



S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing Report

338 & 338.5 CUMBERLAND AVENUE

B.I.Z. Mechanical Inc.

CITY OF HAMILTON

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by B.I.Z. Mechanical Inc. to provide consulting engineering services for the proposed residential development at 338 & 338.5 Cumberland Avenue in the City of Hamilton (see Figure 1.0 for location plan). This report will outline the functional servicing strategy for the proposed development.

The proposed development consists of constructing one townhouse block, resulting in 12 residential units, including asphalt roadways, concrete walkways and landscaped areas. There are two existing dwellings and several existing buildings which are proposed to be demolished.

This Functional Servicing Report will provide detailed information of the proposed servicing scheme for this development. Please refer to the Preliminary Site Engineering Plans prepared by S. Llewellyn and Associates Limited and the Site Plan prepared by Urban Solutions for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

- Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)
- Ref. 2: Engineering Guidelines for Servicing Land under Development Applications (City of Hamilton, December 2012)
- Ref. 3: City of Hamilton Criteria and Guidelines for Stormwater Management Infrastructure (September 2007)
- Ref. 4: City of Hamilton Storm Drainage Policy (2004)
- Ref. 5: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

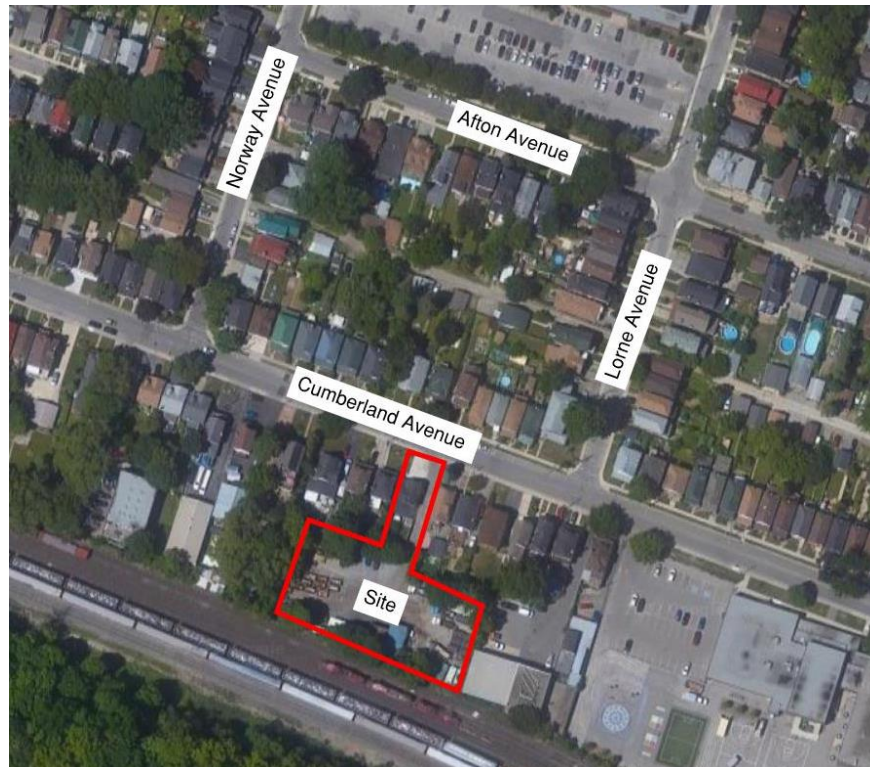


Figure 1.0 – Location Plan

2.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the City of Hamilton:

Quantity Control

The stormwater discharge rate from the subject site shall be controlled to the 2-year pre-development condition discharge rate with a runoff co-efficient of 0.45 for all storm events up to and including 100-year event.

Quality Control

The stormwater runoff from the proposed site must meet Level 1 (Enhanced) stormwater quality control (80% TSS removal, 90% average annual runoff treatment).

Erosion Control

Erosion and sediment control measures will be implemented in accordance with the standards of the City of Hamilton.

2.1 EXISTING CONDITIONS

In the existing condition, the 0.307-hectare site contains two dwellings and several existing buildings which are proposed to be demolished. The site is bound by Cumberland Avenue to the north, existing residential lands to the east and west, and existing railway tracks to the south. The site sheet drains north to Cumberland Avenue, where runoff is captured by the existing storm sewer system along Cumberland Avenue.

One catchment area, Catchment 101, has been identified in the existing condition. Catchment 101 represents discharge from the site to the storm sewer system along Cumberland Avenue. See Table 2.3 below and the Existing Condition Drainage Area Plan in Appendix A for details.

Table 2.1 – Existing Conditions Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
101	To Cumberland Avenue	0.307	93	0.86

The existing conditions discharge from the site was calculated using the Rational Method based on the above runoff coefficient (C) and the City of Hamilton storm intensities at a time of concentration of 10 minutes ($T_c=10\text{min}$). An example of the 2-year calculation for Catchment 101 is shown below and a summary can be found in Table 2.2.

$$\begin{aligned}
 Q_{2\text{-yr (Catchment 101)}} &= 2.78CiA=2.78 (0.86) (74.10\text{mm/hr}) (0.307\text{ha}) \\
 &= \mathbf{54.3 \text{ l/s (0.0543 m}^3\text{/s)}}
 \end{aligned}$$

Table 2.2 – Existing Condition Stormwater Discharge

Storm Event	Catchment 101 Discharge ($\text{m}^3\text{/s}$)
2-Yr Event	0.0543
5-Yr Event	0.0756
10-Yr Event	0.0897
25-Yr Event	0.1071
50-Yr Event	0.1207
100-Yr Event	0.1333

Allowable Discharge

An existing 300mm \varnothing combined sewer and an existing 600mm \varnothing storm relief sewer is located along Cumberland Avenue. The subject site was accounted for in the design of the existing 300mm \varnothing combined sewer along Cumberland Avenue, with a runoff coefficient (C) of 0.45 during the 2-year storm event. See below for the allowable discharge calculation and the Drainage Polygon Figure from the City of Hamilton in Appendix A for details.

$$\begin{aligned}
 Q_{\text{(Allowable)}} &= 2.78 C i A \\
 &= 2.78 (0.45) (74.10 \text{ mm/hr}) (0.307 \text{ ha}) \\
 &= \mathbf{28.5 \text{ l/s (0.0285 m}^3\text{/s)}}
 \end{aligned}$$

2.2 PROPOSED CONDITIONS

The proposed development consists of constructing 12 townhouse units including asphalt roadways, concrete walkways and landscaped areas. It is proposed to service the site with a private storm sewer system designed and constructed in accordance with the standards and specifications of the City of Hamilton.

One catchment area, Catchment 201 has been identified in the proposed condition. Catchment 201 represents the drainage area that is captured from the roof of the proposed townhouses, the asphalt roadways, concrete walkways and landscaped areas which will outlet via the private storm sewer and discharge to the existing 600mm \varnothing storm sewer along Cumberland Avenue. See Table 2.3 below and the Proposed Condition Drainage Area Plan in Appendix A for details.

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
201	Controlled to Cumberland Avenue	0.307	58	0.63

Water Quantity Control

It is proposed to apply quantity control measures to the runoff from Catchment 201 by means of an 85mm \varnothing orifice plate at the outlet of MH2 to restrict discharge from the site to the allowable discharge rate. See the Preliminary Site Servicing Plan for orifice location.

With the installation of on-site quantity control measures for Catchment 201, it will be required to provide stormwater storage during storm events up to and including the 100-year event. The required storage will be provided on the ponding surface of the asphalt parking and within an ACO Stormbrixx SD storage tank beneath the southeastern asphalt parking. Details of the proposed storage tank can be found on the Preliminary Site Servicing Plan. The stage-storage-discharge characteristics can be seen in Table 2.4 below and in Appendix A for details.

Elevation (m)	Storage (m ³)	Discharge (m ³ /s)
97.32 (Bottom of Tank)	0	0.0108
97.52 (0.2m depth)	5	0.0128
97.72 (0.4m depth)	11	0.0144
97.92 (0.6m depth)	16	0.0159
98.23 (Top of Tank)	24	0.0180
99.45 (CB Grate)	24	0.0245
99.50 (5cm Deep)	25	0.0248
99.55 (10cm Deep)	33	0.0250
99.60 (15cm Deep)	63	0.0252
99.65 (20cm Deep)	87	0.0254
99.70 (25cm Deep)	136	0.0257

The maximum discharge rate was calculated using the Rational Method based on the proposed condition runoff coefficients for the 2-year to 100-year storm events. Additionally, the 2-year to 100-year storage volumes for Catchment 201 were calculated using the

Modified Rational Method (MRM). The proposed discharge rates and storage volumes are summarized in Table 2.5 below and in Appendix A for details.

Storm Event	Catchment 201 Controlled Discharge (m ³ /s)	Sanitary Discharge (m ³ /s) ¹	Total Discharge (m ³ /s)	Allowable Discharge (m ³ /s)	Required Storage (m ³)
2-Yr	0.0141	0.00012	0.0142	0.0285	9.7
5-Yr	0.0245		0.0246	0.0285	24.1
10-Yr	0.0250		0.0251	0.0285	35.1
25-Yr	0.0251		0.0252	0.0285	50.1
50-Yr	0.0252		0.0253	0.0285	61.2
100-Yr	0.0253		0.0254	0.0285	74.0

¹ Refer to Table 3.1 and 3.2 for estimated total Sanitary Demand for the proposed development.

This analysis determined the following:

- The proposed condition discharge rate will not exceed the allowable discharge rate during the 2-year to 100-year design storms, with the installation of an 85mmØ orifice plate.
- Catchment 201 will require 74.0m³ of stormwater storage during the 100-year event, which can be accommodated by the on-site surface ponding and the proposed storage tank, having a total storage volume of 136m³.

Water Quality Control

Water quality control will be achieved through a treatment train approach, designed and constructed as per the standards of the City of Hamilton. See the Preliminary Servicing Plan prepared by S. Llewellyn & Associates Limited for details.

The proposed development is required to achieve an “Enhanced” (80% TSS removal) level of water quality protection. To achieve this criteria, discharge from Catchment 201 will be subject to a treatment train that consists of ADS Flexstorm Pure Permanent Inlet Filters and a HydroStorm oil/grit separator before ultimately discharging to the existing storm sewer system along Cumberland Avenue.

ADS Flexstorm Pure Permanent Inlet Filters have been proposed within the proposed catchbasins in the asphalt parking lot. The installation of the ADS Flexstorm Pure Permanent Inlet Filters will contribute to the removal of TSS and the capture of floatables within the catchbasins. The units also provide scour protection and reduce the resuspension of solids during heavy rain events which would otherwise enter the storm system. The technical information regarding the ADS Flexstorm Pure Permanent Inlet Filters can be found in Appendix B.

