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PROPOSED RETIREMENT RESIDENCE DEVELOPMENT
2380 LAKESHORE ROAD WEST
OAKVILLE, ONTARIO

PROJECT No. : 18219

FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

Prepared For:

SUCCESSION DEVELOPMENT CORPORATION

Prepared By:

The Odan/Detech Group Inc.

Original:	July 5th, 2018
Revised:	January 22nd, 2019
Revised:	September 6th, 2019
Revised:	January 26th, 2023

ODAN·DETECH
CONSULTING ENGINEERS

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CETV Verification Statement – Imbrium Systems Inc. Stormceptor EF Filter

1.0 INTRODUCTION

The property under study is a 0.385 Ha (0.95 acre) site located at 2380 Lakeshore Road West in Oakville, Ontario. The site is presently occupied by the following:

- A three-storey commercial building with associated paved parking areas surrounding, located at the east side of the site
- A one-storey detached house building with associated driveway located at the west side of the site

The site is bound by the following:

- To the north: Lakeshore Road West
- To the east: Existing commercial/residential townhouse development
- To the south: Existing residential apartment development
- To the west: Existing commercial development and associated parking lot

For detailed topography of the existing site conditions, as of May 30, 2018, refer to the topographic survey prepared by Cunningham McConnell Limited.

It is proposed to construct a mixed-use six-storey commercial and retirement home development on the property. There is a below-grade parking structure proposed beneath the entire site. A driveway access is proposed from Lakeshore Road West from the site's north property line.

A 2.94m road widening of Lakeshore Road West is proposed in the subject development – refer to the architectural Site Plan and Servicing/Grading Plans. The site's area post-development will be 0.366 Ha (0.90 acres).

Refer to the Site Plan by Michael Spaziani Architect Inc. in Appendix A for the site's layout.

This report will evaluate the serviceability of the site with respect to sanitary waste water, water and storm water management (SWM) and will implement the Servicing criteria identified by Region engineering staff in prior correspondence.

2.0 SCOPE OF WORK

THE ODAN/DETECH GROUP INC. was retained by **Succession Development Corporation.** to review the Site, collect data, evaluate the Site for the proposed use and present the findings in a Functional Servicing and Storm Water Management Report in support of a Site Plan Application. The scope of work in brief involves the following:

a) Collecting existing servicing drawings from the CITY in order to establish availability and feasibility of Site servicing;
b) Meetings/conversations with CITY Engineers and Design Team.
c) Evaluation of the data and presentation of the findings in a FSR and Storm Water Management Report in support of the Site Plan Application.

3.0 WATER DISTRIBUTION

Design Considerations

There is an existing 300mm PVC watermain beneath the north side of Lakeshore Road West, opposite the subject site.

One 150mm fire service with branch 100mm branch domestic water service connection are proposed to the above main. Refer to the Site Servicing Plan.

The unit rate and peaking factors of water consumption, minimum pipe size and allowable pressure in line were established from the City Design Manual Standards. The pressures and volumes must be sufficient for peak hour conditions and under fire conditions as established by the Ontario Building Code 2006. The minimal residual pressure under fire conditions is 140 kpa. (or 20.3 psi).

Fire flow demand is calculated using the Fire Underwriters' Survey Fire Flow calculation, on the following page.

The allowable pressures are as follows:

Condition	**Allowable Pressures (kpa)**	
	min.	**max.**
1) Min. Hour	275	700
2) Peak Hour	275	700
3) Peak Day + Fire Flow	140	700

The water demand for redeveloped Building is calculated as follows:

a)	Average Day domestic demand -		0.86 L/s
b)	Peak day demand -	2.25 x average daily demand	1.94 L/s
c)	Fire flow as per FUS 1999 manual		200 L/s

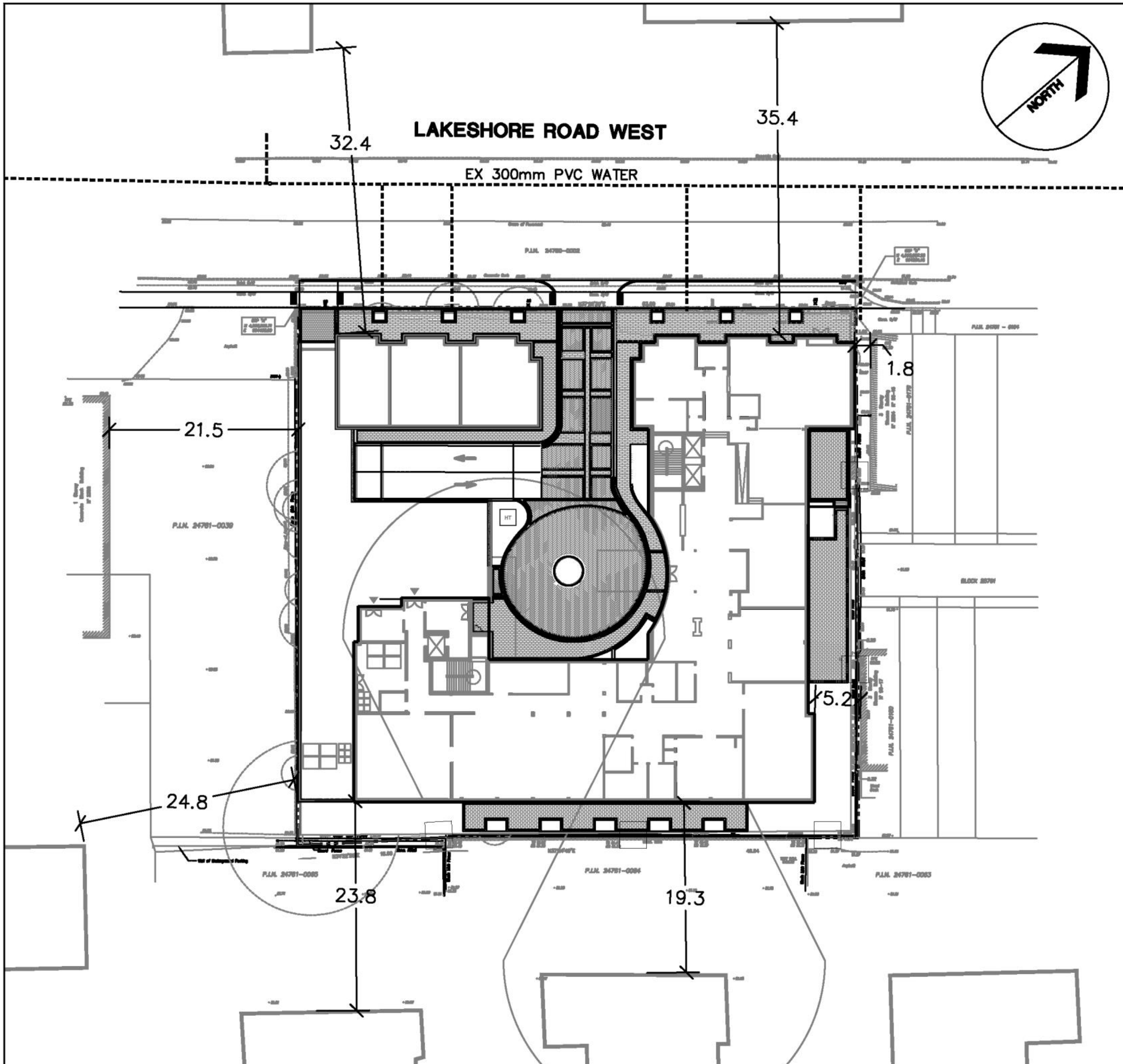
TABLE 1 – Total Water Demand

	L/sec	USGM
Peak Domestic Flow Demand	1.9	30
Fire Flow Demand (FUS)	200	3170
Total Water Demand	202	3200
Available Flow at 20 PSI Residual Pressure	383	6068

The following assumptions were made in the Fire Underwriters' Survey fire flow calculation:

- The building will be of fire-resistive (reinforced concrete) construction
- The contents will be non-combustible (residences)
- The building will be sprinklered as per NFPA 13 and the sprinklers fully monitored
- Horizontal separation from adjacent buildings as shown on the following *Fire Separation Distance Plan*

A hydrant flow test was prepared by Jackson Water Works to the NFPA 291 standard. The flow test reports are included on the following pages. The hydrant flow test shows that there is a flow rate of rate of 6068 USGM available at residual pressure 20 psi, which is greater than the development's water demand (3200 USGM) therefore it follows that ***the existing main is sufficient to provide fire protection to the subject development and no infrastructure improvements are necessary to service the subject development.***



LEGEND

PROPERTY LINE

DRAWING :

FIRE SEPARATION DISTANCE PLAN

DATE:	PROJ. NO.:	SCALE:
JUNE 2018	18219	1:600

PROJECT :

PROPOSED RETIREMENT HOME DEVELOPMENT
2380 LAKESHORE RD. W.
OAKVILLE, ON

ODAN·DETECH
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WATER SUPPLY FOR PUBLIC FIRE PROTECTION , FIRE UNDERWRITERS SURVEY
GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOWS

F = 220 x C x √ A
Where:

F = required fire flow in liters per minute
C= Coefficient related to the type of construction
A = the total floor area in square meters
(excluding basements) in the building
considered

Coefficient related to type of construction	
1.5	Wood Frame
1	Ordinary
0.8	Non combustible
0.6	Fire Resistive

LOCATION: Oakville

OBC OCCUPANCY: Residential & Commercial

BUILDING FOOT PRINT (m2): 2642

OF STOREYS 6

PROJECT: 2380 Lakeshore Road West Retirement Home

PROJECT No: 18219

Contents	Charge
Non-Combustible	-25%
limited Combustible	-15%
Combustible	0%
Free Burning	15%
Rapid Buring	25%

CONSTRUCTION CLASS: Fire Resistive

`

AUTOMATED SPRINKLER PROTECTION		Credit	Total
NFPA 13 sprinkler standard	yes	30%	50%
Standard Water Supply	yes	10%	
Fully Supervised System	yes	10%	
		50%	

CONTENTS FACTOR: Limited Combustible CHARGE: -15%

EXPOSURE 1 (south) Ex Apartments	Distance to Exposure Building (m) Length - Height	19.3	15%
EXPOSURE 2 (east) Existing Townhouses	Distance to Exposure Building (m) Length - Height	1.8	25%
EXPOSURE 3 (west) Existing Comm	Distance to Exposure Building (m) Length - Height	21.5	10%
EXPOSURE 4 (north) Existing House	Distance to Exposure Building (m) Length - Height	32.4	5%
		Total:	55%

no more than 75%

Separation	Charge
0-3 m	25%
3.1 -10 m	20%
10.1 - 20 m	15%
20.1 - 30 m	10%
30.1 - 45	5%
> 45 m	0%

ARE BUILDINGS CONTIGUOUS: Yes

FIRE RESISTANT BUILDING Are vertical openings and exterior vertical communications protected with a minimum one (1) hr rat No

CALCULATIONS

	C =	0.6		Fire Resistive
	A =	8932	m2	(2 Largest floors + 50% of floors above)
	F =	12475	L/min	
Round to Nearest 1000 L/min	F =	13000	L/min	must be > 2000 L/min

STOREY AREAS m2	
1921	1
2305	2
2353	3
2353	4
2353	5
2353	6

CORRECTION FACTORS:

OCCUPANCY	-1950	L/min
FIRE FLOW ADJUSTED FOR OCCUPANCY	11050	L/min
REDUCTION FOR SPRINKLER	-5525	L/min
EXPOSURE CHARGE	6077.5	L/min

REQUIRED FIRE FLOW

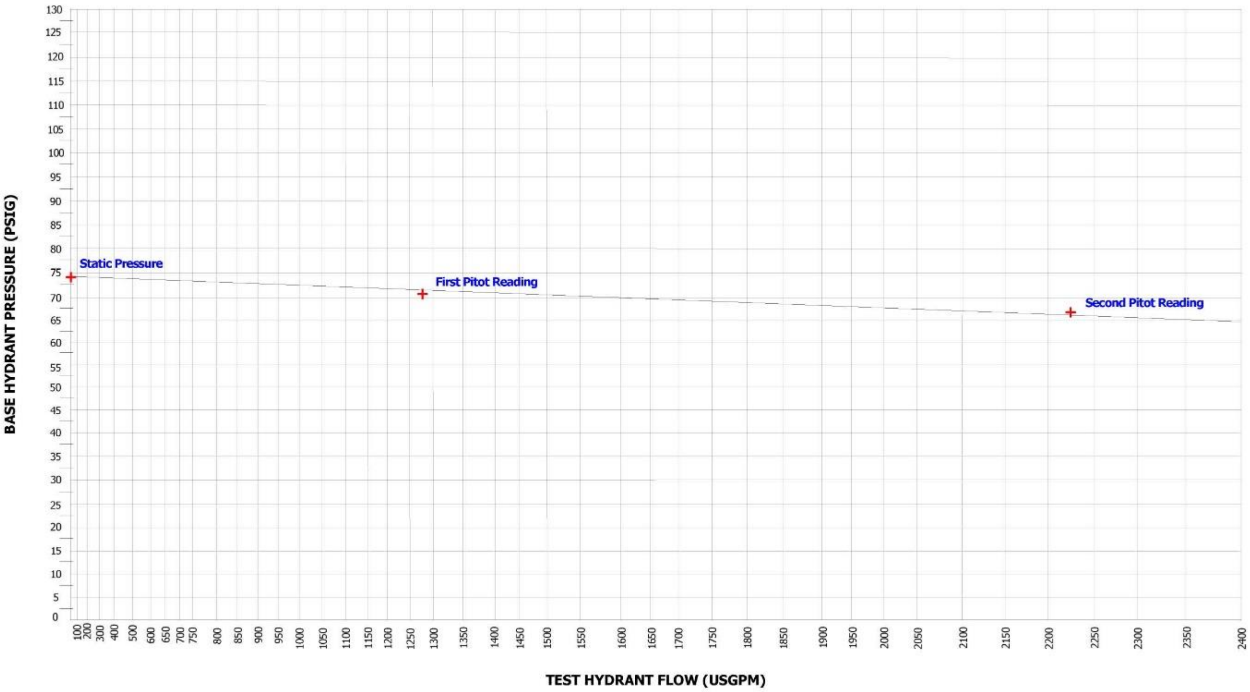
	F =	11603	L/min		
Round to Nearest 1000 L/min	**F =**	12000	L/min	3170	usgm
	F =	200	L/sec		

JACKSON WATERWORKS

Telephone: (905) 547-6770
Toll Free: (800)-734-5732
E-mail: jww@bellnet.ca
Website: www.jacksonwaterworks.ca

FIRE HYDRANT FLOW TEST RESULTS

TEST #1 of 1



No. of Ports Open	Port Dia. (in)	Pitot Reading (psig)	Pitot Conversion (usgpm) Conversion Factor = 0	Residual Pressure (psig)
1	2.50	58	1278	71
2	2.50	44/44	2226	68
THEORETICAL FLOW @ 20psi			6086	

Test Date	25 May 2018
Test Time	11:30am
Pipe Diameter (in)	12
Static Pressure (psig)	74

Site Information		
Site Name or Developer Name	Southbound Developments Inc.	Engineer: Odan Detech Group Inc.
Site Address/Municipality	2380 Lakeshore Road West, Oakville	
Location of Test Hydrant	In Front of 2381 Lakeshore Road West	
Location of Base Hydrant	Lakeshore Road West, 1st West of Jones Street	
Comments	Testing has been completed in accordance with NFPA-291 guidelines wherever and whenever possible and practical. Conversion factors for pitot tube readings have been used depending on hose nozzle internal design and installation profile. Refer to attached cover letter for additional information.	
Verified By	Mark Schmidt	

221 Sherman Avenue North, Hamilton, Ontario L8L 6N2

4.0 SANITARY SEWERS

i) Available & Existing Infrastructure

The following sewers presently exist beneath the streets bordering the subject site. Refer to the Servicing Plan for the layout of the sewers bordering the subject site.

- Lakeshore Road West – there is a 300mm sanitary sewer flowing easterly adjacent to the site's north frontage. There is a high point in the sewer at the site's frontage from which the sewer flows east and west.

ii) Proposed Sanitary Servicing

It is proposed to drain the subject development to the 300mm Lakeshore Road sanitary sewer with a 200mm @ 2.00% sanitary service connection.

The sanitary sewer design criteria and unit flow is provided in the Regional Municipality of Halton's *Water and Wastewater Linear Design Manual* (October 2019), as follows. The following information is provided in Tables 3-1 and 3-2 of the foregoing manual.

- Unit flow: q = average daily residential per capita dry weather unit flow = 0.275 m^3/cap/day
- I/I = Unit of peak inflow/infiltration = 0. 286 L/s/ha
- Light Commercial 90 p/Ha or 24.75 m^3/ha/day
- Apartment (over 6-storey): 285 p/Ha and 0.275 m^3/p/day or 0.003183 x 10^{-3} m^3/p/s
- Apartment (less than 6-storey): 135 p/Ha and 0.275 m^3/p/day or 0.003183 x 10^{-3} m^3/p/s
    - Notwithstanding the above unit population, however, a unit population of 2.7 P/unit is assumed for the proposed retirement home development because the Region standard 135 P/Ha unit population would result in a unit population of approximately 0.5 P/unit for the proposed statistics, which is unrealistic

Peaking Factor (Residential)

$$M = 1 + \frac{4}{4+\sqrt{P}}$$

The peak sanitary flow from the proposed development is thus calculated as follows, in Table 2.

TABLE 2 – Proposed Sanitary Flows

	Population (P)	Average Flow (l/s)	Peak Factor	Peak Sanitary (l/s)	Infiltration Allowance (l/s)	Total Flow (l/s)
Retirement Home Units	421	1.17	4.01	4.69	0.11	**4.85**
Retail	5	0.01	3.55	0.05		

A 150mm @ 2.0% sanitary sewer connection is proposed to the 300mm sanitary sewer beneath Lakeshore Road. The pipe has a capacity of 22 L/s, which is adequate to convey the above post-development sanitary flow.

