

Functional Servicing Report

18 - 20 Hickory Street

Waterloo, Ontario

April 5, 2024

Project Reference Number 23-218



K. SMART ASSOCIATES LIMITED

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1.0 Introduction

This Functional Servicing Report has been prepared for a proposed residential development located at 18 and 20 Hickory Street in Waterloo, Ontario. The site is 0.105 hectares and is currently developed with two detached residential homes. The proposed development is a 9-unit townhouse block. Eight of the townhouse units will have 3 bedrooms and one unit will have two bedrooms.

The site is located on the west side of Spruce Street and north of Hickory Street West. The site location is shown in Figure 1.

This report reviews the functionality of the potable water supply, sanitary sewer servicing, and stormwater management.

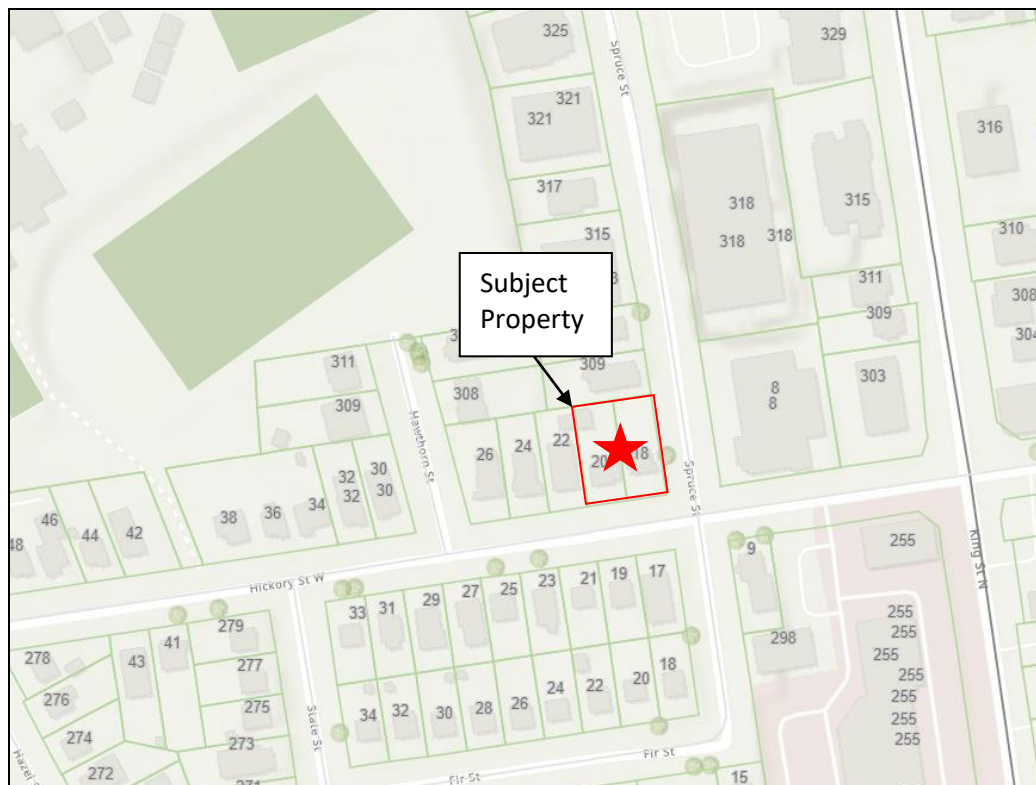


Figure 1: Location of Subject Property (City of Waterloo GIS Mapping)

2.0 Overview of Proposed Development

The total site area is 0.105 ha. The existing single detached houses will be removed to be replaced by the proposed townhouses. Vehicle access to the site will be provided off Hickory Street.

The development will be serviced by municipal watermain, sanitary sewers and storm sewers. The water service will be brought to the site from the existing 150mm dia watermain in Hickory Street West. The existing 450mm diameter sanitary sewer in Hickory Street West will be used to provide sanitary service to the site.

The proposed development will include a storm sewer connection to Hickory Street West. The storm sewer outlet will include an oil grit separator for quality control. Quantity control of stormwater runoff will be provided with parking lot storage and underground storage.

3.0 Water Servicing

The water demand for the residential development has been calculated in accordance with the Region of Waterloo Design Guidelines 2023, the Ministry of the Environment Drinking Water Systems Design Guidelines (2008) and the City of Waterloo Development Charges Background Study dated Jan. 6, 2020.

In accordance with the DGSSMS, the average residential daily demand is 225 L/person/day. The population density is 2.30 persons per unit for row housing based on the Development Charges Background Study.

Townhouse Development = 9 townhouse units x 2.30 persons per unit = 20.7 people

Total Population = 21 people

The peaking factors used to calculate the maximum daily demand and the peak hourly demand are based on the Ministry of the Environment's drinking water systems design guidelines. The peaking factor used to determine the maximum daily demand is 2.75, while the peak hourly demand factor is 4.13.

Average Daily Demand: $225 \text{ L/day/person} \times 21 \text{ people} = 0.054 \text{ L/s}$

Maximum Daily Demand: $0.054 \text{ L/s} \times 2.75 = 0.148 \text{ L/s}$

Peak Hourly Demand: $0.054 \text{ L/s} \times 4.13 = 0.223 \text{ L/s}$

Water demand calculations are included in Appendix A.

The required fire flow is 8000 L/min, as per the Fire Underwriter's Survey, 1999, for contiguous residential housing.

A 50mm diameter watermain will be brought into the site from Hickory Street West. The watermain will extend east to service the Townhouse units fronting Hickory Street West. The watermain will also be extended north to service each townhouse units from the parking lot area at the rear.

Water services will be provided to each unit.

4.0 Sanitary Servicing

A 150mm diameter sanitary sewer will be brought into the site from the 450mm sanitary sewer in Hickory Street. Each townhouse unit will be serviced by 100mm diameter sanitary service.

The sanitary flow calculations are based on the Region of Waterloo's Design Guidelines which stipulate an average flow of 275 L/c/d for residential areas plus an allowance for inflow and infiltration of 0.25 L/s/ha.

The peak sewage flow from the proposed townhouse development to Hickory Street West is 0.389 L/s.

The sanitary sewer design sheets have been included in Appendix B.

5.0 Stormwater Management

5.1 Geotechnical and Hydrogeological Conditions

Site specific geotechnical information was not available at the time this report was prepared. However, based on soils mapping soils are generally fine sand.

5.2 Existing Drainage Patterns

The site is located at the northwest corner of Hickory St West and Spruce St. Under existing conditions, the southwest portion of the site drains overland toward Hickory Street West and northeast portion of

the site drains overland toward Spruce Street. The storm sewer along Spruce Street conveys runoff south towards the existing storm sewer in Street West. All stormwater runoff from the property is ultimately directed to Hickory Street.

5.3 Proposed Drainage Patterns

The site will be graded to capture parking lot runoff and a portion of roof runoff into a catchbasin with orifice restricted discharge. Runoff from the back half of the roof tops will be collected into an underground storage facility with the discharge controlled by a vortex valve at the outlet.

The parking lot storage area and the underground storage area will discharge to an oil grit separator for quality control prior to discharge to the Hickory Street storm sewer.

The landscaped areas at the front of the units will be graded to drain overland towards Spruce Street and Hickory Street West.

The major overflow route will direct runoff to Hickory Street West.

5.4 Stormwater Management Design Criteria

The stormwater management design criteria are in accordance with the City of Waterloo's Development Engineering Manual.

The design criteria are:

1. Control the 2 year, 5 year to 100 year post development peak discharge rates to the existing discharge rates.
2. Provide quality control of runoff to an enhanced level, 80% removal of suspended solids.

The storm sewers have been sized to convey the 5 year storm event. The storm design sheet is included in Appendix F.

5.5 Stormwater Modeling

MIDUSS Modeling was used to determine the volume of runoff generated from the design storm events.

The design storm hyetographs were based on the "Chicago" rainfall distribution, with the A, B, and C parameters fitted to the following IDF curve for the City of Waterloo.

Return Period	A	B	C
2 Year	1101	9.258	0.882
5 Year	1755	12.347	0.895
100 Year	4692	17.437	0.956

The site was divided into the drainage catchment areas for the existing and proposed conditions as shown in the tables below.

Table 1 Existing Drainage Catchment Areas For MIDUSS Modeling

Catchment ID	Description	Area (ha)	Percent Impervious (%)	Flow Length (m)	Slope (%)
101	Site Area to Ex MH L32L-72	0.105 ha	35%	5m	3.0%

Table 2 Proposed Drainage Catchment Areas For MIDUSS Modeling

Catchment ID	Description	Area (ha)	Percent Impervious (%)	Flow Length (m)	Slope (%)
201	Rooftop Area to Infiltration Gallery	0.02 ha	100%	10m	1.0%
202	Parking Areas to CB1	0.058 ha	85%	10m	2.4%
203	Landscaped Areas to Ex MH L32L-28	0.027 ha	20%	2m	2.0%

Stormwater storage will be provided through the use of underground storage chambers (ADS Stormtech SC-740 or equivalent) with a vortex valve-controlled discharge and parking lot storage with orifice-controlled discharge.

The stage storage discharge calculations for the underground storage area are included in Appendix D. The stage storage discharge calculations for the parking lot storage area were calculated within the MIDUSS model.

The results from the MIDUSS modeling are summarized below and the output files are included in Appendix E.

Table 3: MIDUSS Model Results – Peak Discharge Under Existing and Proposed Conditions

Storm Event	Existing Peak Flow (m ³ /s)	Proposed Peak Flow (m ³ /s)
2 Year Storm	0.009 m ³ /s	0.010 m ³ /s
5 Year Storm	0.013 m ³ /s	0.012 m ³ /s
100 Year Storm	0.033 m ³ /s	0.031 m ³ /s

The proposed discharge during the 2 year storm event is slightly higher than existing conditions. However, the increase in flow is only 1 L/s. Given the small property area and the very low runoff flow rates, the increase in discharge can be considered negligible and within acceptable modeling error. The peak flow from the site under proposed conditions is less than the existing flow from the site for the 5 year and 100 year storm events.

The performance of the stormwater management areas is summarized in the table below.

Table 4: Performance of Stormwater Quantity Control Components

	2 Year Storm	5 Year Storm	100 Year Storm
Underground Storage Chambers (Area 201)			
Vortex Valve Location	MH 1		
Invert	324.50		
Base of Storage	324.55		
Top of Storage	325.61		
Total Storage Vol. Provided	6.7 m ³		
Peak Inflow	0.004 m ³ /s	0.006 m ³ /s	0.012 m ³ /s
Peak Discharge	0.003 m ³ /s	0.003 m ³ /s	0.003 m ³ /s
Maximum Water Level	324.70 m	324.82 m	324.86 m
Maximum Storage Volume	1.1 m ³	2.0 m ³	2.3 m ³
Parking Lot Storage (Area 202)			
Orifice Location	CB1 – below grate		
Orifice Diameter	75mm		
Orifice Invert	326.22		
T/G Elevation	326.37		
Overflow Elevation	326.50		
Peak Inflow	0.011 m ³ /s	0.016 m ³ /s	0.029 m ³ /s
Peak Discharge	0.006 m ³ /s	0.007 m ³ /s	0.007 m ³ /s (pipe) 0.015 m ³ /s (overland)
Maximum Water Elevation	326.47 m	326.50 m	326.52 m
Maximum Storage Volume	1.9 m ³	4.4 m ³	7.2 m ³

5.6 Stormwater Quality Control

Stormwater quality control will be provided using an oil grit separator installed on storm sewer outlet prior to discharge to Hickory Street West.

The Stormceptor sizing program was used to select the appropriate OGS model as summarized in the table below. The sizing summary is included in Appendix E.

Table 5: Oil Grit Separator Performance Summary

Catchment ID	Area (ha)	Stormceptor Model	Quality Control Level (TSS Load Reduction)	Runoff Volume Capture
201 & 202	0.078 ha 89% Impervious	EF4	98%	>90%

6.0 Conclusions

The site will be serviced with municipal watermain, sanitary sewers, and storm sewers. The watermain on Hickory Street West will be extended to provide water supply to the townhouses. The sanitary sewer will discharge to the existing sanitary sewer in Hickory Street West and a storm sewer connection will be provided to Hickory Street West.

