

Stormwater Management Report for
143 Columbia Street W
143 Columbia Street West, City of Waterloo

November 03, 2021

Project Reference Number 20-261



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CONSULTING ENGINEERS AND PLANNERS

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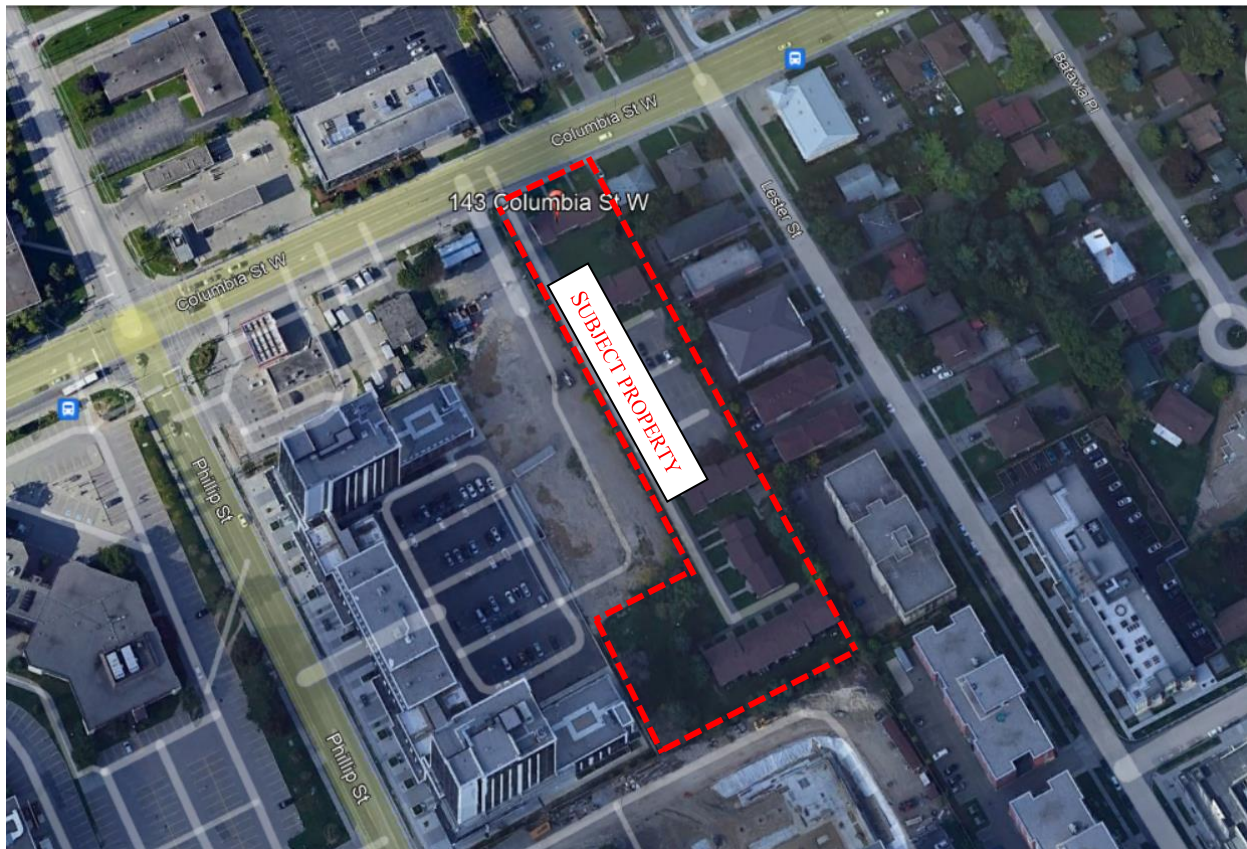
Introduction

This report provides details on the stormwater management design for the proposed building development on Columbia Street West in City of Waterloo, Ontario.

Background Information

The subject property includes block 143 on Columbia Street West in City of Waterloo. The 0.8 ha property is located on the south side of Columbia Street West. The site is currently occupied by five (5) apartment buildings. There is a paved parking lot in the middle of the property, and landscaping fills the remainder of the property land. The ground surface has a gentle slope from south to north. The proposed three (3) - 25 story buildings will replace the existing buildings. The subject property is bounded by Columbia Street West to the north, existing residential buildings to the east, existing asphalt path and property lands to the west, and property lands to the south. The site location is shown below.

Figure 1- Site Location



Geotechnical Information

Chung & Vander Doelen Engineering Ltd. (CVD) conducted a geotechnical investigation in September of 2018. In order to investigate the subsurface conditions at the site, nine (9) boreholes were drilled and sampled to depths between 15.70 and 22.56 m below ground surface between July 26 and August 8, 2018.

According to the geotechnical report, the surficial pavement and topsoil were underlain by loose to compact fill materials, followed by compact to very dense fine granular deposits, which in turn, were underlain by stiff to hard clayey sandy silt and compact to very dense sandy silt to silty sand deposit. These deposits were further underlain by very stiff to hard silty clay till.

The water level measured in the monitoring wells ranged in depths between 3.41 and 4.60 m, corresponding to elevations 335.71 and 336.34 m. It is noted that the observed groundwater table will fluctuate seasonally and in response to major weather events.

Existing Site Drainage Conditions

The site generally drains to Columbia Street West except the landscape of the southwest area that drains to Phillip Street. There are existing catchbasins in Columbia Street West at the north limit of the subject property which inlets the runoff into the municipal 750 mm storm sewer. There are also existing catchbasins in Phillip Street on the west side of the property which inlets the runoff into the municipal 750mm x 1150mm storm sewer.

Proposed Site Drainage Conditions

The proposed development consists of three (3) - 25 story buildings and parking lots. The east areas of buildings A and B will drain to proposed catchbasin CB1, and catchbasin manhole CBMH1. The southeast area of Building B will drain to the proposed catchbasin CB2. The south backyard will drain to the proposed catchbasin CB3. The parking and promenade areas between buildings A and B will drain to the proposed oil grit unit OGS1. The parking and promenade areas between buildings B and C will drain to the proposed oil grit unit OGS2. The northwest area of Building A will directly drain to Columbia Street West. All rooftop storages, catchbasins, manholes, and catchbasin manholes will be drained to the proposed storm sewer located west of buildings A and B and finally to manhole MH1 in Columbia Street West.

The catchbasin CB2 and catchbasin manhole CBMH1 are equipped with 75 mm control orifices for quantity control of the outflow to the storm sewer system of Columbia Street West.

The catchbasin manhole CBMH1 and catchbasin CB2 will discharge to OGS1 and OGS2 units, respectively. The OGS structures will provide quality control prior to drain to Manhole MH1 in Columbia Street West.

The proposed stormwater management will result in a reduction in flows compared to the existing conditions.

Stormwater Management Design Criteria

The design criteria for the stormwater plan area as stipulated by the City of Waterloo:

1. Provide Quantity control of runoff resulting from the 5 year to 100 year storm events to existing discharge rates.
2. Provide quality control of runoff from parking area.

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

Stormwater Management Plan

A stormwater management plan has been prepared for the proposed development. This plan considers quality and quantity control of stormwater runoff from the entire site.

Quality control of runoff will be provided using oil grit separators. Due to the size of the site and the resulting proposed storm sewer network, two OGS units are proposed.

Stormwater quantity control will be achieved using rooftop storages and parking lot ponds equipped with orifice controls.

The stormwater management plan for the proposed development is presented here.

Quality control

The Stormceptor OGS units have been sized to provide TSS removal based on a fine particle size distribution. The OGS sizing information for the quality control structures are included in Appendix D. The drainage area serviced by the OGS units are summarized in the table below.

Table 1: Oil Grit Separator Summary

OGS ID	Drainage Area	Drainage Area ID	OGS Model
OGS # 1	0.178 ha	201, 202, 206	STC 300i
OGS # 2	0.147 ha	203, 205	STC 300i

Quantity Control

The 5-year and 100-year storm events will be attenuated to less than existing discharge rates. The rooftop storages and parking ponds are designed to keep the existing outflow during 5 and 100-year storms. Installed orifices in the outlet of the parking lot ponds restricts outflow from the ponds.

Stormwater Modeling

The MIDUSS Model was used to model the 5 year and 100 year storm events to demonstrate the level of quantity control provided by the proposed stormwater management design.

The design storm hyetographs are derived using the IDF parameters for the City of Waterloo fitted to the 3 hour Chicago Storm distribution.

$$i_{5yr} = \frac{1755}{(t_d + 12.347)^{0.895}}$$

$$i_{100yr} = \frac{4692}{(t_d + 17.437)^{0.956}}$$

Stormwater Model Input Parameters

Table 2 shows the catchment area input parameters into the model under existing and proposed conditions. Drainage catchment areas for the existing and proposed conditions are shown in Appendix A.

Table 2: Model Input Parameters

Catchment	Description	Area (ha)	Percent Impervious (%)	Overland Slope (%)	Flow Length (m)
Existing Conditions					
101	Columbia Street W. catchment	0.642	53	1.00	150
102	Phillip Street catchment	0.158	11	2.00	40.0
Proposed Conditions					
201	East area of Building A to CB1	0.031	85	3.00	10.0
202	East area of Buildings A and B and to CBMH1	0.061	85	1.85	18.0
203	East and south area of Building B to CB2	0.065	85	2.65	16.0
204	Court area to CBMH3	0.048	65	2.30	13.0
205	Parking and promenade areas between buildings B and C to OGS2	0.082	85	1.80	16.0
206	Parking and promenade areas between buildings A and B to OGS1	0.086	80	1.33	21.0
207	North and west areas of Building A to Columbia Street	0.038	75	2.50	30
208	Roof - Building A	0.077	100	0.50	9.0
209	Roof - Building B	0.078	100	0.50	9.0
210	Roof - Building C	0.170	100	0.50	7.0
211	South backyard to CB3	0.064	3	2.10	80

Stormwater Model Results

Table 3 shows the peak flows under the existing and proposed conditions. The overall site peak flow from pre-development conditions to post development has been reduced. The MIDUSS output files are included in Appendix C. Table 4 shows water level and storage of the parking lot ponds and rooftop storages.

Table 3: MIDUSS Model Results Summary

Design Storm	Existing Condition			Proposed Condition		
	<i>Total to Columbia Street West (m³/sec)</i>	<i>Total to Phillip Street (m³/sec)</i>	<i>Total to Municipal Sewer System (m³/sec)</i>	<i>Total to Columbia Street West (m³/sec)</i>	<i>Total to Phillip Street (m³/sec)</i>	<i>Total to Municipal Sewer System (m³/sec)</i>
5 year	0.098	0.006	0.104	0.098	0.00	0.098
100 year	0.191	0.028	0.213	0.175	0.00	0.175

Table 4: Parking Lot Pond and Rooftop - Water Level (W.L.) and Storage (S.)

Design Storm	Ponds				Rooftop Storages					
	Catchment 201, 202		Catchment 203		Building A		Building B		Building C	
	W.L. (m)	S. (m ³)	W.L. (m)	S. (m ³)	W.L. (m)	S. (m ³)	W.L. (m)	S. (m ³)	W.L. (m)	S. (m ³)
5 year	339.44	3.58	339.59	0.64	0.059	20.25	0.059	20.59	0.074	51.28
100 year	339.49	8.16	339.91	6.76	0.100	43.36	0.100	44.09	0.118	108.05

During the 5-year storm event, the total peak flow to the storm sewer system of Columbia Street West is 0.098 m³/sec, which is equal to the peak flow of 0.098 m³/sec under the existing condition. During the 100-year storm event, the total peak flow to the storm sewer system of Columbia Street West is 0.175m³/sec, which is less than the peak flow of 0.191 m³/sec under the existing condition.

During the 5-year and 100 year storm events, there is no flow to the storm sewer system of Phillip Street.

During the 5-year storm event, the total peak flow to the municipal storm sewer system is 0.098 m³/sec, which is less than the peak flow of 0.104 m³/sec under the existing condition. During the 100-year storm event, the total peak flow to the municipal storm sewer system is 0.175m³/sec, which is less than the peak flow of 0.213 m³/sec under the existing condition.

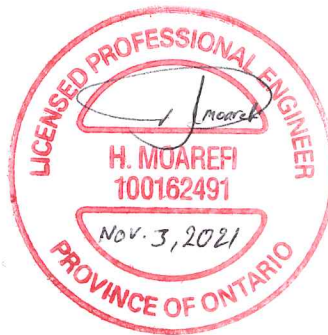
The proposed storm sewer system demonstrates sufficient capacity to service the proposed development and convey the 5 year and 100 year storm events without surcharging.

Conclusions

In summary, the overall site peak flow from pre-development conditions to post development has been reduced and proposed development will not result in an increase in peak discharge rates to the existing storm sewer.

