Appendix H

Existing Conditions Drainage Assessment

DILLON CONSULTING

DILLON CONSULTING

City of Hamilton

Rymal Road

(Upper James St to Dartnall Rd) Municipal Class Environmental Assessment Phases 1 to 4

November 2024

November 26, 2024

City of Hamilton
71 Main St W
Hamilton, Ontario
ON L8P 4Y5

Attention: Megan Salvucci, Project Manager - Capital Infrastructure Planning, Public Works, Engineering Services, City of Hamilton

Drainage Assessment

We are pleased to present the Rymal Road drainage plan between Upper James Street and Dartnall Road. We have reviewed the available background information, identified data gaps, assessed the capacity of the existing sewer, and identified potential low impact development options for next steps.

Sincerely,

DILLON CONSULTING LIMITED

James Michener, P.Eng.
Water Resources Engineer

JVM:js:ic
cc: Maria King, Dillon Project Manager

Our file: 20-3410

DILLON CONSULTING

165 Cross Ave.
Unit 103&104
Oakville, Ontario
Canada
L6J 0A9
Telephone
905.901.2912
Fax
905.901.2918

Dillon Consulting Limited

Table of Contents

1.0 **Introduction** 1

2.0 **Background Information Review and Identification of Data Gaps** 2

2.1 Background Information Review 2
2.2 Data Gaps 4

3.0 **Existing Drainage** 5

3.1 Soils 5
3.2 Karst Topography 5
3.3 Receiving Watercourses 6
3.4 Subcatchments 7

4.0 Drainage Infrastructure 11

4.1 Culverts 11
4.2 External Stormwater Management Controls 11
4.3 Major System 12
4.4 Roadside Ditches 13
4.5 Storm Sewer Analysis 13

5.0 Stormwater Management Design Criteria 15

5.1 City of Hamilton Criteria 15
5.2 Subwatershed Plan Objectives 15

6.0 **Proposed Conditions** 17

6.1 Storm Sewers 17
6.2 Culverts 17
6.3 Roadside Ditches 17

7.0 **Low Impact Development Opportunities and Constraints** 18

8.0 **Conclusions and Recommendations** 19

Tables

Table 1: Existing Culvert Summary 11
Table 2: Existing Sags along Rymal Road 12
Table 3: Over-Capacity Storm Sewer Pipes 14

Appendices

A Background Document Excerpts

A-1 West Mountain Sewershed Plan: City of Hamilton Implementation of Mouse Simulation Package for the Separated Storm Sewer System (2010)

A-2 Karst Locations within Hannon Creek Subwatershed: Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment (2017)

A-3 Upper Hannon Creek Subwatershed Aquatic Stream Classification: Hannon Creek Subwatershed – North Glanbrook Industrial Business Park Master Drainage Plan (2010)

B Storm Sewer Assessment

1.0 Introduction

Dillon Consulting Limited (Dillon) was engaged by the City of Hamilton to complete Phases 1 through 4 of the Municipal Class Environmental Assessment (MCEA) process for improvements to Rymal Road from Upper James Street to Dartnall Road. This report documents the existing drainage conditions to support the development and evaluation of alternatives, potential mitigation solutions, and low impact development (LID) measures associated with stormwater management. This report:

- Characterizes the existing drainage conditions within the study area;
- Delineates significant drainage areas that contribute runoff to the existing Rymal Road corridor;
- Identifies existing drainage deficiencies; and,
- Provides recommendations to assist in the development and evaluation of the proposed road improvement alternatives.

The Rymal Road MCEA study area includes all land within the Rymal Road public right-of-way (ROW) from 100 m west of Upper James Street to 100 m east of Dartnall Road. The study area also includes lands within the public right-of-way 50 m north and/or south at signalized intersections where turning lanes may be added or lengthened to improve traffic operations on Rymal Road. The study area is shown on Figure 1.

2.0 Background Information Review and Identification of Data Gaps

In order to complete the objectives of this report, information is required to characterize the existing drainage conditions and to identify opportunities and constraints within the project area. This information is gathered from previous investigative reports, design reports, design drawings, sewer mapping, publicly available landform data, and other as may be made available by the City or other public sources. Data gaps have also been identified, which include information regarding drainage areas and peak flows directed to Rymal Road, as well as capacity of downstream receivers that receive runoff Rymal Road under future conditions.

2.1 Background Information Review

A summary of the background information that was reviewed to assist with the development of this stormwater assessment is provided below. Select excerpts from this background information review has been included in Appendix A.

Geotechnical Investigation Rymal Road North Glanbrook Industrial Phase 1 (2005)

This geotechnical investigation was completed along Rymal Road between Upper Gage Street and Nebo Road. Ten boreholes were advanced to assess subsurface soil and groundwater conditions. This investigation provides a characterization of subsurface soils for a portion of the project site – which informs infiltration potential for low impact development features.

Hamilton South Mountain Complex Phase 2 and 3 Stormwater Management Report (2006)

This stormwater management report details the design of the Turner Park stormwater management pond – including the contributing area and design release rates of the pond. Pond release rates from this report are incorporated into the storm sewer assessment.

City of Hamilton Implementation of Mouse Simulation Package for the Separated Storm Sewer System (2010)

The project area west of Upper Sherman Avenue is included in this study area. This 2010 report summarizes the storm sewer modelling process of the West Mountain Sewershed. Figure 1-1 from this report is presented in Appendix A and shows that the West Mountain Sewershed trunk sewer begins on Rymal Road west of Upper Wellington Street and continues north and east, outletting to a tributary of Redhill Creek.

The modelling analysis discussed in the 2010 report shows that the storm sewers in this area have sufficient capacity to accommodate the runoff from design storms ranging from the 2-year to 10-year event (individual sewer capacities vary). Note that these results account for inlet capacity of catch basins

– when the model was run assuming all runoff is collected by storm sewers, the system was generally under capacity. From a comparison of aerial imagery when this model was developed and current imagery, it can be seen that development within the sewershed has take place. A residential area has been developed between Upper James Street and Upper Wentworth Street just north of Rymal Road, which may not have been incorporated in the model development. The results in this report are likely outdated, however, the intent of the model was to assess development as it is proposed.

Hannon Creek Subwatershed – North Glanbrook Industrial Business Park Master Drainage Plan (2010)

The project area east of Upper Sherman Avenue is included in the Rymal Road MCEA study area. This study investigates the conditions of the receiving systems that accept runoff from a portion of the project area, as well as a review of the potential karst conditions within the project area. Specific stormwater management criteria for the Hannon Creek subwatershed are recommended within this 2010 report. These criteria were reviewed and considered for the Rymal Road improvements.

Hannon Creek Subwatershed Action Plan (2013)

The project area east of Upper Sherman Avenue is included in the Rymal Road MCEA study area. This action plan provides high level recommendations for stormwater management goals for future development. These goals have been considered as part of the recommended stormwater management strategy for the Rymal Road improvements.

Upper Ottawa Creek Subwatershed Stewardship Action Plan (2013)

The project area west of Upper Sherman Avenue is included in the Rymal Road MCEA study area. This action plan provides high level recommendations for stormwater management goals for future development. These goals have been considered as part of the recommended stormwater management strategy for the Rymal Road improvements.

Geotechnical Investigation Proposed 400m Diameter Watermain Installation and Road Widening Rymal Road East Between Dartnall and Nebo Road (2014)

As described in the title of this document, the geotechnical investigation was completed on Rymal Road between Dartnall Road and Nebo Road. This investigation provides a characterization of subsurface soils for a portion of the project site – which informs infiltration potential for low impact development features.

Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment (2017)

The project area east of Upper Sherman Avenue is included in the Rymal Road MCEA study area. This report builds off the 2010 “Hannon Creek Subwatershed – North Glanbrook Industrial Business Park Master Drainage Plan” report. It furthers the karst conditions investigation and makes recommendations on stormwater management criteria further to the 2010 North Glanbrook report. These criteria were reviewed and considered for the Rymal Road improvements.

Nora Frances Henderson Secondary School Stormwater Management Report (2018)

This stormwater management report details the design of Nora Frances Henderson Secondary School stormwater management pond – including the contributing area and design release rates of the pond. The design pond release rates have been utilized in the storm sewer analysis.

OGS Earth (online database)

OGS Earth databases was reviewed, including surficial soil, historical borehole records, and karst conditions mapping. This mapping has been reviewed along with the local geotechnical reports available to establish subsurface soils conditions for infiltration.

Hamilton Mapping (online database)

Hamilton Mapping was reviewed for storm sewer locations outside of the project study area. External catchments contributing to the Rymal Road storm sewer system were delineated based largely on the Hamilton Mapping tool to locate the extent of external storm sewer networks.

Ontario Watershed Information Tool (OWIT) (online tool)

OWIT was utilized to estimate drainage areas of agricultural lands that contribute runoff to the Rymal Road drainage system.

2.2 Data Gaps

Stormwater management site plan design information for existing development that drains to Rymal Road will be required at the detailed design stage. Private development (particularly newer development) may have on-site stormwater management controls that reduce the peak flows released from these sites to the Rymal Road storm sewers. It is possible that some storm sewers assessed as undersized may be considered adequate once these private controls are accounted for.

3.0 Existing Drainage

Drainage features have been reviewed for the project area as part of the existing conditions assessment. These conditions include subcatchments defined by storm sewer outlets from the site, in-situ soil characteristics, potential properties containing karst features, and receiving subwatersheds. This information is largely collected from the background information review, with available background information summarized in Section 2.1.

3.1 Soils

Site soil characteristics were reviewed from the background information summarized in Section 2.1. From the 2005 and 2014 geotechnical investigations, as well as the OGS Earth online database, soils within and close to the project area consist of silt, clayey silt, silty clay, glacial till, and silty sand. Borehole refusal classified as “assumed bedrock” was encountered between 1.2 m and 3.8 m depth from surface for most boreholes conducted.

From OGS Earth surficial soil types, the site falls under the category of fine-textured glaciolacustrine deposits (silt and clay, minor sand and gravel – massive to well laminated). This indicates poorly draining soils, which will have a higher potential to produce runoff.

3.2 Karst Topography

The project site is classified as potential karst location based on information from OGS Earth. Both the Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment (2017) and the Hannon Creek Subwatershed - North Glanbrook Industrial Business Park Master Drainage Plan (2010) provide investigations of karst conditions within the Upper Hannon Creek subwatershed.

From the 2017 report, Figure 10 shows that Rymal Road falls within the major karst catchment areas; this figure has been included in Appendix A as an excerpt from this report. Dye tracing tests were conducted, and both dyes used travelled to the Rymal Road storm sewer and were also sampled downstream in the tributary to Hannon Creek. This indicates that runoff is conveyed through underground karst features to the Rymal Road sewer. Figure 13 of the 2017 report shows that there are no known sinkholes located within the Rymal Road MCEA study area. The 2017 report concludes that development of lands within the study area should avoid concentrating flow along surface swales as it may result in new suffosion sinkholes.

The risk of sinkholes within the Rymal Road corridor is likely low based on: local knowledge of City staff, the fact that the area is largely developed, surface swales are currently in use, and no sinkholes have been identified.

3.3 Receiving Watercourses

The Rymal Road MCEA project area is located within the Redhill Creek watershed. The study area discharges to two separate tributaries that convey runoff to Redhill Creek:

1. Upper Ottawa Creek
   The project site west of Upper Sherman Avenue is located in the Upper Ottawa Creek subwatershed. Runoff from Rymal Road is collected as part of the West Mountain Sewershed. This sewershed includes a trunk sewer with its furthest upstream extent beginning on Rymal Road west of Upper Wellington Street. This trunk conveys flows north along Upper Wellington Street, and eventually directs flows to an outfall to Upper Ottawa Creek east of Upper Ottawa Street and south of Lincoln M Alexander Parkway.

   The Upper Ottawa Creek Subwatershed Stewardship Action Plan (2013) was completed to provide recommendations and stewardship goals for this subwatershed. It recommends that a treatment train approach be implemented to treat stormwater, utilizing source, conveyance and end-of-pipe measures to treat stormwater.

2. Hannon Creek
   There are two locations where the project area outlets to the Hannon Creek watershed, as outlined below:
   a. The project site east of Upper Sherman Avenue is located in the Hannon Creek subwatershed. Runoff collected from Rymal Road east of Upper Sherman Avenue and west of Nebo Road is conveyed along Rymal Road towards an outfall to a tributary of Hannon Creek. This tributary has been labeled HC1-A in the 2010 Hannon Creek Subwatershed Study;
   b. Runoff collected from the project area east of Nebo Road is conveyed to a tributary of Hannon Creek, which has been labeled HC3 in the 2010 Hannon Creek Subwatershed Study.

   A number of subwatershed studies have been prepared for Hannon Creek. These studies provide a number of recommendations for stormwater management strategies within the watershed including specific design criteria. These studies include:
   i. Hannon Creek Subwatershed Action Plan (2013): This action plan generally recommends that stormwater from future development be treated utilizing a treatment train approach – including source, conveyance, and end-of-pipe measures;
   ii. Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment (2017): This 2017 report identifies lot level stormwater management controls as the preferred strategy moving forward. LID measures are recommended as part of the lot level controls to achieve infiltration to maintain water balance, as well as to provide flow attenuation to meet the creek channel erosion threshold. The 2017 report builds off the 2010 Hannon Creek Subwatershed study of karst conditions, which is also provided as background information for this report. The 2017 report recommends that future development implement LID and detention facilities to achieve stormwater management

objectives. LID measures are recommended to achieve infiltration of the equivalent of 5 mm across the development site to maintain water balance and reduce erosion potential of Hannon Creek;

iii. Hannon Creek Subwatershed - North Glanbrook Industrial Business Park Master Drainage Plan (2010): The project area contributes to Reach HC1-A and HC3 as shown in Appendix A as an excerpt from the 2010 report. HC1-A is identified in the 2010 report as "Important Habitat" and HC3 is identified as "Critical Habitat". Important Habitat has been defined as moderately sensitive, and does not include cold water fisheries (cold water fisheries are considered Critical Habitat in the 2010 report). HC1-A has also been described as having a relatively steep gradient, and exhibits large amounts of erosion, deposition, and incision to the parent-bed material. The 2010 report recommends the following criteria for the watershed as a whole:
   - Water Quality: Enhanced Level;
   - Water Quantity: Control peak flows to existing conditions level for storms up to and including 100-year storm event;
   - Infiltration Target: Not recommended based on low permeability of soils within the study area;
   - Erosion Requirement: Develop erosion threshold for each facility and perform exceedance analysis using continuous flow model;
   - Karst Features: Lesser karst outlets be plugged, while drainage to significant features be maintained.

3.4 Subcatchments

Dillon identified the storm sewer outlets from the Rymal Road study area based on the available background information. Subcatchments that contribute runoff to each outlet were delineated based on storm sewer alignments, road and storm sewer profiles, as well as additional drainage features such as culverts and swales as identified on the plan and profile drawings, and Hamilton Mapping. These subcatchments are shown on Figure 2, Figure 3, and Figure 4 subsets. Note that the Rymal Road Storm Sewer Catchments are delineated based on the estimated area that is captured directly by the Rymal Road catchbasins. External Area Catchments are delineated based on the estimated area that is captured by external storm sewers and conveyed to the Rymal Road storm sewer system.

A brief description of each subcatchment area is provided below:

Outlet A – Upper James Street Storm Sewer

The external catchment areas that contribute flow to this storm sewer include residential and commercial properties. Rymal Road has an urban cross section in this area, which is fronted by a mixture of residential and commercial properties. Stormwater runoff is conveyed via curb and gutter to catchbasins and travels eastward to the Upper James Street storm sewer, which connects to the Upper Wellington Street trunk storm sewer. Major system flows are directed eastward along Rymal Road.

Outlet B – Upper Wellington Street Storm Sewer

The external catchment areas include residential and commercial properties. This section of Rymal Road has both urban and rural cross sections and is fronted by residential and commercial properties. Stormwater runoff is conveyed via curb and gutter and is captured with catchbasins on the south side of the road. Along the north side, runoff is conveyed via swales and is captured by ditch inlets that discharge into the storm sewer. The Rymal Road storm sewer flows eastward to the Upper Wellington Street trunk storm sewer, which ultimately outlets to Upper Ottawa Creek. Major flows are conveyed eastward along Rymal Road.

Outlet C – Massena Drive Storm Sewer

The external catchment areas consist of a cemetery (Mount Hamilton Cemetery). External flows are conveyed to the Rymal Road storm sewer through two storm sewer connections. This section of Rymal Road has both rural and urban cross sections and is fronted by residential properties and the cemetery. Stormwater is conveyed via curb and gutter and is captured with catchbasins on the south side of the road. Along the north side, there is a gravel shoulder, vegetated buffer, sidewalk, and stormwater is captured in catchbasins in the vegetated buffer adjacent to the gravel shoulder. The Rymal Road storm sewer discharges to the Massena Drive storm sewer, which connects to the Upper Wentworth storm sewer. Major flows are conveyed eastward along Rymal Road.

Outlet D – Republic Avenue Storm Sewer

The external drainage area that contributes flow to this storm sewer consists of commercial properties. The Turner Park SWM Pond is located on the northwest corner of the Turner Park plaza. The pond discharges to the Rymal Road storm sewer at the Republic Avenue intersection. This section of Rymal Road has both rural and urban cross-sections and is bounded by residential and commercial properties. The stormwater runoff is conveyed via curb and gutter and is captured by catchbasins on both sides of the road from Massena Drive to immediately west of Turner Park Driveway. From Turner Park Driveway to Hamilton Police Station 30, both sides of the road convey runoff with swales with ditch inlet catchbasins that discharge to the storm sewer. The Rymal Road storm sewer flows west to the Republic Avenue storm sewer, which connects to the Upper Wentworth sub-trunk sewer. Major flows are conveyed by the Rymal Road ROW to Republic Avenue, where they continue northward.

Outlet E – Upper Wentworth Street Storm Sewer

The external drainage area that contributes flow to this storm sewer consists of residential properties. This section of Rymal Road has both rural and urban cross sections and is fronted by both residential and commercial properties. The urban cross section conveys stormwater via curb and gutter with catchbasins that discharge to the local storm sewer. The rural cross section conveys stormwater with swales to ditch inlets that discharge to the storm sewer. The south side of the road has both rural and urban conveyance and capture methods. The cross section on the north side of Rymal Road is exclusively rural. The storm sewer flows eastward to the Upper Wentworth Street sub-trunk storm sewer. Major flows are conveyed west along Rymal Road.

Outlet F – Acadia Drive Storm Sewer

The external drainage areas that contribute flows to this storm sewer consist of residential properties. This stretch of Rymal Road has both rural and urban cross sections, and is fronted by both residential properties and green space. Along the south side of the road, stormwater is primarily conveyed via curb and gutter and is captured with catchbasins. Along the north side, runoff is conveyed via swales and is captured with ditch inlets that discharge to the storm sewer. The storm sewer flows west to the Acadia Drive storm sewer. Major flows are conveyed by the Rymal Road ROW towards Arrowhead Drive. Based on the information provided, major event runoff likely ponds at this intersection where it is collected by catchbasins on Arrowhead Drive just south of the intersection. Excess ponding spills south to a drainage ditch located south of the Rymal Road sidewalk.

Outlet G – To Tributary of Hannon Creek (HC1-A)

The external catchments consists of residential, commercial and industrial properties, as well as green spaces and agricultural land. This stretch of Rymal Road has both rural and urban cross sections. It is bounded by residential and commercial properties. The urban cross-section runoff is conveyed via curb and gutter and is captured with catchbasins on the south side of the road. The rural cross-section runoff is conveyed with swales and is collected with ditch inlets that discharge into the storm sewer. Rymal Road has a rural cross section from Upper Sherman Avenue to Miles Road, Sulmona Drive to west of Derby Street, and Upper Ottawa Street to the outlet. Rymal Road has an urban cross section from Miles Road to Sulmona Drive, and Grayrocks Avenue to Upper Ottawa Street. From Derby Street to Grayrocks Avenue, Rymal Road's cross section is rural on the south side and urban on the north side. The storm sewer flows east and outlets approximately 90 m east of the Rymal Road rail trail into a tributary of Hannon Creek identified as HC1-A. Major flows are conveyed eastward along Rymal Road. Note that between Sulmona Drive and Grayrocks Avenue there is no apparent storm servicing on the south side of Rymal Road. From a review of the as-built drawings, Hamilton mapping, and available online imagery, no swales or catchbasins were observed on the south side of Rymal Road between these streets.

