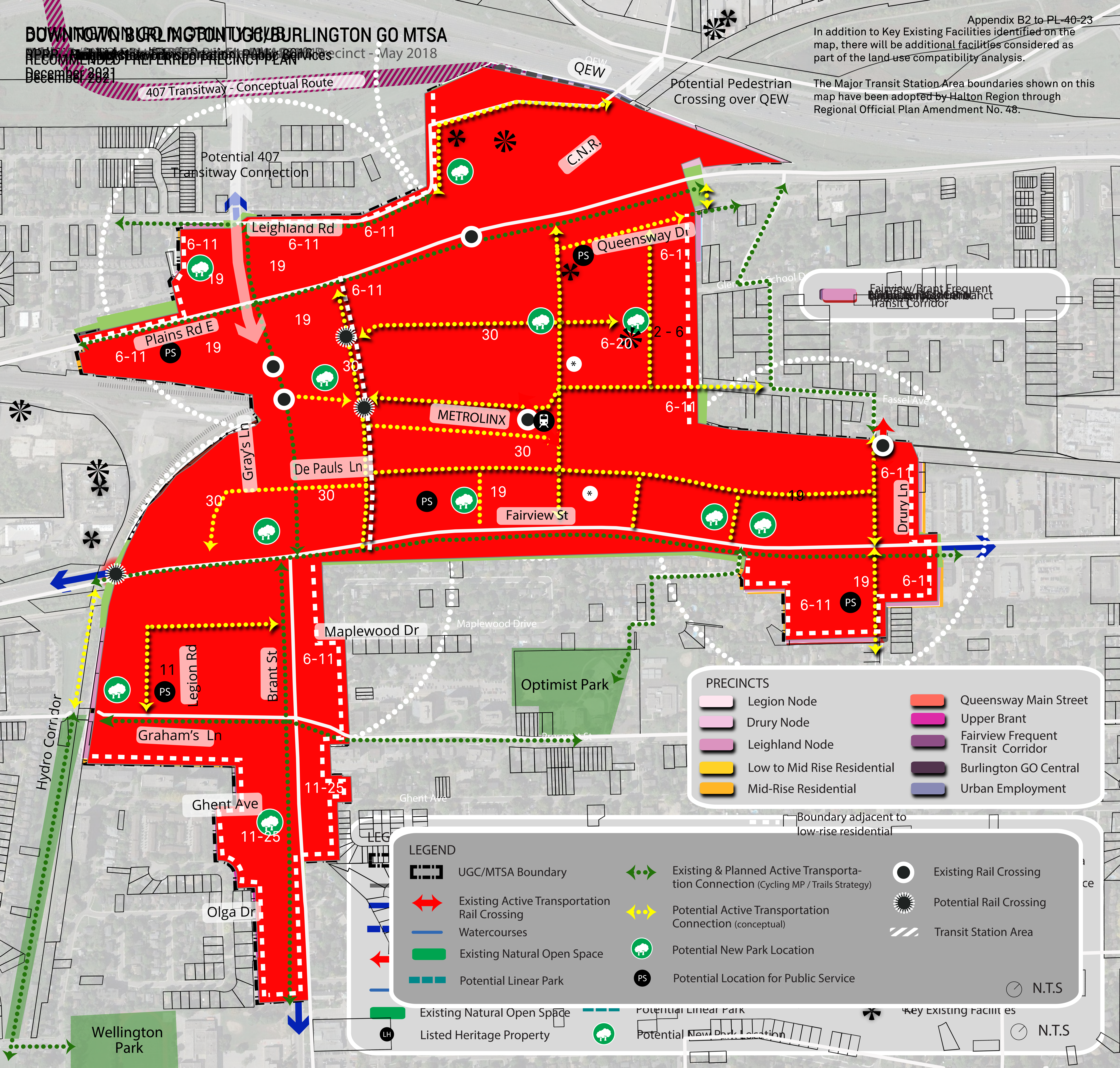
DOWNTOWN BURLINGTON UGC/BURLINGTON GO MTSA
RECOMMENDED PREFERRED PRECINCT PLAN
December 2021
Appendix B2 to PL-40-23
In addition to Key Existing Facilities identified on the map, there will be additional facilities considered as part of the land use compatibility analysis.
The Major Transit Station Area boundaries shown on this map have been adopted by Halton Region through Regional Official Plan Amendment No. 48.
407 Transitway - Conceptual Route
Potential 407 Transitway Connection
Potential Pedestrian Crossing over QEW
QEW
C.N.R.
Leighland Rd
Queensway Dr
Plains Rd E
METROLINX
Gray's Ln
De Pauls Ln
Fairview St
Drury Ln
Maplewood Dr
Maplewood Drive
Legion Rd
Brant St
Graham's Ln
Ghent Ave
Olga Dr
Hydro Corridor
Optimist Park
Wellington Park
Fassel Ave
6-11
19
30
6-20
2 - 6
11
11-25
PS
PRECINCTS
Legion Node
Drury Node
Leighland Node
Low to Mid Rise Residential
Mid-Rise Residential
Queensway Main Street
Upper Brant
Fairview Frequent Transit Corridor
Burlington GO Central
Urban Employment
Boundary adjacent to low-rise residential
LEGEND
UGC/MTSA Boundary
Existing Active Transportation Rail Crossing
Watercourses
Existing Natural Open Space
Potential Linear Park
Existing & Planned Active Transportation Connection (Cycling MP / Trails Strategy)
Potential Active Transportation Connection (conceptual)
Potential New Park Location
Potential Location for Public Service
Existing Rail Crossing
Potential Rail Crossing
Transit Station Area
N.T.S
Listed Heritage Property
Key Existing Facilities

Figure 5: Proposed Revised Precincts

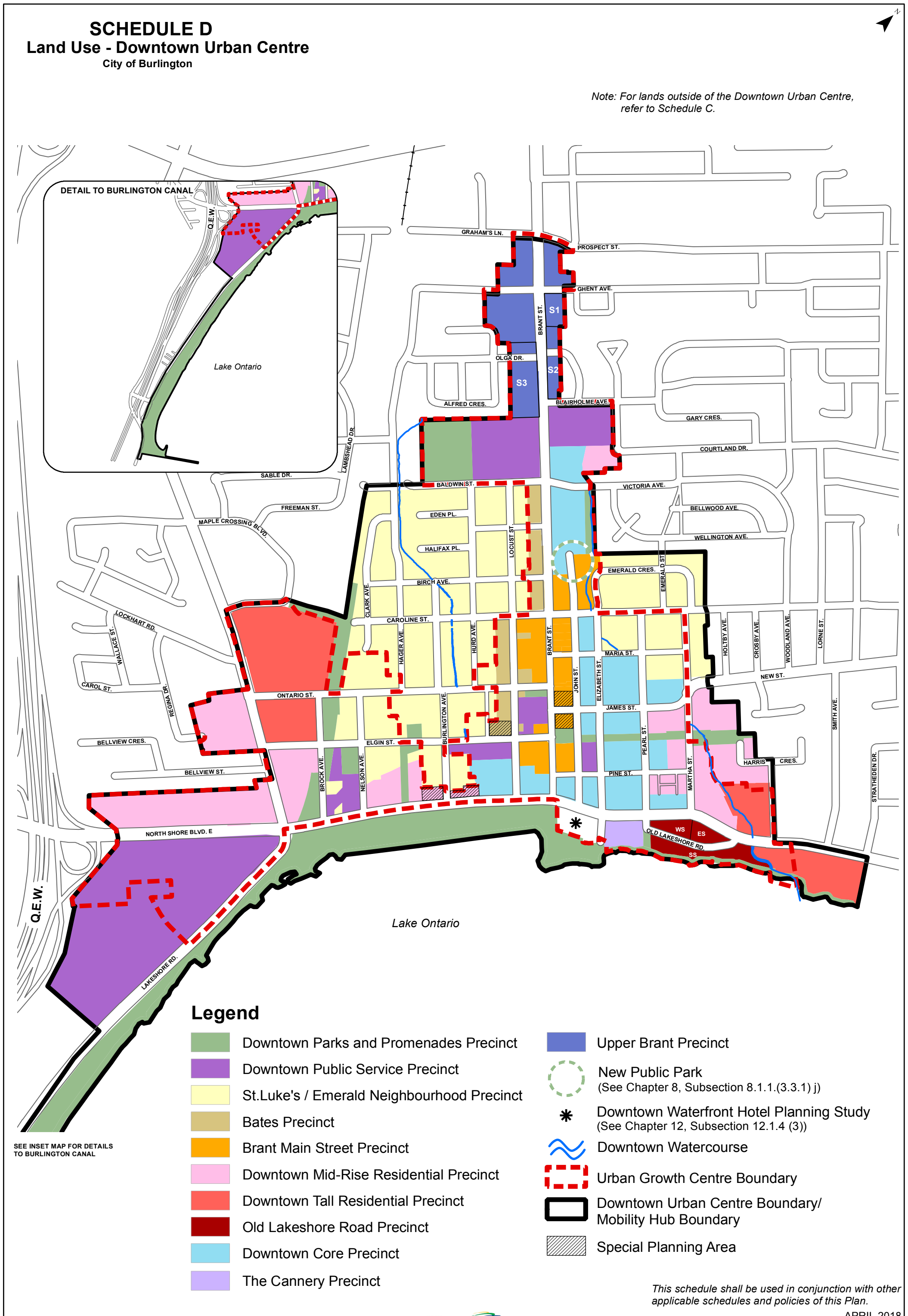

Figure 6: Adopted Official Plan Schedule D – Land Use – Downtown Urban Centre, 2018 showing the existing Precincts

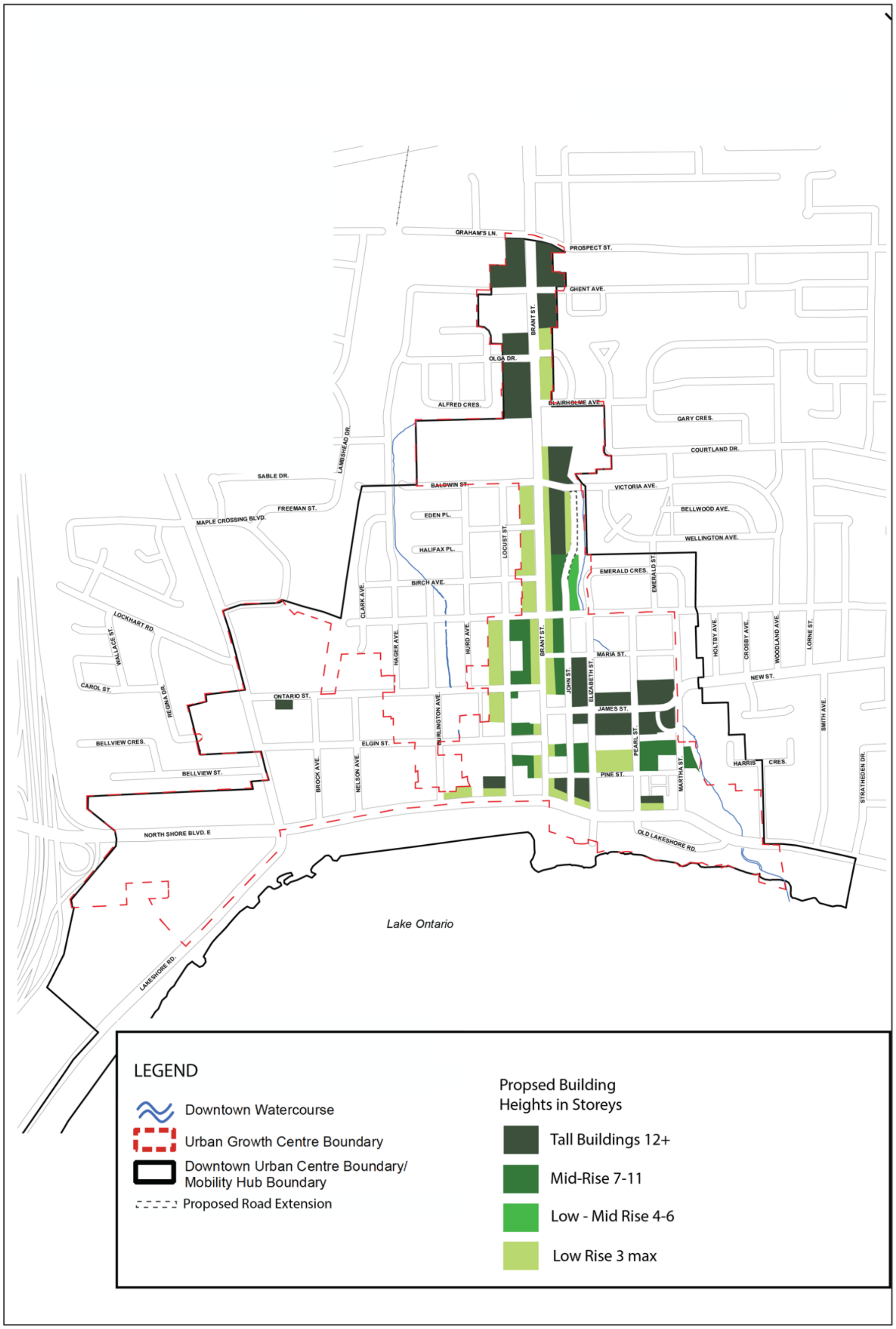

Figure 10: Concept 1 Building Heights

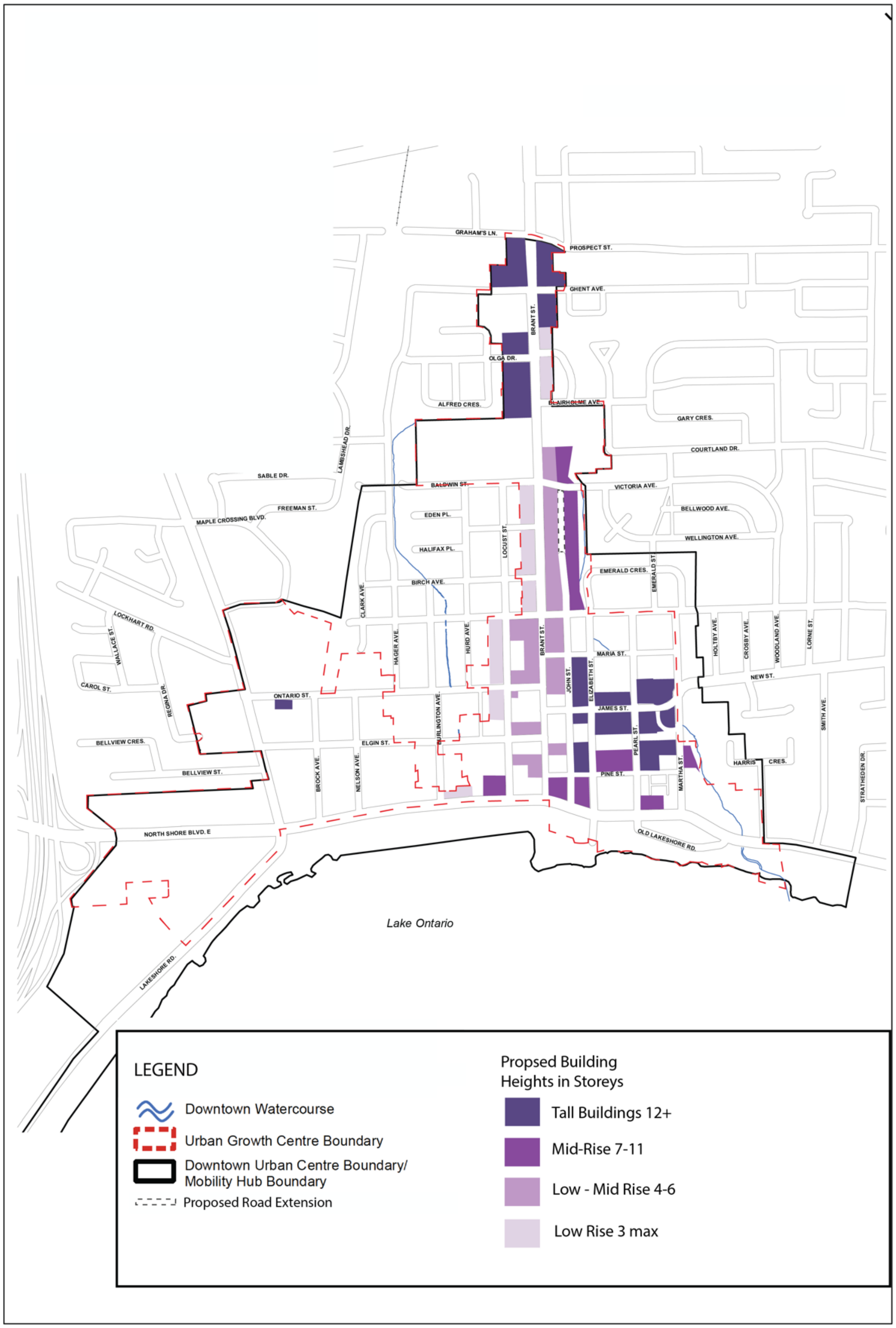

Figure 11: Concept 2 Building Heights

Appendix B

Phase 2 Background Information and Correspondence (Conservation Halton)

Downtown and Burlington GO Major Transit Station Area Flood Hazard and Scoped SWM Assessment

Phase 2 Terms of Reference and Scope of Work – Aug 06, 2021

PURPOSE

The purpose of Phase 2 study is to verify through model simulation that there will be no increased creek peak flows for the full range of the updated City of Burlington design storms and Hurricane Hazel. This modelling will reflect maximum potential impervious levels permitted by the proposed Zoning, or in the case of the area within the Downtown Urban Centre, the coverage associated with the Official Plan policies of the new Official Plan[1]. The Phase 2 study will refine modelling from the Phase 1 study to map flood susceptible areas using latest modelling tools. The Phase 2 report will outline sources of information, modelling approaches, assumptions, model refinements, etc. and shall include summary tables of model results demonstrating no increased flooding or flood risk. The study is expected to provide sufficient information to support the future evaluation of development applications by the City and CH and to support the development of planning studies (Burlington GO MTSA). The findings of the Phase 2 study will also determine if any amendments are required to the Official Plan in the Downtown Urban Center. Deliverables include five hard copies of the study report as well as a digital copy and digital copies of all models, drawings and figures.

Further, it is understood that Conservation Halton is planning an overall update of the hydrologic and hydraulic modelling of the Hager-Rambo and Roseland Creek systems in the future, however a definitive timeline has not been established. As such, the interim modelling work currently proposed is required and necessary to support the timelines of the MTSA study work. It is not expected that any future update work will generate notably different results than the current study, however this potential will need to be considered in the future once the updated flows (hydrologic modelling) are available. Hydraulic modelling would ideally re-purposed to the extent possible.

The new policy approved by the Region of Halton in the City's new Official Plan, with respect to lands within the Downtown Urban Centre, states in subsection 8.1.1(3.16.1) e):

The City will undertake a Phase 2 Flood Hazard Study using more detailed topographical survey data to facilitate future development applications. Amendments to this Plan may be required to

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[1] On Nov. 30, 2020, the Region of Halton issued a Notice of Decision approving the new Burlington Official Plan. Section 17(27) of the Planning Act (R.S.O. 1990, as amended) sets out that all parts of an approved official plan that are not the subject of an appeal will come into effect on the day after the last date for filing a notice of appeal- that date being Dec. 22, 2020 for the new Burlington Official Plan. The appeal record submitted to the Local Planning Appeal Tribunal (LPAT) by the Region of Halton indicates that a total of 48 appeals to various parts of the new Burlington Official Plan were received during the appeal period.

implement the findings of the study, as determined by the City, in consultation with Conservation Halton.

1. **Hydrologic Input Data Refinement (Existing SWMHYMO)**

   a. Update Phase 1 Study's hydrologic modelling for Roseland Creek (SWMHYMO) to use the City's current IDF parameters (with climate change allowance). Generate inflow hydrographs for Roseland Creek upstream of the QEW enclosure for frequency design storms and Hurricane Hazel. Hydrographs are to be used to assess potential for spill from Roseland to East Rambo Creek at QEW, refer to b. below.

   b. Prepare an unsteady state 2D hydraulic model of Roseland Creek (CH preference to use HEC-RAS; potential to leverage draft model prepared by CH as well; to be determined through further discussion with CH and City) to map potential spill from Roseland Creek at the QEW to the downstream receiving system(s) (expected to be primarily East Rambo Creek). Identify and quantify any spill(s) which may contribute to the Hager/Rambo system. Prepare mapping identifying 2D inundation limits, spill points, etc. Discuss findings within reporting and add spill flows into hydrologic modelling for Hager/Rambo Creeks as appropriate.

   c. Update the Phase 1 Study's hydrologic modelling for Hager-Rambo system (SWMHYMO) to use the City's current IDF parameters (with climate change allowance), and revised Flood Control Facility rating curves (as per September 2020 report). Include consideration for partially blocked outlets where appropriate, based on the characteristics of the flood control facility and outlet; generally consider a 50% low flow channel or grating blockage for this scenario unless an alternative recommendation can be supported. Include consideration of any inflows expected from spills. Update peak flows and inflow hydrographs as required for associated hydraulic model updates. Complete analysis for three (3) scenarios; one with flood control facilities included at full capacity, one with flood control facilities credited with partial blockage, and one with flood control facilities removed.

   d. Complete a hydrologic assessment of the future land use condition within the Burlington GO MTSA area only (i.e., no external lands). Future land use must consider maximum imperviousness permitted under proposed Zoning and/or the new Official Plan for study area catchments. Compare findings to existing conditions and verify that there will be no increased creek peak flows for the full range of design storms and Hurricane Hazel. Incorporate and assess impacts of proposed site SWM controls for the 2 to 100 year-storm events as appropriate, based on municipal requirements for over-control (i.e. 100 year post to 5 year pre) where major system capacity is identified as constrained. Where the 100 year storm event is the regulatory event and the City cannot legally ensure the proper operation and maintenance of a privately-owned facility, privately owned 100 year storm event controls will be excluded from the downstream flood hazard impact analysis.

BURLINGTON GO MAJOR TRANSIT STATION AREA

2. West Rambo Creek - Hydraulics

a. Flows to be based on "Scenario 1" only (East Rambo Flood Control Facility (FCF) spills as per existing conditions).

b. Prepare/update unsteady state 2D hydraulic model(s) to map spill from the East Rambo FCF to the downstream receiving system(s) (i.e., Hager Rambo Diversion Channel, etc.). Modelling must use HEC-RAS 2D or PCSWMM 2D. CH has identified a preference for HEC-RAS 2D; City has expressed a preference to continue to use PCSWMM 2D. Which modelling platform will be proposed for use will be defined within the proposal. Confirm additional cost to use HEC-RAS 2D if use of PCSWMM is advanced (Note: CH has developed initial models which can be shared; CH may also financially support use of HEC-RAS 2D). If HEC-RAS 2D is applied, suitable boundary conditions for features such as the CNR underpass gravity storm sewer will be required.

   Modelling will need to comply with the underlying principle that attenuation and/or flood storage caused by bridges/culverts cannot be credited in downstream flood risk mapping. Assume reach-based analysis will be required where mapping uses unsteady state analysis; primary focus is the West Rambo Creek system. Analysis will need to consider practical limitations to future hydraulic structure upgrades (similar to approach to East Rambo FCF). A sequential approach to upgrades will be completed from upstream to downstream (i.e., from Plains Road to Fairview Street). Approach is based on the assumption that land acquisition by City is unlikely to occur to support structure upgrades. This approach will determine likely maximum peak flows to riverine system for most conservative 1D riverine floodplain mapping; existing conditions will likely govern for spill flows (2D). Consideration to be given to unsteady state vs. quasi-steady state modelling as appropriate.

c. Hydraulic modelling shall make use of the best available topographic data, including detailed LiDAR/DEM data (Fall 2018) as appropriate.

d. Provide clear written confirmation/documentation and/or field verification of the connection point and related elevations of West Rambo Creek with the Hager Rambo (HR) Diversion Channel (i.e., that the two culverts are separate).

e. Re-assess anticipated spill flows from the Brant Street underpass to Fairview Street/Brant Street (and to Downtown Urban Centre) from 2D modelling to support separate 2D modelling of Downtown Urban Centre.

f. Update 1D HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data). Re-assess coding for ineffective flow areas and lateral structures. Detailed review and refinement of modelling upstream of Fairview Street is required.

g. Generate 1D floodplain mapping for remaining areas based on best available topographic data and modelling updates. Mapping sheets shall be prepared at a maximum 1:2000 scale. Generate updated flood risk mapping where 2D modelling is applied. Mapping sheets shall be prepared at a maximum 1:2000 scale. Mapping products (digital files) to be prepared include flood depth, flood velocity, flood depth velocity product, and flood risk data (MNRF risk guidelines).

h. Map existing conditions. Map proposed condition flows only where peak flows increase (existing versus proposed flows, as per hydrologic modelling in Part 1). Mapping to reflect the City and CH's decision with respect to crediting of flood control facilities.

3. East Rambo Creek - Hydraulics

a. Flows to be based on "Scenario 1" only (East Rambo FCF spills as per existing conditions).

b. Update 1D HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data).

c. Re-assess and adjust coding for ineffective flow areas as required.

d. Incorporate 1D-2D spill integration for spill at Lateral Structure 3 (CNR track area), to better define floodplain extents (potentially assess separately from 2D modelling for West Rambo Creek). Confirm if spill across CNR tracks is still expected.

e. Generate 1D floodplain mapping for remaining areas based on best available topographic data and modelling updates. Mapping sheets shall be prepared at a maximum 1:2000 scale.

f. Generate updated flood risk mapping where 2D modelling is applied. Mapping sheets shall be prepared at a maximum 1:2000 scale. Mapping products (digital files) to be present include flood depth, flood velocity, flood depth velocity product and flood risk data (MNR risk guidelines)

g. Map existing conditions. Map proposed condition flows only where peak flows increase (existing versus proposed flows, as per hydrologic modelling in Part 1). Mapping to reflect the City and CH's decision with respect to crediting of flood control facilities.

4. Hager-Rambo Diversion Channel - Hydraulics

a. Flows to be based on "Scenario 1" only (East Rambo FCF spills as per existing conditions).

b. Update 1D HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data).

c. Review simulated drop in flood elevations in the vicinity of Thorpe Road, update and refine modelling as necessary to ensure that model reflects a reasonable result with no greater than a 0.5 m drop in water surface elevation between cross sections. Re-generate floodplain mapping in this area as required.

d. Generate 1D floodplain mapping for remaining areas based on best available topographic data and modelling updates. Mapping sheets shall be prepared at a maximum 1:2000 scale.

e. Re-assess spill flows at lateral structures 1 and 2 and overtopping of Fairview Street from 1D HEC-RAS modelling to support separate 2D modelling of these spill areas (using updated PCSWMM 2D or HEC-RAS 2D), include assessment of optimizing lateral structures on an individual basis.

f. Generate updated flood risk mapping where 2D modelling is applied. Mapping sheets shall be prepared at a maximum 1:2000 scale. Mapping products (digital files) to be present include flood depth, flood velocity, flood depth velocity product and flood risk data (MNR risk guidelines)

g. Map existing conditions. Map proposed condition flows only where peak flows increase (existing versus proposed flows, as per hydrologic modelling in Part 1). Mapping to reflect the City and CH's decision with respect to crediting of flood control facilities.

5. Hager Creek at CNR - Hydraulics

a. Update flows consistent with the approach to other watercourses and as per Section 1.

b. Update HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data).

c. Re-assess and adjust coding for ineffective flow areas as required. Ensure proper alignment of the culverts and embankments

d. Implement a lateral structure at expected spill point to the east in 1D HEC-RAS modelling, however do not include any further 2D modelling components or assessments given that spill flows would not be expected to impact study limits, based on findings from February 2019 report provided the findings are still valid following the 2-D modelling/spill analysis (i.e. that no spill flow towards Burlington GO MTSA or Downtown Urban Centre is expected).

6. <u>Impacts of filling on floodplain and/or spill (2D Modelling)</u>

Assess the sensitivity of 2D modelling results to the filling of future redevelopment sites. The assessment shall include:

a. Scenario 1: All lands scheduled for intensification within the identified spill areas from Phase 1 are filled/raised above the flood hazard, while all Roads/ROWs remain unchanged.

b. Scenario 2 (if required): Based on the results of Scenario 1, determine a suitable percentage of lands scheduled for intensification which reside within identified spill areas from Phase 1 are filled/raised above the spill hazard, while all Roads/ROWs remain unchanged. Appropriate assumptions shall be established in consultation with the City and CH.

c. Scenario 3 (if required): Additional Scenario to be determined in conjunction with the study team pending results of Scenario's 1 and 2. It is expected that the study team will make recommendations for the scenarios to be evaluated.

Reporting must document findings and discuss results with respect to the potential impacts of each Scenario. Recommendations as to what filling may be permissible versus what must be avoided shall be included.

<u>DOWNTOWN URBAN CENTRE</u>

7. Lower Hager Creek - Hydraulics

a. Update 1D HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data).

b. Implement a lateral structure at expected spill point near Caroline Street, however do not include any further 2D modelling components or assessments given that spill flows would not be expected to impact MTSA study limits, based on findings from February 2019 report.

c. Generate 1D floodplain mapping for remaining areas based on best available topographic data and modelling updates. Mapping sheets shall be prepared at a maximum 1:2000 scale.

8. Lower Rambo Creek - Hydraulics

a. Update 1D HEC-RAS geometry using best available topographic data (e.g., LiDAR/DEM data).

b. Update flows as required based on updated spill assessment from Burlington GO Major Transit Station Area. Include modelling of the "with" and "without" spill flows from upstream areas, consistent with previous assessment. Flows to reflect with and without crediting of flood control facilities, unless otherwise directed by City and CH.

c. Generate 1D floodplain mapping for remaining areas based on best available topographic data and modelling updates. Mapping to reflect the City and CH's decision with respect to crediting of flood control facilities. Mapping sheets shall be prepared at a maximum 1:2000 scale.

d. Asses potential spill at Caroline Street. Prepare a 2D hydraulic model(s) (HEC-RAS 2D) to map spill as required (limits: Upstream of Caroline Street to Lake Ontario). An appropriate boundary condition at long culverts/storm sewers may be applied based on the PCSWMM modelling.

9. Impacts of filling on floodplain and/or spill

Assess the sensitivity of 2D modelling results to the filling of future redevelopment sites. The assessment shall include:

a. Scenario 1: All lands scheduled for intensification within the identified spill areas from Phase 1 are filled/raised above the flood hazard, while all Roads/ROWs remain unchanged.

b. Scenario 2 (if required): Based on the results of Scenario 1, determine a suitable percentage of lands scheduled for intensification which reside within identified spill areas from Phase 1 are filled/raised above the spill hazard, while all Roads/ROWs remain unchanged. Appropriate assumptions shall be established in consultation with the City and CH.

c. Scenario 3 (if required): Additional Scenario to be determined in conjunction with the study team pending results of Scenario's 1 and 2. It is expected that the study team will make recommendations for the scenarios to be evaluated.

Reporting must document findings and discuss results with respect to the potential impacts of each Scenario. Recommendations as to what filling may be permissible versus what must be avoided shall be included.

Conservation Halton

Planning & Watershed Management
905.336.1158 | Fax: 905.336.6684
2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

November 12, 2021

Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
Burlington, ON L7R 3Z6

BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Mr Malik:

Re: Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
Assessment of Roseland Creek Spill
Downtown and Burlington GO Major Transit Station Area
City of Burlington
CH File Number: MPR 799

Conservation Halton (CH) is pleased to serve as a member of the Technical Advisory Committee (TAC) for Phase 2 of the Flood Hazard and Scoped Stormwater Management Assessment supporting the proposed Downtown and Burlington Go, Major Transit Station Area (MTSA).

Conservation Halton (CH) staff has reviewed the Assessment of Roseland Creek Spill Memo, prepared by Wood Environment and Infrastructure Solutions, dated November 1, 2021, and the hydraulic modelling submitted the same day. We provide the following Key Comments below followed by Detailed Comments in Appendix A.

Summary of Key Comments

Staff has the following key comments based on review of the materials submitted.

A. The 2D HEC-RAS model requires several revisions which staff expect will affect its output/results significantly. It is recommended that all pertinent modelling concerns be resolved with CH staff prior to resubmission/update of reporting.

B. Staff request that reporting be revised to address several contextual concerns and that all results be updated once modelling concerns have been addressed.

Detailed comments and recommendations are provided within Appendix A. The above key comments and detailed comments within Appendix A should be addressed through a revised submission; however, CH staff are supportive of a stepped submission process in this regard.

We trust these comments are of assistance. Please contact me with any questions.

Sincerely,

David Irwin, P.Eng.
Water Resources Engineer
905.336.1158 ext. 2255
dirwin@hrca.on.ca

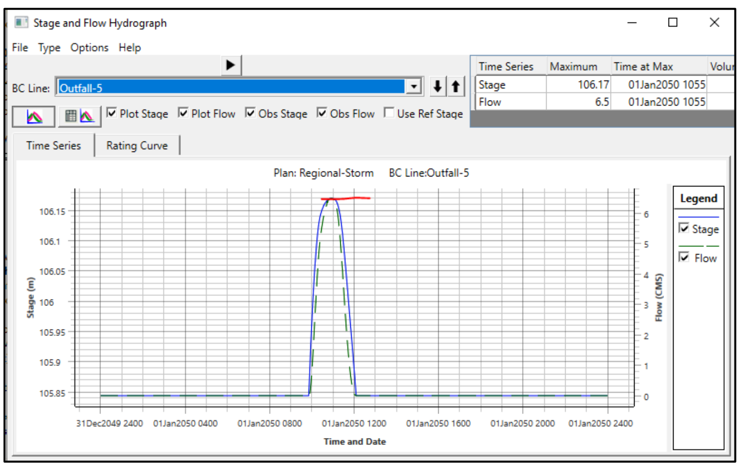
CC:Wood Plc: Matt Senior (matt.senior@woodplc.com), Ron Scheckenberger (ron.scheckenberger@woodplc.com)
City of Burlington: Alison Enns (alison.enns@burlington.ca), Cary Clak (cary.clark@burlington.ca), John Stuart (john.stuart@burlington.ca)
Conservation Halton: Leah Smith (leahsmith@hrca.on.ca), Janette Brenner (jbrenner@hrca.on.ca)

APPENDIX A: DETAILED COMMENTS

HEC-RAS 2D Modelling (Submitted: Nov 1, 2021)

1. **Initial Conditions and Used Storage for Regulatory Conditions**
   When CH evaluates Regulatory Storm controls, we now require modelling consider that the FCF's full storage capacity may not be available at the time a Regulatory Storm occurs. At a minimum, CH generally requires that available storage be calculated by determining what volume would remain in the facility 48 hours after a 2-year design storm. In HEC-RAS 2D this could be applied by creating a 'hot start' file representative of that condition; and applying that as the initial condition for the regulatory plan files. Staff would like to discuss this further with the Study Team as it relates to the East Rambo FCF.

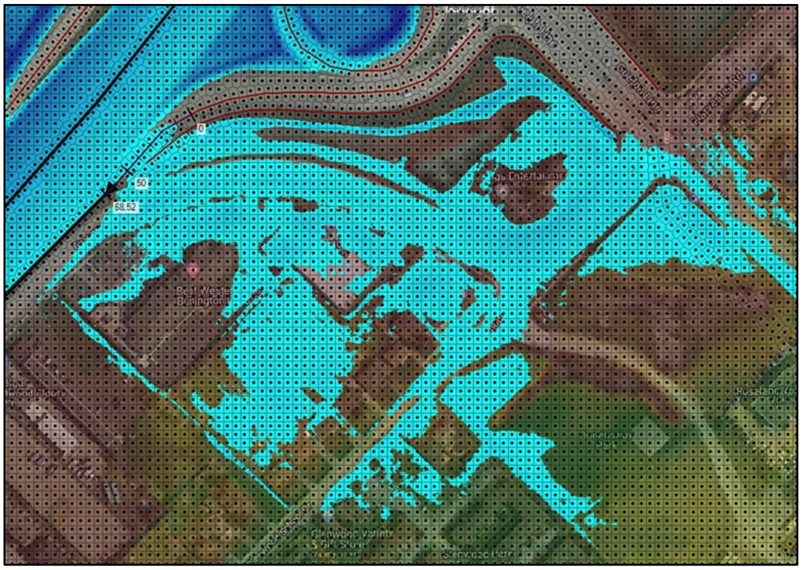
2. **2D Mesh – Non-Supported Boundary Conditions**
   Several 'normal depth' boundary conditions (BC) have been included in the hydraulic model which are not supported by staff. Specifically, inclusion of 'Outfall', 'Outfall 2', 'Outfall 4', and 'Outfall 5' is problematic as flows should not be allowed to leave the system in these locations. These BC lines significantly misrepresent conditions within East Rambo FCF; staff note that 'Outfall 5', 'Outfall 2' and 'Outfall' allow peak flow rates of 6.5 m^3/s, 0.6 m^3/s, and 4.5 m^3/s to leave the 2D mesh respectively.



3. **Model Terrain/Topography**
   Staff request that the 2D model's terrain incorporate buildings/structures present on the landscape. It is understood that the manning's n has been significantly increased for building footprints, however, staff would prefer that terrain be modified instead. A terrain file is available for this purpose upon request.

4. **Incorporation of Steel Beam Guardrails along the QEW**
   There are several sections of guardrail on the QEW which would allow conveyance of flows beneath these structures, with only minor obstruction for shallower flow depths (depths less than 0.2 m). The Storage Area / 2D Connection (SA/2D) used to represent these barriers (i.e., 'QEW Barrier') does not allow conveyance of flows beneath the guardrails as currently coded. Confirmation of CH's recommended approach will be forthcoming, pending further internal discussion.

5. **Mesh Refinements – Downstream of Roseland Spill at Queensway Drive**
   Mesh refinements (i.e., breaklines) are needed to ensure conveyance through areas downstream of the Queensway Drive spill pathway are mapped accurately. These refinements will be required to support mapping and quantification of this spill's potential contributions to East Rambo Creek.



6. **Terrain Data Modifications:**
   Terrain data has been manually edited in several locations. The rationale for and extent of these modifications is not clear to staff. Staff would like to discuss this with the study team as they may be creating some slight model instability.

7. **SA/2D Connection for Roseland Creek Enclosure at QEW:**
   Verify that the invert used for the Roseland Creek enclosure at QEW is of the same vertical datums as the current terrain. Staff believe the invert, as coded, is likely based on the 1928/78 CGVD rather than 2013 CGVD used by terrain (approximately 0.4 m too high); however, this must be confirmed.

8. **Maximum Courant Number:**
   Consider whether reducing the computational timestep or enlarging certain cells is necessary considering courant conditions are exceeding the recommended maximum in several locations. Generally, courant numbers should remain below 2 when applying the full momentum equations.

9. **Boundary Conditions – Inflow to Lower Rambo FCF (Inflow Q):**
   The boundary condition line used to insert flows representative of 'Node Q' should be reviewed and likely adjusted. Current coding appears to be causing some mounding and WSE oscillation, particularly early in the simulation. Consider extending this boundary condition line across entire bottom width of the East Rambo FCF. Considering inlets appear to be distributed throughout this facility this is thought to be more reasonable.

APPENDIX A: DETAILED COMMENTS

Memo: Major Transit Station Areas (MTSA) Phase 2 Flood Hazard Assessment, Burlington Go and Downtown – Assessment of Roseland Creek Spill (Dated: Nov 1, 2021)

10. General Comment

Update modelling results within reporting, as well as associated discussions, in accordance with the refined 2D modelling. Staff have not commented on the report's results considering the need for various modelling refinements.

11. Table 2.1 (Page 3)

Clarify or add a note to identify that the 2020 Update includes the climate change adjustment (i.e., 15 % increase) described.

12. Section 2.2., Hydrologic Modelling Update (Page 6)

Include a Figure/Drawing within the report to represent the drainage schematic for Roseland Creek. Only a portion of Roseland Creek was included within the previously provided drawings and staff are not clear on the location of a few nodes/subcatchments referenced in reporting (e.g., R-11, Node R8.1, etc.).

13. Section 3.1.1, Base Model (Page 7)

Staff request that this section's text be clarified to address the following:

I. The conceptual modeling provided by CH for Roseland Creek was developed in HEC-RAS Version 6.0.

II. This conceptual modelling had been developed internally by CH Staff to provide a theoretical understanding of the potential flow routing effects that a FCF near the QEW could provide if constructed. This conceptual analysis was not intended as a floodplain or spills mapping exercise; however, staff acknowledge that it did highlight the potential for spill at Roseland Creek and the QEW enclosure, as well as the potential for this spill to contribute to the Hager/Rambo System.

III. That use of this modelling for floodplain/spill mapping purposes would require the user to fully vet and take responsibility for the modelling.

In general, staff suggest that a comparison and/or summary of changes made to the base model is not necessary in this case.

14. Figure 3.2 Updated 2D area and QEW Barriers (Page 9)

This Figure appears to be out of date as it is not consistent with the model's 2D Area.

15. Section 3.1.2, Extended Model (Page 10)

Modelling should attempt to quantify potential conveyance provided by the two crossing structures identified, which are thought to contribute to the local drainage systems on Queensway Drive. Although these structure's conveyance may not be significant due to downstream capacity constraints, their potential contributions may still be a pertinent consideration for the downstream floodplain mapping (i.e., for East Rambo Creek). Staff suggest that the study team presume these culverts' combined conveyance approaches that of the limiting downstream sewer (i.e., the 1200 mm diameter sewer); perhaps add a single 1200 mm diameter culvert to the 2D model (to represent both culverts capacity) to estimate potential conveyance afforded across the QEW by these structures.

16. Section 3.1.2, Extended Model (Page 12)
Clarify the last bullet; the boundary condition for ERE-1E does not appear to be situated within the East Rambo FCF based on a review of the modelling.

17. Figure 3.4 Locations of Boundary Condition Lines (Page 13)
Label each boundary condition line on this Figure and summarize each boundary condition line's coding (e.g., inflow hydrograph, normal depth boundary, etc.) within the report's text.

18. Section 4.1.1, Flood Control Facilities (Page 19)

I. Staff support the approach described for considering potential blockages of the low flow channel at East Rambo FCF.

II. Staff will consider the approach suggested for modelling the 'No-SWM' scenario at East Rambo FCF, however, are concerned that it may misrepresent this spill's potential to contribute flows to West Rambo Creek versus East Rambo Creek. Staff request that the study team consider the below and that we reach a consensus on an approach prior to advancing.

