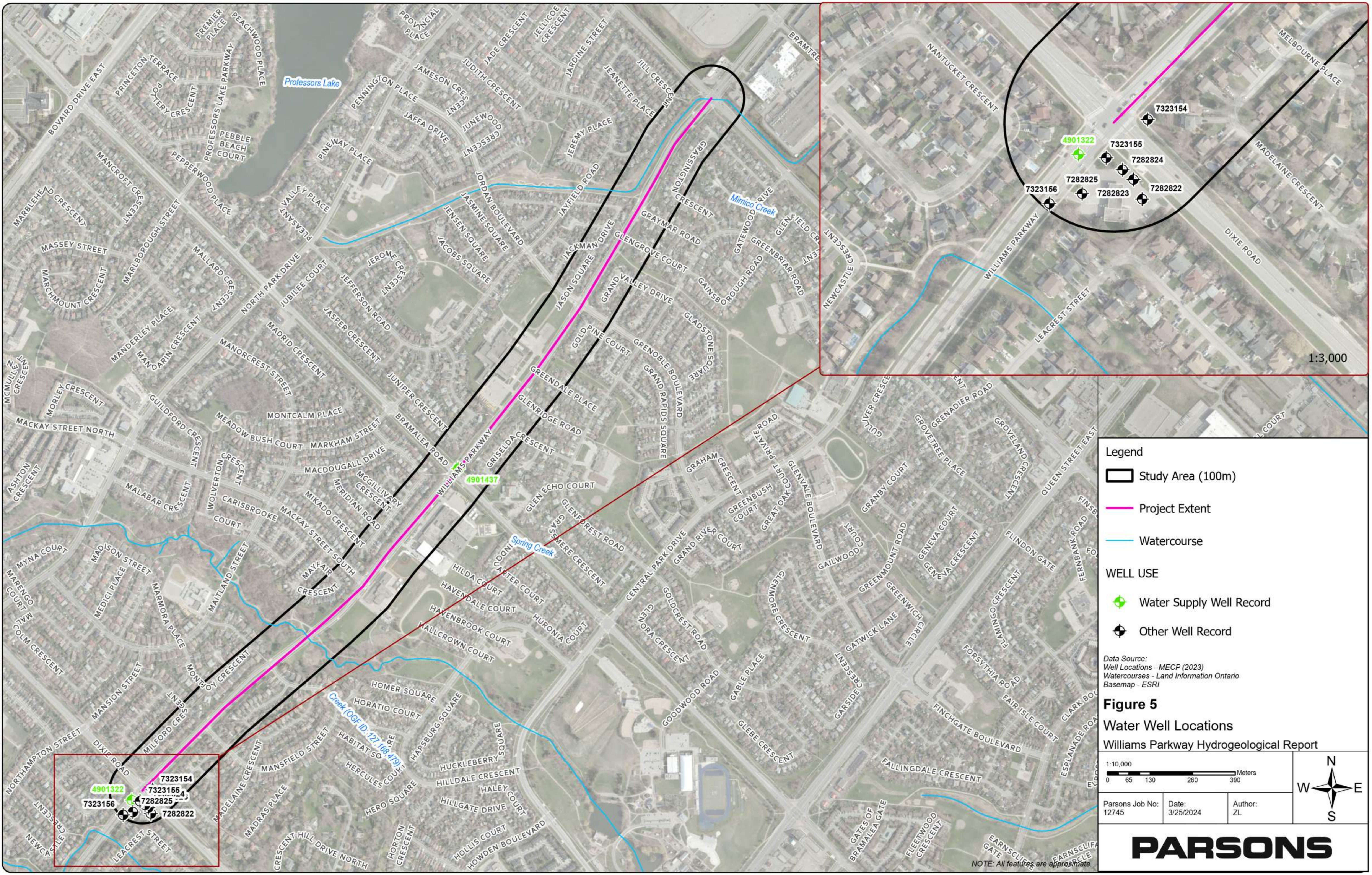
Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

NOTE: All features are approximate

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 4 Quaternary Geology\Figure 4 Quaternary Geology.aprx

User Name: p002230H



Data Source:
Well Locations - MECP (2023)
Watercourses - Land Information Ontario
Basemap - ESRI

Figure 5

Water Well Locations

Williams Parkway Hydrogeological Report

Parsons Job No:	Date:	Author:
12745	3/25/2024	ZL

PARSONS

Document Path: H:\GIS\1-Projects\12000s\12745\Figure 5 Water Well Search\Figure 5.aprx