Stormwater management will be achieved through the use of parking lot storage and underground storage with controlled discharge. The total stormwater discharge from the subject property will be controlled to the existing discharge rates to Hickory Street West.

An oil grit separator unit will be installed the storm outlet to provide quality control to an enhanced, 80% removal, level.

The major overland flow route will direct surface flows to Hickory Street West.

All of which is respectfully submitted,



Sandra Swanton, P.Eng.
K. Smart Associates Limited



APPENDIX A

Water Demand Calculations

WATER SERVICING CALCULATIONS

18 & 20 Hickory Street West, Waterloo, Ontario

K. Smart Associates Limited
Project Number: 23-218
Date: 11-Mar-24

DESIGN CRITERIA

Residential Design Criteria (City of Waterloo Design Guidelines)		Peaking Factors	
Residential Water Demand	225 L/cap/day	Maximum Day	2.75
Density- Single Family	3.49 c/unit	Peak Hour	4.13
Density - Row Housing	2.3 c/unit	(Ministry of the Environment Design Guidelines for Drinking Water System)	
Density - Apartment	1.76 c/unit		

PROPOSED DEVELOPMENT - BUILDING USAGE

Residential Occupancy		Density (persons/unit)	(From Waterloo Development Charges Background Study (Hemson, 2020))
Single Family Units	0	3.49	
Townhouse Units	9	2.3	
Apartment Units	0	2.07	
TOTAL	9 units	20.7 persons	

WATER DEMAND CALCULATIONS

Residential	
Average Day	4,658 L/day
Average Day	0.054 L/s
Maximum Day	0.148 L/s
Peak Hour	0.223 L/s
TOTAL WATER DEMAND	
Average Day	0.054 L/s
Maximum Day	0.148 L/s
Peak Hour	0.223 L/s

APPENDIX B

Sanitary Sewer Design Sheet

18-20 Hickory St, City of Waterloo
SANITARY SEWER DESIGN SHEETS

K. Smart Associates Limited
Ref. Number 23-218
Date 11-Mar-24

City of Waterloo Design Criteria		
Residential Sewage Flow	0.004 L/s/c	(275 L/d/c)
Density- Single Family	3.49 c/unit	
Density - Row Housing	2.3 c/unit	
Residential Peaking Factor	1+(14/4+P ^{0.5}), P = Pop/1000	
Infiltration	0.25 L/s/ha	

LOCATION			POPULATION					SEWAGE FLOWS					SEWER DESIGN						
Street and Area	From MH	To MH	Individual Area (ha)	Total Area (ha)	Number of Units	Individual Pop.	Total Pop.	Res. Peaking Factor	Average Res. Flow (L/s)	Peak Res. Flow (L/s)	Total Infiltration (L/s)	Total Peak Flow (L/s)	Mannings 'n'	Pipe Size (mm)	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Q/Qcap (%)
Hickory ST W OUTLET	Townhouse Site	EX MHU7-86A	0.105	0.105	9	20.7	20.7	4.378	0.083	0.363	0.026	0.389	0.013	150	1	83.7	15.229	0.862	2.4%

APPENDIX C

Underground Storage Stage Storage Discharge Calculations

Hickory Development, City of Waterloo
STORMTECH CHAMBERS STORAGE CALCULATIONS

K. Smart Associates Limited
Project Number 23-218
Date March 11, 2024

Chamber Model -	SC-740	
Units -	Metric	
Number of Chambers -	2	
Number of End Caps -	2	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	324.50	m
Amount of Stone Above Chambers -	152	mm
Amount of Stone Below Chambers -	152	mm
Area of system -	12	sq.meters

Height of System	Incremental Single Chamber	Incremental Total Chamber	Incremental Stone	Incremental Ch & St	Cumulative Chamber	Elevation
(mm)	(cubic meters)	(cubic meters)	(cubic meters)	(cubic meters)	(cubic meters)	(meters)
25	0.00	0.00	0.12	0.12	0.122	324.53
51	0.00	0.00	0.12	0.12	0.244	324.55
76	0.00	0.00	0.12	0.12	0.365	324.58
102	0.00	0.00	0.12	0.12	0.487	324.60
127	0.00	0.00	0.12	0.12	0.609	324.63
152	0.00	0.00	0.12	0.12	0.731	324.65
178	0.06	0.13	0.07	0.20	0.927	324.68
203	0.06	0.12	0.07	0.20	1.124	324.70
229	0.06	0.12	0.07	0.20	1.320	324.73
254	0.06	0.12	0.07	0.19	1.514	324.75
279	0.06	0.12	0.07	0.19	1.709	324.78
305	0.06	0.12	0.07	0.19	1.902	324.80
330	0.06	0.12	0.07	0.19	2.094	324.83
356	0.06	0.12	0.08	0.19	2.286	324.86
381	0.06	0.11	0.08	0.19	2.476	324.88
406	0.06	0.11	0.08	0.19	2.664	324.91
432	0.05	0.11	0.08	0.19	2.852	324.93
457	0.05	0.11	0.08	0.19	3.038	324.96
483	0.05	0.11	0.08	0.18	3.223	324.98
508	0.05	0.10	0.08	0.18	3.406	325.01
533	0.05	0.10	0.08	0.18	3.587	325.03
559	0.05	0.10	0.08	0.18	3.767	325.06
584	0.05	0.09	0.08	0.18	3.944	325.08
610	0.04	0.09	0.09	0.18	4.120	325.11
635	0.04	0.09	0.09	0.17	4.293	325.14
660	0.04	0.08	0.09	0.17	4.465	325.16
686	0.04	0.08	0.09	0.17	4.632	325.19
711	0.04	0.07	0.09	0.16	4.797	325.21
737	0.03	0.07	0.10	0.16	4.959	325.24
762	0.03	0.06	0.10	0.16	5.117	325.26
787	0.03	0.05	0.10	0.15	5.271	325.29
813	0.02	0.05	0.10	0.15	5.420	325.31
838	0.02	0.03	0.11	0.14	5.563	325.34
864	0.01	0.02	0.12	0.13	5.694	325.36
889	0.00	0.01	0.12	0.13	5.821	325.39
914	0.00	0.00	0.12	0.12	5.945	325.41
940	0.00	0.00	0.12	0.12	6.067	325.44
965	0.00	0.00	0.12	0.12	6.188	325.47
991	0.00	0.00	0.12	0.12	6.310	325.49
1016	0.00	0.00	0.12	0.12	6.432	325.52
1041	0.00	0.00	0.12	0.12	6.554	325.54
1067	0.00	0.00	0.12	0.12	6.675	325.57

Vortex Valve Flow Control

Location MH
Inv. 324.53

MIDUSS STAGE STORAGE DISCHARGE CURVE			
Head	Stage	Discharge	Storage
(m)	(meters)	(cubic meters per second)	(cubic meters)
0.00	324.53	0	0.12
0.03	324.55	0.000217	0.24
0.05	324.58	0.000773	0.37
0.08	324.60	0.00179	0.49
0.10	324.63	0.002296	0.61
0.13	324.65	0.002622	0.73
0.15	324.68	0.002726	0.93
0.18	324.70	0.002806	1.12
0.20	324.73	0.002893	1.32
0.23	324.75	0.002933	1.51
0.25	324.78	0.002962	1.71
0.28	324.80	0.002987	1.90
0.30	324.83	0.002996	2.09
0.33	324.86	0.002998	2.29
0.36	324.88	0.002995	2.48
0.38	324.91	0.002987	2.66
0.41	324.93	0.002971	2.85
0.43	324.96	0.002957	3.04
0.46	324.98	0.002931	3.22
0.48	325.01	0.002909	3.41
0.51	325.03	0.002883	3.59
0.53	325.06	0.002834	3.77
0.56	325.08	0.002793	3.94
0.58	325.11	0.002715	4.12
0.61	325.14	0.002651	4.29
0.63	325.16	0.002574	4.46
0.66	325.19	0.002435	4.63
0.69	325.21	0.002458	4.80
0.71	325.24	0.002509	4.96
0.74	325.26	0.002543	5.12
0.76	325.29	0.002576	5.27
0.79	325.31	0.002625	5.42
0.81	325.34	0.002657	5.56
0.84	325.36	0.002705	5.69
0.86	325.39	0.002736	5.82
0.89	325.41	0.002766	5.94
0.91	325.44	0.002812	6.07
0.94	325.47	0.002841	6.19
0.97	325.49	0.002885	6.31
0.99	325.52	0.002914	6.43
1.02	325.54	0.002943	6.55
1.04	325.57	0.002985	6.68

Original Se Hydro International

Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0	0	0.583	2.715
0.011	0.057	0.594	2.685
0.021	0.217	0.605	2.651
0.032	0.463	0.615	2.614
0.042	0.773	0.626	2.574
0.053	1.121	0.636	2.531
0.064	1.475	0.647	2.484
0.074	1.79	0.658	2.435
0.085	2.058	0.668	2.44
0.095	2.296	0.679	2.458
0.106	2.489	0.689	2.475
0.117	2.56	0.7	2.492
0.127	2.622	0.711	2.509
0.138	2.677	0.721	2.526
0.148	2.726	0.732	2.543
0.159	2.769	0.742	2.56
0.17	2.806	0.753	2.576
0.18	2.839	0.764	2.593
0.191	2.868	0.774	2.609
0.202	2.893	0.785	2.625
0.212	2.915	0.795	2.641
0.223	2.933	0.806	2.657
0.233	2.949	0.817	2.673
0.244	2.962	0.827	2.689
0.255	2.972	0.838	2.705
0.265	2.981	0.848	2.72
0.276	2.987	0.859	2.736
0.286	2.992	0.87	2.751
0.297	2.996	0.88	2.766
0.308	2.998	0.891	2.782
0.318	2.999	0.902	2.797
0.329	2.998	0.912	2.812
0.339	2.997	0.923	2.826
0.35	2.995	0.933	2.841
0.361	2.991	0.944	2.856
0.371	2.987	0.955	2.871
0.382	2.983	0.965	2.885
0.392	2.977	0.976	2.9
0.403	2.971	0.986	2.914
0.414	2.965	0.997	2.928
0.424	2.957	1.008	2.943
0.435	2.949	1.018	2.957
0.445	2.94	1.029	2.971
0.456	2.931	1.039	2.985
0.467	2.92	1.05	2.999
0.477	2.909	1.071	3.025
0.488	2.897	1.092	3.051
0.498	2.883	1.113	3.077
0.509	2.868	1.134	3.103
0.52	2.852	1.155	3.13
0.53	2.834	1.176	3.156
0.541	2.814	1.197	3.182
0.552	2.793	1.218	3.208
0.562	2.769	1.239	3.234
0.573	2.744	1.26	3.26

**Hydraulic modeling data for
SHE-0082-3000-1050-3000
Hydro-Brake® Optimum**

Site 18-20 Hickory
Ref 1

**TECHNICAL
SPECIFICATION**

	Head (m)	Flow (l/s)
Design	1.05	3
Flush-FloT	0.32	2.999
Kick-Flo®	0.658	2.424
Mean Flow over head		2.632

Minimum Clearance (m) 0.0053

Guides to modeling the Hydro-Brake® Optimum
using a number of commercial modeling packages
are available from Hydro International