- In principle, staff presume WSEs, within the East Rambo FCF, should be higher under the No SWM Scenario (compared to with SWM) and that these increased WSEs may prevent (or reduce) conveyance of spill toward the East Rambo FCF. If the spill were prevented from entering the FCF (due to tailwater elevations), then theoretically the magnitude of spills occurring via the other pathways would be expected to increase. Under this circumstance spill flows toward Roseland and/or East Rambo Creek would be expected to increase (via. increased spill toward Queensway Drive).

- If the suggested approach were used, most of the theoretical spill flow added into East Rambo FCF would ultimately be routed towards West Rambo Creek via the CNR underpass spill pathway, considering capacity constraints of the low flow channel contributing flows to East Rambo Creek.

Given outcomes based on our theoretical understanding versus that of the suggested approach differ, it is recommended that it conceptually be determined whether the WSEs within East Rambo FCF, under the 'No SWM' scenario would be high enough to theoretically prevent ingress of the potential spill. One possible approach is outlined below.

a. For uncontrolled East Rambo peak flow rates expected to leave the East Rambo FCF, determine expected WSEs upstream of QEW/North Service Road using a rating curve developed for the facility (Suggest developing in HEC-RAS 2D).

b. Compare these WSEs to the WSEs expected adjacent to the North Service Road spill point based on the 2D HEC-RAS model.

c. If WSEs within the East Rambo FCF are above those expected for the Roseland Creek Spill (based on the 2D HEC-RAS model) then assume that no spill from Roseland

Creek can enter the East Rambo FCF under the no SWM scenario. This may result in flows via the other spill pathways increasing (to be assessed).

III. Staff are generally supportive of the approach described for considering the potential blockages at West Hager Pond and Freeman Pond.

19. Section 4.1.2, Future Land Use (Page 20)

I. It is our understanding that the 'existing' conditions modeling assumes imperviousness based on a typical imperviousness calculated from aerial photography for each land use type identified in the Zoning By-law mapping (as shown on Drawing No. 2 from the Phase 1 report) and that this is in keeping with what is currently permitted by the current Zoning by-law. Please confirm.

II. Proposed land use conditions should be presented (i.e., Figures, Maps, Precinct Plans, etc.) for both the Burlington and the Downtown MTSAs. This data should be compared to existing land use conditions. The results of this comparison must be summarized (i.e., Data Tables) and discussed within the reporting, to make clear what levels of imperviousness will be permitted under the future land use condition versus the existing. Implications of any changes must also be discussed and documented within reporting.

III. As existing conditions within the hydrologic model may not match 'on the ground' conditions, while the Phase 1 SWM strategy requires that post-development flows be controlled to pre-development flow rates (or less), there may be a benefit to having the final stormwater strategy presented in the Phase 2 study distinguish that pre-development conditions for the purpose of determining stormwater management controls are based on 'on the ground' conditions as opposed to existing conditions assumed within the hydrologic modeling.

IV. CH agree that further discussion with the City and Wood would be beneficial in this regard to clarify expectations.

20. Section 4.2, Hydraulic Modelling (Page 22)

CH Staff request a technical meeting to discuss the proposed approach for expanding the 2D modelling to encompass West Rambo Creek etc.

21. Section 4.2, Hydraulic Modelling (Page 22)

Please clarify within the second last paragraph that resolution of pond crediting also requires resolution with the province (i.e., MTO, MNDMNRF, etc.).

22. General Comment – Hydrologic Modelling

Please include a copy of the hydrologic modelling (SWM-HYMO) with the next submission.

Conservation Halton

Planning & Watershed Management

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January 27, 2022

Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
Burlington, ON L7R 3Z6

BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Mr Malik:

Re: Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
Draft Flood Hazard Assessment
Downtown and Burlington GO Major Transit Station Area
City of Burlington
CH File Number: MPR 799

Conservation Halton (CH) staff has reviewed the draft Flood Hazard Assessment, prepared by Wood Environment and Infrastructure Solutions, dated January 10, 2022, and the hydraulic modelling submitted the same day. We provide the following Key Comments followed by Detailed Comments in Appendix A.

Key Comments: Issues to be Resolved and Next Steps

Staff's Key Comments are provided in response to each issue identified within Section 4.1 of the Draft Reporting.

A. CH staff have considered and evaluated various potential approaches for modelling a 'No-SWM' condition within a HEC-RAS 2D modelling environment, should it ultimately be required. Our recommended modelling approach is outlined in Appendix A and a conceptual geometry file attached for discussion purposes.

B. If it is confirmed that imperviousness is the same or reduced under the proposed land use condition, then CH would consider this issue resolved. Staff request the text clearly outline the basis for the 'Modelled Existing' imperviousness and confirm it is a reasonable and defensible estimate of imperviousness permitted under current land use documents for the subject lands (i.e., the imperviousness that would result from the permitted uses within the City's OP and past supporting studies/planning documents). As the intent of this analysis is to confirm the proposed land use condition will not negatively affect downstream flood hazards, the analysis needs to consider what is currently supported versus what is proposed.

C. Direct use of hydrographs pulled from the unsteady state 2D hydraulic model for determination of downstream design flows rates would not be supported as this would credit storage upstream of hydraulic structures as well as several spills, which is contrary to provincial guidance. See detailed feedback and recommendations in Appendix A. Staff will continue to work with the study team to develop/determine a mutually supported approach to move forward.

D. Staff appreciates the significant modelling updates incorporated into the current submission, however, a few of staff's previous concerns remain and several new concerns have been identified. In the interests of moving the modelling forward as quickly as possible, a geometry file is being provided which is intended to address several of the concerns (as marked in Appendix A).

E. Staff suggest moving forward with the scenarios described within the TOR for this project. Staff will continue to work with the study team to develop/determine a mutually supported approach to move forward.

Detailed comments and recommendations are provided within Appendix A. The above key comments and detailed comments within Appendix A should be addressed as part of the next submission; CH staff are supportive of a stepped submission process in this regard.

Sincerely,

David Irwin

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Conservation Halton: Leah Smith (leahsmith@hrca.on.ca), Janette Brenner (jbrenner@hrca.on.ca)

APPENDIX A: DETAILED COMMENTS

Note: (Addressed) or (Pending Discussion) refers to whether the CH geometry includes refinements or modifications intended to address the respective comment. This is still subject to review and agreement by the Study Team.

A. HEC-RAS 2D Modelling (Submitted: Jan 10, 2022)

1. DEM/Terrain Data

a) QEW and Guelph Line Overpass *(Addressed)*

Terrain data does not accurately represent topography of the QEW below the Guelph Line overpass. Terrain data modifications are recommended in this area to ensure accuracy of the model's geometry and to improve confidence in results (refer to Figures 1 and 2 in Appendix B).

b) CNR Underpass *(Addressed)*

Terrain data may not accurately represent topography of the CNR underpass below the QEW/NSR overpass. Terrain data modifications are recommended in this area to ensure accuracy of the model geometry and to improve confidence in results (refer to Figures 2 and 3 in Appendix B).

Note: CH staffs' suggested coding for the underpass was derived from a review of aerial imagery and LiDAR data (suggesting it's approximately 15 metres wide). If survey data is available, it should be used for this purpose. Current coding suggests an approximately 13-metre-wide structure.

2. Coding Barriers and Flow Obstructions – Recommended Approach *(Addressed)*

Staff apologize for the delay in identifying this recommendation, however, moving forward CH recommends that barriers be incorporated directly into the underlying DEM/Terrain instead of coding these as lateral structures. This change is intended to support improved model accuracy as well as to simplify model review.

Example: 'Barrier-2' was coded as a consistent 1 m tall barrier having a sag elevation of approximately 107.45 m. This appears reasonable when reviewing the lateral structure, however after comparing it to the underlying terrain it becomes more evident that this is erroneous. Review of unprocessed LiDAR data, as well as aerial and Google Earth imagery identified that the sag elevation for this barrier is closer to 107.15 metres, that the wall is closer to 0.85 m tall, and the wall's top profile varies as the wall/barrier transitions into a retaining wall for South Service Road. A comparison of the two profiles (top of wall) is shown in Figure 5 in Appendix B.

3. Boundary Conditions – Inflow Hydrographs (Subcatchment Runoff) *(Addressed)*

Subcatchments' runoff hydrographs have been inserted into the 2D mesh in locations other than the subcatchments understood outlet, and in general closer to the subcatchments' upstream limit. Staff consider this approach to be problematic because:

a) This approach may lead to confusion or misrepresentation of what CH staff would typically consider 'local drainage' versus riverine flood hazards.

b) Mapping for regulated flood hazards will be made more onerous due to the need to separate 'local drainage' from floodplain and or spill.

c) Applying this runoff hydrograph near the catchment's upstream limit will double the routing effect already accounted for in the hydrologic model.

Staff suggest that subcatchment hydrographs should be added at an outlet location where flows have concentrated and can reasonably be assumed to form part of a regulated watercourse's floodplain or spill.

4. **Manning's n Values – Description**
Include representative descriptions for each of the Manning's n regions used for informing cell's assigned manning's n values.

5. **Runtime Messages and Errors**
A review of the model's runtime messages identifies significant WSEL errors are occurring at various cells and various timesteps. Significant errors should be reviewed and commented on to ensure these have no meaningful impact on results. A summary of each cell's maximum WSEL error, is included within Appendix A wherever a cell's maximum error exceeded 0.5 metres.

If errors persist, use of the diffusion wave approximation may be preferred in this case.

6. **WR-1A3 Catchment – Drainage *(Addressed)***
Consider inclusion of the 1.2 metre diameter sewer, which is understood to provide drainage for the WR-1A3 catchment, in the 2D hydraulic model. This is suggested such that flows (spill) accumulating in portions of this catchment can drain towards West Rambo Creek as we understand to be the case. Refer to Appendix B – Figure 6.

7. **Brant Street Underpass – Drainage *(Addressed)***
Terrain modifications associated with the sewer draining the Brant Street underpass, may interfere with the nearby boundary condition. This may result in a misrepresentation of how/where flows from this sewer are conveyed. Staff's modified geometry has further extended the 2D mesh and moved this sewer's outlet downstream so as not to not interact with the potential spill occurring in this area.

B. Flood Hazard Assessment (Submitted: Jan 10, 2022)

8. **Section 2.1.4.2, East and West Rambo Creeks (Page 10 of 46)**
Staff would like to discuss the described Argon Court spill to ensure we're understanding and supportive of the suggested approach. Duplication of flows should be avoided if possible.

9. **Section 2.1.4.3, Downstream Hager-Rambo (Page 10 of 46)**
Direct use of hydrographs pulled from the unsteady state 2D hydraulic model for the determination of downstream design flows rates would credit attenuation provided by upstream structures and spills. This approach likely cannot be supported by CH as it deviates from provincial guidelines. Staff acknowledge that strict adherence to provincial guidance may not be feasible or reasonable in this circumstance, however the ultimate approach will need to consider the general intent of the current guidelines and reasonable justification provided for any required or un-avoidable deviation

Staff will continue to work with the study team to determine and develop a mutually supported approach to move forward.

10. Section 2.1.6., Alternative FCF Scenarios (Page 13 of 46) **(Pending Discussion)**

As discussed on Nov 21st and December 9th, CH staff have considered and evaluated various potential approaches for modelling a 'No-SWM' condition within a 2D HEC-RAS modelling environment. CH staff recommend replacing the East Rambo FCF with a storage area representative of a channel cross-section that is characteristic of the upstream/downstream watercourse with a similar length as the existing FCF, hydraulically connecting this conceptual storage area to the 2D mesh. A geometry file consistent with this approach has been included for discussion purposes, should it ultimately be required. Staff look forward to discussing this approach further with the study team.

11. Section 2.2.1.1 Hydraulics (Page 15 of 46)

CH staff envision the 2D Unsteady state model would be used to map inundation (spill areas) as well as quantify spills magnitude and volume. It is suggested a 1D steady state model be used to confirm the floodplain proper, and that this model's cross sections be cropped to the channel's/valley's 'top of bank'. It is acknowledged that WSEs produced by the 1D model may overestimate flood depths. Where the predicted WSE's extend above the channel's/valley's top of bank, the limits of the floodplain can be delineated at the top of bank and potential spill arrows shown on the mapping. The 2D model would be used to map the spill (what is not contained within the 1D model's cross sections) and inform review of development applications within the mapped spill areas.

12. Section 2.2.1.1 Hydraulics (Page 20 of 46) **(Addressed)**

As described within preceding comments, CH now recommends coding barriers directly into the DEM/Terrain data.

13. Section 2.2.1.1 Hydraulics (Page 21 of 46)

Further consideration for the guardrail is needed where flows contact with the guardrail (where depth of flow is more than ± 0.2 m). Provide further discussion supporting suggestion that effects are minor or modify the model to account for potential effects of guardrails in this circumstance.

14. Section 2.2.1.2 Flows (Page 24 of 46) **(Addressed)**

Refer to preceding comments concerning CH staff's concerns with how/where subcatchments' runoff hydrographs have been added into the 2D mesh.

15. Section 2.2.2.1 Initial Verification of East… (Page 27 of 46) **(Pending Discussion)**

Refer to preceding comments concerning CH staff's concerns with the DEM/Terrain used to represent geometry for the CNR underpass. Results from CH's updated geometry suggest that flows are likely closer to those previously estimated by the SWMHYMO model. The current model appears to underestimate potential conveyance provided by the underpass. Refer to Table 2 in Appendix B. Results will need to be re-examined based on the final model geometry.

16. Section 2.2.2.3 East and West Rambo Creeks – Existing Structures (Page 36 of 46)

Refer to preceding comments concerning determination of downstream peak flow rates using the 2D hydraulic model.

17. **Section 2.2.2.4 East and West Rambo Creeks – Structure Hydraulic… (Page 38 of 46)**
    Staff appreciates that the included evaluation identifies which hydraulic structures are likely to be causing a backwater condition, however, are concerned that the analysis does not quantify any resulting attenuation.

    Staff acknowledge that elimination of the potential attenuative effects created by each hydraulic structure within the 2D model may not be feasible given the project's constraints (i.e., budget, timelines, etc.) and further, we acknowledge that many of the structures' attenuative effects may be insignificant. We would consider a modeling approach that only addresses structures determined to provide appreciable attenuation, however, we require a clearer understanding of attenuation caused by each structure. Significance could be evaluated based upon several factors such as: level of attenuation, risks to downstream, feasibility of an upgrade, etc. An internal analysis of attenuation at Hydraulic Structure 14 is included as an example in Appendix B; refer to Figures 7 and 8.

18. **Section 3.1.2 Modelling Results (Page 42 of 46)**
    Staff would like to have an opportunity to review the PCSWMM modelling; comments may be forthcoming in this regard.

APPENDIX A: DETAILED COMMENTS

Previous Comment Letter: D. Irwin to U. Malik, November 12, 2021

A. HEC-RAS 2D Modelling (Submitted Nov 1, 2021)

1. **Partially Addressed (Addressed)**
   Staff understand that very limited storage remains occupied after the described condition. Understanding this, we request that a reasonable allowance for baseflows be included in the restart file used to generate initial conditions. Conceptual modelling prepared by staff have applied 1 m^3/s as a baseflow into East Rambo FCF, 1 m^3/s as a baseflow for Roseland Creek, and $0.02^3/s$ as baseflow for West Rambo Creek. Staff are open to using alternative values for this purpose.

2. **Partially Addressed (Pending Discussion)**
   The previously discussed boundary conditions (i.e., outfalls) have been removed. Staff are however unclear on intentions with respect to several new 'outfalls' included in the revised model. We would like to discuss the need for 'Outfall 7', 'Outfall 6', 'Outfall 3', and 'Outfall 5'.

3. **Partially Addressed (Addressed)**
   Refer to new comments for CH's coding recommendation.

4. **Addressed**

5. **Addressed (Pending Discussion)**
   Staff appreciates that the revised modelling incorporates numerous breaklines to support proper mesh alignment. Staff were however unclear on the need for breaklines interior to several larger buildings/structures and noticed that various 'crest' breaklines required refinement. Overall, Wood's mesh refinements addressed staff's previous comments, however, staff have refined breaklines within the geometry file being provided.

6. **to 8. Addressed**

9. **Partially Addressed (Addressed)**
   Refer to New Comment concerning CH's current coding recommendation.

B. Roseland Creek Spill Memo (Submitted Nov 1, 2021)

10. **Partially Addressed**

    Further updates will be required based on the final modelling revision.

11. **to 17. Addressed**

18. **Refer to New Comments**

19. **Pending Updates**

20. **Addressed**

21. **No longer Applicable (Report Text Modified)**

APPENDIX B: TABLES AND FIGURES

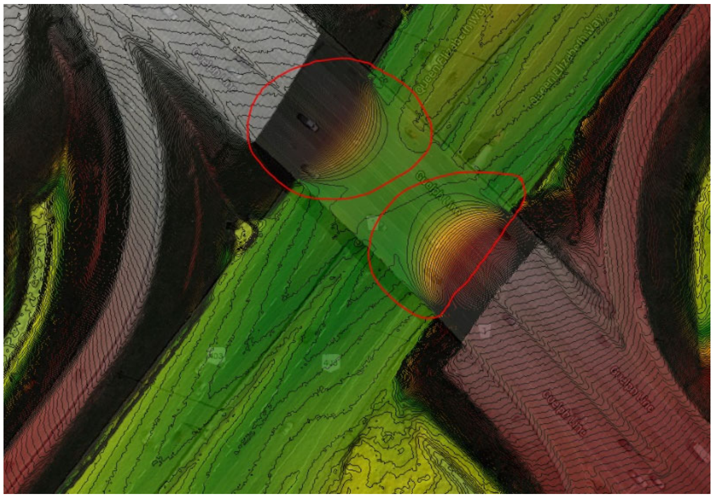

Figure 1: 1. A) Current Submission's Topography

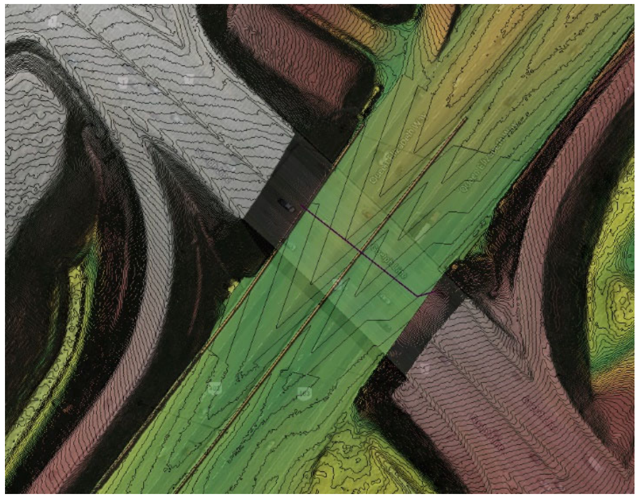

Figure 2: 1. A) Topography with CH Suggested Modifications

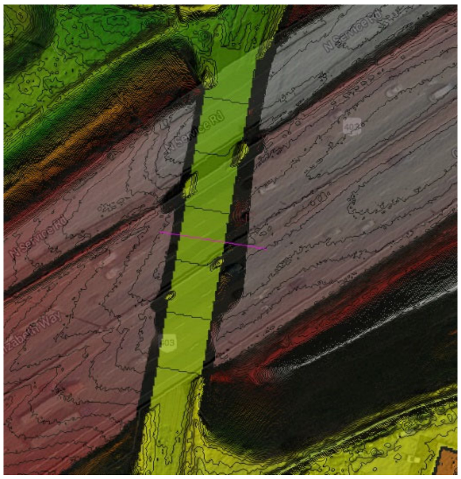

Figure 3: 1. B) Current Submission's Topography

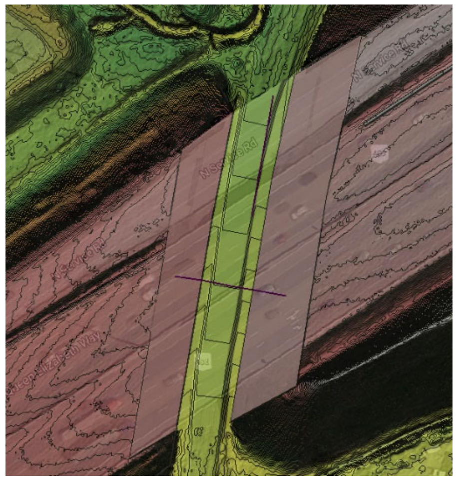

Figure 4: 1. B) Topography with CH Suggested Modifications

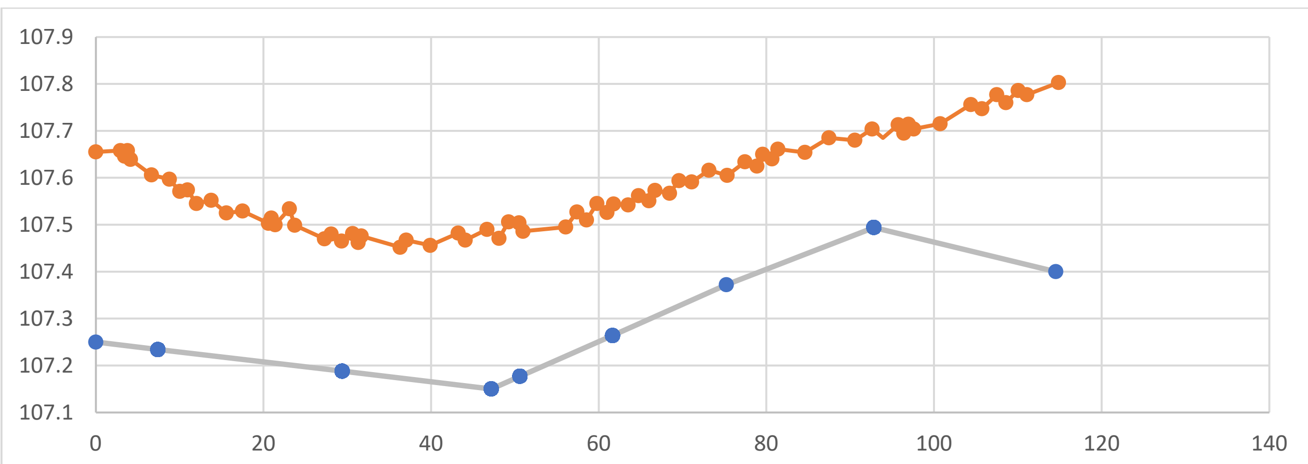

Figure 5: Comparison of 'Barrier 2' Current lateral structure coding versus suggested

APPENDIX B: TABLES AND FIGURES

Figure 6: Sewer Draining WE-1A3 Catchment

Table 1: Regional Storm, Cell's producing errors more than 0.5 metres

Cell	Max WSEL Error (m)	Cell	Max WSEL Error (m)
24880	1.323	28026	0.711
24879	1.321	24871	0.707
24881	1.257	24870	0.701
24882	1.054	24876	0.67
24878	1.021	24909	0.65
24877	0.98	24914	0.644
24873	0.963	24905	0.635
24911	0.859	111481	0.614
24912	0.842	24906	0.604
24872	0.837	24886	0.575
24883	0.816	24903	0.57
24910	0.802	24904	0.563
24913	0.801	24915	0.544
24874	0.782	28028	0.487
24875	0.726		

APPENDIX B: TABLES AND FIGURES

Table 2: Comparison of current model results versus model with suggested edits (ref. Report Table 2.9)

ID	Location Node	Simulated Peak Flow (Current Model)		Simulated Peak Flow (with CH Suggested Edits)	
		100	Regional	100	Regional
6	Culvert Discharge from East Rambo Pond to East Rambo Creek	17.02	18.86	17.25	18.8
7	Spill from East Rambo Pond via CNR Crossing	13.88	34.82	20.2	40.2

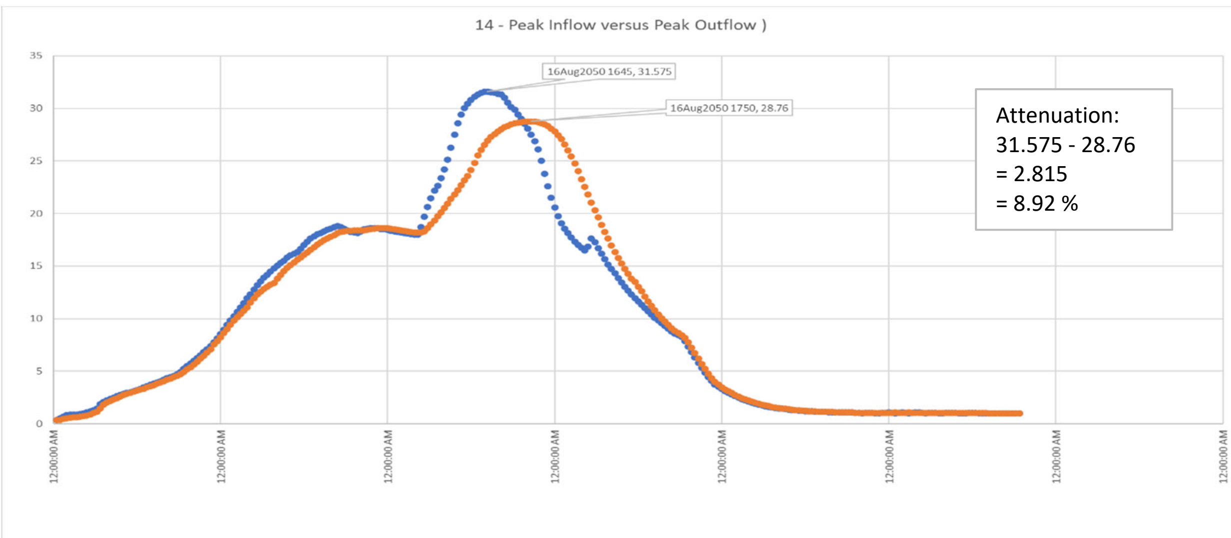

Figure 7: Peak Flow Comparison

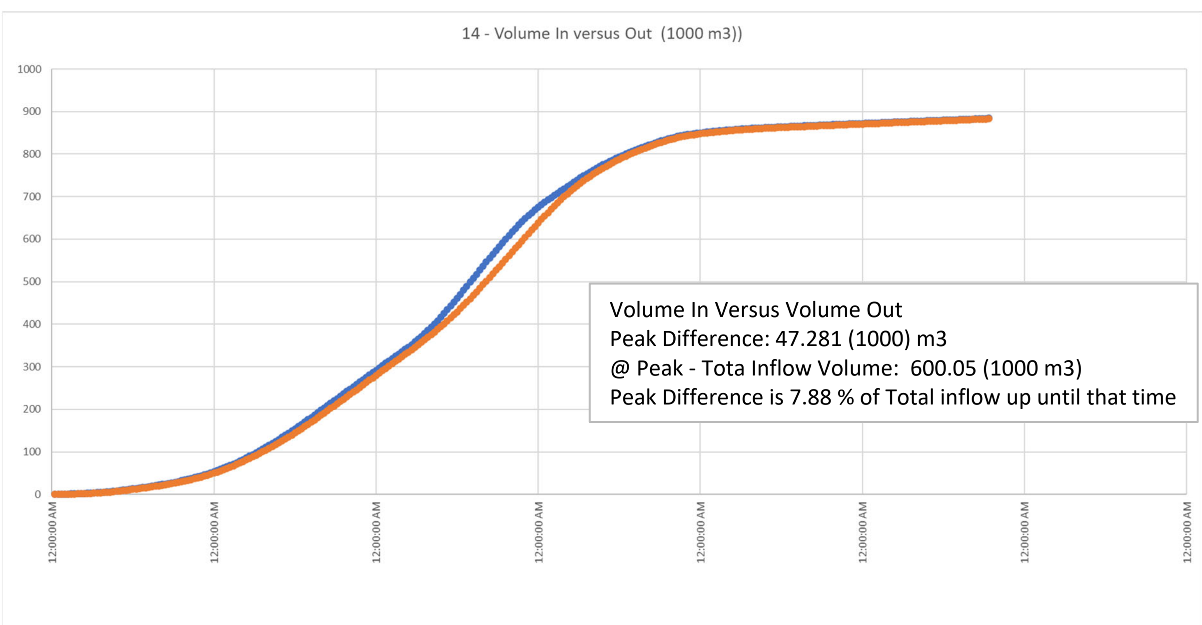

Figure 8: Volume Comparison

May 19, 2022

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Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
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BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Mr Malik:

Re: Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
Draft Flood Hazard Assessment
Downtown and Burlington GO Major Transit Station Area
City of Burlington
CH File Number: MPR 799

Conservation Halton (CH) staff has reviewed the draft Flood Hazard Assessment, prepared by Wood Environment and Infrastructure Solutions, dated March 30, 2022, and the modelling submitted shortly thereafter.

As discussed on April 20 and May 5, CH staff have identified the need for further modeling refinements to ensure the final products can be used to support regulatory and land use decisions. Understanding this study's timelines and Terms of Reference (TOR) and considering our shared interests in the project, CH staff proposed an alternate, collaborative approach to providing feedback into the City's study. To advance this approach, we have prepared conceptual models for the study team's consideration. These concept models are intended to clarify the suggested approaches, recommended updates and expedite delivery of final study products. The updates are intended to support the characterization and differentiation between floodplain and spill, ensure compliance with provincial guidelines, and support future use of these models. We suggest that the study team review the recommended updates outlined below and incorporated into the models and either accept or reject as deemed appropriate. We provide the following Key Comments followed by Detailed Comments in Appendix A.

Key Comments: Issues to be Resolved and Next Steps

A. 1D Hydraulic Modelling

Staff recommend updates to the 1D hydraulic modelling to support delineation of flood hazards.

B. Hydrologic Modelling

Staff recommend updates to the hydrologic models to support delineation of flood hazards.

C. Alternative Flood Control Facility (FCF) Scenarios

Refinement of the alternative FCF scenarios addressing potential blockages is required. Various models must also be updated in order to incorporate the alternative FCF Scenarios required to support delineation of the regulatory flood hazards, which currently still includes the conceptual 'No FCF' scenarios.

D. Spills Downstream of East Rambo FCF

CH Staff are in the process of discussing (internally) how 'spills within the spill' occurring downstream of the credited East Rambo FCF spill (i.e., rail underpass), prior to flows reaching West Rambo Creek, should be modelled. At this time, we anticipate recommending the flows returning to the East Rambo system also be accounted for within the West Rambo Creek 1D hydraulic modelling. CH is working internally to finalize recommendations on this subject which will be forthcoming.

Detailed comments and recommendations are provided within Appendix A. The above key comments and detailed comments within Appendix A should be addressed as part of the next submission. CH staff support a stepped submission process in this regard.

Sincerely,

David Irwin, P.Eng.
Water Resources Engineer
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CC: Wood Plc: Matt Senior (matt.senior@woodplc.com), Ron Scheckenberger (ron.scheckenberger@woodplc.com)
City of Burlington: Alison Enns (alison.enns@burlington.ca), Cary Clak (cary.clark@burlington.ca), John Stuart (john.stuart@burlington.ca)
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APPENDIX A: DETAILED COMMENTS

NEW COMMENTS – CURRENT SUBMISSION

A. Hydrology: Hager/Rambo Diversion Channel (SWMHYMO)

As discussed on May 5th, the SWMMHYMO hydrologic modelling for the Hager-Rambo system should be modified to include for the Roseland Creek spill (TOR Item 1.c). Additionally, while not required by the TOR, we also recommend that routing effects determined by the 2D HEC-RAS model, for the areas between the East Rambo Flood Control Facility (FCF) through to Node K, be incorporated into the model in order to provide a more accurate estimate of downstream flood flows.

In the interests of moving this project forward, CH staff has prepared a revised model for the study team's consideration that presents an approach to address these recommendations. As part of this work, staff have also suggested conversion of the model to a more user-friendly visual platform (SWMHYMO to Visual OTTHYMO). VO was selected as both applications apply similar computational engines (i.e., HYMO based). Staff envision that the recommended updates and suggested conversion will be of benefit to all parties.

B. Hydrology: Downtown Burlington (PCSWMM)

As discussed on April 20th, staff has reviewed the PCSWMM hydrologic modelling for the Downtown Burlington MTSA and identified several concerns which must be addressed. CH staff has prepared a revised model for the study team's consideration which is intended to make clear staff's recommended approach do address our recommendations and requirements.

Note: Comments have been marked Addressed in Concept Model, Not Addressed in Concept Model, or Requires Discussion to identify status in the Concept Model.

1. **In-advertent Spill(s) Crediting** (Addressed in Concept Model)
   The model is allowing flows to 'leave' the system in several locations. Staff recommend that backwater valves be used to prevent these flows from leaving the system. In the revised model this approach necessitated reversing the direction of some pipes to allow flows to enter but not leave.

2. **Surcharged Conduits** (Addressed in Concept Model)
   Various 'conduits' representing open channels were identified as becoming surcharged/full under certain flood conditions. This circumstance should be avoided where possible by either extending the cross section or adding vertical walls (conservative approach) to ensure modelling applies open channel hydraulics and is not reducing peak flow rates.

3. **Inconsistencies between Modelling and Existing Infrastructure/Topography**

   a) **Enclosure at Caroline Street** (Addressed in Concept Model)
      The model must reflect the small section of open channel which exists east of Elizabeth Street and north of Maria Street.

   b) **Pertinent Roadway Sags** (Addressed in Concept Model)
      Several pertinent roadway sags were not captured within the modelling including those which exist on Maria, Pearl, and James Street. Modelling should reflect these conditions.

c) **Overland System - East of Pearl (Addressed in Concept Model)**
The model should reflect the overland flow pathway east of Pearl Street that conveys flows towards the James Street sag.

d) **Overland System – New/Martha to James Intersection (Addressed in Concept Model)**
It is staff's understanding that most overland flows from Martha/New are directed towards the James Street sag rather than continuing southeast along Martha Street. Modelling should reflect these conditions.

4. **Routing of Spill Towards Downtown** (Addressed in Concept Model)
Staff recommend the modelling be updated to introduce spill flows where they are expected to enter the PCSWMM model instead of inserting these flows at East/West Rambo Creeks. This approach should allow for an improved understanding of what depths of flow are expected on streets etc., and a better understanding of conditions expected within sewers etc. in these areas.

5. **Model Grouping and Naming** (Addressed in Concept Model)
Staff recommend grouping all scenarios/plans together such that scenarios can be run and compared easily. Staff also recommend model names use a descriptive naming convention to make clear what each represents.

C. 2D Hydraulic Modelling: East Rambo FCF + Roseland Spill

6. **Data Management**
   a) Duplicated modeling scenarios should be removed from the different models/folders. For example, the 'Hydro-burn' model currently includes a duplication of the 'Baseline Model'. Alternatively, one model could include all scenarios provided each scenario was clearly described.

   b) Staff recommend that naming of Profile Lines adhere to a naming convention. This convention should be used when referencing this data within reporting/modelling. Superfluous or un-necessary profile lines should be removed.

7. **2D Connection: '28_HRDC_DT'**
Coding for this structure should match the 1D hydraulic modelling (i.e., [2] 3.3 m dia. culverts) for all scenarios. Staff regret this error may have originated from the Base Modelling initially shared by CH staff.

8. **'Attenuation Iterations' Models**
As discussed, April 20th and May 5th, the attenuation scenarios included differ from the approach staff had understood would be advanced by this project, concerning the examination and potential elimination of attenuative effects caused by structures (ref. Letter: Jan 27 – Appendix A - Comment 17).

9. **Potential Spills not captured by 2D Modelling**

Understanding this project's constraints and timeline, staff accept that not all potential spill scenarios can be mapped. Staff recommend that the current study focus on assessing the spills expected to occur considering existing drainage systems (i.e., Base Model) as well as those which could conceptually occur if flood conveyance was not limited by existing hydraulic structures (i.e., hydro-burned model), and lastly any additional scenarios deemed necessary to garner the appropriate understanding of flood hazards for the MTSA area. As has been discussed, it is envisioned that the 1D modelling will be used to screen for remaining potential spill locations and it would only credit spills which have met specific criteria.

Staff recommend inclusion of the analysis previously discussed (Feb 2nd) to investigate effects of conceptually removing all hydraulic structures upstream of Fairview Street. Our preliminary findings suggested spill flows reaching downtown were reduced in this circumstance and that spills occurring upstream of the Fairview Street crossing structure(s) were not exacerbated (for both East and West Rambo). This suggests that the Baseline Model is the worse-case scenario with respect to potential impacts on Downtown, supporting the use of the Baseline Model results as inputs into the downtown modelling. It also suggests that upgrading structures upstream of Fairview Street, at least on West Rambo Creek, may be worthwhile revisiting in conjunction with evaluating alternative filling options. Finally, it demonstrated that the benefits to upgrading the Fairview Street crossing of East Rambo Creek can only be realized in conjunction with increasing channel capacity upstream.

D. 2D Hydraulic Modelling: Downtown (NEW)

10. Alternative FCF Scenarios

Modelling must be updated to include all scenarios required to support regulatory flood hazard mapping (including the alternative FCF scenarios).

E. 1D Hydraulic Modelling: Lower Rambo Creek & Hager/Rambo Diversion Channel

As discussed on April 20th as well as May 5th, CH staff has reviewed the 1D hydraulic modelling and identified several concerns which must be addressed. CH staff has prepared a revised model for the study team's consideration which is intended to make clear staff's recommended approach do address our comments.

Note: Comments have been marked Addressed in Concept Model, Not Addressed in Concept Model, or Requires Discussion to identify status in the Concept Model.

11. Cross Section Alignment – Levees (Addressed in Concept Models)

Staff continue to recommend that the 1D models' cross sections be cropped where spill(s) are expected to start, or conceptually at the valley's top of bank (ref. Jan 27 Letter: Comment 11). This is to support the envisioned strategy of using the 1D hydraulic modelling to delineate floodplain as well as identifying potential spill locations, including those which may not have been mapped/identified by 2D modelling. Staff acknowledge that use of levees for this purpose was discussed, however, that approach may lead to confusion in future and is therefore not the recommended approach.

12. **Cross Section Alignment – LiDAR** (Addressed in Concept Models)
Cross-sections' alignment should be adjusted based on the change in topographic data used.

13. **Data Supporting Geometry** (Addressed in Concept Models)
The Bank Lines, Flow Paths, etc. used to create the models were not included within the geometry file provided. To support use of this modelling in future, and to allow for ease of future updates, staff recommend that modelling include this data within the geometry file. This approach allows for cross sections etc. to be shifted or added to the model in future more easily, as well as providing a clearer understanding of the model's source data/assumptions/modelling approach.

14. **Coding of Buildings/Structures** (Addressed in Concept Models)
Cross sections should be cut from the processed (bare earth) dataset and blockages used to represent buildings/structures; instead of cutting cross sections from the topographic dataset which was modified to include structures. This is recommended to support consistency with modelling conventions commonly applied within CH's jurisdiction.

15. **Manning's n within Channel** (Partially Addressed in Concept Models)
The modelling provided has used a surface cover dataset to determine manning's n for cross sections. This approach is supported; however, refinements are necessary to ensure the manning's n assigned is appropriate in all locations. Staff observed that in many locations the manning's n assigned for the channel portion of cross sections was not appropriate. This may be addressed in some areas of the revised modelling provided by staff (for the study team's consideration) however further refinements are likely still required.

16. **Steady Flow Data** (Partially Addressed within Concept Models)
Steady flow data coded into the 1D modelling for West and East Rambo was not adjusted to negate for spills which have not met the criteria for crediting.

17. **Use of 'Lids' for Enclosures** (Addressed within Concept Models)
As discussed on April 20th and May 5th staff recommend that longer enclosures be modelled using a 'lid' to allow for changes in enclosure geometry and to allow for a better representation of where overland flows are expected to occur.

F. Report: MTSA Phase 2 Flood Hazard Assessment, dated: March 30th, 2022

18. **General Comment: Tracked Changes Document**
A tracked changes version of the document will be provided inclusive of minor comments/questions as well as suggested minor contextual edits.

19. **General Comments – Tables / Analyses**
As the 12-hr Regional Storm with AMC III conditions has been adopted it is suggested that further inclusion of the 48-hr Regional Storm with AMC II is not required. For simplicity and to avoid confusion it is suggested that this scenario only be included where required within future submissions.

20. **Section 2.1.4.5 Downstream Hager/Rambo (Page 10)**

Revise text to identify that peak flow rates for the 1D modelling will be adjusted to avoid loss of spill flows where crediting of the spill has not been evaluated and/or agreed.

21. **Section 2.1.5 Future Conditions (Page 12)**
An evaluation/verification of the effectiveness of implementing SWM quantity controls within the MTSA (i.e., TOR Item 1. d) continues to be recommended to ensure the typical approach of incorporating quantity controls remains effective considering the watershed versus site specific response.

22. **Table 2.8 Comparison of Estimated Imperviousness… (Page 15)**
Acknowledging CH Staff's previous comments, staff defer to City staff as to whether the modelled existing imperviousness is an appropriate estimate of what could be supported under the existing zoning bylaws and/or the current land use(s) present within the study area.

23. **Table 2.7 Estimated Imperviousness for Future Precinct Land Uses… (Page 12)**
The imperviousness assumed for 'Residential High Density', 'Residential Medium Density' and 'Mid-Rise Residential' under the Future Land Use Condition are not considered realistic/conservative estimates of the imperviousness which could occur under the land uses proposed and should be reassessed.

CH staff recommend the imperviousness assessed as part of the MTSAs be carried through into the various planning documents to ensure limits are incorporated as part of the zoning permissions. We would appreciate exploring this approach with City staff further.

24. **Section 2.1.6 Alternative FCF Scenarios (Page 16)**
It was staff's understanding that this study would evaluate the potential for outlet blockages based on the characteristics of each FCF and then identify what form(s) of blockage could reasonably be expected during a significant flood event (ref. TOR Item 1. C) as part of this analysis. Please confirm that the analysis of potential blockages (at the grate or low flow channel) included within reporting is representative of the form(s) of blockage which the study team expects could occur during a significant flood event. Staff include some high-level thoughts below for the study team's consideration:

East Rambo: While the grate covering the East Rambo FCFs outlet pipe may experience significant blockage (based on our understanding of past occurrences), it is unlikely that the outlet pipe will experience the same significant blockage as it is protected by the grate. We recommend consideration be given to basing the analysis on the blockage of the grate instead of directly at the outlet pipe.

Freeman Pond: The potential for blockage may be lower than currently assumed considering the large conveyance capacity of the low flow outlet, the urban land cover present upstream and the upstream barriers to large debris. The forms of debris expected may be unlikely to result in a significant blockage in this circumstance.