APPENDIX A

Well Records in Study Area

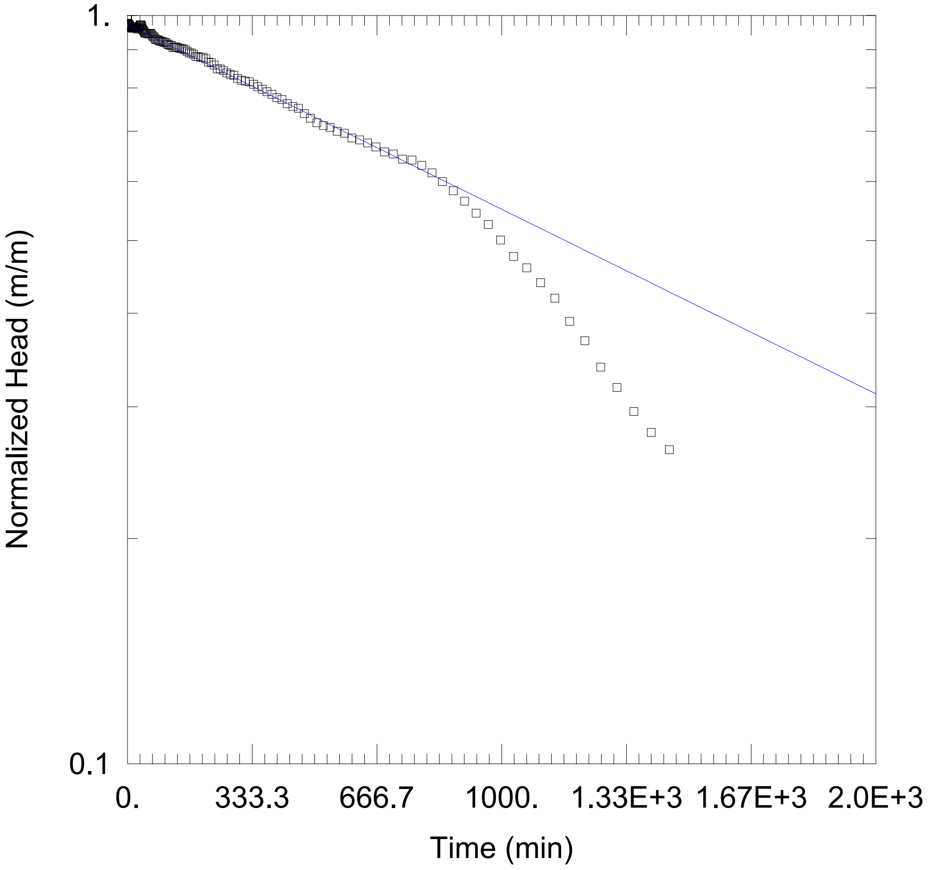
PARSONS

WELL ID	Date Completed	Depth (m)	Depth to Bedrock	Depth to WL (m)	Municipality	Coordinates
4901322	1958-10-31	20.7	N/A	3	BRAMPTON	17 601275 4842112 W
4901437	1956-08-11	34.1	N/A	3	BRAMPTON	17 602272 4843125 W
7282822	2017-02-07	5.8	N/A	N/A	BRAMPTON	17 601333 4842071 W
7282823	2017-02-03	6.1	N/A	N/A	BRAMPTON	17 601325 4842089 W
7282824	2017-02-08	6.1	N/A	N/A	BRAMPTON	17 601315 4842098 W
7282825	2017-02-18	6.1	N/A	N/A	BRAMPTON	17 601278 4842076 W
7323154	2018-06-06	9.1	N/A	N/A	BRAMPTON	17 601338 4842144 W
7323155	2018-06-06	12.2	N/A	N/A	BRAMPTON	17 601300 4842109 W
7323156	2018-06-06	9.1	N/A	N/A	BRAMPTON	17 601248 4842067 W

APPENDIX B

Hydraulic Conductivity Analysis

PARSONS



WELL TEST ANALYSIS

Data Set: C:\...\10-12745 - ANALYSIS - EC1 - test 1.aqt
Date: 03/22/23 Time: 08:51:15

PROJECT INFORMATION

Company: Parsons
Project: 10-12745
Location: Williams Parkway, Brampton ON
Test Well: EC1
Test Date: 2023-01-25