The HydroStorm sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a HydroStorm HS6 will provide 83% TSS

removal and 100% average annual runoff treatment. See HydroStorm unit sizing procedures in Appendix B for details.

With the combination of the proposed HydroStorm Unit and the ADS Flexstorm Pure Permanent Inlet Filters, the requirements for an “Enhanced” level of quality control for the site will be satisfied.

HydroStorm units and ADS Inlet Filters require regular inspection and maintenance as per the manufacture’s specifications to ensure the unit operates properly. See the Maintenance Manuals in Appendix B for details.

2.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;
- Install sediment control (silt sacks) in the proposed catchbasins as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system;
- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or their contractor shall be responsible for any costs incurred during the remediation of problem areas.

For details on the proposed erosion and sediment control for the proposed site, see the Preliminary Grading & Erosion Control Plan included in the engineering drawings.

3.0 SANITARY SEWER SERVICING

3.1 EXISTING CONDITIONS

In the existing condition there is an existing 300mmø combined sewer flowing east along Cumberland Avenue.

3.2 SANITARY DEMAND

The proposed development consists of constructing one townhouse block, resulting in 12 residential units.

Table 3.1 summarizes the sanitary sewer discharge rates for the proposed residential development. Wastewater generation for the site was calculated based on Table 8.2.1.3.A – Residential Occupancies of the 2024 Ontario Plumbing Code. Additionally, Table 3.2 summarizes the sanitary discharge from the site that has been estimated in accordance with the City of Hamilton Comprehensive Development Guidelines and Financial Policies Manual (Ref. 2).

Table 3.1 – Proposed Sanitary Sewer Discharge	
Occupancy Type:	
One-bedroom dwelling	750 l/day x 6 units = 4,500 l/day
Three-bedroom dwelling	1600 l/day x 6 units = 9,600 l/day
Waste Generated (l/day):	14,100
Total Wastewater Estimate (l/s):	0.16

Table 3.2- Proposed Sanitary Sewer Discharge						
Use	Site Area (ha)	Population ^A	Avg. Demand ^B (l/s)	Peaking Factor ^C	Infiltration ^D (l/s)	Peak Flow ^E (l/s)
Residential Units	0.307	48 persons	0.2	5.00	0.18	1.18
^A Residential Population = (6 x 3bdr units x 2 cap/bed) + (6 x 1bdr units x 2 cap/bed) = 48 persons ^B Average demand = 360 l/cap/day x 48 persons = 17,280 L/day ^C Peaking Factor = $5/P^{0.2}$ with P expressed in thousands, $2 < M < 5$ ^D Infiltration flow based on 0.6 l/ha/sec infiltration x site area ^E Peak Flow = (Average Flow x Peaking Factor) + Infiltration						

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed residential site will be serviced by a 200mmø sanitary sewer, designed, and constructed in accordance with the City of Hamilton standards. Drainage from this sewer will be discharged to the existing 300mmø combined sewer located on Cumberland Avenue.

The minimum grade of the proposed 200mmø sanitary sewer will be 1.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.033 m³/s (33 l/s). Therefore, the proposed 200mmø sanitary sewer at 1.0% grade is adequately sized to service the proposed development.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 150mmø watermain located along Cumberland Avenue. Two existing municipal hydrants are located on Cumberland Avenue fronting the site.

4.2 DOMESTIC WATER DEMAND

The following is an estimate of the water usage for the proposed development. Water usage for the site was calculated based on the “Fixture Unit Method” as per Table 7.6.3.2.A. forming part of sentences 7.6.3.1(1) to (3) and 7.6.3.4.(2), (3) and (5) of the 2024 Ontario Building Code. See Table 4.1 for fixture unit (FU) calculations.

Component	FU/ Fixture	No. of Units	Total FU
Dishwasher, domestic	1.4	12	16.8
Lavatory (8.3L/min or less) (Private)	0.7	24	16.8
Sink, kitchen, domestic (8.3L/min or less) (Public)	1.4	12	16.8
Water Closet (6 LPF or less with flush tank) (Private)	2.2	24	52.8
Shower head, 9.5 L/min or less per head	1.4	18	25.2
Clothes Washer (3.5kg)	1.4	12	16.8
Total FU:			145.2

Total peak water usage for the site was derived below from the fixture unit count as per Table 7.4.10.5 of the Ontario Building Code.

Total Fixture Unit Count = 145.2 FU

Water Usage: 65 IGPM (4.95 L/s)

4.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Ontario Building Code (OBC), various codes and standards published by the National Fire Protection Association (NFPA) and most recently, the Target Available Fire Flows provided by the City of Hamilton.

The proposed development consists of constructing one townhouse block, resulting in 12 residential units. Two existing municipal hydrants are located within close proximity to the site, located at 348 and 318 Cumberland Avenue. It is proposed to install a fire hydrant on the site which will be within the required 90m separation from building face adjacent to a street (as per Sentence 3.2.5.5 of the 2024 Ontario Building Code).

The fire flow for this building was determined to be the greater of the OBC fire flow calculation (OBC section A-3.2.5.7) or the City of Hamilton Target Available Fire Flow. The result of the OBC fire flow calculation was a minimum flow rate of 3600 L/min (60 L/sec) (see attached OBC fire flow calculation sheet). This is lower than the city of Hamilton target

available fire flow of 150 l/s for Residential use with more than 3 units, see City of Hamilton Target Flows (Policy PW19096) attached. Therefore, the minimum required fire flow for this site is **150 l/sec**. See Appendix C for fire flow calculations.

The following hydrant flow test data for the public fire hydrant in the closest proximity to the proposed development has been analyzed to determine if the municipal system adjacent to the subject site is adequate to provide the required fire flow, with a minimum pressure of 20 psi. Table 4.2 summarizes the hydrant flow data made available by the City of Hamilton:

Table 4.2 – Hydrant Flow Data	
Hydrant ID	HB01H017
Location	348 Cumberland Ave Hamilton
Test Date	2018-8-11
Static Pressure	43 psi
Residual Pressure During Test Flow	41 psi
Test Flow Rate	680 IGPM (51.52 l/s)
Theoretical Flow @ 20 psi	2543 IGPM (192.68 l/s)
Hydrant ID	HB01H018
Location	318 Cumberland Ave Hamilton
Test Date	2018-8-11
Static Pressure	40 psi
Residual Pressure During Test Flow	38 psi
Test Flow Rate	660 IGPM (50.00 l/s)
Theoretical Flow @ 20 psi	2288 IGPM (173.36 l/s)

Based on the above hydrant flow test data, the theoretical available flow rate is **173.36 l/s**, while the minimum required fire flow for the proposed development is only **150 l/s**.

Therefore, based on the above analysis, the proposed water distribution system will have the capacity and pressure required to adequately service the subject land. An updated hydrant flow test will be completed at the detailed design stage.

4.4 PROPOSED WATER SERVICING AND ANALYSIS

Proposed water servicing for the site consists of connecting a 150mm \varnothing water service off of the existing 150mm \varnothing watermain located on Cumberland Avenue. The proposed 150mm \varnothing water service will provide domestic and fire water service for the proposed residential development. Water services for the site are to be designed and constructed in accordance with City of Hamilton standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development at 338 & 338.5 Cumberland Avenue can be constructed to meet the requirements of the City of Hamilton. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading & Servicing Plans prepared by S. Llewellyn & Associates Limited;
- An 85mmØ orifice plate be installed as per the Preliminary Site Servicing Plan and this report to provide adequate quantity control;
- An underground storage tank be installed as per the Preliminary Site Servicing Plan to provide stormwater storage;
- A HydroStorm HS6 oil/grit separator and ADS Flexstorm Pure Permanent Inlet Filters be installed as per the Preliminary Site Servicing Plan and this report to provide efficient stormwater quality control;
- Erosion and sediment controls be installed as described in this report to meet City of Hamilton requirements;

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

Prepared by:

S. LLEWELLYN & ASSOCIATES LIMITED

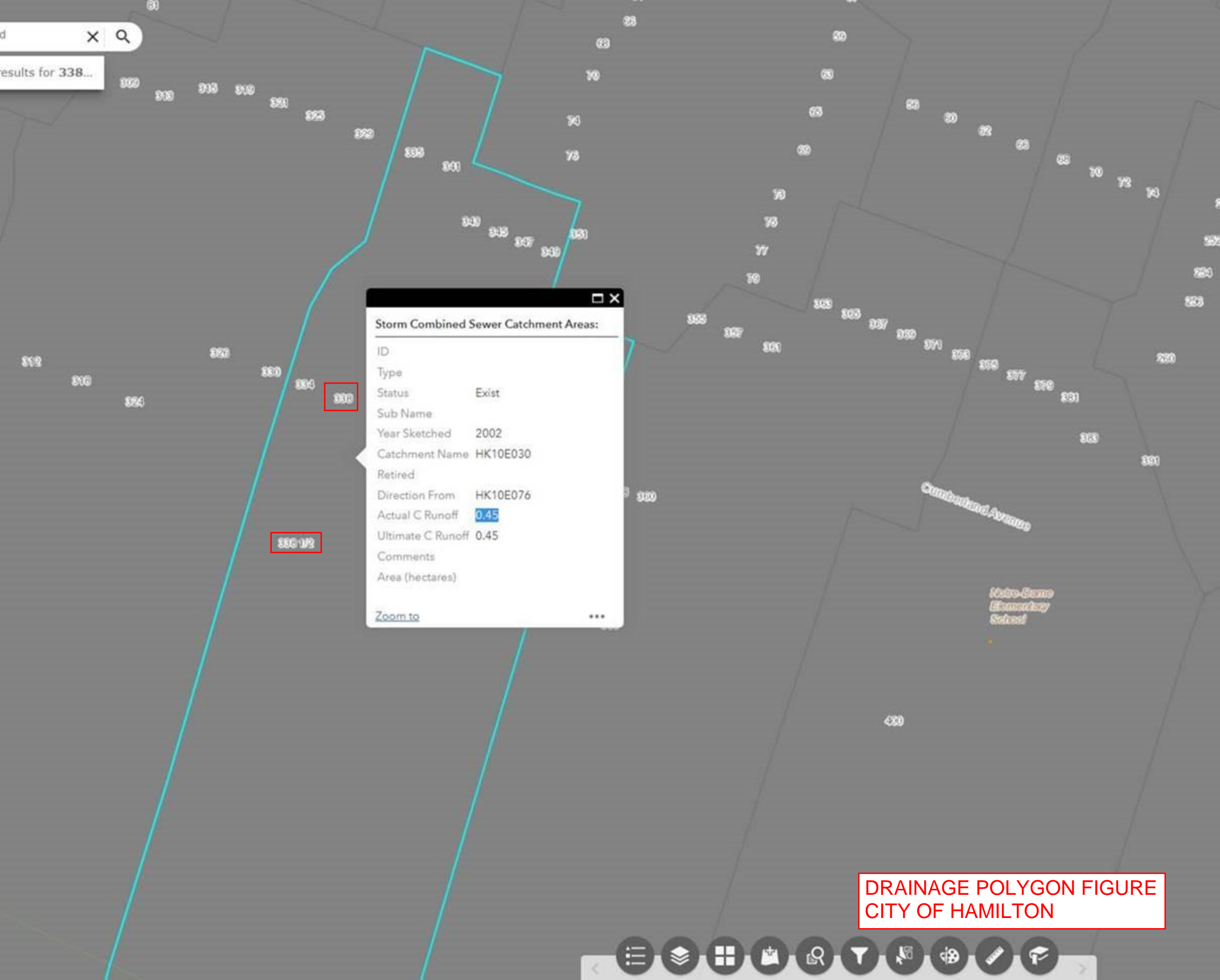
J. Martinez, Designer

S. Nelson, P.Eng.

APPENDIX A

STORMWATER MANAGEMENT INFORMATION

Search results for 338...