West Hager Pond: The potential for blockage may be higher than the Freeman Pond considering the land cover present upstream (naturalized, treed valley, etc.). The forms of debris expected may include large vegetation which could result in more significant blockage. The potential for blockage currently assumed may be appropriate considering this.

It is envisioned that these recommendations will be used to inform the flood hazard mapping should FCFs ultimately be credited. Mapping/modelling will need to be updated accordingly based on final recommendations.

25. Section 2.2.1.2 Flows (Page 33)
The approach described to ‘correct’ for attenuation is not what staff had understood would be advanced by this study. Refer to modelling comments. Revise reporting as required.

26. Section 2.2.2.1 Initial Verification of East Rambo Pond AND 2.2.2.2(page 34-35)
This section of reporting should be removed or updated to reflect the current in-use models’ findings.

27. Table 2.15 Hydraulic Structure Flow Attenuation Assessment (Page 45)
Reporting appears to be equating flows lost to spill as an attenuative effect at several structures. The difference between what is an attenuative effect and what is lost due to spill should be made clear within reporting (ex. Structure ID 21, 22 and 25).

28. Section 2.2.4 Fill Analysis (Page 52)
The first conceptual filling scenario has demonstrated that filling within flood hazard areas (e.g., spill areas) has the potential to negatively effect the control of flooding within surrounding areas. This finding suggests that any proposed filling within existing flood hazards, will need to be carefully evaluated. We look forward to continuing the dialogue with City and Wood staff on potential filling options and related policies. As discussed on May 5th, CH Staff are supportive of a filling scenario which also considers strategic infrastructure improvements.

29. Section 2.2.5 Alternative FCF Crediting Scenarios (Page 55)
Update text as required based on comments provided concerning the blockages assessed.

30. Section 3.1.2 Modelling Results (Page 65)
Update Tables 3.1 and 3.3 as required based on the recommended model updates. Revise table to include the full suite of scenarios requiring assessment.

31. Section 4.1.2 Policy (Page 73)
Consideration for the alternative FCF scenarios will also need to be incorporated.

G. Drawings (Various)

32. General Comment
Staff have not reviewed Drawings in detail considering the recommendations / need for further modeling updates.

Previous Comment Letter: D. Irwin to U. Malik, January 27, 2021

4. **Addressed**

5. **Addressed**

8. **Addressed**

9. **Not Addressed**
   Please refer to New Comment 16.

10. **Addressed**

11. **Partially Addressed**
    Please refer to New Comment 11.

12. **Addressed**
    Review of detailed drawings for the guardrail confirmed that there is sufficient clearance to convey the expected flow depths below the lower rail.

15. **Addressed**

16. **Partially Addressed**
    Please refer to new comment 16.

17. **Partially Addressed**
    Refer to new comments 8, 25, and 27.

18. **Partially Addressed**
    Refer to new comments 1 – 5.

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Memo

To:	**Umar Malik and Cary Clark, City of Burlington**	**Date:**	**16 June 2022**
From:	**Matt Senior, Michael Penney, and Ron Scheckenberger, Wood**		
CC:	**Allison Enns, John Stuart and Jenna Puletto, City of Burlington**		
Ref:	**WW21011078**		
Re:	**Phase 2 Flood Hazard and Scoped Stormwater Management Assessment Downtown and Burlington GO Major Transit Station Area (MTSA) Proposed Approach to Finalize Reports**		

Introduction and Understanding

Further to Wood's ongoing work on the above-noted study on behalf of the City of Burlington (City), we hereby provide you with a proposed approach to finalize the Phase 2 assessment and reporting based on recent and ongoing consultation amongst staff from CH, City and Wood. As you are aware, work on the Phase 2 study began in August 2021. It was understood at the outset of the project that due to discussions with developers potentially impacted by the outcomes of the Phase 2 study, the study would be targeted to be completed by March 31st, 2022. This was discussed both with Wood and Conservation Halton (CH). Due to the complexities of the study (including spill flows, among other issues), the study has not been finalized within the originally intended timeline. A draft report was submitted by Wood on March 30, 2022. Comments from CH were received May 19, 2022, with an ensuing discussion on May 26, 2022.

As documented in the meeting minutes, a number of key items related to the study analyses remain unresolved. No clear direction or recommendations associated with the unresolved matters were received from CH. While Wood recognizes the complexities of several of these issues, it is also understood that the current study must be finalized to provide clear direction to developers within the potentially affected areas. In lieu of addressing all unresolved matters, where necessary, some items or analyses may be deferred to a study addendum, a separate follow-up study, or works required to be undertaken by developers and their consultants. To this end, this current summary has been prepared to outline how Wood proposes to finalize the current Phase 2 study, and what items are recommended to be deferred to future works. It is suggested that this proposed approach be confirmed with City and CH staff at the planned meeting of June 21, 2022, such that the Phase 2 reporting can be finalized accordingly, thereafter. Any items identified for deferral or future study should also be confirmed.

Based on the preceding, we note the following unresolved issues, and the proposed approach recommended by Wood to complete these items as part of the current Phase 2 study. Reference is made to CH's most recent comments of May 19, 2022, and associated comment numbering throughout.

Hydrologic Modelling (Hager-Rambo System – SWMHYMO\VO)

1. Wood to review and confirm the VO model prepared by CH as the governing hydrologic model to be used to set flows in the study area. Incorporate a brief section on flow validation in the updated report related to comparison to past modelling of the system.
2. Do not undertake any further flow routing elements for East\West Rambo Creek area (as per CH Comment A); flows routed from HEC-RAS 2D modelling to be used and manually combined (spreadsheet approach) to confirm downstream flows to Hager-Rambo Diversion Channel.
3. Update rating curves for West Hager and Freeman ponds (FCF) based on estimated degree of potential debris blockage and re-calculate resulting flows which will become the basis for design flows (Comment #24). Based on review, proposed changes are:
    a. West Hager Pond – assume a 50% blockage of low flow culvert outlet (50% of the width) based on the naturalized nature of the upstream creek system.
    b. Freeman Pond – no change; assumption that given size of facility and outlet, degree of vegetation in the facility and upstream, there is a minimal risk of low flow debris blockage.
    c. East Rambo Pond – to be assessed using 2D modelling. Consider a 50% blockage of the grate width and determine whether this is reasonably equivalent to or larger than culvert sizing and therefore if culvert dimensions govern. If reduced grate would govern, consider modelling a two-stage outlet (equivalent weir to the culvert). Determine updated flows; may generate reduced outflows to East Rambo Creek via primary low flow culvert.
4. For Analysis of Future Conditions for Burlington GO MTSA (Comment #21-23):
    a. Consider only areas outletting to Hager-Rambo Diversion system (i.e. SWMHYMO\VO model, excludes the Brant Street underpass from PCSWMM model).
    b. Generate an "actual existing conditions" hydrologic model simulation as per analysis of aerial photography included in the most recent draft report (Figure 2.1 from March 30, 2022 draft report). Correct drainage area for WR-1A5. Use to develop pre-development flow targets for areas assumed to be outletting directly to creek (ER-1C, WR-1A2, WR-1A3, WR-1A5, WR-1A7, WR-1B). Assumed City criteria of post to pre peak flow control for 2 through 100-year storm.
    c. Develop pre-development flow targets for areas where majority of subcatchment would be expected to outlet to a storm sewer (ER-1B, ER-1F, WR-1A4) using City criteria (100-year to 5-year, 5-year based on 36% imperviousness).
    d. For simulation of potential future conditions, assume all proposed development lands at 90% imperviousness uniformly; open space and rail corridor remain at 10%. Assess:
        i. Future uncontrolled conditions.
        ii. Future with SWM (sizing as noted previously; include assumed overflow to allow for assessment of performance for Regional Storm).

e. Extract 5-year, 100-year and Regional Storm flows only from updated 2D modelling for East Rambo Pond area, considering 50% low flow blockage as noted. Import hydrographs into VO modelling and combine with preceding scenarios:
    i. Actual Existing Conditions
    ii. Previously Modeled Existing Conditions
    iii. Future Uncontrolled Conditions
    iv. Future with SWM Conditions

f. Assess differences in resultant creek flows and confirm benefit of SWM quantity controls and most conservative scenario. Apply subcatchment flows directly to HEC-RAS 2D modelling and use for floodplain mapping.

5. Combined flows to Hager-Rambo Diversion channel downstream to be based on VO flows for Hager Creek with flows from HEC-RAS 2D model (hydroburned model).

Hydrologic\Hydraulic Modelling (Lower Hager\Rambo – PCSWMM)

1. Wood to review updates to models completed by CH and confirm agreement with proposed changes. Given Wood is expected to take overall responsibility, Wood's professional judgement to govern in the event not all changes are accepted.
2. Confirm spill flows are added to PCSWMM model at point of entry as requested by CH (Comment #4).

2D Hydraulic Modelling, Structure Attenuation, Spills, and Filling Assessment

1. Address minor comments on modelling noted (comments #6, #7).
2. For modelling of East Rambo Flood Control Facility (Comment #24), update the modelling to consider a 50% blockage of the grate width. Determine whether this is reasonably equivalent to culvert sizing, or whether a two-stage outlet should be modelled (equivalent weir to the culvert). Determine updated flows; may generate reduced outflows to East Rambo Creek via primary low flow culvert.
3. Update HEC-RAS 2D model(s) with flows from hydrologic update as required (i.e. if any changes occur from land use assessment).
4. With respect to structure attenuation (Comments #8, #25, #27), re-compare base 2D model to "hydroburned" 2D model including separating\distinguishing riverine flow from spill flow using multiple cut lines as necessary. Compare results for all structures to determine degree of attenuation. For structures where the degree of attenuation is >5%, calculate the difference in hydrographs, add the resultant difference back in to the model downstream as a correction. Differences less than 5% are considered negligible.
5. Assume no other corrections in flows to account for losses due to spills in baseline model; confirm whether CH is expecting additional correction as per "Balanced" approach for East Burlington Creeks however previous MTSA specific comments focus only on hydraulic structure attenuation corrections.
6. Complete the additional "hydroburned" scenario requested by CH (Comment #9) which leaves the crossings of Fairview Street in place but removes structures upstream; analyze results as a surrogate for benefits of hydraulic structure upgrades. No further assessment of hydraulic structure upgrades to be considered as part of the current study.

7. For filling analysis (Comment #28)
    a. Update filling models (Scenario #1) to reflect any changes made in previous tasks.
    b. Assess Scenario #1 velocity and depth x velocity results for Scenario #1 previously completed and compare to base conditions; assess “sensitive” properties to the extent possible using this information as well as depth.
    c. No further assessment of filling scenarios to be considered as part of the current report.
    d. Provide direction on requirements for future site-specific filling assessments and verifications, but not to a “case study” level of detail as suggested by CH.

1D Riverine Hydraulic Modelling

1. Wood to review and confirm the HEC-RAS model updated by CH (as per Comments #11 – 14, #17).
2. Wood to review and update Manning’s Roughness in channel as required (Comment #15).
3. Wood to update flows based on other noted changes (Comment #16), notwithstanding the understanding that the 1D modelling is generally insufficient to characterize flood risk beyond the primary floodway area given the spill potential.
4. No further assessment of hydraulic structure upgrades as part of the current study.

Reporting

1. Update reporting to clearly state modelling contributions from CH. Review and consider CH edits in track changes version of the report individually.
2. Confirm whether or not CH will consider\prefer co-signing the report, notwithstanding that an extended review period is likely not feasible and further report iterations and revisions are likewise not considered feasible given need to finalize the study.

Conservation Halton

Planning & Watershed Management

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2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

July 7, 2022

Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
Burlington, ON L7R 3Z6

BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Mr Malik:

Re: Review of Spills Management Approach
Draft Flood Hazard Assessment
Downtown and Burlington GO Major Transit Station Area
City of Burlington
CH File Number: MPR 799

As discussed on June 21st and communicated by email on June 27th (ref. L. Smith to M. Senior & U. Malik) CH staff have completed an internal review of the Phase 2 Study's modelling approach to spills and have also evaluated suitability of the 'Balanced Approach' which was recommended for the East Burlington Creeks (EBC) Flood Hazard Mapping Study. As discussed, this review was necessary as strict application of current provincial guidance surrounding spill elimination poses a significant challenge for the MTSAs due to the prevalence of spills as well as their potential interactions with adjoining watersheds. The conclusions and recommendations identified through this review are identified below and further described within Appendix A and B (attached).

A. The modelling approach recommended and applied for the Phase 2 Study continues to be supported and recommended by CH Staff. Application of the 'Balanced Approach' is not being recommended due to the cascading/ recuring nature of various spills which occur within the MTSA Area.

B. Staff are not recommending any additional 2D modelling scenarios be completed as part of the Phase 2 Study, other than those previously defined within staff's comments. As part of staff's internal review various conceptual scenarios were considered, however after further consideration their inclusion has not been recommended.

C. Reporting updates are recommended to define rationale for the modelling approaches and scenarios selected for evaluation, as well as to ensure future study requirements are captured. Further, staff suggest inclusion of recommendations to investigate flood mitigation opportunities. CH staff's recommendations are included within Appendix B and our rationale is also included as a reference.

We are available to discuss these recommendations and next steps.

Sincerely,

David Irwin

David Irwin, P.Eng.
Water Resources Engineer
905.336.1158 ext. 2255
dirwin@hrca.on.ca

CC: Wood Plc: Matt Senior (matt.senior@woodplc.com), Ron Scheckenberger (ron.scheckenberger@woodplc.com)
City of Burlington: Alison Enns (alison.enns@burlington.ca), Cary Clak (cary.clark@burlington.ca), John Stuart (john.stuart@burlington.ca)
Conservation Halton: Leah Smith (leahsmith@hrca.on.ca), Janette Brenner (jbrenner@hrca.on.ca)

APPENDIX A: FIGURES

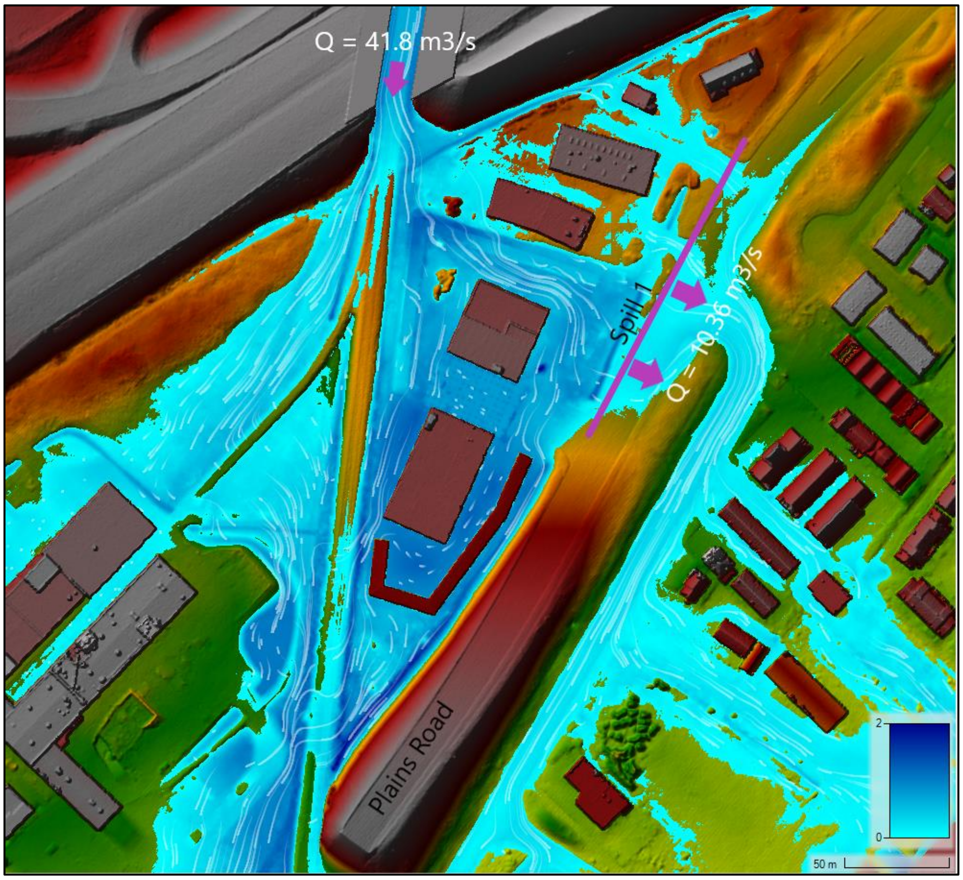

Figure 1: Spill 1 - Plains Road East (East Spill)

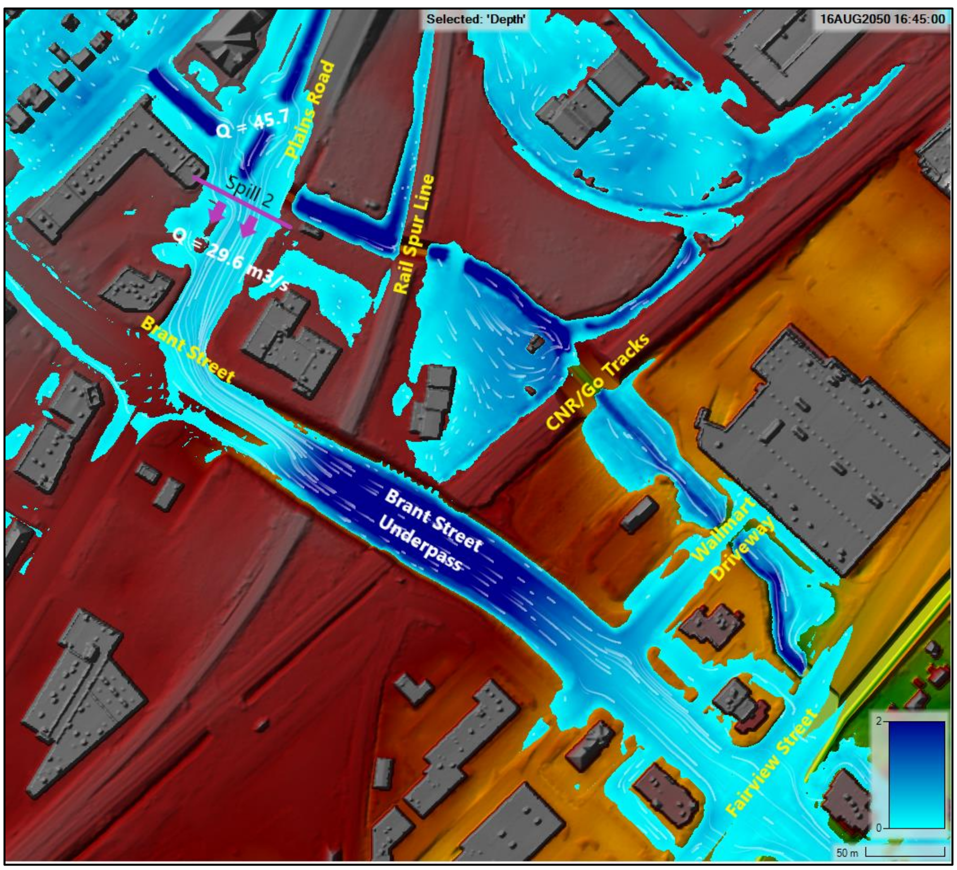

Figure 2: Spill 2 - Plains Road East (West Spill)

APPENDIX A: FIGURES

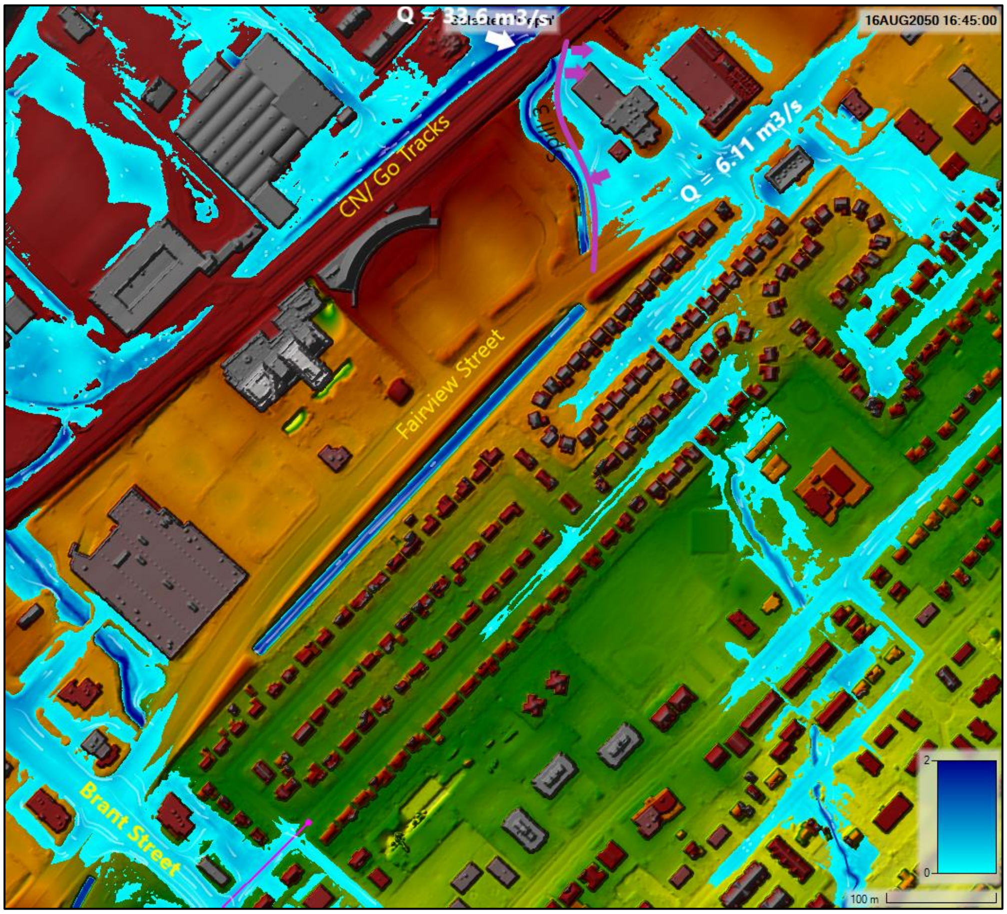

Figure 3: Spill 3 - East Rambo Between Go Tracks and Fairview

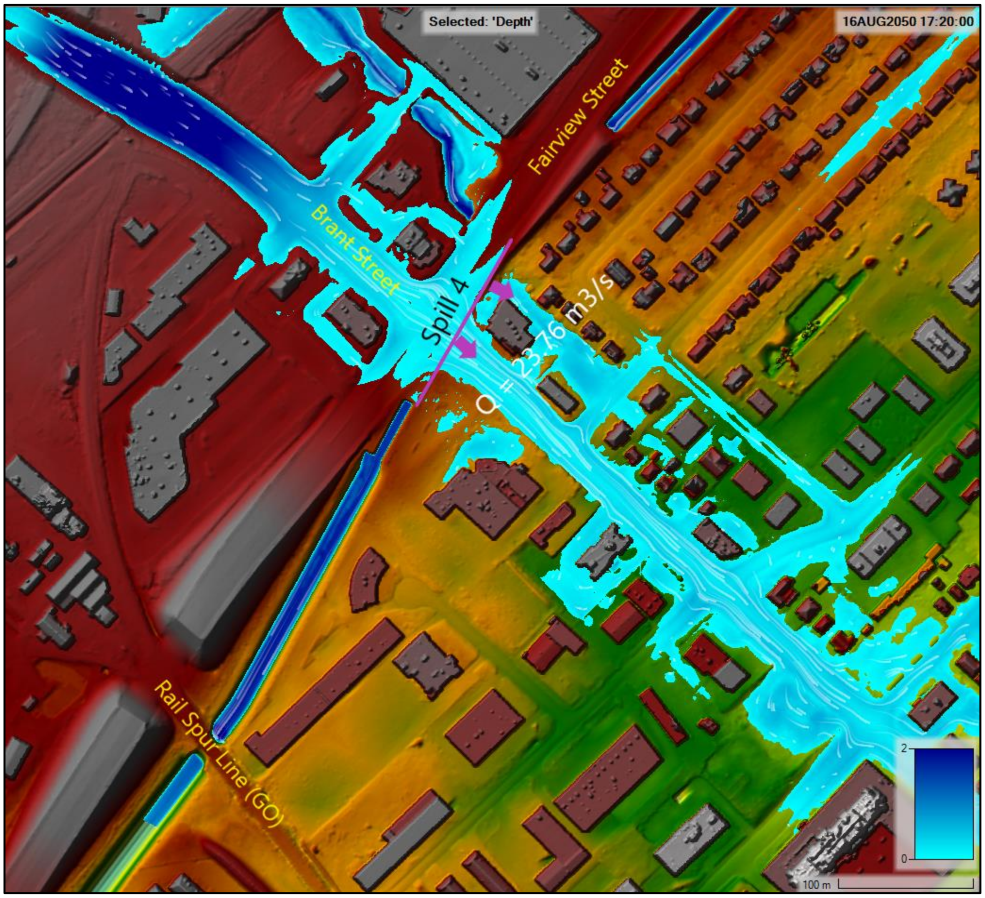

Figure 4: Spill 4 - Brant/Fairview Spill to Downtown

Spill Location and Description	Upstream Flow (Hydro burn Model +Spill)	Spill Flow (Base Model) [Percent Leaving]	Does Spill Remain Under the Hydro Burn Model?	Mitigatable? What would be Required?	EBC Approach (Add Spill Flows Back: Where needed)	Current MTSA Approach (Model Break: Where needed)	EBC versus Current MTSA Spill Considerations Other Approaches?	**Recommendation for MTSA**
1. Plains Road East **South/East Side of CNR Tracks**. **Spill From:** Credited CNR Spill **Spill To**: Combination: East Rambo (Most) but some returns to West Rambo.	**Subjective** 41.8 m^3/s if considering the full CNR Spill 17.62 m^3/s if considering flow on the east side of the CNR tracks only.	**10.36 m^3/s** [24.7%] CNR Spill <u>Or</u> [58.7%] Spill on east side of CNR tracks	**Yes** Spill is not the result of hydraulics structures. Local drainage features are unable to convey the significant spill flow rate; this results in the overland flows observed.	**Foreseeably Yes** **Options:** **A.**Raising of Lands to the East (block the spill) **B.** Improve conveyance of local systems to convey flows downstream. **C.** Combinations If the spill were eliminated by raising lands (Option A and perhaps C) Inundation on westerly lands may increase beyond existing limits. This is because there is no 1D model for this area. Staff would suggest approach B would be the preferred approach to elimination (i.e., improved downstream conveyance systems). However, significant downstream improvements may be required in order to prevent this spill from occurring and/or avoid increases if proposed in conjunction with filling.	**1D Model:** WR - Retain Flow / ER add flow upstream of the GO/CN tracks **2D Model:** No Change As spill remains within the same system (East and West Rambo confluence downstream) The 2D modelling would not be adjusted. The 1D modelling would include evaluation of the worst-case scenario for both systems. It is understood that within the EBC Study most systems' spills and floodplains followed parallel pathways and flows often re-joined the valley system downstream. In this circumstance the two systems are not parallel, and the spill pathway diverges from the floodplain. For this reason, these systems may have been considered as separate (up until their confluence) and spill flows may have been added back into West Rambo Creek – up until the confluence.	**1D Modelling:** Assumes worst case (eliminated WR and remains ER) for each reach upstream of the East and West Rambo confluence. This assumes Spill #1 can be eliminated and flows routed to West Rambo Creek; but it also makes allowances for Spill #1's (baseline spill flows) within East Rambo Creek. Downstream of where East and West Rambo confluence results from the Hydroburn model were applied, as adjusted for any other non-credited spills. **2D Modelling:** Base & Hydroburn models with no flow adjustments (i.e., reflect the on the ground condition at Spill #1.	**EBC and MTSA Approach are generally aligned.** **Additional Modelling Scenario Considerations:** **A.** An additional 2D scenario could be included which assesses impacts of potential spill elimination via option A (i.e., raising of easterly lands). This scenario would conceivably capture the worst-case scenario in terms of potential inundation occurring towards and along West Rambo Creek. **Considerations:** If mapping from the additional 2D modelling scenario (i.e., Option A) were applied for regulatory purposes, this would infer that Spill 1 could be eliminated (without evaluation), as mapping towards and along West Rambo Creek would include the additional flows in accordance with for this condition. By not mapping this scenario, any future application(s) seeking permission to eliminate this spill will need to consider the effects of doing so and mitigation would be required to address associated impacts. Considering the proportion of spill 'leaving' the underpass spill along the east side of the tracks approaches 50%, it is somewhat arbitrary to define Spill 1 as a secondary spill. This circumstance could be viewed as a spill pathway within the broader spill, which further supports not including the additional 2D scenario. From this perspective, once CH policies/guidelines have advanced further and / or further direction is received from the province, it may be possible to use flow rates within the receiving systems (i.e., West Rambo and East Rambo) based on the as is condition (i.e., base 2D model), Meanwhile, maintaining flows within both systems (worst case) within the 1D model appears in keeping with current provincial guidance and allows for future downstream infrastructure improvements should mitigation be sought in the future. **Risk:** Spill flows may erode/washout the tracks causing more flows to move towards West Rambo Creek. If this were to occur more flows would be directed toward West Rambo Creek than has currently been mapped. Typically, staff do not review/consider potential failure mechanisms within spill areas considering the impracticality and subjectivity of identifying where such things could occur. **Proposed Approach:** It is recommended that the current, "middle of the road", MTSA approach be maintained, and reporting updated to define the rationale for this approach. By this approach, the 1D modelling will include reasonable/conservative allowances for spills or spill elimination for downstream systems; and 2D modelling will define existing flood risks	**Maintain Current MTSA Approach.** **Phase 2 report should summarize the recommended approach and rationale, but also identify that further refinement may be required once CH's policies/guidelines are finalized and or further direction is received from the province.**

APPENDIX B: TABLES

Spill Location and Description	Upstream Flow (Hydro burn Model +Spill)	Spill Flow (Base Model) [Percent Leaving]	Does Spill Remain Under the Hydro Burn Model?	Mitigatable? What would be Required?	EBC Approach (Add Spill Flows Back: Where needed)	Current MTSA Approach (Model Break: Where needed)	EBC versus Current MTSA Spill Considerations Other Approaches?	**Recommendation for MTSA**
2. Plains Road East (West Side of CNR Tracks Near Old Courthouse) **Spill From:** Combined: CNR Spill and West Rambo **TO**: Brant Street Underpass Multiple: Lower Rambo (Most) West/East Rambo	45.7 m^3/s CNR Spill Portion 31 m^3/s	Towards Brant Street Underpass 29.60 m^3/s [65.7%] To Lower Rambo Creek (Downtown) 23.8 m^3/s [52 %] *Note: Above flows are based on the Baseline Model which credits/allows spills (i.e., Spill 1).*	**Spill Largely Eliminated** **(< 1 m^3/s remains)** Note: Upgrades inferred by the hydro burn model are significant; the feasibility of such upgrades has not been assessed in detail.	Conceivably Yes however this would be very challenging considering expected costs, coordination requirements, and potential implications on railways during construction. **Options:** **A.** Replace Existing Plains Road Structure to accommodate increased conveyance. The profile of Plains Road may need to be raised and/or the watercourse's inverts lowered. This would need to be undertaken in conjunction with similar downstream improvements in order to avoid recurrence of this spill as flows continue downstream.	**1D Model:** WR - Retain Flow **2D Model:** Add portion of spill flow (which leaves the system) back in downstream of the structure. As the majority of spill leaves the system (To Lower Rambo Creek) the 2D modelling would be adjusted using the 'Balanced Approach'. **Notes:** When spill flow is added back downstream of the Plains Road Crossing Structure the next downstream structure causes a similar spill to occur. This causes the 'balanced' model to overpredict spills to Lower Rambo Creek as well as to East/West Rambo. The balanced model also results in significantly more conservative (may not be justifiable) inundation depths/limits along Plains Road, Brant Street, and at Fairview. This is because the flow additions interact with the existing spill flows in this circumstance. This compounds at each successive downstream structure (CNR Spur, CNR Main, and Walmart Driveway) as the spill recurs towards Brant Street at each successive crossing. As per the EBC approach the Baseline Model would be used for estimating the downstream spills because of these interactions.	**1D Modelling:** Assumes Spill #2 can be eliminated, and flows are retained within West Rambo Creek. **2D modelling:** Base & hydroburn models with no flow adjustments (i.e., reflect the on the ground condition at Spill #2	**EBC and MTSA Approach are not fully aligned.** The EBC and MTSA approach are consistent for the 1D modelling approach; however, the 2D modelling approach differs. **Additional Modelling Scenario(s) Considered:** **A.** Additional 2D modelling scenarios could be used to assess impacts of potential spill elimination via use of sequential model breaks for each downstream structure. This would require at least 3 additional scenarios (one for each downstream structure). **B.** Additional 1D model created which applies lateral structures (not optimized) to produce more 'reasonable' WSEs for this area to support an understanding of the potential spill. While this could be incorporated into the MTSA study, considering the City's timing it can also be deferred to individual landowners if and when development proceeds. **Considerations:** Considering topography and flow dynamics, Plains Road is unlikely to washout in a way which would allow the majority of flows to change direction (flow southerly) and continue within the downstream watercourse. Further, downstream structures would also need to washout (i.e., Rail Line, Rail Spur Line, etc.) for flows to continue in this direction. Such a washout of Plains Road in particular is considered unlikely considering the minimal pressure head acting on the structure during flood conditions, considering the majority of flows (31 of 45 m^3/s) are flowing in a direction which parallels Plains Road, and also considering the width and composition of this crossing structure. It is thought that this structure is much more likely to experience a blockage than a washout. Although the MTSA's 2D modelling approach may not identify the full extents of potential inundation under all hypothetical individual culvert upgrade scenarios or crossing failure scenarios, re-introducing flows at each crossing is problematic due to the cascading and overlapping spills. It is suggested that results from the 1D model, or a modified version thereof, could be applied for the MTSA to produce mapping of potential spill/inundation limits as required. Considering the small number and large size of the properties as well as the commercial/employment land uses in this area, this analysis could be undertaken in conjunction with a planning or regulatory application and would only require the worst-case scenario for the given parcel to be analyzed. **Proposed Approach:** The current approach is thought to achieve a balance in that current spills are identified, the 1D modelling will flag potential spills (not mapped in 2D), and the 1D modelling will also support infrastructure upgrades/sizing considerate of full flows (potential spill mitigation). Seeing as cascading downstream spills are foreseeable if upstream infrastructure upgrades precede downstream improvements, the MTSA Study could include recommendations to undertake a flood mitigation study that includes coordination of potential infrastructure upgrades.	**Maintain Current MTSA Approach.** **Phase 2 report should summarize the recommended approach and rationale, but also identify that further refinement may be required once CH's policies/guidelines are finalized and or further direction is received from the province.** **Include recommendation to investigate flood mitigation opportunities, including coordination of potential infrastructure improvements.** **Identify within reporting that applicants may wish to undertake additional analysis in conjunction with future planning and/or regulatory applications in the area between Fairview Street and Plains Road on either side of West Rambo Creek (i.e., additional 1D model identified under 'B' and possibly one of the 2D scenarios identified under 'A') to further refine flood hazard limits.**

Spill Location and Description	Upstream Flow (Hydro burn Model +Spill)	Spill Flow (Base Model) [Percent Leaving]	Does Spill Remain Under the Hydro Burn Model?	Mitigatable? What would be Required?	EBC Approach (Add Spill Flows Back: Where needed)	Current MTSA Approach (Model Break: Where needed)	EBC versus Current MTSA Spill Considerations Other Approaches?	**Recommendation for MTSA**
3. East Rambo Channel Spill between Go Tracks and Fairview **Spill From:** Combined: East Rambo + portion of CNR Spill + portion of Roseland Spill **TO**: Lower Rambo	Total: 33.6 m^3/s CNR Spill Portion (From Spill 1) [6.55 m^3/s] Roseland Spill Portion [6.00 m^3/s]	Base Model: 6.11 m^3/s [18.2%] Hydro Burn Model 10.61 m^3/s [31.5%] Note: The hydro burn model increases the estimated spill flow rate. This is thought to be in part from elimination of attenuative effects; but may also be due to the conceptual approach used to create the hydro-burning scenario. The approach is somewhat subjective, and changes may reduce spill rates.	**Yes** **(Increases)** Spill is result of the existing watercourse lacking capacity to convey expected peak flow rates.	**Foreseeably Yes** **Options:** **A.**Raising of Lands to the East (block the spill) **B.** Improve conveyance of the watercourse to convey flows downstream. **C.** Combinations This may need to be undertaken in conjunction with similar downstream improvements in order to avoid recurrence/shifting of this spill to an immediately downstream area.	**1D Model:** Retain all flows within East Rambo **2D Model:** Add portion of spill flow (which leaves the system) back in downstream of the structure. As this spill leaves the system (To Lower Rambo Creek) the 2D modelling would need to be adjusted using the 'Balanced Approach'. **Notes:** When spill flow is added downstream of Fairview a new, albeit smaller spill occurs in the downstream channel between Fairview and Brant Street, based on a test CH model developed for this analysis. As the new spill is small (<1 m^3/s) it would be considered reasonable to exclude mapping this spill and therefore including these flows within the 2D model is not critical.	**1D Modelling:** Assumes no loss of flow for East Rambo Creek downstream of the spill (i.e., Spill 3 eliminated). **2D modelling:** Base & hydroburn models with no flow adjustments (i.e., reflect the on the ground condition at Spill #3. One additional 2D modelling scenario was investigated whereby hydraulic structures on West Rambo and East Rambo upstream of Fairview Street were removed. The purpose of this model was to identify whether or not upgrading hydraulic structures (upstream of Fairview Street) would increase the magnitude of spills occurring at Fairview Street (Spill to Downtown / Lower Rambo). This modelling generally suggested that upstream infrastructure improvements did not result in new or increased spills <u>at Fairview Street</u>, which suggested the downstream system may not be operating at its maximum capacity as of current. This scenario did not eliminate Spill 3 however, and Spill 3's magnitude remained consistent with the hydro burn model and continued to be higher than the baseline model. (Note this scenario is the same as discussed for Spill 4)	**EBC and MTSA Approach are not fully aligned.** The EBC and MTSA approach are consistent for the 1D modelling approach; however, the 2D modelling approach differs. The current MTSA approach may not identify the full extents of potential inundation, for all hypothetical scenarios (i.e., if Spill #3 conceptually eliminated), however the 1D modelling does provide insights in this regard. **Additional Modelling Scenarios Considered:** **A.** Additional 2D modelling scenarios could be used to assess impacts of eliminating the potential spill between Fairview Street and the Rail Tracks to understand potential downstream inundation under this conceptual scenario. A model break approach may be preferred to avoid double counting of spill flows; however initial findings suggest that the EBC approach may also be sufficient as it does not appear to result in any significant spill-spill interaction. If the model break approach were advanced, at least one but up to three additional 2D modelling scenarios may be required. These scenarios would assess effects of Spill # 3 being retained within each successive downstream reach (to assess effects of additional flows assuming spill elimination). These scenarios would assume improvements/elimination are not coordinated and not sequenced ideally (i.e., top to bottom). It is envisioned that one scenario would assess the reach between Brant and Fairview Street. If the spill recured in that reach, another would be required to assess between Brant Street and the Rail Spur Line, and similar for downstream of the Rail Spur Line. Some of these scenarios could be completed in conjunction with those suggested for Spill 4 below. **Considerations:** Elimination of this spill would require reach scale works, not just crossing infrastructure improvements. It may be reasonable to formally credit at least a portion of this spill and assume reduced flows within the diversion channel downstream of Fairview Street, however, this has not yet been justified considering current provincial guidance. There may also be interest in eliminating this spill (to support proposed intensifications) and it is not clear that fully crediting the spill would be in the public interest. **Proposed Approach:** A middle of the road approach is recommended at this time, whereby flows will continue to be modeled in the downstream 1D models and potential spills identified, however, the additional 2D modelling scenarios will not be advanced at this time given the low potential for downstream lands to flood. Refinement of the approach may be warranted once CH's policies/guidelines are finalized and or further direction is received from the province	**Maintain Current MTSA Approach** **Phase 2 report should summarize the recommended approach and rationale, but also identify that further refinement may be required once CH's policies/guidelines are finalized and or further direction is received from the province.** **Include recommendation to investigate flood mitigation opportunities, including coordination of potential infrastructure improvements.** **Identify different policies may be appropriate for development for areas within the path of Spill 3 considering elimination may not be possible in the near term.**

Spill Location and Description	Upstream Flow (Hydro burn Model +Spill)	Spill Flow (Base Model) [Percent Leaving]	Does Spill Remain Under the Hydro Burn Model?	Mitigatable? What would be Required?	EBC Approach (Add Spill Flows Back: Where needed)	Current MTSA Approach (Model Break: Where needed)	EBC versus Current MTSA Spill Considerations Other Approaches?	**Recommendation for MTSA**
4. Spill to Downtown Burlington at Fairview and Brant Street **Spill From:** Combined: East + West Rambo + CNR Spill + Roseland Spill **Spill To**: Lower Rambo (Most) East/West Rambo (some)	**Subjective** 88.29 m³/s if it is assumed that Spill 3 is eliminated 77.75 m³/s If Spill 3 excluded	Base Model: 23.76 m³/s [26.9%] Including Spill 3 Or [30.6%] Excluding Spill 3	**No** Spill largely the result of hydraulic structures with the exception of portions potentially tied to Spill 3.	**Conceivably Yes however this would be very challenging considering expected costs, coordination requirements, and potential implications on railways during construction (pending approach to elimination).** **Options:** **A.** Same as approach for resolving Spill 2 in combination with improvements to the enclosures at Fairview Street. **B.** Allow for the Spill at Plains (Spill 2) to continue, but significantly increase capacity of drainage infrastructure along/within Brant Street and/or adjust grading of the intersection at Fairview and Brant such that grading conveys spill toward the Diversion Chanell, and/or an improved enclosure.	**1D Model:** Retain Flow **2D Model:** Add portion of spill flow (which leaves the system) back in downstream of the enclosure. As this spill leaves the system (towards Lower Rambo Creek) the 2D modelling would be adjusted using the 'Balanced Approach'. **Notes:** When spill flow is added back downstream appears to result in a similar downstream spill (via diversion channel). This new spill interacts with the initial spill and these additional spill flows ultimately contribute to the same receiver (i.e., Lower Rambo Creek) as the initial. This results in an overestimate of flooding/spill within the downtown area.	**1D Modelling:** Assumes no loss of flow for East/West Rambo Creek downstream of the spill (i.e., Spill 4 eliminated). **2D modelling:** Base & hydroburn models with no flow adjustments (i.e., reflect the on the ground condition at Spill #3. One Additional 2D Modelling Scenario was investigated whereby all hydraulic structures upstream of Fairview Street were removed. The purpose of this model was to identify whether or not upgrading hydraulic structures (upstream of Fairview Street) would increase the magnitude of spills occurring at Fairview Street (Spill to Downtown / Lower Rambo). Initial findings suggested that upstream infrastructure improvements would result in a smaller spill at Fairview Street which suggested the enclosure at Fairview/ Brant Street has more capacity than is being utilized under the Baseline Condition; and further that the Baseline condition was the worst-case scenario with respect to Spill 4. (Note this scenario is the same as discussed for Spill 3)	**EBC and MTSA Approach are not fully aligned.** The EBC and MTSA approach are consistent for the 1D modelling approach; however, the 2D modelling approach differs. The current MTSA approach may not identify the full extents of potential inundation, for all hypothetical scenarios (i.e., if Spill 4 conceptually eliminated), however the EBC approach overestimates potential inundation under that hypothetical scenario. **Additional Modelling Scenarios Considered:** **A.** Additional 2D modelling scenarios could be used to assess impacts of eliminating the potential spill at Brant/Fairview Street by assuming the full flow makes it downstream of the enclosure. A model break approach would be recommended to avoid double counting of spill flows. This approach would also better serve the mapping requirements needed for the downstream areas. If this approach were advanced at least one, but potentially two 2D modelling scenarios would be required. These scenarios would assume that upstream spills were eliminated, and test impact on each existing downstream reach. The first scenario would be required for the reach between Brant Street and the rail spur line, and the other for downstream of the rail spur line if a new spill resulted under the first. These scenarios could be coordinated with those noted for Spill 3. **Considerations:** Elimination of this spill would require reach scale works (Option A or B). The MTSA Study could include recommendations to undertake a flood mitigation study through an EA process that includes coordination of potential infrastructure upgrades. As the rail lines are owned by other parties and it is understood they have the right under riparian law to increase conveyance through their infrastructure, CH and the City would not have the ability to stop upgrades to this infrastructure unless a flood mitigation study including a public engagement process requires a specific staging of infrastructure improvements. Mitigation of the spill to the downtown area however may also require improvements to the City/CH owned enclosures at Fairview and Brant Street. It is reasonable to assume the City and CH would not undertake these improvements without improvements to the downstream diversion channel, if deemed necessary to contain the floodwaters. Complete failure of the East Rambo and West Rambo enclosures at Fairview/Brant Street are extremely unlikely as it is anticipated that if the enclosures became blocked or started to fail, floodwaters would carve a path towards the south as opposed to along Fairview Street and the downstream diversion channel. Though it may be reasonable to formally credit at least a portion of this spill and assume reduced flows within the diversion channel downstream of Brant Street, it has yet to be demonstrated that this could be supported considering current provincial guidance. Further, considering the significant interest in eliminating this spill (to support proposed intensifications) fully crediting of this spill would require further study to ensure crediting is in the public interest. **Proposed Approach:** A middle of the road approach is recommended at this time, whereby flows will continue to be modeled in the downstream 1D models and potential spills identified, however, these spills will not be modeled and mapped given the low potential for these lands to flood. Refinement of the approach may be warranted once CH's policies/guidelines are finalized and or further direction is received from the province	**Maintain Current MTSA Approach** **Phase 2 report should summarize the recommended approach and rationale, but also identify that further refinement may be required once CH's policies/guidelines are finalized and or further direction is received from the province.** **Include recommendation to investigate flood mitigation opportunities, including coordination of potential infrastructure improvements.** **Identify different policies may be appropriate for development for areas within the path of Spill 4 considering elimination may not be possible in the near term.**

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January 23, 2023

Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
Burlington, ON L7R 3Z6

BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Umar Malik:

Re: Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
City of Burlington
CH File Number: MPR 799

Conservation Halton (CH) staff has reviewed the *Major Transit Station Area (MTSA) Phase 2 Flood Hazard Assessment, Burlington Go and Downtown* and associated modelling prepared by WSP, dated Nov 25th, 2022, and received Nov 30th, 2022.