Sandra Swartz 3/8/2024 1:37 PM

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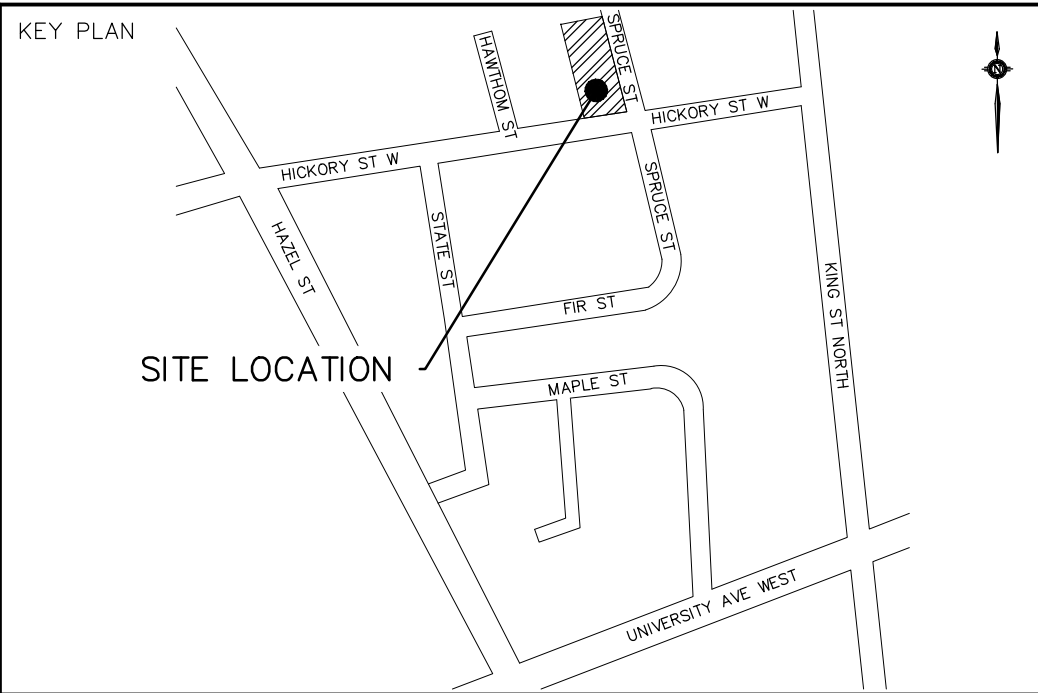
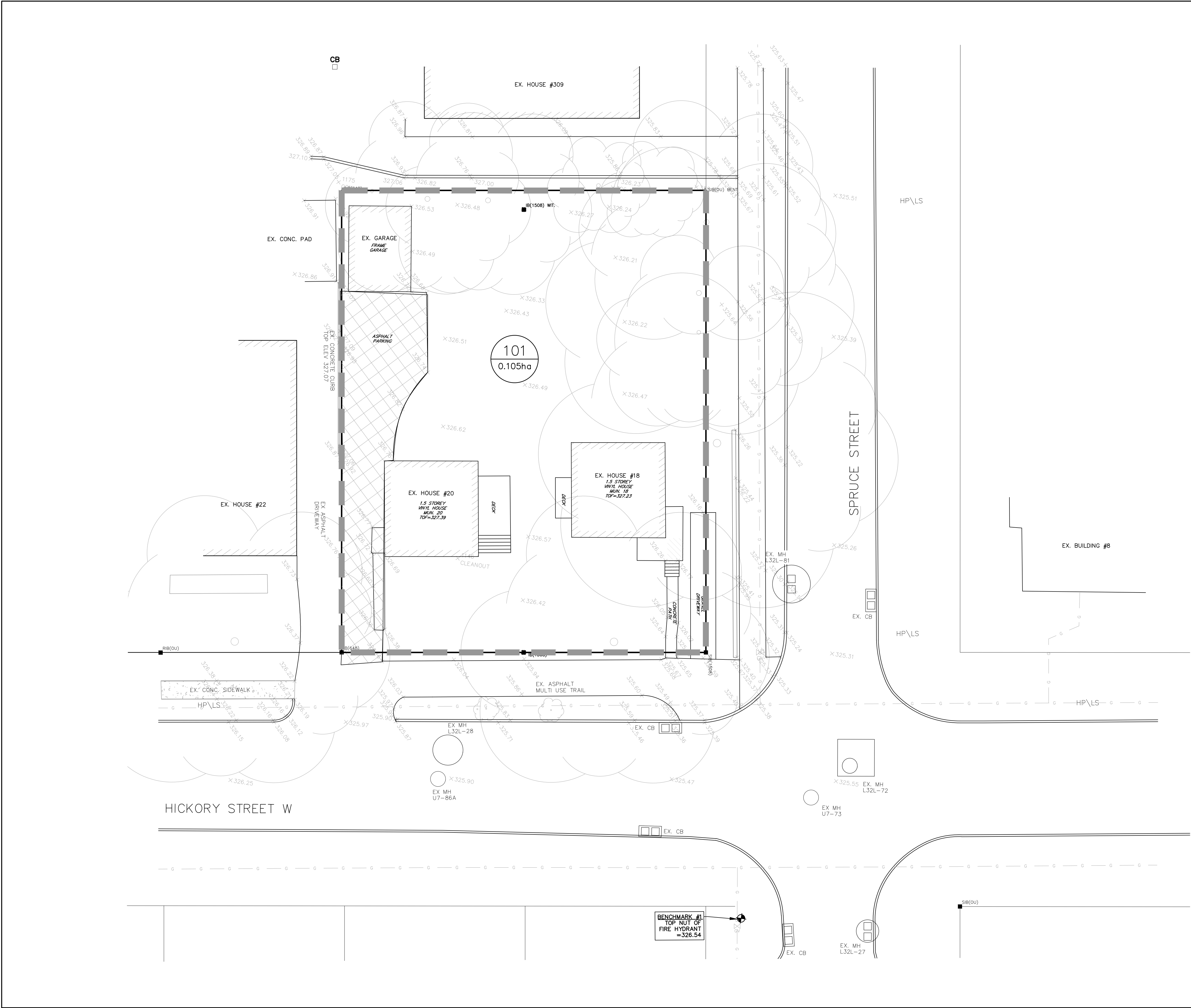
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APPENDIX D

MIDUSS Modeling Output

Existing Conditions

2 Year Storm
5 Year Storm
100 Year Storm



NOTES:

101
0.000ha

EXISTING CATCHMENT AREA I.D.
CATCHMENT AREA

■■■■■ CATCHMENT AREA BOUNDARY

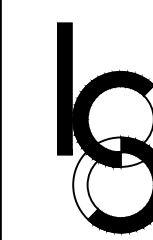
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— G — G —

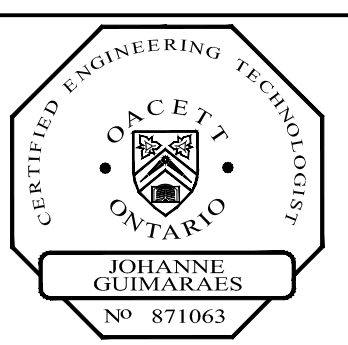
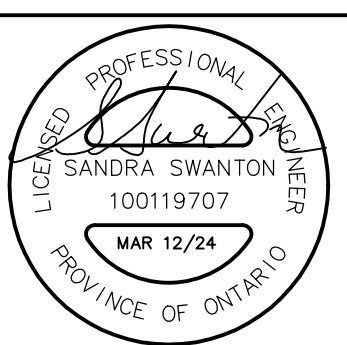
SITE BENCHMARK
ELEVATIONS ARE GEODETIC AND ARE DERIVED FROM GPS OBSERVATION (RTK CAN-NET HT2).
BM #1 TOP NUT OF FIRE HYDRANT ELEV. 326.54

No.	REVISIONS	BY	DATE
	CONSTRUCTION		
	TENDER		
	ISSUE FOR APPROVALS		
	ISSUE BLOCK		

HICKORY DEVELOPMENT
18 & 20 HICKORY STREET WEST
REGION OF WATERLOO CITY OF WATERLOO

EXISTING CATCHMENT AREA PLAN

 **K. SMART ASSOCIATES LIMITED**
CONSULTING ENGINEERS AND PLANNERS
KITCHENER SUDBURY



DESIGNED BY: J.G. 0 3 6 DATE: MAR. 12, 2024
CHECKED BY: S.S. SCALE: 1:150
DRAWN BY: T.B. REVISION No.
CHECKED BY: J.G.
FILE No. 23-218

SHEET
1 OF 2

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"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10 Units used:              ie METRIC"
"          Job folder:                 C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Existing 2 Year Run 2.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:48:20 AM"
" 31          TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32          STORM Chicago storm"
"          1 Chicago storm"
"          1101.000 Coefficient A"
"          9.258 Constant B"
"          0.882 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity           105.659 mm/hr"
"          Total depth                 32.400 mm"
"          6 002hyd Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          101 Site Area to Ex MH L32L-72"
"          35.000 % Impervious"
"          0.105 Total Area"
"          5.000 Flow length"
"          3.000 Overland Slope"
"          0.068 Pervious Area"
"          5.000 Pervious length"
"          3.000 Pervious slope"
"          0.037 Impervious Area"
"          5.000 Impervious length"
"          3.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          75.000 Pervious SCS Curve No."
"          0.162 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.467 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.789 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"

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"          0.009 0.000 0.000 0.000 c.m/sec"
"          Catchment 101 Pervious Impervious Total Area "
"          Surface Area 0.068 0.037 0.105 hectare"
"          Time of concentration 8.464 0.679 2.832 minutes"
"          Time to Centroid 109.983 87.679 93.847 minutes"
"          Rainfall depth 32.400 32.400 32.400 mm"
"          Rainfall volume 22.11 11.91 34.02 c.m"
"          Rainfall losses 27.140 6.843 20.036 mm"
"          Runoff depth 5.260 25.558 12.364 mm"
"          Runoff volume 3.59 9.39 12.98 c.m"
"          Runoff coefficient 0.162 0.789 0.382 "
"          Maximum flow 0.002 0.009 0.009 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.009 0.009 0.000 0.000"
" 40          HYDROGRAPH Copy to Outflow"
"          8 Copy to Outflow"
"          0.009 0.009 0.009 0.000"
" 38          START/RE-START TOTALS 101"
"          3 Runoff Totals on EXIT"
"          Total Catchment area 0.105 hectare"
"          Total Impervious area 0.037 hectare"
"          Total % impervious 35.000"
" 19          EXIT"

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"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10 Units used:              ie METRIC"
"          Job folder:                  C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Existing 5 Year Run 2.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:49:13 AM"
" 31          TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32          STORM Chicago storm"
"          1 Chicago storm"
"          1755.000 Coefficient A"
"          12.347 Constant B"
"          0.895 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity            136.512 mm/hr"
"          Total depth                  47.549 mm"
"          6 005hyd Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          101 Site Area to Ex MH L32L-72"
"          35.000 % Impervious"
"          0.105 Total Area"
"          5.000 Flow length"
"          3.000 Overland Slope"
"          0.068 Pervious Area"
"          5.000 Pervious length"
"          3.000 Pervious slope"
"          0.037 Impervious Area"
"          5.000 Impervious length"
"          3.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          75.000 Pervious SCS Curve No."
"          0.258 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.467 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.819 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"

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"          0.013 0.000 0.000 0.000 c.m/sec"
"          Catchment 101 Pervious Impervious Total Area "
"          Surface Area 0.068 0.037 0.105 hectare"
"          Time of concentration 5.812 0.603 2.524 minutes"
"          Time to Centroid 105.039 87.108 93.721 minutes"
"          Rainfall depth 47.549 47.549 47.549 mm"
"          Rainfall volume 32.45 17.47 49.93 c.m"
"          Rainfall losses 35.298 8.606 25.956 mm"
"          Runoff depth 12.251 38.943 21.593 mm"
"          Runoff volume 8.36 14.31 22.67 c.m"
"          Runoff coefficient 0.258 0.819 0.454 "
"          Maximum flow 0.004 0.012 0.013 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.013 0.013 0.000 0.000"
" 40          HYDROGRAPH Copy to Outflow"
"          8 Copy to Outflow"
"          0.013 0.013 0.013 0.000"
" 38          START/RE-START TOTALS 101"
"          3 Runoff Totals on EXIT"
"          Total Catchment area 0.105 hectare"
"          Total Impervious area 0.037 hectare"
"          Total % impervious 35.000"
" 19          EXIT"