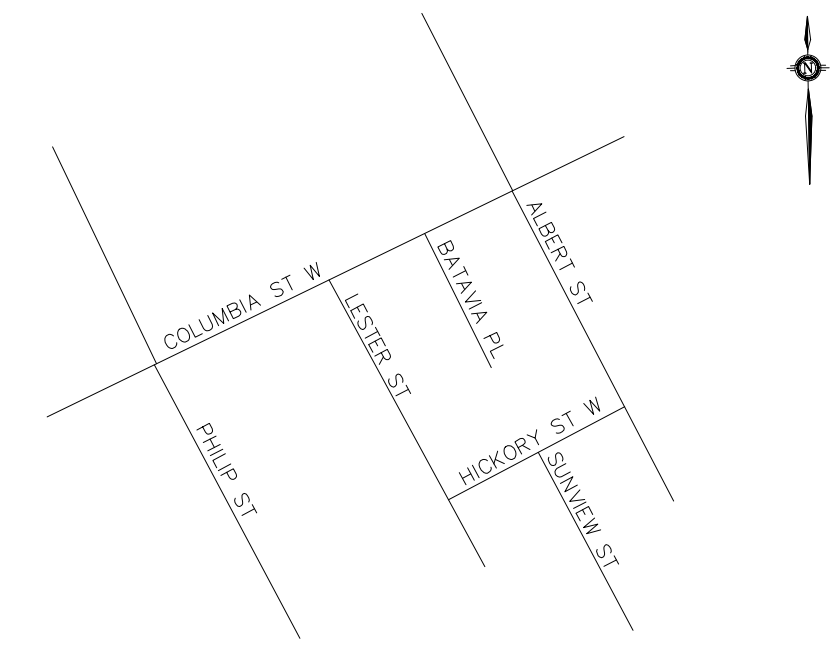
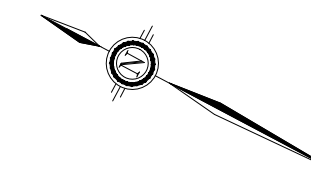
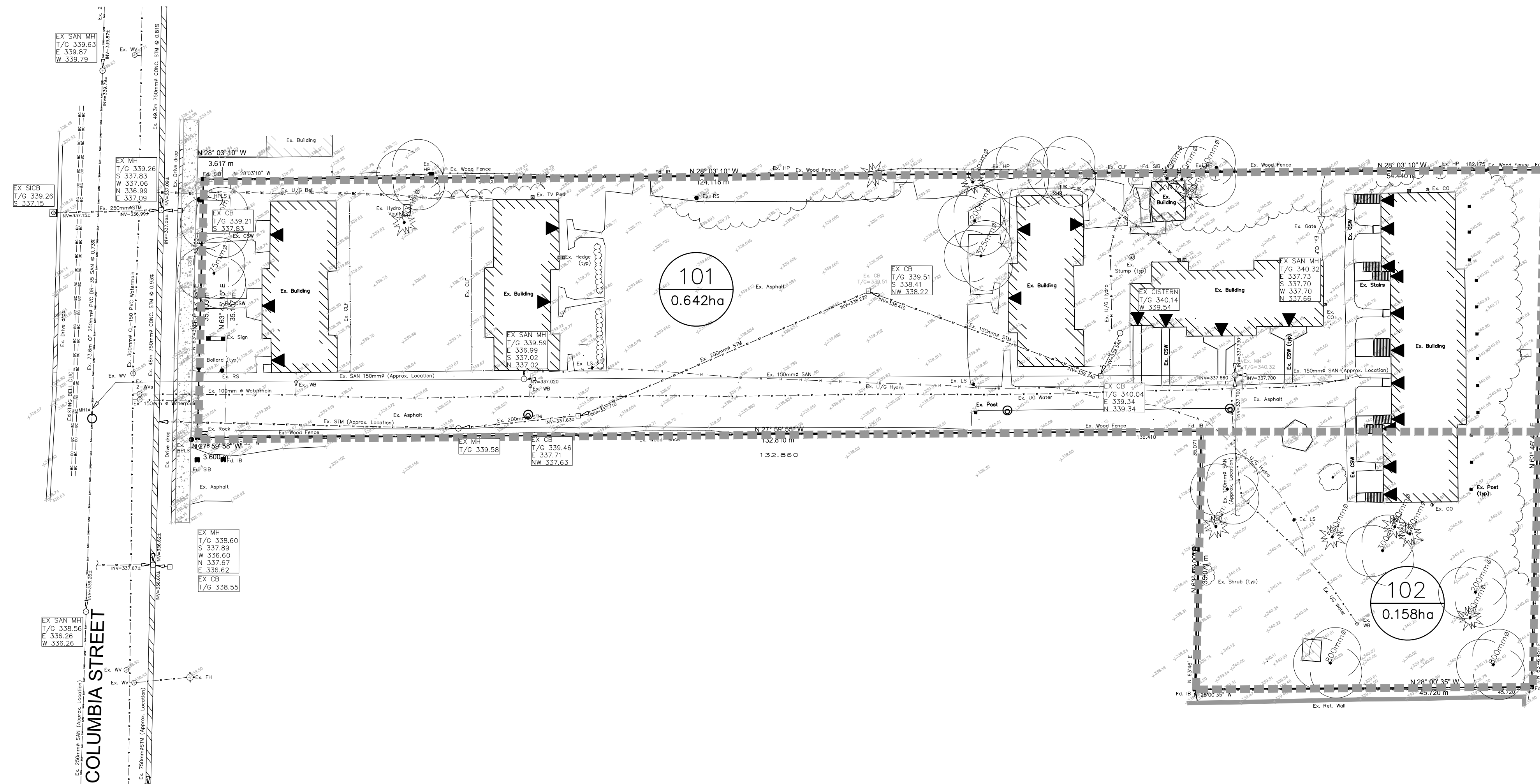
Hossein Moarefi, P.Eng.

K. Smart Associates Limited



Appendix A

Drainage Catchment Areas for Existing and Proposed Conditions



NOTES:

101
0.000ha

EXISTING CATCHMENT AREA I.D.
CATCHMENT AREA

□ □ □ □ □

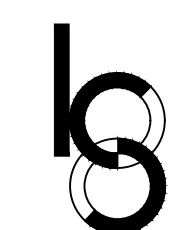
CATCHMENT AREA BOUNDARY

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

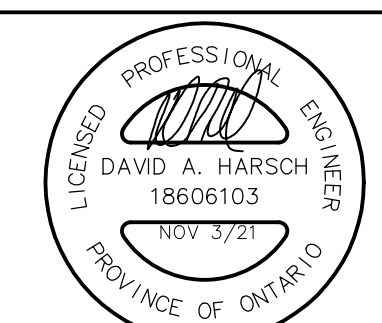
143 COLUMBIA STREET W

REGION OF WATERLOO	CITY OF KITCHENER
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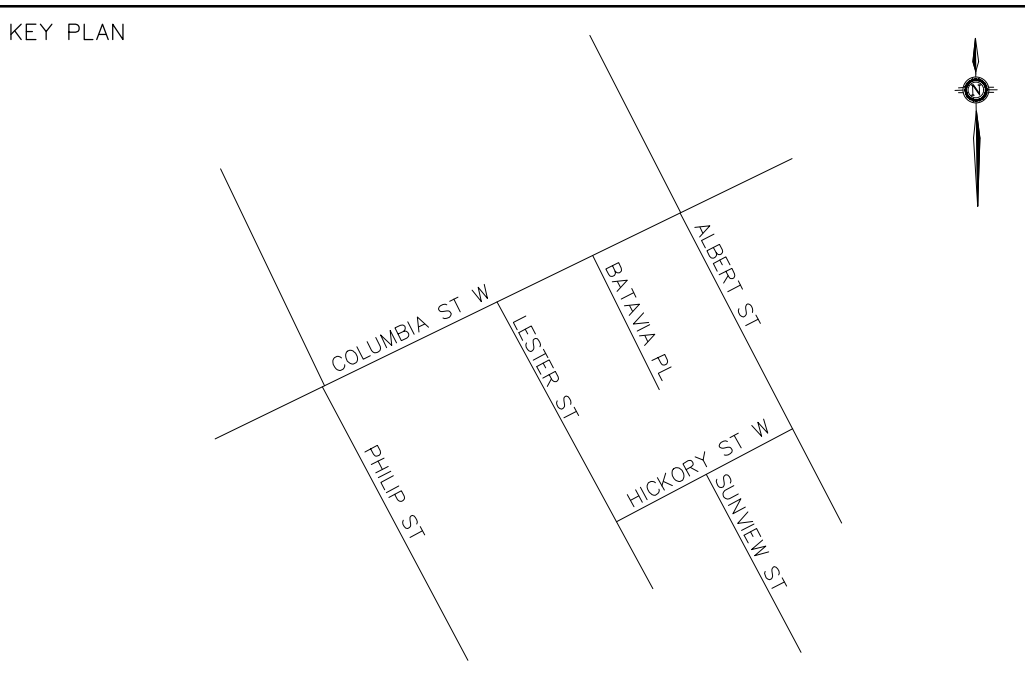
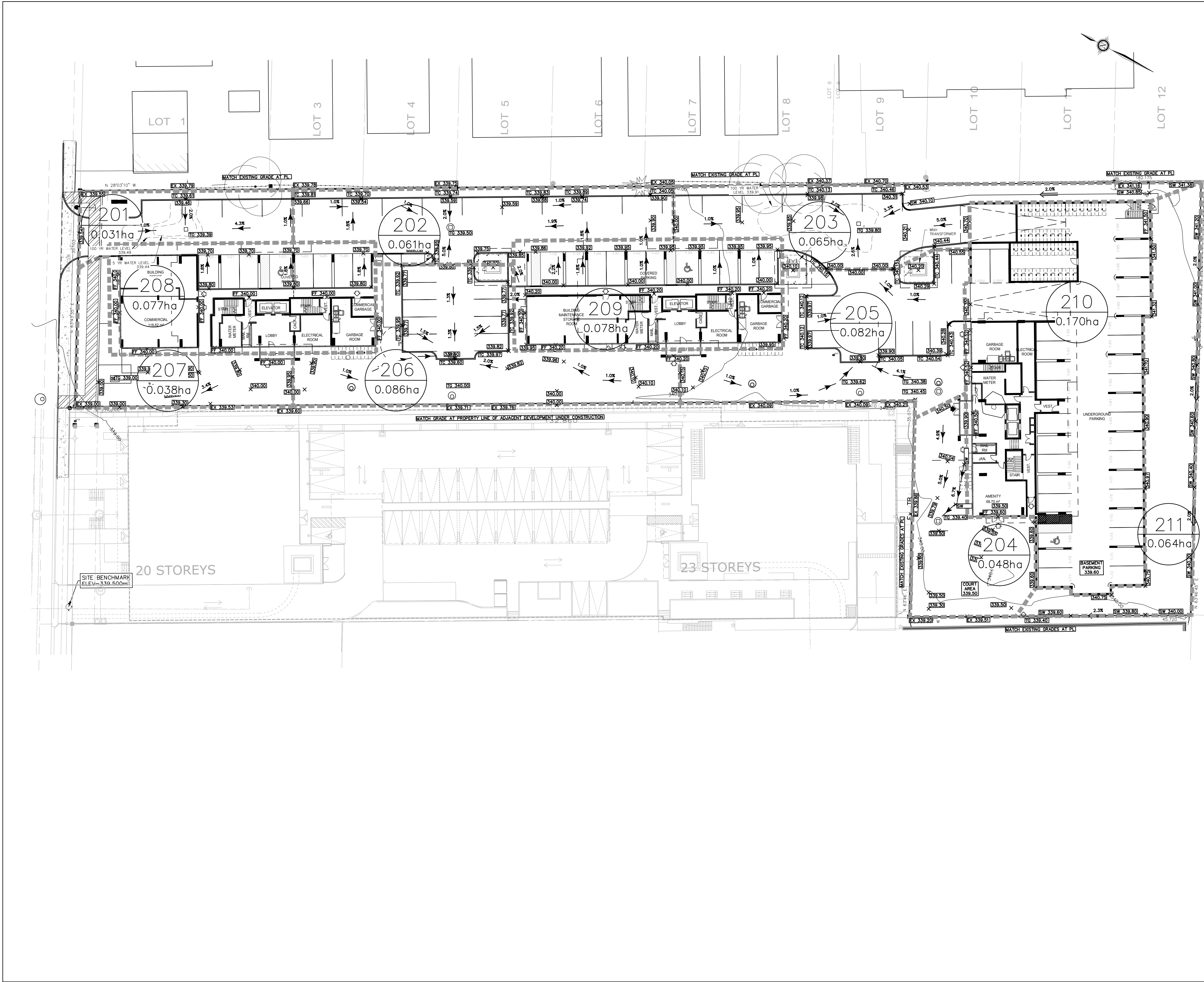
EXISTING CATCHMENT PLAN



K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER SUDBURY



DESIGNED BY: S.L.	0 8 16	DATE: NOV 3, 2021
CHECKED BY: D.A.H.		
DRAWN BY: S.L.	SCALE 1:400	SHEET 1 OF 2
CHECKED BY: D.A.H.	REVISION No.	
FILE No. 20-261		



- NOTES:
- 101 0.000ha PROPOSED CATCHMENT AREA I.D.
 - CATCHMENT AREA
 - CATCHMENT AREA BOUNDARY

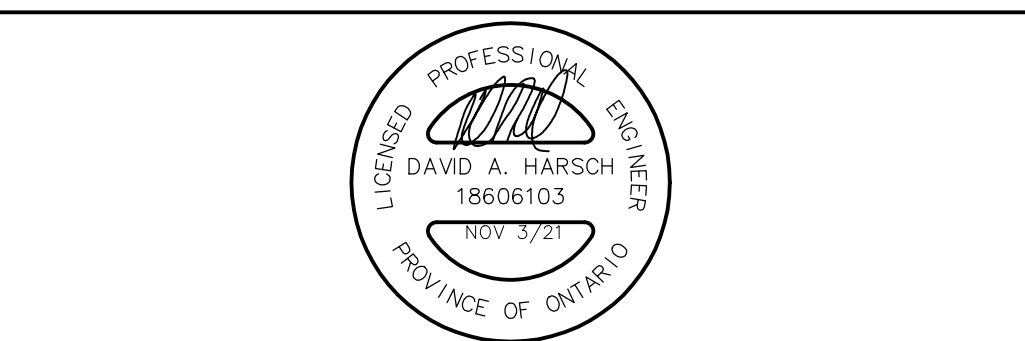
No.	REVISIONS	BY	DATE
	CONSTRUCTION		
	TENDER		
	ISSUE FOR APPROVALS		
	ISSUE BLOCK		

