Appendix F Stormwater Management Report

Barton Street and Fifty Road Improvements, Municipal Class Environmental Assessment

Stormwater Management Report
City of Hamilton
Project #TPB166053

Prepared for:

City of Hamilton
Hamilton, Ontario

8/10/2022

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Prepared for:

City of Hamilton
Hamilton, Ontario

Prepared by:

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8/10/2022

Table of contents

List of figures

List of tables

List of Appendices

1. Introduction

1.1 Introduction

The City of Hamilton (City) is completing a Municipal Class Environmental Assessment (Class EA) for improvements to Barton Street from Fruitland Road Fifty Road to Fifty Road and Fifty Road from South Service Road to Highway #8 (ref. Figure 1.1. Key Plan). The improvements are required to address the current and future transportation needs in the Stoney Creek Urban Boundary Expansion Area (SCUBE). This Class EA is referred to as the Study in this report. The Environmental Study Report (ESR) was prepared to specifically document aspects of Phase 3 and 4 of the Class EA process for the improvements to Barton Street and Fifty Road. This Study builds on the recommendations of Hamilton's (City-Wide) Transportation Master Plan (TMP, 2007), SCUBE TMP (2008), and the Development Charges Study, which fulfilled the requirements of Phases 1 and 2 of the Class EA process for this Project. The Study Area for this Study is shown in Figure 1.1.

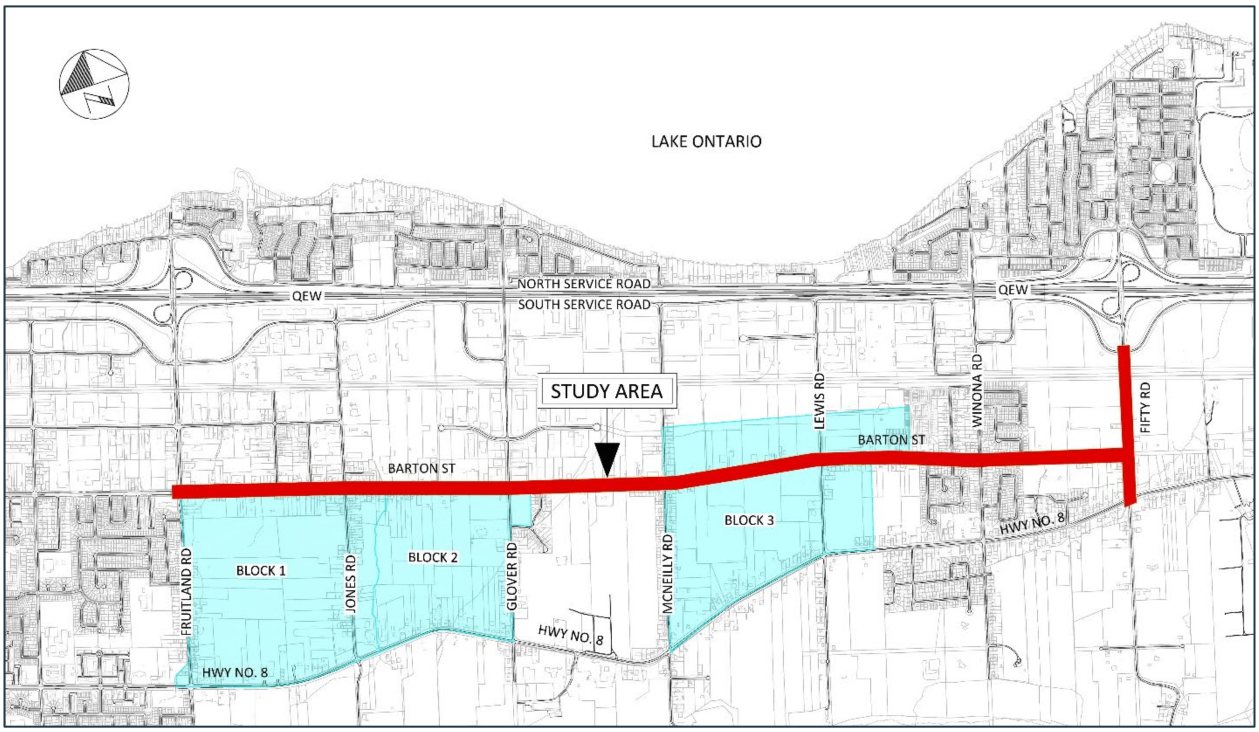


Figure 1.1. Key Plan

1.2 Project Description

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood) has been retained by the City of Hamilton to undertake the technical studies required to complete a Schedule 'C' Municipal Class Environmental Assessment (Class EA) for this section of Barton Street and Fifty Road West.

In order to best address deficiencies (short-term and long-term issues related to future growth, operational, geometric and capacity issues) along Barton Street and Fifty Road, a number of road improvement alternatives will be examined as part of the study, including the widening of the roadway, cross-section improvements, intersection improvements, accommodation of pedestrians and cyclists with additional sidewalks and multi-use trail (MUT), and enhancement of traffic control. In addition, the impact of such improvements on the social and natural environments will be examined.

This section of Barton Street and Fifty Road, in its current 2021 condition, is partially urbanized with extensive rural (ditched) sections with drainage conveyed to roadside ditches, and is primarily a two (2) lane roadway (one lane in each direction) with limited turning lanes.

The road improvements proposed by the Class EA will increase impervious coverage within the Barton Street and Fifty Road right-of-way (R.O.W.) in various sections and will be a fully urbanized R.O.W. (i.e. curb and gutter on both sides).

1.3 Background Information Collection and Review

The project limits, herein referred to as the Study Area, include approximately 6 km of Barton Street and Fifty Road. The Study Area is a major west-east arterial road, located within the Stoney Creek watersheds (Watercourses 5-12), with Fifty Road draining to Fifty Creek (Watercourse 12).

To assess the existing drainage systems and associated hydraulic crossings for the Study Area, previously completed reports, mapping, drawings and other documents have been obtained and reviewed. Summaries of the background information has been provided with this report as noted. The following data have been obtained and reviewed for the purposes of this assessment.

1.3.1. Drawings

Various AutoCAD™ files of the plan and profiles of Barton Street and Fifty Road and their ditches and culverts, and stormwater as-built drawings within the study area, as well as other supporting drawings for site developments, have been obtained from the City of Hamilton. Also, available drawings of the study area in the City of Hamilton's online records management platform '*SPIDER*' have been used to confirm overall storm sewer data such as the location of sewer pipes, geometry, and invert and rim elevations.

Drawing information related to roadway, ditch and culvert elevations has generally not been used for detailed analyses, as it is considered that this information is superseded by information from field surveys and available topographic data.

1.3.2. Reports

Criteria and Guidelines for Stormwater Infrastructure Design, prepared for the City of Hamilton (Philips Engineering, September 2007)

Stoney Creek Urban Boundary Expansion (SCUBE) East Portion Water and Wastewater Master Servicing Plan (Philips Engineering Ltd., November 2008):

The Stoney Creek Urban Boundary Expansion (SCUBE) study area consisted of the lands bounded by Fruitland Road, Highway No. 8, western limits of Winona and Barton Street and lands bounded by the eastern limits of Winona, Highway No. 8, CN Rail, South Service Road and City limits.

SCUBE-East was located in the eastern portion of the Stoney Creek development area. Two development areas, Parcel A of 12.72 ha and Parcel B of 49.79 ha comprise SCUBE-East. Since the study area was restricted to the SCUBE-East area only, water and wastewater services within or adjacent to the Study Area with the capability of servicing lands within the Study area were examined.

The Water and Wastewater Servicing Master Plan was initiated to address the requirements of the Municipal Class EA. For Master Plan, proponents required to complete Phases 1 and 2 of the process, including problem/opportunity statement, identification and assessment of alternatives and Public Consultation.

Lewis Road Reconstruction Class EA Environmental Study Report, City of Hamilton (iTRANS Consulting Inc, October 2008)

Fruitland Road from Barton Street to Highway 8 Municipal Class Environmental Assessment Study PHASES 1 & 2 REPORT (AECOM, December 2010):

The scope of this Municipal Class EA Study which was undertaken as a collaborative effort between the City of Hamilton and AECOM was to provide a comprehensive and environmentally sound planning process, which was open to public participation, and to select the preferred planning solution to improve Fruitland Road between Barton Street and Highway 8.

Stoney Creek Urban Boundary Expansion (SCUBE) West Subwatershed Study Phase 1 and Phase 2 Final Report (Aquafor Beech Limited, May 2013):

This study, termed the SCUBE West Subwatershed Study, is one of two subwatershed studies undertaken in support of the development of the Fruitland-Winona Secondary Plan. The study area of the SCUBE West Subwatershed Study is located within the community of Stoney Creek and is bound by Lake Ontario to the north, the Niagara Escarpment to the south, Fruitland Road to the west and McNeilly Road to the east.

This Subwatershed Study was undertaken in three phases:

1. Existing environmental conditions was established

2. The future impacts were evaluated and from a set of alternatives, a recommended management plan was selected

3. An implementation plan was developed

Block 1 Servicing Strategy for the Fruitland – Winona Secondary Plan Lands, (Wood 2017)

Wood developed a draft servicing strategy for the Block 1 lands, including stormwater management. The servicing strategy and plan has since been taken on and conducted by Urbantech Consulting Inc.

Block 2 Servicing Strategy for the Fruitland – Winona Secondary Plan Lands (Aquafor Beech Limited, September 2018):

The purpose of this study was to develop a Block Servicing Strategy (BSS) for the Block 2 lands located by Barton Street to the north, Highway 8 to the south, Watercourse 6 at the west and Glover Road to the east.

The Block 2 Servicing Strategy shall have regard for existing development in accordance with the Fruitland-Winona Secondary Plan by reflecting the general scale and character of the established development pattern in the surrounding area by taking into consideration lot frontages and areas, building height, coverage, mass, setbacks, privacy and overview. All development within the lands identified as "Servicing Strategies Area" in the Fruitland Winona Secondary Plan – Block Servicing Strategy area delineation shall conform to the Block Servicing Strategies.

Block 3 Servicing Strategy for the Fruitland – Winona Secondary Plan Lands (Urbantech, March 2020):

The Block 3 lands are generally bounded in the north by existing commercial and industrial lands (north of Barton St.), in the east by existing residential development (Tuscani Drive), in the west by McNeilly Avenue and in the South by Highway 8.

This Block Servicing Strategy (BSS) was completed in accordance with the SCUBE Subwatershed Study and provides detail on how development of the subject lands will be achieved in accordance with the Secondary Plan requirements. The goals for this study are to:

- Demonstrate how the requirements illustrated in the subwatershed study are fulfilled in all the Draft plans for the proposed development.

- Provide sufficient level of conceptual design to implement Natural Heritage System (NHS) components and infrastructure in accordance with SCUBESS.
- Ensure servicing requirements are met.
- Identify detailed development constraints or conflicts and options to resolve them.
- Supply implementation details if required.
- Streamline the Draft Plan approval process.
- Facilitate the development of Draft Plan conditions.
- Demonstrate consultation and general landowner support for lands within the subject Block Servicing Strategy area.

Geotechnical Investigation Report, Municipal Class Environmental Assessment Phases 3 & 4, Barton Street and Fifty Road Improvements, Stoney Creek and Winona, Hamilton, Ontario (Wood, March 2020)

The Foothills of Winona – Phase 3, Stormwater Management Review and Supplementary Comment Response Technical Memorandum (Revised) (S. Llewellyn & Associates Limited, May 5, 2021)

1.3.3. GIS and Mapping Data

The City of Hamilton, Hamilton Conservation Authority (HCA), and the Ministry of Natural Resources and Forestry (MNRF), have provided the following GIS data:

- Existing elevation contour data (1.0 metre intervals), which is understood was interpreted from a 2010 DTM (City of Hamilton, October 2017)
- DEM Data (City of Hamilton, October 2017)
- Hamilton Conservation Authority Mapping, inclusive of: Regulation limits, regulatory floodplain mapping, river mapping and water body mapping (HCA, October 2017)
- Polygons containing surficial soils data for the City of Hamilton, (City of Hamilton, October 2017)
- Property Parcel Mapping (City of Hamilton, October 2017)
- Roadway Mapping (City of Hamilton, October 2017)
- Existing, and Official Plan Land Use Mapping (City of Hamilton, October 2017)
- Storm sewer, maintenance hole and catch basin mapping (City of Hamilton, October 2017)
- Aerial Photography for the City of Hamilton (City of Hamilton, December 2017)
- Survey data as provided by the City of Hamilton

2. Existing Conditions

2.1 Existing Conditions Storm Drainage

The existing roadway drainage is split between numerous major/minor drainage outlets to the Stoney Creek Watercourses (5,6,7,9 and 12).

The existing drainage system along the urbanized sections of Barton Street and Fifty Road consists of a series of storm sewers conveying minor system flows, and a series of urban R.O.W.s (curb and gutter) conveying major system flows. The minor system conveys storm events up to the 5-year storm event, and the major system conveys storm events greater than the 5-year, up to the 100-year storm event. The rural road sections of Barton Street and Fifty Road drain to roadside ditches, which are intended to convey drainage up to the 100-year event.

The overall existing drainage boundaries, as well as storm sewers are presented in Figures 1 to 8 (ref. Appendix D). A description of the storm drainage systems, to each outlet is provided in the following sections and should be read in conjunction with the drainage figures within Appendix D. Road Stations corresponding to the drainage system boundaries have been provided for each drainage outlet.

The drainage catchments have been developed using the available background information.

2.1.1. Watercourse 5 – West (0+000 to 0+325)

Drainage from stations 0+000 to 0+325 on Barton Street is conveyed to the west channel of Watercourse 5 via roadside ditches to a culvert crossing Barton Street at station 0+150. The drainage from 0+000 to 0+150 is conveyed in an easterly direction while the drainage from 0+150 to 0+325 is conveyed in a westerly direction. A 600 mm CSP culvert travers Barton Street from the south side to the north side at station 0+260. The total drainage conveyed to the Watercourse 5 crossing from Barton Street is 1.13 ha (+/-).

2.1.2. Sunnyhurst Avenue (0+325 to 0+610)

The major and minor system captures drainage from Barton Street near the Sunnyhurst Avenue intersection from a drainage area of 27.74 ha (+/-). Shallow roadside ditches convey runoff from station 0+325 to a low point within the right-of-way (ROW) at Station 0+430; there are two (2) parallel CSP culverts, one (1) 300 mm culvert and one (1) 450 mm culvert, that traverse Barton Street from the north ditch to the south ditch. The culverts discharge to a 700 mm CSP storm sewer that is conveyed eastward, on the south side of the ROW, to Station 0+520, where it is conveyed northward to Sunnyhurst Avenue. Roadside drainage on the north side of the road from Stations 0+430 to 0+500 and drainage on the south side of the road from Stations 0+430 to 0+575 is also conveyed to the low point within the ROW and ultimately captured by the 700 mm CSP storm sewer.

There are also two (2) CSP inlets on the south side of the ROW at Station 0+435 which discharge to the 700 mm CSP storm sewer; the inlets are 400 mm and 700 mm in diameter. The 400 mm CSP inlet conveys runoff from the south roadside ditch while the 700 mm CSP inlet conveys runoff from the undeveloped external drainage area.

Barton Street drainage on the north side of the ROW from Stations 0+520 to 0+610 is conveyed to a roadside ditch that discharges northward to the Sunnyhurst Avenue east roadside ditch.

2.1.3. Kenmore Avenue (0+570 to 0+890)

The major and minor system captures drainage from Barton Street near the Kenmore Avenue intersection from a drainage area of 13.41 ha (+/-). Shallow roadside ditches convey runoff from Stations 0+610 to 0+700 on the north side of the road and Stations 0+575 to 0+885 on the south side of the road to a 900 mm CSP culvert that conveys flow northward on Kenmore Avenue. There are two (2) CSP inlets on the south side of the ROW, a 350 mm CSP and a 450 mm CSP, which discharge to the 900 mm CSP storm sewer.

Barton Street drainage on the north side of the ROW from Stations 0+700 to 0+835 is conveyed to a roadside ditch that discharges northward to the Kenmore Avenue east roadside ditch.

2.1.4. Jones Road (0+835 to 0+890)

A roadside ditch on the north side of Barton Street conveys runoff from Station 0+835 to the west ditch on Jones Road, at 0+885. The contributing drainage area is 0.10 ha (+/-). There is no storm sewer system on Jones Road.

2.1.5. Watercourse 5 - East (0+890 to 1+420)

Roadside ditches from Stations 0+890 to 1+420 convey Barton Street runoff to two (2) culverts traversing Barton Street at Station 1+100; the culverts are a 1300 mm x 1900 mm CSP box culvert and a 1250 mm x 1250 mm concrete box culvert. The western section of Watercourse 5 is conveyed northward through these culverts. Runoff from Jones Road, south of Barton Street, is also conveyed to the roadside ditch on the south side of Barton Street. The total drainage area contributing to the Barton Street ROW is 31.2 ha (+/-). A portion of this drainage area will be developed as part of the Block 2 plans and will be detained on site and will not discharge to Barton Street as per the City approved proposed Block 2 plans. As such, the contributing drainage area that has been simulated within the PCSWMM model for this section of Barton Street is 22.17 ha (+/-).

2.1.6. Watercourse 6 (1+420 to 1+780)

Roadside ditches from Stations 1+420 to 1+780 at the west side of Glover Road convey Barton Street runoff to a 600 mm CSP culvert that traverses Barton Street at Station 1+460. Watercourse 6 is conveyed through the 600 mm CSP culvert prior to daylighting at the north ditch and passing through a second 600 mm CSP culvert. The channel is conveyed westward for 65 m (+/-) after the second culvert before it discharges northward through private property. The total drainage area contributing to the Barton Street ROW is 19.5 ha (+/-). A portion of this drainage area will be developed as part of the Block 2 plans and will be detained on site and will not discharge to Barton Street as per the City approved proposed Block 3 plans. As such, the contributing drainage area that has been simulated within the PCSWMM model for this section of Barton Street is 1.85 ha (+/-).

2.1.7. Glover Road (1+780 to 1+940)

The roadside ditches from Stations 1+780 to 1+940 convey runoff in a westerly direction to Glover Road, the runoff is discharged to the roadside ditch on the east side of Glover Road and conveyed northward. A 500 mm CSP culvert traverses Barton Street at Station 1+785 and conveys runoff northward. The existing Branthaven development at the south-east corner of Glover Road and Barton Street discharges to two (2) outlet locations; the west side of the development directly discharges to the south Barton Street roadside ditch while the eastern portion of the development discharges to an on site stormwater management pond. The pond discharges to a 450 mm storm sewer within the Barton Street ROW, which discharges eastward to Watercourse 7. The 450 mm storm sewer has been identified as temporary on the received drawings (ref. Appendix A); the Branthaven development will discharge to a permanent storm sewer following the redevelopment of Barton Street. The total drainage area contributing to the outlet at Glover Road is 1.33 ha (+/-).

2.1.8. Watercourse 7 - West (1+940 to 2+160)

Roadside ditches from Stations 1+940 to 2+160 discharge to Watercourse 7 at Station 2+110 on Barton Street. There are two (2) culverts that traverse Barton Street at Watercourse 7; one (1) 1500 mm x 2000 mm arch CSP culvert and a 1000 mm CSP culvert. As noted, the Branthaven development 450 mm storm sewer discharges at Watercourse 7 as well. The total drainage area conveyed to this outlet via Barton Street is 3.84 ha (+/-).

2.1.9. Watercourse 7 - East (2+160 to 2+425)

Roadside ditches from Stations 2+160 to 2+375 on the north side of Barton Street and Station 2+425 on the south side of Barton Street discharge to Watercourse 7 at Station 2+230 on Barton Street. One (1) 800 mm CSP culvert traverses Barton Street which conveys the Watercourse 7. The total drainage area conveyed to this outlet via Barton Street is 14.41 ha (+/-). Approximately 13.48 ha (+/-) of the external drainage area is agricultural land use which extends from Barton Street to the north side of Highway #8.

2.1.10. McNeilly Road (2+380 to 2+660)

Roadside ditches commencing at Stations 2+375 on the north side of Barton Street and Station 2+425 on the south side of Barton Street discharge eastward to a ditch inlet catch basin at the north-west corner of the Barton Street and McNeilly Road intersection, near Station 2+610. A roadside ditch conveys runoff from Station 2+660 to a ditch inlet catch basin on the north-east corner of the intersection; both ditch inlet catch basins discharge to the existing 600 mm storm sewer on McNeilly Road which is conveyed northward.

One (1) 650 mm CSP culvert traverses Barton Street at Station 2+510 which conveys runoff from the south ditch and the McNeilly Road external drainage area to the north ditch and the ditch inlet catch basin. There is a drainage divide for the McNeilly Road (south of Barton Street) external drainage area at Barton Street. The drainage conveyed to the west side of McNeilly Road, south of Barton Street, is conveyed to the McNeilly Road storm sewer north of Barton Street via the 800 mm CSP culvert and ditch inlet. The drainage conveyed to the east side of the McNeilly Road, south of Barton Street, is conveyed eastward on Barton Street via the south roadside ditch, discharging at Lewis Road (Watercourse 9).

The total drainage area conveyed to this outlet via Barton Street is 28.89 ha (+/-). Approximately 27.91 ha (+/-) of the external drainage area is agricultural land use which extends from Barton Street to the Niagara Escarpment. McNeilly Road is the western boundary of the Block 3 development lands.

2.1.11. Lewis Road (Watercourse 9 – West) (2+610 to 3+760)

Roadside ditches commencing at Station 3+760 discharge westward to the Lewis Road east roadside ditch at the north-east corner of the Barton Street and Lewis Road intersection, near Station 3+450. The Lewis Road roadside ditches convey runoff northward, discharging at Watercourse 9. A 1450 mm x 1850 mm concrete box culvert traverses Barton Street at Station 3+450, conveying flow northward. The total drainage area conveyed the Lewis Road west roadside ditch is 150.35 ha (+/-).

Roadside ditches commencing at Stations 2+660 on the north side of Barton Street and Station 2+610 (McNeilly Road) on the south side of Barton Street discharge eastward to the Lewis Road west roadside ditch at the north-west corner of the Barton Street and Lewis Road intersection, near Station 3+450. Two (2) culverts traverse Barton Street in this section of roadway that convey runoff to the north Barton Street roadside ditch; one (1) 400 mm CSP culvert at Station 3+690 and one (1) 650 mm x 950 mm CSP arch culvert at Station 3+475 convey runoff to the north Barton Street roadside ditch. The total drainage area conveyed to the Lewis Road east roadside ditch is 12.70 ha (+/-). The total drainage area conveyed to Lewis Road is 163.05 ha (+/-) which is primarily external drainage area south of Barton Street extending the Niagara Escarpment. The area between McNeilly Road to the west, Tuscani Drive to the east, Highway #8 to the south, Barton Street to the north represents the Block 3 development lands.

2.1.12. Watercourse 9 - East (3+760 to 4+140)

Roadside ditches commencing at Station 4+140 on the north side of Barton Street and Station 4+030 on the south side of Barton Street discharge westward to Watercourse 9 near Station 3+760. The south ditch commences on the west side of Tuscani Drive which conveys major system flow that is not collected by the Tuscani Drive minor system. A 600 mm CSP culvert traverses Barton Street at Station 3+760, conveying flow northward. This culvert also conveys the flow from the Watercourse 9 drainage area. The total drainage area contributing to the Barton Street outlet at Watercourse 9 is 13.50 ha (+/-).

2.1.13. West Avenue (4+030 to 4+450)

A roadside ditch on the south side of Barton Street between Stations 4+030 (Tuscani Drive) and Station 4+180 (Dubonnet Drive) conveys runoff to a 375 mm storm sewer below the ditch, which then discharges to the 2100 mm trunk sewer conveyed northward on West Avenue. A roadside ditch on the south side of Barton Street between Stations 4+180 (Dubonnet Drive) and Station 4+450 conveys runoff to a 1050 mm storm sewer below the ditch, which then discharges to the 2100 mm trunk sewer conveyed northward on West Avenue. The external drainage area south of Barton Street that is conveyed to the 2100 mm trunk storm sewer (104.61 ha (+/-)) does not have a major system outlet; the trunk storm sewer has been sized to convey the peak flow rate produced during the 100-year storm event. The total drainage area conveyed to this Barton Street outlet is 106.47 ha (+/-).

2.1.14. Winona Road (4+180 to 4+440)

A roadside ditch on the north side of Barton Street between Stations 4+180 and Station 4+300 (Winona Road) conveys runoff eastward to a 300 mm CSP inlet pipe that discharges to the 375 mm storm sewer conveyed northward on Winona Road. A roadside ditch on the north side of Barton Street between Stations 4+300 and Station 4+440 conveys runoff westward to a catch basin that discharges to the 375 mm storm sewer conveyed northward on Winona Road. The total drainage area conveyed to this Barton Street outlet is 0.69 ha (+/-).

2.1.15. Napa Lane (4+440 to 4+640)

A roadside ditch on the south side of Barton Street between Stations 4+460 and 4+650 discharges to a 600 mm concrete culvert at Station 4+570; the culvert discharges to a ditch inlet catch basin on the north side of the road where runoff is conveyed northward via the Napa Lane 525 mm storm sewer. A roadside ditch on the north side of Barton Street between Stations 4+440 and 4+540 discharges to a ditch inlet catch basin and to the Napa Lane 525 mm storm sewer. The total drainage area conveyed to this Barton Street outlet is 3.36 ha (+/-) which consists of 2.11 ha (+/-) of drainage area from Winona Park.

2.1.16. Foothills Lane (4+630 to 4+870)

The roadside ditches on the north side of Barton Street between Stations 4+630 and 4+870 discharge to two (2) ditch inlet catch basins located at the intersection with Foothills Lane at Station 4+700. The catch basins discharge to the 975 mm storm sewer on Foothills Lane. The roadside ditches on the south side of Barton Street between Stations 4+650 and 4+760 discharge to two (2) ditch inlet catch basins located at the intersection with Foothills Lane at Station 4+700. The catch basins discharge to the 975 mm storm sewer on Foothills Lane. The total drainage area conveyed to this Barton Street outlet is 2.86 ha (+/-) which consists of 2.19 ha (+/-) of drainage area from Winona Park.

2.1.17. Fifty Creek at Highway #8 (0+000 to 0+220)

Overland runoff is conveyed from Station 2+220 southward on Fifty Road to Station 0+075 where a ditch commences on the west side of the road. The west roadside ditch discharges to a 600 mm CSP culvert at Station 0+005, which traverses Fifty Road easterly to Fifty Creek. Major system flows will sheet flow from the roadway to the creek at the intersection with Highway #8. The total drainage area conveyed to this outlet at Fifty Road on the north side of Highway #8 is 6.52 ha (+/-).

2.1.18. Private Watercourse (Barton Street 4+760 to 5+110 and Fifty Road 0+220 to 0+430)

Roadside Ditches on the south side of Barton Street between Stations 4+760 and 5+100 discharge to three (3) culverts which are conveyed to the north Barton Street roadside ditch. One (1) 600 mm HDPE culvert is located at Station 4+900, one (1) 500 mm CSP culvert is located at Station 4+990, and one (1) 400 mm CSP culvert is located at Station 5+080.

The roadside ditches on the north side of Barton Street between Stations 4+870 and 5+110 discharge to the west roadside ditch on Fifty Road.

The Fifty Road roadside ditches between Stations 0+220 and 0+430 discharge to a 500 mm CSP culvert at Station 0+325. The culvert discharges to a private watercourse that conveys flow from a drainage area of 3.01 ha (+/-) to Fifty Creek.

2.1.19. Fifty Creek at CNR (0+430 to 0+650)

The east roadside ditch on Fifty Road between Station 0+430 and 0+650 discharges to the ditch on the south side of the CN rail corridor. The CN Rail corridor ditch is conveyed eastward to Fifty Creek.

2.1.20. South Service Road (0+400 to 0+770)

The west roadside ditch on Fifty Road between Station 0+400 and 0+650 discharges to the 900 mm CSP culvert that traverses the CN rail corridor northward. The 900 mm CSP culvert also conveys flow from the 3.07 ha (+/-) external drainage area west of Fifty Road. The culvert then discharges to a ditch on the north side of the CN rail corridor and to an 825 mm concrete storm sewer inlet. Drainage between Stations 0+650 and 0+750 is conveyed via catch basins to the 825 mm storm sewer which discharges at the north-east corner of the intersection with South Service Road to a roadside ditch.

The Foothills of Winona Phase 3 development has been proposed to discharge to the 900 mm CSP pipe. The proposed drainage catchments for this development have been incorporated into the PCSWMM model, however, the existing land use imperviousness values have been applied to the catchments.

2.2 Hydraulic Crossings

There are hydraulic crossings within the study area as per the following:

- Watercourse 5: 1.86 m by 1.035 m box culvert
- Watercourse 6: 1.25 by 1.4 concrete arch, 1.88 m by 1.31 m elliptical CSP
- Watercourse 6.1: 0.6 m diameter CSP
- Watercourse 7: 2.1m elliptical CSP and 1.0m CSP
- Watercourse 7.1: 0.95 m by 0.70 m box culvert and a 0.80 m CSP
- Watercourse 12 (Highway 8 Crossing): 3.50 m by 1. 25 m box culvert
- Watercourse 12 (Fifty Road Crossing): 3.50 m by 1.25 m box culvert

Discussion on culverts and upgrade requirements has been provided in Section 7.

2.3 Physiography and Soils

Surficial soils mapping GIS data has been provided by the City of Hamilton; the soil mapping provided by the City has been compared to the Ontario Base Soils Mapping (OBSM) (ref. Soil Survey Report 32 – Soils of Hamilton-Wentworth) to verify that the datasets are consistent. In order to further validate the surficial soils mapping, the data have been compared to selected borehole log data from Barton Street Geotechnical Report (Wood, March 2020); the boreholes advanced for the Geotechnical Report indicate that the Barton Street and Fifty Road ROWs consist of fill overlaid on Silty Clay Till.

The soil parameterization has been applied using the Green and Ampt infiltration methodology. Appropriate soil parameters for the hydraulic conductivity, suction head, and initial deficit have been applied from the User's guide to SWMM5, 13th Edition, based on the available soils mapping (ref. Appendix B). The soils mapping has been aerially weighted based on the subcatchment discretization.

2.4 Existing Conditions Hydrology

An integrated hydrologic/hydraulic model of the existing conditions of the Barton Street and Fifty Road R.O.W. has been developed in PCSWMM Version 7.0. The model has been discretized to assess each storm sewer section and roadside ditch to determine the Barton Street and Fifty Road drainage systems' level of performance.

The following items in relation to the selected parameters are important to note:

Subcatchments

- Impervious coverages for the external areas have been input as per City of Hamilton SWM Guidelines for land use runoff coefficients
- Impervious coverages for the Barton Street and Fifty Road ROWs have been directly measured from the available survey data
- The Manning's 'n' value assigned to impervious surfaces is 0.013;
- The Manning's 'n' value assigned to pervious surfaces is 0.25;
- The depression storage assigned to impervious surfaces is 1 mm and 5 mm for pervious surfaces

Storm Sewers

- The exit loss coefficients assigned to storm sewers are 0.15 to 1 respectively (reference U.S. Department of Transportation Federal Highway Administration Hydraulic Engineering Circular 22 – Urban Drainage Design Manual, September 2009);

- Exit loss coefficients have been applied to the culverts where necessary based on the HEC-RAS River Analysis System Hydraulic Reference Manual Version 5.0, (US Army Corps of Engineers, February 2016)
- The Manning's 'n' value assigned to asphalt road surfaces is 0.014. A typical industry standard for this parameter is 0.013 or 0.014; and
- The Manning's 'n' value assigned to ditches is 0.035 as they are typically manicured grass in the study area. A typical industry standard for this parameter could be as high as 0.045 for poorly manicured grass ditches.

In keeping with these values, the storm sewers and road surfaces added to the PCSWMM model were also assigned these values. Roadside ditches were also added to the PCSWMM model based on road plan and profiles and site reconnaissance. The existing conditions drainage boundaries developed for the PCSWMM model are presented in Figures 1 to 8 (ref. Appendix D).

The PCSWMM model has been executed using the City of Hamilton 6-hour Chicago design storms for the 2, 5, and 100-year storm events. The simulated results for existing conditions at the various minor and major system outlets for Barton Street and Fifty Road have been summarized within Tables 2.1.

Hydraulic conveyance performance criteria for the City of Hamilton storm sewers (minor system) and roadways (major systems) have been reviewed and summarized below:

Minor System

- Minimum depth of cover is 2.75 m
- Maximum capacity of the pipe is 85 % during the 5-year storm event
- Minimum velocity is 0.75 m/s
- Maximum velocity is 3.65 m/s
- Maximum spacing of manholes is 120 m
- Minimum pipe size is 300 mm

Major System

- Urban arterial/emergency routes must have 0 mm depth of flow above the road crown during the 100-year storm event.

Table 2.1. Existing Conditions Peak Flow Rates

Drainage Outlet	Road Stations	Drainage Area (ha)	2 Year (m^3/s)			5 Year (m^3/s)			100 Year (m^3/s)		
			Major	Minor	Total	Major	Minor	Total	Major	Minor	Total
Watercourse 5 - West (east of Fruitland Road)	0+000 to 0+325	1.77	-	0.28	0.28	-	0.40	0.40	-	0.68	0.68
Sunnyhurst Avenue	0+325 to 0+610	27.75	0.12	0.51	0.63	0.17	0.58	0.76	0.71	0.83	1.54
Kenmore Avenue	0+570 to 0+890	13.41	0.08	0.35	0.43	0.12	0.52	0.64	0.23	0.79	1.03
Jones Road	0+835 to 0+890	0.10	0.02	-	0.02	0.02	-	0.02	0.05	-	0.05
Watercourse 5 - East (east of Jones Road)	0+890 to 1+420	31.20	-	0.59	0.59	-	1.02	1.02	-	2.48	2.48
Watercourse 6 (west of Glover Road)	1+420 to 1+780	19.50	0.24	-	0.24	0.35	-	0.35	0.77	-	0.77
Glover Road	1+780 to 1+940	3.61	0.11	-	0.11	0.17	-	0.17	0.34	-	0.34
Watercourse 7 - West	1+940 to 2+160	1.28	-	0.39	0.39	-	0.63	0.63	-	1.00	1.00
Watercourse 7 - East	2+160 to 2+425	15.65	-	0.06	0.06	-	0.21	0.21	-	0.67	0.67
McNeilly Road	2+380 to 2+660	30.42	0.00	0.42	0.42	0.02	0.48	0.50	0.99	0.56	1.55
Lewis Road (Watercourse 9 - West)	2+610 to 3+760	160.26	1.78	-	1.78	3.95	-	3.95	11.10	-	11.10
Watercourse 9 - East	3+760 to 4+140	13.50	0.55	-	0.55	0.80	-	0.80	2.60	-	2.60
West Avenue	4+030 to 4+450	106.47	-	3.84	3.84	-	6.16	6.16	-	11.51	11.51
Winona Road	4+180 to 4+440	0.69	0.00	0.11	0.11	0.00	0.16	0.16	0.02	0.24	0.25
Napa Lane	4+440 to 4+640	3.36	-	0.23	0.23	-	0.40	0.40	-	0.72	0.72
Foothills Lane	4+630 to 4+870	2.86	-	0.14	0.14	-	0.27	0.27	-	0.67	0.67
Fifty Road - Private Watercourse	4+760 to 5+110 (Barton St.) & 0+220 to 0+430 (Fifty Rd.)	5.89	0.23	-	0.23	0.32	-	0.32	1.03	-	1.03
Fifty Creek at Hwy #8	0+000 to 0+220 (Fifty Rd.)	6.52	0.00	0.67	0.67	0.29	0.85	1.14	1.36	1.01	2.37
Fifty Creek at CNR	0+430 to 0+650 (Fifty Rd.)	0.22	0.03	-	0.03	0.05		0.05	0.09	-	0.09
South Service Road	0+400 to 0+770 (Fifty Rd.)	5.32	0.02	0.36	0.38	0.03	0.59	0.62	0.06	1.12	1.18
Fifty Creek at 900 mm CSP	0+400 to 0+650 (Fifty Rd.)	3.35	-	0.15	0.15	-	0.28	0.28	-	0.75	0.75

3. Stormwater Objectives

3.1 Stormwater Management Design Criteria

The stormwater management and hydraulic analyses of the Barton Street and Fifty Road improvements will consider stormwater management design criteria from several agencies including; the City of Hamilton, Hamilton Conservation Authority, the Ministry of Transportation (MTO), the Ministry of Natural Resources and Forestry (MNRF), and the Ministry of Environment, Conservation and Parks (MECP). The stormwater management and hydraulic criteria relevant to the Barton Street and Fifty Road improvements are outlined in the following sections.

The City of Hamilton - Guidelines

- *Minor System:* Storm sewers are to convey the 5-year storm event at 85 % capacity, and are to be designed using City of Hamilton IDF information;
- *Major System:* R.O.W.s, including both urban and rural, are to convey flows generated by the R.O.W. itself, up to the 100-year storm event; and
- Flow depth or flooding depth on roads not to exceed the road centreline.

The City of Hamilton SCUBE East Subwatershed SWM Guidelines

- Groundwater recharge for areas of sand/gravel: 3 mm over the catchment area (residential land uses)
- Groundwater recharge for areas of silty/clay soils: 1.5 mm (residential land uses) and 3 mm (commercial/institutional land uses) over the catchment area
- Wet ponds required for catchment areas > 5 ha and traditional source controls for catchment areas < 5 ha
- Level 2 (normal) water quality control
- Overcontrol of events up to a 2-year storm event for erosion control
- Post-to-pre runoff flood control
- Lands draining directly to the lines channel of Watercourse 9 are exempt from erosion and flood control.

The City of Hamilton SCUBE West Subwatershed SWM Guidelines

- Groundwater recharge for areas of sand/gravel: 2.5 mm over the catchment area (residential land uses)
- Groundwater recharge for areas of silty/clay soils: 1 mm (residential land uses) and 2.5 mm (commercial/institutional land uses) over the catchment area
- Wet ponds required for catchment areas > 5 ha and traditional source controls for catchment areas < 5 ha
- Level 2 (normal) water quality control
- Overcontrol of events up to a 2-year storm event for erosion control
- Post-to-pre runoff flood control

Hamilton Conservation Authority

- *Quantity Control:* Post to pre-development quantity control
- *Quality Control:* MECP Normal Level (Level 2) Water Quality Control for the increase in pavement area. A treatment train solution is recommended when feasible;
- *Erosion Control:* 25 mm for the increase in pavement area as per the 2003 MOE SWM Guidelines or identified values as per the SCUBE West/East Subwatershed Studies

The Ministry of Transportation

- Culverts crossing beneath roads classified as Urban Arterial, with a span less than 6.0 m, are to convey the peak flow generated from a 50-year storm event; and
- Culverts crossing beneath roads classified as Urban Arterial, with a span greater than 6.0 m, are to convey the peak flow generated from a 100-year storm event.
- Culverts crossing beneath roads classified as Urban Arterial are required to provide a freeboard greater than or equal to 1.0 m for the 100-year storm.

The Ministry of Natural Resources and Forestry

- MNRF's vehicle ingress and egress requirements (Technical Guide – River and Stream Systems: Flooding Hazard Limit, 2002),

The Ministry of Environment, Conservation and Parks

- *Quality Control:* MECP Normal Level (Level 2) Water Quality Control for the increase in pavement area. A treatment train solution is recommended when feasible;
- *Erosion Control:* 25 mm for the increase in pavement area as per the 2003 MOE SWM Guidelines or overcontrol of the 2-year storm event as per the SCUBE East/West Subwatershed Studies

4. Future Conditions

4.1 Future Conditions Storm Drainage

Barton Street and Fifty Road improvements would consist of urbanization of rural road sections with curb and gutter, revisions to intersections, adding a 3 m multi-use trail (MUT) on the south side of the road, a 4 m wide promenade between the MUT and the private property on the south side of the road, a 1.5 m sidewalk on the north side of the road, and modifications to the road profile. The proposed Barton Street ROW cross section will typically be 36 m or 40 m wide while the proposed Fifty Road ROW cross sections will be 30 m wide.

Future conditions storm drainage boundaries are presented in Figures 9 to 16 (ref. Appendix D). To determine the impacts of the widening works, the PCSWMM model developed for existing conditions (as per Section 2.4) has been modified to represent future conditions storm drainage (without stormwater management). The revised ROW and the revised impervious values as per the proposed design have been input into the PCSWMM model.

The proposed Block 3 development has been reviewed and incorporated into the PCSWMM model for the proposed conditions scenario. The aspects of the development that have been included are the proposed subcatchments, storm sewers, and stormwater management facilities. Furthermore, the lined channel at the north-west corner of Barton Street and Lewis Road have also been incorporated into the PCSWMM model.

The proposed Block 2 development has not been included within the existing or proposed conditions model as it has been determined that the proposed development will not discharge to Barton Street, rather to will discharge directly to Watercourse 5 - East (east of Jones Road) and Watercourse 6 (west of Glover Road).

The existing drainage areas at the proposed Block 1 development have not been revised. It is understood that this development plan has not been approved by the City. Project information for this development has been reviewed and it is understood that the central portion of the development will discharge to Sunnyhurst Avenue, while the eastern portion of the development will have source controls and potentially discharge directly to Watercourse 5 - East (east of Jones Road). Conveying these catchments to Watercourse 5 - East (east of Jones Road) within the PCSWMM model without controls would artificially increase the proposed conditions peak flow rates to be mitigated on Barton Street. As such, the subcatchments Ext 10, Ext12, Ext14, Ext16_1 and Ext16_2 have been conveyed to a dummy node, to be excluded from the proposed conditions peak flow rates to be mitigated to the existing conditions targets.

Storm sewer design sheets have been used to size the storm sewers for the study area as per the City of Hamilton guidelines (ref. Appendix B). Table 4.1 presents the proposed conditions peak flow rates with a comparison to the existing conditions peak flow rates for the 2, 5, and 100-year design storm events.

In summary, the proposed storm sewer system does not surcharge, for the 5-year storm event as required by the City of Hamilton. However, peak flow rate increases for the 2, 5, and 100-year design storm events have been simulated at selected outlets that require mitigation to the meet the City of Hamilton SCUBE Subwatershed design criteria. Furthermore, several low points (road sags) have been identified within the ROW where the hydraulic capacity to convey the 100-year storm event does not meet the major system performance criteria for 0 mm of flow at the road crown. The peak flow rate increases, and the major system performance deficiencies are due to the following factors:

- Increase in the ROW imperviousness
- Redirection of external drainage areas to adjacent outlets due to the regrading the of the road profile

- Poor performance of the existing drainage system (flooding within the ROW) has been mitigated to provide outlets for attenuated flows which are now conveyed to sags within the ROW.

Stormwater management quantity controls are required to address the peak flow rate increases and mitigate the major system performance.

Table 4.1. Uncontrolled Proposed Conditions Peak Flow Rate Comparison

Drainage Outlet	Road Stations	Drainage Area (ha)	Existing Conditions Total Peak Flow Rates (m³/s)			Uncontrolled Proposed Conditions Peak Flow Peak Flow Rates (m³/s)														
						2 Year					5 Year					100 Year				
			2 Year	5 Year	100 Year	Major	Minor	Total	Total Difference (m³/s)	Total Difference (%)	Major	Minor	Total	Total Difference (m³/s)	Total Difference (%)	Major	Minor	Total	Total Difference (m³/s)	Total Difference (%)
Watercourse 5 - West (east of Fruitland Road)	0+000 to 0+325	1.85	0.28	0.40	0.68	-	0.27	0.27	-0.01	-3.2	-	0.39	0.39	-0.02	-3.8	-	0.67	0.67	-0.01	-1.4
Sunnyhurst Avenue	0+325 to 0.820	29.04	0.63	0.76	1.54	0.00	0.82	0.82	0.19	30.7	0.01	1.30	1.30	0.55	72.6	0.10	2.15	2.25	0.71	46.0
Kenmore Avenue		0.78	0.43	0.64	1.03	0.04	0.03	0.07	-0.37	-84.3	0.07	0.04	0.11	-0.53	-83.2	0.16	0.06	0.22	-0.81	-78.4
Jones Road		0.00	0.02	0.02	0.05	0.01		0.01	-0.01	-66.7	0.01		0.01	-0.02	-67.3	0.02		0.02	-0.03	-66.4
Watercourse 5 - East (east of Jones Road)	0.820 to 1+420	34.49	0.59	1.02	2.48	-	0.81	0.81	0.21	35.8	-	1.43	1.43	0.41	40.5	-	3.38	3.38	0.90	36.3
Watercourse 6 (west of Glover Road)	1+420 to 1+770	2.12	0.24	0.35	0.77	0.33	-	0.33	0.08	34.7	0.43	-	0.43	0.08	21.9	0.66	-	0.66	-0.11	-13.8
Glover Road		0.00	0.11	0.17	0.34	0.01	-	0.01	-0.10	-93.1	0.01	-	0.01	-0.16	-92.9	0.02	-	0.02	-0.31	-92.7
Watercourse 7 - West	1+770 to 2+110	5.00	0.39	0.63	1.00	-	0.44	0.44	0.05	11.4	-	0.84	0.84	0.21	32.6	-	1.48	1.48	0.47	47.2
Watercourse 7 - East	2+110 to 2+460	14.95	0.06	0.21	0.67	-	0.22	0.22	0.16	252.1	-	0.39	0.39	0.18	83.6	-	0.92	0.92	0.24	36.2
McNeilly Road	2+460 to 2+605	2.12	0.42	0.50	1.55	0.02	0.40	0.42	0.00	0.5	0.03	0.49	0.52	0.02	4.8	0.09	0.66	0.74	-0.80	-51.8
Lewis Road (Watercourse 9 - West)	2+605 to 4+030	203.35	1.78	3.95	11.10	1.94	-	1.94	0.16	9.2	3.17	-	3.17	-0.78	-19.8	7.81	-	7.81	-3.29	-29.6
West Avenue	4+030 to 4+430	106.75	3.84	6.16	11.51	0.10	3.68	3.77	-0.06	-1.7	0.15	5.83	5.98	-0.18	-3.0	0.28	12.15	12.43	0.92	8.0
Winona Road	4+315 to 4+430	0.29	0.11	0.16	0.25	0.01	0.06	0.06	-0.05	-41.5	0.01	0.08	0.10	-0.07	-40.5	0.15	0.18	0.33	0.08	30.0
Napa Lane	4+430 to 4+610	2.30	0.23	0.40	0.72	0.08	0.15	0.22	-0.01	-3.6	0.14	0.20	0.34	-0.06	-14.5	0.34	0.34	0.68	-0.05	-6.4
Foothills Lane	4+610 to 4+815	4.21	0.14	0.27	0.67	0.00	0.15	0.15	0.02	12.0	0.01	0.28	0.29	0.02	6.9	0.06	0.68	0.75	0.08	11.8
Fifty Road at Hwy #8	0+000 to 0+220 (Fifty Rd.)	6.26	0.67	1.14	2.37	0	0.66	0.66	-0.01	-1.5	0.07	1.04	1.10	-0.03	-2.8	0.92	1.35	2.28	-0.09	-3.7
Fifty Road at CNR	0+585 to 0+645 (Fifty Rd.)	0.08	0.03	0.05	0.09	0.01	-	0.01	-0.02	-58.0	0.02	-	0.02	-0.03	-57.3	0.35		0.35	0.26	307.6
South Service Road	4+815 to 5+112 (Barton St.) & 0+220 to 0+770 (Fifty Rd.)	11.66	0.38	0.62	1.18	0.00	0.75	0.75	0.37	98.8	0.00	1.28	1.28	0.66	107.2	0.37	1.77	2.14	0.96	80.8
Fifty Road at 900 mm CSP	4+815 to 5+112 (Barton St.) & 0+220 to 0+645 (Fifty Rd.)	9.66	0.15	0.28	0.75	-	0.59	0.59	0.43	288.1	-	1.03	1.03	0.74	261.2	-	1.49	1.49	0.73	97.2

5. Stormwater Management Opportunities

5.1 General Stormwater Management Opportunities

Stormwater Management practices (SWMPs) for the management of roadway runoff generally fall into two categories: those that address stormwater quantity (including erosion) and those that manage the stormwater quality of surface runoff. In addition, Low Impact Development (LID) best management practices (BMPs) are designed to provide water quality treatment and quantity control for smaller, more frequent storm events (i.e. typically up to and including the 25 mm storm event).

Stormwater quantity management issues relate to the proper sizing of minor (sewer) and major (overland flow) conveyance systems for roadway runoff. In addition, stormwater quantity management strategies can include the need for facilities to address downstream flow constraints and erosion potential from alterations of the roadway right-of-way. Based on Barton Street and Fifty Road contributing to the Stoney Creek watercourses, quantity controls are required for the creek systems to reduce or maintain existing peak flows. As multiple sections of Barton Street and Fifty Road have rural cross-sections, new storm sewer systems will be required. Upgrades to existing deficient storm sewer systems will also be required.

In terms of stormwater quality, the SWMPs relate to the treatment of new pavement. Typically, the treatment level is related to the standards defined in a watershed or subwatershed planning study, which are dependent on the quality and sensitivity of the receiving stream system (i.e. Type 1, Type 2, etc.). Barton Street and Fifty Road drainage discharge requires Normal (Level 2 – 70% average annual TSS (total suspended solids) removal) stormwater quality controls.

As noted within Section 3.1, erosion control to each watercourse as defined by the East and West SCUBE Subwatershed Studies requires that the 2-year design storm event be over-controlled.

Lastly, water balance criteria must be met for the study as per the East and West SCUBE Subwatershed Studies; the noted groundwater recharge depths can be addressed with source controls. Various best management practices or stormwater management practices are available to address both the quantity and quality of runoff from roadways. Due to the linear nature of roadway corridors, however, not all stormwater management practices are considered to be appropriate.

5.1.1 Alternative Stormwater Management Practices

Quantity Management (Flood and Erosion Control)

Quantity control impacts, in this case erosion due to increased runoff from existing hard surfaces including MUTs, promenades, sidewalk and intersection improvements, can typically be mitigated by on-site storage and infiltration techniques and/or off-site mitigation measures, such as regulation or stream stabilization.

For the current project, flood and erosion controls are required to address peak flow rate increases from existing conditions. The expected focus is therefore on storage and infiltration-based techniques.

Quality Management

There are numerous stormwater management practices which can be used to treat contaminated stormwater runoff from roadway surfaces. These include the following:

i. Wet ponds/wetlands/hybrids (generally linear facilities)
ii. Enhanced grass swales
iii. Filter strips

iv. Oil and grit separators
v. Off-site stormwater management facilities (existing, retrofitted and/or proposed)
vi. Catch basin shields
vii. LID BMPs – (Bioretention systems, permeable pavement and other infiltration systems)

The respective characteristics, advantages and disadvantages of the foregoing have been well documented in existing Municipal and Provincial literature and hence this information has not been repeated within this document. Some brief advantages and disadvantages, though, are discussed in the following.

5.1.2 General Assessment

The advantages and disadvantages of the various Best Management Practices associated with both quantity and quality control measures are as follows:

Erosion Control

Controlling runoff in stormwater management facilities requires land and future management/ maintenance by municipal staff. The advantages related to maintaining the existing sizing of drainage infrastructure or smaller infrastructure across the roadway, as well as downstream. Disadvantages include the cost of land, infrastructure and maintenance. Increasing the size of drainage infrastructure, while somewhat more costly to the municipality, reduces the need for future maintenance and eliminates the need for the dedication of stand-alone land for surface controls. Inter-subcatchment diversions can be effective on a minor scale in optimizing and/or reducing the number of crossings and are typically followed to address both major and minor runoff conditions.

For erosion control, on-site measures to reduce peak flow impacts can be highly constraining due to the general lack of properly configured land. Roadway corridors, due to their inherent linear nature, can only effectively manage relatively small volumes of increased runoff (peak flows), in the absence of stand-alone land acquisition. Combination of measures to mitigate impacts through some on-site storage, along with off-site upgrades as necessary, is often the 'best' approach, where impacts exceed allowable minimums that said, Barton Street and Fifty Road currently do not drain to any stormwater management facilities.

The following erosion controls have been screened from further consideration due to the reason provided herein:

i. Wet ponds/wetlands/hybrids

Constructing a new wet pond, wetland or hybrid pond is not feasible within Barton Street and Fifty Road right of way based on space constraints. As such this alternative has not been considered further.

ii. Super Pipe Storage

Super pipe storage would require either upgrading existing storm sewers to a larger storm sewer, or sizing a new sewer capable of storing additional runoff to meet erosion control targets. Super pipe storage is one of the costliest methods of providing underground storage. However, due to spatial constraints within the ROW and the requirement to overcontrol the 2-year design storm event, this form of mitigation alternative has been advanced for further consideration.

iii. Conventional Underground Storage (Concrete Tanks)

Conventional underground storage for Barton Street and Fifty Road would require multiple concrete tanks (tanks on either side of the creeks). The concrete tanks would be connected to the downstream end of the proposed storm sewers to maximize the contributing drainage area to the storage elements.

Underground concrete tanks are considered costly to implement. In addition, conventional underground tanks do not filter or infiltrate captured runoff. As such conventional underground storage (concrete) tanks have been screened for further consideration.

iv. Conventional Underground Storage (Cellular Systems)

Notwithstanding the preceding, more cost-effective underground storage systems could be considered to achieve erosion control requirements. This includes cellular type tank systems such as Stormcon™, Brentwood™, Cultec™, or Triton™ systems.

v. Low Impact Development Best Management Practices (LID BMPs)

Low Impact Development Best Management Practices (LID BMPs) can address erosion control requirements by retaining and infiltrating stormwater runoff for more frequent storm events, which are typically those of concern for erosion impacts. These options have been discussed further in the subsequent section with respect to quality control, however, are considered a feasible alternative for erosion control as well.

Quality Control

i. Wet ponds, Wetlands, Hybrids

These systems generally require the dedication of land that most often is not available in linear corridors for roadway projects. Most often when applied to roadway runoff, these SWMPs are located adjacent to creek crossings of roads. Typically, these systems provide an excellent level of treatment and as end-of-pipe systems, the management and performance is more visible, hence less prone to failure. For Barton Street and Fifty Road this particular opportunity is considered impractical due to lack of available land.

ii. Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways. It is generally conceded that treatment levels are at a minimum, Normal (formerly Level 2) 70% TSS removal water quality treatment, and combined with other practices can provide Enhanced (Level 1) 80% TSS removal stormwater quality treatment. Their application in linear corridors is also particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage. Their application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself, and are therefore typically not preferred in those cases. Notwithstanding, gutter outlets along outside lanes have been demonstrated to function effectively where the right-of-way can accommodate the design. Based on the proposed Barton Street and Fifty Road ultimate urbanized road ROW and spatial constraints, enhanced grassed swales may not be considered the preferred stormwater quality treatment measure; however enhanced grass swales could be strategically placed within the Fifty Road corridor where sufficient area is available to provide potential attenuation and infiltration of runoff and have been carried forward for further consideration.

iii. Filter Strips

Filter strips are typically designed for small drainage areas (less than 2 ha +\-) and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event. Based on the limited space within the Barton Street and

Fifty Road West ROW, filter strips are not considered a practical stormwater quality solution and have been screened for further consideration.

iv. Oil and Grit Separators (OGS)

These end-of-pipe systems tend to service smaller drainage areas (2 ha +/-) and provide varying levels of stormwater quality treatment depending on the model selected. OGS units are typically encouraged as part of a "treatment train" approach; many municipalities and regulators will not credit the full TSS removal function of OGS units accordingly (i.e. typical maximum credit of 50% to 70% TSS removal). Disadvantages include the need for frequent maintenance, as well as relatively high capital costs and the ability to service smaller drainage areas. As a pre-treatment approach for other stormwater quality measures, or for providing water quality treatment for pavement areas greater than the proposed additional paved areas, oil and grit separators have been carried forward for further consideration.

v. Off-Site Stormwater Management Facilities

While facilities can often not be constructed within roadway right-of-way lands, roadway runoff can be directed towards existing and proposed subdivisions, which would have their runoff managed by future stormwater management facilities. It is anticipated that the section of Barton Street between McNeilly Road and Tuscani drive will be serviced by two (2) stormwater management facilities that will be implemented as part of the Block 3 development lands. As such this alternative has been advanced for further consideration.

vi. Catch Basin Shields

Catch basin (CB) shields are the application of a catch basin insert to shield accumulated sediment in the catch basin sump from resuspension and washout. The CB shields can increase TSS capture by up to 50 % as shown in Environmental Technology Verification (ETV) testing. The application of CB shields is not to be applied as a stand-alone treatment approach, however, can be combined with other treatment technologies to mitigate water quality. Implementation costs would be comparatively low to other forms of water quality treatment and frequent maintenance would be required to remove accumulated sediment from the catch basin sump to ensure acceptable long-term performance. City of Hamilton Staff have noted that permeable catch basin shields have not been vetted for use within City projects due to life cycle costs and operation and maintenance issues; catch basin shields have been screened from further consideration.

vii. Low Impact Development Best Management Practices

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

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

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. The Toronto and Region Conservation Authority and Credit Valley Conservation have produced the 2010 Low Impact Development Stormwater Management Manual, for the design and application of LID measures, which is used by Conservation Halton. Various LID techniques, as well as their function that are applicable to road projects, are summarized in Table 5.1, not including grassed swales and filter strips which have already been screened as appropriate SWM measures for Barton Street and Fifty Road.

Table 5.1. LID Source and Conveyance Controls

Technique	Function
Bio-retention Cell	▶ Vegetated technique for filtration of storm runoff ▶ Storm water quality control provided through filtration of runoff through soil medium and vegetation ▶ Infiltration/ evapotranspiration/ water balance maintenance and additional erosion control may be achieved if no subdrain provided
Infiltration Trenches	▶ Infiltration technique to provide storm water quality control and maintain water balance ▶ Erosion controls may be achieved depending upon soil conditions
Permeable Pavers/Pavement	▶ Infiltration technique to reduce surface runoff volume ▶ Benefits to storm water quality and erosion control are informal
Pervious Pipes	▶ Technique to reduce storm runoff through the implementation of perforated pipes as part of the storm sewer system (typically a separate lower perforated pipe, with the conventional storm sewer as the "overflow")) ▶ Promotion of infiltration maintains water balance and provides storm water quality and erosion control benefits

Bioretention Systems

Bioretention systems provide effective removal of pollutants by sedimentation, filtering, soil adsorption, microbial processes and plant uptake. Bioretention systems should be approximately 10 to 20% in size of the contributing drainage area, with typical drainage areas of 0.50 ha and a maximum drainage area of 0.8 ha. Slopes within Bioretention systems are typically 1 % to 5 %. Bioretention systems are preferred in areas that have reasonable infiltration properties (15 mm/ hr, $1x10^{-6}$ cm/s), but can be implemented in all soil types as long as the water quality event can be temporarily stored (typical depths 0.15 m to 0.25 m) before infiltrating and an underdrain is provided.

Bioretention systems could be added as an infiltrative LID BMP at specific locations or as supplemental SWM control beyond requirements such as at Station 1+500 near Bronte Athletic Park. The bioretention systems should have forebays for a form of surface water pre-treatment (ref. Figure 16). Catch basins fitted with goss traps should also be used to filter out floatable debris before directing runoff to the infiltrative component of the bioretention system. City of Hamilton Staff have indicated that the bioretention cells are not favourable as they require regular maintenance and additional landscape features. Bioretention systems have been screened from further consideration.

Infiltrative Trenches

Infiltrative Trenches could be implemented as they are similar to bioretention systems but could be positioned not only within the 2 m wide landscaped areas but under the proposed 3 m wide multiuse pathway. All catchbasins should be fitted with goss traps to filter floatable debris. The infiltration trench could be designed to capture the 25 mm storm event with no discharge by setting the overflow to the storm sewer system above the 25 mm storm event capture storage depth. City of Hamilton Staff have noted that should infiltration trenches be applied, they would require pre-treatment for road drainage prior to infiltrating runoff into the groundwater table. Infiltrative Trenches have been carried forward for further consideration.

Silva Cells

Silva Cells are modular suspended paved systems with a cellular soil storage system providing structural support and allows for overland road and pavement drainage to be captured and infiltrated within the cellular soil storage system. Trees are planted within the cellular soil storage system which also use the collected drainage and provide evapotranspiration. Silva cells can be used in confined spaces within urban environments and provide additional stormwater quality benefits. Siva Cells would not be considered to be a standalone water quality measure. Silva Cells have been carried forward for further consideration.

Permeable Pavers/Pavement

Permeable pavement could be used either for the entire length or for sections of the proposed 3 m wide multi-use trail. As a standalone LID BMP, a permeable paved multiuse path would not meet either stormwater quality and/or erosion control targets as it would treat a limited area, and would not treat the roadway itself (which would be expected to generate the highest contaminant loadings). However, a permeable MUP would reduce the runoff volume from paved surfaces within the urban road ROW. This LID BMP would have to be selected by the City to complement other SWM measures during the detailed design stage for road sections that would incur increased roadway pavement area in addition to the proposed MUT and sidewalk. City of Hamilton Staff have noted that permeable pavers/pavement have not been vetted for use within City projects due to life cycle costs and operation and maintenance issues. Permeable Pavers/ Pavement has been screened from further consideration.

Pervious Pipes

Pervious pipes could be used in combination with either bioretention systems or infiltration trenches. As a standalone SWM measure, pervious pipes can be a cost-effective and relatively simple method to accomplish erosion control and infiltration requirements, while eliminating the need for surface space within the right-of-way. Pervious pipes have been carried forward for further consideration.

Based on the foregoing, the following erosion, infiltration and water quality controls have been short-listed:

- Enhanced Grass Swales
- Oil and Grit Separators
- Infiltration Trenches
- Silva Cells
- Pervious Pipes (used with infiltration trenches)

The LID BMPs identified in Section 5.1.2 for water quality control may therefore also be implemented to address the SCUBE East and West source control targets noted within Section 3.1. Based on the foregoing, the following infiltration practices have been short-listed:

- Enhanced Grass Swales
- Infiltration Trenches
- Silva Cells
- Pervious Pipes (used with infiltration trenches)

The following figures illustrate typical examples of the recommended LID BMP source controls:

Figure 5.1 Enhanced Grass Swale (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.2 Enhanced Grass Swale (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.3 Infiltration Trench Construction (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.4 Silva Cell Construction (www.smartcitiesdive.com, 2020)

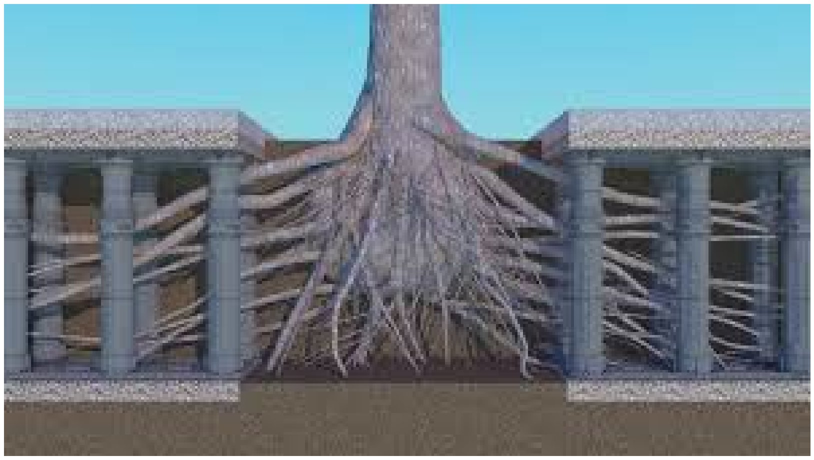


Figure 5.5 Silva Cell Cross Section (info.cambrianrisevt.com, 2020)

6. Short-Listed Drainage System and Stormwater Management Alternatives Assessment

6.1 Quantity Controls

The proposed road drainage and stormwater management requirements have been assessed. The drainage system assessment has included the following:

i. New storm sewers have been implemented to provide conveyance and storage at most of the identified outlet locations. Considerable storage is required at selected outlets due to the lack of the major system outlet for the 100-year storm event, redirection of major system flow to an alternative location (due to the regrading of the Barton Street road profile). Storage has been provided to both mitigate surface flooding and provide controlled discharge flow rates to the receiving outlets.
ii. Resizing existing sewer systems to convey the future conditions peak flow rates. Storm sewers have been sized to convey the 5-year storm event unsurcharged. Where proposed upgraded Barton Street and Fifty Road R.O.W. storm sewers connect to downstream storm sewer systems located not within the Barton Street and Fifty Road R.O.W. that hydraulically constrain and impact the upstream storm sewer system, an effort has been made to reduce the hydraulic impact of the receiving downstream system to the extent possible. There are limited locations where this would apply due to the nature of the existing rurally serviced drainage system.
iii. Downstream receiving systems have been upgraded to the extent considered feasible to remove hydraulic constraints on the Barton Street and Fifty Road storm sewer system.
iv. Several road sections of concern have been identified due to the prediction of existing flooding at road sags; these locations include west of the Barton Street intersection with Sunnyhurst Avenue, west of the Barton Street intersection with Fifty Road, and the sag at the private watercourse on Fifty Road. To reduce flooding within the identified sag locations, additional catch basins have been implemented where the runoff can be conveyed to the super pipes for storage and release at a controlled rate.
v. Road grades have been based on the proposed road plan.