Outlet H – Tributary of Hannon Creek (HC3)

The external catchment areas that contribute flows to this portion of Rymal Road consist of commercial and industrial properties, as well as green space. This section of Rymal Road has an urban cross section. It is fronted by both commercial properties and green space. Runoff is conveyed via curb and gutter and is captured with catchbasins. The storm sewer flows eastward to an existing SWM pond located north of Rymal Road. The SWM pond outlets to a tributary of Hannon Creek. Major flows are conveyed eastward along Rymal Road towards the Hannon Creek tributary identified as HC3.

4.0 Drainage Infrastructure

Existing drainage infrastructure was evaluated within the study area as part of the existing drainage conditions assessment. Stormwater management criteria and objectives were also established. These evaluations are summarized in the following sections, and include storm sewers, culverts, swales, external controls, and the major system.

4.1 Culverts

There are three culvert crossings within the Rymal Road MCEA study area; two of these culverts are located between Eva Street and Upper Gage Avenue. This stretch of road is serviced by a mix of roadside swales and curb and gutter with catchbasins and storm sewer. In some areas, the roadside swales are located behind the curb – with the curb conveying road runoff and the swales conveying runoff from properties fronting the roadway. These crossing culverts convey local runoff from the north swale to the south swale, and into the Rymal Road storm sewer through pipe inlets tied to catchbasins. Ultimately, these culverts will likely be removed when Rymal Road is reconstructed with a fully urbanized cross section.

The third culvert is located at the Outlet G location, which conveys runoff from the lands located south of Rymal Road and ties directly into the maintenance hole at the Hannon Creek tributary (HC1-A) outlet. The contributing area – 1240 to 1280 Rymal Road – has recently been developed, and it is recommended that the stormwater management plan for this development be reviewed as part of the Rymal Road reconstruction detailed design works.

A summary of the existing culverts is provided in the following Table 1.

Table 1: Existing Culvert Summary

Location (Station)	Material	Size (m)
3+010	CSP	900
3+143	CSP	800
4+910	Concrete	1500 x 2700

4.2 External Stormwater Management Controls

Several upstream SWM facilities discharge to the Rymal Road storm sewers. One of these ponds is located at Turner Park and conveys outflow via a storm sewer which crosses Rymal Road and joins with the Rymal Road outlet to the Republic Avenue storm sewer.

The Mile Estate stormwater pond is another pond discharging to the Rymal Road storm sewer. Note that the release rate of this pond has been provided as part of the Nora Frances Henderson Secondary School stormwater management report. Drainage is then directed through open channels to the Terni Boulevard (Sandrina Subdivision) storm sewer, eventually outletting to the Rymal Road storm sewer at

Upper Ottawa Street. The peak pond design release rates from these design reports have been included as fixed values the storm sewer analysis sheets in Appendix B.

Commercial and industrial developments located within the Rymal Road storm sewer service area should be investigated during detailed design to confirm the presence of on-site SWM controls.

4.3 Major System

As Rymal Road has a center crown, major system flows are split between the north and south sides of the ROW. The north side of the Rymal Road ROW has periodic outlets from the ROW towards the north at cross streets. The cross streets that convey the major system from the Rymal Road ROW are listed below:

- Atessa Drive;
- Marilyn Court;
- Upper Wellington Street;
- Republic Avenue;
- Upper Wentworth Street;
- Acadia Drive;
- Eva Street;
- Upper Gage;
- Grayrocks Avenue;
- Nebo Road;
- Hannon Creek Tributary HC1-A; and,
- Dartnall Road.

The major system flows on the south side of the Rymal Road ROW generally drain to sags in Rymal Road. From these sags, the flow may be collected by catchbasins or overtop to a cross street. Sags within the project area have been summarized in Table 2 below. If the direction of outflow is west or east, flow will continue along Rymal Road once the depth of the sag is overtopped. If the direction of outflow is north, runoff does not pond at the sag and is conveyed north along a cross street. Depth of ponding will be assessed as part of the detailed design process and must meet City standards.

Table 2: Existing Sags along Rymal Road

Location (Sta.)	Expected Ponding	Sag Outlet	Direction of Outflow
04+95	No	Atessa Drive	North
08+70	No	Upper Wellington Street	North
22+50	Yes	Catchbasins (Arrowhead Drive)	West
33+15	Yes	Catchbasin	East
47+10	No	Roadside Ditch (south side)	East
51+15	Yes	Catchbasin	East

4.4 Roadside Ditches

A number of roadside ditches convey runoff within the Rymal Road ROW, as described in Section 3.4. The capacities of these ditches have not been assessed as they are anticipated to be removed under future conditions. These roadside ditches contribute runoff to the Rymal Road storm sewer through inlet pipes tied into catchbasins. Their contributing drainage areas have been included in the storm sewer analysis.

4.5 Storm Sewer Analysis

The existing storm sewer capacity was estimated using the design criteria presented in the City of Hamilton's Comprehensive Development Guidelines and Financial Policies Manual (2020). Storm sewers are required to convey the 5-year storm event peak flow at a maximum of 85% of their design capacity, based on the Mount Hope IDF parameters.

The Rational Method was used to estimate the existing condition peak flow rates from the catchments and Manning's formula was used to evaluate the capacity of the storm sewers. To estimate peak runoff flow rates from external areas, the time of concentration was calculated in one of two ways:

1. For external areas that are directly connected to a storm sewer, an inlet time of 10 minutes was assumed (as per the City storm sewer design standards), and pipe travel time was estimated using the minimum pipe velocity as specified by the City design standards, and the length of the sewer through the external catchment;
2. For external areas with large agricultural areas draining into a storm inlet, a similar methodology was used to estimate the time of concentration, however, the Airport or Bransby Williams Formula was used for the agricultural land to calculate the inlet time.

The storm sewer assessment calculations are presented in Appendix B.

The estimated flow rate/capacity levels are colour coded and displayed on Figure 5 (Green: < 85%; Yellow: 85%-100%; and Red: > 100%). The Rymal Road storm sewer assessment results suggest that most of the evaluated sewers have sufficient capacity to accommodate the existing conditions calculated peak discharges. However, approximately 24 pipes have estimated capacities lower than the calculated peak flows. Pipes with flow/capacity ratios greater than 100% are summarized in Table 3 (note that a flow/capacity ratio greater than 100% indicates the pipe receives more flow than it has capacity to convey). This assessment is preliminary, and further analysis should be performed as part of the detailed design process.

Table 3: Over-Capacity Storm Sewer Pipes

Upstream Manhole ID	Downstream Manhole ID	Catchment Flow Rate (L/s)	Pipe Capacity (L/s)	Flow/Capacity (%)
Inlet 02	SMH B024	1849	1402	132%
SMH B076	SMH B166	363	259	140%
SMH B166	SMH B078	656	264	249%
SMH B078	SMH B080	771	380	203%
SMH B080	SMH B084	956	697	137%
Inlet 05	SMH B093	233	175	133%
SMH B106	SMH B108	477	316	151%
SMH B108	SMH B110	810	506	160%
Inlet 09	SMH B066	1405	610	230%
SMH B066	SMH B074	1384	1264	109%
SMH B060	SMH B059	1592	1515	105%
SMH B049	SMH B016	591	480	123%
SMH B016	SMH B020a	571	539	106%
Inlet 11	SMH B051	233	207	113%
SMH B025	SMH B027	1619	1445	112%
SMH B050	SMH B052	914	532	172%
SMH B052	SMH B047a	4513	3922	115%
SMH B047a	SMH B045a	4673	4270	109%
SMH B043	SMH B041	4903	4892	100%
SMH B039	SMH B	4996	4434	113%
SMH B138a	SMH B036	5189	4921	105%
Inlet 17	SMH B025b	2401	1280	188%
SMH B025b	SMH B011a	2376	1578	151%
SMH B011a	Outlet H	2501	2466	101%

5.0 Stormwater Management Design Criteria

Dillon reviewed local stormwater management criteria from the City of Hamilton and Hamilton Conservation Authority, as well as recommendations for future development presented in the subwatershed studies for the Hannon Creek subwatershed. These criteria and recommendations are summarized below and should be incorporated into future drainage designs for the proposed Rymal Road improvements.

5.1 City of Hamilton Criteria

The following drainage design criteria are presented in the City of Hamilton Comprehensive Development Guidelines and Financial Policies Manual (May 2020):

- Minor storm drainage system shall be designed to convey stormwater runoff from the 5-year return period;
- Approved Master Drainage Plans (MDP's) which have established storm sewer sizing criteria other than the 5-year return period standard will govern;
- In the absence of approved MDP's, storm sewers shall be designed to a minimum 5-year, unsurcharged standard (i.e. 85% of pipe capacity);
- Storm sewers must be designed to accommodate runoff from all external catchment areas;
- For any storm sewer to be assumed by the City, the minimum allowable pipe diameter is 300 mm; and,
- The 100-year HGL in the storm sewer system is to remain below the ground surface to verify that there is no interference with the overland flow system as a result of surcharge from the storm sewer system.

5.2 Subwatershed Plan Objectives

The 2017 Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment report provides the following stormwater design guidance for the portion of the project area located east of Upper Sherman Avenue:

- Stormwater management objectives shall be achieved on a lot level basis (as opposed to centralized stormwater management facilities for large drainage areas);
- Quantity control objectives are to attenuate post-development peak flow rates to pre-development peak magnitudes for return period storms up to and including the 100-year storm event;
- Water quality treatment is required to achieve "Enhanced" Protection Level as described in the Stormwater Management Planning and Design Manual (MOE, 2003); and,
- Water Balance and erosion control objectives to infiltrate 5 mm/ha of volume across the development area are required for all new development.

From the 2013 Upper Ottawa Creek Subwatershed Stewardship Action Plan, stormwater is to be treated using a treatment train approach utilizing source, conveyance, and end-of-pipe controls.

6.0 Proposed Conditions

Under the preferred alternative, Rymal Road will be renewed with a fully urbanized cross-section with curb and gutter. The roadway will be made wider through most of the project area, converting the existing gravel shoulder to asphalt driving surface. The existing drainage pattern is anticipated to remain largely unchanged with minor shifts in high and low points along the profile.

6.1 Storm Sewers

The assessment of sewer sizes under proposed conditions follows the methodology outlined in Section 4.5. The change in impervious area caused by the proposed road widening is relatively small as the new asphalt footprint is mostly located within the existing gravel shoulder. The proposed multi-use trail located along the north side of the roadway will result in an increase in impervious area as it is wider than the existing sidewalk, and the proposed south sidewalk will result in an increase in impervious area in areas where no sidewalk is present under existing conditions.

Much of the existing Rymal Road sewer system has been sized to accommodate runoff from large properties fronting Rymal Road, as well as receiving flow from external storm sewers. The overall contributing area from within the right-of-way is small relative to the external areas, which results in little change to the sewer assessment compared to existing conditions. Sewer assessment results are provided in Appendix B.

6.2 Culverts

The roadway cross section will be modified to a fully urbanized design, with curbs and gutters installed along the entire alignment. As a result, the two existing culverts located at station 3+010 and station 3+100, which currently convey flow from the existing roadside ditches, will no longer be necessary. These culverts will be either removed or abandoned.

The third culvert crossing at the Outlet G location will be maintained under the proposed conditions as it serves as the primary outlet for the new development at 1240 and 1280 Rymal Road. It is recommended that this culvert be assessed during detailed design, and that the stormwater management report from the new development at 1240 to 1280 Rymal Road be reviewed to assess the contributing flows to this culvert.

6.3 Roadside Ditches

A number of roadside ditches currently conveying runoff within the Rymal Road ROW will be removed under proposed conditions. The contributing drainage area for these ditches will be serviced by the storm sewer system and is included in the storm sewer analysis for the proposed conditions.

7.0 Low Impact Development Opportunities and Constraints

As part of the proposed design of Rymal Road, the potential for low impact development (LID) implementation is to be assessed, and included if feasible. LID infrastructure typically provides benefits in the form of runoff quality treatment, runoff volume reduction, water balance, and receiving system erosion prevention. These benefits are typically provided through infiltration or filtration and plant uptake of stormwater runoff that passes through engineered soil media. From the available background information, the Rymal Road ROW is poorly suited for infiltration measures due to the presence of silty and/or clayey soils, however, a small amount of infiltration may be anticipated. It is recommended that groundwater monitoring and in-situ percolation testing be completed at proposed LID locations, as well as confirmation that the underlying ground is free of karst features.

In areas with poorly draining in-situ soils, filtration-based measures may still be appropriate with a small amount of the treated water infiltrated. Filtration LID measures pass runoff through a filter medium, with treated runoff then collected by a perforated underdrain that outlets to the storm sewer. Enhanced grassed swales, bioretention cells, permeable hardscapes, and rain gardens are examples of LID filtration features that can treat surface runoff. If there is no feasible flow path to collect surface runoff, water can instead be collected in catchbasins and conveyed to deep vertical walled bioretention cells, or proprietary products such as tree root support systems or subsurface sand filters. These proprietary systems provide structural support for subsurface filter media.

Based on the typical cross section for the proposed alternative, the grassed area and tree planting areas could likely accommodate LID features. Ideal locations are where road runoff can be directed to LID features as surface drainage, which is favourable where the sidewalk and multi-use path are separated from the road by a grasses boulevard. Where the sidewalk and multi use-trail are adjacent to the roadway, directing surface runoff from the road to LID features may not be feasible; however, some features can accommodate inlet pipe connections such as tree root support systems. Furthermore, it may be feasible to implement LID features below the asphalt driving surface of the roadway, as well as below the bike lanes or sidewalk.

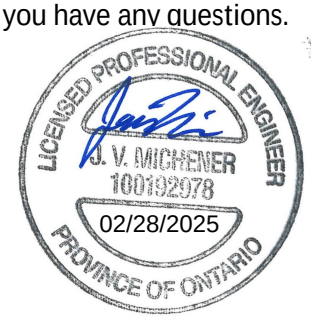
Utility locations must also be identified when implementing LIDs. Locating significant lengths of utilities within LID features should be avoided.

8.0 Conclusions and Recommendations

The following recommendations were developed based on the initial stormwater management and drainage assessment:

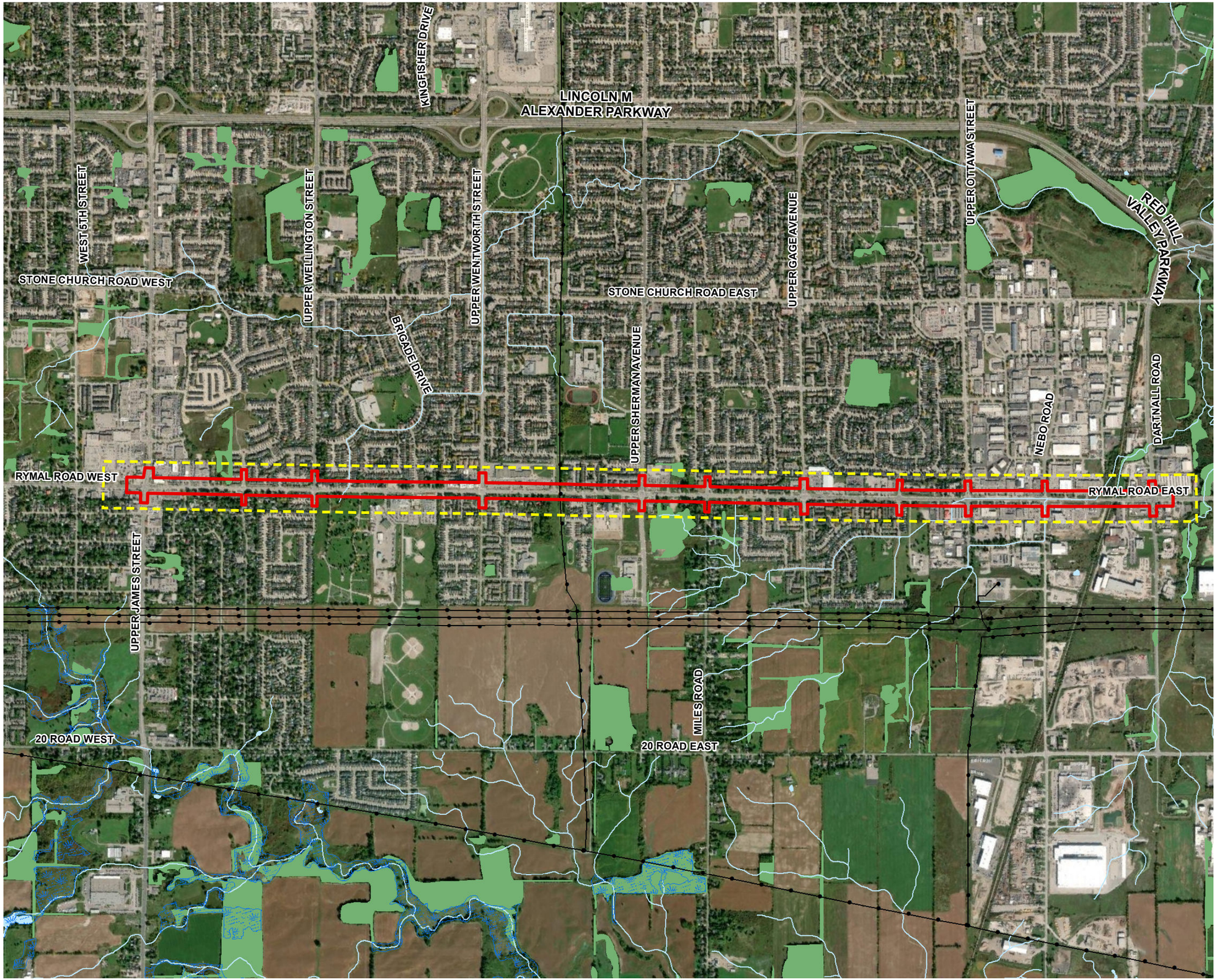
- Data gaps have been identified where further data may impact the results of the technical assessment. It is recommended that these data gaps be investigated and accounted for in the detailed design process – primarily private development stormwater management reporting that ties into the Rymal Road storm sewer;
- The Rymal Road storm sewers have been assessed within the study area, with some sewers identified as under capacity. These sewers should be investigated further during the detailed design process, and a mitigation strategy developed where required;
- The preferred Rymal Road improvement alternative has been assessed for potential impact to the existing storm sewer system. The increase in impervious level is limited to the existing gravel shoulder proposed as asphalt drive lane, and the north sidewalk is proposed to be widened to a multi-use trail. The Rymal Road sewer receives a large portion of runoff from properties fronting the road, as well as external residential and industrial areas. From the analysis conducted, no appreciable impact to the existing storm sewer system is anticipated as a result of the Rymal Road improvements; and,
- Opportunities and Constraints were identified for potential LID measures and locations within the ROW. It is recommended that an LID strategy be selected through coordination with the City of Hamilton through the detailed design process, and additional field level investigation be completed to establish feasibility and design parameters for LID. Filtration based LID features are proposed within the grassed boulevard present in the proposed alternative, however, some products such as tree root support systems may be placed below hardscaped surfaces. Due to poorly draining soil anticipated on site, infiltration capacity is expected to be limited, however, site investigations for groundwater location, infiltration capacity, and karst features are recommended through the detailed design phase.

This report details the results of the initial drainage assessment of Rymal Road within the study limits. This report will be used to inform the development of the proposed stormwater drainage strategy moving forward. Note that this assessment is preliminary, and further investigation is needed as part of the detailed design process. We trust you will find the report to be in order, please do to not hesitate to contact the undersigned should you have any questions.