143 COLUMBIA STREET W

REGION OF WATERLOO CITY OF KITCHENER

PROPOSED CATCHMENT PLAN

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER SUDBURY



DESIGNED BY: S.L.	0 6 12	DATE: NOV 3, 2021
CHECKED BY: D.A.H.	SCALE 1:300	SHEET
DRAWN BY: S.L.		2 OF 2
CHECKED BY: D.A.H.	REVISION No.	
FILE No. 20-261		

Appendix B

Storm Design Sheet

143 Columbia Street W., City of Waterloo
STORM SEWER DESIGN SHEETS

K. Smart Associates Limited															IDF Parameters - City of Waterloo				
Project Number	20-261														5 Year Storm Event				
Designed By	Hosein Moarefi, P. Eng.														A	1755			
Checked By	David Harsch, P. Eng.														B	12.347			
Date	Nov-21														C	0.895			
			Rational Formula: Q=CIA/360					Total time= Tc+pipe travel time (minute)					Manning Equation:Qcap= (D/1000)^2.667*(S/100)^0.5/(3.211*n) (l/sec)						
			Q: peak flow (m³/sec)					Tc: inlet time before pipe (minute)					D: pipe size (mm)						
			C: runoff coefficient					pipe travel time= pipe length/60V (minute)					S: slope of pipe (%)						
			I: rainfall intensity (mm/hr)					V: pipe velocity (m/sec)					n: roughness coefficient						
			A: area(ha)																
1	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
Catchment	From	To	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)	PipeTravel Time (minutes)	Total Time (minutes)	Q/Qcap (%)	
201	CB1	CBMH1	0.031	0.80	0.0248	0.0248	10.00	109.644	0.0080										
202	202	CBMH1	0.061	0.81	0.0494	0.0494	10.00	109.644	0.0231										
201, 202	CBMH1 ¹	OGS1	0.092	0.81	0.0745	0.0745	10.51	107.347	0.0180	300	0.090	1.275	0.013	0.87	19.5	0.255	10.77	20.0%	
206	206	OGS1	0.086	0.78	0.0671	0.0671	10.00	109.644	0.0204										
201, 202, 206	OGS1	MH2	0.178				10.77	106.241	0.0384	300	0.068	0.967	0.013	0.50	5.0	0.086	10.85	56.3%	
203	CB2 ¹	OGS2	0.065	0.81			10.00	109.644	0.0150	300	0.097	1.367	0.013	1.00	21.0	0.256	10.26	15.5%	
205	205	OGS2	0.082	0.81	0.0664	0.0664	10.00	109.644	0.0202										
203, 205	OGS2	MH3	0.147	0.81			10.26	108.482	0.0352	300	0.068	0.967	0.013	0.50	4.0	0.069	10.32	51.6%	
210	Building C - roof	CBMH3	0.170	0.90	0.1530	0.1530	10.00	109.644	0.0040	150	0.011	0.609	0.013	0.50	7.0	0.192	10.19	37.2%	
211	CB3	CBMH3	0.064	0.30	0.0192	0.0192	10.00	109.644	0.0059	375	0.175	1.586	0.013	1.00	19.5	0.205	10.20	3.3%	
211, 204	CBMH3	CBMH2	0.048	0.69	0.0331	0.0523	10.20	108.734	0.0158	375	0.124	1.122	0.013	0.50	20.0	0.297	10.50	12.8%	
204, 210, 211	CBMH2	MH3	0.218				10.50		0.0198	375	0.124	1.122	0.013	0.50	11.5	0.171	10.67	16.0%	
209	Building B - roof ² (per outlet)	MH2	0.039	0.90	0.0351	0.0351	10.00	109.644	0.0015	150	0.011	0.609	0.013	0.50	8.0	0.219	10.22	13.9%	
203, 204, 205, 209, 210, 211	MH3	MH2					10.67	106.667	0.0581	375	0.124	1.122	0.013	0.50	65.0	0.966	11.63	46.9%	
208	Building A - roof ² (per outlet)	MH1	0.385	0.90	0.3465	0.3465	10.00	109.644	0.0015	150	0.011	0.609	0.013	0.50	8.0	0.219	10.22	13.9%	
201, 202, 203, 204, 205, 206, 208, 209, 210, 211	MH2	MH1	0.762				11.63	102.656	0.0995	375	0.124	1.122	0.013	0.50	65.0	0.966	12.60	80.4%	
NOTES:																			
1	Outflow restricted by orifice during 5 year event taken from Miduss model																		
2	Outflow restricted by flow control roof drains during 5 year event taken from Miduss model																		

Appendix C

MIDUSS Output Files

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" Company K. Smart Associates Limited"
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" 1500.000 Max. Hydrograph"
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" 150.000 Impervious length"
" 1.000 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.260 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."
" 0.884 Impervious Runoff coefficient"

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" Surface Area 0.302 0.340 0.642 hectare"
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" Rainfall volume 143.47 161.79 305.26 c.m"
" Rainfall losses 35.207 5.533 19.480 mm"
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" Runoff coefficient 0.260 0.884 0.590 "
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" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.259 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"

```

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" 0.015 Impervious Manning 'n'"
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"      MIDUSS created          February 7, 2010"
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"      1 Lines of comment"
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"      180.000 Max. Storm length"
"      1500.000 Max. Hydrograph"
" 32 STORM Chicago storm"
"      1 Chicago storm"
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"      17.437 Constant B"
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"      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 Columbia Street West catchment"
"      53.000 % Impervious"
"      0.642 Total Area"
"      150.000 Flow length"
"      1.000 Overland Slope"
"      0.302 Pervious Area"
"      150.000 Pervious length"
"      1.000 Pervious slope"
"      0.340 Impervious Area"
"      150.000 Impervious length"
"      1.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.444 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."
"      0.932 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      0.191 0.000 0.000 0.000 c.m/sec"
"      Catchment 101 Pervious Impervious Total Area "

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"      Surface Area      0.302 0.340 0.642 hectare"
"      Time of concentration 37.774 5.088 14.793 minutes"
"      Time to Centroid 140.477 91.200 105.831 minutes"
"      Rainfall depth 89.960 89.960 89.960 mm"
"      Rainfall volume 271.45 306.10 577.54 c.m"
"      Rainfall losses 50.014 6.083 26.731 mm"
"      Runoff depth 39.946 83.878 63.230 mm"
"      Runoff volume 120.53 285.40 405.93 c.m"
"      Runoff coefficient 0.444 0.932 0.703 "
"      Maximum flow 0.028 0.185 0.191 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.191 0.191 0.000 0.000"
" 40 HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.191 0.191 0.191 0.000"
" 40 HYDROGRAPH Combine 1"
"      6 Combine "
"      1 Node #"
"      Columbia Street West"
"      Maximum flow 0.191 c.m/sec"
"      Hydrograph volume 405.934 c.m"
"      0.191 0.191 0.191 0.191"
" 40 HYDROGRAPH Start - New Tributary"
"      2 Start - New Tributary"
"      0.191 0.000 0.191 0.191"
" 33 CATCHMENT 102"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      102 Phillip Street catchment"
"      11.000 % Impervious"
"      0.158 Total Area"
"      40.000 Flow length"
"      2.000 Overland Slope"
"      0.141 Pervious Area"
"      40.000 Pervious length"
"      2.000 Pervious slope"
"      0.017 Impervious Area"
"      40.000 Impervious length"
"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      75.000 Pervious SCS Curve No."
"      0.443 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."
"      0.928 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"

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"      0.518 Impervious Initial abstraction"
"      0.028 0.000 0.191 0.191 c.m/sec"
"      Catchment 102 Pervious Impervious Total Area "
"      Surface Area 0.141 0.017 0.158 hectare"
"      Time of concentration 13.882 1.870 11.414 minutes"
"      Time to Centroid 110.557 86.606 105.636 minutes"
"      Rainfall depth 89.960 89.960 89.960 mm"
"      Rainfall volume 126.50 15.64 142.14 c.m"
"      Rainfall losses 50.072 6.509 45.280 mm"
"      Runoff depth 39.888 83.451 44.680 mm"
"      Runoff volume 56.09 14.50 70.59 c.m"
"      Runoff coefficient 0.443 0.928 0.497 "
"      Maximum flow 0.025 0.010 0.028 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.028 0.028 0.191 0.191"
" 40 HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.028 0.028 0.028 0.191"
" 40 HYDROGRAPH Combine 2"
"      6 Combine "
"      2 Node #"
"      Phillip Street "
"      Maximum flow 0.028 c.m/sec"
"      Hydrograph volume 70.595 c.m"
"      0.028 0.028 0.028 0.028"
" 40 HYDROGRAPH Confluence 2"
"      7 Confluence "
"      2 Node #"
"      Phillip Street "
"      Maximum flow 0.028 c.m/sec"
"      Hydrograph volume 70.595 c.m"
"      0.028 0.028 0.028 0.000"
" 40 HYDROGRAPH Copy to Outflow"
"      8 Copy to Outflow"
"      0.028 0.028 0.028 0.000"
" 40 HYDROGRAPH Combine 1"
"      6 Combine "
"      1 Node #"
"      Columbia Street West"
"      Maximum flow 0.213 c.m/sec"
"      Hydrograph volume 476.528 c.m"
"      0.028 0.028 0.028 0.213"
" 40 HYDROGRAPH Confluence 1"
"      7 Confluence "
"      1 Node #"
"      Columbia Street West"
"      Maximum flow 0.213 c.m/sec"
"      Hydrograph volume 476.528 c.m"
"      0.028 0.213 0.000"

