S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

To:	Jeff McIsaac, C.E.T. Supervisor, Development Engineering City of Burlington	**From:**	Alexandra Porco, P. Eng.
		Date:	August 12, 2024
Project:	5209 Stonehaven Drive Burlington, ON	**Pages:**	3 + Appendix A & B
		Job #:	21052
Re:	Technical Memorandum Stormwater Management		

Introduction

S. Llewellyn and Associates Limited has been retained by Dawn Victoria Homes to review the Stormwater Management Brief prepared by IBI Group, dated April 30, 2020 (refer to **Appendix A**), and confirm the design coincides with the proposed development at 5209 Stonehaven Drive in the City of Burlington (see Figure 1 for location plan). The purpose of this memorandum is to determine the proposed storm sewer system provides adequate storage for all storms up to the 100-year storm event.



Figure 1 - Location Plan

Background and Existing Conditions

The subject site is approximately 1.74ha in area and located in the City of Burlington. The site is bound by Stonehaven Drive to the south, Dundas Street to the north, existing park lands to the east, and CN Rail lines to the west. The proposed development consists of 10 single dwelling lots and 8 townhouse units, along with associated internal private road network and storm sewer, sanitary sewer and watermain services.

The following services exist in the vicinity of the site: an existing 150mmø sanitary sewer flowing east at a slope of 1.33% along Stonehaven Drive, an existing 150mmø watermain within the Stonehaven Drive right-of-way, and an existing 375mmø storm sewer flowing east at a slope of 0.39% along Stonehaven Drive.

As described in the SWM Brief prepared by IBI Group, it is proposed to extend the storm sewer from Stonehaven Drive into the proposed private cul-de-sac within the site. Quantity control is required for all storm events up to the 100-year storm event to be limited to the capacity of the downstream system or pre-development levels (worse case scenario). It was determined that the worse case scenario is the capacity of the downstream 375mmø sewer at 0.39%, providing an allowable flow of 0.110m^3/s. Quantity control is being provided through a proposed 200mmø orifice plate within existing MH8 (refer to Servicing Plan prepared by S. Llewellyn and Associates Limited).

Sanitary and Water Servicing

The proposed townhouse lots will be individually serviced with sanitary and water laterals connected to the existing 150mmø sanitary sewer and 150mmø watermain, respectively, within Stonehaven Drive. The existing 150mmø sanitary sewer and 150mmø watermain on Stonehaven Drive will also be extended into the private cul-de-sac to service the proposed single dwelling units. All lots are to be equipped with a sump pump that discharges to grade.

Storm Storage

The proposed storm drainage area plan was used to calculate a weighted runoff coefficient, which was determined to be 0.45 (refer to **Sheet 7** in **Appendix B**). Using the Modified Ration Method (MRM), the calculated runoff coefficient of 0.56 (calculated C value of 0.45 multiplied by 1.25 to account for 100-year antecedent conditions per City Standard S-3D), total area of 1.74ha, and allowable flow rate of 0.110m^3/s from site, it was determined that 232.82m^3 of storage is required during the 100-year storm event. Refer to **Appendix B** for detailed calculations.

The proposed and existing storm infrastructure within the development area have been analysed to ensure there is adequate storage provided for all storm events, up to the 100-year storm event, to be controlled to the allowable discharge of 0.110m^3/s. It was determined that the storm sewers and structures would provide approximately 180m^3 of storage. An additional 45m^3 of storage is proposed within an ACO SD Stormbrixx Tank within the private cul-de-sac. Together with the storm infrastructure, this provides a total of 235.6m^3, which can accommodate the required

232.82m^3 of storage during the 100-year storm event. Refer to **Appendix B** for detailed storage calculations.

Conclusions and Recommendations

Based on the information provided herein, it is concluded that the development can be serviced off the existing and proposed sanitary sewers and watermains within the development area. Additionally, with the addition of a stormwater storage tank, the proposed and existing storm sewers proposed for the development will provide sufficient storage for all storm events, up to the 100-year storm event.

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

S. Llewellyn & Associates Limited.



Alexandra Porco, P.Eng.

APPENDIX A

IBI GROUP SWM BREIF (APRIL 2020)

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IBI GROUP
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tel 519 472 7328 fax 519 472 9354
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Memorandum

To/Attention	Brian Enter	**Date**	April 30, 2020
From	Sandra Hayman	**Project No**	123369
cc			
Subject	5209 Stonehaven Drive (Dawn Victoria Homes) - Stormwater Management Brief (revised)		

The site is located within the City of Burlington, Region of Halton on the north side of Stonehaven Drive adjacent to the east side of the CNR and directly south of Dundas Street. The site is currently vacant with tall grasses, shrubs and some trees. During development of the surrounding subdivision in the late 1990's/early 2000's, this property was proposed as a future school site. It has now been released by the school board and is available for development. It is proposed to develop 10 single family lots at the extension of Bird Boulevard as well as 8 townhouse units on the north side of Stonehaven Drive.

The Storm Drainage Area Plan (MDR-299) shows that approximately 0.17 ha of this property was allowed into the first run of storm sewer on Stonehaven Drive with a C value of 0.45 as well as 0.76 ha at a C value of 0.20.

It is proposed to extend the storm sewer from Stonehaven Drive into the cul-de-sac proposed for the site. Quantity control is required in order to control storm flows up to the 100 year storm event to the capacity of the downstream system or pre-development levels (worse case scenario). The analysis below has considered the use of asphalt driveways as opposed to permeable pavers and the inclusion of additional sidewalk in Areas 200 and 205.