AQUIFER DATA

Saturated Thickness: 4. m
Anisotropy Ratio (Kz/Kr): 0.1

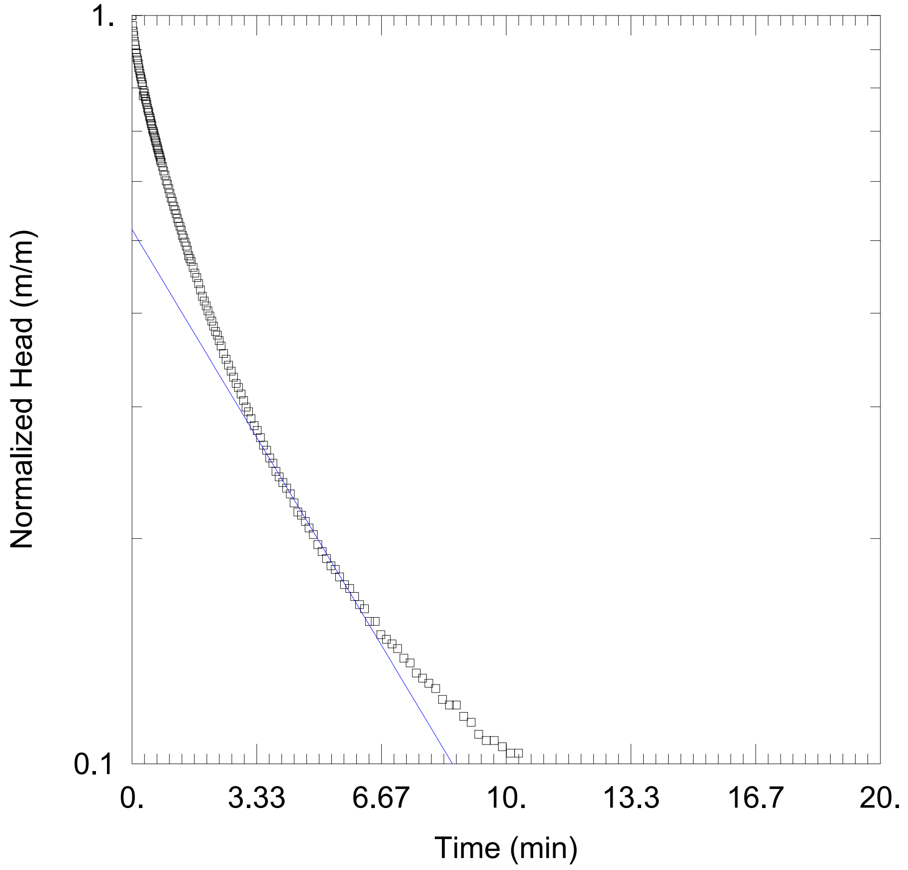
WELL DATA (EC1)

Initial Displacement: 0.487 m
Static Water Column Height: 3.54 m
Total Well Penetration Depth: 3.54 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.0762 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.744E-9 m/sec
y0 = 0.4733 m



WELL TEST ANALYSIS

Data Set: C:\...\10-12745 - ANALYSIS - TC3 - test 1.aqt
Date: 03/22/23 Time: 08:50:47

PROJECT INFORMATION

Company: Parsons
Project: 10-12745
Location: Williams Parkway
Test Well: TC3
Test Date: 2022-12-13

AQUIFER DATA

Saturated Thickness: 6.6 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (TC3)

Initial Displacement: 0.484 m
Static Water Column Height: 3.015 m
Total Well Penetration Depth: 3.015 m
Screen Length: 1.5 m
Casing Radius: 0.0254 m
Well Radius: 0.0762 m

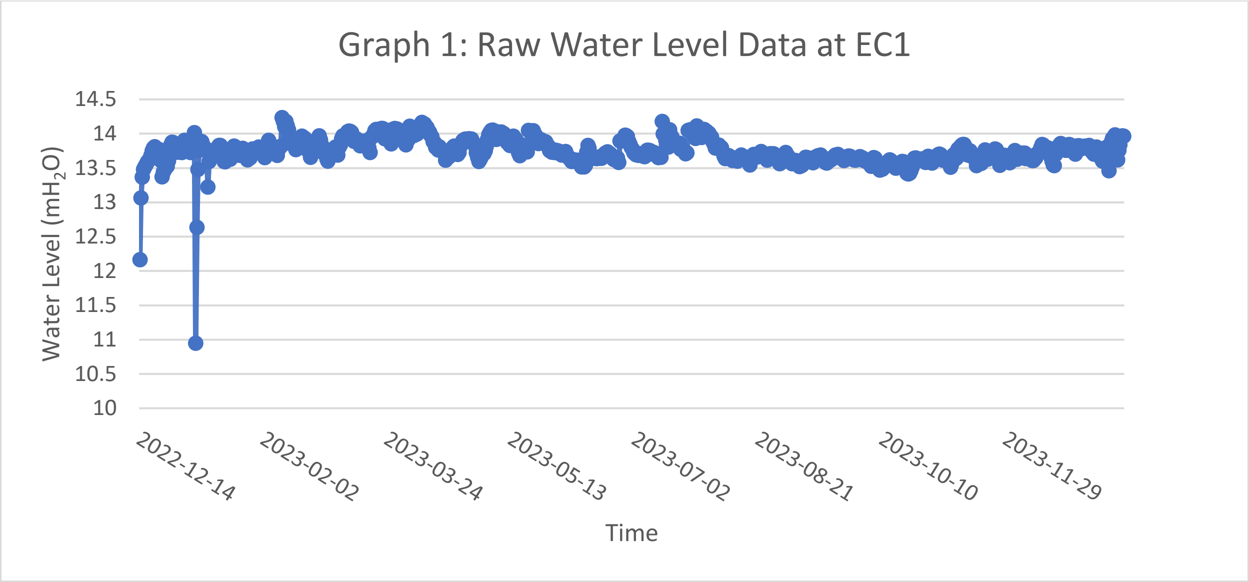
SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.102E-6 m/sec
y0 = 0.2505 m