```

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" 38 START/RE-START TOTALS 1"
"      3 Runoff Totals on EXIT"
"      Total Catchment area 0.800 hectare"
"      Total Impervious area 0.358 hectare"
"      Total % impervious 44.705"
" 19 EXIT"

```

" MIDUSS Output ----->"
" MIDUSS version Version 2.25 rev. 473"
" MIDUSS created February 7, 2010"
" Units used: ie METRIC"
" 10 Job folder: C:\Users\hmoarefi\Desktop"
" 81 ADD COMMENT="-----"
" 1 Lines of comment"
" 31 143 Columbia Street West- post development-5 year- run 3"
" 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"
" 4 Shyd Hydrograph extension used in this file"
" 33 CATCHMENT 201"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 201 East area of Building A to CB1"
" 85.000 % Impervious"
" 0.031 Total Area"
" 10.000 Flow length"
" 3.000 Overland Slope"
" 0.005 Pervious Area"
" 10.000 Pervious length"
" 3.000 Pervious slope"
" 0.026 Impervious Area"
" 10.000 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."
" 0.855 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.008 0.000 0.000 0.000 c.m/sec"
" Catchment 201 Pervious Impervious Total Area "

" Surface Area 0.005 0.026 0.031 hectare"
" Time of concentration 8.809 0.914 1.314 minutes"
" Time to Centroid 108.618 87.124 88.212 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 2.21 12.53 14.74 c.m"
" Rainfall losses 35.262 6.883 11.139 mm"
" Runoff depth 12.287 40.666 36.410 mm"
" Runoff volume 0.57 10.72 11.29 c.m"
" Runoff coefficient 0.258 0.855 0.766 "
" Maximum flow 0.000 0.008 0.008 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.008 0.008 0.000 0.000"
" 33 CATCHMENT 202"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 202 East area of Buildings A and B to CBMH1"
" 85.000 % Impervious"
" 0.061 Total Area"
" 18.000 Flow length"
" 1.850 Overland Slope"
" 0.009 Pervious Area"
" 18.000 Pervious length"
" 1.850 Pervious slope"
" 0.052 Impervious Area"
" 18.000 Impervious length"
" 1.850 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.259 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."
" 0.878 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.016 0.000 0.000 c.m/sec"
" Catchment 202 Pervious Impervious Total Area "
" Surface Area 0.009 0.052 0.061 hectare"
" Time of concentration 14.490 1.504 2.147 minutes"
" Time to Centroid 115.581 87.879 89.251 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 4.35 24.65 29.00 c.m"
" Rainfall losses 35.225 5.818 10.229 mm"
" Runoff depth 12.324 41.731 37.320 mm"
" Runoff volume 1.13 21.64 22.77 c.m"
" Runoff coefficient 0.259 0.878 0.785 "
" Maximum flow 0.000 0.016 0.016 c.m/sec"

" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.016 0.024 0.000 0.000"
" 54 POND DESIGN"
" 0.024 Current peak flow c.m/sec"
" 0.020 Target outflow c.m/sec"
" 34.1 Hydrograph volume c.m"
" 21. Number of stages"
" 337.410 Minimum water level metre"
" 339.800 Maximum water level metre"
" 337.410 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 337.410 0.000 0.000"
" 337.530 0.00326 1.00E-07"
" 337.649 0.00536 1.00E-07"
" 337.768 0.00684 0.2124"
" 337.888 0.00807 0.4284"
" 338.008 0.00913 0.6444"
" 338.127 0.01007 0.8586"
" 338.246 0.01093 1.073"
" 338.366 0.01173 1.289"
" 338.486 0.01249 1.505"
" 338.605 0.01319 1.719"
" 338.724 0.01386 1.933"
" 338.844 0.01450 2.149"
" 338.964 0.01512 2.365"
" 339.083 0.01571 2.579"
" 339.202 0.01627 2.794"
" 339.322 0.01682 3.010"
" 339.441 0.01735 3.523"
" 339.561 0.06455 15.146"
" 339.680 0.8220 74.553"
" 339.800 2.053 234.259"
" 1. WEIRS"
" Crest Weir Crest Left Right"
" elevation coefficient breadth sideslope sideslope"
" 339.540 0.900 10.000 0.000 0.000"
" 1. ORIFICES"
" Orifice Orifice Orifice Number of"
" invert coefficient diameter orifices"
" 337.410 0.630 0.0750 1.000"
" 1. LAYERS"
" Bottom Aspect Bottom Top Average"
" area ratio elevation elevation sideslope"
" 1.800 1.000 337.650 339.450 0.000"
" 8. WEDGES"
" Wedge Grade 1 Grade 2 Angle Number"
" invert g1H:1V g2H:1V subtended of wedges"
" 339.500 53.000 50.000 90.000 1.000"

" 339.500 50.000 100.000 90.000 1.000"
" 339.500 100.000 20.000 90.000 1.000"
" 339.500 20.000 53.000 90.000 1.000"
" 339.390 100.000 20.000 90.000 1.000"
" 339.390 20.000 23.000 90.000 1.000"
" 339.390 23.000 50.000 90.000 1.000"
" 339.390 50.000 100.000 90.000 1.000"
" Peak outflow 0.018 c.m/sec"
" Maximum level 339.442 metre"
" Maximum storage 3.575 c.m"
" Centroidal lag 1.508 hours"
" 0.016 0.024 0.018 0.000 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node # "
" Columbia Street"
" Maximum flow 0.018 c.m/sec"
" Hydrograph volume 33.980 c.m"
" 0.016 0.024 0.018 0.018"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.016 0.000 0.018 0.018"
" 33 CATCHMENT 203"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 203 Southeast area of Building B to CB2"
" 85.000 % Impervious"
" 0.065 Total Area"
" 16.000 Flow length"
" 2.650 Overland Slope"
" 0.010 Pervious Area"
" 16.000 Pervious length"
" 2.650 Pervious slope"
" 0.055 Impervious Area"
" 16.000 Impervious length"
" 2.650 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.259 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."
" 0.873 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.017 0.000 0.018 0.018 c.m/sec"
" Catchment 203 Pervious Impervious Total Area "
" Surface Area 0.010 0.055 0.065 hectare"

" Time of concentration 12.122 1.258 1.798 minutes"
" Time to Centroid 112.681 87.600 88.846 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 4.64 26.27 30.91 c.m"
" Rainfall losses 35.250 6.016 10.401 mm"
" Runoff depth 12.299 41.533 37.148 mm"
" Runoff volume 1.20 22.95 24.15 c.m"
" Runoff coefficient 0.259 0.873 0.781 "
" Maximum flow 0.001 0.017 0.017 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.017 0.017 0.018 0.018"
" 54 POND DESIGN"
" 0.017 Current peak flow c.m/sec"
" 0.020 Target outflow c.m/sec"
" 24.1 Hydrograph volume c.m"
" 21. Number of stages"
" 337.820 Minimum water level metre"
" 340.000 Maximum water level metre"
" 337.820 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 337.820 0.000 0.000"
" 337.929 0.00299 0.03923"
" 338.038 0.00505 0.07848"
" 338.147 0.00649 0.1177"
" 338.256 0.00766 0.1570"
" 338.365 0.00867 0.1962"
" 338.474 0.00958 0.2354"
" 338.583 0.01041 0.2747"
" 338.692 0.01118 0.3139"
" 338.801 0.01190 0.3532"
" 338.910 0.01257 0.3924"
" 339.019 0.01321 0.4316"
" 339.128 0.01383 0.4709"
" 339.237 0.01441 0.5101"
" 339.346 0.01498 0.5494"
" 339.455 0.01552 0.5886"
" 339.564 0.01605 0.6278"
" 339.673 0.01655 0.6671"
" 339.782 0.01705 0.7063"
" 339.891 0.01753 2.675"
" 340.000 0.01799 21.545"
" 1. WEIRS"
" Crest Weir Crest Left Right"
" elevation coefficient breadth sideslope sideslope"
" 340.000 0.900 10.000 0.000 0.000"
" 1. ORIFICES"
" Orifice Orifice Orifice Number of"
" Invert coefficient diameter orifices"

" 337.820 0.630 0.0750 1.000"
" 1. LAYERS"
" Bottom Aspect Bottom Top Average"
" area ratio elevation elevation sideslope"
" 0.360 1.000 337.820 339.800 0.000"
" 4. WEDGES"
" Wedge Grade 1 Grade 2 Angle Number"
" Invert g1H:1V g2H:1V subtended of wedges"
" 339.800 100.000 38.500 90.000 1.000"
" 339.800 38.500 30.000 90.000 1.000"
" 339.800 30.000 38.000 90.000 1.000"
" 339.800 38.000 100.000 90.000 1.000"
" Peak outflow 0.015 c.m/sec"
" Maximum level 339.589 metre"
" Maximum storage 0.637 c.m"
" Centroidal lag 1.488 hours"
" 0.017 0.017 0.015 0.018 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.031 c.m/sec"
" Hydrograph volume 58.103 c.m"
" 0.017 0.017 0.015 0.031"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.000 0.015 0.031"
" 33 CATCHMENT 204"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 204 Court area to CBM42"
" 65.000 % Impervious"
" 0.048 Total Area"
" 13.000 Flow length"
" 2.300 Overland Slope"
" 0.017 Pervious Area"
" 13.000 Pervious length"
" 2.300 Pervious slope"
" 0.031 Impervious Area"
" 13.000 Impervious length"
" 2.300 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.259 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. "
" 0.070 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.010 0.000 0.015 0.031 c.m/sec"
" Catchment 204 Pervious Impervious Total Area "
" Surface Area 0.017 0.031 0.048 hectare"
" Time of concentration 11.166 1.159 2.542 minutes"
" Time to Centroid 111.499 87.464 90.786 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 7.99 14.84 22.82 c.m"
" Rainfall losses 35.225 6.179 16.345 mm"
" Runoff depth 12.324 41.370 31.204 mm"
" Runoff volume 2.07 12.91 14.98 c.m"
" Runoff coefficient 0.259 0.870 0.656 "
" Maximum flow 0.001 0.010 0.010 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.010 0.010 0.015 0.031"
" 33 CATCHMENT 211"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 211 South backyard to CB3"
" 3.000 % Impervious"
" 0.064 Total Area"
" 80.000 Flow length"
" 2.100 Overland Slope"
" 0.062 Pervious Area"
" 80.000 Pervious length"
" 2.100 Pervious slope"
" 0.002 Impervious Area"
" 80.000 Impervious length"
" 2.100 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.259 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. "
" 0.072 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.002 0.010 0.015 0.031 c.m/sec"
" Catchment 211 Pervious Impervious Total Area "
" Surface Area 0.062 0.002 0.064 hectare"
" Time of concentration 34.139 3.543 31.257 minutes"
" Time to Centroid 139.545 90.988 134.972 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 29.52 0.91 30.43 c.m"
" Rainfall losses 35.212 6.074 34.338 mm"

" Runoff depth 12.337 41.476 13.211 mm"
" Runoff volume 7.66 0.80 8.46 c.m"
" Runoff coefficient 0.259 0.872 0.278 "
" Maximum flow 0.002 0.001 0.002 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.002 0.011 0.015 0.031"
" 33 CATCHMENT 205"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 205 Parking and promenade areas between building B and C to OGS2"
" 85.000 % Impervious"
" 0.082 Total Area"
" 16.000 Flow length"
" 1.800 Overland Slope"
" 0.012 Pervious Area"
" 16.000 Pervious length"
" 1.800 Pervious slope"
" 0.070 Impervious Area"
" 16.000 Impervious length"
" 1.800 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.259 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. "
" 0.077 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.022 0.011 0.015 0.031 c.m/sec"
" Catchment 205 Pervious Impervious Total Area "
" Surface Area 0.012 0.070 0.082 hectare"
" Time of concentration 13.613 1.413 2.017 minutes"
" Time to Centroid 114.502 87.763 89.089 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 5.85 33.14 38.99 c.m"
" Rainfall losses 35.229 5.860 10.266 mm"
" Runoff depth 12.320 41.689 37.283 mm"
" Runoff volume 1.52 29.06 30.57 c.m"
" Runoff coefficient 0.259 0.877 0.784 "
" Maximum flow 0.001 0.022 0.022 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.022 0.032 0.015 0.031"
" 33 CATCHMENT 206"
" 1 Triangular SCS"
" 1 Equal length"

" 1 SCS method"
" 206 Parking and promnade areas between Building A and B to OGS1"
" 80.000 % Impervious"
" 0.086 Total Area"
" 21.000 Flow length"
" 1.330 Overland Slope"
" 0.017 Pervious Area"
" 21.000 Pervious length"
" 1.330 Pervious slope"
" 0.069 Impervious Area"
" 21.000 Impervious length"
" 1.330 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.259 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."
" 0.879 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.021 0.032 0.015 0.031 c.m/sec"
" Catchment 206 Pervious Impervious Total Area "
" Surface Area 0.017 0.069 0.086 hectare"
" Time of concentration 17.548 1.821 2.900 minutes"
" Time to Centroid 119.282 88.376 90.496 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 8.18 32.71 40.89 c.m"
" Rainfall losses 35.231 5.749 11.646 mm"
" Runoff depth 12.318 41.800 35.903 mm"
" Runoff volume 2.12 28.76 30.88 c.m"
" Runoff coefficient 0.259 0.879 0.755 "
" Maximum flow 0.001 0.021 0.021 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.021 0.053 0.015 0.031"
" 33 CATCHMENT 207"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 207 North and west areas of Building A to Columbia Street"
" 75.000 % Impervious"
" 0.038 Total Area"
" 30.000 Flow length"
" 2.500 Overland Slope"
" 0.010 Pervious Area"
" 30.000 Pervious length"
" 2.500 Pervious slope"
" 0.028 Impervious Area"

" 30.000 Impervious length"
" 2.500 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.259 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."
" 0.879 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.009 0.053 0.015 0.031 c.m/sec"
" Catchment 207 Pervious Impervious Total Area "
" Surface Area 0.010 0.028 0.038 hectare"
" Time of concentration 17.987 1.867 3.310 minutes"
" Time to Centroid 119.829 88.446 91.256 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 4.52 13.55 18.07 c.m"
" Rainfall losses 35.224 5.772 13.135 mm"
" Runoff depth 12.325 41.777 34.414 mm"
" Runoff volume 1.17 11.91 13.08 c.m"
" Runoff coefficient 0.259 0.879 0.724 "
" Maximum flow 0.000 0.009 0.009 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.009 0.062 0.015 0.031"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
" 0.009 0.062 0.062 0.031"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.092 c.m/sec"
" Hydrograph volume 156.063 c.m"
" 0.009 0.062 0.062 0.092"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.009 0.000 0.062 0.092"
" 33 CATCHMENT 208"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 208 Roof - Building A "
" 100.000 % Impervious"
" 0.077 Total Area"
" 9.000 Flow length"
" 0.500 Overland Slope"
" 0.000 Pervious Area"

" 9.000 Pervious length"
" 0.500 Pervious slope"
" 0.077 Impervious Area"
" 9.000 Impervious length"
" 0.500 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."
" 0.877 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.024 0.000 0.062 0.092 c.m/sec"
" Catchment 208 Pervious Impervious Total Area "
" Surface Area 0.000 0.077 0.077 hectare"
" Time of concentration 14.155 1.469 1.469 minutes"
" Time to Centroid 115.163 87.834 87.834 minutes"
" Rainfall depth 47.549 47.549 47.549 mm"
" Rainfall volume 0.00 36.61 36.61 c.m"
" Rainfall losses 35.220 5.832 5.832 mm"
" Runoff depth 12.329 41.717 41.717 mm"
" Runoff volume 0.00 32.12 32.12 c.m"
" Runoff coefficient 0.000 0.877 0.877 "
" Maximum flow 0.000 0.024 0.024 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.024 0.024 0.062 0.092"
" 54 POND DESIGN"
" 0.024 Current peak flow c.m/sec"
" 0.032 Target outflow c.m/sec"
" 32.1 Hydrograph volume c.m"
" 11. Number of stages"
" 0.000 Minimum water level metre"
" 0.175 Maximum water level metre"
" 0.000 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 0.000 0.000 0.000 "
" 0.01750 0.00084 0.8146 "
" 0.03500 0.00168 6.517 "
" 0.05250 0.00252 16.490 "
" 0.07000 0.00336 26.465 "
" 0.08750 0.00420 36.440 "
" 0.1050 0.00504 46.415 "
" 0.1225 0.00588 56.390 "
" 0.1400 0.00672 66.365 "
" 0.1575 0.00756 76.340 "

" 0.1750 0.00840 86.315"
" 1. ROOFTOP"
" Roof area Store area Area/drain Drain flow Roof slope"
" hectare hectare sq.metre L/min/25mm g H:1V"
" 0.077 0.057 200.000 24.000 280.000"
" Using 3 roofdrains on roofstorage area of 570. square metre"
" Peak outflow 0.003 c.m/sec"
" Maximum level 0.059 metre"
" Maximum storage 20.246 c.m"
" Centroidal lag 2.918 hours"
" 0.024 0.024 0.003 0.092 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.094 c.m/sec"
" Hydrograph volume 188.178 c.m"
" 0.024 0.024 0.003 0.094"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.024 0.000 0.003 0.094"
" 33 CATCHMENT 209"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 209 Roof - Building B"
" 100.000 % Impervious"
" 0.078 Total Area"
" 9.000 Flow length"
" 0.500 Overland Slope"
" 0.000 Pervious Area"
" 9.000 Pervious length"
" 0.500 Pervious slope"
" 0.078 Impervious Area"
" 9.000 Impervious length"
" 0.500 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."
" 0.877 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.024 0.000 0.003 0.094 c.m/sec"
" Catchment 209 Pervious Impervious Total Area "
" Surface Area 0.000 0.078 0.078 hectare"
" Time of concentration 14.155 1.469 1.469 minutes"

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"      Time to Centroid      115.163      87.834      87.834      minutes"
"      Rainfall depth        47.549      47.549      47.549      mm"
"      Rainfall volume        0.00      37.09      37.09      c.m"
"      Rainfall losses        35.220      5.832      5.832      mm"
"      Runoff depth           12.329      41.717      41.717      mm"
"      Runoff volume           0.00      32.54      32.54      c.m"
"      Runoff coefficient      0.000      0.877      0.877      "
"      Maximum flow           0.000      0.024      0.024      c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.024      0.024      0.003      0.094"
" 54  POND DESIGN"
"      0.024 Current peak flow c.m/sec"
"      0.022 Target outflow c.m/sec"
"      32.5 Hydrograph volume c.m"
"      11. Number of stages"
"      0.000 Minimum water level metre"
"      0.175 Maximum water level metre"
"      0.000 Starting water level metre"
"      0 Keep Design Data: 1 = True; 0 = False"
"      Level Discharge Volume"
"      0.000      0.000      0.000"
"      0.01750      0.00084      0.8289"
"      0.03500      0.00168      6.631"
"      0.05250      0.00252      16.779"
"      0.07000      0.00336      26.929"
"      0.08750      0.00420      37.079"
"      0.10500      0.00504      47.229"
"      0.12250      0.00588      57.379"
"      0.14000      0.00672      67.529"
"      0.15750      0.00756      77.679"
"      0.17500      0.00840      87.829"
"      1. ROOFTOP"
"      Roof area Store area Area/drain Drain flow Roof slope"
"      hectare hectare sq.metre L/min/25mm g H:1V"
"      0.078      0.058      200.000      24.000      200.000"
"      Using 3 roofdrains on roofstorage area of 580. square metre"
"      Peak outflow      0.003      c.m/sec"
"      Maximum level      0.050      metre"
"      Maximum storage      20.593      c.m"
"      Centroidal lag      2.943      hours"
"      0.024      0.024      0.003      0.094 c.m/sec"
" 40  HYDROGRAPH Combine 1"
"      6 Combine "
"      1 Node #"
"      Columbia Street"
"      Maximum flow      0.095      c.m/sec"
"      Hydrograph volume      220.714      c.m"
"      0.024      0.024      0.003      0.095"
" 40  HYDROGRAPH Start - New Tributary"

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"      2 Start - New Tributary"
"      0.024      0.000      0.003      0.095"
" 33  CATCHMENT 210"
"      1 Triangular SCS"
"      1 Equal length"
"      1 SCS method"
"      210 Roof - Building C"
"      100.000 % Impervious"
"      0.170 Total Area"
"      7.000 Flow length"
"      0.500 Overland Slope"
"      0.000 Pervious Area"
"      7.000 Pervious length"
"      0.500 Pervious slope"
"      0.170 Impervious Area"
"      7.000 Impervious length"
"      0.500 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"
"      0.053      0.000      0.003      0.095 c.m/sec"
"      Catchment 210 Pervious Impervious Total Area "
"      Surface Area      0.000      0.170      0.170      hectare"
"      Time of concentration      12.174      1.263      1.263      minutes"
"      Time to Centroid      112.743      87.606      87.606      minutes"
"      Rainfall depth      47.549      47.549      47.549      mm"
"      Rainfall volume      0.00      80.83      80.83      c.m"
"      Rainfall losses      35.251      6.008      6.008      mm"
"      Runoff depth      12.299      41.541      41.541      mm"
"      Runoff volume      0.00      70.62      70.62      c.m"
"      Runoff coefficient      0.000      0.874      0.874      "
"      Maximum flow      0.000      0.053      0.053      c.m/sec"
" 40  HYDROGRAPH Add Runoff "
"      4 Add Runoff "
"      0.053      0.053      0.003      0.095"
" 54  POND DESIGN"
"      0.053 Current peak flow c.m/sec"
"      0.045 Target outflow c.m/sec"
"      70.6 Hydrograph volume c.m"
"      11. Number of stages"
"      0.000 Minimum water level metre"
"      0.175 Maximum water level metre"
"      0.000 Starting water level metre"

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"      0 Keep Design Data: 1 = True; 0 = False"
"      Level Discharge Volume"
"      0.000      0.000      0.000"
"      0.01750      0.00084      0.9075"
"      0.03500      0.00168      7.260"
"      0.05250      0.00252      24.342"
"      0.07000      0.00336      46.567"
"      0.08750      0.00420      68.792"
"      0.10500      0.00504      91.017"
"      0.12250      0.00588      113.242"
"      0.14000      0.00672      135.467"
"      0.15750      0.00756      157.692"
"      0.17500      0.00840      179.917"
"      1. ROOFTOP"
"      Roof area Store area Area/drain Drain flow Roof slope"
"      hectare hectare sq.metre L/min/25mm g H:1V"
"      0.170      0.127      400.000      24.000      200.000"
"      Using 3 roofdrains on roofstorage area of 1270. square metre"
"      Peak outflow      0.004      c.m/sec"
"      Maximum level      0.074      metre"
"      Maximum storage      51.280      c.m"
"      Centroidal lag      4.299      hours"
"      0.053      0.053      0.004      0.095 c.m/sec"
" 40  HYDROGRAPH Combine 1"
"      6 Combine "
"      1 Node #"
"      Columbia Street"
"      Maximum flow      0.098      c.m/sec"
"      Hydrograph volume      291.329      c.m"
"      0.053      0.053      0.004      0.098"
" 40  HYDROGRAPH Confluence 1"
"      7 Confluence "
"      1 Node #"
"      Columbia Street"
"      Maximum flow      0.098      c.m/sec"
"      Hydrograph volume      291.329      c.m"
"      0.053      0.098      0.004      0.000"
" 38  START/RE-START TOTALS 1"
"      3 Runoff Totals on EXIT"
"      Total Catchment area      0.800      hectare"
"      Total Impervious area      0.659      hectare"
"      Total % impervious      82.321"
" 19  EXIT"

