

APPENDIX

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STORMWATER DRAINAGE ASSESSMENT



Environmental Assessment Study of Arterial Roads within the Highway 427 Industrial Secondary Plan Area (Area 47)

Part A: Stormwater Drainage Assessment

City of Brampton and Region of Peel
TP115086

Prepared for:

City of Brampton & Region of Peel

9/27/2022

Part A: Stormwater Drainage Assessment

Environmental Assessment Study of Arterial Roads within the
Highway 427 Industrial Secondary Plan Area (Area 47)

TP115086

Prepared for:

City of Brampton & Region of Peel

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9/27/2022

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Preface

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood), has been retained by the City of Brampton and Region of Peel to conduct a Schedule C Municipal Class EA for a future arterial road network within Secondary Plan Area 47.

The City of Brampton, to accommodate future growth in north-east Brampton, has approved a secondary plan for Area 47. The area is bound by Mayfield Road to the north, Castlemore Road to the south, Regional Road 50 (RR50) to the east and The Gore Road to the west.

The City of Brampton has identified through its Transportation and Transit Master Plan (TTMP, 2009), and supporting studies the need for additional road network capacity up to 2031. As part of these studies, road network improvements within Secondary Plan Area 47 were recommended. The recommended road improvements are being addressed by the current Class EA in two parts:

Part A (Region owned R.O.W.s¹):

1. A new six-lane north-south major arterial road (Arterial A2) from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50; and,
2. Widening of Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50; and,

Part B (City owned R.O.W.s):

1. A new four-lane east-west minor arterial road from The Gore Road to Arterial A2 (E-W arterial);
2. Widening of Clarkway Drive from Castlemore Road to E-W Arterial to four lanes and urbanizing Clarkway Drive between E-W arterial and Mayfield Road with possible continuous centre turn lane; and
3. Widening of Countryside Drive to four lanes from Clarkway Drive to RR50 including realignment at RR50.

In order to service this growth, new infrastructure must be provided that recognizes the capacity needs of planned growth and the objectives of protecting established communities and businesses from threats created by surface water drainage. As per Section 4.2.1.1 and Figure 4.4 of the MESP (ref. Aquafor Beech, 2016) the SWM facilities proposed within the Area 47 development blocks are to be designed to service the City and Region R.O.W.s for the required water quantity, water quality, and erosion control SWM requirements. This approach has been adopted as the overall premise for design of the stormwater quantity, quality and erosion features required for all the roadways within the Study Area. Notwithstanding, the following negotiations are still ongoing:

- The Region and City are in discussion to formalize acceptance of stormwater discharge of the Region's roadway drainage systems to City owned drainage systems and SWM facilities; and,
- The Region, City and land owner's are in discussion regarding the overall premise for stormwater management for the Study Area, particularly along Coleraine Drive. This has driven the evaluation of alternatives focused on a stormwater management facility located near the intersection of Coleraine Drive and Arterial A2.

Decisions regarding these ongoing negotiations are a prerequisite to developing a preferred alternative for stormwater management for the Study Area. As such, alternative solutions will be developed and assessed in detailed design leading to a preferred approach and the road drainage as per the catchments divide provided in this report will be the responsibility of the R.O.W. adjacent land owners to accommodate.

¹ R.O.W. = road right-of-way

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1.0 INTRODUCTION

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood), has been retained by the City of Brampton and Region of Peel to conduct a Schedule C Municipal Class EA (Class EA) for a future arterial road network within Secondary Plan Area 47.

The City of Brampton continues to grow and urbanize, and to accommodate future growth in north-east Brampton, Council has approved a secondary plan for Area 47. Area 47 is bound by Mayfield Road to the north, Castlemore Road to the south, Regional Road 50 (RR50) to the east and The Gore Road to the west (ref. Figure 1-1). In order to service this growth, new infrastructure must be provided that recognizes the capacity needs of planned growth and the objectives of protecting established communities and businesses from threats created by surface water drainage.

The City of Brampton has identified through its Transportation and Transit Master Plan (TTMP, 2009), and supporting studies (including the Highway 427 Extension Area Transportation Master Plan and the Highway 427 Industrial Secondary Plan (Area 47) Transportation Master Plan) the need for additional capacity in the road network up to the planning horizon year of 2031. As part of these studies, road network improvements within Secondary Plan Area 47 were recommended. The recommended road improvements are being addressed by the current Class EA in two parts:

Part A (Region owned R.O.W.s²):

3. A new six-lane north-south major arterial road (Arterial A2) from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50; and,
4. Widening of Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50; and,

Part B (City owned R.O.W.s):

4. A new four-lane east-west minor arterial road from The Gore Road to Arterial A2 (E-W arterial);
5. Widening of Clarkway Drive from Castlemore Road to E-W Arterial to four lanes and urbanizing Clarkway Drive between E-W arterial and Mayfield Road with possible continuous centre turn lane; and
6. Widening of Countryside Drive to four lanes from Clarkway Drive to RR50 including realignment at RR50.

The Part A and Part B features, as described above, are illustrated in Figure 1-1, as well as Plans 1 and 5 (ref. Appendix C).

The Highway 427 Industrial Secondary Plan (Area 47) Transportation Master Plan has satisfactorily completed Phases 1 and 2 of the Municipal Class EA process for the recommended arterial road network improvements and recommended commencement of Phases 3 and 4 of the EA process. The current study will satisfy Phases 3 and 4 of the Class EA requirements for the identified arterial road improvements.

This report has been prepared to document the stormwater drainage conditions for Part A of the Study Area. The following sections describe the background review, the assessment of existing and proposed hydraulic structures within Part A of the Study Area including hydraulic analyses, establish the proposed arterial road R.O.W. drainage conditions, and summarize stormwater management criteria for the proposed arterial road improvements, and new arterial roads. Part A of the Study Area includes drainage to Rainbow Creek (a tributary of the Humber River).

Stormwater drainage conditions for Part B of the Study Area are documented under separate cover.

² R.O.W. = road right-of-way

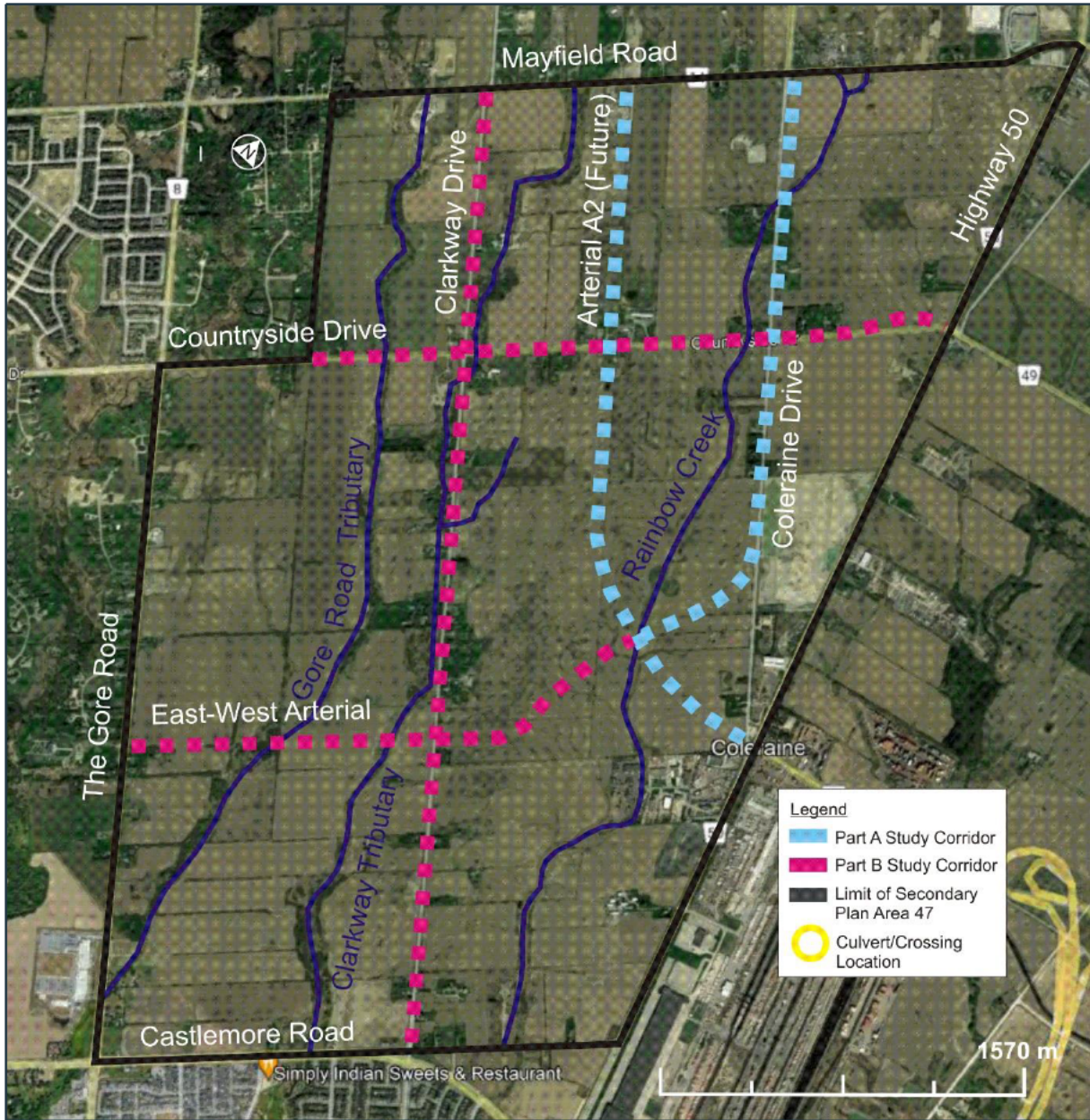


Figure 1-1 Study Corridors
(background image source Google Earth Pro™)

2.0 BACKGROUND REVIEW

2.1 Previous Studies

Several previous studies have been completed which are relevant to the current project as summarized below.

Humber River Hydrology Update, Civica Infrastructure Inc., June 2015

This study, prepared as a joint effort between the Toronto and Region Conservation Authority (TRCA) and Civica Infrastructure Inc. (Civica), was an update to the hydrologic model of the Humber River Watershed. The update was completed to reflect the increase in urban development, including stormwater management facilities constructed within the last 15 years, and included significantly refined subcatchment discretization. The hydrologic model was developed in Visual OTTHYMO 4 (VO4) for existing land uses and future land uses based on approved Regional and local municipality Official Plans. The model for the Humber River Watershed was a new model which superseded the previous SWMHYMO model developed by Aquafor Beech Limited (ref. Humber River Watershed Hydrology Update, November 2002). Peak flows were reported for the 2 to 500-year return periods and the Regional Storm event (Hurricane Hazel). The model was calibrated using rainfall-runoff data from recent storm events. Of the 6-hour, 12-hour, and 24-hour AES distribution design storms simulated, the 6-hour and 12-hour storms were found to be the critical storms (i.e. these storms generated the highest peak flows). The study found that the 2 to 100-year unit flow relationship equations provided in the TRCA Stormwater Management Criteria (2012) are sufficient to maintain existing conditions peak flows under the proposed future land use condition.

Master Environmental Servicing Plan: Highway 427 Industrial Secondary Plan Area ("Area 47"), Aquafor Beech Limited, May 9, 2016

This Master Environmental Servicing Plan (MESP) was prepared for the "Area 47" study area to address the constraints and opportunities associated with the proposed land use changes. The MESP provides a comprehensive management plan including stormwater and natural heritage strategies to protect the natural environment resources within the Study Area. Part of the MESP involved extending and updating TRCA generated HEC-RAS models of The Gore Road Tributary, the Clarkway Tributary, and Rainbow Creek.

Addendum to the Master Environmental Servicing Plan, Highway 427 Industrial Secondary Plan (Area 47), Savanta Inc., January 2018

This addendum to the MESP was prepared to provide an alternative plan for the Rainbow Creek restoration and enhancement. The addendum presents a plan to realign the Rainbow Creek corridor from Mayfield Road to Old Castlemore Road. The addendum provides a comprehensive management plan outlining how objectives relative to hydraulics, natural channel design, geomorphology, etc. will be achieved. Part of the addendum involved revisions to the HEC-RAS model to reflect the proposed realigned corridor and preliminary sizing of watercourse crossings, which was completed by Candevcon Limited (CDC) and The Municipal Infrastructure Group (TMIG) (ref. CDC, TMIG, dated July 2018).

2.2 Data, Mapping & Models

In addition to the reporting described in Section 2.1, additional background data, mapping and models have been provided by the City of Brampton, TRCA, Aquafor Beech, and Wood's Geotechnical Team. The following summarizes the data relevant to this assessment:

City of Brampton

- Various digital GIS base mapping layers including roads, property, watercourses, subwatershed boundaries, Official Plan land use, etc.
- Aerial photography
- Digital terrain mapping

TRCA

- Various digital GIS mapping layers including watercourses, TRCA regulation limit, meander belt, floodplain limits, etc.
- Visual OTTHYMO 4.0 hydrologic model of the Humber River Watershed (2015)
- Approved HEC-RAS hydraulic model of the Rainbow Creek (January 2018)
- Existing Conditions 6-hour AES 2 year – 100-year Design Storm Peak Flows (March 2018) from revised Humber River Hydrology Update
- Existing & Future Conditions Regional Storm Peak Flows (March 2018) from revised Humber River Hydrology Update

Aquafor Beech

- HEC-RAS hydraulic models of The Gore Road Tributary, the Clarkway Tributary, and Rainbow Creek (2016 - Superseded by CDC. TMIG, dated July 2018).
- Various digital GIS base mapping layers including contours, watercourses, HEC-RAS section lines, and floodlines.

Wood's Geotechnical Team

- Borehole logs - 47 borehole logs were advanced by Wood's Geotechnical Team in the period January 2020 to April 2020 along the Coleraine Drive and Arterial A2 R.O.W.s. Relevant borehole logs are provided in Appendix A.

2.3 Headwaters Drainage Features

The Headwaters Drainage Features (HDF) Assessment is documented in the following report:

FINAL REPORT: MASTER ENVIRONMENTAL SERVICING PLAN:
HIGHWAY 427 INDUSTRIAL SECONDARY PLAN AREA ("AREA 47")
Aquafor Beech Limited (Reference: 64608.1)
09 May 2016

Please reference Section 2.2.2 of the above noted report for details.

Please note that the hydraulic model of Rainbow Creek used for the current Part5 A study was updated to include relevant HDFs as directed by TRCA (ref. Figure 2-1) in the 2018/2019 timeframe.

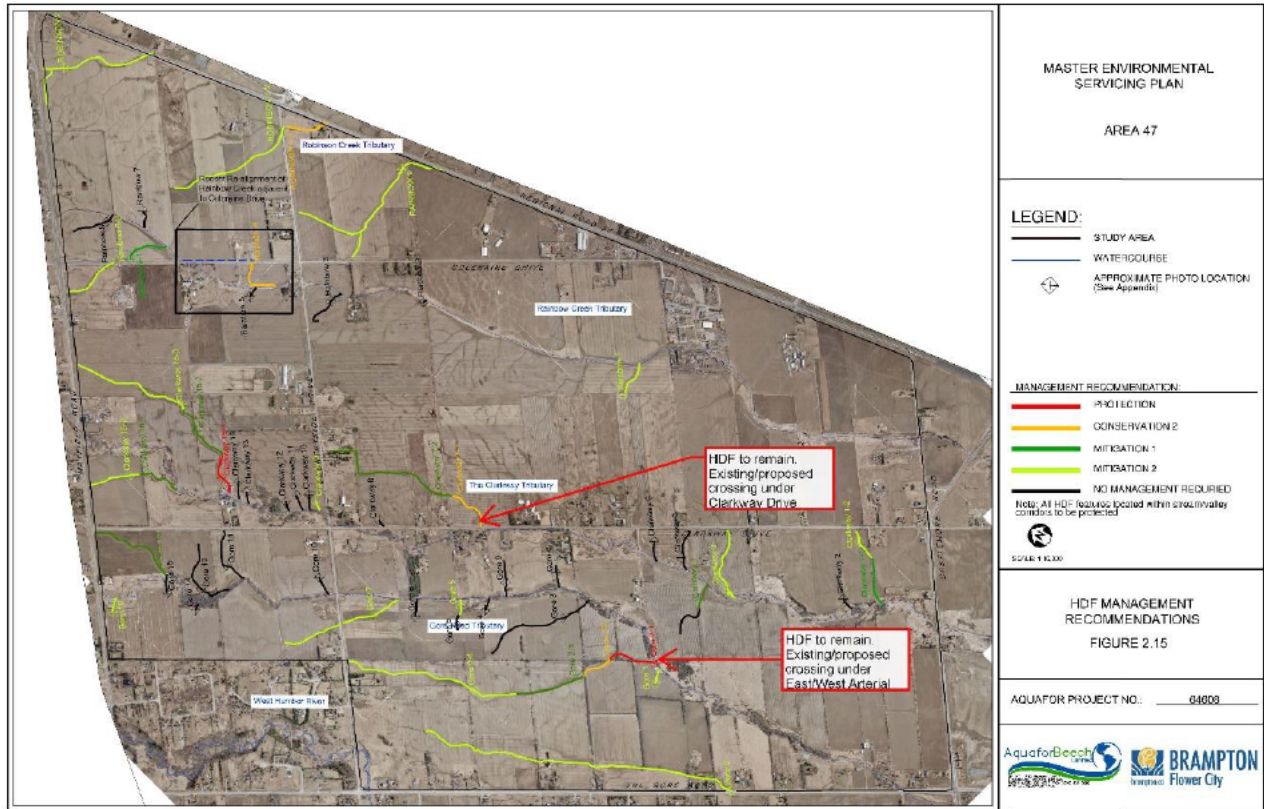


Figure 2-1 HDFs relevant to Area 47 Environmental Assessment

3.0 STORMWATER MANAGEMENT

3.1 Existing Conditions Storm Drainage

The Part A Study Area is located within the Humber River Watershed and contributes drainage to the Main Humber subwatershed. There is one (1) tributary that drains through the Study Area, namely a tributary of the Rainbow Creek (ref. Figure 3-1).

Under existing conditions, approximately 9.35 ha of existing R.O.W. (imperviousness = 22.03%) (i.e. Coleraine Drive and Countryside Drive) contributes stormwater runoff to Rainbow Creek. The existing R.O.W. alignments are illustrated in Plans 1 to 4 (ref. Appendix C). Please note that the drainage boundaries shown on these Figures are not representative of the existing conditions drainage boundaries. Additional details are provided in Section 3.6.

The existing R.O.W.s consist of rural cross-sections with ditches. Overland drainage from external lands enters the existing R.O.W.s at various points and is conveyed by the existing ditches to the watercourse receiver (i.e. Rainbow Creek).

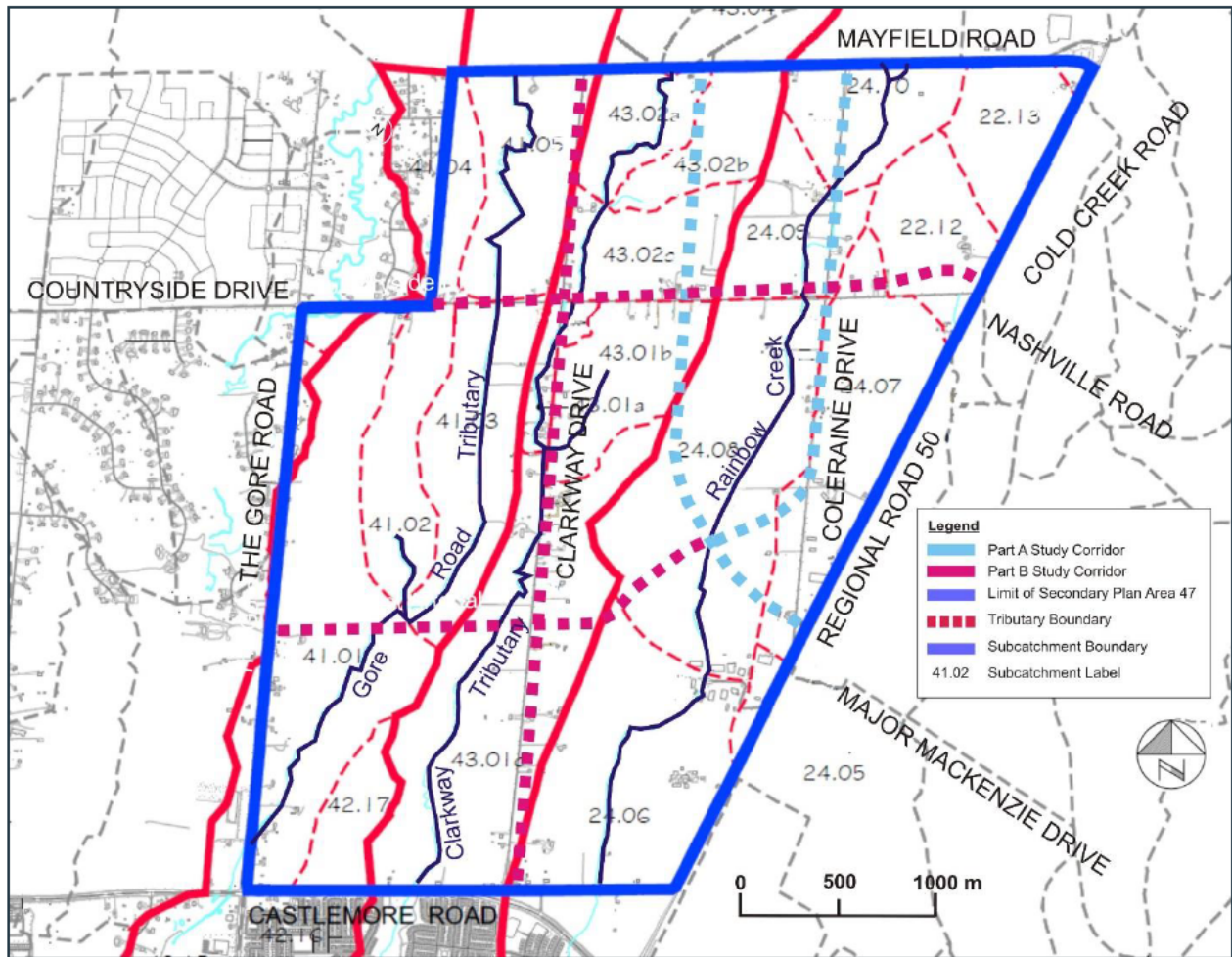


Figure 3-1 Existing Conditions Drainage

3.2 Future Conditions Storm Drainage

As outlined in Section 1.0, the future conditions for Part A of the Study Area proposes a new six-lane north-south major arterial road (Arterial A2) from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50, and widening of Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50. Urbanized cross-sections are proposed for all R.O.W.s.

A proposed road profile was developed by the City, Region, and Wood. The future conditions storm drainage boundaries were developed based on the proposed road profile and are illustrated in Plans 5 to 8 (ref. Appendix C).

Under future conditions, approximately 27.14 ha of future R.O.W. (imperviousness = 74.10%) (i.e. Coleraine Drive and Arterial A2) is proposed to contribute stormwater runoff to Rainbow Creek. This proposes an increase of 17.79 ha of R.O.W. drainage and impervious area of 18.05 ha relative to existing conditions. The increase is made up of the new and widened R.O.W.s.

Under future ultimate development conditions, external drainage will not enter the R.O.W.s. Notwithstanding, the proposed roadways may be constructed prior to the development of adjacent blocks. As such, and until development of adjacent blocks commences, temporary conveyance (e.g. ditches and culverts) to the downstream receiving systems under the interim conditions will be required.

3.3 Soils and Groundwater

Wood has advanced and prepared 47 borehole logs along the Part A road alignments. The soil types encountered within the Study Area are dominated by imperfectly drained stone-free clays, underlain by silty sand. These soils types have a typical saturated hydraulic conductivity value ranging between 7×10^{-5} and 2×10^{-4} (ref. User's Guide to SWMM5, 13th Edition).

Borehole logs indicate that groundwater was encountered within 9 boreholes, ranging in depths of 2.4 m to 8.2 m below ground surface for Coleraine Drive and depths of 1.2 m to 5.8 m for Arterial A2. The remaining boreholes indicate that groundwater was not encountered to the depth of the borehole.

In general, the future conditions road profile proposes to raise grades within the R.O.W. limits. Therefore, depths from surface to groundwater levels will increase under future conditions, ranging in depths of 3.1 m to 8.7 m below the proposed ground surface for Coleraine Drive and depths of 1.2 m to 9.7 m for Arterial A2. A summary of the borehole logs, groundwater levels and separation from existing and proposed grades is provided in Appendix A.

3.4 Stormwater Management Design Criteria

The stormwater management analyses of the Study Area has considered design criteria from several agencies including, the Regional of Peel (Region), the Toronto and Region Conservation Authority (TRCA), the Ministry of Transportation (MTO). In addition to agency design criteria, the stormwater management analyses of the Study Area will also consider design criteria outlined in the MESP (ref. Aquafor Beech, 2016). The stormwater management criteria relevant to the Study Area are outlined below.

3.4.1 Region of Peel (2019)

- *Minor System:* Storm sewers are to convey the 10-year storm event, and are to be designed using Region of Peel IDF information;
- *Major System:* Regional road R.O.W.s, including both urban and rural, are to convey flows generated by the R.O.W. itself, up to the 100-year storm event;
- External lands should not drain to the Region's storm sewer system;

- **Water Balance:** For Low Volume Groundwater Recharge Areas (LGRA), provided the site does not impact a sensitive ecological feature, or require a subwatershed study, or Environmental Impact Study (EIS), the proponent has the option to:
 - provide a minimum post development recharge of the first 5 mm for any precipitation event, or;
 - complete a site-specific water balance to identify pre-development groundwater recharge rates

As per Figure C.10 from the TRCA Stormwater Management Guidelines (ref. TRCA, August 2012) the Study Area is located within a LGRA. Refer to Appendix A for Figure C.10 of (TRCA, August 2012).

- **Road Reconstruction:** New linear projects without restrictions and subject to the approved Source Protection Plan, that results in the creation of impervious surface(s) and/or fully reconstructs the existing impervious surfaces, shall control per the mandatory control hierarchy the larger of the following:
 - The runoff generated from the geographically specific 90th percentile rainfall event (27 mm) from the new and/or fully reconstructed impervious surfaces on the site. The site shall be required to maintain the pre-development water balance, or;
 - The runoff generated from the geographically specific 90th percentile rainfall event (27 mm) from the net increase in impervious area(s) on the site. The site shall be required to maintain the pre-development water balance.

As per Map 3.4 of the “Approved Source Protection Plan: CTC Source Protection Region”, prepared by the CTC Source Protection Committee, dated March 25, 2019 (ref. Appendix A), the Study Area is located outside of the nearest Wellhead Protection Area (WHPA-Q1/Q2), and is therefore not subject to the approved Source Protection Plan. As such, the road reconstruction criteria as stated above would not apply to the Study Area. Despite this, the Region has noted to Wood that the road reconstruction criteria should still be applied to the Regional owned R.O.W.s within the Study Area (ref. Email correspondence Bubas-Khan, dated October 28, 2020). As such, this criterion is to be applied to the Part A R.O.W.s (i.e. Coleraine Drive and Arterial A2).

- **Safety:** Section III “STORM DRAINAGE AND SEWER DESIGN” of the City of Brampton Subdivision Design Manual Part (18) “Overland Flow”; clause (f) ii reads as follows:

“In the event that the major storm overland flow from a subdivision exceeds the capacity of the maximum number of catchbasins as specified above, major storm overland flow shall be allowed to flow onto the arterial or major collector roads with the condition that the additional flow from the subdivisions would not cause the ponding depth to exceed 0.15 m above the gutter along the arterial or major collector roads. A minimum of 2 lanes of roadway pavement must be flood-free at all times for emergency vehicles during the major storm event. However, the major overland flow shall not be permitted to flow across any arterial or major collector roads under any circumstances.”

- **Climate Change:** Per Section 7.2.2 of the Region’s SWM Criteria (2019), the Region has a four (4) step process for considering climate change resiliency in the design of SWM infrastructure.

3.4.2 Toronto and Region Conservation Authority (2012)

- A review of the information presented in Appendix C of TRCA’s Stormwater Management Criteria (ref. TRCA, August 2012) indicates the following:
 - The study area is not located in proximity to any Wellhead Protection Areas (ref Figure C.2 of the TRCA Guidelines).

- Average Annual Recharge in the study area is categorized in the Low range (ref Figure C.3 of the TRCA Guidelines).
- The study area is not considered to be located within a Significant Groundwater Recharge Areas (ref. Figure C.7 of the TRCA Guidelines).
- The study area is not considered to be located within an Ecologically Significant Groundwater Recharge Area (ref Figure C.8 of the TRCA Guidelines).
- The study area is not considered to be located within a High Volume Groundwater Recharge Area (ref Figure C.9 of the TRCA Guidelines).
- The study area is considered to be located within a Low Volume Groundwater Recharge Area (ref Figure C.10 of the TRCA Guidelines).
- *Quantity Control:* Control post-development peak flows to target rates established using the unit flow relationships for Sub Basin 36 (Equation F) for all storms up to and including the 100-year storm (i.e., 2, 5, 10, 25, 50, and 100-year storms);
- *Quality Control:* MOE Enhanced Level (Level 1) Water Quality Control (80% Average Annual Removal of Total Suspended Solids [TSS])³. A treatment train solution is to be implemented.
- *Water Balance:* For sites located within a LGRA best efforts to maintain recharge are expected, provided the site does not impact an ecological feature.
- *Erosion Control:* Minimum infiltration of 5 mm is required. For sites with a SWM pond, extended detention of the 25 mm event for a period of 48 hours may also be required.
- Sizing and design of future bridge structures is to be completed using the TRCA *Crossings Guideline for Valley and Stream Corridors* (September 2015)⁴. TRCA's objectives for natural hazards pertain to the avoidance and mitigation of flood risk, geotechnical risk from slope instability, and geomorphic risk from channel migration over time.

3.4.3 Master Environmental Servicing Plan (2016)

- *Quantity Control: TRCA Criteria – Control* post-development peak flows to target rates established using the unit flow relationships for Sub Basin 36 (Equation F) for all storms up to and including the 100-year storm (i.e., 2, 5, 10, 25, 50, and 100-year storms).
- *Quality Control:* MOE Enhanced Level (Level 1) Water Quality Control.
- *Water Balance:* Infiltration of runoff from a 5 mm storm event using Low-Impact Development (LID) Best Management Practices (BMPs).
- *Erosion Control:* For drainage to Rainbow Creek, Clarkway Tributary, and Gore Road Tributary, extended detention of the 25 mm storm event for a period of 48 hours is required. For drainage to Headwater Drainage Features (HDFs), extended detention of the 25 mm storm event for a period of 120 hours is required.

As per Section 4.2.1.1 and Figure 4.4 of the MESP (ref. Aquafor Beech, 2016) the SWM facilities proposed within the Area 47 development blocks are to be designed to service the City and Region R.O.W.s for the water quantity, water quality, and erosion control SWM requirements noted above. As such, Wood has not

³ Please note that this requirement is also consistent with MECP expectations for quality control.

⁴ Available via URL <https://trca.on.ca/dotAsset/214493.pdf>

addressed these SWM criteria in this report as it is assumed to be addressed by the reporting prepared for the Area 47 development blocks.

Based on the foregoing, the water balance criteria (ref. Section 3.6), and road reconstruction criteria (ref. Section 3.7) are addressed with this report.