SANITARY & WATER FLOW CALCULATIONS **SCENARIO:** PROPOSED DEVELOPMENT

This program calculates the sanitary discharge from various land use

FILL IN COLOURED CELLS AS REQUIRED

COMMERCIAL SITE AREA (ha) =		NOTE:
RESIDENTIAL SITE AREA (ha) =	0.37	
TOTAL SITE AREA (ha) =	0.385	

LAND USE	NUMBER OF UNITS	SITE AREA, (ha)	GROSS FLOOR AREA, m2	TOTAL POPULATION	TOTAL DAILY FLOW (LITERS)	AVERAGE DAILY FLOW l/sec	PEAKING FACTOR, M	TOTAL FLOW FROM LAND USE, l/sec
RESIDENTIAL Detached, using 55 person/site area				0	0	0.00	4.50	0.00
RESIDENTIAL Semi Houses, using 100 persons/site area				0	0	0.00	4.50	0.00
RESIDENTIAL Apartments (<6 st), using 135 persons/site area				0	0	0.00	4.50	0.00
RESIDENTIAL Apartments (>6 st), using 285 persons/site area				0	0	0.00	4.50	0.00
RESIDENTIAL Density 3, using 2.7 persons/unit	156			421	101088	1.17	4.01	4.69
COMMERCIAL, Using 90 persons/ha (Floor Ha)		0.05		5	1238	0.01	3.55	0.05
COMMERCIAL, Using 0.60 L/sec per ha				0	0	0.00	2.50	0.00

TOTAL	V1=	102326	Q1=	4.69
			Q2=	0.05
Q = (MqP/86400) + A * I (L/sec)			Qinfil	0.11
			Qtot	4.85

Q1= total flow from Residential Land Use (L/sec)
Q2= total flow from Commercial Land Use (L/sec)
Qinfil = total flow from infiltration (L/sec)
Qtot = total flow (Land use + infiltration)

V1= Total Volume from Land Use in liters

where : P is population
q = 0.275 m3/d/p = 0.004 L/sec/person for residential and
q = 0.60 L/sec/ha for commercial and offices
A = gross site area
i = 0.286 L/sec/ha (infiltration rate)

Peaking Factor M = 1 + [14 / (4 + (P/1000,1/2)) (for residential)
Peaking Factor M = 0.8* {1 + [14 / (4 + (P/1000,1/2))]} (for Commercial)

iii) Downstream Sanitary Sewer Capacity

Region engineering staff have stated that an independent downstream sanitary sewer analysis is required to confirm the capacity of the receiving sanitary sewers to receiving flows from the subject development.

The following downstream sanitary sewer analysis shows that the receiving sanitary sewers have capacity for the proposed development and no offsite infrastructure improvements are necessary to accommodate the flows from the proposed development.

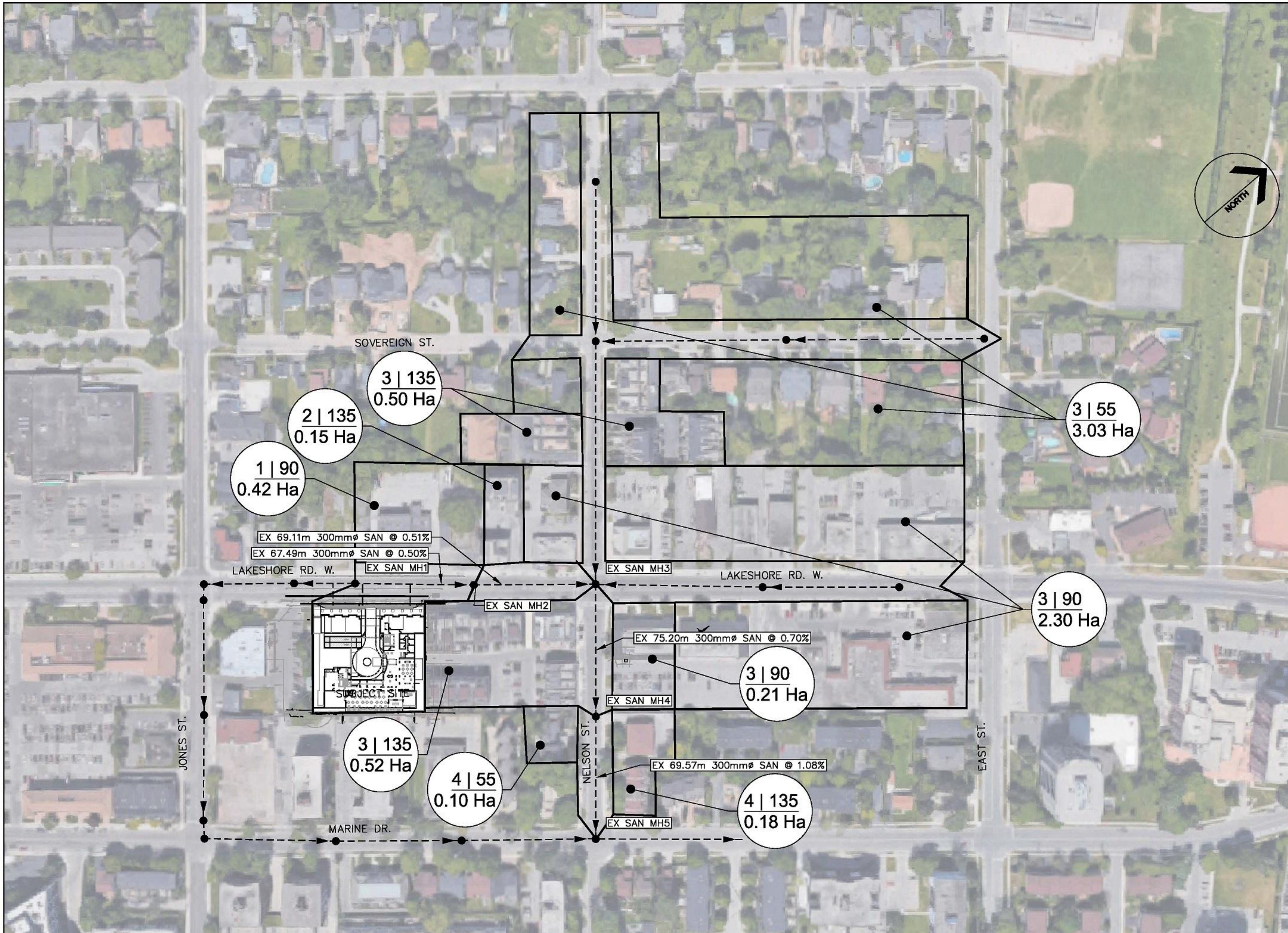
Region staff stated that an independent analysis of the immediate downstream segments is acceptable. That is, it is not necessary to analyze all segments to the trunk discharge point.

The Odan/Detech Group subsequently prepared an original analysis. The methodology for the analysis is as follows.

1) The downstream sewer catchment plan on the following page was prepared to show the tributary catchment areas for sanitary flow, path of the sewer pipe, etc.
2) Catchment areas as shown on the downstream sewer catchment plan were delineated by original research by the Odan/Detech Group.
3) Population density and unit flow was established as given in Tables 3-1 and 3-2 in the Regional Municipality of Halton's Water and Wastewater Linear Design Manual (October 2019).
4) Downstream sewer design sheets were prepared in pre-development and post-development scenarios as shown on the following pages.
5) The slopes, pipe diameters, as-built information was taken from as-built plan & profile drawings provided by the Region of Halton as well as inverts surveyed in the survey prepared for this development by Cunningham McConnell (May 2018).

We provide the following discussion on the downstream sanitary sewer analysis.

1) Pre-development, no pipes are flowing at more than 13.9% of their respective capacity.
2) Post-development, with the additional flow from the subject development, no pipes are flowing at more than 21.4% of their capacity. This is acceptable, therefore no improvements are necessary to the downstream sanitary sewer network on account of the proposed development.
3) There is a high point in the receiving local sanitary sewers adjacent to the site's north frontage to Lakeshore Road West. That is, the site is tributary to two different tributary branches of the downstream sanitary network. Note that the two legs ultimately converge at a bifurcation located at Marine Drive and Nelson Street. The site is proposed to drain to the easterly leg because that is a more direct path to the downstream outlet. Refer to the downstream sanitary sewer catchment plan on the following page for the layout of the receiving sewer network. The westerly leg also serves a much larger catchment area originating on Jones Street, therefore it stands to reason that the easterly leg is a sounder outlet for the proposed development.
4) There is a discrepancy in the Region's sanitary sewer public works information operating maps. The maps show that EX SAN MH1 adjacent to the site's north frontage slopes up to the east. That is, in this case, the sanitary sewers adjacent to the site's north frontage flow westerly across the site's entire north frontage. The as-built plan & profile as well as the inverts surveyed by Cunningham McConnel in this sewer, on the other hand, show that the pipe slopes down to the east away from EX SAN MH1. This is reflected in this analysis.



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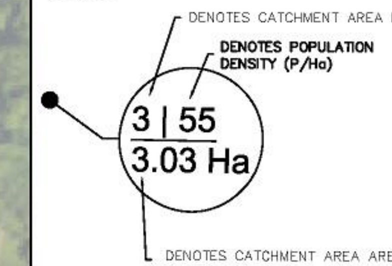

DRAWING :

DOWNSTREAM SANITARY SEWER CATCHMENT PLAN

DATE:	PROJ. NO.:	SCALE:
JUNE 2018	18219	1:2000

PROJECT :

PROPOSED RETIREMENT HOME DEVELOPMENT
2380 LAKESHORE ROAD WEST
OAKVILLE, ON

ODAN·DETECH
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5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2

DOWNSTREAM SANITARY SEWERS (Pre-Development)

Site location: Subject Proposed Development - 2380 Lakeshore Road West

Ref# PN 18219

Location				Existing Industrial/Commercial					Existing Residential Population						Inflow/ Infiltration
Segment SAN Trib ID	Street Name	US Node	DS Node	Commercial (ha)	School (ha)	Acc've Area (ha)	Population (Person)	Acc've Pop'n (Person)	Apartments (>6 St)(Ha)	Apartments (<6 St)(Ha)	Townhouse (Ha)	Detached (Ha)	Population (Person)	Acc've Pop'n (Person)	Area (ha)
1 (Trib of MH 1)	Lakeshore Rd W	EX SAN MH1	EX SAN MH2	0.420		0.420	37.80	37.80	-	-	-	-	-	-	0.98
2 (Trib of MH 2)	Lakeshore Rd W	EX SAN MH2	EX SAN MH3			0.420	-	37.80	-	-	0.150	-	20.25	20.25	0.26
3 (Trib of MH 3)	Nelson St	EX SAN MH3	EX SAN MH4	2.300	-	2.720	207.00	244.80	-	-	1.020	3.030	304.35	324.60	8.27
4 (Trib of MH 4)	Nelson St	EX SAN MH4	EX SAN MH5			2.720	-	244.80	-	0.180	-	0.100	29.80	354.40	0.41

Segment SAN Trib ID	Residential P/F M	Peak Residential Sanitary Flow Q(p) (275 L/c/d) (L/s)	Commercial P/F M	Peak Commercial Sanitary Flow Q (p) (24.75 m3/ha/d) (L/s)	Unit Inflow/ Infiltration I/I (0.28 L/Sec/ha)	Segment Inflow/ Infiltration Q(i) (L/s)	Accumulative Inflow/ Infiltration Q(i) (L/s)	Accumulative Sanitary Flow Q(d) (L/s)	Pipe Length L (m)	Pipe Size D (mm)	Pipe Slope S (%)	Pipe Shape	Pipe Full Flow Capacity Qcap (L/s)	Pipe Full Flow Velocity V (m/s)	Pipe % Full Q(d)/Qcap
1 (Trib of MH 1)	4.50	-	3.47	0.42	0.280	0.27	0.27	0.69	67.49	300	0.50	circle	68.38	0.97	1.01%
2 (Trib of MH 2)	4.38	0.28	3.47	0.42	0.280	0.07	0.35	1.05	69.11	300	0.51	circle	69.06	0.98	1.52%
3 (Trib of MH 3)	4.06	4.20	3.29	2.56	0.280	2.32	2.66	9.43	75.20	300	0.49	circle	67.69	0.96	13.93%
4 (Trib of MH 4)	4.05	4.56	3.29	2.56	0.280	0.11	2.78	9.91	69.57	300	1.08	circle	100.49	1.42	9.86%

Flow Calculation Criteria
(Unit Flowfrom Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)
q = average daily residential per capita dry weather unit flow = 0.275 m3/cap/d
q = average daily commercial dry weather unit flow = 24.750m3/ha/d or 0.28646 L/ha/s
I/I = Unit of peak inflow/infiltration allowance = 0.286 (L/s/ha)
Q(p) = peak population flow (L/s)
Q(I) = peak extraneous flow (L/s)
Q(d) = peak design flow (L/s)

Mannings Equation:
Qcap=(D/1000)^2.667*(S/100)^0.5/(3.211*n)*1000(L/s)
D: pipe size (mm)
S: slope (grade) of pipe (%)
n = Manning roughness coefficient = 0.013

(Unit Population from Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

Single Family Population Density	55 P/ha
Semi-detached/duplex/4-plex	100 P/ha
Townhouse, Maisonette	135 P/ha
Apartment (Over 6 Stories High)	285 P/ha
Commercial	90 P/ha
Community Services (School)	40 P/ha

(Peaking Factor from Section 3.2.3., Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

PEAKING FACTOR (Residential)	M =1 + 14/(4+(P/1000^0.5))
PEAKING FACTOR (Commercial)	M =0.8[1 + 14/(4+(P/1000^0.5))]
PEAK DESIGN FLOW,	Q(d) = Q(p) + Q(i) L / Sec.
PIPE ROUGHNESS,	n = 0.013 For Manning's Equation

Vmin. = 0.6m/s and Vmax. = 3m/s

DOWNSTREAM SANITARY SEWERS (Post-Development)

Site location: Subject Proposed Development - 2380 Lakeshore Road West

Ref# PN 18219

Location				Existing + Proposed Industrial/Commercial					Existing + Proposed Residential Population							Inflow/ Infiltration	Residential P/F	Peak Residential Sanitary Flow	Commercial P/F	Peak Commercial Sanitary Flow	Unit Inflow/ Infiltration	Segment Inflow/ Infiltration	Accumulative Inflow/ Infiltration	Accumulative Sanitary Flow	Pipe						
Segment SAN Trib ID	Street Name	US Node	DS Node	Commercial (ha)	School (ha)	Acc've Area (ha)	Population (Person)	Acc've Pop'n (Person)	Apartments (2.7PPU) (U)	Apartments (>6 St)(Ha)	Apartments (<6 St)(Ha)	Townhouse (Ha)	Detached (Ha)	Population (Person)	Acc've Pop'n (Person)	Area (ha)	M	Q(p) (275 L/c/d) (L/s)	M	Q (p) (24.75 m3/ha/d) (L/s)	I/I (0.28 L/Sec/ha)	Q(i) (L/s)	Q(i) (L/s)	Q(d) (L/s)	Length L (m)	Size D (mm)	Slope S (%)	Shape	Full Flow Capacity Qcap (L/s)	Full Flow Velocity V (m/s)	% Full Q(d)/Qcap
1 (Trib of MH 1)	Lakeshore Rd W	EX SAN MH1	EX SAN MH2	0.467		0.467	42.03	42.03	156.000	-	-	-	-	421.20	421.20	0.98	4.01	5.38	3.46	0.46	0.280	0.27	0.27	6.12	67.49	300	0.50	circle	68.38	0.97	8.9%
2 (Trib of MH 2)	Lakeshore Rd W	EX SAN MH2	EX SAN MH3			0.467	-	42.03	-	-	-	0.150	-	20.25	441.45	0.26	4.00	5.62	3.46	0.46	0.280	0.07	0.35	6.43	69.11	300	0.51	circle	69.06	0.98	9.3%
3 (Trib of MH 3)	Nelson St	EX SAN MH3	EX SAN MH4	2.300	-	2.767	207.00	249.03	-	-	-	1.020	3.030	304.35	745.80	8.27	3.88	9.21	3.29	2.61	0.280	2.32	2.66	14.48	75.20	300	0.49	circle	67.69	0.96	21.4%
4 (Trib of MH 4)	Nelson St	EX SAN MH4	EX SAN MH5			2.767	-	249.03	-	-	0.180	-	0.100	29.80	775.60	0.41	3.87	9.55	3.29	2.61	0.280	0.11	2.78	14.93	69.57	300	1.08	circle	100.49	1.42	14.9%

Flow Calculation Criteria
(Unit Flow from Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)
q = average daily residential per capita dry weather unit flow = 0.275 m3/cap/d
q = average daily commercial dry weather unit flow = 24.750m3/ha/d or 0.28646 L/ha/s
I/I = Unit of peak inflow/infiltration allowance = 0.286 (L/s/ha)
Q(p) = peak population flow (L/s)
Q(I) = peak extraneous flow (L/s)
Q(d) = peak design flow (L/s)

Mannings Equation:
Qcap=(D/1000)^2.667*(S/100)^0.5/(3.211*n)*1000(L/s)
D: pipe size (mm)
S: slope (grade) of pipe (%)
n = Manning roughness coefficient = 0.013

(Unit Population from Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

Single Family Population Density	55 P/ha
Semi-detached/duplex/4-plex	100 P/ha
Townhouse, Maisonette	135 P/ha
Apartment (Over 6 Stories High)	285 P/ha
Commercial	90 P/ha
Community Services (School)	40 P/ha

(Peaking Factor from Section 3.2.3., Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

PEAKING FACTOR (Residential)	M =1 + 14/(4+(P/1000^0.5))
PEAKING FACTOR (Commercial)	M =0.8[1 + 14/(4+(P/1000^0.5))]
PEAK DESIGN FLOW,	Q(d) = Q(p) + Q(i) L / Sec.
PIPE ROUGHGNESS,	n = 0.013 For Manning's Equation

Vmin. = 0.6m/s and Vmax. = 3m/s

5.0 STORM WATER MANAGEMENT

i) Terms of Reference & Available Infrastructure

There is an existing 375mm storm sewer beneath the north side of Lakeshore Road West. The following criteria is assumed based on the Town of Oakville's *Development Engineering Procedures and Guidelines Manual* (May 2005).