Details of minor system upgrades and revisions for each have been provided in Tables 6.1. The existing and proposed storm sewer sizes have been provided, with sewer location depicted by road Stations within the table and on the proposed subcatchment plans (ref. Figures 9 to 16). Surcharging of the proposed storm sewer system does occur for some of the sewer sections during the 100-year storm event; however, the proposed surcharging does not exceed the manhole rim elevation. Two (2) locations that will need evaluation further during detailed design are:

- The section of Barton Street between Stations 0+320 and 0+820 requires considerable storage to mitigate the proposed peak flow rates and the potential for flooding within the ROW during the 100-year storm event. Based on preliminary documentation for Block 1, Kenmore Avenue is not be used for discharging storm flows; as such all proposed flow from this area of Barton Street is conveyed to Sunnyhurst Avenue. Post-to-predevelopment peak flow rate targets for Barton Street and Block 1 should be validated to optimate the required storage.
- The section of Barton Street and Fifty Road between Stations 4+850 and 5+110 on Barton Street Stations 0+220 and 0+800 on Fifty Road requires considerable storage due to the redirection of drainage from the private watercourse to the outlet at South Service Road and the mitigation of the surface flooding at the sag on Barton Street at Station 5+000. Post-to-pre development peak flow rate targets for South Service should be validated to optimate the required storage.

Table 6.1. Controlled Proposed Conditions Peak Flow Rate Comparison

Drainage Outlet	Road Stations	Drainage Area (ha)	Existing Conditions Total Peak Flow Rates (m^3/s)			Proposed Conditions Peak Flow Peak Flow Rates (m^3/s)														
						2 Year					5 Year					100 Year				
			2 Year	5 Year	100 Year	Major	Minor	Total	Total Difference (m^3/s)	Total Difference (%)	Major	Minor	Total	Total Difference (m^3/s)	Total Difference (%)	Major	Minor	Total	Total Difference (m^3/s)	Total Difference (%)
Watercourse 5 - West (east of Fruitland Road)	0+000 to 0+325	1.85	0.28	0.40	0.68	0	0.26	0.26	-0.02	-7.3	0	0.36	0.36	-0.04	-9.7	0	0.66	0.66	-0.02	-3.0
Sunnyhurst Avenue	0+325 to 0.820	29.04	0.63	0.76	1.54	0.01	0.46	0.47	-0.16	-25.8	0.01	0.69	0.70	-0.06	-7.4	0.02	1.47	1.49	-0.05	-3.1
Kenmore Avenue		0.78	0.43	0.64	1.03	0.03	0.02	0.05	-0.38	-88.1	0.05	0.03	0.08	-0.56	-87.5	0.12	0.05	0.16	-0.86	-84.0
Jones Road		0.00	0.02	0.02	0.05	0	-	0.00	-0.01	-86.0	0	-	0.00	-0.02	-85.5	0.01		0.01	-0.04	-84.4
Watercourse 5 - East (east of Jones Road)	0.820 to 1+420	34.49	0.59	1.02	2.48	0	0.50	0.50	-0.09	-15.4	0	0.91	0.91	-0.11	-10.5	0.13	2.34	2.47	-0.01	-0.5
Watercourse 6 (west of Glover Road)	1+420 to 1+770	2.12	0.24	0.35	0.77	0.23	-	0.23	-0.01	-5.6	0.30	-	0.30	-0.05	-15.1	0.43		0.43	-0.34	-44.7
Glover Road		0.00	0.11	0.17	0.34	0	-	0.00	-0.11	-96.7	0.01	-	0.01	-0.16	-96.3	0.01		0.01	-0.32	-95.8
Watercourse 7 - West	1+770 to 2+110	5.00	0.39	0.63	1.00		0.38	0.38	-0.02	-4.4	-	0.54	0.54	-0.09	-14.8		0.99	0.99	-0.01	-0.8
Watercourse 7 - East	2+110 to 2+460	14.95	0.06	0.21	0.67		0.05	0.05	-0.01	-17.1	-	0.14	0.14	-0.07	-33.4		0.66	0.66	-0.01	-1.8
McNeilly Road	2+460 to 2+605	2.12	0.42	0.50	1.55	0.02	0.39	0.41	-0.01	-1.4	0.05	0.47	0.52	0.02	3.9	0.13	0.70	0.84	-0.71	-45.8
Lewis Road (Watercourse 9 - West)	2+605 to 4+030	203.35	1.78	3.95	11.10	2.64	-	2.64	+0.87	+48.6	4.35	-	4.35	0.40	10.1	9.54		9.54	-1.57	-14.1
West Avenue	4+030 to 4+430	106.75	3.84	6.16	11.51	0.01	3.76	3.78	-0.06	-1.6	0.03	6.04	6.07	-0.09	-1.5	0.08	12.11	12.19	0.68	5.9
Winona Road	4+315 to 4+430	0.29	0.11	0.16	0.25	0	0.05	0.06	-0.05	-47.5	0.01	0.08	0.09	-0.07	-43.8	0.10	0.18	0.28	0.03	11.5
Napa Lane	4+430 to 4+610	2.30	0.23	0.40	0.72	0.08	0.15	0.23	0	0	0.15	0.21	0.37	-0.03	-7.5	0.35	0.34	0.69	-0.03	-4.1
Foothills Lane	4+610 to 4+815	4.21	0.14	0.27	0.67	0	0.13	0.14	0	-2.3	0.01	0.24	0.25	-0.02	-6.0	0.08	0.64	0.72	0.05	6.9
Fifty Road at Hwy #8	0+000 to 0+220 (Fifty Rd.)	6.26	0.67	1.14	2.37	0	0.66	0.66	-0.01	-1.5	0	1.04	1.04	-0.10	-8.9	0.74	1.53	2.27	-0.09	-3.9
Fifty Road at CNR	0+585 to 0+645 (Fifty Rd.)	0.08	0.03	0.05	0.09	0.01	-	0.01	-0.01	-55.4	0.02	-	0.02	-0.03	-56.4	0.09		0.09	0	0.3
South Service Road	4+815 to 5+112 (Barton St.) & 0+220 to 0+770 (Fifty Rd.)	11.66	0.38	0.62	1.18	0.01	0.30	0.31	-0.07	-19.3	0.01	0.52	0.54	-0.08	-13.6	0.05	1.21	1.26	0.07	6.2
Fifty Road at 900 mm CSP	4+815 to 5+112 (Barton St.) & 0+220 to 0+645 (Fifty Rd.)	9.66	0.15	0.28	0.75	-	0.08	0.08	-0.07	-47.3	-	0.18	0.18	-0.10	-36.7		0.54	0.54	-0.21	-28.1

As seen within Table 6.1, the vast majority of the proposed conditions peak flow rates have been mitigated to meet or exceed the existing conditions peak flow rates. Storm sewer diameters have been increased to provide storage while orifice controls have been applied at the downstream end of the storms to control release peak flow rates. Additionally, orifices have been applied between storm sewer pipes where necessary to control the available head impacting the downstream pipes; the locations and sizing of the orifices are shown within the PCSWMM model. Despite the proposed storage and orifice controls, select locations have been simulated with increases to the 2, 5, or 100-year peak flow rates. These locations can be summarized as follows:

- **Lewis Road (Watercourse 9)**

  Peak flow rate increases have been simulated during the 2-year and 5-year storm events at the lined channel for Watercourse 9. However, it is indicated within the SCUBE East Subwatershed Study that lands draining directly to the lined channel of Watercourse 9 are exempt from erosion and flood control requirements. As such, the increased peak flow rates have not been mitigated.

- **McNeilly Road**

  A peak flow rate increase of 0.02 m^3/s (+/-) has been simulated within the PCSWMM model to the receiving 600 mm McNeilly Road storm sewer pipe. This is considered a minor increase and the pipe has been simulated as being at 75% of the pipe capacity. Despite this increase, the peak flow rates have been reduced for the 2 and 100-year design storm events.

- **West Avenue**

  The storm sewers on Barton Street which convey flow Silverlace Circle and Winona Road have been increased in diameter to mitigate the poor hydraulic performance as simulated in the existing conditions model. Within the existing conditions model, these storm sewers have been simulated as surcharged during the 5-year storm events and surcharge above the rim elevations during the 100-year storm event. The capacity of the storm sewers has been increased to mitigate the surcharge conditions and convey runoff from the proposed Barton Street ROW. The 2 and 5 year peak flow rates outletting at West Avenue have been reduced, primarily due to the timing of the peak flow rates from the upstream external drainage areas, and the increased capacity (and slope) of the revised storm sewers.

  The aforementioned storm sewers discharge to the 2100 diameter storm conveyed northward on West Avenue. The storm sewer was sized to convey the 100-year peak flow rate; a Manning's equation verification indicates the capacity of the storm sewer as is 12.26 m3/s (+/-), which is greater than the proposed 100-year peak flow rate of 12.13 m3/s (+/-). The storm sewer should not surcharge under the proposed conditions and could convey the additional flow. Stormwater controls could be implemented at this location to mitigate the increase in peak flow rates, however, the increased peak flow rate is largely due to the mitigated Barton Street storm sewers, and not the increased imperviousness on Barton Street.

- **Winona Road**

  The 100-year peak flow rate has been increased by 0.03 m3/s (+/-) to the receiving 375 mm pipe while the 2 and 5-year storm event peak flow rates have been reduced in comparison to the existing conditions peak flow rates. The 375 mm storm sewer is at 95 % (+/-) capacity due to the proposed 100-year peak flow rate and is capable of conveying the peak flow rate without surcharging.

- **Foothills Lane**

  The peak flow rate discharged to the 975 mm storm sewer at Foothills Lane from Barton Street has increased by 0.05 m3/s (+/-) during the 100-year storm event, while the 2 and 5-year storm event peak flow rates have been reduced. The 975 mm storm sewer has been simulated within the PCSWMM model with a pipe capacity of 32 % during the proposed conditions scenario for the 100-year storm event. Further review and consultation are required for this location as it is not clear within the available Foothills of Winona documentation if the storm sewer infrastructure has been sized to convey the 100-year peak flow rates from the upstream external drainage area and the proposed Barton Street ROW. If the Foothills of Winona infrastructure has been designed to convey the upstream drainage area with increased peak flow rates, then the proposed storage requirements at this location could be reduced and or optimized from what has been proposed.

- **South Service Road**

  The 100-year peak flow rate has been increased at the South Service Road outfall by 0.075 m3/s (+/-) to the receiving ditch system while the 2 and 5-year storm event peak flow rates have been reduced in comparison to the existing conditions peak flow rates. The upstream storage and orifice sizing can be optimized at the next stages of planning and design to mitigate this minor increase.

A review of the major system depths reveals that there are no locations where the depth of flow reaches the crown of the roadway; as such the proposed major system performance meets the City's major system criteria for urban arterial roads. The road section has been input into the PCSWMM model with a 2% cross slope resulting in a crown height of 0.19 m on Barton Street and 0.14 m on Fifty Road. The depth of flow is less than the respective crown height at all locations. Additional catch basins have been implemented where roadway sags have been identified. One (1) location has been identified on Barton Street at Station 3+350 where a curb cut should be implemented to convey flow off of the ROW to the lined ditch at Lewis Road. This should be reviewed at the next stages of planning and design to ensure the location will be constructed to meet the City's major system criteria for urban arterial roads.

Erosion control has been provided throughout the study area as per the SCUBE East and West Subwatershed criteria; as noted there is a peak flow rate increase conveyed to the lined channel at Lewis Road which is acceptable based on the criteria. The 2-year peak flow rates have been overcontrolled to exceed the existing conditions peak flow rates as shown within Table 6.1. The peak flow rate decreases range from -2.0% to -88.4%.

6.2 Quality Control

Water quality measures to provide an Enhanced Level of water quality protection for the proposed increase in the pavement to each drainage outlet have been selected with consideration to the contributing drainage area, magnitude in the increase in paved area, R.O.W. spatial constraints, and effectiveness of water quality measures. The SCUBE East and West Subwatershed Studies recommended providing a Normal Level of water quality treatment with through traditional controls, however, an Enhanced Level of water quality protection has been provided to be consistent with the approach taken for the Block 2 and Block 3 studies.

In the case of OGS units, it is understood that a maximum 70% TSS removal is provided, as such OGS units are located and sized for appropriate locations, with drainage areas of approximately 2 ha or less. It is generally accepted based on MECP guidance and treatment standards that OGS units will appropriately treat up to 2 ha (+/-); as the drainage area to an OGS unit increases, the peak flows will also increase and could exceed the flow capacity of the OGS unit. Should the flow capacity of the OGS unit be exceeded, the exceeded flow will bypass the treatment function of the OGS. As such, OGS units are typically combined with another water quality measure when the drainage area to the OGS unit is greater than 2 ha, unless the OGS unit provides greater than equivalent Enhanced Level of water quality protection for the increase in paved area, by treating a larger drainage area. Table 6.2 provides the water quality measures for the Barton Street and Fifty Road West corridor.

Table 6.2. Proposed Stormwater Quality Management

Drainage Outlet	Road Stations	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	OGS ETV Unit or Equivalent
Watercourse 5 - West (east of Fruitland Road)	0+000 to 0+325	1.85	1.23	0.45	0.85	+0.40	+90.6	EF4
Sunnyhurst Avenue	0+325 to 0+820	29.04	1.93	0.34	1.42	+1.08	+315.2	EF10
Kenmore Avenue		0.78	0.00	0.42	0.00	-0.42	-100.0	-
Jones Road		0.00	0.00	0.04	0.00	-0.04	-100.0	-
Watercourse 5 - East (east of Jones Road)	0.820 to 1+420	34.49	2.29	0.63	1.69	+1.06	+166.7	EF6
Watercourse 6 (west of Glover Road)	1+420 to 1+770	2.12	1.31	0.39	0.97	+0.59	+151.2	EF4
Glover Road		0.00	0.00	0.25	0.00	-0.25	-100.0	-
Watercourse 7 - West	1+770 to 2+110	5.00	1.33	0.29	0.98	+0.69	+242.1	EF6
Watercourse 7 - East	2+110 to 2+460	14.95	1.41	0.24	0.96	+0.72	+305.5	EF8
McNeilly Road	2+460 to 2+605	2.12	0.62	0.31	0.45	+0.14	+45.0	EF4
Lewis Road (Watercourse 9 - West)	2+605 to 4+030	203.35	5.57	1.30	3.98	+2.68	+206.1	EF12
West Avenue	4+030 to 4+430	106.75	1.36	0.45	1.01	+0.56	+124.3	EF4
Winona Road	4+315 to 4+430	0.29	0.20	0.19	0.16	-0.04	-18.9	-
Napa Lane	4+430 to 4+610	2.30	0.70	0.27	0.51	+0.23	+86.0	EF4
Foothills Lane	4+610 to 4+815	4.21	0.76	0.24	0.56	+0.32	+131.4	EF4
Fifty Road at Hwy #8	0+000 to 0+220 (Fifty Rd.)	6.26	0.66	0.27	0.40	+0.13	+46.5	EF4
South Service Road	4+815 to 5+112 (Barton St.) & 0+220 to 0+770 (Fifty Rd.)	11.66	2.68	0.33	1.76	+1.43	+436.9	EF12

As shown within Table 6.2, water quality treatment has not been proposed for select locations where there is no increase in the impervious area to the outlet. These locations include Kenmore Avenue, Jones Road, Glover Road, and Winona Road.

A review of the Block 3 Servicing Strategy for the Fruitland – Winona Secondary Plan Lands (Urbantech, March 2020) has been undertaken to evaluate the water quality treatment provided by the two (2) proposed stormwater management facilities. Based on this review, it is unclear if the Block 3 proposed water quality treatment has been designed to treat the Barton Street ROW. As such, an OGS unit has been sized for this area to provide the necessary treatment if required.

A standard high-level unitary costing rate of $100,000/unit for the implementation of the OGS units has been used to estimate the cost of the required OGS units. Thirteen (13) OGS units have been identified as being required to treat the increased impervious area as shown in Table 6.2 for a combined cost of $1,300,000; the OGS sizing reports are provided in Appendix E. Water quality treatment is not required at the outlets for Kenmore Avenue, Jones Road, Glover Road, and Winona Road due to the reduction in the paved area and the redirection of the contributing drainage areas to alternative outlet locations.

6.3 Groundwater Recharge

The implementation of LID BMP source controls to maintain water balance and groundwater recharge have been proposed based on a detailed review of the proposed increase in pavement to each drainage outlet, as well as a review of the site-specific spatial and grading constraints of constructing the LID BMPs within the ROW. This assessment has verified the volume of water that would be required to be infiltrated based on the criteria established within the East and West SCUBE Subwatershed Studies and should be verified at the next stages of planning and design. However, this assessment has not considered the seasonally high groundwater elevation and how it may impact the bottom elevation or depth of the proposed LID BMP source controls as seasonal high groundwater surface elevation data has not been collected as part of this study. The Credit Valley Conservation LID Stormwater Management Planning and Design Guide indicates that the invert of stone reservoirs, for LID features such as infiltration trenches, should be located at a minimum of one (1) meter above the seasonally high groundwater table. Groundwater monitoring data should be collected at the next stages of planning and design to confirm the feasibility of the noted source control infiltration features.

It would be advantageous if shallow roadside swales could be implemented within the 3 m wide grassed boulevard between the curb and the sidewalk or between the curb and the MUT. Where possible, the shallow swales could be converted to enhanced swales to provide a water quality benefit prior to conveyance of the runoff to the infiltration facilities as per guidance from the City of Hamilton.

The locations within the proposed Barton Street and Fifty Road ROWs where potential groundwater recharge locations have been identified are provided within Table 6.3; volume calculations are provided in Appendix F. The suitable locations identified are generally dependent on the spatial area within the ROW and the road profile; LID BMPs have been recommended at low points where the road drainage can be conveyed to the source control features. To ensure the effectiveness of the LID BMPs, it is essential that there be coordination between the grading of the road profile and the location of the LID BMPs. The feasibility of implementing the LID BMP features (assessment of soil conditions, groundwater, utilities configuration and depths) has not been undertaken for this study. Preliminary bedrock depths have been identified within Table 6.3 based on a review of the Geotechnical Report (Wood, March 2020). The feasibility constraints should be reviewed at the next stages of planning and design in addition to confirming the suitable locations to maximize the use of LID BMP source controls to achieve the defined groundwater recharge targets within the City's SCUBE East and West Subwatershed Studies.

Prior to the implementation of the LID BMP features, it is recommended that the City develop standards during the next stages of planning and design for the short-listed LID BMP features identified through this study. The standards should include conveyance and sizing requirements, construction procedures, in addition to considerations for long-term operations and maintenance of the features.

As shown within Table 6.3, the locations for the Fifty Road at Highway #8 and South Service Road groundwater recharge locations should be offset at the groundwater recharge location between Barton Street and the CNR corridor. That facility has been sized based on the available footprint area and incorporated within the PCSWMM model. The available storage at that facility is 689 m^3. A swale has also been provided within the 6.5 m wide east boulevard where the road runoff could be treated prior to conveyance to the infiltration facility. Rather than use a stone-filled infiltration facility, a plastic fabricated facility, such as a Stormcon^{tm} chamber to provide greater storage and infiltration. The available void space of a stone sill infiltration chamber is approximately 40% of the total chamber volume, while a Stormcon^{tm} chamber could provide 96% of the chamber volume for storage. Furthermore, the Stormcon chambers can be designed to either be infiltrative or non-infiltrative.

A swale has also been proposed within the 6.5 m wide east boulevard of Fifty Road north of Highway #8 between station 0+000 to 0+112 (Fifty Rd.) where the road runoff passes through a pre-treatment grass swale and after a check dam connects to an enhanced grass swale. The side slopes of the pre-treatment grass swale is 2:1 and it gradually connects to the enhanced grass swale with a 3:1 side slopes and 1% longitudinal slope which would have a flow velocity of approximately 0.5 (m/s) as per the Low Impact Development Stormwater Management Planning and Design Guide, (CVC and TRCA, 2010) recommendations. The soil properties of the swale area should be further investigated before the detailed design to make sure the infiltration rate of the soil matches the recommendations.

Table 6.3. Proposed Groundwater Recharge Implementation Locations and Required Volumes

Drainage Outlet	Road Stations	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Storage Volume (m^3)	Implementation Location	Surface Ground Elv.	Shale Elv.
Watecourse 5 - West (east of Fruitland Road)	0+000 to 0+325	1.85	1.23	0.45	0.85	0.40	90.6	24.69	0+125	87.3	-
Sunnyhurst Avenue	0+325 to 0.820	29.04	1.93	0.34	1.42	1.08	315.2	34.16	0+450 & 0+622	87.44 & 87.85	85.32 85.15
Kenmore Avenue		0.78	0.00	0.42	0.00	-0.42	-100.0				
Jones Road		0.00	0.00	0.04	0.00	-0.04	-100.0				
Watercourse 5 - East (east of Jones Road)	0.820 to 1+420	34.49	2.29	0.63	1.69	1.06	166.7	40.93	1+066	86.51	84.49
Watercourse 6 (west of Glover Road)	1+420 to 1+770	2.12	1.31	0.39	0.97	0.59	151.2	22.24	1+455	88.66	83.9
Glover Road		0.00	0.00	0.25	0.00	-0.25	-100.0				
Watercourse 7 - West	1+770 to 2+110	5.00	1.33	0.29	0.98	0.69	242.1	23.00	2+110	89.1	82.92
Watercourse 7 - East	2+110 to 2+460	14.95	1.41	0.24	0.96	0.72	305.5	19.36	2+217	88.72	82.76
McNeilly Road	2+460 to 2+605	2.12	0.62	0.31	0.45	0.14	45.0	13.11	2+605	89.2	82.18
Lewis Road (Watercourse 9 - West)	2+605 to 4+030	203.35	5.57	1.30	3.98	2.68	206.1	122.63	2+678 & 2+965 & 3+333	88.8 & 88.25 & 87.12	82.07 81.64 81.09
West Avenue	4+030 to 4+430	106.75	1.36	0.45	1.01	0.56	124.3	21.85	4+300	91.5	89.72
Winona Road	4+315 to 4+430	0.29	0.20	0.19	0.16	-0.04	-18.8				
Napa Lane	4+430 to 4+610	2.30	0.70	0.27	0.51	0.23	86.0	10.50	4+300	91.5	89.72
Foothills Lane	4+610 to 4+815	4.21	0.76	0.24	0.56	0.32	131.4	12.33	4+815	92	89.93
Fifty Road at Hwy #8	0+000 to 0+220 (Fifty Rd.)	6.26	0.66	0.27	0.40	0.13	46.5	12.88	Offset at Fifty Road, south of CNR Corridor		
Fifty Road at 900 mm CSP	4+815 to 5+112 (Barton St.) & 0+220 to 0+645 (Fifty Rd.)	9.74	2.38	0.18	1.54	1.36	762.4	40.23	4+963 & 0+312 (Fifty Rd.) 0+596 (Fifty Rd.)	91.29 & 91.27 (Fifty Rd.) 88.59 (Fifty Rd.)	89.98 88.23 85.98
South Service Road	0+645 to 0+770 (Fifty Rd.)	2.00	0.37	0.22	0.26	0.04	20.0	9.95	Offset at Fifty Road, south of CNR Corridor		

7. Proposed Hydraulics

The hydraulic performance of potential culvert and bridge upgrades is typically assessed using the Ministry of Transportation (MTO) hydraulic criteria, and Ministry of Natural Resources and Forestry (MNRF) vehicle ingress and egress criteria for the calculations, and an assessment of the potential to reduce flooding conditions upstream of the crossing.

Hydraulic performance standards have been established using the MTO Highway Drainage Design Standard (HDDS) (January 2008), which incorporates the hydraulic standards for watercourse crossings from the Canadian Highway Bridge Design Code. The following references the MTO document (in brackets) related to the hydraulic criteria:

i. Design storms used to calculate flood elevations (WC-1)
ii. Minimum top of road freeboard (WC-7)
iii. Desired top of road freeboard (WC-7)
iv. Maximum depth of relief flow over the road (WC-13)
v. Maximum product of depth and velocity of relief flow over the road (WC-13)
vi. Clearance for open-footing culverts (WC-7)

Culvert and bridge crossings are classified based upon WC-1 from the MTO HDDS. As such, the following design criteria apply:

- Design flow as per the MTO's 2008 Highway Design Standards for freeways and urban arterials would be the 50-year event for structures less than or equal to 6 m in span. Structures with a span exceeding 6 m should be designed to convey a minimum of the 100-year storm event.
- Top of Road Freeboard as per the MTO's 2008 Highway Design Standards should be a minimum of 1.0 m measured from the design flow hydraulic grade line elevation to the edge of the travelled lane. The desirable freeboard is 1.0 m measured vertically from the energy grade line for the design flow.
- Relief Flow as per the MTO's 2008 Highway Design Standards should be a maximum depth of flow on the roadway of 0.3 m, while the product of the velocity and depth on the roadway shall not exceed 0.8 m^2/s.
- Clearance for open footing culverts as per MTO HDDS WC-7 shall be 0.3 m (measured from the water surface elevation to the crossing's soffit). Flood depth for open footing culverts should be as follows:
  - Culverts with a diameter or rise <3.0 m will maintain a HW/D less than or equal to 1.5
  - Culverts with a diameter or rise of 3.0 m to 4.5 m will maintain a HW/D less than or equal to 4.5
  - Culverts with a diameter or rise >4.5 m will maintain a HW/D less than or equal to 1.0

In addition to the foregoing, the following Ministry of Natural Resources and Forestry (MNRF) vehicle ingress and egress criteria would also apply should any overtopping of roadway occur:

- Pedestrian passage criteria:
  - Depth of less than 0.8 m
  - Velocity of less than 1.7 m/s
  - Depth x Velocity of less than 0.4 m^2/s
- Private vehicle passage criteria:
  - Depth of less than 0.4 m

  - Velocity of less than 3 m/s
  - Depth x Velocity of less than 1.2 m^2/s
- Emergency vehicle passage criteria:
  - Depth of less than 1.2 m
  - Velocity of less than 4.5 m/s
  - Depth x Velocity of less than 5.4 m^2/s

Hydraulic crossings that are considered to be undersized based on not meeting the provincial hydraulic criteria, or provide poor hydraulic performance, where there is adequate right-of-way space available for crossing upgrades, are typically upgraded or replaced.

For the Stoney Creek watercourses (5, 6, 7, 7.1, and 12) the hydraulic crossing recommendations from the SCUBE West and East Subwatershed Studies have been used, with the exception of Fifty Creek or Watercourse 12 which has been assessed hydraulically herein.

In addition to hydraulic performance criteria, stream morphology recommendations should also be considered. Aqualogic Consulting has assessed each hydraulic crossing, and has provided recommendations for consideration, based on fieldwork observation, stream morphology principles and assessment (ref. Appendix C).

Based on the foregoing, the following has been noted for the watercourse crossings along Barton Street and Fifty Road.

Watercourse 5: The existing culvert is a 1.86 m by 1.65 m horizontal elliptical on the upstream side of the crossing, which is married to a 1.86m by 1.035 m box culvert on the downstream side of the crossing. Hydraulically as per the SCUBE West Subwatershed Study and the Watercourse 5 and 6 Class EA this culvert was recommended to be replaced with a 2.4 m by 1.5 m open box culvert

Aqualogic Consulting has determined that the bankfull channel width varies from 2.5 m to 3.5 m, with bankfull depth of approximately 0.5m. Based on the stream morphology assessment an opening width of approximately 6.0 m has been recommended.

During the detailed design of the culvert crossing upgrade, detailed stream morphology and hydraulic assessment should be conducted and the recommended 6 m by 1.5 m open box culvert be further assessed.

Watercourse 6: The existing crossing is a combination of two (2) culverts, a 1.88 m by 1.31 CSP arch culvert and a 1.25 m by 1.40 m concrete arch culvert. Hydraulically as per the SCUBE West Subwatershed Study and the Watercourse 5 and 6 Class Ea. this culvert was recommended to be replaced by 2 m by 1 m concrete box culvert.

Aqualogic Consulting has determined that the bankfull channel width varies from 2.5 m to 3.5 m, with bankfull depth of approximately 0.5m. Based on the stream morphology assessment a single crossing with an opening width of approximately 6.1 m has been recommended.

During the detailed design of the culvert crossing upgrade, detailed stream morphology and hydraulic assessment should be conducted and the recommended 6.1 m by 1.0 m open box culvert be further assessed.

Watercourse 6.1: The existing crossing is a 0.60m CSP culvert. Hydraulically as per the SCUBE West Subwatershed Study and the Watercourse 5 and 6 Class EA. this culvert was recommended to be replaced by 1.75 m by 0.75 m concrete box culvert.

Aqualogic Consulting has not assessed this culvert based on the current size.

During the detailed design of the culvert crossing upgrade, detailed stream morphology and hydraulic assessment should be conducted and the recommended 1.75 m by 0.75 m open box culvert be further assessed.

Watercourse 7: The existing crossing is a combination of two (2) culverts, a 2.1 m span elliptical CSP and a 1.0m CSP culvert with a CSP extension on the upstream side. Both culverts have a slight skew to the road. Hydraulically as per the SCUBE West Subwatershed Study did not recommend that this culvert be replaced

Wood conducted channel improvements prior to 2021 on the downstream side of the crossing. Aqualogic Consulting comments that a 20 m long riverstone ramp has been tied into a mixed riverstone and natural channel design. The CSP arch culvert is perched by 0.5 m on the downstream side of the road. Bankfull channel varies from 2.5 m to 3 m, with bankfull depth at 0.5m +/-. Based on the stream morphology assessment a single crossing with an opening width of approximately 6.0 m has been recommended.

During detailed design of the culvert crossing upgrade, a detailed stream morphology and hydraulic assessment should be conducted and the recommended 6.0 m span open box culvert be further assessed.

Watercourse 7.1: The existing crossing is a 0.95 m by 0.70 m box culvert, with a 0.80 m CSP culvert on the upstream side. Hydraulically as per the SCUBE West Subwatershed Study did not recommend that this culvert be replaced

Wood conducted channel improvements prior to 2021 on the downstream side of the crossing. Aqualogic Consulting comments that a riverstone ramp has been tied into a mixed riverstone and natural channel design. Th downstream side of the culvert is perched by 0.6 m +/-. Bankfull channel varies from 1.5 m to 2.5 m, with bankfull depth at 0.5m +/-. Based on the stream morphology assessment a single crossing with an opening width of approximately 5.5 m has been recommended.

During the detailed design of the culvert crossing upgrade, detailed stream morphology and hydraulic assessment should be conducted and the recommended 5.5 m span open box culvert be further assessed.

Fifty Creek (Watercourse 12)

The Fifty Creek crossing of Fifty Road and Highway 8 consists of 3.6 m by 1.25 m box culverts with approximately 20 m of open channel between Fifty Road and Highway 8. Both culverts are skewed to the roadways. The hydraulic modelling provided by Hamilton Conservation Authority, includes only the 100 year storm event peak flows. Based on a review of the hydraulic model, both the Fifty Road and Highway 8 culverts have the hydraulic capacity to convey the 100 year peak flow, without overtopping the roadways. The Fifty Road culvert has a freeboard of 1.02 m to centerline of road or approximately 0.95 m to the edge of pavement. The Highway 8 culvert has a freeboard of 1.45 m to centerline of road or approximately 1.38 m to the edge of pavement. Hydraulically each culvert is considered to be adequate.

Aqualogic Consulting has determined that the bankfull channel width varies from 3.5 m to 4.5 m, with bankfull depth of ranging from 0.4 m to 0.7 m. Downstream of Highway 8, a small wetland pocket exists before, the channel transitions to a well-defined channel, 15 m downstream of the crossing. Based on the stream morphology assessment, both the Fifty Road and Highway 8 crossings have been recommended to be upgraded to a 6.5 m width.

The proposed road layout at the intersection of Fifty Road and Highway 8, would not require the existing culverts to be extended. The existing culverts have also been observed to be in reasonable structural condition. Based on the foregoing, it is recommended that once the culverts need to be replaced due to the structural condition, a detailed stream morphology and hydraulic assessment be conducted and the 6.5 m span open box culverts be further assessed.

8. Cost Analysis

A high-level supply and construction cost of implementing the recommended storm sewer infrastructure has been provided in Table 8.1 while additional cost estimate information has been provided within Appendix G.

Table 8.1 Preliminary Stormwater Infrastructure Cost Analysis

Item Number	Item Description	Unit	Estimated Quantity	Supply and Install Total ($)
1	Storm Sewers	m	4000	$ 37,268,580
2	Manholes	ea	118	$ 3,737,559
3	Catch Basins	ea	241	$ 1,441,088
4	Leads	m	2410	$ 682,030
5	Outfalls	ea	1	$18,557
6	Infiltration Gallery	m^3	1057	$ 1,267,956
7	OGS Units	ea	13	$ 1,300,000
Subtotal				**$ 45,715,770**
8	15% Contingency		15.0%	$ 6,857,365
9	Construction Mobilization and Demobilization		2.5%	$ 1,142,894
10	Traffic Controls		6.0%	$ 2,742,946
11	Engineering		10.0%	$ 4,571,577
Total				**$ 61,030,553**

The unitary rates used to develop the preliminary SWM infrastructure estimate provided within Table 8.1 have primarily been obtained from the 2021 ConCast Price List with the exception of the infiltration gallery cost estimate which is based on previous projects completed by Wood. The preliminary cost estimate for implementing SWM infrastructure within the Barton Street and Fifty Road ROWs is approximately $61,031,000 while approximately 61% of the estimate is attributed to the costs for storm sewers for both conveyance and stormwater storage.

9. Conclusions and Recommendations

9.1 Conclusions

Based on the results presented and discussed in this Stormwater Management Report, the following conclusions can be made:

i. The Class EA Study Area drains to Watercourses 5, 6, 6.1, 7, 7.1, 9, and 12 (Fifty Creek) with all events up to and including the 100-year event being captured and conveyed by the existing roadside ditch system and limited storm sewer systems within the right-of-way.
ii. Various sections of the road have flow depths that exceed the capacity of the roadside ditches while select storm sewers have been identified that do not meet the City's 5-year hydraulic performance criteria and surcharge to the surface during the 100-year storm event.
iii. Stormwater management controls are required to offset the increases in impervious coverages due to the proposed road improvements and to meet stormwater management requirements as per the SCUBE East and West Subwatershed Studies, the various agencies, and City of Hamilton requirements.
iv. The hydraulic capacity of the Fifty Creek culverts has been reviewed and they are capable of conveying the 100-year storm event peak flow rate.

9.2 Recommendations

The following recommendations have been made for drainage system improvements and stormwater management:

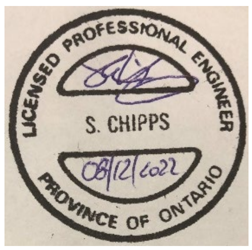
i. Stormwater management controls are being recommended to meet the various criteria of SCUBE East and West Subwatershed Studies, the various agencies, and City of Hamilton.
ii. Extensive new and upgraded storm sewers will be required to provide adequate flow conveyance as per City of Hamilton design requirements.
iii. Quantity controls are recommended to meet the peak flow rate requirements established through the SCUBE East and West Subwatershed Studies, the various agencies, and City of Hamilton.
iv. Water quality controls are recommended in the form of oil/grit separators to address the criteria within the SCUBE East and West Subwatershed Studies.
v. Groundwater recharge has been provided as per the SCUBE East and West Subwatershed Studies through infiltration controls to be further investigated at the next stages of planning and design.
vi. Erosion control for the 2-year storm event has been provided as per the criteria established within the SCUBE East and West Subwatershed Studies.
vii. The cost to implement the stormwater management and drainage infrastructure would be $61,030,000.
viii. The Fifty Creek culverts located at Highway #8 and Fifty Road will remain in place for the duration of the remaining lifespans and would be upgrades at that time for stream morphology requirements.
ix. Culverts for Watercourses which cross Barton Street should be further assessed during detailed design to determine required sizing.

10. Approval and Review Requirements

The aforementioned SWM recommendations are subject to the review and approval of the City of Hamilton, Hamilton Conservation Authority, Ministry of Natural Resources and Forestry, and the Ministry of Environment, Conservation and Parks.

Yours very truly,

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited



Per: Steve Chipps, P.Eng.
Associate Water Resources Engineer

Per: Patrick MacDonald, P.Eng.
Water Resources Engineer

Appendix A
Background Information

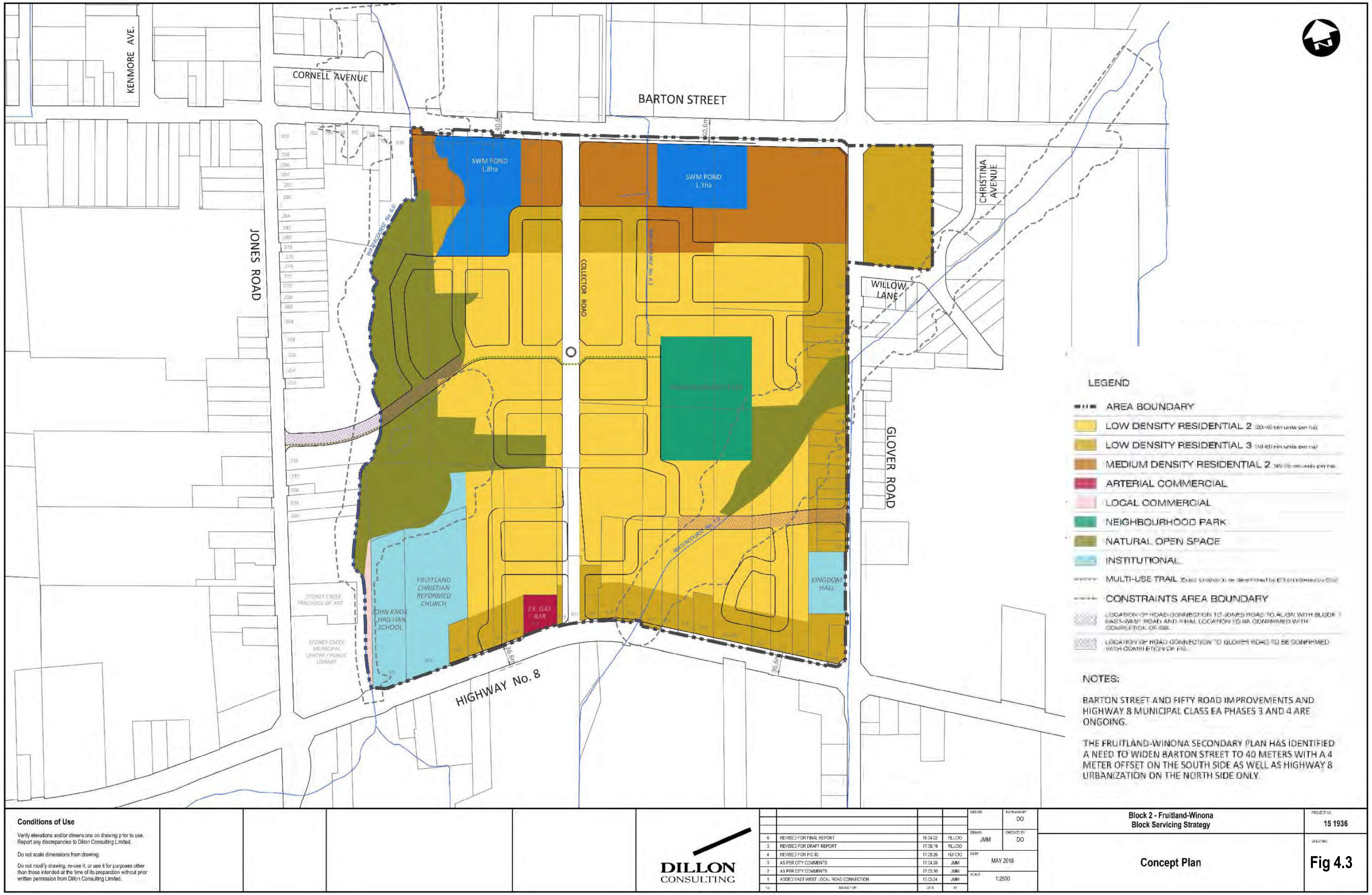
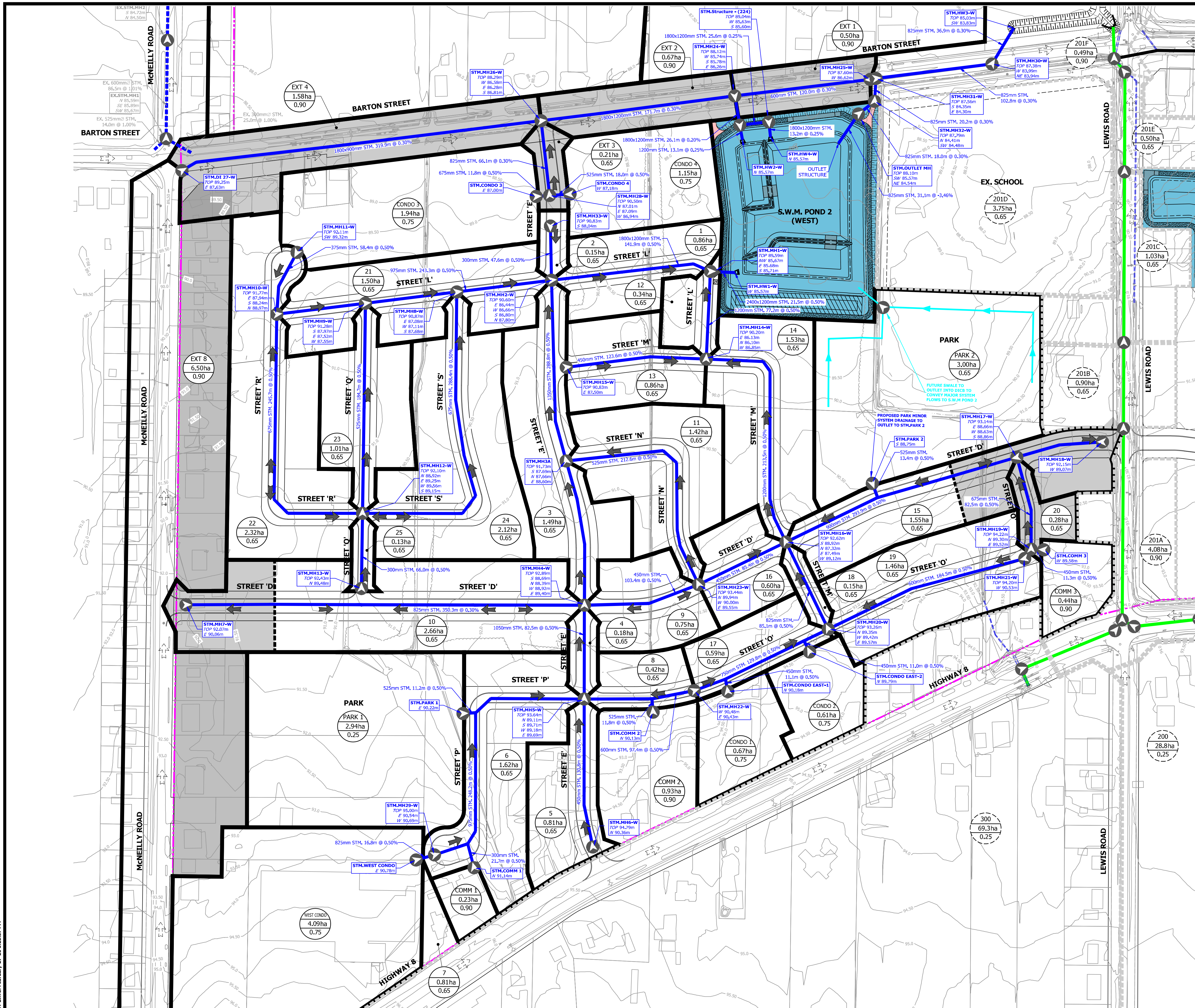


Figure 4-3 – Concept Plan



KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- STORM DRAINAGE AREA BOUNDARY
- EXTERNAL STORM DRAINAGE AREA BOUNDARY
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE PIPE (SEE DWG STM-3)
- EXISTING CONTOUR & ELEVATION
- AREA I.D.
- AREA Ha.
- RUNOFF COEFFICIENT
- MAJOR OVERLAND FLOW
- EXISTING MAJOR OVERLAND FLOW
- 100YR CAPTURE
- STORM MANHOLE ID
- PROPOSED GROUND ELEVATION
- PROPOSED SEWER INVERTS
- FUTURE SWALE

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY STORM DRAINAGE PLAN - WEST

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:1500	STM-1

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_PRELIMINARY WEST STORM DRAINAGE PLAN.DWG

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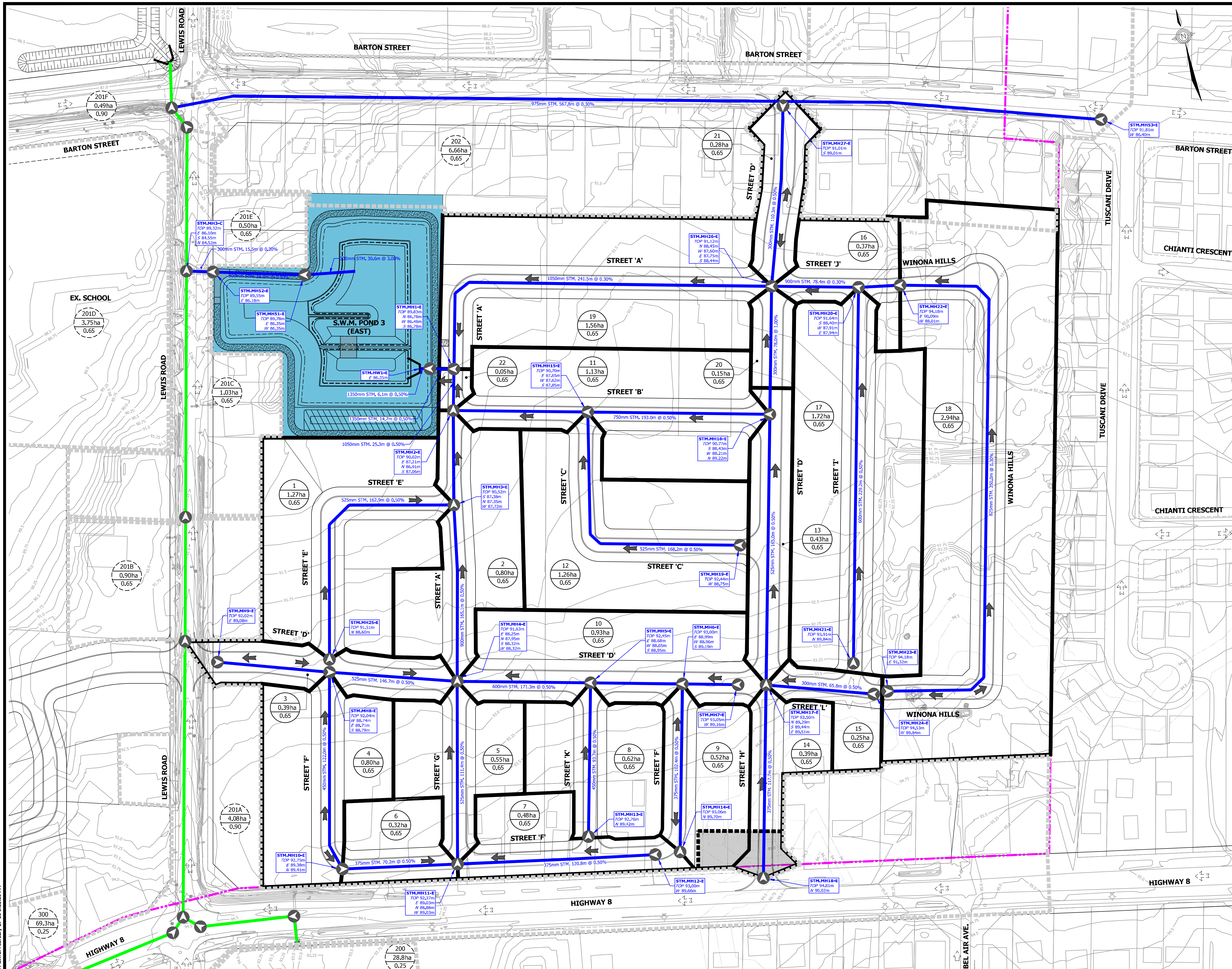

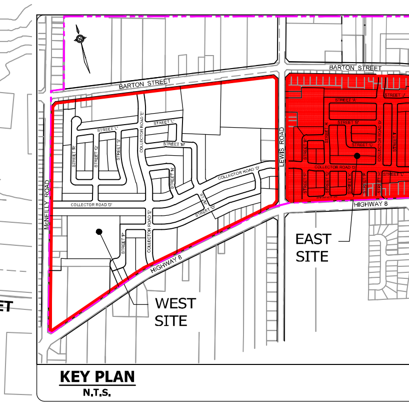

LEGEND

- LIMIT OF STUDY AREA
- STORM DRAINAGE AREA BOUNDARY
- EXTERNAL STORM DRAINAGE AREA BOUNDARY
- PROPOSED STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE PIPE (SEE DWG STM-3)
- EXISTING CONTOUR & ELEVATION
- AREA I.D.
- AREA Ha.
- RUNOFF COEFFICIENT
- MAJOR OVERLAND FLOW
- EXISTING MAJOR OVERLAND FLOW
- 100YR CAPTURE
- STORM MANHOLE ID
- PROPOSED GROUND ELEVATION
- PROPOSED SEWER INVERTS

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY STORM DRAINAGE PLAN - EAST

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:1000	STM-2

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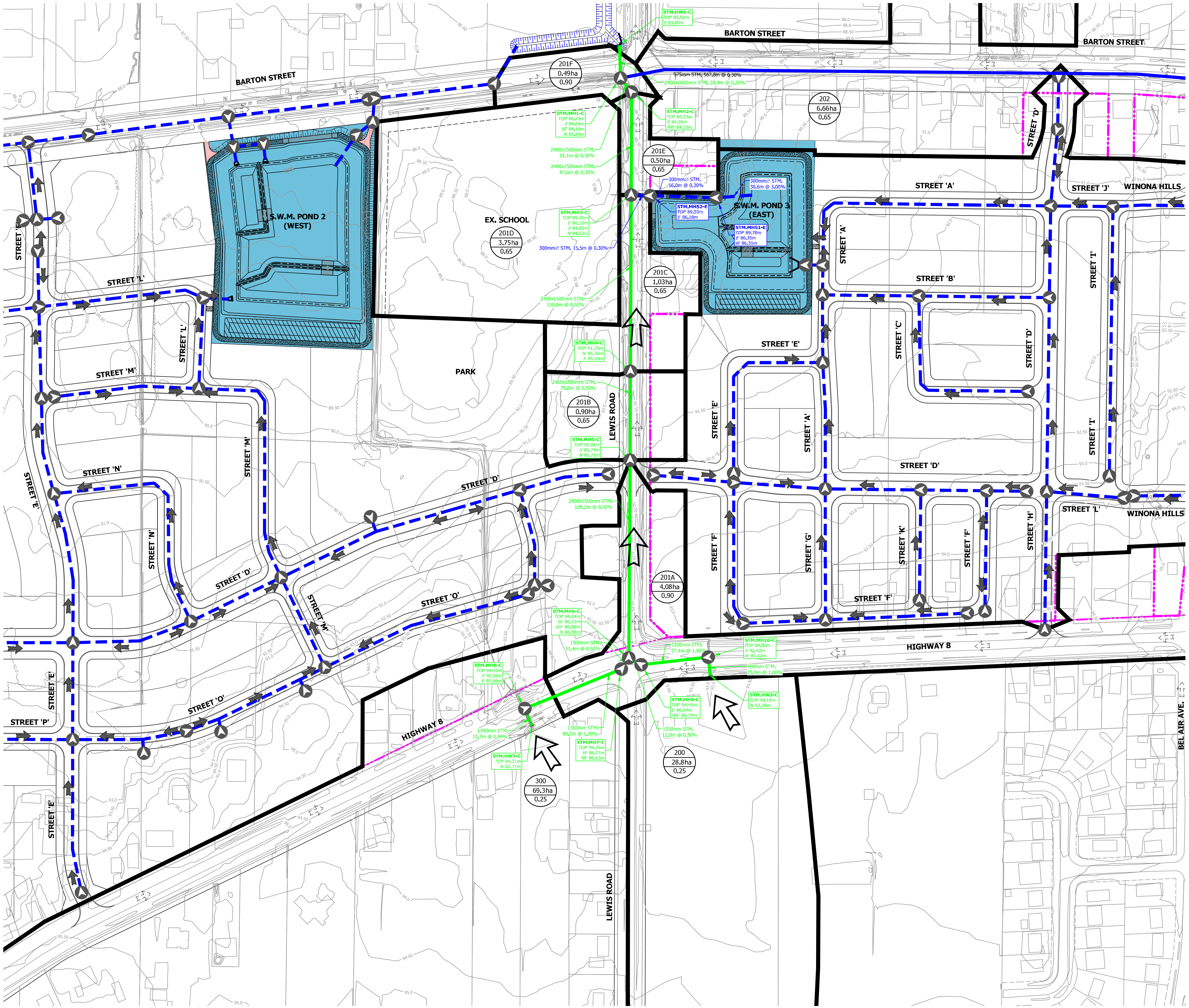

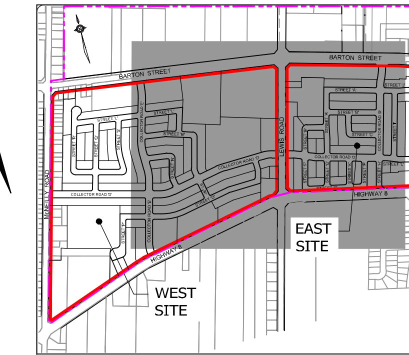

KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- STORM DRAINAGE AREA BOUNDARY
- EXTERNAL CONVEYANCE STORM SEWER
- LOCAL STORM SEWER
- EXISTING CONTOUR & ELEVATION
- AREA I.D.
- AREA Ha.
- RUNOFF COEFFICIENT
- MAJOR OVERLAND FLOW
- EXISTING MAJOR OVERLAND FLOW
- 100YR OVERLAND FLOW

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY EXTERNAL CONVEYANCE DRAINAGE PLAN
(SCENARIO 2a)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:1500	STM-3

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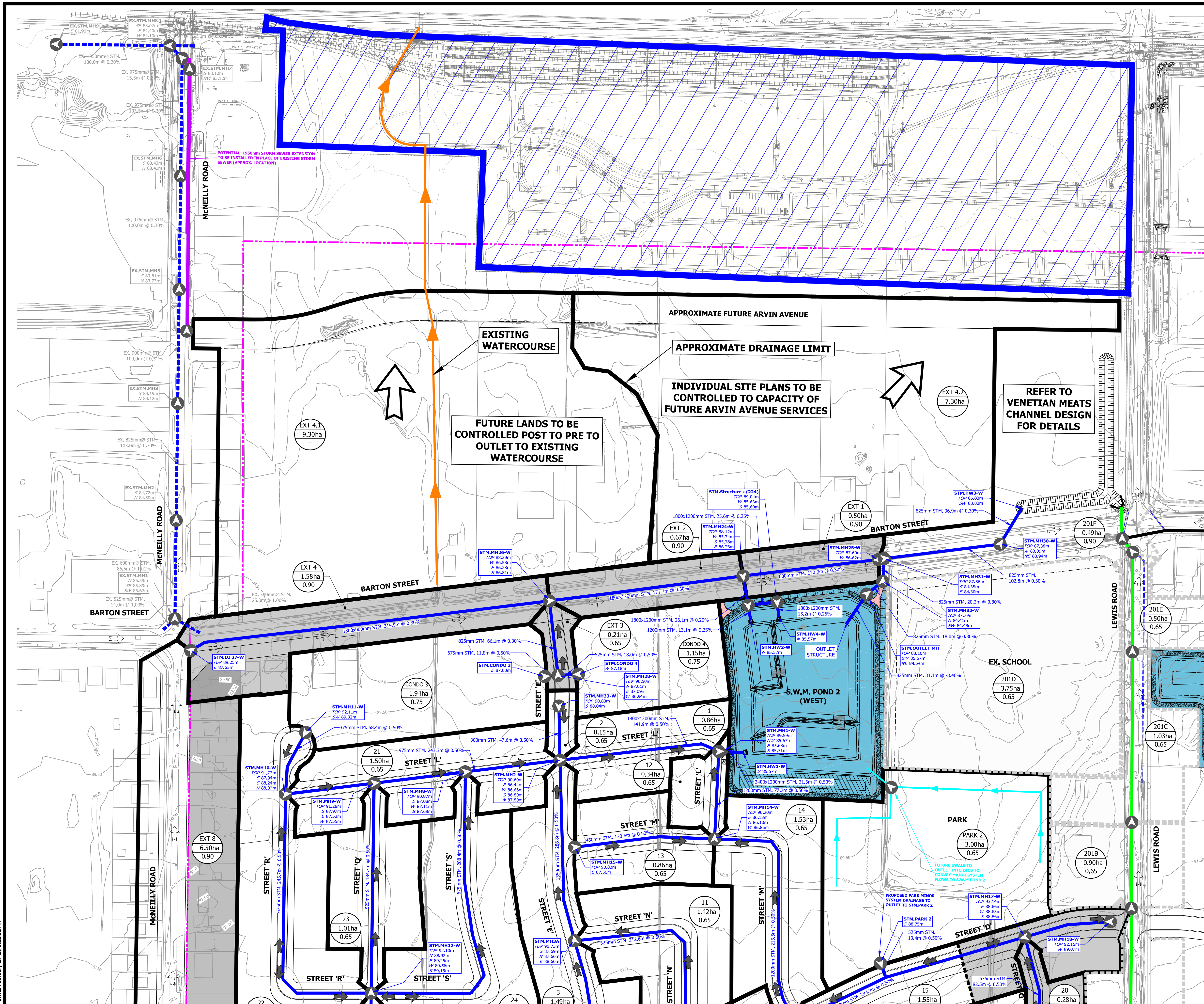

KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- STORM DRAINAGE AREA BOUNDARY
- EXTERNAL STORM DRAINAGE AREA BOUNDARY
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE PIPE (SEE DWG STM-3)
- POTENTIAL 1950mm STORM SEWER EXTENSION
- EXISTING CONTOUR & ELEVATION
- AREA I.D. (41)
- AREA Ha. (0.26ha)
- RUNOFF COEFFICIENT (0.65)
- MAJOR OVERLAND FLOW
- EXISTING MAJOR OVERLAND FLOW
- EXISTING OVERLAND FLOW
- 100YR CAPTURE
- STORM MANHOLE ID
- PROPOSED GROUND ELEVATION
- PROPOSED SEWER INVERTS
- METROLINX RAIL YARD
- EXISTING DRAINAGE DITCH
- FUTURE SWALE

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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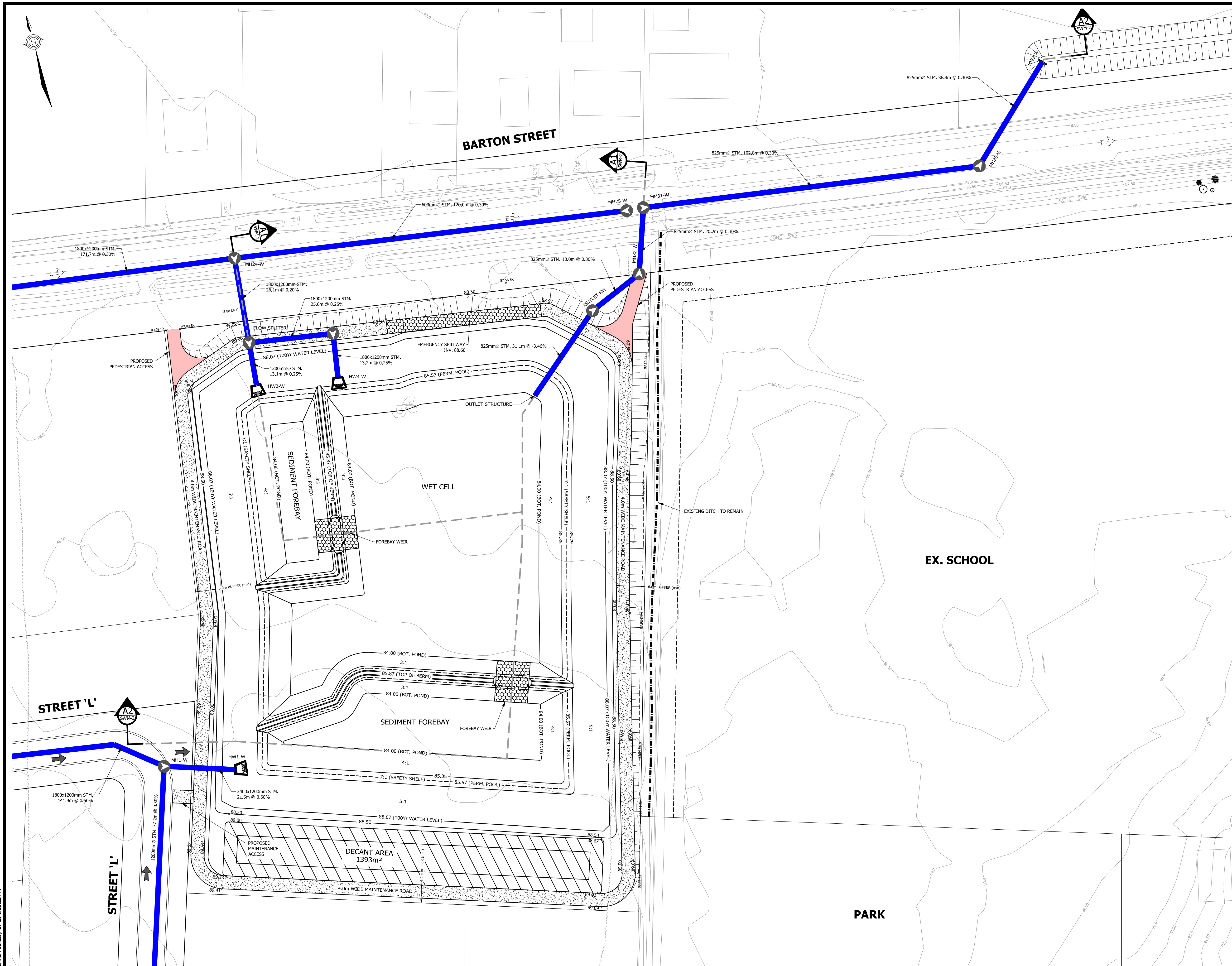
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY STORM DRAINAGE PLAN - WEST (NORTH OF BARTON STREET)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:1500	STM-4

PLOT DATE: February-27-20 6:22:52 PM



KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- PROPOSED STORM SEWER
- EXISTING CONTOUR & ELEVATION
- MAJOR OVERLAND FLOW
- EXISTING MAJOR OVERLAND FLOW

Pond-2 (West)
Area = 53.46 ha; IMP%=69%

	SCUBE SWS, 2013 (Outdated)	BSS, 2019		
	Required Volume [m³]	Elevation [m]	Required Volume [m³]	Provided Volume [m³]
Bottom	0	84	0	0
Permanent Pool	10,742	85.57	9,805	17,142
Extended Detention	16,281	86.1	6,270	7,098
100-year water level	62,686	88.07	39,896	40,085
Emergency Spillway	N/A	88.6	N/A	50,809
Top of Pond	N/A	89	N/A	59,266

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY SWM POND 2 PLAN - WEST (SCENARIO 2a)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:500	SWM-1

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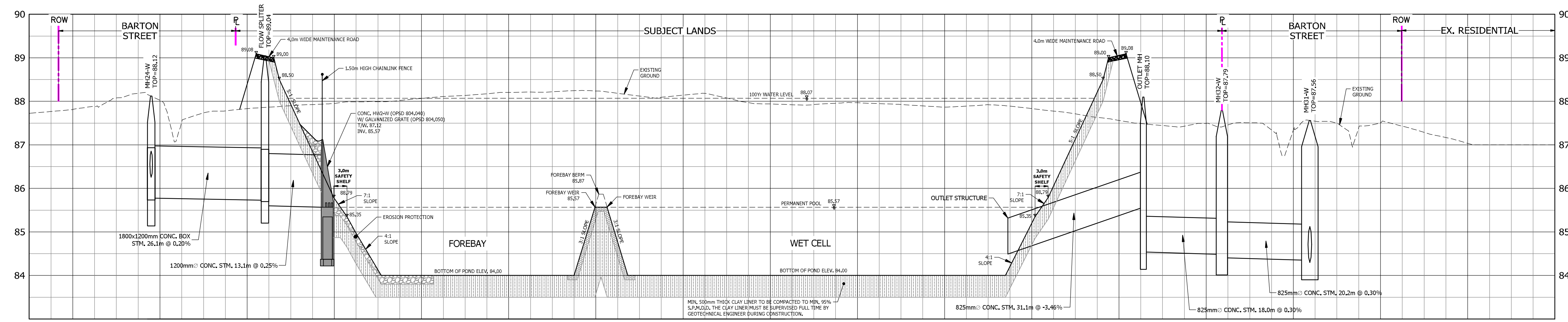
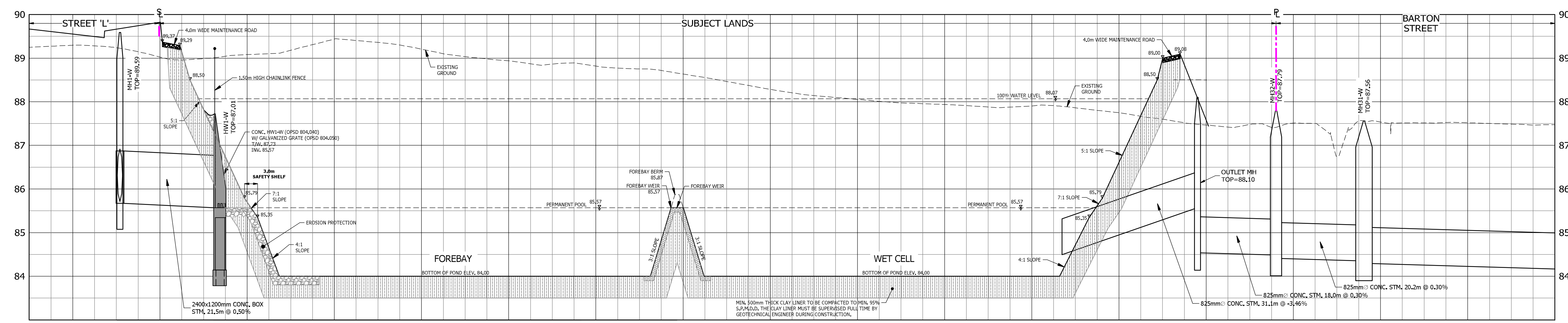


SECTION A1-A1

SCALE HOR. 1:500
VER. 1:50



SECTION A2-A2

SCALE HOR. 1:500
VER. 1:50

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288,717 FT.)