It should be noted that if any of the development blocks that are intended to provide the water quantity, water quality, and erosion control SWM requirements for a portion of the City and Region R.O.W.s be developed with privately owned SWM infrastructure, the City and Region R.O.W. drainage cannot drain into the development block without a formal agreement. If a formal agreement is not established, then the requisite water quantity, water quality, and erosion control SWM requirements for the R.O.W. drainage must be implemented within the R.O.W. These details are to be determined as each development block advances to the detailed design stage.

Notwithstanding, it should be noted that conveyance of R.O.W. drainage to the SWM facilities within the development blocks may not be feasible (e.g., grading constraints). In addition, the proposed roadways may be constructed prior to the development of adjacent blocks. Therefore, consideration of management of stormwater runoff within the R.O.W. is required.

In this context, discussions between the City and Region are ongoing on the issue of possible management of roadway stormwater runoff from each other's R.O.W.'s. Further discussions are required in this regard and any agreement may influence the design of SWM systems for this development area.

3.4.4 Master Environmental Servicing Plan Addendum (2018)

As has been noted, this Addendum to the Block 47 MESP advanced an alternative Rainbow Creek restoration and enhancement plan to that described in the May 2016 MESP (Aquafor Beech 2016). The MESP Addendum does not advance any specific or additional stormwater management criteria or objectives.

3.4.5 Ministry of the Environment, Conservation and Parks (MECP)

The MECP is in the process of issuing a Stormwater Consolidated Linear Infrastructure (CLI) Environmental Compliance Approval (ECA) to the Region of Peel. The Stormwater CLI ECA covers storm assets servicing regional roads, namely storm sewers, ditches, stormwater management facilities and low impact development, and Stormwater Pumping Stations. The Stormwater CLI ECA sets forth conditions for alterations to the stormwater system as well as ongoing operation of the system. The ECA comes with criteria for design of alterations to the Region's existing stormwater system. At the time of completion of the Class EA study, the CLI ECA template and criteria were not available, therefore the Class EA recommendations do not guarantee compliance with the CLI ECA conditions and criteria. It is recommended that at the detailed design stage, the Engineering Consultant re-assess the Class EA recommendations against the CLI ECA criteria and make the necessary adjustments and changes to the stormwater recommendations to be in compliance, where feasible.

3.5 Water Balance

As outlined in Section 3.4, the Region, TRCA, and MESP have water balance criteria which requires the on-site retention of the larger of the runoff volume from a 5 mm storm event and the pre-development water balance/groundwater recharge volume. Table 3-1 below outlines the volumes for each subcatchment, with an identification of the larger volume requirement.

Pre-development water balance volumes were calculated using Table 3.1 (Urban Lawns/Shallow Rooted Crops) of the Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual (SWMPDM, 2003), and historical rainfall data obtained from the Environment

Canada rainfall gauge located at the Toronto Lester B. Pearson International Airport (Gauge A). Monthly and daily precipitation data was obtained for the years 1995 to 2019 and converted into an annual average rainfall depth. The pre-development water balance volumes were calculated using the proposed R.O.W. subcatchments and existing impervious conditions (ref. Plans 1 to 4, Appendix C). Supporting calculations are provided in Appendix B.

Post-Development runoff volumes from the 5 mm storm event were calculated using the proposed R.O.W.s and proposed imperviousness (ref. Figures 5 to 8, Appendix C).

As outlined in Table 3-1, the runoff volumes from the 5 mm storm event govern the water balance retention volume requirements, compared to the pre-development groundwater recharge volume. Water Balance retention volume requirements are discussed further in Section 3.7, and a long list of stormwater management practices suitable to achieving the water balance criteria are outlined in Section 3.8.

Table 3-1 Water Balance Retention Volume Requirements

Subcatchment	Pre-Development Water Balance/Groundwater Recharge Volume (Average Daily Volume in m ³)	Post-Development Runoff Volume from 5 mm Storm Event (m ³)
A1	9	82
A2	7	70
A3	7	72
A4	9	82
A5	9	84
A6	9	76
A7	22	211
CR1	9	103
CR2	6	61
CR3	4	41
CR4	8	66
CR5	5	52

Note(s)

1. Bolded values indicate governing water balance volume

As outlined in Section 3.4.1, the SWM facilities proposed within the Area 47 development blocks are to be designed to service the City and Region R.O.W.s for the water quantity, water quality, and erosion control SWM requirements. Information pertaining to the manner in which the major and minor systems of the City and Region R.O.W.s would be connected to the systems servicing the development blocks has not been made available for the current study. As such, the subcatchments represented on Figures 1 to 8 (ref. Appendix C), and the corresponding water balance volume requirements, should be reviewed and refined when this information becomes available. This is expected to occur at the detailed design stage.

3.6 Road Reconstruction

As outlined in Section 3.4.1, the Region’s road reconstruction criterion is to be applied to the Part A R.O.W.s. The road reconstruction criterion requires new linear projects that result in the creation of impervious surface(s) and/or fully reconstructs the existing impervious surface, to provide storage for the greater volume associated with the following scenarios:

1. The runoff generated from the geographically specific 90th percentile rainfall event (27 mm) from the new and/or fully reconstructed impervious surfaces on the site. The site shall be required to maintain the pre-development water balance, or;
2. The runoff generated from the geographically specific 90th percentile rainfall event (27 mm) from the net increase in impervious area(s) on the site. The site shall be required to maintain the pre-development water balance.

Based on a review of the proposed R.O.W.s, scenario #1, as described above, would generate larger runoff volume as the new and/or fully reconstructed impervious surface area is larger than the net increase in impervious surface area. Therefore, calculations of the runoff from the 90th percentile rainfall event were completed for this scenario. The impervious coverages and resulting runoff volumes are summarized in Table 3-2 below. Supporting calculations for both scenarios are provided in Appendix B.

Table 3-2 Region’s Volume Control Requirements for Linear Developments (m³)

Subcatchment	Total Proposed Impervious Area (ha)	Runoff Volume from 27 mm Storm Event (m ³)
A1	1.64	444
A2	1.41	379
A3	1.44	388
A4	1.64	442
A5	1.67	451
A6	1.53	412
A7	4.22	1140
CR1	2.07	558
CR2	1.23	331
CR3	0.82	221
CR4	1.31	354
CR5	1.05	283

It is concluded from a comparison of the water balance retention requirements, presented in Table 3-1, to the road reconstruction runoff volume control requirements, presented in Table 3-2, that the latter criterion governs. Retention volume requirements are discussed further in Section 3.8, along with a long list of stormwater management practices suitable for the study area.

3.7 Stormwater Management Opportunities

3.7.1 General Stormwater Management Opportunities

Stormwater Management practices (SWMPs) for the management of roadway runoff generally fall into two categories: those that address stormwater quantity (including erosion) and those that manage stormwater quality of surface runoff. In addition, Low Impact Development (LID) best management practices are designed to provide water quality treatment and quantity control for smaller, more frequent storm events, and water retention.

As outlined in Section 3.4.1, stormwater quantity, quality and erosion criteria for the Study Area are to be provided by the internal development blocks within Area 47. As such, proposed works for the current study are limited to water balance and road reconstruction criteria.

In terms of water balance and road reconstruction criteria, the SWMPs relate to the retention (i.e. infiltration) of runoff from the new pavement, and where possible, runoff from the existing pavement; however, current legislation solely relates to the former. Typically, the required retention volumes are dictated by agency standards, and are also often defined in a watershed or subwatershed planning study. Water balance and road reconstruction retention volume requirements for the Study Area are outlined in Table 3-1 and Table 3-2 respectively, and it has been determined that the Region's road reconstruction criteria govern the retention volume requirements.

Various Best Management Practices or Stormwater Management practices are available to address the water balance retention volume requirements of runoff from roadways. Due to the linear nature of roadway corridors however, not all stormwater management practices are considered appropriate. Typically, suitable BMPs for linear roadway corridor come in the form of Low-Impact Development (LID) BMPs. Various LID BMPs are reviewed in the following section. The review was completed to determine suitability of each LID BMP in managing the water balance retention volume requirements, taking into consideration the Study Area topography, soils, groundwater level, and future conditions land use.

3.7.2 Low Impact Development Best Management Practices

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance storm water management controls to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roads and the storm drainage system, as well as the promotion of infiltration of road drainage. General design guidelines and considerations for source and conveyance controls have been advanced since the early 1990's as part of the Ministry of Municipal Affairs and Housing (MMAH) "Making Choices" and in 1994 as part of the Ministry of the Environment's original Best Management Practices Guidelines.

Subsequent to the 1994 MOE Guidelines, technologies and standards have been developed further for the application of source and conveyance controls. These have evolved into a class of BMPs referred to as Low Impact Development (LID) practices, which have advanced as an integrated form of site planning and storm servicing to maintain water balance and providing storm water quality control for urban developments. Initial results from studies in other settings have demonstrated that LID practices provide benefits by way of reducing the erosion potential within receiving watercourses and thereby reducing the total volume of end-of-pipe storm water erosion control requirements. In addition, due to volumetric controls afforded by LID BMP's, water quality is also improved through a reduction in mass loading. The benefits from LID storm water management practices are generally focused on the more frequent storm events (e.g. 2-year storm) of lower volumes as opposed to the less frequent storm events (e.g. 100-year storm) with higher volumes. It is also recognized that the forms of LID practices which promote infiltration or filtration through a granular medium provide thermal mitigation for storm runoff.

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. The Toronto and Region Conservation Authority (TRCA) and Credit Valley Conservation (CVC) have produced the 2010 Low Impact Development Stormwater Management Manual, for the design and application of LID measures, various LID techniques, as well as their function that are applicable to road projects. While most of these are typically implemented to provide water quality and/or water quantity control, they can also be utilized to provide water balance retention given their ability to capture and retain runoff volume. Descriptions of various LID BMPs with infiltration capabilities are provided below.

Infiltration Trenches

Infiltration trenches can be positioned at surface level or below ground (i.e. subsurface). At-surface infiltration trenches are designed to receive surface runoff, while subsurface infiltration trenches receive

runoff that has been captured by catchbasins and/or storm sewers. Infiltration trenches are preferred in areas that have reasonable infiltration properties (15 mm/hr , $1 \times 10^{-6} \text{ cm/s}$), but can be implemented in all soil types as long as they are large enough to store the design volume.

For R.O.W.s, at-surface infiltration trenches are restricted to the pervious areas within the boulevards or island areas (if proposed). Subsurface infiltration trenches can be positioned beneath impervious areas such as sidewalks and multi-use pathways. For subsurface infiltration trenches receiving drainage from catchbasins, all catchbasins should be fitted with Goss traps to filter floatable debris.

Infiltration trenches are restricted in depth by local groundwater levels. As per the Low Impact Development Stormwater Management Planning and Design Guide (ref. CVC, TRCA, 2010), the minimum separation between the underside of an infiltration trench and the seasonally high groundwater level is 1.0 m. As outlined in Section 3.4, depths from surface to groundwater levels will increase under future conditions, ranging in depths of 1.2 m – 9.7 m below proposed ground surface. Infiltration trenches will likely require a depth of at least 500 mm. Therefore, in order to implement an infiltration trench, the minimum depth from surface to groundwater level would have to be at least 1.5 m. Many boreholes did not encounter groundwater during drilling, indicating that there are no restrictions to the depth of infiltration trenches in those areas, up to the termination of the borehole. Infiltration trench feasibility would need to be considered on a location by location basis based on the preceding identified depths.

Permeable Pavers/ Pavement

Permeable pavement could be implemented for the entirety, or for sections, of the proposed sidewalks and multi-use trails. Permeable paved sidewalks and multi-use trails would reduce the runoff volume from paved surfaces within the urban road R.O.W. As a standalone LID BMP, however, it would not be able to meet the water balance criteria, as it would treat a limited area and would not treat the roadway itself (which would be expected to generate the largest portion of runoff). It is understood that the Region does not prefer to implement permeable pavement on their projects due to operations/maintenance issues and performance concerns. As such, permeable pavement is not recommended for implementation.

Pervious Pipes

Pervious pipes could be used in combination with either bioretention systems or infiltration trenches. As a standalone SWM measure, pervious pipes can be a cost-effective and relatively simple method to achieve water balance requirements, while eliminating the need for surface space within the right-of-way.

Conventional Underground Storage (Cellular Systems)

Modular style plastic chambers (e.g. Brentwood™, StormTech™, Triton™ or other equivalent and approved systems), could be considered to achieve water balance requirements. Conventional underground storage can be implemented in a similar manner to subsurface infiltration trenches, receiving runoff that has been captured by catchbasins and/or storm sewers. Conventional underground storage is typically implemented to achieve water quantity requirements; however, these systems often serve also to achieve water balance requirements by making the bottom of the storage tank infiltrative.

Bioretention Systems

Bioretention systems can be implemented in the pervious areas within the boulevards or island areas (if proposed), similar to at-surface infiltration trenches. Bioretention systems should be approximately 10% to 20% in size of the contributing drainage area, with typical drainage areas of 0.50 ha and a maximum drainage area of 0.80 ha. Slopes within bioretention systems are typically 1% to 5%. Bioretention systems are also preferred in areas that have reasonable infiltration properties

(15 mm/hr, 1×10^{-6} cm/s), but can be implemented in all soil types as long as the water quality event can be temporarily stored (typical depths 0.15 m to 0.25 m) before infiltrating and an underdrain is provided. Bioretention systems should have forebays for a form of surface water pre-treatment. Catchbasins fitted with goss traps can be used to filter out floatable debris before directing runoff to the infiltrative component of the bioretention system.

Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely unmaintained turf can provide infiltration, similar to bioretention cells. Their application in linear corridors is particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage. Their application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself and are therefore typically not preferred in those cases. Notwithstanding, gutter outlets along outside lanes have been demonstrated to function effectively where the right-of-way can accommodate the design. Based on the proposed ultimate urbanized road R.O.W., enhanced grassed swales are likely not a practical water balance measure.

Filter Strips

Filter strips are typically designed for small drainage areas (less than 2 ha \pm) and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event. Based on the limited space within the proposed R.O.W.s, filter strips are likely not a practical water balance measure.

Based on the foregoing review, the following LID BMPs have been short-listed:

- Infiltration Trenches
- Pervious Pavers/Pavement
- Pervious Pipes
- Conventional Underground Storage
- Bioretention Systems

As outlined in Section 3.4.1, the SWM facilities proposed within the Area 47 development blocks are to be designed to service the City and Region R.O.W.s for the water quantity, water quality, and erosion control SWM requirements. Information pertaining to the manner in which the major and minor systems of the City and Region R.O.W.s would be connected to the systems servicing the development blocks has not been made available for the current study. As such, the advantages and disadvantages of the short-listed LID BMPs should be further reviewed and refined when this information becomes available. This is expected to occur at the detailed design stage.

3.8 Assessment of Alternative Drainage Plans

As noted in Section 3.4.3, the MESP recommended that the SWM facilities within the Area 47 development blocks be designed to service the City and Region R.O.W.s for the water quantity, water quality, and erosion control SWM requirements (ref. Figure 3-2). This approach requires formal agreement between the City, Region, and private landowners to allow for R.O.W. drainage to enter development blocks. However, the City and Region advised that these discussions with private landowners have not yet reached a positive conclusion by the time of writing of this report. As a result, the SWM approach advanced in the MESP may no longer be a viable approach.

As a formal agreement has not, to date, been established between the City, Region, and landowners, the requisite water quantity, water quality, and erosion control SWM requirements for the R.O.W. drainage may need to be implemented within the R.O.W. In this context, discussions between the City and Region are ongoing on the issue of possible management of roadway stormwater runoff from each other's R.O.W.'s. Further discussions are required in this regard and any agreement may influence the design of SWM systems for this development area.

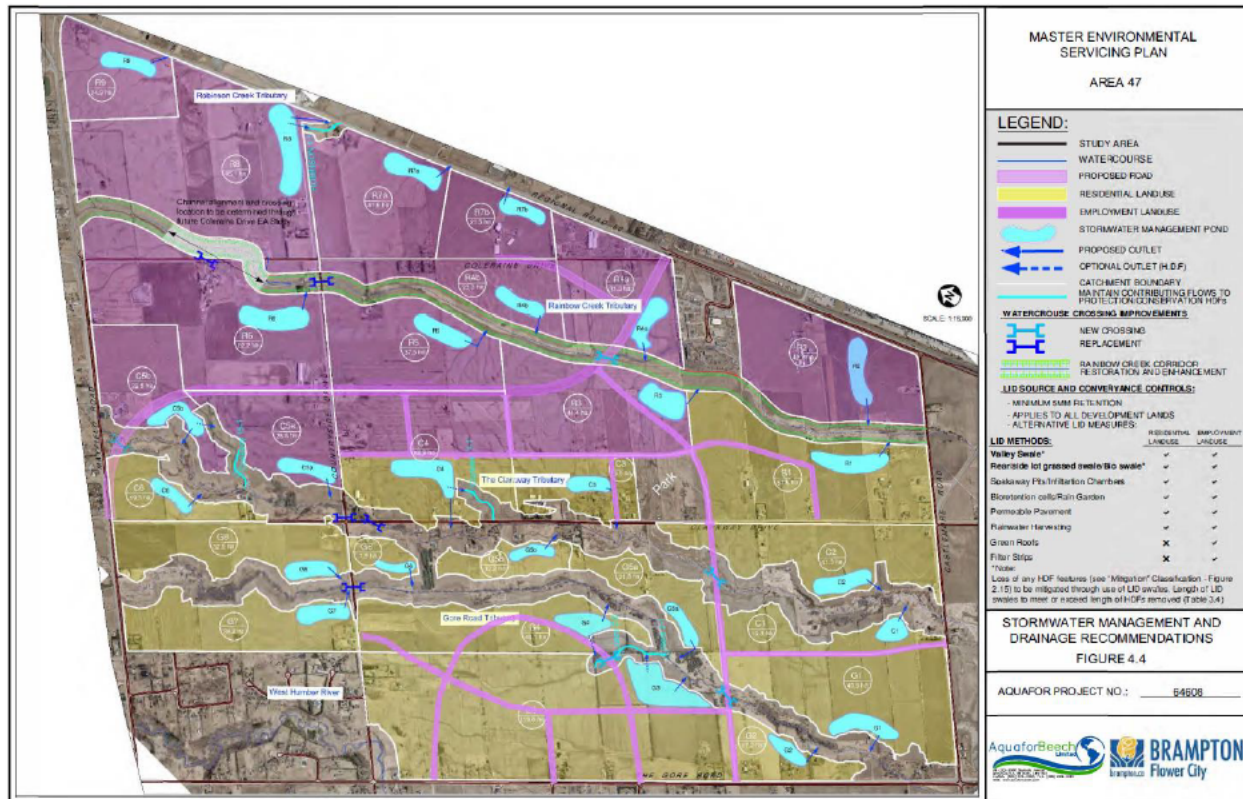


Figure 3-2 MESP SWM and Drainage Recommendations – Locations of Facilities

As noted in Section 1.0, the study scope of this assessment includes both City and Region roadways. Part A includes Region owned R.O.W.'s and Part B includes City owned R.O.W.'s. As has been noted, R.O.W.'s included as components of Part A are:

1. Arterial A2, a new six-lane north-south major arterial road, extending from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50; and,
2. Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50.

A general evaluation of stormwater management alternatives will typically include the following scenarios:

- Do nothing
 For this evaluation, the *Do Nothing* scenario cannot be advanced as it would not address Region and/or City requirements for stormwater management.
- All LIDs within the ROW
 Similarly, LIDs facilitate stormwater control promote infiltration and pollutant removal on a local site by site basis. The benefits from LID storm water management practices are focused on more frequent

storm events (e.g., 2-year storm) of lower volumes as opposed to the less frequent storm events (e.g., 100-year storm) with higher volumes. As such, some form of SWM controls is required to address the less frequent storm events.

- Combination of LIDs and adjacent land SWM facilities

As noted in Section 3.4.1, a premise for design of the stormwater quantity, quality and erosion features required for all the roadways within the Study Area is that these control features/facilities are provided by the internal development blocks within Area 47. This approach is recommended for the Arterial A2 R.O.W. is consistent with the *Combination of LIDs and adjacent land SWM facilities* scenario.

However, the feasibility of internal development blocks SWM controls servicing the R.O.W. along Coleraine Drive has been brought into question by the adjacent landowners. As such, preliminary evaluation of alternatives has been completed as outlined in Section 3.8.1.

3.8.1 Coleraine Drive Drainage Planning

Two alternative stormwater management options have been considered for the Coleraine Drive R.O.W., namely (ref Appendix E):

1. Alternative #1 - Redirecting R.O.W. drainage from Subcatchments CR4, CR5, CR6, CS6 and A7, away from SWMFs R7b and R4b, to SWMF R4a.

A high-level review of alternative (1) has been completed based on the following:

- a) Determine Technical Feasibility of Alternative Drainage Plan: confirmation of sufficient elevation to support a gravity conveyance system to SWMF R4a.
- b) Preliminary Storm Sewer Design for Alternate Drainage Plan: preparation of a preliminary storm sewer design and layout for the noted drainage scenario.
- c) Hydrologic Modelling: development of a hydrologic model to simulate the 100-year stormwater runoff in support of the assessment of the feasibility of redirection of runoff to SWMF R4a.
- d) Costing: development of a high-level cost of the preliminary storm sewer design and alternate storage framework for the noted drainage concept.

Each of these component tasks is documented in Appendix E.

2. Alternative #2 - Redirecting R.O.W. drainage to a new SWM facility to be located (under discussion) in the north-west quadrant of the intersection of Coleraine Drive and Arterial A2 as illustrated in Figure 3-2.

The multi-lateral discussions have not reached conclusion, regarding SWM facility location, at the time of writing of this report. However, the developer group has generally agreed to locate the proposed stormwater management near the intersection of Coleraine Drive and future Arterial Road A2 that will accommodate storm runoff from the realigned Coleraine Drive (ref. Agreement from ██████████ ██████████ in Appendix D). Further, the exact facility location, dimensions and design details will be determined during future phases of work. Discussions between the Region of Peel and City of Brampton have concluded that the Region of Peel will arrange for the design and construction of the stormwater management pond and the City of Brampton will accept conveyance and maintenance of the pond after the maintenance/warranty period. As Alternative #1 is considered viable, as demonstrated by the assessment outlined in Appendix E, it is presupposed that Alternative #2 will also be found to be viable technically and should be of similar cost. As such, this scenario should be further evaluated during detailed design and the R.O.W. drainage, per the catchments divide provided in this

SWM report (ref Appendix C Plans 6, 7 and 8), be the responsibility of the adjacent landowners to accommodate.



Figure 3-3 Approximate Location of Possible Future SWM Facility
(background image source Google Earth Pro™)

4.0 HYDRAULICS

4.1 Purpose

Hydraulics relates to the calculation of water surface elevations and velocities for the design storm peak flows generated by the hydrologic models and supports assessment of hydraulic structure performance (i.e. capacity, overtopping conditions, etc.) and delineation of floodplains. Structures included in this evaluation are outlined in Table 4-1 and illustrated in Figure 4-1.

This report section documents the evaluation of crossings G, H and I.

Table 4-1 Structures included for Assessment for Parts A and B

Project Component	Crossing Reference	HEC-RAS Reference			Watercourse	Crossing Location
		River	Reach	Section		
Part A	I	River-4	Reach-1	24.4425	Rainbow Creek	Coleraine Drive
	G	River-4	Reach-1	24.343		proposed intersection of Coleraine Drive and E-W Arterial A2
Part B	H	River-4	Reach-1	24.424	Gore Road Tributary	Countryside Drive
	B	Gore Road Trib	Reach1	1412.42		Countryside Drive
	A	Gore Road Trib	Reach1	1410.052	Clarkway Tributary	E-W Arterial A2
	E	Clarkway Trib	Reach3	1512.505		Countryside Drive
	D	Clarkway Trib	Reach2	1512.372		Clarkway Drive
	F	River11	Reach 11	356.6		Clarkway Drive
	C	Clarkway Trib	Reach31	1510.123		E-W Arterial A2

4.2 Methodology

TRCA provided Wood with the current Rainbow Creek HEC-RAS models (ref. email correspondence Chekol-Parajuli, dated Mach 11, 2019). It is understood that the models were most recently updated by Candevcon Limited (CDC) and The Municipal Infrastructure Group (TMIG) in January 2018 to reflect the Rainbow Creek realignment proposed by the MESP Addendum (ref. Savanta, January 2018). As per the email correspondence, Wood is of the understanding that the provided models are approved for use in the current study.

Two (2) models were provided by TRCA. It is understood that the two models are identical, with the exception of the steady flow files assigned in each model. One (1) model contains steady flow files for the 2-year to 100-year storm events and the other model contains the steady flow files for the Regulatory conditions. It is understood that the Regulatory model is to be utilized to simulate the Regional Storm steady flow profile. Lastly, as per the model description box, it is understood that the steady flow files are representative of the 2016 TRCA hydrology update (for River-4 Reach 1, only). It is noted that, to Wood's knowledge, the steady flow values contained in the steady flow files are not reflective of climate change projections. Per Section 7.2.2 of the Region's SWM Criteria (2019), the Region has a four (4) step process for considering climate change resiliency in the design of SWM infrastructure. As such, Wood recommends that climate change influences be assessed at the detailed design stage.

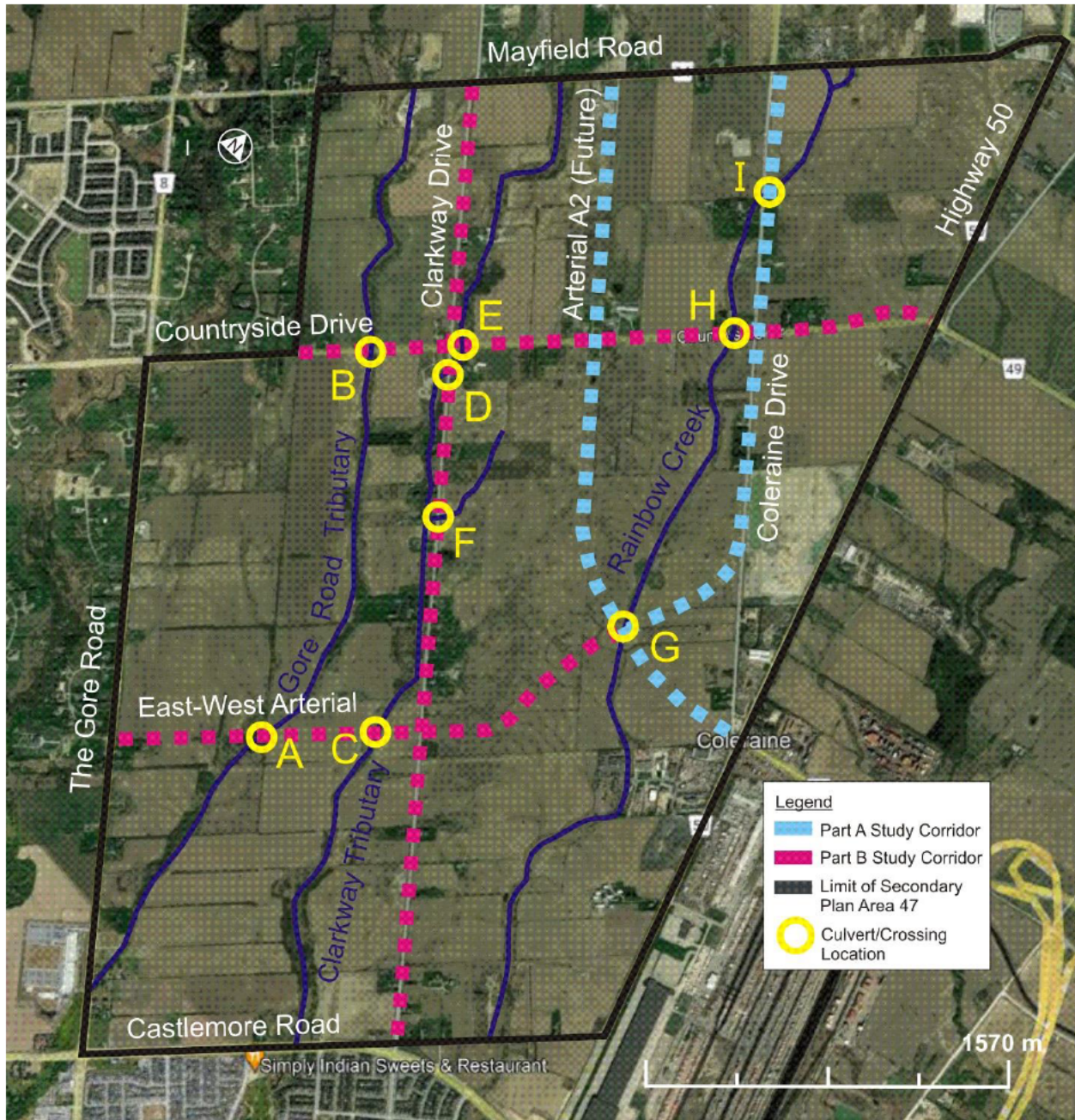


Figure 4-1 Structures included for Assessment for Parts A and B

(background image source Google Earth Pro™)

The model representing the 2-year to 100-year storm events contains six (6) plans. It is understood that the plan file named "Existing Condition Updated Flows" is representative of the geometry and flow conditions for the existing conditions of the Study Area, and the plan named "Scenario A" is representative of the geometry and flow conditions for the proposed conditions of the realigned Rainbow Creek through the Study Area. Similarly, the model representing the Regulatory conditions contains three (3) plans. It is understood that the plan file named "Existing Condition Updated Flows" is representative of the geometry and flow conditions for the existing conditions of the Study Area, and the plan named "Proposed Ultimate Condition" is representative of the geometry and flow conditions for the proposed conditions of the realigned Rainbow Creek through the Study Area. As such, hydraulic assessments of the existing and proposed conditions have been carried out using these plan files.

The Rainbow Creek hydraulic model extends from its confluence with the Main Humber River at Highway 407 (downstream limit) to about Kirby Road (upstream limit). Only one (1) of the west branches of the Rainbow Creek model is relevant to the current study as it is the only branch that drains Part A of the Study Area. This branch of the Rainbow Creek is designated River4-Reach 1 in the HEC-RAS model.

The provided HEC-RAS models have been revised for the evaluation of the proposed structures. Revisions include adjustments to the Coleraine Drive culvert (ref. Figure 4-1, Culvert I) and an additional structure added at the proposed intersection of Coleraine Drive and Arterial A2 (ref. Figure 4-1, Culvert G). Note that the Rainbow Creek crossing at Countryside Drive (ref. Figure 4-1, Culvert H) has also been sized and included in the proposed conditions model to ensure that the hydraulic impact of this proposed crossing is represented. The Countryside Drive crossing evaluation, however, is included as a component of the Part B Report.

Note that boundary conditions in the TRCA provided HEC-RAS models were not changed for this evaluation.

4.3 Hydraulic Structure Performance Assessment

4.3.1 Hydraulic Structure Sizing Criteria

The hydraulic assessment of the Study Area has considered design criteria from several agencies including, the Region, the MTO, and the Ministry of Natural Resources and Forestry (MNRF) as follows.

Region of Peel

No overtopping of the roadway during the Regional Storm Event is to occur at culverts and bridges.

MTO

MTO guidelines for culvert and bridge hydraulic design are based on providing a set freeboard and clearance. Freeboard is measured from the design event water surface elevation to the edge of travelled way. Clearance is measured from the design event water surface elevation to the obvert of the crossing. The design event, freeboard and clearance required consider the road classification and the total structure span. MTO guidelines are summarized in Table 4-2. The existing crossings have been assessed based on the future road classifications which are proposed to be classified as Urban Arterial.