1) Quantity Control: Control 100-year post-development storm events to 5-year pre-development storm events
2) Quality Control: 50% TSS Removal by an Oil/Grit Separator or other such measure

Design storm data for the Town of Oakville 5-year and 100-year storms are shown below.

$$I_5 = 1170 / (5.8 + t)^{0.843}$$
$$I_{100} = 2150 / (5.7 + t)^{0.861}$$

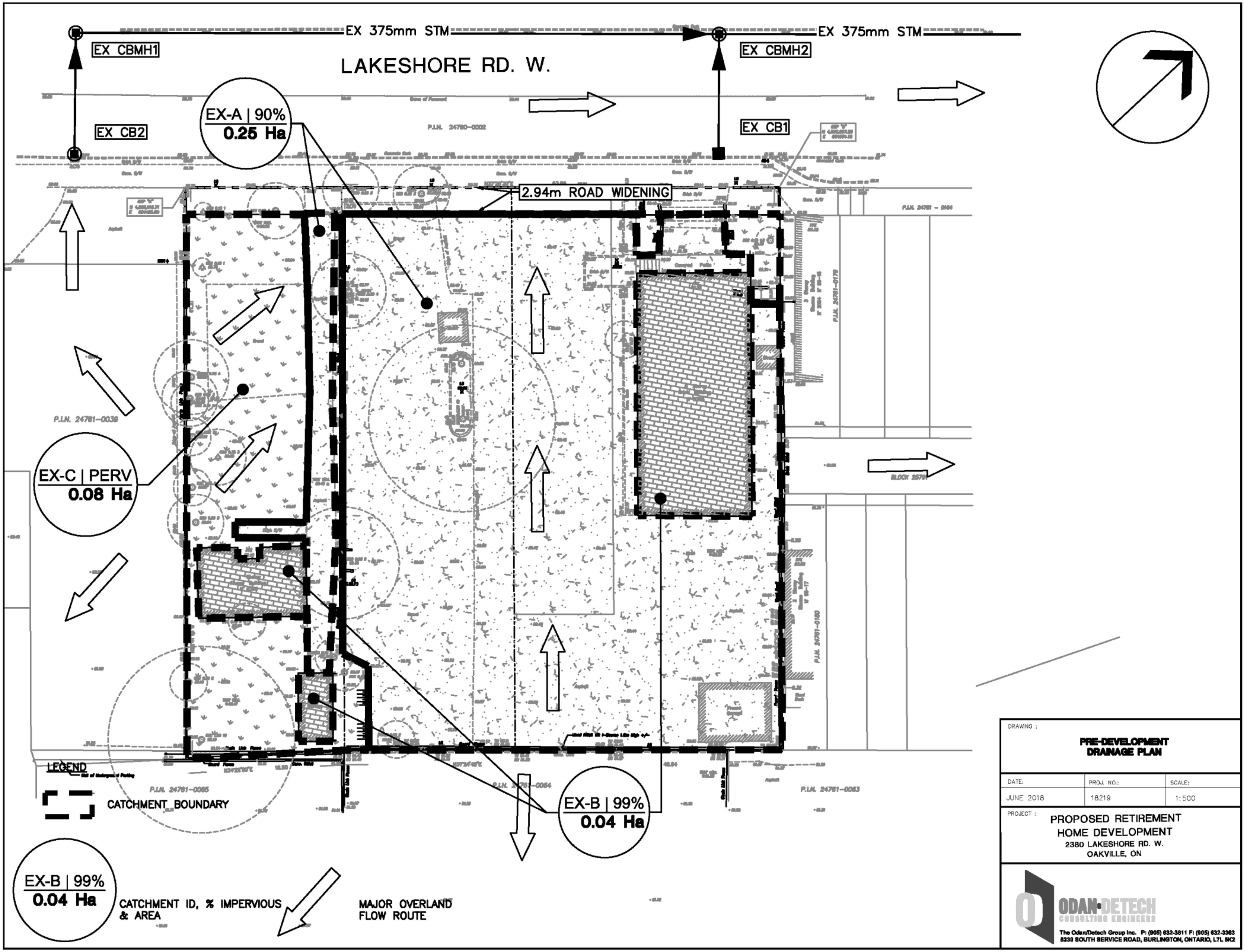
When time of concentration, *t*, is 10 minutes, the 5-year and 100-year rainfall intensities are as follows.

$$I_5 = 114.2 \text{ mm/hr}$$
$$I_{100} = 200.8 \text{ mm/hr}$$

ii) Allowable & Pre-Development Discharge Rate

The subject site drained in pre-development conditions as shown on the *Pre-Development Drainage Plan* on the following page. Pre-development catchment areas are delineated on that plan.

The site drained predominantly northerly to Lakeshore Road West in pre-development conditions. There is no evidence that any of the adjacent properties drained onto the subject site. All adjacent properties are graded to drain internally and appear to have internal catchbasins etc.



EX 375mm STM
EX 375mm STM
EX CBMH1
EX CBMH2
LAKESHORE RD. W.
EX CB2
EX CB1
EX-A | 90%
0.25 Ha
2.94m ROAD WIDENING
EX-C | PERV
0.08 Ha
EX-B | 99%
0.04 Ha
LEGEND
CATCHMENT BOUNDARY
EX-B | 99%
0.04 Ha
CATCHMENT ID, % IMPERVIOUS & AREA
MAJOR OVERLAND FLOW ROUTE
DRAWING :
PRE-DEVELOPMENT DRAINAGE PLAN
DATE:
JUNE 2018
PROJ. NO.:
18219
SCALE:
1:500
PROJECT :
PROPOSED RETIREMENT HOME DEVELOPMENT
2380 LAKESHORE RD. W.
OAKVILLE, ON
ODAN-DETECH
CONSULTING ENGINEERS
The Odan/Detech Group Inc. P: (905) 632-3811 F: (905) 632-3363
5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2

The site was modelled in the pre-development scenario using Visual OTTHYMO 2.3.2 to determine the pre-development 2-year storm runoff flow rates. Note that the pre-development catchment areas used to establish the allowable release rate conservatively considers the post-development 2.94m Lakeshore Road West road widening.

For drainage areas with significant imperviousness the calculation of effective rainfall in Visual OTTHYMO is accomplished using the "Standhyd" method. This method is used in urban watersheds to simulate runoff by combining two parallel standard unit hydrographs resulting from the effective rainfall intensity over the pervious and impervious surfaces. For pervious surfaces, losses are calculated using the SCS modified CN method.

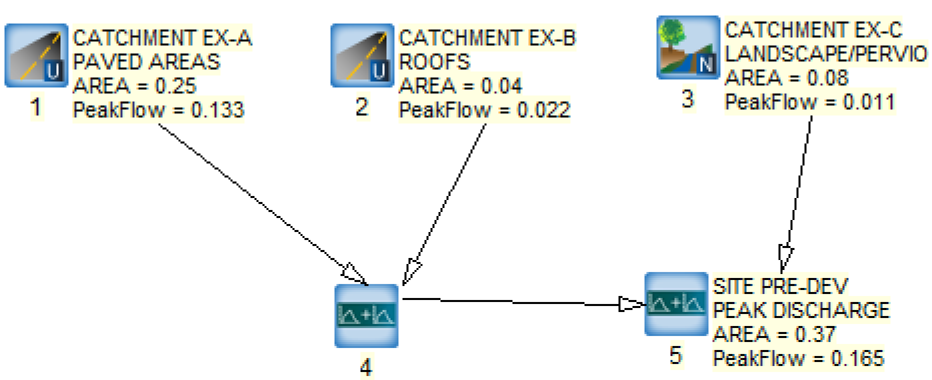
The catchment area statistics in the pre-development scenario are as follows.

TABLE 3 - Catchment Characteristics for Site, Pre-Development

Area I.D.	Area (ha)	Hydrology Method	% impervious	imperviousness directly connected %	Loss Method for Pervious Area	CN for Pervious Area	Initial Abstraction for Pervious (mm)	Time to peak (T_p)
EX-A Paved Surfaces	0.25	StandHyd	90	90	SCS	80	1	-
EX-B Roofs	0.04	StandHyd	99	99	SCS	80	1	-
EX-C Landscape/ Pervious	0.08	NashHyd	-	-	SCS	80	5	0.11

The pre-development Visual OTTHYMO Model is as follows. Refer to the output in Appendix B.

Figure 1 - Pre-Development Visual OTTHYMO Model (100-Year Storm)



The peak pre-development 2-year storm discharge rate on the 375mm storm sewer beneath Lakeshore Road West is as follows. Refer to the pre-development visual OTTHYMO output in Appendix B. These flow rates form the basis for the allowable release rate.

TABLE 4 – Pre-Development (allowable) Discharge

Outlet Location	5-Year Storm	100-Year Storm
Flow to Lakeshore Road West	90 L/s	165 L/s

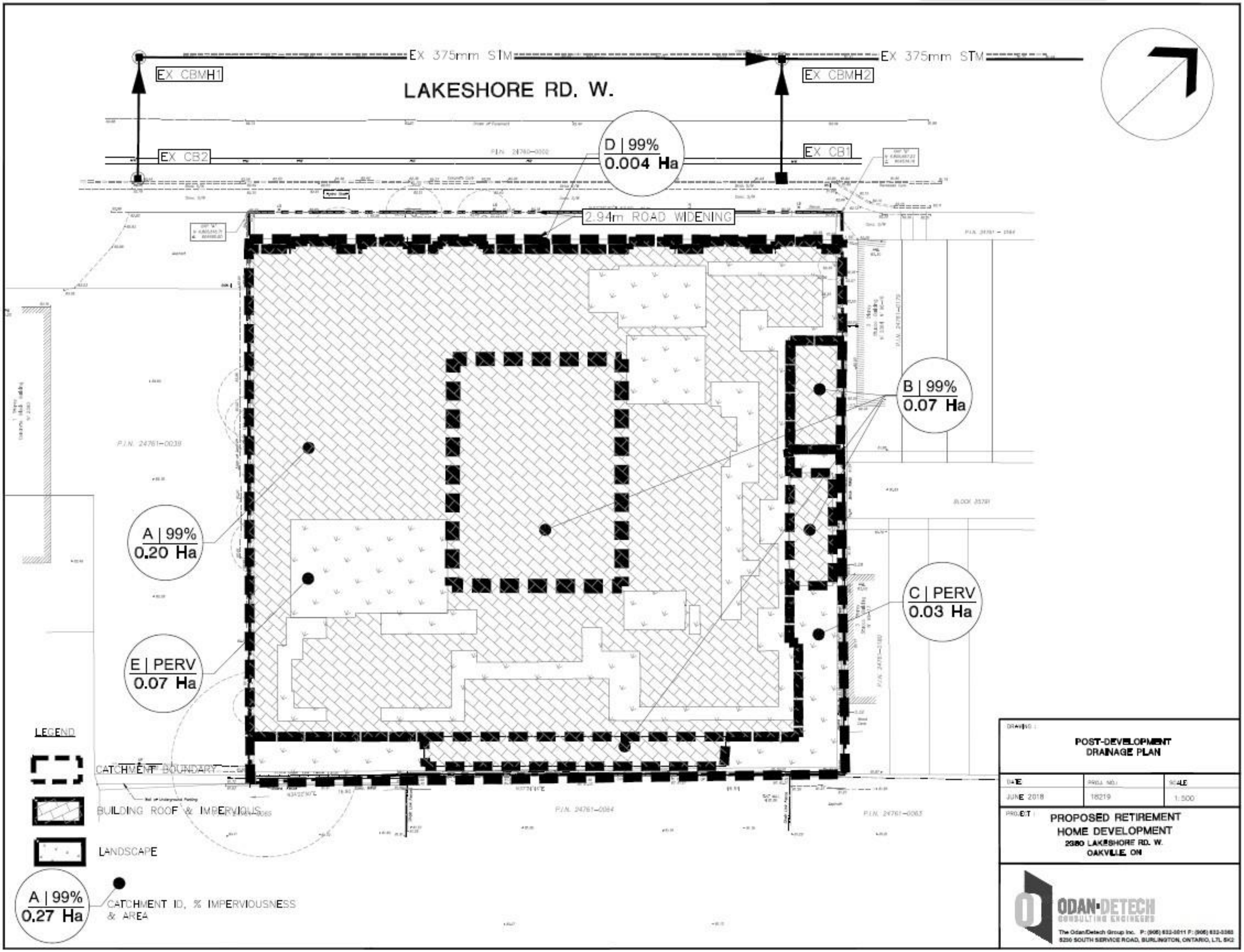
iii) Proposed Conditions & Post-Development Flow Analysis

City staff have not provided preconsultation comments regarding stormwater management quantity control criteria, therefore it is proposed to control storm flows 100-Year-Post-Development to 5-year-Pre-Development based on the pre-development flows established in Table 4, above.

The following table summarizes the parameters used in Visual OTTHYMO to characterize the post development catchment areas. Refer to the Post-Development Drainage Plan on the following page and the Post-Development Visual OTTHYMO Model thereafter.

TABLE 5 - Catchment Characteristics for Post-Developed Site

Area I.D.	Area (ha)	Hydrology Method	% impervious	imperviousness directly connected %	Loss Method for Pervious Area	CN for Pervious Area	Initial Abstraction for Pervious (mm)	Time to peak (T_p)
A – Tower Rooftop	0.20	StandHyd	99	99	SCS	80	1	-
B – Ground Level Paved	0.07	StandHyd	99	99	SCS	80	1	-
C – Landscape Areas	0.03	NashHyd	-	-	SCS	80	5	0.11
D – Uncontrolled Ground Level Paved	0.004	StandHyd	99	99	SCS	80	1	-
E – Tower Green Roof	0.07	StandHyd	60	60	SCS	80	1	-



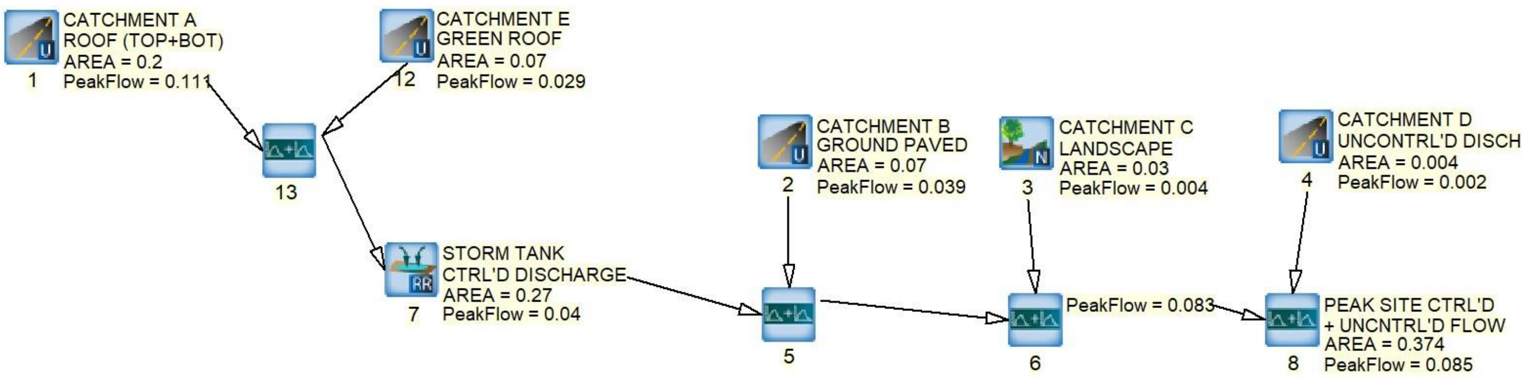
EX 375mm STM
EX 375mm STM
EX CBMH1
EX CBMH2
LAKESHORE RD. W.
EX CB2
EX CB1
D | 99%
0.004 Ha
2.94m ROAD WIDENING
B | 99%
0.07 Ha
A | 99%
0.20 Ha
C | PERV
0.03 Ha
E | PERV
0.07 Ha
P.I.N. 24761-0038
P.I.N. 24761-0084
P.I.N. 24761-0083
BLOCK 35791
LEGEND
CATCHMENT BOUNDARY
BUILDING ROOF & IMPERVIOUS
LANDSCAPE
A | 99%
0.27 Ha
CATCHMENT ID, % IMPERVIOUSNESS & AREA
DRAWING :
POST-DEVELOPMENT DRAINAGE PLAN
DATE
JUNE 2018
PROJ. NO.:
18219
SCALE
1:500
PROJECT :
PROPOSED RETIREMENT HOME DEVELOPMENT
2380 LAKESHORE RD. W.
OAKVILLE, ON
ODAN·DETECH
CONSULTING ENGINEERS

Visual OTTHYMO 2.3.2. will be used to model and determine the detention volume required. For drainage areas with significant imperviousness the calculation of effective rainfall in Visual OTTHYMO is accomplished using the "Standhyd" method. This method is used in urban watersheds to simulate runoff by combining two parallel standard unit hydrographs resulting from the effective rainfall intensity over the pervious and impervious surfaces. For pervious surfaces, losses are calculated using the SCS modified CN method.

The foregoing catchment areas appear in the post-development Visual OTTHYMO Model, as follows. The model shows flows in a 100-year storm. Refer to the detailed Visual OTTHYMO Output in Appendix B for detailed results for both 5-year and 100-year storms.

Stormwater quantity controls will be provided in the basement (via storm tank) of the proposed building to provide controlled release

Figure 2 – Post-Development Visual OTTHYMO Model (100Y Storm Flows)



As evident above, the discharge to the Lakeshore Road West 375mm storm sewer is 85 L/s, which is less than the 5-year pre-development flow rate (90 L/s – Table 4), therefore the development is in compliance with the stormwater quantity control criteria identified above.

The following is a description of the SWM quantity control system via storm tank:

- storm tank will be a cast in place concrete structure located in the basement underneath the underground parking entrance ramp.
- Using a combination of impervious roof and pervious green roof, runoff form the building's roof will be directed (uncontrolled) via mechanical storm drains to the storm tank
- A mechanical sump pump will be installed in the storm tank, pumping at a release rate of 40 L/s to the Control MH
- The mechanical sump pump requires submersion in water to remain operational. A float valve will be used to activate the pump once incoming storm flows raise the water level above the pumps baseline.
- 100 year flows are expected to raise the storage depth of water to 1.36m utilizing less than half of the provided capacity in the storm tank.

Adequate stormwater storage is provided to the 100-year storm in the basement of the building based on the foregoing storm tank as follows in Table 6.

Catchment Areas B and C (Ground-level areas) are to drain directly to the Jellyfish Filter, uncontrolled – as shown in Figure 2, those catchment areas do not contribute to the 100-Year storm tank.

TABLE 6 – Stormwater Storage

	5 Yr. Storm (m^3)	**100 Yr. Storm** (m^3)
Required Storage Volume (Roof drains)	23	61
Provided Storage Volume via Storm Tank	138.7	

The controlled and uncontrolled discharge from the site is as follows based on the Visual OTTHYMO Model. The site's peak storm flow in the 100-year storm (85 L/s) is less than the 5-year pre-development storm flow (90 L/s – Table 4) therefore the development meets the stormwater quantity control criteria.

TABLE 7 - Summary of Discharge from Site

	5 Yr. Storm (L/s)	**100 Yr. Storm** (L/s)
Controlled flow from Storm Tank (Catchment A&E)	40	40
Flow from ground-level paved areas (Catchment B)	22	39
Flow from ground-level landscape areas (Catchment C)	2	4
Flow from ground level paved (overland to Lakeshore Rd) (Catchment D)	1	2
Entire Development Peak Flow (Controlled + Uncontrolled)*	***65***	***85***

**Note: The entire development's Peak Discharge Rate to Lakeshore Rd. W. is not the sum of the peak flows from all tributary areas within the site. Rather, the peak discharge considers the different peaking time between the attenuated/controlled discharge and the uncontrolled drainage areas based on "overlaying" the hydrographs in the Visual OTTHYMO Model.*

iv) Erosion Control

Erosion and sediment control will be implemented on-site prior to construction and be maintained through the entire duration of construction. Erosion control measures to be implemented are:

- silt fence around the entire site
- sediment socks within existing and proposed catchbasins
- an entrance mud mat for trucks
- daily cleaning and weekly washing of roads

v) Stormwater Quality Control

The City of Oakville's *Development Engineering Procedures & Guidelines Manual* states in Section 6.2.4, *Storm Drainage Criteria*, that:

> *Quality treatment of stormwater is required. The level of treatment is to be determined per the receiving system (see Halton Conservation). Wet Ponds, Oil/Grit Separators and Landscape Filter Strips are acceptable methods.*

It is accordingly proposed to provide a Stormceptor EF6-model Oil/Grit Separator which is certified by the Canadian Environmental Technology Verification (CETV) program and sized to provide 64% TSS Removal. The Stormceptor design report and CETV verification statement is provided here in Appendix B. Refer to the Site Servicing Plan for the location of the Stormceptor OGS.