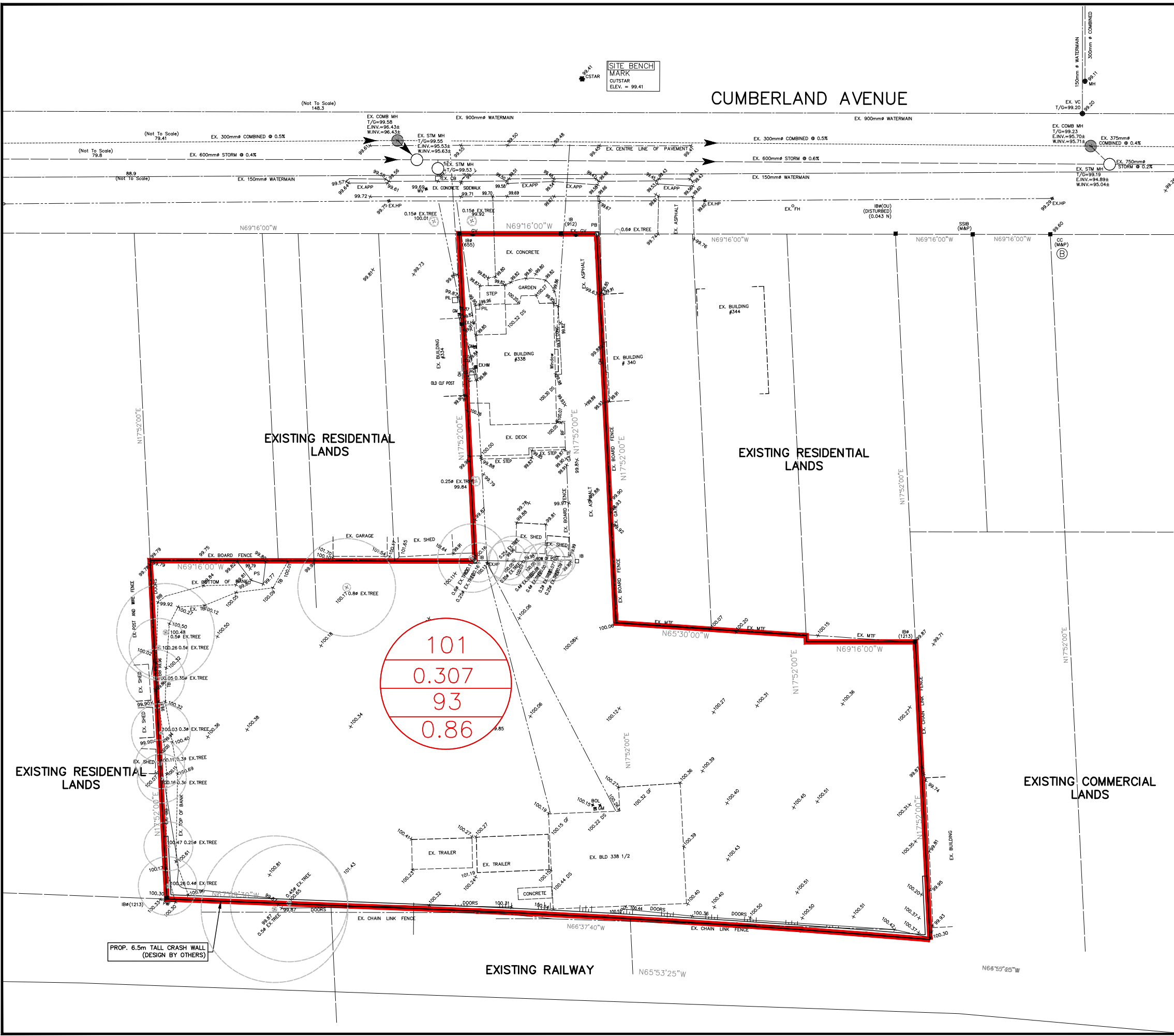
Storm Combined Sewer Catchment Areas:

ID	
Type	
Status	Exist
Sub Name	
Year Sketched	2002
Catchment Name	HK10E030
Retired	
Direction From	HK10E076
Actual C Runoff	0.45
Ultimate C Runoff	0.45
Comments	
Area (hectares)	

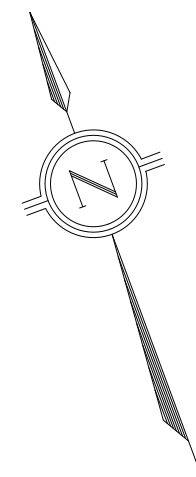
[Zoom to](#) ...

**DRAINAGE POLYGON FIGURE
CITY OF HAMILTON**





SITE BENCH MARK
OUTSTAR
ELEV. = 99.41



LEGEND

101	DRAINAGE AREA I.D. DRAINAGE AREA (ha) PERCENT IMPERVIOUS RUNOFF COEFFICENT
0.450	
11	
0.32	

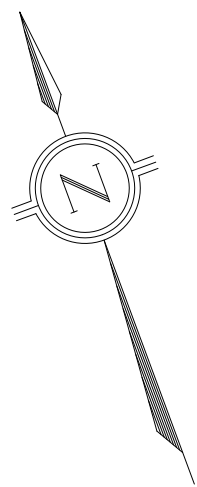
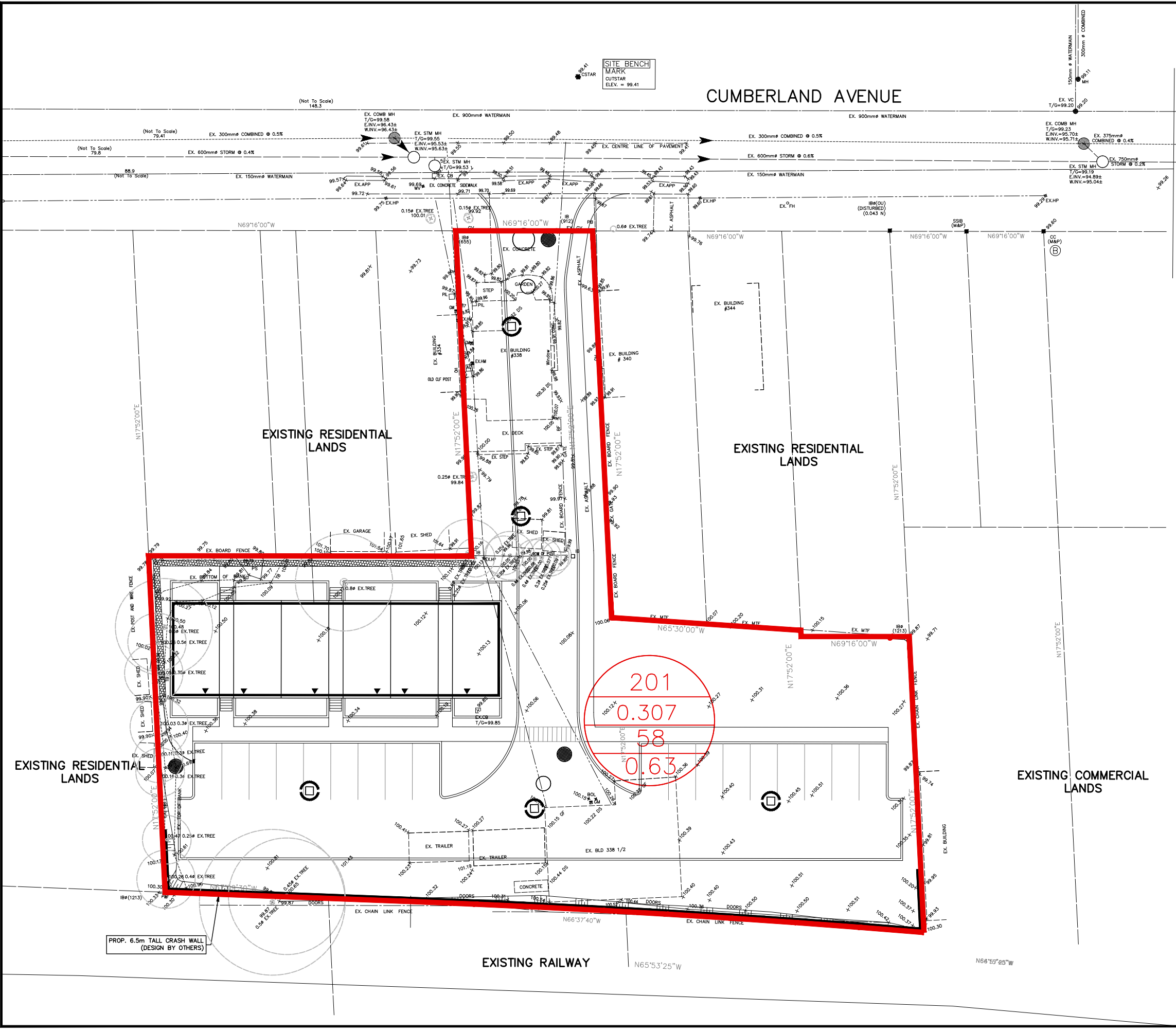
EXISTING CONDITION
STORM DRAINAGE AREA PLAN
SCALE: 1:400
PROJECT: 338 CUMBERLAND AVENUE, HAMILTON, ON
PROJECT No.: 21081