MNRF

The MNRF's guidelines relate to the safe passage of pedestrians and passenger and emergency vehicles across the length of road over which the Regulatory storm event may overtop. Safe passage is determined by overtopping depths, overtopping velocities and consideration for the combined impact (i.e. product of depth and velocity) and represents 'low risk' to the method of transportation (i.e. pedestrian or vehicle). Table 4-3 summarizes the maximum allowable depths and velocities.

Table 4-2 Design Flow Return Period for Bridges and Culverts (Years) – Standard Road Classification

Functional Road Classification	MTO ¹		Freeboard Criteria (m) ¹	Clearance Criteria for Bridges (m) ¹	Clearance Criteria for Open-Footing Culverts (m) ^{1,2}
	Total Span less than or equal to 6.0 m	Total Span greater than 6.0 m			
Freeway, Urban Arterial	50	100	1.0	1.0	0.3
Rural Arterial, Collector	25	50	1.0	1.0	0.3
Local	10	25	0.3	0.3	0.3

Note(s)

1. Highway Drainage Design Standard (MTO, January 2008)
2. It is noted that there are no clearance criteria for closed-footing culverts

Table 4-3 Design Criteria for Pedestrian and Vehicular Access

Access	Maximum Overtopping Depth (m)	Maximum Overtopping Velocity (m/s)	Maximum Product (m ² /s)
Pedestrian	0.3	1.7	0.4
Passenger Vehicle	0.3	3.0	N/A ¹
Emergency Vehicle	0.9	4.5	N/A ¹

Note(s)

1. Highway Drainage Design Standard (MTO, January 2008)

4.3.2 Existing Conditions

All existing roads within the Study Area are proposed to be classified as Urban Arterial in the future and have been assessed on this basis. It is noted that the MNRF criteria are not relevant for the proposed conditions since the travelled way is required to be flood-free for the Regional Storm (ref. Section 4.3.1) as directed by Region of Peel requirements. However, the existing conditions assessment has considered these criteria for information purposes. The criteria for safe passage have been applied assuming ingress/egress for pedestrians. The results of the hydraulic structure performance assessment are summarized in Table 4-4. The HEC-RAS model is provided in Appendix B.

The results outlined in Table 4-4 indicate that the existing Study Area crossing does not meet either the MTO or MNRF design criteria, nor the Region’s design criteria to convey the Regional Storm event without overtopping the roadway. Therefore, the existing crossing must be resized for the proposed conditions, in addition to the new crossing for Arterial A2.

Table 4-4 Coleraine Drive Culvert I – Existing Performance

Structure – Culvert I	
Type/Configuration	Concrete Box Culvert Closed Bottom
Size (m)	2.40 (W) x 0.60 (H) x 10.0 (L)

MTO Design Criteria		Existing Performance	MNRF Design Criteria		Existing Performance
Design Event (Return Period)	50 Year	< 2 Year	Access mode	Pedestrian	
Freeboard (m)	1 m	Overtopped	Maximum Overtopping Depth (D)	0.3 m	0.16 m
Clearance (m)	N/A	N/A	Maximum Overtopping Velocity (V)	1.70 m/s	1.85 m/s
			Maximum Product (D x V)	0.4	0.3

Note(s)

1. Values in this table reference the design storm conveyance requirement
2. The existing conditions Coleraine Drive culvert is referenced as HEC-RAS section 24.475

4.3.3 Proposed Conditions

As outlined in Section 1.0, the future conditions for Part A of the Study Area proposes a new six-lane north-south major arterial road (Arterial A2) from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50 and widening of Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50. Due to the realignment of the Rainbow Creek, Culvert I is proposed to be relocated under Coleraine Drive, and has a HEC-RAS reference of River-4/Reach-1/24.4425 under proposed conditions. The proposed Arterial A2 roadway and reconstructed Coleraine Drive are proposed to intersect at Rainbow Creek (ref. Plans 4 and 8, Appendix C), therefore an additional crossing along Rainbow Creek is required at this location (Culvert G having HEC-RAS reference River-4/Reach-1/24.343).

The proposed crossings have been sized using the Rainbow Creek HEC-RAS model provided by TRCA. The geometry files representing the proposed conditions of the realigned Rainbow Creek have been revised, including adjustments to structure coding, as well as the addition, removal and adjustment to bounding cross sections. Geometries for the added cross sections have been estimated by interpolating between two (2) original cross sections contained in the received model (ref. Appendix B for HEC-RAS model details). The Part A crossings have been sized to meet the criteria outlined under Section 4.3.1 with the proposed configurations outlined in Table 4-5.

Table 4-5 Culvert I and G Proposed Configurations

Culvert	Span (m)	Rise (m)	Length (m)	Description
I (Coleraine Drive)	17.0 m	2.2 m	47.3 m	Bridge to replace the existing culvert crossings at Coleraine Drive (Culverts at HEC-RAS Section 24.475 in the existing conditions model)
G (Arterial A2/ Coleraine Drive)	25.0 m	2.5 m	75.0 m	New bridge crossing proposed at the intersection of Arterial A2 and Coleraine Drive.

The hydraulic performance of the proposed Crossing I and G is summarized in Table 4-6. The results indicate that the proposed sizes for the two (2) crossings within the Study Area satisfy both the MTO and Region design criteria. As previously noted, the MNRF criteria are not relevant for the proposed conditions as the travelled way is required to be flood-free for the Regional Storm (ref. Section 4.3.1). As such, the results for the MNRF criteria have not been presented.

Table 4-6 Part A Crossings - Proposed Configuration Hydraulic Performance

Coleraine Drive - Culvert I		MTO Design Criteria		Hydraulic Performance
Type/Configuration	Bridge	Design Event (Return Period)	100-Year	Regional
Size (m)	17.0 (W) x 2.2 (H) x 47.3 (L)	Freeboard (m)	1 m	1.54 m
		Clearance (m)	0.3 m	0.8 m

Countryside Drive – Culvert G		MTO Design Criteria		Hydraulic Performance
Type/Configuration	Bridge	Design Event (Return Period)	100-Year	Regional
Size (m)	25.0 (W) x 2.5 (H) x 75.0 (L)	Freeboard (m)	1 m	2.84
		Clearance (m)	1.0 m	1.39

Tables 4-7 and 4-8 summarize the comparison of existing and proposed conditions along Rainbow Creek from Highway 50 to Mayfield Road. It is noted that there are no changes in computed water surface elevations or computed channel velocities between proposed and existing conditions downstream of Old Castlemore Road, where no changes are contemplated as part of the Area 47 development plans.

Between Old Castlemore Road and Mayfield, channel alterations are contemplated, as are new and replaced watercourse crossings at roadways (specifically culverts G, H and I). In this reach of Rainbow Creek, the reconfiguration of the HEC-RAS model to model proposed conditions does not allow direct comparison, section for section, with the existing conditions model, however, the following observations are noted:

- Between Old Castlemore Road and the new structure proposed at the intersection of Arterial A2 and Coleraine Drive, computed water surface elevations for proposed conditions are generally lower than those computed under existing conditions, for both Regional and 100-year flood conditions.
- Between the new structure proposed at the intersection of Arterial A2 and the new Countryside Drive culvert, computed water surface elevations for proposed conditions are generally higher than those computed under existing conditions, for both Regional and 100-year flood conditions.
- Between the new Countryside Drive culvert and the new culvert on Coleraine Drive, computed water surface elevations for proposed conditions are generally higher than those computed under existing conditions, for both Regional and 100-year flood conditions.
- Between the new culvert on Coleraine Drive and Mayfield Road, computed water surface elevations for proposed conditions are generally higher than those computed under existing conditions, for both Regional and 100-year flood conditions.
- At Mayfield Road, water surface elevations are computed as being 18 cm and 15 cm higher, respectively, for the Regional Flood and 100-year Flood conditions.

**Table 4-7 Rainbow Creek (River-4/Reach-1) –
 Comparison of Existing and Proposed Hydraulic Conditions – Regional Flood Event**

HEC-RAS Section	Profile	Proposed Conditions		Existing Conditions		Change in	
		Water Surface Elevation (m)	Channel Velocity (m/s)	Water Surface Elevation (m)	Channel Velocity (m/s)	Water Surface Elevation (m)	Channel Velocity (m/s)
		A	B	C	D	=A - C	=B - D
24.52	Regional	228.90	3.00	228.72	3	0.18	0
24.51	Regional	226.96	2.58	226.73	1.89	0.23	0.69
24.5	Regional	226.11	1.87	225.57	2.9	0.54	-1.03
24.49	Regional	225.05	2.11	223.92	2.2	1.13	-0.09
24.46	Regional	224.00	3.02	222.72	1.42	1.28	1.6
24.45	Regional	223.05	0.98	222.19	2.55	0.86	-1.57
24.445*	Regional	222.91	2.04				
24.4425	Coleraine Drive						
24.4419*	Regional	222.10	3.70				
24.441	Regional	221.59	1.94				
24.44	Regional	221.23	1.51	221.2	1.49	0.03	0.02
24.432*	Regional	220.48	2.46				
24.424	Countryside Drive						
24.417*	Regional	219.20	2.82				
24.411	Regional	218.33	0.80				
24.41	Regional	218.13	1.44	217.8	2.8	0.33	-1.36
24.401	Regional	217.86	1.87				
24.4	Regional	217.08	2.82	216.73	2.52	0.35	0.3
24.391	Regional	216.70	1.22				
24.39	Regional	216.12	3.02	215.83	2.24	0.29	0.78
24.381	Regional	215.61	1.03				
24.38	Regional	215.16	3.07	214.53	2.12	0.63	0.95
24.372	Regional	214.66	2.30				
24.371	Regional	213.96	3.63				
24.37	Regional	213.54	1.72	212.61	2.52	0.93	-0.8
24.362	Regional	212.93	2.31				
24.361	Regional	212.45	1.53				
24.36	Regional	212.28	1.28	211.69	1.01	0.59	0.27
24.351	Regional	211.63	3.47				
24.35	Regional	210.99	2.18	210.92	3.48	0.07	-1.3
24.348*	Regional	210.84	1.50				
24.3459	Regional	210.84	0.78				
24.344	Regional	210.76	1.31				
24.343	New Intersection of Coleraine & Arterial A2						
24.342	Regional	210.06	2.68				
24.3415	Regional	209.94	1.97				
24.3409*	Regional	209.72	2.88				
24.34	Regional	209.58	1.95	210.27	1.13	-0.69	0.82
24.33	Regional	208.77	1.77	210.13	1	-1.36	0.77
24.328	Regional	208.58	1.39				
24.322	Regional	208.38	1.61				
24.32	Regional	208.30	1.63	209	4.15	-0.7	-2.52
24.31	Regional	207.95	2.09	208.56	1.65	-0.61	0.44
24.3	Regional	207.78	1.85	208.28	2	-0.5	-0.15
24.29	Regional	207.46	1.76	207.6	2.56	-0.14	-0.8
24.28	Regional	206.61	2.12	207.09	1.42	-0.48	0.7
24.27	Regional	205.72	1.73	206.09	3.1	-0.37	-1.37
24.26	Regional	204.48	2.54	205.12	1.84	-0.64	0.7
24.25	Regional	204.18	1.00	204.18	2.72	0	-1.72
24.24	Regional	204.14	0.66	204.08	1.15	0.06	-0.49
24.235	Old Castlemore Road						
24.23	Regional	203.43	2.37	203.43	2.37	0	0
24.22	Regional	203.09	2.30	203.09	2.3	0	0
24.21	Regional	202.73	1.92	202.73	1.92	0	0
24.205	Castlemore Road						
24.2	Regional	201.79	3.10	201.79	3.1	0	0
24.19	Regional	201.58	1.87	201.58	1.87	0	0
24.18	Regional	201.58	0.41	201.58	0.41	0	0
24.17	Regional	201.58	0.2	201.58	0.2	0	0
24.16	Regional	201.57	0.27	201.57	0.27	0	0
24.155	Highway 50						

**Table 4-8 Rainbow Creek (River-4/Reach-1) –
 Comparison of Existing and Proposed Hydraulic Conditions – 100-Year Flood Event**

HEC-RAS Section	Profile	Proposed Conditions		Existing Conditions		Change in	
		Water Surface Elevation (m)	Channel Velocity (m/s)	Water Surface Elevation (m)	Channel Velocity (m/s)	Water Surface Elevation (m)	Channel Velocity (m/s)
		A	B	C	D	=A - C	=B - D
24.52	100-yr	228.93	3.18	228.78	3.11	0.15	0.07
24.51	100-yr	227.01	2.6	226.79	1.94	0.22	0.66
24.5	100-yr	226.16	1.93	225.61	3.02	0.55	-1.09
24.49	100-yr	225.11	2.15	223.97	2.26	1.14	-0.11
24.46	100-yr	224.03	3.18	222.77	1.47	1.26	1.71
24.45	100-yr	223.34	0.84	222.23	2.65	1.11	-1.81
24.445*	100-yr	223.24	1.82				
24.4425	Coleraine Drive						
24.4419*	100-yr	222.16	3.91				
24.441	100-yr	221.65	1.96				
24.44	100-yr	221.31	1.52	220.94	2.05	0.37	-0.53
24.432*	100-yr	220.58	2.56				
24.424	Countryside Drive						
24.417*	100-yr	219.27	2.95				
24.411	100-yr	218.39	0.8				
24.41	100-yr	218.19	1.52	217.86	2.88	0.33	-1.36
24.401	100-yr	217.91	1.94				
24.4	100-yr	217.11	2.97	216.76	2.64	0.35	0.33
24.391	100-yr	216.73	1.33				
24.39	100-yr	216.12	3.05	215.84	2.25	0.28	0.8
24.381	100-yr	215.63	1.03				
24.38	100-yr	215.18	3.08	214.53	2.13	0.65	0.95
24.372	100-yr	214.67	2.32				
24.371	100-yr	213.98	3.65				
24.37	100-yr	213.55	1.74	212.62	2.54	0.93	-0.8
24.362	100-yr	212.95	2.28				
24.361	100-yr	212.42	1.64				
24.36	100-yr	212.24	1.26	211.66	0.99	0.58	0.27
24.351	100-yr	211.6	3.38				
24.35	100-yr	210.94	2.16	210.9	3.39	0.04	-1.23
24.348*	100-yr	210.78	1.51				
24.3459	100-yr	210.78	0.77				
24.344	100-yr	210.71	1.28				
24.343	New Intersection of Coleraine & Arterial A2						
24.342	100-yr	210.03	2.6				
24.3415	100-yr	209.92	1.92				
24.3409*	100-yr	209.7	2.81				
24.34	100-yr	209.54	1.93	210.14	1.26	-0.6	0.67
24.33	100-yr	208.74	1.72	209.97	1.03	-1.23	0.69
24.328	100-yr	208.54	1.41				
24.322	100-yr	208.31	1.73				
24.32	100-yr	208.22	1.55	208.93	3.77	-0.71	-2.22
24.31	100-yr	207.88	2.03	208.61	1.38	-0.73	0.65
24.3	100-yr	207.71	1.79	208.2	1.83	-0.49	-0.04
24.29	100-yr	207.37	1.75	207.56	2.43	-0.19	-0.68
24.28	100-yr	206.44	2.08	206.9	1.2	-0.46	0.88
24.27	100-yr	205.64	1.48	205.9	3.06	-0.26	-1.58
24.26	100-yr	204.18	3.32	204.87	1.78	-0.69	1.54
24.25	100-yr	203.98	0.74	203.97	2.31	0.01	-1.57
24.24	100-yr	203.96	0.45	203.95	0.82	0.01	-0.37
24.235	Old Castlemore Road						
24.23	100-yr	203.2	2.05	203.2	2.05	0	0
24.22	100-yr	202.51	3.01	202.51	3.01	0	0
24.21	100-yr	202.23	1.51	202.23	1.51	0	0
24.205	Castlemore Road						
24.2	100-yr	201.61	2.21	201.61	2.21	0	0
24.19	100-yr	200.84	2.98	200.84	2.98	0	0
24.18	100-yr	200.62	0.64	200.62	0.64	0	0
24.17	100-yr	200.61	0.24	200.61	0.24	0	0
24.16	100-yr	200.42	1.83	200.42	1.83	0	0
24.155	Highway 50						

For Tables 4-7 and 4-8, please note that there is not direct section to section comparison available at all locations between the proposed and existing conditions models. This due to the addition of proposed and/or relocated crossings in the proposed model resulting in new sections being added to the model.

The noted increases in computed water surface elevations are limited in spatial extent and are considered easily addressed with limited re-grading and/or landscaped flood proofing measures to ensure no impacts to the adjacent developable lands.

As well, computed channel velocities in some reaches may necessitate implementation of erosion controls.

Figure 4-2 illustrates the existing and proposed condition computed water surface elevation information presented in Table 4-7. As visualized, computed flood extents at the downstream limit of the assessment identify a reduced flooded area. There is some expansion of the floodplain in the mid-reach area south of Countryside Drive, but it is expected that, as noted above, these areas can be easily addressed with limited re-grading and/or landscaped flood proofing measures to ensure no impacts to the adjacent developable lands. Lands north of Countryside Drive benefit from channel realignment to facilitate new crossings which results in reduced roadway flooding and reduced flooding of adjacent lands.

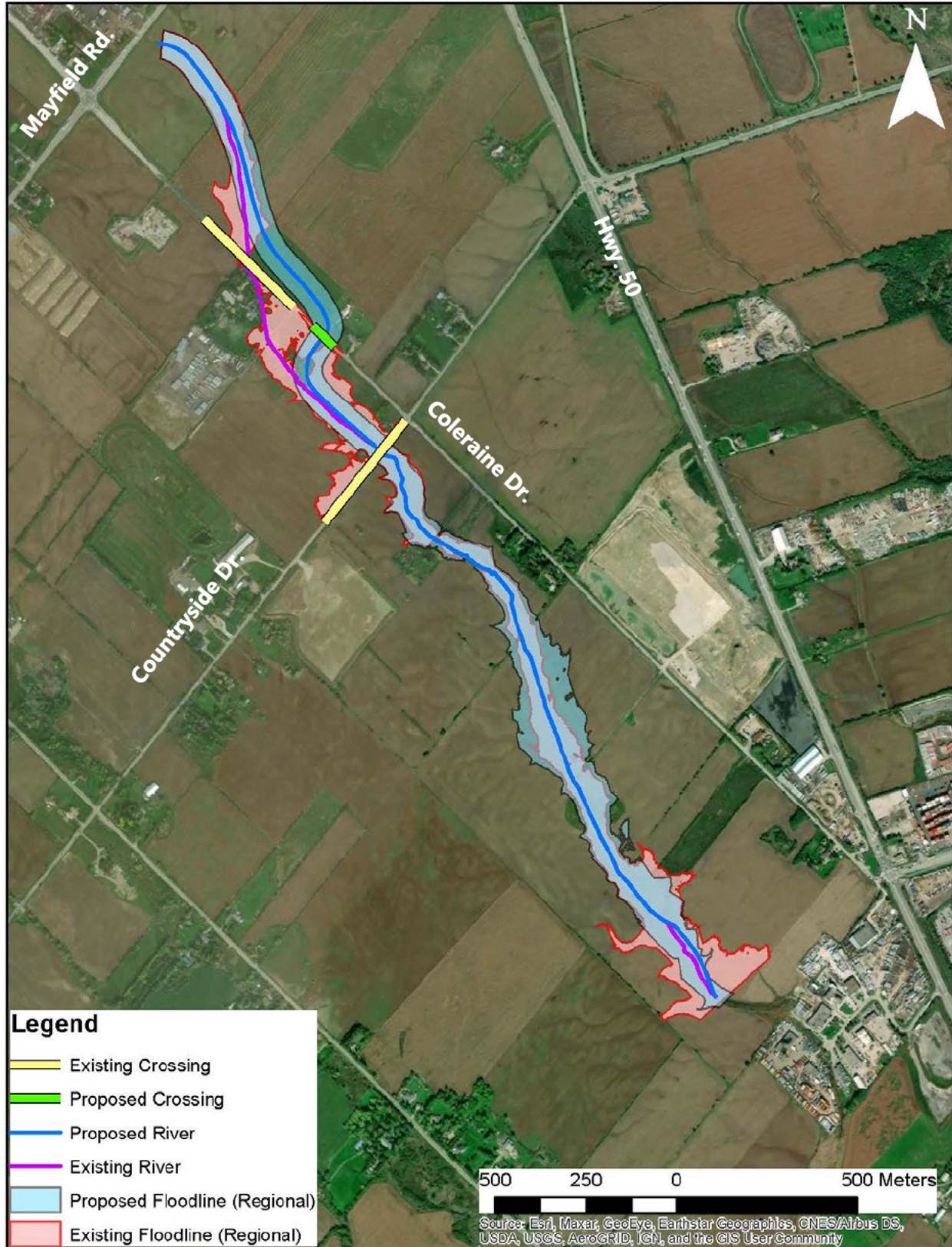


Figure 4-2 Regional Storm Event Flood Mapping of the Existing and Proposed Condition

5.0 CONCLUSIONS AND RECOMMENDATIONS

The City of Brampton has identified through its Transportation and Transit Master Plan (TTMP, 2009), and supporting studies (including the Highway 427 Extension Area Transportation Master Plan and the Highway 427 Industrial Secondary Plan (Area 47) Transportation Master Plan) the need for additional capacity in the road network up to the planning horizon year of 2031. As part of these studies, road network improvements within Secondary Plan Area 47 were recommended. The recommended road improvements are being addressed by the current Class EA in two parts:

Part A (Region owned R.O.W.s⁵):

1. A new six-lane north-south major arterial road (Arterial A2) from Mayfield Road east of Clarkway Drive to Major Mackenzie Drive/RR50; and,
2. Widening of Coleraine Drive from Arterial A2 to Mayfield Road including realignment at Arterial A2 west of RR50; and,

Part B (City owned R.O.W.s):

3. A new four-lane east-west minor arterial road from The Gore Road to Arterial A2 (E-W arterial);
4. Widening of Clarkway Drive from Castlemore Road to E-W Arterial to four lanes and urbanizing Clarkway Drive between E-W arterial and Mayfield Road with possible continuous centre turn lane; and,
5. Widening of Countryside Drive to four lanes from Clarkway Drive to RR50 including realignment at RR50.

The following conclusions and recommendations stem from the foregoing hydrologic and hydraulic assessments for the **Part A** right-of-ways.

5.1 Conclusions

1. Stormwater management design criteria for the following organizations and sources have been reviewed and integrated as relevant into this evaluation; Toronto and Region Conservation Authority (TRCA), Ministry of Environment and Parks (MECP), Region of Peel, City of Brampton, and the Master Environmental Servicing Plan (2016) and the Master Environmental Servicing Plan Addendum (2018). It has also been noted that the MECP is in the process of issuing a Stormwater Consolidated Linear Infrastructure (CLI) Environmental Compliance Approval (ECA) to the Region of Peel.
2. The MESP noted that stormwater management planning for this study area be based on the SWM facilities proposed within the Area 47 development blocks being designed to service the City of Brampton and Region of Peel owned right-of-ways for the water quantity, water quality, and erosion control SWM requirements. This approach requires formal agreement between the City, Region, and private landowners to allow for R.O.W. drainage to enter development blocks. However, the City and Region advised that these discussions with private landowners have not yet reached a positive conclusion by the time of writing of this report. As a result, the SWM approach advanced in the MESP may no longer be a viable approach.

As a formal agreement has not, to date, been established between the City, Region, and landowners, the requisite water quantity, water quality, and erosion control SWM requirements for the R.O.W. drainage may need to be implemented within the R.O.W. In this context, discussions between the City and Region are ongoing on the issue of possible management of roadway stormwater runoff from each

⁵ R.O.W. = road right-of-way

other's R.O.W.'s. Further discussions are required in this regard and any agreement may influence the design of SWM systems for this development area.

3. Two alternate stormwater management options for Coleraine Drive have been advanced, namely:
 - a) Alternative #1 - Redirecting R.O.W. drainage from Subcatchments CR4, CR5, CR6, CS6 and A7, away from SWMFs R7b and R4b, to SWMF R4a.
 - b) Alternative #2 - Redirecting R.O.W. drainage to a new SWM facility to be located in the north-west quadrant of the intersection of Coleraine Drive and Arterial A2.
4. The right-of-ways are required to control the runoff from the 90th percentile storm event, as per the Region of Peel road reconstruction criteria.
5. Based on available borehole logs and groundwater information, the runoff from the 90th percentile storm event can be controlled via on-site retention by implementing Low-Impact Development Best Management Practices within the right-of-way.
6. The existing crossing of Coleraine Drive does not meet the applicable Ministry of Transportation criteria for freeboard and conveyance, and the applicable Region of Peel criteria for conveyance.
7. The proposed crossings of Coleraine Drive and Arterial A2 have been sized to meet the applicable Ministry of Transportation criteria for freeboard, clearance, and conveyance, and the applicable Region of Peel criteria for conveyance.
8. A comparison of computed water surface elevations and computed channel velocities under existing and proposed conditions, indicates that changes are expected, within Area 47. HEC-RAS results at the upstream boundary, at Mayfield Road, indicate a small increase in computed water surface elevations of 20 cm and 15 cm, respectively, for the Regional and 100-year Flood events.
9. Increases in computed water surface elevations along the study reach are limited in spatial extent and are considered easily addressed with limited re-grading and/or landscaped flood proofing measures to ensure no impacts to the adjacent developable lands.
10. Computed channel velocities in some reaches may necessitate implementation of erosion controls.

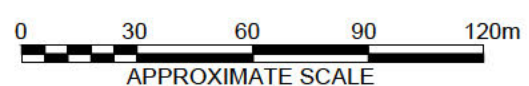
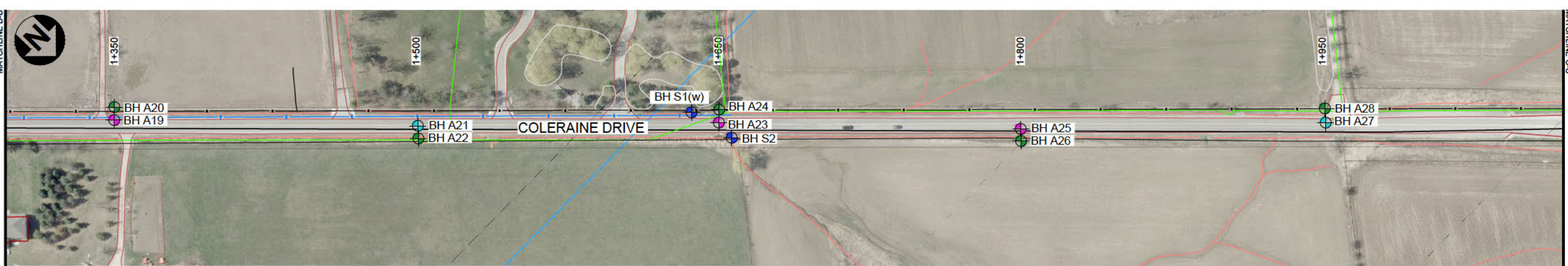
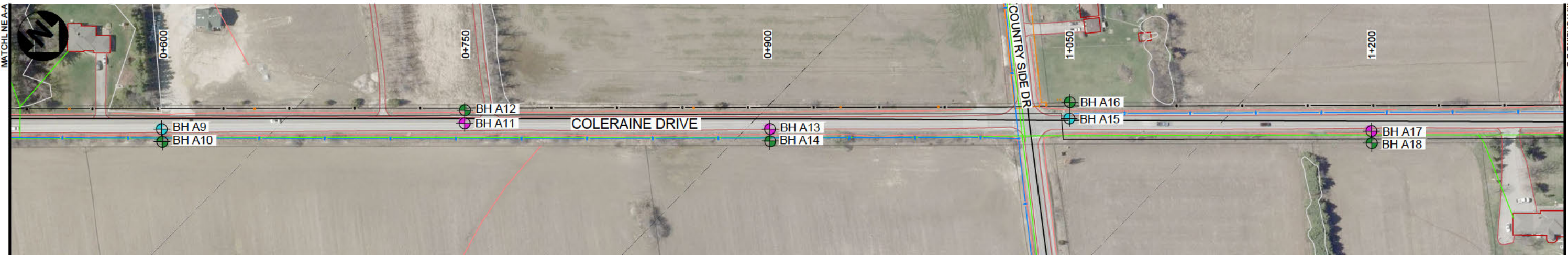
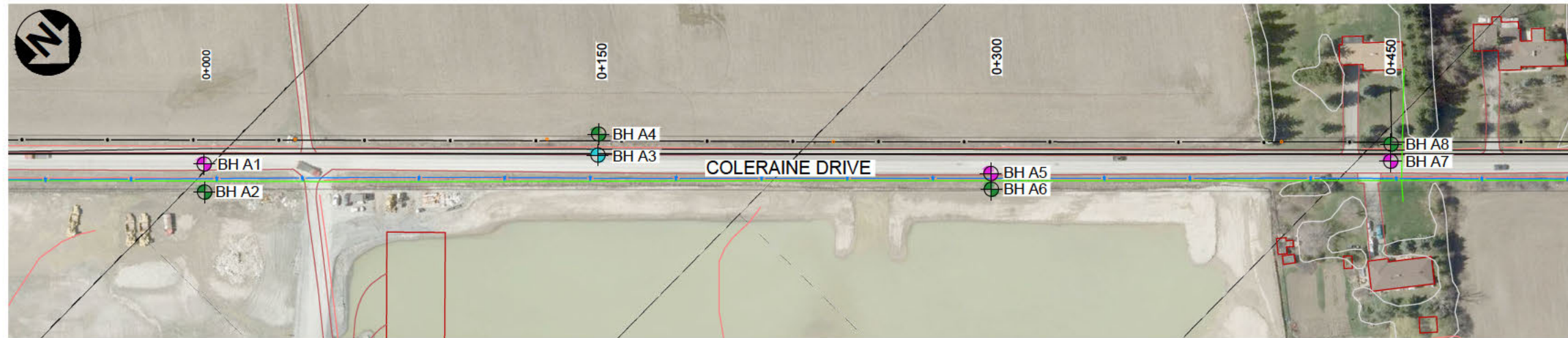
5.2 Recommendations

1. The SWM facilities proposed within the Area 47 development blocks are to be designed to service the City of Brampton and Region of Peel owned right-of-ways for the water quantity, water quality, and erosion control SWM requirements. Information pertaining to the manner in which the major and minor systems of the City of Brampton and Region of Peel owned right-of-ways would be connected to the systems servicing the development blocks has not been made available for the current study. As such, the road reconstruction retention volume requirements, as well as the short-listed Low-Impact Development Best Management Practices, should be further reviewed and refined when this information becomes available.
2. The developer group has agreed to locate the proposed storm water management pond near the intersection of Coleraine Drive and future Arterial Road A2 that will accommodate storm run-off from the realigned Coleraine Drive (generally drainage areas encompass the Coleraine Drive R.O.W. from north of Countryside Drive, south, to the facility [ref Appendix A for plans depicting catchments]). Further, the exact pond location, dimensions and design details will be determined during future phases of work. Discussions between the Region of Peel and City of Brampton have concluded that the Region of Peel will arrange for the design and construction of the stormwater management pond

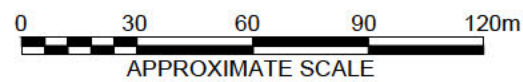
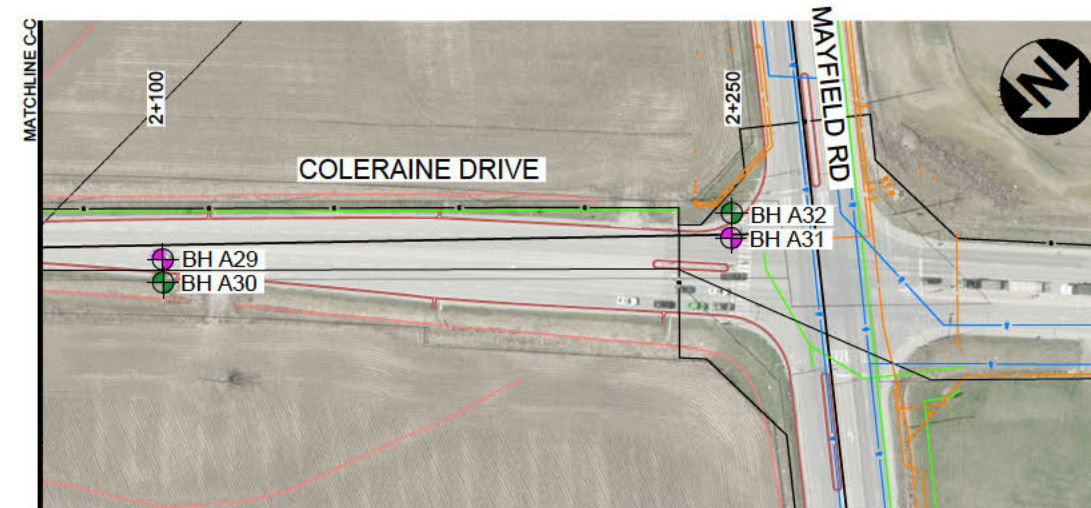
and the City of Brampton will accept conveyance and maintenance of the pond after the maintenance/warranty period.