Town engineering review staff stated in the SPA review memorandum of October 3, 2018 that stormwater quality control criteria is to provide 80% TSS Removal for the whole development. 81% TSS Removal is provided for the whole development using the Stormceptor EF6 based on an area-weighted approach as follows, therefore the quality control criteria is satisfied.

Catchment ID	Area (Ha)	Area (% of total)	TSS Removal	Weighted TSS Removal (%) (=%A x %TSSR)
Catchment 'A'&'E' – Reg. Roofs	0.27	69%	90%	62%
Catchment 'B' – Paved areas subject to winter maintenance – drains to Stormceptor OGS	0.06	15%	64%	10%
Catchment 'C' – Landscape Surfaces	0.04	10%	90%	9%
Catchment 'D' – Paved areas – drain uncontrolled to Lakeshore Road	0.004	1%	0%	0%
Total	***0.37***			***81%***

6.0 CONCLUSIONS

From the foregoing investigation, the site is serviceable utilizing existing sanitary, storm and watermain infrastructure within and adjacent to the site. Storm water management can be accommodated with on-site storage as described in this report.

The following table summarizes the SWM and Servicing components of the proposed development.

TABLE 8 - Summary

Peak Sanitary Discharge (L/s)	3.6 L/s (City criteria)
Proposed Sanitary Service	150mm at 2.00%
Receiving Sanitary Sewer	Lakeshore Rd. W. 300mm Sanitary
Development Water Demand (Fire + Domestic)	3200 USGM
Proposed Fire Service	150mm Fire Service
Proposed Domestic Service	Branch 100mm Domestic
Allowable release rate from site	90 L/s (5-Y Pre-Development)
Proposed release rate from site to (100 year storm)	85 L/s (100-Y Post-Development)
Quantity Control	Controlling Roof Drains

7.0 REFERENCES

1. Town of Oakville *Development Engineering Procedures and Guidelines Manual* (May 2005).

2. Storm water Management Planning and Design Manual, Ontario Ministry of the Environment, March 2003.

3. Visual OTTHYMO v2.0 Reference Manual, July 2002

Respectfully Submitted;
The Odan Detech Group Inc.

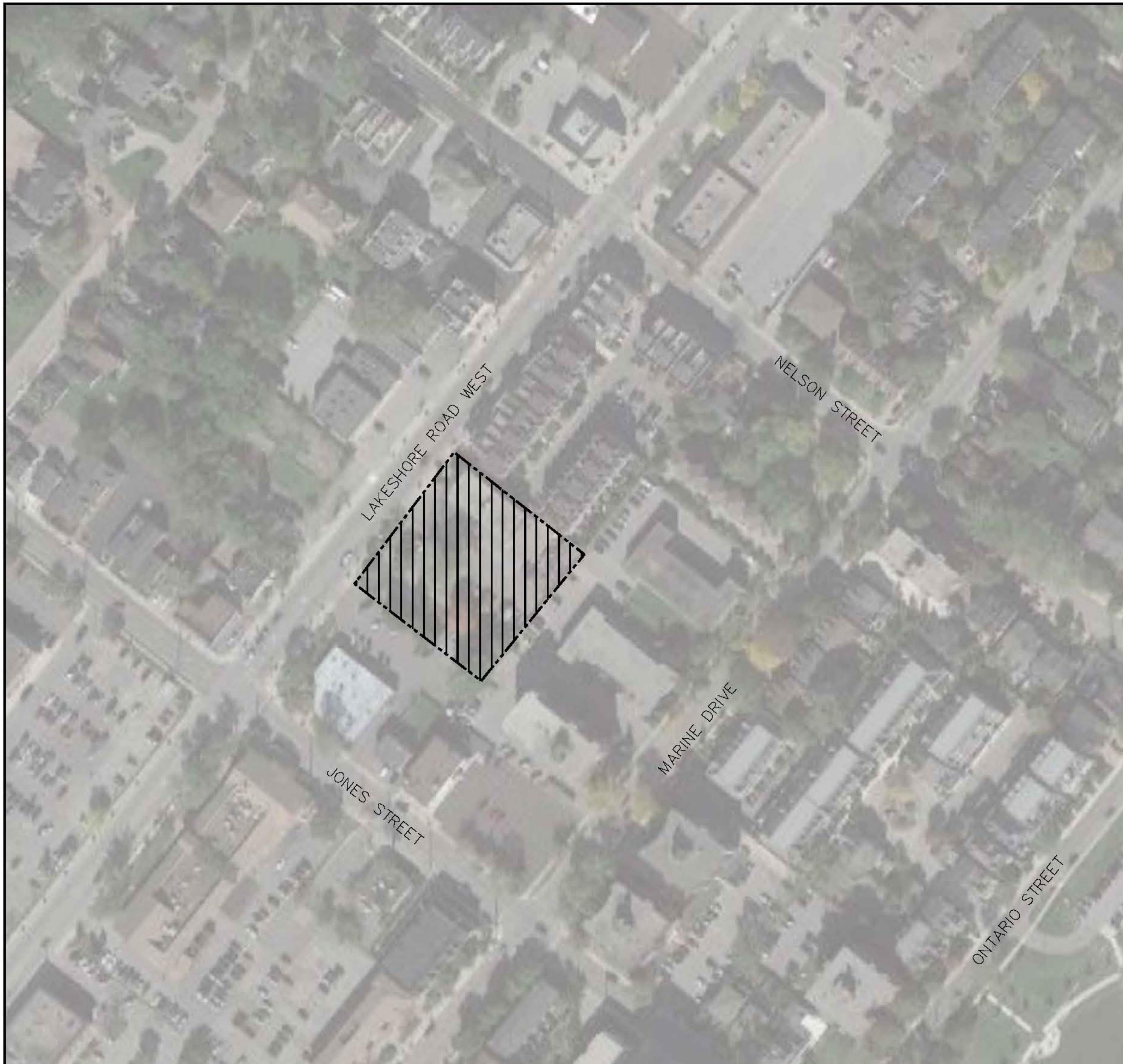
Jan. 26/23

Paul Hecimovic, P.Eng.

Mark Harris, Dipl. Tech.

APPENDIX A

Existing Site	Aerial view of Site and surrounding areas
Site Plan	by Michael Spaziani Architect Inc.
Development statistics	by Michael Spaziani Architect Inc.



LEGEND

PROPERTY LINE

DRAWING :

KEY PLAN

DATE:	PROJ. NO.:	SCALE:
JUNE 2018	18219	N.T.S.

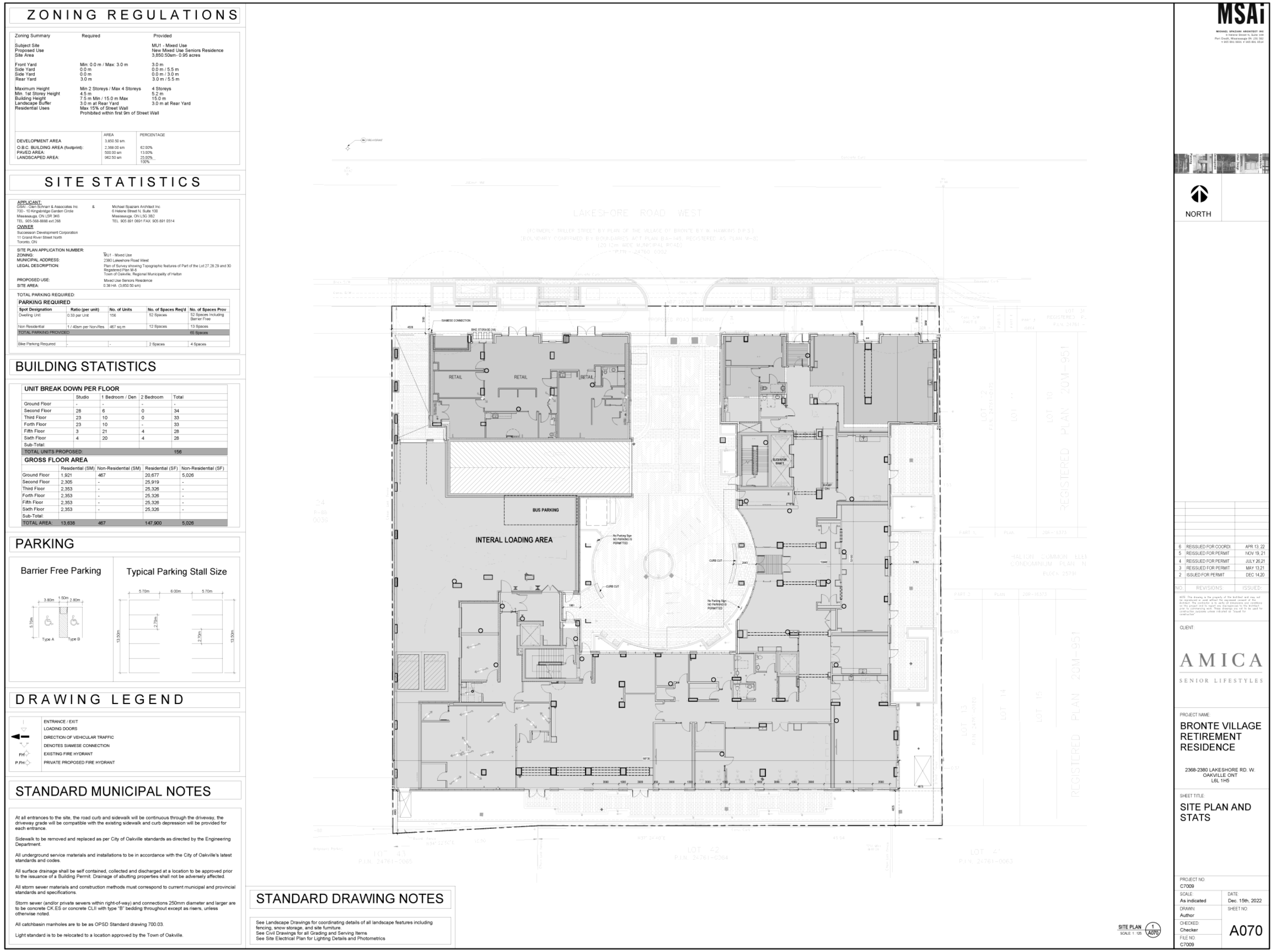
PROJECT :

PROPOSED RETIREMENT RESIDENCE

2380 LAKESHORE ROAD WEST

OAKVILLE, ON

ODAN·DETECH
CONSULTING ENGINEERS
The Odan/Detech Group Inc. P: (905) 632-3811 F: (905) 632-3363
5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2


ZONING REGULATIONS
SITE STATISTICS
BUILDING STATISTICS
UNIT BREAK DOWN PER FLOOR
GROSS FLOOR AREA
PARKING
Barrier Free Parking
Typical Parking Stall Size
DRAWING LEGEND
STANDARD MUNICIPAL NOTES
STANDARD DRAWING NOTES
LAKESHORE ROAD WEST
INTERAL LOADING AREA
BUS PARKING
RETAIL
NORTH
MSAi
AMICA
SENIOR LIFESTYLES
BRONTE VILLAGE RETIREMENT RESIDENCE
2368-2380 LAKESHORE RD. W. OAKVILLE ONT L6L 1H5
SITE PLAN AND STATS
A070

APPENDIX B

Pre-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

Post-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

Stormceptor sizing report

CETV Verification Statement – Imbrium Systems Inc. Stormceptor EF Filter

Pre-Development Visual OTTHYMO Output (5-year & 100-year Storm)

```
==========================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.3\voin.dat
  Output  filename: P:\2018\18219\Visual OTTHYMO\Rev1\18219 VO2\Pre-Dev.out
  Summary filename: P:\2018\18219\Visual OTTHYMO\Rev1\18219 VO2\Pre-Dev.sum


DATE: 7/2/2019                           TIME: 10:14:03 AM

USER:


COMMENTS: ____________________________________________________________

----------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1170.000
| Ptotal= 45.17 mm |                          B=   5.800
--------------------                          C=    .843
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    2.32 |  1.17   24.01 |  2.17    6.09 |  3.17    2.81
                  .33    2.70 |  1.33  114.21 |  2.33    5.07 |  3.33    2.59
                  .50    3.24 |  1.50   32.30 |  2.50    4.35 |  3.50    2.40
                  .67    4.08 |  1.67   15.74 |  2.67    3.82 |  3.67    2.24
                  .83    5.57 |  1.83   10.30 |  2.83    3.41 |  3.83    2.10
                 1.00    8.96 |  2.00    7.65 |  3.00    3.08 |  4.00    1.98


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=    .08   Curve Number   (CN)= 80.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .20

     Unit Hyd Qpeak  (cms)=    .015

     PEAK FLOW       (cms)=    .004 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  15.155
     TOTAL RAINFALL   (mm)=  45.171
     RUNOFF COEFFICIENT   =    .335

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
```

```
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      16.30        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    2.32 | 1.083   24.01 | 2.083    6.09 |  3.08    2.81
                 .167    2.32 | 1.167   24.01 | 2.167    6.09 |  3.17    2.81
                 .250    2.70 | 1.250  114.21 | 2.250    5.07 |  3.25    2.59
                 .333    2.70 | 1.333  114.21 | 2.333    5.07 |  3.33    2.59
                 .417    3.24 | 1.417   32.30 | 2.417    4.35 |  3.42    2.40
                 .500    3.24 | 1.500   32.30 | 2.500    4.35 |  3.50    2.40
                 .583    4.08 | 1.583   15.74 | 2.583    3.82 |  3.58    2.24
                 .667    4.08 | 1.667   15.74 | 2.667    3.82 |  3.67    2.24
                 .750    5.57 | 1.750   10.30 | 2.750    3.41 |  3.75    2.10
                 .833    5.57 | 1.833   10.30 | 2.833    3.41 |  3.83    2.10
                 .917    8.96 | 1.917    7.65 | 2.917    3.08 |  3.92    1.98
                1.000    8.96 | 2.000    7.65 | 3.000    3.08 |  4.00    1.98

     Max.Eff.Inten.(mm/hr)=     114.21        42.13
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .82 (ii)    1.88 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .32
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .013 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12         43.91
     TOTAL RAINFALL   (mm)=      45.17        45.17         45.17
     RUNOFF COEFFICIENT   =        .98          .40           .97

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0001) |   Area    (ha)=    .25
|ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  90.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .22          .03
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      40.80        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=     114.21        42.13
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.41 (ii)    4.19 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .33          .24
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .07          .00          .074 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12         41.56
     TOTAL RAINFALL   (mm)=      45.17        45.17         45.17
     RUNOFF COEFFICIENT   =        .98          .40           .92

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0004) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0002):      .04    .013     1.33    43.91
        + ID2= 2 (0001):      .25    .074     1.33    41.56
```

```
          ==================================================
          ID = 3 (0004):      .29    .087     1.33    41.88

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0003):      .08    .004     1.50    15.15
        + ID2= 2 (0004):      .29    .087     1.33    41.88
          ==================================================
          ID = 3 (0005):      .37    .090     1.33    35.97

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
  ***************************
  ** SIMULATION NUMBER:   2 **
  ***************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=2150.000
| Ptotal= 75.20 mm |                          B=   5.700
--------------------                          C=    .861
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    3.49 |  1.17   39.75 |  2.17    9.50 |  3.17    4.26
                  .33    4.08 |  1.33  200.80 |  2.33    7.85 |  3.33    3.91
                  .50    4.93 |  1.50   54.01 |  2.50    6.70 |  3.50    3.62
                  .67    6.26 |  1.67   25.55 |  2.67    5.85 |  3.67    3.37
                  .83    8.66 |  1.83   16.41 |  2.83    5.19 |  3.83    3.15
                 1.00   14.21 |  2.00   12.04 |  3.00    4.68 |  4.00    2.96


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=    .08   Curve Number   (CN)= 80.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .20

     Unit Hyd Qpeak  (cms)=    .015

     PEAK FLOW       (cms)=    .011 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  35.894
     TOTAL RAINFALL   (mm)=  75.204
     RUNOFF COEFFICIENT   =    .477

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      16.30        40.00
     Mannings n          =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    3.49 | 1.083   39.75 | 2.083    9.50 |  3.08    4.26
                 .167    3.49 | 1.167   39.75 | 2.167    9.50 |  3.17    4.26
                 .250    4.08 | 1.250  200.80 | 2.250    7.85 |  3.25    3.91
                 .333    4.08 | 1.333  200.80 | 2.333    7.85 |  3.33    3.91
                 .417    4.93 | 1.417   54.01 | 2.417    6.70 |  3.42    3.62
                 .500    4.93 | 1.500   54.01 | 2.500    6.70 |  3.50    3.62
                 .583    6.26 | 1.583   25.55 | 2.583    5.85 |  3.58    3.37
                 .667    6.26 | 1.667   25.55 | 2.667    5.85 |  3.67    3.37
```

```
               .750    8.66 | 1.750   16.41 | 2.750    5.19 |  3.75    3.15
               .833    8.66 | 1.833   16.41 | 2.833    5.19 |  3.83    3.15
               .917   14.21 | 1.917   12.04 | 2.917    4.68 |  3.92    2.96
              1.000   14.21 | 2.000   12.04 | 3.000    4.68 |  4.00    2.96

     Max.Eff.Inten.(mm/hr)=     200.80       210.66
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .65 (ii)    1.50 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .33
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .02          .00            .022 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33           1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99          73.86
     TOTAL RAINFALL   (mm)=      75.20        75.20          75.20
     RUNOFF COEFFICIENT   =        .99          .53            .98

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD  (0001) |   Area    (ha)=    .25
|ID= 1 DT= 5.0 min |   Total Imp(%)=  90.00   Dir. Conn.(%)=  90.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .22          .03
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      40.80        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=     200.80       103.62
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.13 (ii)    3.35 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .26
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .13          .01            .133 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33           1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99          70.77
     TOTAL RAINFALL   (mm)=      75.20        75.20          75.20
     RUNOFF COEFFICIENT   =        .99          .53            .94

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0004) |
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0002):      .04    .022     1.33    73.86
        + ID2= 2 (0001):      .25    .133     1.33    70.77
          ==================================================
          ID = 3 (0004):      .29    .155     1.33    71.20

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0003):      .08    .011     1.50    35.89
        + ID2= 2 (0004):      .29    .155     1.33    71.20
          ==================================================
          ID = 3 (0005):      .37    .165     1.33    63.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
 FINISH
```