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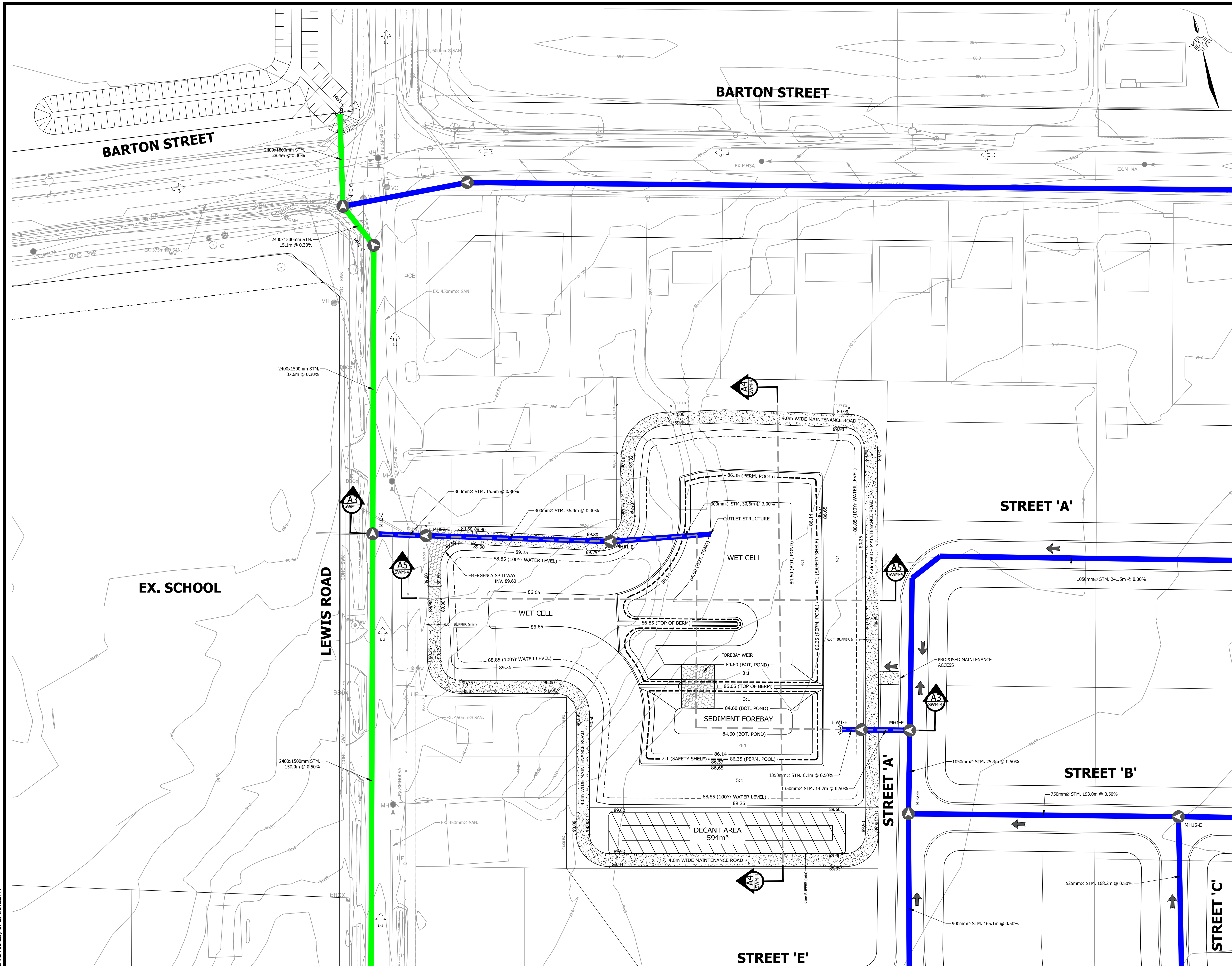
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY SWM POND SECTIONS - WEST (SCENARIO 2a)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:500	SWM-2

PLOT DATE: February-27-20 6:23:51 PM



KEY PLAN
N.T.S.

LEGEND

LIMIT OF STUDY AREA
PROPOSED STORM SEWER
PROPOSED EXTERNAL CONVEYANCE PIPE (SEE DWG STM-3)
EXISTING CONTOUR & ELEVATION
MAJOR OVERLAND FLOW
EXISTING MAJOR OVERLAND FLOW

Pond-2 (East) Area = 18.56 ha; IMP%=69%				
	SCUBE SWS, 2013 (Outdated)	BSS, 2019		
	Required Volume [m³]	Elevation [m]	Required Volume [m³]	Provided Volume [m³]
Bottom	0	84.6	0	0
Permanent Pool	4,565	86.35	3,387	4,565
Extended Detention	3,787	86.85	2,334	2,394
100-year water level	14,507	88.85	16,273	17,173
Emergency Spillway	N/A	89.60	N/A	24,637
Top of Pond	N/A	89.90	N/A	30,546

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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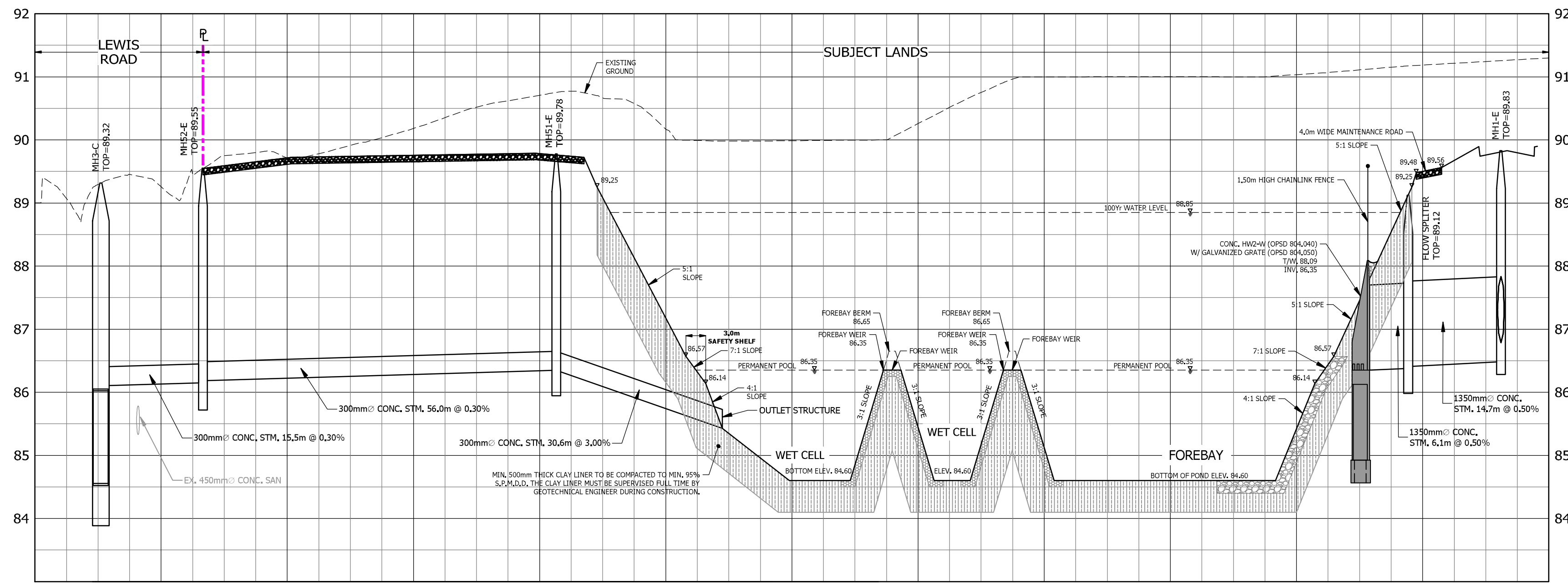
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY SWM POND PLAN - EAST

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:500	SWM-3

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_PRELIMINARY EAST SWM POND PLAN.DWG

PLOT DATE: February-27-20 6:24:32 PM



SECTION A3-A3

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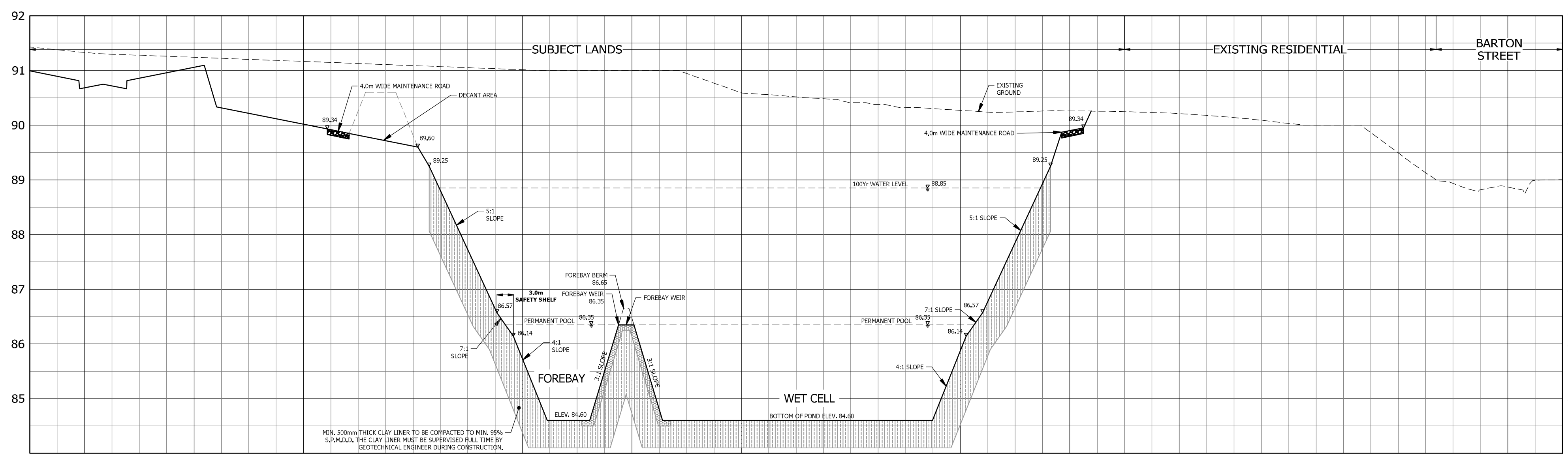
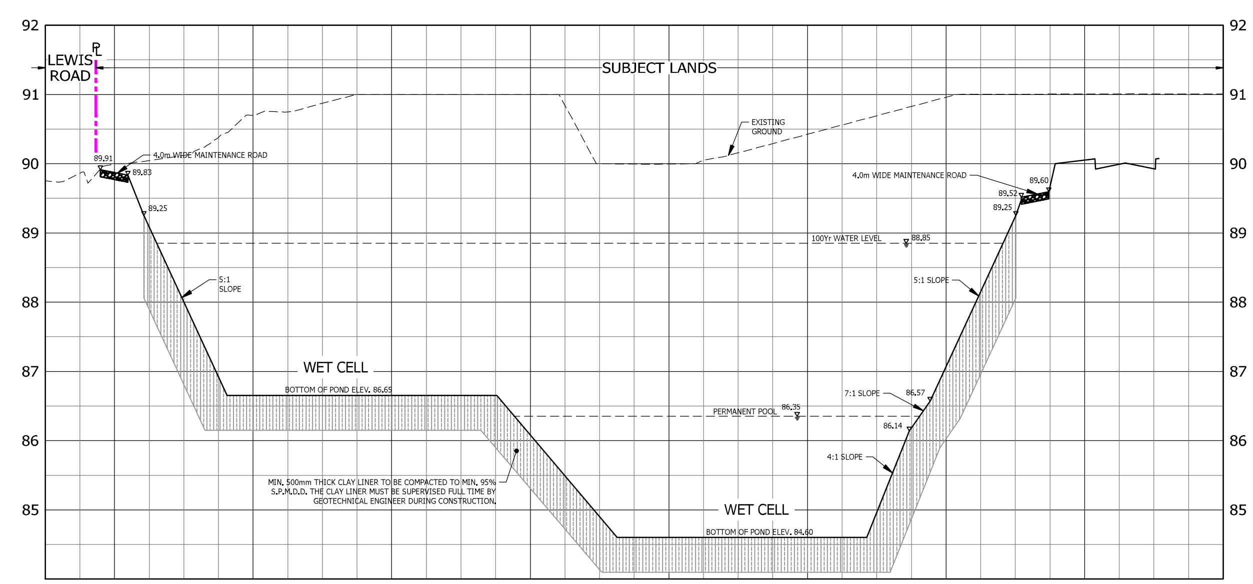
VER. 1:50





SECTION A5-A5

SCALE HOR. 1:500
VER. 1:50

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY SWM POND SECTIONS - EAST

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:500	SWM-4

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_PRELIMINARY EAST SWM POND SECTIONS.DWG

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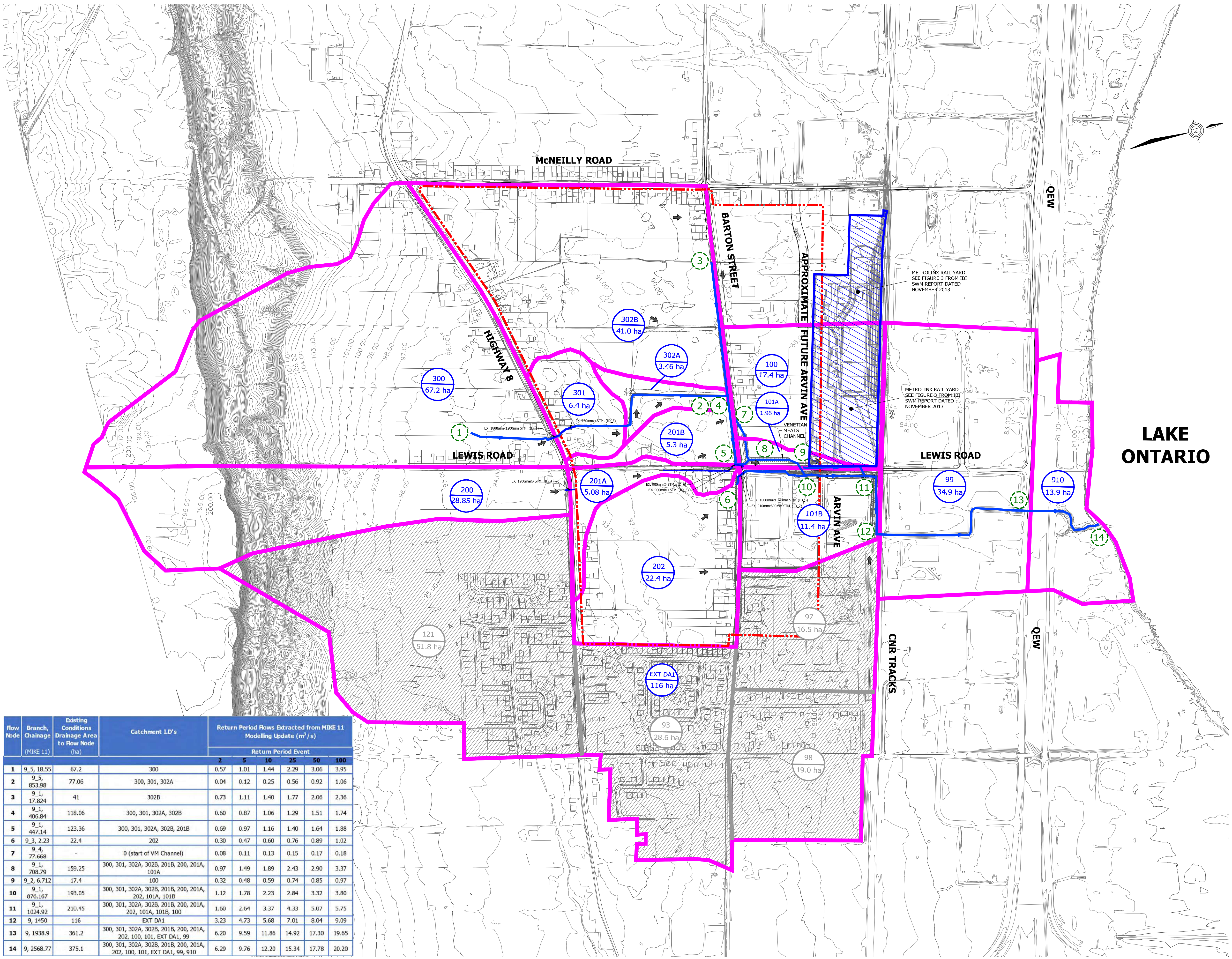
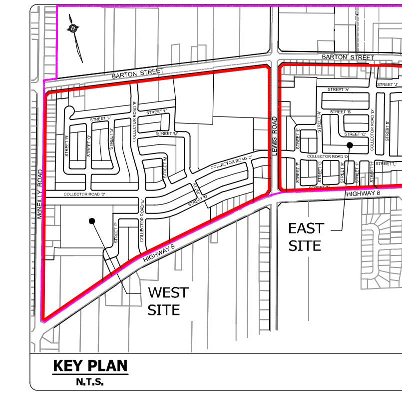


Flow Node	Branch, Chainage (MIKE 11)	Existing Conditions Drainage Area to Flow Node (ha)	Catchment I.D's	Return Period Flows Extracted from MIKE 11 Modelling Update (m^3/s) — Return Period Event: 2	5	10	25	50	100
1	9_5, 18.55	67.2	300	0.57	1.01	1.44	2.29	3.06	3.95
2	9_5, 853.98	77.06	300, 301, 302A	0.04	0.12	0.25	0.56	0.92	1.06
3	9_1, 17.824	41	302B	0.73	1.11	1.40	1.77	2.06	2.36
4	9_1, 406.84	118.06	300, 301, 302A, 302B	0.60	0.87	1.06	1.29	1.51	1.74
5	9_1, 447.14	123.36	300, 301, 302A, 302B, 201B	0.69	0.97	1.16	1.40	1.64	1.88
6	9_3, 2.23	22.4	202	0.30	0.47	0.60	0.76	0.89	1.02
7	9_4, 77.668	-	0 (start of VM Channel)	0.08	0.11	0.13	0.15	0.17	0.18
8	9_1, 708.79	159.25	300, 301, 302A, 302B, 201B, 200, 201A, 101A	0.97	1.49	1.89	2.43	2.90	3.37
9	9_2, 6.712	17.4	100	0.32	0.48	0.59	0.74	0.85	0.97
10	9_1, 876.167	193.05	300, 301, 302A, 302B, 201B, 200, 201A, 202, 101A, 101B	1.12	1.78	2.23	2.84	3.32	3.80
11	9_1, 1024.92	210.45	300, 301, 302A, 302B, 201B, 200, 201A, 202, 101A, 101B, 100	1.60	2.64	3.37	4.33	5.07	5.75
12	9, 1450	116	EXT DA1	3.23	4.73	5.68	7.01	8.04	9.09
13	9, 1938.9	361.2	300, 301, 302A, 302B, 201B, 200, 201A, 202, 100, 101, EXT DA1, 99	6.20	9.59	11.86	14.92	17.30	19.65
14	9, 2568.77	375.1	300, 301, 302A, 302B, 201B, 200, 201A, 202, 100, 101, EXT DA1, 99, 910	6.29	9.76	12.20	15.34	17.78	20.20

PLOT DATE: February-27-20 6:25:25 PM



KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- EXISTING INTERNAL DRAINAGE AREA BOUNDARY
- WATERCOURSE
- EXISTING CONTOUR & ELEVATION
- CATCHMENT I.D.
- DRAINAGE AREA (Ha.)
- OVERLAND FLOW
- FLOW NODE
- ORIGINAL SCUBE STUDY CATCHMENT

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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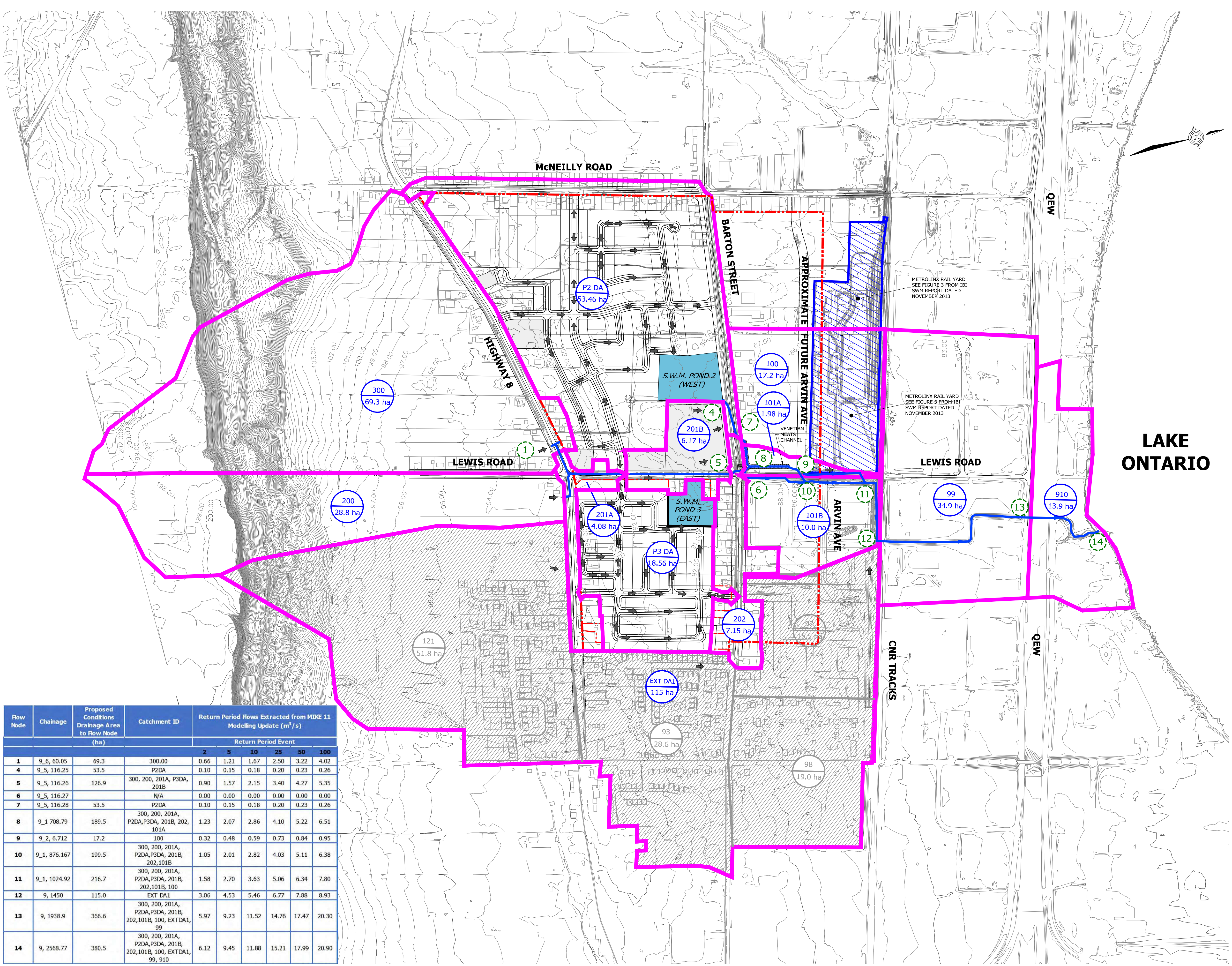
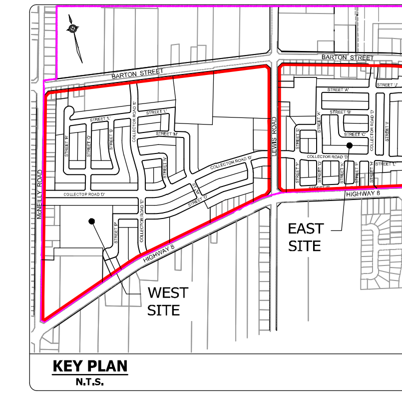
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

EXISTING DRAINAGE PLAN
(SCENARIO 1)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:5000	**SWM-5**

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_EXISITING MAJOR DRAINAGE PLAN.DWG





LEGEND

- LIMIT OF STUDY AREA
- PROPOSED INTERNAL DRAINAGE AREA BOUNDARY
- WATERCOURSE
- EXISTING CONTOUR & ELEVATION
- CATCHMENT I.D.
- DRAINAGE AREA (Ha.)
- OVERLAND FLOW
- FLOW NODE
- ORIGINAL SCUBE STUDY CATCHMENT

Flow Node	Chainage	Proposed Conditions Drainage Area to Flow Node (ha)	Catchment ID	Return Period Flows Extracted from MIKE 11 Modelling Update (m^3/s)					
				Return Period Event					
				2	5	10	25	50	100
1	9_6, 60.05	69.3	300.00	0.66	1.21	1.67	2.50	3.22	4.02
4	9_5, 116.25	53.5	P2DA	0.10	0.15	0.18	0.20	0.23	0.26
5	9_5, 116.26	126.9	300, 200, 201A, P3DA, 201B	0.90	1.57	2.15	3.40	4.27	5.35
6	9_5, 116.27		N/A	0.00	0.00	0.00	0.00	0.00	0.00
7	9_5, 116.28	53.5	P2DA	0.10	0.15	0.18	0.20	0.23	0.26
8	9_1 708.79	189.5	300, 200, 201A, P2DA,P3DA, 201B, 202, 101A	1.23	2.07	2.86	4.10	5.22	6.51
9	9_2, 6.712	17.2	100	0.32	0.48	0.59	0.73	0.84	0.95
10	9_1, 876.167	199.5	300, 200, 201A, P2DA,P3DA, 201B, 202,101B	1.05	2.01	2.82	4.03	5.11	6.38
11	9_1, 1024.92	216.7	300, 200, 201A, P2DA,P3DA, 201B, 202,101B, 100	1.58	2.70	3.63	5.06	6.34	7.80
12	9, 1450	115.0	EXT DA1	3.06	4.53	5.46	6.77	7.88	8.93
13	9, 1938.9	366.6	300, 200, 201A, P2DA,P3DA, 201B, 202,101B, 100, EXTDA1, 99	5.97	9.23	11.52	14.76	17.47	20.30
14	9, 2568.77	380.5	300, 200, 201A, P2DA,P3DA, 201B, 202,101B, 100, EXTDA1, 99, 910	6.12	9.45	11.88	15.21	17.99	20.90

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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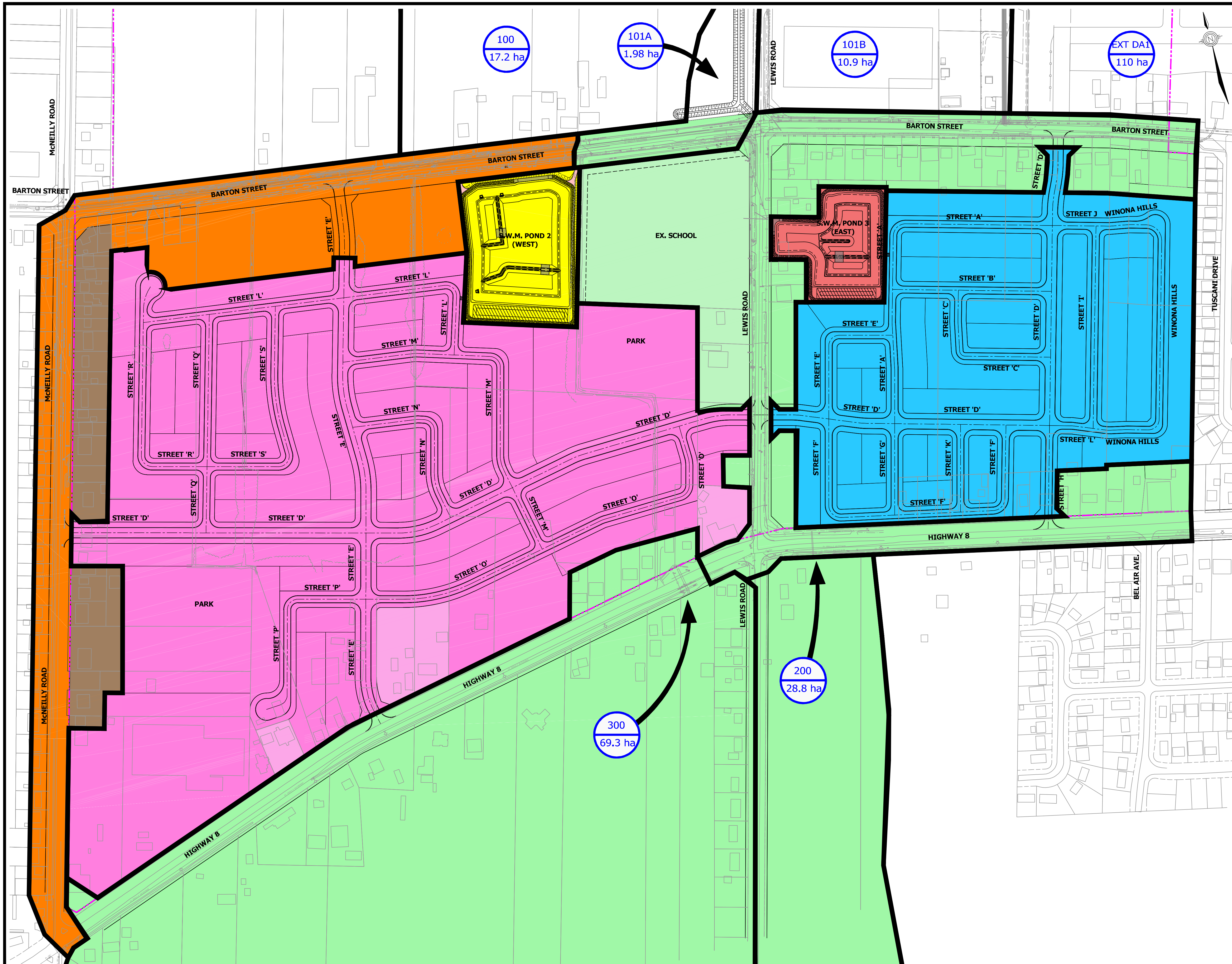
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PROPOSED DRAINAGE PLAN
(SCENARIO 2a)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:5000	SWM-6

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_PROPOSED MAJOR DRAINAGE PLAN.DWG

PLOT DATE: February-27-20 6:25:44 PM



KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- POST-DEVELOPMENT DRAINAGE AREA TO WEST POND HW-2 (12.59 ha, 75% Imperviousness)
- POST-DEVELOPMENT DRAINAGE AREA TO WEST POND HW-1 (37.99 ha, 66% Imperviousness)
- POST-DEVELOPMENT DRAINAGE AREA TO CHANNEL
- POST-DEVELOPMENT DRAINAGE AREA TO EAST POND (17.00 ha, Imperviousness 66.7%)
- WEST POND-2 (2.54 ha, 100% Imperviousness)
- EAST POND-3 (1.51 ha, 100% Imperviousness)

300 — CATCHMENT I.D.
69.3 ha — DRAINAGE AREA (ha)

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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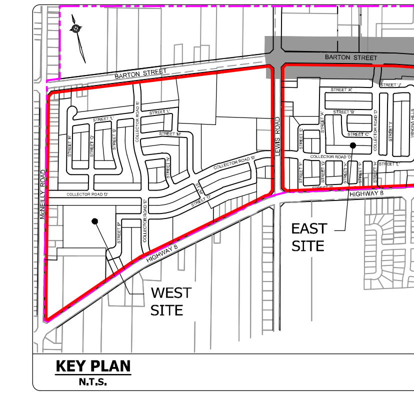
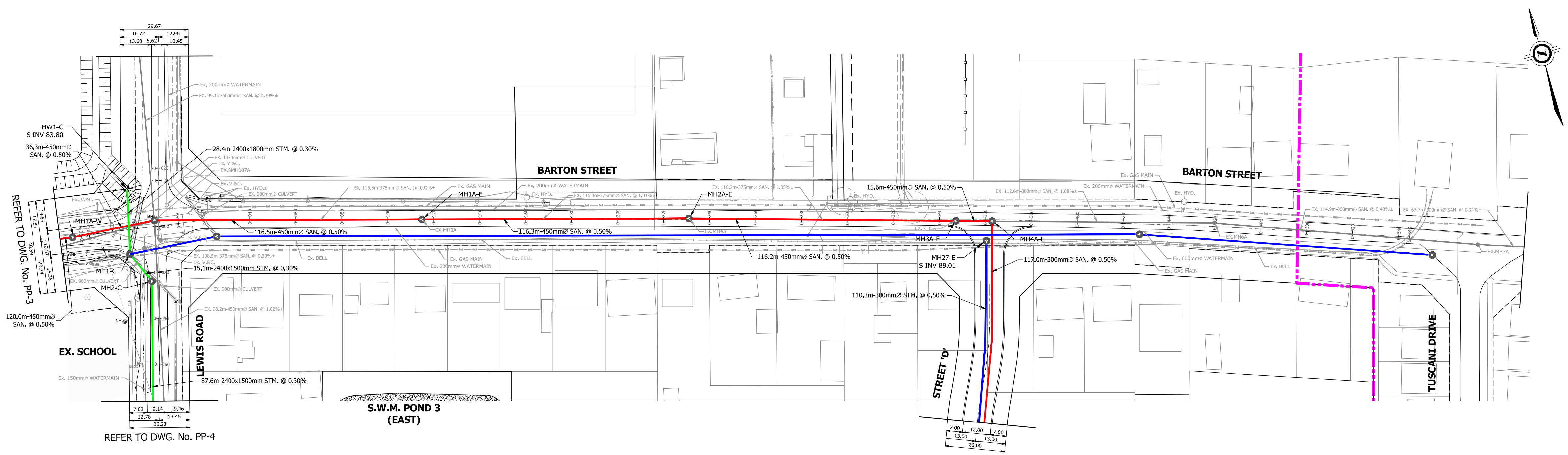
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

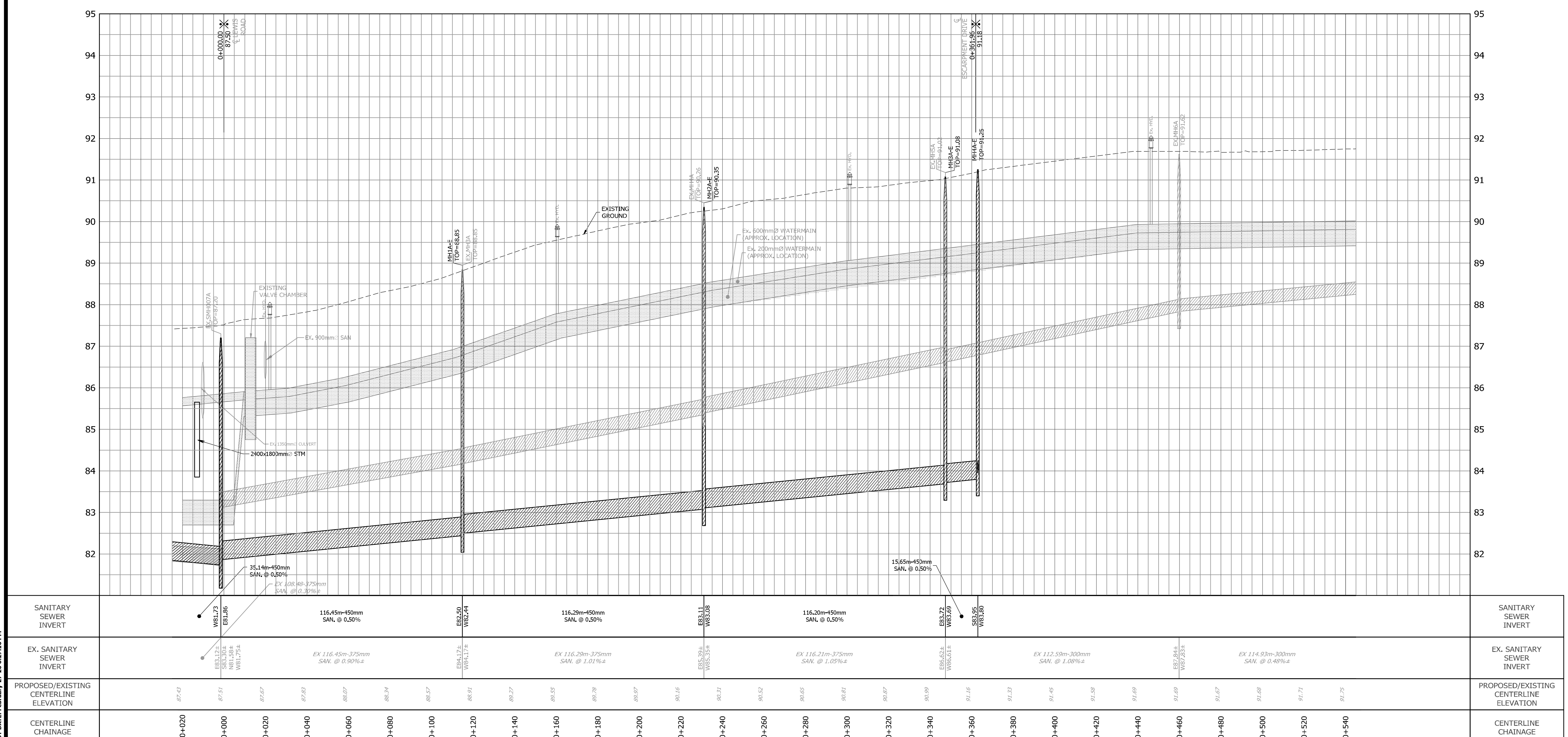
SWM DESIGN OVERVIEW ULTIMATE CONDITION

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	1:2000	SWM-7

F:\PROJECTS\12-062W (BRANTHAVEN-FRUITLAND WINONA)\DRAWINGS\FIGURES\12-062W_SWM DESIGN OVERVIEW.DWG







LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND

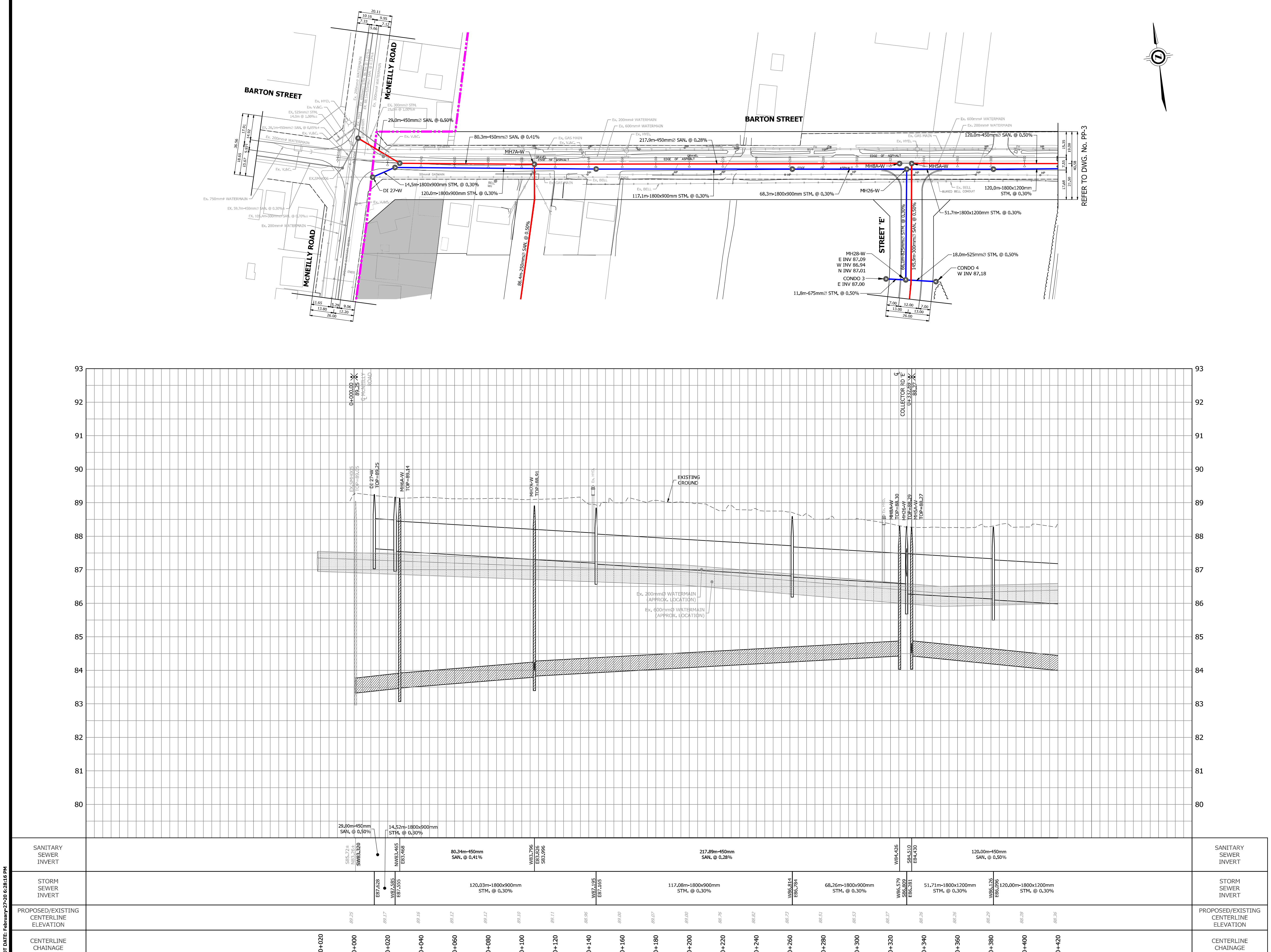
CITY OF HAMILTON

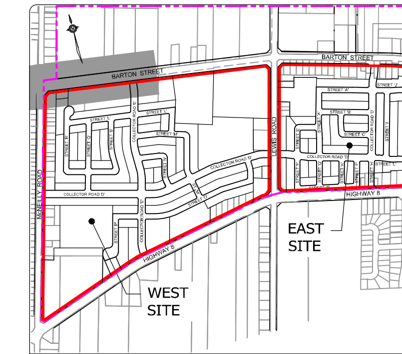
PRELIMINARY BARTON STREET EAST PLAN & PROFILE

FROM STA. -0+020.0m TO STA. 0+540.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-1

PLOT DATE: February-27-20 6:27:10 PM





KEY PLAN
N.T.S.

LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY BARTON STREET WEST PLAN & PROFILE 1
FROM STA. 0+000.0m TO STA. 0+420.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-2

PLOT DATE: February-27-20 6:28:16 PM
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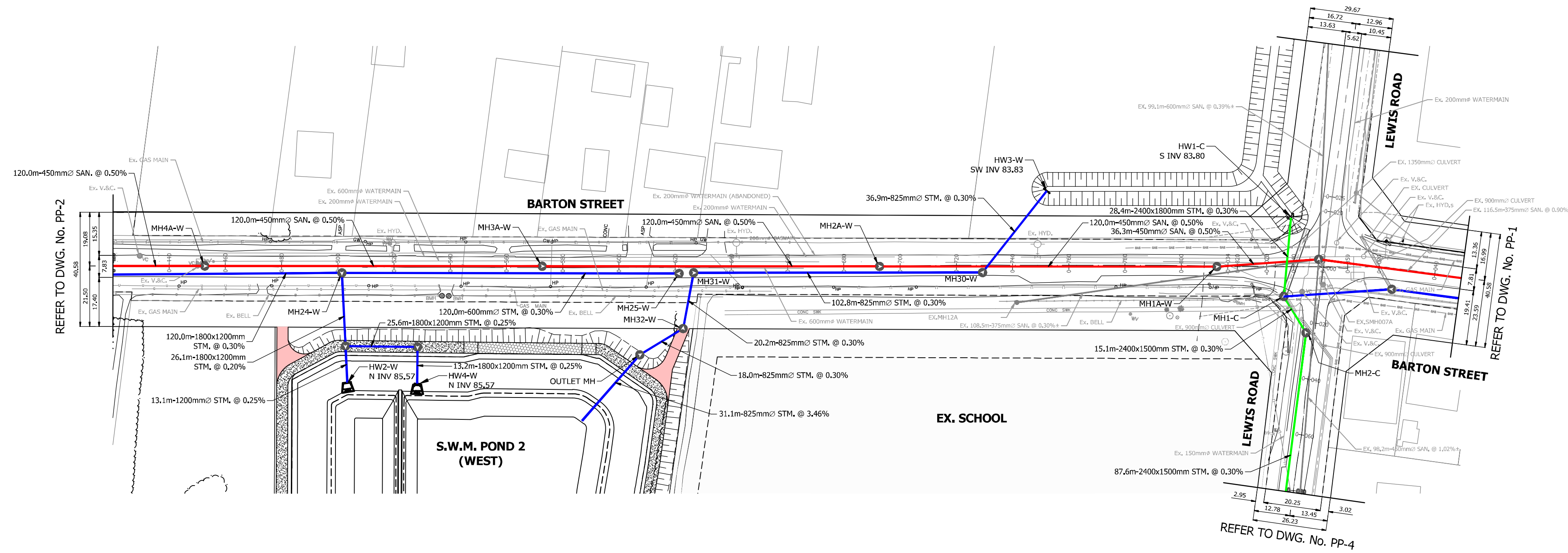
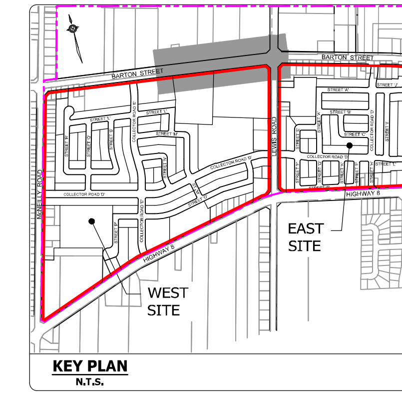
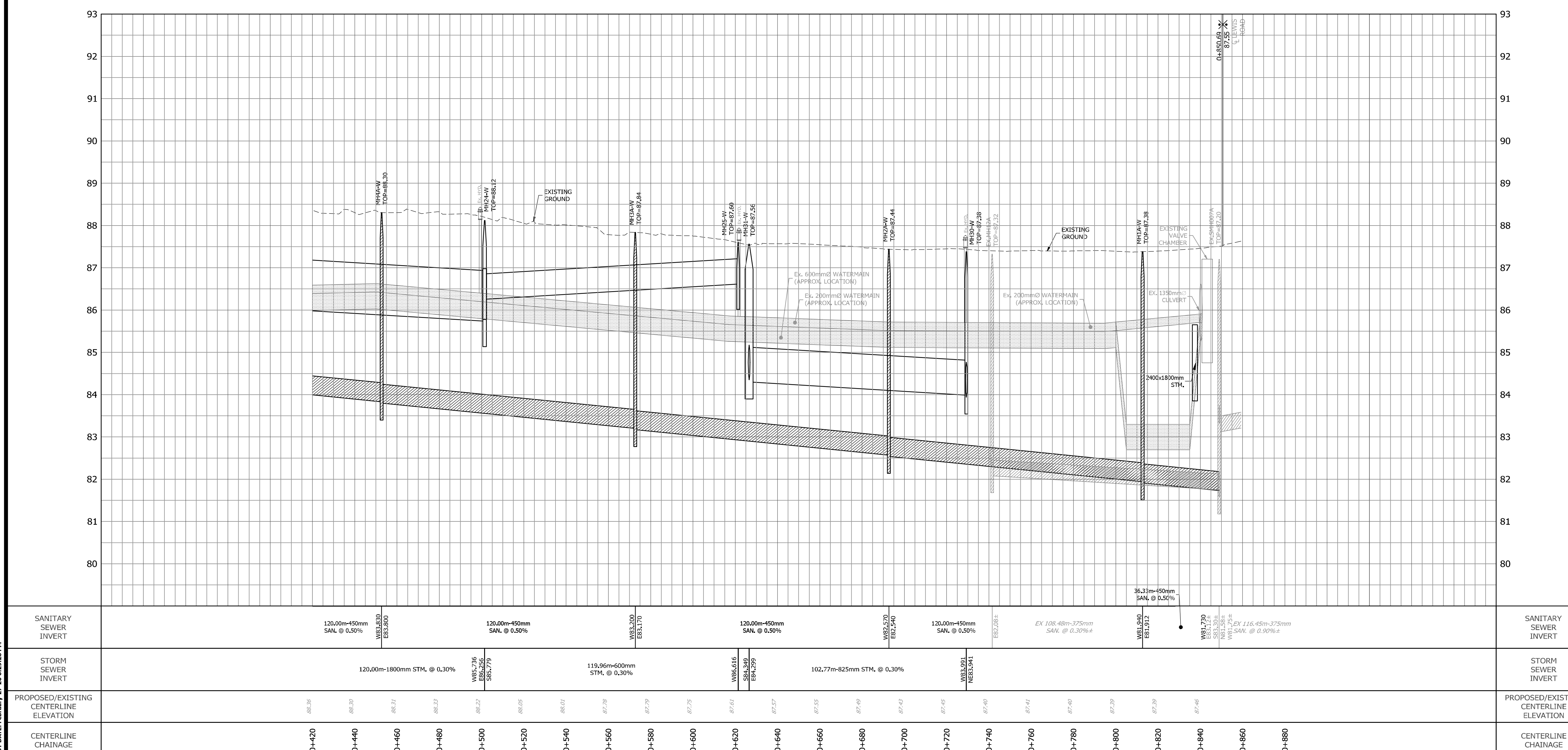




LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER



BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY BARTON STREET WEST PLAN & PROFILE 2
FROM STA. 0+420.0m TO STA. 0+840.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-3

PLOT DATE: February-27-20 6:29:26 PM
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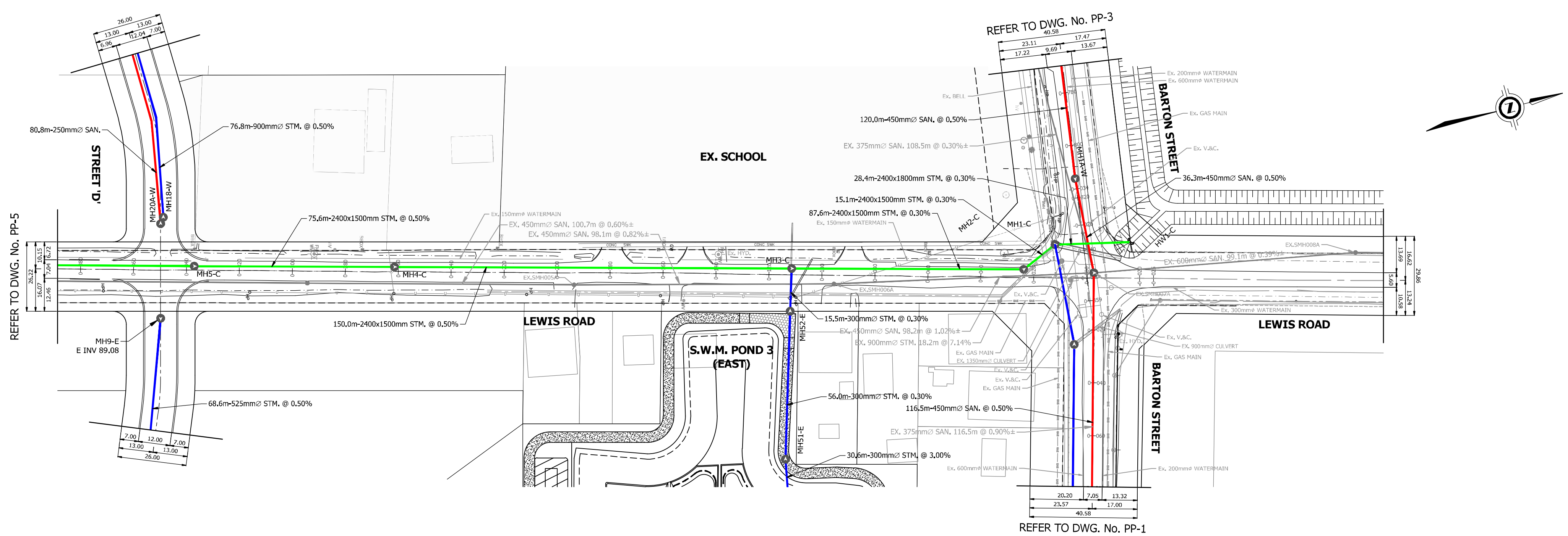
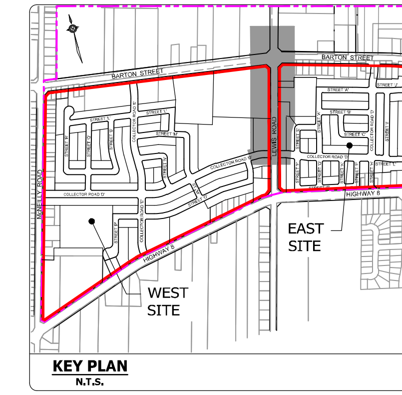
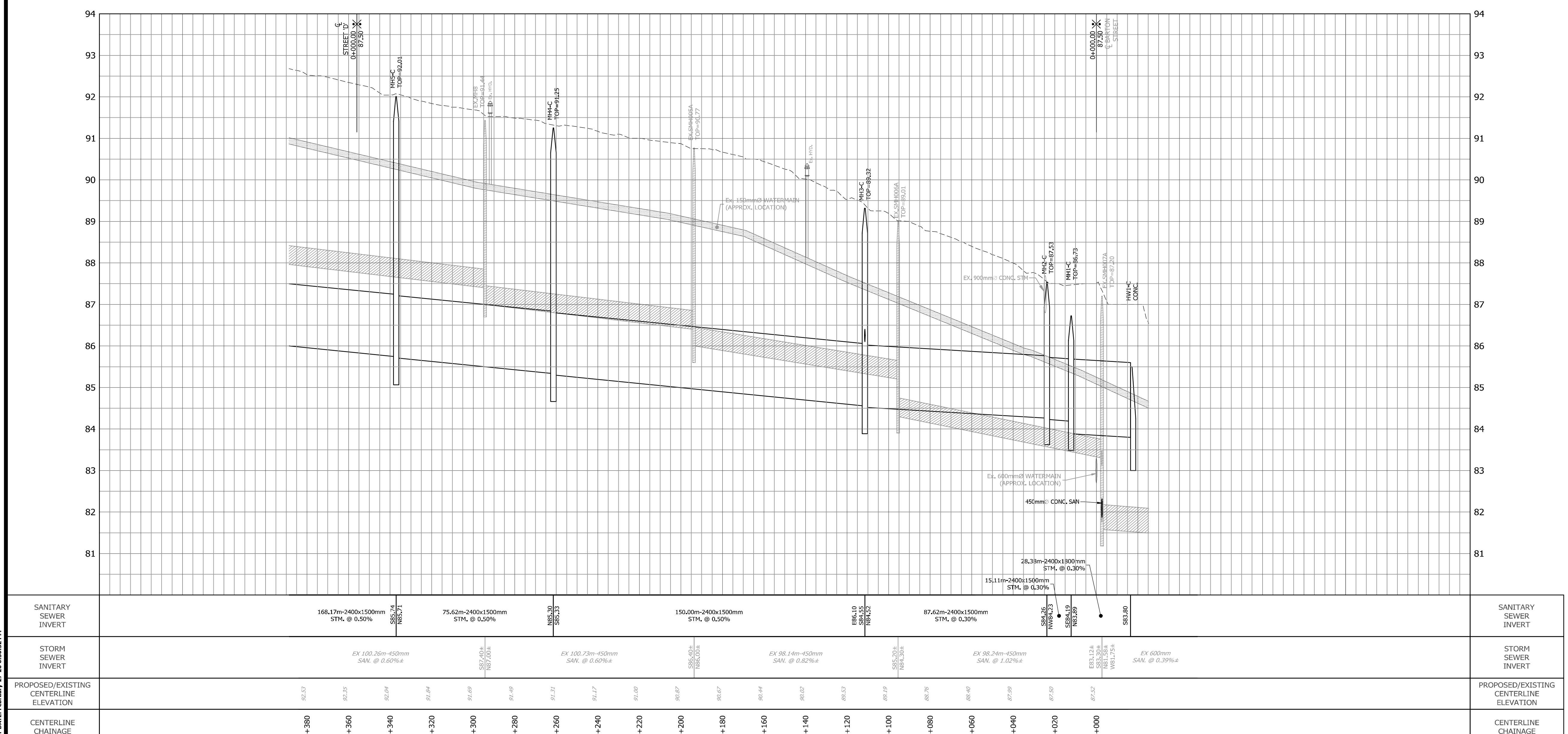




LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER



BENCHMARK

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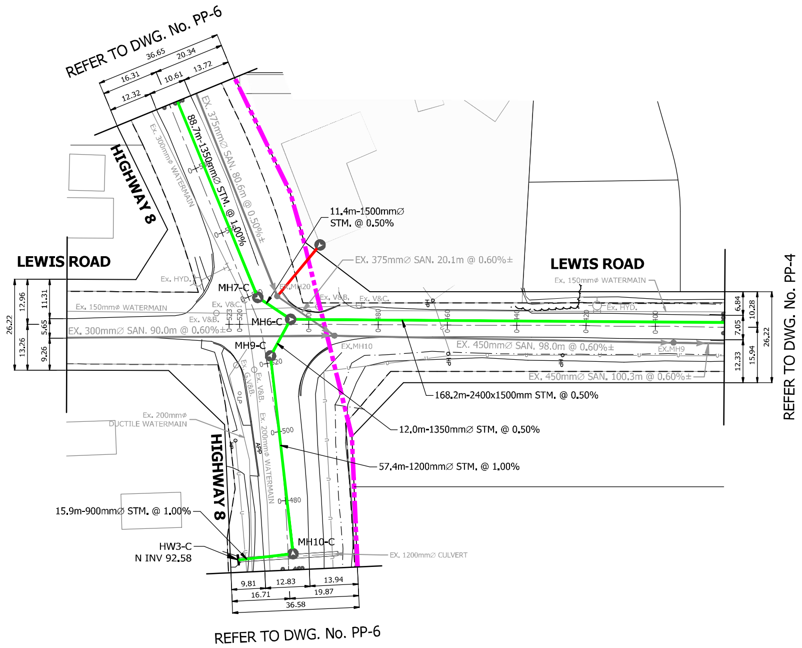
www.urbantech.com

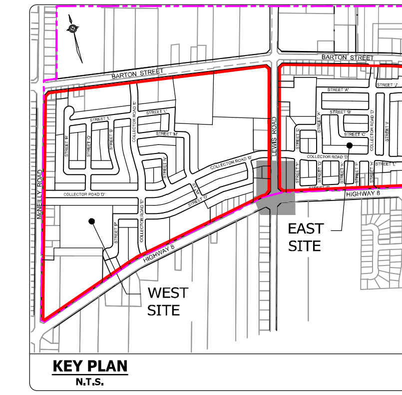
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY LEWIS ROAD PLAN & PROFILE
FROM STA. 0+000.0m TO STA. 0+380.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-4

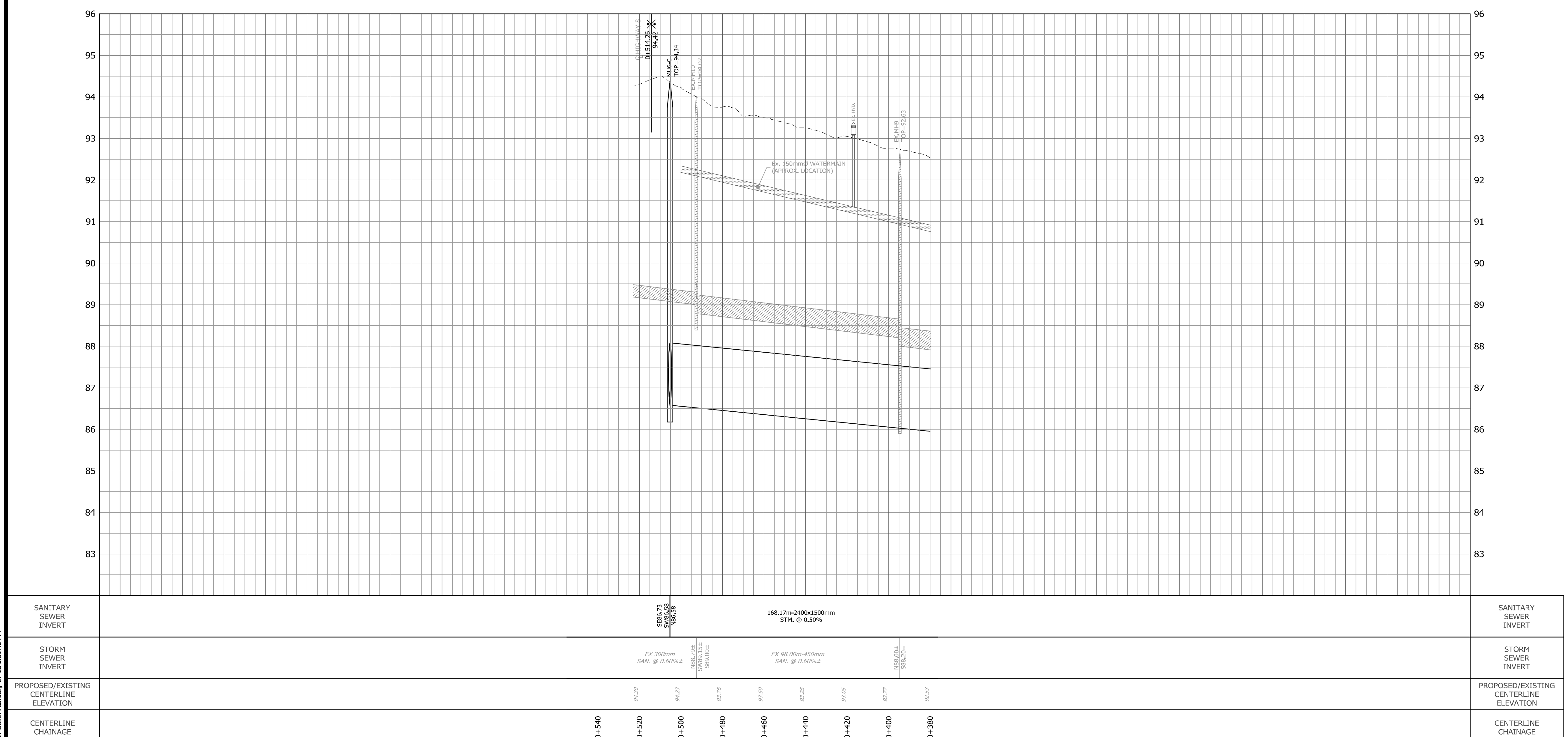
PLOT DATE: February-27-20 6:30:32 PM





LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER



BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

urbantech west
Urbantech Consulting, A Division of Leighton-Zec West Ltd.
2030 Bristol Circle, Suite 105 Oakville, Ontario L6H 0H2
tel: 905.829.8818 fax: 905.829.8904
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BRANTHAVEN FRUITLAND

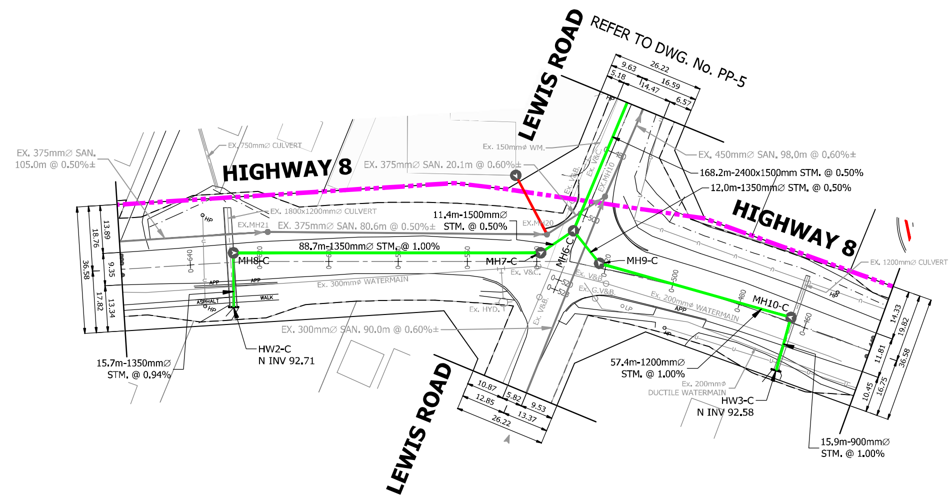
CITY OF HAMILTON

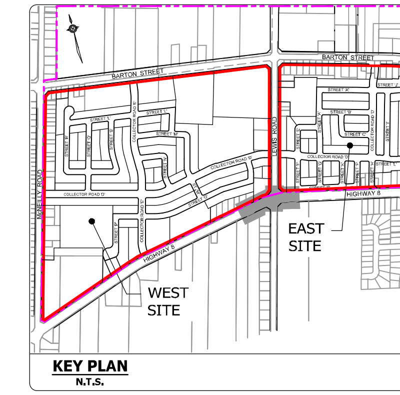
PRELIMINARY LEWIS ROAD PLAN & PROFILE

FROM STA. 0+380.0m TO STA. 0+540.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-5

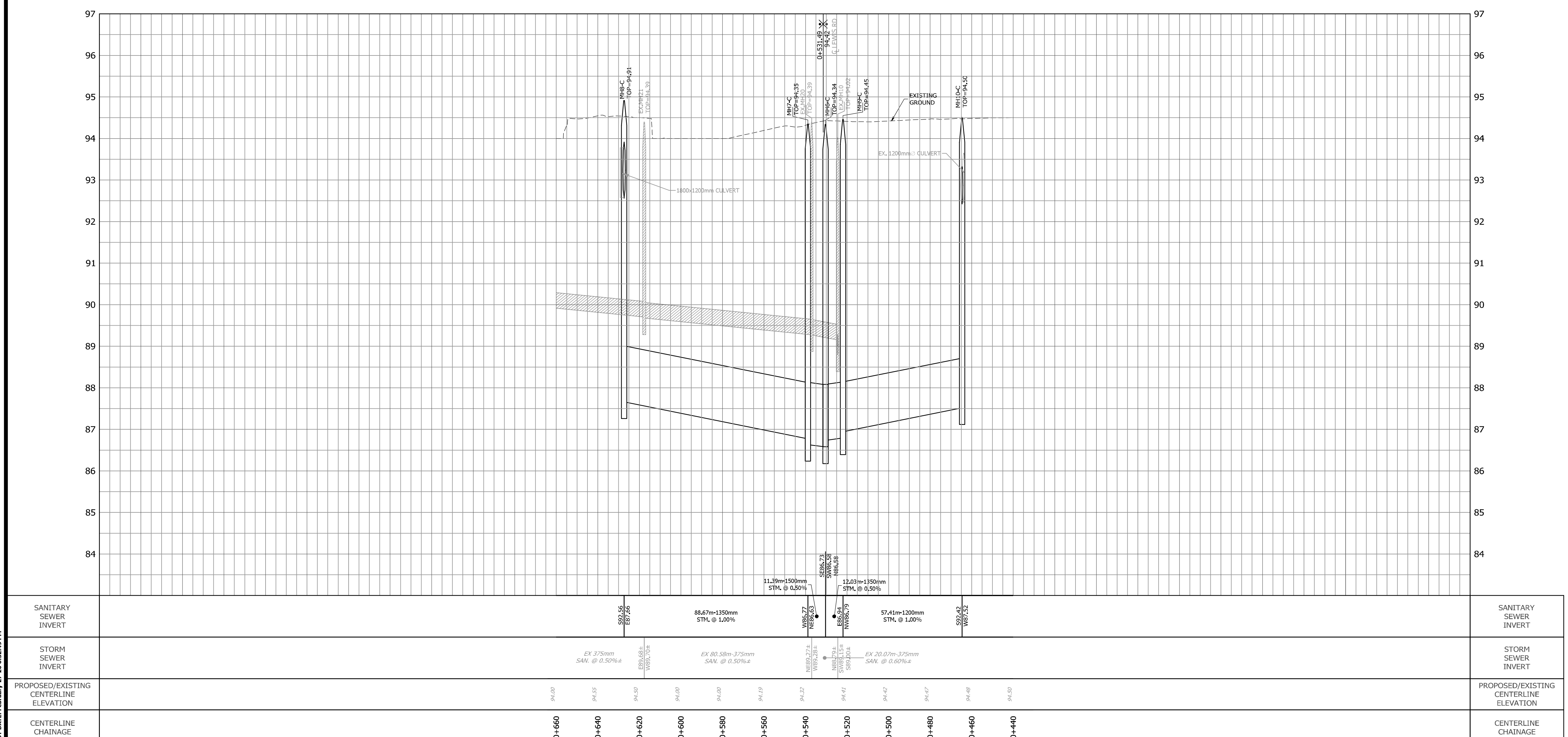
PLOT DATE: February-27-20 6:31:42 PM





LEGEND

- LIMIT OF STUDY AREA
- PROPOSED SANITARY SEWER
- PROPOSED PUBLIC STORM SEWER
- PROPOSED EXTERNAL CONVEYANCE SEWER
- EX SANITARY SEWER
- EX PUBLIC STORM SEWER



BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288.717 FT.)