```

" MIDUSS Output ----->"
" MIDUSS version Version 2.25 rev. 473"
" MIDUSS created February 7, 2010"
" Units used: ie METRIC"
" 10 Job folder: C:\Users\hmoarefi\Desktop"
" 81 ADD COMMENT="-----"
" 1 Lines of comment"
" 31 143 Columbia Street West- post development-100 year- run 3"
" 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 201"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 201 East area of Building A to CB1"
" 85.000 % Impervious"
" 0.031 Total Area"
" 10.000 Flow length"
" 3.000 Overland Slope"
" 0.005 Pervious Area"
" 10.000 Pervious length"
" 3.000 Pervious slope"
" 0.026 Impervious Area"
" 10.000 Impervious length"
" 3.000 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.442 Pervious Runoff coefficient"
" 0.100 Pervious Ia/S coefficient"
" 8.467 Pervious Initial abstraction"
" 0.015 Impervious Manning 'n'"
" 98.000 Pervious SCS Curve No."
" 0.880 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.016 0.000 0.000 0.000 c.m/sec"
" Catchment 201 Pervious Impervious Total Area "

" Surface Area 0.005 0.026 0.031 hectare"
" Time of concentration 5.351 0.721 1.097 minutes"
" Time to Centroid 99.893 85.204 86.399 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 4.18 23.70 27.89 c.m"
" Rainfall losses 50.209 10.752 16.671 mm"
" Runoff depth 39.751 79.208 73.289 mm"
" Runoff volume 1.85 20.87 22.72 c.m"
" Runoff coefficient 0.442 0.880 0.815 "
" Maximum flow 0.001 0.015 0.016 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.016 0.016 0.000 0.000"
" 33 CATCHMENT 202"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 202 East area of Buildings A and B to CBMH1"
" 85.000 % Impervious"
" 0.061 Total Area"
" 18.000 Flow length"
" 1.850 Overland Slope"
" 0.009 Pervious Area"
" 18.000 Pervious length"
" 1.850 Pervious slope"
" 0.052 Impervious Area"
" 18.000 Impervious length"
" 1.850 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.442 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."
" 0.919 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.031 0.016 0.000 0.000 c.m/sec"
" Catchment 202 Pervious Impervious Total Area "
" Surface Area 0.009 0.052 0.061 hectare"
" Time of concentration 8.801 1.185 1.781 minutes"
" Time to Centroid 104.169 85.709 87.153 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 8.23 46.64 54.88 c.m"
" Rainfall losses 50.183 7.256 13.695 mm"
" Runoff depth 39.777 82.704 76.265 mm"
" Runoff volume 3.64 42.88 46.52 c.m"
" Runoff coefficient 0.442 0.919 0.848 "
" Maximum flow 0.002 0.030 0.031 c.m/sec"

" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.031 0.046 0.000 0.000"
" 54 POND DESIGN"
" 0.046 Current peak flow c.m/sec"
" 0.020 Target outflow c.m/sec"
" 69.2 Hydrograph volume c.m"
" 21. Number of stages"
" 337.410 Minimum water level metre"
" 339.800 Maximum water level metre"
" 337.410 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 337.410 0.000 0.000"
" 337.530 0.00326 1.00E-07"
" 337.649 0.00536 1.00E-07"
" 337.768 0.00684 0.2124"
" 337.888 0.00807 0.4284"
" 338.008 0.00913 0.6444"
" 338.127 0.01007 0.8586"
" 338.246 0.01093 1.073"
" 338.366 0.01173 1.289"
" 338.486 0.01249 1.505"
" 338.605 0.01319 1.719"
" 338.724 0.01386 1.933"
" 338.844 0.01450 2.149"
" 338.964 0.01512 2.365"
" 339.083 0.01571 2.579"
" 339.202 0.01627 2.794"
" 339.322 0.01682 3.010"
" 339.441 0.01735 3.523"
" 339.561 0.06455 15.146"
" 339.680 0.8220 74.553"
" 339.800 2.053 234.259"
" 1. WEIRS"
" Crest Weir Crest Left Right"
" elevation coefficient breadth sideslope sideslope"
" 339.540 0.900 10.000 0.000 0.000"
" 1. ORIFICES"
" Orifice Orifice Orifice Number of"
" invert coefficient diameter orifices"
" 337.410 0.630 0.0750 1.000"
" 1. LAYERS"
" Bottom Aspect Bottom Top Average"
" area ratio elevation elevation sideslope"
" 1.800 1.000 337.650 339.450 0.000"
" 8. WEDGES"
" Wedge Grade 1 Grade 2 Angle Number"
" invert g1H:1V g2H:1V subtended of wedges"
" 339.500 53.000 50.000 90.000 1.000"

" 339.500 50.000 100.000 90.000 1.000"
" 339.500 100.000 20.000 90.000 1.000"
" 339.500 20.000 53.000 90.000 1.000"
" 339.390 100.000 20.000 90.000 1.000"
" 339.390 20.000 23.000 90.000 1.000"
" 339.390 23.000 50.000 90.000 1.000"
" 339.390 50.000 100.000 90.000 1.000"
" Peak outflow 0.036 c.m/sec"
" Maximum level 339.489 metre"
" Maximum storage 8.160 c.m"
" Centroidal lag 1.489 hours"
" 0.031 0.046 0.036 0.000 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node # "
" Columbia Street"
" Maximum flow 0.036 c.m/sec"
" Hydrograph volume 69.385 c.m"
" 0.031 0.046 0.036 0.036"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.031 0.000 0.036 0.036"
" 33 CATCHMENT 203"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 203 Southeast area of Building B to CB2"
" 85.000 % Impervious"
" 0.065 Total Area"
" 16.000 Flow length"
" 2.650 Overland Slope"
" 0.010 Pervious Area"
" 16.000 Pervious length"
" 2.650 Pervious slope"
" 0.055 Impervious Area"
" 16.000 Impervious length"
" 2.650 Impervious slope"
" 0.250 Pervious Manning 'n'"
" 75.000 Pervious SCS Curve No."
" 0.442 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"
" 0.033 0.000 0.036 0.036 c.m/sec"
" Catchment 203 Pervious Impervious Total Area "
" Surface Area 0.010 0.055 0.065 hectare"