Post-Development Visual OTTHYMO Output (5-year & 100-year Storms)

```
===============================================================================================================

      V    V   I    SSSSS  U   U    A    L
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO

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                   *****  D E T A I L E D   O U T P U T *****

  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.3\voin.dat
  Output  filename: C:\Users\Saad\Desktop\18219 VO2\Post-Dev.out
  Summary filename: C:\Users\Saad\Desktop\18219 VO2\Post-Dev.sum

DATE: 5/14/2021                           TIME: 10:10:59 AM

USER:

COMMENTS: ____________________________________________________________

---------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1170.000
| Ptotal= 45.17 mm |                          B=   5.800
--------------------                          C=    .843
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    2.32 |  1.17   24.01 |  2.17    6.09 |  3.17    2.81
                  .33    2.70 |  1.33  114.21 |  2.33    5.07 |  3.33    2.59
                  .50    3.24 |  1.50   32.30 |  2.50    4.35 |  3.50    2.40
                  .67    4.08 |  1.67   15.74 |  2.67    3.82 |  3.67    2.24
                  .83    5.57 |  1.83   10.30 |  2.83    3.41 |  3.83    2.10
                 1.00    8.96 |  2.00    7.65 |  3.00    3.08 |  4.00    1.98

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=    .03   Curve Number   (CN)= 80.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .20

     Unit Hyd Qpeak  (cms)=    .006

     PEAK FLOW       (cms)=    .002 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  15.137
     TOTAL RAINFALL   (mm)=  45.171
     RUNOFF COEFFICIENT   =    .335

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0012) |   Area    (ha)=    .07
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
```

```
     Surface Area     (ha)=        .04          .03
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      21.60        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    2.32 | 1.083   24.01 | 2.083    6.09 |  3.08    2.81
                 .167    2.32 | 1.167   24.01 | 2.167    6.09 |  3.17    2.81
                 .250    2.70 | 1.250  114.21 | 2.250    5.07 |  3.25    2.59
                 .333    2.70 | 1.333  114.21 | 2.333    5.07 |  3.33    2.59
                 .417    3.24 | 1.417   32.30 | 2.417    4.35 |  3.42    2.40
                 .500    3.24 | 1.500   32.30 | 2.500    4.35 |  3.50    2.40
                 .583    4.08 | 1.583   15.74 | 2.583    3.82 |  3.58    2.24
                 .667    4.08 | 1.667   15.74 | 2.667    3.82 |  3.67    2.24
                 .750    5.57 | 1.750   10.30 | 2.750    3.41 |  3.75    2.10
                 .833    5.57 | 1.833   10.30 | 2.833    3.41 |  3.83    2.10
                 .917    8.96 | 1.917    7.65 | 2.917    3.08 |  3.92    1.98
                1.000    8.96 | 2.000    7.65 | 3.000    3.08 |  4.00    1.98

     Max.Eff.Inten.(mm/hr)=     114.21        42.13
                over (min)        5.00        15.00
     Storage Coeff.  (min)=        .97 (ii)   10.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .34          .09
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .00           .014 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12          33.62
     TOTAL RAINFALL   (mm)=      45.17        45.17          45.17
     RUNOFF COEFFICIENT   =        .98          .40            .74

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=    .20
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .20          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      36.50        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=     114.21       842.65
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.32 (ii)    2.39 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .33          .30
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .06          .00           .063 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33           1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12          43.91
     TOTAL RAINFALL   (mm)=      45.17        45.17          45.17
     RUNOFF COEFFICIENT   =        .98          .40            .97

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .07
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .07          .00
     Dep. Storage     (mm)=       1.00         1.00
```

```
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      21.60        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     114.21       421.32
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .97 (ii)     2.03 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .31
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .02          .00          .022 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12         43.91
     TOTAL RAINFALL   (mm)=      45.17        45.17         45.17
     RUNOFF COEFFICIENT   =        .98          .40           .97

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0004) |   Area    (ha)=    .00
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .00          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=       5.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     114.21       210.66
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .41 (ii)     1.48 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .33
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .001 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      44.17        18.12         36.01
     TOTAL RAINFALL   (mm)=      45.17        45.17         45.17
     RUNOFF COEFFICIENT   =        .98          .40           .80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0013) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0012):      .07    .014     1.33    33.62
        + ID2= 2 (0001):      .20    .063     1.33    43.91
          ==================================================
          ID = 3 (0013):      .27    .077     1.33    41.23

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0007) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0001    |    .0401       .0138
                          .0400      .0002    |    .0000       .0000

                                  AREA      QPEAK       TPEAK       R.V.
                                  (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0013)        .270       .077        1.33       41.23
     OUTFLOW: ID= 1 (0007)        .270       .040        1.42       40.96

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 51.76
                   TIME SHIFT OF PEAK FLOW         (min)=  5.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0023
```

```
-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0007):      .27    .040     1.42    40.96
        + ID2= 2 (0002):      .07    .022     1.33    43.91
          ===============================================
          ID = 3 (0005):      .34    .062     1.33    41.57

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0006) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0003):      .03    .002     1.50    15.14
        + ID2= 2 (0005):      .34    .062     1.33    41.57
          ===============================================
          ID = 3 (0006):      .37    .063     1.33    39.42

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0008) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0006):      .37    .063     1.33    39.42
        + ID2= 2 (0004):      .00    .001     1.33    36.01
          ===============================================
          ID = 3 (0008):      .37    .065     1.33    39.39

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=2150.000
| Ptotal= 75.20 mm |                          B=   5.700
--------------------                          C=    .861
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =    .33

                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    3.49 |  1.17   39.75 |  2.17    9.50 |  3.17    4.26
                  .33    4.08 |  1.33  200.80 |  2.33    7.85 |  3.33    3.91
                  .50    4.93 |  1.50   54.01 |  2.50    6.70 |  3.50    3.62
                  .67    6.26 |  1.67   25.55 |  2.67    5.85 |  3.67    3.37
                  .83    8.66 |  1.83   16.41 |  2.83    5.19 |  3.83    3.15
                 1.00   14.21 |  2.00   12.04 |  3.00    4.68 |  4.00    2.96


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=    .03   Curve Number   (CN)= 80.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .20

     Unit Hyd Qpeak  (cms)=    .006

     PEAK FLOW       (cms)=    .004 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  35.892
     TOTAL RAINFALL   (mm)=  75.204
     RUNOFF COEFFICIENT   =    .477

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0012) |   Area    (ha)=    .07
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
```

```
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .03
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      21.60        40.00
     Mannings n           =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    3.49 | 1.083   39.75 | 2.083    9.50 |  3.08    4.26
                 .167    3.49 | 1.167   39.75 | 2.167    9.50 |  3.17    4.26
                 .250    4.08 | 1.250  200.80 | 2.250    7.85 |  3.25    3.91
                 .333    4.08 | 1.333  200.80 | 2.333    7.85 |  3.33    3.91
                 .417    4.93 | 1.417   54.01 | 2.417    6.70 |  3.42    3.62
                 .500    4.93 | 1.500   54.01 | 2.500    6.70 |  3.50    3.62
                 .583    6.26 | 1.583   25.55 | 2.583    5.85 |  3.58    3.37
                 .667    6.26 | 1.667   25.55 | 2.667    5.85 |  3.67    3.37
                 .750    8.66 | 1.750   16.41 | 2.750    5.19 |  3.75    3.15
                 .833    8.66 | 1.833   16.41 | 2.833    5.19 |  3.83    3.15
                 .917   14.21 | 1.917   12.04 | 2.917    4.68 |  3.92    2.96
                1.000   14.21 | 2.000   12.04 | 3.000    4.68 |  4.00    2.96

     Max.Eff.Inten.(mm/hr)=     200.80       103.62
                over (min)        5.00        10.00
     Storage Coeff.  (min)=        .77 (ii)    5.31 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .34          .16
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .02          .01          .029 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42          1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99         60.48
     TOTAL RAINFALL   (mm)=      75.20        75.20         75.20
     RUNOFF COEFFICIENT   =        .99          .53           .80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=    .20
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .20          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      36.50        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     200.80      2072.30
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.06 (ii)    1.91 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .32
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .11          .00          .111 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99         73.86
     TOTAL RAINFALL   (mm)=      75.20        75.20         75.20
     RUNOFF COEFFICIENT   =        .99          .53           .98

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .07
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
```

```
     Surface Area     (ha)=        .07          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      21.60        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     200.80      1036.15
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .77 (ii)    1.62 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .32
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .04          .00          .039 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99         73.86
     TOTAL RAINFALL   (mm)=      75.20        75.20         75.20
     RUNOFF COEFFICIENT   =        .99          .53           .98

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0004) |   Area    (ha)=    .00
|ID= 1 DT= 5.0 min |   Total Imp(%)=  99.00   Dir. Conn.(%)=  99.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .00          .00
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=       5.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     200.80       518.08
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .33 (ii)    1.18 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .34
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .002 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      74.20        39.99         65.29
     TOTAL RAINFALL   (mm)=      75.20        75.20         75.20
     RUNOFF COEFFICIENT   =        .99          .53           .87

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0013) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0012):      .07    .029     1.33    60.48
        + ID2= 2 (0001):      .20    .111     1.33    73.86
          ==================================================
          ID = 3 (0013):      .27    .140     1.33    70.38

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0007) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0001    |    .0401      .0138
                          .0400      .0002    |    .0000      .0000

                                AREA      QPEAK       TPEAK       R.V.
                                (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0013)      .270       .140        1.33       70.38
     OUTFLOW: ID= 1 (0007)      .270       .040        1.50       70.02

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 28.60
```

```
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0061

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0007):      .27    .040     1.50    70.02
        + ID2= 2 (0002):      .07    .039     1.33    73.86
          ==================================================
          ID = 3 (0005):      .34    .079     1.33    70.81

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0006) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0003):      .03    .004     1.50    35.89
        + ID2= 2 (0005):      .34    .079     1.33    70.81
          ==================================================
          ID = 3 (0006):      .37    .083     1.33    67.98

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0008) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0006):      .37    .083     1.33    67.98
        + ID2= 2 (0004):      .00    .002     1.33    65.29
          ==================================================
          ID = 3 (0008):      .37    .085     1.33    67.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

 FINISH
==============================================================================================================
```

Hydroworks Sizing Summary

2380 Lakeshore Rd W-Retirement Home
Oakville, Ontario

12-07-2022

Recommended Size: HydroDome HD 4

A HydroDome HD 4 is recommended to provide 79 % annual TSS removal based on a drainage area of .37 (ha) with an imperviousness of 60 % and Toronto Central, Ontario rainfall for the ETV/NJDEP particle size distribution.

The recommended HydroDome HD 4 treats 100 % of the annual runoff and provides 79 % annual TSS removal for the Toronto Central rainfall records and ETV/NJDEP particle size distribution.

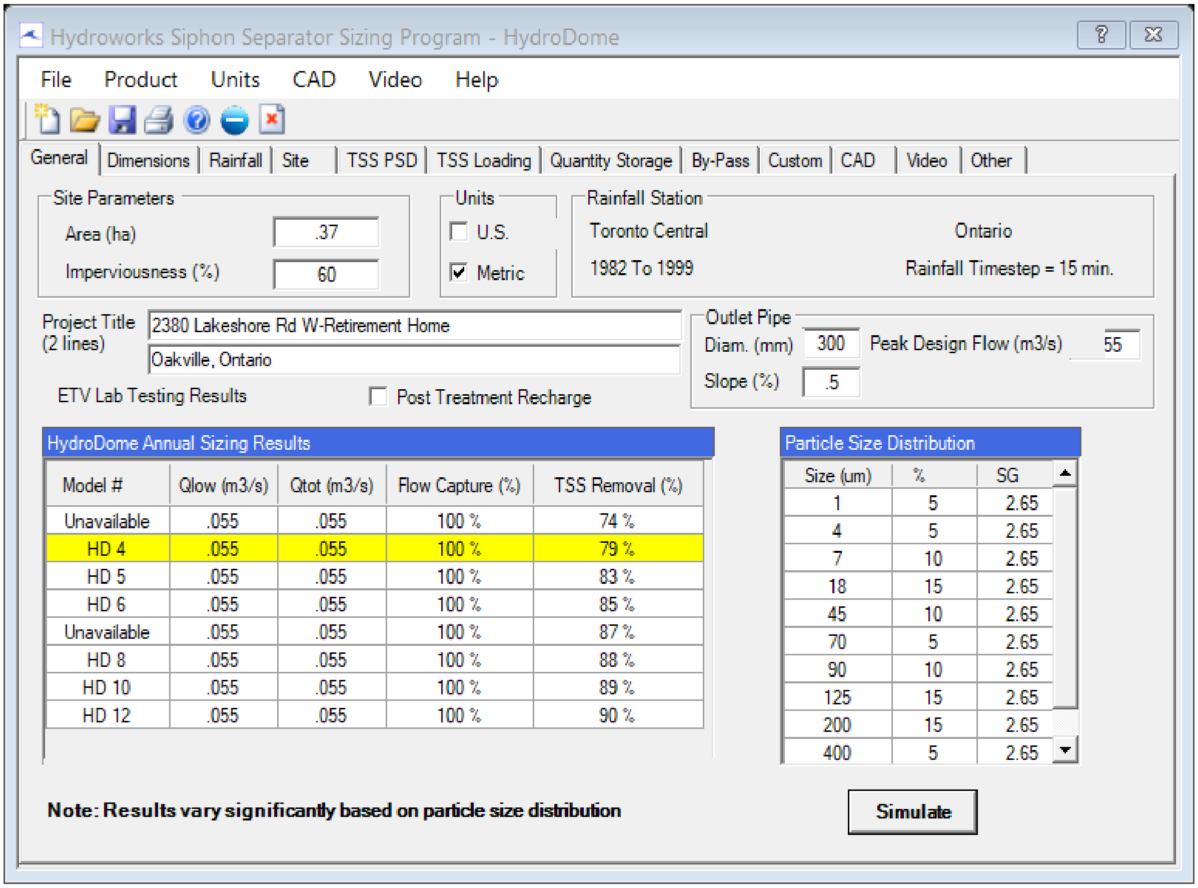
The HydroDome has a siphon which creates a discontinuity in headloss. The given peak flow of .06 (m3/s) is greater than the full pipe flow of .01 (m3/s) indicating the pipe will be surcharged during the peak flow. Full pipe flow was assumed for the headloss calculations. The pressure head in the pipe was not evaluated since this would require a hydraulic gradeline analysis. The headloss was calculated to be 262 (mm) above the crown of the 300 (mm) outlet pipe.

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

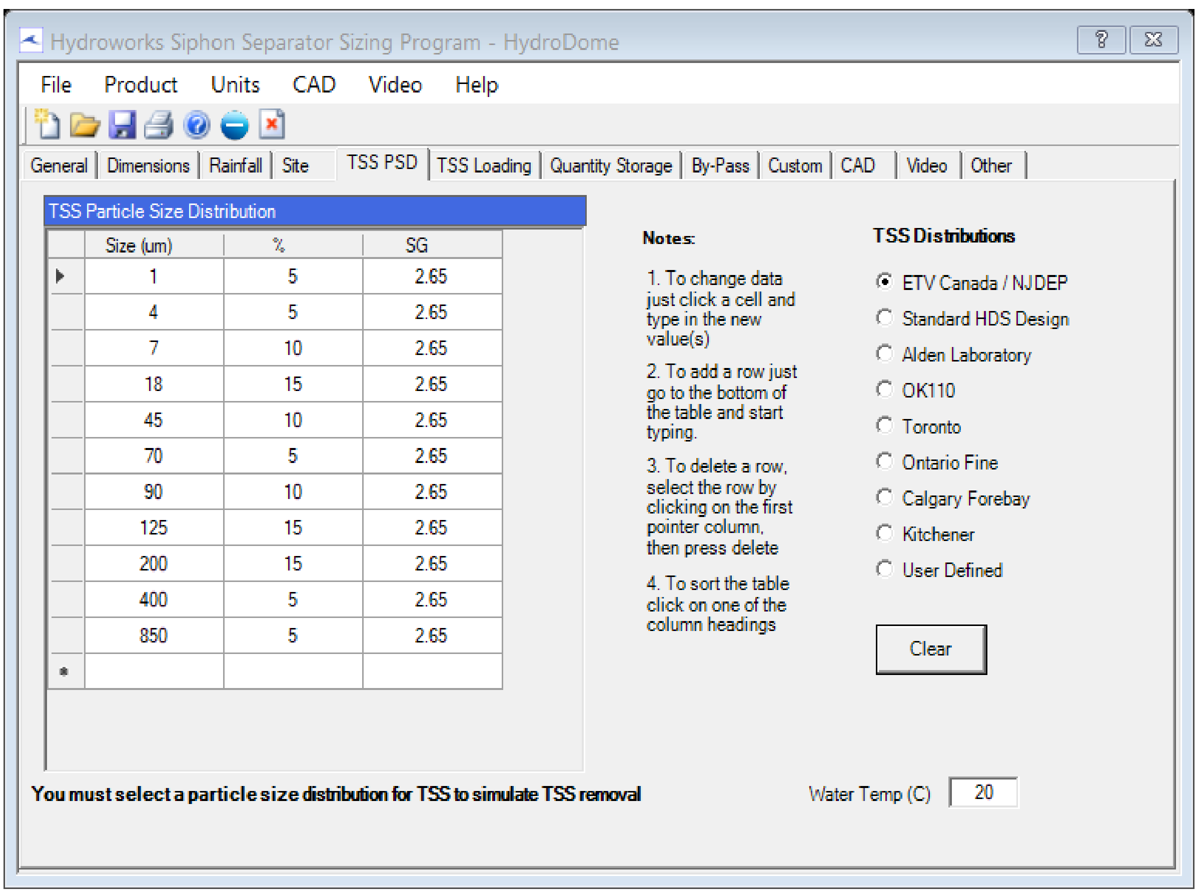
If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