We provide the following Key Comments followed by Detailed Comments in Appendix A.

Key Comments: Issues to be Resolved and Next Steps

A. To advance the possibility of including the West Hager, Freeman and East Rambo flood control facilities to reduce flows within downstream flood hazard mapping, CH requires a letter from the City outlining the items identified in CH's July 5, 2022 email. For next steps, CH suggests City staff prepare a draft letter for review by CH staff and legal counsel. Alternatively, until these arrangements are finalized, the hydraulic analysis and mapping will need to be based on the hydrologic modelling which excludes flood control facilities.

B. Reporting has not assessed or verified a Stormwater Management Strategy for Downtown Burlington. As discussed with the City and WSP on January 10th, at minimum it is recommended that reporting include an analysis of the potential implications of the future land use changes being contemplated. Reporting should define requirements for future development applications to assess and verify the effectiveness of their SWM strategy with the hydrologic modelling of record using a systems-based approach, along with any tools required for implementation (e.g., policies, guidelines, etc.).

C. As discussed with the City and WSP on January 10th, it is CH staff's understanding that the Stormwater Management Strategy proposed for the Burlington Go MTSA Area may negatively impact flooding within the downstream Hager Rambo System(s). Staff request that the study team review the analysis completed by CH staff (shared with WSP on December 22nd) and that the Stormwater Management Strategy be revised as needed to ensure potential peak flow rate increases are assessed and mitigated as necessary. The revised approach could be like that outlined above for Downtown Burlington.

D. CH staff recommend that regulatory storm controls, if required, be provided within municipally owned facilities. If it is determined that privately owned regulatory storm flood control facilities may be needed to mitigate the impacts of development, reporting should include text noting that the acceptability and design requirements for such controls will be reviewed on a case-by-case basis by City and CH staff until a standard approach to privately owned regulatory storm control facilities is established.

E. Staff recommend revisions to the report's text to reflect additional findings and CH advice. Refer to comments and recommendations included within the attached markup of the report's text.

Detailed comments and recommendations are provided within Appendix A. The above key comments and detailed comments within Appendix A should be addressed as part of the next submission. CH staff would be pleased to meet to discuss further as required.

Sincerely,

Leah Smith, Manager, Environmental Planning

Cc. Matt Senior, WSP
Alison Enns, City of Burlington
Cary Clark, City of Burlington
John Stuart, City of Burlington

APPENDIX A: DETAILED COMMENTS

Report

1. Comments on Reporting (General)

Refer to Key Comment E and the attached markup of the report.

2D Hydraulic Modelling

2. 2D Modelling: Equation Set (Final Run)

We recommend that reporting include recommendations for future Site-Specific analyses to use the SWE-EM equation set with turbulence added to support the delineation of flooding hazards and to support the characterization of flood risks. Staff also recommend that reporting include a brief discussion of the differences between the various equations sets available for use as well as rationale for using the selected approach as part of this higher-level study.

VO Modelling (Burlington Go MTSA)

3. Missing 'Read Hyd' Files

Read Hyd files used by the VO modelling must be included within the final submission. Staff were unable to execute the modelling provided as these files were not included with the submission.

4. SCS Type II – 24 Hour Storm Hyetographs

Staff have compared the hyetographs included within the previous SWM-HYMO modelling to Design Chart 1.05 included within MTO's Drainage Management Manual and identified that the hyetograph's shape is different than expected. Please define and justify the source used to create the design storm, and/or modify it to ensure it is consistent with Design Chart 1.05. The VO modelling outlined in Comment 6 below used hyetographs developed based on MTO's design chart.

5. Future Conditions (Imperviousness)

Imperviousness coded into the future conditions modelling is not consistent with Table 2.1.5 from the report. In general, the imperviousness identified in the modelling is lower than the values presented within Table 2.1.5. Revise modeling or reporting to ensure consistency.

6. Stormwater Management Strategy

The analysis provided assessed impacts at only a single downstream node. CH Staff prepared conceptual modelling scenario(s) to test and understand the potential impacts of the proposed stormwater management strategy at other locations.

Results from this analysis suggests that the proposed SWM strategy may negatively affect flooding (ref. Table 1). As discussed on January 10th, Staff request that the study team review the analysis completed by CH staff (shared with WSP on December 22nd) and that the Stormwater Management Strategy be revised as needed.

CH staff recommend that regulatory storm controls, if required, be provided within municipally owned facilities. Should the revised SWM strategy rely on privately-owned regulatory storm flood control facilities to attenuate downstream flood hazard flow rates, CH recommends the City minimize the use of private regulatory storm facilities via policy, planning mechanisms and other potential tools. CH's Guidelines for Stormwater Management Engineering Submissions requires evidence that the municipality has the legal right to ensure the proper operation and maintenance of privately-owned regulatory storm ponds and tanks. Other privately-owned SWM methods were not contemplated for regulatory storm controls in the guidelines.

Recently, CH staff indicated we are open to considering alternative approaches. Significant interest in establishing a consistent approach within the Halton area municipalities and conservation authorities was expressed at a recent Halton Area Stormwater Committee. As a region wide approach may take some time to establish, CH recommends City staff prepare, in collaboration with CH, an interim approach to private SWM facilities that will ensure that it is reasonable for the public agencies to assume the facilities will function as intended during the regulatory storm event. An interim approach must be in place before CH staff can support the use of private SWM controls to attenuate storm flows within flood hazard mapping for the purpose of land use or regulatory decisions. To assist, CH staff will provide under separate cover a summary of background information on this topic, including the interim approach and measures being considered by the Town of Halton Hills. The Phase 2 study's reporting should include text noting that if it is determined that a privately-owned regulatory storm flood control facility is needed to mitigate the impacts of the development, the acceptability of a private facility and the design requirements of such controls will be reviewed by the City and CH on a case-by-case basis.

PC Modelling (Downtown Burlington)

7. Modelling for Brant Street Underpass

The 1:100 Year modelling which includes spills, should be revised to ensure the spill flows which contribute to the sewer which drains the Brant Street Underpass are accounted for within the modelling. The conceptual models used for staff's assessment have made this adjustment and will be shared with the study team for reference.

8. Impacts to Flooding

Staff prepared conceptual modelling scenario(s) based on the submission provided, to gain a more fulsome understanding of the potential effects of the land use changes contemplated. Results from this modelling suggest that the contemplated land use changes could negatively affect flooding (ref. Table 2, Table 3, and Table 4). As discussed on January 10th, Staff request that the study team review the analysis completed by CH staff (shared with WSP on December 22nd) and that reporting be revised as needed.

9. Stormwater Management Strategy

Reporting has not assessed or verified a Stormwater Management Strategy for Downtown Burlington. CH Staff recommend that this be completed at the current stage to understand and address potential implications of the land use changes being contemplated. As discussed on January 10th, at minimum, it is recommended that reporting include an analysis of the potential implications of the future land use changes being contemplated, and that reporting define requirements for future development applications to assess and verify the effectiveness of their SWM strategy with the hydrologic modelling of record using a systems-based approach. See Comment 6 regarding privately-owned regulatory storm control facilities.

1D / 2D Hydraulic Modelling (Downtown Burlington)

10. Inflows / Peak Flow Data

Inflows / Peak Flow data will need to be revised based on the final version(s) of the hydrologic modelling.

11. Waterfront Trail - Crossing Structure (Lower Rambo Creek)

Staff have recently become aware that measurements used to code the Waterfront Trail crossing structure had not been adjusted to reflect the structure's skew. Staff request that the width of the crossing structure be revised to measure 4.58 metres in both the 1D and 2D models.

Drawings

12. General Comment

Drawings will need to be made reflective of the modelling approach(es) which are ultimately agreed upon.

APPENDIX B: TABLES AND FIGURES

Table 1: Conceptual Assessment of the proposed SWM Strategy, results are based on the 1:100 Year storm with FCFs included in the hydrologic modelling.

Flow Node		Estimated Peak Flow Rates (m3/s) For Specified Scenario				Percent Change from Baseline Scenario		
Location (NHYD)	Location (Description)	Baseline (Existing Land Use)	Measured Baseline (Based on Aerial Imagery)	Contemplated Landuse (90% Imp Assumed)	Contemplated Landuse (90% Imp Assumed) with SWM Strategy	Measured Baseline	Contemplated Landuse	Contemplated Landuse w/ SWM Strategy
9002	B.2	17.65	17.65	17.65	17.65	0.0%	0.0%	0.0%
9001	B.1	2.92	2.92	2.92	2.92	0.0%	0.0%	0.0%
9003	B.3	29.90	29.90	29.90	29.90	0.0%	0.0%	0.0%
9004	B.4	30.10	30.10	30.10	30.10	0.0%	0.0%	0.0%
9005	A	10.42	10.42	10.42	10.42	0.0%	0.0%	0.0%
9006	510	22.62	22.62	22.62	22.62	0.0%	0.0%	0.0%
9007	Q	44.48	44.48	44.48	44.48	0.0%	0.0%	0.0%
9008	6D	12.28	12.28	12.28	12.28	0.0%	0.0%	0.0%
9009	6C	5.06	5.06	5.06	5.06	0.0%	0.0%	0.0%
9010	6B	11.73	11.73	11.73	11.73	0.0%	0.0%	0.0%
9011	6A	6.99	6.99	6.99	6.99	0.0%	0.0%	0.0%
9013	R-8.1	10.52	10.52	10.52	10.52	0.0%	0.0%	0.0%
9014	Q	67.96	67.96	67.96	67.96	0.0%	0.0%	0.0%
9017	R-11.2	34.78	34.78	34.78	34.78	0.0%	0.0%	0.0%
9016	K	45.81	45.00	47.07	47.60	-1.8%	2.7%	3.9%
9015	P	17.38	17.38	17.38	17.38	0.0%	0.0%	0.0%
9018	D	55.44	55.44	55.44	55.44	0.0%	0.0%	0.0%
9019	E	69.12	69.12	69.12	69.12	0.0%	0.0%	0.0%
9020	F	79.45	79.45	79.45	79.45	0.0%	0.0%	0.0%
9021	H1	17.30	17.30	17.30	17.30	0.0%	0.0%	0.0%
9022	H2	10.30	10.30	10.30	10.30	0.0%	0.0%	0.0%
9023	407-Junction - 255	82.39	82.39	82.39	82.39	0.0%	0.0%	0.0%
9024	G	85.42	85.42	85.42	85.42	0.0%	0.0%	0.0%
9025	G1	18.25	18.25	18.25	18.25	0.0%	0.0%	0.0%
9026	H3	35.07	35.07	35.07	35.07	0.0%	0.0%	0.0%
9027	H	30.25	30.25	30.25	30.25	0.0%	0.0%	0.0%
9028	Q-Out	30.81	30.81	30.81	30.81	0.0%	0.0%	0.0%
9029	O	5.75	5.75	5.75	5.75	0.0%	0.0%	0.0%
9030	L	56.37	53.40	58.20	55.86	-5.3%	3.2%	-0.9%
9031	M	74.80	75.21	75.67	77.88	0.5%	1.2%	4.1%
9032	N	78.68	78.91	80.07	81.93	0.3%	1.8%	4.1%
51721	Junction - 316	5.10	5.10	5.10	5.10	0.0%	0.0%	0.0%
331	Argon Court Major	2.31	2.10	2.51	0.79	-9.1%	8.7%	-66.0%
333	J1	23.59	23.63	23.59	23.78	0.2%	0.0%	0.8%
334	J2	22.94	22.97	22.93	23.07	0.1%	0.0%	0.6%
335	J	25.41	25.49	25.60	26.08	0.3%	0.7%	2.6%
342	P1	23.54	22.82	24.26	25.11	-3.1%	3.1%	6.7%
345	P2	22.45	22.05	23.09	24.47	-1.8%	2.8%	9.0%
348	P3	20.45	20.13	20.57	22.09	-1.6%	0.6%	8.0%
355	Q2	14.38	14.38	14.38	14.38	0.0%	0.0%	0.0%
358	Q1	16.43	16.43	16.43	16.43	0.0%	0.0%	0.0%

APPENDIX B: TABLES AND FIGURES

Table 2: Conceptual Assessment of the potential impacts of the Land Use changes being contemplated under various scenarios (Includes spills from Upper Hager/Rambo with Spills)

Location Description Hydrologic Model	PC SWMM Model Node	Peak Flow - Existing Land Use				Peak Flow - Future Land Use			
		FCFs In 12 hr Hazel w/ Spills	No FCFs 12 hr Hazel w/ Spills	FCFs In SCS 24hr 100Yr w/ Spills	No FCFs SCS 24hr 100Yr w/ Spills	FCFs In 12 hr Hazel w/ Spills	No FCFs 12 hr Hazel w/ Spills	FCFs In SCS 24hr 100Yr w/ Spills	No FCFs SCS 24hr 100Yr w/ Spills
D.S Limit	J39.16557	8.65	8.93	7.953	7.95	8.65	8.93	7.96	7.96
D.S Limit	J24.80444	12.24	13.55	6.166	10.6	12.24	13.55	6.24	10.6
Blairholm Ave. Enclosure	J8	30.61	33.72	21.9	25.3	30.62	33.73	22.05	25.31
Mid Blairholm Ave. Enclosure	J433.9925	31.60	35.14	23.85	25.59	31.60	35.15	24	25.58
Outfall - Blairholm	J349.0129	33.97	37.71	24.09	26.57	33.98	37.71	24.28	26.56
D.S. Victoria Ave.	J284.0674	35.14	38.91	24.73	27.04	35.14	38.92	24.94	27.03
U.S. Caroline Street	J2.929314	34.60	38.38	24.18	26.23	34.60	38.39	24.02	27.22
Pearl Street - Enclosure	J612.0832	36.33	40.59	26.98	26.98	36.34	40.59	26.91	26.91
Outfall - James Street	J582.0831	36.41	40.77	27.13	27.12	36.41	40.77	27.12	27.12
D.S. Martha Street	J498.3497	40.77	46.17	33.45	33.45	40.78	46.18	33.48	33.48
D.S. Waterfront Trail	J449.5095	41.05	46.67	33.97	33.97	41.05	46.87	33.99	33.99
U.S. Lakeshore Road	J149.2253	41.28	47.18	40.08	40.08	41.29	47.19	40.15	40.14
D.S. Lakeshore Road	J89.22531	43.83	50.33	44.79	44.79	43.85	50.34	44.87	44.86

APPENDIX B: TABLES AND FIGURES

Table 3: Summary of Findings from the Conceptual Assessment of the Land Use changes being contemplated under various scenarios (Includes spills from Upper Hager/Rambo with Spills)

1D HECRAS Model			Location Description Hydrologic Model	PC SWMM Model Node	Change			
River	Reach	Cross Section			FCFs In 12 hr Hazel w/ Spills	No FCFs 12 hr Hazel w/ Spills	FCFs In SCS 24hr 100Yr w/ Spills	No FCFs SCS 24hr 100Yr w/ Spills
Rambo	East Branch	0.284	D.S Limit	J39.16557	0.00	0.00	0.00	0.00
Rambo	West Branch	1.809	D.S Limit	J24.80444	0.00	0.00	0.07	0.00
Rambo	Lower Main	1.628	Blairholm Ave. Enclosure	J8	0.01	0.01	0.15	0.01
Rambo	Lower Main	1.53	Mid Blairholm Ave. Enclosure	J433.9925	0.00	0.01	0.15	-0.01
Rambo	Lower Main	1.447	Outfall - Blairholm	J349.0129	0.01	0.00	0.19	-0.01
Rambo	Lower Main	1.316	D.S. Victoria Ave.	J284.0674	0.00	0.01	0.21	-0.01
Rambo	Lower Main	1.187	U.S. Caroline Street	J2.929314	0.00	0.01	-0.16	0.99
Rambo	Lower Main	0.775	Pearl Street - Enclosure	J612.0832	0.01	0.00	-0.07	-0.07
Rambo	Lower Main	0.61	Outfall - James Street	J582.0831	0.00	0.00	-0.01	0.00
Rambo	Lower Main	0.493	D.S. Martha Street	J498.3497	0.01	0.01	0.03	0.03
Rambo	Lower Main	0.442	D.S. Waterfront Trail	J449.5095	0.00	0.20	0.02	0.02
Rambo	Lower Main	0.267	U.S. Lakeshore Road	J149.2253	0.01	0.01	0.07	0.06
Rambo	Lower Main	0.092	D.S. Lakeshore Road	J89.22531	0.02	0.01	0.08	0.07

APPENDIX B: TABLES AND FIGURES

Table 4: Summary of Findings from the Conceptual Assessment of the Land Use changes being contemplated under various scenarios (Baseline – Excludes Spills from Upper Hager/Rambo)

1D HECRAS Model			Location Description Hydrologic Model	PC SWMM Model Node	Existing Land Use		Future Land Use		Change	
River	Reach	Cross Section			12 hr Hazel	100 Yr	12 hr Hazel	100 Yr	12 hr Hazel	100 Yr
Rambo	East Branch	0.284	D.S Limit	J39.16557	4.31	7.04	4.31	7.04	0.00	0.00
Rambo	West Branch	1.809	D.S Limit	J24.80444	0.98	2.71	1.00	2.88	0.02	0.165
Rambo	Lower Main	1.628	Blairholm Ave. Enclosure	J8	12.72	17.20	12.74	17.44	0.02	0.24
Rambo	Lower Main	1.53	Mid Blairholm Ave. Enclosure	J433.9925	14.07	19.15	14.09	19.37	0.02	0.22
Rambo	Lower Main	1.447	Outfall - Blairholm	J349.0129	14.70	20.01	14.72	20.19	0.02	0.18
Rambo	Lower Main	1.316	D.S. Victoria Ave.	J284.0674	15.16	20.56	15.19	20.76	0.03	0.2
Rambo	Lower Main	1.187	U.S. Caroline Street	J2.929314	16.63	21.10	16.66	20.73	0.03	-0.37
Rambo	Lower Main	0.775	Pearl Street - Enclosure	J612.0832	20.56	25.98	20.60	26.07	0.04	0.09
Rambo	Lower Main	0.61	Outfall - James Street	J582.0831	20.81	26.11	20.84	26.18	0.03	0.07
Rambo	Lower Main	0.493	D.S. Martha Street	J498.3497	26.22	32.35	26.26	32.44	0.04	0.09
Rambo	Lower Main	0.442	D.S. Waterfront Trail	J449.5095	26.90	32.76	26.94	32.86	0.04	0.1
Rambo	Lower Main	0.267	U.S. Lakeshore Road	J149.2253	28.22	37.80	28.27	37.94	0.05	0.14
Rambo	Lower Main	0.092	D.S. Lakeshore Road	J89.22531	32.09	42.43	32.13	42.57	0.04	0.14

Conservation Halton

Planning & Watershed Management
905.336.1158 | Fax: 905.336.6684
2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

April 26, 2023

Umar Malik, M.Eng., P.Eng.
426 Brant Street P.O. Box 5013
Burlington, ON L7R 3Z6

BY EMAIL ONLY (Umar.Malik@burlington.ca)

Dear Umar Malik:

Re: Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
City of Burlington
CH File Number: MPR 799/AMPR-75

Conservation Halton (CH) staff has reviewed the *Major Transit Station Area (MTSA) Phase 2 Flood Hazard Assessment, Burlington Go and Downtown* and associated modelling prepared by WSP, dated March 6, 2023, and received March 9, 2023.

CH considers the Phase 2 study the best available information for understanding the magnitude and extent of the hazard, assessing potential risk to life and property, identifying areas requiring further analysis, and/or decision making when development is contemplated in identified hazardous areas.

CH has also reviewed the City's February 9, 2023 letter that outlines ownership and maintenance responsibilities for the West Hager, East Rambo and Freeman flood control facilities (FCFs). The City has acknowledged maintenance responsibilities for the West Hager and East Rambo FCFs, and CH acknowledges maintenance responsibilities for the Freeman FCF. On this basis, in conjunction with previous assessments and commitments, these FCFs can be considered to reduce flows downstream and incorporated into the Phase 2 study's flood hazard modeling and mapping.

As discussed with City staff and WSP, CH staff supports the release of an interim package containing the hydraulic and hydrological models to applicants, to support development applications in the short-term, pending preparation of the models and instructions for use. In consultation with City staff, CH staff will also prepare a final data package, including final modeling and mapping and instructions for use, to support the long-term implementation of the study.

To finalize the Phase 2 study reporting and implementation, we recommend the following:

1. CH be included as a recipient within the report's disclaimer (page ii). CH staff has also identified a list of clarifications to the text and recommendations within the report, which we have summarized in Appendix A. We request that this correspondence be included in the Phase 2 study appendices for clarification (i.e., We do not request edits to the Phase 2 study report text. Rather, we recommend that Appendix A of this letter be appended to the Phase 2 study).
2. To support the long-term implementation of the Phase 2 Study, CH would like to work with the City to:
   i. confirm expectations, roles, and responsibilities for the incremental update process(es) to hydrologic modelling and associated SWM verification;
   ii. confirm expectations, roles, and responsibilities for the analysis of any proposed filling/development within low-risk spill flood hazards and any mitigation strategies proposed through future development applications; and
   iii. develop a term(s) of reference to ensure future applicants understand the scope of SWM design briefs and flood hazard analysis in the Phase 2 area.

We look forward to working with the City on the implementation of the Phase 2 Study.

Sincerely,

Leah Smith, Policy and Special Initiatives Lead

Cc. Matt Senior, WSP
Alison Enns, City of Burlington
Cary Clark, City of Burlington
John Stuart, City of Burlington

APPENDIX A

Conservation Halton

Planning & Watershed Management
905 336 1158 | Fax 905 336 6684
2596 Britannia Road West
Burlington, Ontario L7P 0G3
conservationhalton.ca

April 26, 2023

Re: Report Text and Recommendation Clarifications
Phase 2 Flood Hazard and Scoped Stormwater Management Assessment
City of Burlington
CH File Number: MPR 799/AMPR-75

Conservation Halton (CH) staff has reviewed the *Major Transit Station Area (MTSA) Phase 2 Flood Hazard Assessment, Burlington Go and Downtown* and associated modelling prepared by WSP, dated March 6, 2023, and received March 9, 2023. CH staff identified the following clarifications to the text and recommendations within the final report.

1. **General Comment:**
   CH shared data, inclusive of conceptual modelling, with the City's study team in the interests of advancing this study. CH understands that the practitioner(s) thoroughly vetted data shared, confirmed its appropriateness for use if it was incorporated into the study and take full responsibility for the final deliverables.

2. **Section 2.1.3.1 Impervious Calculations, Figures, Pages 10 -11**
   A digital copy of all pertinent data, such as the land use mapping, pervious lands mapping, and precinct areas, shown on Figures 2.1.1, 2.1.2, and Drawing No. 2 should be included with the final modelling package from WSP to the City and CH to support future model use and data sharing efforts.

3. **Section 2.1.3.2 SWM Sizing and Flow Assessment, Page 13**
   To ensure flood risks do not increase as a result of the contemplated land use changes, CH supports the study recommendation to complete a SWM verification as part of future development applications using watershed-based modelling.

   As discussed on April 19, 2023, SWM quantity control targets will be established using the '*Actual Existing*' model. CH and the City will apply this model for the purpose of delineating the flooding hazard limits and for regulatory and land use decision purposes. Models included within the final data package (for external distribution) will reflect this approach.

4. **Section 2.1.3.2 SWM Sizing and Flow Assessment, Page 15**
   Text crossed out within the below report excerpt is not accurate. The conceptual analysis referenced used flow routing in VO not HEC-RAS 2D.

   > The simulated results provided by CH indicate that flow routing through the Burlington GO MTSA (~~as represented by inclusion of flow routing through the HEC-RAS 2D hydraulic modelling~~) does have an influence on hydrograph timing and ultimately yields different conclusions with respect to the preliminary effectiveness of the direct application of the City's Stormwater Management Guidelines for on-site SWM quantity controls.

5. **Section 2.1.4 SWM Sizing and Flow Assessment, Page 15**
   Regulatory flood flow rates downstream of West Hager FCF must have consideration for blockages; however, these blockages should only be applied if they are expected to increase downstream peak flow rates and generally only for the regulatory storm(s). As discussed on April 19, 2023, the final modelling included with the final data package (for external distribution) will be updated to reflect this.

6. **Section 2.1.5.1 East Rambo Pond Area, Page 18**
   Each individual development application, within the Hager/Rambo system, will be required to demonstrate that their proposed SWM strategy will minimize erosion and mitigate risks to human health, safety, property, and the environment. To meet this requirement, we understand that the City is not supportive of increases in downstream peak flow rates under future development conditions.

7. **Section 2.1.5.1 East Rambo Pond Area, Page 18**
   Refer to be highlighted excerpt from the report. To clarify, the portion of spill occurring downstream of Node 11.2 is incorporated into the VO model through use of a 'ReadHyd' command which contributes to model node 'K'.

> It should be noted that flows are generated at Node R8.1 in the combined Roseland Creek and Hager-Rambo Creek VO model. The flows from Node R8.1 are included in the flow to Node Q, while the local subcatchment ER-1E flow contributes to the model downstream of the East Rambo FCF (i.e., not included in Node Q). The flows from Node R11.2 have not been added to additional flows in the Hager-Rambo VO model (rather this spill flow is determined by the HEC-RAS 2D model separately) and hence the peak flows presented in Table 2.1.8 do not include the influence of the potential spill along the QEW (hydrologic modelling results only). The spill flow from the Roseland Creek Node R11.2 is understood to contribute to the spill flows from the East Rambo Creek over the QEW and impact the hydraulics at the outlet of the East Rambo FCF, which is explored in detail in subsequent sections on hydraulic modelling.

Figure 1: Section 2.1.5.1 East Rambo Pond Area (Page 18)

8. **Section 2.1.5.3 Downstream Hager-Rambo, Page 21**
   To clarify the report's references to "CH criteria", CH staff currently relies on guidance from the province's Technical Guide River and Stream Systems: Flooding Hazard Limit (MNRF, 2002) when providing feedback on spills and whether downstream flows should be reduced as result of spill.

9. **Section 3.1.2 Modelling Results, Page 56**
   The 'without spills' scenario is not being used to inform regulatory peak flow rates. To clarify, the 100-year synthetic frequency design storm generally produces higher peak flow rate estimates than the regional storm (i.e., Hurricane Hazel) does, for the 'without spills' scenario. The Regional storm (i.e., Hurricane Hazel) produces higher peak flow rate estimates for the 'with spills' scenario, and the 'with spills' scenario is generally being used by CH for regulatory purposes.

10. **Section 3.1.2 Modelling Results (Table 3.1.2), Page 58**
    Flows that contribute to the sewer draining the Brant Street underpass, including spill(s), should be accounted for in downstream modelling. The current modelling neglects to consider these flows for certain scenarios (i.e., with FCF – 100 year). This update will be made within the final version(s) of the models to be shared with applicants to support development applications.

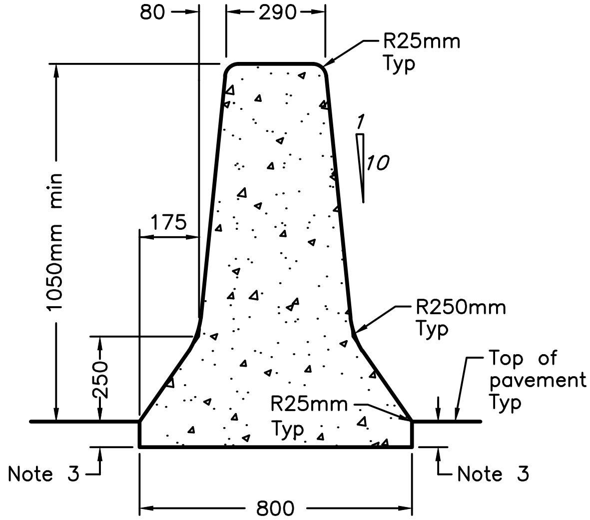
11. **Section 3.3.1.1 Lower Rambo Creek..., Page 61**
    2D modelling for this area incorporated local flows as output from the PCSWMM modelling, at riverine receivers, contrary to the report's text.

12. **Section 4.2 Policy..., Page 66**
    For clarity, CH now refers to quantity controls which have met the criteria for inclusion within the regulatory hydrologic model (i.e., credited) as regulatory controls rather than as regional controls. Staff acknowledges that these terms may have historically been used interchangeably.

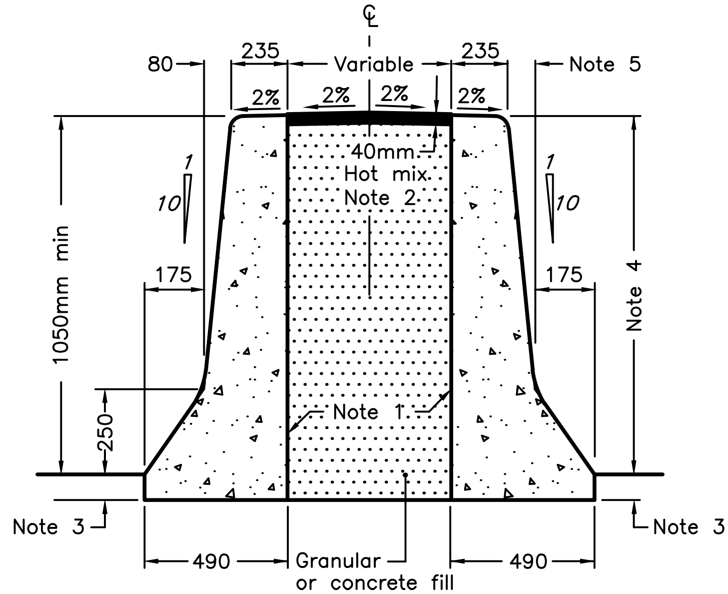
13. **Hydrologic and Hydraulic Modelling**
    As discussed on April 17 and 19, 2023, an interim model package will be prepared by CH and shared with the City to support implementation and share data with current applicants. A document summarizing how to use the models will be included in the package. Following this, minor model and mapping refinements will be completed to support the preparation of final model package(s) and associated mapping. CH staff will continue to work with the City through this process.

Appendix C

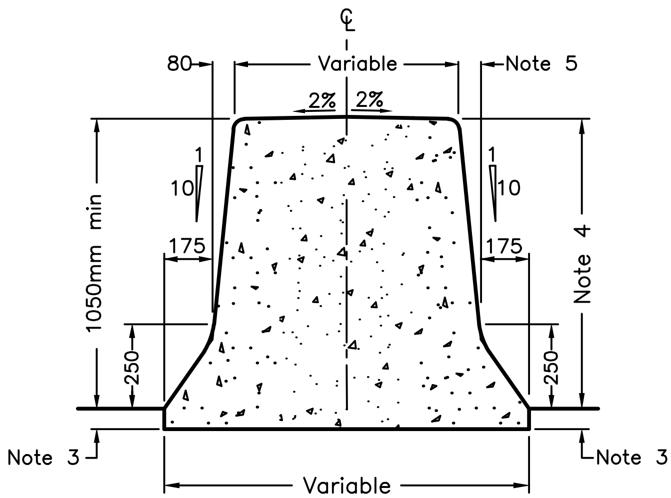
Background Drawings and Field Investigations (Burlington GO)



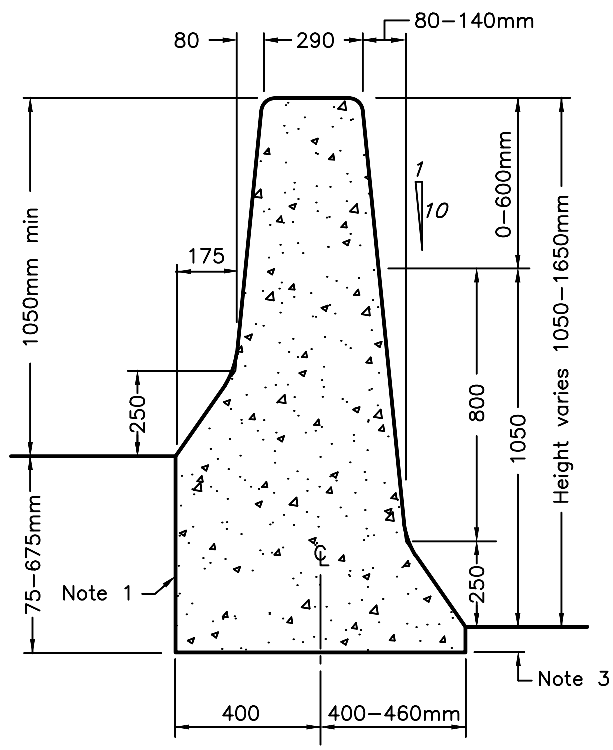
TYPE TW



TYPE TW–2



TYPE TW–3

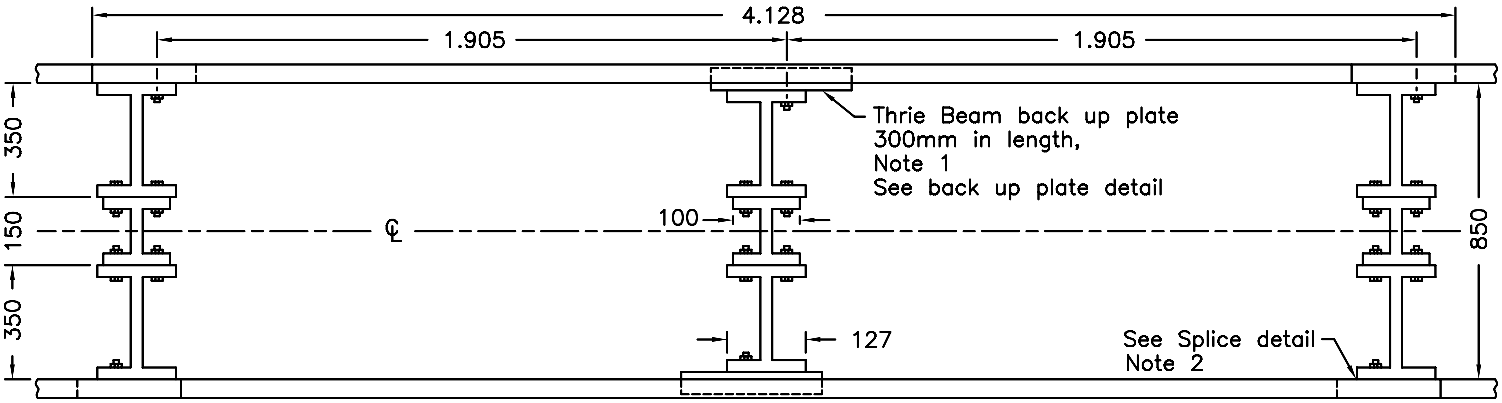


TYPE TW–1
ASYMMETRIC SECTION

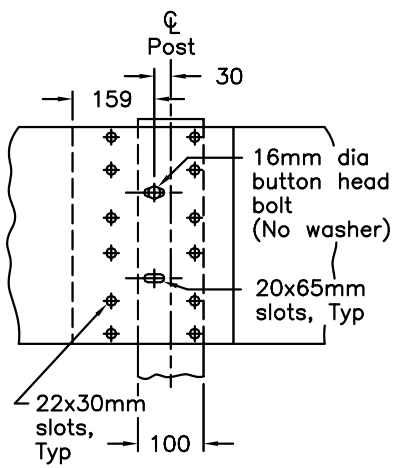
NOTES:

1 For slipforming procedure, a 1H:20V batter is acceptable.
2 Hot mix not required when concrete fill is placed to the top of the concrete barriers.
3 Embedment shall be 75mm into pavement at least 3m wide on both sides of barrier.
4 Height may vary from 1050 to 1650mm in an asymmetric cross section.
5 Width may vary from 80 to 140mm in an asymmetric cross section.
A System configuration equivalent to AASHTO MASH TL–5.
B All dimensions are in millimetres unless otherwise shown.

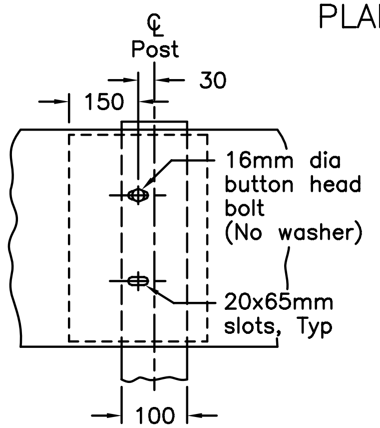
ONTARIO PROVINCIAL STANDARD DRAWING	Apr 2021	Rev 2
GUIDE RAIL SYSTEM, CONCRETE BARRIER CAST–IN–PLACE, TALL WALL INSTALLATION	**OPSD 911.132**	



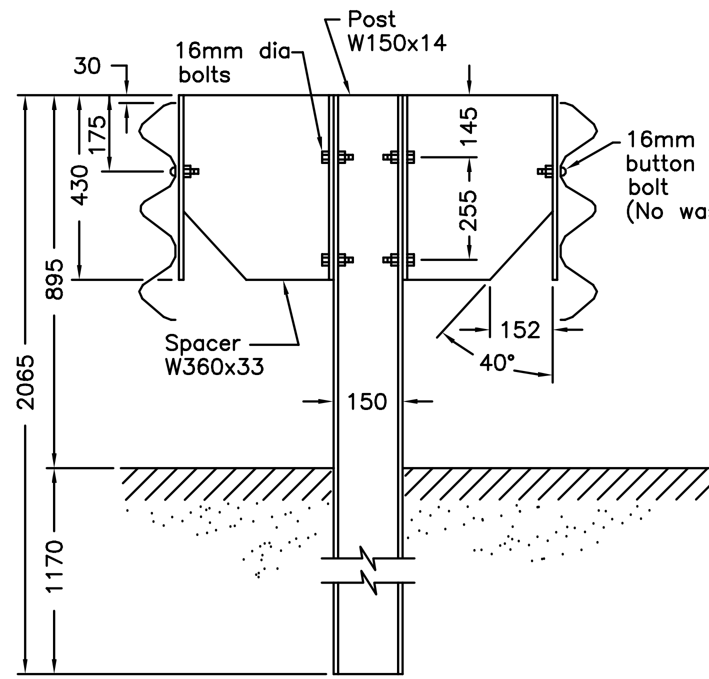
PLAN



SPLICE DETAIL



THRIE BEAM
BACK UP PLATE
DETAIL



CROSS SECTION

NOTES:

1 The 300mm section of Thrie Beam (back up plate) shall be installed at intermediate posts only.

2 Overlap guide rail elements in direction of traffic flow.

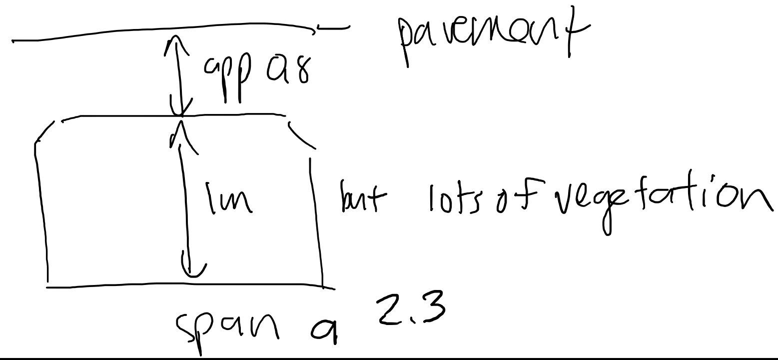
A All dimensions are in millimetres or metres unless otherwise shown.