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"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10  Units used:              ie METRIC"
"          Job folder:                  C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Existing 100 Year Run 2.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:50:13 AM"
" 31    TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32    STORM Chicago storm"
"          1      Chicago storm"
"          4692.000 Coefficient A"
"          17.437  Constant B"
"          0.956   Exponent C"
"          0.400   Fraction R"
"          180.000 Duration"
"          1.000   Time step multiplier"
"          Maximum intensity            239.793  mm/hr"
"          Total depth                  89.960  mm"
"          6  100hyd Hydrograph extension used in this file"
" 33    CATCHMENT 101"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          101    Site Area to Ex MH L32L-72"
"          35.000 % Impervious"
"          0.105  Total Area"
"          5.000  Flow length"
"          3.000  Overland Slope"
"          0.068  Pervious Area"
"          5.000  Pervious length"
"          3.000  Pervious slope"
"          0.037  Impervious Area"
"          5.000  Impervious length"
"          3.000  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          75.000 Pervious SCS Curve No."
"          0.434  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          8.467  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.836  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"

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"          0.033  0.000  0.000  0.000 c.m/sec"
"          Catchment 101      Pervious  Impervious Total Area "
"          Surface Area      0.068    0.037    0.105  hectare"
"          Time of concentration 3.530    0.475    1.975  minutes"
"          Time to Centroid    97.737    85.064    91.284  minutes"
"          Rainfall depth      89.960    89.960    89.960  mm"
"          Rainfall volume     61.40     33.06     94.46   c.m"
"          Rainfall losses     50.931    14.761    38.272  mm"
"          Runoff depth        39.029    75.199    51.688  mm"
"          Runoff volume       26.64     27.64     54.27   c.m"
"          Runoff coefficient   0.434     0.836     0.575   "
"          Maximum flow        0.018     0.021     0.033   c.m/sec"
" 40    HYDROGRAPH Add Runoff "
" 4      Add Runoff "
"          0.033  0.033  0.000  0.000"
" 40    HYDROGRAPH Copy to Outflow"
" 8      Copy to Outflow"
"          0.033  0.033  0.033  0.000"
" 38    START/RE-START TOTALS 101"
" 3      Runoff Totals on EXIT"
"          Total Catchment area              0.105  hectare"
"          Total Impervious area              0.037  hectare"
"          Total % impervious                35.000"
" 19    EXIT"

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Proposed Conditions

2 Year Storm
5 Year Storm
100 Year Storm

1. GENERAL

THIS PLAN IS TO BE READ IN CONJUNCTION WITH THE EXISTING CONDITIONS PLAN, SERVICING PLAN, LANDSCAPE PLAN AND STORM WATER MANAGEMENT REPORT.

THIS PLAN IS TO BE USED FOR GRADING ONLY; ANY OTHER INFORMATION SHOWN IS FOR ILLUSTRATION PURPOSES ONLY. THIS PLAN MUST NOT BE USED TO SITE THE PROPOSED BUILDING.

NO CHANGES ARE TO BE MADE WITHOUT NOTIFICATION TO THE CITY OF WATERLOO PROJECT
MANAGER AND THE APPROVAL OF THE DESIGN ENGINEER.

ENGINEERING ACCEPTANCE OF THIS PLAN DOES NOT EXEMPT THE OWNER'S BONDED CONTRACTOR FROM THE REQUIREMENTS TO OBTAIN THE VARIOUS PERMITS AND ADDITIONAL APPROVALS REQUIRED TO COMPLETE THE PROJECT.

THIS PLAN NOT TO BE REPRODUCED IN WHOLE OR IN PART WITHOUT THE PERMISSION OF K. SMART ASSOCIATES LIMITED.

PRIOR TO CONSTRUCTION, THE CONTRACTOR MUST:

CHECK AND VERIFY ALL EXISTING CONDITIONS, LOCATIONS AND ELEVATIONS WHICH INCLUDES BUT IS NOT LIMITED TO THE BENCHMARK ELEVATIONS, EXISTING SERVICE CONNECTIONS AND EXISTING INVERTS. REPORT ALL DISCREPANCIES TO THE ENGINEER PRIOR TO PROCEEDING.

THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN. THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

OBTAIN ALL UTILITY LOCATES AND REQUIRED PERMITS AND LICENSES. REFER TO BY-LAW 09-111 'THE CITY OF WATERLOO WORK PERMIT'

VERIFY THAT THE FINISHED FLOOR ELEVATIONS (WHICH MAY APPEAR ON THIS PLAN) COMPLY WITH THE FINAL ARCHITECTURAL DRAWINGS.

CONFIRM ALL DRAWINGS USED FOR CONSTRUCTION ARE OF THE MOST RECENT REVISION.

CONTRACTOR IS RESPONSIBLE FOR RESTORING ALL AFFECTED PROPERTY TO ORIGINAL CONDITIONS AT OWNER'S EXPENSE.

ALL SERVICE CONNECTIONS TO THE PROPERTY LINE MUST BE INSTALLED WITHIN THE RIGHT-OF-WAY TO CITY'S SATISFACTION PRIOR TO ANY INTERNAL SERVICING WORKS

ALL UNDERGROUND SERVICES ARE TO BE CONSTRUCTED IN FULL COMPLIANCE WITH THE ONTARIO BUILDING CODE (PART 7, PLUMBING), THE ONTARIO PROVINCIAL STANDARD SPECIFICATIONS (OPSS) AND IN COMPLIANCE WITH LOCAL APPLICABLE CODES AND REGULATIONS; WHICH CODES AND REGULATIONS SHALL SUPERSEDE ALL OTHERS.

CONTRACTOR IS RESPONSIBLE FOR CONTACTING ENGINEER 48 HOURS PRIOR TO COMMENCING WORK TO ARRANGE FOR INSPECTION, ENGINEER TO DETERMINE DEGREE OF INSPECTION AND TESTING REQUIRED FOR CERTIFICATION OF UNDERGROUND SERVICE INSTALLATION AS MANDATED BY ONTARIO BUILDING CODE SECTION 2.3.2. FAILURE TO NOTIFY ENGINEER WILL RESULT IN EXTENSIVE POST CONSTRUCTION INSPECTION AT CONTRACTOR'S EXPENSE.

NO WORK SHALL BE COMPLETED ON THE SUBJECT PROPERTY WITHOUT A BUILDING PERMIT, INCLUDING PRE-GRADING OR TREE REMOVAL. SHOULD THE DEVELOPER OR CONTRACTOR WISH TO PREPARE THE SITE FOR CONSTRUCTION PRIOR TO ENGINEERING ACCEPTANCE OR ISSUANCE OF THE BUILDING PERMIT, AN APPLICATION FOR A SITE ALTERATION PERMIT SHALL BE SUBMITTED TO THE ENGINEERING AND CONSTRUCTION DIVISION FOR REVIEW AND APPROVAL.

IF, FOR UNFORESEEN REASONS, THE OWNER AND/OR HIS/HER REPRESENTATIVE MUST ENCROACH ON PRIVATE LAND TO UNDERTAKE ANY WORK, HE/SHE MUST OBTAIN WRITTEN PERMISSION FROM THE PROPERTY OWNER. COPIES OF THESE LETTERS OF CONSENT MUST BE SUBMITTED TO THE ENGINEERING AND CONSTRUCTION DIVISION PRIOR TO ANY WORK BEING PERFORMED. THE CITY OF WATERLOO DOES NOT PERMIT THE USE OF ANY ADJACENT PROPERTY FOR THE USE OF CONSTRUCTION.

SITE PLAN INFORMATION PROVIDED BY KOZLOWSKI ARCHITECT.

LEGAL INFORMATION OBTAINED FROM MCKECHNIE SURVEYING.

REFER TO BY-LAW 08-077 'THE CITY OF WATERLOO TRAFFIC AND PARKING BY-LAW'

CONTRACTOR TO INSTALL EROSION CONTROL MEASURES AS SHOWN PRIOR TO CONSTRUCTION AND MAINTAIN IN GOOD CONDITION UNTIL CONSTRUCTION IS COMPLETED AND VEGETATIVE COVER IS ESTABLISHED.

SITE SERVICING CONTRACTOR TO TERMINATE ALL SERVICES 1.0 METRE FROM FOUNDATION WALL.

FILTER FABRIC TO BE TERRAFIX 200R OR APPROVED EQUIVALENT.

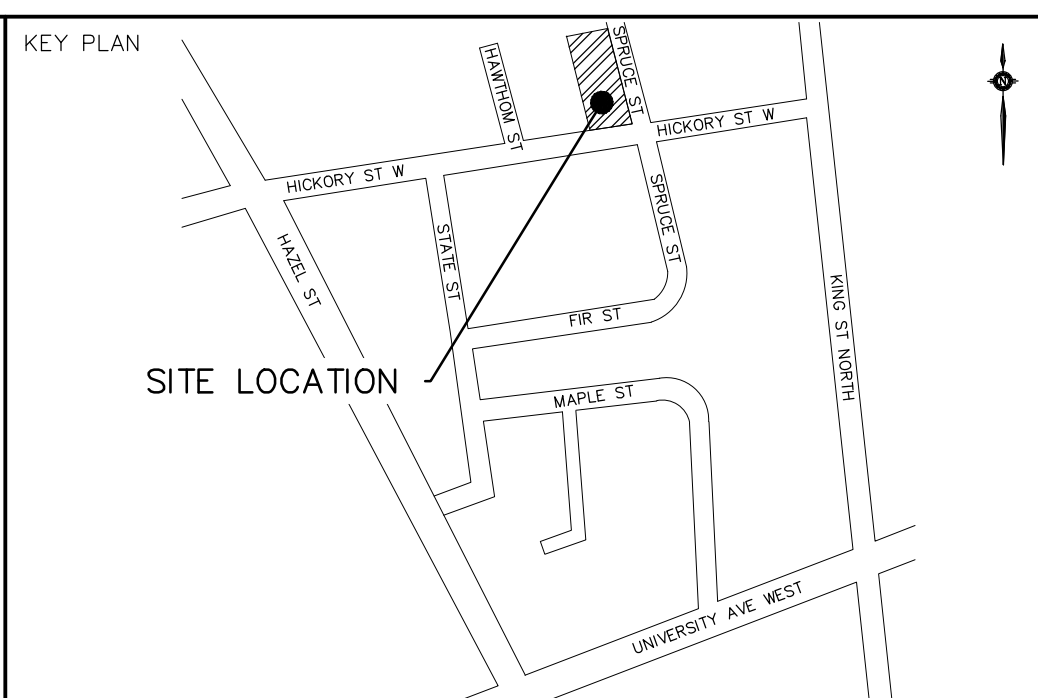
GRASS SLOPES SHALL BE 4:1 WHEN POSSIBLE. MAXIMUM GRASSED SLOPE TO BE 3:1.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD INCLUDING THE SUPPLY, INSTALLATION AND REMOVAL OF ALL NECESSARY SIGNALS, DELINEATORS, MARKERS AND BARRIERS. ALL SIGNS, ETC. SHALL CONFORM TO THE STANDARDS OF THE LOCAL MUNICIPALITY AND THE MTO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.

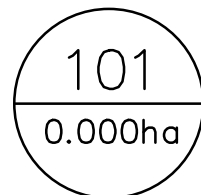
CONTRACTOR TO MAINTAIN SAFE WORKING CONDITIONS IN ALL EXCAVATIONS AND TRENCHES IN ACCORDANCE WITH THE CURRENT MINISTRY OF LABOUR REGULATIONS.