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

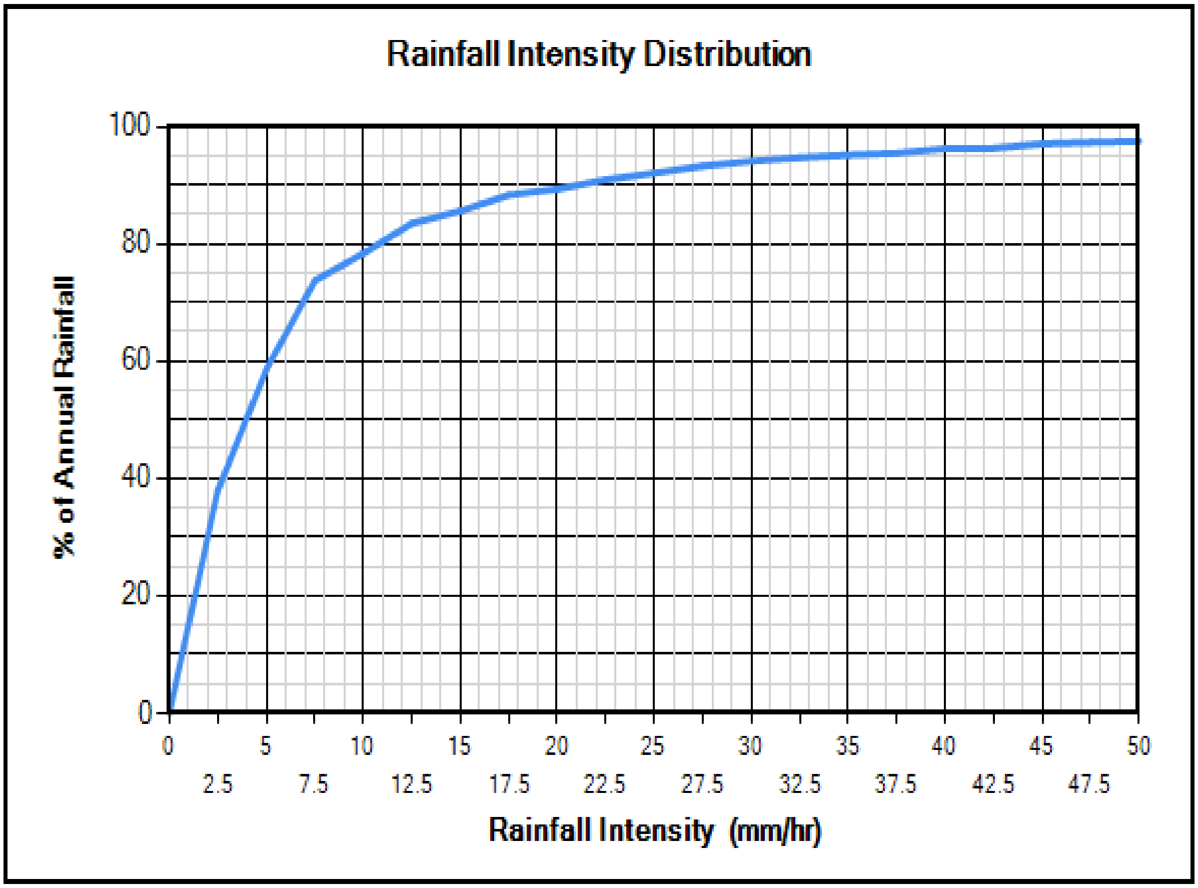
TSS Removal Sizing Summary



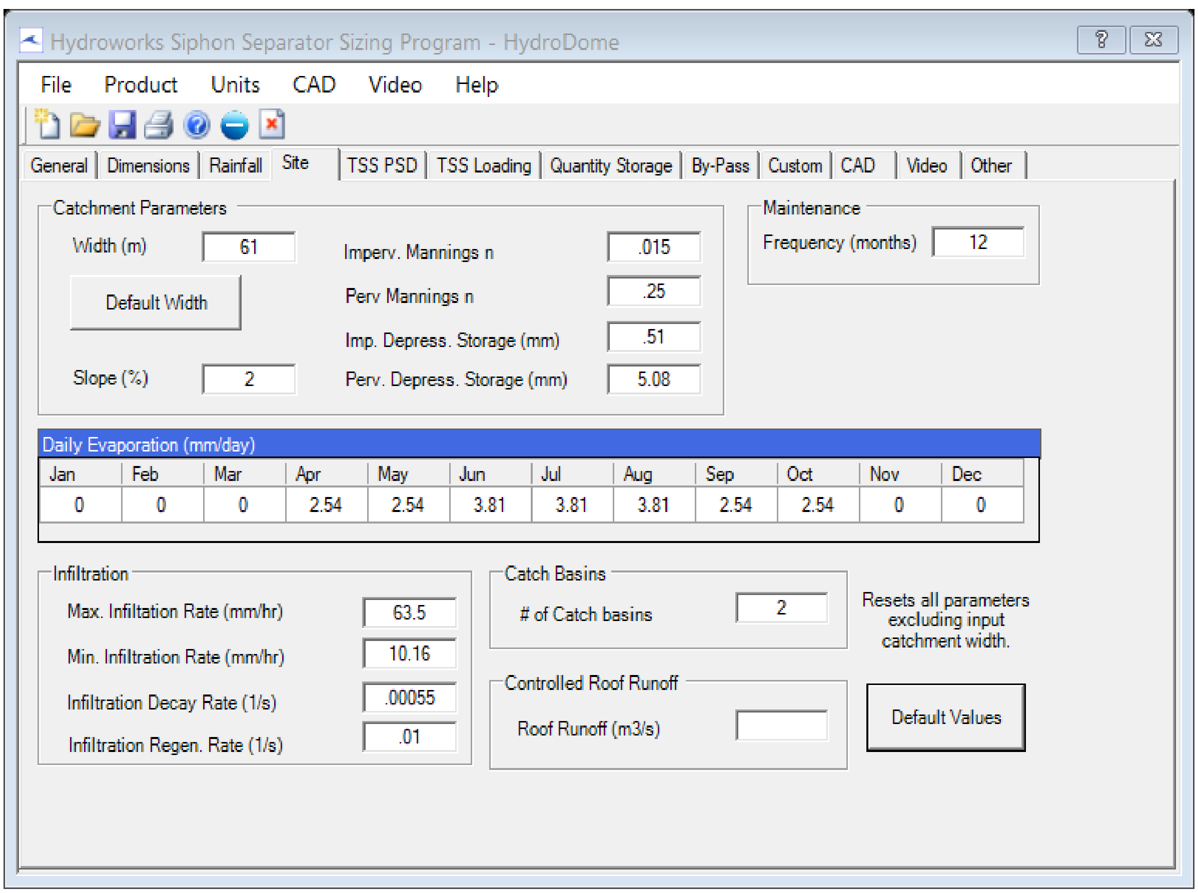
TSS Particle Size Distribution



Rainfall Station - Toronto Central, Ontario(1982 To 1999)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Siphon Separator Sizing Program - HydroDome

File Product Units CAD Video Help

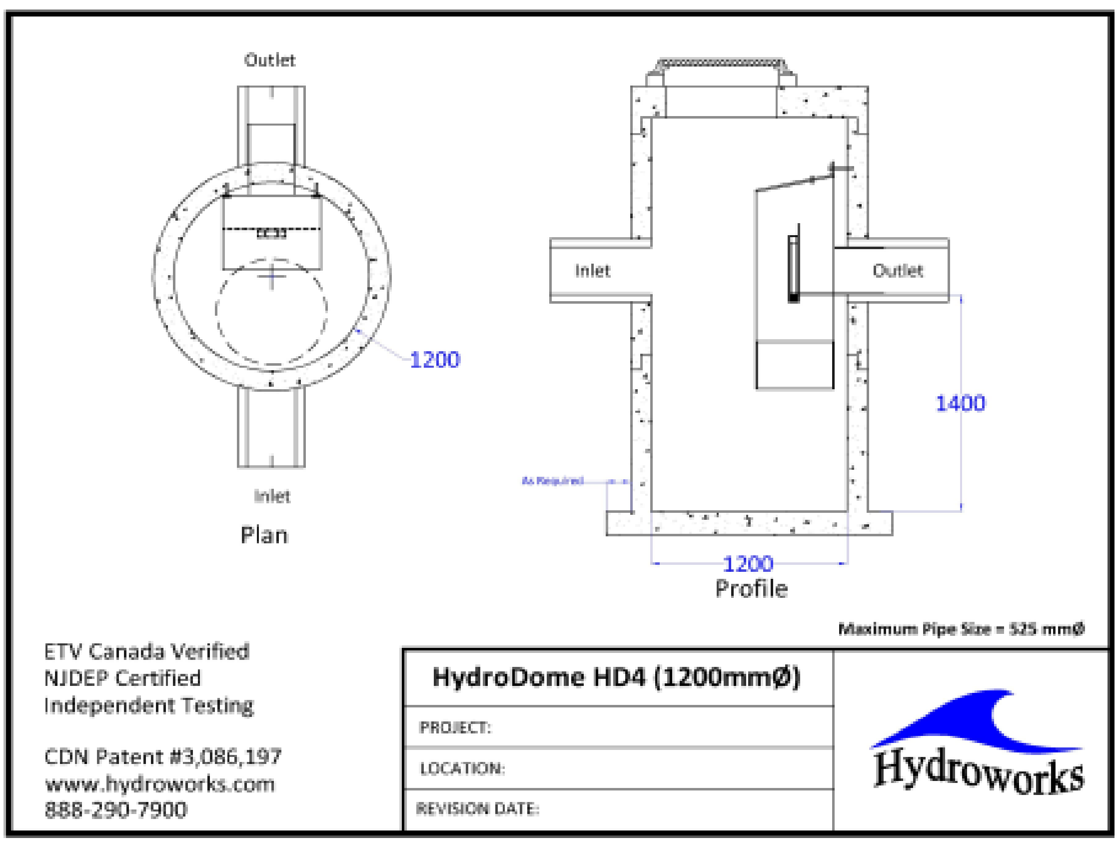
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Video | Other

Dimensions and Capacities

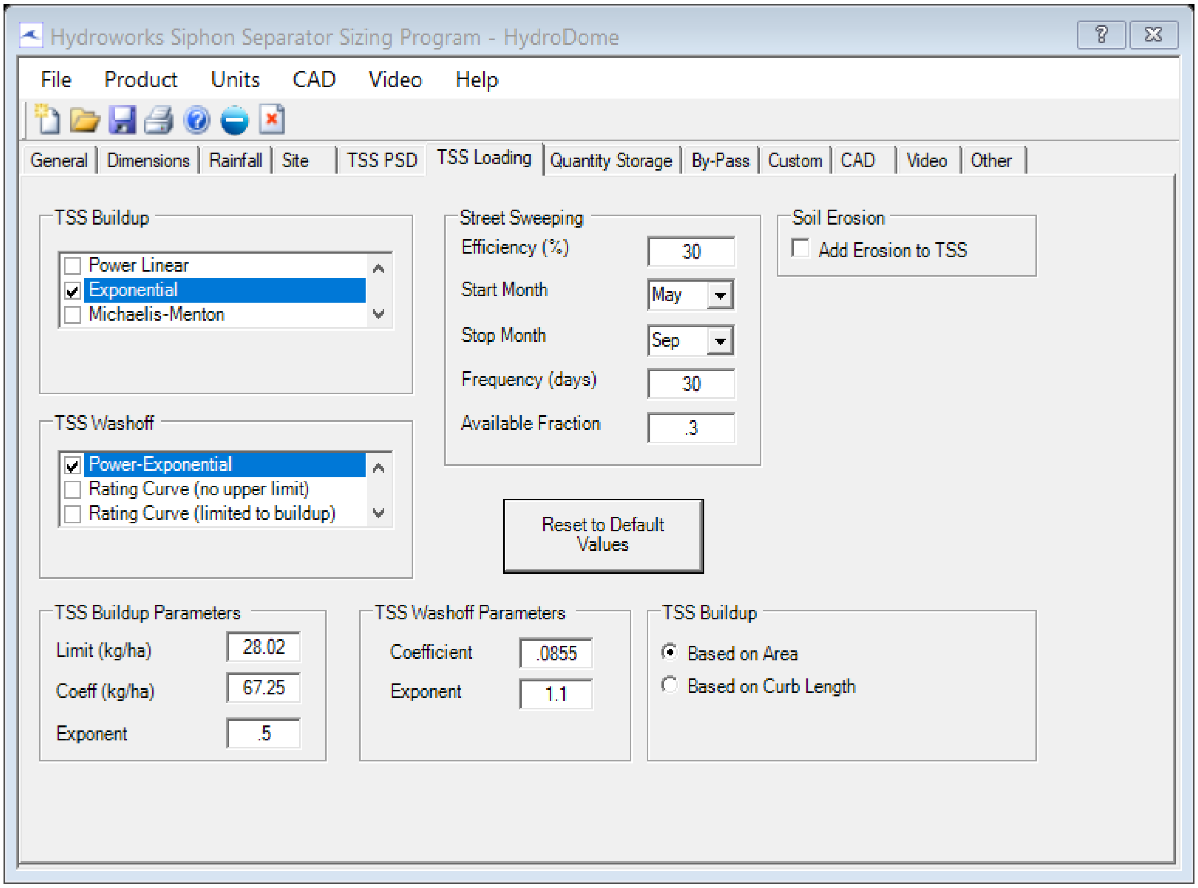
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HD 3	0.91	1.22	123	0.5	0.8
HD 4	1.22	1.37	266	0.9	1.6
HD 5	1.52	1.68	483	1.7	3.1
HD 6	1.83	1.98	803	2.9	5.2
HD 7	2.13	2.29	1226	4.6	8.2
HD 8	2.44	2.59	1863	6.8	12.1
HD 10	3.05	3.2	3617	13	23.3
HD 12	3.66	3.81	6224	22.2	40

Depth = Depth from outlet invert to inside bottom of tank

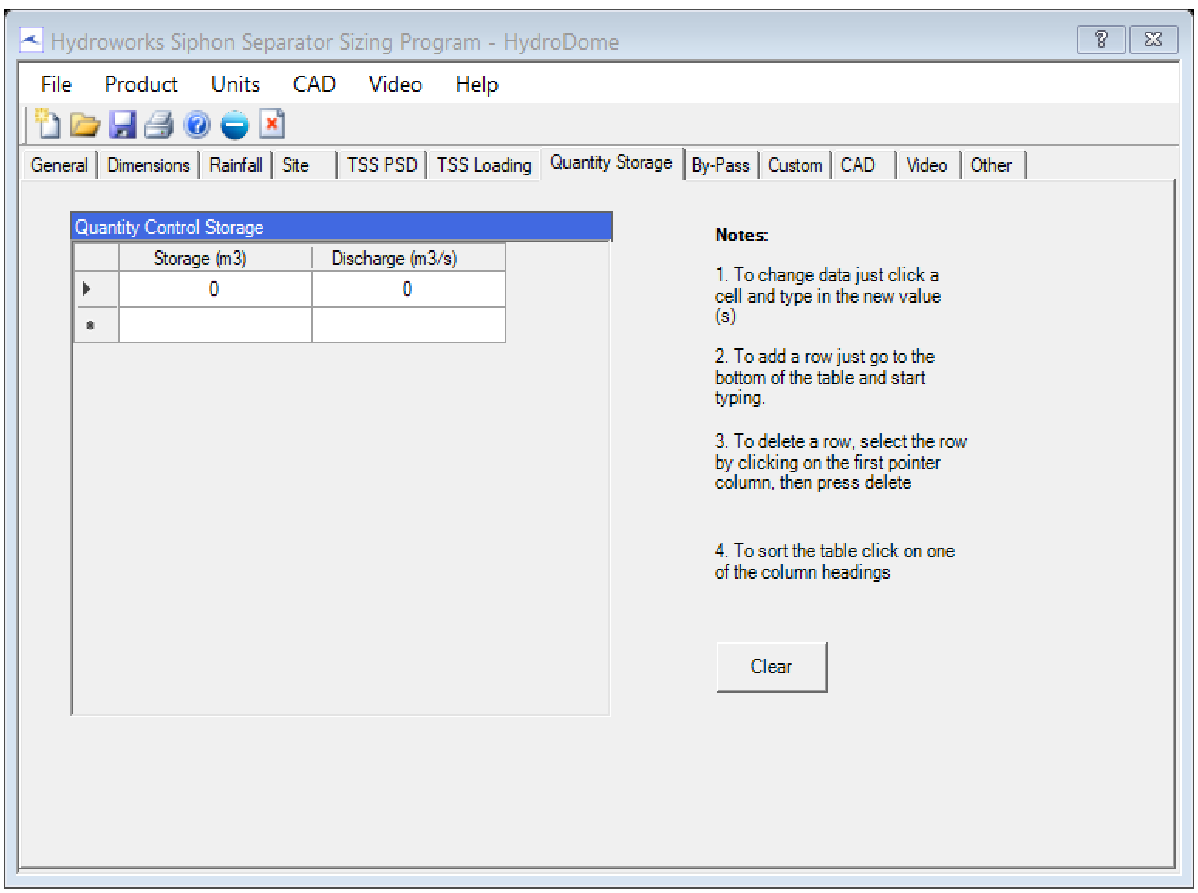
Generic HD 4 CAD Drawing



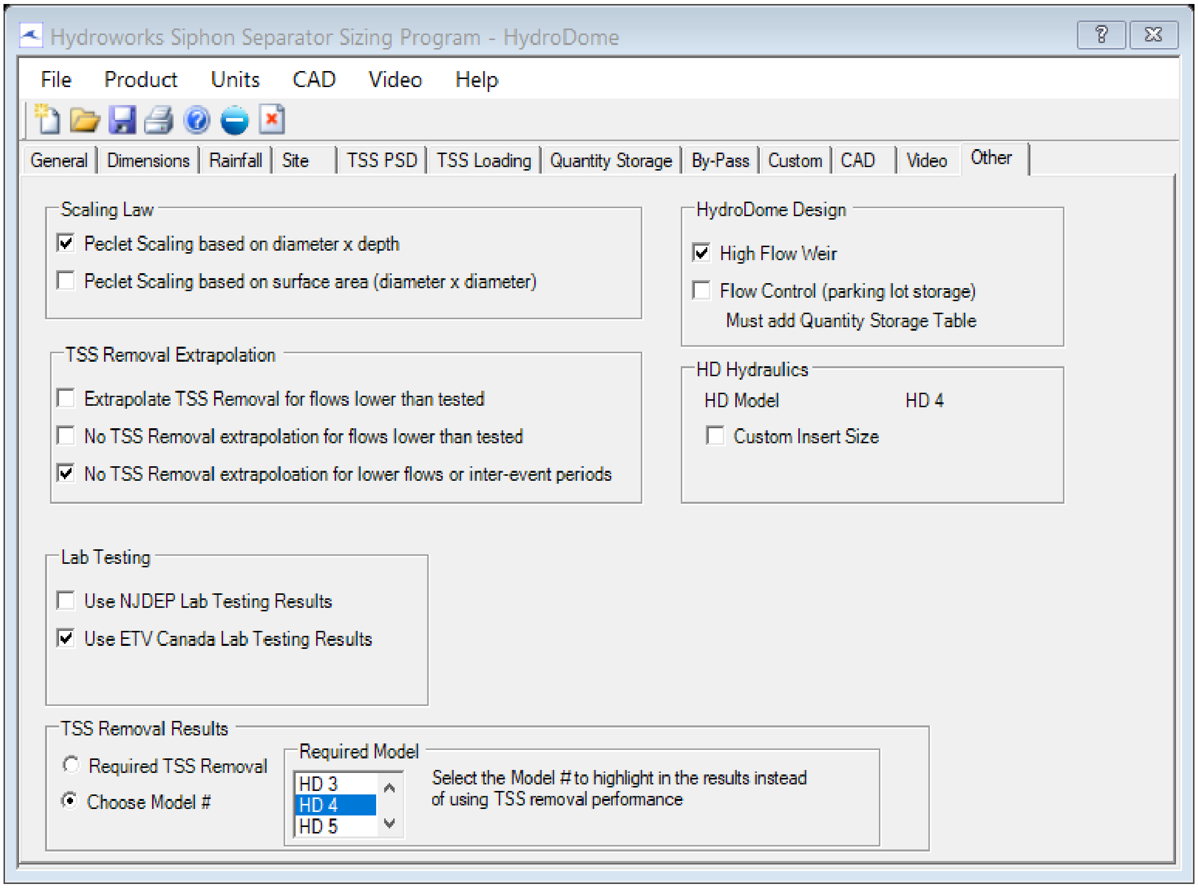
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Flagged Issues

If there is underground detention storage upstream of the HydroDome please contact Hydroworks to ensure it has been modeled correctly.