3. It is recommended that the proposed crossings of Coleraine Drive and Arterial A2 be advanced to the detailed design stage.
4. It is recommended that the Region's four (4) step process for considering climate change resiliency in the design of SWM infrastructure should be implemented at the detailed design stage.
5. It is recommended that Rainbow Creek alterations or floodproofing measures associated with adjacent developable lands for the reach from Coleraine Drive to Mayfield Road be designed/implemented to achieve a near zero change in computed results between existing and proposed conditions or to accommodate minor changes in computed water surface elevations.
6. At the time of completion of the Class EA study, the CLI ECA template and criteria were not available, therefore the Class EA recommendations do not guarantee compliance with the CLI ECA conditions and criteria. It is recommended that at the detailed design stage, the Engineering Consultant re-assess the Class EA recommendations against the CLI ECA criteria and make the necessary adjustments and changes to the stormwater recommendations to be in compliance, where feasible.

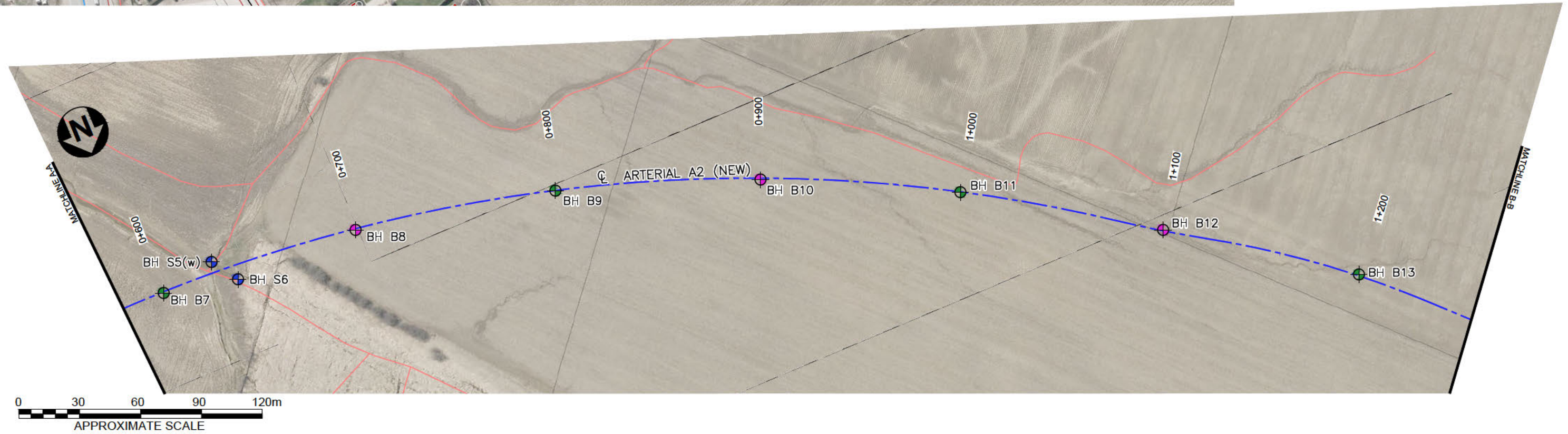
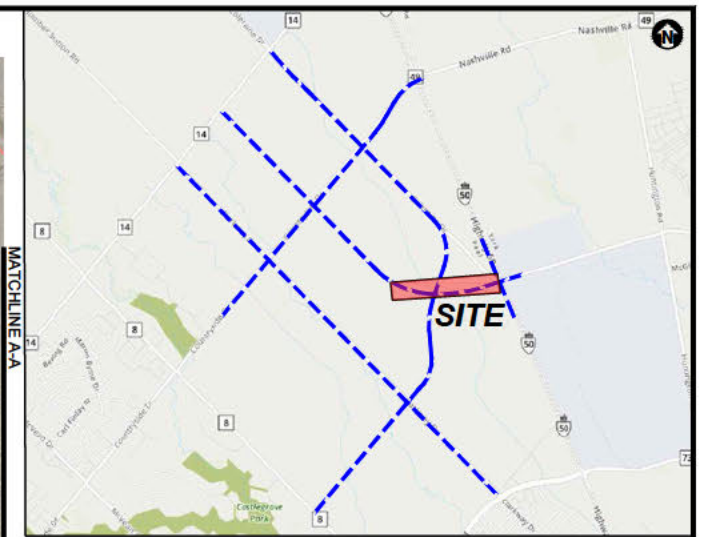
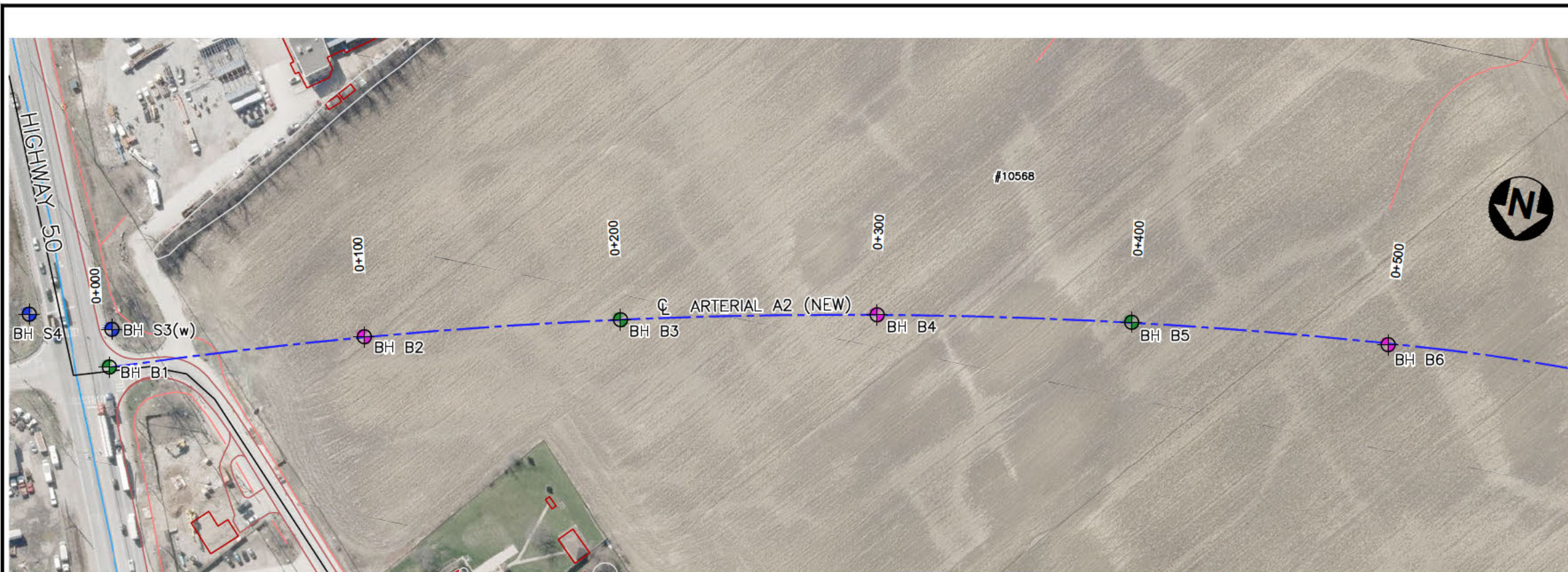
Appendix A: Background Information



LEGEND BOREHOLE LOCATION (MDL/EP - depth 1.5m) BOREHOLE LOCATION (SHR/TOS - depth 1.5m) BOREHOLE LOCATION (MDL/EP - depth 3m to 5m) BOREHOLE LOCATION (depth 10m) MONITORING WELL LOCATIONS	CL ENT LOGO 	CL ENT: THE CORPORATION OF THE CITY OF BRAMPTON Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited 50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6	KW CHK'D BY: SM	TITLE SITE AND BOREHOLE LOCATION PLAN (COLERAINE DRIVE) PROJECT GEOTECHNICAL INVESTIGATIONS ARTERIAL ROADS WITHIN HIGHWAY 427 INDUSTRIAL SECONDARY PLAN AREA (AREA 17) CITY OF BRAMPTON, ONTARIO	DATE: NOVEMBER 2019 PROJECT NO: TP115068
			DATUM: NAD83 PROJECTION: UTM Zone 17T SCALE: AS SHOWN		



LEGEND 	CLIENT LOGO 	CLIENT: THE CORPORATION OF THE CITY OF BRAMPTON Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited 50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6	KW	TITLE SITE AND BOREHOLE LOCATION PLAN (COLERAINE DRIVE)	DATE: NOVEMBER 2019
			CHK'D BY: SM		PROJECT GEOTECHNICAL INVESTIGATIONS ARTERIAL ROADS WITHIN HIGHWAY 427 INDUSTRIAL SECONDARY PLAN AREA (AREA 17) CITY OF BRAMPTON, ONTARIO
			DATUM: NAD83		RFQ NO: 2015-016
			PROJECTION: UTM Zone 17T		FIGURE No. 1B
			SCALE: AS SHOWN		



LEGEND BOREHOLE LOCATION (MDL/EP - depth 1.5m) BOREHOLE LOCATION (SHR/TOS - depth 1.5m) BOREHOLE LOCATION (MDL/EP - depth 3m to 5m) BOREHOLE LOCATION (depth 10m) MONITORING WELL LOCATIONS	CLIENT LOGO 	CLIENT: THE CORPORATION OF THE CITY OF BRAMPTON Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited 50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6	KW CHK'D BY: SM	TITLE SITE AND BOREHOLE LOCATION PLAN (ARTERIAL A2)	DATE: NOVEMBER 2019 PROJECT NO: TP115068
			DATUM: NAD83 PROJECTION: UTM Zone 17T SCALE: AS SHOWN		PROJECT GEOTECHNICAL INVESTIGATIONS ARTERIAL ROADS WITHIN HIGHWAY 427 INDUSTRIAL SECONDARY PLAN AREA (AREA 17) CITY OF BRAMPTON, ONTARIO



LEGEND BOREHOLE LOCATION (MDL/EP - depth 1.5m) BOREHOLE LOCATION (SHR/TOS - depth 1.5m) BOREHOLE LOCATION (MDL/EP - depth 3m to 5m) BOREHOLE LOCATION (depth 10m) MONITORING WELL LOCATIONS	CL ENT LOGO 	CL ENT: THE CORPORATION OF THE CITY OF BRAMPTON Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited 50 Vogell Road, Units 3 & 4, Richmond Hill, Ontario, L4B 3K6	KW CHK'D BY: SM	TITLE SITE AND BOREHOLE LOCATION PLAN (ARTERIAL A2) PROJECT GEOTECHNICAL INVESTIGATIONS ARTERIAL ROADS WITHIN HIGHWAY 427 INDUSTRIAL SECONDARY PLAN AREA (AREA 17) CITY OF BRAMPTON, ONTARIO	DATE: NOVEMBER 2019 PROJECT NO: TP115068
			DATUM: NAD83 PROJECTION: UTM Zone 17T SCALE: AS SHOWN		

RECORD OF BOREHOLE No. **BHA1**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605646 N:4853212** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 215.5 m										
about 180 mm ASPHALT						215.3				
Sand and Gravel FILL moist						216.2				
dark grey/brown Silty Clay FILL trace gravel trace organics	SS	1	100	10		215	○	○ ₂₅		
	SS	2	83	25	1	215	○	○ ₁₄		
brown/grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	3	100	37	2	214	○	○ ₁₈		
cobbles/boulders	SS	4	83	37	3	213	○	○ ₁₄		
	SS	5	100	38	4	212	○	○ ₁₂		
grey sandy	SS	6	100	25	4	212	○	○ ₁₀		3 30 45 22
	SS	7	100	33	5	211	○	○ ₁₃		
END OF BOREHOLE					5	210.5				

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHA2**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605648 N:4853213** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 215.4 m										
Sand and Gravel FILL moist 214.9	SS	1	100	61	215					Ground frozen to about 300 mm below surface
dark grey/brown Silty Clay FILL trace sand trace gravel with oxidation 214.1	SS	2	100	10	214					
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti 213.5	SS	3	100	29						
END OF BOREHOLE 213.5										

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∇ No restanding groundwater measured in open borehole on completion of drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHA3**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605516 N:4853330** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 216.3 m										
about 200 mm ASPHALT										
Sand and Gravel FILL moist										
dark grey/brown Silty Clay FILL trace gravel trace organics	SS	1	50	9	1	216	○	○ 29		
	SS	2	100	12	1	215	○	○ 26		
	SS	3	100	7	2	215	○	○ 22		
brown SILTY CLAY / CLAYEY SILT TILL some sand trace gravel very sti	SS	4	100	20	3	214	○	● 14		3 18 52 27
END OF BOREHOLE										

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▽ Groundwater encountered on completion of drilling on 1/21/2020 at a depth of 2.7 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHLA5**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605408 N:4853441** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 216.5 m										
about 200 mm ASPHALT 216.3										
Sand and Gravel FILL moist 216.2 0.3										
brown Silty Clay FILL trace gravel trace organics	SS	1	79	12	216					
215.3 1.2	SS	2	100	18	215					
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti 215.0 1.5										
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BLAZ**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605353 N:4853491** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)						
Geodetic Ground Surface Elevation: 218.2 m										
	about 180 mm ASPHALT					218				
	Sand and Gravel FILL moist					218.3				
	dark grey Silty Clay FILL trace gravel	SS	1	75	11					
	brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti	SS	2	100	20	217				
	END OF BOREHOLE					216.6				

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLA8**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605353 N:4853490** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 217.9 m										
Sand and Gravel FILL trace organics moist 217.5	SS	1	100	14						
brown Silty Clay FILL trace gravel 216.7	SS	2	83	8	1	217				
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti 216.1	SS	3	25	20						
END OF BOREHOLE 18										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLA9**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605252 N:4853597** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.1 m										
about 190 mm ASPHALT					219					
Sand and Gravel FILL moist					218.8					
dark grey/dark brown Silty Clay FILL trace gravel	SS	1	75	10	218.2					
brown/grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel trace cobbles very sti to hard	SS	2	63	21	218.09					
	SS	3	100	72	217.2					
	SS	4	100	44	216.8					
	SS	5	100	66	216.4					
grey	SS	6	100	34	215.6					
	SS	7	100	33	214.8					
END OF BOREHOLE					214.1					

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BLA10**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605253 N:4853600** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.0 m										
Gravelly Sand FILL some fines some topsoil moist	SS	1	100	8						GR 27 SA 60 (13)
brown/grey Silty Clay FILL trace gravel	SS	2	83	12	1	218				
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti	SS	3	83	24						
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BHA11**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605117 N:4853720** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.9 m										
about 200 mm ASPHALT 219.7										
Sand and Gravel FILL moist 219.8 0.3										
dark grey Silty Clay FILL trace gravel trace organics trace cobbles 219.0	SS	1	25	12			○ 24			
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders sti to hard 219.0 0.9	SS	2	58	14	1		○ 14			
	SS	3	83	28	2		○ 14			
	SS	4	100	38	3		○ 14			
216.8 END OF BOREHOLE 3.0										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHA13**



Project Number **TP115086** Drilling Location **Coleraine Drive E:605006 N:4853836** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 21, 2020** Date Completed **Jan 21, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 220.2 m										
about 200 mm ASPHALT					220					
Sand and Gravel FILL moist					219.9					
dark grey/grey Silty Clay FILL trace sand trace gravel trace organics	SS	1	67	9	1	219	○	■		
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders hard	SS	2	83	14	2	218.6	○	■		
END OF BOREHOLE	SS	3	100	36		217.3	○	■		
	SS	4	100	82		217.3	○	■		

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▽ Groundwater encountered on completion of drilling on 1/21/2020 at a depth of 2.4 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHA15**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604898 N:4853934** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

Lithology Plo	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION		Sample type	Sample Number	Recovery (%)	SP 'N' / ROD (%)	DEPTH (m)	ELEVATION (m)	Penetration esting ○ SPT □ PPT ● DCPT		Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL)		
	Geodetic Ground Surface Elevation: 221.5 m												
	about 190 mm ASPHALT	221.3											
	About 110 mm CONCRETE	220.2											
	dark grey Silty Clay FILL trace gravel trace organics	0.3	SS	1	46	10	221						
	brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel sti	0.9	SS	2	100	8	1						
	END OF BOREHOLE	1.5					220						

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∇ No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BHA17**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604785 N:4854053** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.5 m										
about 200 mm ASPHALT						222.3				
Sand and Gravel FILL moist						222.2				
grey/brown Silty Clay FILL trace sand and gravel	SS	1	83	9		222.0				
	SS	2	83	6		221.5				
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	3	100	20		221.0				
cobbles /boulders	SS	4	100	41		220.0				
	SS	5	100	101		219.5				
greyish brown	SS	6	100	45		218.5				
	SS	7	100	34		217.5				
END OF BOREHOLE						217.0				

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLA18**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604785 N:4854054** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP ¹ N ¹ / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.9 m										
Lithology Pio	Sand and Gravel FILL trace organics moist	SS	1	100	17	222.5	○	■		
	brown/dark brown Silty Clay FILL trace gravel with oxidation	SS	2	83	12	221.7	○	■		
	brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti	SS	3	100	22	221.1	○	■		
END OF BOREHOLE 18										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHA19**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604701 N:4854134** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.6 m										
about 200 mm ASPHALT						222.4				
Sand and Gravel FILL moist						222.3				
dark grey/brown Silty Clay FILL trace sand trace organics	SS	1	100	12		222	○	○ 28		
	SS	2	67	12	1		○	○ 17		
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel hard	SS	3	100	34	2	221.1	○	○ 15		
	SS	4	100	57	3	220	○	○ 10		
END OF BOREHOLE						219.6				

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHA20**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604693 N:4854133** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.4 m										
Sand and Gravel FILL moist	SS	1	100	26		222	○			
dark grey/brown Silty Clay FILL trace gravel trace organics trace cobbles										
	SS	2	100	12		1	○			
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel sti										
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHA21**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604576 N:4854257** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 223.2 m										
about 200 mm ASPHALT 223.0										
Sand and Gravel FILL moist 222.9										
dark grey Silty Clay FILL trace sand trace organics 0.3	SS	1	50	10						
221.9										
greyish brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel sti 221.4	SS	2	58	9						
221.5										
END OF BOREHOLE										

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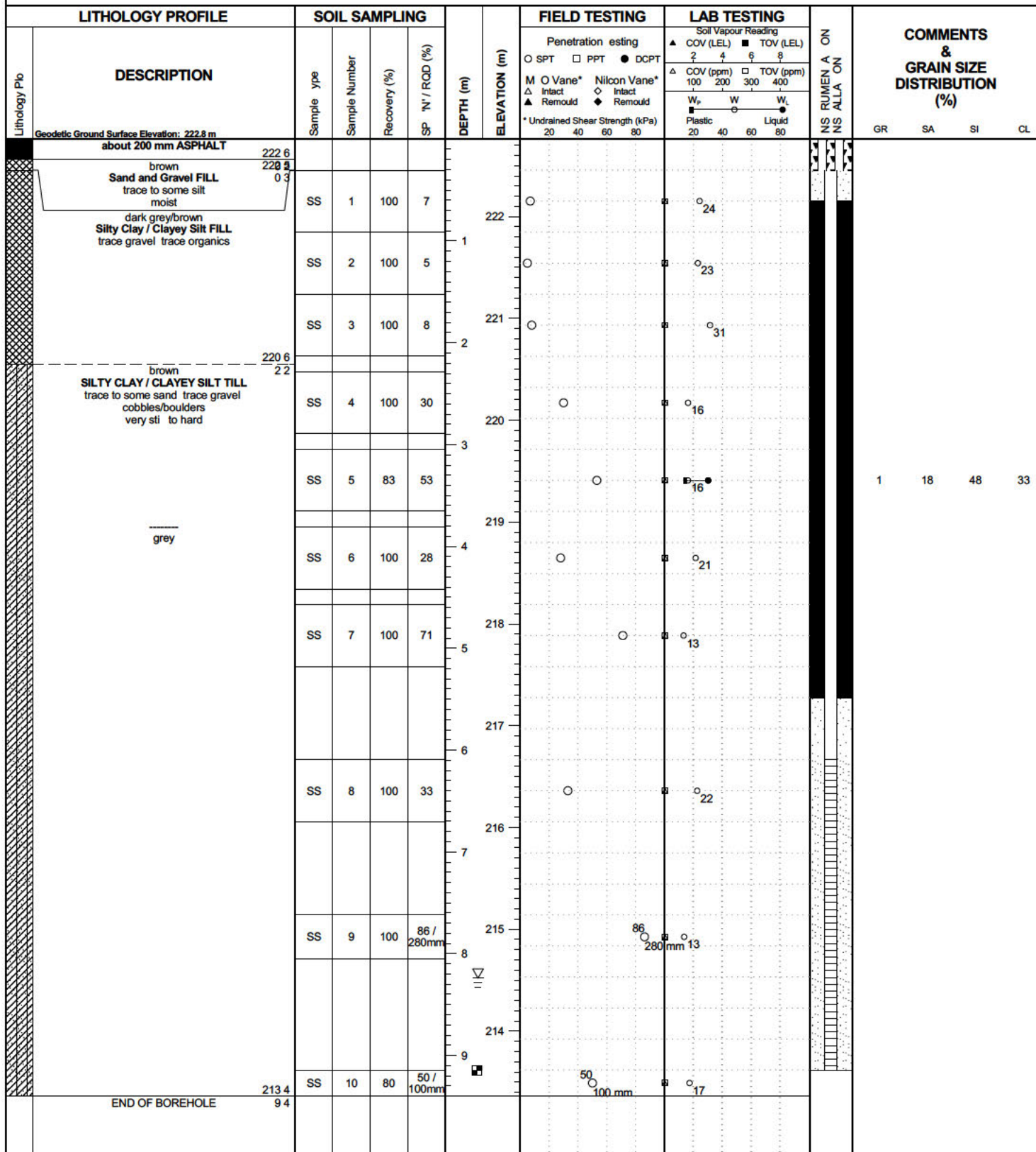
∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHA23 / BH S1**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604481 N:4854343** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 20, 2020** Date Completed **Jan 20, 2020** Revision No **0, 8/14/20**



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▽ Groundwater encountered on completion of drilling on 1/20/2020 at a depth of 8.2 m ■ Cave in depth after removal of augers 9.1 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHA25**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604381 N:4854447** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 225.0 m										
about 200 mm ASPHALT										
Sand and Gravel FILL moist										
grey/brown Silty Clay FILL trace gravel trace cobbles	SS	1	100	13						
brown/grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	2	100	25	1	224				
	SS	3	75	31	2	223				
	SS	4	100	76 / 180mm			76 180mm			
	SS	5	100	91	3	222				
grey	SS	6	92	57	4	221				
	SS	7	100	74						
END OF BOREHOLE					5	220				

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHLA26**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604384 N:4854450** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP ¹ N ¹ / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 224.4 m										
Lithology Plo	Sand and Gravel FILL trace organics moist 224.0	SS	1	100	19	224	○	■		
	0.4 dark grey/brown Silty Clay FILL trace gravel trace cobbles	SS	2	100	18	223	○	■		
	223.2 1.2 brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel hard	SS	3	100	40	222.6	○	■		
222.6	END OF BOREHOLE				18					

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHA27**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604250 N:4854566** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 226.8 m										
about 250 mm ASPHALT						226.6				
Sand and Gravel FILL moist						226.4				
brown Silty Clay FILL trace gravel trace cobbles	SS	1	100	13		226.0	○	○ 16		
						225.9				
	SS	2	100	29		225.8	○	○ 13		
						225.7				
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders hard	SS	3	100	41		225.3	○	○ 12		
						225.1				
	SS	4	100	57		224.8	○	○ 12		
END OF BOREHOLE						223.8				
						223.0				

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∇ No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BHA28**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604250 N:4854566** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)						
Geodetic Ground Surface Elevation: 226.8 m										
Lithology Plo	Sand and Gravel FILL moist	SS	1	100	46					
	226.2									
	brown Silty Clay FILL trace gravel	SS	2	100	12	226				
	225.6									
	END OF BOREHOLE									
	1.2									

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLA29**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604157 N:4854675** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 228.6 m										
about 200 mm ASPHALT										
Sand and Gravel FILL moist										
brown Silty Clay FILL trace gravel trace cobbles	SS	1	100	44	228					
	SS	2	100	18	1					
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHLA30**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604159 N:4854679** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 228.7 m										
Gravelly Sand FILL some fines some topsoil moist 228.2	SS	1	100	16						30 57 (13)
dark grey/brown Silty Clay FILL trace gravel with oxidation 227.5	SS	2	100	13	1					
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders hard 226.9	SS	3	100	38						
END OF BOREHOLE 18										

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∇ No restanding groundwater measured in open borehole on completion of drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHA31**



Project Number **TP115086** Drilling Location **Coleraine Drive E:604075 N:4854743** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 22, 2020** Date Completed **Jan 22, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould		
Geodetic Ground Surface Elevation: 230.7 m										
about 200 mm ASPHALT										
Sand and Gravel FILL moist	SS	1	100	38		230	○	■ 5		
grey/brown Silty Clay FILL trace gravel	SS	2	100	16	1	229.8	○	■ 21		
brown/brownish grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	3	100	27	2	229.2	○	■ 14		
	SS	4	100	29	3	228	○	■ 15		
	SS	5	100	39	4	227	○	■ 14		
	SS	6	92	44	5	226	○	■ 13		
	SS	7	100	36	5	225.7	○	■ 13		
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BLS2**



Project Number **TP115086** Drilling Location **Culvert at Coleraine Drive E:604486 N:4854343** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Coleraine Drive, Brampton, Ontario** Date Started **Jan 20, 2020** Date Completed **Jan 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.4 m										
about 200 mm ASPHALT						222.3				
brown Sand and Gravel FILL trace to some silt moist	SS	1	100	8		222.0	○	○ ₂₄		
dark grey/brown Silty Clay / Clayey Silt FILL trace gravel trace organics	SS	2	42	8	1	221.0	○	○ ₂₆		
brown	SS	3	75	7	2	220.5	○	○ ₂₆		
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	4	100	29		220.2	○	○ ₁₃		
	SS	5	46	42	3	219.5	○	○ ₁₂		
grey	SS	6	100	28	4	218.5	○	○ ₂₁		
	SS	7	100	19	5	217.5	○	○ ₁₆		
	SS	8	100	35	6	216.5	○	○ ₂₁		
	SS	9	100	36	7	215.5	○	○ ₁₁		
	SS	10	100	50 / 100mm	8	214.5	○	○ ₁₀		
END OF BOREHOLE					9	213.1				

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∇ No restanding groundwater measured in open borehole on completion o drilling ■ Cave in depth a ter removal o augers 7.9 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB1**



Project Number **TP115086** Drilling Location **Arterial A2 E:606238 N:4852654** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 10, 2020** Date Completed **Jan 10, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 211.5 m										
about 140 mm ASPHALT brown Gravelly Sand FILL some fines moist					211					32 56 (12) Located at the intersection of Coleraine Drive and Highway 50
210.7 brown/dark grey Silty Clay FILL some sand trace to some gravel trace organics	SS	1	100	27	1					
210.0 END OF BOREHOLE					210					

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∇ No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BHLB2**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)	
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould			Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) △ COV (ppm) □ TOV (ppm) W _p W _L W _u Plastic Liquid
Geodetic Ground Surface Elevation: 210.2 m about 300 mm TOPSOIL											
209.9 0.3 brown Silty Clay FILL (reworked soil)	SS	1	75	7		210	○	□	○	30	
209.5 0.7 brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	17	1	209	○	□	○	13	
	SS	3	100	22	2	208	○	□	○	13	
cobbles/boulders	SS	4	100	45		208	○	□	○	13	
207.2 3.0 brown SILTY SAND / SANDY SILT some gravel trace clay very dense wet	SS	5	75	65	3	207	○	□	○	11	14 49 33 4
206.5 3.7 brown/grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel hard to very sti	SS	6	83	34	4	206	○	□	○	11	
grey	SS	7	100	27		206	○	□	○	11	
205.2 5.0 END OF BOREHOLE					5	205					

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▽ Groundwater encountered on completion of drilling on 1/23/2020 at a depth of 3.7 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHLB3**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 211.8 m										
about 200 mm TOPSOIL										
211.6 dark grey/brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	58	5		211.6				
211.1 brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	2	100	21	1	211.1				
	SS	3	100	28	2	210.7				
brownish grey										
	SS	4	100	46		209.8				
208.8 END OF BOREHOLE					3	208.8				

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHLB4**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 211.7 m										
about 200 mm TOPSOIL										
211.5										
dark brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	83	5						
211.1										
0.6										
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel sti to very sti	SS	2	100	13	1					
	SS	3	100	24						
209.9										
END OF BOREHOLE										
1.8										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLB5**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 211.3 m about 300 mm TOPSOIL										
211.0 dark grey/brown Silty Clay FILL trace gravel (reworked soil)	SS	1	83	6		211	○	□	17	
210.6 brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders sti to hard	SS	2	100	10	1	210	○	□	14	
	SS	3	100	18	2	209	○	□	13	
	SS	4	100	35	3	208	○	□	13	
grey	SS	5	100	28	4	207	○	□	11	
	SS	6	100	20	5	206.2	○	□	11	
206.2 END OF BOREHOLE					5.0				14	

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLB6**



Project Number **TP115086** Drilling Location **Arterial A2 E:605759 N:4852529** Logged by **MM**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 7, 2020** Date Completed **Feb 7, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 210.9 m										
about 150 mm TOPSOIL										
brown Silty Clay / Clayey Silt FILL trace sand trace rootlets (reworked soil)	SS	1	83	6						
210.2										
brown SILTY CLAY / CLAYEY SILT TILL trace sand to sandy trace gravel very silty	SS	2	100	20	1	210				
208.8										
END OF BOREHOLE					2	209				
2.1										

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∇ No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BH B7 / BH S5**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Arterial A2, Brampton, Ontario**

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
	DESCRIPTION	Sample type	Sample Number	Recovery (%)	SP 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	Penetration esting	COV (LEL)	TOV (LEL)	COV (ppm)	TOV (ppm)		GR	SA	SI	CL
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 9.1 m Screen 6.1																			