THE DEVELOPMENT WILL BE SUBJECT TO ALL INSPECTION REQUIREMENTS:
ROB NOLAN: 519-747-8517 FOR PRIVATE

BENCHMARK #1
TOP NUT OF
FIRE HYDRANT
= 326.54



NOTES:



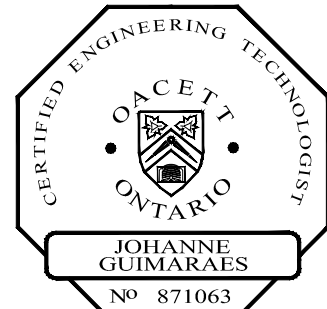
PROPOSED CATCHMENT AREA I.D.
CATCHMENT AREA

CATCHMENT AREA BOUNDARY

No.	REVISIONS	BY	DATE
	CONSTRUCTION		
	TENDER		
	ISSUE FOR APPROVALS		
	ISSUE BLOCK		

HICKORY DEVELOPMENT
18 & 20 HICKORY STREET WEST
REGION OF WATERLOO CITY OF WATERLOO

**PROPOSED CATCHMENT AREA
PLAN**



DESIGNED BY: JG	0 3 6	DATE: APRIL 5, 2024
CHECKED BY: SS		
DRAWN BY: JG	SCALE: 1:150	
CHECKED BY: SS		
FILE No. 23-218	REVISION No.	
		SHEET 2 OF 2

```

"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10  Units used:              ie METRIC"
"          Job folder:                 C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Proposed 2 Year Run 3.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:53:32 AM"
" 31    TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32    STORM Chicago storm"
"          1      Chicago storm"
"          1101.000 Coefficient A"
"          9.258   Constant B"
"          0.882   Exponent C"
"          0.400   Fraction R"
"          180.000 Duration"
"          1.000   Time step multiplier"
"          Maximum intensity            105.659   mm/hr"
"          Total depth                  32.400   mm"
"          6  002hyd Hydrograph extension used in this file"
" 33    CATCHMENT 201"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          201    Rooftop Areas to Underground Storage"
"          100.000 % Impervious"
"          0.020   Total Area"
"          10.000   Flow length"
"          1.000   Overland Slope"
"          0.000   Pervious Area"
"          10.000   Pervious length"
"          1.000   Pervious slope"
"          0.020   Impervious Area"
"          10.000   Impervious length"
"          1.000   Impervious slope"
"          0.250   Pervious Manning 'n'"
"          75.000   Pervious SCS Curve No."
"          0.000   Pervious Runoff coefficient"
"          0.100   Pervious Ia/S coefficient"
"          8.467   Pervious Initial abstraction"
"          0.015   Impervious Manning 'n'"
"          98.000   Impervious SCS Curve No."
"          0.833   Impervious Runoff coefficient"
"          0.100   Impervious Ia/S coefficient"
"          0.518   Impervious Initial abstraction"

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"          0.004   0.000   0.000   0.000 c.m/sec"
"          Catchment 201      Pervious   Impervious Total Area "
"          Surface Area      0.000      0.020      0.020   hectare"
"          Time of concentration 17.838      1.431      1.431   minutes"
"          Time to Centroid    120.976      88.398      88.398   minutes"
"          Rainfall depth      32.400      32.400      32.400   mm"
"          Rainfall volume      0.00      6.48      6.48   c.m"
"          Rainfall losses      27.131      5.418      5.418   mm"
"          Runoff depth         5.270      26.983      26.983   mm"
"          Runoff volume        0.00      5.40      5.40   c.m"
"          Runoff coefficient    0.000      0.833      0.833   "
"          Maximum flow         0.000      0.004      0.004   c.m/sec"
" 40    HYDROGRAPH Add Runoff "
"          4  Add Runoff "
"          0.004   0.004   0.000   0.000"
" 54    POND DESIGN"
"          0.004   Current peak flow   c.m/sec"
"          0.005   Target outflow       c.m/sec"
"          5.4     Hydrograph volume    c.m"
"          41.     Number of stages"
"          0.000   Minimum water level  metre"
"          3.000   Maximum water level  metre"
"          0.000   Starting water level metre"
"          0       Keep Design Data: 1 = True; 0 = False"
"          Level Discharge Volume"
"          324.550  0.00022  0.2400"
"          324.580  0.00077  0.3700"
"          324.600  0.00179  0.4900"
"          324.630  0.00230  0.6100"
"          324.650  0.00262  0.7300"
"          324.680  0.00273  0.9300"
"          324.700  0.00281  1.120"
"          324.730  0.00289  1.320"
"          324.750  0.00293  1.510"
"          324.780  0.00296  1.710"
"          324.800  0.00299  1.900"
"          324.830  0.00300  2.090"
"          324.860  0.00300  2.290"
"          324.880  0.00299  2.480"
"          324.910  0.00299  2.660"
"          324.930  0.00297  2.850"
"          324.960  0.00296  3.040"
"          324.980  0.00293  3.220"
"          325.010  0.00291  3.410"
"          325.030  0.00288  3.590"
"          325.060  0.00283  3.770"
"          325.080  0.00279  3.940"
"          325.110  0.00271  4.120"
"          325.140  0.00265  4.290"
"          325.160  0.00257  4.460"

```

"	325.190	0.00243	4.630"	
"	325.210	0.00246	4.800"	
"	325.240	0.00251	4.960"	
"	325.260	0.00254	5.120"	
"	325.290	0.00258	5.270"	
"	325.310	0.00262	5.420"	
"	325.340	0.00266	5.560"	
"	325.360	0.00271	5.690"	
"	325.390	0.00274	5.820"	
"	325.410	0.00277	5.940"	
"	325.440	0.00281	6.070"	
"	325.470	0.00284	6.190"	
"	325.490	0.00289	6.310"	
"	325.520	0.00291	6.430"	
"	325.540	0.00294	6.550"	
"	325.570	0.00298	6.680"	
"	Peak outflow	0.003	c.m/sec"	
"	Maximum level	324.695	metre"	
"	Maximum storage	1.070	c.m"	
"	Centroidal lag	1.581	hours"	
"	0.004	0.004	0.003	0.000 c.m/sec"
" 40	HYDROGRAPH Combine	1"		
"	6 Combine "			
"	1 Node #"			
"	Ex MH L32L-72"			
"	Maximum flow	0.003	c.m/sec"	
"	Hydrograph volume	5.380	c.m"	
"	0.004	0.004	0.003	0.003"
" 40	HYDROGRAPH Start - New Tributary"			
"	2 Start - New Tributary"			
"	0.004	0.000	0.003	0.003"
" 33	CATCHMENT 202"			
"	1 Triangular SCS"			
"	1 Equal length"			
"	1 SCS method"			
"	202 Parking Areas to CB1"			
"	85.000 % Impervious"			
"	0.058 Total Area"			
"	10.000 Flow length"			
"	2.400 Overland Slope"			
"	0.009 Pervious Area"			
"	10.000 Pervious length"			
"	2.400 Pervious slope"			
"	0.049 Impervious Area"			
"	10.000 Impervious length"			
"	2.400 Impervious slope"			
"	0.250 Pervious Manning 'n'"			
"	75.000 Pervious SCS Curve No."			
"	0.162 Pervious Runoff coefficient"			
"	0.100 Pervious Ia/S coefficient"			