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LEGEND

201	DRAINAGE AREA I.D.
0.391	DRAINAGE AREA (ha)
11	PERCENT IMPERVIOUS
0.32	RUNOFF COEFFICIENT

→ DIRECTION OF SHEET FLOW

PROPOSED CONDITION
STORM DRAINAGE AREA PLAN
 SCALE: 1:400
 PROJECT: 338 CUMBERLAND AVENUE, HAMILTON, ON
 PROJECT No.: 21081

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338 & 338.5 Cumberland Ave.
Hamilton, Ontario

STAGE-STORAGE-DISCHARGE CALCULATIONS

Catchment 201

Outlet Device No. 1 (Quantity)

Type: Orifice Plate
Diameter (mm) **85**
Area (m²) 0.00567
Invert Elev. (m) 96.76
C/L Elev. (m) 96.80
Disch. Coeff. (C_d) 0.6
Discharge (Q) = C_d A (2 g H)^{0.5}
Number of Orifices: 1

	Elevation m	SWM Pond Volumes						Outlet No. 1	
		Area m ²	Tank Incremental Volume	Additional Incremental Underground	Additional Incremental Surface m ³	Cumulative Volume m ³	Active Storage Volume m ³	H m	Discharge m ³ /s
Orifice Invert	96.76	0	0	0.0	0	0	0	0.000	0.0000
Bottom of Tank	97.32	26	0	0.0	0	0	0	0.517	0.0108
0.20m Deep	97.52	26	5	0.0	0	5	5	0.717	0.0128
0.40m Deep	97.72	26	5	0.0	0	11	11	0.917	0.0144
0.60m Deep	97.92	26	5	0.0	0	16	16	1.117	0.0159
Top of Tank	98.23	26	8	0.0	0	24	24	1.427	0.0180
Top of Grate	99.45	0	0	0.0	0	24	24	2.647	0.0245
0.05m Ponding	99.50	58	0	0.0	1	25	25	2.697	0.0248
0.10m Ponding	99.55	256	0	0.0	8	33	33	2.747	0.0250
0.15m Ponding	99.60	528	0	0.0	20	53	63	2.797	0.0252
0.20m Ponding	99.65	846	0	0.0	34	87	87	2.848	0.0254
0.25m Ponding	99.70	1127	0	0.0	49	136	136	2.897	0.0257

2-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	2 Years
A =	646.000
B =	6.000
C =	0.781
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.307** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post-development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	99.290	0.0000276	0.053	0.0	0.0533	16.00	11.55	4.45
10	600	74.099	0.0000206	0.040	0.0	0.0398	23.89	15.40	8.48
15	900	59.921	0.0000166	0.032	0.0	0.0322	28.97	19.25	9.72
20	1200	50.715	0.0000141	0.027	0.0	0.0272	32.70	23.10	9.59
25	1500	44.206	0.0000123	0.024	0.0	0.0237	35.62	26.95	8.67
30	1800	39.333	0.0000109	0.021	0.0	0.0211	38.04	30.81	7.23
35	2100	35.534	0.0000099	0.019	0.0	0.0191	40.09	34.66	5.44
40	2400	32.480	0.0000090	0.017	0.0	0.0174	41.88	38.51	3.37
45	2700	29.965	0.0000083	0.016	0.0	0.0161	43.47	42.36	1.11
50	3000	27.855	0.0000077	0.015	0.0	0.0150	44.89	46.21	-1.31
55	3300	26.055	0.0000072	0.014	0.0	0.0140	46.19	50.06	-3.86
60	3600	24.500	0.0000068	0.013	0.0	0.0132	47.39	53.91	-6.52
65	3900	23.142	0.0000064	0.012	0.0	0.0124	48.49	57.76	-9.27
70	4200	21.944	0.0000061	0.012	0.0	0.0118	49.52	61.61	-12.09
75	4500	20.879	0.0000058	0.011	0.0	0.0112	50.48	65.46	-14.98
80	4800	19.925	0.0000055	0.011	0.0	0.0107	51.38	69.31	-17.93
85	5100	19.064	0.0000053	0.010	0.0	0.0102	52.24	73.16	-20.93
90	5400	18.284	0.0000051	0.010	0.0	0.0098	53.05	77.01	-23.97
95	5700	17.573	0.0000049	0.009	0.0	0.0094	53.82	80.86	-27.05
100	6000	16.923	0.0000047	0.009	0.0	0.0091	54.55	84.71	-30.16
105	6300	16.324	0.0000045	0.009	0.0	0.0088	55.25	88.56	-33.31
110	6600	15.772	0.0000044	0.008	0.0	0.0085	55.93	92.42	-36.49
115	6900	15.261	0.0000042	0.008	0.0	0.0082	56.57	96.27	-39.69
120	7200	14.786	0.0000041	0.008	0.0	0.0079	57.19	100.12	-42.92

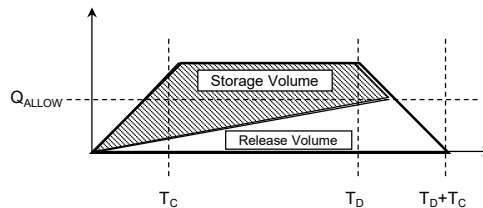
Max. required storage volume = 9.72 m³

$$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha} \text{ (Rational Method)}$$

$$\text{Runoff Volume} = \text{Area under trapezoidal hydrograph} = (T_D - T_C)Q_{POST} + (T_C Q_{POST})$$

$$\text{Release Volume} = \text{Area under triangular outflow hydrograph} = \frac{1}{2} (T_D + T_C) Q_{ALLOW}$$

$$\text{Storage Volume} = \text{Runoff Volume} - \text{Release Volume}$$



5-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	5 Years
A =	1049.500
B =	8.000
C =	0.803
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.31** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post-development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	133.809	0.0000372	0.072	0.0	0.0719	21.57	11.55	10.01
10	600	103.038	0.0000286	0.055	0.0	0.0554	33.21	15.40	17.81
15	900	84.628	0.0000235	0.045	0.0	0.0455	40.92	19.25	21.67
20	1200	72.263	0.0000201	0.039	0.0	0.0388	46.59	23.10	23.48
25	1500	63.331	0.0000176	0.034	0.0	0.0340	51.04	26.95	24.08
30	1800	56.548	0.0000157	0.030	0.0	0.0304	54.68	30.81	23.88
35	2100	51.204	0.0000142	0.028	0.0	0.0275	57.77	34.66	23.11
40	2400	46.875	0.0000130	0.025	0.0	0.0252	60.44	38.51	21.93
45	2700	43.290	0.0000120	0.023	0.0	0.0233	62.80	42.36	20.44
50	3000	40.267	0.0000112	0.022	0.0	0.0216	64.90	46.21	18.69
55	3300	37.680	0.0000105	0.020	0.0	0.0202	66.80	50.06	16.75
60	3600	35.439	0.0000098	0.019	0.0	0.0190	68.54	53.91	14.63
65	3900	33.476	0.0000093	0.018	0.0	0.0180	70.14	57.76	12.38
70	4200	31.742	0.0000088	0.017	0.0	0.0171	71.62	61.61	10.01
75	4500	30.197	0.0000084	0.016	0.0	0.0162	73.00	65.46	7.54
80	4800	28.811	0.0000080	0.015	0.0	0.0155	74.30	69.31	4.99
85	5100	27.561	0.0000077	0.015	0.0	0.0148	75.52	73.16	2.35
90	5400	26.426	0.0000073	0.014	0.0	0.0142	76.67	77.01	-0.35
95	5700	25.391	0.0000071	0.014	0.0	0.0136	77.75	80.86	-3.11
100	6000	24.442	0.0000068	0.013	0.0	0.0131	78.79	84.71	-5.92
105	6300	23.570	0.0000065	0.013	0.0	0.0127	79.78	88.56	-8.79
110	6600	22.765	0.0000063	0.012	0.0	0.0122	80.72	92.42	-11.69
115	6900	22.019	0.0000061	0.012	0.0	0.0118	81.62	96.27	-14.64
120	7200	21.325	0.0000059	0.011	0.0	0.0115	82.49	100.12	-17.63

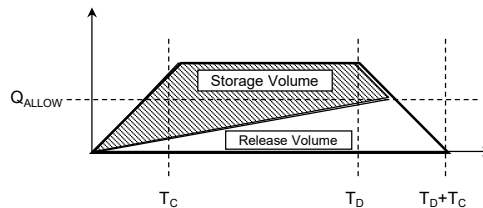
Max. required storage volume = 24.08 m³

$$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha} \text{ (Rational Method)}$$

$$\text{Runoff Volume} = \text{Area under trapezoidal hydrograph} \\ = (T_D - T_C)Q_{POST} + (T_C Q_{POST})$$

$$\text{Release Volume} = \text{Area under triangular outflow hydrograph} \\ = \frac{1}{2} (T_D + T_C) Q_{ALLOW}$$

$$\text{Storage Volume} = \text{Runoff Volume} - \text{Release Volume}$$



10-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	10 Years
A =	1343.700
B =	9.000
C =	0.814
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.31** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post-development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)



Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	156.803	0.0000436	0.084	0.0	0.0842	25.27	11.55	13.72
10	600	122.292	0.0000340	0.066	0.0	0.0657	39.42	15.40	24.02
15	900	101.114	0.0000281	0.054	0.0	0.0543	48.89	19.25	29.64
20	1200	86.678	0.0000241	0.047	0.0	0.0466	55.88	23.10	32.78
25	1500	76.152	0.0000212	0.041	0.0	0.0409	61.37	26.95	34.41
30	1800	68.104	0.0000189	0.037	0.0	0.0366	65.86	30.81	35.06
35	2100	61.735	0.0000171	0.033	0.0	0.0332	69.65	34.66	35.00
40	2400	56.557	0.0000157	0.030	0.0	0.0304	72.92	38.51	34.42
45	2700	52.256	0.0000145	0.028	0.0	0.0281	75.80	42.36	33.44
50	3000	48.622	0.0000135	0.026	0.0	0.0261	78.37	46.21	32.16
55	3300	45.506	0.0000126	0.024	0.0	0.0244	80.68	50.06	30.62
60	3600	42.803	0.0000119	0.023	0.0	0.0230	82.79	53.91	28.88
65	3900	40.434	0.0000112	0.022	0.0	0.0217	84.72	57.76	26.96
70	4200	38.338	0.0000106	0.021	0.0	0.0206	86.51	61.61	24.90
75	4500	36.470	0.0000101	0.020	0.0	0.0196	88.17	65.46	22.71
80	4800	34.794	0.0000097	0.019	0.0	0.0187	89.73	69.31	20.41
85	5100	33.279	0.0000092	0.018	0.0	0.0179	91.18	73.16	18.02
90	5400	31.905	0.0000089	0.017	0.0	0.0171	92.56	77.01	15.55
95	5700	30.650	0.0000085	0.016	0.0	0.0165	93.86	80.86	13.00
100	6000	29.501	0.0000082	0.016	0.0	0.0158	95.10	84.71	10.38
105	6300	28.443	0.0000079	0.015	0.0	0.0153	96.27	88.56	7.71
110	6600	27.467	0.0000076	0.015	0.0	0.0148	97.39	92.42	4.98
115	6900	26.562	0.0000074	0.014	0.0	0.0143	98.47	96.27	2.20
120	7200	25.721	0.0000071	0.014	0.0	0.0138	99.49	100.12	-0.62