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB8**



Project Number **TP115086** Drilling Location **Arterial A2 E:605564 N:4852529** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◊ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 211.1 m about 100 mm TOPSOIL dark brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	100	9		211				
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	22		210				
END OF BOREHOLE	SS	3	44	36						

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No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHLB9**



Project Number **TP115086** Drilling Location **Arterial A2 E:605461 N:4852548** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT	M O Vane* △ Intact ▲ Remould	Nilcon Vane* ◇ Intact ◆ Remould		
Geodetic Ground Surface Elevation: 212.5 m												
about 100 mm TOPSOIL						212.3						
dark brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	100	15		212.0	○					
brown SILTY CLAY / CLAYEY SILT TILL trace sand and sandy trace gravel cobbles/boulders very sti to hard	SS	2	100	13	1	211.8	○					
grey	SS	3	100	34	2	211.0	○					
	SS	4	100	68	3	210.0	○					
	SS	5	100	48	4	209.0	○					
	SS	6	100	72	5	208.0	○					
END OF BOREHOLE	SS	7	100	49	5	207.4	○					

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∇ Groundwater encountered on completion of drilling on 2/20/2020 at a depth of 4.3 m

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RECORD OF BOREHOLE No. **BHL10**



Project Number **TP115086** Drilling Location **Arterial A2 E:605365 N:4852580** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)						
Geodetic Ground Surface Elevation: 212.7 m										
about 150 mm TOPSOIL										
dark brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	79	8						
212.1										
brown/brownish grey SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	18	1					
211.0										
END OF BOREHOLE										
211.7										

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No restanding groundwater measured in open borehole on completion of drilling

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RECORD OF BOREHOLE No. **BHL11**



Project Number **TP115086** Drilling Location **Arterial A2 E:605279 N:4852627** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 212.3 m										
about 100 mm TOPSOIL					212.2					
dark brown/brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	100	16	212.0					
211.6										
brown SILTY CLAY / CLAYEY SILT TILL trace sand to sandy trace gravel very sti to hard	SS	2	100	25	211.0					
	SS	3	100	43	210.0					2 24 49 25
brownish grey										
	SS	4	100	56	209.3					
209.3										
END OF BOREHOLE					3.0					

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHL12**



Project Number **TP115086** Drilling Location **Arterial A2 E:605192 N:4852676** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

Lithology Plo	LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)		ELEVATION (m)		FIELD TESTING		LAB TESTING		NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	DESCRIPTION		Sample type	Sample Number	Recovery (%)	SP 'N' / ROD (%)			Penetration esting ○ SPT □ PPT ● DCPT	M O Vane* △ Intact ◊ Intact ▲ Remould ◆ Remould	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) △ COV (ppm) □ TOV (ppm)	W _p W _L Plastic Liquid				
	Geodetic Ground Surface Elevation: 214.3 m															
	about 150 mm TOPSOIL	214.1														
	dark brown Silty Clay FILL trace gravel trace organics (reworked soil)	0.2 213.6	SS	1	83	17										
	greyish brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	0.6 212.6	SS	2	100	24	1									
	END OF BOREHOLE	1.7	SS	3	100	69										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHL13**



Project Number **TP115086** Drilling Location **Arterial A2 E:605111 N:4852740** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 20, 2020** Date Completed **Feb 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 215.7 m about 100 mm TOPSOIL dark brown/brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	75	8		215.6		32		
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders hard to very sti	SS	2	54	36	1	215.07		17		
	SS	3	100	44	2	214.07		14		
	SS	4	100	64	3	213.07		13		
	SS	5	100	39	3	212.07		13		
grey	SS	6	100	19	4	211.07		13		
END OF BOREHOLE	SS	7	100	21	5	210.75		12		

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHL14**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / RQD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 217.1 m										
about 200 mm TOPSOIL 216.9										
drak brown / brown Silty Clay FILL 216.5 trace gravel trace organics (reworked soil) 0.8	SS	1	100	7						
brown SILTY CLAY / CLAYEY SILT TILL 216 trace sand trace gravel very sti to hard	SS	2	100	25	1	216				
215.2	SS	3	100	56						
END OF BOREHOLE 1.8										

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHL15**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 217.3 m										
about 150 mm TOPSOIL					217.2					
dark brown / brown Silty Clay FILL trace gravel (reworked soil)	SS	1	100	6	217.0					
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel hard	SS	2	100	32	216.8					
	SS	3	100	35	216.6					
	SS	4	100	52	215.8					
END OF BOREHOLE					214.3					

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∇ No restanding groundwater measured in open borehole on completion o drilling

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RECORD OF BOREHOLE No. **BHL16**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)						
Geodetic Ground Surface Elevation: 217.9 m										
about 150 mm TOPSOIL										
dark brown / brown Silty Clay FILL trace gravel (reworked soil)	SS	1	100	8						
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	21	1	217				
	SS	3	100	56						
END OF BOREHOLE										

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No restanding groundwater measured in open borehole on completion of drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB17**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 218.5 m										
about 150 mm TOPSOIL					218.3					
dark brown / brown Silty Clay FILL (reworked soil)	SS	1	100	8	218.0					
217.9										
brown SILTY CLAY / CLAYEY SILT TILL trace sand to sandy trace gravel cobbles/boulders very sti to hard	SS	2	100	21	217.6					
					217.0					
	SS	3	100	30	216.6					5 21 47 27
					216.0					
	SS	4	100	42	215.6					
					215.0					
	SS	5	100	50	214.6					
					214.0					
grey	SS	6	100	39	213.6					
					213.0					
END OF BOREHOLE	SS	7	100	29	213.4					
					213.0					

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BHL18**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / RQD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.2 m										
about 150 mm TOPSOIL					219					
dark brown / brown Silty Clay FILL trace gravel (reworked soil)	SS	1	100	8	219					
218.6										
0.6										
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	2	100	20	218					
217.4										
1.8										
END OF BOREHOLE										

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHL19**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.5 m										
about 200 mm TOPSOIL					219.3					
dark brown/brown Silty Clay FILL trace gravel (reworked soil)	SS	1	100	7	219.0					
218.9										
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	29	218.0					
	SS	3	83	37	217.5					
greyish brown					217.0					
	SS	4	100	40	216.5					
216.5										
END OF BOREHOLE					3.0					

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB20**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.9 m										
about 100 mm TOPSOIL						219.8				
dark grey / brown Silty Clay FILL trace gravel (reworked soil)	SS	1	75	9		219.3	○			
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel very sti to hard	SS	2	100	26		219.0	○			
	SS	3	100	56		218.1	○			
END OF BOREHOLE						218.1				

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Groundwater encountered on completion of drilling on 1/24/2020 at a depth of 1.2 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB21**



Project Number **TP115086** Drilling Location **Arterial A2** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 24, 2020** Date Completed **Jan 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample type	Sample Number	Recovery (%)			SP 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 220.8 m										
about 200 mm TOPSOIL										
dark grey / dark brown / brown Silty Clay FILL trace gravel trace organics (reworked soil)	SS	1	100	12		220.6	○	○ 14		
	SS	2	100	9	1	220	○	○ 22		
	SS	3	100	9	2	219	○	○ 39		
brown SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel sti to hard	SS	4	100	13		218.6	○	○ 17		
	SS	5	100	27	3	218	○	○ 16		
grey	SS	6	100	22	4	217	○	○ 17		
	SS	7	100	30	5	216	○	○ 20		
END OF BOREHOLE						215.8				

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▽ Groundwater encountered on completion of drilling on 1/24/2020 at a depth of 2.7 m ■ Cave in depth after removal of augers 4.3 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHLB22**



Project Number **TP115086** Drilling Location **Arterial A2 E:604484 N:4853360** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Truck Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Jan 23, 2020** Date Completed **Jan 23, 2020** Revision No **0, 8/14/20**

Lithology Plo	LITHOLOGY PROFILE		SOIL SAMPLING				FIELD TESTING		LAB TESTING				NS RUMEN A ON NS ALLA ON	COMMENTS & GRAIN SIZE DISTRIBUTION (%)					
	DESCRIPTION	DEPTH (m)	Sample type	Sample Number	Recovery (%)	SP 'N' / ROD (%)	DEPTH (m)	ELEVATION (m)	Penetration esting ○ SPT □ PPT ● DCPT	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL)		COV (ppm) □ TOV (ppm)		GR	SA	SI	CL		
	Geodetic Ground Surface Elevation: 220.5 m																		
	about 200 mm ASPHALT	220.3																	
	Gravelly Sand FILL some fines moist	219.9	SS	1	75	9	220	○									33	58	(9)
	brown/dark grey Silty Clay FILL trace gravel	219.0	SS	2	100	18	219	○											
	END OF BOREHOLE	219.15																	

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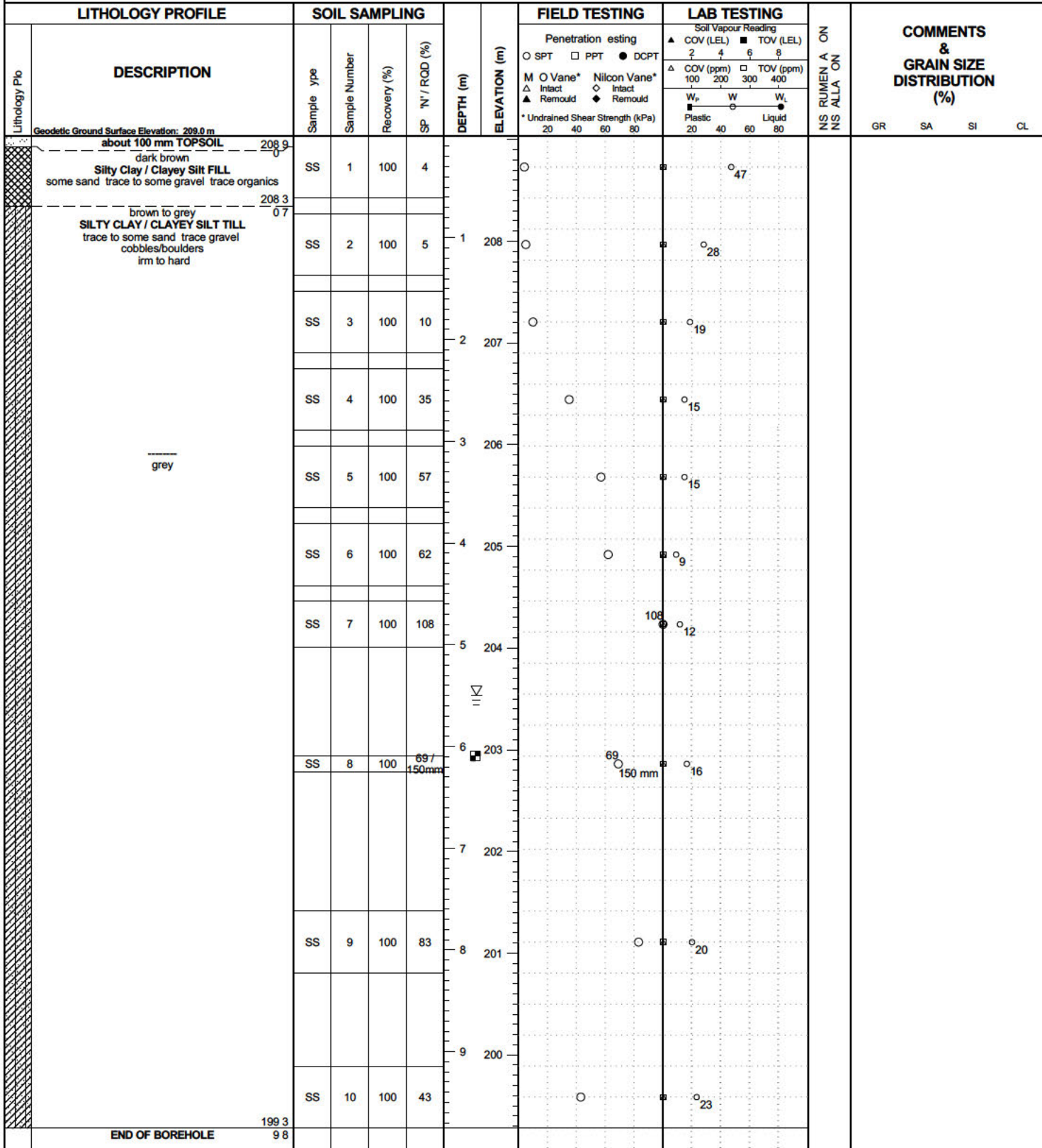
∇ No restanding groundwater measured in open borehole on completion of drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS6**



Project Number **TP115086** Drilling Location **Culvert at Arterial A2 E-W E:605620 N:4852529** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Arterial A2, Brampton, Ontario** Date Started **Feb 26, 2020** Date Completed **Feb 26, 2020** Revision No **0, 8/14/20**



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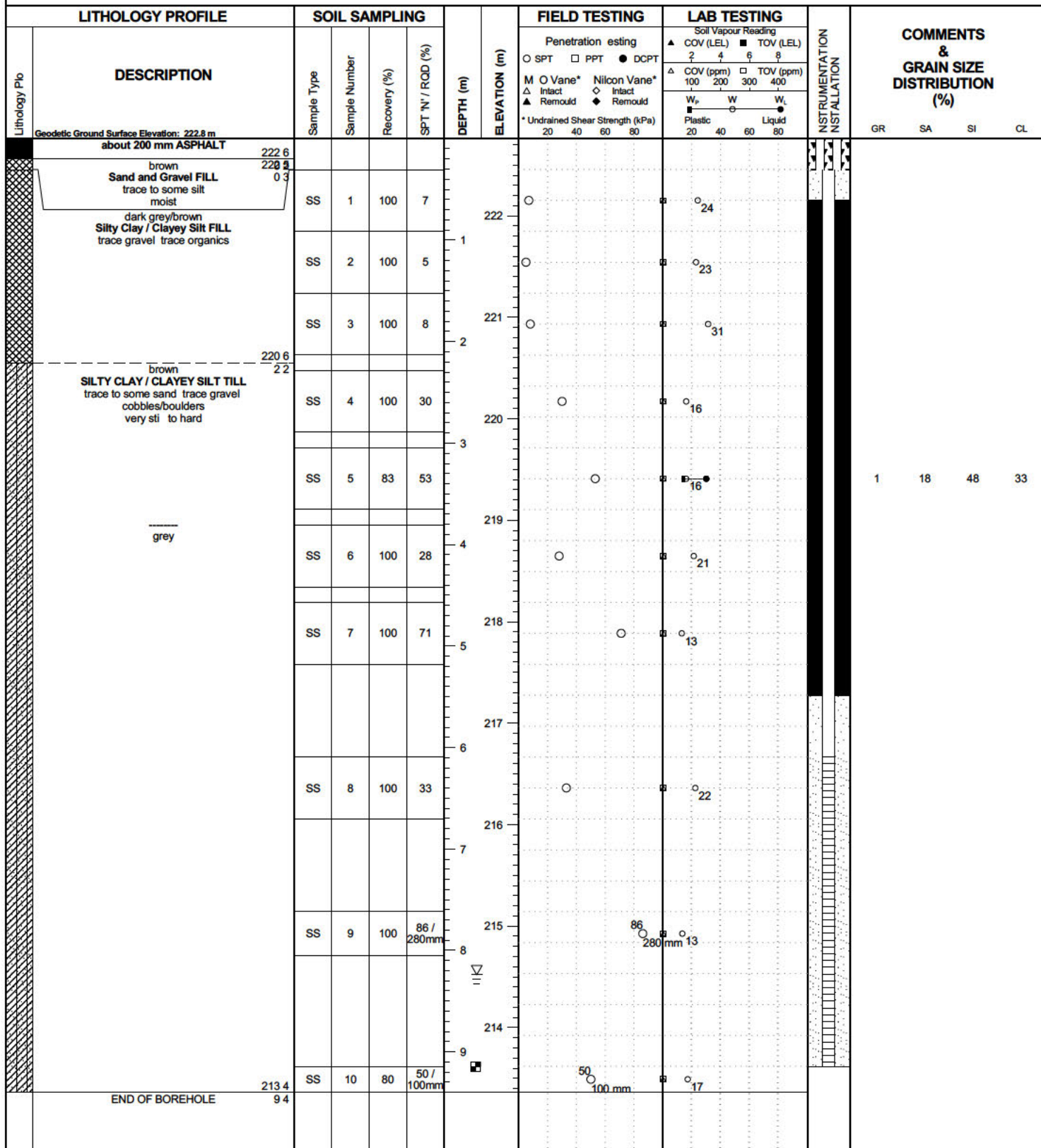
▽ Groundwater encountered on completion of drilling on 2/26/2020 at a depth of 5.5 m ■ Cave in depth after removal of augers .61 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BHS1 / BH A23**



Project Number **TP115086** Drilling Location **Culvert at Coleraine Drive E:604481 N:4854343** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Jan 20, 2020** Date Completed **Jan 20, 2020** Revision No **0, 8/14/20**



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▽ Groundwater encountered on completion of drilling on 1/20/2020 at a depth of 8.2 m ■ Cave in depth after removal of augers 9.1 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. BHS1 / BH A23



Project Number TP115086

Project Name Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)

Project Location Brampton, Ontario

Lithology Plot	LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	M O Vane*			Niloon Vane*	Penetration esting	Soil Vapour Reading	W _p	W	W _L	GR	SA		
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface)																	
	Concrete 0.0 - 0.3 m Sand 0.3 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 6.1 m Screen 6.1 - 9.1 m																	

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS2**



Project Number **TP115086** Drilling Location **Culvert at Coleraine Drive E:604486 N:4854343** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Jan 20, 2020** Date Completed **Jan 20, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 222.4 m										
about 200 mm ASPHALT 222.3										
brown 222.2 Sand and Gravel FILL 0.3 trace to some silt moist	SS	1	100	8	222					
dark grey/brown Silty Clay / Clayey Silt FILL trace gravel trace organics	SS	2	42	8	221					
brown	SS	3	75	7	220					
220.2 brown 2.2 SILTY CLAY / CLAYEY SILT TILL trace sand trace gravel cobbles/boulders very sti to hard	SS	4	100	29	220					
	SS	5	46	42	219					
grey	SS	6	100	28	218					
	SS	7	100	19	217					
	SS	8	100	35	216					
	SS	9	100	36	215					
	SS	10	100	50 / 100mm	214					
213.1 END OF BOREHOLE 9.4					213					

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∇ No restanding groundwater measured in open borehole on completion o drilling ■ Cave in depth a ter removal o augers 7.9 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS3**



Project Number **TP115086** Drilling Location **Culvert at Highway 50 E:606278 N:4852633** Logged by **RM/MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Jan 10, 2020** Date Completed **Jan 10, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 210.7 m										
dark grey/brown Sand and Gravel FILL moist	SS	1	100	30		210	○	7		
210.07										
dark grey/brownish grey Silty Clay / Clayey Silt FILL trace to some sand some gravel trace organics	SS	2	75	16	1	209	○	13		
	SS	3	83	10	2	208	○	22		
	SS	4	100	10		208	○	20		
207.730										
brown/grey SILTY CLAY / CLAYEY SILT TILL trace sand to sandy trace gravel cobbles/boulders sti to hard	SS	5	100	15	3	207	○	15		
	SS	6	100	88	4	206	○	10		3 33 46 18
	SS	7	100	90 / 250mm	5	206	○	90 250 mm		
	SS	8	100	44	6	204	○	10		
203.572										
grey SILTY SAND / SANDY SILT TILL trace clay trace gravel very dense moist to wet	SS	9	100	87 / 280mm	8	203	○	87 280 mm 15		1 35 56 8
	SS	10	100	50 / 150mm	9	202	○	50 150 mm 17		
201.294										
END OF BOREHOLE										

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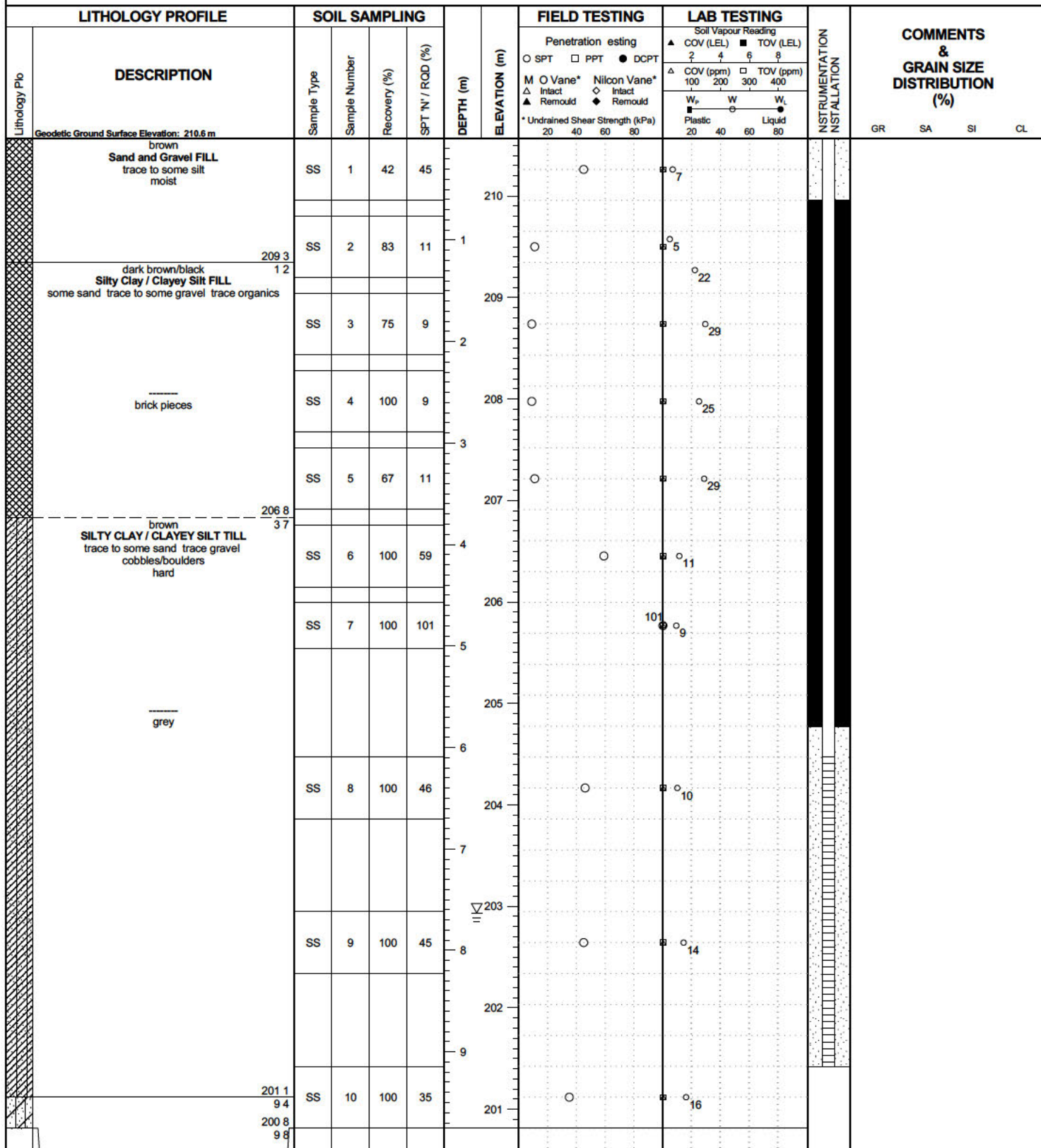
▽ Groundwater encountered on completion of drilling on 1/10/2020 at a depth of 7.0 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS4**



Project Number **TP115086** Drilling Location **Culvert at Highway 50 E:606254 N:4852631** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Jan 10, 2020** Date Completed **Jan 10, 2020** Revision No **0, 8/14/20**



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Groundwater encountered on completion of drilling on 1/10/2020 at a depth of 7.6 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. **BLS4**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Brampton, Ontario**

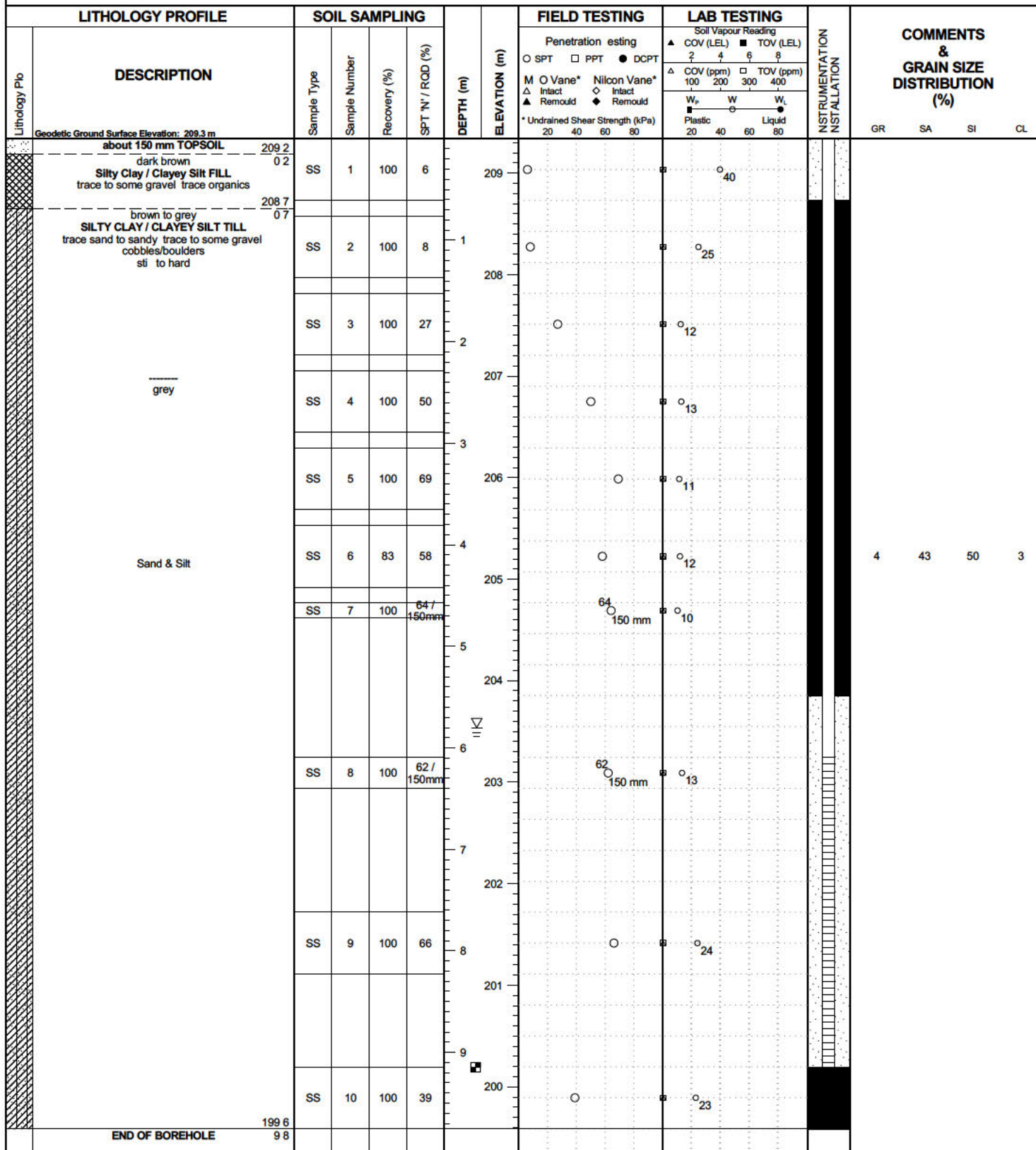
Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	COV (LEL)		
	<p>grey SILTY SAND / SANDY SILT TILL trace clay trace gravel dense moist</p> <p>END OF BOREHOLE 50 mm dia monitoring well with lushmount protective casing installed (depth below ground sur ace)</p> <p>Sand 0 0 - 0 6 m Bentonite 0 6 - 5 8 m Sand Filter 5 8 - 6 1 m Screen 6 1 - 9 1 m</p>												

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BH S5 / BH B7**



Project Number **TP115086** Drilling Location **Culvert at Arterial A2 E-W E:605633 N:4852520** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 26, 2020** Date Completed **Feb 26, 2020** Revision No **0, 8/14/20**



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▽ Groundwater encountered on completion of drilling on 2/26/2020 at a depth of 5.8 m ■ Cave in depth after removal of augers 9.1 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Continued on Next Page

RECORD OF BOREHOLE No. **BH S5 / BH B7**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Brampton, Ontario**

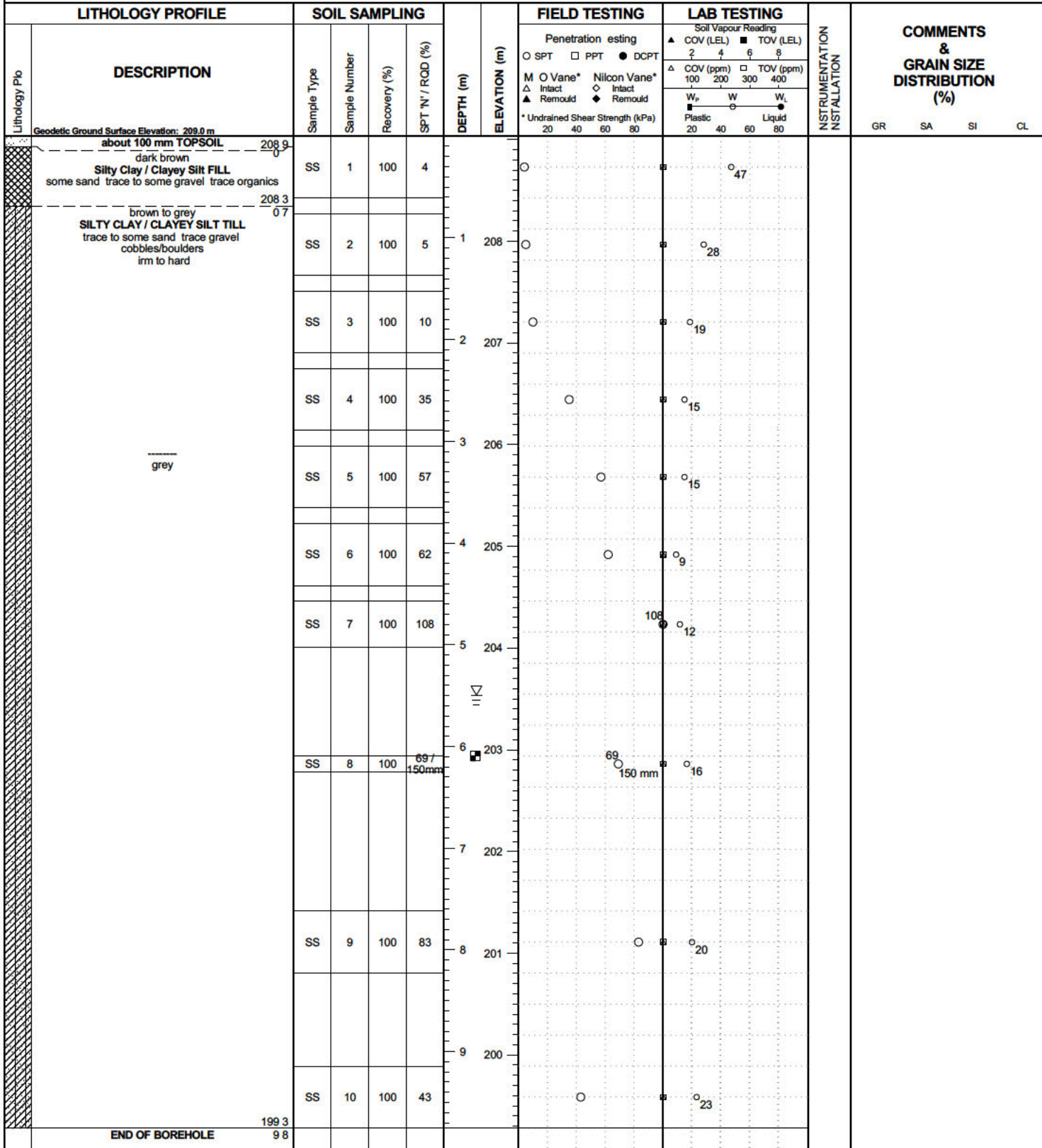
Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	COV (LEL)		
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 9.1 m Screen 6.1 - 9.1 m							Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Niloon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W _p W W _L Plastic Liquid 20 40 60 80				GR SA SI CL