"	8.467	Pervious Initial abstraction"		
"	0.015	Impervious Manning 'n'"		
"	98.000	Impervious SCS Curve No."		
"	0.823	Impervious Runoff coefficient"		
"	0.100	Impervious Ia/S coefficient"		
"	0.518	Impervious Initial abstraction"		
"	0.011	0.000	0.003	0.003 c.m/sec"
"	Catchment 202	Pervious	Impervious	Total Area "
"	Surface Area	0.009	0.049	0.058 hectare"
"	Time of concentration	13.717	1.100	1.525 minutes"
"	Time to Centroid	116.169	88.019	88.965 minutes"
"	Rainfall depth	32.400	32.400	32.400 mm"
"	Rainfall volume	2.82	15.97	18.79 c.m"
"	Rainfall losses	27.138	5.723	8.935 mm"
"	Runoff depth	5.262	26.678	23.465 mm"
"	Runoff volume	0.46	13.15	13.61 c.m"
"	Runoff coefficient	0.162	0.823	0.724 "
"	Maximum flow	0.000	0.011	0.011 c.m/sec"
" 40	HYDROGRAPH Add Runoff "			
"	4 Add Runoff "			
"	0.011	0.011	0.003	0.003"
" 54	POND DESIGN"			
"	0.011	Current peak flow	c.m/sec"	
"	0.006	Target outflow	c.m/sec"	
"	13.6	Hydrograph volume	c.m"	
"	21.	Number of stages"		
"	326.220	Minimum water level	metre"	
"	326.550	Maximum water level	metre"	
"	326.220	Starting water level	metre"	
"	0	Keep Design Data: 1 = True; 0 = False"		
"	Level Discharge	Volume"		
"	326.220	0.000	0.000"	
"	326.237	0.00081	0.00612"	
"	326.253	0.00218	0.01188"	
"	326.270	0.00277	0.01800"	
"	326.286	0.00318	0.02376"	
"	326.302	0.00354	0.02952"	
"	326.319	0.00389	0.03564"	
"	326.336	0.00421	0.04176"	
"	326.352	0.00449	0.04752"	
"	326.368	0.00475	0.05328"	
"	326.385	0.00502	0.06078"	
"	326.401	0.00526	0.1137"	
"	326.418	0.00550	0.2757"	
"	326.434	0.00571	0.5793"	
"	326.451	0.00594	1.119"	
"	326.467	0.00614	1.884"	
"	326.484	0.00634	3.025"	
"	326.500	0.00653	4.458"	
"	326.517	0.01568	6.421"	

```

"          326.533  0.03657  8.733"
"          326.550  0.07326  11.742"
"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie breadth sideslope sideslope"
"          326.500   0.900   2.000   50.000   50.000"
"
"      1.  HOR. ORIFICES"
"          Orifice  Orifice  Orifice Number of"
"          invert  coefficie diameter orifices"
"          326.220   0.630   0.0750   1.000"
"
"      1.  LAYERS"
"          Bottom      Aspect      Bottom      Top      Average"
"          area      ratio  elevation elevation sideslope"
"          0.360   1.000   326.220   326.370   0.000"
"
"      4.  WEDGES"
"          Wedge      Grade 1      Grade 2      Angle      Number"
"          invert      g1H:1V      g2H:1V      subtended of wedges"
"          326.370   33.000   33.000   90.000   1.000"
"          326.370   33.000   83.000   90.000   1.000"
"          326.370   83.000   33.000   90.000   1.000"
"          326.370   33.000   33.000   90.000   1.000"
"
"      Peak outflow              0.006      c.m/sec"
"      Maximum level              326.466      metre"
"      Maximum storage              1.858      c.m"
"      Centroidal lag              1.517      hours"
"
"          0.011   0.011   0.006   0.003 c.m/sec"
"
" 40  HYDROGRAPH Combine 1"
"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"          Maximum flow              0.009      c.m/sec"
"          Hydrograph volume              19.010      c.m"
"          0.011   0.011   0.006   0.009"
"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.011   0.000   0.006   0.009"
"
" 33  CATCHMENT 203"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      203  Landscaped Areas to Ex MH L32L-28"
"
" 20.000 % Impervious"
"      0.027  Total Area"
"      2.000  Flow length"
"      2.000  Overland Slope"
"      0.022  Pervious Area"
"      2.000  Pervious length"
"      2.000  Pervious slope"
"      0.005  Impervious Area"
"      2.000  Impervious length"

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"      2.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      75.000  Pervious SCS Curve No."
"      0.162  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      8.467  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.753  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"          0.001   0.000   0.006   0.009 c.m/sec"
"
"      Catchment 203      Pervious      Impervious Total Area "
"      Surface Area              0.022   0.005   0.027      hectare"
"      Time of concentration      5.516   0.442   2.786      minutes"
"      Time to Centroid      106.610   87.586   96.372      minutes"
"      Rainfall depth              32.400   32.400   32.400      mm"
"      Rainfall volume              7.00   1.75   8.75      c.m"
"      Rainfall losses              27.162   7.988   23.327      mm"
"      Runoff depth              5.238   24.412   9.073      mm"
"      Runoff volume              1.13   1.32   2.45      c.m"
"      Runoff coefficient      0.162   0.753   0.280      "
"      Maximum flow              0.001   0.001   0.001      c.m/sec"
"
" 40  HYDROGRAPH Add Runoff "
"      4  Add Runoff "
"          0.001   0.001   0.006   0.009"
"
" 40  HYDROGRAPH Copy to Outflow"
"      8  Copy to Outflow"
"          0.001   0.001   0.001   0.009"
"
" 40  HYDROGRAPH Combine 1"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"          Maximum flow              0.010      c.m/sec"
"          Hydrograph volume              21.460      c.m"
"          0.001   0.001   0.001   0.010"
"
" 38  START/RE-START TOTALS 203"
"      3  Runoff Totals on EXIT"
"      Total Catchment area              0.105      hectare"
"      Total Impervious area              0.075      hectare"
"      Total % impervious              71.143"
"
" 19  EXIT"

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"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10 Units used:              ie METRIC"
"          Job folder:                  C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Proposed 5 Year Run 3.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:55:34 AM"
" 31      TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"          1 Chicago storm"
"          1755.000 Coefficient A"
"          12.347 Constant B"
"          0.895 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity            136.512 mm/hr"
"          Total depth                  47.549 mm"
"          6 005hyd Hydrograph extension used in this file"
" 33      CATCHMENT 201"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          201 Rooftop Areas to Underground Storage"
"          100.000 % Impervious"
"          0.020 Total Area"
"          10.000 Flow length"
"          1.000 Overland Slope"
"          0.000 Pervious Area"
"          10.000 Pervious length"
"          1.000 Pervious slope"
"          0.020 Impervious Area"
"          10.000 Impervious length"
"          1.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          75.000 Pervious SCS Curve No."
"          0.000 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.467 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.874 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"

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"          0.006 0.000 0.000 0.000 c.m/sec"
"          Catchment 201 Pervious Impervious Total Area "
"          Surface Area 0.000 0.020 0.020 hectare"
"          Time of concentration 12.248 1.271 1.271 minutes"
"          Time to Centroid 112.836 87.615 87.615 minutes"
"          Rainfall depth 47.549 47.549 47.549 mm"
"          Rainfall volume 0.00 9.51 9.51 c.m"
"          Rainfall losses 35.250 5.997 5.997 mm"
"          Runoff depth 12.299 41.552 41.552 mm"
"          Runoff volume 0.00 8.31 8.31 c.m"
"          Runoff coefficient 0.000 0.874 0.874 "
"          Maximum flow 0.000 0.006 0.006 c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.006 0.006 0.000 0.000"
" 54      POND DESIGN"
"          0.006 Current peak flow c.m/sec"
"          0.005 Target outflow c.m/sec"
"          8.3 Hydrograph volume c.m"
"          41. Number of stages"
"          0.000 Minimum water level metre"
"          3.000 Maximum water level metre"
"          0.000 Starting water level metre"
"          0 Keep Design Data: 1 = True; 0 = False"
"          Level Discharge Volume"
"          324.550 0.00022 0.2400"
"          324.580 0.00077 0.3700"
"          324.600 0.00179 0.4900"
"          324.630 0.00230 0.6100"
"          324.650 0.00262 0.7300"
"          324.680 0.00273 0.9300"
"          324.700 0.00281 1.120"
"          324.730 0.00289 1.320"
"          324.750 0.00293 1.510"
"          324.780 0.00296 1.710"
"          324.800 0.00299 1.900"
"          324.830 0.00300 2.090"
"          324.860 0.00300 2.290"
"          324.880 0.00299 2.480"
"          324.910 0.00299 2.660"
"          324.930 0.00297 2.850"
"          324.960 0.00296 3.040"
"          324.980 0.00293 3.220"
"          325.010 0.00291 3.410"
"          325.030 0.00288 3.590"
"          325.060 0.00283 3.770"
"          325.080 0.00279 3.940"
"          325.110 0.00271 4.120"
"          325.140 0.00265 4.290"
"          325.160 0.00257 4.460"

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"	325.190	0.00243	4.630"	
"	325.210	0.00246	4.800"	
"	325.240	0.00251	4.960"	
"	325.260	0.00254	5.120"	
"	325.290	0.00258	5.270"	
"	325.310	0.00262	5.420"	
"	325.340	0.00266	5.560"	
"	325.360	0.00271	5.690"	
"	325.390	0.00274	5.820"	
"	325.410	0.00277	5.940"	
"	325.440	0.00281	6.070"	
"	325.470	0.00284	6.190"	
"	325.490	0.00289	6.310"	
"	325.520	0.00291	6.430"	
"	325.540	0.00294	6.550"	
"	325.570	0.00298	6.680"	
"	Peak outflow	0.003	c.m/sec"	
"	Maximum level	324.815	metre"	
"	Maximum storage	1.995	c.m"	
"	Centroidal lag	1.593	hours"	
"	0.006	0.006	0.003	0.000 c.m/sec"
" 40	HYDROGRAPH Combine	1"		
"	6 Combine "			
"	1 Node #"			
"	Ex MH L32L-72"			
"	Maximum flow	0.003	c.m/sec"	
"	Hydrograph volume	8.312	c.m"	
"	0.006	0.006	0.003	0.003"
" 40	HYDROGRAPH Start - New Tributary"			
"	2 Start - New Tributary"			
"	0.006	0.000	0.003	0.003"
" 33	CATCHMENT 202"			
"	1 Triangular SCS"			
"	1 Equal length"			
"	1 SCS method"			
"	202 Parking Areas to CB1"			
"	85.000 % Impervious"			
"	0.058 Total Area"			
"	10.000 Flow length"			
"	2.400 Overland Slope"			
"	0.009 Pervious Area"			
"	10.000 Pervious length"			
"	2.400 Pervious slope"			
"	0.049 Impervious Area"			
"	10.000 Impervious length"			
"	2.400 Impervious slope"			
"	0.250 Pervious Manning 'n'"			
"	75.000 Pervious SCS Curve No."			
"	0.258 Pervious Runoff coefficient"			
"	0.100 Pervious Ia/S coefficient"			

"	8.467	Pervious Initial abstraction"		
"	0.015	Impervious Manning 'n'"		
"	98.000	Impervious SCS Curve No."		
"	0.860	Impervious Runoff coefficient"		
"	0.100	Impervious Ia/S coefficient"		
"	0.518	Impervious Initial abstraction"		
"	0.016	0.000	0.003	0.003 c.m/sec"
"	Catchment 202	Pervious	Impervious	Total Area "
"	Surface Area	0.009	0.049	0.058 hectare"
"	Time of concentration	9.419	0.978	1.402 minutes"
"	Time to Centroid	109.394	87.204	88.320 minutes"
"	Rainfall depth	47.549	47.549	47.549 mm"
"	Rainfall volume	4.14	23.44	27.58 c.m"
"	Rainfall losses	35.274	6.654	10.947 mm"
"	Runoff depth	12.275	40.895	36.602 mm"
"	Runoff volume	1.07	20.16	21.23 c.m"
"	Runoff coefficient	0.258	0.860	0.770 "
"	Maximum flow	0.001	0.016	0.016 c.m/sec"
" 40	HYDROGRAPH Add Runoff "			
"	4 Add Runoff "	0.016	0.016	0.003 0.003"
" 54	POND DESIGN"			
"	0.016 Current peak flow	c.m/sec"		
"	0.006 Target outflow	c.m/sec"		
"	21.2 Hydrograph volume	c.m"		
"	21. Number of stages"			
"	326.220 Minimum water level	metre"		
"	326.550 Maximum water level	metre"		
"	326.220 Starting water level	metre"		
"	0 Keep Design Data: 1 = True; 0 = False"			
"	Level Discharge	Volume"		
"	326.220	0.000	0.000"	
"	326.237	0.00081	0.00612"	
"	326.253	0.00218	0.01188"	
"	326.270	0.00277	0.01800"	
"	326.286	0.00318	0.02376"	
"	326.302	0.00354	0.02952"	
"	326.319	0.00389	0.03564"	
"	326.336	0.00421	0.04176"	
"	326.352	0.00449	0.04752"	
"	326.368	0.00475	0.05328"	
"	326.385	0.00502	0.06078"	
"	326.401	0.00526	0.1137"	
"	326.418	0.00550	0.2757"	
"	326.434	0.00571	0.5793"	
"	326.451	0.00594	1.119"	
"	326.467	0.00614	1.884"	
"	326.484	0.00634	3.025"	
"	326.500	0.00653	4.458"	
"	326.517	0.01568	6.421"	

```

"          326.533  0.03657  8.733"
"          326.550  0.07326  11.742"
"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie breadth sideslope sideslope"
"          326.500   0.900   2.000   50.000   50.000"
"
"      1.  HOR. ORIFICES"
"          Orifice  Orifice  Orifice Number of"
"          invert  coefficie diameter orifices"
"          326.220   0.630   0.0750   1.000"
"
"      1.  LAYERS"
"          Bottom      Aspect      Bottom      Top      Average"
"          area      ratio  elevation elevation sideslope"
"          0.360   1.000   326.220   326.370   0.000"
"
"      4.  WEDGES"
"          Wedge      Grade 1      Grade 2      Angle      Number"
"          invert      g1H:1V      g2H:1V      subtended of wedges"
"          326.370   33.000   33.000   90.000   1.000"
"          326.370   33.000   83.000   90.000   1.000"
"          326.370   83.000   33.000   90.000   1.000"
"          326.370   33.000   33.000   90.000   1.000"
"
"          Peak outflow              0.007      c.m/sec"
"          Maximum level              326.499      metre"
"          Maximum storage              4.396      c.m"
"          Centroidal lag              1.557      hours"
"
"          0.016   0.016   0.007   0.003 c.m/sec"
"
" 40  HYDROGRAPH Combine 1"
"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"          Maximum flow              0.010      c.m/sec"
"          Hydrograph volume              29.594      c.m"
"          0.016   0.016   0.007   0.010"
"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.016   0.000   0.007   0.010"
"
" 33  CATCHMENT 203"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      203 Landscaped Areas to Ex MH L32L-28"
"
" 20.000 % Impervious"
"      0.027 Total Area"
"      2.000 Flow length"
"      2.000 Overland Slope"
"      0.022 Pervious Area"
"      2.000 Pervious length"
"      2.000 Pervious slope"
"      0.005 Impervious Area"
"      2.000 Impervious length"

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```

"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.254 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.467 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.782 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.003   0.000   0.007   0.010 c.m/sec"
"          Catchment 203      Pervious      Impervious Total Area "
"          Surface Area              0.022   0.005   0.027      hectare"
"          Time of concentration      3.788   0.393   2.312      minutes"
"          Time to Centroid      102.699   86.775   95.777      minutes"
"          Rainfall depth              47.549   47.549   47.549      mm"
"          Rainfall volume              10.27   2.57   12.84      c.m"
"          Rainfall losses              35.452   10.345   30.431      mm"
"          Runoff depth              12.097   37.204   17.118      mm"
"          Runoff volume              2.61   2.01   4.62      c.m"
"          Runoff coefficient      0.254   0.782   0.360      "
"          Maximum flow              0.002   0.002   0.003      c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4  Add Runoff "
"          0.003   0.003   0.007   0.010"
"
" 40  HYDROGRAPH Copy to Outflow"
"      8  Copy to Outflow"
"          0.003   0.003   0.003   0.010"
"
" 40  HYDROGRAPH Combine 1"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"          Maximum flow              0.012      c.m/sec"
"          Hydrograph volume              34.216      c.m"
"          0.003   0.003   0.003   0.012"
"
" 38  START/RE-START TOTALS 203"
"      3  Runoff Totals on EXIT"
"          Total Catchment area              0.105      hectare"
"          Total Impervious area              0.075      hectare"
"          Total % impervious              71.143"
"
" 19  EXIT"

```

```

"          MIDUSS Output ----->"
"          MIDUSS version              Version 2.25 rev. 473"
"          MIDUSS created              February 7, 2010"
"          10  Units used:              ie METRIC"
"          Job folder:                  C:\Users\sswanton.KSALTD\Documents\
"                                     Job Folders\23-218\MIDUSS\Sandra's modeling"
"          Output filename:            Proposed 100 Year Run 3.out"
"          Licensee name:              Sandra Swanton"
"          Company                     K. Smart Associates Limited"
"          Date & Time last used:      2024-03-08 at 8:57:31 AM"
" 31    TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32    STORM Chicago storm"
"          1      Chicago storm"
"          4682.000 Coefficient A"
"          17.437  Constant B"
"          0.956   Exponent C"
"          0.400   Fraction R"
"          180.000 Duration"
"          1.000   Time step multiplier"
"          Maximum intensity            239.281  mm/hr"
"          Total depth                  89.768  mm"
"          6  100hyd Hydrograph extension used in this file"
" 33    CATCHMENT 201"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          201    Rooftop Areas to Underground Storage"
"          100.000 % Impervious"
"          0.020  Total Area"
"          10.000 Flow length"
"          1.000  Overland Slope"
"          0.000  Pervious Area"
"          10.000 Pervious length"
"          1.000  Pervious slope"
"          0.020  Impervious Area"
"          10.000 Impervious length"
"          1.000  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          75.000 Pervious SCS Curve No."
"          0.000  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          8.467  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.909  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"

```