" Time of concentration 7.363 0.992 1.495 minutes"
" Time to Centroid 102.476 85.464 86.808 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 8.77 49.70 58.47 c.m"
" Rainfall losses 58.218 8.220 14.520 mm"
" Runoff depth 39.742 81.740 75.440 mm"
" Runoff volume 3.87 45.16 49.04 c.m"
" Runoff coefficient 0.442 0.909 0.839 "
" Maximum flow 0.002 0.032 0.033 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.033 0.033 0.036 0.036"
" 54 POND DESIGN"
" 0.033 Current peak flow c.m/sec"
" 0.020 Target outflow c.m/sec"
" 49.0 Hydrograph volume c.m"
" 21. Number of stages"
" 337.820 Minimum water level metre"
" 340.000 Maximum water level metre"
" 337.820 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 337.820 0.000 0.000"
" 337.929 0.00299 0.03923"
" 338.038 0.00505 0.07848"
" 338.147 0.00649 0.1177"
" 338.256 0.00766 0.1570"
" 338.365 0.00867 0.1962"
" 338.474 0.00958 0.2354"
" 338.583 0.01041 0.2747"
" 338.692 0.01118 0.3139"
" 338.801 0.01190 0.3532"
" 338.910 0.01257 0.3924"
" 339.019 0.01321 0.4316"
" 339.128 0.01383 0.4709"
" 339.237 0.01441 0.5101"
" 339.346 0.01498 0.5494"
" 339.455 0.01552 0.5886"
" 339.564 0.01605 0.6278"
" 339.673 0.01655 0.6671"
" 339.782 0.01705 0.7063"
" 339.891 0.01753 2.675"
" 340.000 0.01799 21.545"
" 1. WEIRS"
" Crest Weir Crest Left Right"
" elevation coefficient breadth sideslope sideslope"
" 340.000 0.900 10.000 0.000 0.000"
" 1. ORIFICES"
" Orifice Orifice Orifice Number of"
" Invert coefficient diameter orifices"

" 337.820 0.630 0.0750 1.000"
" 1. LAYERS"
" Bottom Aspect Bottom Top Average"
" area ratio elevation elevation sideslope"
" 0.360 1.000 337.820 339.800 0.000"
" 4. WEDGES"
" Wedge Grade 1 Grade 2 Angle Number"
" Invert g1H:1V g2H:1V subtended of wedges"
" 339.800 100.000 38.500 90.000 1.000"
" 339.800 38.500 30.000 90.000 1.000"
" 339.800 30.000 38.000 90.000 1.000"
" 339.800 38.000 100.000 90.000 1.000"
" Peak outflow 0.018 c.m/sec"
" Maximum level 339.915 metre"
" Maximum storage 6.758 c.m"
" Centroidal lag 1.495 hours"
" 0.033 0.033 0.018 0.036 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.054 c.m/sec"
" Hydrograph volume 119.016 c.m"
" 0.033 0.033 0.018 0.054"
" 40 HYDROGRAPH Start - New Tributary"
" 2 Start - New Tributary"
" 0.033 0.000 0.018 0.054"
" 33 CATCHMENT 204"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 204 Court area to CBMH2"
" 65.000 % Impervious"
" 0.048 Total Area"
" 13.000 Flow length"
" 2.300 Overland Slope"
" 0.017 Pervious Area"
" 13.000 Pervious length"
" 2.300 Pervious slope"
" 0.031 Impervious Area"
" 13.000 Impervious length"
" 2.300 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.444 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. "
" 0.902 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.020 0.000 0.018 0.054 c.m/sec"
" Catchment 204 Pervious Impervious Total Area "
" Surface Area 0.017 0.031 0.048 hectare"
" Time of concentration 6.782 0.914 2.133 minutes"
" Time to Centroid 101.787 85.369 88.781 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 15.11 28.07 43.18 c.m"
" Rainfall losses 58.415 8.796 23.362 mm"
" Runoff depth 39.545 81.164 66.598 mm"
" Runoff volume 6.64 25.32 31.97 c.m"
" Runoff coefficient 0.440 0.902 0.740 "
" Maximum flow 0.004 0.018 0.020 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.020 0.020 0.018 0.054"
" 33 CATCHMENT 211"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 211 South backyard to CB3"
" 3.000 % Impervious"
" 0.064 Total Area"
" 80.000 Flow length"
" 2.100 Overland Slope"
" 0.062 Pervious Area"
" 80.000 Pervious length"
" 2.100 Pervious slope"
" 0.002 Impervious Area"
" 80.000 Impervious length"
" 2.100 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.444 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. "
" 0.918 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.009 0.020 0.018 0.054 c.m/sec"
" Catchment 211 Pervious Impervious Total Area "
" Surface Area 0.062 0.002 0.064 hectare"
" Time of concentration 20.736 2.793 19.657 minutes"
" Time to Centroid 119.124 87.994 117.252 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 55.85 1.73 57.57 c.m"
" Rainfall losses 58.016 7.354 48.736 mm"

" Runoff depth 39.944 82.606 41.224 mm"
" Runoff volume 24.80 1.59 26.38 c.m"
" Runoff coefficient 0.444 0.918 0.458 "
" Maximum flow 0.009 0.001 0.009 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.009 0.022 0.018 0.054"
" 33 CATCHMENT 205"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 205 Parking and promenade areas between building B and C to OGS2"
" 85.000 % Impervious"
" 0.082 Total Area"
" 16.000 Flow length"
" 1.800 Overland Slope"
" 0.012 Pervious Area"
" 16.000 Pervious length"
" 1.800 Pervious slope"
" 0.070 Impervious Area"
" 16.000 Impervious length"
" 1.800 Impervious slope"
" 0.250 Pervious Manning 'n' "
" 75.000 Pervious SCS Curve No. "
" 0.443 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. "
" 0.916 Impervious Runoff coefficient"
" 0.100 Impervious Ia/S coefficient"
" 0.518 Impervious Initial abstraction"
" 0.041 0.022 0.018 0.054 c.m/sec"
" Catchment 205 Pervious Impervious Total Area "
" Surface Area 0.012 0.070 0.082 hectare"
" Time of concentration 8.269 1.114 1.676 minutes"
" Time to Centroid 103.561 85.621 87.030 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 11.07 62.70 73.77 c.m"
" Rainfall losses 50.133 7.542 13.930 mm"
" Runoff depth 39.827 82.418 76.030 mm"
" Runoff volume 4.90 57.45 62.34 c.m"
" Runoff coefficient 0.443 0.916 0.845 "
" Maximum flow 0.003 0.040 0.041 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.041 0.063 0.018 0.054"
" 33 CATCHMENT 206"
" 1 Triangular SCS"
" 1 Equal length"

" 1 SCS method"

" 206 Parking and promnade areas between Building A and B to OGS1"

" 80.000 % Impervious"

" 0.006 Total Area"

" 21.000 Flow length"

" 1.330 Overland Slope"

" 0.017 Pervious Area"

" 21.000 Pervious length"

" 1.330 Pervious slope"

" 0.069 Impervious Area"

" 21.000 Impervious length"

" 1.330 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.443 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."

" 0.926 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.040 0.063 0.018 0.054 c.m/sec"

" Catchment 206 Pervious Impervious Total Area "

" Surface Area 0.017 0.069 0.086 hectare"

" Time of concentration 10.659 1.436 2.422 minutes"

" Time to Centroid 106.500 85.990 88.182 minutes"

" Rainfall depth 89.960 89.960 89.960 mm"

" Rainfall volume 15.47 61.89 77.37 c.m"

" Rainfall losses 50.090 6.681 15.363 mm"

" Runoff depth 39.870 83.279 74.597 mm"

" Runoff volume 6.86 57.30 64.15 c.m"

" Runoff coefficient 0.443 0.926 0.829 "

" Maximum flow 0.003 0.039 0.040 c.m/sec"

" 40 HYDROGRAPH Add Runoff "

" 4 Add Runoff "

" 0.040 0.103 0.018 0.054"

" 33 CATCHMENT 207"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 207 North and west areas of Building A to Columbia Street"

" 75.000 % Impervious"

" 0.038 Total Area"

" 30.000 Flow length"

" 2.500 Overland Slope"

" 0.010 Pervious Area"

" 30.000 Pervious length"

" 2.500 Pervious slope"

" 0.028 Impervious Area"

" 30.000 Impervious length"

" 2.500 Impervious slope"

" 0.250 Pervious Manning 'n'"

" 75.000 Pervious SCS Curve No."

" 0.443 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."

" 0.926 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.017 0.103 0.018 0.054 c.m/sec"

" Catchment 207 Pervious Impervious Total Area "

" Surface Area 0.010 0.028 0.038 hectare"

" Time of concentration 10.925 1.472 2.773 minutes"

" Time to Centroid 106.823 86.038 88.898 minutes"

" Rainfall depth 89.960 89.960 89.960 mm"

" Rainfall volume 8.55 25.64 34.18 c.m"

" Rainfall losses 50.066 6.632 17.491 mm"

" Runoff depth 39.894 83.328 72.469 mm"

" Runoff volume 3.79 23.75 27.54 c.m"

" Runoff coefficient 0.443 0.926 0.806 "

" Maximum flow 0.002 0.016 0.017 c.m/sec"

" 40 HYDROGRAPH Add Runoff "

" 4 Add Runoff "

" 0.017 0.120 0.018 0.054"

" 40 HYDROGRAPH Copy to Outflow"

" 8 Copy to Outflow"

" 0.017 0.120 0.120 0.054"

" 40 HYDROGRAPH Combine 1"

" 6 Combine "

" 1 Node #"

" Columbia Street"

" Maximum flow 0.167 c.m/sec"

" Hydrograph volume 331.402 c.m"

" 0.017 0.120 0.120 0.167"

" 40 HYDROGRAPH Start - New Tributary"

" 2 Start - New Tributary"

" 0.017 0.000 0.120 0.167"

" 33 CATCHMENT 208"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 208 Roof - Building A "

" 100.000 % Impervious"

" 0.077 Total Area"

" 9.000 Flow length"

" 0.500 Overland Slope"

" 0.000 Pervious Area"

" 9.000 Pervious length"

" 0.500 Pervious slope"

" 0.077 Impervious Area"

" 9.000 Impervious length"

" 0.500 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."

" 0.918 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.045 0.000 0.120 0.167 c.m/sec"

" Catchment 208 Pervious Impervious Total Area "

" Surface Area 0.000 0.077 0.077 hectare"

" Time of concentration 8.598 1.158 1.158 minutes"

" Time to Centroid 103.906 85.674 85.674 minutes"

" Rainfall depth 89.960 89.960 89.960 mm"

" Rainfall volume 0.00 69.27 69.27 c.m"

" Rainfall losses 50.160 7.356 7.356 mm"

" Runoff depth 39.800 82.604 82.604 mm"

" Runoff volume 0.00 63.60 63.60 c.m"

" Runoff coefficient 0.000 0.918 0.918 "

" Maximum flow 0.000 0.045 0.045 c.m/sec"

" 40 HYDROGRAPH Add Runoff "

" 4 Add Runoff "

" 0.045 0.045 0.120 0.167"

" 54 POND DESIGN"

" 0.045 Current peak flow c.m/sec"

" 0.032 Target outflow c.m/sec"

" 63.6 Hydrograph volume c.m"

" 11. Number of stages"

" 0.000 Minimum water level metre"

" 0.175 Maximum water level metre"

" 0.000 Starting water level metre"

" 0 Keep Design Data: 1 = True; 0 = False"

" Level Discharge Volume"

" 0.000 0.000 0.000"

" 0.01750 0.00084 0.8146"

" 0.03500 0.00168 6.517"

" 0.05250 0.00252 16.490"

" 0.07000 0.00336 26.465"

" 0.08750 0.00420 36.440"

" 0.1050 0.00504 46.415"

" 0.1225 0.00588 56.390"

" 0.1400 0.00672 66.365"

" 0.1575 0.00756 76.340"

" 0.1750 0.00840 86.315"

" 1. ROOFTOP"

" Roof area Store area Area/drain Drain flow Roof slope"

" hectare hectare sq.metre L/min/25mm g H:1V"

" 0.077 0.057 200.000 24.000 280.000"

" Using 3 roofdrains on roofstorage area of 570. square metre"

" Peak outflow 0.005 c.m/sec"

" Maximum level 0.100 metre"

" Maximum storage 43.364 c.m"

" Centroidal lag 3.389 hours"

" 0.045 0.045 0.005 0.167 c.m/sec"

" 40 HYDROGRAPH Combine 1"

" 6 Combine "

" 1 Node #"

" Columbia Street"

" Maximum flow 0.169 c.m/sec"

" Hydrograph volume 395.008 c.m"

" 0.045 0.045 0.005 0.169"

" 40 HYDROGRAPH Start - New Tributary"

" 2 Start - New Tributary"

" 0.045 0.000 0.005 0.169"

" 33 CATCHMENT 209"

" 1 Triangular SCS"

" 1 Equal length"

" 1 SCS method"

" 209 Roof - Building B"

" 100.000 % Impervious"

" 0.078 Total Area"

" 9.000 Flow length"

" 0.500 Overland Slope"

" 0.000 Pervious Area"

" 9.000 Pervious length"

" 0.500 Pervious slope"

" 0.078 Impervious Area"

" 9.000 Impervious length"

" 0.500 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."