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS6**



Project Number **TP115086** Drilling Location **Culvert at Arterial A2 E-W E:605620 N:4852529** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 26, 2020** Date Completed **Feb 26, 2020** Revision No **0, 8/14/20**



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Groundwater encountered on completion of drilling on 2/26/2020 at a depth of 5.5 m
 Cave in depth after removal of augers .61 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BH S7 / BH C27**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:604850** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 26, 2020** Date Completed **Mar 26, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◊ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 217.8 m										
about 130 mm ASPHALT brown						217.6				
Sand and Gravel FILL trace to some silt moist	SS	1	83	17		217.0	○	■		
216.9						216.9				
dark brown / dark grey Silty Clay / Clayey Silt FILL some sand trace to some gravel trace organics	SS	2	100	11	1	216.9	○	■		
215.6						215.6				
brown SILTY CLAY / CLAYEY SILT TILL trace to some sand trace gravel cobbles/boulders hard	SS	3	100	13	2	215.6	○	■		
215.6						215.6				
	SS	4	21	40	3	215.6	○	■		
	SS	5	100	59	3	215.6	○	■		
	SS	6	50	62 / 150mm	4	214.0	○	■		
	SS	7	100	55 / 150mm	5	213.0	○	■		
					5	213.0				
					6	212.0				
grey	SS	8	25	67	6	211.0	○	■		
					7	211.0				
	SS	9	100	44	8	210.0	○	■		
					9	209.0				
	SS	10	67	50	9	209.0	○	■		
END OF BOREHOLE					9.8	208.0				

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Groundwater encountered on completion of drilling on 3/26/2020 at a depth of 2.7 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Continued on Next Page

RECORD OF BOREHOLE No. BH S7 / BH C27



Project Number TP115086

Project Name Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)

Project Location Brampton, Ontario

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	W _p		
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 6.1 m Screen 6.1 - 9.1 m							Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Niloon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 Plastic Liquid 20 40 60 80				GR SA SI CL

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS8**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:604854** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 26, 2020** Date Completed **Mar 26, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 219.5 m										
about 140 mm ASPHALT brown						219.4				
Sand and Gravel FILL trace to some silt moist	SS	1	42	15		219.0				
218.6										
dark brown Silty Clay / Clayey Silt FILL some sand trace to some gravel trace organics	SS	2	92	6	1	218.9				
	SS	3	83	6	2	218.0				
217.3										
brown SILTY CLAY / CLAYEY SILT TILL trace to some sand trace gravel cobbles/boulders hard	SS	4	100	56	3	217.2				
	SS	5	33	45	4	216.5				
	SS	6	100	72 / 150mm	4	215.5				
	SS	7	100	50 / 80mm	5	215.0				
trace to some shale ragments					6	214.0				
	SS	8	100	60	7	213.0				
grey					8	212.0				
	SS	9	100	31	9	211.0				
	SS	10	100	50	10	210.0				
END OF BOREHOLE						209.9				

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▽ Groundwater encountered on completion of drilling on 3/26/2020 at a depth of 2.4 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Continued on Next Page

RECORD OF BOREHOLE No. **BLS8**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Brampton, Ontario**

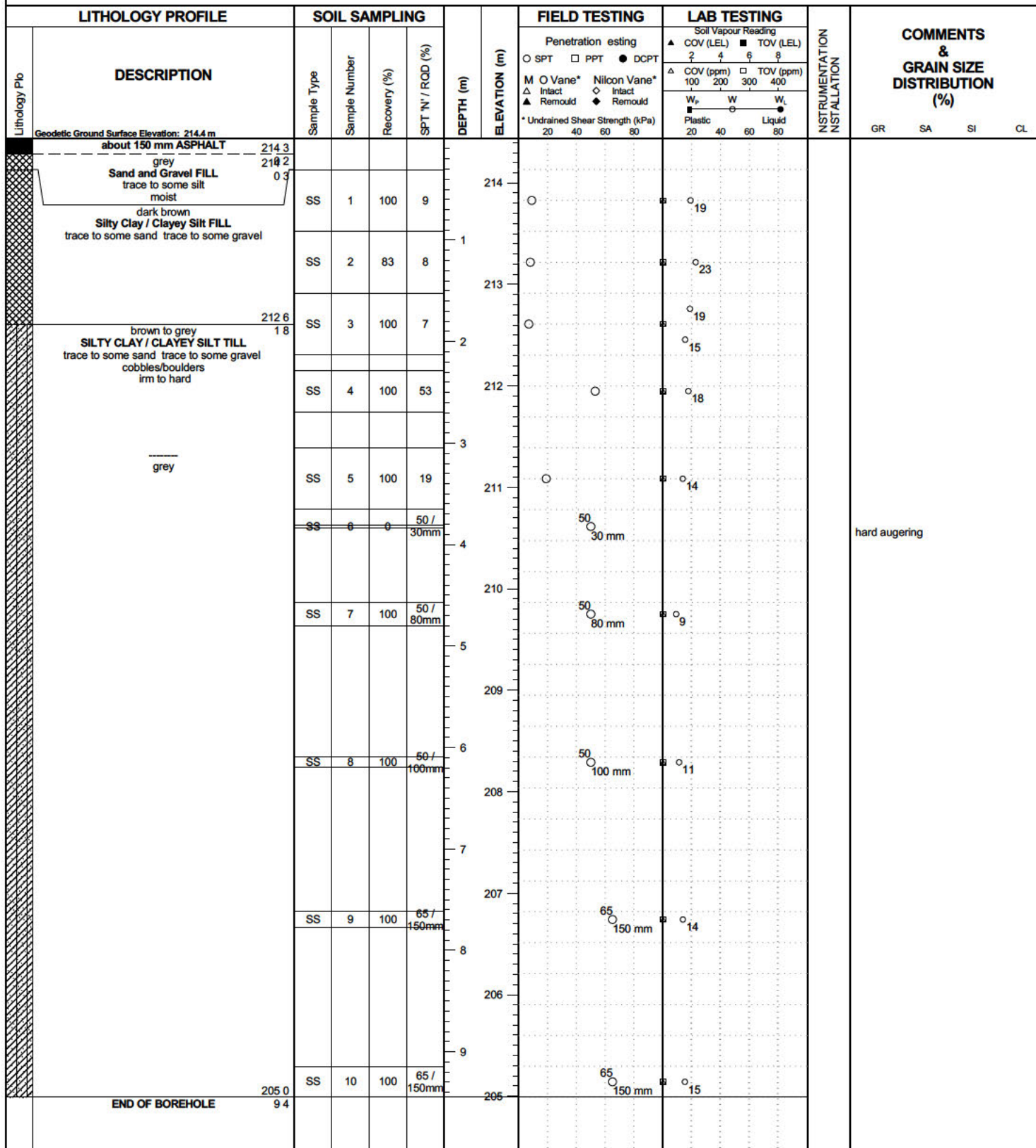
Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	W _p		
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.8 m Sand Filter 5.8 - 6.1 m Screen 6.1 - 9.1 m							Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Niloon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL) 2 4 6 8 △ COV (ppm) □ TOV (ppm) 100 200 300 400 W _p W W _L Plastic Liquid 20 40 60 80			GR SA SI CL	

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS9**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:604080** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 18, 2020** Date Completed **Mar 18, 2020** Revision No **0, 8/14/20**



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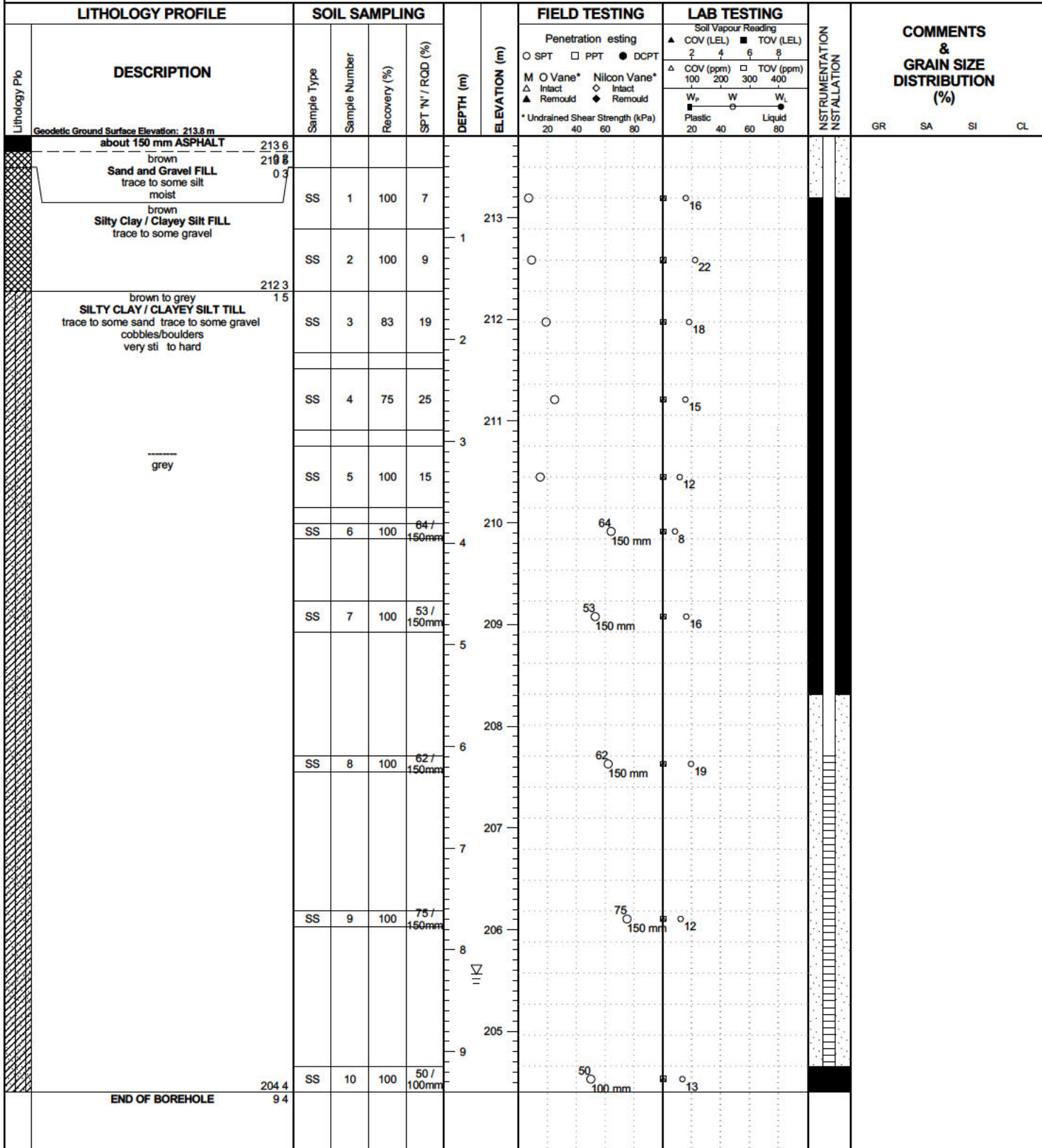
∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS10**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:604082** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 18, 2020** Date Completed **Mar 18, 2020** Revision No **0, 8/14/20**



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▽ Groundwater encountered on completion of drilling on 3/18/2020 at a depth of 8.2 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Continued on Next Page

RECORD OF BOREHOLE No. **BLS10**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Brampton, Ontario**

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	Penetration esting	COV (LEL)	TOV (LEL)	COV (ppm)	TOV (ppm)		GR	SA	SI	CL
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground sur ace) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 9.1 m Screen 6.1 - 9.1 m																			

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS11**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:603849** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 24, 2020** Date Completed **Mar 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting ○ SPT □ PPT ● DCPT	Soil Vapour Reading ▲ COV (LEL) ■ TOV (LEL)	△ COV (ppm) □ TOV (ppm)		
Geodetic Ground Surface Elevation: 213.2 m												
about 200 mm ASPHALT brown					213.0							
Sand and Gravel FILL trace to some silt moist	SS	1	100	9	212.6							
dark grey/brown Silty Clay / Clayey Silt FILL trace to some gravel trace organics	SS	2	83	7	212.0							
	SS	3	100	16	211.6							
Geodetic Ground Surface Elevation: 211.0 m					211.0							
brown to grey SILTY SAND / SANDY SILT trace gravel dense moist to wet	SS	4	100	46	210.2							
	SS	5	83	39	210.0							
grey	SS	6	83	44	209.2							
	SS	7	333	35	208.2							
					208.0							
					207.0							
	SS	8	88	35	207.2							
					206.0							
trace shale ragments	SS	9	100	55 / 150mm	205.5							
					205.0							
brown to grey SILTY CLAY / CLAYEY SILT TILL trace sand to sandy trace to some gravel cobbles/boulders hard	SS	0	00	50 / 80mm	204.7							
END OF BOREHOLE					204.0							

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▽ Groundwater encountered on completion of drilling on 3/24/2020 at a depth of 2.1 m ■ Cave in depth after removal of augers 7.6 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS12**



Project Number **TP115086** Drilling Location **Culvert at Countryside Drive E:603857** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Mar 24, 2020** Date Completed **Mar 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / RQD (%)	Penetration esting ○ SPT □ PPT ● DCPT M O Vane* Nilcon Vane* △ Intact ◇ Intact ▲ Remould ◆ Remould * Undrained Shear Strength (kPa) 20 40 60 80		
Geodetic Ground Surface Elevation: 213.5 m										
Lithology Plo about 140 mm ASPHALT brown Sand and Gravel FILL trace to some silt moist darkgrey/ brown Silty Clay / Clayey Silt FILL trace to some gravel trace organics brown to grey SILTY SAND / SANDY SILT trace gravel compact to very dense moist to wet grey	SS	1	100	12	213	0.1				
	SS	2	67	6	212	0.6				
	SS	3	83	7	211	2.2				
	SS	4	75	20	210	2.2				
	SS	5	83	36	209	2.2				
	SS	6	100	91	208	2.2				
	SS	7	100	104	207	2.2				
	SS	8	100	50/30mm	207	2.2				
END OF BOREHOLE Auger re used at 5.8 m depth 50 mm dia monitoring well with lushmount protective casing installed (depth below ground sur ace) Sand 0.0 - 0.6 m Bentonite 0.6 - 2.1 m Sand Filter 2.1 - 5.8 m Screen 2.7 - 5.8 m										

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∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Scale 1 53
 Page 1 of 1

RECORD OF BOREHOLE No. **BLS13**



Project Number **TP115086** Drilling Location **Culvert at Clarkway Drive E:604621 N:4852286** Logged by **MM**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 25, 2020** Date Completed **Feb 25, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / RQD (%)	Penetration esting	Soil Vapour Reading	COV (LEL)		
Geodetic Ground Surface Elevation: 210.2 m												
about 80 mm ASPHALT brown Sand and Gravel FILL trace to some silt moist	SS	1	100	62	210							
greyish brown Silty Clay / Clayey Silt FILL trace to some sand trace organics	SS	2	63	8	209.1							
	SS	3	100	15	208.5							
	SS	4	100	9	208							
	SS	5	100	7	207.5							
grey SILTY CLAY / CLAYEY SILT TILL trace to some sand trace gravel very sti	SS	6	100	27	206.1							
grey SILTY SAND / SANDY SILT trace gravel cobbles/boulders loose to very dense moist to wet	SS	7	133	22	204.6							
	SS	8	100	9	203.5							
	SS	9	100	55 / 130mm	200.9							
END OF BOREHOLE					200.9							

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Groundwater encountered on completion of drilling on 2/25/2020 at a depth of 4.3 m
 Cave in depth after removal of augers 1.5 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Scale 1/53
 Page 1 of 2

RECORD OF BOREHOLE No. **BLS13**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

Project Location **Brampton, Ontario**

Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	Penetration esting	COV (LEL)	TOV (LEL)	COV (ppm)	TOV (ppm)		W _p	W	W _L	GR
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 4.0 m Sand Filter 4.0 - 7.6 m Screen 4.6 - 7.6 m																			

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS14**



Project Number **TP115086** Drilling Location **Culvert at Clarkway Drive E:604618 N:4852293** Logged by **MM**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 25, 2020** Date Completed **Feb 25, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)						
Geodetic Ground Surface Elevation: 210.0 m										
about 90 mm ASPHALT										
grey Sand and Gravel FILL trace to some silt moist	SS	1	100	67		209.9				
	SS	2	63	30	1	209.1				
brown to grey Silty Clay / Clayey Silt FILL trace to some sand trace to some gravel	SS	3	92	14	2	208.7				
	SS	4	63	6		208.1				
	SS	5	100	10	3	207.2				
						206.9				
grey SILTY CLAY / CLAYEY SILT TILL trace to some sand trace gravel so t to sti	SS	6	83	3	4	206.4				
						205.9				
	SS	7	133	13	5	205.4				
						204.9				
	SS	8	67	31	6	204.4				
						203.9				
grey SILTY SAND / SANDY SILT trace to some clay trace gravel dense to very dense moist to wet	SS	9	100	60 / 150mm	7	202.8				
						202.2				51 47 2
END OF BOREHOLE					9	200.7				

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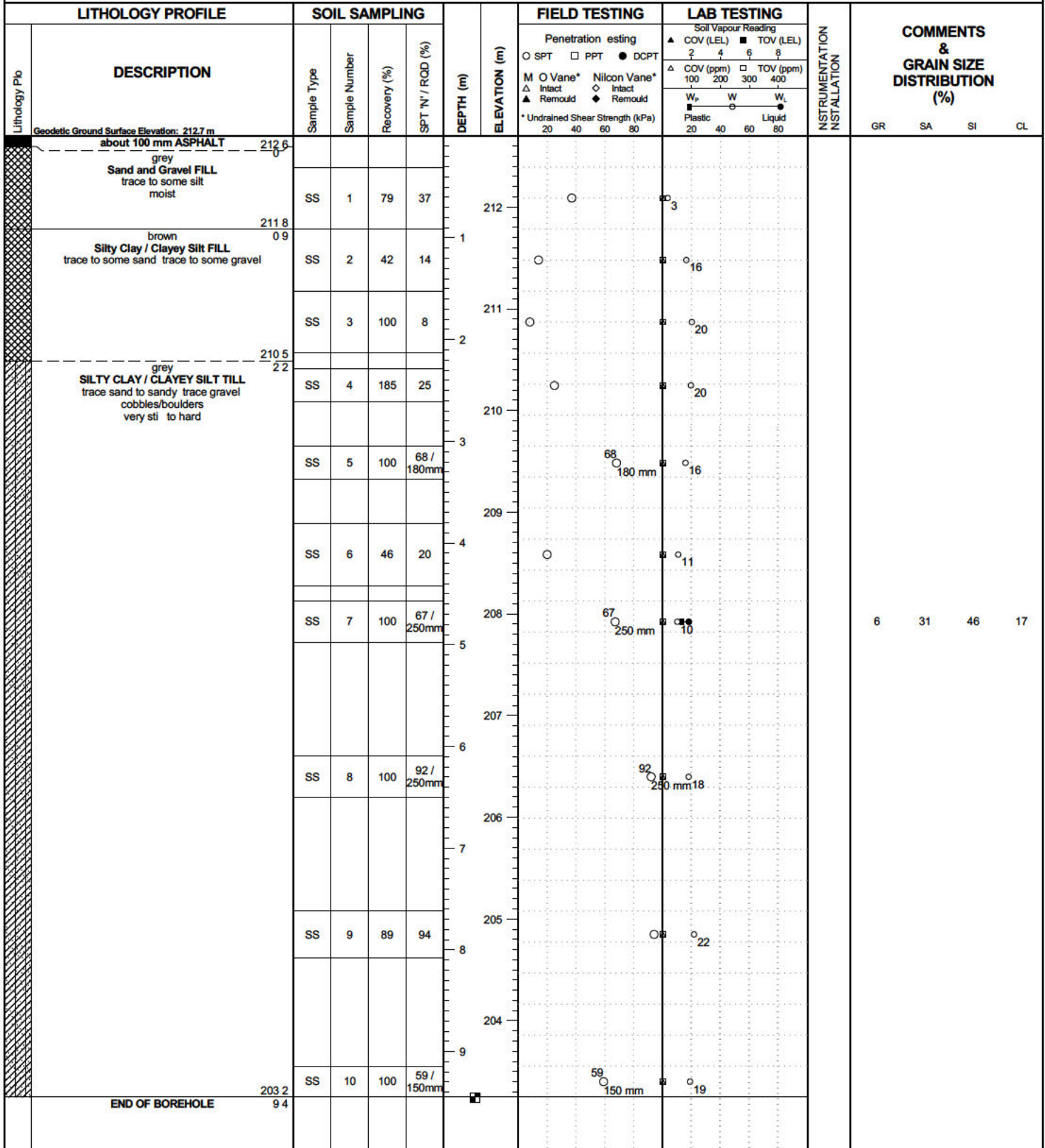
▽ Groundwater encountered on completion of drilling on 2/25/2020 at a depth of 4.1 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS15**



Project Number **TP115086** Drilling Location **Culvert at Clarkway Drive E:604169 N:4852729** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 24, 2020** Date Completed **Feb 24, 2020** Revision No **0, 8/14/20**



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∇ No restanding groundwater measured in open borehole on completion o drilling ■ Cave in depth a ter removal o augers .94 m

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. **BLS16**



Project Number **TP115086** Drilling Location **Culvert at Clarkway Drive E:604158 N:4852745** Logged by **MS**
 Project Client **City of Brampton** Drilling Method **150 mm Solid Stem Augers** Compiled by **PR**
 Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)** Drilling Machine **Track Mounted Drill** Reviewed by **SM**
 Project Location **Brampton, Ontario** Date Started **Feb 24, 2020** Date Completed **Feb 24, 2020** Revision No **0, 8/14/20**

LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)			SPT 'N' / ROD (%)	Penetration esting	Soil Vapour Reading	COV (LEL)		
Geodetic Ground Surface Elevation: 213.0 m about 90 mm ASPHALT grey Sand and Gravel FILL trace to some silt moist	SS	1	100	32		213.0						
dark grey Silty Clay / Clayey Silt FILL trace to some sand trace to some gravel	SS	2	83	14	1	212.09						
	SS	3	100	8	2	211.8						
brown to grey SILTY CLAY / CLAYEY SILT TILL trace to some sand trace gravel cobbles/boulders very sti to hard	SS	4	100	22	2	210.82						
	SS	5	100	37	3	210.8						
	SS	6	100	29	4	209.8						
grey	SS	7	100	62	5	208.8						
	SS	8	100	50 / 100mm	6	207.8						
	SS	9	100	70 / 150mm	8	205.8						
	SS	10	100	71	9	204.8						
END OF BOREHOLE						203.3						

Wood E&S, a Division of Wood Canada Limited
 50 Vogell Road Units 3 & 4
 Richmond Hill Ontario L4B 3K6
 Canada
 tel No (905) 415-2632
 www.woodplc.com

∇ No restanding groundwater measured in open borehole on completion o drilling

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require Interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Continued on Next Page

RECORD OF BOREHOLE No. **BHS16**



Project Number **TP115086**

Project Name **Arterial Roads within Highway 427 Industrial Secondary Plan Area (Area 47)**

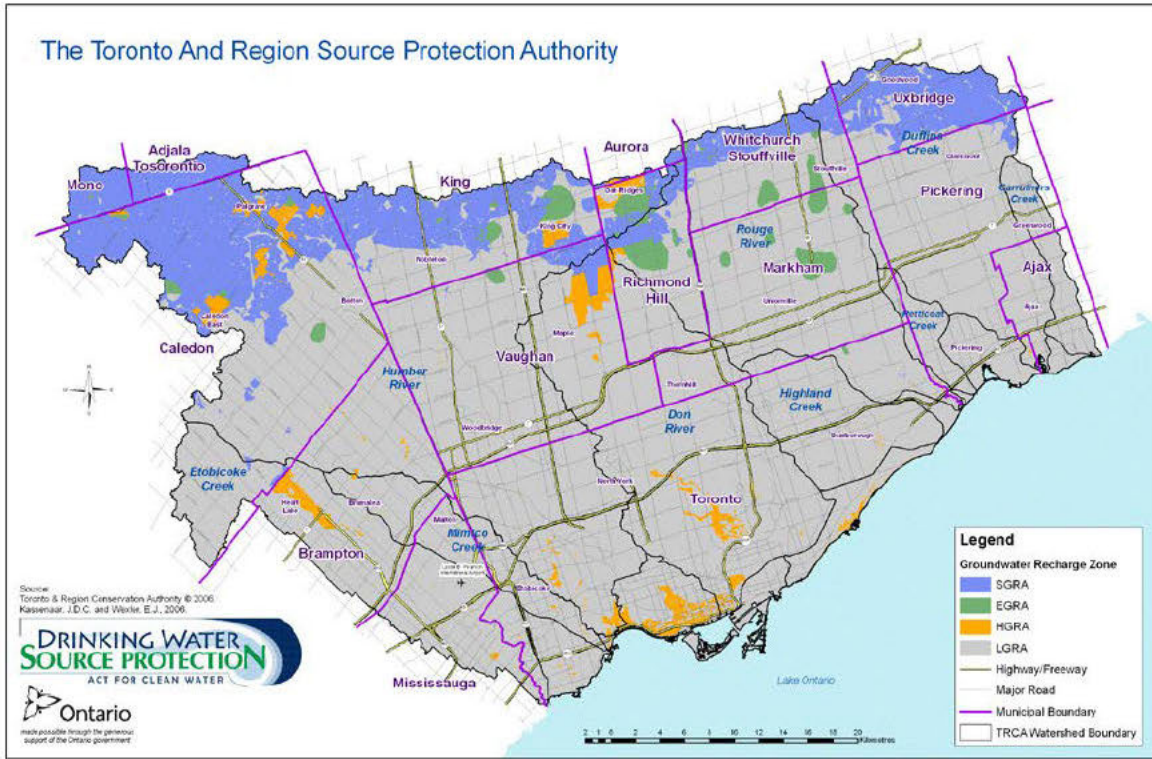
Project Location **Brampton, Ontario**

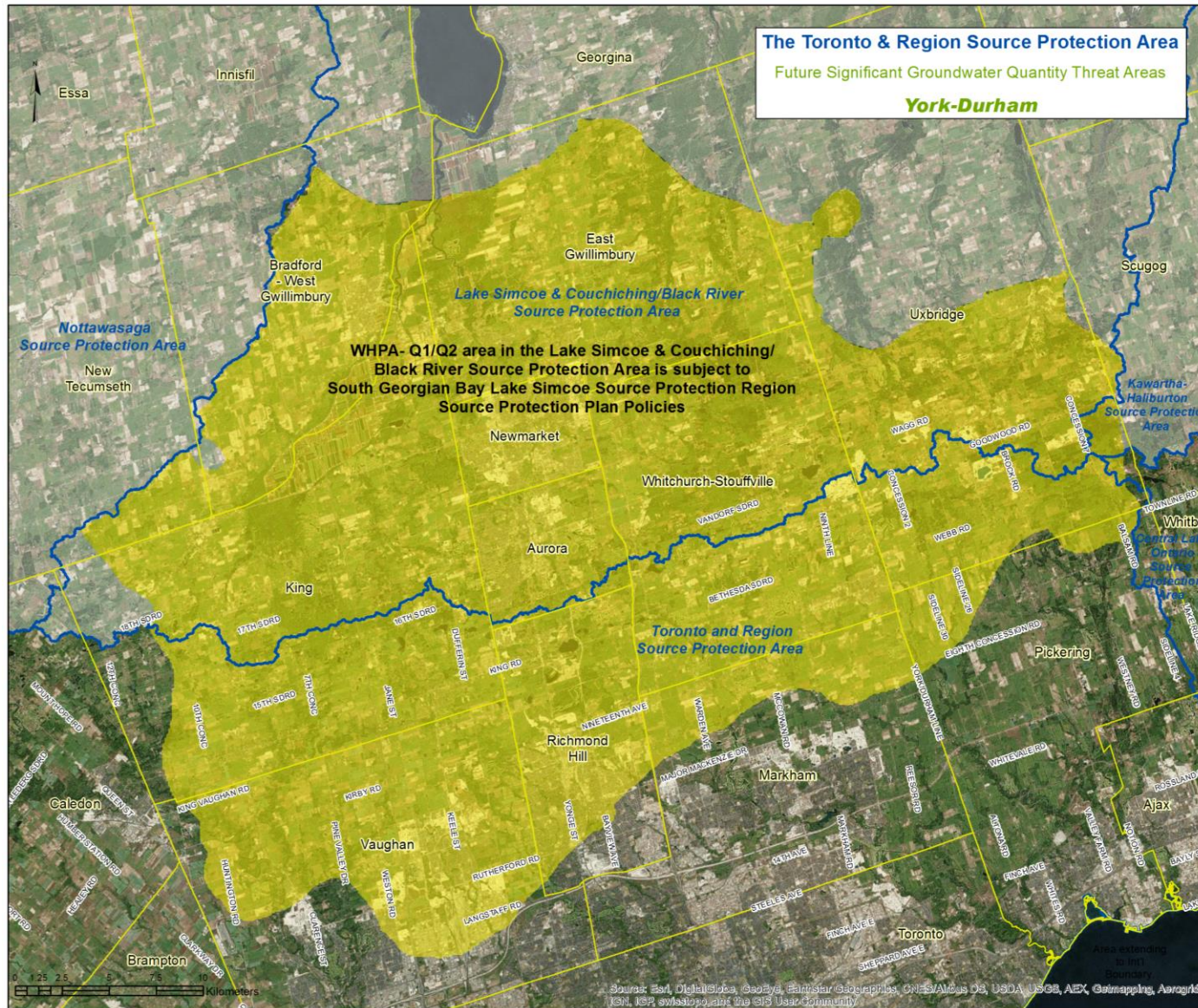
Lithology Plot	LITHOLOGY PROFILE	SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING				LAB TESTING				INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)			M O Vane*	Niloon Vane*	Soil Vapour Reading	Penetration esting	COV (LEL)	TOV (LEL)	COV (ppm)	TOV (ppm)		GR	SA	SI	CL
	50 mm dia monitoring well with lushmount protective casing installed (depth below ground surface) Sand 0.0 - 0.6 m Bentonite 0.6 - 5.5 m Sand Filter 5.5 - 9.1 m Screen 6.1 - 9.1 m																			

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

Borehole Log ID	BH Plan Station	Road Profile Station	Ground Surface Elevation (m)	End of Borehole Elevation (m)	GW Depth (m)	GW Level Elev. (m)	Proposed Road Surface Elevation (m)	GW Depth from Proposed Road Surface (m)
<i>Coleraine Drive</i>								
A1	0+000	12+270	215.5	210.5	(DRY)	-	215.6	> 5.1
A2	0+000	12+270	215.4	213.5	(DRY)	-	215.6	> 2.1
A3	0+150	12+120	216.1	213.3	2.7	213.4	216.5	3.1
A5	0+300	11+970	216.3	215.0	(DRY)	-	217.4	> 2.4
A7	0+450	11+820	218.2	216.6	(DRY)	-	218.4	> 1.8
A8	0+450	11+820	217.9	216.1	(DRY)	-	218.4	> 2.3
A9	0+600	11+670	219.1	214.1	(DRY)	-	219.3	> 5.2
A10	0+600	11+670	219.0	217.2	(DRY)	-	219.3	> 2.1
A11	0+750	11+520	219.9	216.8	(DRY)	-	220.2	> 3.4
A13	0+900	11+370	220.0	217.3	2.4	217.6	221.2	3.6
A15	1+050	11+220	221.5	220.0	(DRY)	-	222.1	> 2.1
A17	1+200	11+070	222.5	217.5	(DRY)	-	223.0	> 5.5
A18	1+200	11+070	222.9	221.1	(DRY)	-	223.0	> 1.9
A19	1+350	10+920	222.6	219.6	(DRY)	-	224.0	> 4.4
A20	1+350	10+920	222.4	221.2	(DRY)	-	224.0	> 2.8
A21	1+500	10+770	223.2	221.9	(DRY)	-	224.1	> 2.2
A23	1+650	10+620	222.8	213.4	8.2	214.6	223.3	8.7
A25	1+800	10+470	225.0	220.0	(DRY)	-	224.7	> 4.7
A26	1+800	10+470	224.4	222.6	(DRY)	-	224.7	> 2.1
A27	1+950	10+320	226.8	223.8	(DRY)	-	226.7	> 2.9
A28	1+950	10+320	226.8	225.6	(DRY)	-	226.7	> 1.1
A29	2+100	10+170	228.6	227.1	(DRY)	-	228.7	> 1.6
A30	2+100	10+170	228.7	226.9	(DRY)	-	228.7	> 1.8
A31	2+250	10+020	230.7	225.7	(DRY)	-	230.7	> 5.1
<i>Arterial A2</i>								
B2	0+100	13+210	210.2	205.2	3.7	206.5	210.4	3.9
B3	0+200	13+110	211.8	208.8	(DRY)	-	210.9	> 2.1
B4	0+300	13+010	211.7	209.9	(DRY)	-	211.4	> 1.5
B5	0+400	12+910	211.3	206.2	(DRY)	-	212.0	> 5.8
B6	0+500	12+810	210.9	208.8	(DRY)	-	212.5	> 3.7
B7	0+600	12+710	209.3	199.6	5.8	203.5	213.0	9.5
S6	0+637	12+673	209.0	199.3	5.5	203.5	213.2	9.7
B8	0+700	12+610	211.1	209.4	(DRY)	-	213.5	> 4.1
B9	0+800	12+510	212.5	207.4	4.3	208.2	214.1	5.9
B10	0+900	12+410	212.7	211.0	(DRY)	-	214.6	> 3.6
B11	1+000	12+310	212.3	209.3	(DRY)	-	215.1	> 5.8
B12	1+100	12+210	214.3	212.6	(DRY)	-	215.6	> 3.0
B13	1+200	12+110	215.7	210.7	(DRY)	-	216.2	> 5.5
B14	1+300	12+010	217.1	215.2	(DRY)	-	216.7	> 1.5
B15	1+400	11+910	217.3	214.3	(DRY)	-	217.2	> 2.9
B16	1+500	11+810	217.9	216.1	(DRY)	-	217.7	> 1.6
B17	1+600	11+710	218.5	213.4	(DRY)	-	218.2	> 4.8
B18	1+700	11+610	219.2	217.4	(DRY)	-	218.8	> 1.4
B19	1+800	11+510	219.5	216.5	(DRY)	-	219.3	> 2.8
B20	1+900	11+410	219.8	218.1	1.2	218.6	219.8	1.2
B21	2+015	11+295	220.8	215.8	2.7	218.1	220.4	2.3
B22	2+080	11+230	220.5	219.0	(DRY)	-	220.8	> 1.8

Figure C 10: Recharge Area Classification





Legend




- WHPA- Q1/Q2 - Moderate Risk Level
- DEM - Demand: Water Taking
- REC - Recharge: Recharge Reduction

Source Protection Area (SPA) Boundary

Reference: Prescribed threat circumstances as listed in the Ministry of the Environment Table of Drinking Water Threats (2009)

(c) Copyright: Toronto & Region Source Protection Area, 2014.
Source: TRCA, 2014; ESRI (ArcGIS Online), 2014.