```

"          0.012  0.000  0.000  0.000 c.m/sec"
"          Catchment 201      Pervious  Impervious Total Area "
"          Surface Area      0.000  0.020  0.020  hectare"
"          Time of concentration 7.451  1.003  1.003  minutes"
"          Time to Centroid    102.537  85.484  85.484  minutes"
"          Rainfall depth      89.768  89.768  89.768  mm"
"          Rainfall volume     0.00  17.95  17.95  c.m"
"          Rainfall losses     50.158  8.140  8.140  mm"
"          Runoff depth        39.610  81.628  81.628  mm"
"          Runoff volume       0.00  16.33  16.33  c.m"
"          Runoff coefficient   0.000  0.909  0.909  "
"          Maximum flow        0.000  0.012  0.012  c.m/sec"
" 40    HYDROGRAPH Add Runoff "
"          4  Add Runoff "
"          0.012  0.012  0.000  0.000"
" 54    POND DESIGN"
"          0.012  Current peak flow  c.m/sec"
"          0.005  Target outflow  c.m/sec"
"          16.3   Hydrograph volume  c.m"
"          41.    Number of stages"
"          0.000  Minimum water level  metre"
"          3.000  Maximum water level  metre"
"          0.000  Starting water level  metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge  Volume"
"          324.550  0.00022  0.2400"
"          324.580  0.00077  0.3700"
"          324.600  0.00179  0.4900"
"          324.630  0.00230  0.6100"
"          324.650  0.00262  0.7300"
"          324.680  0.00273  0.9300"
"          324.700  0.00281  1.120"
"          324.730  0.00289  1.320"
"          324.750  0.00293  1.510"
"          324.780  0.00296  1.710"
"          324.800  0.00299  1.900"
"          324.830  0.00300  2.090"
"          324.860  0.00300  2.290"
"          324.880  0.00299  2.480"
"          324.910  0.00299  2.660"
"          324.930  0.00297  2.850"
"          324.960  0.00296  3.040"
"          324.980  0.00293  3.220"
"          325.010  0.00291  3.410"
"          325.030  0.00288  3.590"
"          325.060  0.00283  3.770"
"          325.080  0.00279  3.940"
"          325.110  0.00271  4.120"
"          325.140  0.00265  4.290"
"          325.160  0.00257  4.460"

```

"	325.190	0.00243	4.630"	
"	325.210	0.00246	4.800"	
"	325.240	0.00251	4.960"	
"	325.260	0.00254	5.120"	
"	325.290	0.00258	5.270"	
"	325.310	0.00262	5.420"	
"	325.340	0.00266	5.560"	
"	325.360	0.00271	5.690"	
"	325.390	0.00274	5.820"	
"	325.410	0.00277	5.940"	
"	325.440	0.00281	6.070"	
"	325.470	0.00284	6.190"	
"	325.490	0.00289	6.310"	
"	325.520	0.00291	6.430"	
"	325.540	0.00294	6.550"	
"	325.570	0.00298	6.680"	
"	Peak outflow	0.003	c.m/sec"	
"	Maximum level	324.862	metre"	
"	Maximum storage	2.306	c.m"	
"	Centroidal lag	1.785	hours"	
"	0.012	0.012	0.003	0.000 c.m/sec"
" 40	HYDROGRAPH	Combine	1"	
"	6	Combine	"	
"	1	Node #"		
"		Ex MH L32L-72"		
"	Maximum flow	0.003	c.m/sec"	
"	Hydrograph volume	16.267	c.m"	
"	0.012	0.012	0.003	0.003"
" 40	HYDROGRAPH Start - New Tributary"			
"	2	Start - New Tributary"		
"	0.012	0.000	0.003	0.003"
" 33	CATCHMENT 202"			
"	1	Triangular SCS"		
"	1	Equal length"		
"	1	SCS method"		
"	202	Parking Areas to CB1"		
"	85.000	% Impervious"		
"	0.058	Total Area"		
"	10.000	Flow length"		
"	2.400	Overland Slope"		
"	0.009	Pervious Area"		
"	10.000	Pervious length"		
"	2.400	Pervious slope"		
"	0.049	Impervious Area"		
"	10.000	Impervious length"		
"	2.400	Impervious slope"		
"	0.250	Pervious Manning 'n'"		
"	75.000	Pervious SCS Curve No."		
"	0.440	Pervious Runoff coefficient"		
"	0.100	Pervious Ia/S coefficient"		

"	8.467	Pervious Initial abstraction"		
"	0.015	Impervious Manning 'n'"		
"	98.000	Impervious SCS Curve No."		
"	0.887	Impervious Runoff coefficient"		
"	0.100	Impervious Ia/S coefficient"		
"	0.518	Impervious Initial abstraction"		
"	0.029	0.000	0.003	0.003 c.m/sec"
"	Catchment 202	Pervious	Impervious	Total Area "
"	Surface Area	0.009	0.049	0.058 hectare"
"	Time of concentration	5.730	0.771	1.171 minutes"
"	Time to Centroid	100.397	85.227	86.448 minutes"
"	Rainfall depth	89.768	89.768	89.768 mm"
"	Rainfall volume	7.81	44.26	52.07 c.m"
"	Rainfall losses	50.251	10.142	16.158 mm"
"	Runoff depth	39.517	79.627	73.610 mm"
"	Runoff volume	3.44	39.26	42.69 c.m"
"	Runoff coefficient	0.440	0.887	0.820 "
"	Maximum flow	0.002	0.028	0.029 c.m/sec"
" 40	HYDROGRAPH Add Runoff "			
"	4	Add Runoff "		
"	0.029	0.029	0.003	0.003"
" 54	POND DESIGN"			
"	0.029	Current peak flow	c.m/sec"	
"	0.006	Target outflow	c.m/sec"	
"	42.7	Hydrograph volume	c.m"	
"	21.	Number of stages"		
"	326.220	Minimum water level	metre"	
"	326.550	Maximum water level	metre"	
"	326.220	Starting water level	metre"	
"	0	Keep Design Data: 1 = True; 0 = False"		
"	Level Discharge	Volume"		
"	326.220	0.000	0.000"	
"	326.237	0.00081	0.00612"	
"	326.253	0.00218	0.01188"	
"	326.270	0.00277	0.01800"	
"	326.286	0.00318	0.02376"	
"	326.302	0.00354	0.02952"	
"	326.319	0.00389	0.03564"	
"	326.336	0.00421	0.04176"	
"	326.352	0.00449	0.04752"	
"	326.368	0.00475	0.05328"	
"	326.385	0.00502	0.06078"	
"	326.401	0.00526	0.1137"	
"	326.418	0.00550	0.2757"	
"	326.434	0.00571	0.5793"	
"	326.451	0.00594	1.119"	
"	326.467	0.00614	1.884"	
"	326.484	0.00634	3.025"	
"	326.500	0.00653	4.458"	
"	326.517	0.01568	6.421"	

```

"          326.533  0.03657  8.733"
"          326.550  0.07326  11.742"
"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie breadth sideslope sideslope"
"          326.500  0.900  2.000  50.000  50.000"
"
"      1.  HOR. ORIFICES"
"          Orifice  Orifice  Orifice Number of"
"          invert  coefficie diameter orifices"
"          326.220  0.630  0.0750  1.000"
"
"      1.  LAYERS"
"          Bottom      Aspect      Bottom      Top      Average"
"          area      ratio  elevation elevation sideslope"
"          0.360  1.000  326.220  326.370  0.000"
"
"      4.  WEDGES"
"          Wedge      Grade 1      Grade 2      Angle      Number"
"          invert      g1H:1V      g2H:1V      subtended of wedges"
"          326.370  33.000  33.000  90.000  1.000"
"          326.370  33.000  83.000  90.000  1.000"
"          326.370  83.000  33.000  90.000  1.000"
"          326.370  33.000  33.000  90.000  1.000"
"
"      Peak outflow      0.022  c.m/sec"
"      Maximum level      326.523  metre"
"      Maximum storage      7.237  c.m"
"      Centroidal lag      1.526  hours"
"
"          0.029  0.029  0.022  0.003 c.m/sec"
"
" 40  HYDROGRAPH Combine 1"
"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"
"      Maximum flow      0.024  c.m/sec"
"      Hydrograph volume      58.315  c.m"
"          0.029  0.029  0.022  0.024"
"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.029  0.000  0.022  0.024"
"
" 33  CATCHMENT 203"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      203  Landscaped Areas to Ex MH L32L-28"
"
" 20.000 % Impervious"
"      0.027  Total Area"
"      2.000  Flow length"
"      2.000  Overland Slope"
"      0.022  Pervious Area"
"      2.000  Pervious length"
"      2.000  Pervious slope"
"      0.005  Impervious Area"
"      2.000  Impervious length"

```