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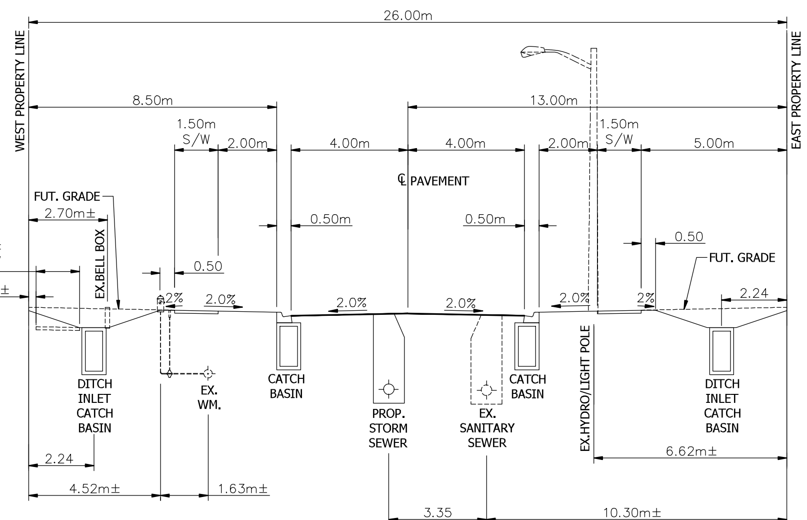
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY HIGHWAY 8 PLAN & PROFILE
FROM STA. 0+440.0m TO STA. 0+660.0m

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	V 1:50 H 1:1000	PP-6

PLOT DATE: February-27-20 6:32:49 PM

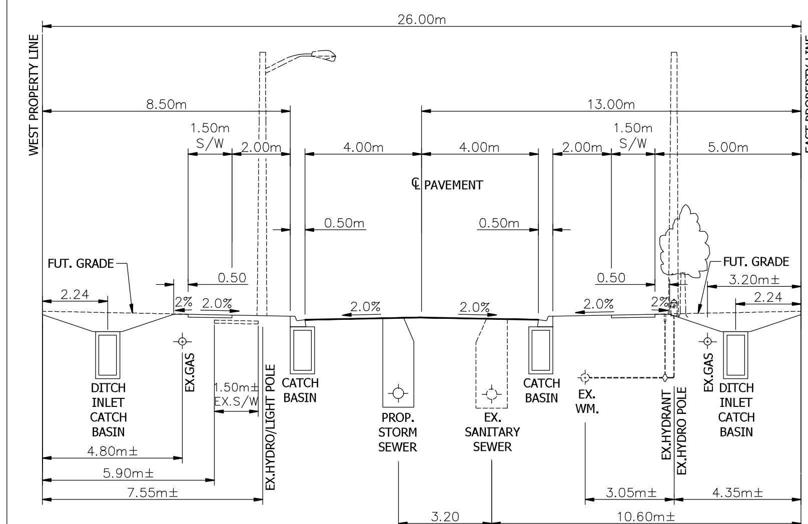


MINIMUM DEPTH OF COVER
SANITARY SEWER - 2.75m
STORM SEWER - 2.75m
WATERMAIN - 1.60m
HYDRO - 0.90m
CABLE - 0.90m
BELL - 0.90m
GAS - 0.60m

City of Hamilton
Public Works Department

LEWIS ROAD - 26.0m R.O.W.

DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED (N.T.S.)	DATE	REV. No.		HAMILTON STD. No.

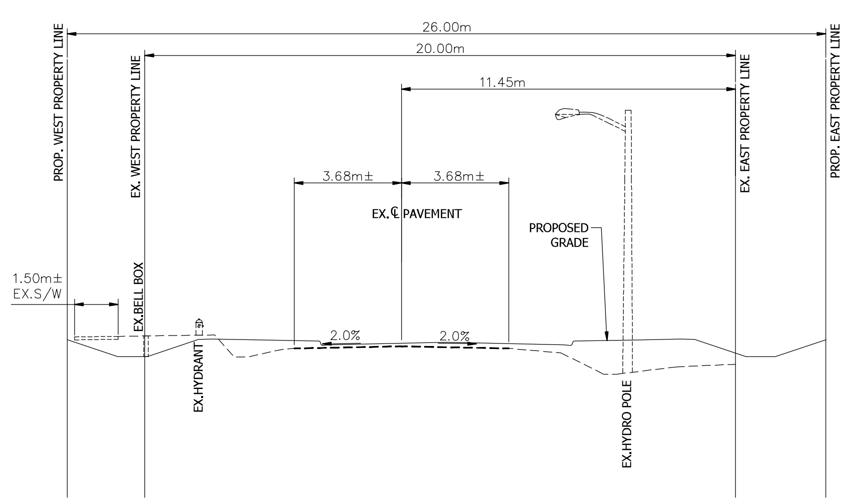


MINIMUM DEPTH OF COVER
SANITARY SEWER - 2.75m
STORM SEWER - 2.75m
WATERMAIN - 1.60m
HYDRO - 0.90m
CABLE - 0.90m
BELL - 0.90m
GAS - 0.60m

City of Hamilton
Public Works Department

McNEILLY ROAD - 26.0m R.O.W.

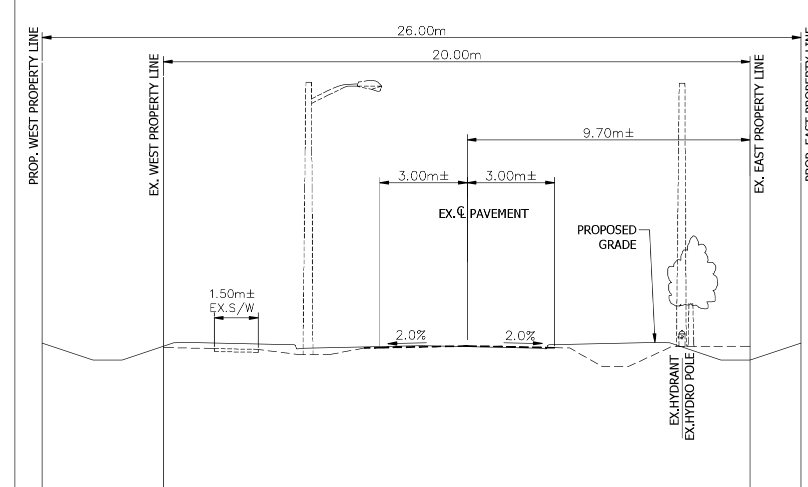
DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED (N.T.S.)	DATE	REV. No.		HAMILTON STD. No.



City of Hamilton
Public Works Department

EXISTING LEWIS ROAD - 20.0m R.O.W.

DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED (N.T.S.)	DATE	REV. No.		HAMILTON STD. No.



City of Hamilton
Public Works Department

EXISTING McNEILLY ROAD - 20.0m R.O.W.

DIMENSIONS SHOWN ARE IN MILLIMETRES UNLESS OTHERWISE NOTED (N.T.S.)	DATE	REV. No.		HAMILTON STD. No.

BENCHMARK

DEEP BENCH MARK IN MANHOLE AT WINONA HIGH SCHOOL, ALONG LEWIS ROAD AT BARTON STREET, IN FRONT LAWN 28.3m WEST OF CENTRE LINE OF LEWIS ROAD, 15.5m NORTH OF EAST CORNER OF SCHOOL, 12.2m SOUTHWEST OF CENTRE LINE OF PARKING LOT ENTRANCE, 12.8m SOUTHEAST OF FLAG POLE. ELEVATION 1978 ADJUSTMENT 88.001m (288,717 FT.)

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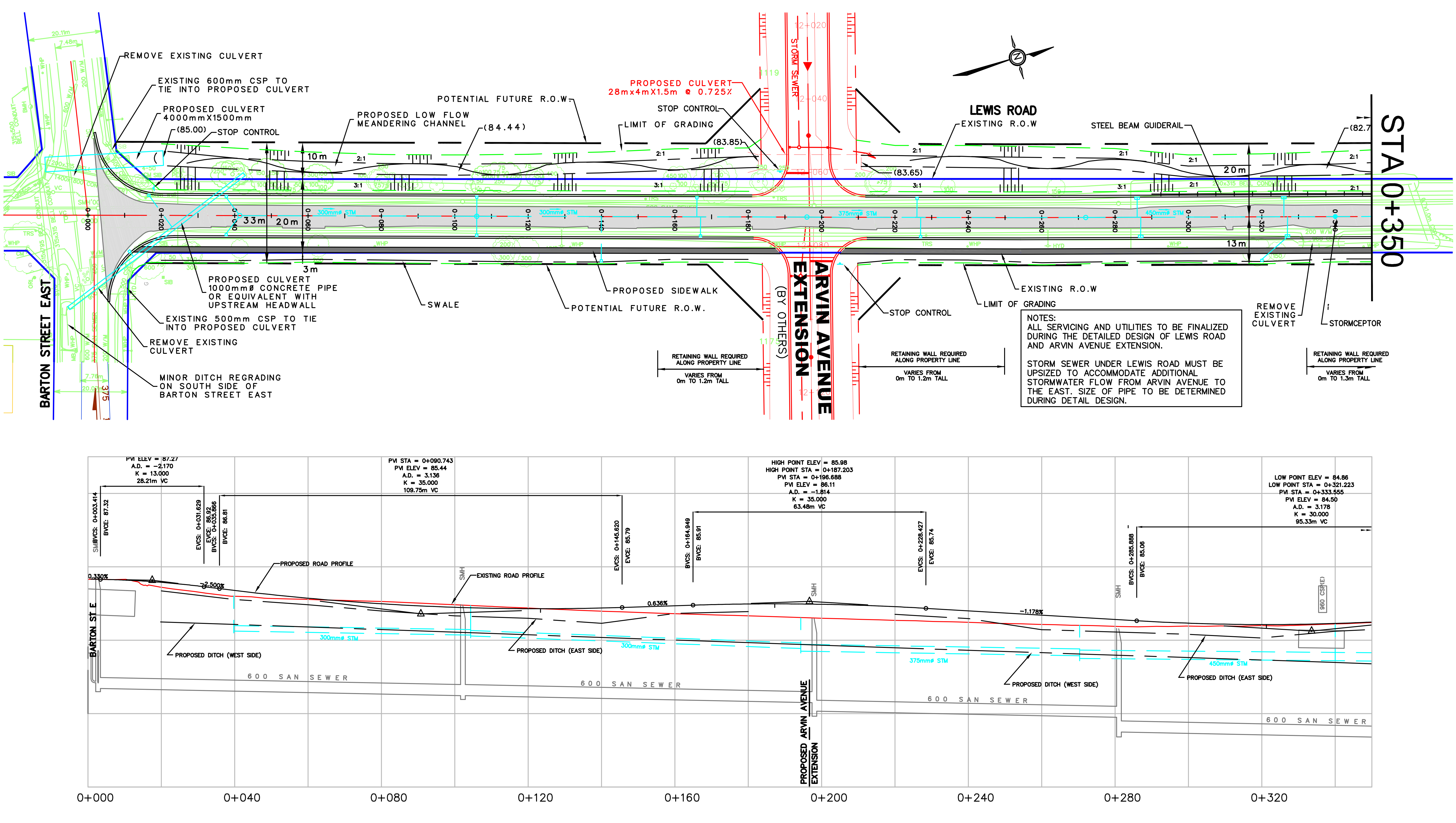
BRANTHAVEN FRUITLAND
CITY OF HAMILTON

PRELIMINARY ROAD CROSS-SECTIONS
(LEWIS ROAD & MCNEILLY ROAD)

PROJECT No.	DATE	SCALE	DWG No.
12-062W	AUG. 2018	N.T.S	ROW-1

ISSUED FOR INTERNAL REVIEW, Dec. 7, 2018

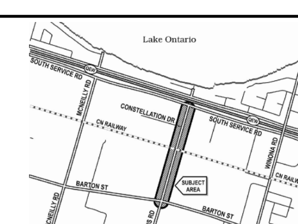
PLOT DATE: February-27-20 6:32:57 PM



PUBLIC WORKS DEPARTMENT
Capital Planning & Implementation Division
Strategic and Environmental Planning Section

iTRANS transportation planning and traffic consultants

KEYPLAN



SCALES
10m 0 25m
HORIZONTAL 1:1000
2m 0 5m
VERTICAL 1:100

LEWIS ROAD
Class Environmental Assessment Study
- CONCEPTUAL DESIGN -

Lewis Road
STA 0+000 TO STA 0+350

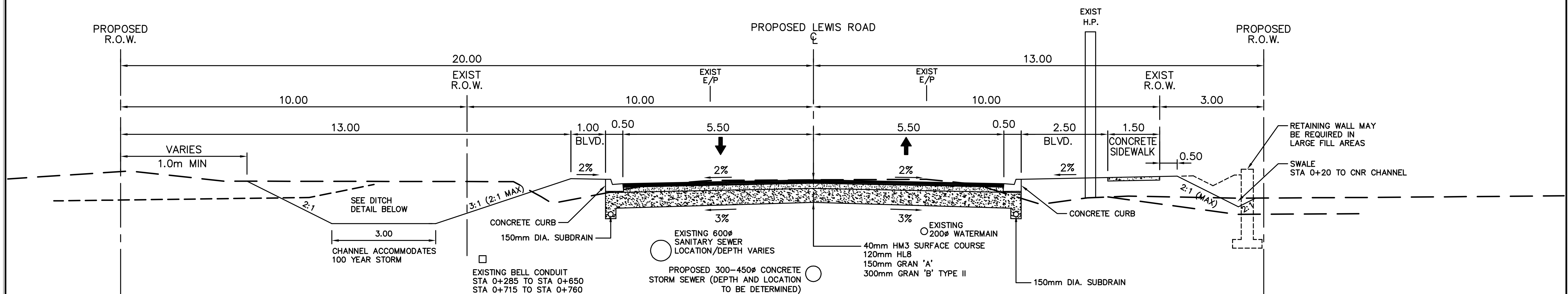
PLATE No.
1

FILENAME: M:\Hamilton City of\3321 Lewis Road Reconstruction EA\Design\5.2 Functional Designs\Active\3321-ESR-Plate-01.dwg
PLOTDATE: Oct 22, 2008 - 1:10pm
PLOTTED BY: chrisg

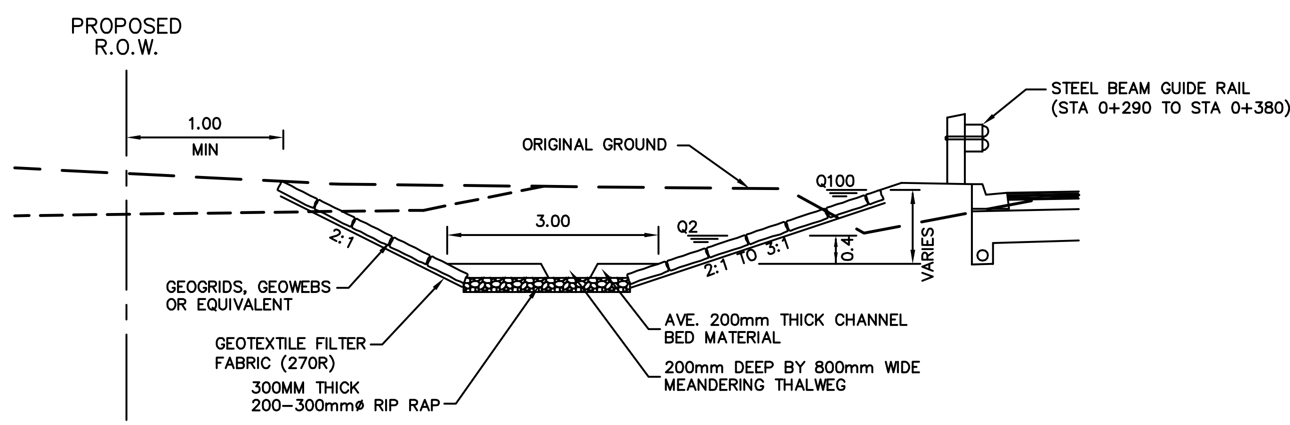
Preferred Typical Section
(Barton St to CNR)
Refined To Accommodate Arvin Avenue Extension

Lewis Road Reconstruction EA
September 11, 2008

Not to Scale



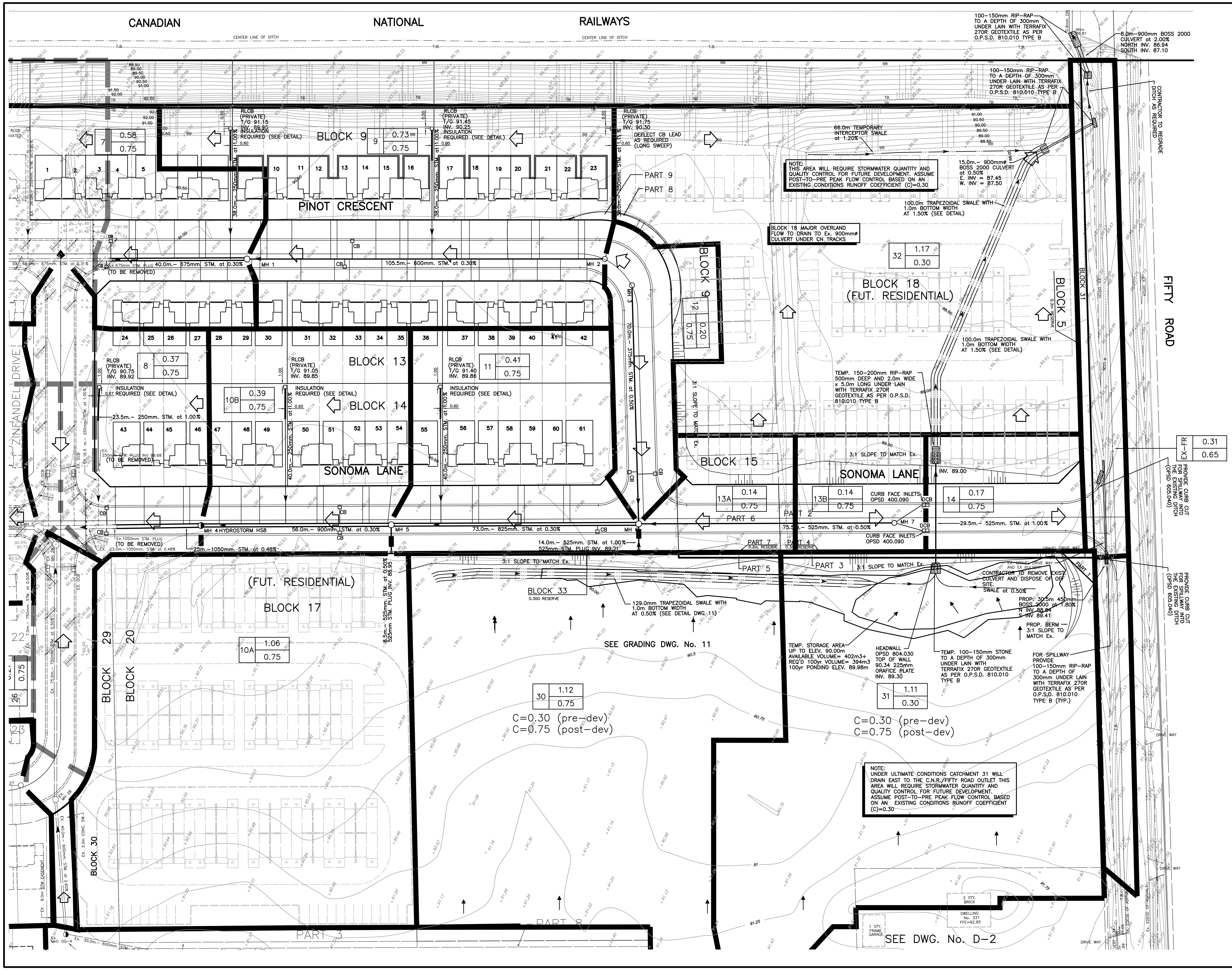
LEWIS ROAD PREFERRED TYPICAL SECTION (33.0m ROW)
FROM BARTON STREET TO CN RAILWAY
OPEN DRAINAGE DITCH WEST SIDE, STORM SEWER UNDER ROAD
ALTERNATIVE 3 – WIDEN ABOUT THE CENTRELINE



WEST CHANNEL DETAIL
WATERCOURSE 9

NOTE:
STORM SEWER UNDER LEWIS ROAD MUST BE UPSIZED TO ACCOMMODATE ADDITIONAL STORMWATER FLOW FROM ARVIN AVENUE TO THE EAST. SIZE OF PIPE TO BE DETERMINED DURING DETAIL DESIGN.

PRELIMINARY – TO BE CONFIRMED DURING DETAILED DESIGN



LEGEND:

1 / 0.53 / 0.45	AREA IN HECTARES; RUN-OFF CO-EFFICIENT; AREA NUMBER
(heavy line)	STORM AREA DRAINAGE BOUNDARY
(arrow)	OVERLAND FLOW ROUTE

NOTES:

1. FOR GENERAL NOTES AND DETAILS SEE DWG. No. 1

BENCH MARK NOTE:

ELEVATIONS SHOWN HEREON ARE GEODETIC AND ARE REFERRED TO HAMILTON-WENTWORTH BENCHMARK 75U181, LOCATED ON TOP OF CONCRETE MONUMENT, NORTH-EAST CORNER OF HIGHWAY 8 AND FIFTY ROAD ON BOX CULVERT 88.574 METRES.

NO.	DATE	BY	REVISIONS
3.	MAY/21		ISSUED FOR REVISED SECOND SUBMISSION
2.	MARCH/21		ISSUED FOR SECOND SUBMISSION
1.	JULY/20		ISSUED FOR FIRST SUBMISSION

DESIGN	SL	CHK'D	SL	DATE MAY 2020
DRAWN	B.E.K.	CHK'D	S.L.	

SCALE HORIZ. 1:500

APPROVALS

STAMP: LICENSED PROFESSIONAL ENGINEER — MAY 03 2021 — B.S. LLEWELLYN — PROVINCE OF ONTARIO

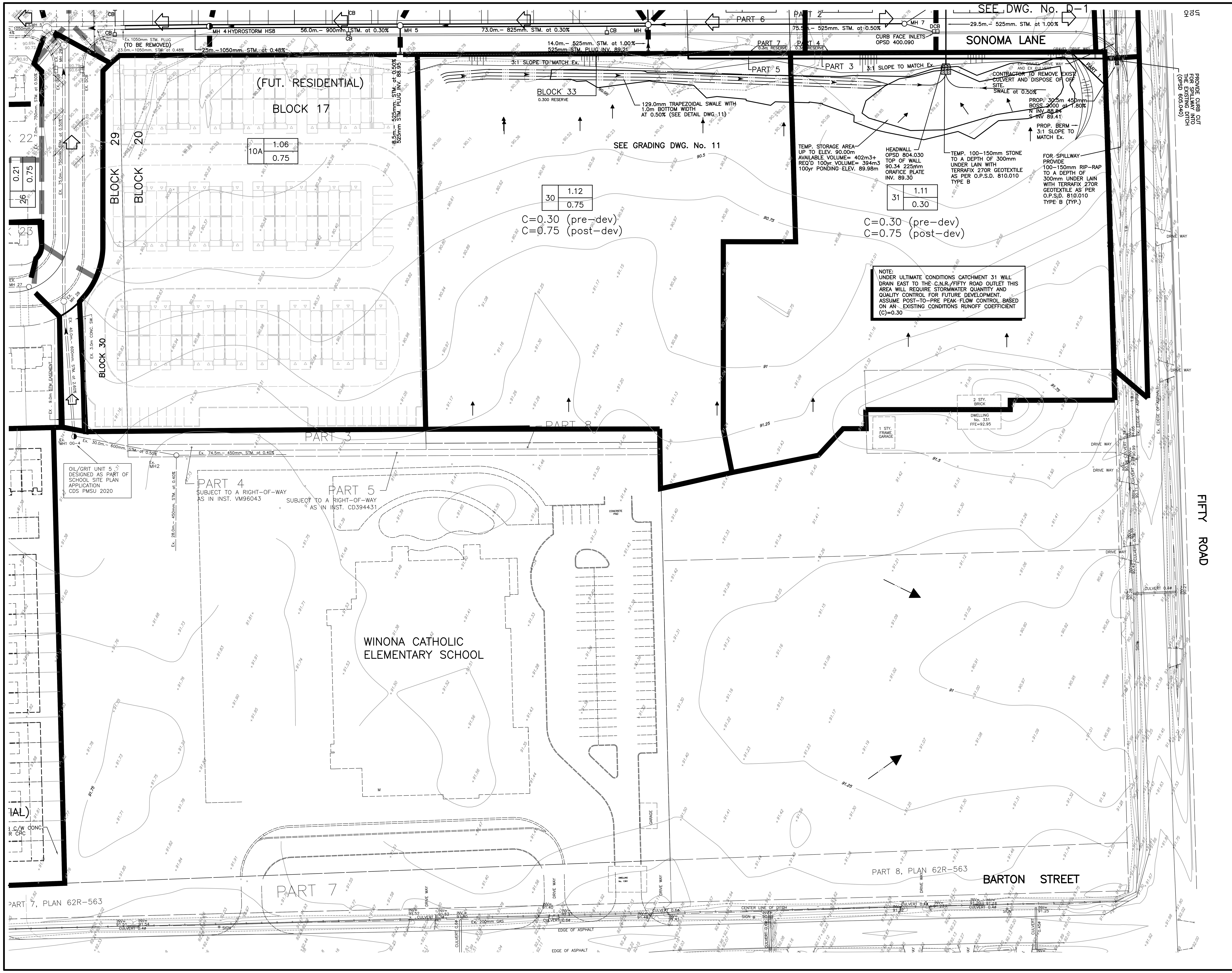
S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS
Tel. (905) 631-6978
email: info@sla.on.ca
3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

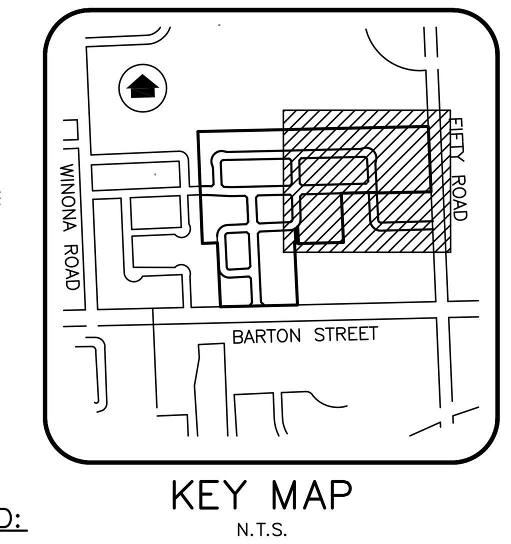
THE CITY OF HAMILTON

5000933 ONTARIO INC.
THE FOOTHILLS OF WINONA PHASE 3
25T-201107 AND 25T-201304

STORM DRAINAGE AREA PLAN

PROJECT 18136 — D-1





KEY MAP
N.T.S.

LEGEND:

1 | 0.53 / 0.45 — AREA IN HECTARES; RUN-OFF CO-EFFICIENT; AREA NUMBER

STORM AREA DRAINAGE BOUNDARY

OVERLAND FLOW ROUTE

NOTES:

1. FOR GENERAL NOTES AND DETAILS SEE DWG. No. 1

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NO.	DATE	BY	REVISIONS
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DESIGN	SL	CHK'D	SL	DATE MAY 2020
DRAWN	B.E.K.	CHK'D	S.L.	

SCALE HORIZ. 15 10 5 0 15 1:500

APPROVALS

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THE CITY OF
HAMILTON

5000933 ONTARIO INC.
THE FOOTHILLS OF WINONA PHASE 3
25T–201107 AND 25T–201304

STORM DRAINAGE AREA PLAN

PROJECT 18136

D–2

Appendix B
Calculations

A.2 Soil Characteristics

Soil Texture Class	K	Ψ	ϕ	FC	WP
Sand	4.74	1.93	0.437	0.062	0.024
Loamy Sand	1.18	2.40	0.437	0.105	0.047
Sandy Loam	0.43	4.33	0.453	0.190	0.085
Loam	0.13	3.50	0.463	0.232	0.116
Silt Loam	0.26	6.69	0.501	0.284	0.135
Sandy Clay Loam	0.06	8.66	0.398	0.244	0.136
Clay Loam	0.04	8.27	0.464	0.310	0.187
Silty Clay Loam	0.04	10.63	0.471	0.342	0.210
Sandy Clay	0.02	9.45	0.430	0.321	0.221
Silty Clay	0.02	11.42	0.479	0.371	0.251
Clay	0.01	12.60	0.475	0.378	0.265

K = saturated hydraulic conductivity, in/hr
Ψ = suction head, in.
ϕ = porosity, fraction
FC = field capacity, fraction
WP = wilting point, fraction

Source: Rawls, W.J. et al., (1983). *J. Hyd. Engr.*, 109:1316.

Note: The following relation between Ψ and K can be derived from this table:

$$\mathbf{\Psi} = 3.23\,\mathbf{K}^{-0.328} \quad (R^2 = 0.9)$$

Obtained from Table A.2 (page 178) from the EPA SWMM 5.1 Manual					
Soil Texture Class	**Saturated Hydraulic Conductivity (in/hr)**	**Suction Head (in)**	**Porosity (Fraction)**	**Field Capacity (Fraction)**	**Wilting Point (Fraction)**
Sand	4.74	1.93	0.437	0.062	0.024
Loamy Sand	1.18	2.4	0.437	0.105	0.047
Sandy Loam	0.43	4.33	0.453	0.19	0.085
Loam	0.13	3.5	0.463	0.232	0.116
Silt Loam	0.26	6.69	0.501	0.284	0.135
Sandy Clay Loam	0.06	8.66	0.398	0.244	0.136
Clay Loam	0.04	8.27	0.464	0.31	0.187
Silty Clay Loam	0.04	10.63	0.471	0.342	0.21
Sandy Clay	0.02	9.45	0.43	0.321	0.221
Silty Clay Loam	0.02	11.42	0.479	0.371	0.251
Clay	0.01	12.6	0.475	0.378	0.265

Soil Texture Class	**Saturated Hydraulic Conductivity (mm/hr)**	**Suction Head (mm)**	**Porosity (Fraction)**	**Field Capacity (Fraction)**	**Wilting Point (Fraction)**
Sand	120.4	49.0	0.437	0.062	0.024
Loamy Sand	30.0	61.0	0.437	0.105	0.047
Sandy Loam	10.9	110.0	0.453	0.19	0.085
Loam	3.3	88.9	0.463	0.232	0.116
Silt Loam	6.6	169.9	0.501	0.284	0.135
Sandy Clay Loam	1.5	220.0	0.398	0.244	0.136
Clay Loam	1.0	210.1	0.464	0.31	0.187
Silty Clay Loam	1.0	270.0	0.471	0.342	0.21
Sandy Clay	0.5	240.0	0.43	0.321	0.221
Silty Clay Loam	0.5	290.1	0.479	0.371	0.251
Clay	0.3	320.0	0.475	0.378	0.265

Soil Name	**Symbol**	**Soil Type**	**Green and Ampt Parameters**		
			Suction Head (mm)	**Conductivity (mm/hr)**	**Initial Deficit (-)**
Jeddo	Jo	Sandy Loam	109.98	10.92	0.246
Morley	Mo	Silty Clay Loam	270.00	1.02	0.105
Trafalgar	Tr	Silty Clay Loam	270.00	1.02	0.105
Winona	Wi	Sandy Loam	109.98	10.92	0.246
Stream Course		Silty Clay Loam	270.00	1.02	0.105
Oneida	Ol	Loam	88.90	3.30	0.193
CHINGUACOUSY	Ci	Silt Loam	169.93	6.60	0.171
FARMINGTON	Fl	Loam	88.90	3.30	0.193
Escarpment		Clay	320.04	0.25	0.079

City of Hamilton
STORM SEWER DESIGN CALCULATIONS

Wood Environment & Infrastructure Solutions

Job No.: TPB166053 - Barton Street & Fifty Road Class EA

Designed by: J Milton

Date: May 31, 2021

Revised by: P MacDonald

Date: July 8, 2021

wood.

DESIGN INFORMATION

Design Storm Parameters		Pipe Roughness
Min. Tc = 10 mins	A = 1049.5	n = 0.013
$i = A / (B + T_C)^C$	B = 8.0	min. v = 0.75 m/sec
	C = 0.803	max. v = 3.65 m/sec

Drainage Area No.	Street Name	STRUCTURE LOCATION		DRAINAGE AREA				RUNOFF					PROPOSED STORM SEWER DESIGN								REMARKS
		From	To	A (ha)	C	AC	Cumul. AC	Cumul. T_C	i (mm/hr)	5 Year Q (m^3/s)	100 Year Q From Trapped Area (m^3/s)	Total Q	Dia. (mm)	Pipe Material	Pipe Slope (%)	Actual Capacity (full) (m^3/s)	Velocity (full) m/s)	Pipe Length (m)	Time of Flow (min)	% Full	
N/A	Barton Street	MH 1A	MH 2A	0.57	0.70	0.399	0.399	10.00	103.04	0.11	0.00	0.114	450	RCP	0.30	0.163	0.99	87.69	1.47	70	NO SURCHARGE
N/A	Barton Street	MH 3A	MH 2A	1.28	0.74	0.942	0.942	10.00	103.04	0.27	0.00	0.270	600	RCP	0.30	0.351	1.20	119.31	1.65	77	NO SURCHARGE
N/A	Barton Street	MH 4A	MH 5A	1.14	0.82	0.929	0.929	10.00	103.04	0.27	0.00	0.266	525	RCP	0.50	0.317	1.42	75.00	0.88	84	NO SURCHARGE
N/A	Barton Street	MH 5A	MH 6A	0.70	0.85	0.598	1.527	10.88	99.16	0.42	0.00	0.420	675	RCP	0.50	0.621	1.68	71.64	0.71	68	NO SURCHARGE
N/A	Barton Street	MH 10A	MH 9A	0.60	0.73	0.439	0.439	10.00	103.04	0.13	0.00	0.126	450	RCP	0.25	0.149	0.91	102.00	1.88	85	NO SURCHARGE
N/A	Barton Street	MH 9A	MH 7A	1.02	0.79	0.803	1.242	11.88	95.15	0.33	0.00	0.328	675	RCP	0.25	0.439	1.19	120.00	1.68	75	NO SURCHARGE
N/A	Barton Street	MH 7A	MH 6A	0.45	0.83	0.374	1.615	13.56	89.13	0.40	0.00	0.400	675	RCP	0.50	0.621	1.68	57.36	0.57	64	NO SURCHARGE
N/A	Barton Street	MH 6A	Outlet	25.13	0.37	9.318	12.460	14.13	87.29	3.02	0.00	3.021	1350	RCP	0.50	3.940	2.67	36.50	0.23	77	NO SURCHARGE
N/A	Barton Street	MH 11A	MH 12A	0.71	1.15	0.816	0.816	10.00	103.04	0.23	0.00	0.234	525	RCP	0.50	0.317	1.42	62.77	0.74	74	NO SURCHARGE
N/A	Barton Street	MH 12A	MH 13A	0.57	0.76	0.432	1.248	10.74	99.77	0.35	0.00	0.346	675	RCP	0.25	0.439	1.19	120.00	1.68	79	NO SURCHARGE
N/A	Barton Street	MH 17A	MH 16A	0.85	0.74	0.626	0.626	10.00	103.04	0.18	0.00	0.179	525	RCP	0.30	0.245	1.10	120.00	1.82	73	NO SURCHARGE
N/A	Barton Street	MH 16A	MH 15A	0.76	0.79	0.599	1.224	11.82	95.37	0.32	0.00	0.324	675	RCP	0.35	0.519	1.40	120.00	1.42	62	NO SURCHARGE
N/A	Barton Street	MH 15A	MH 14A	0.17	0.69	0.117	1.342	13.24	90.20	0.34	0.00	0.336	675	RCP	0.40	0.555	1.50	44.32	0.49	61	NO SURCHARGE
N/A	Barton Street	MH 21A	MH 20A	0.73	0.78	0.567	0.567	10.00	103.04	0.16	0.00	0.162	525	RCP	0.25	0.224	1.00	90.00	1.49	72	NO SURCHARGE
N/A	Barton Street	MH 20A	MH 19A	0.55	0.79	0.436	1.003	11.49	96.64	0.27	0.00	0.269	600	RCP	0.25	0.321	1.10	90.00	1.37	84	NO SURCHARGE
N/A	Barton Street	MH 19A	MH 18A	0.84	0.79	0.665	1.667	12.86	91.53	0.42	0.00	0.424	750	RCP	0.20	0.519	1.14	120.00	1.76	82	NO SURCHARGE
N/A	Barton Street	MH 18A	OUTLET	0.00	0.00	0.000	1.667	14.62	85.78	0.40	0.00	0.397	750	RCP	0.20	0.519	1.14	27.10	0.40	76	NO SURCHARGE
N/A	Barton Street	MH 22A	MH 23A	0.58	0.74	0.431	0.431	10.00	103.04	0.12	0.00	0.123	450	RCP	0.50	0.210	1.28	64.00	0.83	59	NO SURCHARGE
N/A	Barton Street	MH 23A	MH 24A	1.19	0.57	0.674	1.104	10.83	99.36	0.30	0.23	0.535	750	RCP	0.50	0.821	1.80	94.60	0.88	65	NO SURCHARGE
N/A	Barton Street	MH 24A	MH 25A	1.55	0.72	1.121	2.226	11.71	95.80	0.59	0.00	0.592	750	RCP	0.50	0.821	1.80	84.80	0.78	72	NO SURCHARGE
N/A	Barton Street	MH 25A	MH 26A	0.00	0.00	0.000	2.226	12.49	92.85	0.57	0.00	0.574	750	RCP	0.50	0.821	1.80	89.10	0.82	70	NO SURCHARGE
N/A	Barton Street	MH 27A	MH 28A	0.52	0.66	0.343	0.343	10.00	103.04	0.10	0.00	0.098	450	RCP	0.25	0.149	0.91	73.50	1.35	66	NO SURCHARGE
N/A	Barton Street	MH 30A	MH 29A	14.19	0.22	3.183	3.183	10.00	103.04	0.91	0.00	0.911	825	RCP	0.55	1.110	2.01	91.46	0.76	82	NO SURCHARGE
N/A	Barton Street	MH 29A	MH 28A	0.22	0.66	0.145	3.328	10.76	99.68	0.92	0.00	0.922	825	RCP	0.55	1.110	2.01	70.00	0.58	83	NO SURCHARGE
N/A	Barton Street	MH 31A	MH 32A	0.74	0.68	0.504	0.504	10.00	103.04	0.14	0.00	0.144	450	RCP	0.50	0.210	1.28	110.00	1.43	69	NO SURCHARGE
N/A	Barton Street	MH 32A	EX MH J44	1.33	0.22	0.293	0.796	11.43	96.90	0.21	0.00	0.214	525	RCP	0.65	0.361	1.62	17.30	0.18	59	NO SURCHARGE
N/A	Barton Street	EX MH J-228	EX MH J-229	0.00	0.00	0.000	0.000	0.00	197.61	1.21	0.00	1.210	900	RCP	0.60	1.461	2.23	14.78	0.11	83	NO SURCHARGE
N/A	Barton Street	EX MH J-229	EX MH J-230	0.00	0.00	0.000	0.000	0.00	197.61	1.21	0.00	1.210	975	RCP	0.60	1.813	2.35	5.20	0.04	67	NO SURCHARGE
N/A	Barton Street	EX MH J-230	EX MH J-233	0.37	0.69	0.255	0.255	10.00	103.04	0.07	0.00	1.283	975	RCP	0.60	1.813	2.35	102.50	0.73	71	NO SURCHARGE

City of Hamilton
STORM SEWER DESIGN CALCULATIONS

Wood Environment & Infrastructure Solutions
Job No.: TPB166053 - Barton Street & Fifty Road Class EA
Designed by: J Milton
Date: May 31, 2021
Revised by: P MacDonald
Date: July 8, 2021

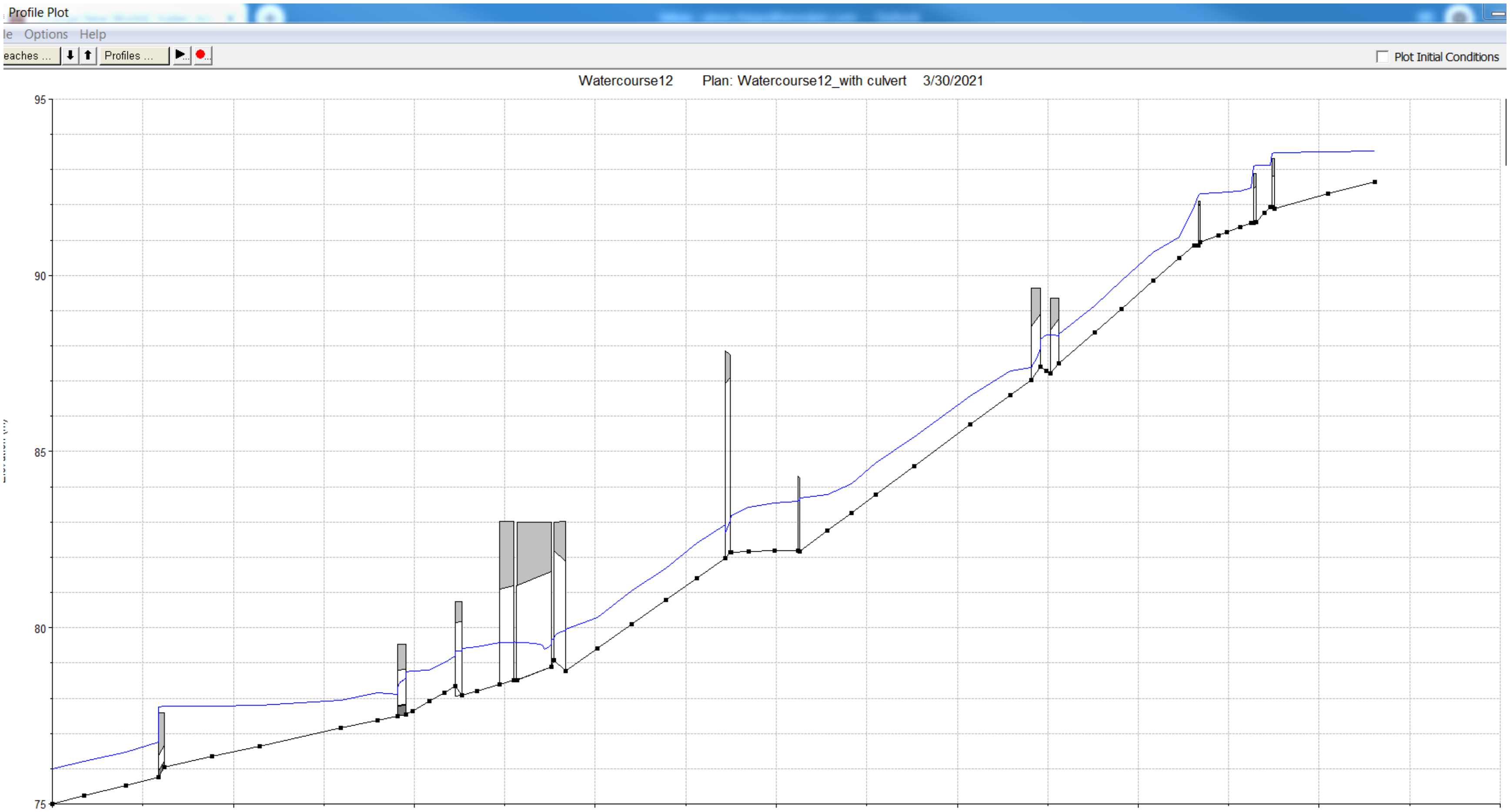
wood.

DESIGN INFORMATION

Design Storm Parameters		Pipe Roughness
Min. Tc = 10 mins	A = 1049.5	n = 0.013
$i = A / (B + T_C)^C$	B = 8.0	min. v = 0.75 m/sec
	C = 0.803	max. v = 3.65 m/sec

		STRUCTURE LOCATION		DRAINAGE AREA				RUNOFF					PROPOSED STORM SEWER DESIGN								
Drainage Area No.	Street Name	From	To	A (ha)	C	AC	Cumul. AC	Cumul. T_C	i (mm/hr)	5 Year Q (m^3/s)	100 Year Q From Trapped Area (m^3/s)	Total Q	Dia. (mm)	Pipe Material	Pipe Slope (%)	Actual Capacity (full) (m^3/s)	Velocity (full) m/s)	Pipe Length (m)	Time of Flow (min)	**% Full**	**REMARKS**
N/A	Barton Street	EX MH J-232	EX MH J-233	0.00	0.00	0.000	0.000	10.73	99.81	0.50	0.00	0.500	525	RCP	2.00	0.633	2.84	19.00	0.11	79	NO SURCHARGE
N/A	Barton Street	EX MH J-233	EX MH J-234	0.89	0.69	0.612	0.612	10.84	99.34	0.17	0.00	1.952	1050	RCP	1.00	2.850	3.19	117.00	0.61	68	NO SURCHARGE
N/A	Barton Street	EX MH J-234	EX MH J-235	0.00	0.00	0.000	0.000	10.00	103.04	0.00	0.00	1.952	1050	RCP	1.00	2.850	3.19	28.00	0.15	68	NO SURCHARGE
N/A	Barton Street	MH 42A	EX MH J-236	1.08	0.68	0.730	0.730	10.15	102.37	0.21	0.00	0.207	450	RCP	1.00	0.297	1.81	116.00	1.07	70	NO SURCHARGE
N/A	Barton Street	EX MH J-235	EX MH J-236	0.00	0.00	0.000	0.000	10.00	103.04	6.87	0.00	9.029	2100	RCP	0.40	11.078	3.17	3.30	0.02	82	NO SURCHARGE
N/A	Barton Street	MH 49A	EX MH J-243	0.29	0.69	0.201	0.201	10.00	103.04	0.06	0.00	0.058	300	RCP	0.60	0.078	1.07	85.00	1.32	73	NO SURCHARGE
N/A	Barton Street	MH 51A	MH 53A	1.13	0.67	0.754	0.754	10.00	103.04	0.22	0.00	0.216	450	RCP	0.75	0.257	1.57	60.00	0.64	84	NO SURCHARGE
N/A	Barton Street	MH 55A	MH 53A	1.17	0.37	0.434	0.434	10.00	103.04	0.12	0.00	0.124	375	RCP	0.75	0.158	1.39	44.00	0.53	78	NO SURCHARGE
N/A	Barton Street	MH 53A	EX MH J-245	0.00	0.00	0.000	1.187	10.64	100.20	0.33	0.00	0.330	525	RCP	1.00	0.448	2.01	13.40	0.11	74	NO SURCHARGE
N/A	Barton Street	MH 56A	EX MH J65	1.56	0.34	0.533	0.533	10.00	103.04	0.15	0.00	0.152	450	RCP	0.50	0.210	1.28	46.00	0.60	73	NO SURCHARGE
N/A	Barton Street	MH 57A	EX MH J65	2.64	0.33	0.863	0.863	10.00	103.04	0.25	0.00	0.247	525	RCP	0.50	0.317	1.42	76.00	0.89	78	NO SURCHARGE
N/A	Barton Street	EX MH J65	EX MH J66	0.00	0.00	0.000	1.395	10.89	99.11	0.38	0.00	0.384	975	RCP	0.40	1.480	1.92	27.00	0.23	26	NO SURCHARGE

Appendix C
Hydraulics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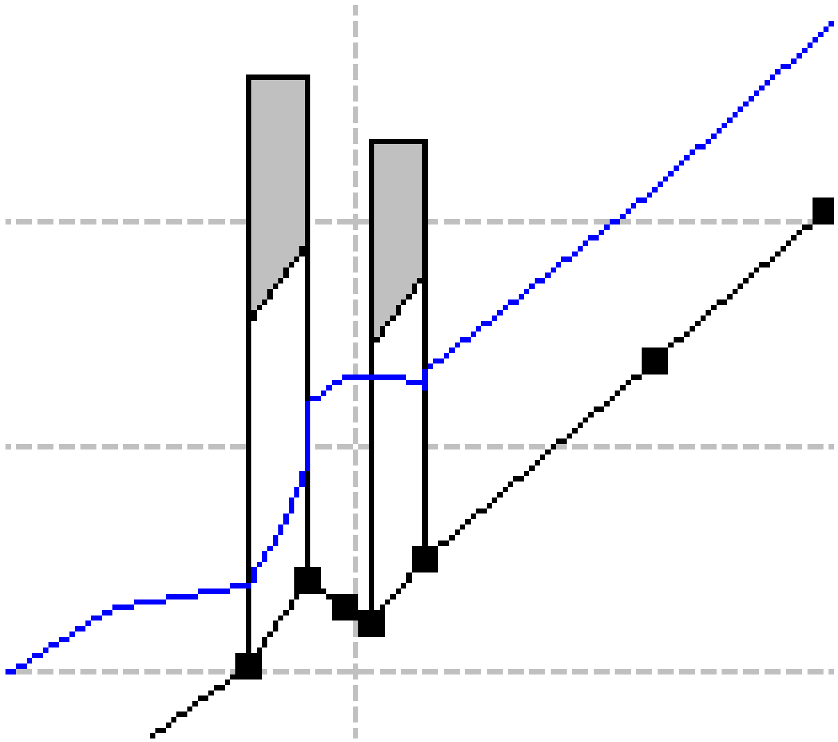
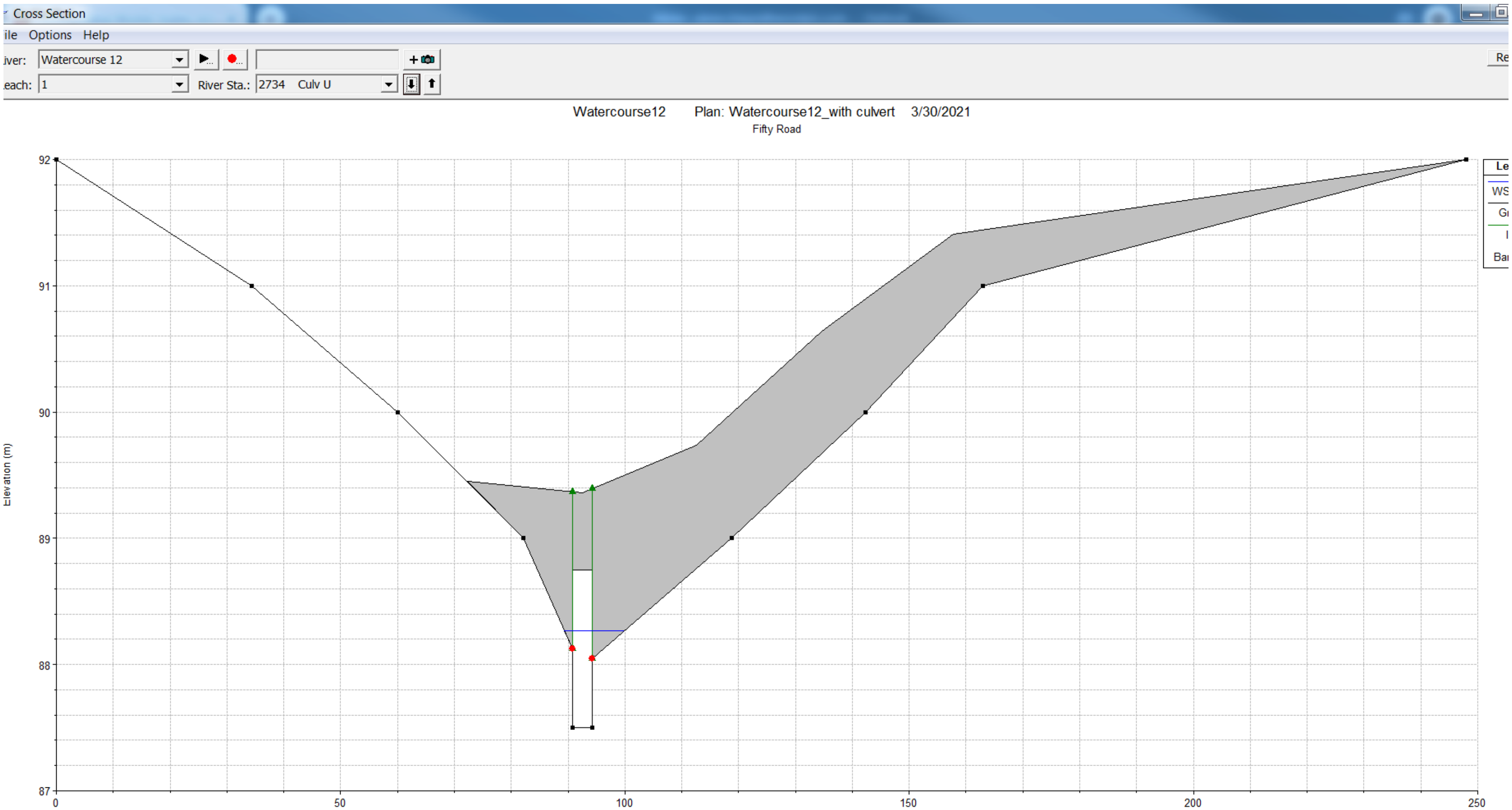
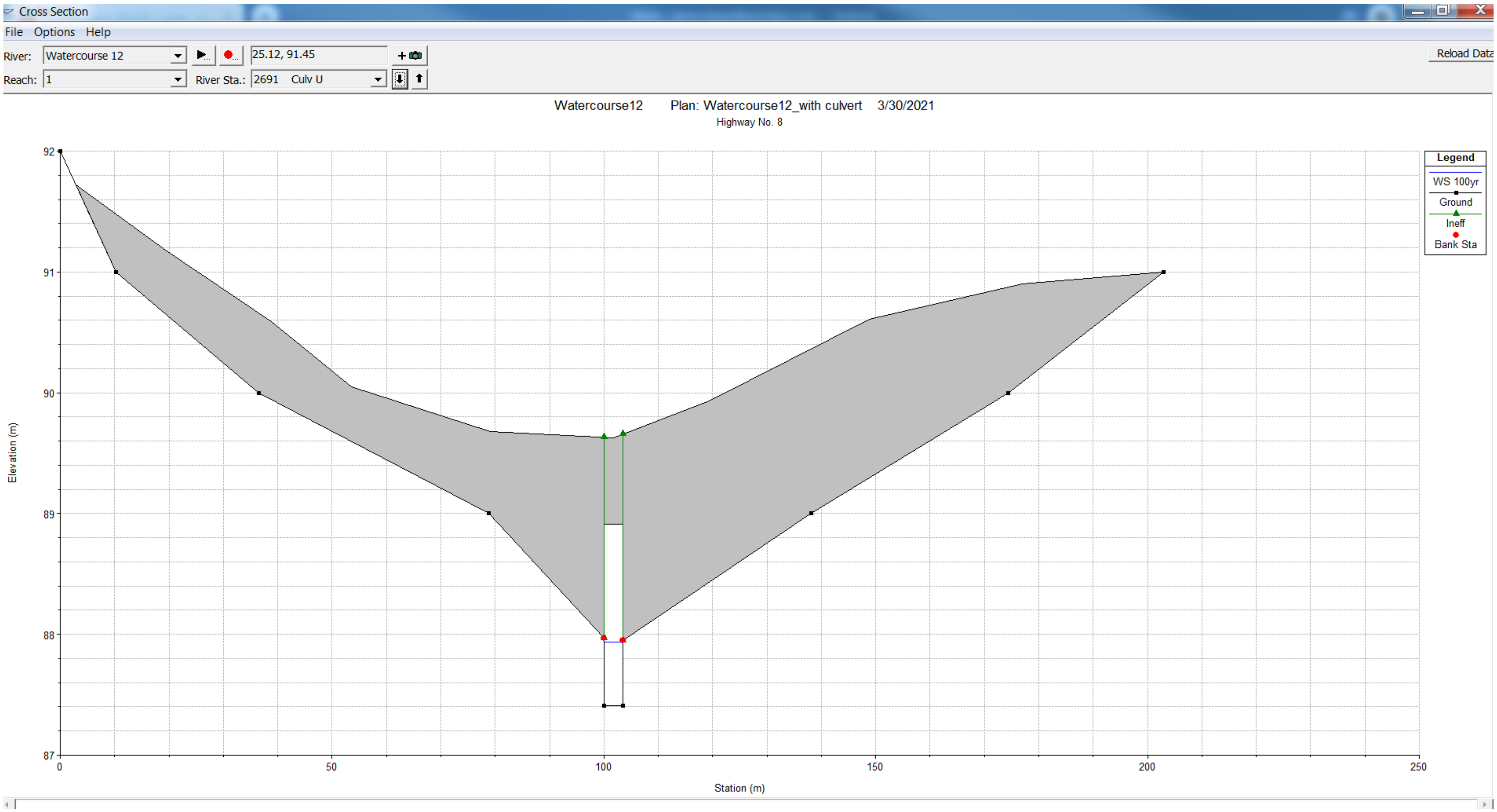
Profiles ...
Plot Initial Conditions
Watercourse12 Plan: Watercourse12_with culvert 3/30/2021
95
90
85
80
75