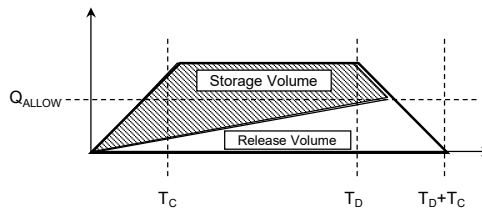
Max. required storage volume = 35.06 m³

$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha}$ (Rational Method)

Runoff Volume = Area under trapezoidal hydrograph
 = $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph
 = $\frac{1}{2} (T_D + T_C) Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



25-Year Storm - Modified Rational Method Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	25 Years
A =	1719.500
B =	10.000
C =	0.823
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.31** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post-development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	185.131	0.0000514	0.099	0.0	0.0995	29.84	11.55	18.29
10	600	146.101	0.0000406	0.078	0.0	0.0785	47.10	15.40	31.69
15	900	121.590	0.0000338	0.065	0.0	0.0653	58.79	19.25	39.54
20	1200	104.648	0.0000291	0.056	0.0	0.0562	67.47	23.10	44.36
25	1500	92.179	0.0000256	0.050	0.0	0.0495	74.29	26.95	47.33
30	1800	82.586	0.0000229	0.044	0.0	0.0444	79.86	30.81	49.06
35	2100	74.956	0.0000208	0.040	0.0	0.0403	84.57	34.66	49.91
40	2400	68.731	0.0000191	0.037	0.0	0.0369	88.62	38.51	50.11
45	2700	63.545	0.0000177	0.034	0.0	0.0341	92.18	42.36	49.82
50	3000	59.154	0.0000164	0.032	0.0	0.0318	95.34	46.21	49.13
55	3300	55.383	0.0000154	0.030	0.0	0.0298	98.19	50.06	48.13
60	3600	52.106	0.0000145	0.028	0.0	0.0280	100.78	53.91	46.87
65	3900	49.230	0.0000137	0.026	0.0	0.0264	103.15	57.76	45.39
70	4200	46.683	0.0000130	0.025	0.0	0.0251	105.34	61.61	43.73
75	4500	44.411	0.0000123	0.024	0.0	0.0239	107.37	65.46	41.91
80	4800	42.370	0.0000118	0.023	0.0	0.0228	109.26	69.31	39.95
85	5100	40.526	0.0000113	0.022	0.0	0.0218	111.04	73.16	37.88
90	5400	38.851	0.0000108	0.021	0.0	0.0209	112.71	77.01	35.70
95	5700	37.322	0.0000104	0.020	0.0	0.0201	114.29	80.86	33.43
100	6000	35.920	0.0000100	0.019	0.0	0.0193	115.79	84.71	31.07
105	6300	34.630	0.0000096	0.019	0.0	0.0186	117.21	88.56	28.65
110	6600	33.438	0.0000093	0.018	0.0	0.0180	118.56	92.42	26.15
115	6900	32.333	0.0000090	0.017	0.0	0.0174	119.86	96.27	23.59
120	7200	31.306	0.0000087	0.017	0.0	0.0168	121.10	100.12	20.98

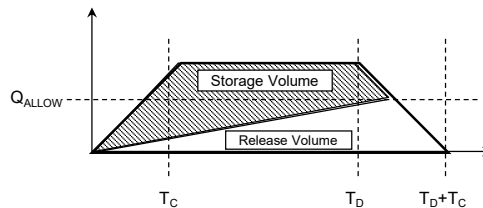
Max. required storage volume = 50.11 m³

$$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha} \text{ (Rational Method)}$$

$$\text{Runoff Volume} = \text{Area under trapezoidal hydrograph} = (T_D - T_C) Q_{POST} + (T_C Q_{POST})$$

$$\text{Release Volume} = \text{Area under triangular outflow hydrograph} = \frac{1}{2} (T_D + T_C) Q_{ALLOW}$$

$$\text{Storage Volume} = \text{Runoff Volume} - \text{Release Volume}$$



50-Year Storm - Modified Rational Method Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	50 Years
A =	1954.800
B =	10.000
C =	0.826
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.31** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post-development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	208.762	0.0000580	0.112	0.0	0.1122	33.65	11.55	22.10
10	600	164.608	0.0000457	0.088	0.0	0.0884	53.06	15.40	37.66
15	900	136.900	0.0000380	0.074	0.0	0.0735	66.19	19.25	46.94
20	1200	117.761	0.0000327	0.063	0.0	0.0633	75.92	23.10	52.82
25	1500	103.682	0.0000288	0.056	0.0	0.0557	83.55	26.95	56.60
30	1800	92.854	0.0000258	0.050	0.0	0.0499	89.79	30.81	58.99
35	2100	84.246	0.0000234	0.045	0.0	0.0453	95.05	34.66	60.39
40	2400	77.224	0.0000215	0.041	0.0	0.0415	99.57	38.51	61.07
45	2700	71.378	0.0000198	0.038	0.0	0.0383	103.54	42.36	61.18
50	3000	66.428	0.0000185	0.036	0.0	0.0357	107.06	46.21	60.86
55	3300	62.178	0.0000173	0.033	0.0	0.0334	110.24	50.06	60.18
60	3600	58.486	0.0000162	0.031	0.0	0.0314	113.12	53.91	59.21
65	3900	55.246	0.0000153	0.030	0.0	0.0297	115.76	57.76	58.00
70	4200	52.378	0.0000145	0.028	0.0	0.0281	118.19	61.61	56.58
75	4500	49.820	0.0000138	0.027	0.0	0.0268	120.45	65.46	54.99
80	4800	47.522	0.0000132	0.026	0.0	0.0255	122.55	69.31	53.24
85	5100	45.447	0.0000126	0.024	0.0	0.0244	124.52	73.16	51.36
90	5400	43.561	0.0000121	0.023	0.0	0.0234	126.38	77.01	49.37
95	5700	41.841	0.0000116	0.022	0.0	0.0225	128.13	80.86	47.27
100	6000	40.264	0.0000112	0.022	0.0	0.0216	129.79	84.71	45.08
105	6300	38.812	0.0000108	0.021	0.0	0.0209	131.37	88.56	42.80
110	6600	37.471	0.0000104	0.020	0.0	0.0201	132.87	92.42	40.45
115	6900	36.229	0.0000101	0.019	0.0	0.0195	134.30	96.27	38.04
120	7200	35.074	0.0000097	0.019	0.0	0.0188	135.67	100.12	35.56

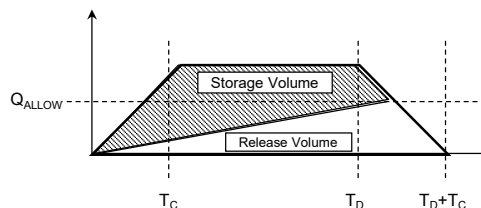
Max. required storage volume = 61.18 m³

$$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha} \text{ (Rational Method)}$$

$$\text{Runoff Volume} = \text{Area under trapezoidal hydrograph} \\ = (T_D - T_C) Q_{POST} + (T_C Q_{POST})$$

$$\text{Release Volume} = \text{Area under triangular outflow hydrograph} \\ = \frac{1}{2} (T_D + T_C) Q_{ALLOW}$$

$$\text{Storage Volume} = \text{Runoff Volume} - \text{Release Volume}$$



100-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	Hamilton
Return Period:	100 Years
A =	2317.400
B =	11.000
C =	0.836
Tc =	10 minutes 600 seconds

Area of site being investigated (ha) = **0.31** (Lot Area)
 Composite Runoff Coeff. (C) = **0.63** (Post development "C")
 Release Rate - Q_{ALLOW} (m³/s) = **0.0257** (Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T _D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume (m ³)	Release Volume (m ³)	Storage Volume (m ³)
(min)	(sec)	(mm/hr)	(m/s)	Site (m ³ /s)	Roof (m ³ /s)	Total "Q _{POST} " (m ³)			
5	300	228.222	0.0000634	0.123	0.0	0.1226	36.78	11.55	25.23
10	600	181.813	0.0000505	0.098	0.0	0.0977	58.61	15.40	43.21
15	900	152.084	0.0000422	0.082	0.0	0.0817	73.54	19.25	54.28
20	1200	131.287	0.0000365	0.071	0.0	0.0705	84.64	23.10	61.54
25	1500	115.860	0.0000322	0.062	0.0	0.0622	93.37	26.95	66.41
30	1800	103.923	0.0000289	0.056	0.0	0.0558	100.50	30.81	69.69
35	2100	94.392	0.0000262	0.051	0.0	0.0507	106.50	34.66	71.84
40	2400	86.591	0.0000241	0.047	0.0	0.0465	111.65	38.51	73.14
45	2700	80.078	0.0000222	0.043	0.0	0.0430	116.16	42.36	73.80
50	3000	74.553	0.0000207	0.040	0.0	0.0401	120.16	46.21	73.95
55	3300	69.801	0.0000194	0.038	0.0	0.0375	123.75	50.06	73.69
60	3600	65.667	0.0000182	0.035	0.0	0.0353	127.01	53.91	73.10
65	3900	62.036	0.0000172	0.033	0.0	0.0333	129.98	57.76	72.22
70	4200	58.818	0.0000163	0.032	0.0	0.0316	132.72	61.61	71.11
75	4500	55.945	0.0000155	0.030	0.0	0.0301	135.25	65.46	69.79
80	4800	53.363	0.0000148	0.029	0.0	0.0287	137.61	69.31	68.30
85	5100	51.030	0.0000142	0.027	0.0	0.0274	139.82	73.16	66.66
90	5400	48.909	0.0000136	0.026	0.0	0.0263	141.89	77.01	64.88
95	5700	46.973	0.0000130	0.025	0.0	0.0252	143.85	80.86	62.98
100	6000	45.197	0.0000126	0.024	0.0	0.0243	145.69	84.71	60.98
105	6300	43.563	0.0000121	0.023	0.0	0.0234	147.45	88.56	58.88
110	6600	42.053	0.0000117	0.023	0.0	0.0226	149.11	92.42	56.70
115	6900	40.653	0.0000113	0.022	0.0	0.0218	150.70	96.27	54.44
120	7200	39.352	0.0000109	0.021	0.0	0.0211	152.22	100.12	52.10

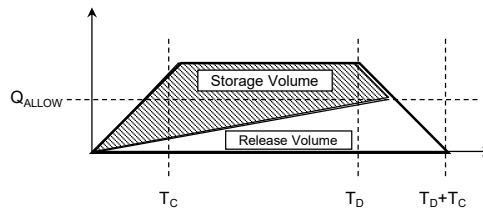
Max. required storage volume = 73.95 m³

$Q_{POST} = (C i A) \times 10000 \text{ m}^2/\text{ha}$ (Rational Method)

Runoff Volume = Area under trapezoidal hydrograph
 = $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph
 = $\frac{1}{2} (T_D + T_C) Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



APPENDIX B

QUALITY CONTROL INFORMATION



Hydroworks Sizing Summary

338 & 338.5 Cumberland Avenue

Hamilton, Ontario

07-07-2025

Recommended Size: HydroStorm HS 6

Hydroworks Sizing Program Version 5.8.5

A HydroStorm HS 6 is recommended to provide 80 % annual TSS removal based on a drainage area of .307 (ha) with an imperviousness of 58 % and Hamilton Airport, Ontario rainfall for the ETV particle size distribution.