MINISTRY OF TRANSPORTATION ONTARIO DRAWING	Date	1993 06 02	Rev	
THRIE BEAM GUIDE RAIL MEDIAN BARRIER DETAILS	Issue Date WP Issued By			
	MTOD – 925.100			

Queensway Drive West

Additional Field Notes:

Structure at Queensway was filled in. No visible opening. Measurements taken at QEW entrance.



Sketch/Dimensions

QEW Structure Face (Photo)

Queensway Structure Face (Photo)

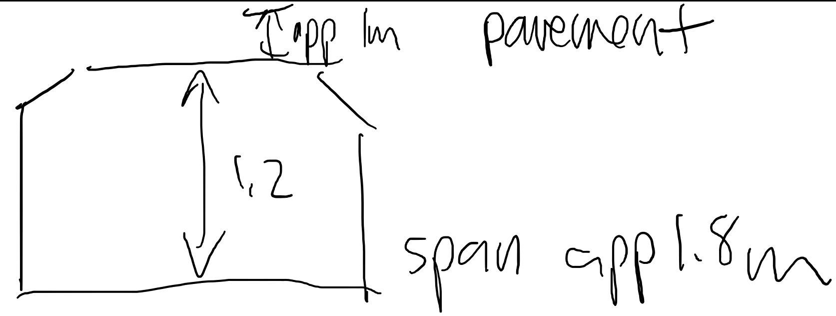
Watercourse at QEW

Watercourse at Queensway

Queensway Drive East

Additional Field Notes:

Structure at Queensway was filled in. No visible opening. Measurements taken at QEW entrance.



Sketch/Dimensions

QEW Structure Face (Photo)

Queensway Structure Face (Photo)

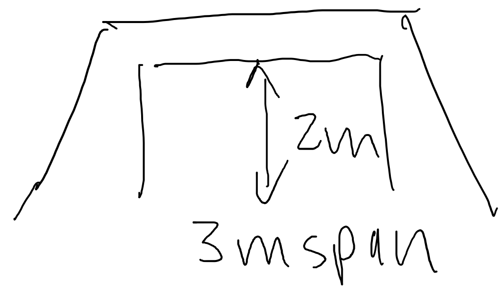
Watercourse at QEW

Watercourse at Queensway

CNR Crossing (East Rambo Creek)

Additional Field Notes:

Height is approximate as the water depth was quite high. Obvert to top of the tracks was approximately 1m.



Sketch/Dimensions

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

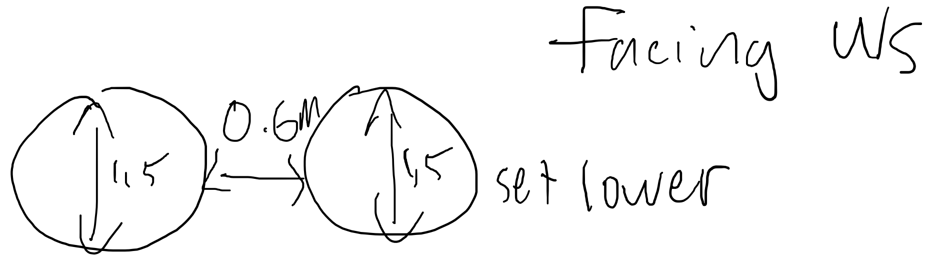
Watercourse Looking Upstream

Watercourse Looking Downstream

East Rambo Pond Access Road (East Rambo Creek)

Additional Field Notes:

Both culverts are 1.5 but LB one is set at a lower elevation and slightly crushed



Sketch/Dimensions

Upstream Structure Face (Photo)

Could not get clear shot from banks.

Downstream Structure Face (Photo)

Watercourse Looking Upstream

Watercourse Looking Downstream

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR2 — Location: Leighland

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	Outfall	Gated (Yes/No):		Yes	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	Concrete
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		No		
Watershed Name:		Opening Shape:	Oval	Material (Conc/Steel/PVC):		Concrete	Flow Present (Y/N):	No
River Name:		Opening Height (m):	1.5	Opening / Span (m):		2.4	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):	NA	Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			flared WW		Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	1.00	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	Open	Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):	NA	NA		

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

NA

Watercourse Looking Upstream

Watercourse Looking Downstream

NA

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR3 — Location: US of Plains

Watershed and Location Information	
Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions				
Structure Type (Culvert/Bridge):	culvery	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	oval	Material (Conc/Steel/PVC):		CSP
Opening Height (m):	1.7	Opening / Span (m):		2.5
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			flared WW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.85	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information	
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone and gravel
Flow Present (Y/N):	yes
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR4 — Location: Plains Road East

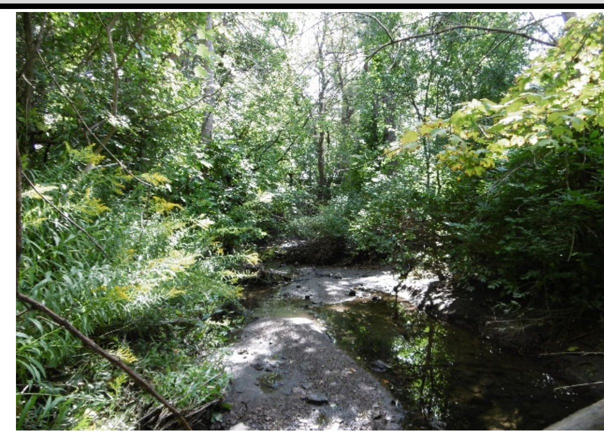
Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	silt and gravel
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:		Opening Height (m):	1.6	Opening / Span (m):		4.2	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			projecting		Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	na	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)				
		Railing Height (m):	na	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream



Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR5 — Location: CNR

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.7	Opening / Span (m):		4.2
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			projecting	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.60	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)		
Railing Height (m):	na	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	silt
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Inaccessible

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Inaccessible

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR6 Location: CNR

Watershed and Location Information	
Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions				
Structure Type (Culvert/Bridge):	Bridge	Gated (Yes/No):		No
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	arch	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	3	Opening / Span (m):		2.8
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	3.30	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information	
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR7 — Location: DePauls Lane

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2	Opening / Span (m):		7.8
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.70	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	closed	Surveyed Obvert (m)		
Railing Height (m):	1.2	Depth of Siltation (mm):		

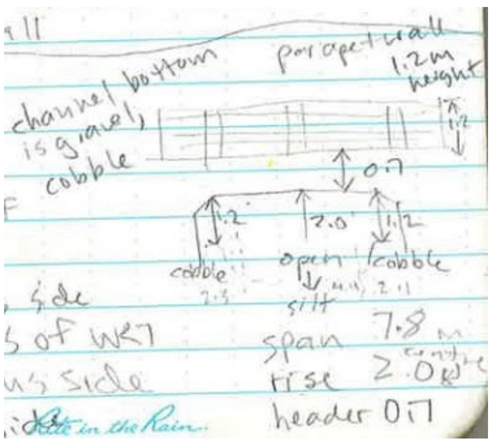
Current Flow Information

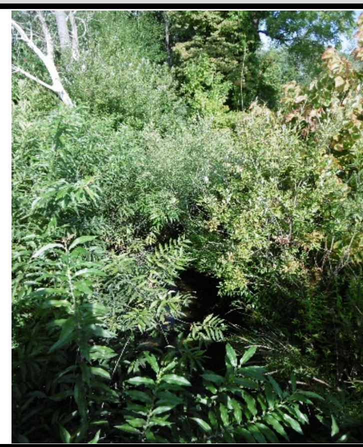
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel, stone
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.




Watercourse Looking Upstream


Watercourse Looking Downstream


Upstream Structure Face (Photo)


Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : WR8 — Location: Fairview Street

Watershed and Location Information	
Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions				
Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.3	Opening / Span (m):		4.4
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.60	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):		Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information	
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	Stone, large rock
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

NA

Watercourse Looking Downstream

Upstream Structure Face (Photo)

NA

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : ER1 **Location: Glenwood**

Watershed and Location Information	
Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions				
Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.7	Opening / Span (m):		3
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.60	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)		
Railing Height (m):	na	Depth of Siltation (mm):		

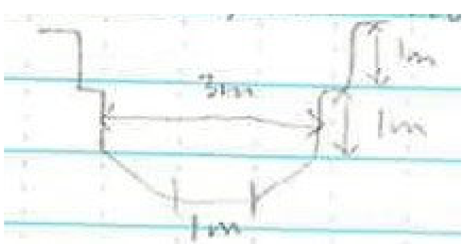
Current Flow Information	
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Gabion lined channel



Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : ER2 Location: CNR

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.5	Opening / Span (m):		3
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.00	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)		
Railing Height (m):	na	Depth of Siltation (mm):		

Current Flow Information

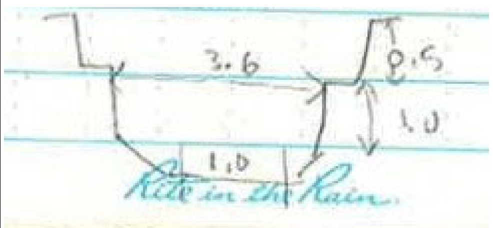
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Gabion lined channel



Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : ER3 — Location: Fairview

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	2	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.3	Opening / Span (m):		3.8 each
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.60	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

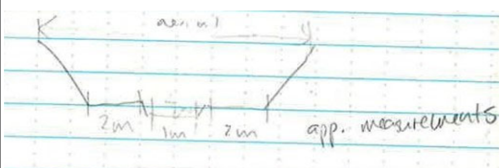
Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.



Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : DC1 Location: Fairview

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Field Crew:	KL	Number of Openings:	2	Open Footing (Yes/No):		no		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:		Opening Height (m):	3.8	Opening / Span (m):		na	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	1.00	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)				
		Railing Height (m):	na	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Inaccessible

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Inaccessible

Downstream Structure Face (Photo)

CROSSING # : DC2 — Location: Brant/Fairview (east)

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete, silt, sand
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		no		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:		Opening Height (m):	2.7	Opening / Span (m):		6.2	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW		Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	1.50	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):		Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Concrete walls

NA

Watercourse Looking Upstream

Watercourse Looking Downstream

NA

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : DC3 — Location: Brant/Fairview (west)

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		
Number of Openings:	1	Open Footing (Yes/No):		No
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.5	Opening / Span (m):		6.4
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.50	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	None	Surveyed Obvert (m)		
Railing Height (m):	na	Depth of Siltation (mm):		

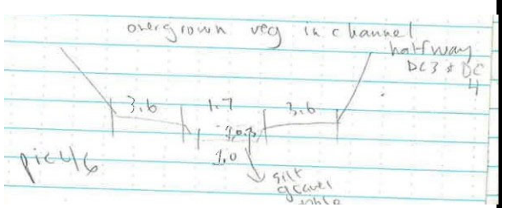
Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete and grasses
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.



Watercourse Looking Upstream

NA

Watercourse Looking Downstream

Upstream Structure Face (Photo)

NA

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : DC4 Location: CNR

Watershed and Location Information		Structure Configuration and Dimensions				Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):	no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Field Crew:	KL	Number of Openings:	2	Open Footing (Yes/No):	no		
Watershed Name:		Opening Shape:	circular	Material (Conc/Steel/PVC):	CSP	Flow Present (Y/N):	
River Name:		Opening Height (m):	3.3 each	Opening / Span (m):	3.3 each	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S** / **D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.60	Surveyed Invert (m)		Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)			
		Railing Height (m):	na	Depth of Siltation (mm):			

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : DC5 — Location: Between Stephenson/Fairview

Watershed and Location Information

Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.75	Opening / Span (m):		4.3
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.60	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	

Additional Flow Information / Notes:

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

NA

Watercourse Looking Downstream

Upstream Structure Face (Photo)

NA

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

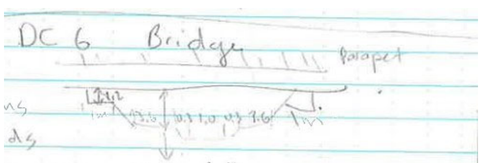
CROSSING # : DC6 Location: Thorpe

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	06/09/2017	Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		no		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:		Opening Height (m):	3.3	Opening / Span (m):		10.6	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):		Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.



NA

Watercourse Looking Upstream

NA

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : DC7 **Location: Maple**

Watershed and Location Information	
Date (dd/mm/yyyy):	06/09/2017
Field Crew:	KL
Watershed Name:	
River Name:	
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions				
Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no
Number of Openings:	2	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	2.8	Opening / Span (m):		5.5 each
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.30	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information	
Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	concrete
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

NA

Watercourse Looking Upstream

NA

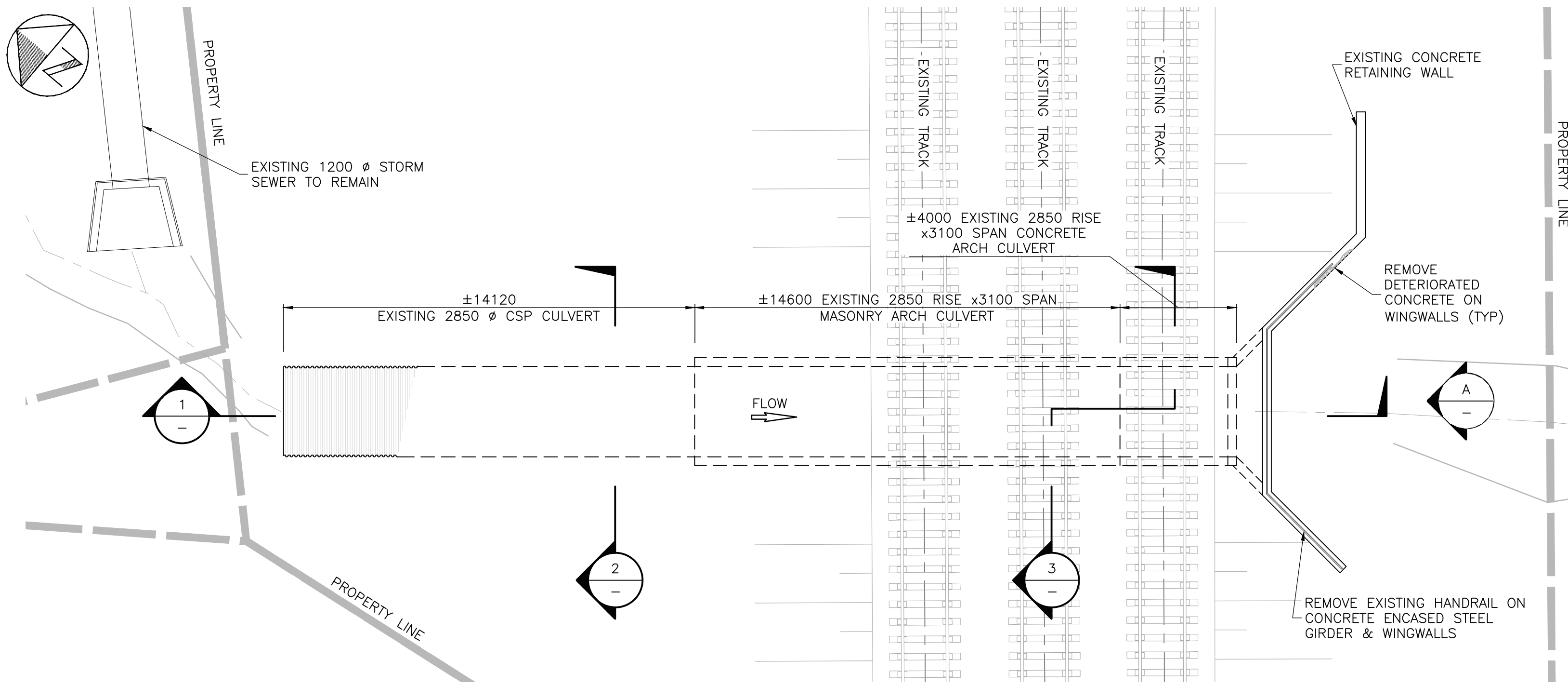
Watercourse Looking Downstream

Upstream Structure Face (Photo)

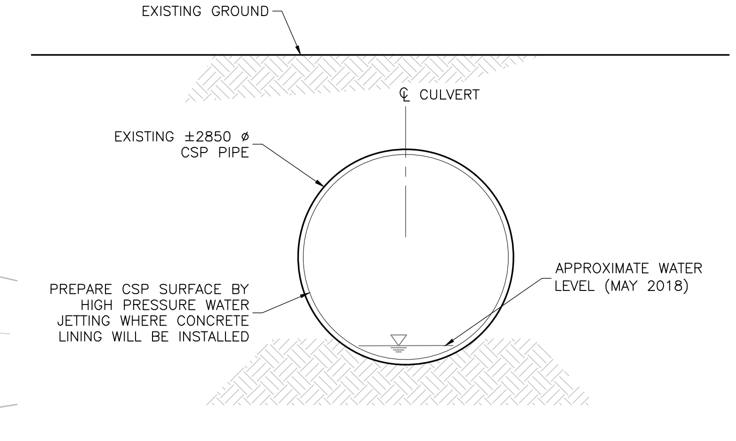
Downstream Structure Face (Photo)

Photo 1 – Outlet – South Side

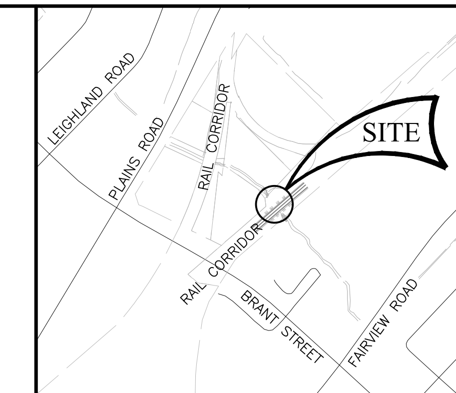
Photo 2 – Inlet & Storm Drain – North Side



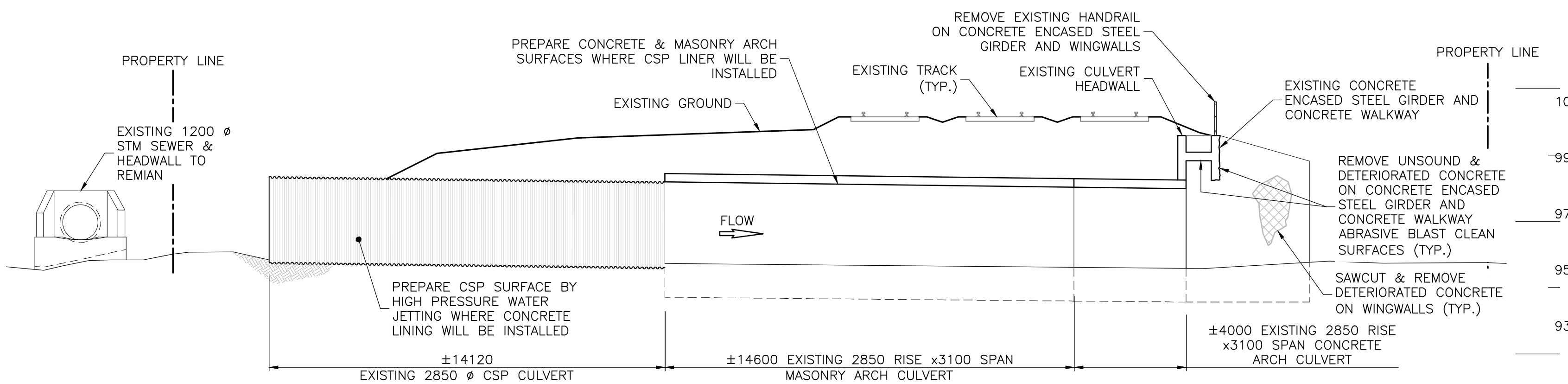
PLAN
SCALE 1:125



SECTION–EXISTING (2)
SCALE: 1:50



KEY PLAN



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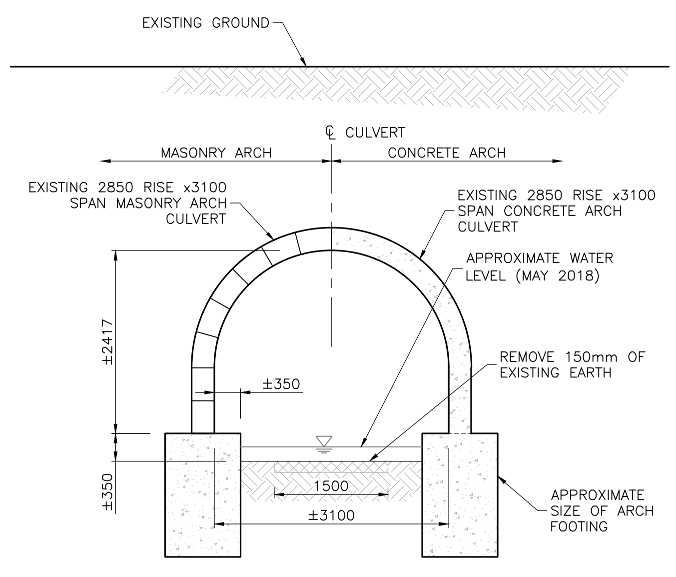

SECTION–EXISTING & REMOVALS (3)
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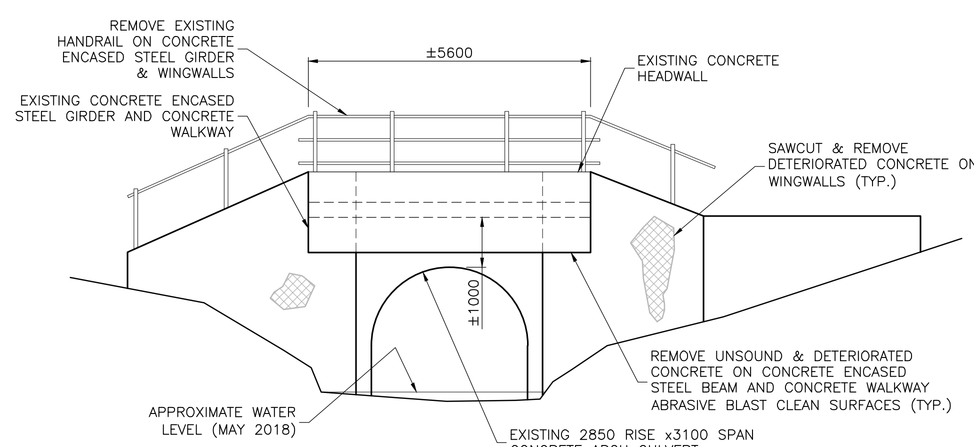


SOUTH ELEVATION
EXISTING & REMOVALS (A)
SCALE: 1:75

LEGEND

REMOVAL

GENERAL CONSTRUCTION NOTES:

1. NEW CSP LINER IN ARCH CULVERT TO BE DESIGNED BY CONTRACTOR ASSUMING EXISTING ARCH IS FULLY DETERIORATED.
2. NEW CSP LINER TO BE DESIGNED FOR ACTUAL EARTH COVER AND COOPER E80 LIVE LOAD.
3. DESIGN TO BE CARRIED OUT AS PER AREMA MANUAL AND METROLINX GENERAL GUIDELINES FOR DESIGN OF RAILWAY BRIDGES AND STRUCTURES.
4. STRUCTURAL DRAWINGS MUST BE READ IN CONJUNCTION WITH ALL PROJECT DRAWINGS AND SPECIFICATIONS. SHOULD THERE BE ANY DISCREPANCY BETWEEN THE INFORMATION PRESENTED ON THE DRAWINGS AND SPECIFICATIONS, THE ONE WHICH CLEARLY DEFINES THE INTENT OF THE DESIGN SHALL TAKE PRECEDENCE.
5. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, DETAILS AND ELEVATIONS OF THE EXISTING AND PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
6. ALL SERVICES ARE TO BE ACCURATELY LOCATED PRIOR TO CONSTRUCTION AND ADEQUATE PROTECTION PROVIDED AT ALL TIMES. ANY INTERFERENCE OF EXISTING SERVICES OR UTILITIES WITH PROPOSED STRUCTURE OR CONSTRUCTION OPERATION IS TO BE REPORTED TO THE CONTRACT ADMINISTRATOR PRIOR TO CONSTRUCTION.
7. DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
8. DO NOT SCALE THESE DRAWINGS.
9. ALL CODES AND REGULATIONS QUOTED SHALL BE THE LATEST EDITION.
10. ALL CONSTRUCTION TO BE COMPLETED IN ACCORDANCE WITH LOCAL GOVERNING REQUIREMENTS, INCLUDING THE OCCUPATIONAL HEALTH AND SAFETY ACT.
11. SAWCUTS SHALL BE 25 mm OR TO THE FIRST LAYER OF REINFORCING STEEL WHICHEVER IS LESS.
12. THE CONTRACTOR SHALL ENSURE APPLICABLE EROSION AND SEDIMENT CONTROL MEASURES ARE IN PLACE PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES AND REMAIN IN PLACE UNTIL ALL DISTURBED AREAS ARE FULLY STABILIZED SO AS TO RETAIN SEDIMENT ON–SITE AND PREVENT ITS ENTRY INTO THE WATERCOURSE.
13. CONTRACTOR TO DEWATER AREA AND PROVIDE TEMPORARY FLOW/BYPASS FOR WATER IN CREEK, PRIOR TO COMMENCING WORK ON CULVERT REPAIRS.

CLASS OF CONCRETE:

1. SPECIFIED COMPRESSIVE STRENGTH SHALL BE 35 MPa AT 28 DAYS, UNLESS NOTED OTHERWISE.
2. THE MINIMUM SPECIFIED COMPRESSIVE STRENGTH SHALL BE:
   – 35 MPa – CLASS C–1 UNLESS NOTED OTHERWISE
   – GROUT FOR GROUTING ANNULAR SPACE BETWEEN EXISTING ARCH AND NEW CSP LINER SHALL BE MIN. 10 MPa.
3. CONCRETE MIX DESIGNS SHALL BE SUBMITTED TO THE CONTRACT ADMINISTRATOR FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.

CLEAR COVER TO REINFORCING STEEL

4. PATCHES 50 mm +/– 10
5. REMAINDER 70 mm +/– 20 UNLESS NOTED OTHERWISE

REINFORCING STEEL:

1. REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO CSA G30.18, GRADE 400W, UNLESS OTHERWISE NOTED.
2. STAINLESS STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE NOTED.
3. ALL DIMENSIONS ARE OUT/OUT BARS (TYPICAL).
4. UNLESS SHOWN OTHERWISE, TENSION LAP SHALL BE CLASS 'B'.
5. BAR HOOKS SHALL HAVE STANDARD DIMENSIONS USING MINIMUM BEND DIAMETERS WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWINGS SS12–1 UNLESS OTHERWISE NOTED.

STRUCTURAL STEEL NOTES:

1. NEW CSP LINER SHALL BE AS PER CAN/CSA G401–14, 230 MPa MINIMUM YIELD STRENGTH.
2. NEW CSP LINER SHALL BE GALVANIZED ACCORDING TO CAN/CSA G164–18.
3. SHEAR STUD CONNECTORS SHALL CONFORM TO ASTM A108 AND CSA W59, TYPE 'B'.
4. ALL WELDING SHALL BE CARRIED OUT IN ACCORDANCE WITH CSA W59. THE WELDER SHALL BE FULLY APPROVED BY THE CANADIAN WELDING BUREAU IN CONFORMANCE WITH CSA W47.1.

LICENSED PROFESSIONAL ENGINEER M. GALLOWAY 100167280 13 MARCH 2020 PROVINCE OF ONTARIO

Path: P:\2017\Projects\TPB175145 – Railway Crossing Insp And Design\06_DES-ENG\01_CAD\02_DWGS\03_STRUC\Brant Street\TPB175145 BS –S1.dwg

Plotted By: mariusz.eizenbart
Last Saved By: mariusz.eizenbart
Plotted: 2020-03-13
Last Saved: 2020-03-13

No	Date	Drawn	Appr'd	Revisions
1	2020/03/13	ME	MG	PRELIMINARY DESIGN DRAWING

APPROVALS

Design	KK/MG	Checked	MG
Drawn	ME	Checked	
Scale	AS SHOWN		
Date	MARCH 2020		

PRELIMINARY
NOT TO BE USED
FOR CONSTRUCTION

STORMWATER RAILWAY CROSSING
INSPECTION AND DESIGN
Burlington

EAST OF BRANT STREET
METROLINX MILEAGE 31.85 OAKVILLE SUBDIVISION
GENERAL ARRANGEMENT
EXISTING CONDITION & REMOVALS

wood.

Contract No.

Consultant File No. TPB175145

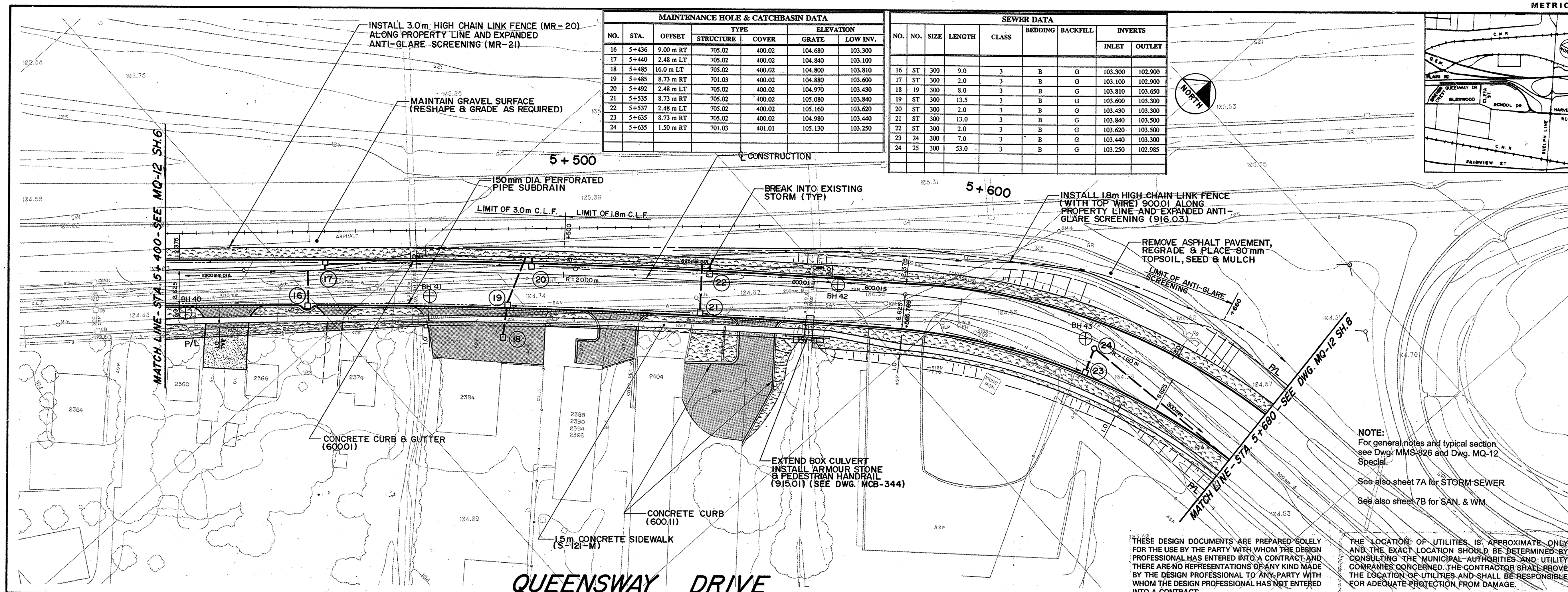
Drawing No. SHEET S1 OF S5

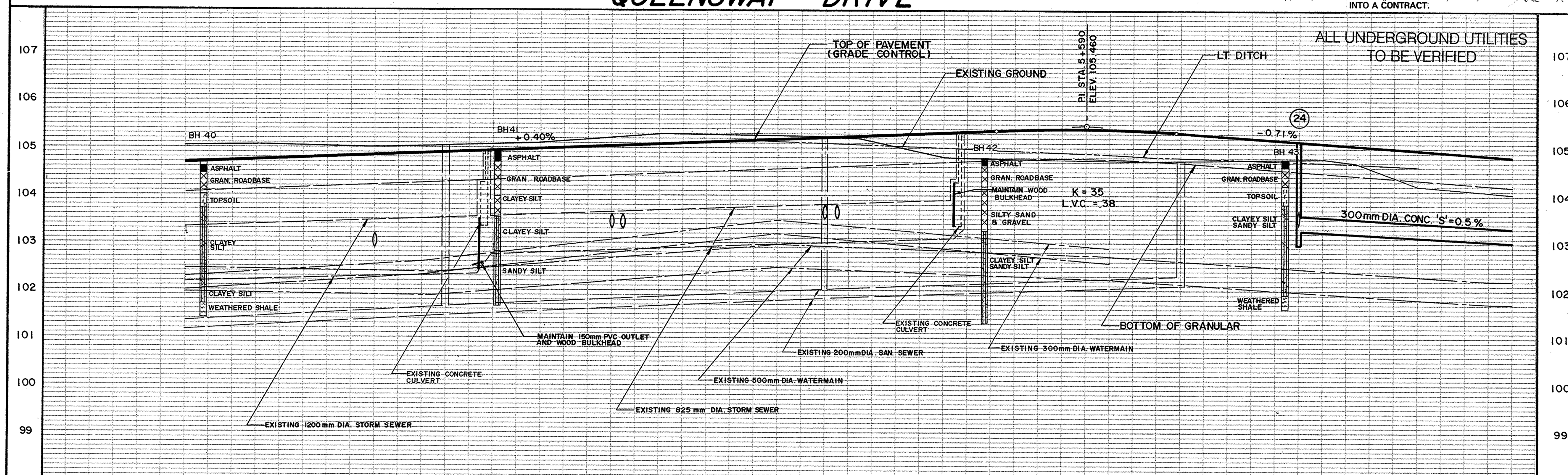
MQ-12
SH. 7

METRIC

MAINTENANCE HOLE & CATCHBASIN DATA						
NO.	STA.	OFFSET	TYPE		ELEVATION	
			STRUCTURE	COVER	GRATE	LOW INV.
16	5+436	9.00 m RT	705.02	400.02	104.680	103.300
17	5+440	2.48 m LT	705.02	400.02	104.840	103.100
18	5+485	16.0 m LT	705.02	400.02	104.800	103.810
19	5+485	8.73 m RT	701.03	400.02	104.880	103.600
20	5+492	2.48 m LT	705.02	400.02	104.970	103.430
21	5+535	8.73 m RT	705.02	400.02	105.080	103.840
22	5+537	2.48 m LT	705.02	400.02	105.160	103.620
23	5+635	8.73 m RT	705.02	400.02	104.980	103.440
24	5+635	1.50 m RT	701.03	401.01	105.130	103.250

SEWER DATA								
NO.	NO.	SIZE	LENGTH	CLASS	BEDDING	BACKFILL	INVERTS	
							INLET	OUTLET
16	ST	300	9.0	3	B	G	103.300	102.900
17	ST	300	2.0	3	B	G	103.100	102.900
18	19	300	8.0	3	B	G	103.810	103.650
19	ST	300	13.5	3	B	G	103.600	103.300
20	ST	300	2.0	3	B	G	103.430	103.300
21	ST	300	13.0	3	B	G	103.840	103.500
22	ST	300	2.0	3	B	G	103.620	103.500
23	24	300	7.0	3	B	G	103.440	103.300
24	25	300	53.0	3	B	G	103.250	102.985





STATIONS	5+400	5+420	5+440	5+460	5+480	5+500	5+520	5+540	5+560	5+580	5+600	5+620	5+640	5+660
TOP OF PAVEMENT ELEVATIONS	105.700	105.780	105.860	104.940	105.020	105.100	105.180	105.260	105.340	105.408	105.377	105.248	105.106	104.965

Nº	Date	By	REVISIONS

Design D.S.W. Checked
Drawn A.K.S. Checked R.I.R.
Date JANUARY, 1994
Scale HORIZ. VERT.
REFERENCES
FIELD NOTES

APPROVALS

Municipal
DIRECTOR OF ENGINEERING.
DATE May 9/94

Regional
COMMISSIONER OF PUBLIC WORKS.
DIRECTOR OF DESIGN & CONSTRUCTION.

STAMP
REGISTERED PROFESSIONAL ENGINEER
R.I. ROOK
4/22/94
PROVINCE OF ONTARIO

CONSULTANT
McCORMICK RANKIN
CONSULTING ENGINEERS

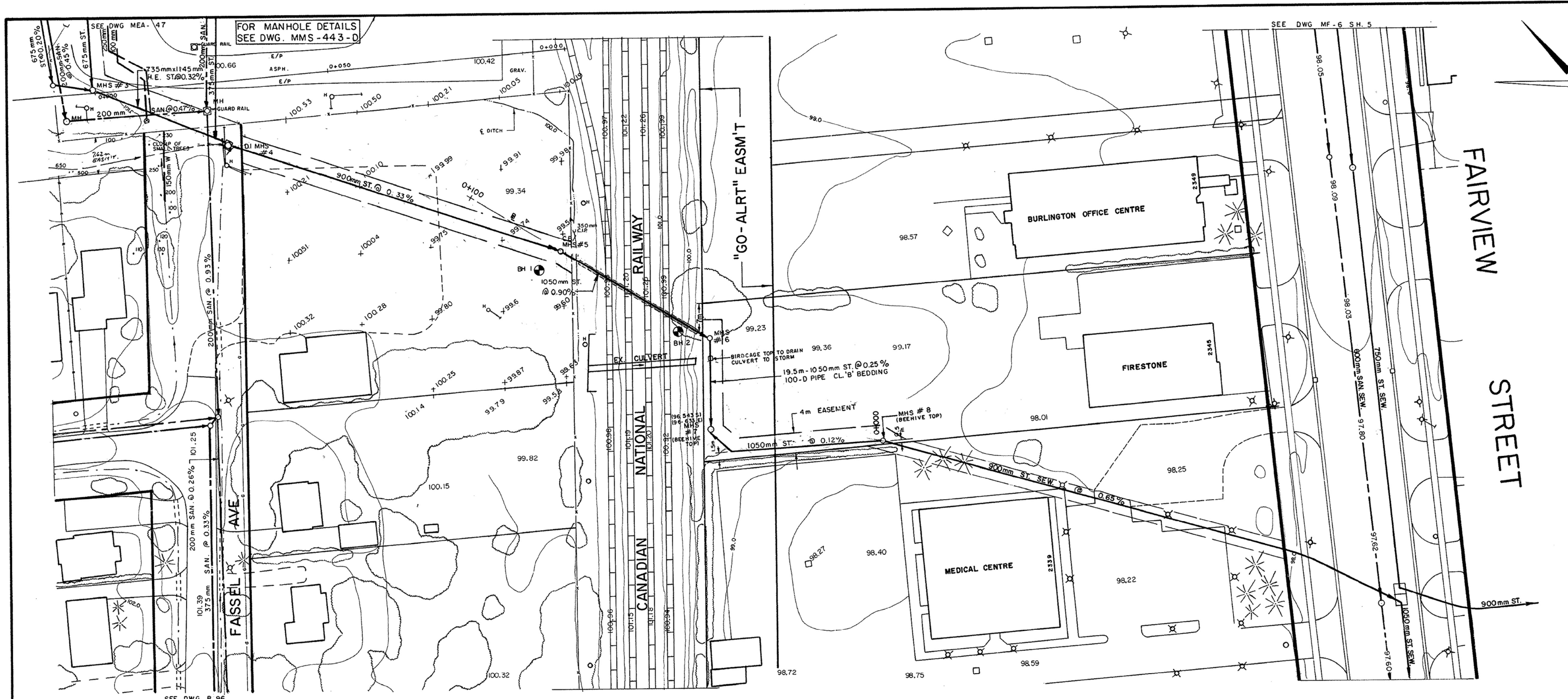
MUNICIPALITY
The Corporation of the
City of Burlington

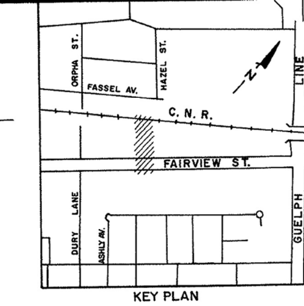
TITLE
QUEENSWAY DRIVE
BRENDA CRESCENT TO GUELPH LINE
STA. 5 + 400 TO STA. 5 + 680

GRADING, PAVEMENT & DRAINAGE

MUNICIPAL DRAWING Nº MQ-12
REGIONAL DRAWING Nº
CONTRACT Nº 94-2
SHEET 7 OF

MEA-RC-44





GEOD. B.M.