James Michener, P.Eng.
Project Engineer, Water Resources

Figures



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

PROJECT BOUNDARY
FIGURE 1

- Project Boundary
- Study Area (120m)
- Utlitiy Line
- Watercourse
- Water Body
- Provinically Significant Wetland
- Wooded Area

SCALE 1:19,000

0 125 250 500 m

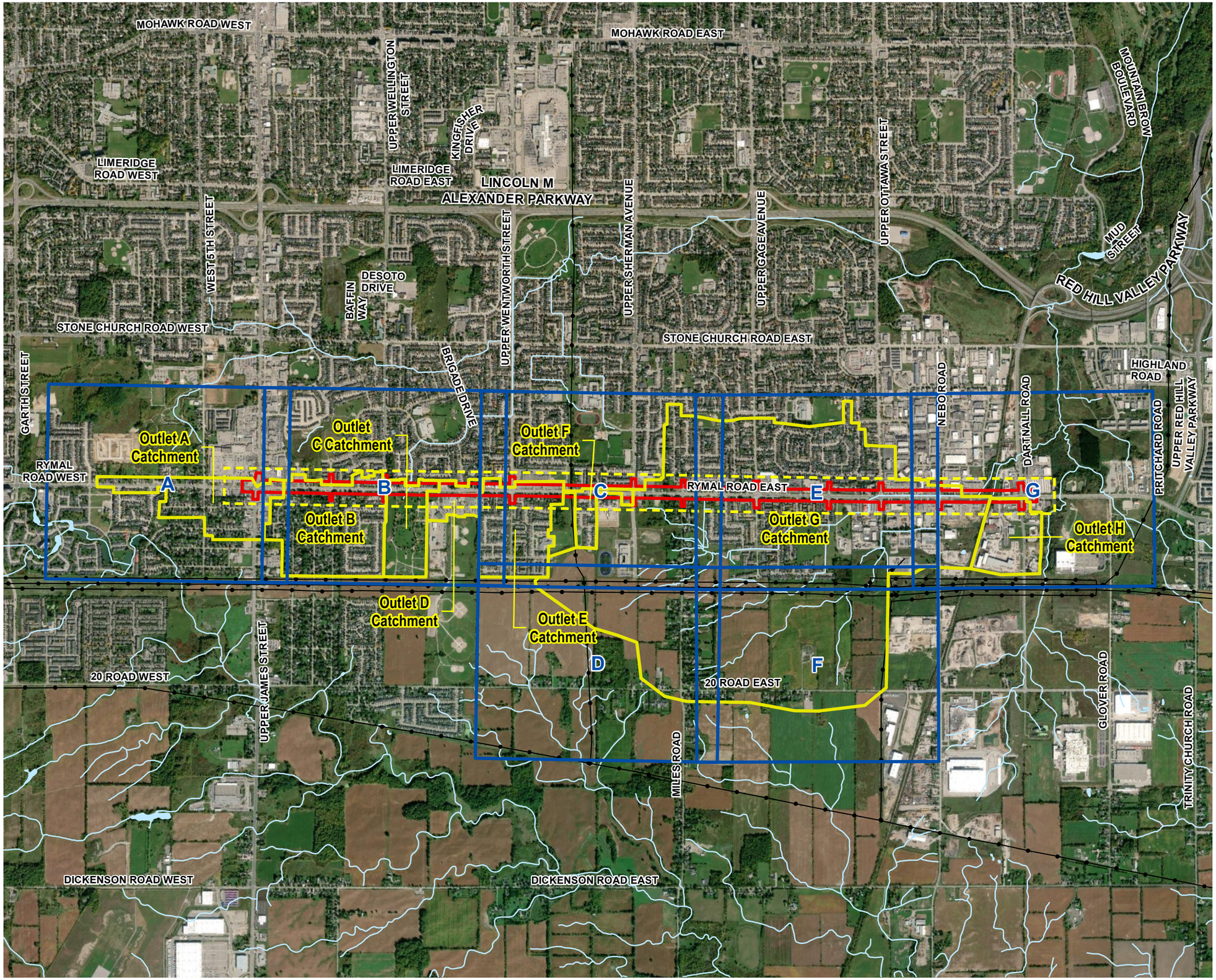
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: LMM
MAP CHECKED BY: JVM
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: E:\Shared drives\SIM\2020\203410\Product\Client\DrainageMemo\203410_F1_ProjectBoundary.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD CATCHMENT OVERVIEW
FIGURE 2

- Project Boundary
- Study Area (120m)
- Drainage Catchment
- Page
- Utlitiy Line
- Watercourse
- Water Body

SCALE 1:25,000

0 165 330 660 m

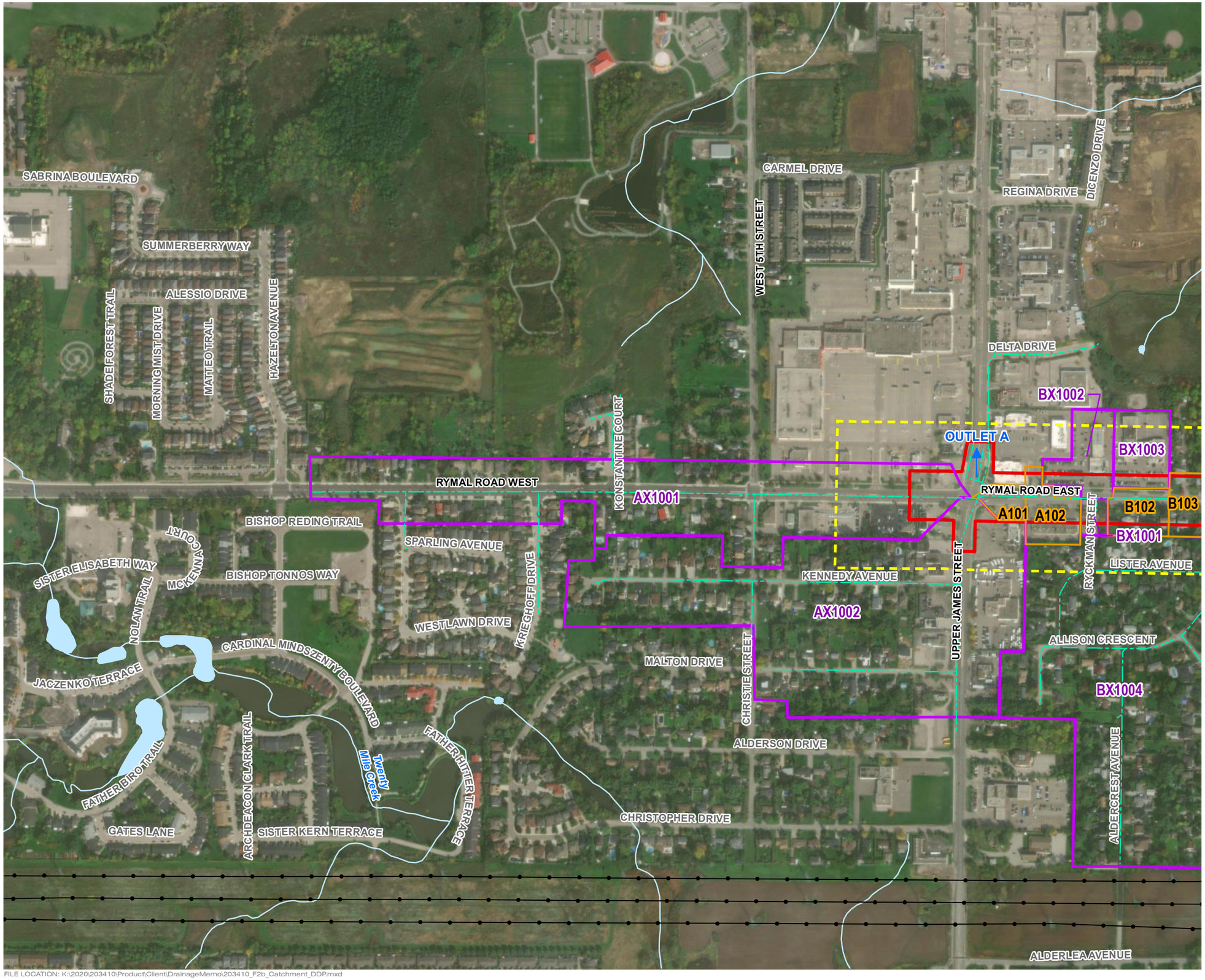
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: LMM
MAP CHECKED BY: JVM
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

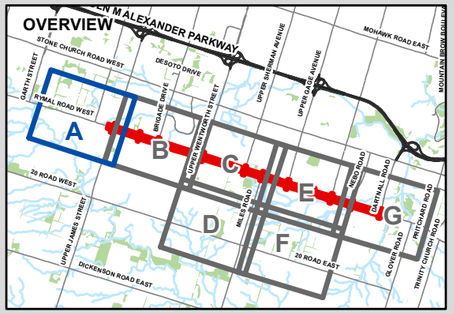
FILE LOCATION: E:\Shared drives\SIM\2020\203410\Product\Client\DrainageMemo\203410_F2a_Catchment_Overview.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2A

- Project Boundary
- Study Area (120m)
- Outlet Flow
- Rymal Road Storm Sewer Catchment
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:6,000

0 37.5 75 150 m

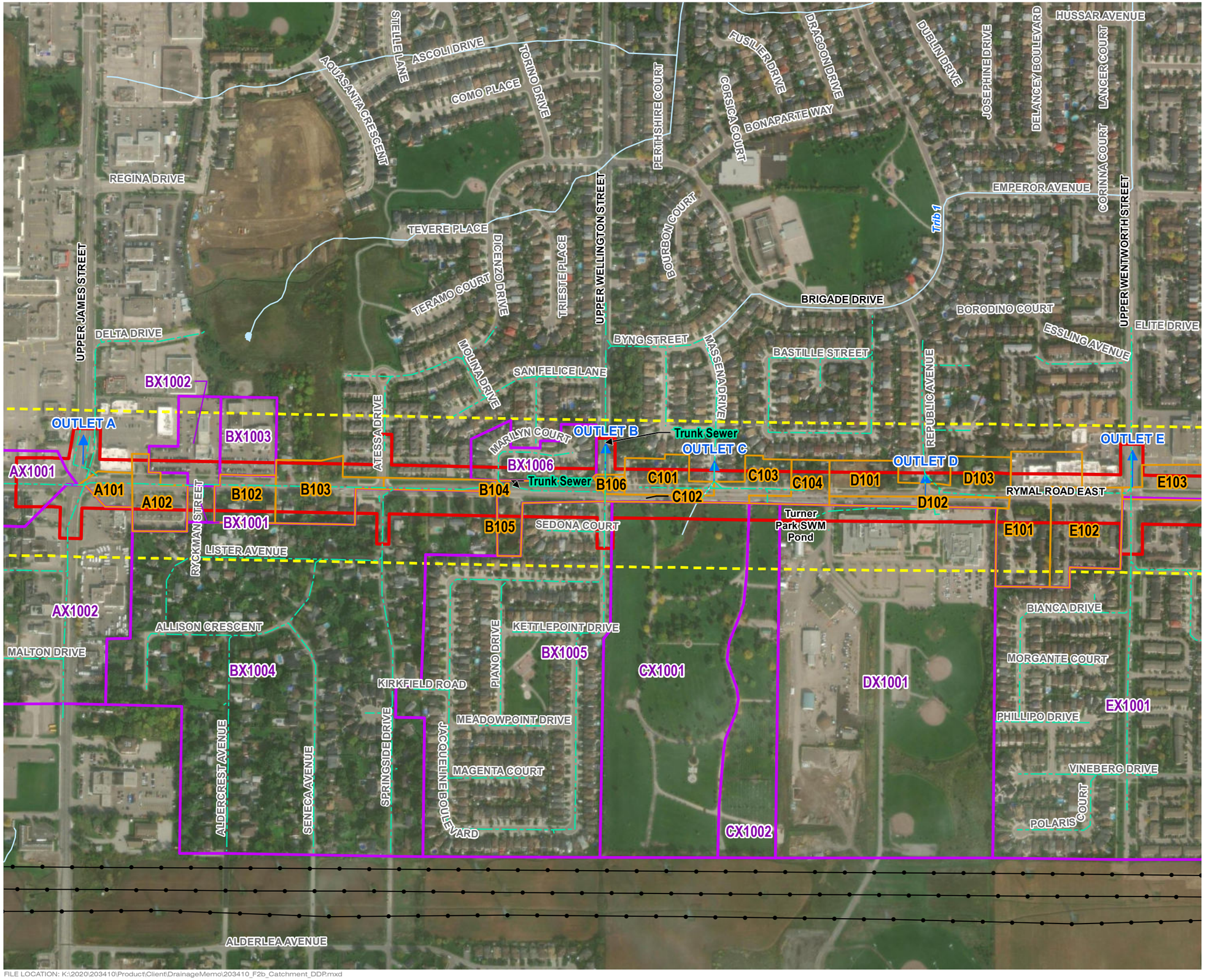
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

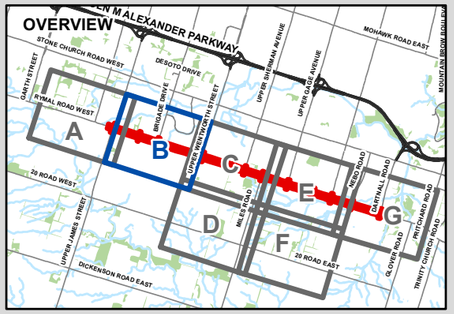
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2B

- Project Boundary
- Study Area (120m)
- Outlet Flow
- Rymal Road Storm Sewer Catchment
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:6,000

0 37.5 75 150 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

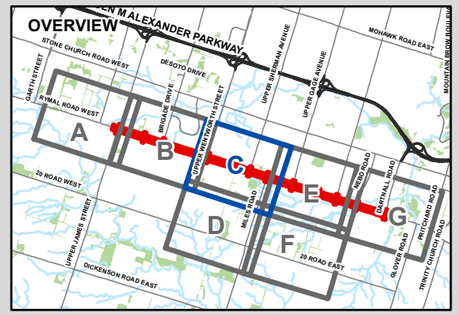
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2C

- Project Boundary
- Study Area (120m)
- Outlet Flow
- Rymal Road Storm Sewer Catchment
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse



SCALE 1:6,000

0 37.5 75 150 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

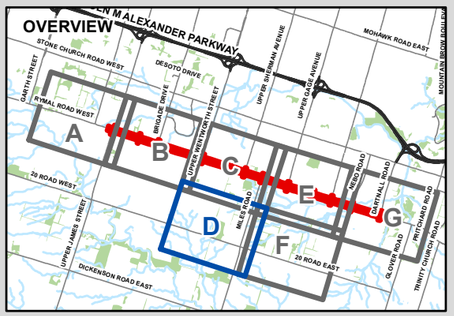
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd

DX1001
VINEBERG DRIVE
POLARIS COURT
EX1001
FX1001
HUSKIES
Trib 3
GX1005
Nora Frances Henderson Secondary School
GX1007
MILES ROAD
20 ROAD EAST
GRETI DRIVE

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2D

External Drainage Catchment
Utlitiy Line
Storm Sewer
Watercourse



SCALE 1:6,000

0 37.5 75 150 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

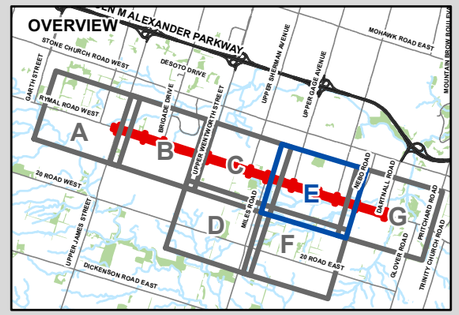
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2E

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:6,000

0 37.5 75 150 m

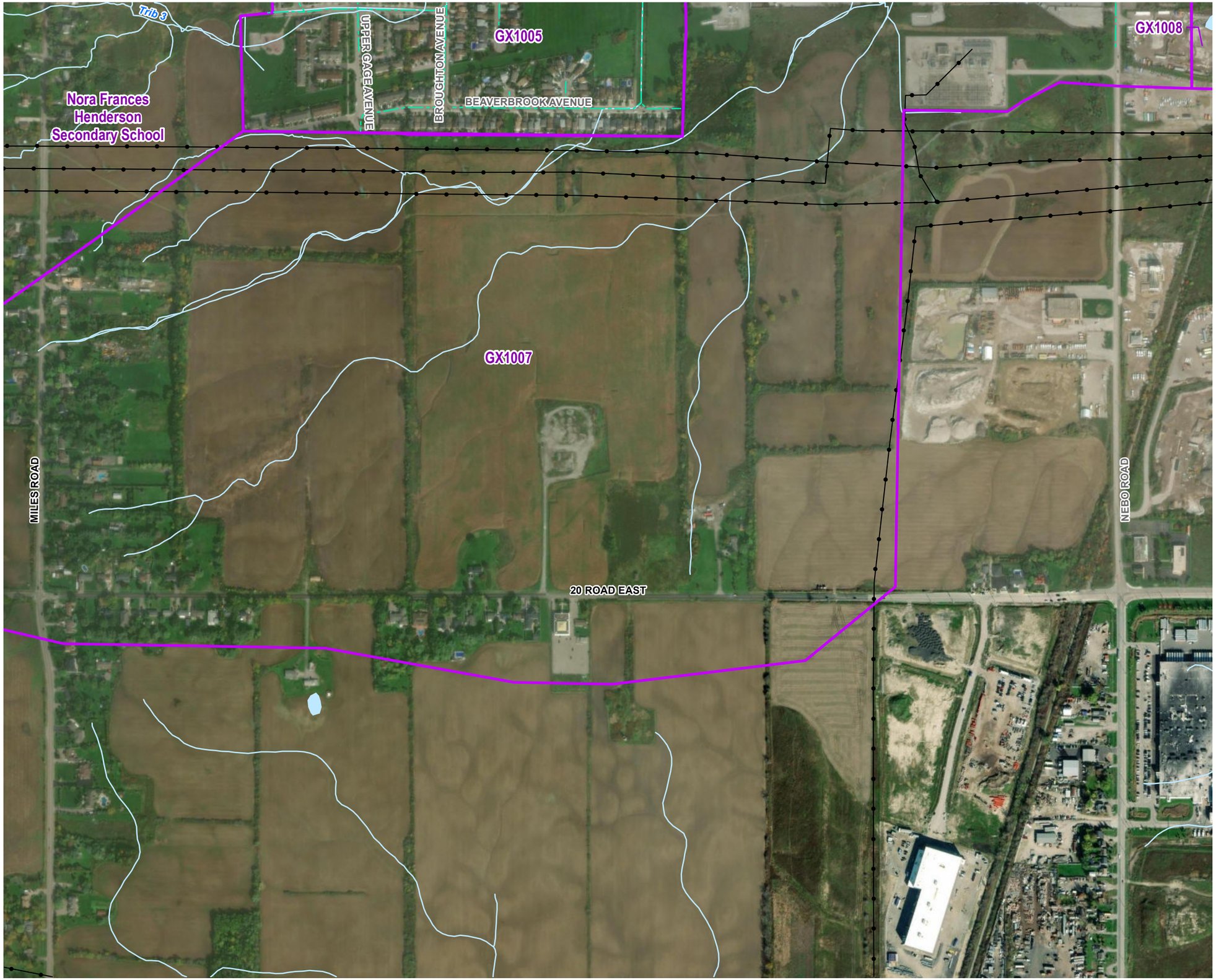
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

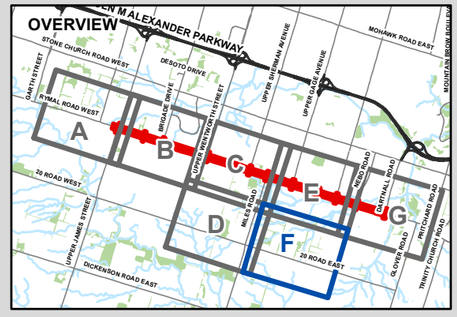
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2F

- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:6,000

0 37.5 75 150 m

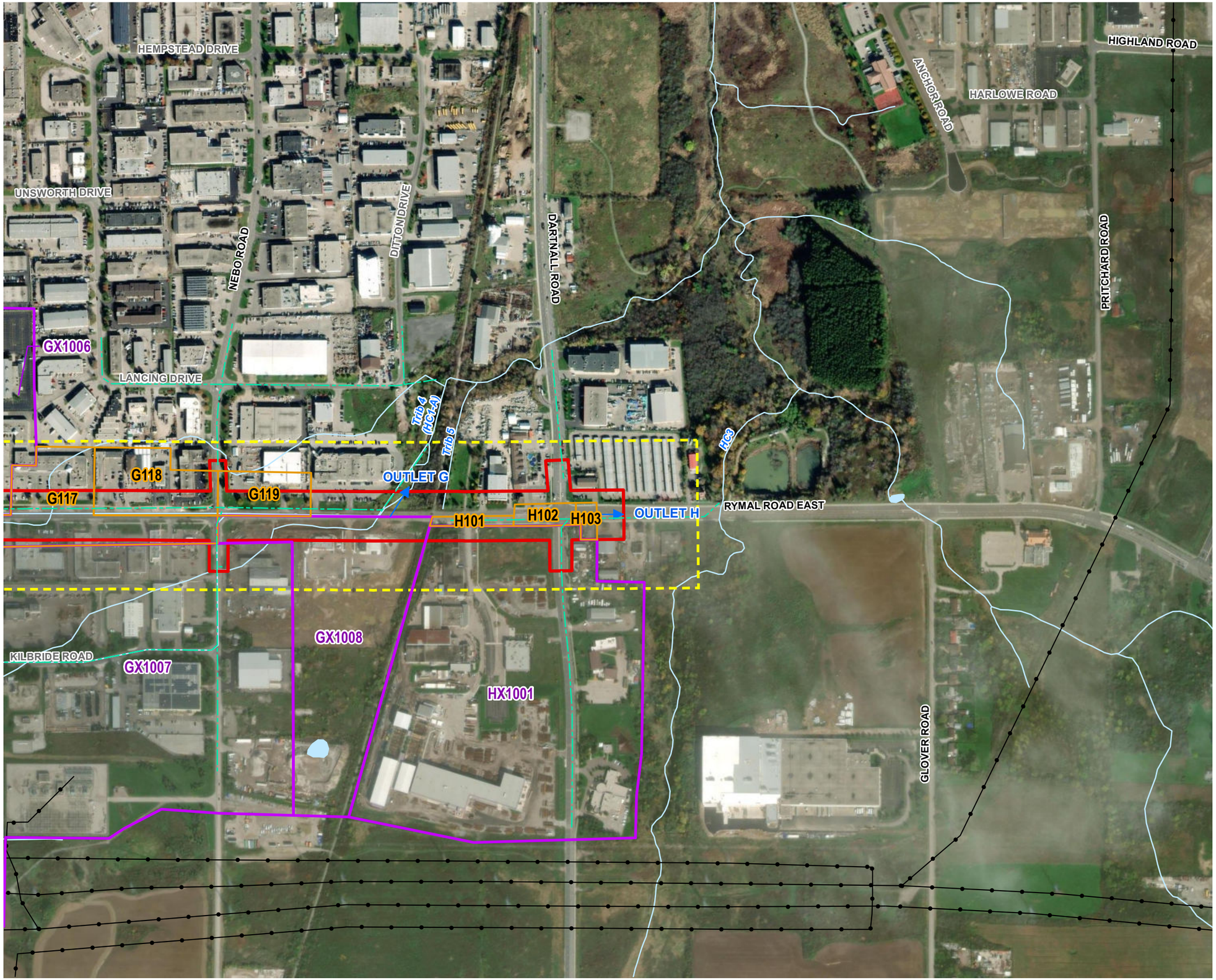
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

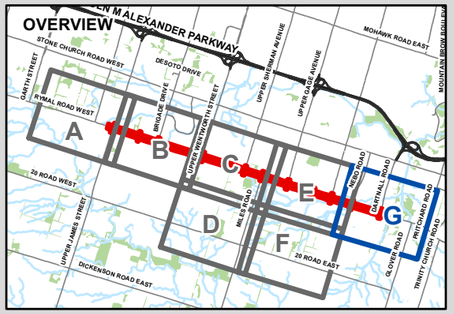
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM CATCHMENT OVERVIEW
FIGURE 2G

- Project Boundary
- Study Area (120m)
- Outlet Flow
- Rymal Road Storm Sewer Catchment
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:6,000

0 37.5 75 150 m

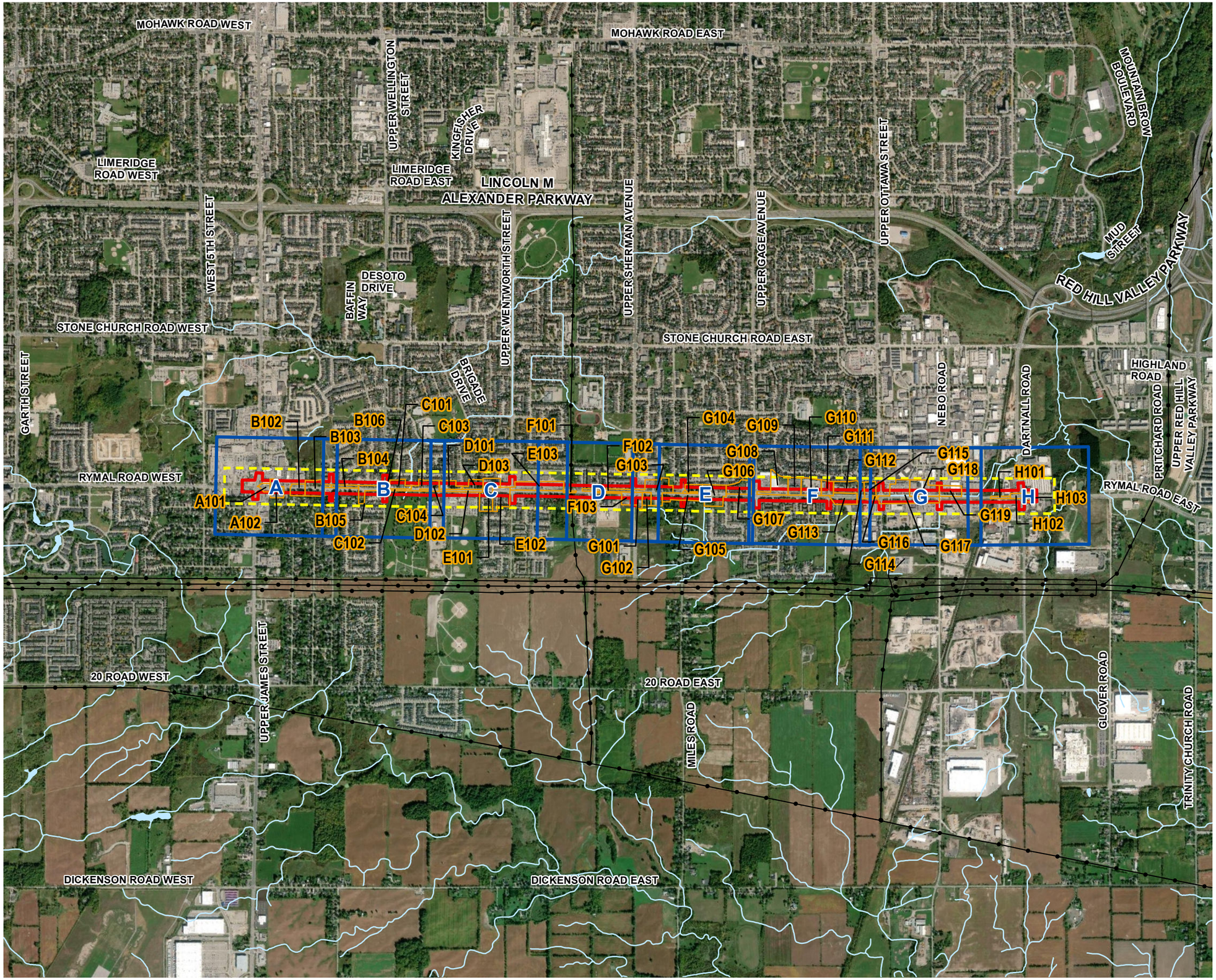
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F2b_Catchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Page
- Utlitiy Line
- Watercourse
- Water Body

SCALE 1:25,000

0 165 330 660 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3a_LocalCatchment_Overview.mxd

DELTA DRIVE

DICENZO DRIVE

ATESSA DRIVE

RYMAL ROAD WEST

UPPER JAMES STREET

RYMAL ROAD EAST

RYCKMAN STREET

LISTER AVENUE

KENNEDY AVENUE

SPRINGSIDE DRIVE

ALLISON CRESCENT

SENECA AVENUE

BARTLETT AVENUE

ALDERCREST AVENUE

MALTON DRIVE

A101 0.37 0.90

A102 0.86 0.90

B102 0.77 0.64

B103 1.40 0.58

B104 0.35 0.67

RYMAL ROAD, HAMILTON, ON

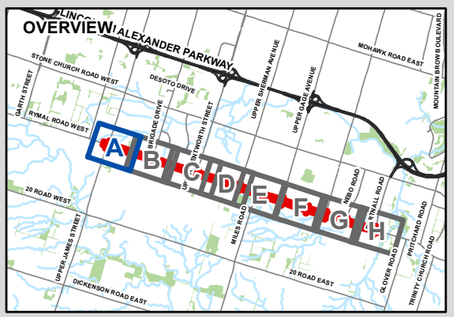
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW

FIGURE 3A

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse
- Water Body

Label Sample:



SCALE 1:2,500

0 15 30 60 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

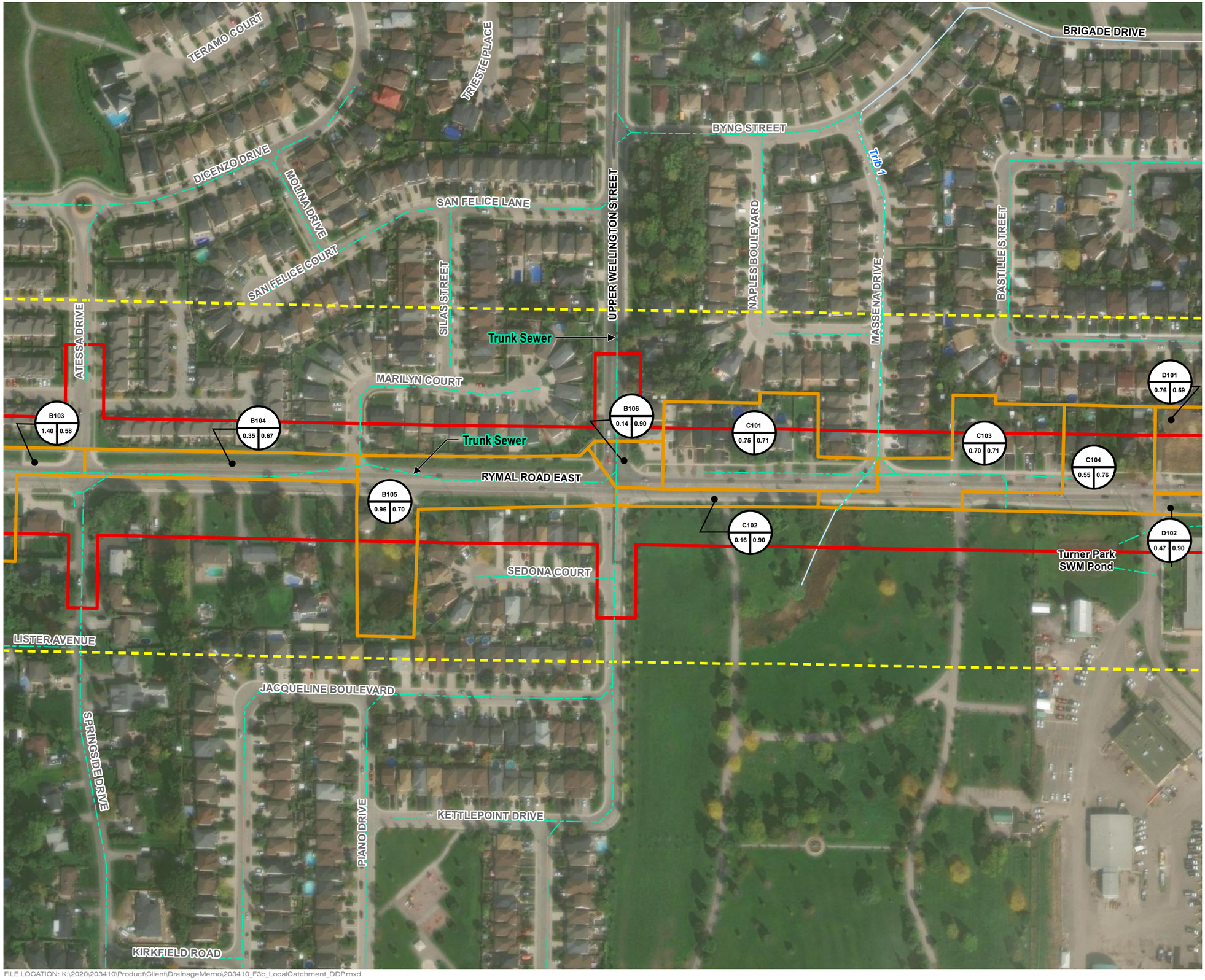
DILLON CONSULTING

PROJECT: 20-3410

STATUS: DRAFT

DATE: 2024-11-29

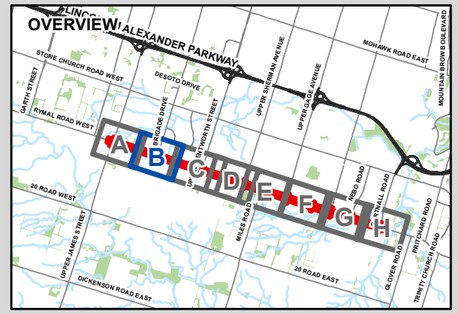
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3B

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse



SCALE 1:2,500

0 15 30 60 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd

Trib 1 BRIGADE DRIVE
BORODINO COURT
ESSLING AVENUE
SUPREME DRIVE
ELITE DRIVE
FANO DRIVE
MAPLERIDGE DRIVE
ACADIA DRIVE
UPPER WENTWORTH STREET
ROBESPIERRE COURT
BASTILLE STREET
REPUBLIC AVENUE
BORDEAUX COURT
RYMAL ROAD EAST
ARROWHEAD DRIVE
BIANCA DRIVE
PATTON PLACE
ONYX DRIVE
CONCH ROAD
ONYX COURT
MORGANTE COURT
JESSICA STREET
PHILLIPO DRIVE
Turner Park SWM Pond

C103 0.70 0.71
C104 0.55 0.76
D101 0.76 0.59
D103 0.74 0.58
D102 0.47 0.90
E101 2.05 0.81
E102 1.64 0.78
E103 2.03 0.90
F101 0.10 0.90

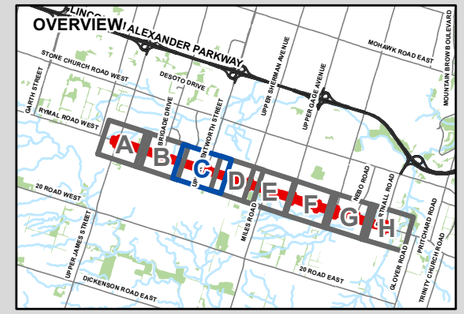
RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3C

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse

Label Sample: A101 (CATCHMENT ID) 0.37 (CATCHMENT AREA (ha)) 0.90 (RUNOFF COEFFICIENT)

OVERVIEW



SCALE 1:3,000

0 20 40 80 m

N E S W

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd

FANO DRIVE
MAPLERIDGE DRIVE
ACADIA DRIVE
JONATHON COURT
UPPER SHERMAN AVENUE
CHAMOMILE DRIVE
RYMAL ROAD EAST
GERSHWIN COURT
ARROWHEAD DRIVE
CONCH ROAD
ONYX COURT
WAGNER DRIVE
TURQUOISE DRIVE
Trib 2
Nora Frances Henderson Secondary School SWM Pond

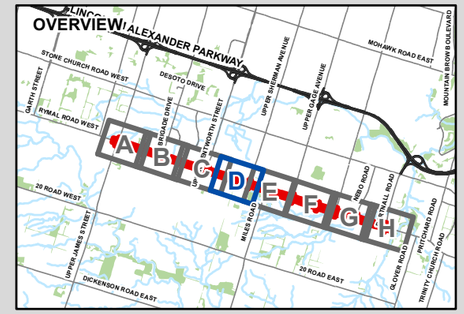
E103 2.03 0.90
F101 0.10 0.90
F102 0.66 0.90
F103 0.83 0.85
G101 0.61 0.85
G102 0.51 0.46
G103 2.44 0.61

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3D

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse

Label Sample: A101 (CATCHMENT ID) 0.37 (CATCHMENT AREA (ha)) 0.90 (RUNOFF COEFFICIENT)



SCALE 1:2,500

0 15 30 60 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

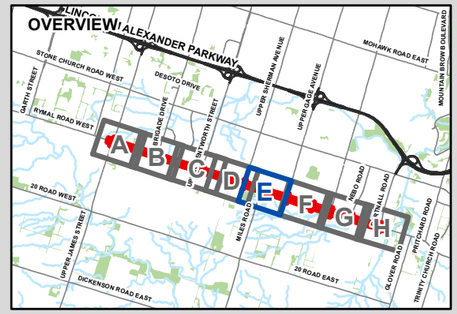
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3E

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse



SCALE 1:2,500

0 15 30 60 m

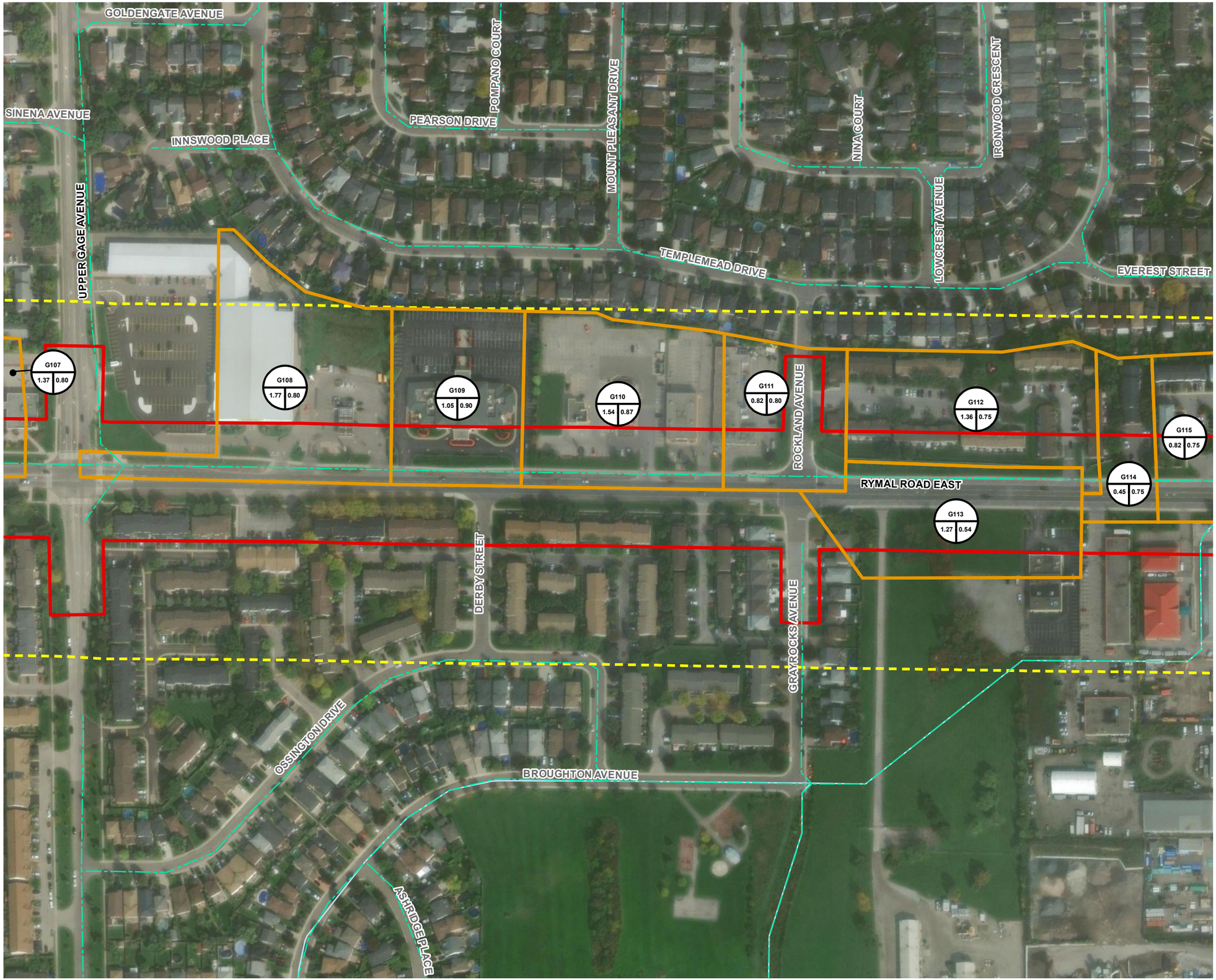
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd



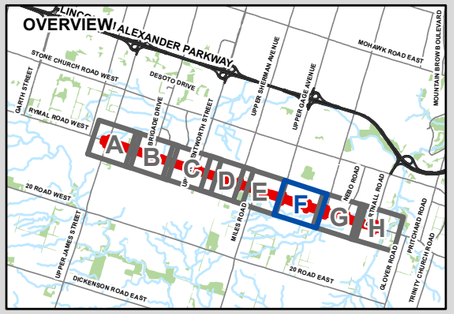
RYMAL ROAD, HAMILTON, ON

DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW

FIGURE 3F

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse



SCALE 1:2,500

0 15 30 60 m

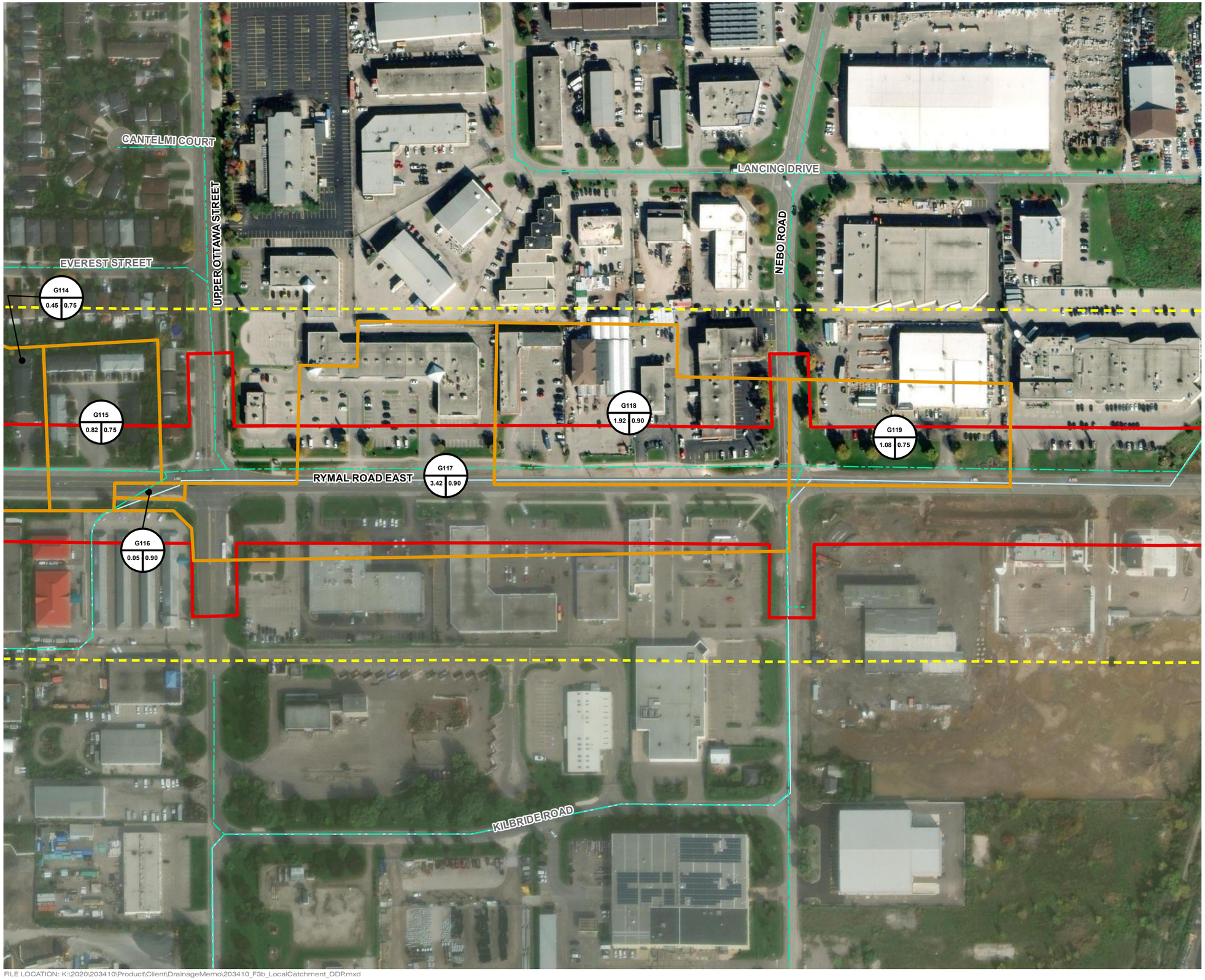
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd



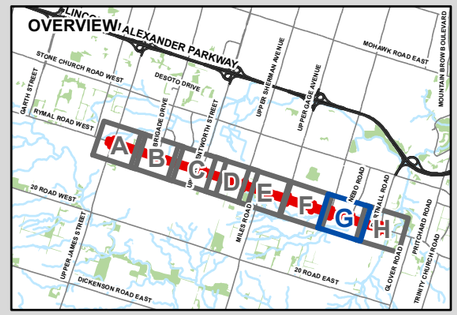
RYMAL ROAD, HAMILTON, ON

DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW

FIGURE 3G

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse



SCALE 1:2,500

0 15 30 60 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410

STATUS: DRAFT

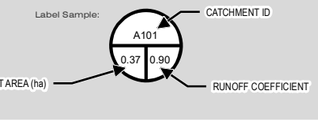
DATE: 2024-11-29

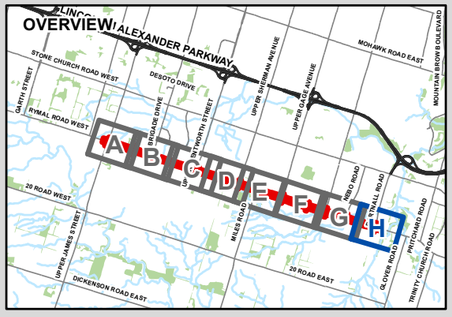
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

RYMAL ROAD
STORM SEWER CATCHMENT OVERVIEW
FIGURE 3H

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Storm Sewer
- Watercourse





SCALE 1:2,500

0 15 30 60 m

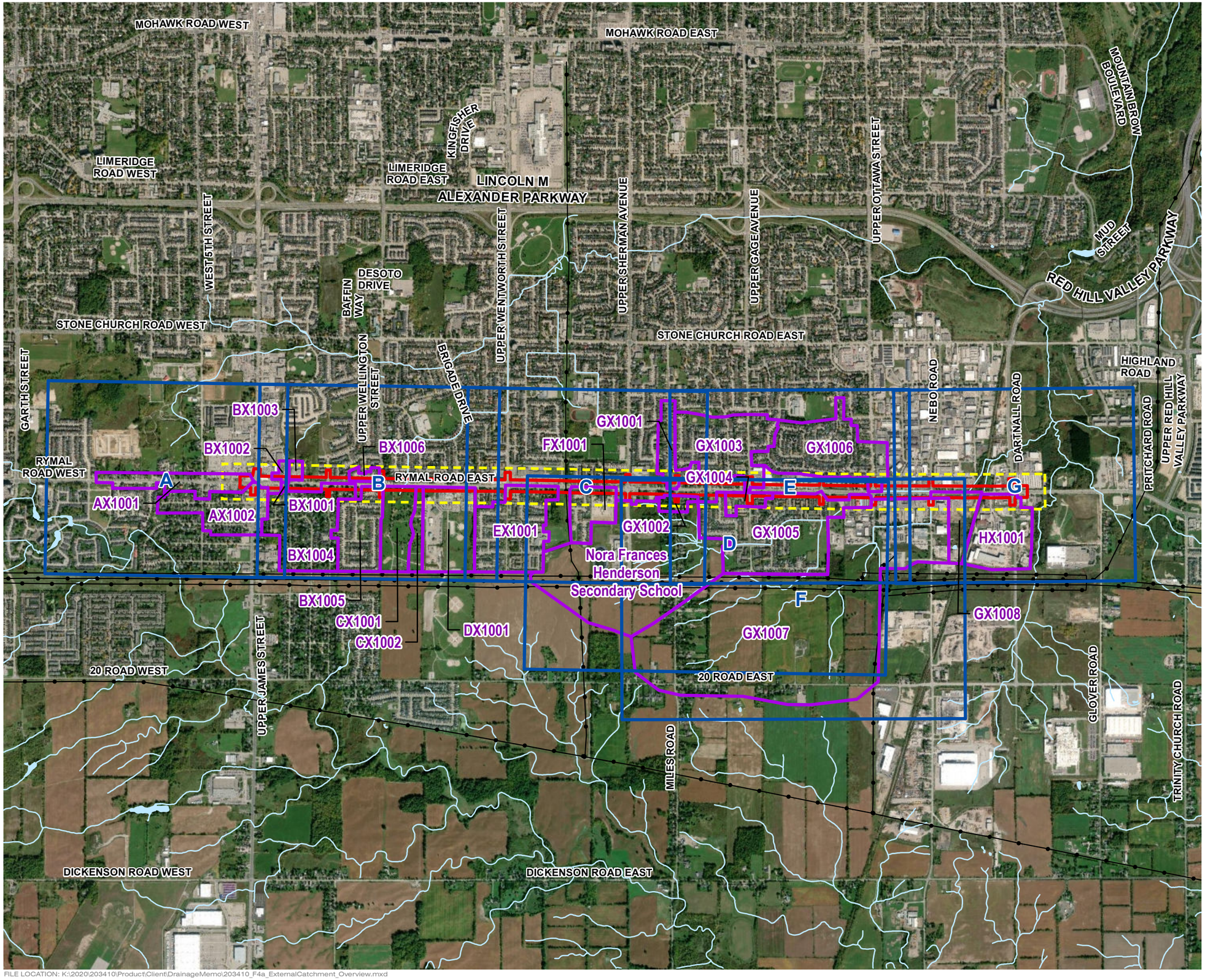
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F3b_LocalCatchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT OVERVIEW
FIGURE 4

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Page
- Utlitiy Line
- Watercourse
- Water Body

SCALE 1:25,000

0 165 330 660 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

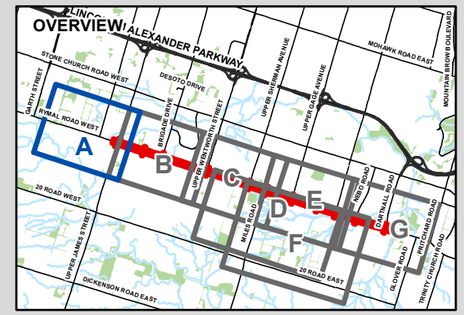
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4a_ExternalCatchment_Overview.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4A

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:5,000

0 30 60 120 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

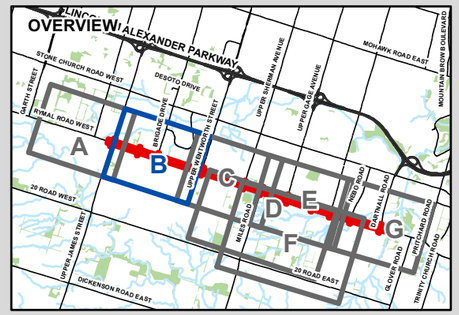
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4B

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:5,000

0 30 60 120 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

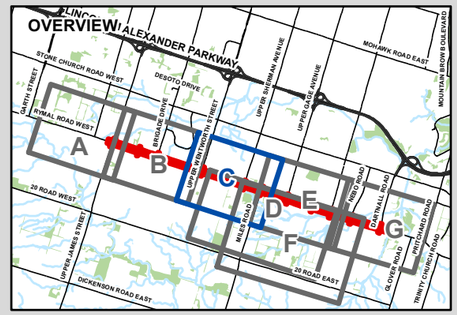
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4C

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse



SCALE 1:5,000

0 30 60 120 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

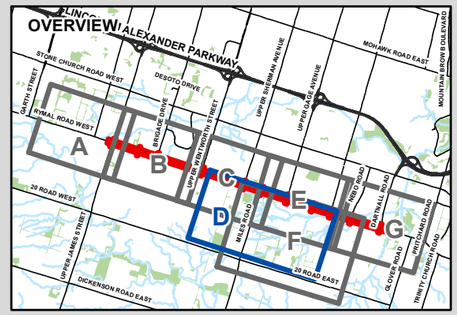
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4D

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:8,000

0 55 110 220 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

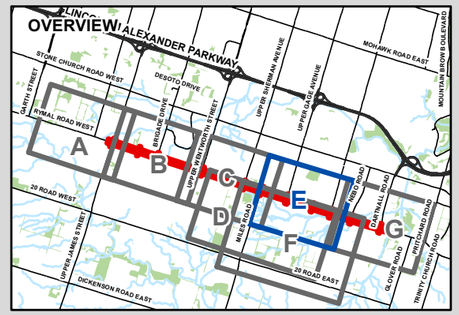
PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4E

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse



SCALE 1:5,000

0 30 60 120 m

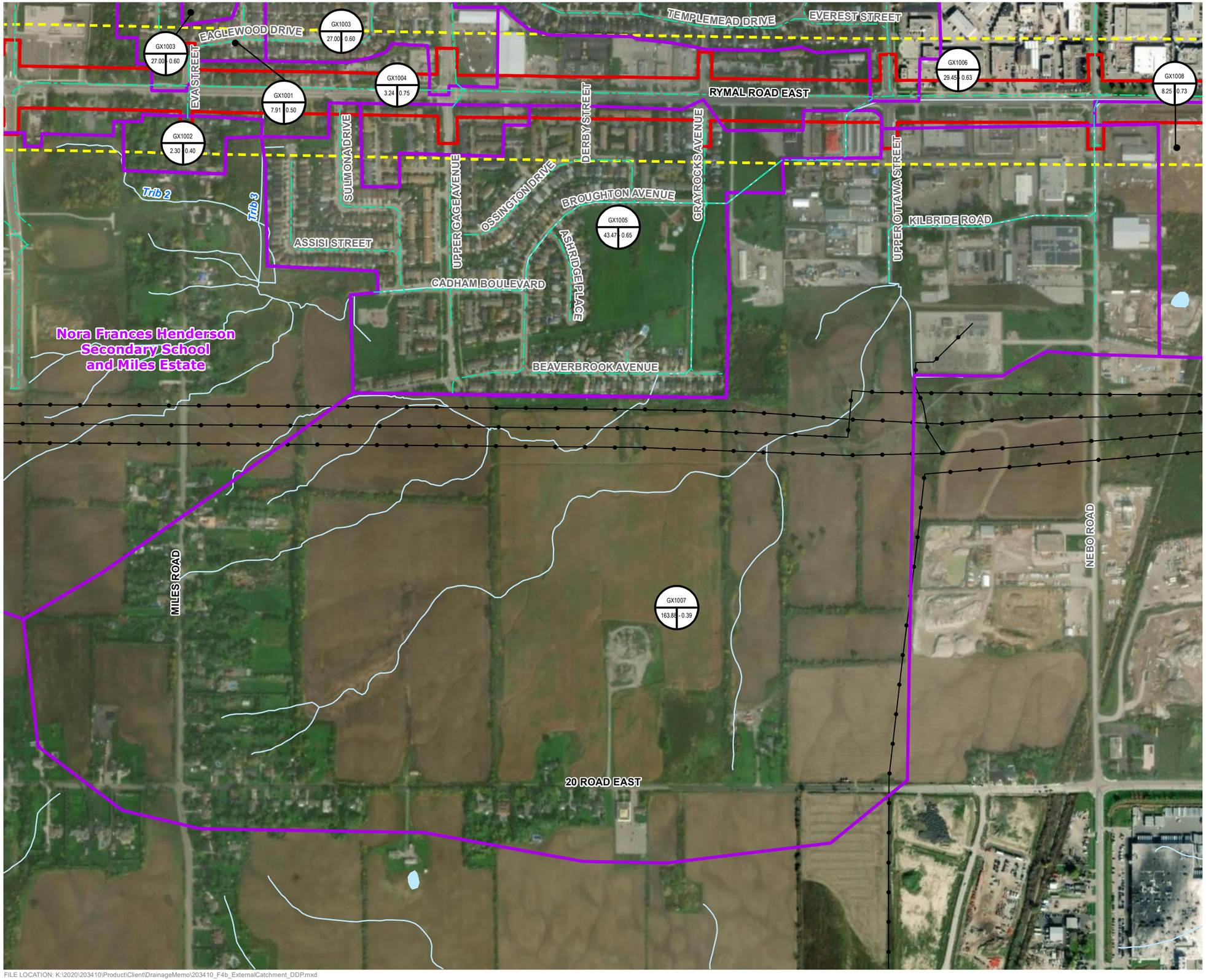
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

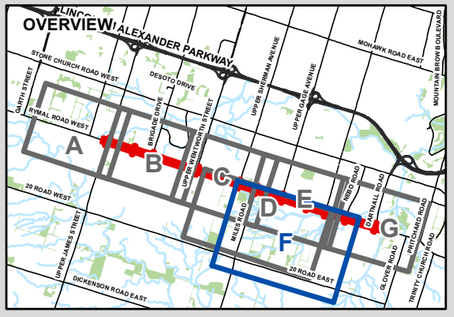
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4F

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:7,000

0 45 90 180 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

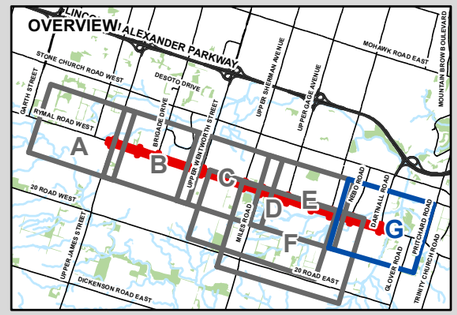
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd

HEMPSTEAD DRIVE
NEBO ROAD
DITTON DRIVE
DARTNALL ROAD
HARLOWE ROAD
ANCHOR ROAD
LANCING DRIVE
TrD 4 (HC1-4)
TrD 5
HC3
RYMAL ROAD EAST
KILBRIDE ROAD
GLOVER ROAD
GX1008
8.25 - 0.73
GX1007
163.88 - 0.39
HX1001
20.05 - 0.60

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

EXTERNAL CATCHMENT
FIGURE 4G

- Project Boundary
- Study Area (120m)
- External Drainage Catchment
- Utlitiy Line
- Storm Sewer
- Watercourse
- Water Body



SCALE 1:5,000

0 30 60 120 m

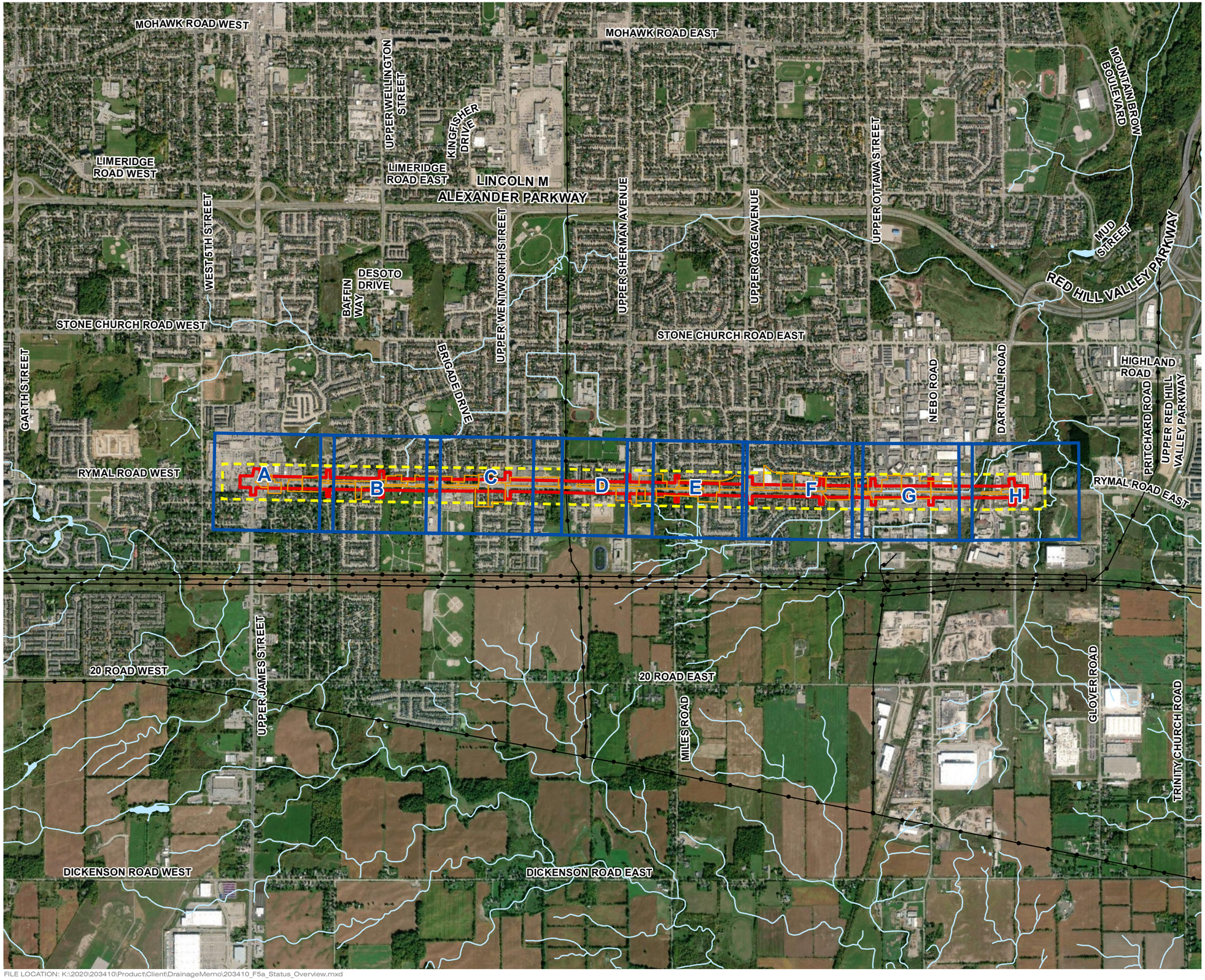
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F4b_ExternalCatchment_DDP.mxd



RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

STORM CATCHMENT STATUS OVERVIEW
FIGURE 5

- Project Boundary
- Study Area (120m)
- Rymal Road Storm Sewer Catchment
- Page
- Utlitiy Line
- Watercourse
- Water Body

SCALE 1:25,000

0 165 330 660 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2024-11-29

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5a_Status_Overview.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

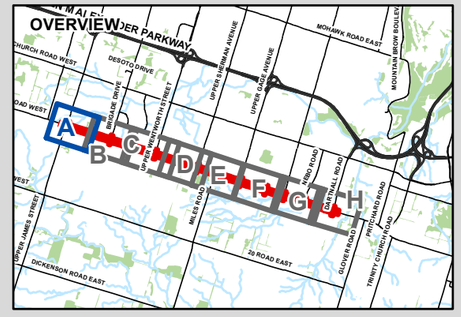
STORM CATCHMENT STATUS

FIGURE 5A

- Project Boundary
- Study Area (120m)
- Watercourse
- Water Body
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

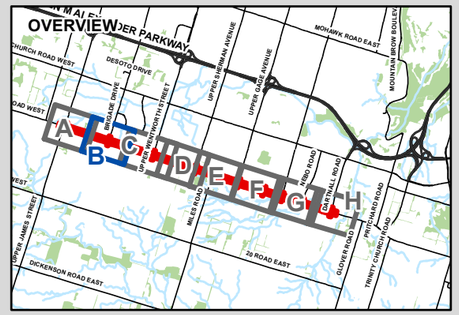
RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

STORM CATCHMENT STATUS
FIGURE 5B

- Project Boundary
- Study Area (120m)
- Watercourse
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

BRIGADE DRIVE
Trib 1
BORODINO COURT
ESSLING AVENUE
ELITE DRIVE
SUPREME DRIVE
FANO DRIVE
MAPLERIDGE DRIVE
ACADIA DRIVE
UPPER WENTWORTH STREET
ROBESPIERRE COURT
BASTILLE STREET
REPUBLIC AVENUE
BORDEAUX COURT
C103
C104
D101
D103
D102
E101
E102
E103
F101
HI21B142 to HI21B144
HI21B146 to HI21B144
HI21B042 to HI21B040
HI21B102 to HI21B042
HI21B105 to HI21B102
HI21B106 to HI21B108
HI21B108 to HI21B110
HI21B110 to HI21B002
HI21B002 to HI21B004
HI21B060 to HI21B059
HI21B005 to HI21B002
RYMAL ROAD EAST
ARROWHEAD DRIVE
BIANCA DRIVE
PATTON PLACE
MORGANTE COURT
PHILLIPO DRIVE
ONYX DRIVE
ONYX COURT
CONCH ROAD
JESSICA STREET

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

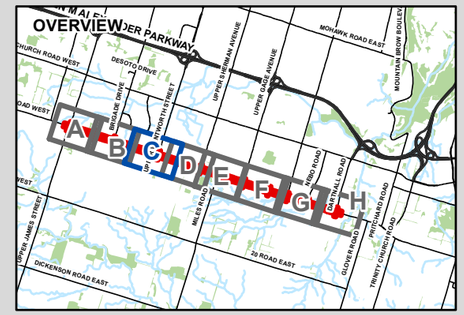
RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

STORM CATCHMENT STATUS
FIGURE 5C

- Project Boundary
- Study Area (120m)
- Utlitiy Line
- Watercourse
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

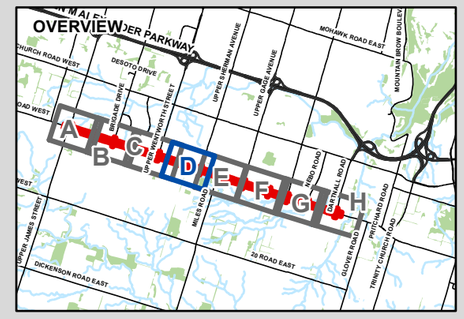
STORM CATCHMENT STATUS

FIGURE 5D

- Project Boundary
- Study Area (120m)
- Utlitiy Line
- Watercourse
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

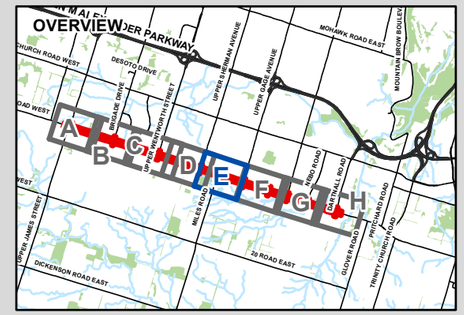
STORM CATCHMENT STATUS

FIGURE 5E

- Project Boundary
- Study Area (120m)
- Watercourse
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

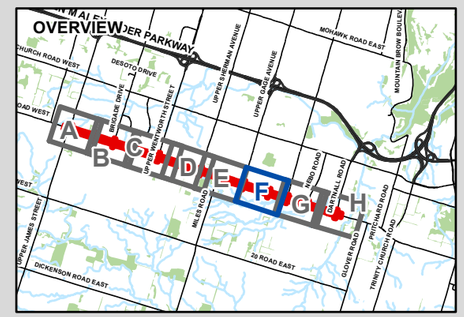
RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

STORM CATCHMENT STATUS
FIGURE 5F

- Project Boundary
- Study Area (120m)
- Watercourse
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

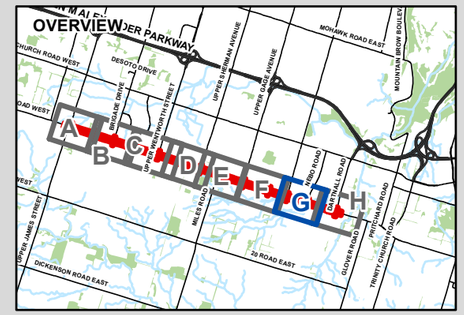
RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

STORM CATCHMENT STATUS
FIGURE 5G

- Project Boundary
- Study Area (120m)
- Watercourse
- Water Body
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- 85% - 100&
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

RYMAL ROAD, HAMILTON, ON
DRAINAGE ASSESSMENT

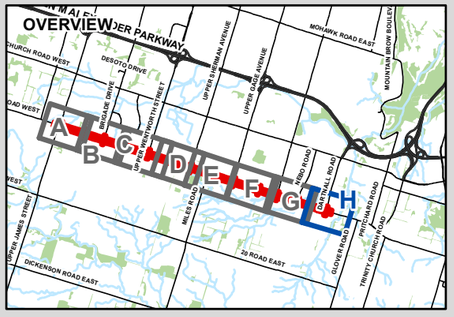
STORM CATCHMENT STATUS

FIGURE 5H

- Project Boundary
- Study Area (120m)
- Watercourse
- Water Body
- Rymal Road Storm Sewer Catchment
- Storm Sewer

ID(Current Conveyance Ratio) {Road Improvements Conveyance Ratio}

- < 85%
- >100%



SCALE 1:3,000

0 20 40 80 m

MAP DRAWING INFORMATION:
DATA PROVIDED BY MNR, City of Hamilton

MAP CREATED BY: LMM
MAP CHECKED BY: -
MAP PROJECTION: NAD 1983 CSRS UTM Zone 17N

DILLON CONSULTING

PROJECT: 20-3410
STATUS: DRAFT
DATE: 2025-02-14

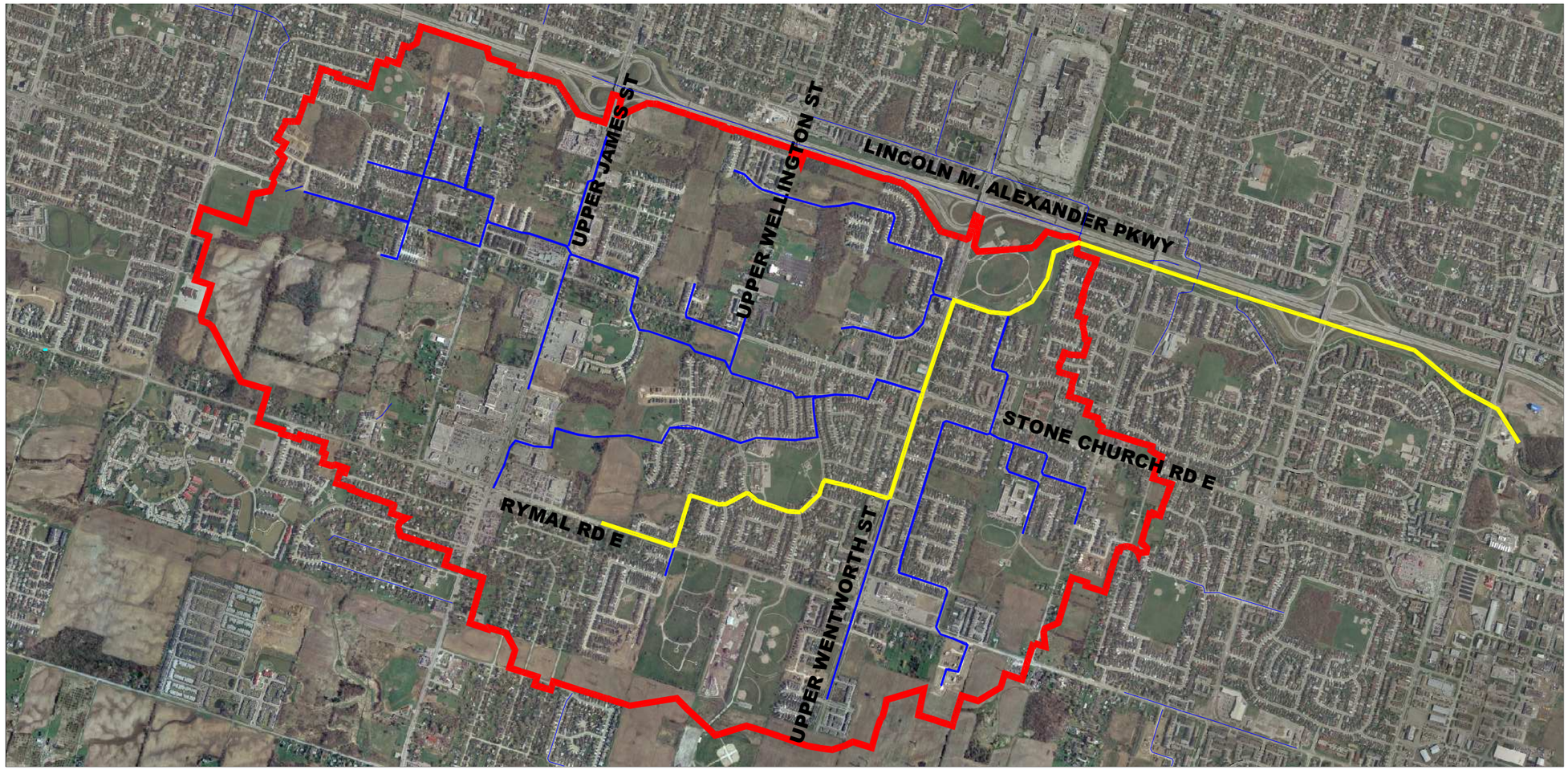
FILE LOCATION: K:\2020\203410\Product\Client\DrainageMemo\203410_F5b_Status_DDP.mxd

Appendix A

Background Document Excerpts

Appendix A-1

West Mountain Sewershed Plan: City of ***Hamilton Implementation of Mouse Simulation Package for the Separated Storm*** Sewer System (2010)



Legend:

- DRAINAGE AREA
- TRUNK SEWERS
- SUB TRUNK SEWERS

0 250 500
METRES

Figure ES-1 Study Area

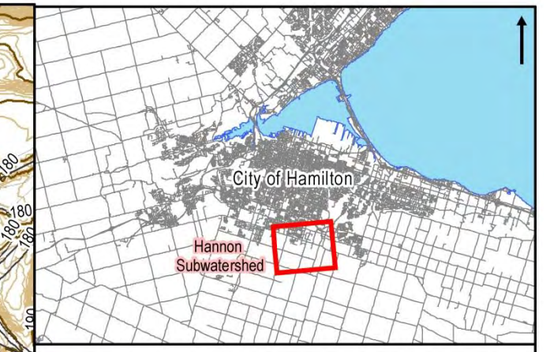
Hamilton

Aquafor Beech Limited

Appendix A-2

Karst Locations within Hannon Creek

Subwatershed: Upper Hannon Creek Master Drainage Plan Municipal Class Environmental Assessment (2017)



N

Legend

- Locations Described in Karst Report
- Flow Path (From Previous Studies)
- Assumed Flow Paths
- Reach Breaks

Contours

- Major
- Minor

Base Layers

- Roads
- Watercourses
- Hannon Subwatershed Boundary
- Major Karst Catchment Areas
- Parcels

0 0.25 0.5 1
Kilometers

Upper Hannon Creek Master Drainage and Servicing Study

Karst Locations within Hannon Creek Subwatershed

July 2017	1:15,000	Datum: NAD 83, Zone 17 Source: City of Hamilton
P#: 60320496	V#: 004	

AECOM

Figure 10

Map location: \\CAC\CN1FP001\Data Projects\60320496 Upper Hannon Ck\900-Work\920-929 (GIS-Graphics)\Design\2017 FINAL REPORT MAPS\Karst_Subwatershed_10_11x7_20170726.mxd
Date Saved: 7/26/2017 11:28:03 AM

Appendix A-3

Upper Hannon Creek Subwatershed Aquatic Stream Classification: Hannon Creek Subwatershed – North Glanbrook Industrial Business Park Master Drainage Plan (2010)

Hannon Creek Subwatershed

North Glanbrook Industrial Business Park Master Drainage Plan

Legend

- Watercourses
- North Glanbrook Industrial Business Park
- Reach Breaks

Aquatic Habitat

- Critical Habitat
- Important Habitat
- Marginal Habitat
- No Habitat
- Intermittent
- Subwatershed Boundary

N

0 285 570 1,140

Meters

Aquatic Stream Classification

AECOM

Hamilton

Datum: NAD 83, Zone 17
Source: City of Hamilton

1:16,000

March 2009

Figure 2.2.3

G:\Pj\2230\22303A-01 Hannon Creek\GIS\Report Maps 2009

Table 2.2.5 Habitat Component for Classifications*

Stream Categorization	Rarity of Habitat	Sensitivity to Development	Function of habitat in sustaining fisheries	Groundwater Discharge	Existing Level of Habitat Degradation and Modification	Habitat Supports Threatened or Endangered Species or Species of Concern	Coldwater Status
Critical Habitat	Habitat is rare within the study area	Highly sensitive to activities associated with urban development (i.e. temperature modifications, sedimentation)	Plays a critical role in sustaining the resident fish community (i.e. spawning or nursery habitat)	Groundwater discharge present	Channel not been modified or degraded (i.e. stream in natural state)	Has been confirmed as supporting significant species	Habitat is known to support coldwater species
Important Habitat	Habitat is common within the study area	Moderately sensitive to activities associated with urban development	Important but not critical in sustaining the resident fish community (i.e. feeding areas, benthic production areas)	No groundwater discharge present	Channel has been somewhat modified or degraded but habitat features remain	Habitat is not known to support significant species	Habitat is not known to support coldwater species
Marginal Habitat	Habitat is very common within the study area	Not sensitive to activities associated with urban development	No specific habitat function, but provides generalized opportunity. Habitat may also be used seasonally when flow is available.	No groundwater discharge present	Channel is highly modified or degraded (no buffer, channelized or plowed through)	Habitat is not known to support significant species	Habitat is not known to support coldwater species
No Habitat	No habitat	No sensitivity	No habitat	No groundwater	No habitat	No habitat	No habitat

* Habitat components for classification were developed through a review of Provincial Policy Statement's *Natural Heritage Reference Manual* (MNR, 1999) and the DFO's *Agricultural Drain Classification System* (DFO, 1999) and the study team's recent work as part of the North Oakville Subwatershed Study.

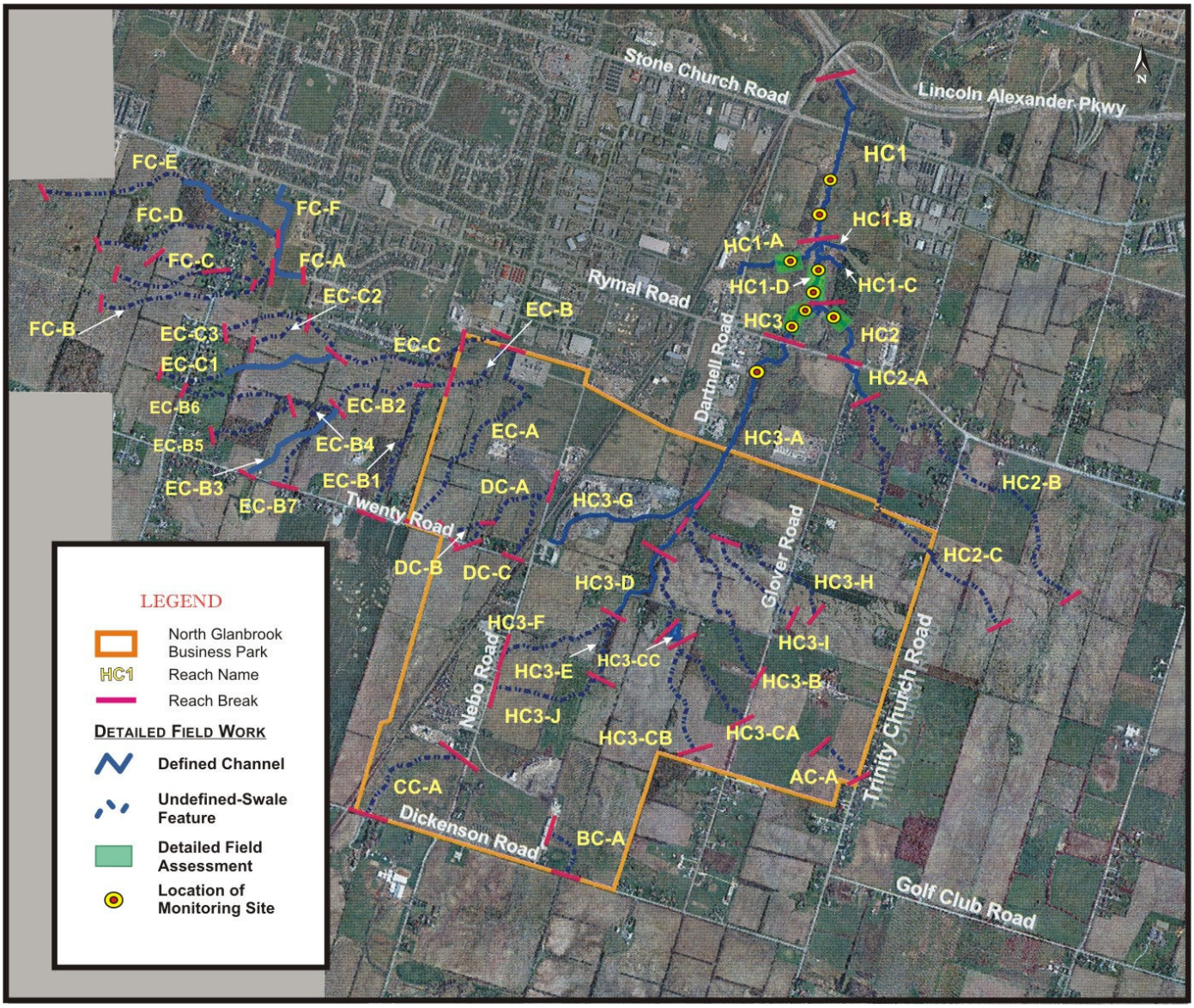


Figure 2.3.1 Reach Map and Geomorphological Field and Monitoring Work Locations

A photographic log of geomorphic characteristics of all the reaches was also completed during the course of the field analysis to aid in the identification and support of the reaches characterized within the study area (see **Appendix K**).