Cross Section
ile Options Help
iver: Watercourse 12
each: 1
River Sta.: 2734 Culv U
Watercourse12 Plan: Watercourse12_with culvert 3/30/2021
Fifty Road
Elevation (m)
92
91
90
89
88
87
0
50
100
150
200
250
WS
Ba



Cross Section
File Options Help
River: Watercourse 12
25.12, 91.45
Reload Data
Reach: 1
River Sta.: 2691 Culv U
Watercourse12 Plan: Watercourse12_with culvert 3/30/2021
Highway No. 8
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
92
91
90
89
88
87
0
50
100
150
200
250

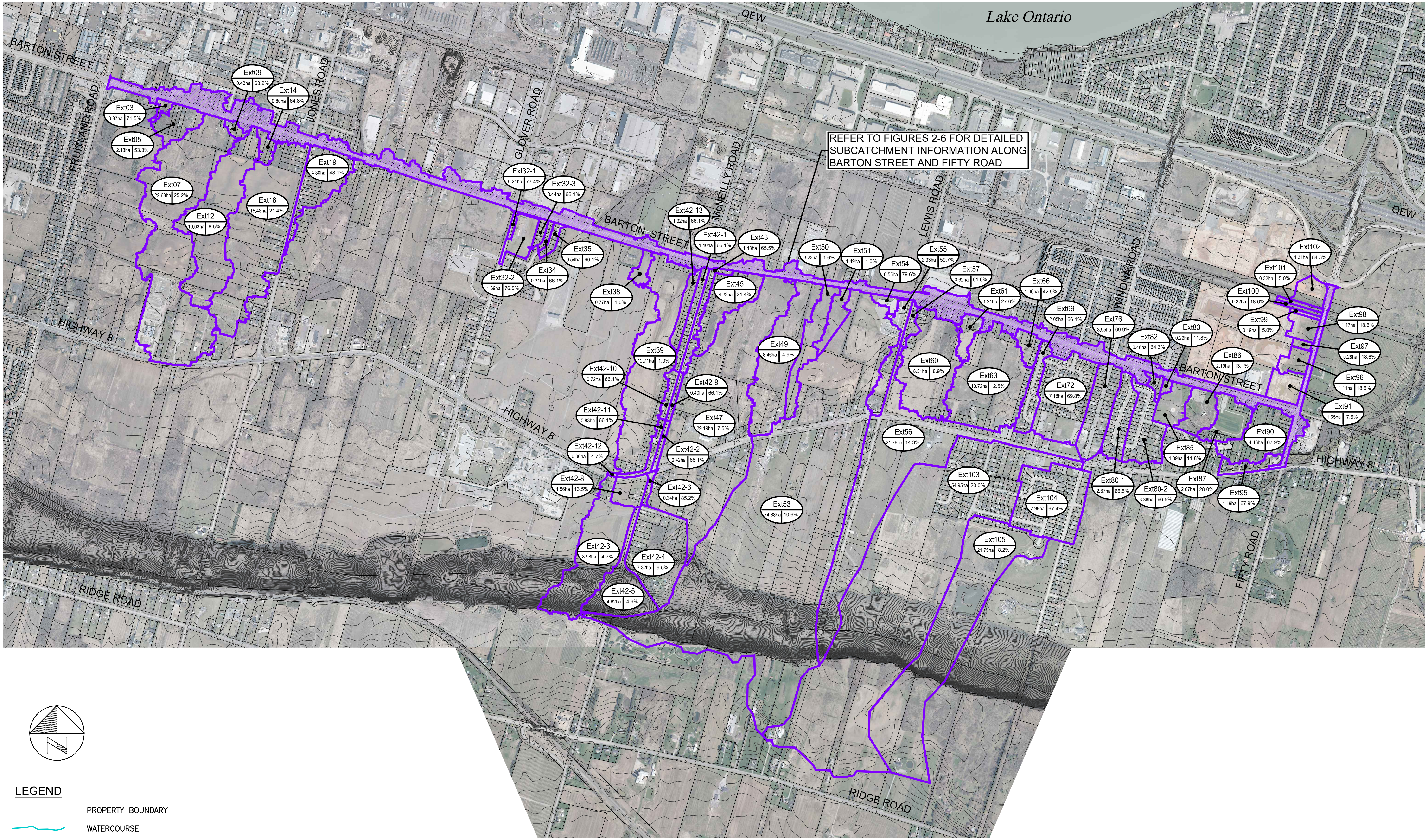
File Options Std. Tables Locations Help

HEC-RAS Plan: 2 River: Waterc

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	3332		Culvert									
1	3325	100yr	4.20	91.95	93.12	92.85	93.14	0.000742	0.60	7.99	28.37	0.23
1	3310	100yr	4.20	91.78	93.13		93.13	0.000086	0.28	37.82	86.96	0.08
1	3287	100yr	4.20	91.51	93.13	92.75	93.13	0.000029	0.27	54.33	99.65	0.07
1	3280		Culvert									
1	3273	100yr	4.20	91.49	92.49	92.49	92.60	0.004846	1.61	3.95	10.43	0.57
1	3244	100yr	4.20	91.38	92.39	92.16	92.46	0.002902	1.31	4.82	11.97	0.45
1	3205	100yr	4.20	91.22	92.37		92.39	0.000933	0.81	10.27	27.11	0.26
1	3182	100yr	4.20	91.14	92.35		92.37	0.000756	0.77	11.41	31.94	0.24
1	3132	100yr	4.20	90.94	92.32	92.10	92.34	0.000318	0.80	12.64	32.63	0.23
1	3124		Culvert									
1	3116	100yr	4.20	90.86	91.96	91.96	92.02	0.002174	1.19	5.33	11.90	0.40
1	3075	100yr	4.20	90.49	91.08	91.26	91.63	0.045666	3.28	1.31	3.65	1.61
1	3003	100yr	4.20	89.84	90.67	90.62	90.77	0.006022	1.60	4.46	18.22	0.63
1	2915	100yr	4.20	89.05	89.85	89.82	90.06	0.010879	2.09	2.36	6.11	0.84
1	2840	100yr	4.20	88.38	89.13	89.13	89.27	0.009617	1.86	3.55	14.27	0.78
1	2742	100yr	4.20	87.50	88.34	88.03	88.44	0.000647	1.43	2.93	13.01	0.50
1	2734		Culvert									
1	2726	100yr	4.20	87.21	88.32	87.73	88.38	0.001839	1.08	3.89	18.52	0.33
1	2714	100yr	4.20	87.29	88.32		88.35	0.000886	0.76	6.33	10.30	0.26
1	2697	100yr	4.20	87.41	88.18	87.94	88.31	0.000823	1.55	2.71	15.61	0.56
1	2691		Culvert									
1	2685	100yr	4.20	87.04	87.39	87.57	88.00	0.077743	3.48	1.21	3.50	1.89
1	2627	100yr	4.20	86.60	87.28	87.22	87.45	0.009835	1.85	2.48	6.75	0.79
1	2517	100yr	4.20	85.76	86.58		86.69	0.004930	1.51	2.85	4.55	0.58
1	2362	100yr	6.10	84.58	85.42	85.34	85.63	0.008734	2.06	3.24	6.17	0.78
1	2257	100yr	6.10	83.78	84.67	84.55	84.83	0.006527	1.85	3.95	8.65	0.68
1	2189	100yr	6.10	83.26	84.09	84.02	84.31	0.009034	2.08	3.23	6.34	0.79
1	2122	100yr	6.10	82.75	83.78		83.89	0.003652	1.55	4.73	8.23	0.52
1	2045	100yr	6.10	82.16	83.68	83.02	83.82	0.000405	1.63	3.74	27.69	0.42
1	2038		Culvert									
1	2030	100yr	6.10	82.19	83.59	83.05	83.76	0.003147	1.78	3.43	22.25	0.48
1	1967	100yr	6.10	82.18	83.53		83.59	0.001212	1.10	6.99	8.90	0.32
1	1895	100yr	6.10	82.16	83.43		83.49	0.001483	1.16	6.78	9.74	0.35
1	1845	100yr	8.00	82.15	83.18	83.04	83.39	0.000908	2.09	5.23	11.21	0.70

Appendix D

Existing and Proposed Conditions Drainage Figures



LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- SUBCATCHMENT BOUNDARY
- S150 / 0.75ha / 73.4%: SUBCATCHMENT ID# — PERCENTAGE OF IMPERVIOUS AREA — SUBCATCHMENT AREA

SCALE VALID ONLY FOR 24"x36" VERSION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:750 Consultant File No. TPB166053 Drawing No. 1

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PRO\2021-08\Fig Subcatchment-EX.dwg

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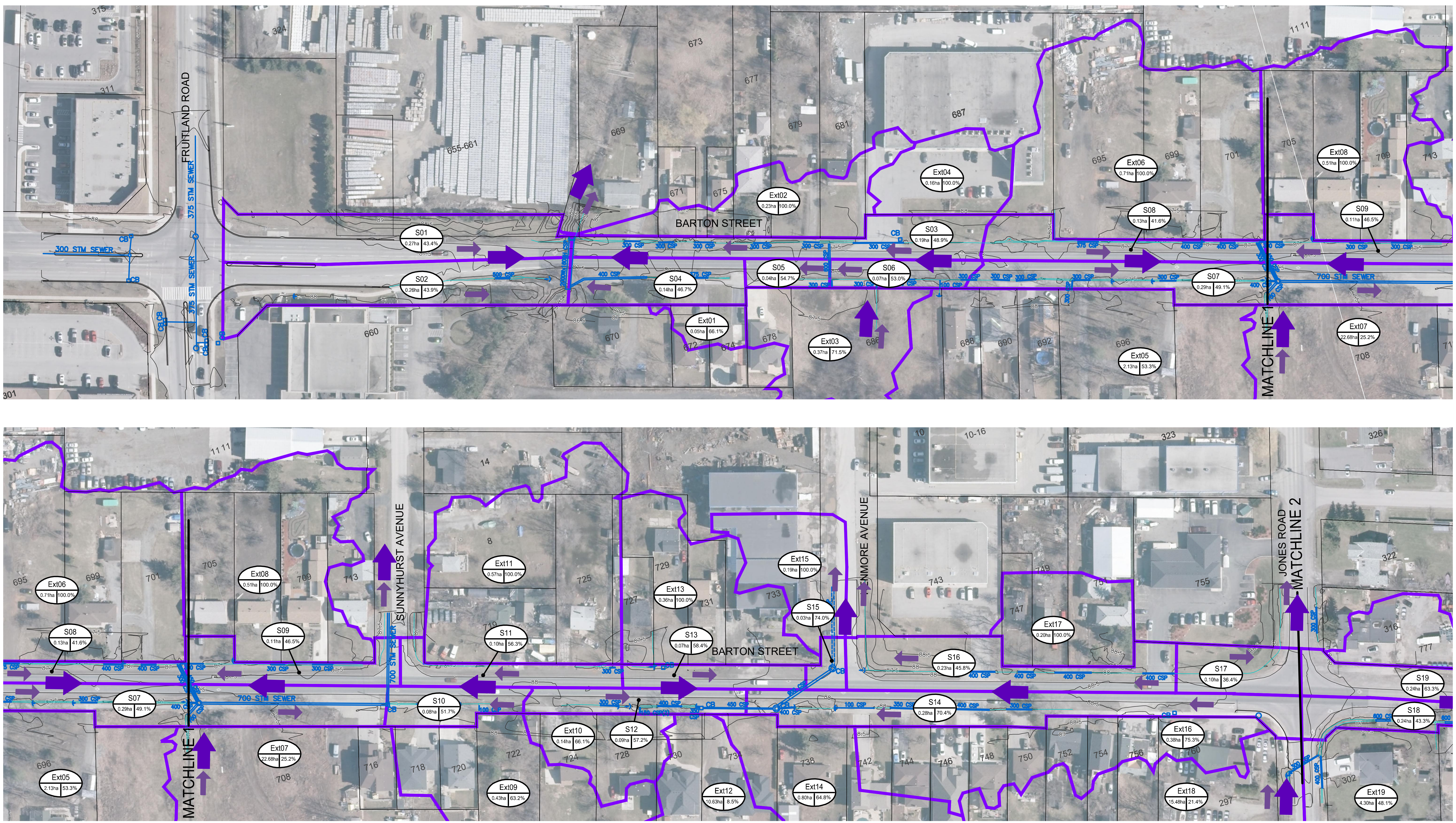
Last Saved: 2021-08-26 Last Saved By: richard.bartolo



LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- SUBCATCHMENT BOUNDARY
- S150 0.75ha 73.4%: SUBCATCHMENT ID#, PERCENTAGE OF IMPERVIOUS AREA, SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:750 (0 7.5 15 30); Consultant File No. TPB166053; Drawing No. 2

SCALE VALID ONLY FOR 24"x36" VERSION

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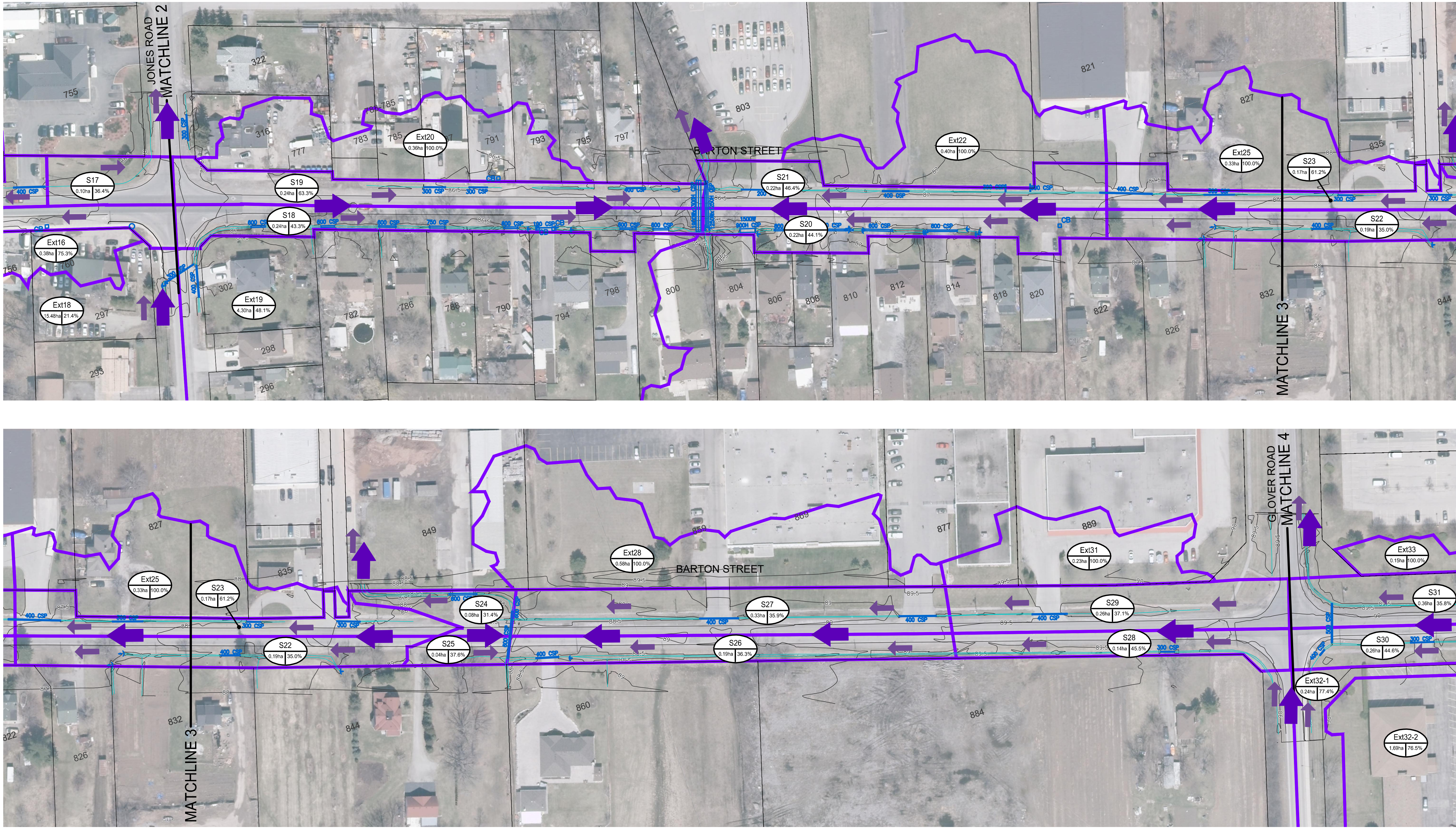

LEGEND

PROPERTY BOUNDARY
WATERCOURSE
CONTOUR (1m)
EXISTING CULVERT
450 EXISTING STORM SEWER AND PIPE SIZE
SUBCATCHMENT BOUNDARY
S150 0.75ha 73.4% — SUBCATCHMENT ID#; PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA
MAJOR SYSTEM FLOW DIRECTION
MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(EXISTING CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 3

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-EX-BU.dwg

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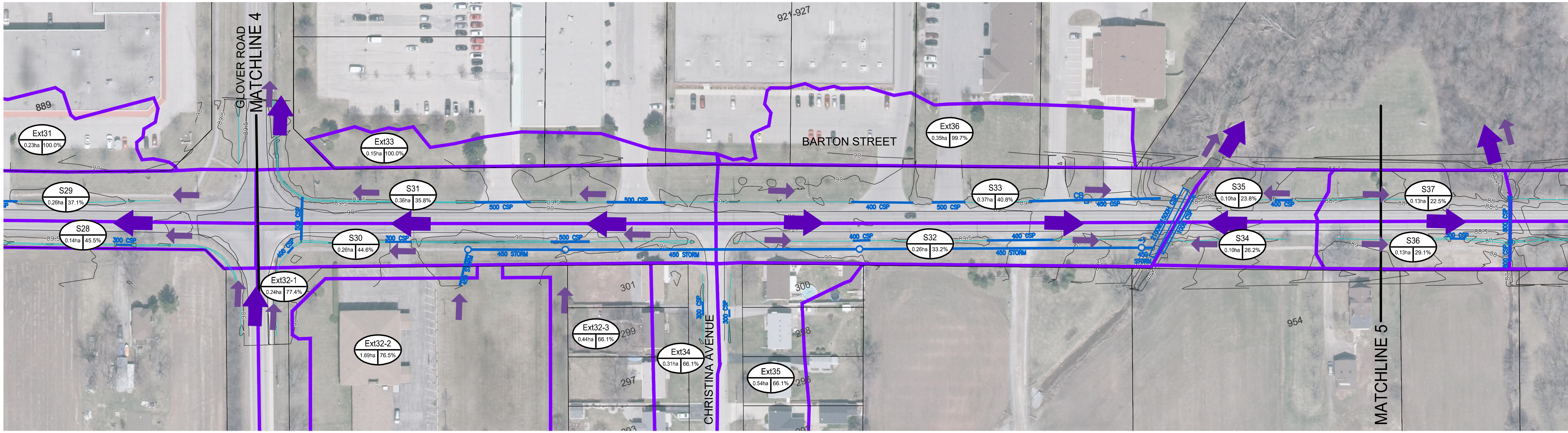
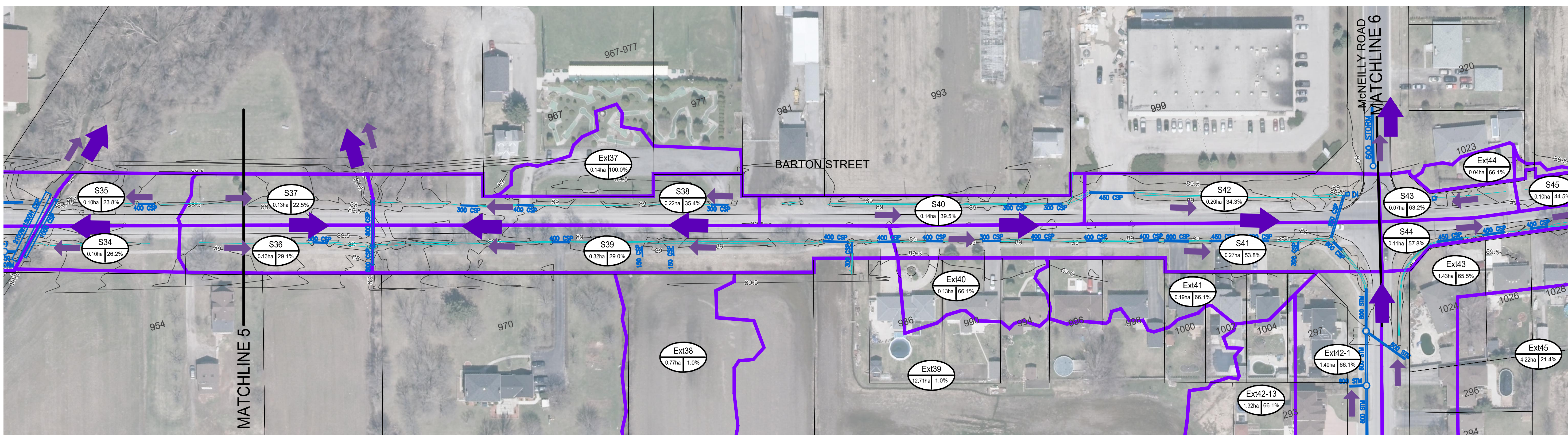
Last Saved By: richard.bartolo
Plotted: 2021-08-26
Last Saved: 2021-08-26





LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- SUBCATCHMENT BOUNDARY
- S150 / 0.75ha / 73.4% — SUBCATCHMENT ID#; PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:750 (0 7.5 15 30); Consultant File No. TPB166053; Drawing No. 4

SCALE VALID ONLY FOR 24"x36" VERSION

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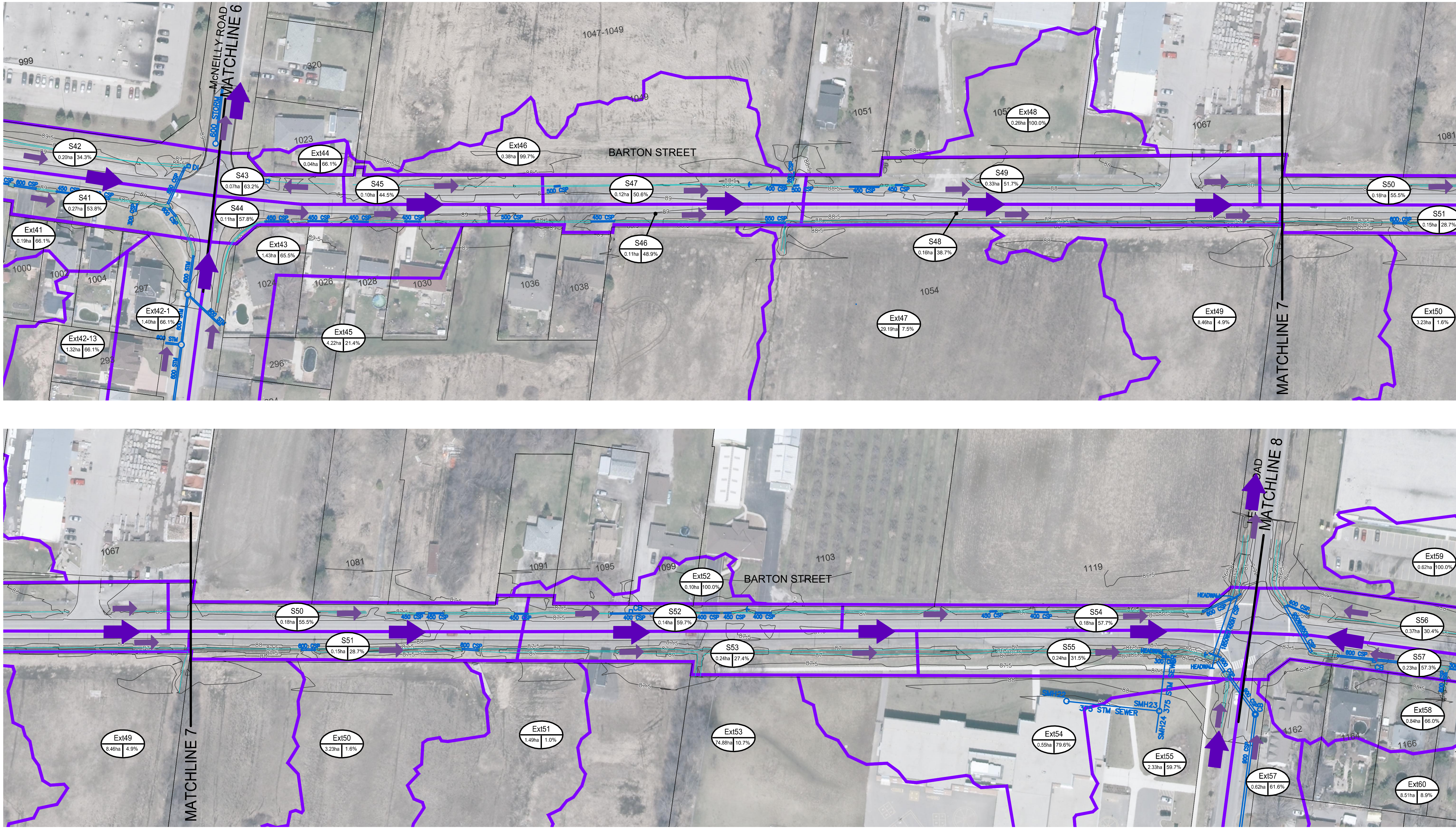
Last Saved: 2021-08-26

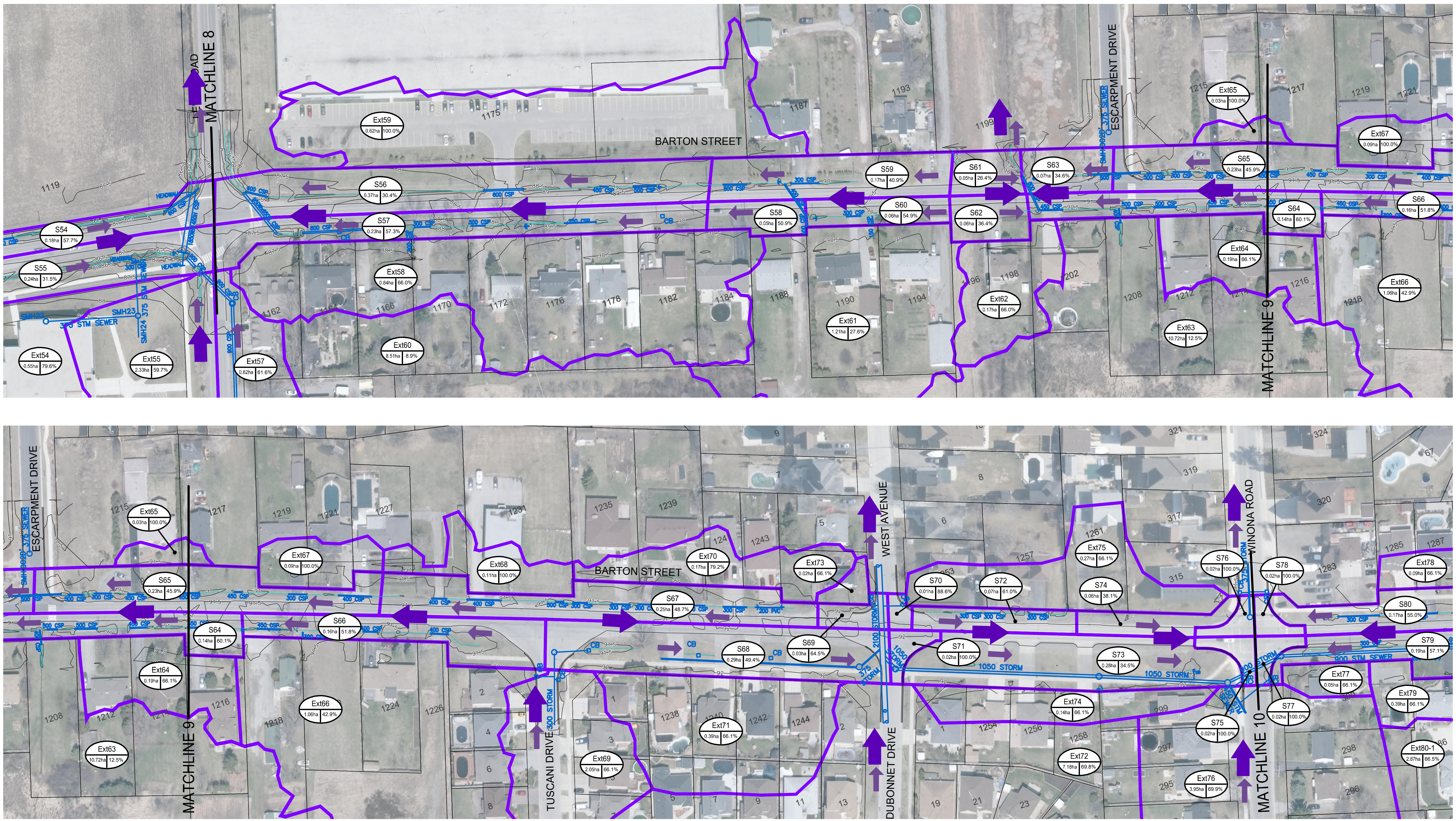


LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- SUBCATCHMENT BOUNDARY
- S150 0.75ha 73.4% — SUBCATCHMENT ID#; PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

SCALE VALID ONLY FOR 24"x36" VERSION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:750 (0 7.5 15 30)
			Consultant File No. TPB166053
			Drawing No. 5



LEGEND

PROPERTY BOUNDARY

WATERCOURSE

CONTOUR (1m)

EXISTING CULVERT

450 EXISTING STORM SEWER AND PIPE SIZE

SUBCATCHMENT BOUNDARY

S150 — SUBCATCHMENT ID#

0.75ha | 73.4% — PERCENTAGE OF IMPERVIOUS AREA / SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	SCALE VALID ONLY FOR 24"x36" VERSION Scale 1:750 (0 7.5 15 30) Consultant File No. TPB166053 Drawing No. 6

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Plotted: 2021-08-26
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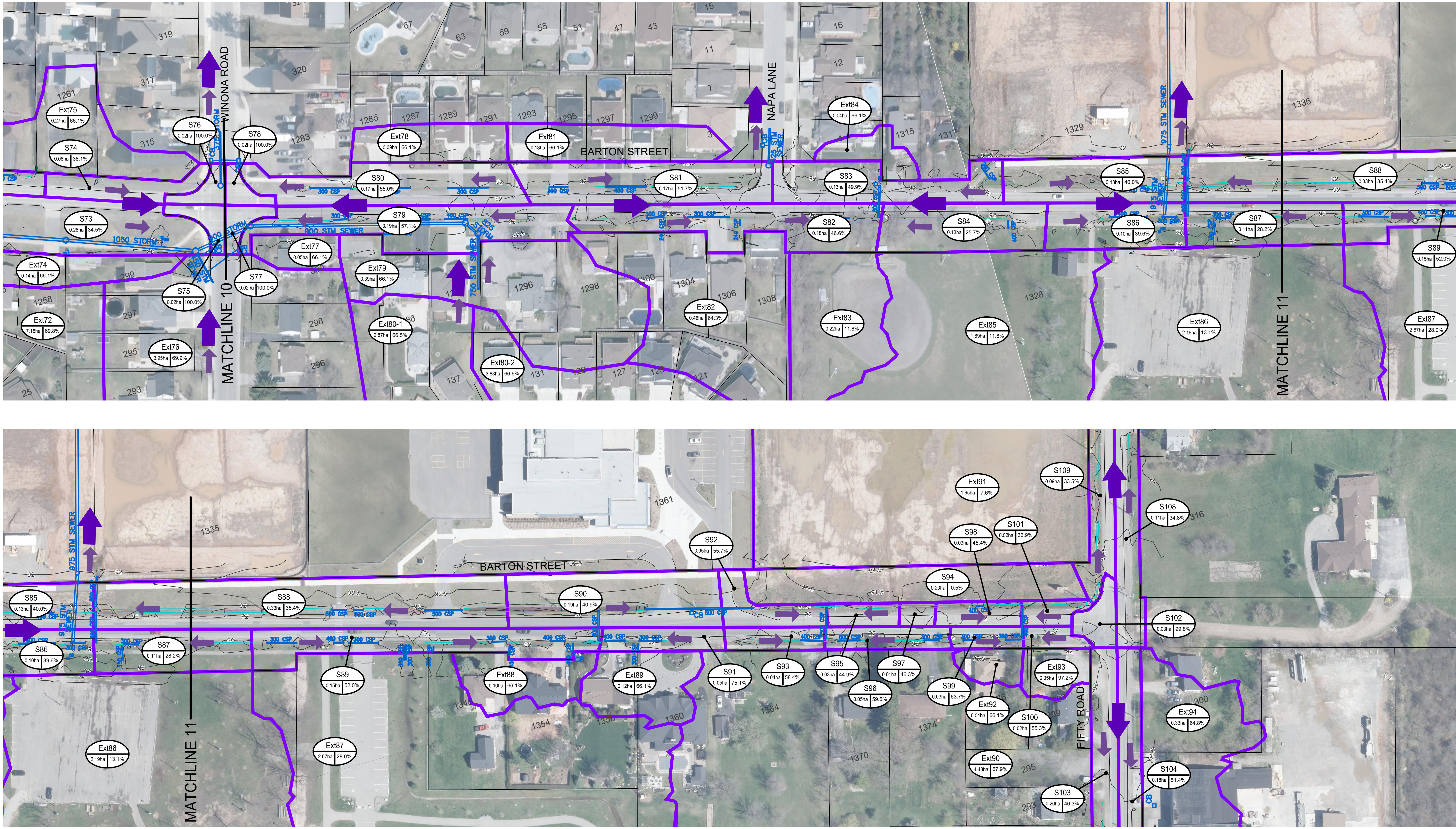

LEGEND

PROPERTY BOUNDARY

WATERCOURSE

CONTOUR (1m)

EXISTING CULVERT

450 EXISTING STORM SEWER AND PIPE SIZE

SUBCATCHMENT BOUNDARY

S150 — SUBCATCHMENT ID#

73.4% — PERCENTAGE OF IMPERVIOUS AREA

0.75ha — SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(EXISTING CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No.
TPB166053

Drawing No.
7

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Plotted: 2021-08-26
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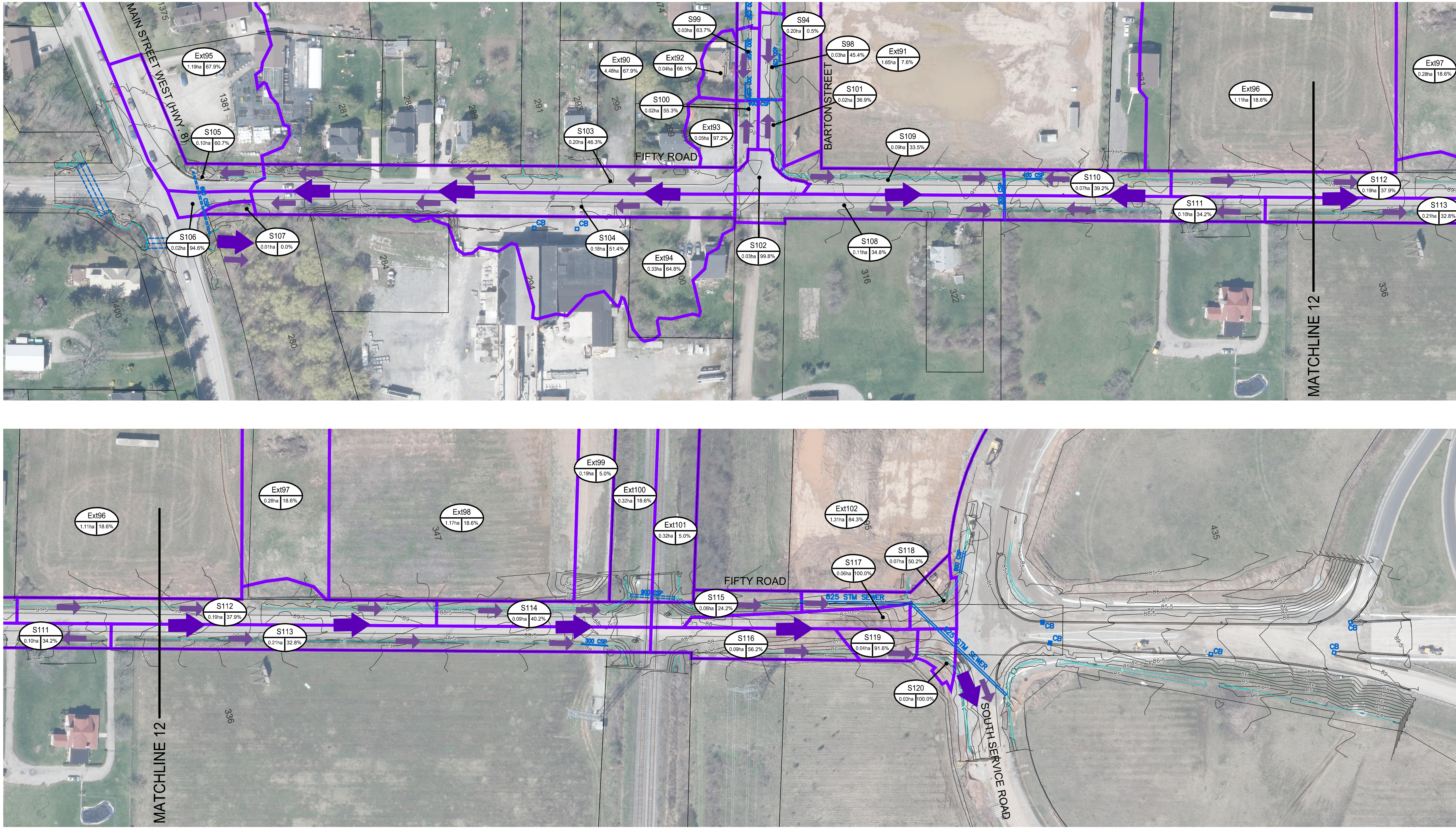

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- SUBCATCHMENT BOUNDARY
- S150 0.75ha 73.4% — SUBCATCHMENT ID#, PERCENTAGE OF IMPERVIOUS AREA, SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	SCALE VALID ONLY FOR 24"x36" VERSION Scale 1:750 (0 7.5 15 30) Consultant File No. TPB166053 Drawing No. 8

Path: I:\TPB166053 – Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-EX-BU.dwg

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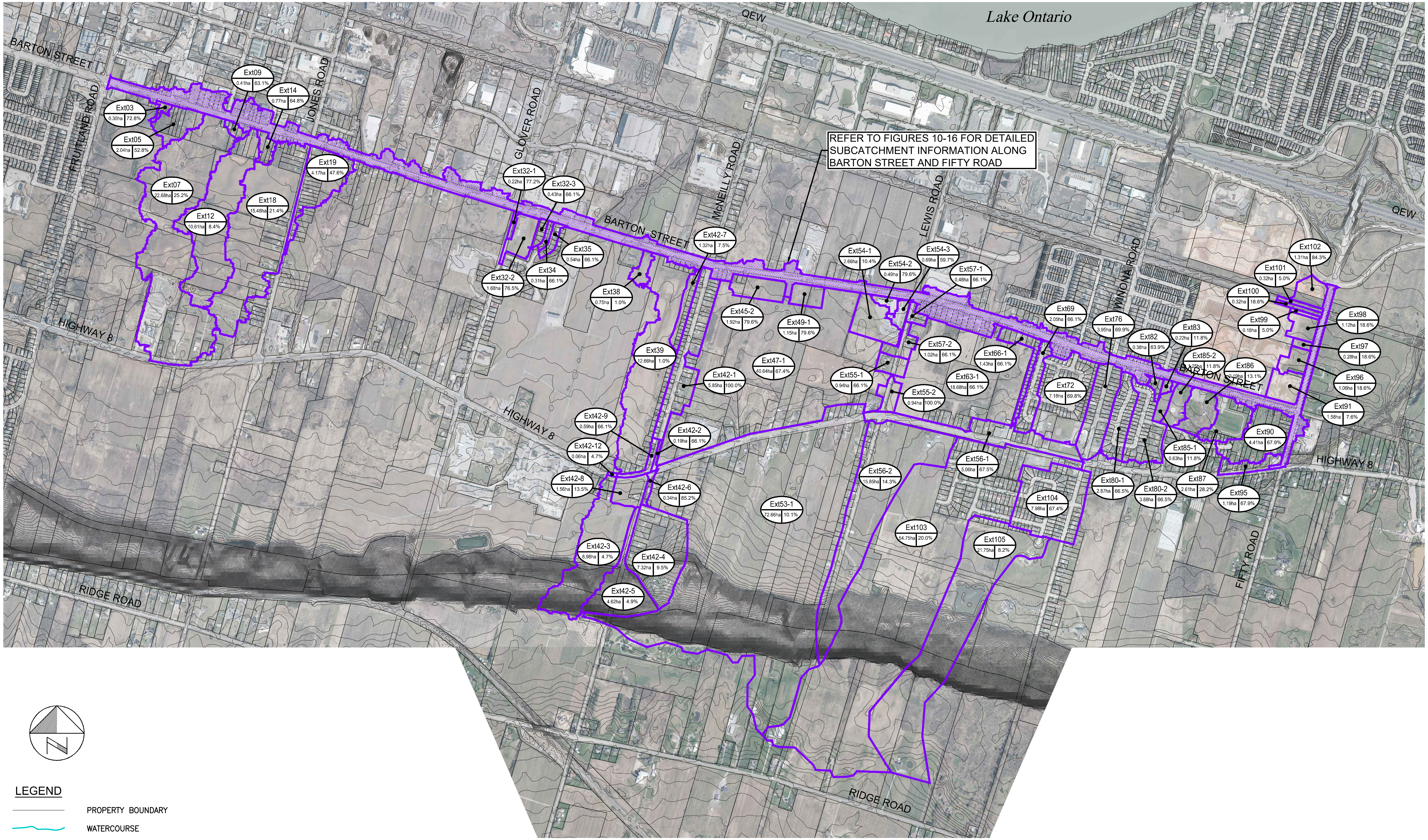
Plotted: 2021-08-26 Last Saved: 2021-08-26



LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- SUBCATCHMENT BOUNDARY
- S150 — SUBCATCHMENT ID#
- 0.75ha | 73.4% — PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA

SCALE VALID ONLY FOR 24"x36" VERSION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	Scale 1:750 (0 7.5 15 30) Consultant File No. TPB166053 Drawing No. 9

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-FT.dwg

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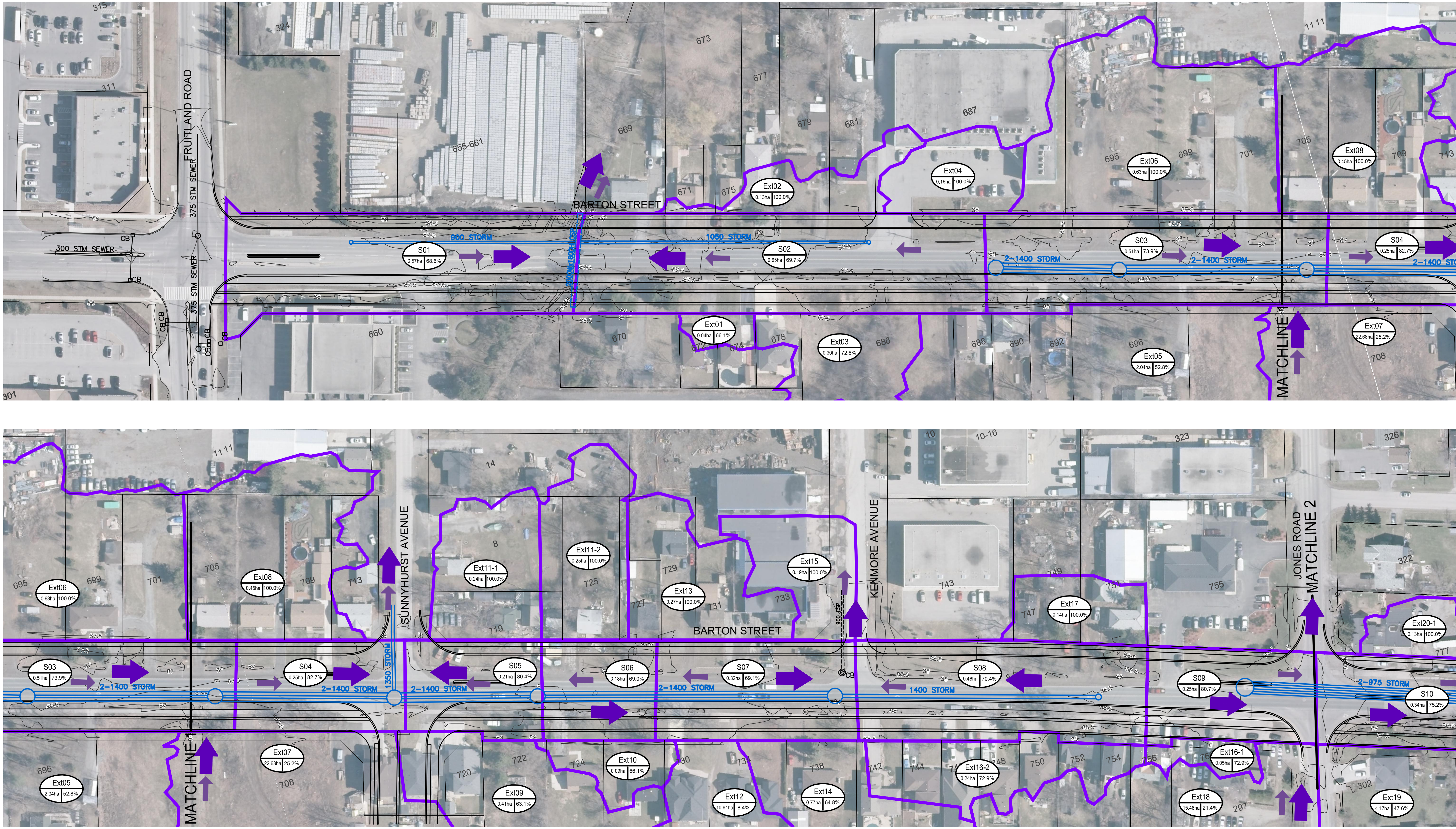
Plotted: 2021-08-26
Last Saved: 2021-08-26



LEGEND

PROPERTY BOUNDARY

WATERCOURSE

CONTOUR (1m)

EXISTING CULVERT

450 EXISTING STORM SEWER AND PIPE SIZE

PROPOSED SWALE

PROPOSED CULVERT OR CULVERT EXTENSION

450 PROPOSED STORM SEWER AND PIPE SIZE

450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)

SUBCATCHMENT BOUNDARY

S150 0.75ha 73.4%

SUBCATCHMENT ID#

PERCENTAGE OF IMPERVIOUS AREA

SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	SCALE VALID ONLY FOR 24"x36" VERSION Scale 1:750 (0 7.5 15 30) Consultant File No. TPB166053 Drawing No. 10

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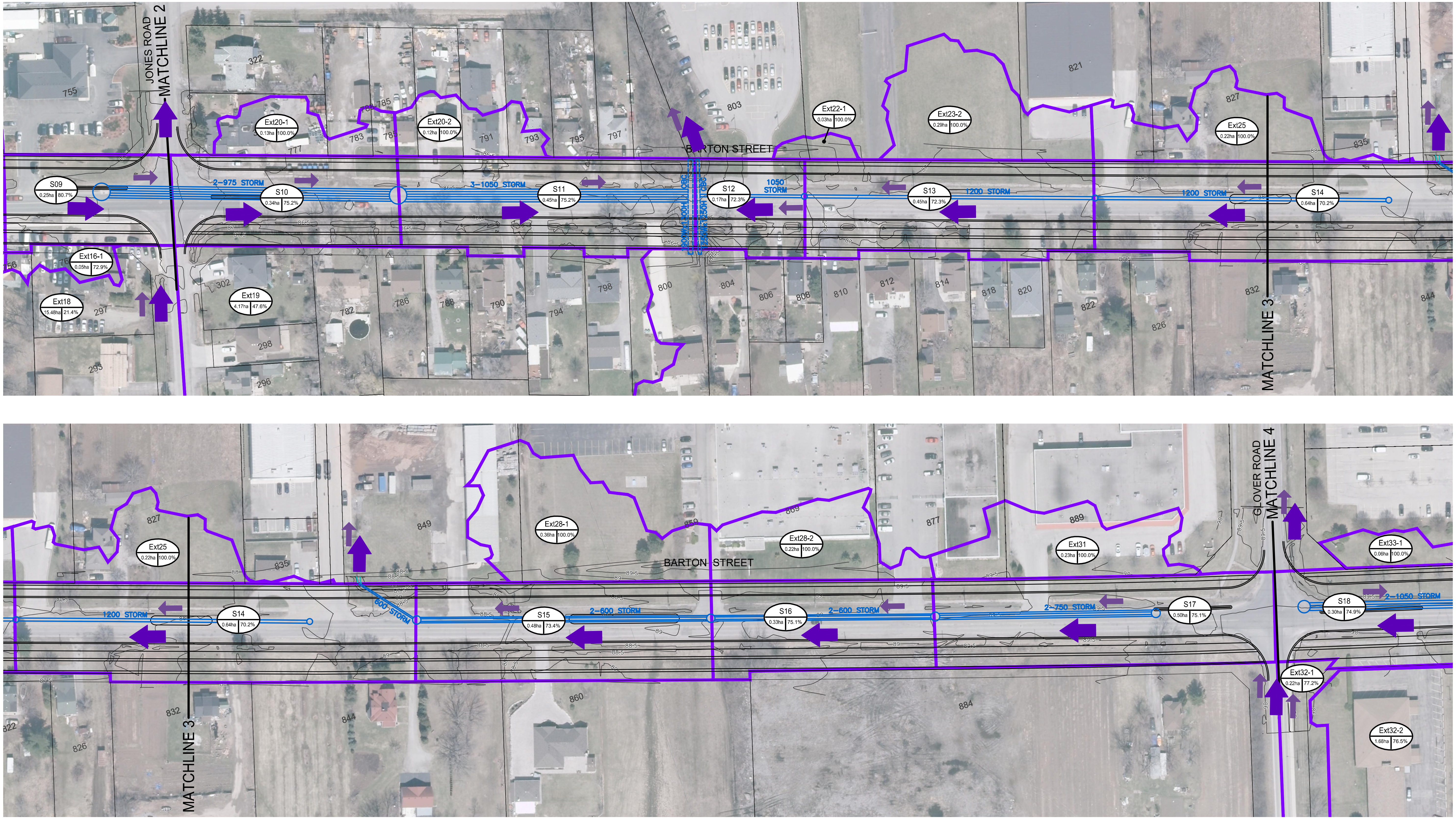

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- PROPOSED SWALE
- PROPOSED CULVERT OR CULVERT EXTENSION
- 450 PROPOSED STORM SEWER AND PIPE SIZE
- 450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)
- SUBCATCHMENT BOUNDARY
- S150 SUBCATCHMENT ID#
- 73.4% PERCENTAGE OF IMPERVIOUS AREA
- 0.75ha SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(FUTURE CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 11

Plotted: 2021-08-26 Plotted By: richard.bartolo
Last Saved: 2021-08-26 Last Saved By: richard.bartolo
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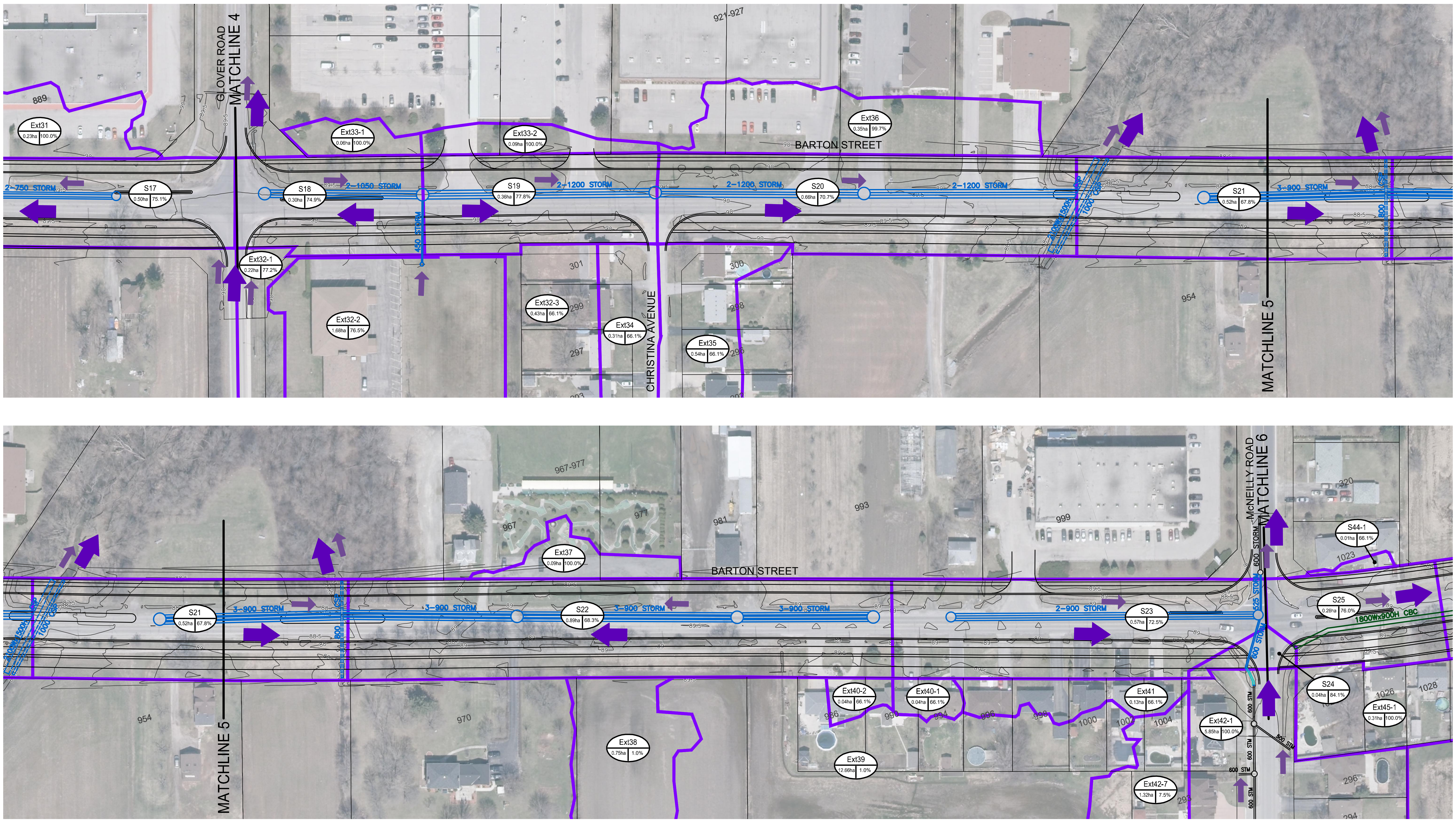

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- PROPOSED SWALE
- PROPOSED CULVERT OR CULVERT EXTENSION
- 450 PROPOSED STORM SEWER AND PIPE SIZE
- 450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)
- SUBCATCHMENT BOUNDARY
- S150 0.75ha 73.4%: SUBCATCHMENT ID#; PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

SCALE VALID ONLY FOR 24"x36" VERSION

BARTON STREET AND FIFTY ROAD
CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(FUTURE CONDITION)

wood.