" 0.918 Impervious Runoff coefficient"

" 0.100 Impervious Ia/S coefficient"

" 0.518 Impervious Initial abstraction"

" 0.045 0.000 0.005 0.169 c.m/sec"

" Catchment 209 Pervious Impervious Total Area "

" Surface Area 0.000 0.078 0.078 hectare"

" Time of concentration 8.598 1.158 1.158 minutes"

" Time to Centroid 103.906 85.674 85.674 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 0.00 70.17 70.17 c.m"
" Rainfall losses 50.160 7.356 7.356 mm"
" Runoff depth 39.800 82.604 82.604 mm"
" Runoff volume 0.00 64.43 64.43 c.m"
" Runoff coefficient 0.000 0.918 0.918 "
" Maximum flow 0.000 0.045 0.045 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.045 0.045 0.005 0.169"
" 54 POND DESIGN"
" 0.045 Current peak flow c.m/sec"
" 0.022 Target outflow c.m/sec"
" 64.4 Hydrograph volume c.m"
" 11. Number of stages"
" 0.000 Minimum water level metre"
" 0.175 Maximum water level metre"
" 0.000 Starting water level metre"
" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 0.000 0.000 0.000"
" 0.01750 0.00084 0.8289"
" 0.03500 0.00168 6.631"
" 0.05250 0.00252 16.779"
" 0.07000 0.00336 26.929"
" 0.08750 0.00420 37.079"
" 0.1050 0.00504 47.229"
" 0.1225 0.00588 57.379"
" 0.1400 0.00672 67.529"
" 0.1575 0.00756 77.679"
" 0.1750 0.00840 87.829"
" 1. ROOFTOP"
" Roof area Store area Area/drain Drain flow Roof slope"
" hectare hectare sq.metre L/min/25mm g H:1V"
" 0.078 0.058 200.000 24.000 200.000"
" Using 3 roofdrains on roofstorage area of 580. square metre"
" Peak outflow 0.005 c.m/sec"
" Maximum level 0.100 metre"
" Maximum storage 44.086 c.m"
" Centroidal lag 3.423 hours"
" 0.045 0.045 0.005 0.169 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.172 c.m/sec"
" Hydrograph volume 459.440 c.m"
" 0.045 0.045 0.005 0.172"
" 40 HYDROGRAPH Start - New Tributary"

" 2 Start - New Tributary"
" 0.045 0.000 0.005 0.172"
" 33 CATCHMENT 210"
" 1 Triangular SCS"
" 1 Equal length"
" 1 SCS method"
" 210 Roof - Building C"
" 100.000 % Impervious"
" 0.170 Total Area"
" 7.000 Flow length"
" 0.500 Overland Slope"
" 0.000 Pervious Area"
" 7.000 Pervious length"
" 0.500 Pervious slope"
" 0.170 Impervious Area"
" 7.000 Impervious length"
" 0.500 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"
" 0.098 0.000 0.005 0.172 c.m/sec"
" Catchment 210 Pervious Impervious Total Area "
" Surface Area 0.000 0.170 0.170 hectare"
" Time of concentration 7.394 0.996 0.996 minutes"
" Time to Centroid 102.515 85.470 85.470 minutes"
" Rainfall depth 89.960 89.960 89.960 mm"
" Rainfall volume 0.00 152.93 152.93 c.m"
" Rainfall losses 50.216 8.192 8.192 mm"
" Runoff depth 39.744 81.768 81.768 mm"
" Runoff volume 0.00 139.01 139.01 c.m"
" Runoff coefficient 0.000 0.909 0.909 "
" Maximum flow 0.000 0.098 0.098 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
" 0.098 0.098 0.005 0.172"
" 54 POND DESIGN"
" 0.098 Current peak flow c.m/sec"
" 0.045 Target outflow c.m/sec"
" 139.0 Hydrograph volume c.m"
" 11. Number of stages"
" 0.000 Minimum water level metre"
" 0.175 Maximum water level metre"
" 0.000 Starting water level metre"

" 0 Keep Design Data: 1 = True; 0 = False"
" Level Discharge Volume"
" 0.000 0.000 0.000"
" 0.01750 0.00084 0.9075"
" 0.03500 0.00168 7.260"
" 0.05250 0.00252 24.342"
" 0.07000 0.00336 46.567"
" 0.08750 0.00420 68.792"
" 0.1050 0.00504 91.017"
" 0.1225 0.00588 113.242"
" 0.1400 0.00672 135.467"
" 0.1575 0.00756 157.692"
" 0.1750 0.00840 179.917"
" 1. ROOFTOP"
" Roof area Store area Area/drain Drain flow Roof slope"
" hectare hectare sq.metre L/min/25mm g H:1V"
" 0.170 0.127 400.000 24.000 200.000"
" Using 3 roofdrains on roofstorage area of 1270. square metre"
" Peak outflow 0.006 c.m/sec"
" Maximum level 0.118 metre"
" Maximum storage 108.049 c.m"
" Centroidal lag 5.365 hours"
" 0.098 0.098 0.006 0.172 c.m/sec"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.175 c.m/sec"
" Hydrograph volume 598.445 c.m"
" 0.098 0.098 0.006 0.175"
" 40 HYDROGRAPH Confluence 1"
" 7 Confluence "
" 1 Node #"
" Columbia Street"
" Maximum flow 0.175 c.m/sec"
" Hydrograph volume 598.445 c.m"
" 0.098 0.175 0.006 0.000"
" 38 START/RE-START TOTALS 1"
" 3 Runoff Totals on EXIT"
" Total Catchment area 0.800 hectare"
" Total Impervious area 0.659 hectare"
" Total % impervious 82.321"
" 19 EXIT"

Appendix D

OGS Sizing Information

Detailed Stormceptor Sizing Report – 143 Columbia Street W.

Project Information & Location			
Project Name	143 Columbia Street W. - OGS1	Project Number	20-261
City	Waterloo	State/ Province	Ontario
Country	Canada	Date	10/15/2021
Designer Information		EOR Information (optional)	
Name	Hossein Moarefi	Name	
Company	K.Smart Associates Limited	Company	
Phone #	705-222-6175	Phone #	
Email	hmoarefi@ksmart.ca	Email	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	143 Columbia Street W.
Recommended Stormceptor Model	STC 300
Target TSS Removal (%)	80.0
TSS Removal (%) Provided	81
PSD	Fine Distribution
Rainfall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	% TSS Removal Provided
STC 300	81
STC 750	88
STC 1000	89
STC 1500	90
STC 2000	91
STC 3000	93
STC 4000	94
STC 5000	95
STC 6000	96
STC 9000	97
STC 10000	97
STC 14000	98
StormceptorMAX	Custom

Stormceptor

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for each rainfall event, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur. Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Design Methodology

Stormceptor is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology using local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective. The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. The Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing:

- Site parameters
- Continuous historical rainfall data, including duration, distribution, peaks & inter-event dry periods
- Particle size distribution, and associated settling velocities (Stokes Law, corrected for drag)
- TSS load
- Detention time of the system

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour). Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	Total Number of Rainfall Events	2980
Rainfall Station Name	WATERLOO WELLINGTON A	Total Rainfall (mm)	16119.1
Station ID #	9387	Average Annual Rainfall (mm)	474.1
Coordinates	43°27'N, 80°23'W	Total Evaporation (mm)	1131.1
Elevation (ft)	1028	Total Infiltration (mm)	2707.0
Years of Rainfall Data	34	Total Rainfall that is Runoff (mm)	12281.0

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

Drainage Area		Up Stream Storage	
Total Area (ha)	0.178	Storage (ha-m)	Discharge (cms)
Imperviousness %	83.00	0.000	0.000
Water Quality Objective		Up Stream Flow Diversion	
TSS Removal (%)	80.0	Max. Flow to Stormceptor (cms)	
Runoff Volume Capture (%)		Design Details	
Oil Spill Capture Volume (L)		Stormceptor Inlet Invert Elev (m)	
Peak Conveyed Flow Rate (L/s)		Stormceptor Outlet Invert Elev (m)	
Water Quality Flow Rate (L/s)		Stormceptor Rim Elev (m)	
		Normal Water Level Elevation (m)	
		Pipe Diameter (mm)	
		Pipe Material	
		Multiple Inlets (Y/N)	No
		Grate Inlet (Y/N)	Yes

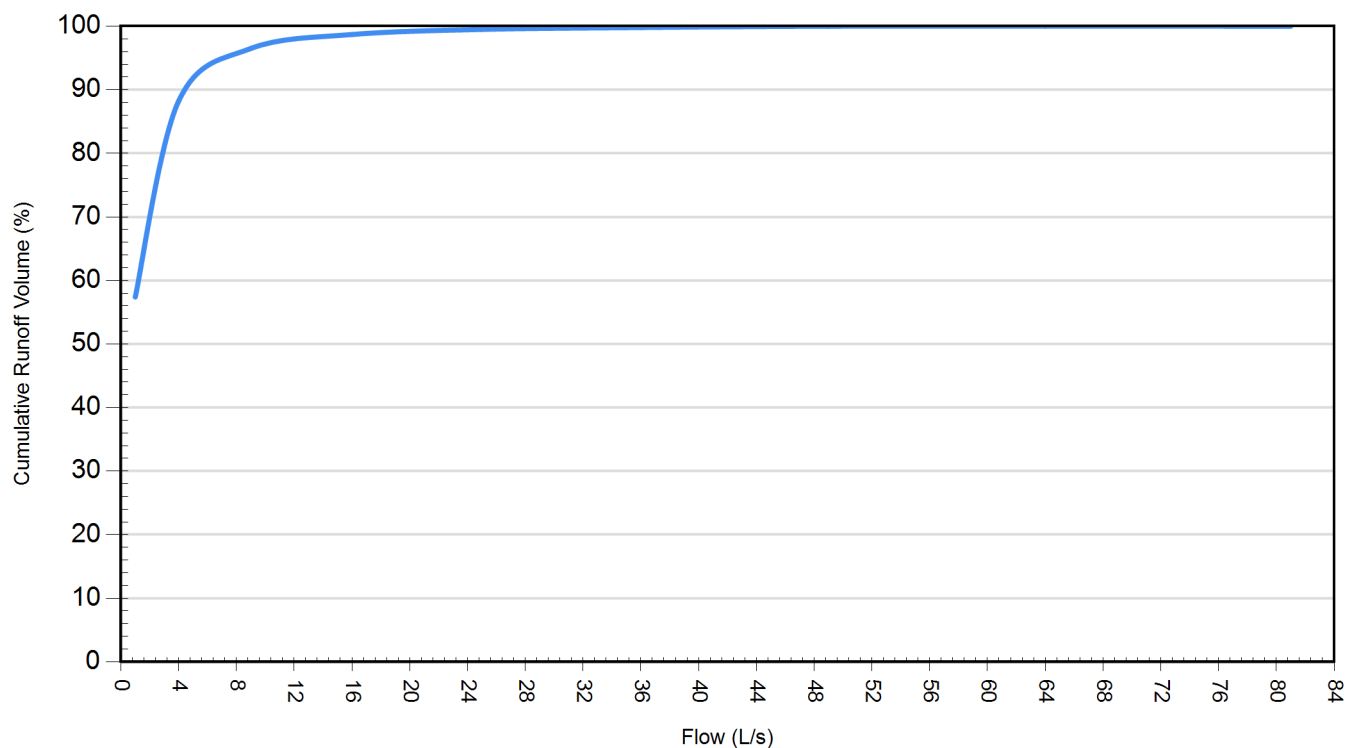
Particle Size Distribution (PSD)		
Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.		
Fine Distribution		
Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Site Name		143 Columbia Street W.	
Site Details			
Drainage Area		Infiltration Parameters	
Total Area (ha)	0.178	Horton's equation is used to estimate infiltration	
Imperviousness %	83.00	Max. Infiltration Rate (mm/hr)	61.98
Surface Characteristics		Min. Infiltration Rate (mm/hr)	10.16
Width (m)	84.00	Decay Rate (1/sec)	0.00055
Slope %	2	Regeneration Rate (1/sec)	0.01
Impervious Depression Storage (mm)	0.508	Evaporation	
Pervious Depression Storage (mm)	5.08	Daily Evaporation Rate (mm/day)	2.54
Impervious Manning's n	0.015	Dry Weather Flow	
Pervious Manning's n	0.25	Dry Weather Flow (lps)	0
Maintenance Frequency		Winter Months	
Maintenance Frequency (months) >	12	Winter Infiltration	0
TSS Loading Parameters			
TSS Loading Function			
Buildup/Wash-off Parameters		TSS Availability Parameters	
Target Event Mean Conc. (EMC) mg/L		Availability Constant A	
Exponential Buildup Power		Availability Factor B	
Exponential Washoff Exponent		Availability Exponent C	
		Min. Particle Size Affected by Availability (micron)	

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	Runoff Volume (m³)	Volume Over (m³)	Cumulative Runoff Volume (%)
1	12630	9386	57.4
4	19422	2595	88.2
9	21237	780	96.5
16	21728	289	98.7
25	21903	114	99.5
36	21981	36	99.8
49	22007	10	100.0
64	22017	0	100.0
81	22017	0	100.0