Overall, the majority of the channels were found to be in a stable to transitional state with the exception of four reaches located in the downstream portion of the watershed (HC1, HC1-A, HC1-D and HC3). These reaches exhibited large amounts of erosion, deposition, and incision to the parent-bed material. Reach HC1 was a relatively straight reach, with poor bed morphology and a poor riparian zone. Reach HC1-A had a relatively steep gradient, with several knick-points and exposed bedrock. The channel bankfull width varied from 1.5 to 3.25 m and the bankfull depth was 0.3 to 0.6 m. There were several debris jams, artificial riffles and bank slumps due to the vertical banks. Reach HC1-D was a relatively sinuous reach with well-defined riffle-pool sequences. The reach had many high flow channels, with overbank deposition and several bar formations. Due to the channels sinuous nature, there were great

amounts of bank erosion present throughout the reach. Reach HC3 was a moderately sinuous reach composed of a bedrock bed. The channel bankfull width varied from 3.0 to 8.0 m and the bankfull depth was 0.3 to 1.0 m. Bank erosion was prominent in the meander bends of the reach, with several leaning trees, large undercuts, and exposed roots.

Table 2.3.1 RGA and RSAT Values for the Defined Channel Sections on Hannon Creek*

Reach Name	RGA Value	Condition	RSAT Value	Condition	Comments
HC1	0.47	In Adjustment	20	Moderate	Aggradation and Widening
HC1-A	0.46	In Adjustment	24	Moderate	Degradation and Widening
HC1-B	0.08	In Regime	27	Moderate	Widening
HC1-C	0.08	In Regime	27	Moderate	Widening
HC1-D	0.54	In Adjustment	22	Moderate	Widening and Aggradation
HC2	0.40	In Transition	21.5	Moderate	Widening
HC2-A	0.23	In Transition	23	Moderate	Aggradation and Widening
HC2-B	0.18	In Regime	21	Moderate	Aggradation and Widening
HC2-C	0.27	In Transition	18	Low	Widening and Aggradation
HC3	0.41	In Adjustment	22.5	Moderate	Widening and Degradation
HC3-A	0.37	In Transition	24	Moderate	Widening
HC3-B	0.18	In Regime	17	Low	Aggradation and Widening
HC3-C	0.14	In Regime	17	Low	Aggradation and Widening
HC3-CA	0.21	In Transition	13.5	Low	Aggradation and Widening
HC3-CB	0.18	In Regime	13	Low	Aggradation and Widening
HC3-D	0.17	In Regime	19	Low	Aggradation and Widening
HC3-E	0.14	In Regime	18	Low	Aggradation and Widening
HC3-F	0.18	In Regime	9	Low	Aggradation and Widening
CC-A	0.14	In Regime	17	Low	Aggradation and Widening
*Note the swales and undefined reaches have not been included in the table.					

2.3.4 Swale Field Assessment

A description for all the swales draining the study area was collected to understand the overall channel system. This information is described below on a reach by reach basis. A photographic appendix containing pictures of all field sites and observations described here has also been included in **Appendix K** and **Appendix L**, respectively. Note: the comments included in **Appendix L** for individual cross-sections may not necessarily coincide with the channel processes for the overall reaches as listed in Table 2.3.1.

Appendix B

Storm Sewer Assessment

Dillon Consulting Limited **City of Hamilton**

STORM SEWER ASSESSMENT - EXISTING CONDITIONS

Project: Rymal Road Mun. Class EA - Ph. 1-4
Date: 22-Nov-24

Minimum T 10 min
Min. dia. 0.3 m

Design Storm
Frequency 5 yr
Location Mount Hope
a 1049.5
b 8
c 0.803

Mannings n = 0.015 dia. < 0.6 m
0.013 dia. => 0.6 m
Min.Velocity = 0.8 m/s
Max. Velocity = 3.65 m/s

Outlet System	Catchment ID	From MH No.	To MH No.	Area (ha)	Total Area (ha)	C Value	Area x C	Cumm. A x C	Cumm. Tc	I (mm/hr)	Total Flow (L/s)	Diameter /height (m)	Width (m)	Pipe Slope m/m	n	Length (m)	A Full m2	Q Full (L/s)	V Full (m/s)	% Flow Capacity
A	AX1001	Inlet 01	SMH B022	12.08	12.08	0.70	8.45	8.45	32.3	53.91	1265	0.90		0.009	0.013	80.0	0.64	1717	2.70	74%
		SMH B022	SMH B024	0.00	12.08	0.00	0.00	8.45	32.8	53.38	1252	0.90		0.006	0.013	19.4	0.64	1402	2.20	89%
	A102	SMH B014	SMH B012	0.92	0.92	0.90	0.83	0.83	10.0	103.04	238	0.68		0.002	0.013	63.7	0.36	376	1.05	63%
	A101	SMH B012	SMH B011	0.38	1.31	0.90	0.35	1.18	11.0	98.62	322	0.68		0.002	0.013	79.9	0.36	385	1.08	84%
		SMH B011	SMH B024	0.00	1.31	0.00	0.00	1.18	12.2	93.75	306	0.68		0.018	0.013	7.1	0.36	1112	3.11	28%
	AX1002	Inlet 02	SMH B024	16.95	16.95	0.63	10.67	10.67	25.6	62.38	1849	0.90		0.006	0.013	72.0	0.64	1402	2.20	132%
		SMH B024	SMH B018	0.00	30.33	0.00	0.00	20.29	33.0	53.23	3000	1.35		0.004	0.013	24.6	1.43	3376	2.36	89%
B	BX1001	SMH B075	SMH B076	0.27	0.27	0.90	0.24	0.24	10.0	103.04	69	0.30		0.012	0.015	22.6	0.07	92	1.30	75%
	BX1002	SMH B076	SMH B166	1.16	1.43	0.90	1.04	1.28	10.3	101.73	363	0.45		0.011	0.015	33.4	0.16	259	1.63	140%
	BX1003	SMH B166	SMH B078	1.19	2.62	0.90	1.07	2.36	10.6	100.22	656	0.45		0.011	0.015	61.3	0.16	264	1.66	249%
	B102	SMH B078	SMH B080	0.77	3.38	0.64	0.49	2.84	11.2	97.64	771	0.53		0.010	0.015	99.4	0.22	380	1.76	203%
	B103	SMH B080	SMH B084	1.40	4.79	0.58	0.82	3.66	12.2	93.96	956	0.60		0.013	0.013	113.7	0.28	697	2.47	137%
	BX1004	Inlet 04	SMH B090	26.00	26.00	0.50	13.00	13.00	26.4	61.23	2211	0.98		0.016	0.013	102.0	0.75	2835	3.80	78%
		SMH B090	SMH B084	0.00	26.00	0.00	0.00	13.00	26.9	60.60	2188	1.05		0.009	0.013	28.9	0.87	2591	2.99	84%
	B104	SMH B084	SMH B086	0.35	31.13	0.67	0.23	16.89	27.0	60.37	2833	1.35		0.004	0.013	110.7	1.43	3418	2.39	83%
		SMH B086	SMH B092	0.00	31.13	0.00	0.00	16.89	27.8	59.32	2784	1.35		0.004	0.013	61.2	1.43	3418	2.39	81%
	BX1006	Inlet 05	SMH B093	1.55	1.55	0.60	0.93	0.93	13.3	90.11	233	0.45		0.005	0.015	40.0	0.16	175	1.10	133%
		SMH B093	SMH B092	0.00	1.55	0.00	0.00	0.93	13.9	88.10	227	0.45		0.010	0.015	7.6	0.16	248	1.56	92%
		SMH B092	SMH B088	0.00	32.68	0.00	0.00	17.82	28.2	58.76	2910	1.35		0.004	0.013	48.8	1.43	3376	2.36	86%
	B105	SMH B088	SMH B120	0.96	33.64	0.65	0.62	18.44	28.6	58.32	2988	1.35		0.004	0.013	112.3	1.43	3376	2.36	89%
		SMH B120	SMH B121	0.00	33.64	0.00	0.00	18.44	29.4	57.32	2937	1.35		0.005	0.013	4.2	1.43	3736	2.61	79%
	BX1005	Inlet 06	SMH B121	16.13	16.13	0.60	9.68	9.68	30.9	55.55	1493	1.05		0.008	0.013	76.0	0.87	2442	2.82	61%
	B106	SMH B121	Outlet B	0.14	49.90	0.90	0.12	28.24	31.3	55.04	4318	1.50		0.008	0.013	138.0	1.77	6323	3.58	68%
C	C102	SMH B136	SMH B137	0.16	0.16	0.90	0.15	0.15	10.0	103.04	42	0.38		0.015	0.015	103.2	0.11	183	1.66	23%
	C101	SMH B137	SMH B138	0.75	0.91	0.71	0.53	0.68	11.3	97.50	183	0.38		0.029	0.015	36.5	0.11	257	2.32	71%
	C104	SMH B142	SMH B144	0.55	0.55	0.76	0.41	0.41	10.0	103.04	118	0.60		0.004	0.013	65.1	0.28	363	1.28	33%
	C103	SMH B144	SMH B138	0.70	5.50	0.71	0.50	1.98	47.4	41.80	229	0.83		0.009	0.013	71.2	0.53	1362	2.55	17%
		SMH B138	SMH B084a	0.00	6.41	0.00	0.00	2.65	48.0	41.42	305	0.60		0.013	0.013	16.4	0.28	700	2.48	44%
	CX1001	Inlet 07	SMH B086a	12.16	12.16	0.30	3.65	3.65	47.2	41.92	425	1.35		0.001	0.013	38.0	1.43	1688	1.18	25%
		SMH B086a	SMH B084a	0.00	12.16	0.00	0.00	3.65	47.7	41.60	421	0.90		0.026	0.013	7.5	0.64	2941	4.62	14%
	CX1002	Inlet 07a	SMH B146	4.25	4.25	0.25	1.06	1.06	47.2	41.92	124	0.68		0.005	0.013	18.0	0.36	594	1.66	21%
		SMH B146	SMH B144	0.00	4.25	0.00	0.00	1.06	47.3	41.81	123	0.68		0.020	0.013	4.0	0.36	1189	3.32	10%
D	D103	SMH B105	SMH B102	0.74	0.74	0.58	0.43	0.43	10.0	103.04	122	0.53		0.006	0.015	76.0	0.22	296	1.37	41%
		SMH B102	SMH B042	0.00	0.74	0.00	0.00	0.43	10.9	98.97	117	0.53		0.005	0.015	10.0	0.22	269	1.24	44%
		SMH B042	SMH B040	0.00	25.40	0.00	0.00	0.43	16.5	80.49	866	0.90		0.016	0.013	33.0	0.64	2318	3.64	37%
	D101	SMH B151	SMH B040	0.76	0.76	0.59	0.45	0.45	10.0	103.04	128	0.90		0.004	0.013	24.0	0.64	1131	1.78	11%
	DX1001/D102	SMH B153	SMH B042	24.66	24.66	-	0.00	0.00	15.3	83.78	770	0.93	0.93	0.015	0.013	254.0	0.86	3081	3.56	25%
E	E101	SMH B106	SMH B108	2.05	2.05	0.81	1.67	1.67	10.0	103.04	477	0.53		0.007	0.015	81.4	0.22	316	1.46	151%
	E102	SMH B108	SMH B110	1.64	3.69	0.78	1.28	2.95	10.9	98.96	810	0.60		0.007	0.013	99.5	0.28	506	1.79	160%
		SMH B110	SMH B002	0.00	3.69	0.00	0.00	2.95	11.9	95.23	779	0.60		0.068	0.013	9.4	0.28	1601	5.66	49%
	EX1001	Inlet 08	SMH B002	26.31	26.31	0.60	15.79	15.79	25.4	62.79	2754	1.20		0.009	0.013	737.0	1.13	3699	3.27	74%

DILLON CONSULTING

Outlet System	Catchment ID	From MH No.	To MH No.	Area (ha)	Total Area (ha)	C Value	Area x C	Cumm. A x C	Cumm. Tc	I (mm/hr)	Total Flow (L/s)	Diameter /height (m)	Width (m)	Pipe Slope m/m	n	Length (m)	A Full m2	Q Full (L/s)	V Full (m/s)	% Flow Capacity
F	E103	SMH B002	Outlet E	2.03	32.03	0.90	1.82	20.56	29.1	57.63	3291	1.20		0.010	0.013	0.0	1.13	3899	3.45	84%
	F103	SMH B064	SMH B074	0.83	0.83	0.85	0.70	0.70	10.0	103.04	201	0.75	1.15	0.003	0.013	74.0	0.86	1375	1.59	15%
	FX1001	Inlet 09	SMH B066	9.49	9.49	0.73	6.97	6.97	19.8	72.61	1405	0.75		0.003	0.013	44.0	0.44	610	1.38	230%
		SMH B066	SMH B074	0.00	9.49	0.00	0.00	6.97	20.4	71.52	1384	0.75		0.013	0.013	12.0	0.44	1264	2.86	109%
	F102	SMH B074	SMH B062	0.66	10.97	0.90	0.59	8.26	20.4	71.37	1638	0.86	1.35	0.003	0.013	63.0	1.15	1844	1.60	89%
	F101	SMH B062	SMH B072	0.10	11.07	0.90	0.09	8.35	21.1	70.08	1625	0.86	1.35	0.003	0.013	58.0	1.15	1913	1.66	85%
		SMH B072	SMH B060	0.00	11.07	0.00	0.00	8.35	21.7	68.98	1599	0.86	1.35	0.004	0.013	21.0	1.15	2287	1.99	70%
		SMH B060	SMH B059	0.00	11.07	0.00	0.00	8.35	21.8	68.65	1592	0.90		0.007	0.013	17.0	0.64	1515	2.38	105%
G	G101	SMH B045	SMH B047	0.61	0.61	0.85	0.52	0.52	10.0	103.04	150	0.53		0.004	0.015	79.5	0.22	236	1.09	63%
	G102	SMH B047	SMH B049	0.51	1.13	0.46	0.23	0.76	11.2	97.76	206	0.60		0.005	0.013	78.3	0.28	438	1.55	47%
	G103	SMH B049	SMH B016	2.44	3.57	0.61	1.49	2.25	12.1	94.46	591	0.60		0.006	0.013	87.2	0.28	480	1.70	123%
		SMH B016	SMH B020a	0.00	3.57	0.00	0.00	2.25	12.9	91.34	571	0.60		0.008	0.013	65.8	0.28	539	1.91	106%
	GX1001	Inlet 10	SMH B018a	7.91	7.91	0.50	3.96	3.96	23.2	66.27	728	0.83		0.003	0.013	45.0	0.53	786	1.47	93%
		SMH B018a	SMH B020a	0.00	7.91	0.00	0.00	3.96	23.7	65.41	719	0.83		0.003	0.013	11.6	0.53	786	1.47	91%
	GX1002	Inlet 11	SMH B051	2.30	2.30	0.40	0.92	0.92	12.9	91.26	233	0.45		0.007	0.015	53.0	0.16	207	1.30	113%
		SMH B051	SMH B020a	0.00	2.30	0.00	0.00	0.92	13.6	88.95	227	0.45		0.009	0.015	17.2	0.16	234	1.47	97%
	G104	SMH B020a	SMH B021	0.11	13.89	0.90	0.10	7.23	23.8	65.20	1309	1.05		0.004	0.013	86.0	0.87	1749	2.02	75%
	G105	SMH B021	SMH B023	2.10	15.99	0.59	1.25	8.48	24.5	64.05	1508	1.05		0.004	0.013	98.8	0.87	1749	2.02	86%
	G106	SMH B023	SMH B025	2.01	18.00	0.50	1.00	9.48	25.4	62.79	1654	1.05		0.004	0.013	107.6	0.87	1749	2.02	95%
		SMH B025	SMH B027	0.00	18.00	0.00	0.00	9.48	26.2	61.48	1619	1.05		0.003	0.013	109.0	0.87	1445	1.67	112%
	G107	SMH B027	SMH B052	1.37	19.37	0.80	1.09	10.57	27.3	59.95	1761	1.05		0.006	0.013	122.4	0.87	2133	2.46	83%
	GX1003	Inlet 12	SMH B133	27.00	27.00	0.60	16.07	16.07	31.5	54.82	2447	1.20		0.005	0.013	66.0	1.13	2757	2.44	89%
		SMH B133	SMH B052	0.00	27.00	0.00	0.00	16.07	32.0	54.32	2425	1.20		0.008	0.013	18.5	1.13	3509	3.10	69%
	GX1004	SMH B050	SMH B052	4.43	4.43	0.75	3.33	3.33	10.9	98.92	914	0.68		0.004	0.013	45.1	0.36	532	1.49	172%
		SMH B052	SMH B047a	0.00	50.80	0.00	0.00	29.97	32.1	54.21	4513	1.35		0.005	0.013	93.5	1.43	3922	2.74	115%
	G108	SMH B047a	SMH B045a	1.77	52.57	0.80	1.41	31.38	32.6	53.60	4673	1.35		0.006	0.013	111.3	1.43	4270	2.98	109%
	G109	SMH B045a	SMH B043	1.05	53.63	0.90	0.95	32.33	33.2	52.95	4756	1.35		0.009	0.013	111.5	1.43	5092	3.56	93%
	G110	SMH B043	SMH B041	1.54	55.17	0.87	1.34	33.67	33.8	52.42	4903	1.35		0.008	0.013	114.0	1.43	4892	3.42	100%
	G111	SMH B041	SMH B039	0.82	55.99	0.80	0.66	34.33	34.3	51.86	4946	1.35		0.009	0.013	114.2	1.43	5175	3.62	96%
	G113	SMH B039	SMH B	1.27	57.26	0.54	0.69	35.02	34.8	51.35	4996	1.35		0.007	0.013	101.3	1.43	4434	3.10	113%
	G112	SMH B	SMH B037	1.36	58.61	0.75	1.02	36.04	35.4	50.83	5089	1.35		0.014	0.013	22.5	1.43	6383	4.46	80%
	G114	SMH B037	SMH B138a	0.45	59.07	0.75	0.34	36.37	35.5	50.75	5129	1.35		0.010	0.013	63.5	1.43	5337	3.73	96%
	G115	SMH B138a	SMH B036	0.82	59.89	0.75	0.62	36.99	35.8	50.49	5189	1.35		0.009	0.013	48.1	1.43	4921	3.44	105%
	GX1005	Inlet 14	SMH B130	43.47	43.47	0.65	28.25	28.25	127.5	20.37	3299	2.10		0.005	0.013	131.0	3.46	12261	3.54	27%
	G116	SMH B130	SMH B036	0.05	43.52	0.90	0.05	28.30	128.1	20.30	1596	2.10		0.134	0.013	4.6	3.46	63495	18.33	3%
		SMH B036	SMH B004	0.00	103.41	0.00	0.00	65.29	128.1	20.30	5381	2.55		0.003	0.013	36.1	5.11	16202	3.17	33%
	GX1006	Inlet 15	SMH B005	29.45	29.45	0.63	18.46	18.46	31.4	54.91	2816	1.35		0.010	0.013	67.0	1.43	5337	3.73	53%
		SMH B005	SMH B004	0.00	29.45	0.00	0.00	18.46	31.7	54.58	2799	1.35		0.005	0.013	13.5	1.43	3774	2.64	74%
	G117	SMH B004	SMH B019	3.42	136.27	0.90	3.07	86.83	128.3	20.27	6590	2.55		0.004	0.013	197.6	5.11	18633	3.65	35%
	G118	SMH B019	SMH B025a	1.92	138.19	0.90	1.73	88.56	129.2	20.17	6661	2.55		0.004	0.013	192.9	5.11	18404	3.60	36%
	GX1007	Inlet 16	SMH B023a	163.88	163.88	0.39	63.88	63.88	123.0	20.93	3715	2.40		0.003	0.013	90.0	4.52	13559	3.00	27%
		SMH B023a	SMH B025a	0.00	163.88	0.00	0.00	63.88	123.5	20.87	3703	2.40		0.003	0.013	27.5	4.52	13559	3.00	27%
	G119	SMH B025a	SMH C	1.08	303.15	0.75	0.81	153.25	130.1	20.06	10241	3.60		0.002	0.013	218.1	10.18	32641	3.21	31%
	GX1008	SMH C	SMH B074a	8.25	311.40	0.73	6.02	159.27	131.2	19.93	10519	3.60		0.002	0.013	34.7	10.18	34234	3.36	31%
		SMH B074a	Outlet G	0.00	311.40	0.00	0.00	159.27	131.4	19.91	10510	3.60		0.003	0.013	0.0	10.18	39977	3.93	26%
H	H101	SMH B059a	SMH B009	0.21	0.21	0.90	0.19	0.19	10.0	103.04	54	0.60		0.004	0.013	95.2	0.28	393	1.39	14%
	H102	SMH B009	SMH B011a	0.36	0.57	0.90	0.32	0.51	11.1	98.08	139	0.75		0.004	0.013	95.3	0.44	704	1.59	20%
	HX1001	Inlet 17	SMH B025b	20.05	20.05	0.60	12.03	12.03	20.2	71.83	2401	0.90		0.005	0.013	44.0	0.64	1280	2.01	188%
		SMH B025b	SMH B011a	0.00	20.05	0.00	0.00	12.03	20.6	71.10	2376	0.90		0.008	0.013	18.2	0.64	1578	2.48	151%
	H103	SMH B011a	Outlet H	0.19	20.80	0.90	0.17	12.71	20.7	70.85	2501	1.20		0.004	0.013	20.0	1.13	2466	2.18	101%