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 12

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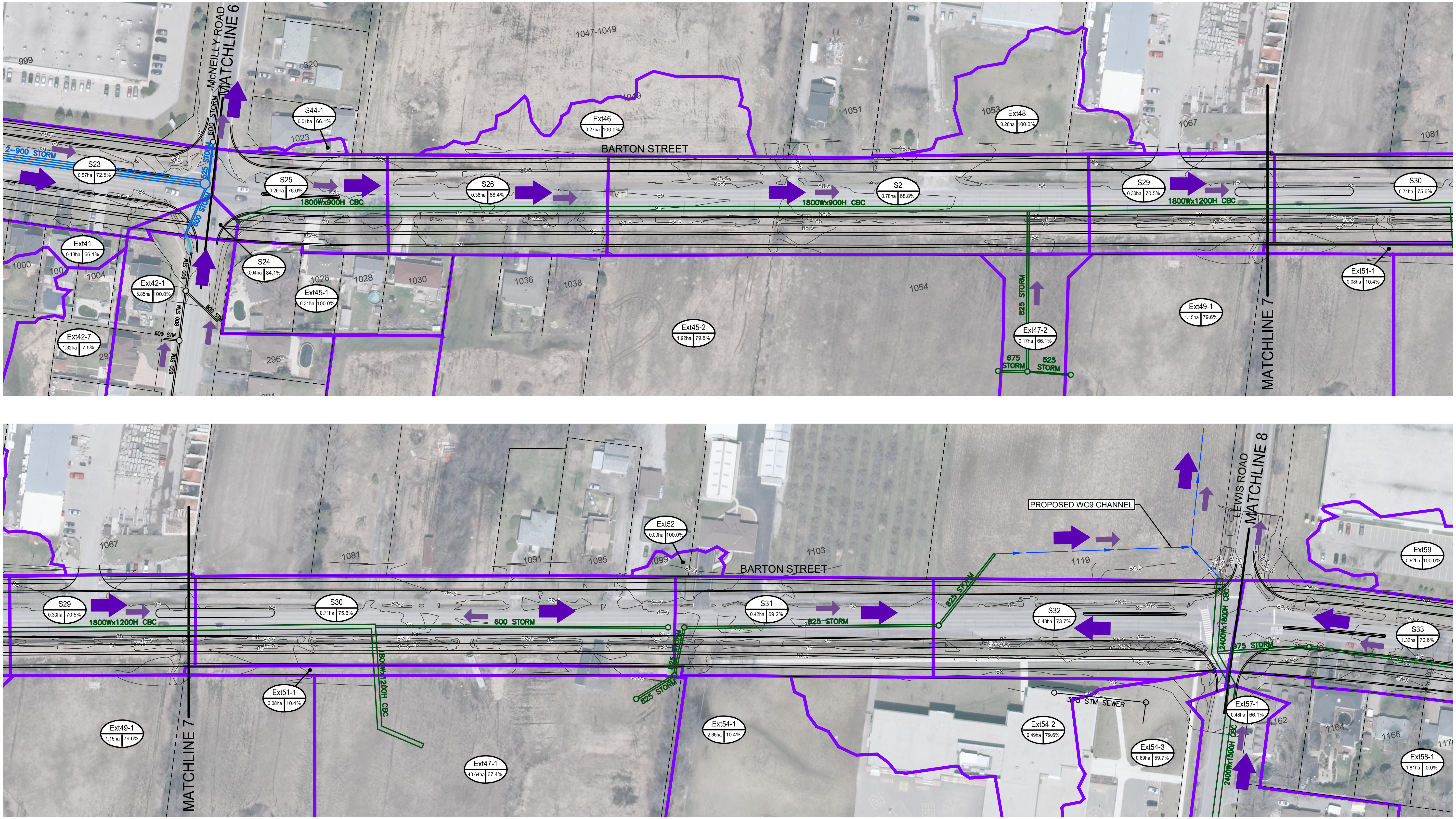
Plotted: 2021-08-26
Last Saved: 2021-08-26



LEGEND

PROPERTY BOUNDARY

WATERCOURSE

CONTOUR (1m)

EXISTING CULVERT

450 EXISTING STORM SEWER AND PIPE SIZE

PROPOSED SWALE

PROPOSED CULVERT OR CULVERT EXTENSION

450 PROPOSED STORM SEWER AND PIPE SIZE

450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)

SUBCATCHMENT BOUNDARY

S150 — SUBCATCHMENT ID#

PERCENTAGE OF IMPERVIOUS AREA

0.75ha 73.4% — SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

N

BARTON STREET AND FIFTY ROAD CLASS EA CITY OF HAMILTON	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	SCALE VALID ONLY FOR 24"x36" VERSION Scale 1:750 (0 7.5 15 30) Consultant File No. TPB166053 Drawing No. 13

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-FT-BU.dwg

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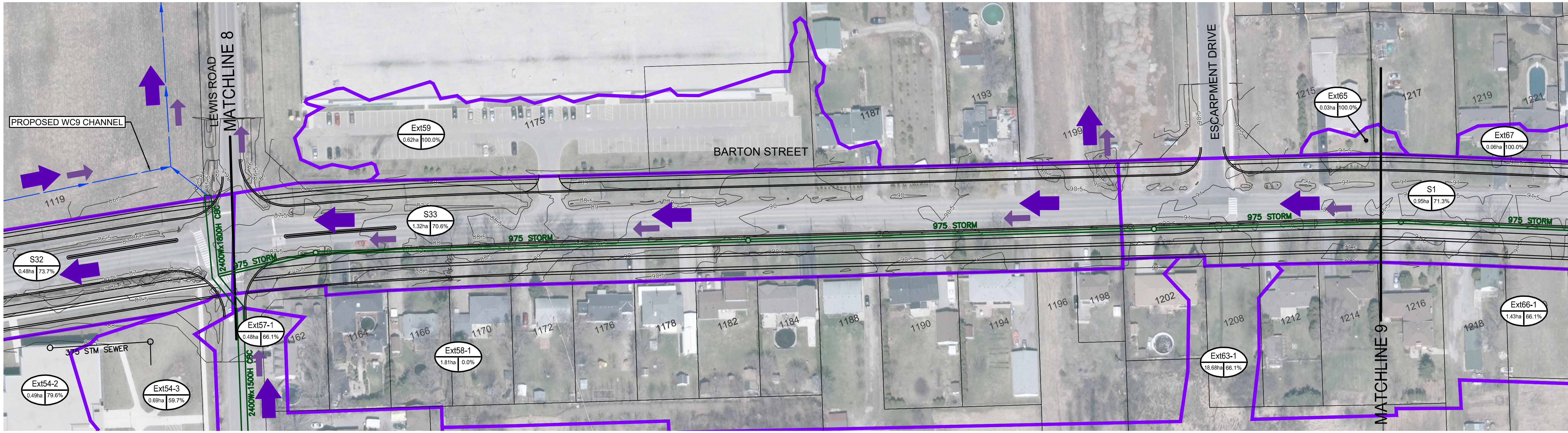
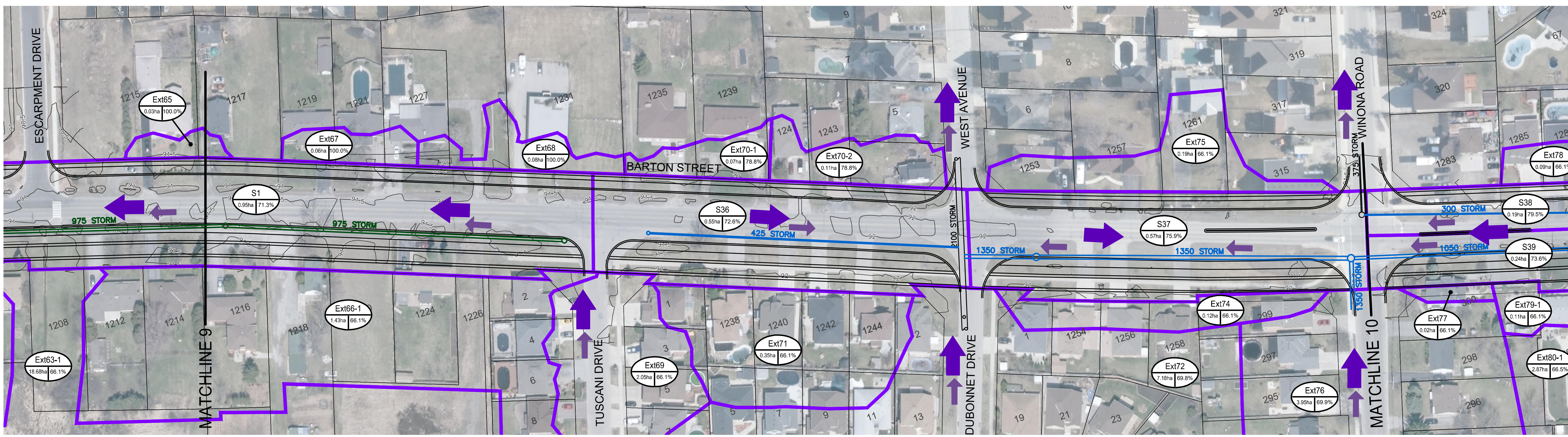
Plotted: 2021-08-26 Last Saved: 2021-08-26





LEGEND

	PROPERTY BOUNDARY
	WATERCOURSE
	CONTOUR (1m)
	EXISTING CULVERT
450	EXISTING STORM SEWER AND PIPE SIZE
	PROPOSED SWALE
	PROPOSED CULVERT OR CULVERT EXTENSION
450	PROPOSED STORM SEWER AND PIPE SIZE
450	PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)
	SUBCATCHMENT BOUNDARY
S150	SUBCATCHMENT ID#
73.4%	PERCENTAGE OF IMPERVIOUS AREA
0.75ha	SUBCATCHMENT AREA
	MAJOR SYSTEM FLOW DIRECTION
	MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(FUTURE CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 14

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-FT-BU.dwg

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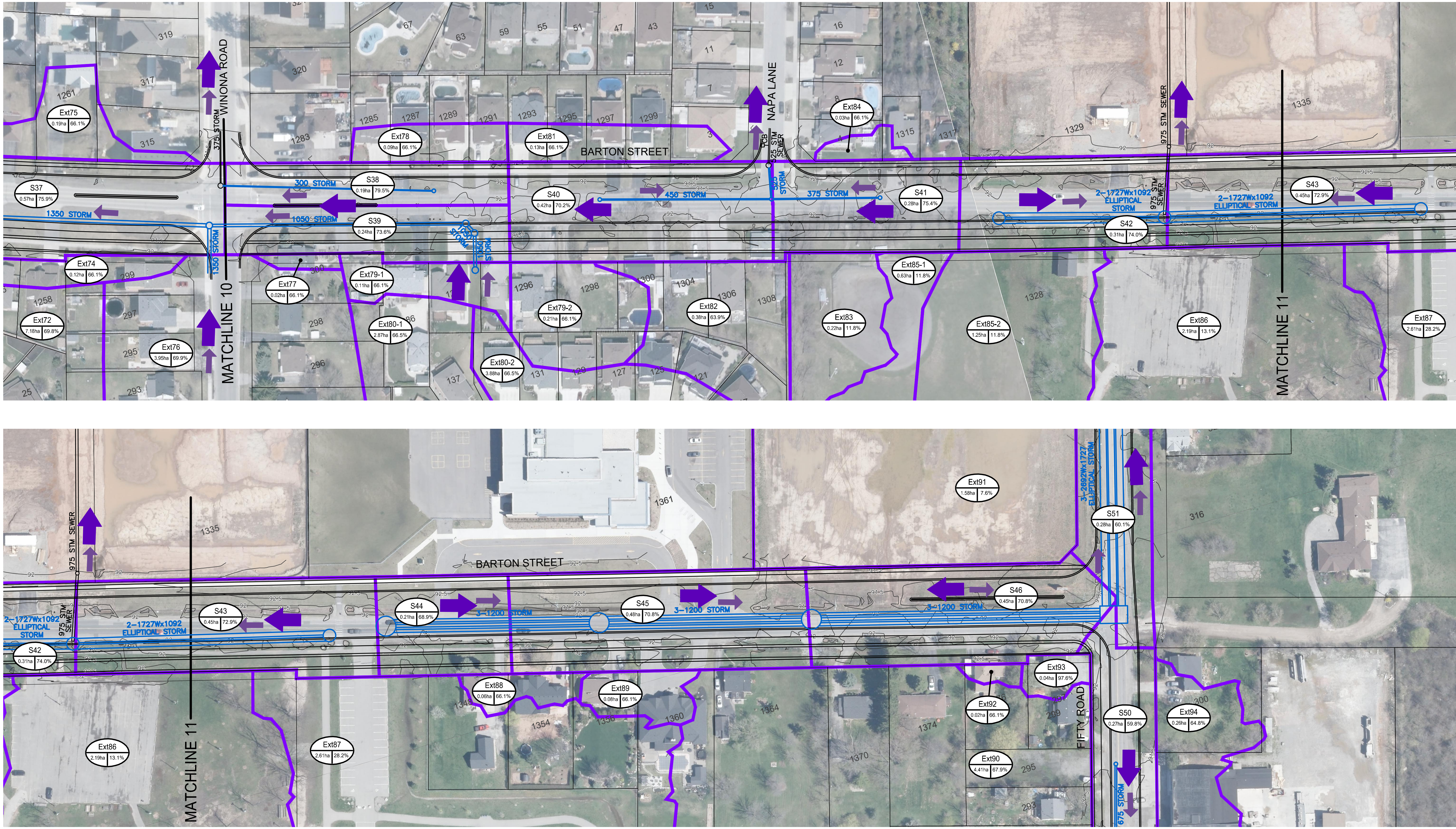
Last Saved: 2021-08-26 Last Saved By: richard.bartolo



LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- PROPOSED SWALE
- PROPOSED CULVERT OR CULVERT EXTENSION
- 450 PROPOSED STORM SEWER AND PIPE SIZE
- 450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)
- SUBCATCHMENT BOUNDARY
- S150 SUBCATCHMENT ID#
- 73.4% PERCENTAGE OF IMPERVIOUS AREA
- 0.75ha SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(FUTURE CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 15

Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2021-08-26
Last Saved: 2021-08-26
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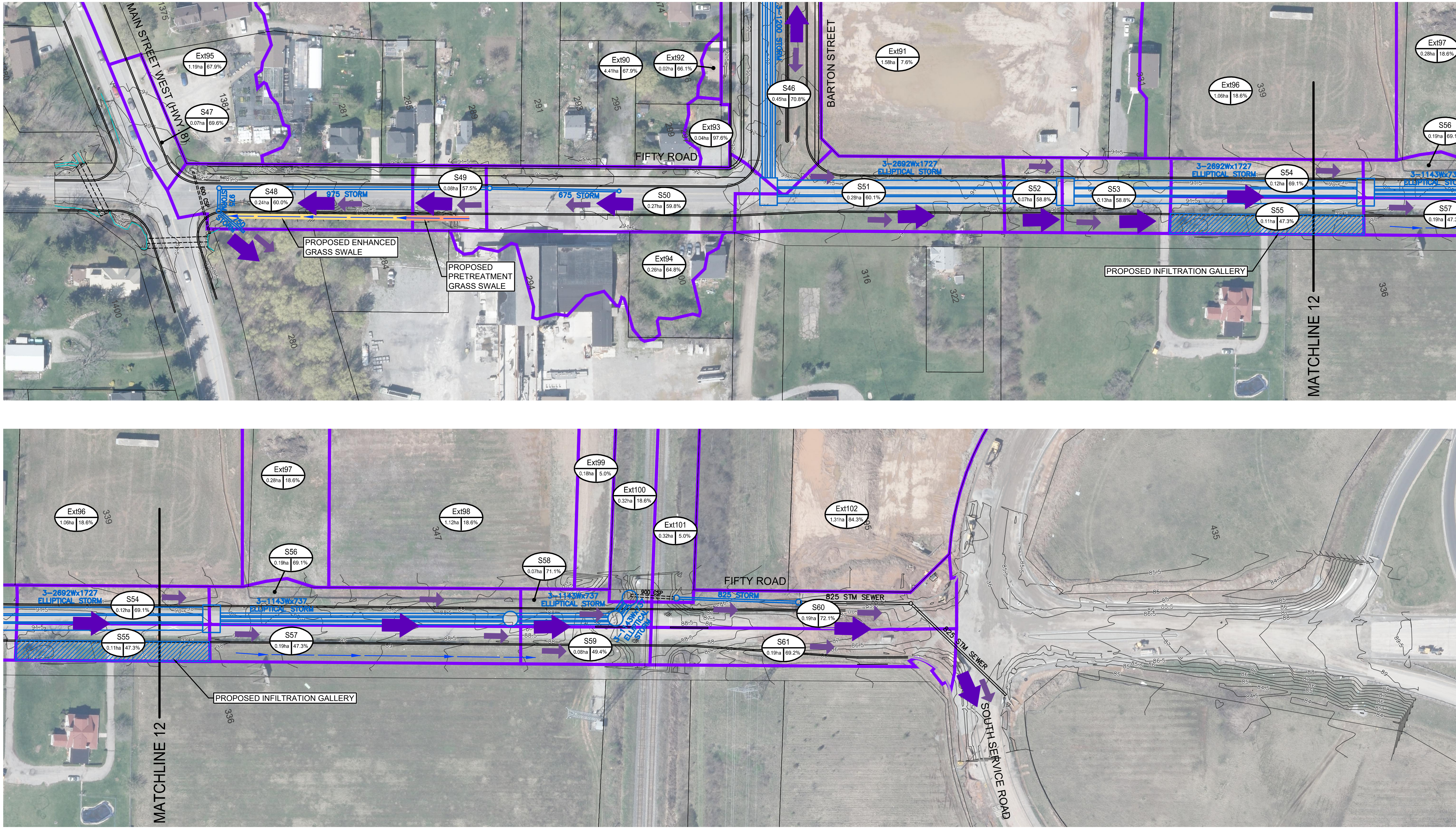

LEGEND

PROPERTY BOUNDARY	PROPOSED SWALE
WATERCOURSE	PROPOSED CULVERT OR CULVERT EXTENSION
CONTOUR (1m)	450 PROPOSED STORM SEWER AND PIPE SIZE
EXISTING CULVERT	450 PROPOSED STORM SEWER AND PIPE SIZE (URBANTECH)
450 EXISTING STORM SEWER AND PIPE SIZE	

SUBCATCHMENT BOUNDARY

S150 0.75ha 73.4% — SUBCATCHMENT ID#, PERCENTAGE OF IMPERVIOUS AREA, SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

BARTON STREET AND FIFTY ROAD CLASS EA
CITY OF HAMILTON

STORM DRAINAGE BOUNDARIES
(FUTURE CONDITION)

wood.

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:750
0 7.5 15 30

Consultant File No. TPB166053

Drawing No. 16

Path: I:\TPB166053 - Barton Street\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2021-08\Fig Subcatchment-FT-BU.dwg

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Last Saved By: richard.bartolo
Plotted: 2022-06-08
Last Saved: 2022-05-16

Appendix E

OGS Sizing Reports

Barton St. & Fifty Rd. - OGS TSS Removal Calculations and Summary									
Location	Change in Paved Area	TSS Removal Required	Drainage Area			Equivalent TSS Removal Required	Recommended Stormceptor EF Model	TSS Removal Provided	Particle Size Distribution
	(ha)	(%)	Total (ha)	Imp (%)	Imp (ha)	(%)		(%)	
Water Course 5 - West (east of Fruitland Road)	0.4040	80	1.228	69.2	0.85	38.02	EF4	50	CA ETV
Sunnyhurst Avenue	1.0810	80	1.933	73.7	1.42	60.73	EF10	62	CA ETV
Kenmore Avenue	-0.4200	80	0	0.0	0.00				
Jones Road	-0.0360	80	0	0.0	0.00				
Water Course 6 - East (east of Jones Road)	1.0550	80	2.293	73.6	1.69	50.00	EF6	51	CA ETV
Water Course 6 (west of Glover Road)	0.5850	80	1.305	74.5	0.97	48.15	EF4	49	CA ETV
Glover Road	-0.2470	80	0	0.0	0.00				
Water Course 7 - West	0.6900	80	1.325	73.6	0.98	56.62	EF6	57	CA ETV
Water Course 7 - East	0.7210	80	1.405	68.1	0.96	60.27	EF8	62	CA ETV
McNeilly Road	0.1403	80	0.6167	73.3	0.45	24.81	EF4	57	CA ETV
Lewis Road (Water Course 9 - West)	2.6776	80	5.5717	71.4	3.98	53.87	EF12	57	CA ETV
West Avenue	0.5570	80	1.356	74.1	1.01	44.34	EF4	48	CA ETV
Winona Road	-0.0360	80	0.20	79.5	0.16				
Napa Lane	0.2340	80	0.7	72.3	0.51	37.00	EF4	56	CA ETV
Foothills Lane	0.3180	80	0.76	73.3	0.56	45.43	EF4	55	CA ETV
Fifty Creek at Hwy #8	0.1270	80	0.66	60.5	0.40	25.40	EF4	57	CA ETV
Fifty Creek at CNR	-0.0320	80	0.078	48.7	0.04				
South Service Road	1.4010	80	2.76	65.3	1.80	62.30	EF12	63	CA ETV

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/03/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Water Course 5 - West (east of Fruitland Road)
Drainage Area (ha):	1.228
% Imperviousness:	69.20
Runoff Coefficient 'c':	0.71
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	38.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	33.43
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	50
EFO6	59
EFO8	63
EFO10	65
EFO12	66

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**50**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

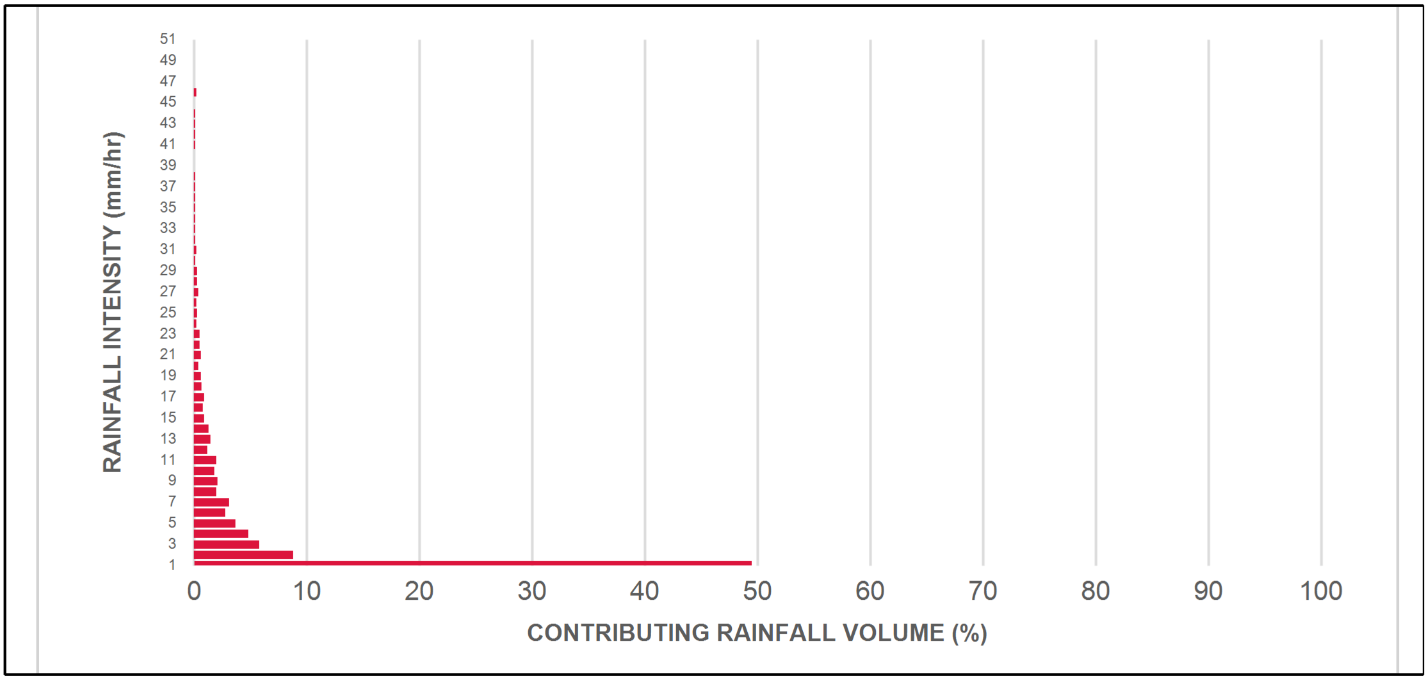
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

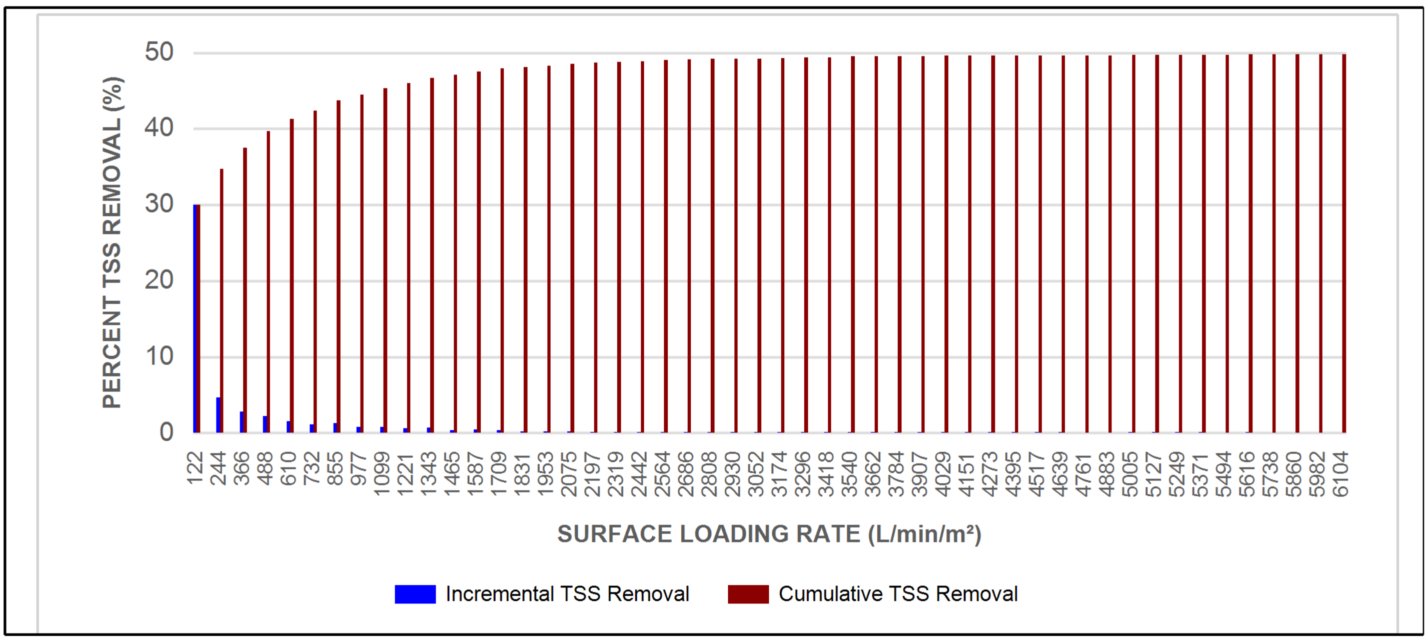
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.44	146.0	122.0	61	30.0	30.0
2	8.8	58.3	4.88	293.0	244.0	53	4.6	34.7
3	5.8	64.1	7.32	439.0	366.0	49	2.9	37.5
4	4.8	68.9	9.77	586.0	488.0	46	2.2	39.7
5	3.7	72.6	12.21	732.0	610.0	42	1.6	41.3
6	2.8	75.4	14.65	879.0	732.0	41	1.2	42.4
7	3.1	78.5	17.09	1025.0	855.0	41	1.3	43.7
8	2.0	80.5	19.53	1172.0	977.0	40	0.8	44.5
9	2.1	82.6	21.97	1318.0	1099.0	39	0.8	45.3
10	1.8	84.4	24.42	1465.0	1221.0	37	0.7	46.0
11	2.0	86.4	26.86	1611.0	1343.0	35	0.7	46.7
12	1.2	87.6	29.30	1758.0	1465.0	33	0.4	47.1
13	1.5	89.1	31.74	1904.0	1587.0	30	0.5	47.5
14	1.3	90.4	34.18	2051.0	1709.0	28	0.4	47.9
15	0.9	91.3	36.62	2197.0	1831.0	26	0.2	48.1
16	0.8	92.1	39.07	2344.0	1953.0	24	0.2	48.3
17	0.9	93.0	41.51	2490.0	2075.0	23	0.2	48.5
18	0.7	93.7	43.95	2637.0	2197.0	22	0.2	48.7
19	0.6	94.3	46.39	2783.0	2319.0	21	0.1	48.8
20	0.4	94.7	48.83	2930.0	2442.0	20	0.1	48.9
21	0.6	95.3	51.27	3076.0	2564.0	19	0.1	49.0
22	0.5	95.8	53.71	3223.0	2686.0	18	0.1	49.1
23	0.5	96.3	56.16	3369.0	2808.0	18	0.1	49.2
24	0.2	96.5	58.60	3516.0	2930.0	18	0.0	49.2
25	0.3	96.8	61.04	3662.0	3052.0	18	0.1	49.2

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	63.48	3809.0	3174.0	18	0.0	49.3
27	0.4	97.4	65.92	3955.0	3296.0	18	0.1	49.4
28	0.3	97.7	68.36	4102.0	3418.0	18	0.1	49.4
29	0.3	98.0	70.81	4248.0	3540.0	18	0.1	49.5
30	0.1	98.1	73.25	4395.0	3662.0	18	0.0	49.5
31	0.2	98.3	75.69	4541.0	3784.0	18	0.0	49.5
32	0.1	98.4	78.13	4688.0	3907.0	18	0.0	49.5
33	0.1	98.5	80.57	4834.0	4029.0	18	0.0	49.6
34	0.1	98.6	83.01	4981.0	4151.0	18	0.0	49.6
35	0.1	98.7	85.46	5127.0	4273.0	18	0.0	49.6
36	0.1	98.8	87.90	5274.0	4395.0	18	0.0	49.6
37	0.1	98.9	90.34	5420.0	4517.0	18	0.0	49.6
38	0.1	99.0	92.78	5567.0	4639.0	18	0.0	49.6
39	0.0	99.0	95.22	5713.0	4761.0	18	0.0	49.6
40	0.0	99.0	97.66	5860.0	4883.0	18	0.0	49.6
41	0.1	99.1	100.10	6006.0	5005.0	18	0.0	49.7
42	0.1	99.2	102.55	6153.0	5127.0	18	0.0	49.7
43	0.1	99.3	104.99	6299.0	5249.0	18	0.0	49.7
44	0.1	99.4	107.43	6446.0	5371.0	18	0.0	49.7
45	0.0	99.4	109.87	6592.0	5494.0	18	0.0	49.7
46	0.2	99.6	112.31	6739.0	5616.0	18	0.0	49.8
47	0.0	99.6	114.75	6885.0	5738.0	18	0.0	49.8
48	0.0	99.6	117.20	7032.0	5860.0	18	0.0	49.8
49	0.0	99.6	119.64	7178.0	5982.0	18	0.0	49.8
50	0.0	99.6	122.08	7325.0	6104.0	18	0.0	49.8
Estimated Net Annual Sediment (TSS) Load Reduction =								50 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

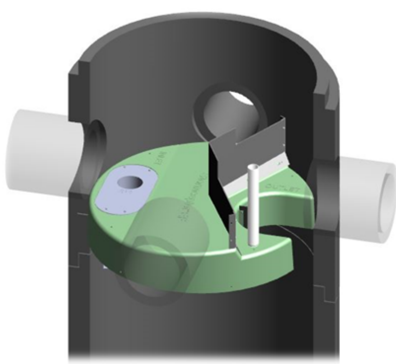
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

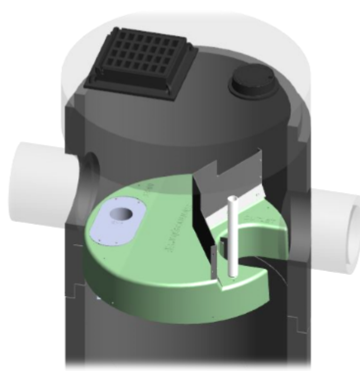
DESIGN FLEXIBILITY

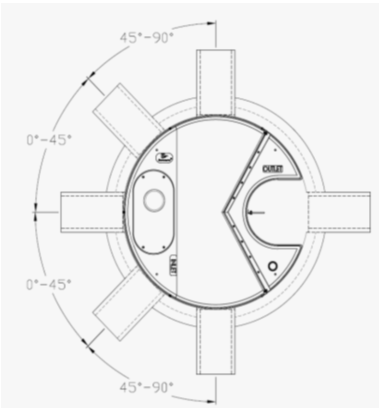
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/24/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Sunnyhurst Avenue
Drainage Area (ha):	1.933
% Imperviousness:	73.70
Runoff Coefficient 'c':	0.74
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	60.7
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	54.61
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	43
EFO6	53
EFO8	59
EFO10	62
EFO12	64

Recommended Stormceptor EFO Model: EFO10

Estimated Net Annual Sediment (TSS) Load Reduction (%): 62

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

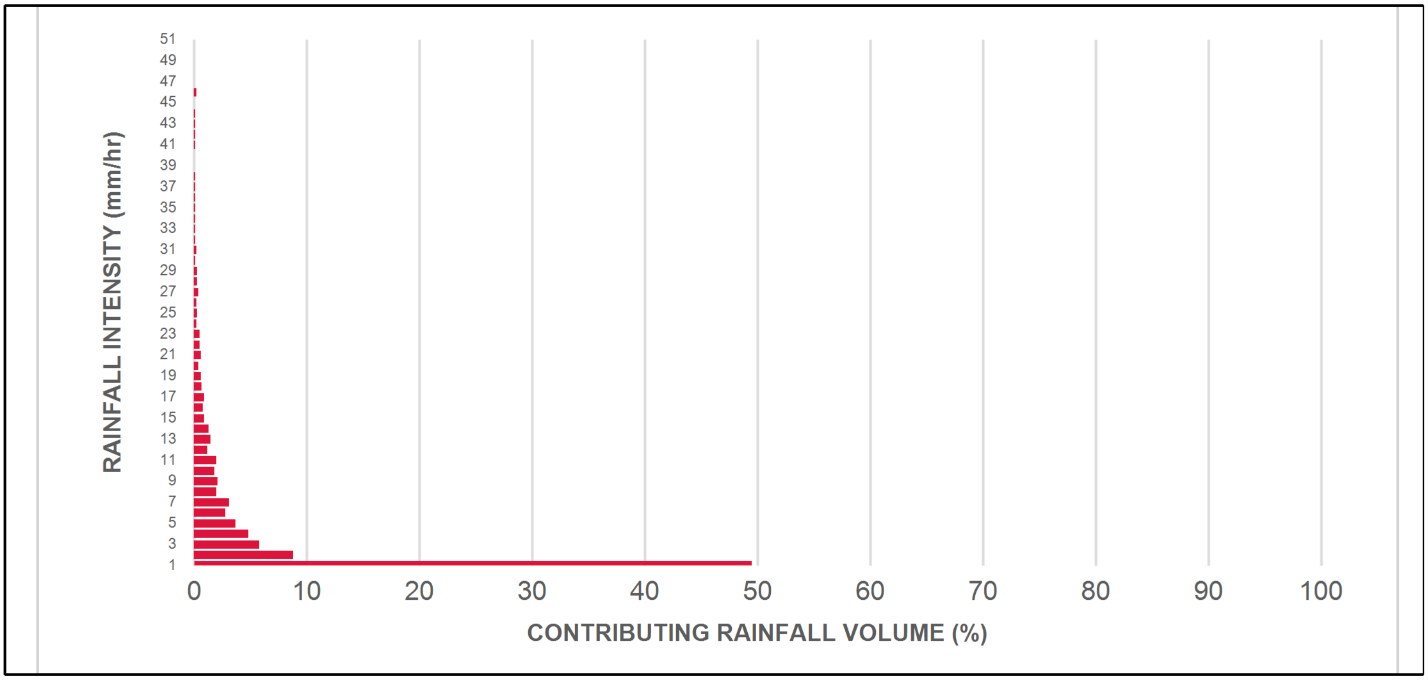
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

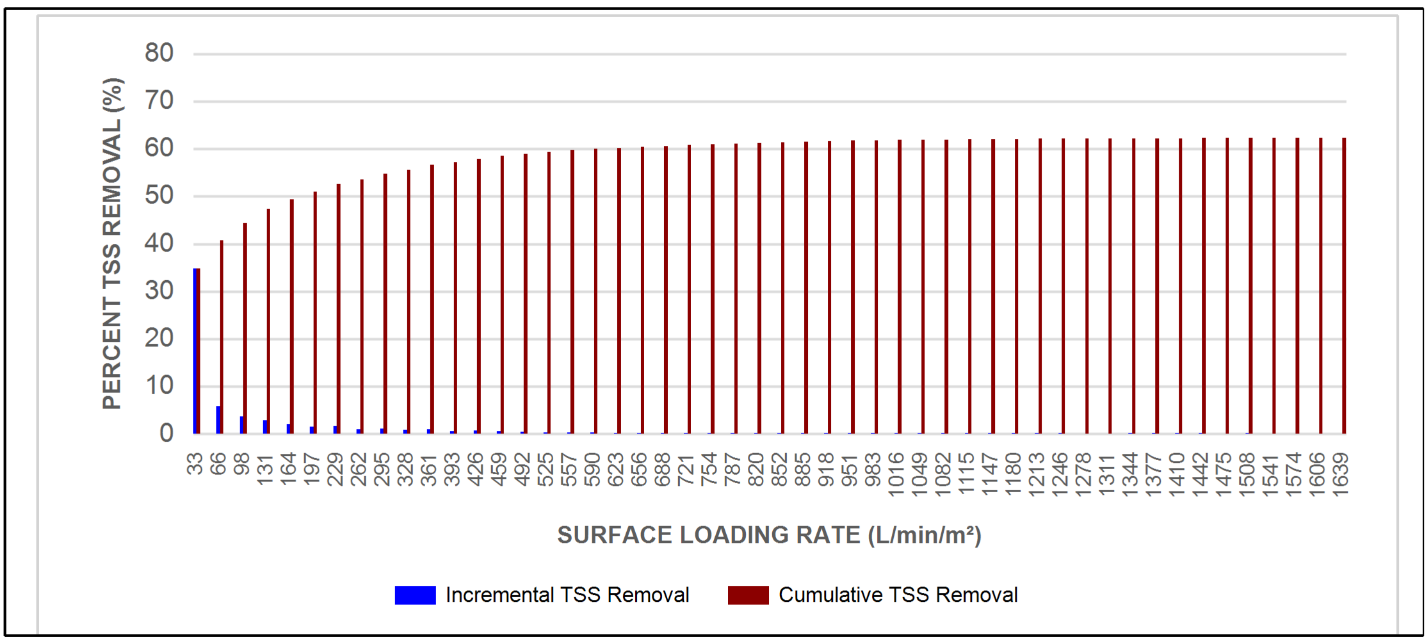
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	3.99	239.0	33.0	70	34.8	34.8
2	8.8	58.3	7.98	479.0	66.0	67	5.9	40.8
3	5.8	64.1	11.97	718.0	98.0	63	3.7	44.4
4	4.8	68.9	15.95	957.0	131.0	60	2.9	47.3
5	3.7	72.6	19.94	1197.0	164.0	57	2.1	49.4
6	2.8	75.4	23.93	1436.0	197.0	55	1.5	51.0
7	3.1	78.5	27.92	1675.0	229.0	53	1.6	52.6
8	2.0	80.5	31.91	1914.0	262.0	52	1.0	53.6
9	2.1	82.6	35.90	2154.0	295.0	51	1.1	54.7
10	1.8	84.4	39.88	2393.0	328.0	50	0.9	55.6
11	2.0	86.4	43.87	2632.0	361.0	49	1.0	56.6
12	1.2	87.6	47.86	2872.0	393.0	48	0.6	57.2
13	1.5	89.1	51.85	3111.0	426.0	47	0.7	57.9
14	1.3	90.4	55.84	3350.0	459.0	47	0.6	58.5
15	0.9	91.3	59.83	3590.0	492.0	45	0.4	58.9
16	0.8	92.1	63.81	3829.0	525.0	44	0.4	59.3
17	0.9	93.0	67.80	4068.0	557.0	44	0.4	59.7
18	0.7	93.7	71.79	4307.0	590.0	42	0.3	60.0
19	0.6	94.3	75.78	4547.0	623.0	42	0.3	60.2
20	0.4	94.7	79.77	4786.0	656.0	42	0.2	60.4
21	0.6	95.3	83.76	5025.0	688.0	42	0.3	60.6
22	0.5	95.8	87.74	5265.0	721.0	41	0.2	60.8
23	0.5	96.3	91.73	5504.0	754.0	41	0.2	61.0
24	0.2	96.5	95.72	5743.0	787.0	41	0.1	61.1
25	0.3	96.8	99.71	5983.0	820.0	41	0.1	61.2

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	103.70	6222.0	852.0	41	0.1	61.3
27	0.4	97.4	107.69	6461.0	885.0	41	0.2	61.5
28	0.3	97.7	111.67	6700.0	918.0	40	0.1	61.6
29	0.3	98.0	115.66	6940.0	951.0	40	0.1	61.7
30	0.1	98.1	119.65	7179.0	983.0	40	0.0	61.8
31	0.2	98.3	123.64	7418.0	1016.0	40	0.1	61.9
32	0.1	98.4	127.63	7658.0	1049.0	39	0.0	61.9
33	0.1	98.5	131.62	7897.0	1082.0	39	0.0	61.9
34	0.1	98.6	135.61	8136.0	1115.0	38	0.0	62.0
35	0.1	98.7	139.59	8376.0	1147.0	38	0.0	62.0
36	0.1	98.8	143.58	8615.0	1180.0	37	0.0	62.0
37	0.1	98.9	147.57	8854.0	1213.0	37	0.0	62.1
38	0.1	99.0	151.56	9094.0	1246.0	36	0.0	62.1
39	0.0	99.0	155.55	9333.0	1278.0	36	0.0	62.1
40	0.0	99.0	159.54	9572.0	1311.0	35	0.0	62.1
41	0.1	99.1	163.52	9811.0	1344.0	35	0.0	62.1
42	0.1	99.2	167.51	10051.0	1377.0	34	0.0	62.2
43	0.1	99.3	171.50	10290.0	1410.0	34	0.0	62.2
44	0.1	99.4	175.49	10529.0	1442.0	33	0.0	62.3
45	0.0	99.4	179.48	10769.0	1475.0	32	0.0	62.3
46	0.2	99.6	183.47	11008.0	1508.0	32	0.1	62.3
47	0.0	99.6	187.45	11247.0	1541.0	31	0.0	62.3
48	0.0	99.6	191.44	11487.0	1574.0	30	0.0	62.3
49	0.0	99.6	195.43	11726.0	1606.0	30	0.0	62.3
50	0.0	99.6	199.42	11965.0	1639.0	29	0.0	62.3
Estimated Net Annual Sediment (TSS) Load Reduction =								**62 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	(ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	(in)	Max Outlet Pipe Diameter (mm)	(in)	Peak Conveyance Flow Rate (L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

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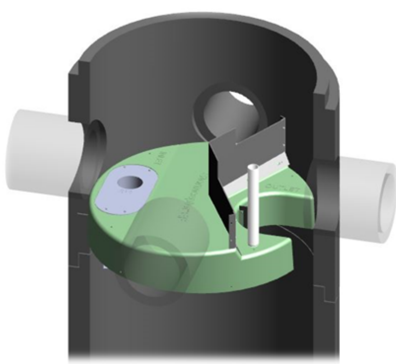
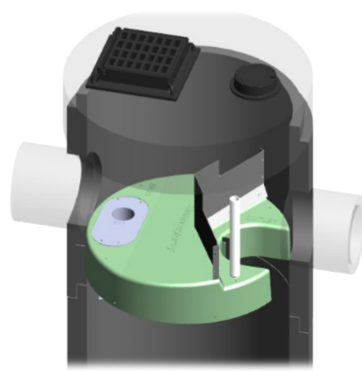
DESIGN FLEXIBILITY

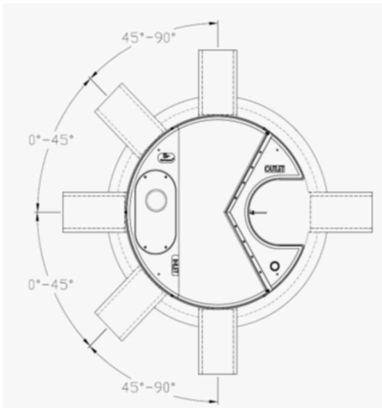
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Water Course 6 - East (east of Jones Road)
Drainage Area (ha):	2.293
% Imperviousness:	73.60

Runoff Coefficient 'c': 0.74

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	50.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	64.73
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	42
EFO6	51
EFO8	57
EFO10	61
EFO12	63

Recommended Stormceptor EFO Model:	**EFO6**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**51**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

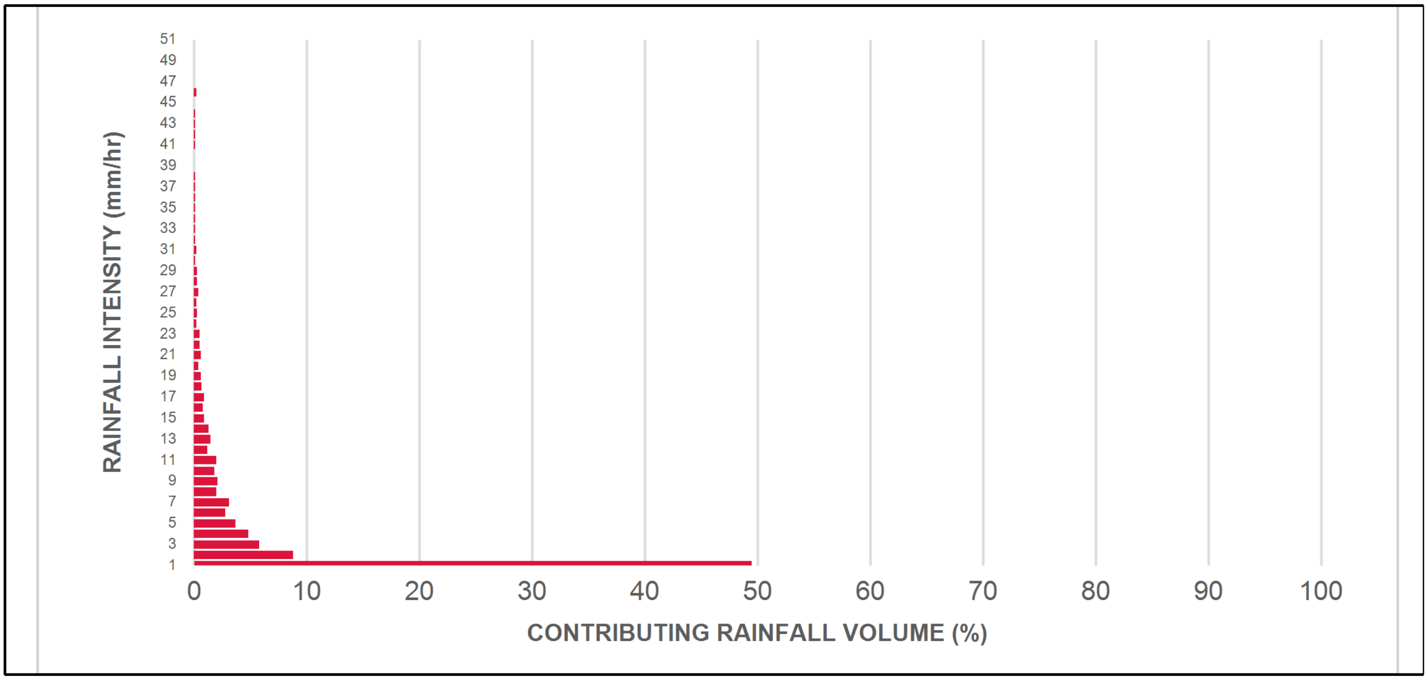
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

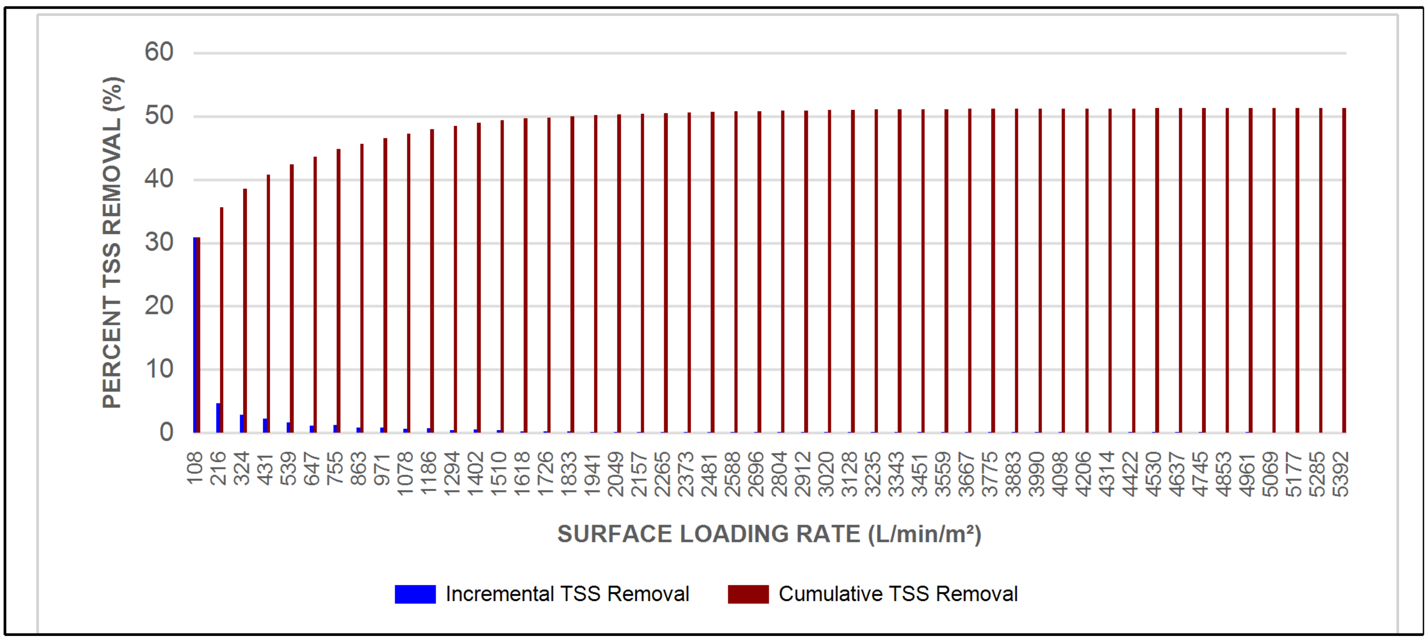
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	4.73	284.0	108.0	62	30.9	30.9
2	8.8	58.3	9.45	567.0	216.0	54	4.7	35.6
3	5.8	64.1	14.18	851.0	324.0	50	2.9	38.5
4	4.8	68.9	18.91	1135.0	431.0	47	2.3	40.8
5	3.7	72.6	23.64	1418.0	539.0	44	1.6	42.4
6	2.8	75.4	28.36	1702.0	647.0	42	1.2	43.6
7	3.1	78.5	33.09	1985.0	755.0	41	1.3	44.8
8	2.0	80.5	37.82	2269.0	863.0	41	0.8	45.6
9	2.1	82.6	42.55	2553.0	971.0	40	0.8	46.5
10	1.8	84.4	47.27	2836.0	1078.0	39	0.7	47.2
11	2.0	86.4	52.00	3120.0	1186.0	37	0.7	47.9
12	1.2	87.6	56.73	3404.0	1294.0	36	0.4	48.4
13	1.5	89.1	61.46	3687.0	1402.0	34	0.5	48.9
14	1.3	90.4	66.18	3971.0	1510.0	32	0.4	49.3
15	0.9	91.3	70.91	4255.0	1618.0	30	0.3	49.6
16	0.8	92.1	75.64	4538.0	1726.0	28	0.2	49.8
17	0.9	93.0	80.37	4822.0	1833.0	26	0.2	50.0
18	0.7	93.7	85.09	5106.0	1941.0	25	0.2	50.2
19	0.6	94.3	89.82	5389.0	2049.0	23	0.1	50.3
20	0.4	94.7	94.55	5673.0	2157.0	22	0.1	50.4
21	0.6	95.3	99.27	5956.0	2265.0	21	0.1	50.5
22	0.5	95.8	104.00	6240.0	2373.0	20	0.1	50.6
23	0.5	96.3	108.73	6524.0	2481.0	19	0.1	50.7
24	0.2	96.5	113.46	6807.0	2588.0	18	0.0	50.8
25	0.3	96.8	118.18	7091.0	2696.0	18	0.1	50.8

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	122.91	7375.0	2804.0	18	0.0	50.9
27	0.4	97.4	127.64	7658.0	2912.0	18	0.1	50.9
28	0.3	97.7	132.37	7942.0	3020.0	18	0.1	51.0
29	0.3	98.0	137.09	8226.0	3128.0	18	0.1	51.0
30	0.1	98.1	141.82	8509.0	3235.0	18	0.0	51.1
31	0.2	98.3	146.55	8793.0	3343.0	18	0.0	51.1
32	0.1	98.4	151.28	9077.0	3451.0	18	0.0	51.1
33	0.1	98.5	156.00	9360.0	3559.0	18	0.0	51.1
34	0.1	98.6	160.73	9644.0	3667.0	18	0.0	51.2
35	0.1	98.7	165.46	9927.0	3775.0	18	0.0	51.2
36	0.1	98.8	170.18	10211.0	3883.0	18	0.0	51.2
37	0.1	98.9	174.91	10495.0	3990.0	18	0.0	51.2
38	0.1	99.0	179.64	10778.0	4098.0	18	0.0	51.2
39	0.0	99.0	184.37	11062.0	4206.0	18	0.0	51.2
40	0.0	99.0	189.09	11346.0	4314.0	18	0.0	51.2
41	0.1	99.1	193.82	11629.0	4422.0	18	0.0	51.2
42	0.1	99.2	198.55	11913.0	4530.0	18	0.0	51.3
43	0.1	99.3	203.28	12197.0	4637.0	18	0.0	51.3
44	0.1	99.4	208.00	12480.0	4745.0	18	0.0	51.3
45	0.0	99.4	212.73	12764.0	4853.0	18	0.0	51.3
46	0.2	99.6	217.46	13048.0	4961.0	18	0.0	51.3
47	0.0	99.6	222.19	13331.0	5069.0	18	0.0	51.3
48	0.0	99.6	226.91	13615.0	5177.0	18	0.0	51.3
49	0.0	99.6	231.64	13898.0	5285.0	18	0.0	51.3
50	0.0	99.6	236.37	14182.0	5392.0	18	0.0	51.3
Estimated Net Annual Sediment (TSS) Load Reduction =								51 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

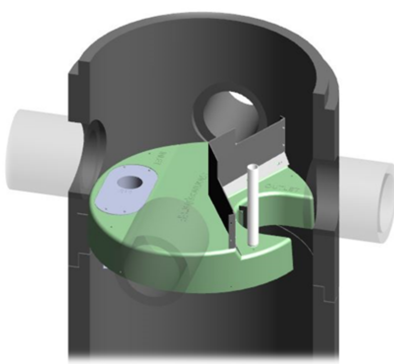
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

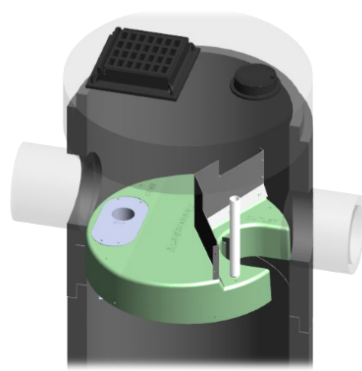
DESIGN FLEXIBILITY

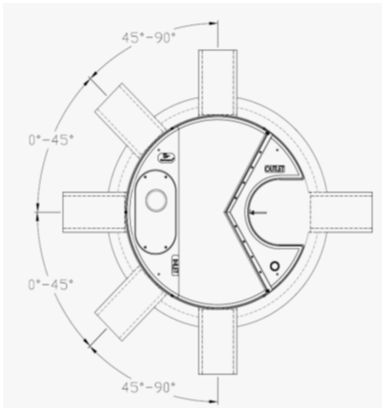
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

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180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
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STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

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1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
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PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/15/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	Water Course 6 (west of Glover Road)
Drainage Area (ha):	1.305
% Imperviousness:	74.50

Runoff Coefficient 'c': 0.74

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	48.1
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	37.11
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	49
EFO6	57
EFO8	62
EFO10	64
EFO12	66

Recommended Stormceptor EFO Model: EFO4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 49

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

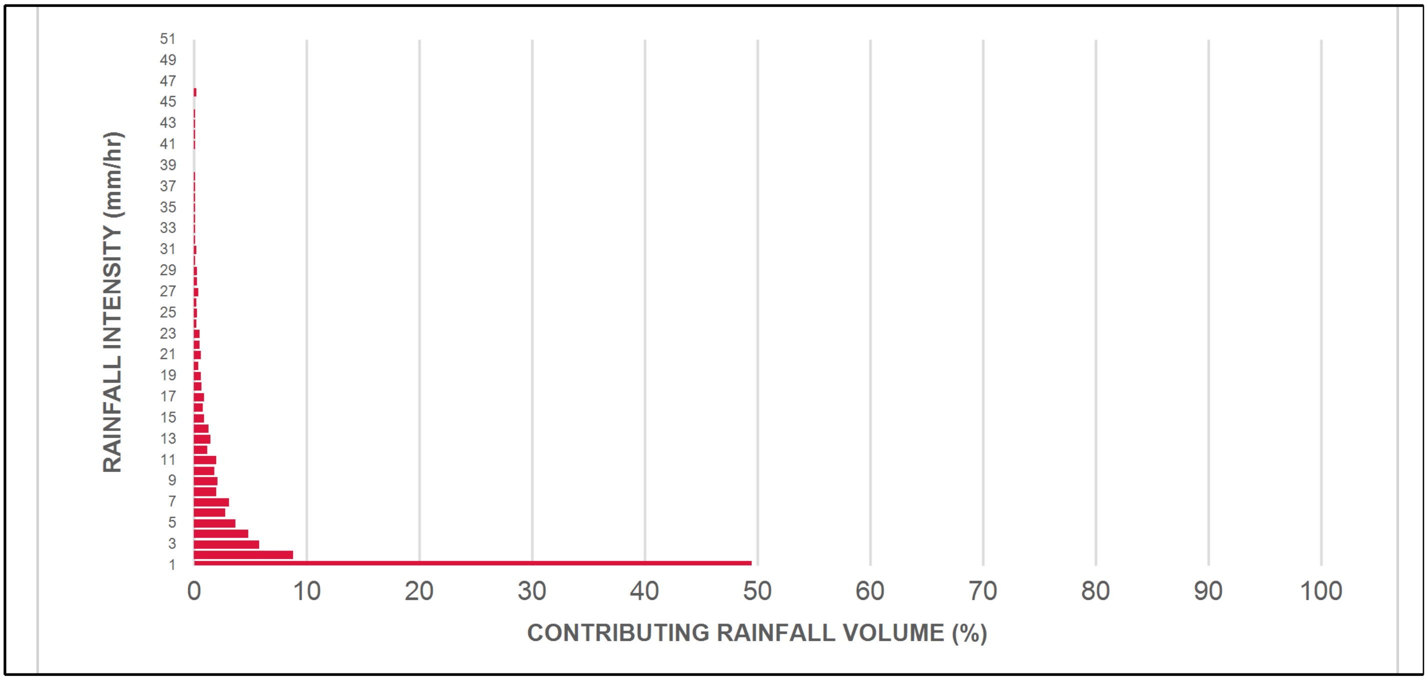
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

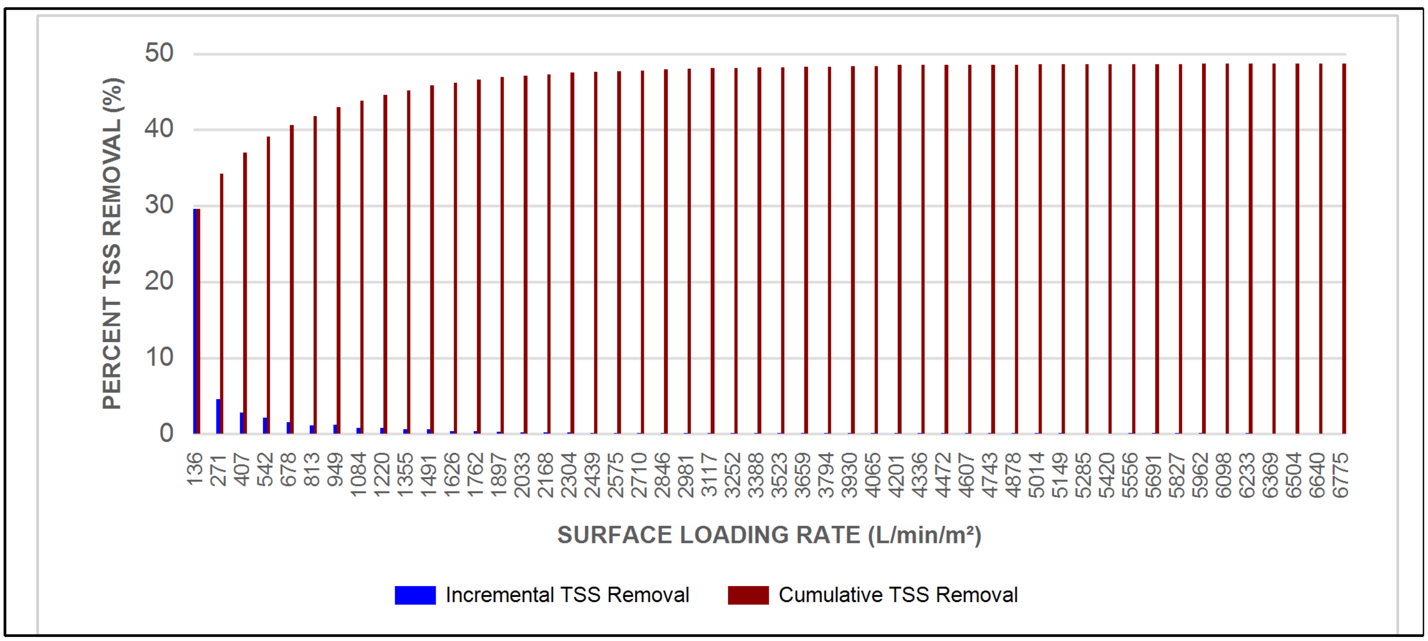
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.71	163.0	136.0	60	29.6	29.6
2	8.8	58.3	5.42	325.0	271.0	52	4.6	34.2
3	5.8	64.1	8.13	488.0	407.0	48	2.8	37.0
4	4.8	68.9	10.84	650.0	542.0	44	2.1	39.1
5	3.7	72.6	13.55	813.0	678.0	42	1.5	40.6
6	2.8	75.4	16.26	976.0	813.0	41	1.1	41.8
7	3.1	78.5	18.97	1138.0	949.0	40	1.2	43.0
8	2.0	80.5	21.68	1301.0	1084.0	39	0.8	43.8
9	2.1	82.6	24.39	1463.0	1220.0	37	0.8	44.6
10	1.8	84.4	27.10	1626.0	1355.0	35	0.6	45.2
11	2.0	86.4	29.81	1789.0	1491.0	32	0.6	45.8
12	1.2	87.6	32.52	1951.0	1626.0	29	0.4	46.2
13	1.5	89.1	35.23	2114.0	1762.0	27	0.4	46.6
14	1.3	90.4	37.94	2276.0	1897.0	25	0.3	46.9
15	0.9	91.3	40.65	2439.0	2033.0	23	0.2	47.1
16	0.8	92.1	43.36	2602.0	2168.0	22	0.2	47.3
17	0.9	93.0	46.07	2764.0	2304.0	21	0.2	47.5
18	0.7	93.7	48.78	2927.0	2439.0	20	0.1	47.6
19	0.6	94.3	51.49	3089.0	2575.0	19	0.1	47.7
20	0.4	94.7	54.20	3252.0	2710.0	18	0.1	47.8
21	0.6	95.3	56.91	3415.0	2846.0	18	0.1	47.9
22	0.5	95.8	59.62	3577.0	2981.0	18	0.1	48.0
23	0.5	96.3	62.33	3740.0	3117.0	18	0.1	48.1
24	0.2	96.5	65.04	3902.0	3252.0	18	0.0	48.1
25	0.3	96.8	67.75	4065.0	3388.0	18	0.1	48.2

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	70.46	4228.0	3523.0	18	0.0	48.2
27	0.4	97.4	73.17	4390.0	3659.0	18	0.1	48.3
28	0.3	97.7	75.88	4553.0	3794.0	18	0.1	48.3
29	0.3	98.0	78.59	4715.0	3930.0	18	0.1	48.4
30	0.1	98.1	81.30	4878.0	4065.0	18	0.0	48.4
31	0.2	98.3	84.01	5041.0	4201.0	18	0.0	48.5
32	0.1	98.4	86.72	5203.0	4336.0	18	0.0	48.5
33	0.1	98.5	89.43	5366.0	4472.0	18	0.0	48.5
34	0.1	98.6	92.14	5528.0	4607.0	18	0.0	48.5
35	0.1	98.7	94.85	5691.0	4743.0	18	0.0	48.5
36	0.1	98.8	97.56	5854.0	4878.0	18	0.0	48.5
37	0.1	98.9	100.27	6016.0	5014.0	18	0.0	48.6
38	0.1	99.0	102.98	6179.0	5149.0	18	0.0	48.6
39	0.0	99.0	105.69	6341.0	5285.0	18	0.0	48.6
40	0.0	99.0	108.40	6504.0	5420.0	18	0.0	48.6
41	0.1	99.1	111.11	6667.0	5556.0	18	0.0	48.6
42	0.1	99.2	113.82	6829.0	5691.0	18	0.0	48.6
43	0.1	99.3	116.53	6992.0	5827.0	18	0.0	48.6
44	0.1	99.4	119.24	7155.0	5962.0	18	0.0	48.7
45	0.0	99.4	121.95	7317.0	6098.0	18	0.0	48.7
46	0.2	99.6	124.66	7480.0	6233.0	18	0.0	48.7
47	0.0	99.6	127.37	7642.0	6369.0	18	0.0	48.7
48	0.0	99.6	130.08	7805.0	6504.0	18	0.0	48.7
49	0.0	99.6	132.79	7968.0	6640.0	18	0.0	48.7
50	0.0	99.6	135.50	8130.0	6775.0	18	0.0	48.7
							Estimated Net Annual Sediment (TSS) Load Reduction =	**49 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

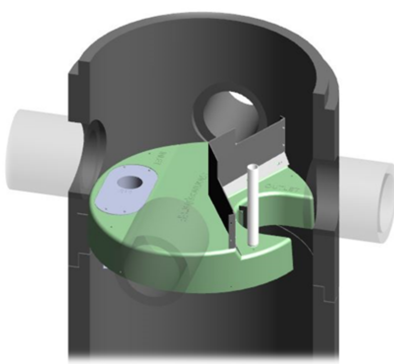
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

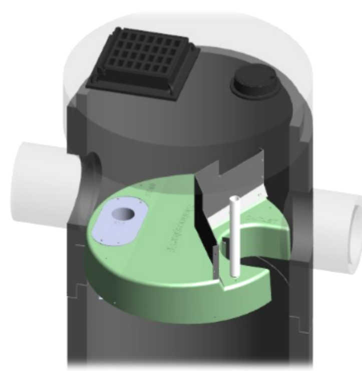
DESIGN FLEXIBILITY

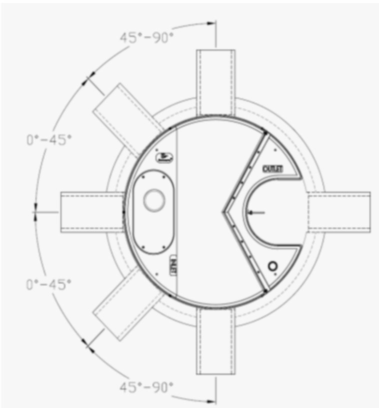
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	Water Course 7 - West

Drainage Area (ha):	1.325
% Imperviousness:	73.60

Runoff Coefficient 'c': 0.74

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	56.6

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	37.40
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	49
EFO6	57
EFO8	62
EFO10	64
EFO12	66

Recommended Stormceptor EFO Model:	**EFO6**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**57**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

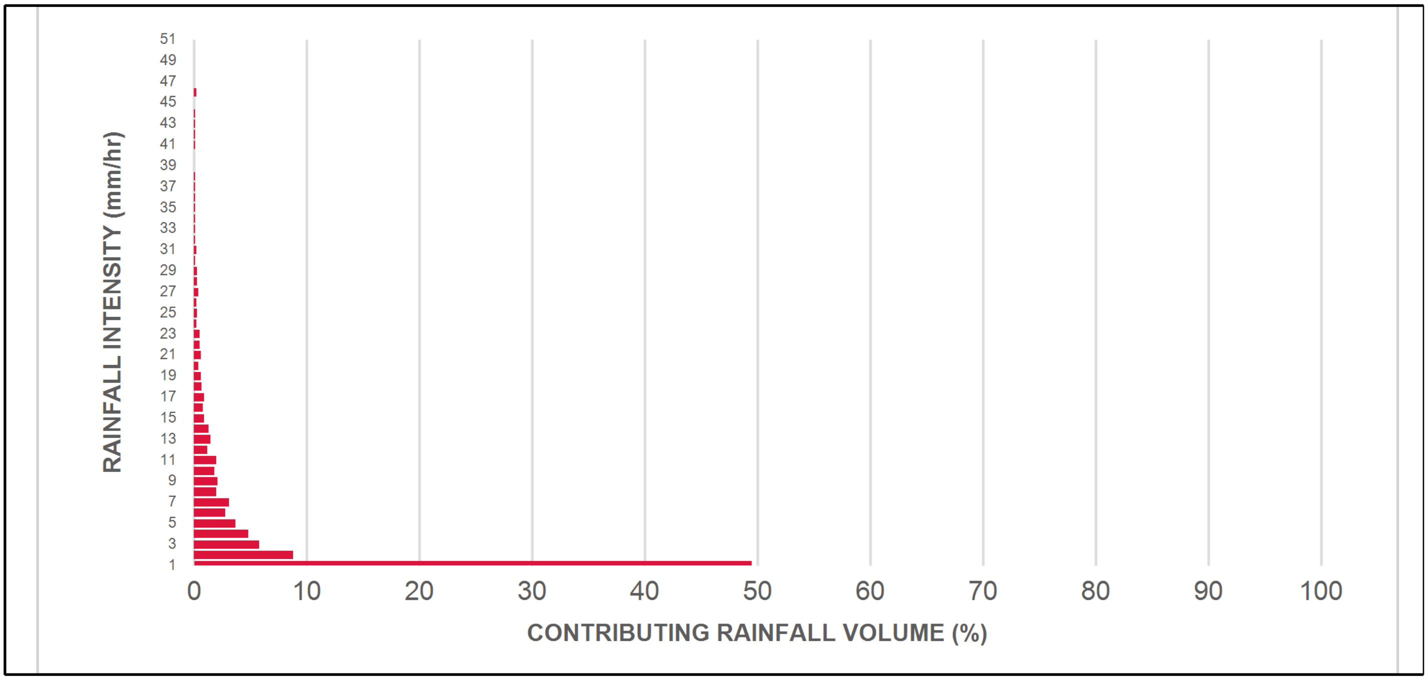
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