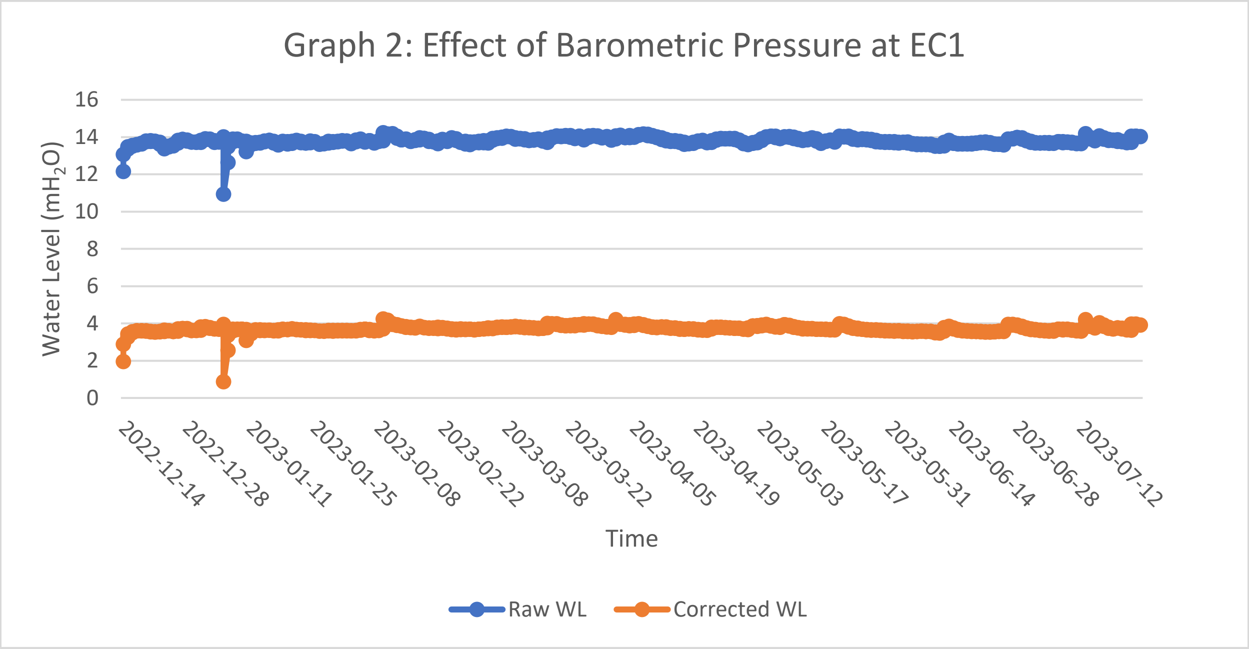
APPENDIX C

Long Term Groundwater Monitoring

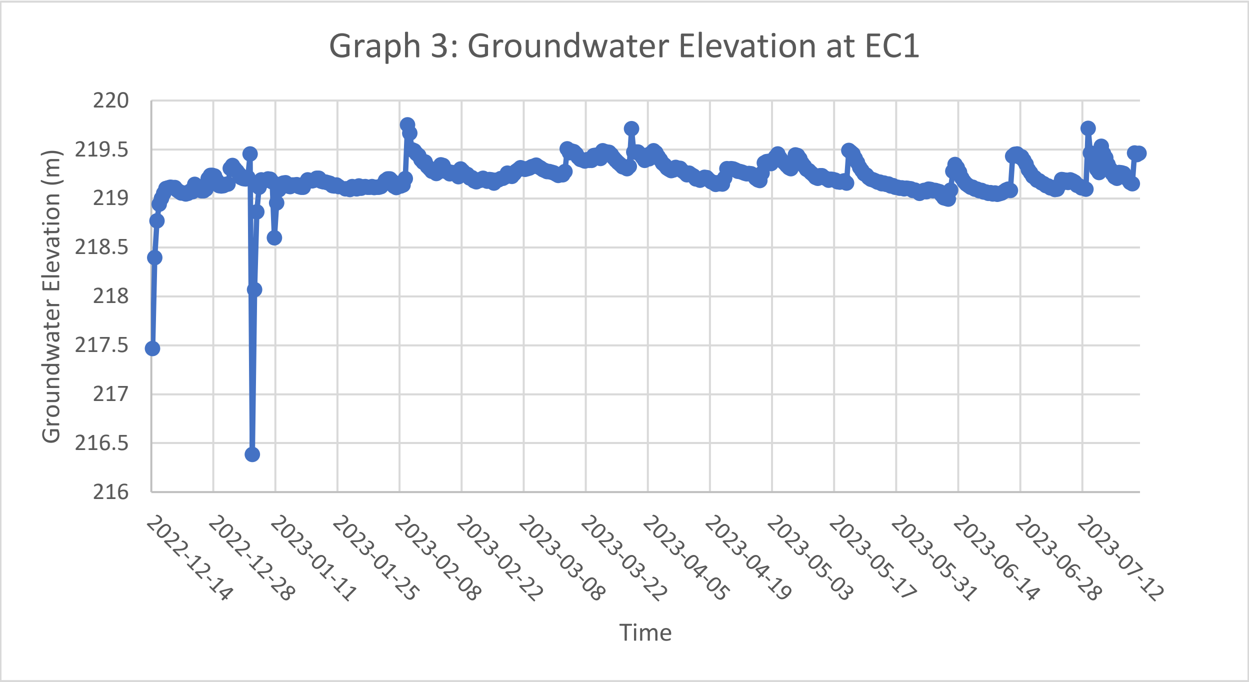
PARSONS

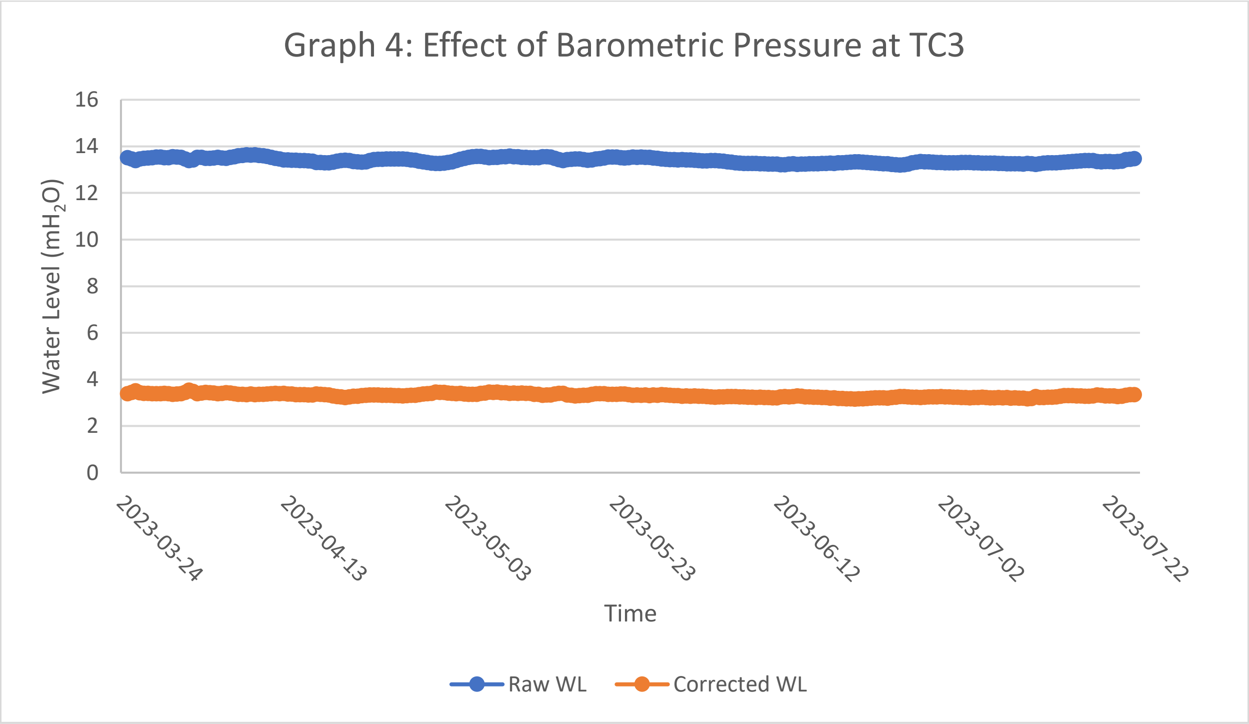


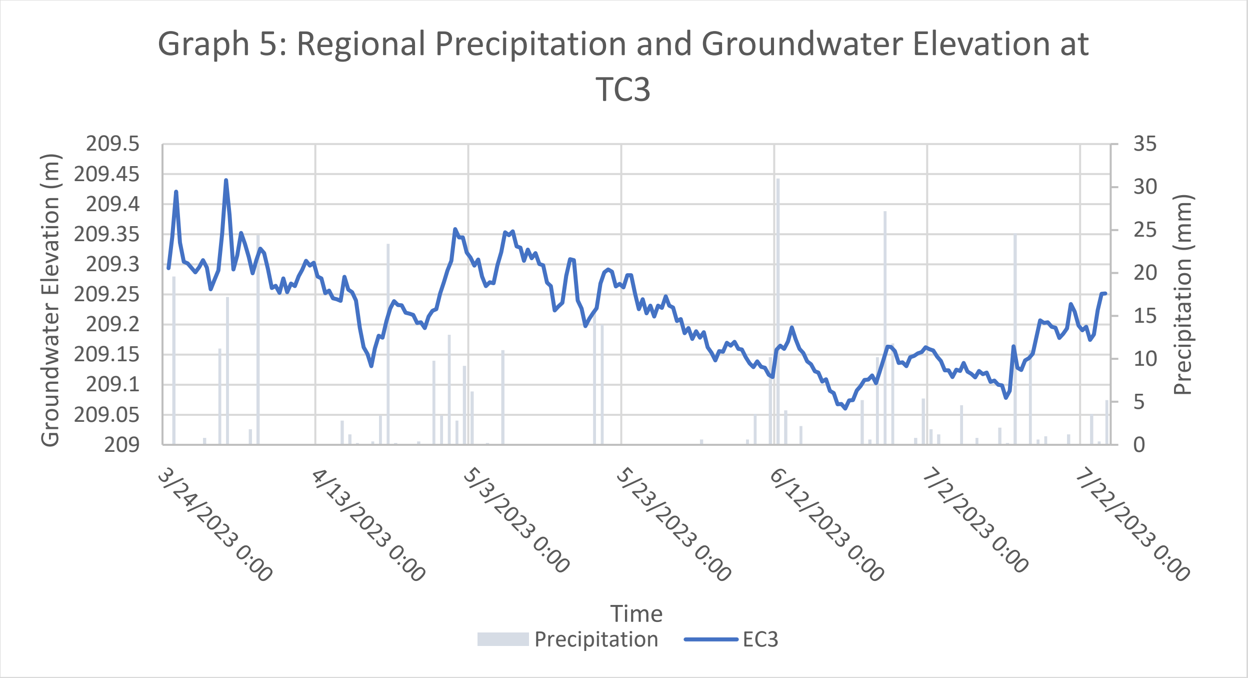
Graph 1: Raw Water Level Data at EC1