Dillon Consulting Limited **City of Hamilton**

STORM SEWER ASSESSMENT - PREFERRED ALTERNATIVE

Project: Rymal Road Mun. Class EA - Ph. 1-4
Date: 22-Nov-24

Minimum T 10 min
Min. dia. 0.3 m

Design Storm
Frequency 5 yr
Location Mount Hope
a 1049.5
b 8
c 0.803

Manning's n = 0.015 dia. < 0.6 m
0.013 dia. => 0.6 m
Min.Velocity = 0.8 m/s
Max. Velocity = 3.65 m/s

Outlet System	Catchment ID	From MH No.	To MH No.	Area (ha)	Total Area (ha)	C Value	Area x C	Cumm. A x C	Cumm. Tc	I (mm/hr)	Total Flow (L/s)	Diameter /height (m)	Width (m)	Pipe Slope m/m	n	Length (m)	A Full m2	Q Full (L/s)	V Full (m/s)	% Flow Capacity
A	AX1001	Inlet 01	SMH B022	12.08	12.08	0.70	8.45	8.45	32.3	53.91	1265	0.90		0.009	0.013	80.0	0.64	1717	2.70	74%
		SMH B022	SMH B024	0.00	12.08	0.00	0.00	8.45	32.8	53.38	1252	0.90		0.006	0.013	19.4	0.64	1402	2.20	89%
	A102	SMH B014	SMH B012	0.92	0.92	0.90	0.83	0.83	10.0	103.04	238	0.68		0.002	0.013	63.7	0.36	376	1.05	63%
	A101	SMH B012	SMH B011	0.38	1.31	0.90	0.35	1.18	11.0	98.62	322	0.68		0.002	0.013	79.9	0.36	385	1.08	84%
		SMH B011	SMH B024	0.00	1.31	0.00	0.00	1.18	12.2	93.75	306	0.68		0.018	0.013	7.1	0.36	1112	3.11	28%
	AX1002	Inlet 02	SMH B024	16.95	16.95	0.63	10.67	10.67	25.6	62.38	1849	0.90		0.006	0.013	72.0	0.64	1402	2.20	132%
		SMH B024	SMH B018	0.00	30.33	0.00	0.00	20.29	33.0	53.23	3000	1.35		0.004	0.013	24.6	1.43	3376	2.36	89%
B	BX1001	SMH B075	SMH B076	0.27	0.27	0.90	0.24	0.24	10.0	103.04	69	0.30		0.012	0.015	22.6	0.07	92	1.30	75%
	BX1002	SMH B076	SMH B166	1.16	1.43	0.90	1.04	1.28	10.3	101.73	363	0.45		0.011	0.015	33.4	0.16	259	1.63	140%
	BX1003	SMH B166	SMH B078	1.19	2.62	0.90	1.07	2.36	10.6	100.22	656	0.45		0.011	0.015	61.3	0.16	264	1.66	249%
	B102	SMH B078	SMH B080	0.77	3.38	0.64	0.49	2.84	11.2	97.64	771	0.53		0.010	0.015	99.4	0.22	380	1.76	203%
	B103	SMH B080	SMH B084	1.40	4.79	0.62	0.87	3.71	12.2	93.96	968	0.60		0.013	0.013	113.7	0.28	697	2.47	139%
	BX1004	Inlet 04	SMH B090	26.00	26.00	0.50	13.00	13.00	26.4	61.23	2211	0.98		0.016	0.013	102.0	0.75	2835	3.80	78%
		SMH B090	SMH B084	0.00	26.00	0.00	0.00	13.00	26.9	60.60	2188	1.05		0.009	0.013	28.9	0.87	2591	2.99	84%
	B104	SMH B084	SMH B086	0.35	31.13	0.83	0.29	17.00	27.0	60.37	2851	1.35		0.004	0.013	110.7	1.43	3418	2.39	83%
		SMH B086	SMH B092	0.00	31.13	0.00	0.00	17.00	27.8	59.32	2801	1.35		0.004	0.013	61.2	1.43	3418	2.39	82%
	BX1006	Inlet 05	SMH B093	1.55	1.55	0.60	0.93	0.93	13.3	90.11	233	0.45		0.005	0.015	40.0	0.16	175	1.10	133%
		SMH B093	SMH B092	0.00	1.55	0.00	0.00	0.93	13.9	88.10	227	0.45		0.010	0.015	7.6	0.16	248	1.56	92%
		SMH B092	SMH B088	0.00	32.68	0.00	0.00	17.93	28.2	58.76	2926	1.35		0.004	0.013	48.8	1.43	3376	2.36	87%
	B105	SMH B088	SMH B120	0.99	33.67	0.66	0.65	18.58	28.6	58.32	3010	1.35		0.004	0.013	112.3	1.43	3376	2.36	89%
		SMH B120	SMH B121	0.00	33.67	0.00	0.00	18.58	29.4	57.32	2959	1.35		0.005	0.013	4.2	1.43	3736	2.61	79%
	BX1005	Inlet 06	SMH B121	16.13	16.13	0.60	9.68	9.68	30.9	55.55	1493	1.05		0.008	0.013	76.0	0.87	2442	2.82	61%
	B106	SMH B121	Outlet B	0.14	49.93	0.90	0.12	28.38	31.3	55.04	4339	1.50		0.008	0.013	138.0	1.77	6323	3.58	69%
C	C102	SMH B136	SMH B137	0.16	0.16	0.90	0.15	0.15	10.0	103.04	42	0.38		0.015	0.015	103.2	0.11	183	1.66	23%
	C101	SMH B137	SMH B138	0.75	0.91	0.70	0.52	0.67	11.3	97.50	181	0.38		0.029	0.015	36.5	0.11	257	2.32	70%
	C104	SMH B142	SMH B144	0.55	0.55	0.75	0.41	0.41	10.0	103.04	117	0.60		0.004	0.013	65.1	0.28	363	1.28	32%
	C103	SMH B144	SMH B138	0.70	5.50	0.74	0.52	1.99	47.4	41.80	231	0.83		0.009	0.013	71.2	0.53	1362	2.55	17%
		SMH B138	SMH B084a	0.00	6.41	0.00	0.00	2.66	48.0	41.43	306	0.60		0.013	0.013	16.4	0.28	700	2.48	44%
	CX1001	Inlet 07	SMH B086a	12.16	12.16	0.30	3.65	3.65	47.2	41.92	425	1.35		0.001	0.013	38.0	1.43	1688	1.18	25%
		SMH B086a	SMH B084a	0.00	12.16	0.00	0.00	3.65	47.7	41.60	421	0.90		0.026	0.013	7.5	0.64	2941	4.62	14%
	CX1002	Inlet 07a	SMH B146	4.25	4.25	0.25	1.06	1.06	47.2	41.92	124	0.68		0.005	0.013	18.0	0.36	594	1.66	21%
		SMH B146	SMH B144	0.00	4.25	0.00	0.00	1.06	47.3	41.81	123	0.68		0.020	0.013	4.0	0.36	1189	3.32	10%
D	D103	SMH B105	SMH B102	0.74	0.74	0.61	0.45	0.45	10.0	103.04	129	0.53		0.006	0.015	76.0	0.22	296	1.37	44%
		SMH B102	SMH B042	0.00	0.74	0.00	0.00	0.45	10.9	98.97	124	0.53		0.005	0.015	10.0	0.22	269	1.24	46%
		SMH B042	SMH B040	0.00	25.40	0.00	0.00	0.45	16.5	80.49	871	0.90		0.016	0.013	33.0	0.64	2318	3.64	38%
	D101	SMH B151	SMH B040	0.76	0.76	0.90	0.69	0.69	10.0	103.04	197	0.90		0.004	0.013	24.0	0.64	1131	1.78	17%
	DX1001/D102	SMH B153	SMH B042	24.66	24.66	-	0.00	0.00	15.3	83.78	770	0.93	0.93	0.015	0.013	254.0	0.86	3081	3.56	25%
E	E101	SMH B106	SMH B108	2.05	2.05	0.81	1.67	1.67	10.0	103.04	477	0.53		0.007	0.015	81.4	0.22	316	1.46	151%
	E102	SMH B108	SMH B110	1.64	3.69	0.78	1.28	2.95	10.9	98.96	810	0.60		0.007	0.013	99.5	0.28	506	1.79	160%
		SMH B110	SMH B002	0.00	3.69	0.00	0.00	2.95	11.9	95.23	779	0.60		0.068	0.013	9.4	0.28	1601	5.66	49%
	EX1001	Inlet 08	SMH B002	26.31	26.31	0.60	15.79	15.79	25.4	62.79	2754	1.20		0.009	0.013	737.0	1.13	3699	3.27	74%

Outlet System	Catchment ID	From MH No.	To MH No.	Area (ha)	Total Area (ha)	C Value	Area x C	Cumm. A x C	Cumm. Tc	I (mm/hr)	Total Flow (L/s)	Diameter /height (m)	Width (m)	Pipe Slope m/m	n	Length (m)	A Full m2	Q Full (L/s)	V Full (m/s)	% Flow Capacity
	E103	SMH B002	Outlet E	2.03	32.03	0.90	1.82	20.56	29.1	57.63	3291	1.20		0.010	0.013	0.0	1.13	3899	3.45	84%
	F103	SMH B064	SMH B074	0.88	0.88	0.85	0.75	0.75	10.0	103.04	214	0.75	1.15	0.003	0.013	74.0	0.86	1375	1.59	16%
	FX1001	Inlet 09	SMH B066	9.49	9.49	0.73	6.97	6.97	19.8	72.61	1405	0.75		0.003	0.013	44.0	0.44	610	1.38	230%
F		SMH B066	SMH B074	0.00	9.49	0.00	0.00	6.97	20.4	71.52	1384	0.75		0.013	0.013	12.0	0.44	1264	2.86	109%
	F102	SMH B074	SMH B062	0.66	11.02	0.90	0.59	8.30	20.4	71.37	1647	0.86	1.35	0.003	0.013	63.0	1.15	1844	1.60	89%
	ma	SMH B062	SMH B072	0.32	11.34	0.90	0.29	8.59	21.1	70.08	1672	0.86	1.35	0.003	0.013	58.0	1.15	1913	1.66	87%
		SMH B072	SMH B060	0.00	11.34	0.00	0.00	8.59	21.7	68.98	1646	0.86	1.35	0.004	0.013	21.0	1.15	2287	1.99	72%
		SMH B060	SMH B059	0.00	11.34	0.00	0.00	8.59	21.8	68.65	1638	0.90		0.007	0.013	17.0	0.64	1515	2.38	108%
	G101	SMH B045	SMH B047	0.61	0.61	0.85	0.52	0.52	10.0	103.04	150	0.53		0.004	0.015	79.5	0.22	236	1.09	63%
	G102	SMH B047	SMH B049	0.51	1.13	0.49	0.25	0.77	11.2	97.76	209	0.60		0.005	0.013	78.3	0.28	438	1.55	48%
	G103	SMH B049	SMH B016	2.44	3.57	0.64	1.56	2.33	12.1	94.46	612	0.60		0.006	0.013	87.2	0.28	480	1.70	128%
		SMH B016	SMH B020a	0.00	3.57	0.00	0.00	2.33	12.9	91.34	592	0.60		0.008	0.013	65.8	0.28	539	1.91	110%
	GX1001	Inlet 10	SMH B018a	7.91	7.91	0.50	3.96	3.96	23.2	66.27	728	0.83		0.003	0.013	45.0	0.53	786	1.47	93%
		SMH B018a	SMH B020a	0.00	7.91	0.00	0.00	3.96	23.7	65.41	719	0.83		0.003	0.013	11.6	0.53	786	1.47	91%
	GX1002	Inlet 11	SMH B051	2.30	2.30	0.40	0.92	0.92	12.9	91.26	233	0.45		0.007	0.015	53.0	0.16	207	1.30	113%
		SMH B051	SMH B020a	0.00	2.30	0.00	0.00	0.92	13.6	88.95	227	0.45		0.009	0.015	17.2	0.16	234	1.47	97%
	G104	SMH B020a	SMH B021	0.11	13.89	0.90	0.10	7.31	23.8	65.20	1323	1.05		0.004	0.013	86.0	0.87	1749	2.02	76%
	G105	SMH B021	SMH B023	2.10	15.99	0.62	1.30	8.61	24.5	64.05	1531	1.05		0.004	0.013	98.8	0.87	1749	2.02	88%
	G106	SMH B023	SMH B025	2.01	18.00	0.51	1.03	9.63	25.4	62.79	1680	1.05		0.004	0.013	107.6	0.87	1749	2.02	96%
		SMH B025	SMH B027	0.00	18.00	0.00	0.00	9.63	26.2	61.48	1645	1.05		0.003	0.013	109.0	0.87	1445	1.67	114%
	G107	SMH B027	SMH B052	1.37	19.37	0.80	1.09	10.73	27.3	59.95	1786	1.05		0.006	0.013	122.4	0.87	2133	2.46	84%
	GX1003	Inlet 12	SMH B133	27.00	27.00	0.60	16.07	16.07	31.5	54.82	2447	1.20		0.005	0.013	66.0	1.13	2757	2.44	89%
		SMH B133	SMH B052	0.00	27.00	0.00	0.00	16.07	32.0	54.32	2425	1.20		0.008	0.013	18.5	1.13	3509	3.10	69%
	GX1004	SMH B050	SMH B052	4.43	4.43	0.75	3.33	3.33	10.9	98.92	914	0.68		0.004	0.013	45.1	0.36	532	1.49	172%
		SMH B052	SMH B047a	0.00	50.80	0.00	0.00	30.12	32.1	54.21	4536	1.35		0.005	0.013	93.5	1.43	3922	2.74	116%
	G108	SMH B047a	SMH B045a	1.77	52.57	0.80	1.41	31.54	32.6	53.60	4696	1.35		0.006	0.013	111.3	1.43	4270	2.98	110%
G	G109	SMH B045a	SMH B043	1.05	53.63	0.90	0.95	32.49	33.2	52.95	4778	1.35		0.009	0.013	111.5	1.43	5092	3.56	94%
	G110	SMH B043	SMH B041	1.54	55.17	0.87	1.34	33.83	33.8	52.42	4926	1.35		0.008	0.013	114.0	1.43	4892	3.42	101%
	G111	SMH B041	SMH B039	0.82	55.99	0.80	0.66	34.48	34.3	51.86	4968	1.35		0.009	0.013	114.2	1.43	5175	3.62	96%
	G113	SMH B039	SMH B	1.27	57.26	0.62	0.79	35.27	34.8	51.35	5031	1.35		0.007	0.013	101.3	1.43	4434	3.10	113%
	G112	SMH B	SMH B037	1.36	58.61	0.75	1.02	36.29	35.4	50.83	5124	1.35		0.014	0.013	22.5	1.43	6383	4.46	80%
	G114	SMH B037	SMH B138a	0.45	59.07	0.75	0.34	36.63	35.5	50.75	5164	1.35		0.010	0.013	63.5	1.43	5337	3.73	97%
	G115	SMH B138a	SMH B036	0.82	59.89	0.75	0.62	37.24	35.8	50.49	5224	1.35		0.009	0.013	48.1	1.43	4921	3.44	106%
	GX1005	Inlet 14	SMH B130	43.47	43.47	0.65	28.25	28.25	127.5	20.37	3299	2.10		0.005	0.013	131.0	3.46	12261	3.54	27%
	G116	SMH B130	SMH B036	0.05	43.52	0.90	0.05	28.30	128.1	20.30	1596	2.10		0.134	0.013	4.6	3.46	63495	18.33	3%
		SMH B036	SMH B004	0.00	103.41	0.00	0.00	65.54	128.1	20.30	5396	2.55		0.003	0.013	36.1	5.11	16202	3.17	33%
	GX1006	Inlet 15	SMH B005	29.45	29.45	0.63	18.46	18.46	31.4	54.91	2816	1.35		0.010	0.013	67.0	1.43	5337	3.73	53%
		SMH B005	SMH B004	0.00	29.45	0.00	0.00	18.46	31.7	54.58	2799	1.35		0.005	0.013	13.5	1.43	3774	2.64	74%
	G117	SMH B004	SMH B019	3.42	136.27	0.90	3.07	87.08	128.3	20.27	6604	2.55		0.004	0.013	197.6	5.11	18633	3.65	35%
	G118	SMH B019	SMH B025a	1.92	138.19	0.90	1.73	88.81	129.2	20.17	6675	2.55		0.004	0.013	192.9	5.11	18404	3.60	36%
	GX1007	Inlet 16	SMH B023a	163.88	163.88	0.39	63.88	63.88	123.0	20.93	3715	2.40		0.003	0.013	90.0	4.52	13559	3.00	27%
		SMH B023a	SMH B025a	0.00	163.88	0.00	0.00	63.88	123.5	20.87	3703	2.40		0.003	0.013	27.5	4.52	13559	3.00	27%
	G119	SMH B025a	SMH C	1.08	303.15	0.75	0.81	153.50	130.1	20.06	10255	3.60		0.002	0.013	218.1	10.18	32641	3.21	31%
	GX1008,G120	SMH C	SMH B074a	8.47	311.62	0.76	6.42	159.92	131.2	19.93	10554	3.60		0.002	0.013	34.7	10.18	34234	3.36	31%
		SMH B074a	Outlet G	0.00	311.62	0.00	0.00	159.92	131.4	19.91	10546	3.60		0.003	0.013	0.0	10.18	39977	3.93	26%
	H101A,H101B	SMH B059a	SMH B009	0.40	0.40	0.90	0.36	0.36	10.0	103.04	104	0.60		0.004	0.013	95.2	0.28	393	1.39	26%
	H102	SMH B009	SMH B011a	0.36	0.76	0.90	0.32	0.68	11.1	98.08	186	0.75		0.004	0.013	95.3	0.44	704	1.59	26%
H	HX1001	Inlet 17	SMH B025b	20.05	20.05	0.60	12.03	12.03	20.2	71.83	2401	0.90		0.005	0.013	44.0	0.64	1280	2.01	188%
		SMH B025b	SMH B011a	0.00	20.05	0.00	0.00	12.03	20.6	71.10	2376	0.90		0.008	0.013	18.2	0.64	1578	2.48	151%
	H103	SMH B011a	Outlet H	0.19	21.00	0.90	0.17	12.88	20.7	70.85	2536	1.20		0.004	0.013	20.0	1.13	2466	2.18	103%