This map has been prepared to meet provincial requirements under the Clean Water Act, 2006 and should be used for other purposes ONLY after consultation with the responsible conservation authority or source protection authority. The analysis used to produce this map relies on best available information as of the date of the map. Priority should be given to site specific information collected in accordance with accepted scientific protocols when being used for other purposes.

Map 3.4: York-Durham – Future Significant Groundwater Quantity Threat Areas

Appendix B: Supporting Calculations

Runoff Generated from the 90th Percentile Rainfall Event (27mm)

Subcatchment	Total Area (ha)	Pervious Area (ha)		Impervious Area (ha)			27 mm Runoff Volume (m ³)	
		Proposed	Existing	Proposed	Existing	Net	Total Imp Area	Net Increase
<i>Aerial A2</i>								
A1	2.08	0.43	2.08	1.64	0.00	1.64	443.8	443.8
A2	1.80	0.40	1.76	1.41	0.04	1.36	379.4	367.6
A3	1.83	0.40	1.76	1.44	0.07	1.36	387.9	367.8
A4	2.07	0.43	2.05	1.64	0.01	1.62	442.4	438.7
A5	2.09	0.42	2.02	1.67	0.07	1.60	451.4	431.5
A6	2.04	0.51	2.04	1.53	0.00	1.53	412.0	412.0
A7	5.31	1.09	5.31	4.22	0.00	4.22	1139.7	1139.7
<i>Coleraine Drive</i>								
CR1	2.94	0.88	2.16	2.07	0.78	1.29	558.2	348.0
CR2	1.66	0.43	1.33	1.23	0.33	0.90	331.4	243.1
CR3	1.15	0.33	0.95	0.82	0.20	0.62	221.4	167.1
CR4	2.39	1.08	1.96	1.31	0.44	0.88	354.2	236.6
CR5	1.39	0.34	1.19	1.05	0.20	0.85	282.9	228.2

Pre-Development Water Balance Volume Calculations - Arterial A2

Notes: Ratios of runoff, evapotranspiration, and infiltration as per Table 3.1 of MOE SWMPDM 2003

Drainage Area Table (ha)								
Land Cover	Soil Group	Subcatchment A1	Subcatchment A2	Subcatchment A3	Subcatchment A4	Subcatchment A5	Subcatchment A6	Subcatchment A7
		Contributing Area (ha)	Contributing Area (ha)	Contributing Area (ha)	Contributing Area (ha)	Contributing Area (ha)	Contributing Area (ha)	Contributing Area (ha)
Pervious Area	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	2.08	1.76	1.76	2.05	2.02	2.04	5.31
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Area	N/A	0.00	0.04	0.07	0.01	0.07	0.00	0.00
Totals		2.08	1.80	1.83	2.07	2.09	2.04	5.31

Soil Group Weighting (per Table 3.1 of SWMPDM 2003)				
Soil Group	Runoff	Infiltration	Evapotranspiration	Precipitation
A	149	276	515	940
B	187	228	525	940
C	222	182	536	940
D	270	145	525	940
A	16%	29%	55%	100%
B	20%	24%	56%	100%
C	24%	19%	57%	100%
D	29%	15%	56%	100%

Annual Soil Infiltration (mm)					
Year Range	Average Annual Precipitation (mm)	Soil A Infiltration (mm)	Soil B Infiltration (mm)	Soil C Infiltration (mm)	Soil D Infiltration (mm)
1995 - 2019	797.6	234.19	193.46	154.43	123.03

Annual Subcatchment Infiltration (m³)							
Subcatchment #:	Subcatchment A1	Subcatchment A2	Subcatchment A3	Subcatchment A4	Subcatchment A5	Subcatchment A6	Subcatchment A7
Volume:	3204.83	2718.85	2717.30	3170.09	3120.51	3144.91	8200.09

Daily Subcatchment Infiltration (m³)							
Subcatchment #:	Subcatchment A1	Subcatchment A2	Subcatchment A3	Subcatchment A4	Subcatchment A5	Subcatchment A6	Subcatchment A7
Volume:	8.78	7.45	7.44	8.69	8.55	8.62	22.47

Pre-Development Water Balance Volume Calculations - Coleraine Drive

Notes: Ratios of runoff, evapotranspiration, and infiltration as per Table 3.1 of MOE SWMPDM 2003

Drainage Area Table (ha)						
Land Cover	Soil Group	Subcatchment CR1 Contributing Area (ha)	Subcatchment CR2 Contributing Area (ha)	Subcatchment CR3 Contributing Area (ha)	Subcatchment CR4 Contributing Area (ha)	Subcatchment CR5 Contributing Area (ha)
Pervious Area	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	2.16	1.33	0.95	1.96	1.19
	D	0.00	0.00	0.00	0.00	0.00
Impervious Area	N/A	0.78	0.33	0.20	0.44	0.20
Totals		2.94	1.66	1.15	2.39	1.39

Soil Group Weighting (per Table 3.1 of SWMPDM 2003)				
Soil Group	Runoff	Infiltration	Evapotranspiration	Precipitation
A	149	276	515	940
B	187	228	525	940
C	222	182	536	940
D	270	145	525	940
A	16%	29%	55%	100%
B	20%	24%	56%	100%
C	24%	19%	57%	100%
D	29%	15%	56%	100%

Annual Soil Infiltration (mm)					
Year Range	Average Annual Precipitation (mm)	Soil A Infiltration (mm)	Soil B Infiltration (mm)	Soil C Infiltration (mm)	Soil D Infiltration (mm)
1995 - 2019	797.6	234.19	193.46	154.43	123.03

Annual Subcatchment Infiltration (m³)					
Subcatchment #:	Subcatchment CR1	Subcatchment CR2	Subcatchment CR3	Subcatchment CR4	Subcatchment CR5
Volume:	3342.58	2054.81	1467.68	3023.07	1830.27

Daily Subcatchment Infiltration (m³)					
Subcatchment #:	Subcatchment CR1	Subcatchment CR2	Subcatchment CR3	Subcatchment CR4	Subcatchment CR5
Volume:	9.16	5.63	4.02	8.28	5.01

Runoff Generated from a 5mm Rainfall Event

Subcatchment	Impervious Area (ha)	5 mm Runoff Volume (m ³)
<i>Aerial A2</i>		
A1	1.64	82
A2	1.41	70
A3	1.44	72
A4	1.64	82
A5	1.67	84
A6	1.53	76
A7	4.22	211
<i>Coleraine Drive</i>		
CR1	2.07	103
CR2	1.23	61
CR3	0.82	41
CR4	1.31	66
CR5	1.05	52

Appendix C: Plans



REFER TO FIGURE 2 FOR ENLARGED VIEW

REFER TO FIGURE 4 FOR ENLARGED VIEW

CULVERT ID: 24.475
EXISTING 2.4mx0.6mx10.0m LONG
CONCRETE BOX CULVERT,
CLOSED BOTTOM

EXISTING 3.05mx1.22mx12.2m
CONCRETE BOX CULVERT

REFER TO FIGURE 3 FOR ENLARGED VIEW

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
CITY OF BRAMPTON
REGION OF PEEL

SUBCATCHMENT
BOUNDARY PLAN
(EXISTING CONDITION)

- LEGEND**
- EXISTING ROADWAY
 - WATERCOURSE
 - CONTOUR (0.5m)
 - ROAD DRAINAGE 'PART A'**
 - SUBCATCHMENT BOUNDARY
 - ROAD DRAINAGE 'PART B'**
 - SUBCATCHMENT BOUNDARY
 - MESP DEVELOPMENT DRAINAGE**
 - SUBCATCHMENT BOUNDARY
 - SUBCATCHMENT ID#
 - SUBCATCHMENT AREA

SCALE VALID ONLY FOR
24"x36" VERSION

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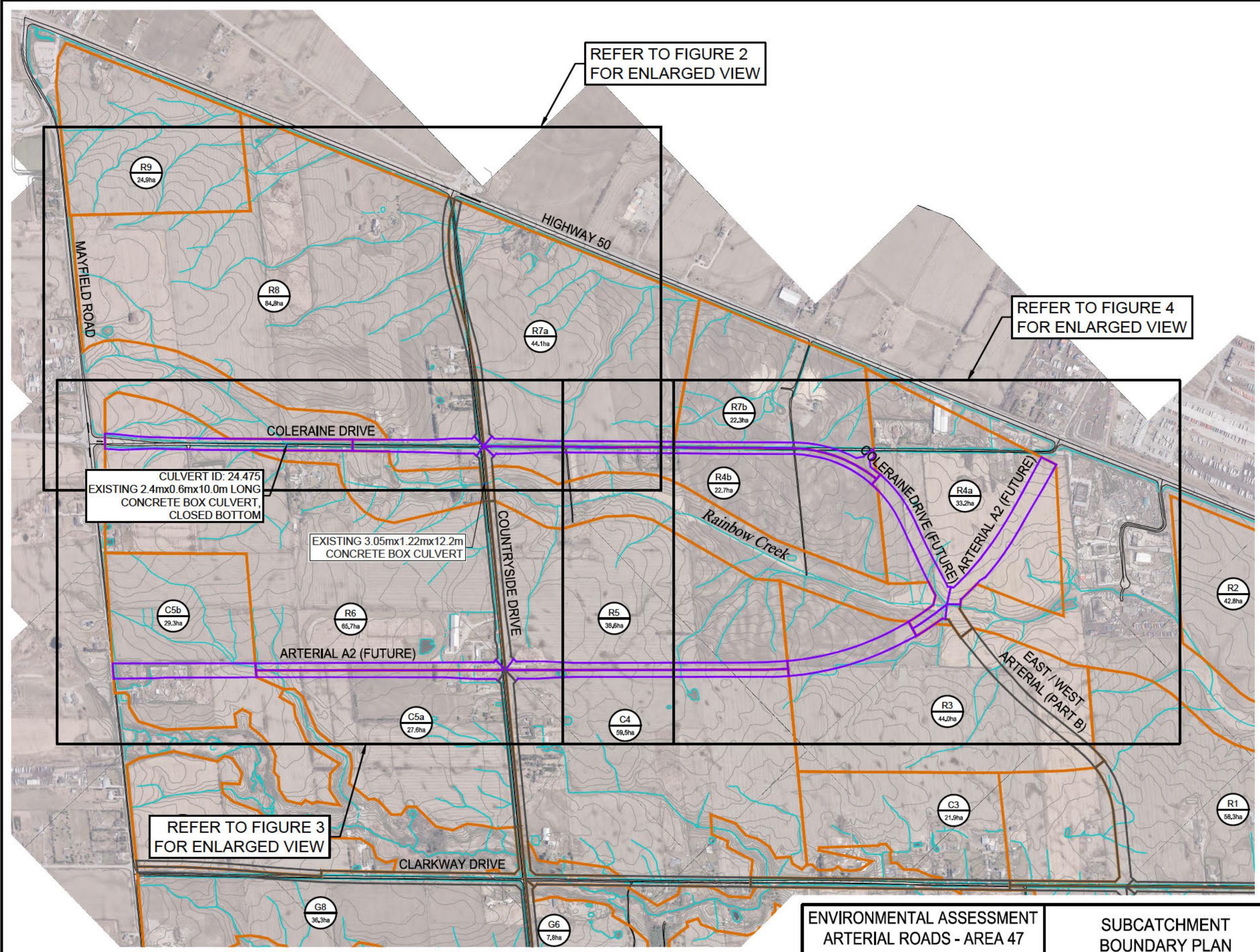


Consultant File No.
TP115086

Plan No.
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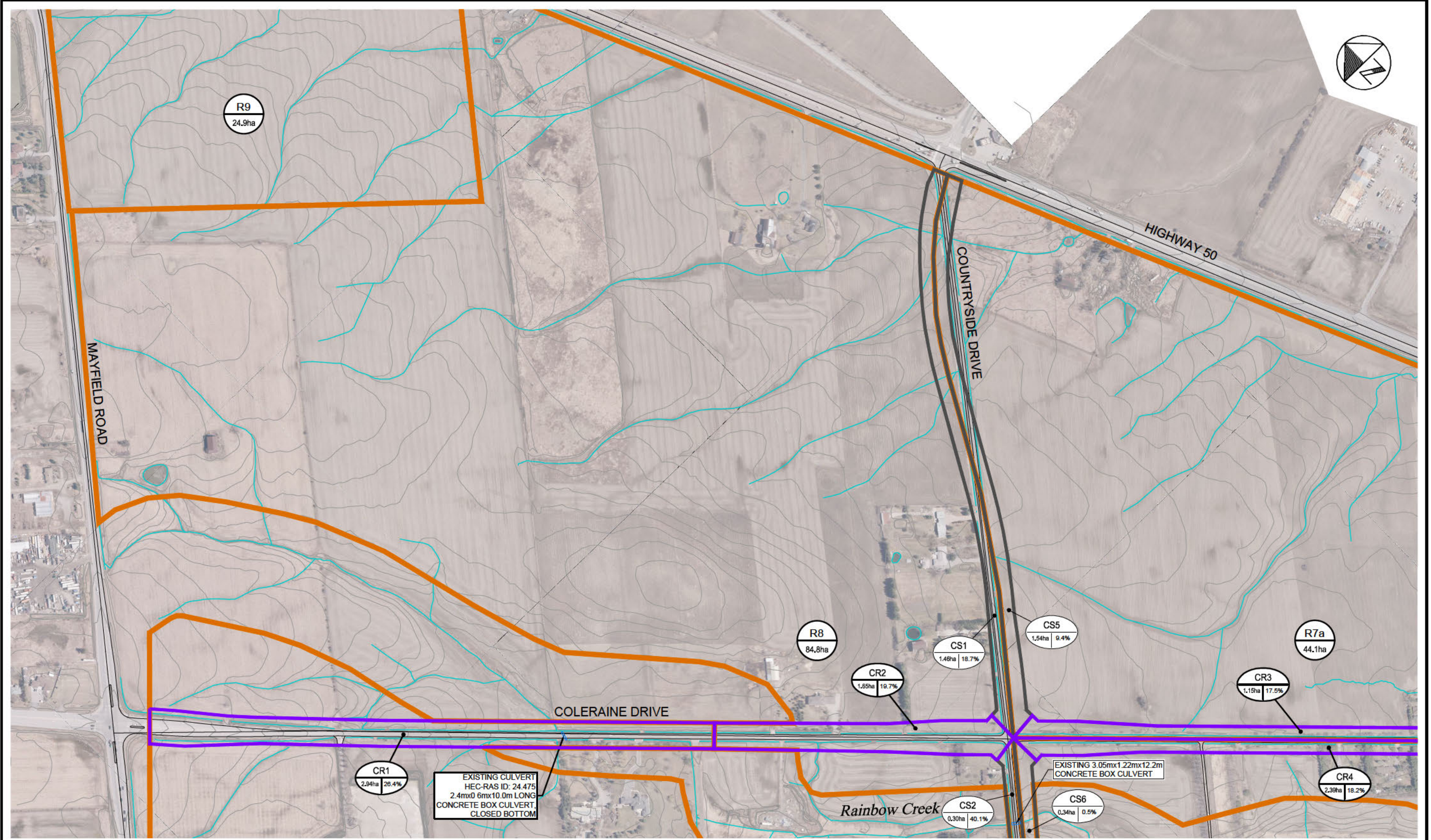
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2021-11-05
2021-11-05



EXISTING CULVERT
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2.4mx0.6mx10.0m LONG
CONCRETE BOX CULVERT,
CLOSED BOTTOM

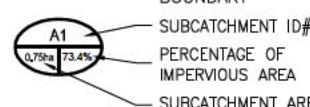
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CONCRETE BOX CULVERT

LEGEND

- EXISTING ROADWAY
- WATERCOURSE
- CONTOUR (0.5m)

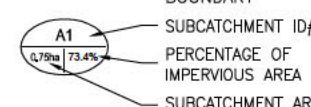
ROAD DRAINAGE 'PART A'

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- PERCENTAGE OF IMPERVIOUS AREA
- SUBCATCHMENT AREA



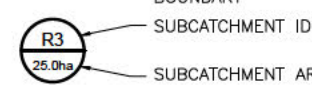
ROAD DRAINAGE 'PART B'

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- PERCENTAGE OF IMPERVIOUS AREA
- SUBCATCHMENT AREA



MESP DEVELOPMENT DRAINAGE

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- SUBCATCHMENT AREA



ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
CITY OF BRAMPTON
REGION OF PEEL

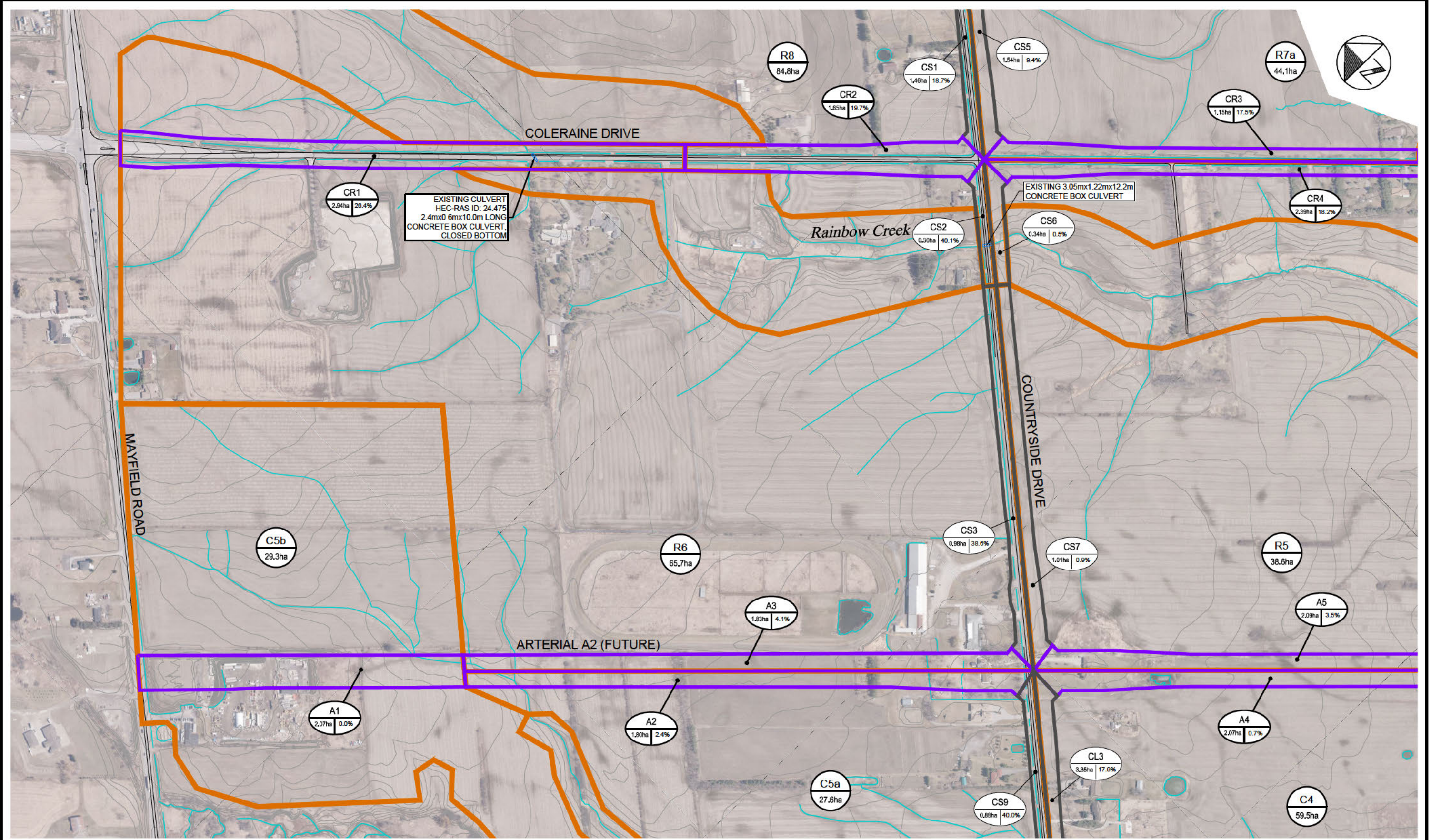
SUBCATCHMENT
BOUNDARY PLAN
(EXISTING CONDITION)



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TP115086
Plan No.
2

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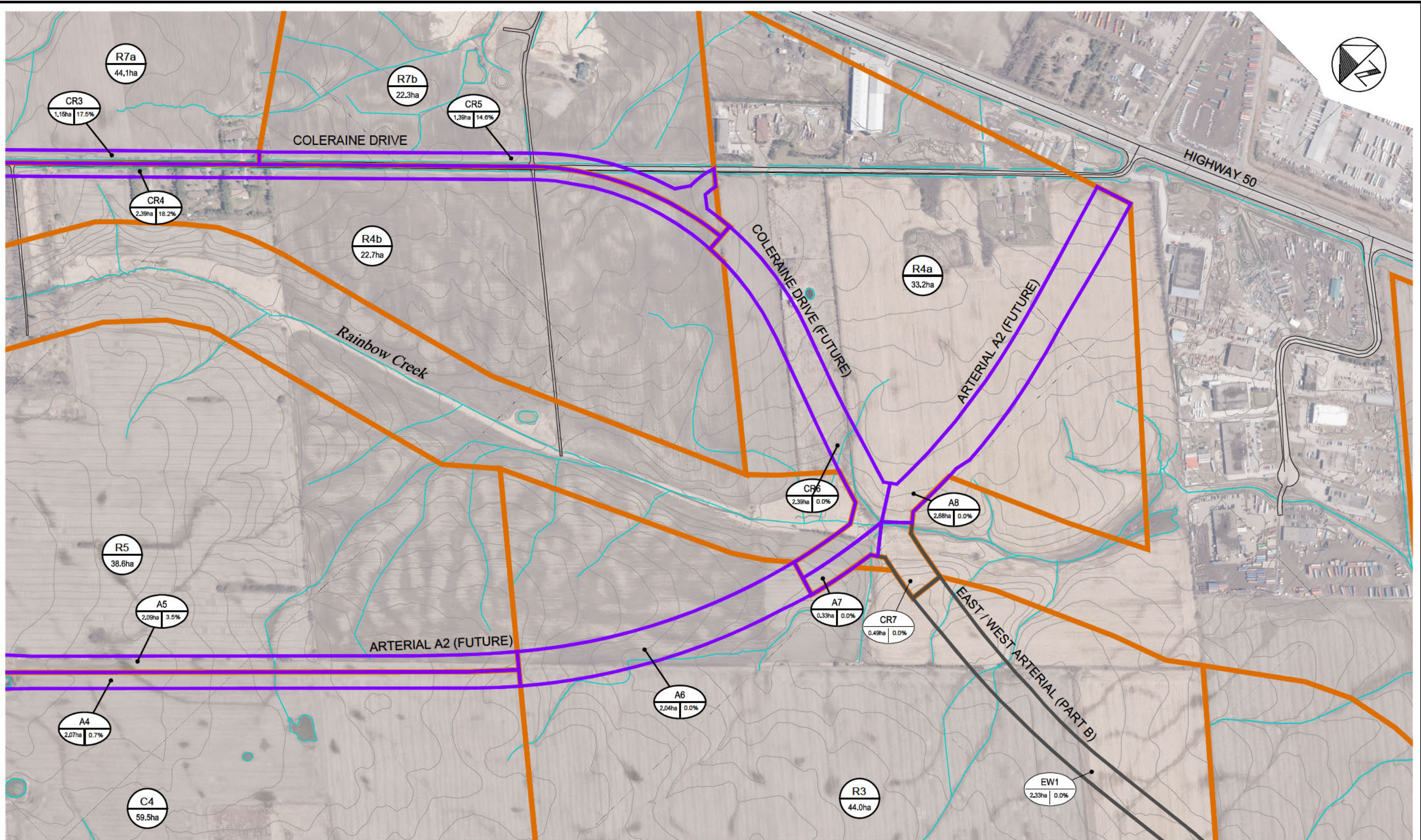
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2021-11-05



LEGEND		ROAD DRAINAGE 'PART A'	ROAD DRAINAGE 'PART B'	MESP DEVELOPMENT DRAINAGE
	EXISTING ROADWAY			
	WATERCOURSE			
	CONTOUR (0.5m)	SUBCATCHMENT ID#	SUBCATCHMENT ID#	SUBCATCHMENT ID#
		PERCENTAGE OF IMPERVIOUS AREA	PERCENTAGE OF IMPERVIOUS AREA	SUBCATCHMENT AREA
		SUBCATCHMENT AREA	SUBCATCHMENT AREA	

<p>ENVIRONMENTAL ASSESSMENT ARTERIAL ROADS - AREA 47 CITY OF BRAMPTON REGION OF PEEL</p>	<p>SUBCATCHMENT BOUNDARY PLAN (EXISTING CONDITION)</p>	<p>SCALE VALID ONLY FOR 24"x36" VERSION</p> <p>Scale 1:2500</p> <p>0 25 50 100</p>
		<p>wood.</p>
		<p>Consultant File No. TP115086</p> <p>Plan No. 3</p>

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 Last Saved By: richard.bartolo
 2021-11-05
 2021-11-05
 Path: I:\TP115086\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08(PA-Rev)\Fig2-4 Catchment-Exc.dwg



LEGEND

- EXISTING ROADWAY
- WATERCOURSE
- CONTOUR (0.5m)

ROAD DRAINAGE 'PART A'

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- PERCENTAGE OF IMPERVIOUS AREA
- SUBCATCHMENT AREA

ROAD DRAINAGE 'PART B'

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- PERCENTAGE OF IMPERVIOUS AREA
- SUBCATCHMENT AREA

MESP DEVELOPMENT DRAINAGE

- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID#
- SUBCATCHMENT AREA

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
 CITY OF BRAMPTON
 REGION OF PEEL

SUBCATCHMENT
BOUNDARY PLAN
 (EXISTING CONDITION)



SCALE VALID ONLY FOR
 24"x36" VERSION

Scale 1:2500
 0 25 50 100

Consultant File No.
 TP115086

Plan No.
 4



REFER TO FIGURE 6 FOR ENLARGED VIEW

REFER TO FIGURE 8 FOR ENLARGED VIEW

RAINBOW CREEK PROPOSED TO BE REALIGNED (BY OTHERS) IN THIS LOCATION

COUNTRYSIDE DRIVE WILL BE ADDRESSED UNDER PART B REPORTING

PROPOSED CROSSING REPLACEMENT (PART 'B' ROADS) 17.0mx2.0mx53.4m

CULVERT ID: 24.4425 PROPOSED CROSSING REPLACEMENT 17.0mx2.2mx47.3m LONG BRIDGE

RAINBOW CREEK PROPOSED TO BE MODIFIED (BY OTHERS) IN THIS LOCATION

CULVERT ID: 24.343 PROPOSED NEW CROSSING 25.0mx2.5mx75.0m LONG BRIDGE

RAINBOW CREEK PROPOSED TO BE REALIGNED (BY OTHERS) IN THIS LOCATION

EAST/WEST ARTERIAL WILL BE ADDRESSED UNDER PART B REPORTING

CLARKWAY DRIVE WILL BE ADDRESSED UNDER PART B REPORTING

REFER TO FIGURE 7 FOR ENLARGED VIEW

- LEGEND**
- EXISTING ROADWAY
 - WATERCOURSE
 - CONTOUR (0.5m)
 - ROAD DRAINAGE 'PART A'**
 - SUBCATCHMENT BOUNDARY
 - MAJOR/MINOR SYSTEM FLOW DIRECTION
 - ROAD DRAINAGE 'PART B'**
 - SUBCATCHMENT BOUNDARY
 - MAJOR/MINOR SYSTEM FLOW DIRECTION
 - MESP DEVELOPMENT DRAINAGE**
 - SUBCATCHMENT BOUNDARY
 - SUBCATCHMENT ID#
 - SUBCATCHMENT AREA
 - STORMWATER MANAGEMENT FACILITY AND REFERENCE ID#