The recommended HydroStorm HS 6 treats 100 % of the annual runoff and provides 83 % annual TSS removal for the Hamilton Airport rainfall records and ETV particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .1 (m³/s) for the given 300 (mm) pipe diameter at 1% slope. The headloss was calculated to be 99 (mm) based on a flow depth of 300 (mm) (full pipe flow).

This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm .

TSS Removal Sizing Summary

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

Site Parameters
 Area (ha)
 Imperviousness (%)

Units
 U.S.
 Metric

Rainfall Station
 Hamilton Airport Ontario
 1970 To 2006 Rainfall Timestep = 60 min.

Project Title
 (2 lines)

ETV Lab Testing Results Post Treatment Recharge

Outlet Pipe
 Diam. (mm) Peak Design Flow (m3/s)
 Slope (%)

HydroStorm Annual Sizing Results

Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)
Unavailable	.019	.097	97 %	62 %
HS 4	.033	.097	99 %	70 %
HS 5	.041	.097	99 %	77 %
HS 6	.05	.097	100 %	83 %
Unavailable	.069	.097	100 %	86 %
HS 8	.089	.097	100 %	89 %
HS 10	.097	.097	100 %	94 %
HS 12	.097	.097	100 %	96 %

Particle Size Distribution

Size (um)	%	SG
1	5	2.65
4	5	2.65
6	5	2.65
7	5	2.65
18	15	2.65
45	10	2.65
70	5	2.65
90	10	2.65
125	15	2.65
200	15	2.65

Note: Results vary significantly based on particle size distribution

TSS Particle Size Distribution

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

TSS Particle Size Distribution

Size (um)	%	SG
1	5	2.65
4	5	2.65
6	5	2.65
7	5	2.65
18	15	2.65
45	10	2.65
70	5	2.65
90	10	2.65
125	15	2.65
200	15	2.65
400	5	2.65
850	5	2.65
*		

Notes:

- To change data just click a cell and type in the new value(s)
- To add a row just go to the bottom of the table and start typing.
- To delete a row, select the row by clicking on the first pointer column, then press delete
- To sort the table click on one of the column headings

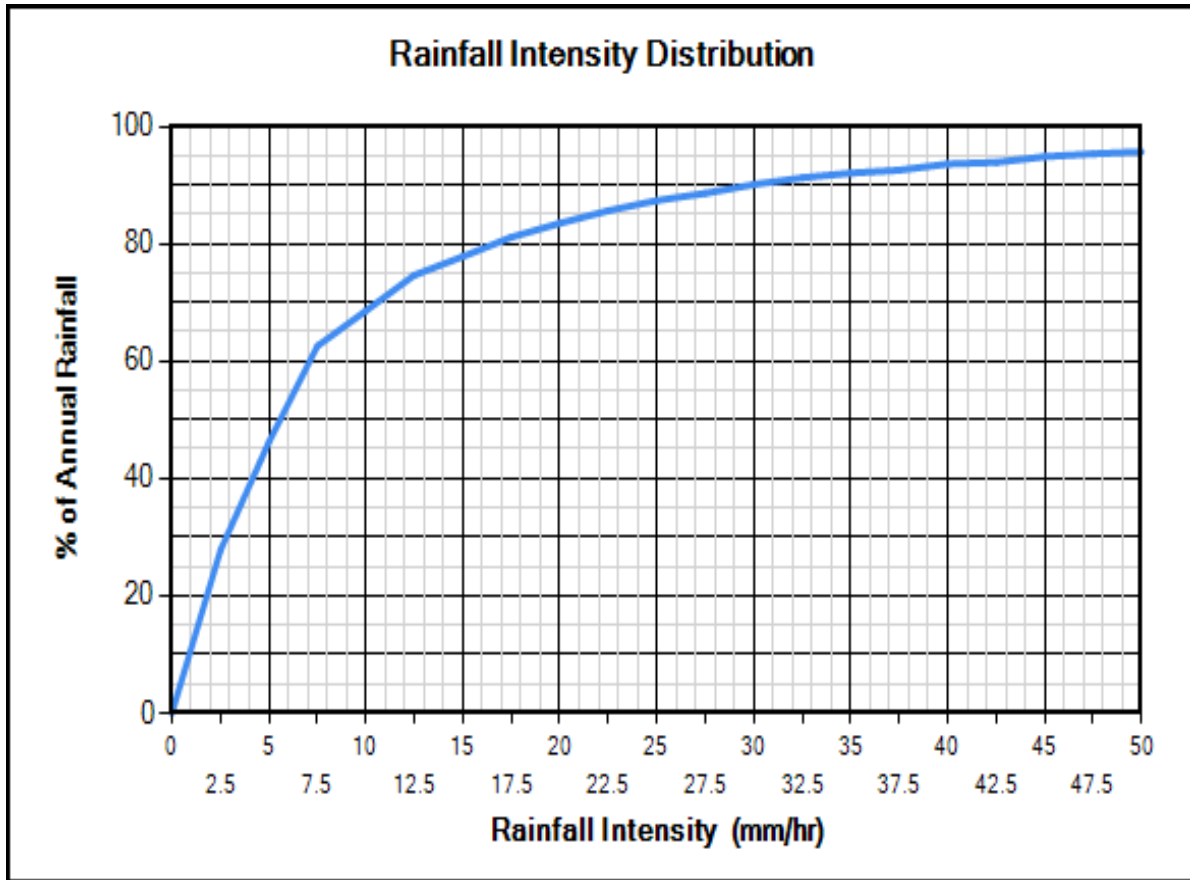
TSS Distributions

ETV Canada
 Standard HDS Design
 Alden Laboratory
 OK110
 Toronto
 Ontario Fine
 ETV Canada (Calgary)
 Calgary Forebay
 Kitchener
 User Defined

You must select a particle size distribution for TSS to simulate TSS removal

Water Temp (C)

Rainfall Station - Hamilton Airport, Ontario(1970 To 2006)



Site Physical Characteristics

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main | Dimensions | Rainfall | Site | TSS PSD | TSS Load | Site Storage | By-Pass | Custom | CAD | Video | Other

Catchment Parameters

Width (m) Imperv. Mannings n Maintenance Frequency (months)

 Perv Mannings n

Slope (%) Imp. Depress. Storage (mm) Perv. Depress. Storage (mm)

Daily Evaporation (mm/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	2.54	2.54	3.81	3.81	3.81	2.54	2.54	0	0

Infiltration

Max. Infiltration Rate (mm/hr)

Min. Infiltration Rate (mm/hr)

Infiltration Decay Rate (1/s)

Infiltration Regen. Rate (1/s)

Catch Basins

of Catch basins

Constant Baseflow

Roof Runoff (m3/s)

Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

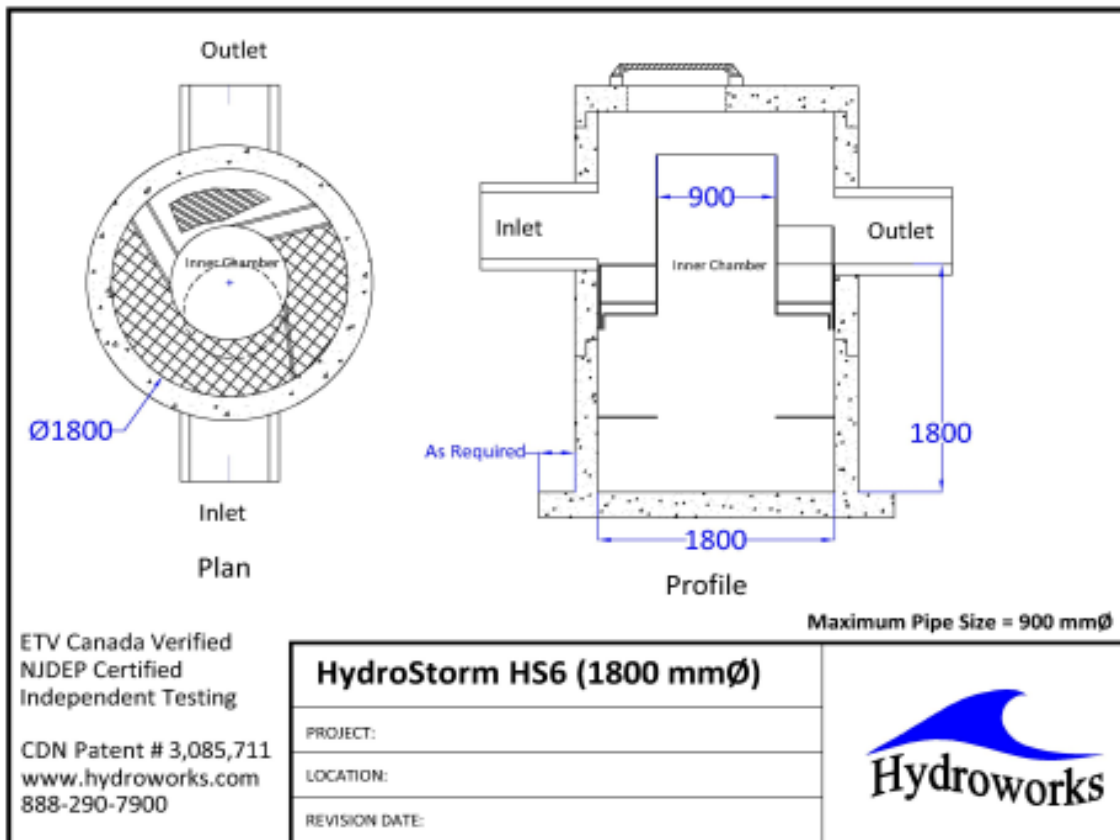
File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