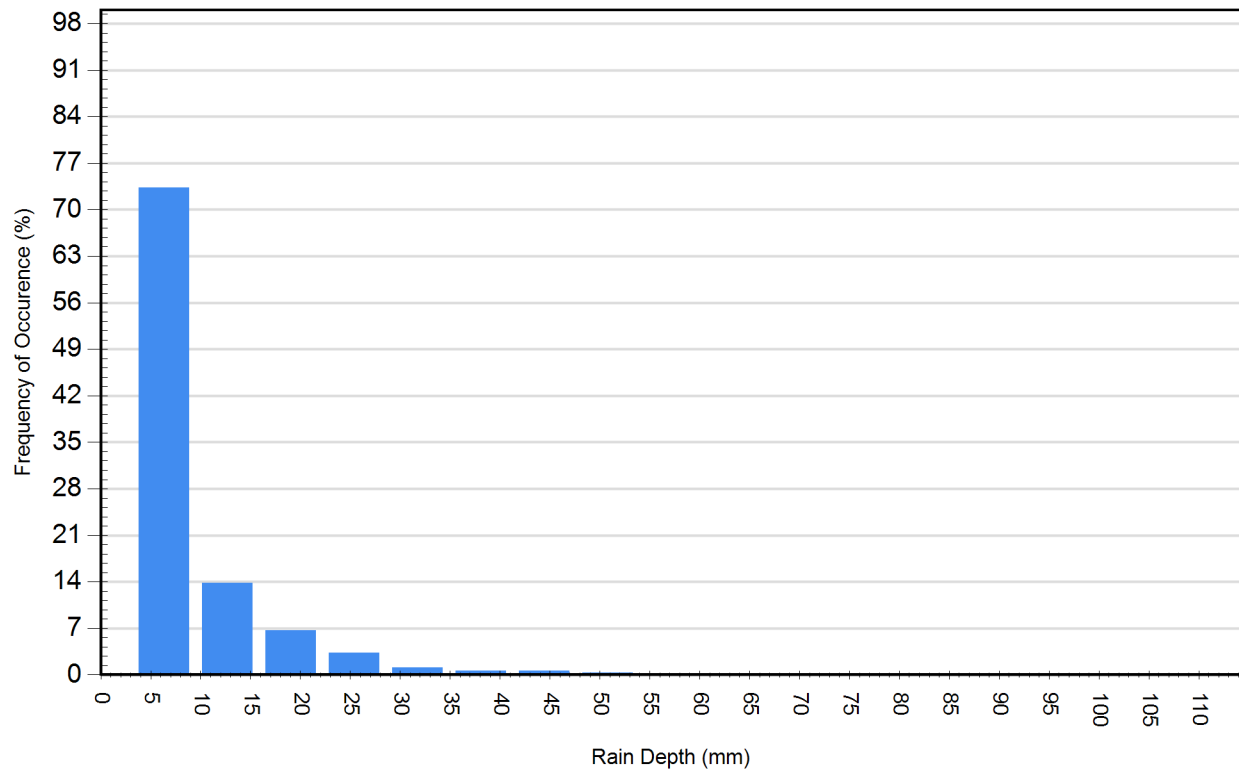
Cumulative Runoff Volume by Runoff Rate

For area: 0.178(ha), imperviousness: 83.00%, rainfall station: WATERLOO WELLINGTON A



Rainfall Event Analysis				
Rainfall Depth (mm)	No. of Events	Percentage of Total Events (%)	Total Volume (mm)	Percentage of Annual Volume (%)
6.35	2184	73.3	3643	22.6
12.70	411	13.8	3779	23.4
19.05	199	6.7	3108	19.3
25.40	97	3.3	2102	13.0
31.75	34	1.1	964	6.0
38.10	17	0.6	590	3.7
44.45	18	0.6	723	4.5
50.80	8	0.3	380	2.4
57.15	4	0.1	212	1.3
63.50	0	0.0	0	0.0
69.85	4	0.1	267	1.7
76.20	0	0.0	0	0.0
82.55	0	0.0	0	0.0
88.90	3	0.1	256	1.6
95.25	1	0.0	93	0.6
101.60	0	0.0	0	0.0
107.95	0	0.0	0	0.0

Frequency of Occurrence by Rainfall Depths



For Stormceptor Specifications and Drawings Please Visit:
<http://www.imbriumsystems.com/technical-specifications>

Detailed Stormceptor Sizing Report – 143 Columbia Street W.

Project Information & Location			
Project Name	143 Columbia Street W. - OGS2	Project Number	20-261
City	Waterloo	State/ Province	Ontario
Country	Canada	Date	10/15/2021
Designer Information		EOR Information (optional)	
Name	Hossein Moarefi	Name	
Company	K.Smart Associates Limited	Company	
Phone #	705-222-6175	Phone #	
Email	hmoarefi@ksmart.ca	Email	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	143 Columbia Street W.
Recommended Stormceptor Model	STC 300
Target TSS Removal (%)	80.0
TSS Removal (%) Provided	82
PSD	Fine Distribution
Rainfall Station	WATERLOO WELLINGTON A

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	% TSS Removal Provided
STC 300	82
STC 750	89
STC 1000	90
STC 1500	91
STC 2000	92
STC 3000	93
STC 4000	95
STC 5000	95
STC 6000	96
STC 9000	97
STC 10000	97
STC 14000	98
StormceptorMAX	Custom

Stormceptor

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for each rainfall event, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur. Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Design Methodology

Stormceptor is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology using local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective. The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. The Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing:

- Site parameters
- Continuous historical rainfall data, including duration, distribution, peaks & inter-event dry periods
- Particle size distribution, and associated settling velocities (Stokes Law, corrected for drag)
- TSS load
- Detention time of the system

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour). Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	Ontario	Total Number of Rainfall Events	2980
Rainfall Station Name	WATERLOO WELLINGTON A	Total Rainfall (mm)	16119.1
Station ID #	9387	Average Annual Rainfall (mm)	474.1
Coordinates	43°27'N, 80°23'W	Total Evaporation (mm)	1155.6
Elevation (ft)	1028	Total Infiltration (mm)	2387.1
Years of Rainfall Data	34	Total Rainfall that is Runoff (mm)	12576.4

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

Drainage Area		Up Stream Storage	
Total Area (ha)	0.147	Storage (ha-m)	Discharge (cms)
Imperviousness %	85.00	0.000	0.000
Water Quality Objective		Up Stream Flow Diversion	
TSS Removal (%)	80.0	Max. Flow to Stormceptor (cms)	
Runoff Volume Capture (%)		Design Details	
Oil Spill Capture Volume (L)		Stormceptor Inlet Invert Elev (m)	
Peak Conveyed Flow Rate (L/s)		Stormceptor Outlet Invert Elev (m)	
Water Quality Flow Rate (L/s)		Stormceptor Rim Elev (m)	
		Normal Water Level Elevation (m)	
		Pipe Diameter (mm)	
		Pipe Material	
		Multiple Inlets (Y/N)	No
		Grate Inlet (Y/N)	Yes

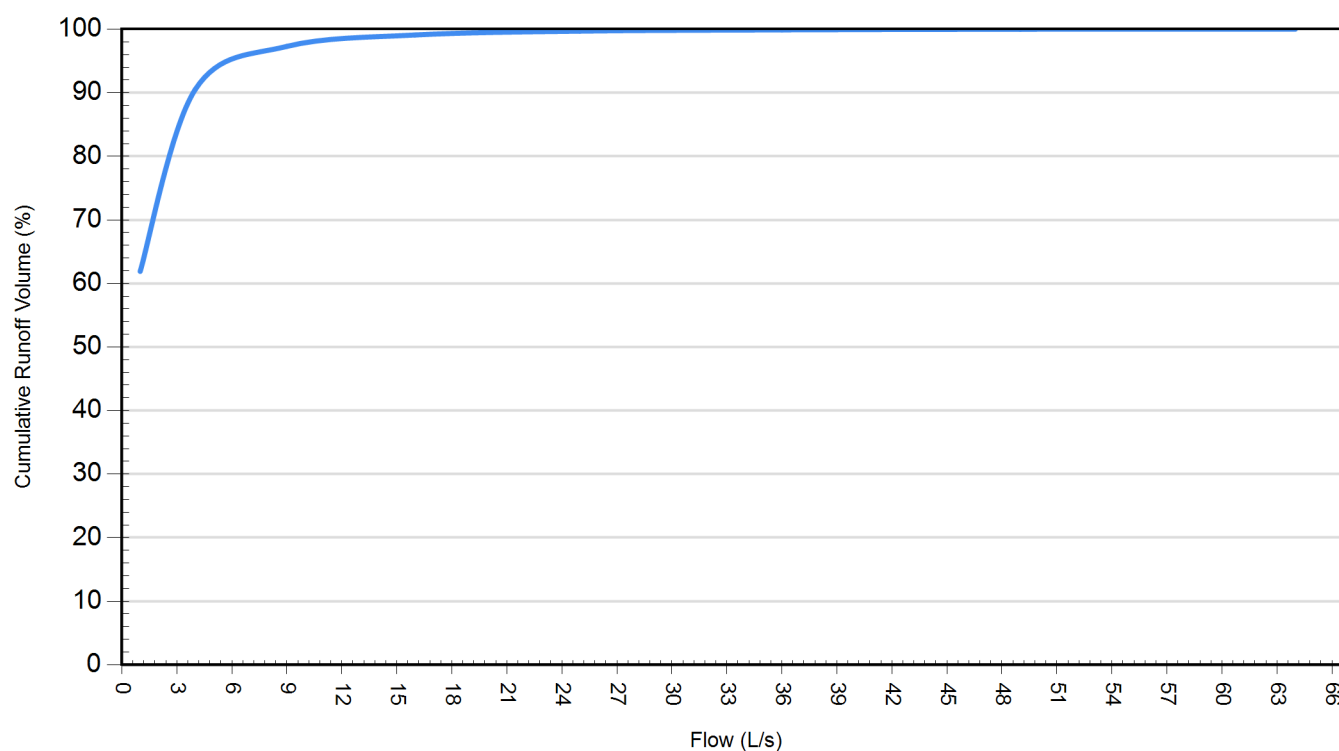
Particle Size Distribution (PSD)		
Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.		
Fine Distribution		
Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Site Name		143 Columbia Street W.	
Site Details			
Drainage Area		Infiltration Parameters	
Total Area (ha)	0.147	Horton's equation is used to estimate infiltration	
Imperviousness %	85.00	Max. Infiltration Rate (mm/hr)	61.98
Surface Characteristics		Min. Infiltration Rate (mm/hr)	10.16
Width (m)	77.00	Decay Rate (1/sec)	0.00055
Slope %	2	Regeneration Rate (1/sec)	0.01
Impervious Depression Storage (mm)	0.508	Evaporation	
Pervious Depression Storage (mm)	5.08	Daily Evaporation Rate (mm/day)	2.54
Impervious Manning's n	0.015	Dry Weather Flow	
Pervious Manning's n	0.25	Dry Weather Flow (lps)	0
Maintenance Frequency		Winter Months	
Maintenance Frequency (months) >	12	Winter Infiltration	0
TSS Loading Parameters			
TSS Loading Function			
Buildup/Wash-off Parameters		TSS Availability Parameters	
Target Event Mean Conc. (EMC) mg/L		Availability Constant A	
Exponential Buildup Power		Availability Factor B	
Exponential Washoff Exponent		Availability Exponent C	
		Min. Particle Size Affected by Availability (micron)	

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	Runoff Volume (m³)	Volume Over (m³)	Cumulative Runoff Volume (%)
1	11533	7092	61.9
4	16855	1770	90.5
9	18131	494	97.3
16	18453	172	99.1
25	18571	54	99.7
36	18612	14	99.9
49	18623	2	100.0
64	18626	0	100.0

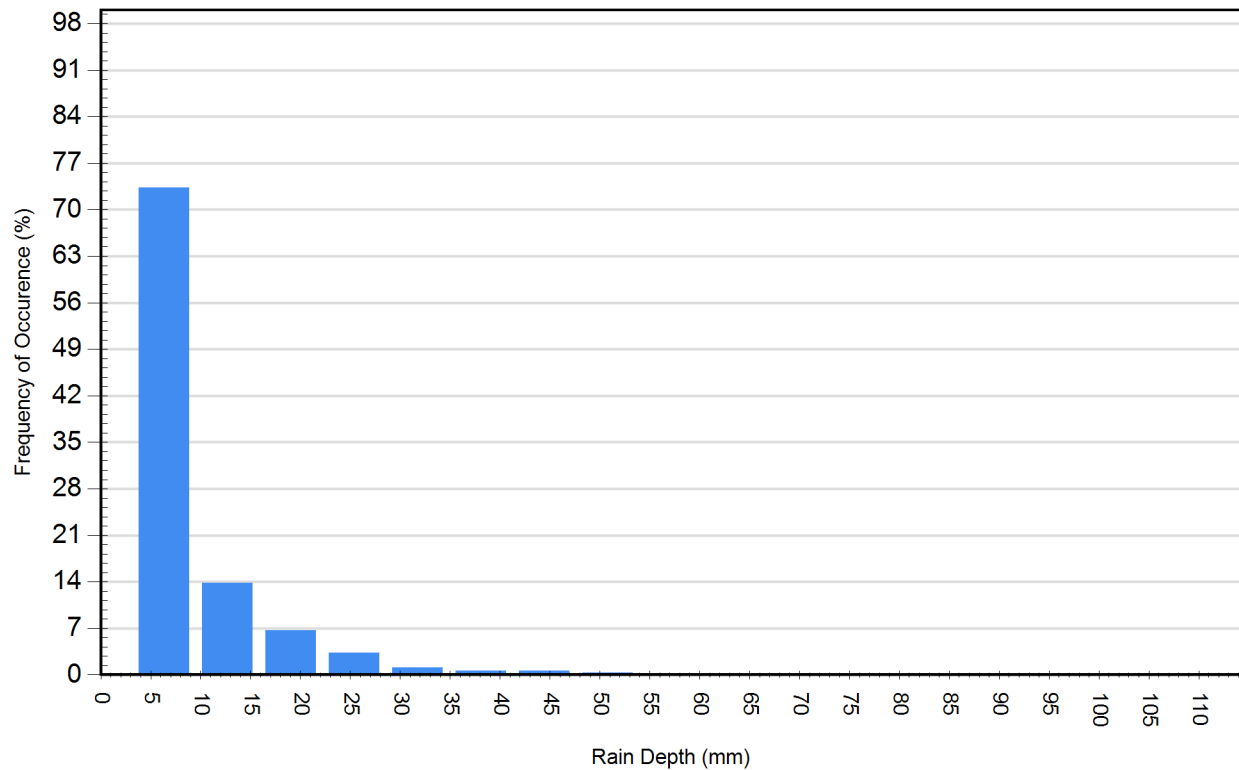
Cumulative Runoff Volume by Runoff Rate

For area: 0.147(ha), imperviousness: 85.00%, rainfall station: WATERLOO WELLINGTON A



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