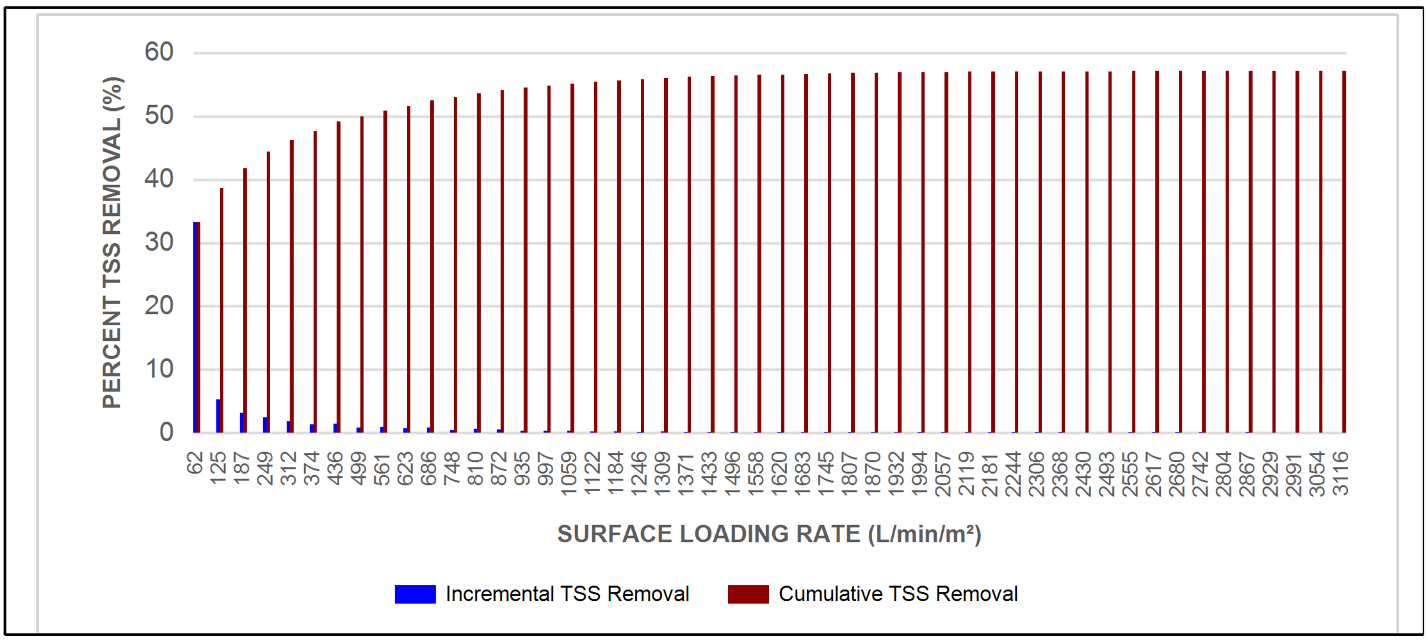
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.73	164.0	62.0	67	33.3	33.3
2	8.8	58.3	5.46	328.0	125.0	61	5.3	38.6
3	5.8	64.1	8.20	492.0	187.0	56	3.2	41.8
4	4.8	68.9	10.93	656.0	249.0	53	2.5	44.4
5	3.7	72.6	13.66	820.0	312.0	51	1.9	46.2
6	2.8	75.4	16.39	983.0	374.0	49	1.4	47.6
7	3.1	78.5	19.12	1147.0	436.0	47	1.5	49.1
8	2.0	80.5	21.85	1311.0	499.0	45	0.9	50.0
9	2.1	82.6	24.59	1475.0	561.0	43	0.9	50.9
10	1.8	84.4	27.32	1639.0	623.0	42	0.8	51.6
11	2.0	86.4	30.05	1803.0	686.0	42	0.8	52.5
12	1.2	87.6	32.78	1967.0	748.0	41	0.5	53.0
13	1.5	89.1	35.51	2131.0	810.0	41	0.6	53.6
14	1.3	90.4	38.24	2295.0	872.0	41	0.5	54.1
15	0.9	91.3	40.98	2459.0	935.0	40	0.4	54.5
16	0.8	92.1	43.71	2622.0	997.0	40	0.3	54.8
17	0.9	93.0	46.44	2786.0	1059.0	39	0.4	55.1
18	0.7	93.7	49.17	2950.0	1122.0	38	0.3	55.4
19	0.6	94.3	51.90	3114.0	1184.0	37	0.2	55.6
20	0.4	94.7	54.63	3278.0	1246.0	36	0.1	55.8
21	0.6	95.3	57.37	3442.0	1309.0	36	0.2	56.0
22	0.5	95.8	60.10	3606.0	1371.0	34	0.2	56.2
23	0.5	96.3	62.83	3770.0	1433.0	33	0.2	56.3
24	0.2	96.5	65.56	3934.0	1496.0	32	0.1	56.4
25	0.3	96.8	68.29	4098.0	1558.0	31	0.1	56.5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	71.02	4261.0	1620.0	29	0.1	56.5
27	0.4	97.4	73.76	4425.0	1683.0	28	0.1	56.6
28	0.3	97.7	76.49	4589.0	1745.0	27	0.1	56.7
29	0.3	98.0	79.22	4753.0	1807.0	26	0.1	56.8
30	0.1	98.1	81.95	4917.0	1870.0	25	0.0	56.8
31	0.2	98.3	84.68	5081.0	1932.0	25	0.0	56.9
32	0.1	98.4	87.41	5245.0	1994.0	24	0.0	56.9
33	0.1	98.5	90.15	5409.0	2057.0	23	0.0	56.9
34	0.1	98.6	92.88	5573.0	2119.0	23	0.0	57.0
35	0.1	98.7	95.61	5737.0	2181.0	22	0.0	57.0
36	0.1	98.8	98.34	5900.0	2244.0	21	0.0	57.0
37	0.1	98.9	101.07	6064.0	2306.0	21	0.0	57.0
38	0.1	99.0	103.80	6228.0	2368.0	20	0.0	57.0
39	0.0	99.0	106.54	6392.0	2430.0	20	0.0	57.0
40	0.0	99.0	109.27	6556.0	2493.0	19	0.0	57.0
41	0.1	99.1	112.00	6720.0	2555.0	19	0.0	57.1
42	0.1	99.2	114.73	6884.0	2617.0	18	0.0	57.1
43	0.1	99.3	117.46	7048.0	2680.0	18	0.0	57.1
44	0.1	99.4	120.19	7212.0	2742.0	18	0.0	57.1
45	0.0	99.4	122.93	7376.0	2804.0	18	0.0	57.1
46	0.2	99.6	125.66	7539.0	2867.0	18	0.0	57.1
47	0.0	99.6	128.39	7703.0	2929.0	18	0.0	57.1
48	0.0	99.6	131.12	7867.0	2991.0	18	0.0	57.1
49	0.0	99.6	133.85	8031.0	3054.0	18	0.0	57.1
50	0.0	99.6	136.58	8195.0	3116.0	18	0.0	57.1
							Estimated Net Annual Sediment (TSS) Load Reduction =	**57 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

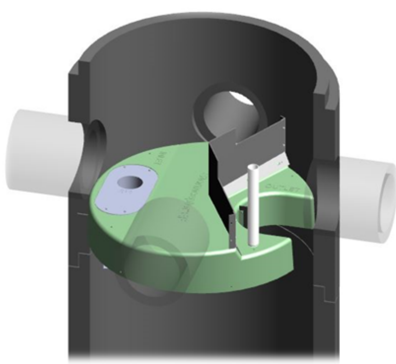
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

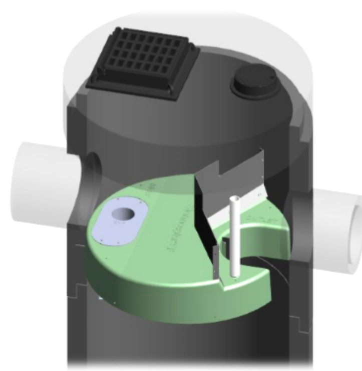
DESIGN FLEXIBILITY

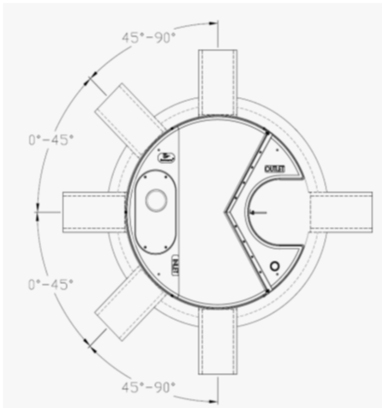
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Water Course 7 - East
Drainage Area (ha):	1.405
% Imperviousness:	68.10

Runoff Coefficient 'c': 0.70

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	60.2
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	37.90
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	49
EFO6	57
EFO8	62
EFO10	64
EFO12	66

Recommended Stormceptor EFO Model:	**EFO8**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**62**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

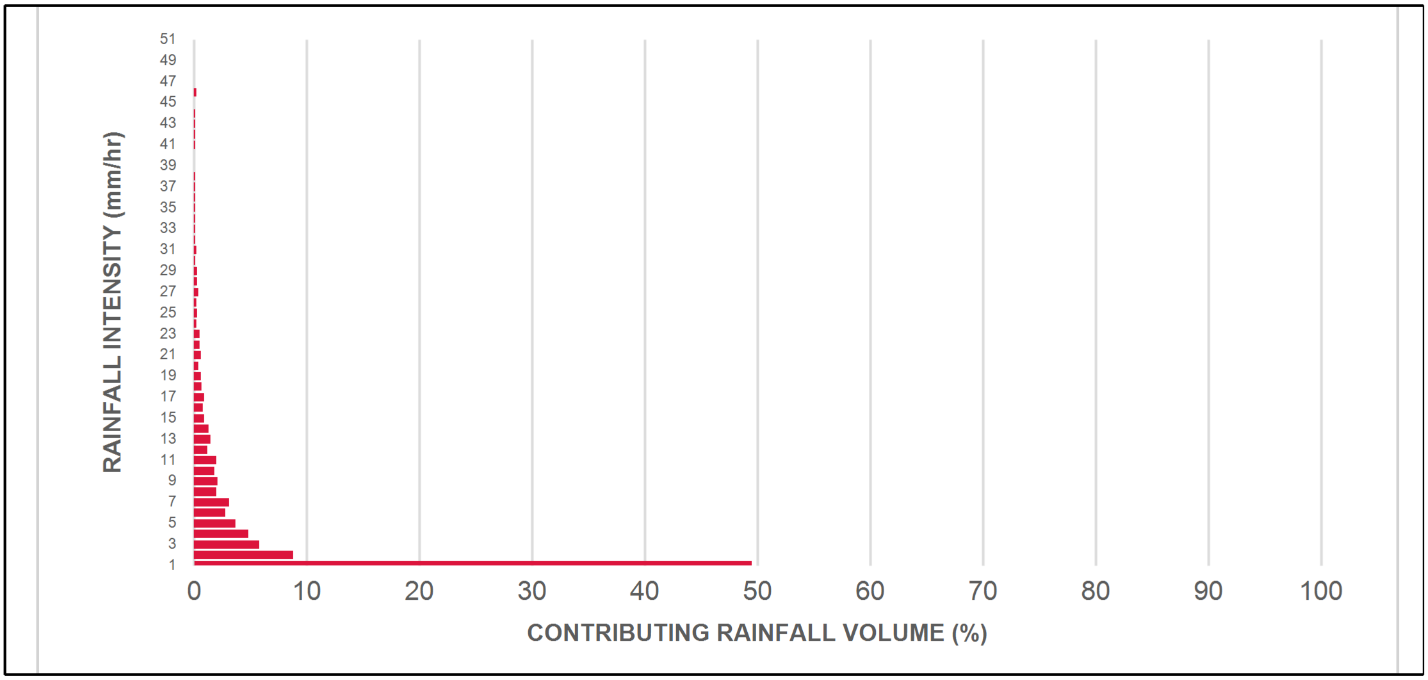
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

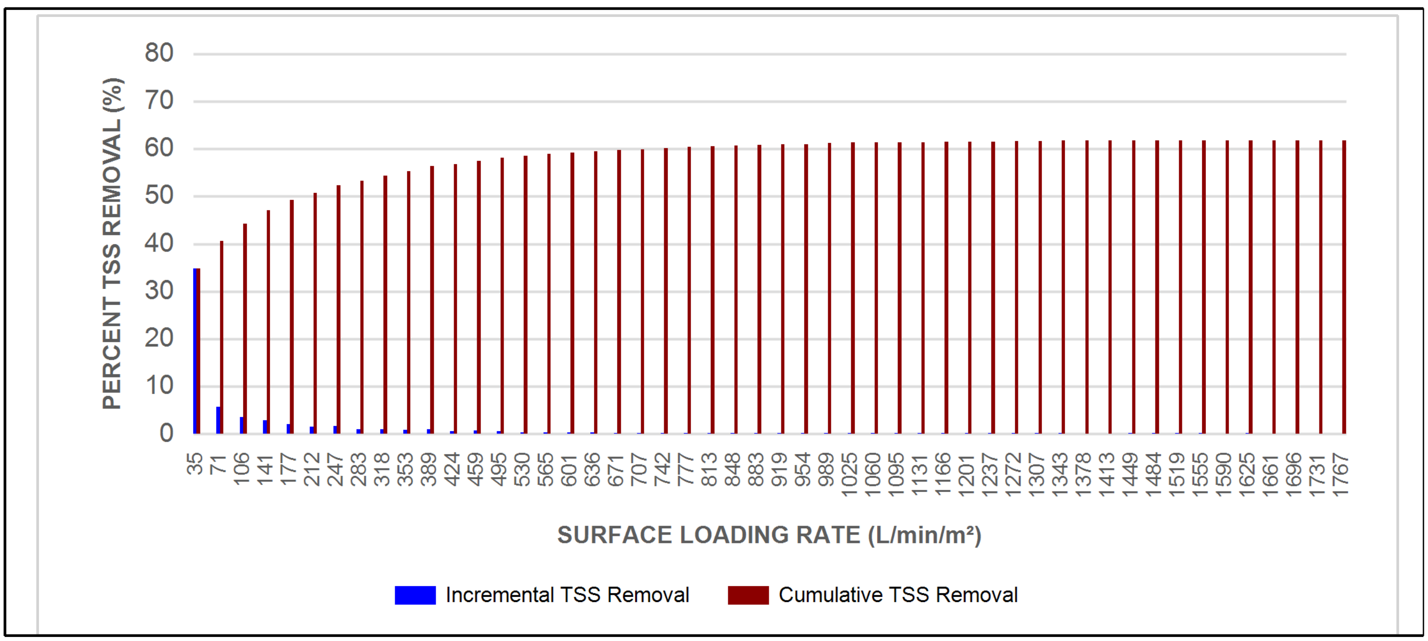
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.77	166.0	35.0	70	34.8	34.8
2	8.8	58.3	5.54	332.0	71.0	66	5.8	40.6
3	5.8	64.1	8.30	498.0	106.0	62	3.6	44.2
4	4.8	68.9	11.07	664.0	141.0	59	2.8	47.1
5	3.7	72.6	13.84	830.0	177.0	57	2.1	49.2
6	2.8	75.4	16.61	996.0	212.0	54	1.5	50.7
7	3.1	78.5	19.37	1162.0	247.0	53	1.6	52.3
8	2.0	80.5	22.14	1329.0	283.0	52	1.0	53.3
9	2.1	82.6	24.91	1495.0	318.0	51	1.1	54.4
10	1.8	84.4	27.68	1661.0	353.0	50	0.9	55.3
11	2.0	86.4	30.44	1827.0	389.0	49	1.0	56.3
12	1.2	87.6	33.21	1993.0	424.0	47	0.6	56.8
13	1.5	89.1	35.98	2159.0	459.0	46	0.7	57.5
14	1.3	90.4	38.75	2325.0	495.0	45	0.6	58.1
15	0.9	91.3	41.52	2491.0	530.0	44	0.4	58.5
16	0.8	92.1	44.28	2657.0	565.0	43	0.3	58.9
17	0.9	93.0	47.05	2823.0	601.0	42	0.4	59.2
18	0.7	93.7	49.82	2989.0	636.0	42	0.3	59.5
19	0.6	94.3	52.59	3155.0	671.0	42	0.3	59.8
20	0.4	94.7	55.35	3321.0	707.0	42	0.2	59.9
21	0.6	95.3	58.12	3487.0	742.0	41	0.2	60.2
22	0.5	95.8	60.89	3653.0	777.0	41	0.2	60.4
23	0.5	96.3	63.66	3819.0	813.0	41	0.2	60.6
24	0.2	96.5	66.43	3986.0	848.0	41	0.1	60.7
25	0.3	96.8	69.19	4152.0	883.0	41	0.1	60.8

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	71.96	4318.0	919.0	40	0.1	60.9
27	0.4	97.4	74.73	4484.0	954.0	40	0.2	61.0
28	0.3	97.7	77.50	4650.0	989.0	40	0.1	61.2
29	0.3	98.0	80.26	4816.0	1025.0	40	0.1	61.3
30	0.1	98.1	83.03	4982.0	1060.0	39	0.0	61.3
31	0.2	98.3	85.80	5148.0	1095.0	39	0.1	61.4
32	0.1	98.4	88.57	5314.0	1131.0	38	0.0	61.4
33	0.1	98.5	91.33	5480.0	1166.0	38	0.0	61.5
34	0.1	98.6	94.10	5646.0	1201.0	37	0.0	61.5
35	0.1	98.7	96.87	5812.0	1237.0	37	0.0	61.5
36	0.1	98.8	99.64	5978.0	1272.0	36	0.0	61.6
37	0.1	98.9	102.41	6144.0	1307.0	36	0.0	61.6
38	0.1	99.0	105.17	6310.0	1343.0	35	0.0	61.7
39	0.0	99.0	107.94	6476.0	1378.0	34	0.0	61.7
40	0.0	99.0	110.71	6643.0	1413.0	34	0.0	61.7
41	0.1	99.1	113.48	6809.0	1449.0	33	0.0	61.7
42	0.1	99.2	116.24	6975.0	1484.0	32	0.0	61.7
43	0.1	99.3	119.01	7141.0	1519.0	31	0.0	61.8
44	0.1	99.4	121.78	7307.0	1555.0	31	0.0	61.8
45	0.0	99.4	124.55	7473.0	1590.0	30	0.0	61.8
46	0.2	99.6	127.32	7639.0	1625.0	29	0.1	61.8
47	0.0	99.6	130.08	7805.0	1661.0	29	0.0	61.8
48	0.0	99.6	132.85	7971.0	1696.0	28	0.0	61.8
49	0.0	99.6	135.62	8137.0	1731.0	28	0.0	61.8
50	0.0	99.6	138.39	8303.0	1767.0	27	0.0	61.8
Estimated Net Annual Sediment (TSS) Load Reduction =								62 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

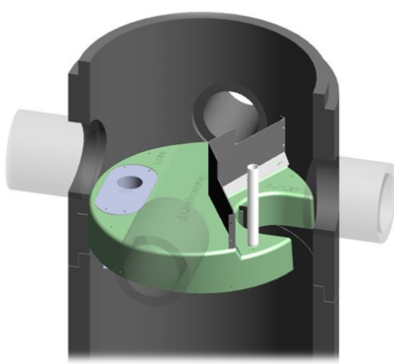
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

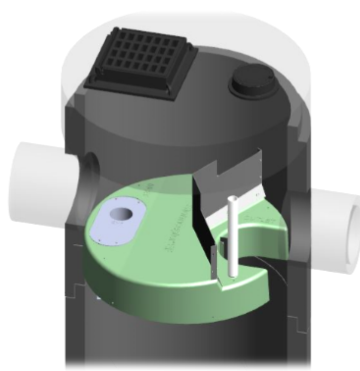
DESIGN FLEXIBILITY

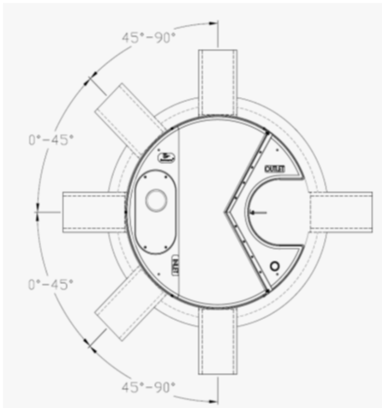
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/26/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	McNeilly Road

Drainage Area (ha):	0.62
% Imperviousness:	73.30

Runoff Coefficient 'c': 0.73

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	24.8

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	17.46
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	57
EFO6	63
EFO8	66
EFO10	67
EFO12	68

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**57**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

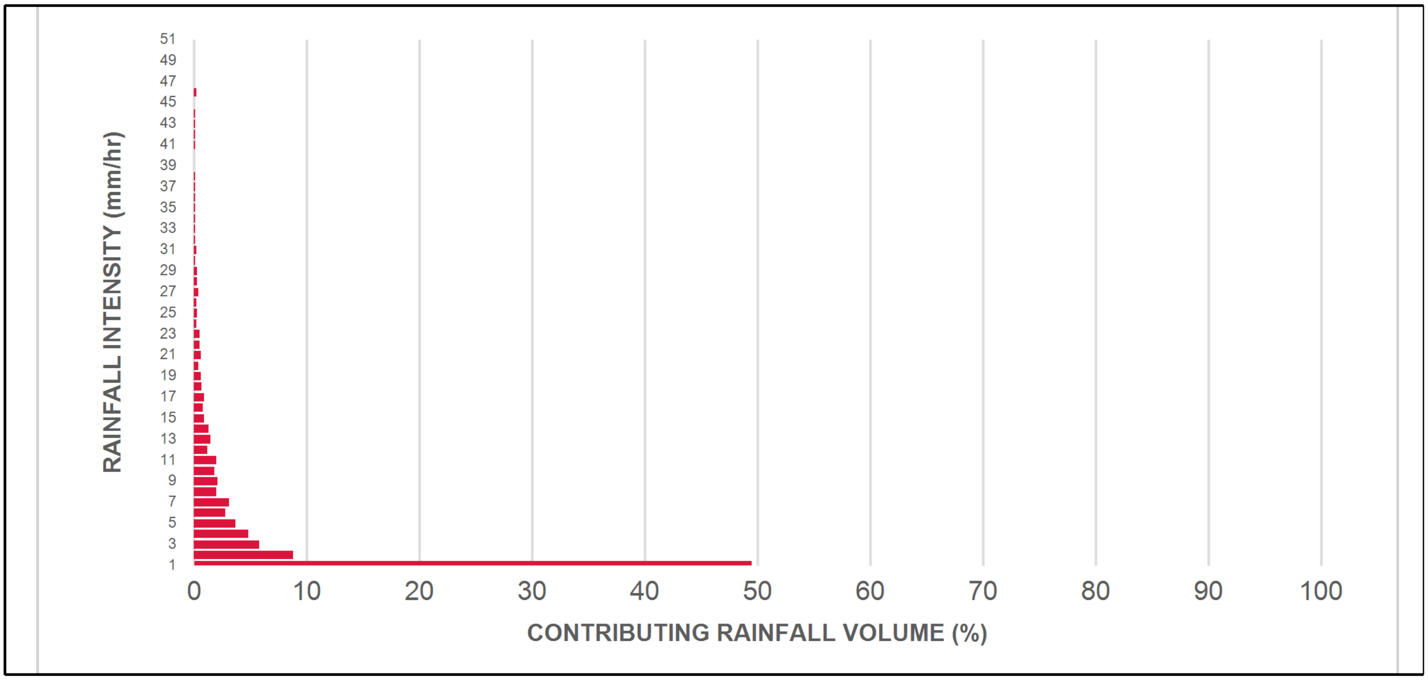
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

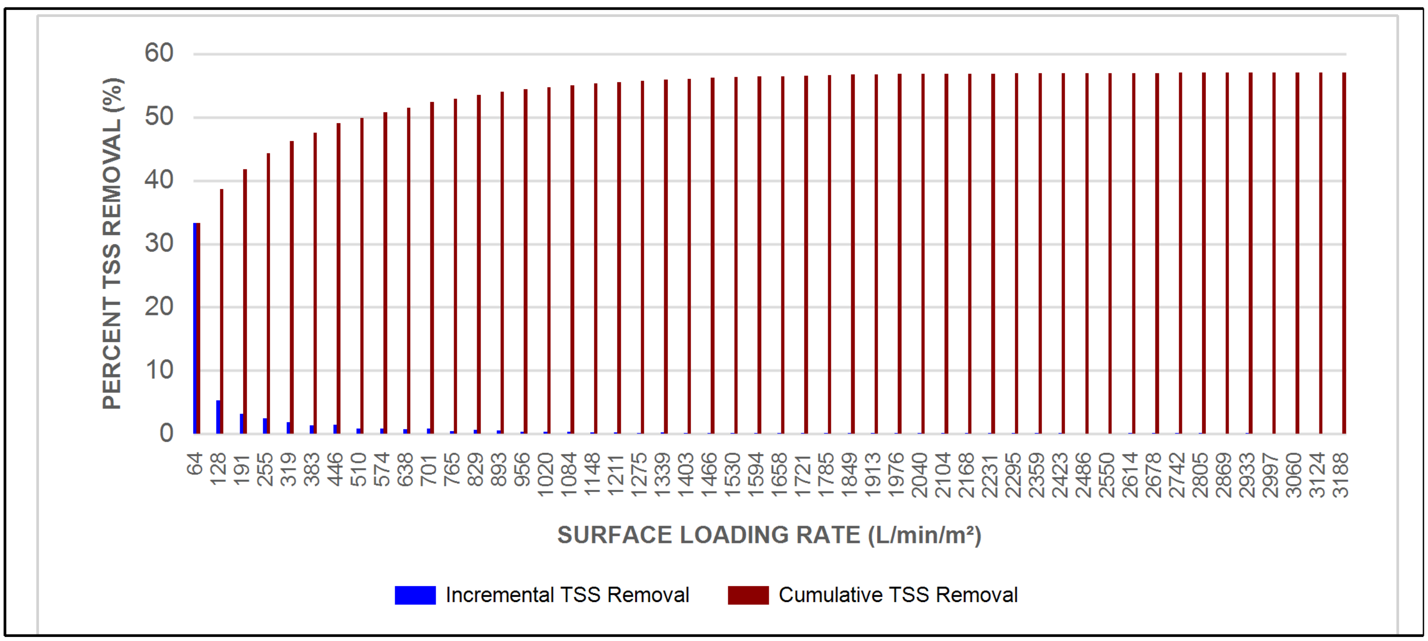
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.28	77.0	64.0	67	33.3	33.3
2	8.8	58.3	2.55	153.0	128.0	61	5.3	38.6
3	5.8	64.1	3.83	230.0	191.0	55	3.2	41.8
4	4.8	68.9	5.10	306.0	255.0	53	2.5	44.3
5	3.7	72.6	6.38	383.0	319.0	51	1.9	46.2
6	2.8	75.4	7.65	459.0	383.0	49	1.4	47.5
7	3.1	78.5	8.93	536.0	446.0	47	1.5	49.0
8	2.0	80.5	10.20	612.0	510.0	45	0.9	49.9
9	2.1	82.6	11.48	689.0	574.0	43	0.9	50.8
10	1.8	84.4	12.75	765.0	638.0	42	0.8	51.5
11	2.0	86.4	14.03	842.0	701.0	42	0.8	52.4
12	1.2	87.6	15.30	918.0	765.0	41	0.5	52.9
13	1.5	89.1	16.58	995.0	829.0	41	0.6	53.5
14	1.3	90.4	17.85	1071.0	893.0	41	0.5	54.0
15	0.9	91.3	19.13	1148.0	956.0	40	0.4	54.4
16	0.8	92.1	20.40	1224.0	1020.0	40	0.3	54.7
17	0.9	93.0	21.68	1301.0	1084.0	39	0.3	55.0
18	0.7	93.7	22.95	1377.0	1148.0	38	0.3	55.3
19	0.6	94.3	24.23	1454.0	1211.0	37	0.2	55.5
20	0.4	94.7	25.50	1530.0	1275.0	36	0.1	55.7
21	0.6	95.3	26.78	1607.0	1339.0	35	0.2	55.9
22	0.5	95.8	28.05	1683.0	1403.0	34	0.2	56.0
23	0.5	96.3	29.33	1760.0	1466.0	33	0.2	56.2
24	0.2	96.5	30.60	1836.0	1530.0	31	0.1	56.3
25	0.3	96.8	31.88	1913.0	1594.0	30	0.1	56.4

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	33.15	1989.0	1658.0	29	0.1	56.4
27	0.4	97.4	34.43	2066.0	1721.0	28	0.1	56.5
28	0.3	97.7	35.70	2142.0	1785.0	27	0.1	56.6
29	0.3	98.0	36.98	2219.0	1849.0	26	0.1	56.7
30	0.1	98.1	38.25	2295.0	1913.0	25	0.0	56.7
31	0.2	98.3	39.53	2372.0	1976.0	24	0.0	56.8
32	0.1	98.4	40.80	2448.0	2040.0	23	0.0	56.8
33	0.1	98.5	42.08	2525.0	2104.0	23	0.0	56.8
34	0.1	98.6	43.35	2601.0	2168.0	22	0.0	56.8
35	0.1	98.7	44.63	2678.0	2231.0	21	0.0	56.8
36	0.1	98.8	45.90	2754.0	2295.0	21	0.0	56.9
37	0.1	98.9	47.18	2831.0	2359.0	20	0.0	56.9
38	0.1	99.0	48.45	2907.0	2423.0	20	0.0	56.9
39	0.0	99.0	49.73	2984.0	2486.0	19	0.0	56.9
40	0.0	99.0	51.00	3060.0	2550.0	19	0.0	56.9
41	0.1	99.1	52.28	3137.0	2614.0	18	0.0	56.9
42	0.1	99.2	53.56	3213.0	2678.0	18	0.0	56.9
43	0.1	99.3	54.83	3290.0	2742.0	18	0.0	57.0
44	0.1	99.4	56.11	3366.0	2805.0	18	0.0	57.0
45	0.0	99.4	57.38	3443.0	2869.0	18	0.0	57.0
46	0.2	99.6	58.66	3519.0	2933.0	18	0.0	57.0
47	0.0	99.6	59.93	3596.0	2997.0	18	0.0	57.0
48	0.0	99.6	61.21	3672.0	3060.0	18	0.0	57.0
49	0.0	99.6	62.48	3749.0	3124.0	18	0.0	57.0
50	0.0	99.6	63.76	3825.0	3188.0	18	0.0	57.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**57 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

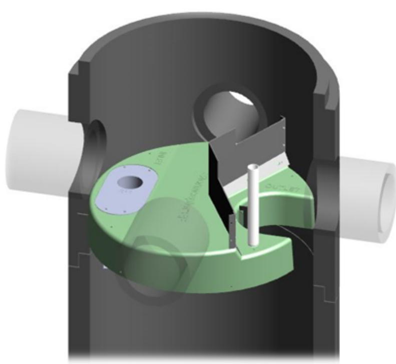
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

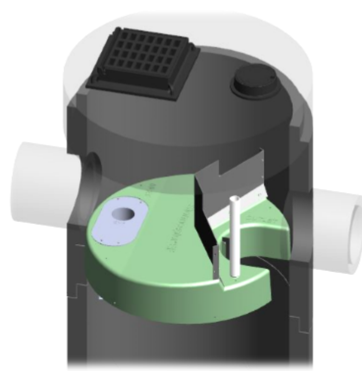
DESIGN FLEXIBILITY

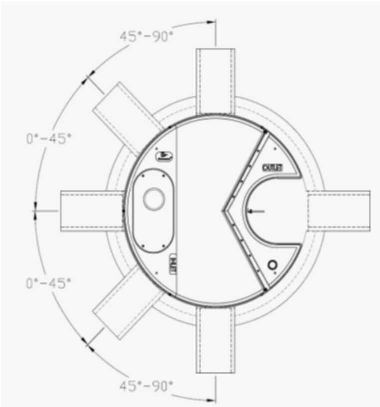
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/26/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	Lewis Road (Water Course 9 - West)

Drainage Area (ha):	5.572
% Imperviousness:	71.40

Runoff Coefficient 'c': 0.72

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	53.8

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	154.49
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	33
EFO6	41
EFO8	48
EFO10	53
EFO12	57

Recommended Stormceptor EFO Model:	**EFO12**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**57**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

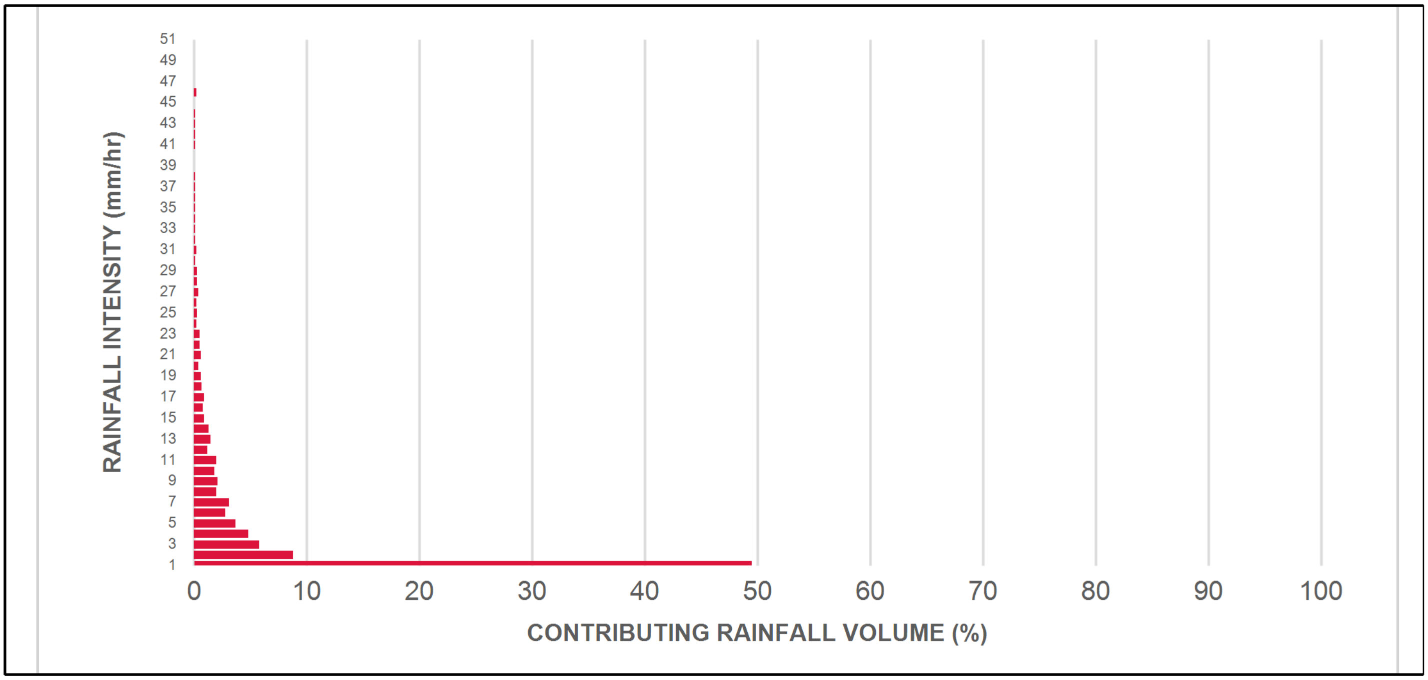
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

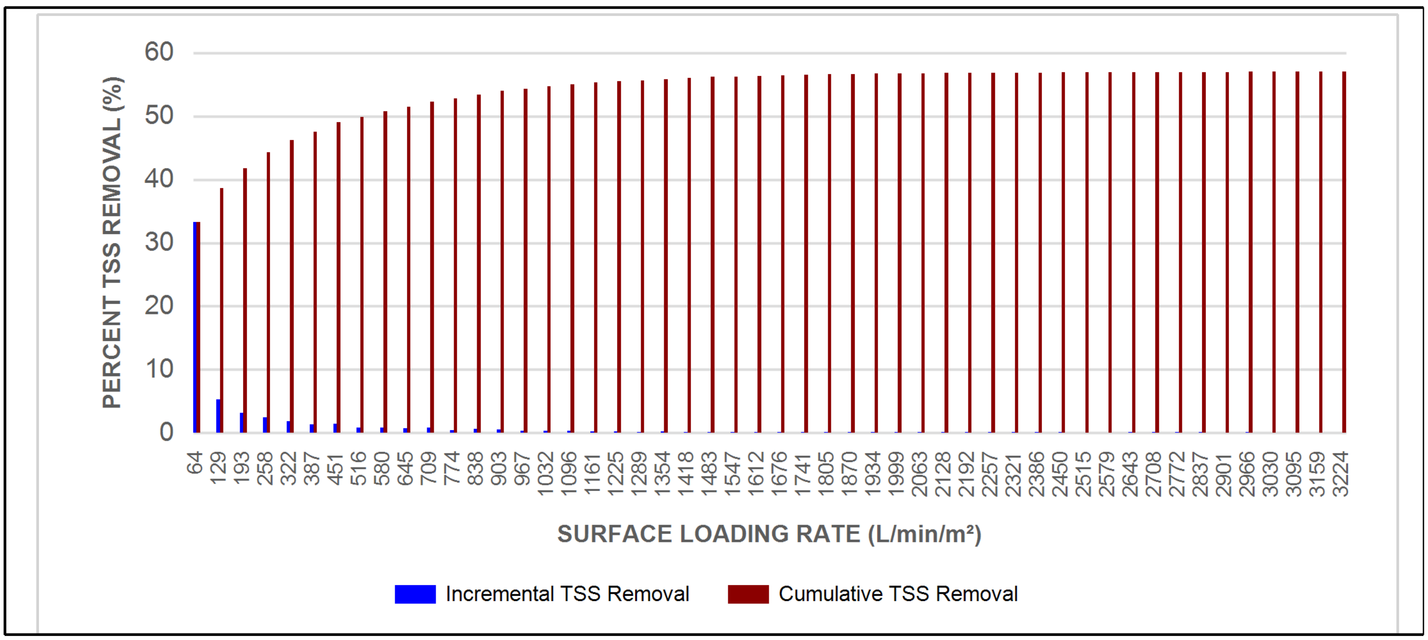
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	11.28	677.0	64.0	67	33.3	33.3
2	8.8	58.3	22.57	1354.0	129.0	61	5.3	38.6
3	5.8	64.1	33.85	2031.0	193.0	55	3.2	41.8
4	4.8	68.9	45.13	2708.0	258.0	53	2.5	44.3
5	3.7	72.6	56.42	3385.0	322.0	50	1.9	46.2
6	2.8	75.4	67.70	4062.0	387.0	49	1.4	47.5
7	3.1	78.5	78.98	4739.0	451.0	47	1.4	49.0
8	2.0	80.5	90.26	5416.0	516.0	45	0.9	49.9
9	2.1	82.6	101.55	6093.0	580.0	43	0.9	50.8
10	1.8	84.4	112.83	6770.0	645.0	42	0.8	51.5
11	2.0	86.4	124.11	7447.0	709.0	41	0.8	52.3
12	1.2	87.6	135.40	8124.0	774.0	41	0.5	52.8
13	1.5	89.1	146.68	8801.0	838.0	41	0.6	53.4
14	1.3	90.4	157.96	9478.0	903.0	41	0.5	54.0
15	0.9	91.3	169.25	10155.0	967.0	40	0.4	54.3
16	0.8	92.1	180.53	10832.0	1032.0	40	0.3	54.7
17	0.9	93.0	191.81	11509.0	1096.0	39	0.3	55.0
18	0.7	93.7	203.09	12186.0	1161.0	38	0.3	55.3
19	0.6	94.3	214.38	12863.0	1225.0	37	0.2	55.5
20	0.4	94.7	225.66	13540.0	1289.0	36	0.1	55.6
21	0.6	95.3	236.94	14217.0	1354.0	35	0.2	55.8
22	0.5	95.8	248.23	14894.0	1418.0	34	0.2	56.0
23	0.5	96.3	259.51	15571.0	1483.0	32	0.2	56.2
24	0.2	96.5	270.79	16248.0	1547.0	31	0.1	56.2
25	0.3	96.8	282.08	16925.0	1612.0	30	0.1	56.3

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	293.36	17602.0	1676.0	29	0.1	56.4
27	0.4	97.4	304.64	18279.0	1741.0	27	0.1	56.5
28	0.3	97.7	315.92	18955.0	1805.0	26	0.1	56.6
29	0.3	98.0	327.21	19632.0	1870.0	25	0.1	56.6
30	0.1	98.1	338.49	20309.0	1934.0	25	0.0	56.7
31	0.2	98.3	349.77	20986.0	1999.0	24	0.0	56.7
32	0.1	98.4	361.06	21663.0	2063.0	23	0.0	56.7
33	0.1	98.5	372.34	22340.0	2128.0	22	0.0	56.8
34	0.1	98.6	383.62	23017.0	2192.0	22	0.0	56.8
35	0.1	98.7	394.91	23694.0	2257.0	21	0.0	56.8
36	0.1	98.8	406.19	24371.0	2321.0	21	0.0	56.8
37	0.1	98.9	417.47	25048.0	2386.0	20	0.0	56.8
38	0.1	99.0	428.76	25725.0	2450.0	19	0.0	56.9
39	0.0	99.0	440.04	26402.0	2515.0	19	0.0	56.9
40	0.0	99.0	451.32	27079.0	2579.0	19	0.0	56.9
41	0.1	99.1	462.60	27756.0	2643.0	18	0.0	56.9
42	0.1	99.2	473.89	28433.0	2708.0	18	0.0	56.9
43	0.1	99.3	485.17	29110.0	2772.0	18	0.0	56.9
44	0.1	99.4	496.45	29787.0	2837.0	18	0.0	56.9
45	0.0	99.4	507.74	30464.0	2901.0	18	0.0	56.9
46	0.2	99.6	519.02	31141.0	2966.0	18	0.0	57.0
47	0.0	99.6	530.30	31818.0	3030.0	18	0.0	57.0
48	0.0	99.6	541.59	32495.0	3095.0	18	0.0	57.0
49	0.0	99.6	552.87	33172.0	3159.0	18	0.0	57.0
50	0.0	99.6	564.15	33849.0	3224.0	18	0.0	57.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**57 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

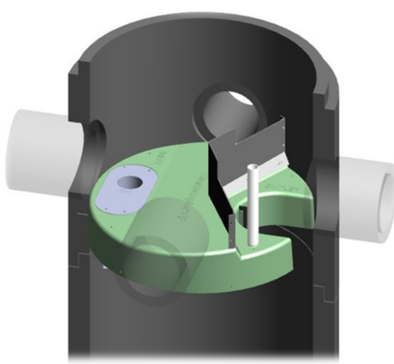
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

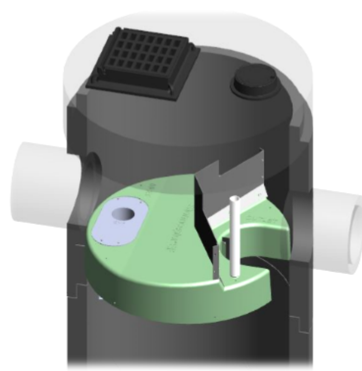
DESIGN FLEXIBILITY

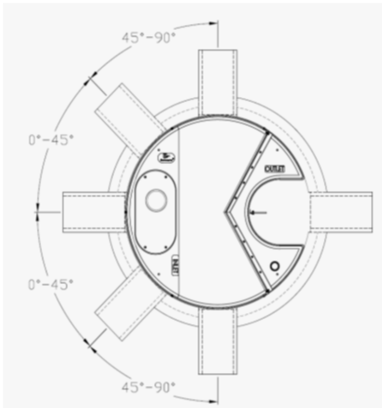
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	West Avenue

Drainage Area (ha):	1.356
% Imperviousness:	74.10

Runoff Coefficient 'c': 0.74

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	44.3

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	38.43
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	48
EFO6	57
EFO8	62
EFO10	64
EFO12	66

Recommended Stormceptor EFO Model: EFO4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 48

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

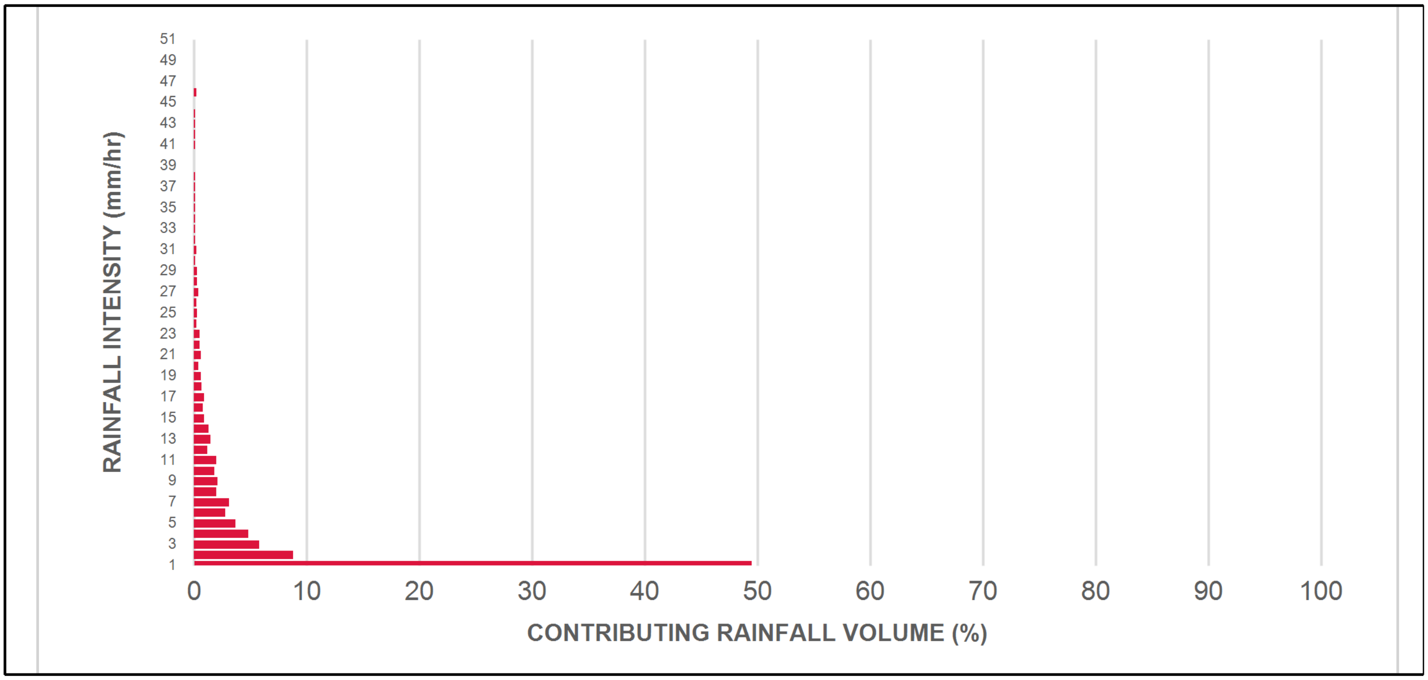
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

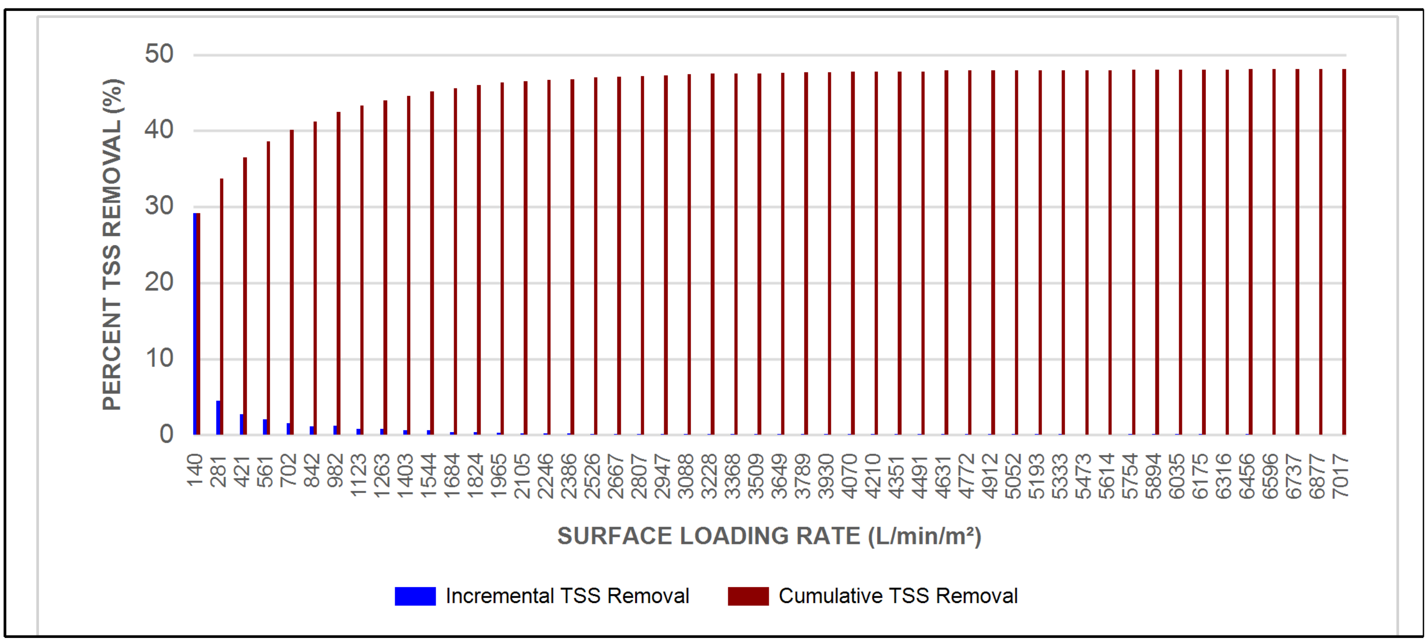
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.81	168.0	140.0	59	29.2	29.2
2	8.8	58.3	5.61	337.0	281.0	52	4.5	33.7
3	5.8	64.1	8.42	505.0	421.0	47	2.7	36.5
4	4.8	68.9	11.23	674.0	561.0	43	2.1	38.6
5	3.7	72.6	14.03	842.0	702.0	42	1.5	40.1
6	2.8	75.4	16.84	1010.0	842.0	41	1.1	41.2
7	3.1	78.5	19.65	1179.0	982.0	40	1.2	42.5
8	2.0	80.5	22.46	1347.0	1123.0	38	0.8	43.3
9	2.1	82.6	25.26	1516.0	1263.0	36	0.8	44.0
10	1.8	84.4	28.07	1684.0	1403.0	34	0.6	44.6
11	2.0	86.4	30.88	1853.0	1544.0	31	0.6	45.2
12	1.2	87.6	33.68	2021.0	1684.0	28	0.3	45.6
13	1.5	89.1	36.49	2189.0	1824.0	26	0.4	46.0
14	1.3	90.4	39.30	2358.0	1965.0	24	0.3	46.3
15	0.9	91.3	42.10	2526.0	2105.0	23	0.2	46.5
16	0.8	92.1	44.91	2695.0	2246.0	21	0.2	46.7
17	0.9	93.0	47.72	2863.0	2386.0	20	0.2	46.8
18	0.7	93.7	50.52	3031.0	2526.0	19	0.1	47.0
19	0.6	94.3	53.33	3200.0	2667.0	18	0.1	47.1
20	0.4	94.7	56.14	3368.0	2807.0	18	0.1	47.2
21	0.6	95.3	58.94	3537.0	2947.0	18	0.1	47.3
22	0.5	95.8	61.75	3705.0	3088.0	18	0.1	47.4
23	0.5	96.3	64.56	3874.0	3228.0	18	0.1	47.5
24	0.2	96.5	67.37	4042.0	3368.0	18	0.0	47.5
25	0.3	96.8	70.17	4210.0	3509.0	18	0.1	47.5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	72.98	4379.0	3649.0	18	0.0	47.6
27	0.4	97.4	75.79	4547.0	3789.0	18	0.1	47.7
28	0.3	97.7	78.59	4716.0	3930.0	18	0.1	47.7
29	0.3	98.0	81.40	4884.0	4070.0	18	0.1	47.8
30	0.1	98.1	84.21	5052.0	4210.0	18	0.0	47.8
31	0.2	98.3	87.01	5221.0	4351.0	18	0.0	47.8
32	0.1	98.4	89.82	5389.0	4491.0	18	0.0	47.8
33	0.1	98.5	92.63	5558.0	4631.0	18	0.0	47.9
34	0.1	98.6	95.43	5726.0	4772.0	18	0.0	47.9
35	0.1	98.7	98.24	5894.0	4912.0	18	0.0	47.9
36	0.1	98.8	101.05	6063.0	5052.0	18	0.0	47.9
37	0.1	98.9	103.86	6231.0	5193.0	18	0.0	47.9
38	0.1	99.0	106.66	6400.0	5333.0	18	0.0	47.9
39	0.0	99.0	109.47	6568.0	5473.0	18	0.0	47.9
40	0.0	99.0	112.28	6737.0	5614.0	18	0.0	47.9
41	0.1	99.1	115.08	6905.0	5754.0	18	0.0	48.0
42	0.1	99.2	117.89	7073.0	5894.0	18	0.0	48.0
43	0.1	99.3	120.70	7242.0	6035.0	18	0.0	48.0
44	0.1	99.4	123.50	7410.0	6175.0	18	0.0	48.0
45	0.0	99.4	126.31	7579.0	6316.0	18	0.0	48.0
46	0.2	99.6	129.12	7747.0	6456.0	18	0.0	48.1
47	0.0	99.6	131.92	7915.0	6596.0	18	0.0	48.1
48	0.0	99.6	134.73	8084.0	6737.0	18	0.0	48.1
49	0.0	99.6	137.54	8252.0	6877.0	18	0.0	48.1
50	0.0	99.6	140.35	8421.0	7017.0	18	0.0	48.1
							Estimated Net Annual Sediment (TSS) Load Reduction =	**48 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance									
Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

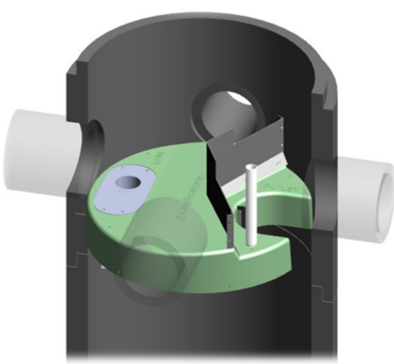
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

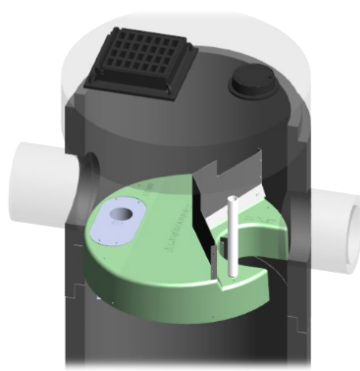
DESIGN FLEXIBILITY

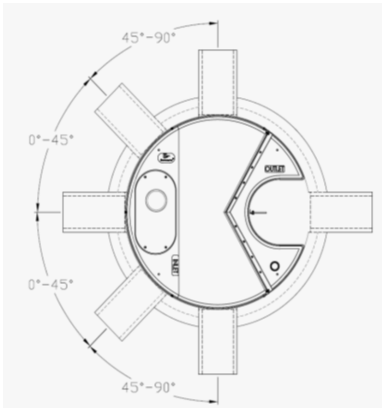
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
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30	70	690	46	1350	48	2010	34

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90	63	750	45	1410	49	2070	33
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180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 <u>WORK INCLUDED</u>

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 <u>REFERENCE STANDARDS & PROCEDURES</u>

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 <u>SUBMITTALS</u>

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 <u>OGS POLLUTANT STORAGE</u>

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 <u>GENERAL</u>

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	Napa Lane

Drainage Area (ha):	0.70
% Imperviousness:	72.30

Runoff Coefficient 'c': 0.73

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	37.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	19.55
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	56
EFO6	62
EFO8	65
EFO10	67
EFO12	68

Recommended Stormceptor EFO Model: EFO4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 56

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

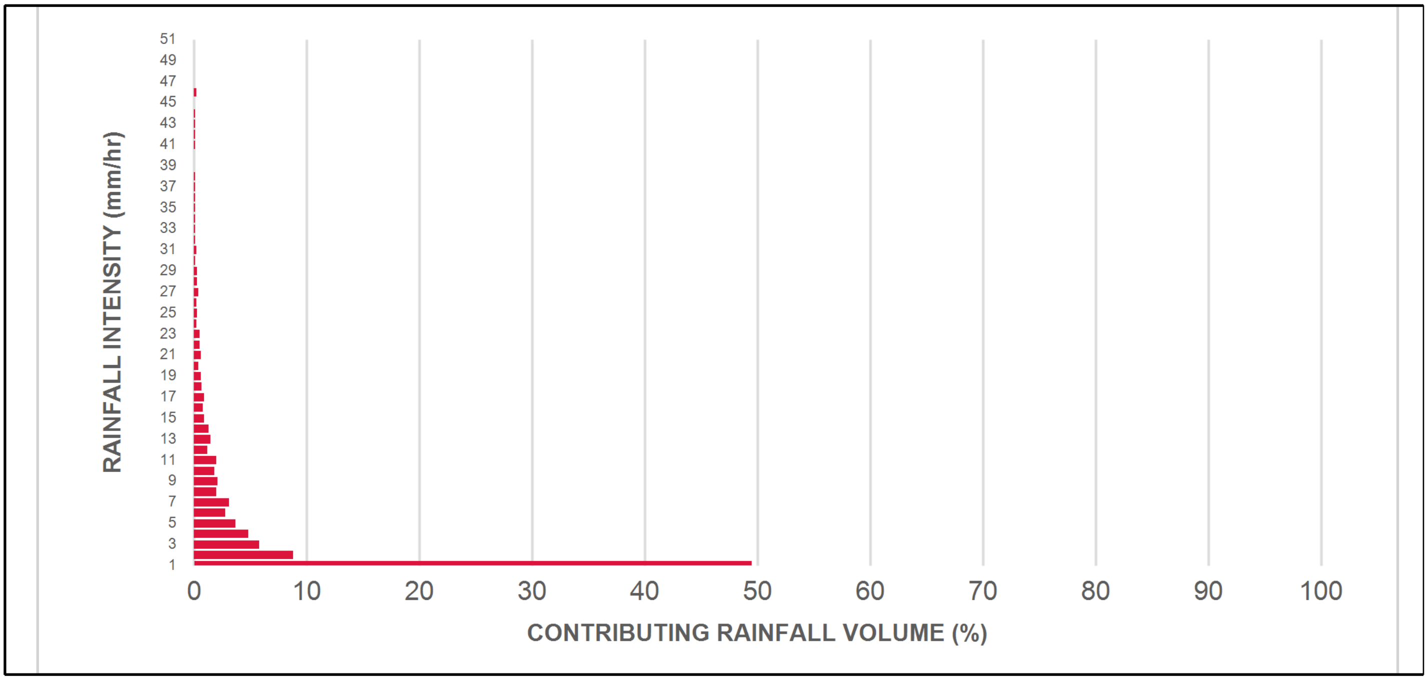
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

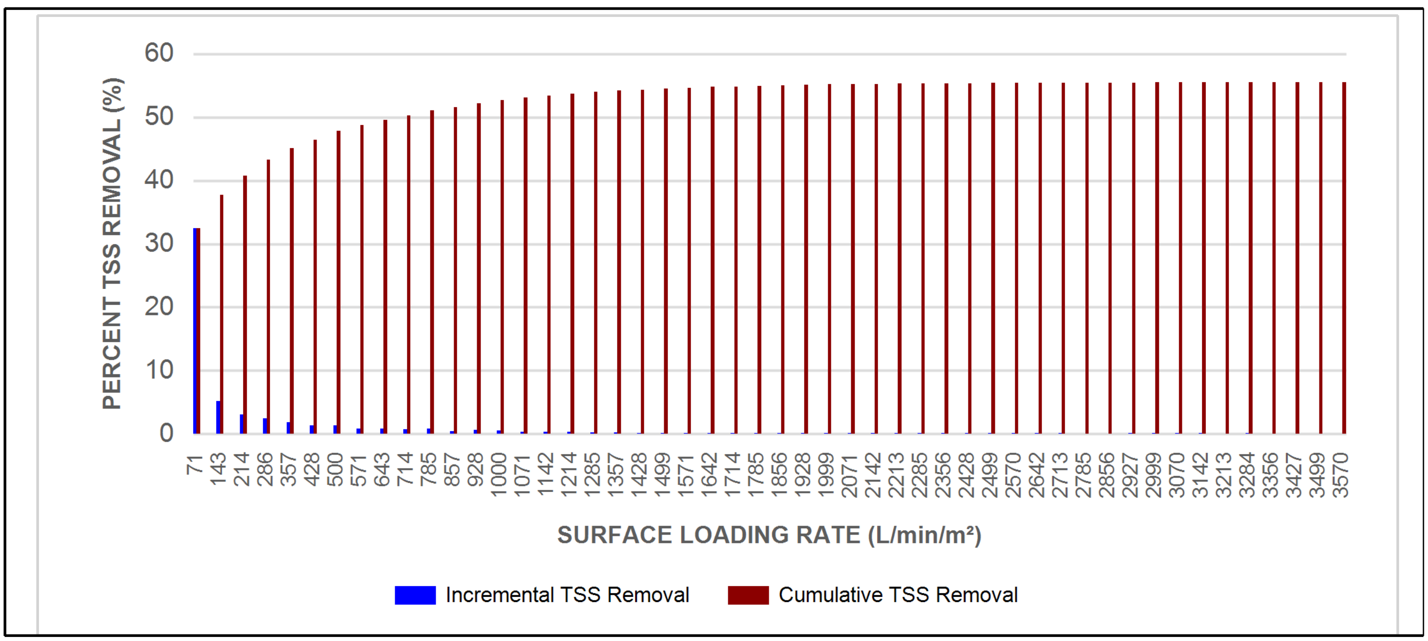
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.43	86.0	71.0	66	32.5	32.5
2	8.8	58.3	2.86	171.0	143.0	59	5.2	37.7
3	5.8	64.1	4.28	257.0	214.0	54	3.1	40.8
4	4.8	68.9	5.71	343.0	286.0	52	2.5	43.3
5	3.7	72.6	7.14	428.0	357.0	50	1.8	45.1
6	2.8	75.4	8.57	514.0	428.0	47	1.3	46.4
7	3.1	78.5	10.00	600.0	500.0	45	1.4	47.8
8	2.0	80.5	11.42	685.0	571.0	43	0.9	48.7
9	2.1	82.6	12.85	771.0	643.0	42	0.9	49.5
10	1.8	84.4	14.28	857.0	714.0	41	0.7	50.3
11	2.0	86.4	15.71	942.0	785.0	41	0.8	51.1
12	1.2	87.6	17.14	1028.0	857.0	41	0.5	51.6
13	1.5	89.1	18.56	1114.0	928.0	40	0.6	52.2
14	1.3	90.4	19.99	1199.0	1000.0	40	0.5	52.7
15	0.9	91.3	21.42	1285.0	1071.0	39	0.4	53.1
16	0.8	92.1	22.85	1371.0	1142.0	38	0.3	53.4
17	0.9	93.0	24.28	1457.0	1214.0	37	0.3	53.7
18	0.7	93.7	25.70	1542.0	1285.0	36	0.3	54.0
19	0.6	94.3	27.13	1628.0	1357.0	35	0.2	54.2
20	0.4	94.7	28.56	1714.0	1428.0	34	0.1	54.3
21	0.6	95.3	29.99	1799.0	1499.0	32	0.2	54.5
22	0.5	95.8	31.42	1885.0	1571.0	30	0.2	54.6
23	0.5	96.3	32.84	1971.0	1642.0	29	0.1	54.8
24	0.2	96.5	34.27	2056.0	1714.0	28	0.1	54.8
25	0.3	96.8	35.70	2142.0	1785.0	27	0.1	54.9