Hydroworks Sizing Program - Version 5.7
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1-800-290-7900
www.hydroworks.com

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

12/07/2022

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON RBG CS
Climate Station Id:	6153301
Years of Rainfall Data:	20
Site Name:	2380 Lakeshore Rd. W
Drainage Area (ha):	0.37
Runoff Coefficient 'c':	0.76
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	60.0
Required Water Quality Runoff Volume Capture (%):	90.0
Estimated Water Quality Flow Rate (L/s):	8.80
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	Yes
Upstream Orifice Control Flow Rate to Stormceptor (L/s):	55
Peak Conveyance (maximum) Flow Rate (L/s):	55

Project Name:	2380 Lakeshore Rd. W
Project Number:	18219
Designer Name:	Brandon O'Leary
Designer Company:	Forterra
Designer Email:	brandon.oleary@forterrabp.com
Designer Phone:	905-630-0359
EOR Name:	Mark Harris
EOR Company:	The Odan/Detech Group Inc.
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	60
EFO6	65
EFO8	68
EFO10	69
EFO12	70

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**60**
Water Quality Runoff Volume Capture (%):	**> 90**

imbrium

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREAMENT 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	4ft (1219mm) Diameter OGS Units:	1.19m^3 sediment / 265L oil
	6ft (1829mm) Diameter OGS Units:	3.48m^3 sediment / 609Ll oil
	8ft (2438mm) Diameter OGS Units:	8.78m^3 sediment / 1,071L oil
	10ft (3048mm) Diameter OGS Units:	17.78m^3 sediment / 1,673L oil
	12ft (3657mm) Diameter OGS Units:	31.23m^3 sediment / 2,476L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

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

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

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

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

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

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

> 3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators**. However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

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.

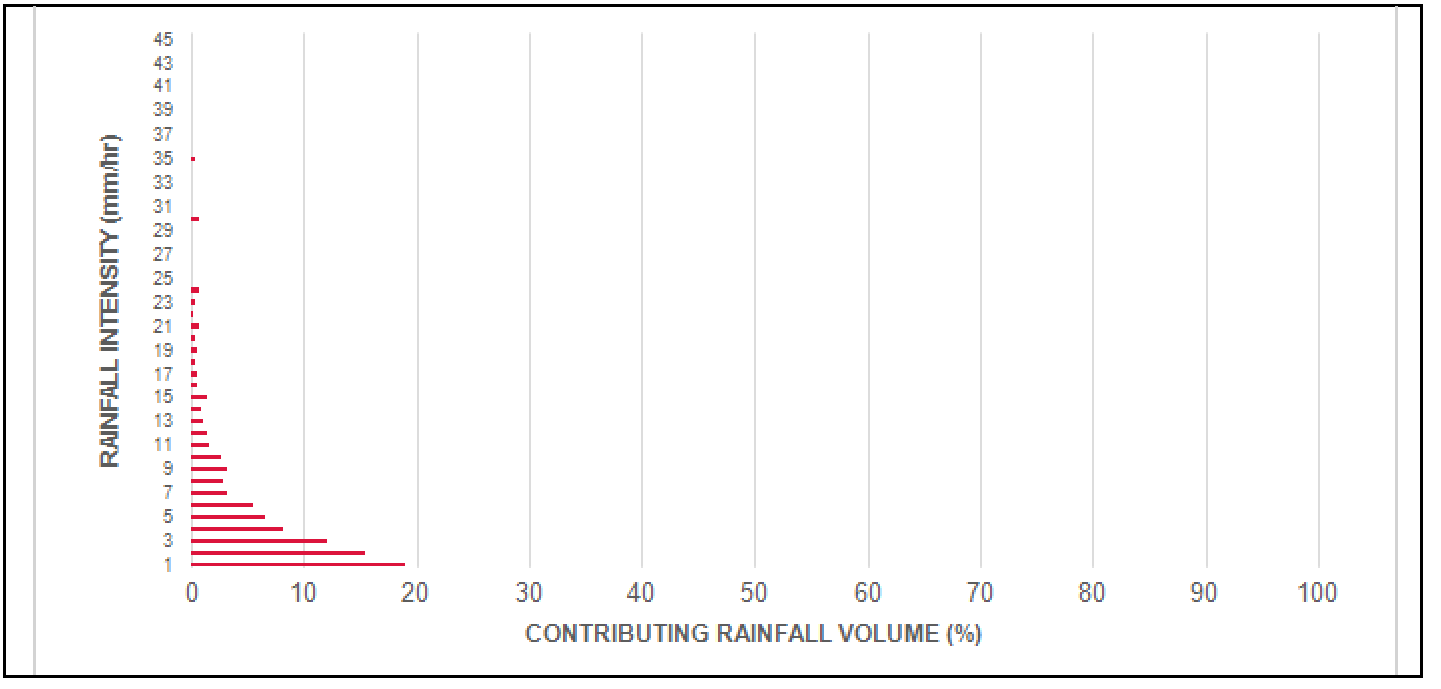
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Upstream Flow Controlled Results

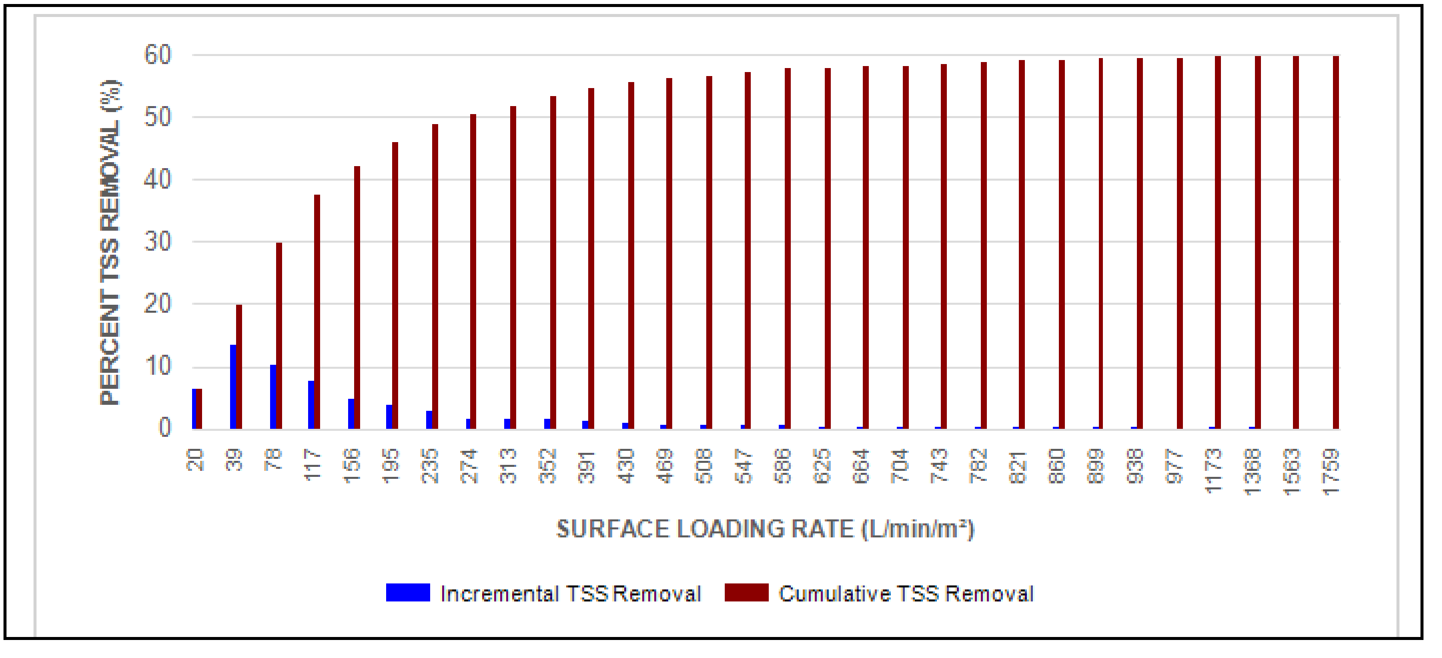
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
0.5	9.1	9.1	0.39	23.0	20.0	70	6.4	6.4
1	19.0	28.0	0.78	47.0	39.0	70	13.4	19.7
2	15.5	43.5	1.56	94.0	78.0	66	10.2	29.9
3	12.1	55.6	2.35	141.0	117.0	62	7.4	37.4
4	8.2	63.8	3.13	188.0	156.0	58	4.8	42.1
5	6.5	70.4	3.91	235.0	195.0	55	3.6	45.7
6	5.5	75.9	4.69	281.0	235.0	53	2.9	48.6
7	3.2	79.0	5.47	328.0	274.0	52	1.6	50.3
8	2.9	81.9	6.25	375.0	313.0	51	1.5	51.7
9	3.2	85.2	7.04	422.0	352.0	50	1.6	53.3
10	2.7	87.9	7.82	469.0	391.0	48	1.3	54.6
11	1.7	89.6	8.60	516.0	430.0	47	0.8	55.5
12	1.5	91.1	9.38	563.0	469.0	46	0.7	56.1
13	1.1	92.2	10.16	610.0	508.0	45	0.5	56.6
14	0.9	93.1	10.94	657.0	547.0	44	0.4	57.0
15	1.4	94.5	11.73	704.0	586.0	43	0.6	57.6
16	0.6	95.1	12.51	750.0	625.0	42	0.3	57.9
17	0.5	95.6	13.29	797.0	664.0	42	0.2	58.1
18	0.3	95.9	14.07	844.0	704.0	42	0.1	58.2
19	0.5	96.4	14.85	891.0	743.0	41	0.2	58.4
20	0.4	96.8	15.63	938.0	782.0	41	0.2	58.6
21	0.8	97.6	16.42	985.0	821.0	41	0.3	58.9
22	0.2	97.8	17.20	1032.0	860.0	41	0.1	59.0
23	0.4	98.2	17.98	1079.0	899.0	41	0.2	59.2
24	0.7	98.9	18.76	1126.0	938.0	40	0.3	59.4
25	1.1	100.0	19.54	1173.0	977.0	40	0.4	59.9
30	0.7	100.7	23.45	1407.0	1173.0	37	0.3	60.2
35	0.3	101.1	27.36	1642.0	1368.0	35	0.1	60.3
40	-1.1	100.0	31.27	1876.0	1563.0	31	0.0	59.9
45	0.0	100.0	35.18	2111.0	1759.0	27	0.0	59.9
Estimated Net Annual Sediment (TSS) Load Reduction =								**60 %**

Climate Station ID: 6153301 *Years of Rainfall Data*: 20

RAINFALL DATA FROM HAMILTON RBG CS RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



imbrium

Maximum Pipe Diameter / Peak Conveyance

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

SCOUR PREVENTION AND ONLINE CONFIGURATION

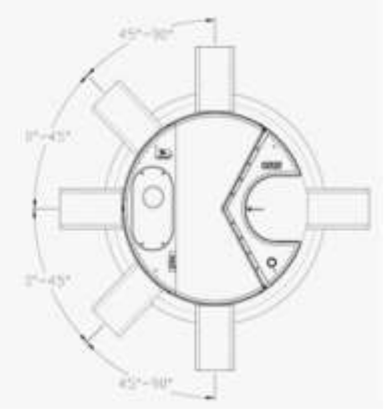
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test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

DESIGN FLEXIBILITY

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

OIL CAPTURE AND RETENTION

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



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.
0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.
45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

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

Pollutant Capacity

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

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

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

STANDARD STORMCEPTOR EF/EFO DRAWINGS

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

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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

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

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	42	1320	35	1980	24
30	70	690	42	1350	35	2010	24
60	67	720	41	1380	34	2040	23
90	63	750	41	1410	34	2070	23
120	61	780	41	1440	33	2100	23
150	58	810	41	1470	32	2130	22
180	56	840	41	1500	32	2160	22
210	54	870	41	1530	31	2190	22
240	53	900	41	1560	31	2220	21
270	52	930	40	1590	30	2250	21
300	51	960	40	1620	29	2280	21
330	50	990	40	1650	29	2310	21
360	49	1020	40	1680	28	2340	20
390	48	1050	39	1710	28	2370	20
420	47	1080	39	1740	27	2400	20
450	47	1110	38	1770	27	2430	20
480	46	1140	38	1800	26	2460	19
510	45	1170	37	1830	26	2490	19
540	44	1200	37	1860	26	2520	19
570	43	1230	37	1890	25	2550	19
600	42	1260	36	1920	25	2580	18
630	42	1290	36	1950	24		

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

PART 1 – GENERAL

1.1 WORK INCLUDED

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

1.2 REFERENCE STANDARDS & PROCEDURES

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

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

1.3 SUBMITTALS

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

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

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

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

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

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

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing 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/m^2 to 1400 L/min/m^2, 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/m^2 and 1400 L/min/m^2 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/m^2 shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m^2. No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m^2.

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m^2 shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m^2, and shall be calculated using a simple proportioning formula, with 1400 L/min/m^2 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/m^2.

The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

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

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

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

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

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.** However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

◆ Verification Statement ◆ Verification Statement ◆ Verification Statement ◆

VERIFICATION STATEMENT

GLOBE Performance Solutions

Verifies the performance of

Stormceptor® EF4 and EFO4 Oil-Grit Separators

Developed by Imbrium Systems, Inc.,
Whitby, Ontario, Canada

In accordance with

ISO 14034:2016

Environmental management —
Environmental technology verification (ETV)

John D. Wiebe, PhD
Executive Chairman
GLOBE Performance Solutions

November 10, 2017
Vancouver, BC, Canada

GLOBE PERFORMANCE SOLUTIONS

Verification Body
GLOBE Performance Solutions
404 – 999 Canada Place | Vancouver, B.C | Canada |V6C 3E2

Technology description and application

The Stormceptor® EF4 and EFO4 are treatment devices designed to remove oil, sediment, trash, debris, and pollutants attached to particulates from Stormwater and snowmelt runoff. The device takes the place of a conventional manhole within a storm drain system and offers design flexibility that works with various site constraints. The EFO4 is designed with a shorter bypass weir height, which accepts lower surface loading rate into the sump, thereby reducing re-entrainment of captured free floating light liquids.

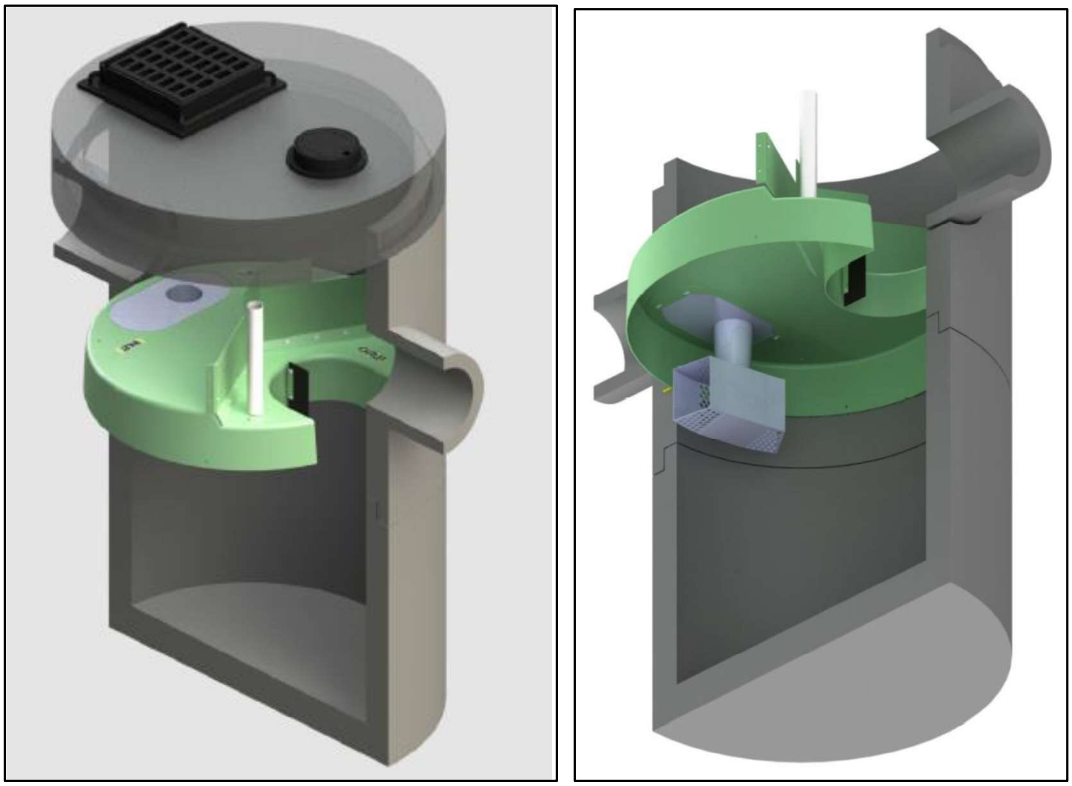


Figure 1. Graphic of typical inline Stormceptor® unit and core components.

Stormwater and snowmelt runoff enters the Stormceptor® EF/EFO's upper chamber through the inlet pipe(s) or a surface inlet grate. An insert divides the unit into lower and upper chambers and incorporates a weir to reduce influent velocity and separate influent (untreated) from effluent (treated) flows. Influent water ponds upstream of the insert's weir providing driving head for the water flowing downwards into the drop pipe where a vortex pulls the water into the lower chamber. The water diffuses at lower velocities in multiple directions through the drop pipe outlet openings. Oil and other floatables rise up and are trapped beneath the insert, while sediments undergo gravitational settling to the sump's bottom. Water from the sump can exit by flowing upward to the outlet riser onto the top side of the insert and downstream of the weir, where it discharges through the outlet pipe.

Maximum flow rate into the lower chamber is a function of weir height and drop pipe orifice diameter. The Stormceptor® EF and EFO are designed to allow a surface loading rate of 1135 L/min/m^2 (27.9 gal/min/ft^2) and 535 L/min/m^2 (13.1 gal/min/ft^2) into the lower chamber, respectively. When prescribed surface loading rates are exceeded, ponding water can overtop the weir height and bypass the lower treatment chamber, exiting directly through the outlet pipe. Hydraulic testing and scour testing demonstrate that the internal bypass effectively prevents scour at all bypass flow rates. Increasing the bypass flow rate does not increase the orifice-controlled flow rate into the lower treatment chamber where sediment is stored. This internal bypass feature allows for in-line installation, avoiding the cost of additional bypass structures. During bypass, treatment continues in the lower chamber at the maximum flow rate. The Stormceptor® EFO's lower design surface loading rate is favorable for minimizing re-entrainment and washout of captured light liquids. Inspection of Stormceptor® EF and EFO devices is performed from grade by inserting a sediment probe through the outlet riser and an oil dipstick through the oil inspection pipe. The unit can be maintained by using a vacuum hose through the outlet riser.