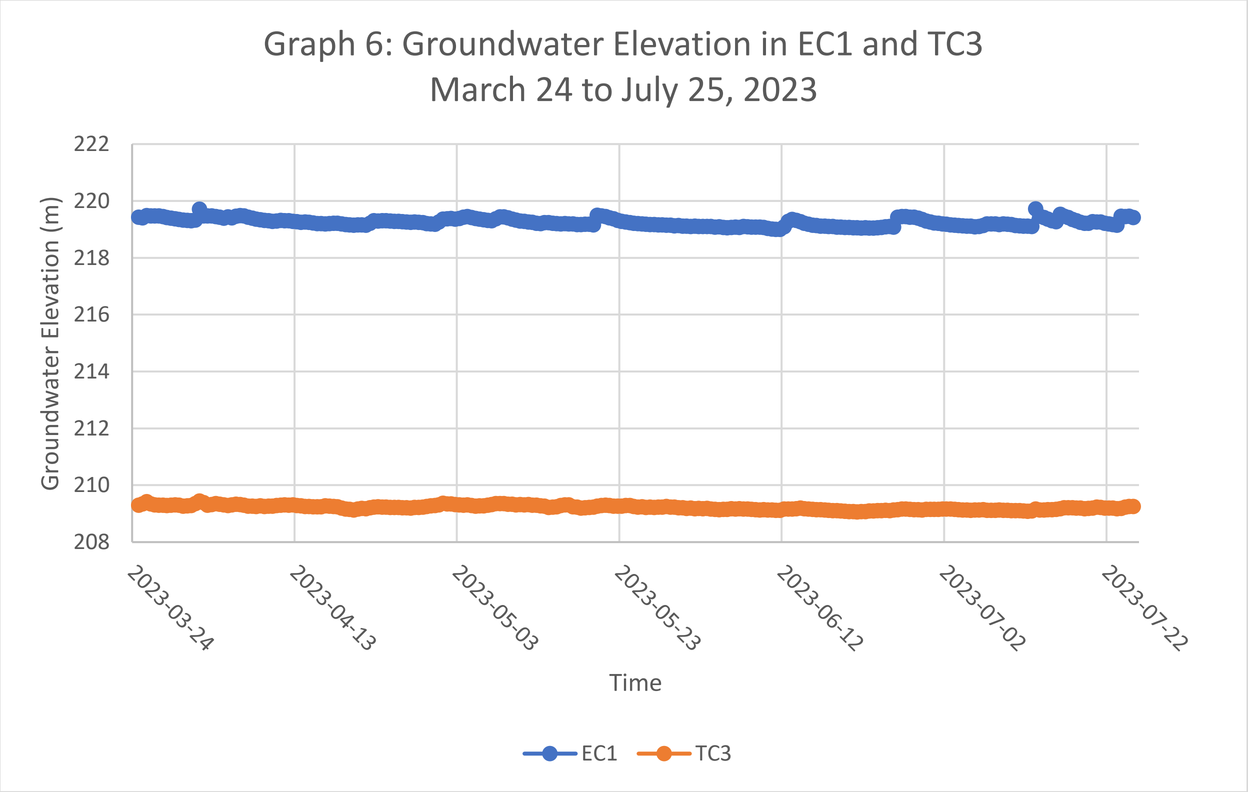


Graph 2: Effect of Barometric Pressure at EC1


Graph 3: Groundwater Elevation at EC1
Groundwater Elevation (m)
220
219.5
219
218.5
218
217.5
217
216.5
216
2022-12-14
2022-12-28
2023-01-11
2023-01-25
2023-02-08
2023-02-22
2023-03-08
2023-03-22
2023-04-05
2023-04-19
2023-05-03
2023-05-17
2023-05-31
2023-06-14
2023-06-28
2023-07-12
Time


Graph 4: Effect of Barometric Pressure at TC3
Water Level (mH2O)
16
14
12
10
8
6
4
2
0
2023-03-24
2023-04-13
2023-05-03
2023-05-23
2023-06-12
2023-07-02
2023-07-22
Time
Raw WL
Corrected WL