Dimensions and Capacities					
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 3	0.91	1.07	185	0.4	0.7
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

Generic HS 6 CAD Drawing



TSS Buildup And Washoff

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

TSS Buildup

Power Linear
 Exponential
 Michaelis-Menton
 No Buildup Required

TSS Washoff

Power-Exponential
 Rating Curve (no upper limit)
 Rating Curve (limited to buildup)
 Event Mean Concentration

Street Sweeping

Efficiency (%)
 Start Month
 Stop Month
 Frequency (days)
 Available Fraction

Soil Erosion

Add Erosion to TSS

TSS Buildup Parameters

Limit (kg/ha)
 Coeff (kg/ha)
 Exponent

TSS Washoff Parameters

Coefficient
 Exponent

TSS Buildup

Based on Area
 Based on Curb Length

Upstream Quantity Storage

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

Quantity Control Storage

	Storage (m3)	Discharge (m3/s)
▶	0	0
*		

Other Parameters

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main Dimensions Rainfall Site TSS PSD TSS Load Site Storage By-Pass Custom CAD Video Other

Scaling Law

- Peclet Scaling based on diameter x depth
- Peclet Scaling based on surface area (diameter x diameter)

TSS Removal Extrapolation

- Extrapolate TSS Removal for flows lower than tested
- No TSS Removal extrapolation for flows lower than tested
- No TSS Removal extrapolation for lower flows or inter-event periods

Lab Testing

- Use NJDEP Lab Testing Results
- Use ETV Canada Lab Testing Results

Oil / Sediment Storage

- Oil Spill Storage in Pretreatment Area
- Sediment Storage in Pretreatment Area
- 50% Oil Spill / 50% Sediment Storage in Pretreatment Area

TSS Removal Results

- Required TSS Removal
- Choose Model #

TSS Removal Required

TSS Removal (%) Enter required TSS Removal (%)

Flagged Issues

None

Hydroworks Sizing Program - Version 5.8.5

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1-800-290-7900

www.hydroworks.com



FLEXSTORM™ Inlet Filter Specifications and Work Instructions

Product: FLEXSTORM Inlet Filters

Manufacturer: Inlet & Pipe Protection, Inc www.inletfilters.com

A subsidiary of Advanced Drainage Systems (ADS) www.ads-pipe.com

1.0 Description of Work:

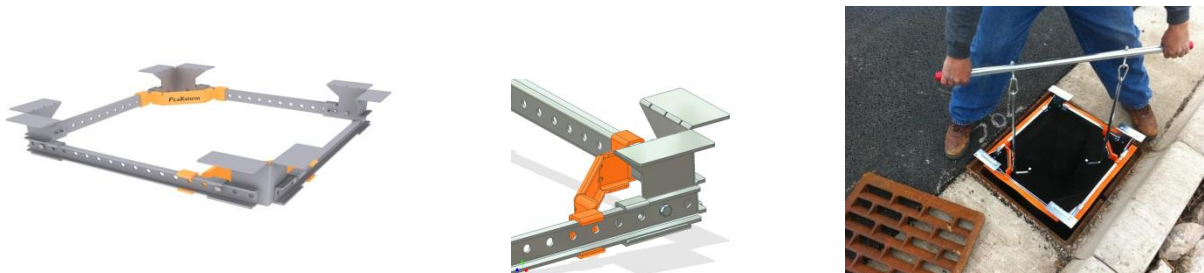
- 1.1 The work covered shall consist of supplying, installing, and maintaining/cleaning of the FLEXSTORM Inlet Filter assembly. The purpose of the FLEXSTORM Inlet Filter system is to collect silt and sediment from surface storm water runoff at drainage locations shown on the plans or as directed by the Engineer. FLEXSTORM PURE, permanent filters, are capable of removing small particles, hydrocarbons, and other contaminants from drainage “hot spots”.

2.0 Material:

- 2.1 The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile sediment bag attached to the frame with a stainless steel locking band. The sediment bag hangs suspended from the rigid frame at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment.



- 2.2 The FLEXSTORM Inlet Filter frame includes lifting handles in addition to the standard overflow feature. A FLEXSTORM Removal Tool engages the lifting bars or handles to allow manual removal of the assembly without machine assistance. The frame suspension system on most rectangular designs is adjustable in 1/2” increments up to 5” per side should the casting or drainage structure have imperfections.

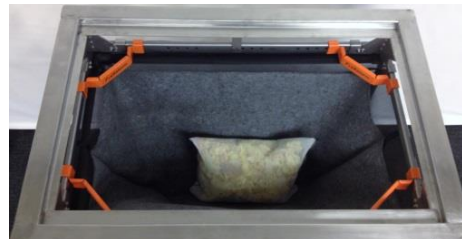




2.3 **FLEXSTORM CATCH-IT** Inlet Filters for temporary inlet protection: The FLEXSTORM CATCH-IT framing is galvanized or zinc plated for corrosion resistance. The “FX” Woven Polypropylene filter bag is the design standard, although the “IL” Nonwoven geotextile is also available if preferred by the engineer. These products are typically used for temporary inlet protection lasting 3 months (short term road work) to 5 years (residential developments).



2.4 **FLEXSTORM PURE** Inlet Filters for permanent inlet protection: The FLEXSTORM PURE framing is comprised of 304 stainless steel with a 25 year life rating. Multiple filter bags are available: **FX, FX+, PC, PC+, LL** and others. The Post Construction “PC+” is the design standard consisting of the “FX” Woven Polypropylene sediment bag lined with Adsorb-it filter fabric, which is made from recycled polyester fibers. The “PC+” includes a replaceable hydrocarbon skimmer pouch strapped to the bottom of the bag for advanced TPH removal.



3.0 Filter Bag Specifications and Capabilities:

3.1 Material Properties (taken from manufacturers average roll value):

FLEXSTORM FILTER BAGS	(22" depth)	(12" depth)	Clean Water Flow Rate (GPM/SqFt)	Min A.O.S. (US Sieve)
	STD Bag P/N	Short Bag P/N		
FX: Standard Woven Bag	FX	FX-S	200	40
FX+: Woven w/ Oil Skimmer	FXP	FXP-S	200	40
FXO: Woven w/ Oil Boom	FXO	FXO-S	200	40
PC: Post Construction Bag	PC	PC-S	137	140
PC+: PC w/ Oil Skimmer	PCP	PCP-S	137	140
LL: Litter and Leaf Bag	LL	LL-S	High	3.5
IL: IDOT Non-Woven Bag	IL	IL-S	145	70



3.2 Standard Bag Sizes and Capabilities: Bag Sizes are determined by clear opening dimensions of the drainage structure. Once frame design size is confirmed, Small - XL bag ratings can be confirmed to meet design criteria. Ratings below are for standard 22” deep bags.

Standard Bag Size ⁶	Solids Storage Capacity (CuFt)	Filtered Flow Rate at 50% Max (CFS)			Oil Retention (Oz)	
		FX	PC	IL	PC*	PCP**
Small	1.6	1.2	0.8	0.9	66	155
Medium	2.1	1.8	1.2	1.3	96	185
Large	3.8	2.2	1.5	1.6	120	209
XL	4.2	3.6	2.4	2.6	192	370

4.0 **Tested Filtration Efficiency and Removal Rates:** Filtration Efficiency, TSS, and TPH testing performed under large scale, real world conditions at accredited third party erosion and sediment control testing laboratory. (See Full Test Reports at www.inletfilters.com)



Inside View of Hopper Agitator



Hopper With Outlet Pipe Leading To Area Inlet



Area Inlet Simulated Showing Influent Discharge From Pipe

4.1 **FLEXSTORM “FX” Filtration Efficiency Test Results:** All testing performed in general accordance with the ASTM D 7351, *Standard Test Method For Determination of Sediment Retention Device Effectiveness in Sheet Flow Application*, with flow diverted into an area inlet. Test Soil used as sediment had the following characteristics with a nominal 7% sediment to water concentration mix. This is representative of a heavy sediment load running off of a construction site.

Soil Characteristics	Test Method	Value	Filtration Efficiency of “FX” FLEXSTORM Bag 82%
% Gravel	ASTM D 422	2	
% Sand		60	
% Silt		24	
% Clay		14	
Liquid Limit, %	ASTM D 4318	34	
Plasticity Index, %		9	
Soil Classification	USDA	Sandy Loam	
Soil Classification	USCS	Silty Sand (SM)	



4.2 FLEXSTORM “PC” and “PC+” Test Results: TSS measured on effluent samples in accordance with SM 2540D and TPH in accordance with EPA 1664A.

Product Tested	110 micron Sediment Load	Ave Flow Rate GPM	% TSS Removal	Soil Retention Efficiency
FLEXSTORM PC Sediment Bag	1750 mg/L using OK-110 Silica Sand and Clean Water	23	99.28%	98.96%
		48	99.32%	99.25%
		70	98.89%	98.80%

Product Tested	Street Sweep Sediment Load	Particle Size of Sediment Load	% TSS Removal	Soil Retention Efficiency
FLEXSTORM PC Sediment Bag	2.5% = 100 lbs Sed / 4000 lbs water	.001 mm – 10.0 mm (median 200 micron)	99.68%	95.61%

Product Tested	Hydrocarbon Load	Ave Flow Rate GPM	% TPH Removal	Oil Retention Efficiency
FLEXSTORM PC+	243 mg/L using 750 mL (1.45 lb) used motor oil + lube oil and clean water	19	99.04%	97.22%
FLEXSTORM PC		20	97.67%	91.61%
FLEXSTORM PC+		92	96.88%	99.11%

5.0 Identification of Drainage Structures to Determine FLEXSTORM Item Codes:

5.1 The Installer (Contractor) shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number or the exact grate size and clear opening size will provide the information necessary to identify the required FLEXSTORM Inlet Filter part number. Inlet Filters are supplied to the field pre-configured to fit the specified drainage structure. Item Codes can be built using the FLEXSTORM Product Configurator at www.inletfilters.com. Detailed Submittal / Specification drawings are linked to each Item Code and available for download by engineers and contractors to include on plans and/or verify field inlet requirements. An example of a typical drawing is shown below.