GUELPH LINE OVERPASS OVER Q.E.W. TABLET IN TOP OF SIDEWALK ON N.E. SIDE OF BRIDGE, 2.4384 m S.E. OF CONC. WALL AT N.W. END, 0.79 m N.E. OF EDGE OF CURB EST.'D BY TOPO. SVY. 650029

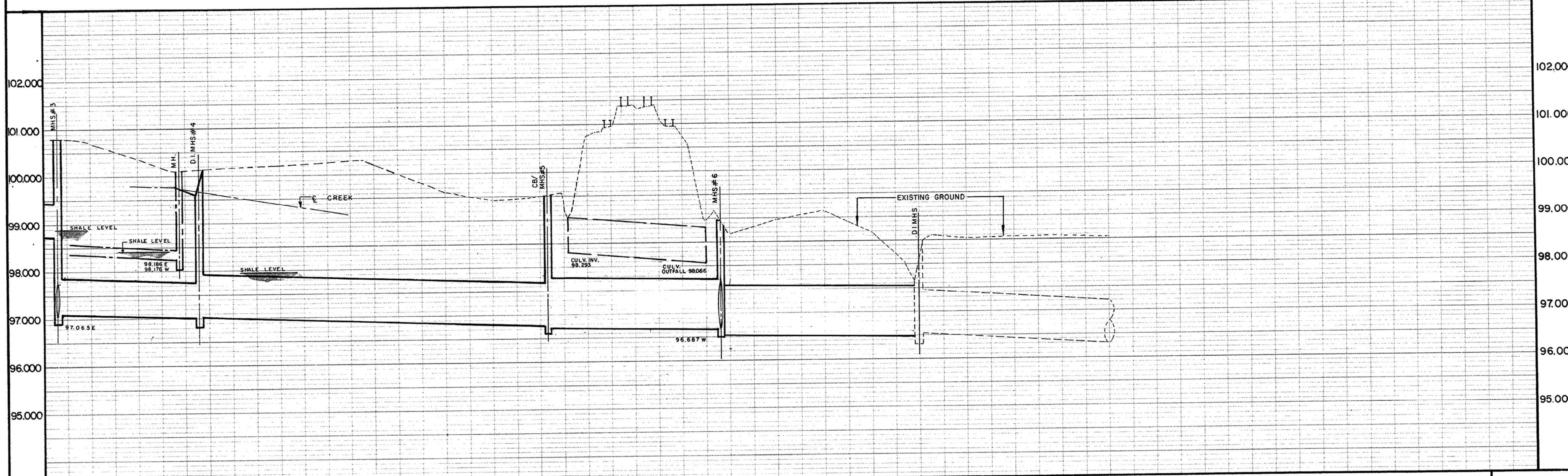
ELEV. – 114.053

B.M.

2429 REDFERN RD., LOT 2 R.P. 1375; BRASS CAP, S.'LY WALL 0.10 m FROM S.W.'LY CORNER 0.18m ABOVE GRADE.

ELEV. - 95.425

ALL ELEVATIONS ARE REFERRED TO 1978 ADJUSTMENT



	200 mm SAN. @ 0.47% — 98.211
STORM SEWER	98.746 / 97.112 — 30 m - 735mm x 1145mm H.E. ST. @ 0.32% 65-D PIPE CL. 'B' BEDDING — 97.015 / 97.032 — 73.5 m - 900mm ST. @ 0.33% 65-D PIPE, CL. 'B' BEDDING — 96.789 / 96.714 — 36.5 m - 1050mm ST. @ 0.9% 140-D PIPE — 96.682 — 37.5 m - 1050 mm ST. @ 0.12% 100-D PIPE CL. 'B' BEDDING — 96.497 / 96.432 — 112 m - 900 mm ST. SEW. @ 0.65 %
CHAINAGE	0+077 / 0+074 — 0+045 — 0+000

Nº	Date	By	REVISIONS
1	JUL/85	A.C.	AS CONSTR. 85-1 FN. B-318 & INSPECT.'S DWGS.

Design	I.V.	Checked		Date: FEBRUARY, 1984.
Drawn	J.D.S.	Checked		REFERENCES
Scale: HOR 1:500, VER 1:50				FIELD NOTES: R - 131

APPROVALS

Municipal

DIRECTOR OF PUBLIC WORKS

DATE

Regional

STAMP

CONSULTANT

MUNICIPALITY

CITY OF BURLINGTON

DEPARTMENT OF PUBLIC WORKS

TITLE

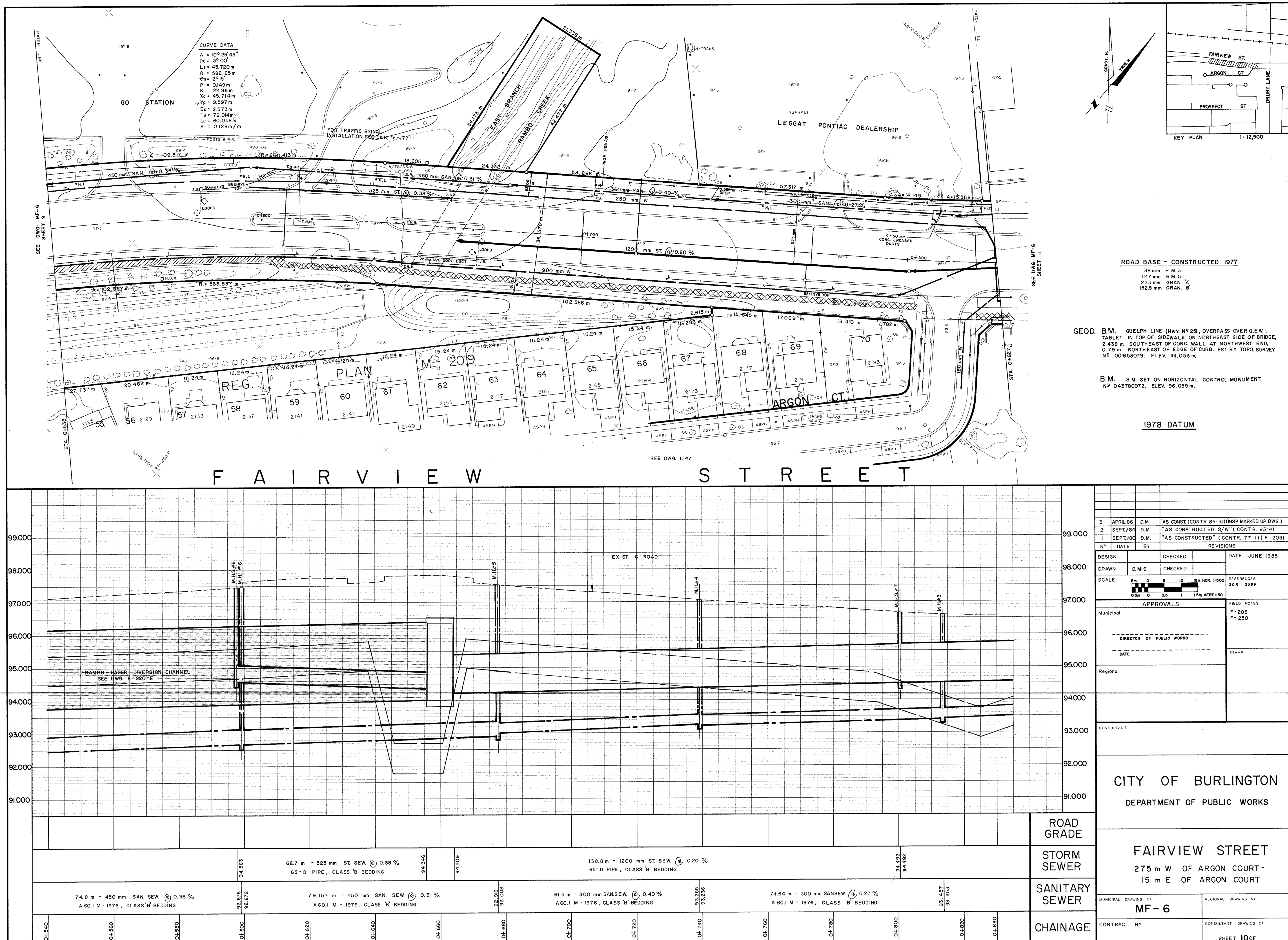
ROSELAND CREEK ENCLOSURE @ C.N.R.

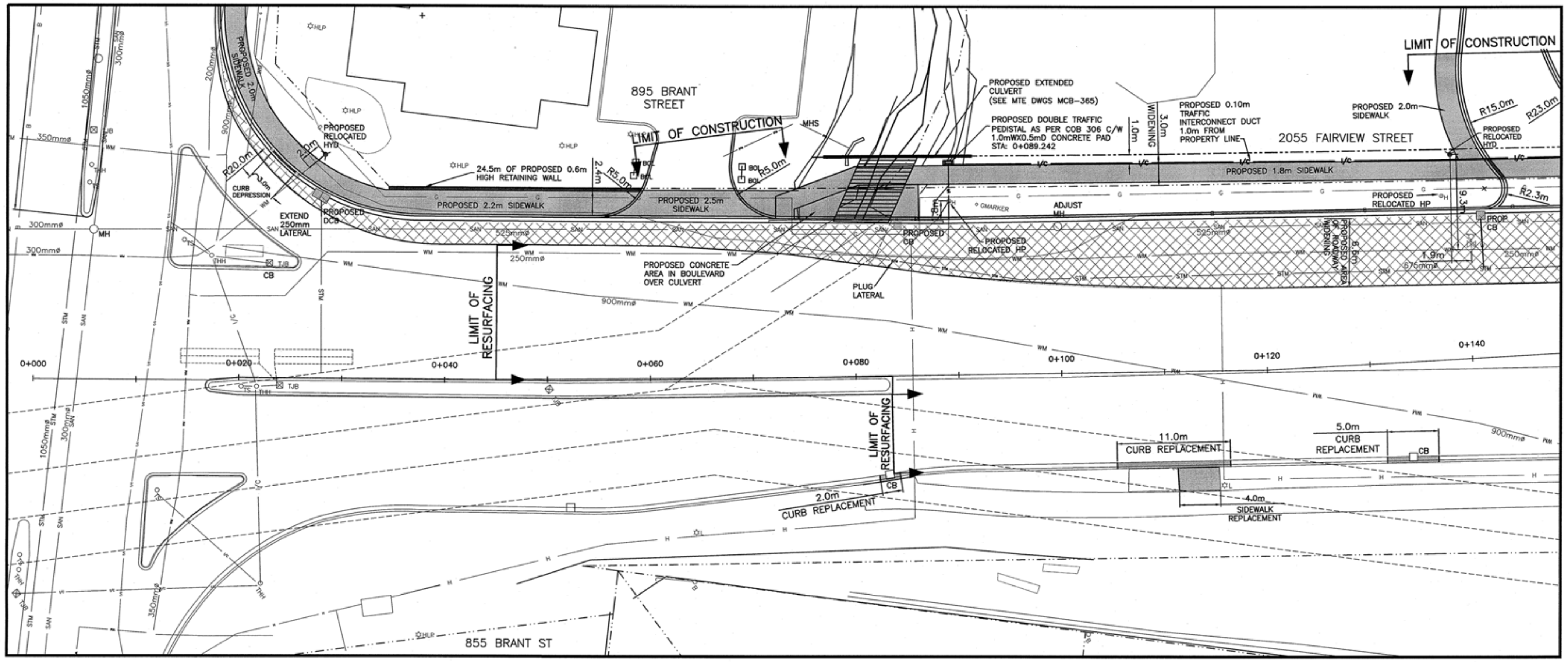
MUNICIPAL DRAWING Nº: MEA-RC-44

REGIONAL DRAWING Nº:

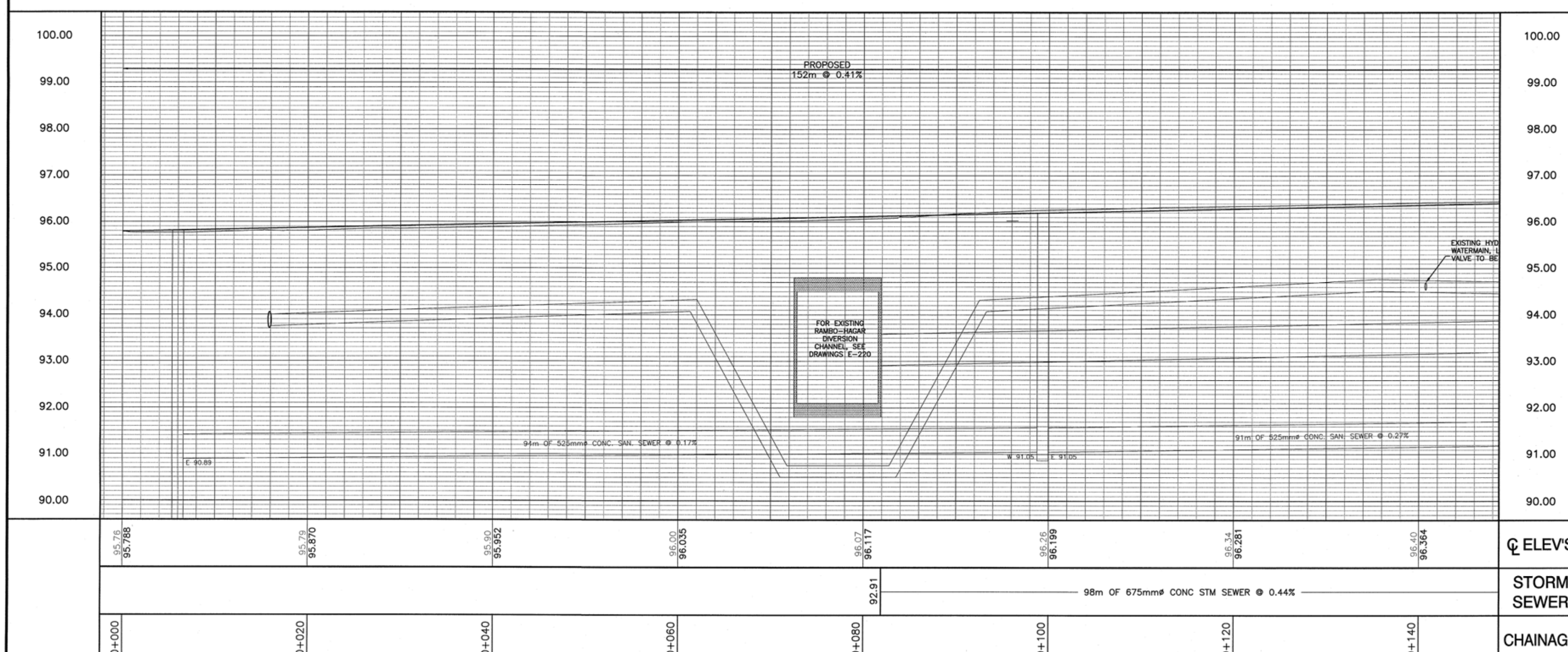
CONTRACT Nº:

SHEET 1 OF 1


MF-6
SH 10
CURVE DATA
Δ = 10° 25' 45"
Dc = 3° 00'
Ls = 45.720 m
R = 582.125 m
θs = 2° 15'
P = 0.149 m
K = 22.86 m
Xc = 45.714 m
Yc = 0.597 m
Es = 2.573 m
Ts = 76.014 m
Lc = 60.058 m
S = 0.128 m/m
GO STATION
FOR TRAFFIC SIGNAL INSTALLATION SEE DWG. TC-177-1
EAST BRANCH
RAMBO CREEK
LEGGAT PONTIAC DEALERSHIP
450 mm SAN. @ 0.36 %
525 mm ST. @ 0.38 %
450 mm SAN. @ 0.31 %
300 mm SAN. @ 0.40 %
300 mm SAN. @ 0.27 %
250 mm W
1200 mm ST @ 0.20 %
900 mm W
4-50 mm CONC. ENCASED DUCTS
25 mm U/G LOOP DUCT
BEEHIVE TOP
SEE DWG. MF-6 SHEET 9
SEE DWG. MF-6 SHEET 11
REG. PLAN M-209
ARGON CT.
SEE DWG. L 47
F A I R V I E W S T R E E T
KEY PLAN 1:12,500
FAIRVIEW ST.
ARGON CT
PROSPECT ST
DRURY LANE
CONST. N.
TRUE N.
ROAD BASE - CONSTRUCTED 1977
38 mm H.M. 3
127 mm H.M. 5
225 mm GRAN. 'A'
152.5 mm GRAN. 'B'
GEOD. B.M. GUELPH LINE (HWY. Nº 25), OVERPASS OVER Q.E.W.; TABLET IN TOP OF SIDEWALK ON NORTHEAST SIDE OF BRIDGE, 2.438 m SOUTHEAST OF CONC. WALL AT NORTHWEST END, 0.79 m NORTHEAST OF EDGE OF CURB. EST. BY TOPO. SURVEY Nº 001653079. ELEV. 114.053 m.
B.M. B.M. SET ON HORIZONTAL CONTROL MONUMENT Nº 043780072. ELEV. 96.059 m.
1978 DATUM
EXIST. ℄ ROAD
RAMBO - HAGER DIVERSION CHANNEL SEE DWG. E-220-E
M.H.S.#6
M.H.#6
M.H.#5
M.H.#4
M.H.S.#7
M.H.#3
ROAD GRADE
STORM SEWER
62.7 m - 525 mm ST. SEW. @ 0.38 % 65-D PIPE, CLASS 'B' BEDDING
138.8 m - 1200 mm ST. SEW. @ 0.20 % 65-D PIPE, CLASS 'B' BEDDING
SANITARY SEWER
74.8 m - 450 mm SAN. SEW. @ 0.36 % A 60.1 M - 1976, CLASS 'B' BEDDING
79.157 m - 450 mm SAN. SEW. @ 0.31 % A 60.1 M - 1976, CLASS 'B' BEDDING
61.5 m - 300 mm SAN. SEW. @ 0.40 % A 60.1 M - 1976, CLASS 'B' BEDDING
74.64 m - 300 mm SAN. SEW. @ 0.27 % A 60.1 M - 1976, CLASS 'B' BEDDING
CHAINAGE
3 APRIL 86 D.M. "AS CONST." (CONTR. 85-10) (INSP. MARKED UP DWG.)
2 SEPT/84 D.M. "AS CONSTRUCTED S/W" (CONTR. 83-4)
1 SEPT/80 D.M. "AS CONSTRUCTED" (CONTR. 77-1) (F-205)
Nº DATE BY REVISIONS
DESIGN CHECKED DATE JUNE 1985
DRAWN D.MIS CHECKED
SCALE 15m HOR. 1:500 1.5m VERT. 1:50
REFERENCES 20R-3399
APPROVALS
Municipal
DIRECTOR OF PUBLIC WORKS
DATE
Regional
FIELD NOTES F-205 F-250
STAMP
CONSULTANT
CITY OF BURLINGTON
DEPARTMENT OF PUBLIC WORKS
FAIRVIEW STREET
275 m W OF ARGON COURT - 15 m E OF ARGON COURT
MUNICIPAL DRAWING Nº MF-6
REGIONAL DRAWING Nº
CONTRACT Nº
CONSULTANT DRAWING Nº
SHEET 10 OF
MF-6 SHEET



FAIRVIEW STREET



No.	DATE	BY	REVISIONS
2	07/05/08	AXI	ISSUED FOR CONSTRUCTION
1	06/20/07	AXI	ISSUED FOR TENDER

DESIGN: A. IVANAJ — CHECKED
DRAWN: A. IVANAJ — CHECKED
DATE: JUNE 2007
SCALE: HORZ. 1:250, VERT 1:50
REFERENCES:
FIELD NOTES:
STAMP

APPROVALS
MUNICIPAL
MANAGER OF DESIGN AND CONSTRUCTION
DATE May 6/2008
REGIONAL
COMMISSIONER OF PUBLIC WORKS
DIRECTOR OF DESIGN & CONSTRUCTION
CONSULTANT

CITY OF Burlington

TITLE
FAIRVIEW STREET
BRANT ST TO FUTURE WAL-MART ENTRANCE

MUNICIPAL DRAWING NO. MF-06
CAD FILENAME M:\2007 CONTRACTS\FAIRVIEWCUNAGO-2\DWG\PHASE ONE.DWG
CONTRACT NO. 07-13
SHEET 1 OF 4

FAIRVIEW STREET WIDENING
07-13

Appendix D

Hydrologic and Hydraulic Modelling Files (Burlington GO Area)

Location	Drainage Area (ha)	Table D1: Actual Existing Condition Subcatchment Flows Simulated Peak Flow (m^3/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A	28.4	2.13	3.01	3.78	4.64	5.26	5.87	3.82
ER-1B-E	3.34	0.41	0.56	0.65	0.78	0.88	0.97	0.48
ER-1B-F	6.59	0.86	1.17	1.37	1.64	1.83	2.12	0.95
ER-1D-E	21.79	2.08	3	3.57	4.47	5.07	5.64	3.1
ER-1D-F	1.85	0.21	0.29	0.34	0.41	0.46	0.51	0.26
ER-1C	8.08	0.85	1.18	1.4	1.73	1.96	2.17	1.15
ER-1F	8.21	0.94	1.29	1.51	1.83	2.05	2.27	1.16
WR-1A7	4.66	0.4	0.56	0.66	0.82	0.92	1.03	0.64
WR-1A5	11.56	1.04	1.47	1.74	2.14	2.42	2.68	1.59
WR-1A6	12.47	1.12	1.58	1.94	2.36	2.68	3	1.75
WR-1A2	1.79	0.16	0.23	0.27	0.32	0.36	0.42	0.24
WR-1A3	13.8	1.07	1.61	1.94	2.5	2.86	3.21	1.94
WR-1A4	10.34	1.16	1.6	1.88	2.29	2.58	2.86	1.47
WR-1B-E	4.17	0.25	0.38	0.5	0.63	0.72	0.82	0.58
WR-1B-F	4.99	0.6	0.82	0.96	1.17	1.31	1.45	0.72

Location	Drainage Area (ha)	Table D2: Future Intensification (90% Imperviousness) Uncontrolled Subcatchment Flows Simulated Peak Flow (m³/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A	28.4	2.13	3.01	3.78	4.64	5.26	5.87	3.82
ER-1B-E	3.34	0.44	0.59	0.69	0.83	0.92	1.02	0.48
ER-1B-F	6.59	0.9	1.23	1.43	1.7	1.97	2.17	0.95
ER-1D-E	21.79	2.08	3	3.57	4.47	5.07	5.64	3.1
ER-1D-F	1.85	0.29	0.39	0.45	0.53	0.59	0.65	0.27
ER-1C	8.08	1.12	1.57	1.83	2.17	2.43	2.67	1.17
ER-1F	8.21	0.96	1.32	1.55	1.87	2.1	2.32	1.16
WR-1A7	4.66	0.63	0.85	0.99	1.18	1.32	1.51	0.67
WR-1A5	11.56	1.54	2.1	2.45	2.98	3.33	3.71	1.66
WR-1A6	12.47	1.12	1.58	1.94	2.36	1.68	3	1.75
WR-1A2	1.79	0.22	0.29	0.34	0.41	0.46	0.51	0.25
WR-1A3	13.8	1.72	2.35	2.75	3.3	3.69	4.07	1.97
WR-1A4	10.34	1.29	1.76	2.06	2.58	2.89	3.2	1.48
WR-1B-E	4.17	0.5	0.69	0.81	0.98	1.1	1.21	0.6
WR-1B-F	4.99	0.67	0.91	1.06	1.32	1.47	1.62	0.72

Location	Drainage Area (ha)	Table D3: Difference between Actual Existing and Future Intensification (90% Imperviousness) Uncontrolled Subcatchment Flows Difference in Simulated Peak Flow (m^3/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A	28.4	0	0	0	0	0	0	0
ER-1B-E	3.34	0.03	0.03	0.04	0.05	0.04	0.05	0
ER-1B-F	6.59	0.04	0.06	0.06	0.06	0.14	0.05	0
ER-1D-E	21.79	0	0	0	0	0	0	0
ER-1D-F	1.85	0.08	0.1	0.11	0.12	0.13	0.14	0.01
ER-1C	8.08	0.27	0.39	0.43	0.44	0.47	0.5	0.02
ER-1F	8.21	0.02	0.03	0.04	0.04	0.05	0.05	0
WR-1A7	4.66	0.23	0.29	0.33	0.36	0.4	0.48	0.03
WR-1A5	11.56	0.5	0.63	0.71	0.84	0.91	1.03	0.07
WR-1A6	12.47	0	0	0	0	-1	0	0
WR-1A2	1.79	0.06	0.06	0.07	0.09	0.1	0.09	0.01
WR-1A3	13.8	0.65	0.74	0.81	0.8	0.83	0.86	0.03
WR-1A4	10.34	0.13	0.16	0.18	0.29	0.31	0.34	0.01
WR-1B-E	4.17	0.25	0.31	0.31	0.35	0.38	0.39	0.02
WR-1B-F	4.99	0.07	0.09	0.1	0.15	0.16	0.17	0

Location	Drainage Area (ha)	Table D4: Percent Difference between Actual Existing and Future Intensification (90% Imperviousness) Uncontrolled Subcatchment Flows Percent Difference in Simulated Peak Flow (m^3/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A	28.4	0%	0%	0%	0%	0%	0%	0%
ER-1B-E	3.34	7.3%	5.4%	6.2%	6.4%	4.6%	5.2%	0%
ER-1B-F	6.59	4.7%	5.1%	4.4%	3.7%	7.7%	2.4%	0%
ER-1D-E	21.79	0%	0%	0%	0%	0%	0%	0%
ER-1D-F	1.85	38.1%	34.5%	32.4%	29.3%	28.3%	27.5%	3.9%
ER-1C	8.08	31.8%	33.1%	30.7%	25.4%	24.0%	23.0%	1.7%
ER-1F	8.21	2.1%	2.3%	2.7%	2.2%	2.4%	2.2%	0%
WR-1A7	4.66	57.5%	51.8%	50.0%	43.9%	43.5%	46.6%	4.7%
WR-1A5	11.56	48.1%	42.9%	40.8%	39.3%	37.6%	38.4%	4.4%
WR-1A6	12.47	0.%	0%	0%	0%	-37.3%	0%	0%
WR-1A2	1.79	37.5%	26.1%	25.9%	28.1%	27.8%	21.4%	4.2%
WR-1A3	13.8	60.8%	46.0%	41.8%	32.0%	29.0%	26.8%	1.6%
WR-1A4	10.34	11.2%	10.0%	9.6%	12.7%	12.0%	11.9%	0.7%
WR-1B-E	4.17	100.0%	81.6%	62.0%	55.6%	52.8%	47.6%	3.5%
WR-1B-F	4.99	11.7%	11.0%	10.4%	12.8%	12.2%	11.7%	0%

Table D5: SWM Quantity Control Sizing Parameters								
Subcatchment	Discharge (m^3/s)				Storage (ha.m)			
	2yr	25yr	100yr	Overflow	2yr	25yr	100yr	Overflow
WR-1B-F	0.6	1.17	1.45	14.5	0.02	0.04	0.05	0.10
EH-1-F			0.23	2.3			0.09	0.11
ER-1D-F	0.21	0.41	0.51	5.1	0.02	0.03	0.04	0.05
ER-1B-F			0.62	6.2			0.26	0.33
WR-1A2	0.16	0.32	0.42	4.2	0.01	0.018	0.022	0.028
WR-1A3	1.07	2.5	3.21	32.1	0.12	0.21	0.23	0.30
WR-1A4			1.03	10.3			0.35	0.44
WR-1A5	1.04	2.14	2.68	26.8	0.09	0.16	0.2	0.25
WR-1A7	0.4	0.82	1.03	10	0.04	0.075	0.095	0.11
ER-1C	0.85	1.73	2.17	21.7	0.05	0.095	0.115	0.14
ER-1F			0.76	7.6			0.26	0.33

Location	Drainage Area (ha)	Table D6: Future Intensification (with SWM) Results Simulated Peak Flow (m^3/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A	28.4	2.13	3.01	3.78	4.64	5.26	5.87	3.82
ER-1B-E	3.34	0.41	0.56	0.65	0.78	0.88	0.97	0.48
ER-1B-F	6.59	0.26	0.35	0.41	0.48	0.55	0.61	0.81
ER-1D-E	21.79	2.08	3.00	3.57	4.47	5.07	5.64	3.10
ER-1D-F	1.85	0.18	0.26	0.32	0.4	0.43	0.46	0.27
ER-1C	8.08	0.82	1.17	1.38	1.65	1.86	2.08	1.16
ER-1F	8.21	0.32	0.43	0.51	0.61	0.68	0.75	1.11
WR-1A7	4.66	0.40	0.55	0.65	0.78	0.86	0.98	0.65
WR-1A5	11.56	1.03	1.47	1.74	2.13	2.36	2.61	1.63
WR-1A6	12.47	1.12	1.58	1.94	2.36	2.68	3.00	1.75
WR-1A2	1.79	0.16	0.22	0.26	0.31	0.36	0.41	0.25
WR-1A3	13.8	1.03	1.58	1.90	2.32	2.71	3.06	1.92
WR-1A4	10.34	0.42	0.57	0.67	0.82	0.92	1.02	1.30
WR-1B-E	4.17	0.25	0.38	0.50	0.63	0.72	0.82	0.60
WR-1B-F	4.99	0.58	0.78	0.91	1.18	1.25	1.38	0.72

Location	Drainage Area (ha)	Table D7: Difference between Existing and Future with SWM Peak Flows Simulated Peak Flow (m^3/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A[1]	28.4	0	0	0	0	0	0	0
ER-1B-E[1]	3.34	0	0	0	0	0	0	0
ER-1B-F	6.59	-0.6	-0.82	-0.96	-1.16	-1.28	-1.51	-0.14
ER-1D-E[1]	21.79	0	0	0	0	0	0	0
ER-1D-F	1.85	-0.03	-0.03	-0.02	-0.01	-0.03	-0.05	0.01
ER-1C	8.08	-0.03	-0.01	-0.02	-0.08	-0.1	-0.09	0.01
ER-1F	8.21	-0.62	-0.86	-1	-1.22	-1.37	-1.52	-0.05
WR-1A7[1]	4.66	0	-0.01	-0.01	-0.04	-0.06	-0.05	0.01
WR-1A5	11.56	-0.01	0	0	-0.01	-0.06	-0.07	0.04
WR-1A6[1]	12.47	0	0	0	0	0	0	0
WR-1A2	1.79	0	-0.01	-0.01	-0.01	0	-0.01	0.01
WR-1A3	13.8	-0.04	-0.03	-0.04	-0.18	-0.15	-0.15	-0.02
WR-1A4	10.34	-0.74	-1.03	-1.21	-1.47	-1.66	-1.84	-0.17
WR-1B-E[1]	4.17	0	0	0	0	0	0	0.02
WR-1B-F	4.99	-0.02	-0.04	-0.05	0.01	-0.06	-0.07	0

[1]These catchments did not include the addition of SWM (outside limits of Burlington GO MTSA)

Location	Drainage Area (ha)	Table D8: Percent Difference between Existing and Future with SWM Peak Flows Simulated Peak Flow (m³/s) for Return Period (Years) or Storm						
		2	5	10	25	50	100	Regional Storm (12 Hr AMC III)
ER-1A[1]	28.4	0%	0%	0%	0%	0%	0%	0%
ER-1B-E[1]	3.34	0%	0%	0%	0%	0%	0%	0%
ER-1B-F	6.59	-69.8%	-70.1%	-70.1%	-70.7%	-70.0%	-71.2%	-14.7%
ER-1D-E[1]	21.79	0%	0%	0%	0%	0%	0%	0%
ER-1D-F	1.85	-14.3%	-10.3%	-5.9%	-2.4%	-6.5%	-9.8%	3.9%
ER-1C	8.08	-3.5%	-0.8%	-1.4%	-4.6%	-5.1%	-4.2%	0.9%
ER-1F	8.21	-66.0%	-66.7%	-66.2%	-66.7%	-66.8%	-67.0%	-4.3%
WR-1A7	4.66	0%	-1.8%	-1.5%	-4.9%	-6.5%	-4.9%	1.6%
WR-1A5	11.56	-1.0%	0%	0%	-0.5%	-2.5%	-2.6%	2.5%
WR-1A6[1]	12.47	0%	0%	0%	0%	0%	0%	0%
WR-1A2	1.79	0%	-4.4%	-3.7%	-3.1%	0%	-2.4%	4.2%
WR-1A3	13.8	-3.7%	-1.9%	-2.1%	-7.2%	-5.2%	-4.7%	-1.0%
WR-1A4	10.34	-63.8%	-64.4%	-64.4%	-64.2%	-64.3%	-64.3%	-11.6%
WR-1B-E[1]	4.17	0.%	0%	0%	0%	0%	0.00%	3.5%
WR-1B-F	4.99	-3.3%	-4.0%	-5.2%	0.9%	-4.6%	-4.8%	0%

[1]These catchments did not include the addition of SWM (outside limits of Burlington GO MTSA)

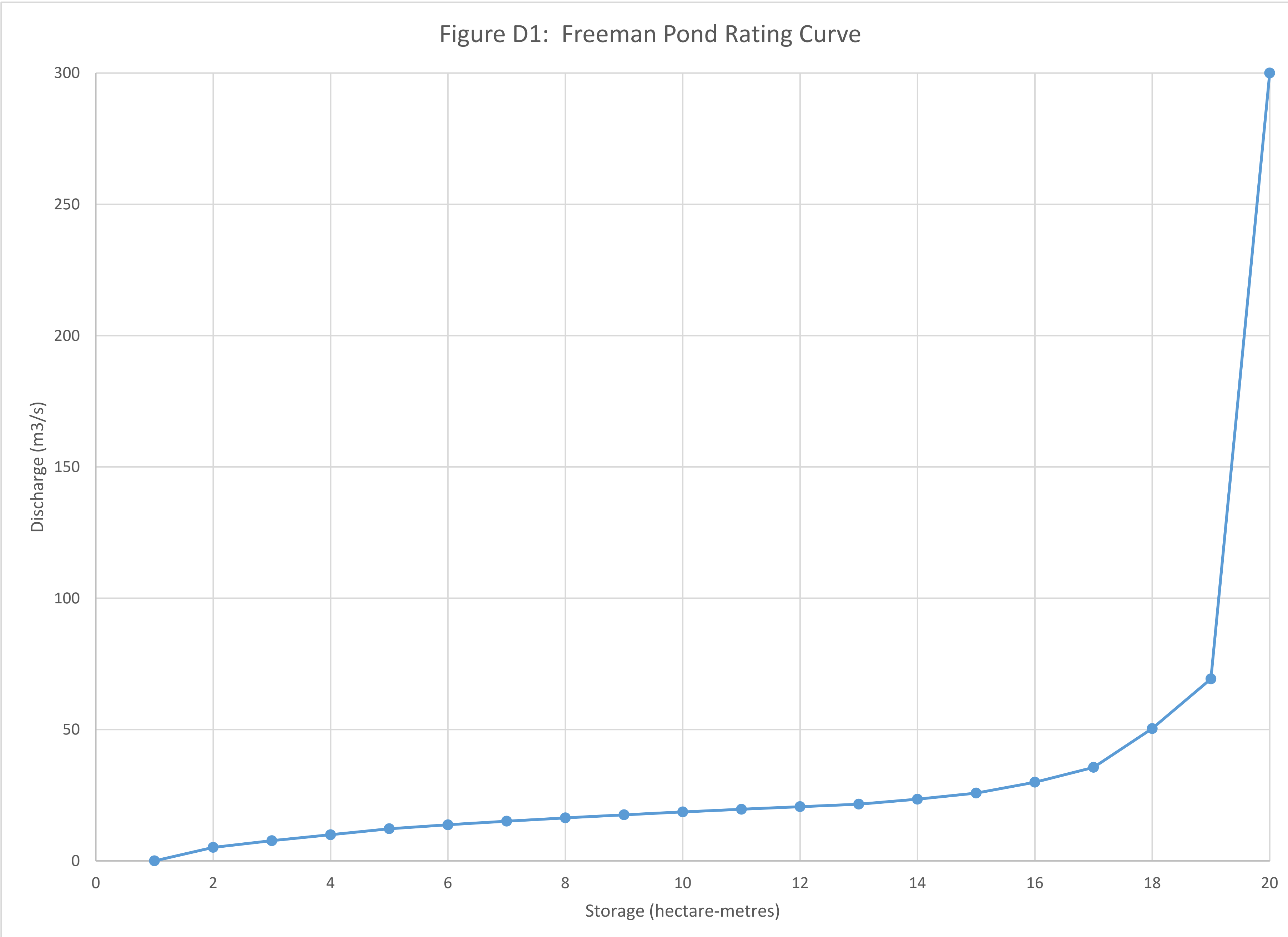


Figure D1: Freeman Pond Rating Curve
Discharge (m3/s)
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
Storage (hectare-metres)

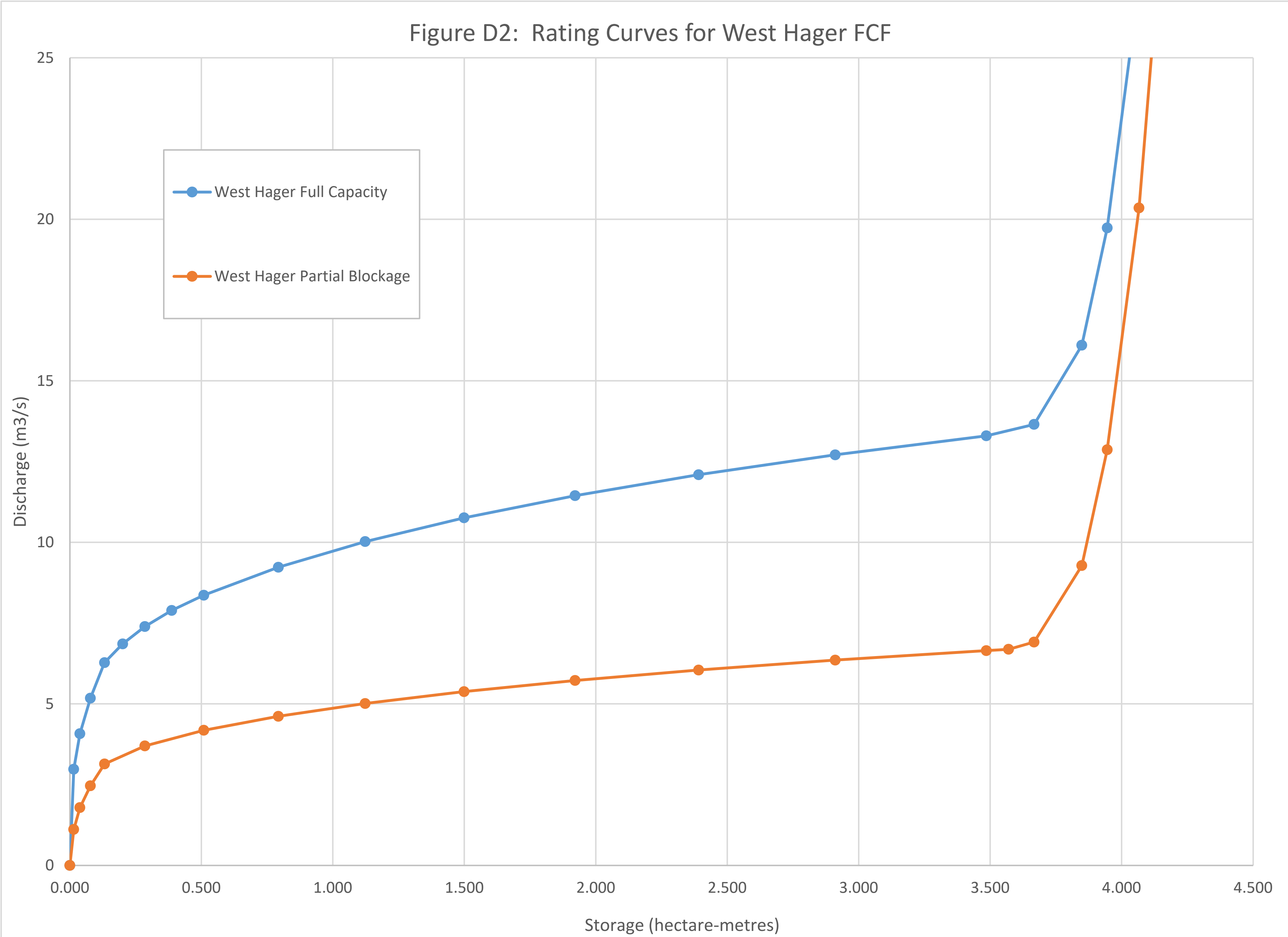


Figure D2: Rating Curves for West Hager FCF
West Hager Full Capacity
West Hager Partial Blockage
Discharge (m3/s)
Storage (hectare-metres)
0
5
10
15
20
25
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500

TABLE D9: HYDRAULIC STRUCTURES CODED IN HEC-RAS 2D MODELLING

ID	Type/ Configuration	Watercourse	Location	Span (m)	Rise (m)	Length (m)	Inverts (us/ds) (m)
1	Culvert (1 RCB)	Roseland Creek	North Service Road	3	1.82	30	105.88/105.83
2	Culvert (1 RCB)	Roseland Creek	QEW	3.73	1.85	453	104.95/100.9
3	Culvert (1 RCB)	Roseland Creek	CNR	3	1.85	155	96.81/95
4	Culvert (1 CMP)	N/A	QEW off-ramp near Roseland Creek	0.8	-	30.8	106.18/106.18
5	Culvert (1 CMP)	N/A	QEW on-ramp near Roseland Creek	0.8	-	19.8	106.18/105.75
6	Culvert (1 CMP)	N/A	S Service Road	0.8	-	23.2	104.64/104.6
7	Culvert (2 CMP)	ER Pond Overflow	Unknown Road, Just North of N Service Road	1	-	22.1	103.23/103.22
8	Culvert (2 CMP)	ER Pond	Near CNR and North of N Service Road	1.5	-	20.2	102.49/102.4 102.64/102.35
9	Culvert (1 RCB)	WR Creek	CNR, near ER Pond	3	2	13.5	102.36/102.26
10	Culvert (1 RCB)	ER Pond/ER Creek	ER Pond, north of N Service Road	3	1.5	269.1	102.33/100.7
11	Culvert (Storm sewer Pipe, 1 CMP)	N/A	QEW/Queensway Drive	1.2	-	513.8	103.1/100.7
12	Culvert (1RCB)	ER Creek	Glenwood School Drive	3.05	2	21.1	98.5/98.45
13	Culvert (1 RCB)	ER Creek	CNR, just u/s of Fairview Street	3	2.5	28.5	96.05/95.85
14	Culvert (1 RCB)	HR Diversion	Fairview Street	7.6	2.3	66.4	93.7/93.5
15	Culvert (1 RCB)	HR Diversion	Brant Street, South and parallel to Fairview Street	7	2	259.5	92.6/91.4
16	Culvert (1 CMP)	N/A	In between Glendale Ct and Hazel Street	0.25	-	59.6	100.8/100.24
17	Culvert (Storm sewer pipe, 1 CMP)	N/A	CNR and runs west along Fairview Street	1.05	-	833.4	96.28/93.82
18	Culvert (1 RCP-Ellipse)	WR Creek	Near Churchill Ave and Leighland Road	2.49	1.6	184	99.8/98.14
19	Culvert (1 RCB)	WR Creek	Parking Lot, just u/s of Plains Road E	2.5	1.7	26.06	97.6/97.56
20	Culvert (1 RCB)	N/A	Parking Lot connection, just next to WR Creek	4	1	27.4	98.29/98.15