Graph 5: Regional Precipitation and Groundwater Elevation at TC3
Groundwater Elevation (m)
209.5
209.45
209.4
209.35
209.3
209.25
209.2
209.15
209.1
209.05
209
Precipitation (mm)
35
30
25
20
15
10
5
0
3/24/2023 0:00
4/13/2023 0:00
5/3/2023 0:00
5/23/2023 0:00
6/12/2023 0:00
7/2/2023 0:00
7/22/2023 0:00
Time
Precipitation
EC3


Graph 6: Groundwater Elevation in EC1 and TC3
March 24 to July 25, 2023
Groundwater Elevation (m)
222
220
218
216
214
212
210
208
2023-03-24
2023-04-13
2023-05-03
2023-05-23
2023-06-12
2023-07-02
2023-07-22
Time
EC1
TC3

APPENDIX D

Borehole Logs

PARSONS

LOG OF BOREHOLE EC1

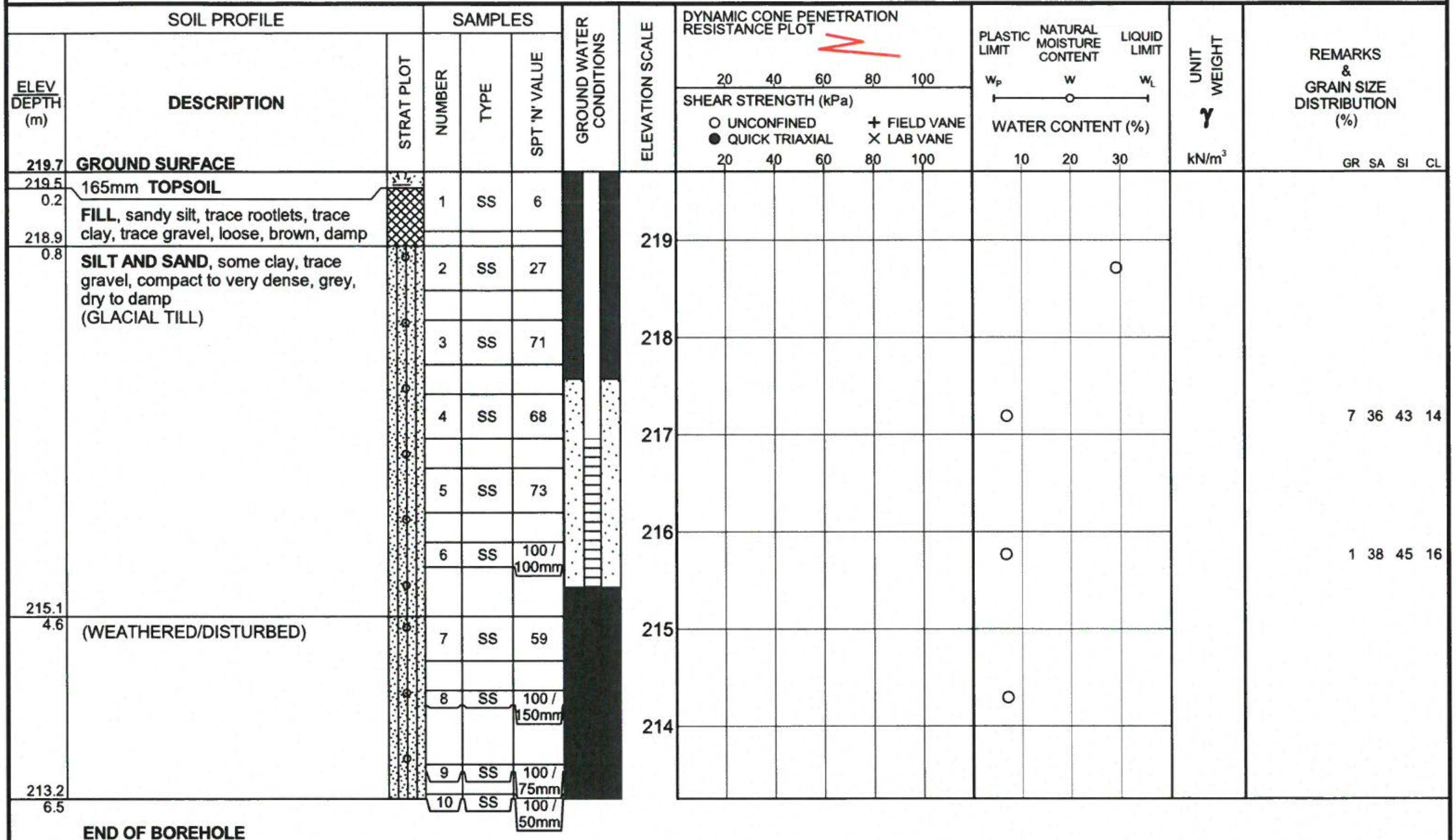
Project No. : 1-22-0499-01
Date started : October 19, 2022
Sheet No. : 1 of 1

Client : Parsons Corporation
Project : Williams Parkway
Location : Brampton, Ontario

Originated by : DH
Compiled by : SD
Checked by :

Position : E: 601805.7, N: 4842625.5 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers



ELEV DEPTH (m)	DESCRIPTION
219.7	**GROUND SURFACE**
219.5 0.2	165mm **TOPSOIL**
218.9 0.8	**FILL**, sandy silt, trace rootlets, trace clay, trace gravel, loose, brown, damp
215.1 4.6	**SILT AND SAND**, some clay, trace gravel, compact to very dense, grey, dry to damp (GLACIAL TILL)
213.2 6.5	(WEATHERED/DISTURBED)

NUMBER	TYPE	SPT 'N' VALUE	GR	SA	SI	CL
1	SS	6				
2	SS	27				
3	SS	71				
4	SS	68	7	36	43	14
5	SS	73				
6	SS	100 / 100mm	1	38	45	16
7	SS	59				
8	SS	100 / 150mm				
9	SS	100 / 75mm				
10	SS	100 / 50mm				

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

+ 3, × 3: Numbers refer to Sensitivity   ○ 3% STRAIN AT FAILURE

Terraprobe

LOG OF BOREHOLE TC3

Project No. : 1-22-0499-01
Client : Parsons Corporation
Originated by : SM

Date started : September 14, 2022
Project : Williams Parkway
Compiled by : SD

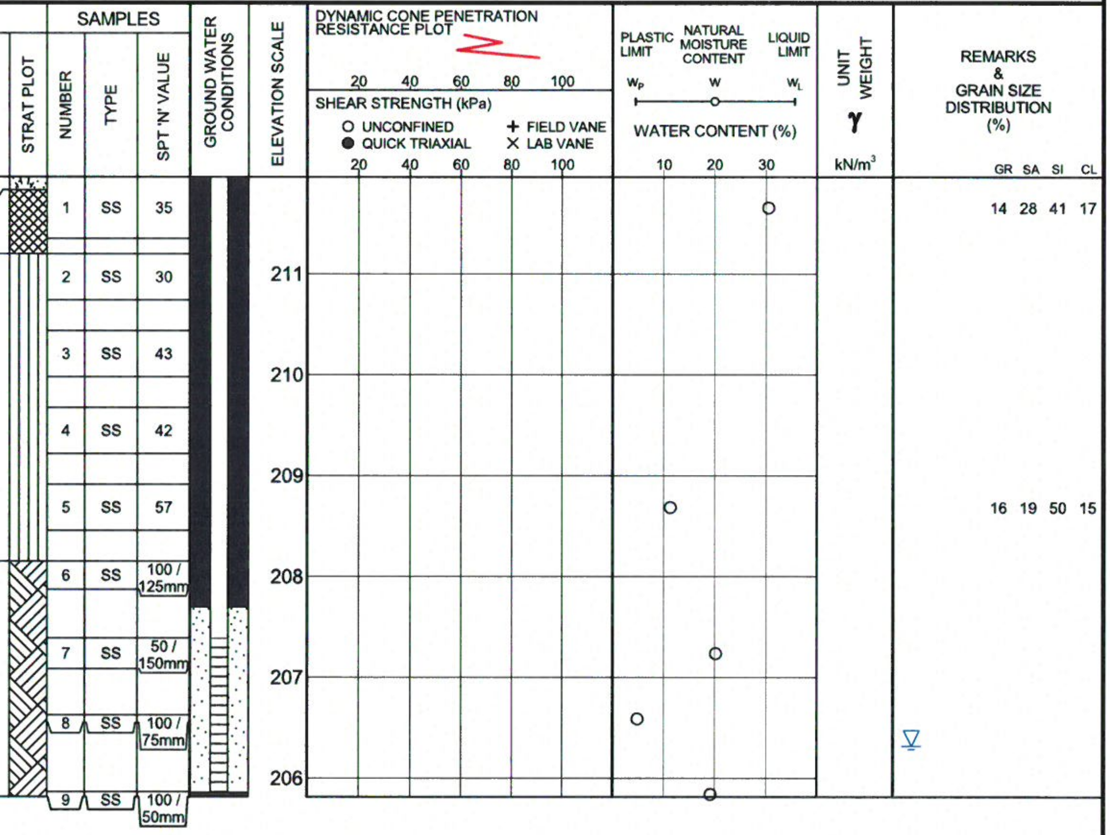
Sheet No. : 1 of 1
Location : Brampton, Ontario
Checked by :

Position : E: 603005.4, N: 4844241.3 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Hollow stem augers

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION
212.0	**GROUND SURFACE**
	125mm **TOPSOIL**
	FILL, sandy silt, some clay, some gravel, hard, brown, moist
211.2 0.8	**SILT**, some sand, some gravel, some clay, hard, brown, moist
	...shale fragments
208.2 3.8	**INFERRED BEDROCK**
205.9 6.1	**END OF BOREHOLE**

SAMPLES NUMBER	TYPE	SPT 'N' VALUE	GR	SA	SI	CL
1	SS	35	14	28	41	17
2	SS	30				
3	SS	43				
4	SS	42				
5	SS	57	16	19	50	15
6	SS	100 / 125mm				
7	SS	50 / 150mm				
8	SS	100 / 75mm				
9	SS	100 / 50mm				



Unstabilized water level measured at 5.6 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

file: 1-22-0499 bh logs.gpj

+³, ×³: Numbers refer to Sensitivity   ○³% STRAIN AT FAILURE