FLEXSTORM P/Ns 62SHDFX & 62SHDFXP
 HD4 INLET TYPE: SQUARE/RECT PRECAST OPENING WITH 4 SEAT GRATE SUPPORT

A: GRATE SIZE (LEFT TO RIGHT)
 B: CLEAR OPENING (FRONT TO BACK)
 C: GRATE SIZE (LEFT TO RIGHT)
 D: CLEAR OPENING (FRONT TO BACK)

Pure Frame with FX Bag		Field Inlet Dimensions		Flexstorm Framing Dims				Flexstorm Ratings (Flow at 50% Max)			Pure Frame with FX Bag	
ADS P/N	Flexstorm Item Code	Grate Size (A x C)	Clear Opening (B x D)	B1	D1	A1	C1	Bag Capacity (ft³)	PC/PC+ Flow Rate (CFR)	Bypass (CFR)	ADS P/N	Flexstorm Item Code
62SHDFX	PHD4-95-95-90-80-FX	9 1/2 X 9 1/2	8 X 8	6.0	5.0	9.5	9.3	0.2	0.5	1.2	62SHDFXP	PHD4-95-95-90-80-FXP
62SHDFX	PHD4-115-115-105-105-FX	11.5 x 11.5	10.5 x 10.5	8.0	7.5	11.5	11.3	0.4	0.7	1.7	62SHDFXP	PHD4-115-115-105-105-FXP
62SHDFX	PHD4-118-118-105-105-FX	11.75 x 11.75	10.5 x 10.5	8.0	7.5	11.5	11.5	0.4	0.7	1.7	62SHDFXP	PHD4-118-118-105-105-FXP
62SHDFX	PHD4-120-120-105-105-FX	12 X 12	10.5 X 10.5	8.5	7.5	12.0	11.8	0.4	0.7	1.7	62SHDFXP	PHD4-120-120-105-105-FXP
62SHDFX	PHD4-134-134-110-110-FX	13.375 X 13.375	11.50 X 11.50	9.5	8.5	13.0	13.1	0.5	0.8	1.9	62SHDFXP	PHD4-134-134-110-110-FXP
62SHDFX	PHD4-130-130-120-120-FX	13 x 13	12 x 12	9.5	9.0	13.0	12.8	0.5	0.8	2.0	62SHDFXP	PHD4-130-130-120-120-FXP
62SHDFX	PHD4-144-144-133-133-FX	14.375 x 14.375	13.25 x 13.25	10.5	10.5	14.0	14.1	0.7	0.9	2.3	62SHDFXP	PHD4-144-144-133-133-FXP
62SHDFX	PHD4-145-145-133-133-FX	14.5 X 14.5	13.25 X 13.25	11.0	10.5	14.5	14.3	0.7	0.9	2.3	62SHDFXP	PHD4-145-145-133-133-FXP
62SHDFX	PHD4-159-159-143-143-FX	15.87 X 15.87	14.25 X 14.25	12.0	11.5	15.5	15.6	0.9	1.0	2.5	62SHDFXP	PHD4-159-159-143-143-FXP
62SHDFX	PHD4-176-176-160-160-FX	17.75 x 17.75	16 x 16	14.0	13.0	17.5	17.5	1.2	1.1	2.9	62SHDFXP	PHD4-176-176-160-160-FXP

NOTES:

- RATINGS SHOWN ARE FOR STANDARD 22" BAG DEPTH; "SHORT" 12" DEPTH BAGS ARE AVAILABLE WITH -S SUFFIX; RATINGS REDUCED BY ~50%.
- THE FOLLOWING REQUIRES ADDITIONAL REVIEW
 - GRATES WITH EXTENDED BOTTOMS
 - ANY OBSTRUCTED INLET OPENINGS



7.0 Maintenance Guidelines: The frequency of maintenance will vary depending on the application (during construction, post construction, or industrial use), the area of installation (relative to grade and runoff exposure), and the time of year relative to the geographic location (infrequent rain, year round rain, rain and snow conditions). The FLEXSTORM Operation & Maintenance Plan (as shown in 7.5) or other maintenance log should be kept on file.

- 7.1 Frequency of Inspections: Construction site inspection should occur following each ½” or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with year round rainfall and three times per year (every three months) in areas with rainy seasons before and after snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.
- 7.2 General Maintenance for standard sediment bags: Upon inspection, the FLEXSTORM Inlet Filter should be emptied if the sediment bag is more than half filled with sediment and debris, or as directed by the Engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift the FLEXSTORM Inlet Filter from the drainage structure. Machine assistance is not required. Dispose of the sediment or debris as directed by the Engineer. As an alternative, an industrial vacuum may be used to collect the accumulated sediment if available. Remove any caked on silt from the sediment bag and reverse flush the bag for optimal filtration. Replace the bag if the geotextile is torn or punctured to ½” diameter or greater on the lower half of the bag. If properly maintained, the Woven sediment bag will last a minimum of 4 years in the field.
- 7.3 Inspection and Handling of the FLEXSTORM PC / PC+ post construction sediment bag: The PC+ sediment bags will collect oil until saturated. Both the Adsorb-it filter liner and the skimmer pouch will retain oil. The volume of oils retained will depend on sediment bag size. Unlike other passive oil sorbent products, Adsorb-it filter fabric has the ability to remove hydrocarbons at high flow rates while retaining 10- 20 times its weight in oil (weight of fabric is 12.8 oz / sq yd). The average 2’ x 2’ PC Bag contains approx .8 sq yds, or 10 oz of fabric. At 50% saturation, the average Adsorb-it lined PC filter will retain approximately 75 oz (4.2 lbs) of oil. Once the bag has become saturated with oils, it can be centrifuged or passed through a wringer to recover the oils, and the fabric reused with 85% to 90% efficacy. If it is determined, per Maintenance Contracts or Engineering Instructions, that the saturated PC sediment bags will be completely replaced, it is the responsibility of the service technician to place the filter medium and associated debris in an approved container and dispose of in accordance with EPA regulations. Spent Adsorb-it can be recycled for its fuel value through waste to energy incineration with a higher BTU per pound value than coal. The oil skimmers start white in color and will gradually turn brown/black as they become saturated, indicating time for replacement. The average skimmer pouch will absorb approximately 62 oz (4 lbs) of oil before requiring replacement. To remove the pouch simply unclip it from the swivel strap sewn to the bottom of the bag. Dispose of all oil contaminated products in accordance to EPA guidelines. The ClearTec Rubberizer media used in the pouch, since a solidifier, will not leach under pressure and can be disposed of in most landfills, recycled for industrial applications, or burned as fuel.



- 7.4 Sediment Bag Replacement: When replacing a Sediment Bag, remove the bag by loosening or cutting off the clamping band. Take the new sediment bag, which is equipped with a stainless steel worm drive clamping band, and use a drill or screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band. For Oil absorbent boom bags, simply replace the oil boom or pouch when saturated by sliding it through the mesh support sleeve.



APPENDIX C

FIRE FLOW INFORMATION

OBC FIRE FLOW WATER SUPPLY



Project: 338 & 338.5 Cumberland Avenue
 Project Number: 21081
 Date: Jul-25

Type of Development: **Residential (Greater than 3 units)**

Required Fire Water Supply (Q) per OBC: $Q = K V S_{tot}$ (OBC Tables and Figures attached)

Where: Q = Minimum supply of water in litres
 K = Water supply coefficient from Table 1
 V = total building volume in cubic meters
 S_{tot} = total of spatial coefficient values from property line exposures on all sides
 $S_{tot} = 1.0 + [S_{side1} + S_{side2} + S_{side3} + \dots]$ from Figure 1. Max. 2.0

Water Supply Coefficient (K)

Building Group/Division Classification: **C (Residential Occupancies)**

From Table 1, **K = 16**

Building Volume (V)

Building Footprint Area: **342 m²**

Building Height: **10.3 m** (Assuming attic has same footprint)

Building Volume (V): 3515.76 m³

Spatial Coefficient (S)

Side	Dist (m)	S _{coeff}
Front	>10	0
Back	5	0.5
Left	>10	0
Right	2.5	0.5
Total		1.0

Therefore, $S_{tot} = 2.0$

Required Water Supply

$$Q = K V S_{tot} = 112504.3 \text{ m}^3$$

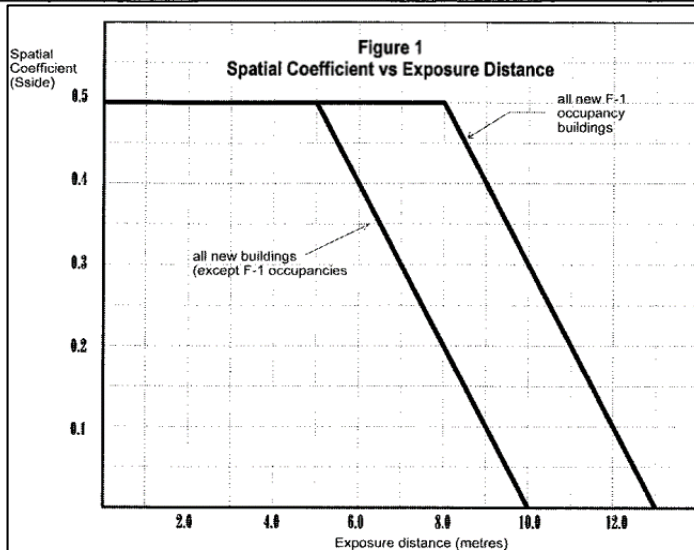
From Table 2, the minimum required water supply flow rate = **3600 l/min or 60 l/s**

City of Hamilton Target flow for residential multi (greater than 3 units) = **150 l/s <-- governs**

OBC Tables and Figures

Table 1					
Water Supply Coefficient - K					
Type of Construction	Classification by Group or Division in Accordance with Table 3.1.2.1. of the Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustibile construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2.	18	22	25	31	41
Building is of combustibile construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Table 2	
Part 3 Buildings under the Building Code	Required Minimum Water Supply Flow Rate, L/min
One-storey building with building area not exceeding 600 m ²	1 800
All other buildings	2 700 (if Q ≤ 108 000 L) ⁽¹⁾ 3 600 (if Q > 108 000 L and ≤ 135 000 L) ⁽¹⁾ 4 500 (if Q > 135 000 L and ≤ 162 000 L) ⁽¹⁾ 5 400 (if Q > 162 000 L and ≤ 190 000 L) ⁽¹⁾ 6 300 (if Q > 190 000 L and ≤ 270 000 L) ⁽¹⁾ 9 000 (if Q > 270 000 L) ⁽¹⁾



City of Hamilton Target Flows (Policy PW19096)

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m ³) ¹	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50