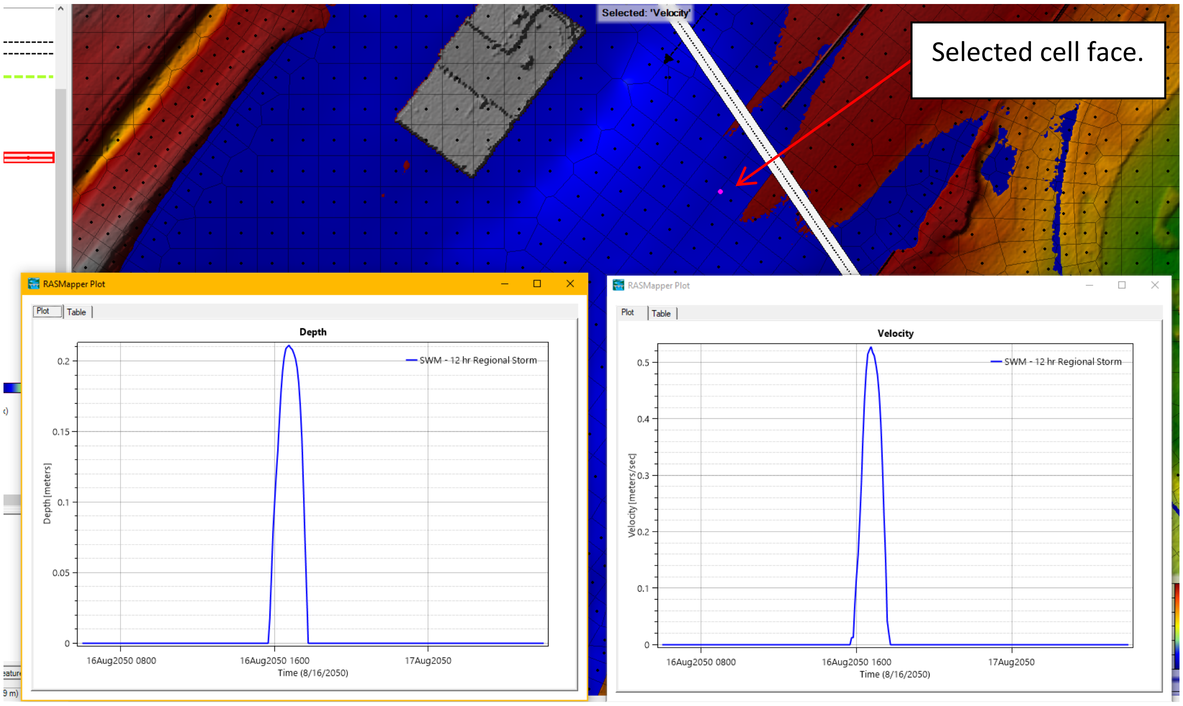
TABLE D9: HYDRAULIC STRUCTURES CODED IN HEC-RAS 2D MODELLING

ID	Type/ Configuration	Watercourse	Location	Span (m)	Rise (m)	Length (m)	Inverts (us/ds) (m)
21	Culvert (1 RCB)	WR Creek	Plains Road E	4.2	1.6	37.2	97.45/97.15
22	Culvert (1 RCB)	WR Creek	CNR, just d/s of Plains Road E	4.2	1.6	22.66	97.05/96.9
23	Culvert (1 RCB)	WR Creek	Private crossing just d/s of CNR	4	1.5	17.2	97.01/96.2
24	Culvert (1 CMP)	N/A	Just u/s of CNR to the left looking d/s	0.75	-	15.5	97.2/95.45
25	Culvert (1 CMP)	WR Creek	CNR, just u/s of De Paul's Ln	2.85	-	32.2	95.46/94.9
26	Culvert (1 RCB)	WR Creek	De Paul's Ln behind Walmart	8	1.8	17.4	93.94/93.5
27	Culvert (1 RCB)	WR Creek	Fairview Street	5	2	334.2	91.9/91.3
28	Culvert (2 CMP)	DC	CNR, west of Brant St and South of Fairview St	3.3	-	22.85	90.3/89.7
29	Culvert (Storm sewer, 1 RCP)	N/A	Brant Street Under-pass	2.05	-	358.8	90.94/89.62

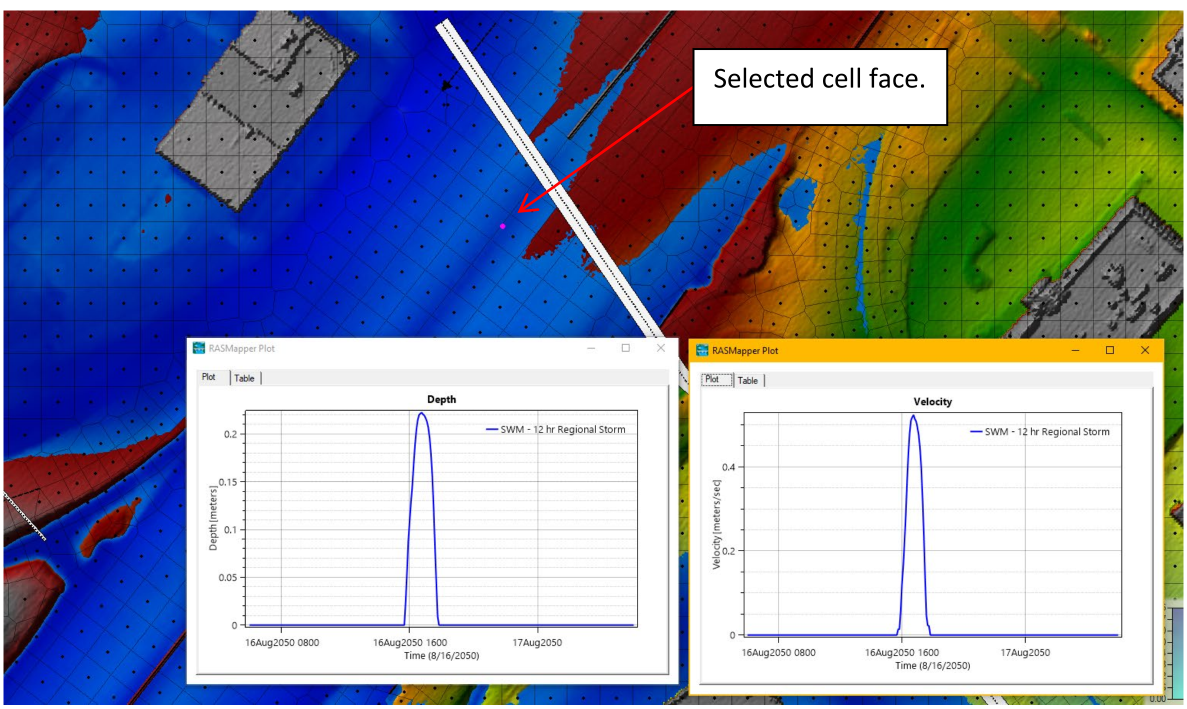
MTSA PHASE 2 FLOOD HAZARD ASSESSMENT (BURLINGTON GO AND DOWNTOWN)

APPENDIX D - SENSITIVITY ANALYSIS FOR QEW GUARD RAIL IN 2D MODELLING

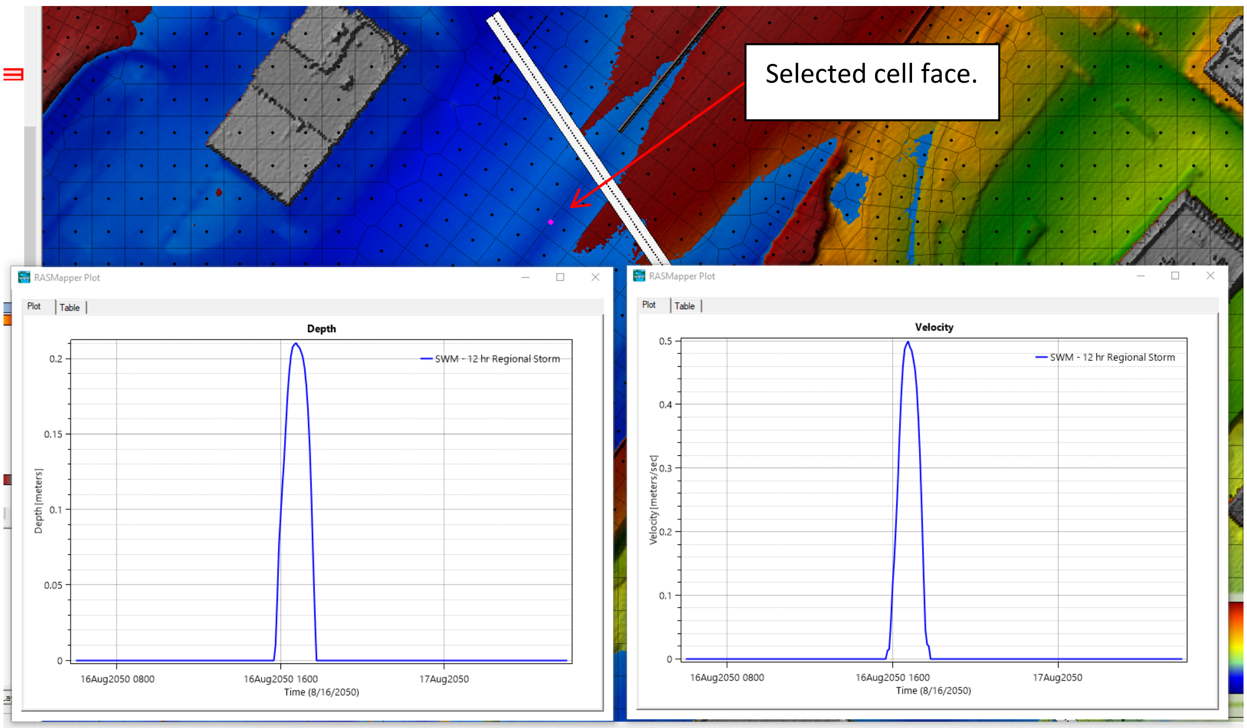
1. **Considering a Manning's n-value of 0.02 at the open guard rail section.**



2. **Considering a Manning's n-value of 0.05 at the open guard rail section.**



3. **Considering a Manning's n-value of 0.08 at the open guard rail section.**



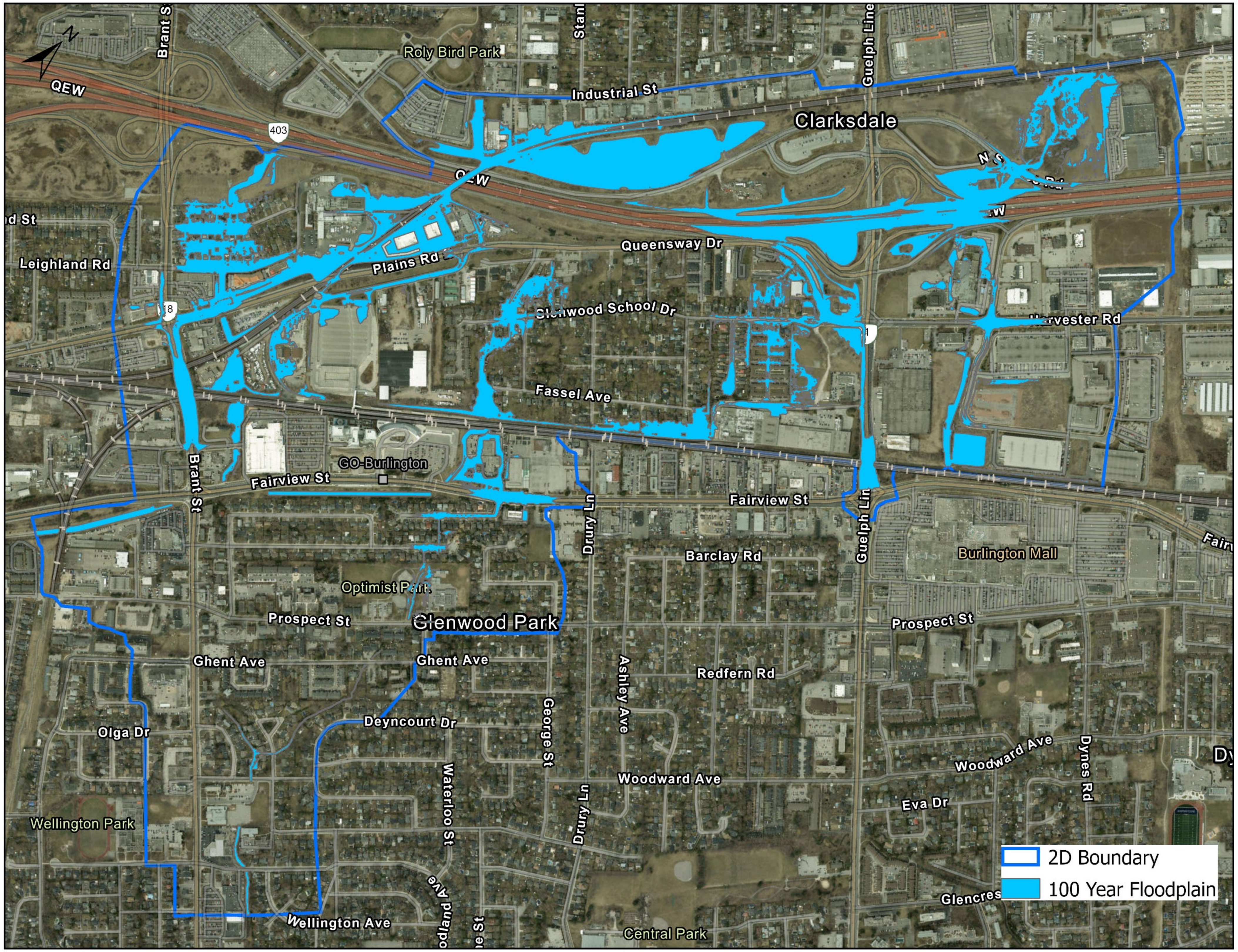


Figure D3: Simulated Inundation Extents for 100-Year Storm Event

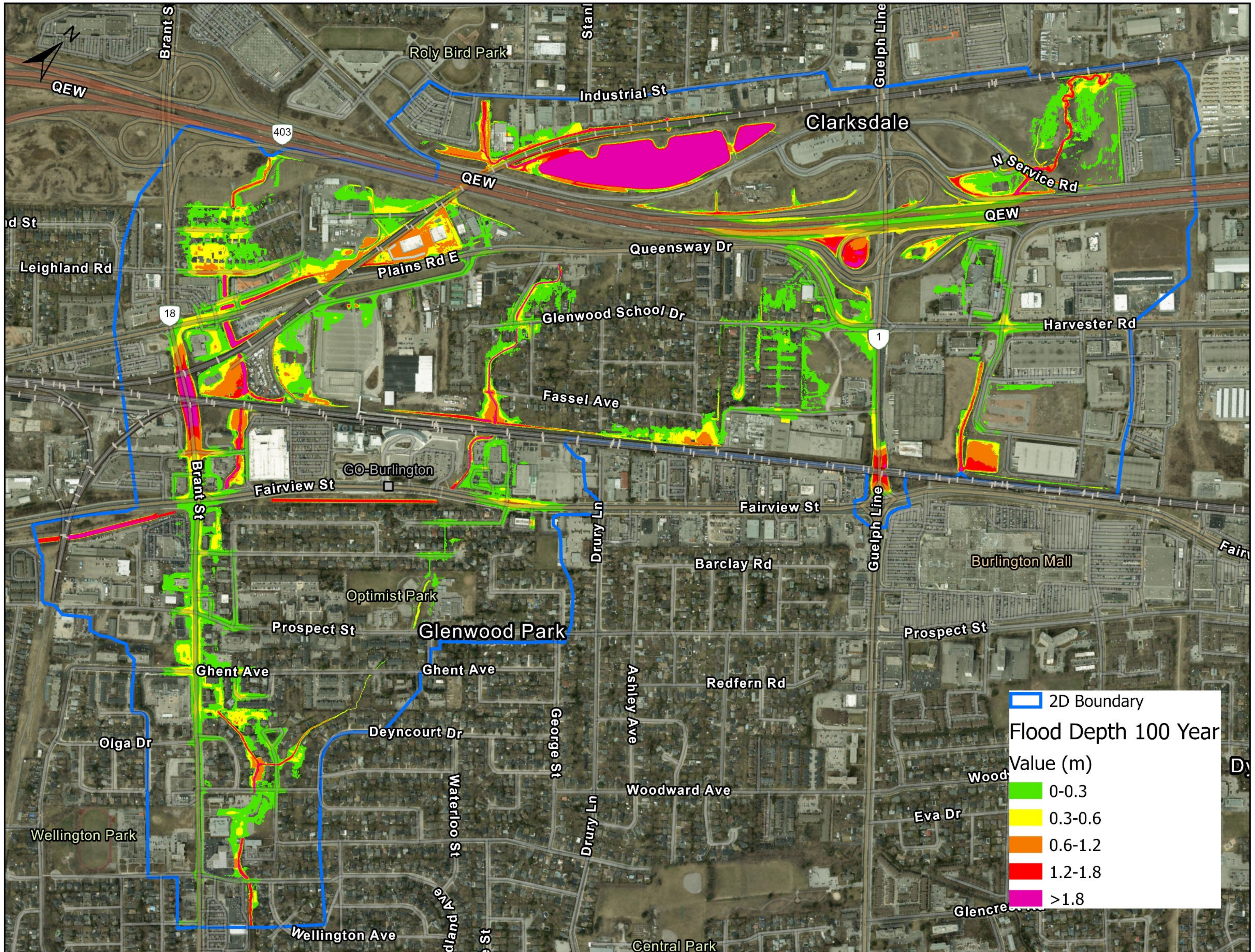


Figure D4: Simulated Depth Grid for 100-Year Storm Event

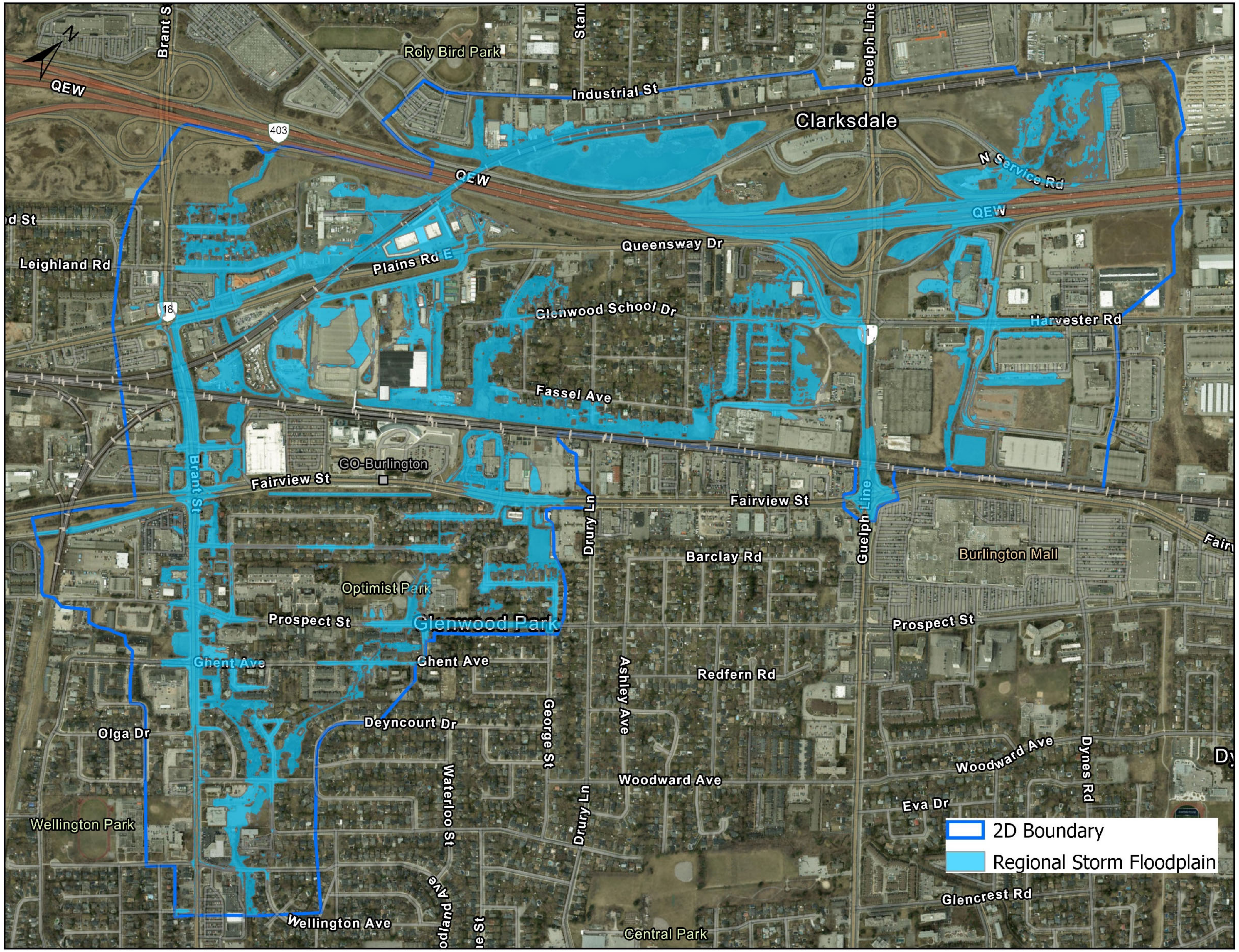


Figure D5: Simulated Inundation Extents for Regional Storm Event

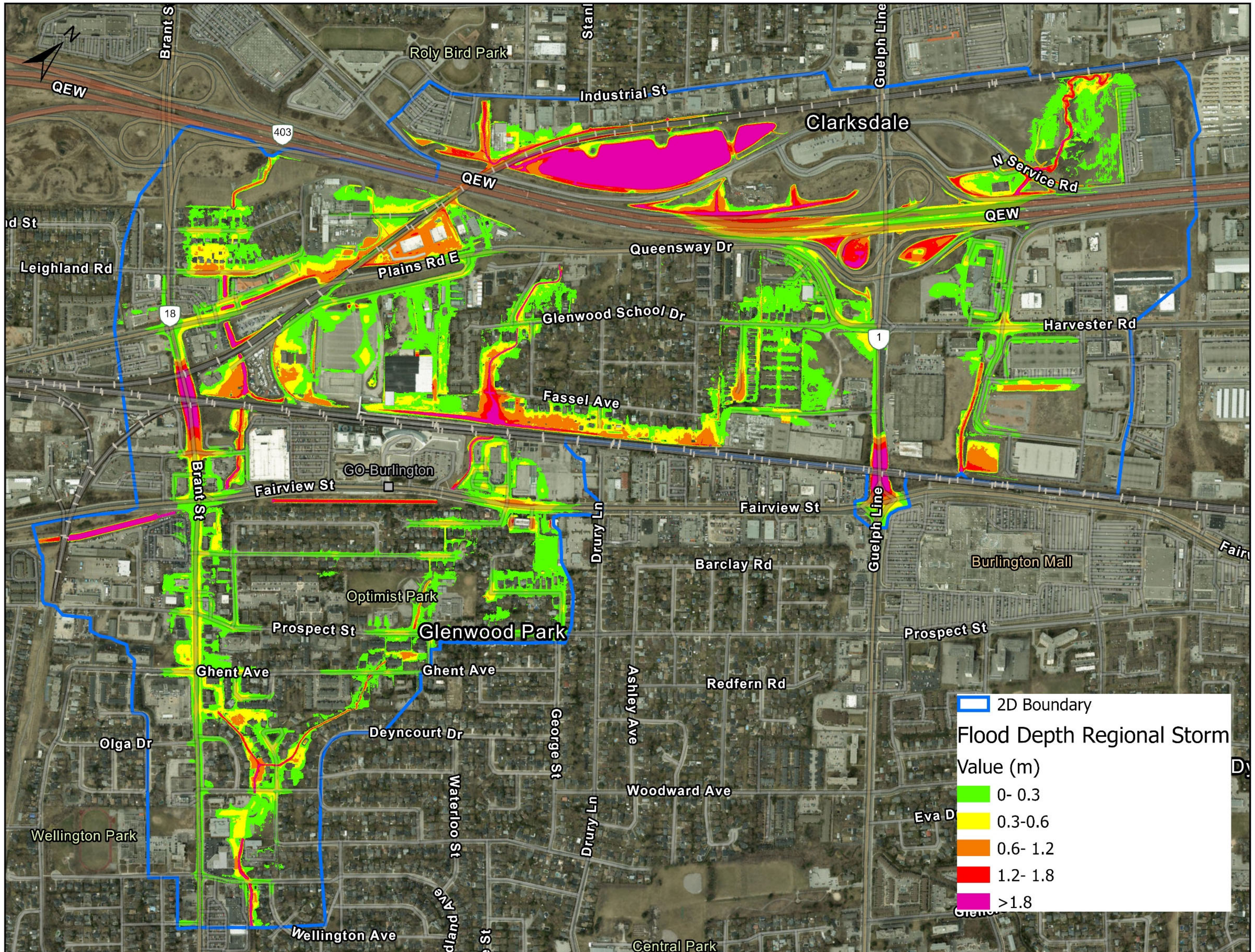


Figure D6: Simulated Depth Grid for Regional Storm Event

BURLINGTON GO MTSA FILLING ANALYSIS – APPENDIX D

A total of three (3) scenarios were envisioned to consider the potential range of re-development and filling scenarios. For the purposes of the current summary, only one (1) scenario has been included; the most conservative scenario of filling all lands scheduled for intensification. This excludes lands already identified to be within the primary floodway area (as defined by the creek topography\high points as per the 1D hydraulic modelling described in the report), as well as public lands (roads and railways). Based on the preceding and available property boundary mapping, potential infilling areas have been identified and are presented in Figure D7 along with key comparison locations

To model filling of all lands scheduled for intensification, the base terrain has been raised up to an elevation of 110 m, 115m and 120m (all in CGVD:2013 Datum) within RAS Mapper in the base model and the HB model with the primary intention to force flows around the buildings. Additional breaklines have been added and the 2D mesh cells adjusted for better flow paths and to prevent leakage onto the top of buildings.

The analysis described herein was originally completed in support of the March 2022 version of the MTSA Flood Hazard Assessment reporting. It is noted that the hydrologic and hydraulic modelling has since been updated (November 2022), however it was not considered necessary to re-do the analyses to reflect the modelling results.

The comparison of flows and water surface elevations at key locations are presented in Tables D10 and D11. The results have been presented for the base model (hydraulic structures in place, no added flows to compensate for hydraulic structure attenuation) and the hydroburned (HB) model.

The results of filling all lands for intensification indicate that peak flows and water surface elevations generally increase at key locations. For the base modelling, peak flows along West Rambo Creek increase by between 11 and 18%; peak flows at the Hager-Rambo Diversion increase 14%. The hydroburned model indicates generally similar results for the creek flows; differences are more notable for spill flows.

Flood depths along West Rambo Creek and the Hager-Rambo Diversion Channel also increase for the base scenario by between 0.20 and 0.46 m, and between 0.17 and 0.62 m for the hydroburned modelling.

As a result of simulated full infilling, no spill occurs near Argon Court (ID 11) and Lower Rambo Creek South of Maplewood Drive in the base model (FP fill) and HB (FP Fill) model and water is forced to travel alongside the raised infill areas in the remaining available space between public areas and the infills.

No spill is indicated from the CNR underpass south on Brant Street in the HB (with FP fill) mode (ID 18). Spill into the Brant Street underpass (ID 14) decreases from 29.11 m^3/s (base model-FP fill) to 1.81 m^3/s (HB model-FP fill). This is because most of the flows would leave the 2D system following the hydro-burned route from West Rambo Creek at CNR, Fairview Street and eventually to the HR-Diversion Channel (85.31 m^3/s). About 4.44 m^3/s of flow is observed to leave the 2D system at Brant Street (ID 20) for the base model (FP fill) in contrast to the HB model (FP fill) where all the flows exit the system from the HR-Diversion Channel.

Flood depth grids for the Regional Storm event for the base model (FP fill) and HB model (FP fill) are provided in Appendix D

Overall, the preceding suggests that West Rambo Creek would experience the greatest increases in peak flows and flood depths due to the theoretical infilling scenario. It should be noted that the preceding is a highly conservative scenario and does not reflect grading restrictions associated with matching road grades for entrances and open areas on sites. Alternative infilling scenarios require further analysis to determine the range of potential impacts and identify areas of higher impact.

For the area downstream of the Hager-Rambo Diversion Channel (i.e. south of Fairview Street), simulated floodplain filling also resulted in a simulated increase of spill onto Brant Street near the outlet of the 2D model (ID 20 in Table 2.19) to 4.44 m^3/s for the base model (FP fill) when compared to the base model (0.20 m^3/s, no FP fill). However, no spill is indicated for the HB model (FP fill) at this same location.

The total flow at the limits of the 2D model (Lower Rambo Creek past Victoria - ref. Figure D7, ID 23) is 33.17 m^3/s for the Regional Storm event for the base model (including infill areas). This flow is approximately 4.83 m^3/s lower as compared to the base model (without infill areas added). The 2D flows at the same location in the HB model (with infill areas) is 15.83 m^3/s. This indicates that the simulated infill areas actually partially block off spill flows from reaching Lower Rambo Creek and forces a greater amount of spill flow to continue to drain southerly along Brant Street.

The Blairholm Avenue long enclosure conveys approximately 11.86 m^3/s and 10.41 m^3/s for the base and hydroburned models respectively with infilling in place. Due to floodplain filling at this location (ref. Figure D7), flows would travel on Courtland Drive and spill towards the residential areas in between Victoria Avenue and Courtland Drive and then onto Wellington Avenue.

An assessment of the potential impact of filling in the Lower Rambo Creek area due to the expected spill at Caroline Street (Regional Storm Event with spills scenario) has not been assessed as part of the current summary. This may be considered further as part of subsequent updates.

Figure D7: Filling of all lands (infill areas) scheduled for intensification and key locations

Table D10: Simulated Peak Flows at locations of Interest for Regional Storm for Floodplain Filling

ID	Location	Simulated Peak Flows (m^3/s) for Regional Storm					
		Base Model			Hydroburned Model		
		No FP Fill	With FP Fill	Diff	No FP Fill	With FP Fill	Diff
8	ERC at Plains Road	21.75	21.80	+0.2%	21.80	21.80	0%
9	ERC at CNR (Node J1)	30.47	27.49	-10%	35.16	29.84	-15%
10	H-R Diversion at Fairview (Node J)	27.67	30.32	+10%	27.31	33.00	+21%
11	Fairview Street Spill towards Argon Court and Joyce Street	6.03	0	-100%	11.36	0	-100%
12	Spill to Lower Rambo Creek Just South of Maplewood Drive	2.60	0	-100%	3.16	0	-100%
13	WRC at Plains Road (Node P3)	16.44	16.40	-0.2%	41.17	40.51	-2%
14	Spill into the Brant Street Underpass	26.12	29.11	+11%	2.42	1.81	-25%
15	WRC at CNR (Node P2)	20.52	24.25	+18%	46.83	53.35	+14%
16	WRC at Fairview (Node P1)	23.80	28.11	+18%	47.92	54.41	+14%
17	Total H-R Diversion West of Brant (Node K)	51.50	58.64	+14%	75.31	85.31	+13%
18	Spill Flow from CNR Underpass South on Brant Street	21.83	31.50	+44%	0	0	0%
19	Spill flow onto Brant Street at Fairview Street	20.60	22.70	+10%	0	0	0%
20	Spill flow along Brant Street near outlet of 2D model	0.20	4.44	>+100%	0	0	0%
21	Spill flow near u/s end of Lower Rambo Creek	19.81	7.71	-61%	0.50	0.50	0%
22	Spill flow near Ghent Avenue	6.73	3.60	-47%	11.80	3.66	-69%

Table D11: Simulated Peak Flows at locations of Interest for Regional Storm for Floodplain Filling

ID	Location	Simulated Peak Water Surface Elevation (m) for Regional Storm (CGVD:2013 datum)					
		Base Model			Hydroburned Model		
		No FP Fill	With FP Fill	Diff	No FP Fill	With FP Fill	Diff
8	ERC at Plains Road	102.27	102.27	0	102.27	102.27	0
9	ERC at CNR (Node J1)	100.06	99.68	-0.38	98.65	98.50	-0.15
10	H-R Diversion at Fairview (Node J)	95.04	95.13	+0.09	95.11	95.32	+0.21
11	Fairview Street Spill towards Argon Court and Joyce Street	96.71	0	N/A	96.75	0	N/A
12	Spill to Lower Rambo Creek Just South of Maplewood Drive	93.06	0	N/A	93.10	0	N/A
13	WRC at Plains Road (Node P3)	99.78	100.05	+0.27	99.55	99.54	-0.01
14	Spill into the Brant Street Underpass	96.47	97.30	+0.83	96.64	96.63	-0.01
15	WRC at CNR (Node P2)	99.24	99.70	+0.46	97.18	97.80	+0.62
16	WRC at Fairview (Node P1)	94.18	94.49	+0.31	93.55	94.10	+0.55
17	Total H-R Diversion West of Brant (Node K)	92.76	92.96	+0.20	92.78	92.95	+0.17
18	Spill Flow from CNR Underpass South on Brant Street	96.39	96.43	+0.04	0	0	0
19	Spill flow onto Brant Street at Fairview Street	95.13	95.13	0	0	0	0
20	Spill flow along Brant Street near outlet of 2D model	87.92	88.10	+0.18	0	0	0
21	Spill flow near u/s end of Lower Rambo Creek	90.61	90.14	-0.47	89.75	89.78	+0.03
22	Spill flow near Ghent Avenue	91.31	91.15	-0.16	91.47	91.15	-0.32

Appendix E

Background Drawings and Field Investigations (Downtown)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 16 — Location: South of Olga

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	27/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	
Field Crew:	KL	Number of Openings:	2	Open Footing (Yes/No):		no		
Watershed Name:		Opening Shape:	oval	Material (Conc/Steel/PVC):		csp	Flow Present (Y/N):	
River Name:	Lower Hager Creek	Opening Height (m):	app 1 each	Opening / Span (m):		app 1.3 each	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):		Surveyed Invert (m)				
		Railing Type (None/Open/Solid Wall):		Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Hard to access, estimated measurements

Upstream Structure Face (Photo)

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 18 | **Location: Baldwin**

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	27/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone, gravel
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Hager Creek	Opening Height (m):	0.8	Opening / Span (m):		1.8	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.75	Surveyed Invert (m)				
		Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)				
		Railing Height (m):	na	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Upstream Structure Face (Photo)

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 22 — Location: Birch Street

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	27/06/2017	Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Hager Creek	Opening Height (m):	0.5	Opening / Span (m):		5.2	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.8	Surveyed Invert (m)				
		Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Upstream Structure Face (Photo)

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 20 — Location: Caroline Street

Watershed and Location Information

Date (dd/mm/yyyy):	27/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Hager Creek
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	0.85	Opening / Span (m):		3
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.5	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):	1.2	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone, gravel
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Upstream Structure Face (Photo)

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 21 — Location: Ontario Street

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	27/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		no		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Hager Creek	Opening Height (m):	2.3	Opening / Span (m):		3.8	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.4	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)				
		Railing Height (m):		Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Outer measurements noted above, inner masurements are a 1.8m concrete box.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 22 — Location: Elgin Street

Watershed and Location Information

Date (dd/mm/yyyy):	27/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Hager Creek
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		yes
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	box	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.8	Opening / Span (m):		1.8
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.6	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Upstream Structure Face (Photo)

NA

Watercourse Looking Downstream

Upstream Structure Face (Photo)

NA

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 13 — Location: Prospect Street

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	28/06/2017	Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel, stone
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Rambo (East)	Opening Height (m):	0.9	Opening / Span (m):		4.75	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.4	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)				
		Railing Height (m):	1.3	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 12 — Location: Ghent Avenue

Watershed and Location Information

Date (dd/mm/yyyy):	28/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Rambo (East)
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	oval	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	0.9	Opening / Span (m):		1.9
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.75	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):		Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 11 — Location: Courtland Place

Watershed and Location Information

Date (dd/mm/yyyy):	28/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Rambo (East)
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	bridge	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.25	Opening / Span (m):		4.6
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):				
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.6	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):	1.1	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 10 Location: Blairholm

Watershed and Location Information

Date (dd/mm/yyyy):	28/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Rambo Creek
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	outfall	Gated (Yes/No):		yes
Number of Openings:	1	Open Footing (Yes/No):		no
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.725	Opening / Span (m):		2.7
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			WW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	0.6	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)		
Railing Height (m):	1.2	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	
Additional Flow Information / Notes:	

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 8 Location: Victoria

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	28/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel, stone
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Rambo Creek	Opening Height (m):	1.5	Opening / Span (m):		3	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW		Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.6	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)				
		Railing Height (m):	1.15	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 7 — Location: Caroline

Watershed and Location Information

Date (dd/mm/yyyy):	28/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Rambo Creek
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	1.6	Opening / Span (m):		3.6
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			WW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	1.5	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)		
Railing Height (m):	1	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	gravel
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	

Additional Flow Information / Notes:

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 4 Location: James

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	28/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone, gravel
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Rambo Creek	Opening Height (m):	1.7	Opening / Span (m):		3	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			WW		Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	1.3	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	open	Surveyed Obvert (m)				
		Railing Height (m):	1.3	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Could not determine for sure if open or closed, but gravel and stone on bottom.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 3 — Location: Martha

Watershed and Location Information		Structure Configuration and Dimensions				Current Flow Information	
Date (dd/mm/yyyy):	28/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):	no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):	no		
Watershed Name:		Opening Shape:	arch	Material (Conc/Steel/PVC):	concrete	Flow Present (Y/N):	
River Name:	Lower Rambo Creek	Opening Height (m):	2.35	Opening / Span (m):	2.95	Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			gabion WW	Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S** / **D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	0.5	Surveyed Invert (m)		Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	both	Surveyed Obvert (m)			
		Railing Height (m):	1.2	Depth of Siltation (mm):			

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 2 — Location: Waterfront Trail

Watershed and Location Information

Date (dd/mm/yyyy):	28/06/2017
Field Crew:	KL
Watershed Name:	
River Name:	Lower Rambo Creek
Reach ID:	
Municipality:	
Easting:	
Northing:	

Structure Configuration and Dimensions

Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		No
Number of Openings:	1	Open Footing (Yes/No):		yes
Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete
Opening Height (m):	0.9	Opening / Span (m):		2.6app
Length in Direction of Flow (m):		Top of Road Survey Elev. (m)		
Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):			HW	
Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**
Height from Obv to Top of Road (m):	na	Surveyed Invert (m)		
Railing Type (None/Open/Solid Wall):	none	Surveyed Obvert (m)		
Railing Height (m):	na	Depth of Siltation (mm):		

Current Flow Information

Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone
Flow Present (Y/N):	
Approx. Depth (mm):	
Approx. Velocity (m/s):	
Upstream Erosion (Y/N):	
Downstream Erosion (Y/N):	

Additional Flow Information / Notes:

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

HYDRAULIC STRUCTURE INVENTORY SHEET

CROSSING # : 1 Location: Lakeshore

Watershed and Location Information		Structure Configuration and Dimensions					Current Flow Information	
Date (dd/mm/yyyy):	28/06/2017	Structure Type (Culvert/Bridge):	culvert	Gated (Yes/No):		no	Bed Material (Gravel, Stone, Sand, Silt, Till, Bedrock (Shale/Limestone)):	stone/bedrock
Field Crew:	KL	Number of Openings:	1	Open Footing (Yes/No):		yes		
Watershed Name:		Opening Shape:	rectangle	Material (Conc/Steel/PVC):		concrete	Flow Present (Y/N):	
River Name:	Lower Rambo Creek	Opening Height (m):	2.1	Opening / Span (m):			Approx. Depth (mm):	
Reach ID:		Length in Direction of Flow (m):		Top of Road Survey Elev. (m)			Approx. Velocity (m/s):	
Municipality:		Inlet Type (Projecting/Mitered/Headwall/Wingwall (Flared/Parallel)):					Upstream Erosion (Y/N):	
Easting:		Skew Angle of Crossing (Degrees):		**Structure Elevation**	**U/S**	**D/S**	Downstream Erosion (Y/N):	
Northing:		Height from Obv to Top of Road (m):	1.1	Surveyed Invert (m)			Additional Flow Information / Notes:	
		Railing Type (None/Open/Solid Wall):	solid	Surveyed Obvert (m)				
		Railing Height (m):	1.1	Depth of Siltation (mm):				

Site Photograph and Additional Field Notes

Additional Field Notes:

i.e. Bridge Piers (#, dimensions, spacing, etc.), Overbank Zones, Potential Spill Pathways, etc.