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	37.13	2228.0	1856.0	26	0.1	55.0
27	0.4	97.4	38.56	2313.0	1928.0	25	0.1	55.1
28	0.3	97.7	39.98	2399.0	1999.0	24	0.1	55.2
29	0.3	98.0	41.41	2485.0	2071.0	23	0.1	55.2
30	0.1	98.1	42.84	2570.0	2142.0	22	0.0	55.2
31	0.2	98.3	44.27	2656.0	2213.0	22	0.0	55.3
32	0.1	98.4	45.70	2742.0	2285.0	21	0.0	55.3
33	0.1	98.5	47.12	2827.0	2356.0	20	0.0	55.3
34	0.1	98.6	48.55	2913.0	2428.0	20	0.0	55.3
35	0.1	98.7	49.98	2999.0	2499.0	19	0.0	55.4
36	0.1	98.8	51.41	3084.0	2570.0	19	0.0	55.4
37	0.1	98.9	52.84	3170.0	2642.0	18	0.0	55.4
38	0.1	99.0	54.26	3256.0	2713.0	18	0.0	55.4
39	0.0	99.0	55.69	3341.0	2785.0	18	0.0	55.4
40	0.0	99.0	57.12	3427.0	2856.0	18	0.0	55.4
41	0.1	99.1	58.55	3513.0	2927.0	18	0.0	55.4
42	0.1	99.2	59.97	3598.0	2999.0	18	0.0	55.5
43	0.1	99.3	61.40	3684.0	3070.0	18	0.0	55.5
44	0.1	99.4	62.83	3770.0	3142.0	18	0.0	55.5
45	0.0	99.4	64.26	3856.0	3213.0	18	0.0	55.5
46	0.2	99.6	65.69	3941.0	3284.0	18	0.0	55.5
47	0.0	99.6	67.11	4027.0	3356.0	18	0.0	55.5
48	0.0	99.6	68.54	4113.0	3427.0	18	0.0	55.5
49	0.0	99.6	69.97	4198.0	3499.0	18	0.0	55.5
50	0.0	99.6	71.40	4284.0	3570.0	18	0.0	55.5
Estimated Net Annual Sediment (TSS) Load Reduction =								**56 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

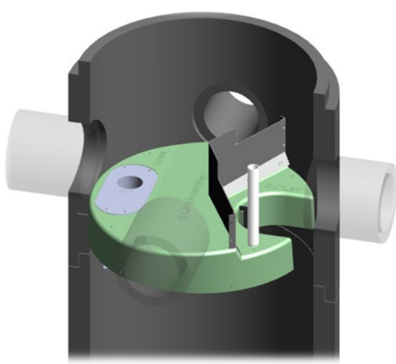
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

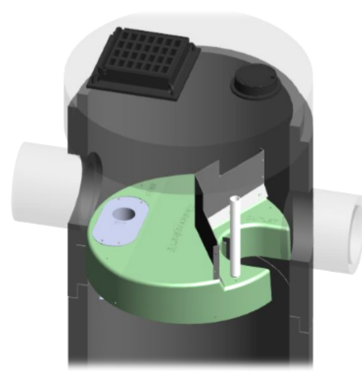
DESIGN FLEXIBILITY

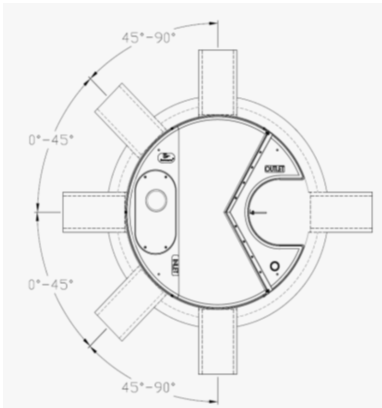
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	Foothills Lane

Drainage Area (ha):	0.76
% Imperviousness:	73.30

Runoff Coefficient 'c': 0.73

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	45.4

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	21.40
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	55
EFO6	62
EFO8	65
EFO10	67
EFO12	68

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**55**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

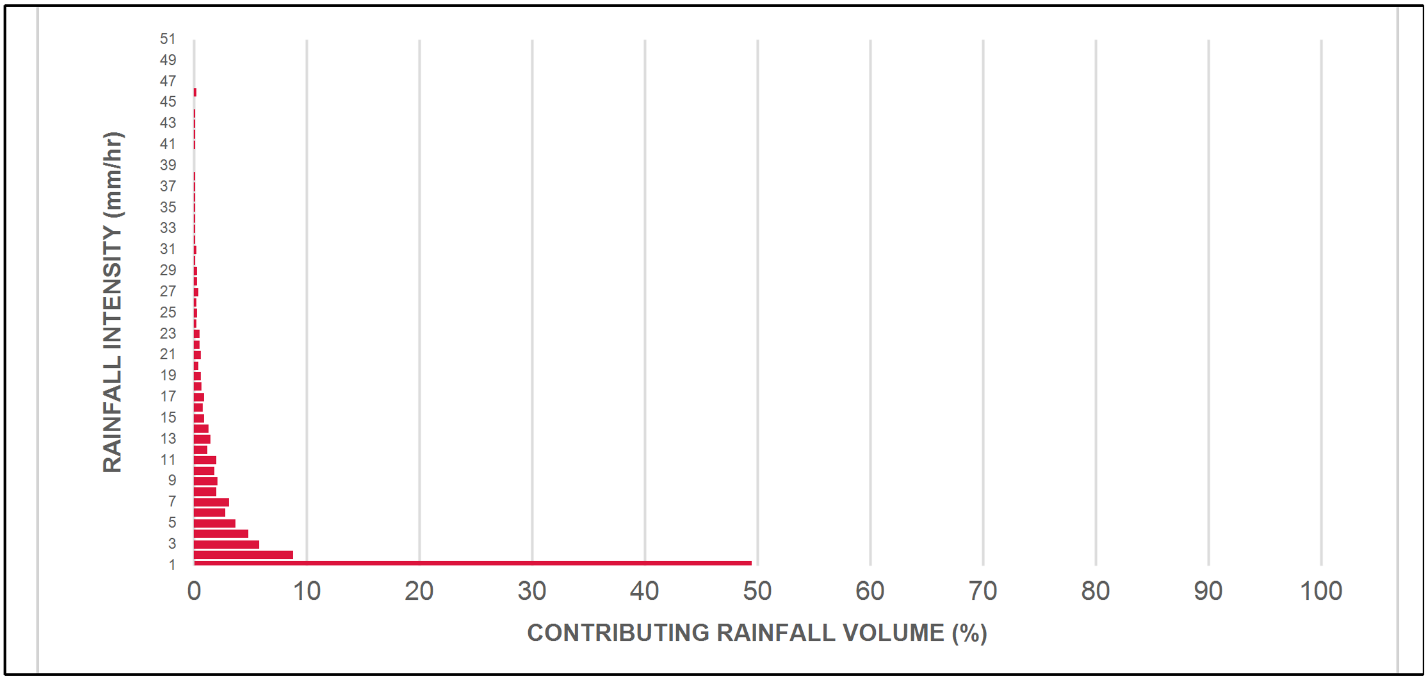
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

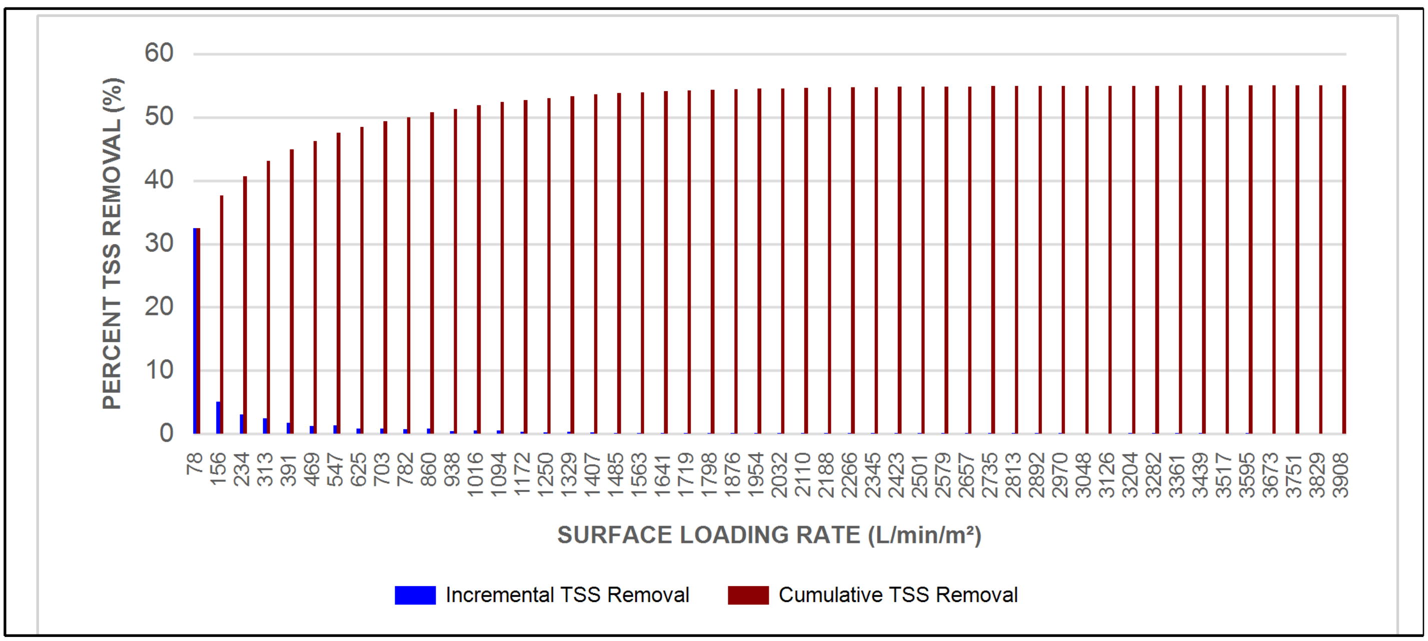
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.56	94.0	78.0	66	32.5	32.5
2	8.8	58.3	3.13	188.0	156.0	58	5.1	37.6
3	5.8	64.1	4.69	281.0	234.0	53	3.1	40.7
4	4.8	68.9	6.25	375.0	313.0	51	2.4	43.1
5	3.7	72.6	7.82	469.0	391.0	48	1.8	44.9
6	2.8	75.4	9.38	563.0	469.0	46	1.3	46.2
7	3.1	78.5	10.94	656.0	547.0	44	1.4	47.5
8	2.0	80.5	12.50	750.0	625.0	42	0.8	48.4
9	2.1	82.6	14.07	844.0	703.0	42	0.9	49.3
10	1.8	84.4	15.63	938.0	782.0	41	0.7	50.0
11	2.0	86.4	17.19	1032.0	860.0	41	0.8	50.8
12	1.2	87.6	18.76	1125.0	938.0	40	0.5	51.3
13	1.5	89.1	20.32	1219.0	1016.0	40	0.6	51.9
14	1.3	90.4	21.88	1313.0	1094.0	39	0.5	52.4
15	0.9	91.3	23.45	1407.0	1172.0	37	0.3	52.7
16	0.8	92.1	25.01	1501.0	1250.0	36	0.3	53.0
17	0.9	93.0	26.57	1594.0	1329.0	35	0.3	53.3
18	0.7	93.7	28.13	1688.0	1407.0	34	0.2	53.6
19	0.6	94.3	29.70	1782.0	1485.0	32	0.2	53.8
20	0.4	94.7	31.26	1876.0	1563.0	31	0.1	53.9
21	0.6	95.3	32.82	1969.0	1641.0	29	0.2	54.1
22	0.5	95.8	34.39	2063.0	1719.0	28	0.1	54.2
23	0.5	96.3	35.95	2157.0	1798.0	27	0.1	54.3
24	0.2	96.5	37.51	2251.0	1876.0	25	0.1	54.4
25	0.3	96.8	39.08	2345.0	1954.0	24	0.1	54.5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	40.64	2438.0	2032.0	23	0.0	54.5
27	0.4	97.4	42.20	2532.0	2110.0	23	0.1	54.6
28	0.3	97.7	43.77	2626.0	2188.0	22	0.1	54.7
29	0.3	98.0	45.33	2720.0	2266.0	21	0.1	54.7
30	0.1	98.1	46.89	2813.0	2345.0	20	0.0	54.7
31	0.2	98.3	48.45	2907.0	2423.0	20	0.0	54.8
32	0.1	98.4	50.02	3001.0	2501.0	19	0.0	54.8
33	0.1	98.5	51.58	3095.0	2579.0	18	0.0	54.8
34	0.1	98.6	53.14	3189.0	2657.0	18	0.0	54.8
35	0.1	98.7	54.71	3282.0	2735.0	18	0.0	54.9
36	0.1	98.8	56.27	3376.0	2813.0	18	0.0	54.9
37	0.1	98.9	57.83	3470.0	2892.0	18	0.0	54.9
38	0.1	99.0	59.40	3564.0	2970.0	18	0.0	54.9
39	0.0	99.0	60.96	3658.0	3048.0	18	0.0	54.9
40	0.0	99.0	62.52	3751.0	3126.0	18	0.0	54.9
41	0.1	99.1	64.09	3845.0	3204.0	18	0.0	54.9
42	0.1	99.2	65.65	3939.0	3282.0	18	0.0	54.9
43	0.1	99.3	67.21	4033.0	3361.0	18	0.0	55.0
44	0.1	99.4	68.77	4126.0	3439.0	18	0.0	55.0
45	0.0	99.4	70.34	4220.0	3517.0	18	0.0	55.0
46	0.2	99.6	71.90	4314.0	3595.0	18	0.0	55.0
47	0.0	99.6	73.46	4408.0	3673.0	18	0.0	55.0
48	0.0	99.6	75.03	4502.0	3751.0	18	0.0	55.0
49	0.0	99.6	76.59	4595.0	3829.0	18	0.0	55.0
50	0.0	99.6	78.15	4689.0	3908.0	18	0.0	55.0
							Estimated Net Annual Sediment (TSS) Load Reduction =	**55 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

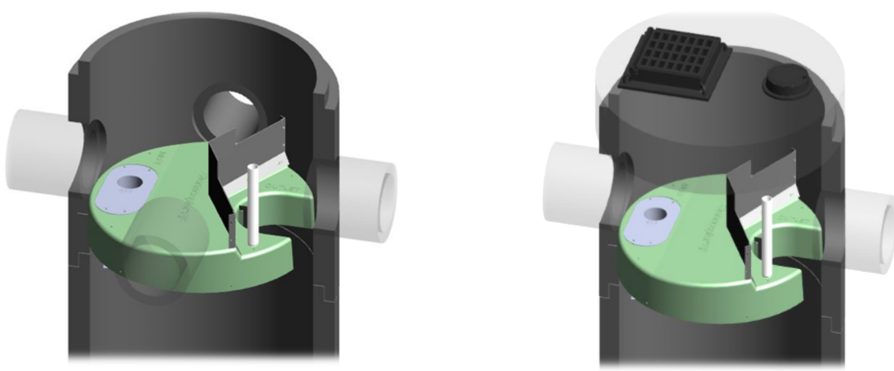
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

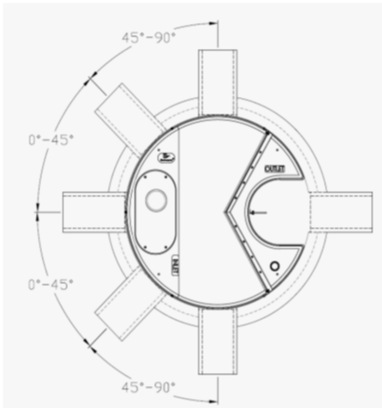
DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.





INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/04/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	Fifty Creek at Hwy #8

Drainage Area (ha):	0.66
% Imperviousness:	60.50

Runoff Coefficient 'c': 0.66

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	25.4

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	16.66
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	57
EFO6	63
EFO8	66
EFO10	67
EFO12	68

Recommended Stormceptor EFO Model: EFO4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 57

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

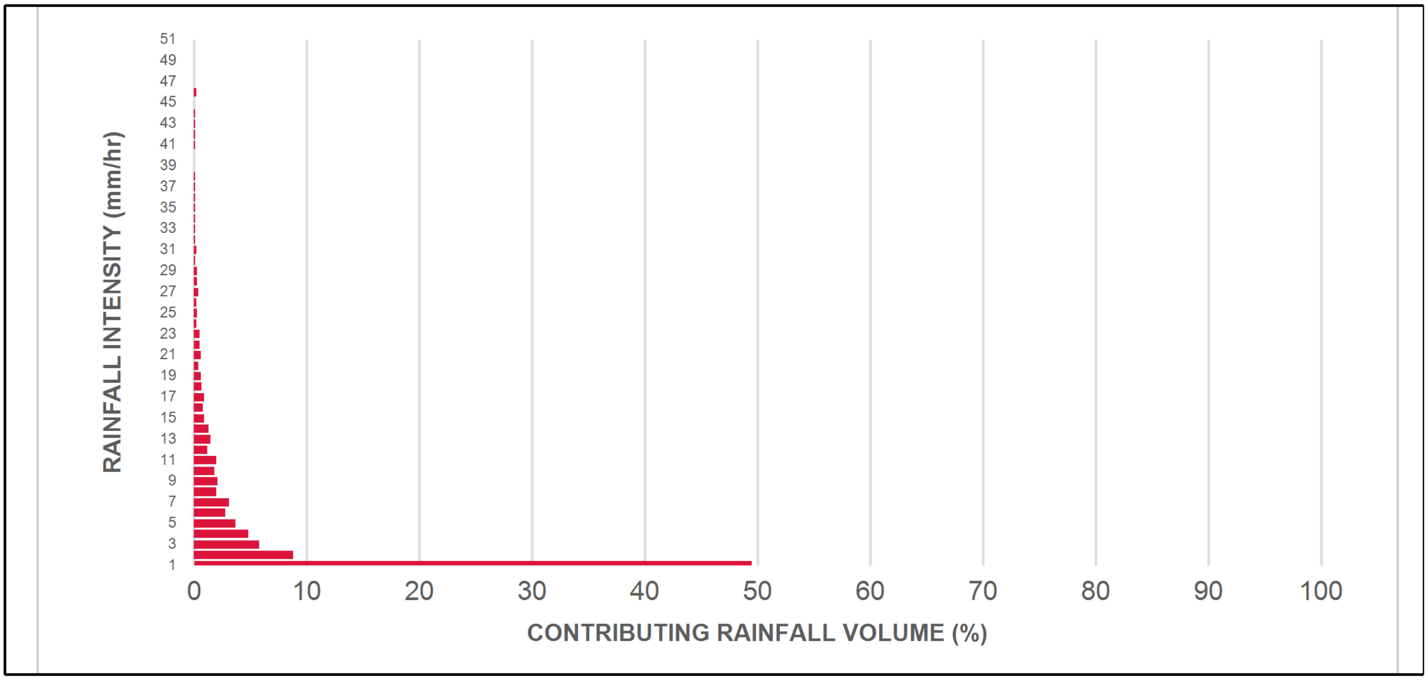
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

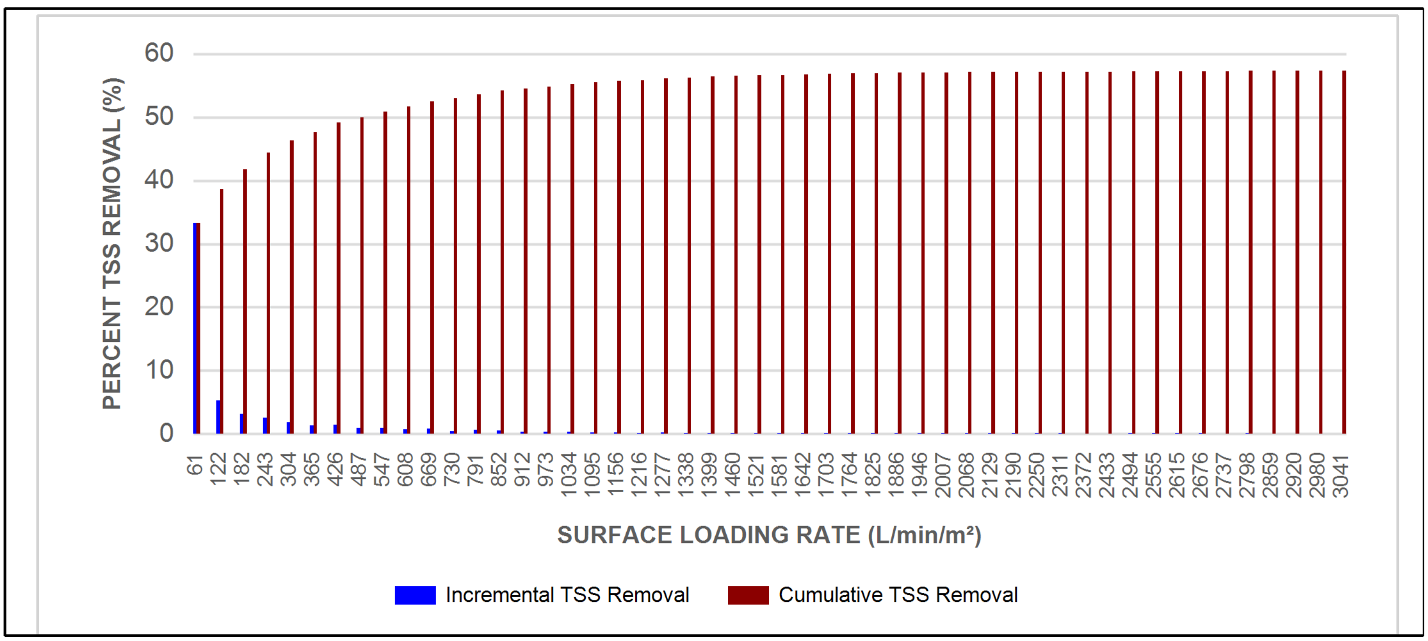
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.22	73.0	61.0	67	33.3	33.3
2	8.8	58.3	2.43	146.0	122.0	61	5.3	38.6
3	5.8	64.1	3.65	219.0	182.0	56	3.2	41.8
4	4.8	68.9	4.87	292.0	243.0	53	2.5	44.4
5	3.7	72.6	6.08	365.0	304.0	51	1.9	46.3
6	2.8	75.4	7.30	438.0	365.0	49	1.4	47.6
7	3.1	78.5	8.52	511.0	426.0	47	1.5	49.1
8	2.0	80.5	9.73	584.0	487.0	46	0.9	50.0
9	2.1	82.6	10.95	657.0	547.0	44	0.9	50.9
10	1.8	84.4	12.16	730.0	608.0	42	0.8	51.7
11	2.0	86.4	13.38	803.0	669.0	42	0.8	52.5
12	1.2	87.6	14.60	876.0	730.0	41	0.5	53.0
13	1.5	89.1	15.81	949.0	791.0	41	0.6	53.6
14	1.3	90.4	17.03	1022.0	852.0	41	0.5	54.2
15	0.9	91.3	18.25	1095.0	912.0	40	0.4	54.5
16	0.8	92.1	19.46	1168.0	973.0	40	0.3	54.8
17	0.9	93.0	20.68	1241.0	1034.0	40	0.4	55.2
18	0.7	93.7	21.90	1314.0	1095.0	39	0.3	55.5
19	0.6	94.3	23.11	1387.0	1156.0	38	0.2	55.7
20	0.4	94.7	24.33	1460.0	1216.0	37	0.1	55.8
21	0.6	95.3	25.55	1533.0	1277.0	36	0.2	56.1
22	0.5	95.8	26.76	1606.0	1338.0	35	0.2	56.2
23	0.5	96.3	27.98	1679.0	1399.0	34	0.2	56.4
24	0.2	96.5	29.20	1752.0	1460.0	33	0.1	56.5
25	0.3	96.8	30.41	1825.0	1521.0	31	0.1	56.6

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	31.63	1898.0	1581.0	30	0.1	56.6
27	0.4	97.4	32.84	1971.0	1642.0	29	0.1	56.7
28	0.3	97.7	34.06	2044.0	1703.0	28	0.1	56.8
29	0.3	98.0	35.28	2117.0	1764.0	27	0.1	56.9
30	0.1	98.1	36.49	2190.0	1825.0	26	0.0	56.9
31	0.2	98.3	37.71	2263.0	1886.0	25	0.1	57.0
32	0.1	98.4	38.93	2336.0	1946.0	25	0.0	57.0
33	0.1	98.5	40.14	2409.0	2007.0	24	0.0	57.0
34	0.1	98.6	41.36	2482.0	2068.0	23	0.0	57.1
35	0.1	98.7	42.58	2555.0	2129.0	22	0.0	57.1
36	0.1	98.8	43.79	2628.0	2190.0	22	0.0	57.1
37	0.1	98.9	45.01	2701.0	2250.0	21	0.0	57.1
38	0.1	99.0	46.23	2774.0	2311.0	21	0.0	57.1
39	0.0	99.0	47.44	2847.0	2372.0	20	0.0	57.1
40	0.0	99.0	48.66	2920.0	2433.0	20	0.0	57.1
41	0.1	99.1	49.88	2993.0	2494.0	19	0.0	57.2
42	0.1	99.2	51.09	3066.0	2555.0	19	0.0	57.2
43	0.1	99.3	52.31	3138.0	2615.0	18	0.0	57.2
44	0.1	99.4	53.52	3211.0	2676.0	18	0.0	57.2
45	0.0	99.4	54.74	3284.0	2737.0	18	0.0	57.2
46	0.2	99.6	55.96	3357.0	2798.0	18	0.0	57.3
47	0.0	99.6	57.17	3430.0	2859.0	18	0.0	57.3
48	0.0	99.6	58.39	3503.0	2920.0	18	0.0	57.3
49	0.0	99.6	59.61	3576.0	2980.0	18	0.0	57.3
50	0.0	99.6	60.82	3649.0	3041.0	18	0.0	57.3
							Estimated Net Annual Sediment (TSS) Load Reduction =	**57 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

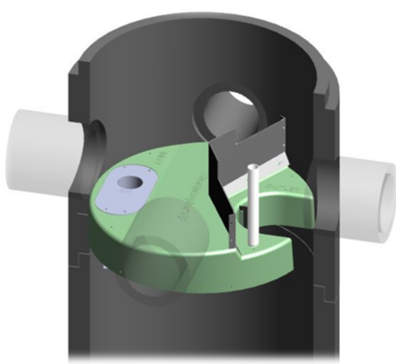
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

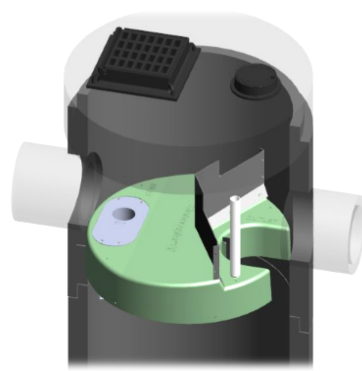
DESIGN FLEXIBILITY

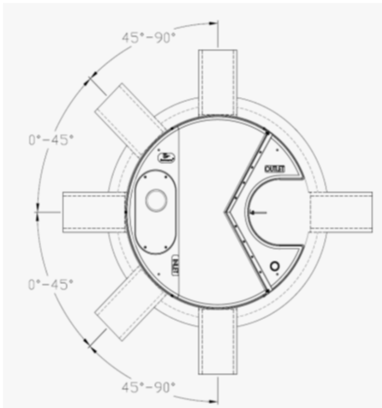
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.
0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.
45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program’s **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

08/26/2021

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	South Service Road
Drainage Area (ha):	2.755
% Imperviousness:	65.30
Runoff Coefficient 'c':	0.69
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	62.3
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	72.55
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Barton St. & Fifty Rd.
Project Number:	TPB166053
Designer Name:	Amin Azarkhish
Designer Company:	Wood
Designer Email:	amin.azarkhish@woodplc.com
Designer Phone:	519-731-7296
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	41
EFO6	50
EFO8	57
EFO10	61
EFO12	63

Recommended Stormceptor EFO Model: EFO12

Estimated Net Annual Sediment (TSS) Load Reduction (%): 63

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

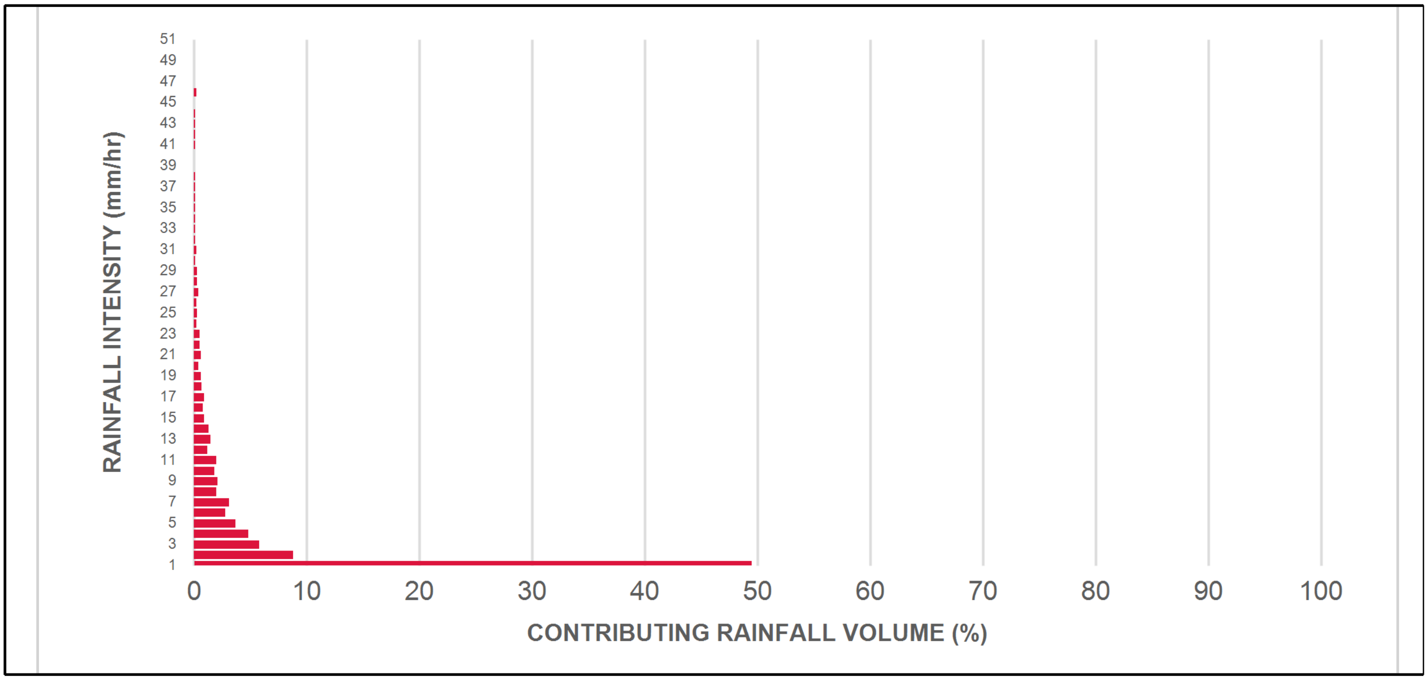
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

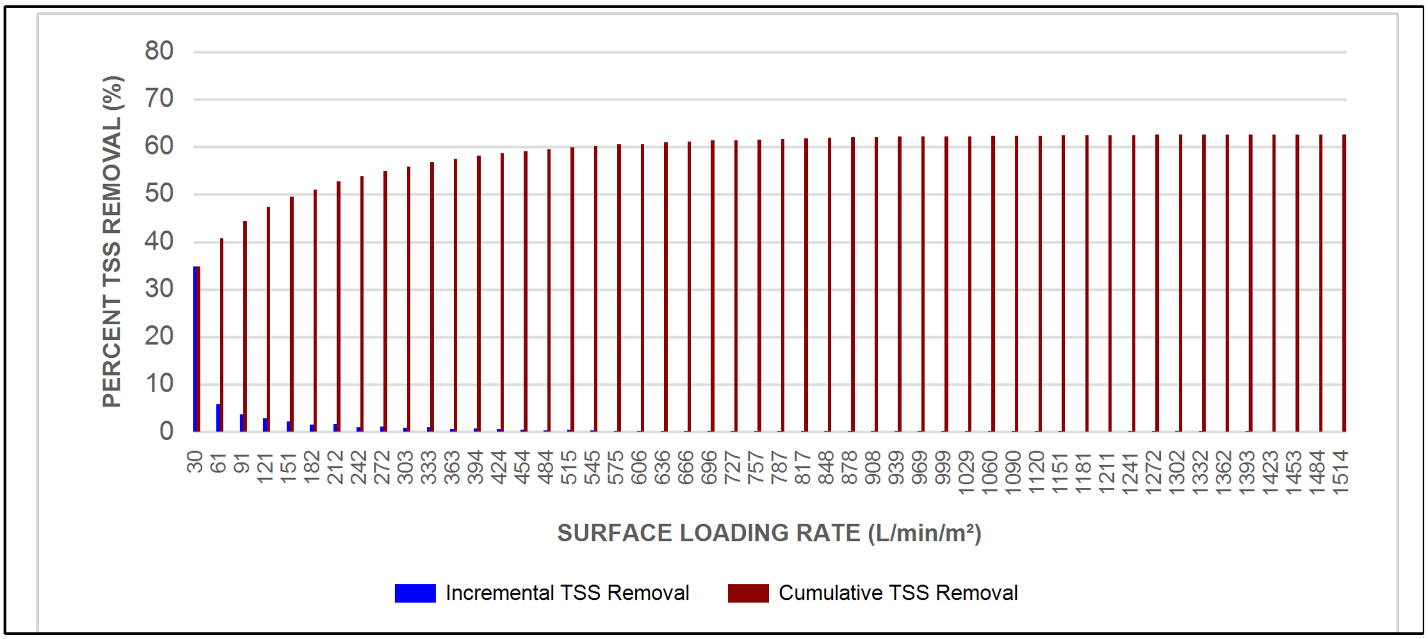
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	5.30	318.0	30.0	70	34.8	34.8
2	8.8	58.3	10.60	636.0	61.0	67	5.9	40.8
3	5.8	64.1	15.90	954.0	91.0	63	3.7	44.4
4	4.8	68.9	21.19	1272.0	121.0	61	2.9	47.3
5	3.7	72.6	26.49	1590.0	151.0	58	2.2	49.5
6	2.8	75.4	31.79	1907.0	182.0	56	1.6	51.0
7	3.1	78.5	37.09	2225.0	212.0	54	1.7	52.7
8	2.0	80.5	42.39	2543.0	242.0	53	1.1	53.8
9	2.1	82.6	47.69	2861.0	272.0	52	1.1	54.9
10	1.8	84.4	52.98	3179.0	303.0	51	0.9	55.8
11	2.0	86.4	58.28	3497.0	333.0	50	1.0	56.8
12	1.2	87.6	63.58	3815.0	363.0	49	0.6	57.4
13	1.5	89.1	68.88	4133.0	394.0	48	0.7	58.1
14	1.3	90.4	74.18	4451.0	424.0	47	0.6	58.7
15	0.9	91.3	79.48	4769.0	454.0	47	0.4	59.1
16	0.8	92.1	84.77	5086.0	484.0	46	0.4	59.5
17	0.9	93.0	90.07	5404.0	515.0	45	0.4	59.9
18	0.7	93.7	95.37	5722.0	545.0	44	0.3	60.2
19	0.6	94.3	100.67	6040.0	575.0	43	0.3	60.5
20	0.4	94.7	105.97	6358.0	606.0	42	0.2	60.6
21	0.6	95.3	111.27	6676.0	636.0	42	0.3	60.9
22	0.5	95.8	116.57	6994.0	666.0	42	0.2	61.1
23	0.5	96.3	121.86	7312.0	696.0	42	0.2	61.3
24	0.2	96.5	127.16	7630.0	727.0	41	0.1	61.4
25	0.3	96.8	132.46	7948.0	757.0	41	0.1	61.5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	137.76	8266.0	787.0	41	0.1	61.6
27	0.4	97.4	143.06	8583.0	817.0	41	0.2	61.7
28	0.3	97.7	148.36	8901.0	848.0	41	0.1	61.9
29	0.3	98.0	153.65	9219.0	878.0	41	0.1	62.0
30	0.1	98.1	158.95	9537.0	908.0	41	0.0	62.0
31	0.2	98.3	164.25	9855.0	939.0	40	0.1	62.1
32	0.1	98.4	169.55	10173.0	969.0	40	0.0	62.2
33	0.1	98.5	174.85	10491.0	999.0	40	0.0	62.2
34	0.1	98.6	180.15	10809.0	1029.0	40	0.0	62.2
35	0.1	98.7	185.44	11127.0	1060.0	39	0.0	62.3
36	0.1	98.8	190.74	11445.0	1090.0	39	0.0	62.3
37	0.1	98.9	196.04	11763.0	1120.0	38	0.0	62.3
38	0.1	99.0	201.34	12080.0	1151.0	38	0.0	62.4
39	0.0	99.0	206.64	12398.0	1181.0	37	0.0	62.4
40	0.0	99.0	211.94	12716.0	1211.0	37	0.0	62.4
41	0.1	99.1	217.24	13034.0	1241.0	36	0.0	62.4
42	0.1	99.2	222.53	13352.0	1272.0	36	0.0	62.5
43	0.1	99.3	227.83	13670.0	1302.0	36	0.0	62.5
44	0.1	99.4	233.13	13988.0	1332.0	35	0.0	62.5
45	0.0	99.4	238.43	14306.0	1362.0	35	0.0	62.5
46	0.2	99.6	243.73	14624.0	1393.0	34	0.1	62.6
47	0.0	99.6	249.03	14942.0	1423.0	34	0.0	62.6
48	0.0	99.6	254.32	15259.0	1453.0	33	0.0	62.6
49	0.0	99.6	259.62	15577.0	1484.0	32	0.0	62.6
50	0.0	99.6	264.92	15895.0	1514.0	32	0.0	62.6
Estimated Net Annual Sediment (TSS) Load Reduction =								63 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

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DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

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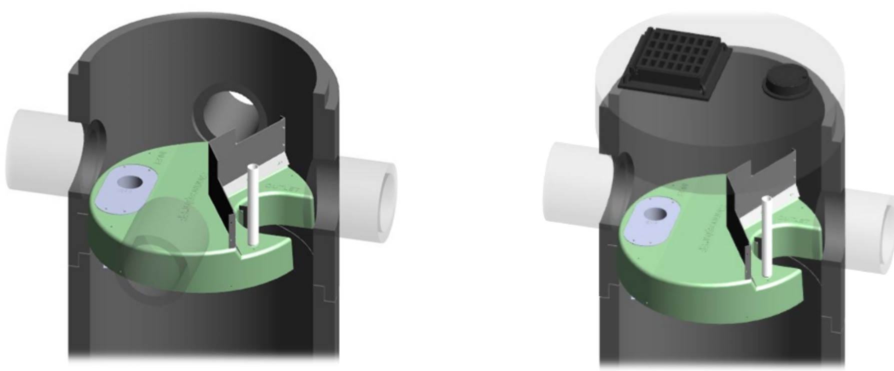

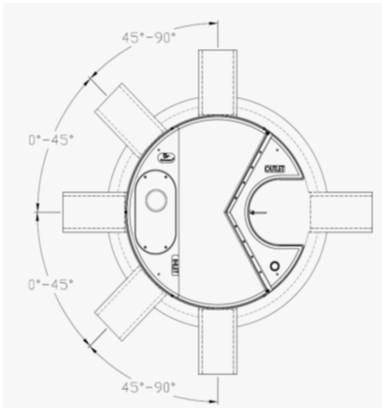

INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Appendix F

Groundwater Recharge Volume Calculations

Barton St. & Fifty Rd. - Ground Water Recharge Volume Summary						
Location	Proposed (SWM) ROW Drainage Area			Required Groundwater Recharge		
	Total (ha)	Commercial (ha)	Residential (ha)	Commercial (mm)	Residential (mm)	Total Recharge (m^3)
Water Course 5 - West (east of Fruitland Road)	1.228	0.837	0.376	2.5	1	24.69
Sunnyhurst Avenue	1.933	0.989	0.944	2.5	1	34.16
Kenmore Avenue	0					
Jones Road	0					
Water Course 6 - East (east of Jones Road)	2.293	1.200	1.093	2.5	1	40.93
Water Course 6 (west of Glover Road)	1.305	0.613	0.693	2.5	1	22.24
Glover Road	0					
Water Course 7 - West	1.325	0.650	0.675	2.5	1	23.00
Water Course 7 - East	1.405	0.354	1.051	2.5	1	19.36
McNeilly Road	0.8731	0.292	0.581	2.5	1	13.11
Lewis Road (Water Course 9 - West)	5.3153	2.869	2.438	3	1.5	122.63
West Avenue	1.356	0.101	1.255	3	1.5	21.85
Winona Road	0.20	0.084	0.110			
Napa Lane	0.7	0.000	0.700	3	1.5	10.50
Foothills Lane	0.76	0.058	0.706	3	1.5	12.33
Fifty Creek at Hwy #8	0.66	0.198	0.463	3	1.5	12.88
Fifty Creek at CNR	0.078	0.002	0.075			
South Service Road	2.68	0.668	2.010	3	1.5	50.18

Appendix G

Preliminary SWM Infrastructure Cost Estimates

Catch Basin Preliminary Cost Estimate								
Name	Inlet Node	Outlet Node	Description	Number	Type	Unitary Rate ($/ea)	Supply Costs ($)	Suply and Install ($)
OR40	J103	MH_23A	4 CB Lids	4	CB	$ 986.20	$ 3,944.80	$ 11,834.40
OR91	J1-S	J1	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR44	J-230-S	J-230	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR24	J-233-S	J-233	3 CB Lids	3	CB	$ 986.20	$ 2,958.60	$ 8,875.80
OR45	J-233-S	J-233	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR46	J-234-S	J-234	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR47	J-235-S	J-235	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR87	J-243-S	J-243	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR25	J65-S	J65	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR54	J8-S	J8	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR55	J9-S	J9	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR77	MH_10A-S	MH_10A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR76	MH_11A-S	MH_11A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR75	MH_12A-S	MH_12A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR74	MH_13A-S	MH_13A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR73	MH_14A-S	MH_14A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR72	MH_15A-S	MH_15A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR71	MH_16A-S	MH_16A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR70	MH_17A-S	MH_17A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR68	MH_19A-S	MH_19A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR85	MH_1A-S	MH_1A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR67	MH_20A-S	MH_20A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR66	MH_21A-S	MH_21A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR65	MH_22A-S	MH_22A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR64	MH_23A-S	MH_23A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR63	MH_24A-S	MH_24A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR62	MH_25A-S	MH_25A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR61	MH_26A-S	MH_26A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR60	MH_27A-S	MH_27A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR59	MH_28A-S	MH_28A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR58	MH_29A-S	MH_29A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR100	MH_2A-S	MH_2A	1 DCB Lid	1	DCB	$ 2,164.30	$ 2,164.30	$ 6,492.90
OR84	MH_2A-S	MH_2A_Orifice1	1 DCB Lid	1	DCB	$ 2,164.30	$ 2,164.30	$ 6,492.90
OR20	MH_2B-S	MH_2B	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR57	MH_30A-S	MH_30A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR56	MH_31A-S	MH_31A	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR51	MH_32A-S	MH_32A_Orifice	2 DCB Lid	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR83	MH_3A-S	MH_3A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR19	MH_3B-S	MH_3B	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR48	MH_42A-S	MH_42A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR86	MH_49A-S	MH_49A	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR82	MH_4A-S	MH_4A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR18	MH_4B-S	MH_4B	2 DCB Lids	2	DCB	$ 2,164.30	$ 4,328.60	$ 12,985.80
OR43	MH_51A-S	MH_51A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR42	MH_53A-S	MH_53A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR41	MH_55A-S	MH_55A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR26	MH_56A-S	MH_56A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR22	MH_57A-S	MH_57A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR1	MH_58A-S	MH_58A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR2	MH_59A-S	MH_59A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR81	MH_5A-S	MH_5A	10 DCB Lid	10	DCB	$ 2,164.30	$ 21,643.00	$ 64,929.00
OR7	MH_5B-S	MH_5B	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
OR6	MH_60A-S	MH_60A	4 DCB Lid	4	DCB	$ 2,164.30	$ 8,657.20	$ 25,971.60
OR80	MH_6A-S	MH_6A_M	1 CB Lid	1	CB	$ 986.20	$ 986.20	$ 2,958.60
OR110	MH_6B-S	Tank1	6 DCB Lid	6	DCB	$ 2,164.30	$ 12,985.80	$ 38,957.40
OR8	MH_6B-S	MH_6B	6 DCB Lid	6	DCB	$ 2,164.30	$ 12,985.80	$ 38,957.40
OR79	MH_7A-S	MH_7A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR10	MH_8B-S	MH_8B	1 CB Lid	1	CB	$ 986.20	$ 986.20	$ 2,958.60
OR78	MH_9A-S	MH_9A	8 DCB Lid	8	DCB	$ 2,164.30	$ 17,314.40	$ 51,943.20
OR17	MH_9B-S	MH_9B	2 CB Lid	2	CB	$ 986.20	$ 1,972.40	$ 5,917.20
			Total:	**241**		**Total:**	**$ 480,362.80**	**$ 1,441,088.40**

Ground Recharge Preliminary Storage Cost Estimate				
Name	**Storage Volume (m^3)**	**Unitary Rate ($/$m^3$)**	**Supply Costs ($)**	**Suply and Install ($)**
Water Course 5 - West (east of Fruitland Road)	24.69	$ 400.00	$ 9,876.00	$ 29,628.00
Sunnyhurst Avenue	34.16	$ 400.00	$ 13,664.00	$ 40,992.00
Water Course 5 - East (east of Jones Road)	40.93	$ 400.00	$ 16,372.00	$ 49,116.00
Water Course 6 (west of Glover Road)	22.24	$ 400.00	$ 8,896.00	$ 26,688.00
Water Course 7 - West	23	$ 400.00	$ 9,200.00	$ 27,600.00
Water Course 7 - East	19.36	$ 400.00	$ 7,744.00	$ 23,232.00
McNeilly Road	13.11	$ 400.00	$ 5,244.00	$ 15,732.00
Lewis Road (Water Course 9 - West)	122.63	$ 400.00	$ 49,052.00	$ 147,156.00
West Avenue	21.85	$ 400.00	$ 8,740.00	$ 26,220.00
Napa Lane	10.5	$ 400.00	$ 4,200.00	$ 12,600.00
Foothills Lane	12.33	$ 400.00	$ 4,932.00	$ 14,796.00
Fifty Creek at Hwy #8	12.88	$ 400.00	$ 5,152.00	$ 15,456.00
Fifty Creek at 900 mm CSP	**689**	$ 400.00	$ 275,600.00	$ 826,800.00
South Service Road	9.95	$ 400.00	$ 3,980.00	$ 11,940.00
	1056.63	**Total:**	**$ 422,652.00**	**$ 1,267,956.00**

Concrete Headwalls				
Pipe Diameter (mm)	**OPSD 804.030 Headwall ($)**	**Grate ($)**	**Supply Total ($)**	**Supply and Install ($)**
600	$ 5,340.50	$ 845.00	$ 6,185.50	$ 18,556.50

Manhole Preliminary Cost Estimate									
Name	Description	Tag	Depth (m)	Size (mm)	Barrels	Assumed Depth	Unitary Rate ($/ea)	Supply Costs ($)	Suply and Install ($)
MH_1A	01-WC5-W	Proposed_Manhole	2.01	1200	1	2.17	$ 2,762.00	$ 2,762.00	$ 8,286.00
MH_2A	01-WC5-W	Proposed_Manhole	2.064	1200	1	2.17	$ 2,762.00	$ 2,762.00	$ 8,286.00
MH_3A	01-WC5-W	Proposed_Manhole	2.15	1200	1	2.17	$ 2,762.00	$ 2,762.00	$ 8,286.00
J11	02-Sunnyhurst	Proposed_Manhole	3.1	3000	2	2.93	$ 23,616.00	$ 47,232.00	$ 141,696.00
MH_10A	02-Sunnyhurst	Proposed_Manhole	2.65	3000	2	2.93	$ 23,616.00	$ 47,232.00	$ 141,696.00
MH_4A	02-Sunnyhurst	Proposed_Manhole	3.06	3000	2	3.56	$ 24,763.00	$ 49,526.00	$ 148,578.00
MH_5A	02-Sunnyhurst	Proposed_Manhole	2.89	3000	2	2.93	$ 23,616.00	$ 47,232.00	$ 141,696.00
MH_6A	02-Sunnyhurst	Proposed_Manhole	3.37	3000	2	3.56	$ 24,763.00	$ 49,526.00	$ 148,578.00
MH_7A	02-Sunnyhurst	Proposed_Manhole	3.48	3000	2	3.56	$ 24,763.00	$ 49,526.00	$ 148,578.00
MH_9A	02-Sunnyhurst	Proposed_Manhole	3.04	3000	1	3.56	$ 24,763.00	$ 24,763.00	$ 74,289.00
MH_11A	03-WC5-E	Proposed_Manhole	3.2	1500	3	3.25	$ 6,183.00	$ 18,549.00	$ 55,647.00
MH_12A	03-WC5-E	Proposed_Manhole	2	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_13A	03-WC5-E	Proposed_Manhole	2.054	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_14A	03-WC5-E	Proposed_Manhole	1.925	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_15A	03-WC5-E	Proposed_Manhole	2.32	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_16A	03-WC5-E	Proposed_Manhole	2.65	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_17A	03-WC5-E	Proposed_Manhole	3.25	1500	3	3.25	$ 6,183.00	$ 18,549.00	$ 55,647.00
MH_18A	04-WC6-W	Proposed_Manhole	1.41	1200	2	2.17	$ 2,762.00	$ 5,524.00	$ 16,572.00
MH_19A	04-WC6-W	Proposed_Manhole	1.46	1200	2	2.17	$ 2,762.00	$ 5,524.00	$ 16,572.00
MH_20A	04-WC6-W	Proposed_Manhole	1.7	1200	2	2.17	$ 2,762.00	$ 5,524.00	$ 16,572.00
MH_21A	04-WC6-W	Proposed_Manhole	1.87	1200	1	2.17	$ 2,762.00	$ 2,762.00	$ 8,286.00
MH_22A	05-WC7-W	Proposed_Manhole	2.37	1500	2	2.62	$ 5,423.00	$ 10,846.00	$ 32,538.00
MH_23A	05-WC7-W	Proposed_Manhole	2.97	1500	2	3.25	$ 6,183.00	$ 12,366.00	$ 37,098.00
MH_24A	05-WC7-W	Proposed_Manhole	2.96	1500	2	3.25	$ 6,183.00	$ 12,366.00	$ 37,098.00
MH_25A	05-WC7-W	Proposed_Manhole	2.69	1500	2	3.25	$ 6,183.00	$ 12,366.00	$ 37,098.00
MH_26A	05-WC7-W	Proposed_Manhole	2.273	1500	2	3.25	$ 6,183.00	$ 12,366.00	$ 37,098.00
J26	06-WC7-E	Proposed_Manhole	2.36	1200	3	2.17	$ 2,762.00	$ 8,286.00	$ 24,858.00
MH_27A	06-WC7-E	Proposed_Manhole	1.77	1200	3	2.17	$ 2,762.00	$ 8,286.00	$ 24,858.00
MH_28A	06-WC7-E	Proposed_Manhole	1.786	1200	3	2.17	$ 2,762.00	$ 8,286.00	$ 24,858.00
MH_29A	06-WC7-E	Proposed_Manhole	1.97	1200	3	2.17	$ 2,762.00	$ 8,286.00	$ 24,858.00
MH_30A	06-WC7-E	Proposed_Manhole	2.11	1200	3	2.17	$ 2,762.00	$ 8,286.00	$ 24,858.00
MH_31A	07-McNeilly	Proposed_Manhole	3.57	1200	2	3.96	$ 3,875.00	$ 7,750.00	$ 23,250.00
MH_32A	07-McNeilly	Proposed_Manhole	3.34	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
MH_42A	08-West	Proposed_Manhole	3.87	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
MH_49A	09-Winona	Proposed_Manhole	2.53	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
MH_51A	10-Napa	Proposed_Manhole	2.99	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
MH_53A	10-Napa	Proposed_Manhole	3.85	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
MH_55A	10-Napa	Proposed_Manhole	3.69	1200	1	3.96	$ 3,875.00	$ 3,875.00	$ 11,625.00
J20	11-Foothills	Proposed_Manhole	2.7	2400	3	2.93	$ 14,573.00	$ 43,719.00	$ 131,157.00
MH_56A	11-Foothills	Proposed_Manhole	2.65	2400	3	2.93	$ 14,573.00	$ 43,719.00	$ 131,157.00
MH_57A	11-Foothills	Proposed_Manhole	1.82	2400	3	2.93	$ 14,573.00	$ 43,719.00	$ 131,157.00
MH_58A	12-SSR	Proposed_Manhole	2.37	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_59A	12-SSR	Proposed_Manhole	2.37	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_5B	12-SSR	Proposed_Manhole	3.61	1500	3	3.88	$ 6,949.00	$ 20,847.00	$ 62,541.00
MH_8B	12-SSR	Proposed_Manhole	1.9	1500	3	2.62	$ 5,423.00	$ 16,269.00	$ 48,807.00
MH_9B	12-SSR	Proposed_Manhole	2.32	1500	1	2.62	$ 5,423.00	$ 5,423.00	$ 16,269.00
MH_60A	12-SSR	Proposed_Manhole	2.49	3000	3	2.93	$ 23,616.00	$ 70,848.00	$ 212,544.00
MH_6B	12-SSR	Proposed_Manhole	3.9	3000	3	3.88	$ 24,888.00	$ 74,664.00	$ 223,992.00
MH_7B	12-SSR	Proposed_Manhole	3.08	3000	3	3.56	$ 24,763.00	$ 74,289.00	$ 222,867.00
CBMH_1B	13-HW8	Proposed_Manhole	2.81	1500	1	2.93	$ 5,802.00	$ 5,802.00	$ 17,406.00
MH_2B	13-HW8	Proposed_Manhole	2.77	3000	3	2.93	$ 23,616.00	$ 70,848.00	$ 212,544.00
MH_3B	13-HW8	Proposed_Manhole	3.84	3000	3	3.88	$ 24,888.00	$ 74,664.00	$ 223,992.00
MH_4B	13-HW8	Proposed_Manhole	3.87	3000	3	3.88	$ 24,888.00	$ 74,664.00	$ 223,992.00
					118		**Total:**	**$ 1,245,853.00**	**$ 3,737,559.00**

Storm Sewer Preliminary Cost Estimate

Name	Inlet Node	Outlet Node	Description	Length (m)	Cross-Section	Size (mm) or Type	Barrels	Unitary Rate ($/m)	Supply Costs ($)	Suply and Install ($)
C1	MH_1A	MH_2A_Orifice1	01-WC5-W	**90.555**	CIRCULAR	900	**1**	$ 593.20	$ 53,717.23	$ 161,151.68
C2	MH_3A	MH_2A_Orifice2	01-WC5-W	**116.511**	CIRCULAR	1050	**1**	$ 783.50	$ 91,286.37	$ 273,859.11
C3	MH_4A	MH_5A	02-Sunnyhurst	**75.037**	HORIZ_ELLIPSE	14	**2**	$ 3,272.30	$ 491,087.15	$ 1,473,261.45
C4	MH_5A	MH_6A_M	02-Sunnyhurst	**71.64**	HORIZ_ELLIPSE	14	**2**	$ 3,272.30	$ 468,855.14	$ 1,406,565.43
C47	J11	MH_4A	02-Sunnyhurst	**70.8**	HORIZ_ELLIPSE	14	**2**	$ 3,272.30	$ 463,357.68	$ 1,390,073.04
C7	MH_7A	MH_6A_M	02-Sunnyhurst	**57.36**	HORIZ_ELLIPSE	14	**2**	$ 3,272.30	$ 375,398.26	$ 1,126,194.77
C8	MH_9A	MH_7A	02-Sunnyhurst	**121.806**	HORIZ_ELLIPSE	14	**2**	$ 3,272.30	$ 797,171.55	$ 2,391,514.64
C9	MH_10A	MH_9A	02-Sunnyhurst	**102**	HORIZ_ELLIPSE	14	**1**	$ 3,272.30	$ 333,774.60	$ 1,001,323.80
C10	MH_12A	MH_13A_M	03-WC5-E	**118.254**	CIRCULAR	1050	**3**	$ 783.50	$ 277,956.03	$ 833,868.08
C11	MH_11A	MH_12A	03-WC5-E	**120**	CIRCULAR	975	**3**	$ 681.60	$ 245,376.00	$ 736,128.00
C11_2	MH_15A	MH_14A_M	03-WC5-E	**42.748**	CIRCULAR	1050	**3**	$ 783.50	$ 100,479.17	$ 301,437.52
C12_2	MH_16A	MH_15A	03-WC5-E	**117.623**	CIRCULAR	1200	**3**	$ 981.40	$ 346,305.64	$ 1,038,916.91
C13	MH_17A	MH_16A	03-WC5-E	**118.85**	CIRCULAR	1200	**3**	$ 981.40	$ 349,918.17	$ 1,049,754.51
C12	MH_18A	J-66	04-WC6-W	**27.125**	CIRCULAR	600	**1**	$ 211.80	$ 5,745.08	$ 17,235.23
C14	MH_19A	MH_18A_M	04-WC6-W	**119.15**	CIRCULAR	600	**2**	$ 211.80	$ 50,471.94	$ 151,415.82
C15	MH_20A	MH_19A	04-WC6-W	**90.014**	CIRCULAR	600	**2**	$ 211.80	$ 38,129.93	$ 114,389.79
C16	MH_21A	MH_20A_M	04-WC6-W	**90.037**	CIRCULAR	750	**2**	$ 425.90	$ 76,693.52	$ 230,080.55
C17	MH_22A	MH_23A	05-WC7-W	**64**	CIRCULAR	1050	**2**	$ 783.50	$ 100,288.00	$ 300,864.00
C18_1	MH_24A	MH_25A_M	05-WC7-W	**84.8**	CIRCULAR	1200	**2**	$ 981.40	$ 166,445.44	$ 499,336.32
C18_2	MH_25A	MH_26A_M	05-WC7-W	**89.1**	CIRCULAR	1200	**2**	$ 981.40	$ 174,885.48	$ 524,656.44
C32	MH_23A	MH_24A_M	05-WC7-W	**94.6**	CIRCULAR	1200	**2**	$ 981.40	$ 185,680.88	$ 557,042.64
C19	MH_29A	MH_28A_M2	06-WC7-E	**70.476**	CIRCULAR	900	**3**	$ 593.20	$ 125,419.09	$ 376,257.27
C20	MH_30A	MH_29A_M	06-WC7-E	**91.46**	CIRCULAR	900	**3**	$ 593.20	$ 162,762.22	$ 488,286.65
C69	MH_27A	MH_28A_M1	06-WC7-E	**73.398**	CIRCULAR	900	**3**	$ 593.20	$ 130,619.08	$ 391,857.24
C86	J26	MH_30A	06-WC7-E	**51.961**	CIRCULAR	900	**3**	$ 593.20	$ 92,469.80	$ 277,409.39
C119	J-M30	MH_32A	07-McNeilly	**22.294**	CIRCULAR	600	**1**	$ 211.80	$ 4,721.87	$ 14,165.61
C21	MH_31A	MH_32A_Orifice	07-McNeilly	**120**	CIRCULAR	900	**2**	$ 593.20	$ 142,368.00	$ 427,104.00
C6	MH_32A	J44	07-McNeilly	**17.306**	CIRCULAR	525	**1**	$ 160.00	$ 2,768.96	$ 8,306.88
C162	J-232	J-233	08-West	**19**	CIRCULAR	1350	**1**	$ 1,261.40	$ 23,966.60	$ 71,899.80
C183	J-233	J-234	08-West	**116.7**	CIRCULAR	1350	**1**	$ 1,261.40	$ 147,205.38	$ 441,616.14
C187	J-234	J-235	08-West	**27.7**	CIRCULAR	1350	**1**	$ 1,261.40	$ 34,940.78	$ 104,822.34
C195	J-230	J-233	08-West	**102.567**	CIRCULAR	1050	**1**	$ 783.50	$ 80,361.24	$ 241,083.73
C196	J-229	J-230	08-West	**5.194**	CIRCULAR	1050	**1**	$ 783.50	$ 4,069.50	$ 12,208.50
C198	J-228	J-229	08-West	**14.785**	CIRCULAR	1050	**1**	$ 783.50	$ 11,584.05	$ 34,752.14
C40	MH_42A	J-236	08-West	**116**	CIRCULAR	450	**1**	$ 125.60	$ 14,569.60	$ 43,708.80
C50	MH_49A	J-243	09-Winona	**85.359**	CIRCULAR	300	**1**	$ 98.90	$ 8,442.01	$ 25,326.02
C48	MH_53A	J-245	10-Napa	**13.408**	CIRCULAR	525	**1**	$ 160.00	$ 2,145.28	$ 6,435.84
C55	MH_51A	MH_53A	10-Napa	**59.948**	CIRCULAR	450	**1**	$ 125.60	$ 7,529.47	$ 22,588.41
C56	MH_55A	MH_53A	10-Napa	**44.073**	CIRCULAR	375	**1**	$ 121.90	$ 5,372.50	$ 16,117.50
C127	J20	MH_56A	11-Foothills	**19.958**	HORIZ_ELLIPSE	10	**3**	$ 1,675.10	$ 100,294.94	$ 300,884.81
C45	MH_56A	J65_M	11-Foothills	**46**	HORIZ_ELLIPSE	10	**3**	$ 1,675.10	$ 231,163.80	$ 693,491.40
C59	MH_57A	J65_M	11-Foothills	**76**	HORIZ_ELLIPSE	10	**3**	$ 1,675.10	$ 381,922.80	$ 1,145,768.40
C147_2	J29	J-224	12-SSR	**40.96**	CIRCULAR	825	**1**	$ 549.70	$ 22,515.71	$ 67,547.14
C60	MH_58A	MH_59A	12-SSR	**85.059**	CIRCULAR	1200	**3**	$ 981.40	$ 250,430.71	$ 751,292.12
C61	MH_59A	MH_60A	12-SSR	**84.902**	CIRCULAR	1200	**3**	$ 981.40	$ 249,968.47	$ 749,905.41
C65	MH_60A	MH_5B	12-SSR	**120.194**	CIRCULAR	1200	**3**	$ 981.40	$ 353,875.17	$ 1,061,625.52
C51	MH_9B	J-220	12-SSR	**10.732**	HORIZ_ELLIPSE	6	**1**	$ 881.10	$ 9,455.97	$ 28,367.90
C62	MH_8B	MH_9B	12-SSR	**40.038**	HORIZ_ELLIPSE	6	**1**	$ 881.10	$ 35,277.48	$ 105,832.45
C63	MH_7B	MH_8B_M	12-SSR	**119.967**	HORIZ_ELLIPSE	6	**3**	$ 881.10	$ 317,108.77	$ 951,326.31
C64	MH_6B	MH_7B_M	12-SSR	**120.176**	HORIZ_ELLIPSE	15	**3**	$ 3,732.10	$ 1,345,526.55	$ 4,036,579.65
C66	MH_5B	MH_6B_M	12-SSR	**119.979**	HORIZ_ELLIPSE	15	**3**	$ 3,732.10	$ 1,343,320.88	$ 4,029,962.63
C49	CBMH_1B	OF16	13-HW8	**13.167**	CIRCULAR	600	**1**	$ 211.80	$ 2,788.77	$ 8,366.31
C68	MH_4B	MH_3B	13-HW8	**51.75**	HORIZ_ELLIPSE	14	**3**	$ 3,272.30	$ 508,024.58	$ 1,524,073.73
C73	MH_3B	MH_2B	13-HW8	**108.264**	HORIZ_ELLIPSE	14	**3**	$ 3,272.30	$ 1,062,816.86	$ 3,188,450.58
C75	MH_2B	CBMH_1B_M	13-HW8	**9.102**	CIRCULAR	1500	**1**	$ 1,541.40	$ 14,029.82	$ 42,089.47
				3999.887				**Total:**	**$ 12,422,859.93**	**$ 37,268,579.80**