```

"      2.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      75.000  Pervious SCS Curve No."
"      0.435  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      8.467  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.813  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"          0.008  0.000  0.022  0.024 c.m/sec"
"
"      Catchment 203      Pervious      Impervious Total Area "
"      Surface Area      0.022  0.005  0.027  hectare"
"      Time of concentration 2.304  0.310  1.670  minutes"
"      Time to Centroid 95.974  84.493  92.322  minutes"
"      Rainfall depth      89.768  89.768  89.768  mm"
"      Rainfall volume      19.39  4.85  24.24  c.m"
"      Rainfall losses      50.675  16.825  43.905  mm"
"      Runoff depth      39.093  72.944  45.863  mm"
"      Runoff volume      8.44  3.94  12.38  c.m"
"      Runoff coefficient 0.435  0.813  0.511  "
"      Maximum flow      0.005  0.003  0.008  c.m/sec"
"
" 40  HYDROGRAPH Add Runoff "
"      4  Add Runoff "
"          0.008  0.008  0.022  0.024"
"
" 40  HYDROGRAPH Copy to Outflow"
"      8  Copy to Outflow"
"          0.008  0.008  0.008  0.024"
"
" 40  HYDROGRAPH Combine 1"
"      6  Combine "
"      1  Node #"
"          Ex MH L32L-72"
"
"      Maximum flow      0.031  c.m/sec"
"      Hydrograph volume      70.698  c.m"
"          0.008  0.008  0.008  0.031"
"
" 38  START/RE-START TOTALS 203"
"      3  Runoff Totals on EXIT"
"      Total Catchment area      0.105  hectare"
"      Total Impervious area      0.075  hectare"
"      Total % impervious      71.143"
"
" 19  EXIT"

```

APPENDIX E

Quality Control – Oil Grit Separator Sizing Report

Stormceptor® EF Sizing Report

Imbrium® Systems

ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

03/08/2024

Province:	Ontario	Project Name:	18-20 Hickory
City:	Waterloo	Project Number:	23-218
Nearest Rainfall Station:	WATERLOO WELLINGTON AP	Designer Name:	Sandra Swanton
Climate Station Id:	6149387	Designer Company:	K. Smart Associates Limited
Years of Rainfall Data:	34	Designer Email:	sswanton@ksmart.ca
		Designer Phone:	519-748-1199
Site Name:	201&202	EOR Name:	
		EOR Company:	
Drainage Area (ha):	0.08	EOR Email:	
% Imperviousness:	89.00	EOR Phone:	
Runoff Coefficient 'c': 0.83			

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	2.53
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	Yes
Upstream Orifice Control Flow Rate to Stormceptor (L/s):	9.00
Peak Conveyance (maximum) Flow Rate (L/s):	9.00
Influent TSS Concentration (mg/L):	200
Estimated Average Annual Sediment Load (kg/yr):	95
Estimated Average Annual Sediment Volume (L/yr):	77

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	98
EF6	100
EF8	100
EF10	100
EF12	100

Recommended Stormceptor EF Model: EF4
Estimated Net Annual Sediment (TSS) Load Reduction (%): 98
Water Quality Runoff Volume Capture (%): > 90

Stormceptor® EF Sizing Report

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

Stormceptor®EF Sizing Report

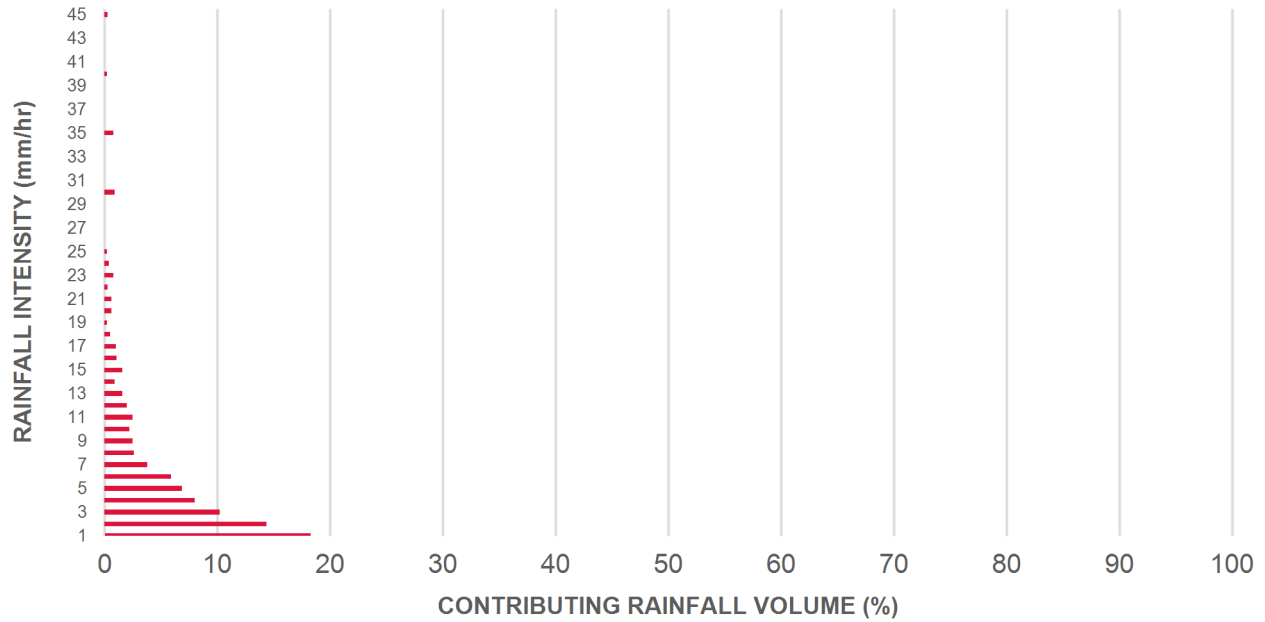
Upstream Flow Controlled Results

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 (%)
0.50	8.5	8.5	0.09	6.0	5.0	100	8.5	8.5
1.00	18.3	26.8	0.19	11.0	9.0	100	18.3	26.8
2.00	14.4	41.3	0.37	22.0	19.0	100	14.4	41.3
3.00	10.2	51.5	0.56	33.0	28.0	100	10.2	51.5
4.00	8.0	59.5	0.74	45.0	37.0	100	8.0	59.5
5.00	6.9	66.4	0.93	56.0	46.0	100	6.9	66.4
6.00	5.9	72.3	1.11	67.0	56.0	100	5.9	72.3
7.00	3.8	76.1	1.30	78.0	65.0	100	3.8	76.1
8.00	2.6	78.7	1.48	89.0	74.0	100	2.6	78.7
9.00	2.5	81.1	1.67	100.0	83.0	98	2.4	81.1
10.00	2.2	83.3	1.85	111.0	93.0	97	2.1	83.2
11.00	2.5	85.8	2.04	122.0	102.0	96	2.4	85.6
12.00	2.0	87.8	2.23	134.0	111.0	95	1.9	87.5
13.00	1.6	89.4	2.41	145.0	121.0	93	1.5	89.0
14.00	0.9	90.4	2.60	156.0	130.0	92	0.9	89.9
15.00	1.6	91.9	2.78	167.0	139.0	91	1.4	91.3
16.00	1.1	93.0	2.97	178.0	148.0	91	1.0	92.3
17.00	1.0	94.0	3.15	189.0	158.0	89	0.9	93.2
18.00	0.5	94.6	3.34	200.0	167.0	88	0.5	93.7
19.00	0.2	94.8	3.52	211.0	176.0	87	0.2	93.9
20.00	0.6	95.4	3.71	223.0	185.0	86	0.5	94.4
21.00	0.6	96.1	3.90	234.0	195.0	84	0.5	95.0
22.00	0.3	96.4	4.08	245.0	204.0	83	0.2	95.2
23.00	0.8	97.2	4.27	256.0	213.0	83	0.7	95.9
24.00	0.4	97.6	4.45	267.0	223.0	82	0.4	96.2
25.00	0.2	97.8	4.64	278.0	232.0	82	0.1	96.4
30.00	0.9	98.7	5.56	334.0	278.0	80	0.7	97.1
35.00	0.8	99.5	6.49	390.0	325.0	78	0.6	97.7
40.00	0.2	99.7	7.42	445.0	371.0	75	0.2	97.9
45.00	0.3	100.0	8.35	501.0	417.0	74	0.2	98.1
Estimated Net Annual Sediment (TSS) Load Reduction =								98 %

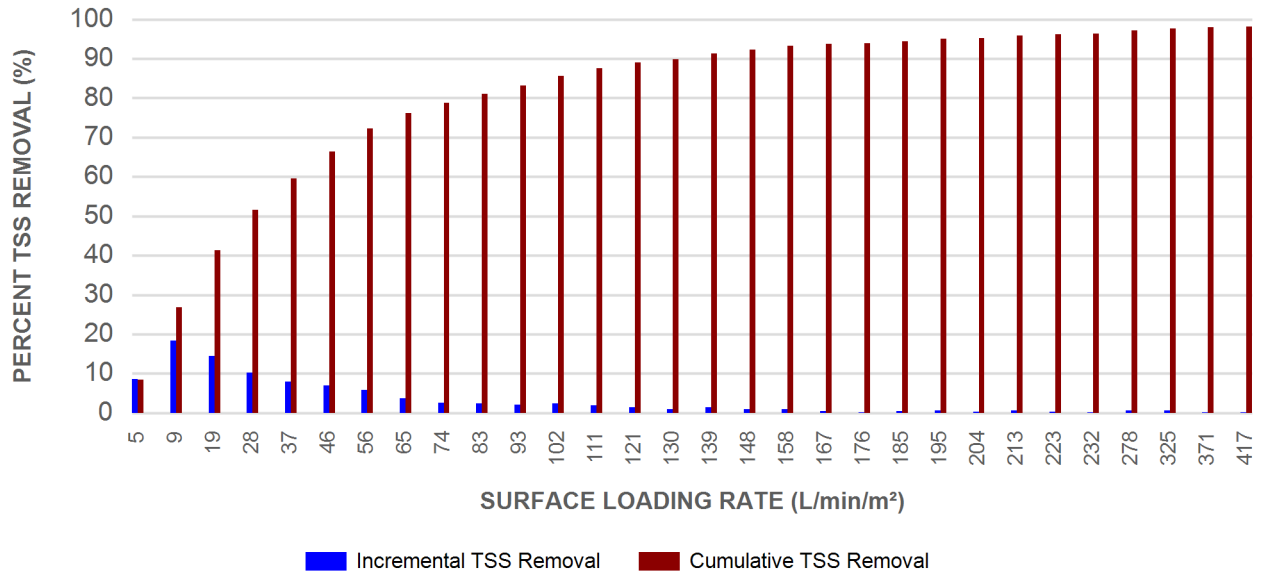
Climate Station ID: 6149387 Years of Rainfall Data: 34

Stormceptor®EF Sizing Report

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Stormceptor® EF Sizing Report

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

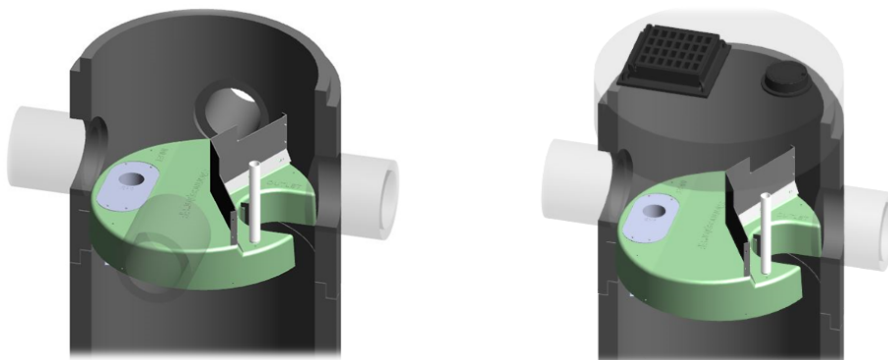
► **Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test 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

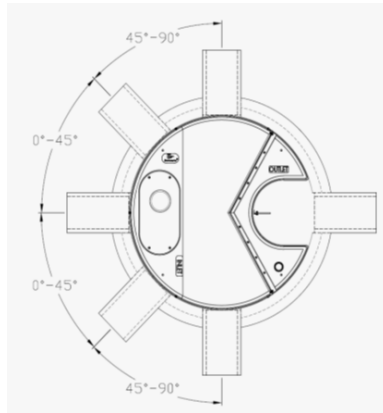
► **Stormceptor® EF and EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend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



Stormceptor® EF Sizing Report



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>

Stormceptor®EF Sizing Report

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

Stormceptor®EF Sizing Report

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 of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada. Sizing shall also be determined by use of the sediment removal performance data derived from the ISO 14034 ETV third-party verified laboratory testing data from testing conducted in accordance with the Canadian ETV protocol Procedure for Laboratory Testing of Oil-Grit Separators, as follows:

3.2.1 Sediment removal efficiency for a given surface loading rate and its associated flow rate shall be based on sediment removal efficiency demonstrated at the seven (7) tested surface loading rates specified in the protocol, ranging 40 L/min/m² to 1400 L/min/m², and as stated in the ISO 14034 ETV Verification Statement for the OGS device.

3.2.2 Sediment removal efficiency for surface loading rates between 40 L/min/m² and 1400 L/min/m² shall be based on linear interpolation of data between consecutive tested surface loading rates.

3.2.3 Sediment removal efficiency for surface loading rates less than the lowest tested surface loading rate of 40 L/min/m² shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m². No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m².

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m² shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m², and shall be calculated using a simple proportioning formula, with 1400 L/min/m² in the numerator and the higher surface loading rate in the denominator, and multiplying the resulting fraction times the sediment removal efficiency at 1400 L/min/m².

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/m².

APPENDIX F

Storm Sewer Design Sheet

18 & 20 Hickory Street West, City of Waterloo
STORM SEWER DESIGN SHEETS

K. Smart Associates Limited
Ref. Number 23-218
Date 06-Mar-24

Region of Waterloo DGSSMS IDF	
	5 Year Storm
A	1593
B	11
C	0.8789

Reach	Design Storm	From	To	Δ Area (ha)	C	AC	Total AC	Tc (minutes)	Rain (mm/hr)	Q design (cms)	Design Pipe Size	Qcap (cms)	Velocity (m/sec)	Mannings N	Pipe Slope (%)	Pipe Length (meters)	Travel Time (minutes)	Total Time (minutes)	Remaining Capacity (%)	Q/Qcap (%)
HICKORY STREET STORM SEWER OUTLET																				
Orifice Control ¹	5	CB1	OGS	0.058	0.85	0.0493	0.0493	10.00	109.677	0.007	300	0.0684	0.967	0.013	0.5	16	0.276	10.276	89.8%	10.2%
	5	Roofs	U/G Storage	0.02	0.90	0.018	0.018	10.00	109.677	0.005	200	0.0232	0.738	0.013	0.5	24	0.542	10.542	76.3%	23.7%
Vortex Valve Control ²	5	U/G Storage/MH1	OGS		0.20	0	0.018	10.54	107.249	0.003	300	0.0684	0.967	0.013	0.5	14	0.241	10.783	95.6%	4.4%
	5	OGS	EXMH	0	0.60	0	0.0673	10.78	106.205	0.008	300	0.0684	0.967	0.013	0.5	7	0.121	10.904	87.6%	12.4%