Performance conditions

The data and results published in this Technology Fact Sheet were obtained from the testing program conducted on the Imbrium Systems Inc.'s Stormceptor® OGS device, in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014). The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) Program. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

Performance claim(s)

Capture test [a]:

During the capture test, the Stormceptor® EF OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 70, 64, 54, 48, 46, 44, and 49 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Stormceptor® EFO, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 70, 64, 54, 48, 42, 40, and 34 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Scour test [a]:

During the scour test, the Stormceptor® EF and Stormceptor® EFO OGS devices, with 10.2 cm (4 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment storage depth, generate corrected effluent concentrations of 4.6, 0.7, 0, 0.2, and 0.4 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

Light liquid re-entrainment test[a]:

During the light liquid re-entrainment test, the Stormceptor® EFO OGS device with surrogate low-density polyethylene beads preloaded within the lower chamber oil collection zone, representing a floating light liquid volume equal to a depth of 50.8 mm over the sedimentation area, retained 100, 99.5, 99.8, 99.8, and 99.9 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2.

[a] The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014)

Performance results

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* requires that the three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD to the CETV specified PSD in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition.

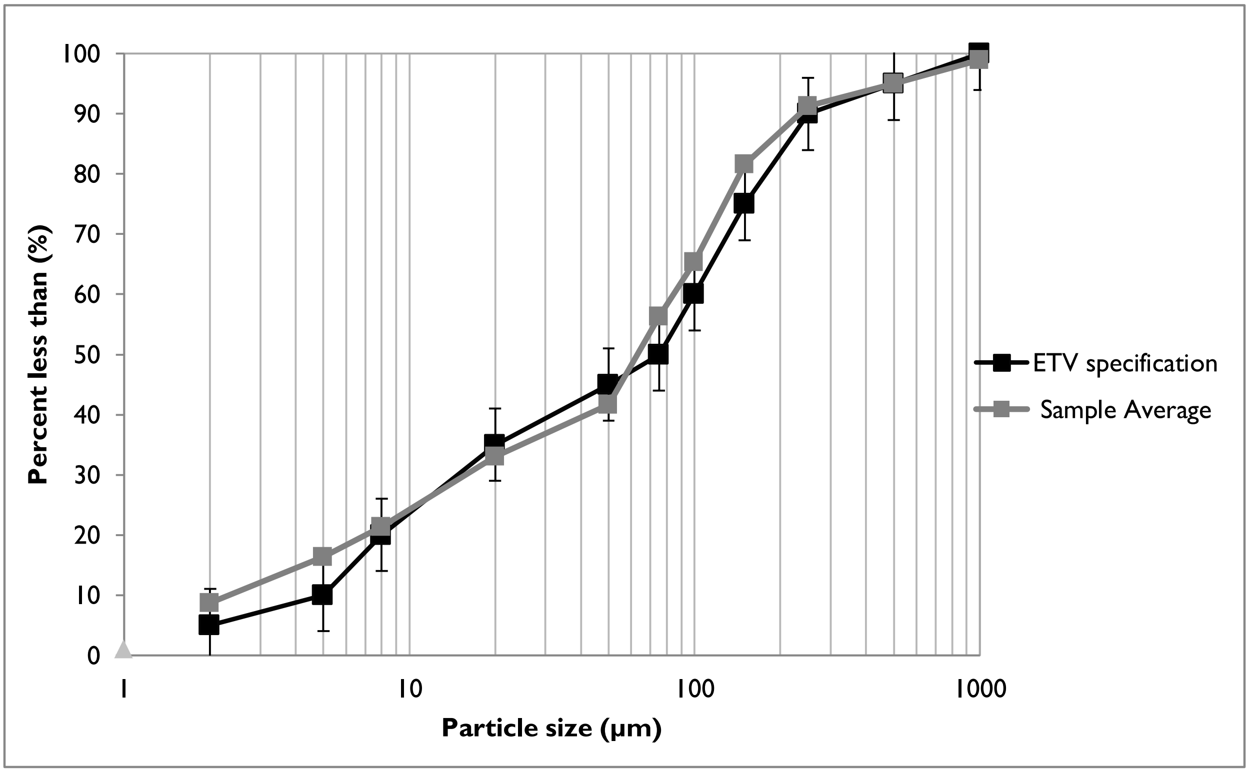


Figure 2. The three sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD.

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment as a whole were determined for each of the tested surface loading rates (Table 1). Since the EF and EFO models are identical except for the weir height, which bypasses flows from the EFO model at a surface loading rate of 535 L/min/m^2 (13.1 gpm/ft^2), sediment capture tests at surface loading rates from 40 to 400 L/min/m^2 were only performed on the EF unit. Surface loading rates of 600, 1000, and 1400 L/min/m^2 were tested on both units separately. Results for the EFO model at these higher flow rates are presented in Table 2.

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and may be attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001). The results for "all particle sizes by mass balance" (see Table 1 and 2) are based on measurements of the total injected and retained sediment mass, and are therefore not subject to blending, sampling or PSD analysis errors.

Table 1. Removal efficiencies (%) of the EF4 at specified surface loading rates

Particle size fraction (µm)	Surface loading rate (L/min/m²)						
	40	80	200	400	600	1000	1400
>500	90	58	58	100*	86	72	100*
250 - 500	100*	100*	100	100*	100*	100*	100*
150 - 250	90	82	26	100*	100*	67	90
105 - 150	100*	100*	100*	100*	100*	100*	100
75 - 105	100*	92	74	82	77	68	76
53 - 75	Undefined [a]	56	100*	72	69	50	80
20 - 53	54	100*	54	33	36	40	31
8 - 20	67	52	25	21	17	20	20
5 – 8	33	29	11	12	9	7	19
<5	13	0	0	0	0	0	4
All particle sizes by mass balance	**70.4**	**63.8**	**53.9**	**47.5**	**46.0**	**43.7**	**49.0**

[a] An outlier in the feed sample sieve data resulted in a negative removal efficiency for this size fraction.
* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 101 and 171% (average 128%). See text and Bulletin # CETV 2016-11-0001 for more information.

Table 2. Removal efficiencies (%) of the EFO4 at surface loading rates above the bypass rate of 535 L/min/m²

Particle size fraction (µm)	Surface loading rate (L/min/m²)		
	600	1000	1400
>500	89	83	100*
250 - 500	90	100*	92
150 - 250	90	67	100*
105 - 150	85	92	77
75 - 105	80	71	65
53 - 75	60	31	36
20 - 53	33	43	23
8 - 20	17	23	15
5 – 8	10	3	3
<5	0	0	0
All particle sizes by mass balance	**41.7**	**39.7**	**34.2**

* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 103 and 111% (average 107%). See text and Bulletin # CETV 2016-11-0001 for more information.

Figure 3 compares the particle size distribution (PSD) of the three sample average of the test sediment to the PSD of the sediment retained by the EF4 at each of the tested surface loading rates. Figure 4 shows the same graph for the EFO4 unit at surface loading rates above the bypass rate of 535 L/min/m².

As expected, the capture efficiency for fine particles in both units was generally found to decrease as surface loading rates increased.

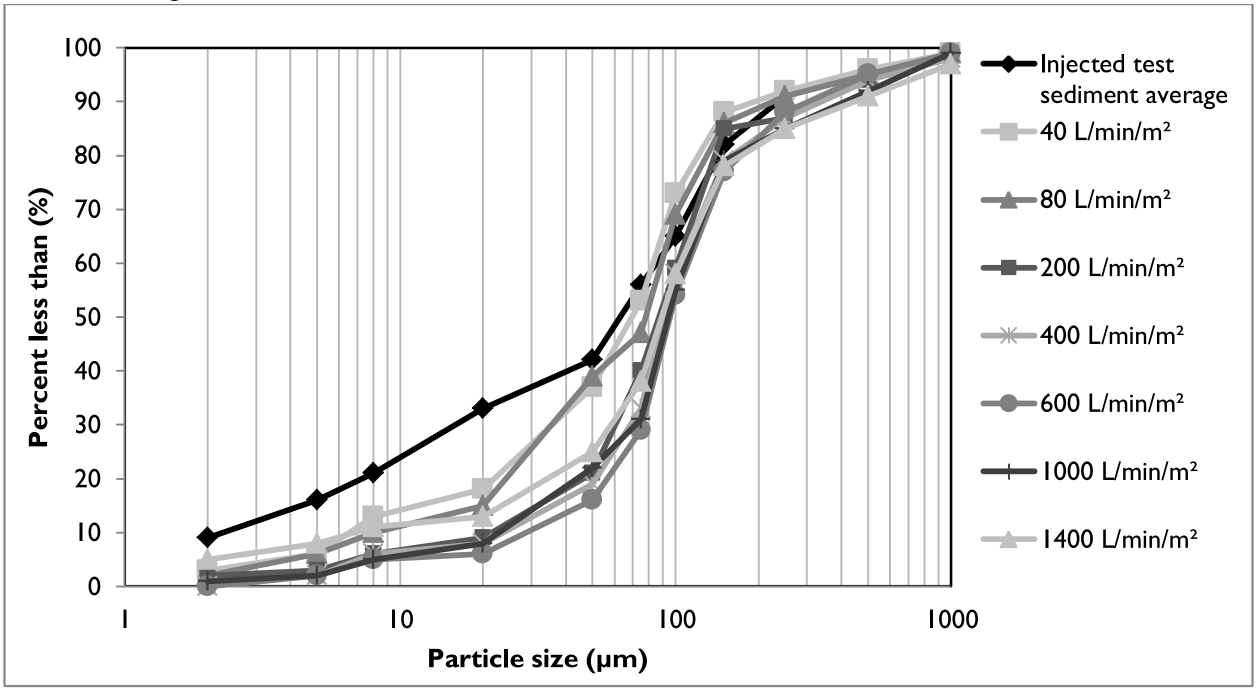


Figure 3. Particle size distribution of sediment retained in the EF4 in relation to the injected test sediment average.

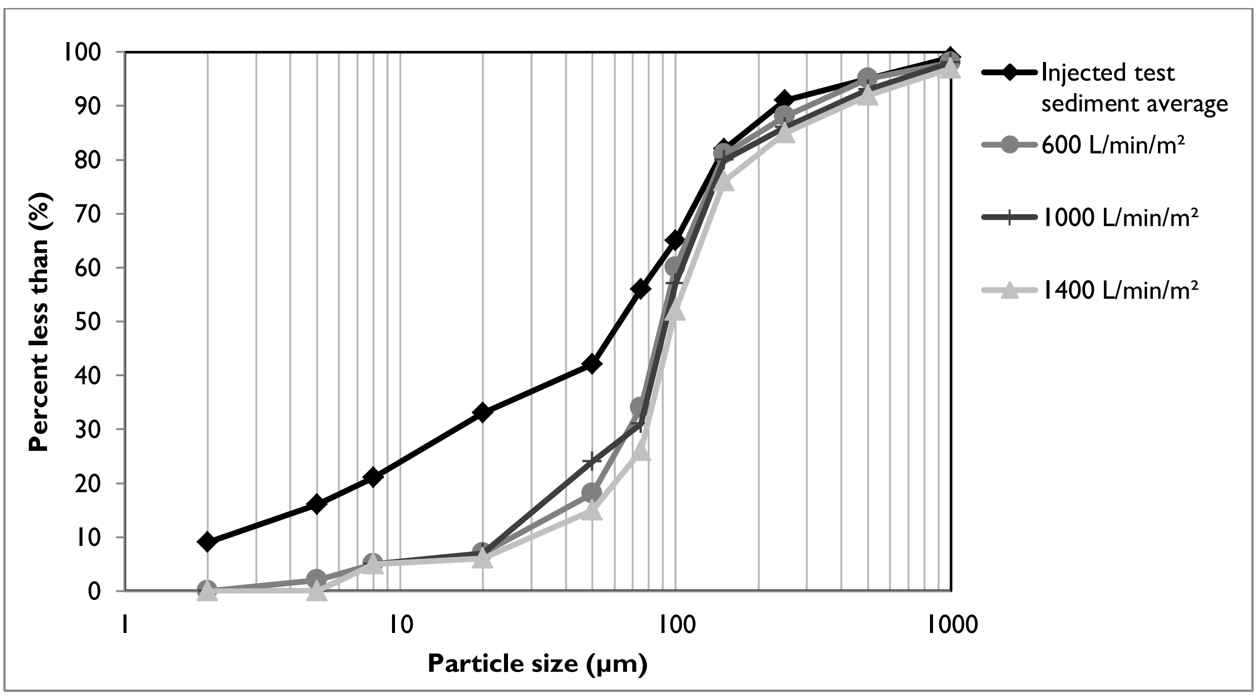


Figure 4. Particle size distribution of sediment retained in the EFO4 in relation to the injected test sediment average at surface loading rates above the bypass rate of 535 L/min/m^2

Table 4 shows the results of the sediment scour and re-suspension test for the EF4 unit. The EFO4 was not tested as it was reasonably assumed that scour rates would be lower given that flow bypass occurs at a lower surface loading rate. The scour test involved preloading 10.2 cm of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth. Clean water was run through the device at five surface loading rates over a 30 minute period. Each flow rate was maintained for 5 minutes with a one minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water. Typically, the smallest 5% of particles captured during the 40 L/min/m² sediment capture test is also used to adjust the concentration, as per the method described in Bulletin # CETV 2016-09-0001. However, since the composites of effluent concentrations were below the Reporting Detection Limit of the Laser Diffraction PSD methodology, this adjustment was not made. Results showed average adjusted effluent sediment concentrations below 5 mg/L at all tested surface loading rates.

It should be noted that the EF4 starts to internally bypass water at 1135 L/min/m², potentially resulting in the dilution of effluent concentrations, which would not normally occur under typical field conditions because the field influent concentration would contain a much higher sediment concentration than during the lab test. Recalculation of effluent concentrations to account for dilution at surface loading rates above the bypass rate showed sediment effluent concentrations to be below 1.6 mg/L.

Table 4. Scour test adjusted effluent sediment concentration.

Run	Surface loading rate (L/min/m²)	Run time (min)	Background sample concentration (mg/L)	Adjusted effluent suspended sediment concentration (mg/L) [a]	Average (mg/L)
1	200	1:00	<RDL	11.9	4.6
		2:00		7.0	
		3:00		4.4	
		4:00		2.2	
		5:00		1.0	
		6:00		1.2	
2	800	7:00	<RDL	1.1	0.7
		8:00		0.9	
		9:00		0.6	
		10:00		1.4	
		11:00		0.1	
		12:00		0	
3	1400	13:00	<RDL	0	0
		14:00		0.1	
		15:00		0	
		16:00		0	
		17:00		0	
		18:00		0	
4	2000	19:00	1.2	0.2	0.2
		20:00		0	
		21:00		0	
		22:00		0.7	
		23:00		0	

		24:00		0.4	
5	2600	25:00	1.6	0.3	0.4
		26:00		0.4	
		27:00		0.7	
		28:00		0.4	
		29:00		0.2	
		30:00		0.4	

[a] The adjusted effluent suspended sediment concentration represents the actual measured effluent concentration minus the background concentration. For more information see Bulletin # CETV 2016-09-0001.

The results of the light liquid re-entrainment test used to evaluate the unit's capacity to prevent re-entrainment of light liquids are reported in Table 5. The test involved preloading 58.3 L (corresponding to a 5 cm depth over the collection sump area of 1.17m²) of surrogate low-density polyethylene beads within the oil collection skirt and running clean water through the device continuously at five surface loading rates (200, 800, 1400, 2000, and 2600 L/min/m²). Each flow rate was maintained for 5 minutes with approximately 1 minute transition time between flow rates. The effluent flow was screened to capture all re-entrained pellets throughout the test.

Table 5. Light liquid re-entrainment test results for the EFO4.

Surface Loading Rate (L/min/m2)	Time Stamp	Amount of Beads Re-entrained			
		Mass (g)	Volume (L)[a]	% of Pre-loaded Mass Re-entrained	% of Pre-loaded Mass Retained
200	62	0	0	0.00	100
800	247	168.45	0.3	0.52	99.48
1400	432	51.88	0.09	0.16	99.83
2000	617	55.54	0.1	0.17	99.84
2600	802	19.73	0.035	0.06	99.94
Total Re-entrained		295.60	0.525	0.91	--
Total Retained		32403	57.78	--	99.09
Total Loaded		32699	58.3	--	--

[a] Determined from bead bulk density of 0.56074 g/cm³

Variances from testing Procedure

The following minor deviations from the *Procedure for Laboratory Testing of Oil-Grit Separators* (Version 3.0, June 2014) have been noted:

1. During the capture test, the 40 L/min/m² and 80 L/min/m² surface loading rates were evaluated over 3 and 2 days respectively due to the long duration needed to feed the required minimum of 11.3 kg of test sediment into the unit at these lower flow rates. Pumps were shut down at the end of each intermediate day, and turned on again the following morning. The target flow rate was re-established within 30 seconds of switching on the pump. This procedure may have allowed sediments to be captured that otherwise may have exited the unit if the test was

continuous. On the basis of practical considerations, this variance was approved by the verifier prior to testing.

2. During the scour test, the coefficient of variation (COV) for the lowest flow rate tested (200 L/min/m^2) was 0.07, which exceeded the specified limit of 0.04 target specified in the OGS Procedure. A pump capable of attaining the highest flow rate of 3036 L/min had difficulty maintaining the lowest flow of 234 L/min but still remained within +/- 10% of the target flow and is viewed as having very little impact on the observed results. Similarly, for the light liquid re-entrainment test the COV for the flow rate of the 200 L/min/m^2 run was 0.049, exceeding the limit of 0.04, but is believed to introduce negligible bias.

3. Due to pressure build up in the filters, the runs at 1000 L/min/m^2 for the Stormceptor® EF4 and 1000 and 1400 L/min/m^2 for the Stormceptor® EFO4 were slightly shorter than the target. The run times were 54, 59 and 43 minutes respectively, versus targets of 60 and 50 minutes. The final feed samples were timed to coincide with the end of the run. Since >25 lbs of sediment was fed, the shortened time did not invalidate the runs.

Verification

The verification was completed by the Verification Expert, Toronto and Region Conservation Authority, contracted by GLOBE Performance Solutions, using the International Standard ***ISO 14034:2016 Environmental management -- Environmental technology verification (ETV)***. Data and information provided by Imbrium Systems Inc. to support the performance claim included the following: Performance test report prepared by Good Harbour Laboratories, and dated September 8, 2017; the report is based on testing completed in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).

What is ISO14034:2016 Environmental management – Environmental technology verification (ETV)?

ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV), and was developed and published by the *International Organization for Standardization (ISO)*. The objective of ETV is to provide credible, reliable and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact. Such technologies have an increasingly important role in addressing environmental challenges and achieving sustainable development.

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