Watercourse Looking Upstream

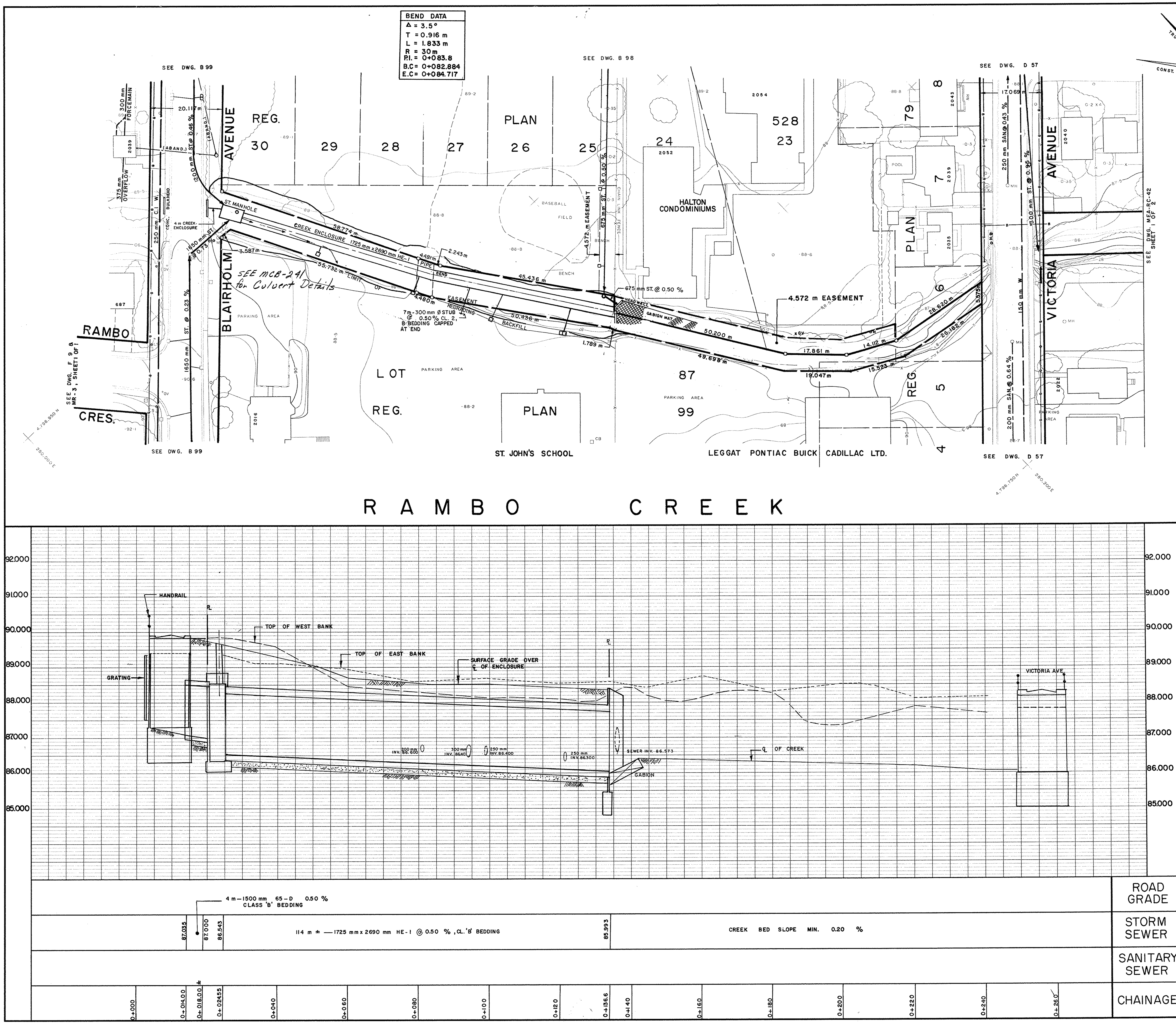
Watercourse Looking Downstream

Upstream Structure Face (Photo)

Downstream Structure Face (Photo)

FIGURE E1: UPSTREAM FACE OF BLAIRHOLM AVENUE STORM SEWER ENCLOSURE

MEA-RC-42
sh. 2



GEOD. B.M

CITY HALL, AT SOUTHWEST SIDE OF BRANT ST, 0.32 km N.W OF LAKESHORE RD., IMMEDIATELY N.W OF & OPPOSITE JAMES ST. TABLET IN N.W CONC. FOUNDATION WALL, 1.6 m N.E OF CURVED PORTION AT REAR OF BUILDING, 0.3048 m BELOW METAL SIDING ELEVATION = 86.441 m

CITY B.M

B.M SET ON CITY PLATE, S.W CORNER SOUTH OF CENTRAL PUBLIC SCHOOL FACING BALDWIN ST. ELEVATION = 90.583

ELEVATIONS REFERRED TO "1978 GEODETIC ADJUSTMENT"

Nº	DATE	BY	REVISIONS
1	NOV. 87	M.A	AS CONSTRUCTED CONTR. 84-7

DESIGN	T.E	CHECKED	DATE NOV. 83
DRAWN	M.A	CHECKED	

SCALE HOR. 1:500 VER. 1:50

REFERENCES: REG. 79, 99 & 528; REF. 20R-3846; DWG. B 98, B 99 & D 57; XMEA-RC-42

FIELD NOTES: R-126, R-139

APPROVALS

Municipal

DIRECTOR OF PUBLIC WORKS

DATE

Regional

STAMP

CONSULTANT

CITY OF BURLINGTON

DEPARTMENT OF PUBLIC WORKS

RAMBO CREEK

BLAIRHOLM AVE. - 20 m S. VICTORIA AVE.

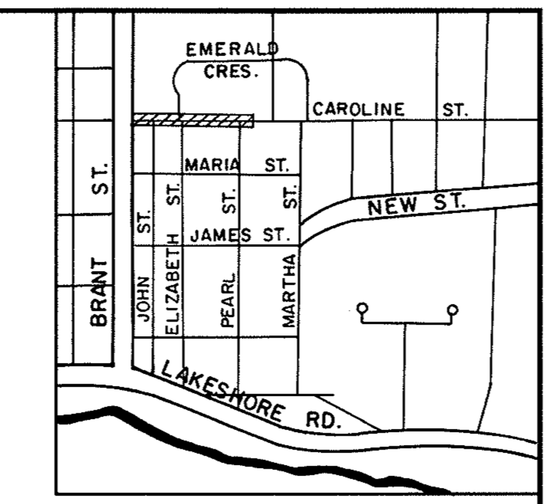
MUNICIPAL DRAWING Nº MEA-RC-42

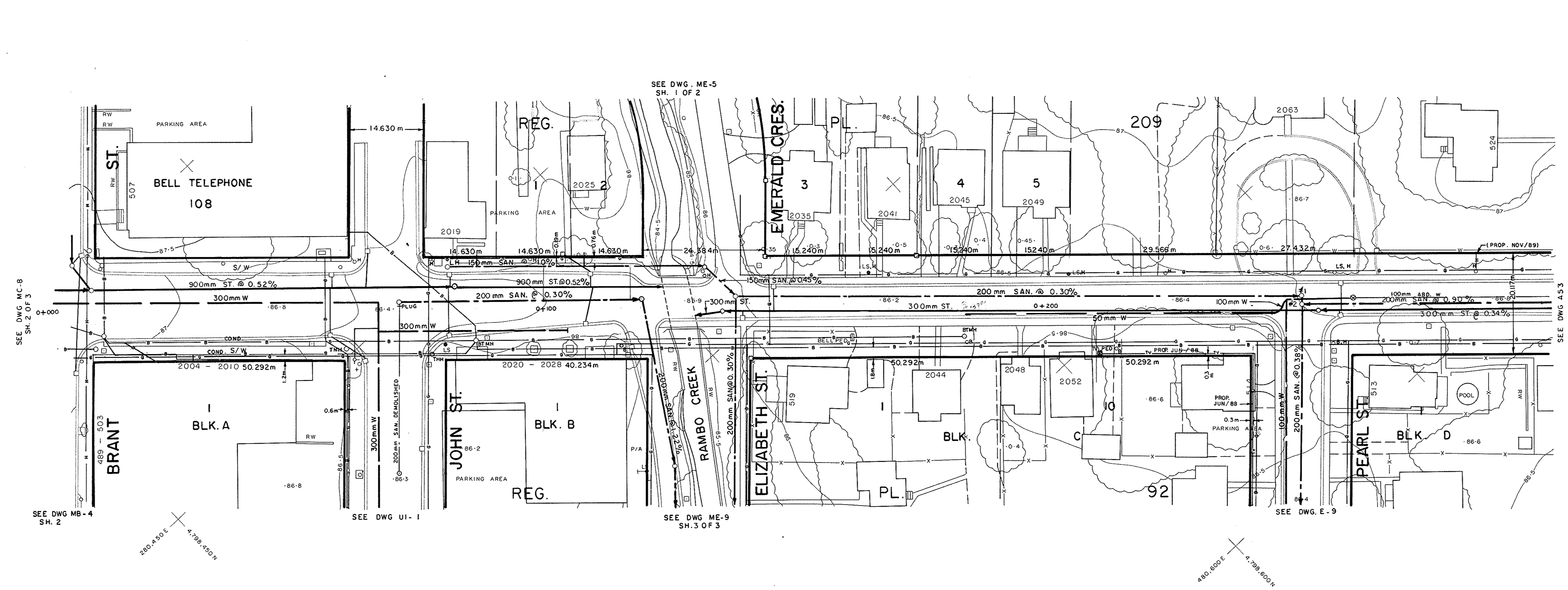
REGIONAL DRAWING Nº

CONTRACT Nº

CONSULTANT DRAWING Nº

SHEET 2 OF 2



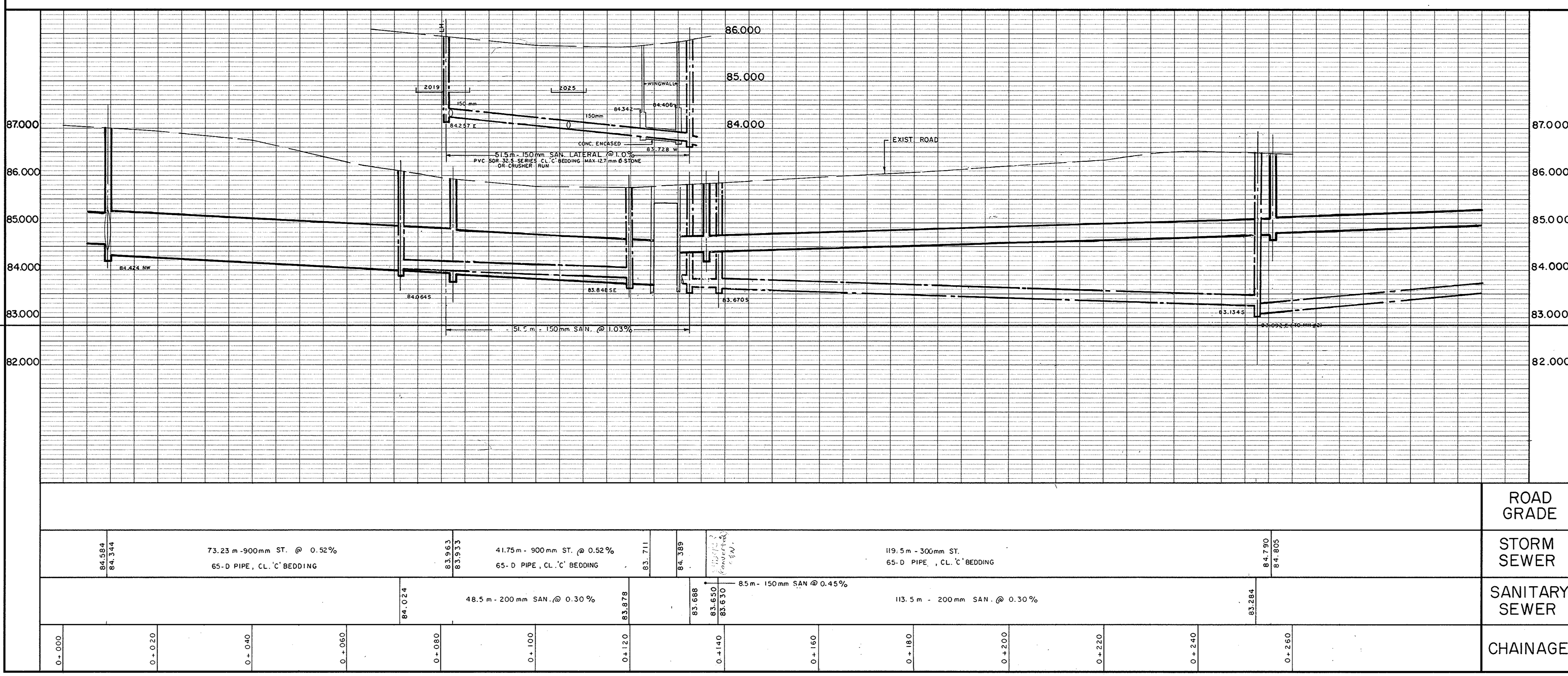


CAROLINE STREET

GEOD. BM. BM SET ON HORIZONTAL CONTROL MONUMENT 650013 IN THE CITY OF BURLINGTON LOCATED ON THE WEST SIDE OF MARTHA ST. AT THE INTERSECTION OF MARTHA ST. AND NEW ST. 4.3282 m WEST OF FACE OF CURB, 5.15m NORTH OF NEW ST. CENTRE LINE ELEV. 84.866

BM BRASS CAP IN TOP OF CURB, PARAPALEGIC RAMP, OF CURB-FACE SIDEWALK AT THE MIDDLE OF THE RADIUS LOCATED AT THE S/E CORNER OF THE INTERSECTION OF CAROLINE ST. AND MARTHA ST. HORIZONTAL CONTROL MONUMENT 043820131

ELEVATIONS REFERRED TO "1978 GEODETIC ADJUSTMENT"



Nº	DATE	BY	REVISIONS

DESIGN — CHECKED — DATE: MAY 1984
DRAWN: A.C. — CHECKED
SCALE: HOR. 1:500, VER. 1:50
REFERENCES
FIELD NOTES: M-232

APPROVALS
Municipal
DIRECTOR OF PUBLIC WORKS
DATE
Regional
STAMP

CONSULTANT

CITY OF BURLINGTON

DEPARTMENT OF PUBLIC WORKS

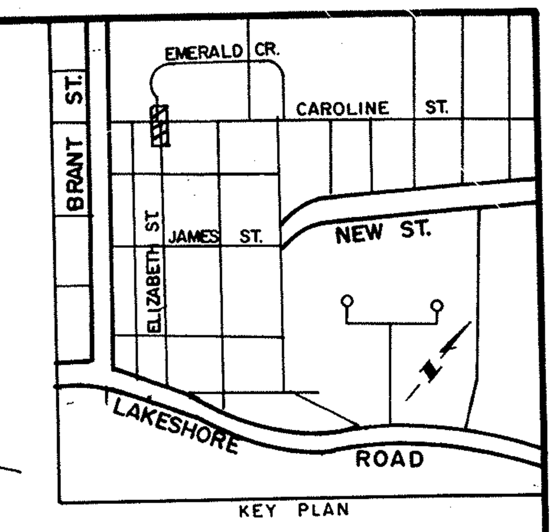
CAROLINE STREET

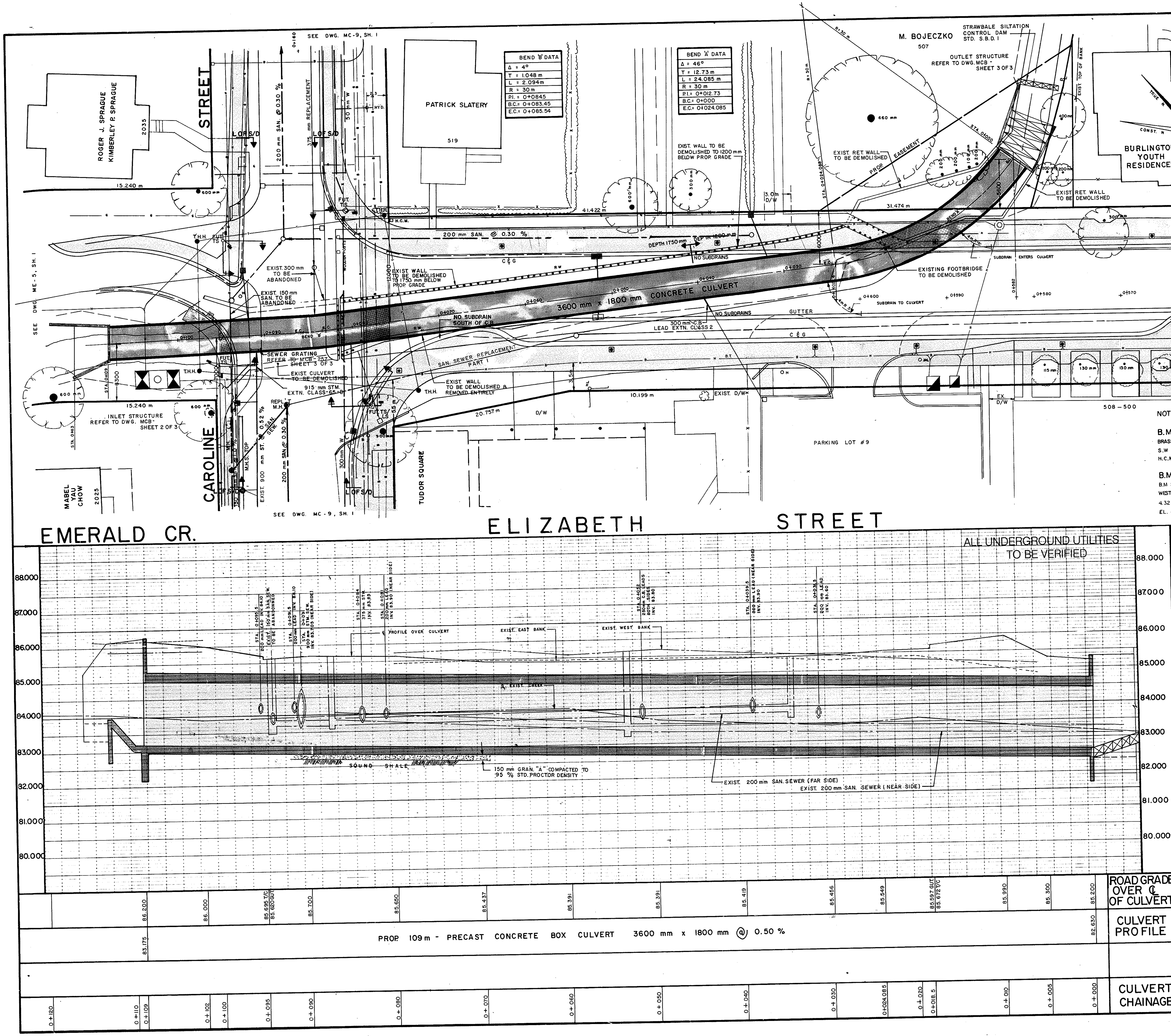
BRANT ST. - 50m E. OF PEARL ST.

MUNICIPAL DRAWING Nº: MC-8
REGIONAL DRAWING Nº
CONTRACT Nº
CONSULTANT DRAWING Nº
SHEET 3 OF

MCB-257
SH. 1 OF 3

METRIC





NOTE: FOR GENERAL NOTES SEE DWG. No. 465-D.

B.M # 319 — **1978 DATUM**

BRASS CAP IN THE TOP OF CURB, PARAPLEGIC RAMP, OF CURB-FACE S/W AT THE S.W CORNER OF THE INTERSECTION OF BRANT ST. & ONTARIO ST. H.C.M # 043820129 EL. 85.597

B.M # 207 — **1978 DATUM**

B.M SET ON H.C.M # 650013 IN THE CITY OF BURLINGTON LOCATED ON THE WEST SIDE OF MARTHA ST. AT THE INTERSECTION OF MARTHA & NEW ST. 4.32 m WEST OF FACE OF CURB. 5.15 m NORTH OF NEW ST. CENTER LINE EL. 84.866

Nº	Date	By	REVISIONS
7	AUG./85	M.A	SHOWN SUBDRAIN "TURNOUTS" FROM C.&G. TO CULVERT ON BOTH SIDES
6	AUG./85	M.A	SUBDRAIN ON EAST SIDE, FROM NORTH, CONTINUING TO D.C.B
5	AUG./85	M.A	ST. SEWER SIZE REVISED TO 375 mm AT CAROLINE ST.
4	AUG./85	D.M.	T.H.H. & H.C.M. LOCATIONS @ S/E CORNER REVISED
3	AUG./85	D.M.	FUT. TS/LS LOCATION @ S/W CORNER CHANGED
2	AUG./85	D.M.	SUBDRAINS ADDED, C.B. LOCATION @ S/W CORNER REVISED
1	AUG./85	D.M.	915 mm ST. SEW. ON CAROLINE ST. CHANGED TO 900 mm

Design	J. HODSON T.E	Checked	(initials)	Date FEB/85
Drawn	M.A	Checked		

Scale: HOR. 1:200 (4 m, 2, 0, 4, 8 m); VERT. 1:50 (1 m, 0.5, 0, 1, 2 m)

REFERENCES
ME-9, SH. 3

APPROVALS

Municipal

DIRECTOR OF PUBLIC WORKS

DATE July 17/85

Regional

FIELD NOTES
M-232
E-70 II
E-102
E-134

STAMP

CONSULTANT

MUNICIPALITY

CITY OF BURLINGTON
DEPARTMENT OF PUBLIC WORKS

TITLE

RAMBO CREEK CULVERT
ELIZABETH STREET RECONSTRUCTION

MUNICIPAL DRAWING Nº: MCB - 257
REGIONAL DRAWING Nº:
CONTRACT Nº: 85 - 15
SHEET 1 OF 3

25

TOPOGRAPHICAL SURVEY OF

ALL OF LOTS 15 AND 16 AND PART OF LOT 1 BLOCK "L" REGISTERED PLAN 92

CITY OF BURLINGTON

REGIONAL MUNICIPALITY OF HALTON

SCALE 1 : 200

5m 4 3 2 1 0 5 10 15m

R. AVIS SURVEYING INC.

METRIC : DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

NOTES AND LEGEND

BEARINGS SHOWN HEREON ARE GRID BEARINGS AND ARE DERIVED FROM HORIZONTAL CONTROL MONUMENTS No. 043924487 AND No. 043850166, ZONE 17 UTM SYSTEM
CENTRAL MERIDIAN 81° WEST LONGITUDE
(6° UNIVERSAL TRANSVERSE MERCATOR PROJECTION, NAD 83 (CSRS–2014)

HCM No. 043924487	HCM No. 043850166
N 4797986.473	N 4798109.658
E 597684.906	E 597702.388

ELEVATIONS SHOWN HEREON ARE GEODETIC AND ARE REFERRED TO CITY OF BURLINGTON BENCH MARK No. 207, HAVING AN ELEVATION = 84.866 metres.

DISTANCES SHOWN HEREON ARE ADJUSTED GROUND DISTANCES AND CAN BE CONVERTED TO GRID DISTANCES BY MULTIPLYING BY A COMBINED SCALE FACTOR OF 0.9997098

■	DENOTES	SURVEY MONUMENT FOUND
□	DENOTES	SURVEY MONUMENT PLANTED
SIB	DENOTES	STANDARD IRON BAR
SSIB	DENOTES	SHORT STANDARD IRON BAR
IB	DENOTES	IRON BAR
CC	DENOTES	CUT CROSS
WIT	DENOTES	WITNESS
M/MEAS	DENOTES	MEASURED
N,S,E,W	DENOTES	NORTH, SOUTH, EAST, WEST
P1	DENOTES	PLAN 20R–12443
P2	DENOTES	PLAN OF SURVEY BY J.H. GELBLOOM SURVEYING LIMITED, O.L.S. DATED JUNE 6, 2012
P3	DENOTES	PLAN 20R–6597
P4	DENOTES	PLAN 20R–3844
BP	DENOTES	BELL POLE
CB	DENOTES	CATCH BASIN
FH	DENOTES	FIRE HYDRANT
GVK	DENOTES	GAS VALVE KEY
HBP	DENOTES	HYDRO BELL POLE
HP	DENOTES	HYDRO POLE
LS	DENOTES	LIGHT STANDARD
MH	DENOTES	MANHOLE
HW	DENOTES	HAND WELL
TL	DENOTES	TRAFFIC LIGHT
WV	DENOTES	WATER VALVE
AD	DENOTES	AREA DRAIN
BB	DENOTES	BELL PEDESTAL
TS	DENOTES	TRAFFIC SIGN
GM	DENOTES	GAS MAIN
GP	DENOTES	GAS PIPE
ILB	DENOTES	INTERLOCKING BRICK
DS	DENOTES	DOOR STILL
LP	DENOTES	LIGHT POLE
OH	DENOTES	OVERHEAD WIRE
AD SIGN	DENOTES	ADVERTISING SIGN
CSW	DENOTES	CONCRETE SIDEWALK
PROD	DENOTES	PRODUCTION
D1	DENOTES	INSTRUMENT No. 636755
BURL	DENOTES	CITY OF BURLINGTON
WW	DENOTES	WINDOW WELL
HLP	DENOTES	HYDRO LIGHT POLE
(B)	DENOTES	BOTTOM OF CURB
BMH	DENOTES	BELL MANHOLE
SRW	DENOTES	STONE RETAINING WALL
MW	DENOTES	MONITORING WALL
OU	DENOTES	ORGIN UNKNOWN
BMH	DENOTES	BELL MANHOLE
(G)	DENOTES	GUTTER ELEVATION
(C)	DENOTES	CURB ELEVATION
INV	DENOTES	INVERT
TOP	DENOTES	TOP OF PIPE
0.10ø	DENOTES	DECIDUOUS TREE WITH TRUNK DIAMETER 0.10 metres
000.00	DENOTES	SPOT ELEVATION

AREA: 2340.8 m2

NOTE:
- UPDATED ON MAY 19, 2016 TO SHOW STAKEOUT TOP OF BANK
- UPDATED ON OCTOBER 07, 2016
- UPDATED ON OCTOBER 19, 2016 TO SHOW ADDITIONAL SHOTS OF THE CREEK

SURVEYOR'S CERTIFICATE

I CERTIFY THAT

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE 6th DAY OF FEBRUARY , 2016

FEBRUARY 11, 2016
DATE

PIRATHEEPAN RAMACHANDRAN
Ontario Land Surveyor

R. AVIS SURVEYING INC.
SUITE 203
235 YORKLAND BOULEVARD
TORONTO, ONTARIO
M2J 4Y8
TEL.: (416) 490–8352 FAX: (416) 491–6206
EMAIL : office@ravissurveying.com

CHECKED BY : P.R., O.L.S.	
CALCULATED BY :	PROJECT No. : 2982–1
DRAWN BY : AM/JB/BL	DRAWING No. : 2982–1CREEK.DWG

Appendix F

Hydrologic and Hydraulic Modelling Files (Downtown Area)

TABLE F1: PCSWMM HYDROLOGY PARAMETERS

Name	Outlet	Area (ha)	Flow Length (m)	ACTUAL EXISTING (REGIONAL STORM)		FUTURE INTENSIFICATION (100Y STORM)	
				Existing Imperv (%)	CN (AMC-III)	Future Imperv (%)	CN (AMC-II)
S1-E	3646-S	6.06	34.8	52.10	88.3	52.10	76.9
S1-F	3646-S	0.42	34.8	89.60	88.3	**90.00**	76.9
S2	J16.89306	3.97	52.2	46.71	85.8	46.71	72.5
S3	J19	0.61	171.1	19.57	82.4	19.57	67.0
S4	J21	1.95	177.3	10.33	82.4	10.33	67.0
ST1	2252-S	3.47	35.5	86.70	82.4	86.70	67.0
ST10_1	7555-S	2.50	31.2	56.33	88.8	56.33	77.7
ST10_2	7555-S	5.18	31.2	54.80	88.7	54.80	77.6
ST10_3	2602-S	3.08	31.2	57.89	87.8	57.89	76.0
ST10_5	7549-S	1.86	31.2	67.68	90.4	67.68	80.6
ST100	J449.5095	0.70	48.5	10.82	82.4	10.82	67.0
ST101	39807-S	2.75	30.9	62.83	87.6	62.83	75.6
ST102	2220-S	2.35	40.0	39.98	87.4	39.98	75.3
ST103	12839-S	1.27	25.6	61.60	88.6	61.60	77.4
ST104	2232-S	2.17	30.0	82.84	82.4	82.84	67.0
ST105	J359.2253	3.17	63.4	56.84	82.4	56.84	67.0
ST106	J10	1.30	30.0	88.19	82.4	88.19	67.0
ST107	2246-S	1.69	27.1	90.00	82.4	90.00	67.0
ST108_1	2430-S	0.98	32.7	90.00	82.4	90.00	67.0
ST108_2	2434-S	2.20	32.7	89.53	82.4	89.53	67.0
ST109	2425-S	0.75	25.2	90.00	82.4	90.00	67.0
ST11	2555-S	3.54	35.4	65.06	90.2	65.06	80.3
ST110	8060-S	3.40	58.9	66.18	82.4	66.18	67.0
ST111	J872.2523	5.41	160.0	34.10	82.5	34.10	67.2
ST112	J44.5527	0.81	37.5	53.89	85.6	53.89	72.3
ST113	11792-S	1.32	40.3	69.07	88.6	69.07	77.5
ST114	J662.2523	1.17	40.0	47.52	87.9	47.52	76.2
ST115	10518-S	2.62	39.6	51.46	88.1	51.46	76.6
ST116	2464-S	1.11	50.0	54.98	88.3	54.98	76.9
ST118	J216.0621	0.84	40.0	48.49	87.9	48.49	76.3
ST119	2438-S	1.72	37.1	89.95	82.6	89.95	67.3
ST12	2556-S	2.96	48.2	65.35	90.0	65.35	79.9
ST120	8072-S	0.94	29.3	63.79	88.6	63.79	77.4
ST121	2506-S	1.00	30.0	70.78	84.7	70.78	70.8
ST122	2501-S	2.99	34.9	54.20	87.4	54.20	75.3
ST123	2707-S	3.07	35.4	64.98	83.9	64.98	69.4
ST124	2566-S	1.98	42.5	68.45	86.5	68.45	73.7
ST125	2568-S	1.03	27.9	72.05	88.4	72.05	77.1
ST126	7542-S	1.13	30.5	66.05	90.3	66.05	80.5
ST127	7541-S	2.16	30.9	68.53	90.4	68.53	80.6
ST128	7535-S	2.14	26.0	65.76	90.3	65.76	80.5
ST129	7531-S	2.76	29.1	61.52	84.9	61.52	71.1
ST13	40922-S	3.52	60.3	53.11	82.4	53.11	67.0
ST130	11754-S	2.16	38.5	64.08	84.0	64.08	69.5
ST131	7532-S	2.79	33.4	48.47	83.9	48.47	69.4
ST132	2342-S	2.91	88.2	52.05	88.2	52.05	76.7

TABLE F1: PCSWMM HYDROLOGY PARAMETERS

Name	Outlet	Area (ha)	Flow Length (m)	ACTUAL EXISTING (REGIONAL STORM)		FUTURE INTENSIFICATION (100Y STORM)	
				Existing Imperv (%)	CN (AMC-III)	Future Imperv (%)	CN (AMC-II)
ST133	2339-S	2.95	72.3	50.32	88.1	50.32	76.5
ST134_1	2344-S	0.96	31.4	66.99	88.4	66.99	77.2
ST134_2	2333-S	0.53	31.4	40.00	87.4	40.00	75.3
ST135	2085-S	3.70	65.2	36.09	82.8	36.09	67.6
ST136	12517-S	4.95	77.9	20.79	82.4	20.79	67.0
ST137	2059-S	4.01	80.1	59.97	82.5	59.97	67.1
ST138	2059-S	0.99	26.0	65.81	87.8	65.81	76.0
ST139	2066-S	3.60	30.0	60.38	84.5	60.38	70.4
ST14	12615-S	1.08	27.8	69.17	82.4	69.17	67.0
ST140	8834-S	1.94	39.5	64.53	82.4	64.53	67.0
ST141	2067-S	1.77	30.0	51.87	84.4	51.87	70.3
ST142	12517-S	1.31	24.7	54.41	82.4	54.41	67.0
ST143	2070-S	2.15	33.4	59.45	85.6	59.45	72.2
ST144	2089-S	0.98	33.9	70.76	82.5	70.76	67.2
ST145	2071-S	0.89	27.4	60.93	88.5	60.93	77.3
ST146	7694-S	3.79	37.0	53.79	88.2	53.79	76.7
ST147	2475-S	1.77	43.0	47.49	87.7	47.49	75.9
ST148	J43	1.41	27.3	56.08	88.3	56.08	76.9
ST149	2701	2.15	50.9	10.11	82.4	10.11	67.0
ST15	J29-S1	2.43	34.8	60.60	88.0	60.60	76.3
ST150	2705-S	1.61	44.6	56.42	87.0	56.42	74.7
ST151	2446-S	2.35	32.0	86.92	82.4	86.92	67.0
ST152	15848-S	4.22	50.0	90.00	82.4	90.00	67.0
ST153	7700-S	1.65	36.4	63.15	88.6	63.15	77.4
ST154	J722.2523	0.56	50.0	39.34	87.3	39.34	75.1
ST155	J542.2524	1.94	25.5	52.35	88.1	52.35	76.6
ST156	J396.062	1.65	88.8	52.51	88.1	52.51	76.6
ST158	2476-S	0.40	30.0	64.20	88.6	64.20	77.4
ST159	J306.062	1.06	50.0	37.12	87.1	37.12	74.9
ST16	8031-S	4.36	31.3	64.21	90.1	64.21	80.1
ST160	J6	1.54	37.3	67.75	87.1	67.75	74.8
ST161	2023-S	1.31	45.2	69.60	82.4	69.60	67.0
ST162	J144.8044	2.05	98.3	54.30	88.3	54.30	76.9
ST163	2377-S	2.41	30.4	77.50	88.3	**90.00**	76.9
ST166	11788-S	1.56	71.7	89.98	82.4	89.98	67.0
ST167	J403.9925	0.75	30.0	56.40	85.7	56.40	72.4
ST169	2388-S	1.08	31.5	90.00	82.4	90.00	67.0
ST17	2544-S	3.87	64.8	66.04	88.2	66.04	76.8
ST170	J22	1.14	50.0	53.67	88.2	53.67	76.7
ST172	10772-S	0.66	36.3	69.24	82.4	69.24	67.0
ST173	2100-S	1.34	68.0	67.71	82.4	67.71	67.1
ST174_1	J449.5095	1.29	40.0	77.50	82.4	**90.00**	67.0
ST174_2	J582.0831	1.71	40.0	77.50	82.4	**90.00**	67.0
ST177	2239-S	0.39	30.0	89.31	82.4	89.31	67.0
ST178	2216	0.75	30.0	73.73	88.5	73.73	77.3
ST18	7571-S	0.89	30.0	73.08	90.3	73.08	80.4

TABLE F1: PCSWMM HYDROLOGY PARAMETERS

Name	Outlet	Area (ha)	Flow Length (m)	ACTUAL EXISTING (REGIONAL STORM)		FUTURE INTENSIFICATION (100Y STORM)	
				Existing Imperv (%)	CN (AMC-III)	Future Imperv (%)	CN (AMC-II)
ST19	2558-S	2.95	29.6	68.90	82.4	68.90	67.0
ST2	2401-S	2.79	24.5	90.00	82.4	90.00	67.0
ST20	2721-S	2.21	42.1	66.82	82.4	66.82	67.0
ST21_1	7567-S	0.90	28.3	60.79	88.5	60.79	77.3
ST21_3	8065-S	1.08	28.3	59.94	88.5	59.94	77.3
ST21_4	2565-S	0.53	28.3	58.24	88.4	58.24	77.2
ST22	7535-S	1.27	35.7	68.29	90.4	68.29	80.6
ST23	8043-S	1.43	25.5	57.22	88.2	57.22	76.8
ST25	8051-S	4.49	44.4	52.52	87.8	52.52	76.0
ST26_2	J11	1.85	200.0	10.13	82.4	10.13	67.0
ST28	2489-S	0.75	50.0	10.17	82.4	10.17	67.0
ST29	11379-S	4.53	50.0	62.96	82.4	62.96	67.0
ST3	J28.35437	4.22	30.8	63.58	88.3	63.58	76.9
ST30	2492-S	2.16	43.5	65.63	82.4	65.63	67.0
ST31	8043-S	2.78	35.5	61.32	85.8	61.32	72.6
ST32	2485-S	3.88	70.9	60.77	82.4	60.77	67.0
ST33	2570-S	3.31	31.0	66.88	82.4	66.88	67.0
ST34	7573-S	1.84	79.9	60.34	87.0	60.34	74.7
ST35	2506-S	1.10	45.8	63.99	82.4	63.99	67.0
ST36	2500	1.73	51.2	56.76	85.4	56.76	71.9
ST37	3679-S	2.16	28.0	89.70	83.1	**90.00**	68.1
ST38	3679-S	1.59	60.8	84.00	82.4	84.00	67.0
ST4_1	7559-S	0.95	36.0	28.94	82.4	28.94	67.0
ST4_2	2562-S	2.51	36.0	54.34	83.9	54.34	69.5
ST41-E	15179-S	5.60	43.4	55.10	88.0	55.10	76.4
ST43	2021-S	3.71	51.5	61.71	86.4	61.71	73.6
ST44	2018-S	4.22	47.9	53.22	88.2	53.22	76.8
ST46	2018-S	0.90	31.9	63.42	88.7	63.42	77.7
ST47	15852-S	6.13	81.2	83.50	82.4	83.50	67.0
ST48-E	2372-S	1.90	72.9	64.90	82.4	**90.00**	67.0
ST48-F	2372-S	1.48	72.9	90.00	82.4	90.00	67.0
ST49-E	2380-S	2.80	49.6	61.40	87.7	**90.00**	75.8
ST49-F	2380-S	1.71	49.6	90.00	87.7	90.00	75.8
ST5	40928-S	4.78	58.9	65.53	82.4	65.53	67.0
ST50	2480-S	3.39	32.7	64.51	83.9	64.51	69.4
ST51	2454-S	3.02	46.8	55.22	88.3	55.22	76.9
ST52	J9	1.80	73.1	55.42	88.3	55.42	76.9
ST53	2355-S	2.43	50.0	34.48	82.4	34.48	67.0
ST54	J76.89307	1.53	77.5	52.83	82.4	52.83	67.1
ST55	2360-S	5.24	40.0	62.52	82.6	62.52	67.3
ST56-E	12524-S	0.68	44.8	70.40	82.7	**90.00**	67.4
ST56-F_2	12524-S	0.69	44.8	63.80	82.7	**90.00**	67.4
ST57-E	J1-S	0.52	34.2	89.70	82.4	**90.00**	67.0
ST57-F	J1-S	0.29	34.2	90.00	82.4	90.00	67.0
ST58	J4	0.96	35.7	60.02	85.1	60.02	71.5
ST59-E	2369-S	1.44	45.8	68.70	83.7	**90.00**	69.2

TABLE F1: PCSWMM HYDROLOGY PARAMETERS

Name	Outlet	Area (ha)	Flow Length (m)	ACTUAL EXISTING (REGIONAL STORM)		FUTURE INTENSIFICATION (100Y STORM)	
				Existing Imperv (%)	CN (AMC-III)	Future Imperv (%)	CN (AMC-II)
ST59-F	2369-S	0.55	45.8	90.00	83.7	90.00	69.2
ST6_1	2714	0.77	36.3	44.61	82.4	44.61	67.0
ST6_2	2713-S	1.51	36.3	76.44	82.4	76.44	67.0
ST60_1-E	10332-S	1.85	25.6	61.10	89.8	**90.00**	79.6
ST60_1-F	10332-S	0.23	25.6	89.90	89.8	90.00	79.6
ST60_2	3680-S	4.04	47.2	85.70	82.4	87.00	67.0
ST60_4	3687-S	2.85	30.0	89.90	82.4	90.00	67.0
ST60_5	12908-S	0.31	25.6	90.00	82.4	90.00	67.0
ST61	J357.8489	4.46	89.1	51.53	86.7	51.53	74.1
ST62	2337-S	3.31	56.7	52.64	88.2	52.64	76.7
ST63	2331-S	6.59	47.0	54.19	88.3	54.19	76.9
ST64_1	2333-S	0.20	39.0	85.67	86.2	85.67	73.2
ST64_2	J433.9925	2.12	39.0	73.59	82.4	73.59	67.0
ST65	2272	3.93	30.0	51.17	88.1	51.17	76.6
ST66	2084-S	5.82	52.2	52.61	88.1	52.61	76.6
ST67	2057-S	5.69	74.5	29.43	83.6	29.43	68.9
ST68	2059-S	5.08	53.1	50.05	86.2	50.05	73.3
ST69	2278-S	1.08	49.1	52.78	88.2	52.78	76.7
ST7	2710-S	3.89	51.5	30.04	82.4	30.04	67.0
ST70	2272-S	0.62	30.0	59.57	88.5	59.57	77.2
ST71	2071-S	2.52	42.6	51.52	88.1	51.52	76.6
ST72	2091-S	5.23	48.5	53.65	87.9	53.65	76.3
ST73	2295-S	4.38	68.6	53.42	88.2	53.42	76.8
ST74	2279-S	1.15	42.2	53.64	88.2	53.64	76.8
ST75	2280-S	1.41	49.3	52.53	88.2	52.53	76.7
ST76-E	2386-S	2.05	47.0	71.60	82.4	**90.00**	67.1
ST76-F	2386-S	1.11	47.0	89.70	82.4	90.00	67.1
ST77	2390-S	1.20	41.9	85.71	86.5	85.71	73.9
ST78	2398-S	3.46	40.9	51.14	88.1	51.14	76.5
ST79	2393-S	0.96	45.4	89.99	82.4	89.99	67.0
ST8_1	16016-S	1.34	32.4	63.36	84.4	63.36	70.3
ST8_2	2585-S	7.59	32.4	58.32	86.1	58.32	73.0
ST80	11783-S	2.88	50.4	54.13	88.3	54.13	76.8
ST81	J284.0674	4.00	95.2	72.72	87.2	72.72	75.0
ST82	2312-S	5.50	55.8	52.50	87.8	52.50	76.0
ST83	2317-S	1.38	53.0	51.78	88.1	51.78	76.6
ST84	2295-S	1.83	43.0	53.26	88.2	53.26	76.8
ST85	2283-S	1.36	49.7	58.77	87.0	58.77	74.6
ST86	2091-S	0.35	31.3	58.10	88.4	58.10	77.1
ST87	2301-S	1.40	67.4	57.69	89.3	57.69	78.7
ST88	2302-S	3.64	84.1	57.25	86.4	57.25	73.7
ST89	10771-S	1.39	34.6	57.34	87.4	57.34	75.4
ST9	2216-S	5.15	50.0	67.17	83.4	67.17	68.7
ST90	11049-S	2.15	31.1	76.05	83.9	76.05	69.5
ST91	10768-S	0.79	28.8	53.34	87.9	53.34	76.2
ST92	2413-S	2.28	27.3	90.00	82.4	90.00	67.0

TABLE F1: PCSWMM HYDROLOGY PARAMETERS

Name	Outlet	Area (ha)	Flow Length (m)	ACTUAL EXISTING (REGIONAL STORM)		FUTURE INTENSIFICATION (100Y STORM)	
				Existing Imperv (%)	CN (AMC-III)	Future Imperv (%)	CN (AMC-II)
ST93	2414-S	1.21	30.4	89.83	82.4	89.83	67.0
ST94	12572-S	1.45	82.5	89.99	82.4	89.99	67.0
ST95	2092-S	7.28	42.8	55.51	88.3	55.51	76.9
ST96	J449.5095	2.74	41.3	48.61	88.0	48.61	76.3
ST97	12756-S	3.82	33.3	57.06	88.3	57.06	76.9
ST98	12756-S	0.81	50.0	10.09	82.4	10.09	67.0
ST99	9182	4.11	55.5	50.75	87.8	50.75	76.1