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:6000

Consultant File No. TP115086

Plan No. 5

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
CITY OF BRAMPTON
REGION OF PEEL

SUBCATCHMENT
BOUNDARY PLAN
(FUTURE CONDITION)

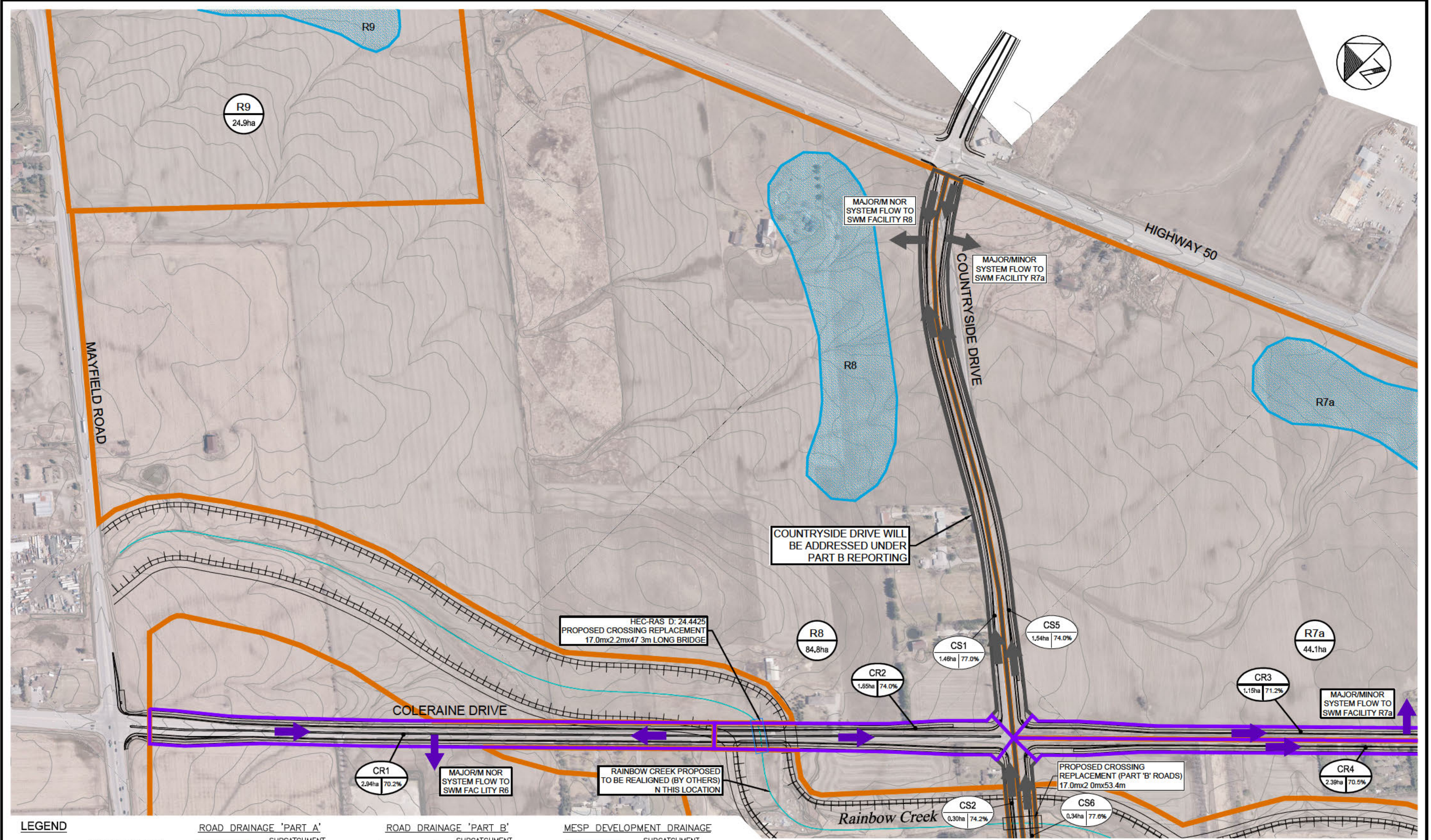


Path: I:\TP115086\06_DES-ENG\01_CAD\02_DWG\05_WR_01_PROJ\2021-08(PA-Rev)\Fig5 Catchment-Fut(Overall).dwg

Plotted By: richard.bartolo
Last Saved By: richard.bartolo
2021-11-05
Last Saved: 2021-11-05

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Plotted By: richard.bartolo
Last Saved By: richard.bartolo
2021-11-05
Last Saved: 2021-11-05



LEGEND		ROAD DRAINAGE 'PART A'		ROAD DRAINAGE 'PART B'		MESP DEVELOPMENT DRAINAGE	
	EXISTING ROADWAY		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY
	WATERCOURSE		SUBCATCHMENT ID#		SUBCATCHMENT ID#		SUBCATCHMENT ID#
	CONTOUR (0.5m)		PERCENTAGE OF IMPERVIOUS AREA		PERCENTAGE OF IMPERVIOUS AREA		SUBCATCHMENT AREA
			SUBCATCHMENT AREA		SUBCATCHMENT AREA		STORMWATER MANAGEMENT FACILITY AND REFERENCE ID#
			MAJOR/MINOR SYSTEM FLOW DIRECTION		MAJOR/MINOR SYSTEM FLOW DIRECTION		

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
CITY OF BRAMPTON
REGION OF PEEL

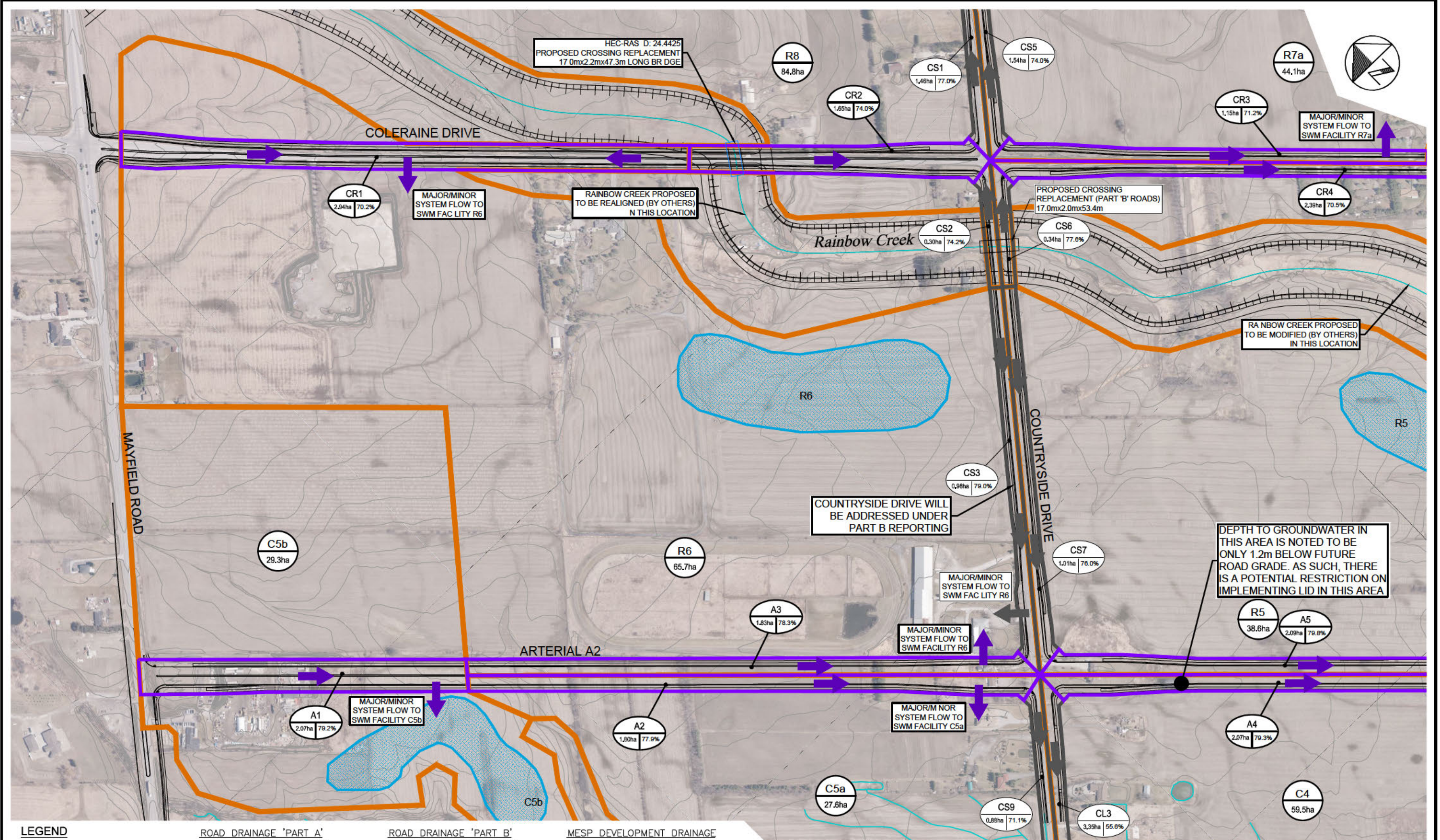
SUBCATCHMENT BOUNDARY PLAN
(FUTURE CONDITION)



SCALE VALID ONLY FOR 24"x36" VERSION
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Consultant File No. TP115086
Plan No. 6

Path: I:\TP115086\06_DES-ENG\01_CAD\02_DWG\05_WR\01_PROJ\2021-08(PA-Rev)\Fig-8 Catchment-Fut.dwg

Plotted By: richard.bartolo
 Last Saved By: richard.bartolo
 2021-11-05
 Last Saved: 2021-11-05



ROAD DRAINAGE 'PART A'		ROAD DRAINAGE 'PART B'		MESP DEVELOPMENT DRAINAGE	
	EXISTING ROADWAY		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY
	WATERCOURSE		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY
	CONTOUR (0.5m)		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY
	SUBCATCHMENT ID#		SUBCATCHMENT ID#		SUBCATCHMENT ID#
	PERCENTAGE OF IMPERVIOUS AREA		PERCENTAGE OF IMPERVIOUS AREA		SUBCATCHMENT AREA
	SUBCATCHMENT AREA		SUBCATCHMENT AREA		SUBCATCHMENT AREA
	MAJOR/MINOR SYSTEM FLOW DIRECTION		MAJOR/MINOR SYSTEM FLOW DIRECTION		STORMWATER MANAGEMENT FACILITY AND REFERENCE ID#

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
 CITY OF BRAMPTON
 REGION OF PEEL

SUBCATCHMENT BOUNDARY PLAN
 (FUTURE CONDITION)

wood.

Scale 1:2500
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Consultant File No. TP115086
 Plan No. 7

DEPTH TO GROUNDWATER IN THIS AREA IS NOTED TO BE ONLY 1.2m BELOW FUTURE ROAD GRADE. AS SUCH, THERE IS A POTENTIAL RESTRICTION ON IMPLEMENTING LID IN THIS AREA

COUNTRYSIDE DRIVE WILL BE ADDRESSED UNDER PART B REPORTING

HEC-RAS D: 24.4425
 PROPOSED CROSSING REPLACEMENT
 17.0m x 2.2m x 47.3m LONG BR DGE

PROPOSED CROSSING REPLACEMENT (PART 'B' ROADS)
 17.0m x 2.0m x 53.4m

RAINBOW CREEK PROPOSED TO BE REALIGNED (BY OTHERS) IN THIS LOCATION

RAINBOW CREEK PROPOSED TO BE MODIFIED (BY OTHERS) IN THIS LOCATION

MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY R6

MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY R6

MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY C5b

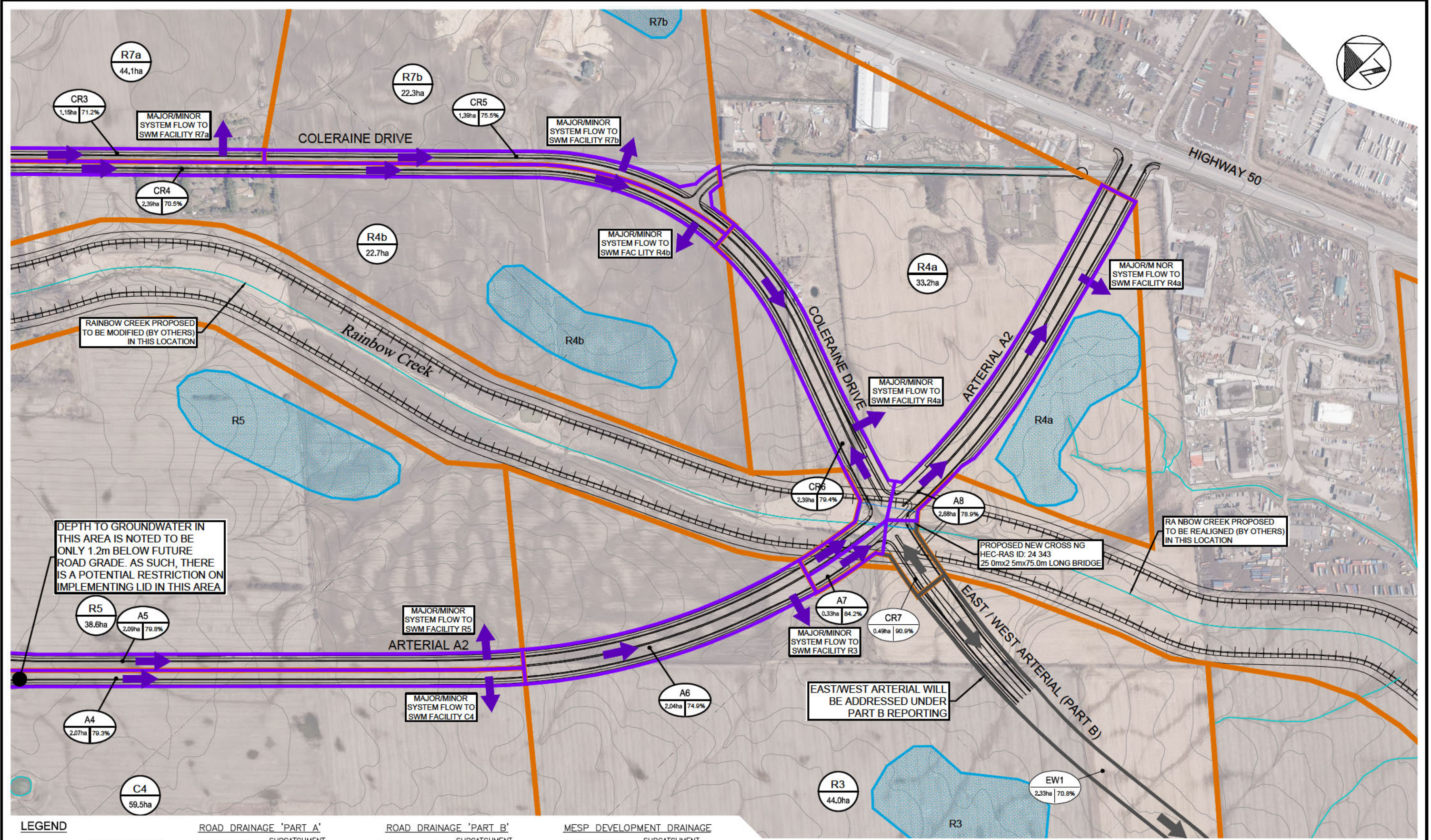
MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY R6

MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY C5a

MAJOR/MINOR SYSTEM FLOW TO SWM FACILITY R7a

Path: I:\TP115086\06_DES-ENG\01_CAD\02_DWG\05_WR_01_PROJ\2021-08(PA-Rev)\Fig8-8 Catchment-Fut.dwg

Plotted By: richard.bartolo
Last Saved By: richard.bartolo
2021-11-05
Last Saved: 2021-11-05



DEPTH TO GROUNDWATER IN THIS AREA IS NOTED TO BE ONLY 1.2m BELOW FUTURE ROAD GRADE. AS SUCH, THERE IS A POTENTIAL RESTRICTION ON IMPLEMENTING LID IN THIS AREA

RAINBOW CREEK PROPOSED TO BE REALIGNED (BY OTHERS) IN THIS LOCATION

PROPOSED NEW CROSSING HEC-RAS ID: 24 343 25.0m x 2.5m x 75.0m LONG BRIDGE

EAST/WEST ARTERIAL WILL BE ADDRESSED UNDER PART B REPORTING

LEGEND		ROAD DRAINAGE 'PART A'		ROAD DRAINAGE 'PART B'		MESP DEVELOPMENT DRAINAGE	
	EXISTING ROADWAY		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY		SUBCATCHMENT BOUNDARY
	WATERCOURSE		SUBCATCHMENT ID#		SUBCATCHMENT ID#		SUBCATCHMENT AREA
	CONTOUR (0.5m)		PERCENTAGE OF IMPERVIOUS AREA		PERCENTAGE OF IMPERVIOUS AREA		SUBCATCHMENT AREA
			SUBCATCHMENT AREA		SUBCATCHMENT AREA		STORMWATER MANAGEMENT FACILITY AND REFERENCE ID#
			MAJOR/MINOR SYSTEM FLOW DIRECTION		MAJOR/MINOR SYSTEM FLOW DIRECTION		

ENVIRONMENTAL ASSESSMENT
ARTERIAL ROADS - AREA 47
CITY OF BRAMPTON
REGION OF PEEL

SUBCATCHMENT BOUNDARY PLAN
(FUTURE CONDITION)



SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:2500

0 25 50 100

Consultant File No. TP115086

Plan No. 8

Appendix D: Correspondence

[Redacted]

December 24, 2021

[Redacted]

Development Services, Public Works
10 Peel Centre Drive, Suite A, 6th Floor
Brampton, Ontario
L6T 4B9

Dear Mr [Redacted]

As you know, the Region of Peel has requested the developers fronting Coleraine Drive from Countryside Drive to future Arterial Road A2 provide land for a stormwater management pond to accommodate storm run off from the realigned Coleraine Drive

The developer group, including [Redacted], have agreed to locate the proposed pond on lands owned by [Redacted] as identified on the attached figure all subject to a final design.

If you have any questions or require any further information, please do not hesitate to contact the undersigned.

Yours truly,

[Redacted]

cd

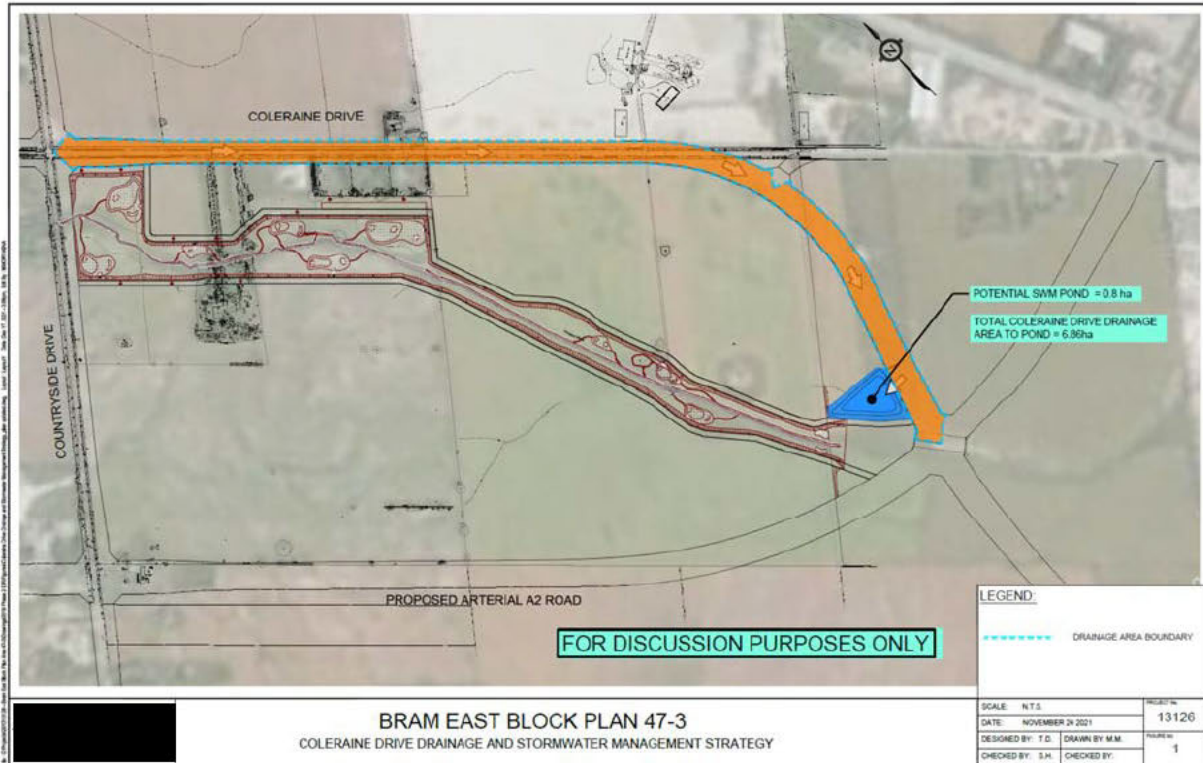
[Redacted]

[Redacted]

[Redacted]

Figure 1

Proposed Location of Coleraine SWM Pond and Drainage Area Boundary



Appendix E: Coleraine Drive Drainage Planning – Alternatives Assessment

Coleraine Drive Drainage Planning

Two alternative stormwater management options have been considered for the Coleraine Drive R.O.W., namely:

1. **Alternative #1** - Redirecting R.O.W. drainage from Subcatchments CR4, CR5, CR6, CS6 and A7, away from SWMFs R7b and R4b, to SWMF R4a.

A high-level review of this alternative has been completed based on the following:

- a) Determine Technical Feasibility of Alternative Drainage Plan: confirmation of sufficient elevation to support a gravity conveyance system to SWMF R4a.
- b) Preliminary Storm Sewer Design for Alternate Drainage Plan: preparation of a preliminary storm sewer design and layout for the noted drainage scenario.
- c) Hydrologic Modelling: development of a hydrologic model to simulate the 100-year stormwater runoff in support of the assessment of the feasibility of redirection of runoff to SWMF R4a.
- d) Costing: development of a high-level cost of the preliminary storm sewer design and alternate storage framework for the noted drainage concept.

Each of these component tasks is documented in the following sections.

2. **Alternative #2** - Redirecting R.O.W. drainage to a new SWM facility to be located (under discussion) in the north-west quadrant of the intersection of Coleraine Drive and Arterial A2 as illustrated in Figure E-1.

The multi-lateral discussions have not reached conclusion, regarding SWM facility location, at the time of writing of this report. As such, this scenario should be further evaluated during detailed design and the R.O.W. drainage, per the catchments divide provided in this SWM report (ref Appendix C), be the responsibility of the adjacent landowners to accommodate.



Figure E-1 Approximate Location of Possible Future SWM Facility

(background image source Google Earth Pro™)

Assessment of Drainage Alternative #1

Determine Technical Feasibility of Alternative Drainage Plan

A key element of the feasibility of the Alternative Drainage Plan is confirmation of sufficient elevation to support a gravity conveyance system. The following information is considered relevant to this determination:

- The proposed road profile of Arterial A2, adjacent to the MESP proposed stormwater management facility (SWMF) R4a, has an elevation of 210.84 m.
- The proposed channel invert of Rainbow Creek adjacent to the expected discharge point of the SWMF R4a outlet headwall ranges from 206.99 m to 207.22 m.
- Based on this, the vertical drop between the proposed road profile elevation and the proposed Rainbow Creek channel invert ranges from 3.62 m to 3.85 m.

It is noted that a minimum vertical drop of 3.0 m would typically be necessary to implement a SWMF in this configuration. Therefore, based on the information presented above there appears to be sufficient vertical drop between the proposed roadway and the receiving Rainbow Creek to allow SWMF R4a to be implemented.

A high-level review to determine if the proposed siting of SWMF R4a would be suitable to accommodate the roadway drainage from the arterial roadways has been completed. Based on the assessment completed as part of Task 2 and 3, it is concluded that the siting of SWMF R4a would be suitable to allow for major and minor system conveyance of the arterial roadway drainage into SWMF R4a.

Lastly, a high-level review has been completed of the estimated storage volume capacity to determine if the proposed SWMF R4a would have sufficient storage capacity to accept drainage from the arterial roadways. It is noted that, under ideal circumstances, the proposed grading of SWMF R4a would have been made available to this assessment to calculate an accurate storage volume capacity, however it is understood that the proposed grading is not available at this time. As such, the available information has been used in order to draw a reasonable conclusion. Based on the footprint of the proposed SWMF R4a as presented on the attached Figures, the surface area of SWMF R4a is noted to be approximately 24,700 m². Assuming an active storage depth of 2.0 m, and 5H:1V side sloping, the storage volume of SWMF R4a would be approximately 42,000 m³. In comparison to the 100-year runoff volumes presented under Task 3 below, it would appear that SWMF R4a could be designed with sufficient storage volume capacity to accommodate the arterial roadway drainage.

Preliminary Storm Sewer Design

Preliminary storm sewer designs and layouts have been developed for two drainage scenarios, namely:

- a) Subcatchments CR4, CR5, CR6, CR7, and A7 directed to adjacent ponds as originally planned; and
- b) Subcatchments CR4, CR5, CR6, CR7, and A7 directed to SWMF R4a.

As Coleraine Drive is a Region owned R.O.W., the sizing and layout were completed using the Region of Peel IDF data (which is marginally higher than the City's design IDF rainfall). Storm sewers were sized to convey the 1 in 10-year storm event based on City of Brampton Intensity-Duration-Frequency (IDF) curves. The storm sewer design sheet is provided in Appendix B. As indicated on the storm sewer design sheet, the storm sewer sizes required to convey the 10-year peak flows under this drainage scenario range in size from 250 mm to 1050 mm.

For scenario b), it is noted that the proposed Coleraine Drive profile has been re-graded to eliminate the originally proposed low point north of the Coleraine Drive/Arterial A2 intersection. The intention of removing this low point is to eliminate the need to capture the 100-year peak flow within Coleraine Drive and subsequently upsize the proposed storm sewer to provide sufficient conveyance capacity to convey the 100-year peak flow to SWMF R4a. Upsizing the storm sewers would result in additional costs.

Lastly, major system conveyance capacity calculations have been made to ensure that the major system peak flows generated by the arterial roadways can be conveyed overland within the R.O.W., while adhering to the applicable Region of Peel Major System Design criteria. The Region of Peel Major System Design criteria requires one lane of traffic in each direction to be free from flooding during the 100-year event. It is noted that the major system peak flows are peak flows greater than the minor system storm event (i.e., 10-year storm event) up to the 100-year storm event. Following the assessment of the major system conveyance capacity calculations, it was determined that some of the major systems conveying drainage to SWMF R4b and SWMF R4a along Coleraine Drive provide insufficient major system conveyance capacity. As such, the respective storm sewers have been upsized to accommodate additional conveyance capacity so that the overland flows within these major systems can adhere to the Region of Peel Major System Design criteria.

Hydrologic Modelling

A hydrologic model using Visual Otthymo has been developed to simulate the 100-year runoff volumes from the roadway subcatchments draining to the MESP proposed SWMFs R7b, R4b and R4a, as well the drainage condition in which these drainage areas are re-directed to SWMF R4a. In accordance with the TRCA SWM Criteria (TRCA, 2012), the 6-hour and 12-hour AES design storms have been simulated to generate the hyetographs for each roadway subcatchment. The results of the modelling are presented in Tables E-1 and E-2 below:

Table E-1 MESP Proposed Drainage Plan

MESP/ Receiver Pond	Wood Subcatchment ID	Drainage Area (ha)	100-year Runoff Depth (mm)	100-year Runoff Volume (m ³)
R4b	CR, CR4	2.73	68.00	1,856
R7b	CR5	1.39	76.35	1,061
R4a	CR6, CR7, A7, A8	5.80	78.11	4,530
<i>Total</i>				<i>7,448</i>
R4b	CR, CR4	2.73	68.00	1,856
R7b	CR5	1.39	76.35	1,061
R4a	CR6, CR7, A7, A8	5.80	78.11	4,530
<i>Total</i>				<i>7,448</i>

Table E-2 Drainage Areas Re-directed to SWMF R4a

MESP/Receiver Pond	Wood Subcatchment ID	Drainage Area (ha)	100-year Runoff Depth (mm)	100-year Runoff Volume (m ³)
R4a	CS6, CR4, CR5, CR6, CR7, A7, A8	9.93	74.93	7,441

As indicated in Tables D-1 and D-2, the total volume between the two drainage scenarios is comparable, with an overall difference of only 7 m³. The notable difference between the two scenarios is that for the scenario where drainage areas are re-directed to SWMF R4a, the full volume (i.e., 7,441 m³) would have to be accommodated within SWMF R4a, whereas under the MESP Proposed Drainage Plan scenario, only 4,530 m³ would have to be accommodated within SWMF R4a. This constitutes a difference of 2,911 m³.

High-Level Costing

Using the information presented under Task 1b above, high-level costing of the preliminary storm sewer designs has been estimated, summarized below:

Scenario 1

• Drainage to SWM Pond R4a:	\$992,909
• Drainage to SWM Pond R4b:	\$997,214
• Drainage to SWM Pond R7b:	\$288,662
Total:	\$2,278,785

Scenario 2

• Combined Drainage to SWM Pond R4a:	\$2,962,440
--------------------------------------	--------------------

Detailed costing sheets for both scenarios are provided in Appendix B.

Using the information presented under Task 1c above, high-level costing of the 100-year runoff volumes generated under the two drainage scenarios has been developed. Costing has been developed using Wood's available pool of construction pricing. Tables E-3 and E-4 below present the high-level costing for the two drainage scenarios.

Table E-3 MESP Proposed Drainage Plan

MESP Pond	Wood Subcatchment ID	Drainage Area (ha)	100-year Runoff Volume (m ³)	Unitary Storage Cost (\$/m ³)	Cost (\$)
R4b	CS6, CR4	2.73	1,856	\$ 123	\$ 228,228
R7b	CR5	1.39	1,061	\$ 123	\$ 130,503
R4a	CR6, CR7, A7, A8	5.80	4,530	\$ 123	\$ 557,190
Total			7,448		\$ 915,981

Table E-4 Drainage Areas Re-directed to SWMF R4a

MESP Pond	Wood Subcatchment ID	Drainage Area (ha)	100-year Runoff Volume (m ³)	Unitary Storage Cost (\$/m ³)	Cost (\$)
R4a	CS6, CR4, CR5, CR6, CR7, A7, A8	9.93	7,441	\$ 123	\$ 915,243

3.8.1.2 Assessment of Drainage Alternative #2

As already noted, multi-lateral discussions have not reached conclusion at the time of writing of this report, and as such quantitative evaluation of this alternative has not been completed. It is directed that detailed evaluation of this alternative be completed as a component of detailed design. However, given that

Alternative #1 is considered viable, as demonstrated by the assessment outlined in Section 3.8.1, it is presupposed that Alternative #2 will also be found to be viable.