A summary of the design follows:

- The site area is approximately 0.86 ha, including the proposed 10 single family lots and 8 townhouse units.
- Existing Storm Drainage: Drawing MDR-299 shows the existing drainage areas accounted for in the storm sewer on Stonehaven Drive.
- The proposed Storm Drainage Area plan shows the proposed drainage areas and C values for the proposed site as well as the existing areas entering the storm sewer on Stonehaven Drive. C values have been calculated using the City of Burlington Dwg S-3D.
- A "C" value of 0.30 has been used for the proposed park areas as per the City's standards.
- An impervious surface such as asphalt is proposed on the new driveways within the development. A "C" value of 0.90 was used for these areas.
- Table 1 includes an analysis of the storm sewer without any quantity control. The storm pipe (MH9 to MH 8) is shown to be over capacity by 165%.

Brian Enter
– April 30, 2020

- Table 2 includes an analysis to determine the quantity control parameters. It is shown that the original design from drawing MDR-299 allowed for an area of 1.62 ha at an average C of 0.33 into the storm sewer from MH9 to MH8. An analysis of the storm sewer, shows that a total area of 1.74 ha, C=0.27 is required in order to ensure that this same run of storm sewer is not over capacity. Therefore this governs and is the basis for the storage volume calculations. For the new development area only, this equates to an average C value of 0.18 for the 0.86 ha which also corresponds to a pre-development level. Therefore the storage volume required to control the 100 year storm to the 5 year level is based upon an average C value of 0.27 and a total area of 1.74 ha entering at MH8.
- Tables 3 and 4 contain calculations showing the 5 year and 100 year storm events respectively. It is shown that a total storage volume of 182m3 is required during the 100 year storm event to restrict the flows upstream of MH8 to the values noted above. The "C" value for the 100 year storm has been multiplied by 1.25 to account for antecedent precipitation conditions as per City Standard S-3D.
- Table 5 shows calculations of the underground volume provided within the storm system upstream of the orifice. It is shown that the system provides the adequate amount of storage for the 100 year storm event.
- It is calculated that a 200mm diameter orifice within MH8 will provide the necessary restrictions to control the upstream flows (See Table 6). The storage/ponding elevation is calculated to be at the highest obvert of the proposed 1200mm dia storm pipe at approximately 154.97m.
- Double catchbasins are proposed just upstream of MH1 in order to capture the flow from a 100 year storm event.

Therefore as outlined above, stormwater management has been provided for quantity and quality control for the planned development.

SH/encl.

RUNOFF COEFFICIENT 'C'	
PARKS AND PAYGROUNDS	- 0.20
RESIDENTIAL - SINGLE AND DUPLEX	- 0.50 and 0.55
- ROW HOUSING	- 0.65
- APARTMENTS	- 0.65 and 0.70
COMMERCIAL AND INDUSTRIAL	- 0.90 and 0.70
DENSLEY BUILT, PAVED	- 0.90

STORM SEWER DESIGN SHEET
CITY OF BURLINGTON

FLOW Q = 2.78CiA where Q = PEAK FLOW IN LITRES PER SECOND (l/s)
A = AREA IN HECTARES (ha)
C = RUNOFF COEFFICIENT
i = RAINFALL INTENSITY (mm/hr)
RETURN PERIOD 5 YEARS

DATE June 20/17 (revised April 23/20)
DESIGN SAH
CHECKED
PROJECT 105842

Park areas revised to C=0.30

Table 1

Proposed Design with no SWM

PROJECT NAME: **Halton District School Board Lands**

LOCATION				AREA			TOTAL (A X C)					RAINFALL INTENSITY			Q	SEWER DESIGN						PROFILE						
AREA NO.	STREET	FROM	TO	DIMENSIONS	DELTA HEC.	TOTAL HEC.	RUNOFF C	INCR. AxC	SECTION AxC	SEWER AxC	DELTA 2.78AxC	TIME ENTRY mm SECTION	TIME ENTRY mm ACCUM.	INTENSITY mm/hr	l/sec	SIZE mm	n	SLOPE %	CAP. l/sec	VEL. m/sec	LENGTH m	TIME OF FLOW	DROP MH	FALL IN SEWER	INVERT ELEV. U.S.	INVERT ELEV. D.S.	Q/Qcap (%)
Storm Sewer in Park																											
203	Park	CB1	CBMH2		0.14	0.14	0.30	0.04	nil	0.04	0.11	nil	10.00	88.00	9.68	250	0.013	0.49	41.72	0.85	0.00	0.00		0.000	153.850	153.850	23.2%
201	Park	CB1	CBMH2		0.09	0.23	0.39	0.03	nil	0.07	0.19	0.00	10.00	88.00	16.72	250	0.013	0.49	41.72	0.85	46.66	0.91	0.000	0.229	153.850	153.621	40.1%
204	Park	CBMH2	Ex St		0.14	0.37	0.30	0.04	nil	0.11	0.31	0.91	10.91	84.00	26.04	250	0.013	0.55	44.18	0.90	0.00	0.00	0.000	0.000	153.621	153.621	58.9%
202	Park	CB2	Ex St		0.11	0.47	0.48	0.05	nil	0.16	0.44	0.00	10.91	84.00	36.96	250	0.013	0.55	44.18	0.90	34.00	0.63	0.000	0.187	153.621	153.434	83.7%
200	Bird Blvd (New)	MH4	MH2		0.56	0.56	0.51	0.28	nil	0.28	0.78	nil	10.00	88.00	68.64	1200	0.013	0.25	1945.27	1.72	46.15	0.45		0.115	0.000	-0.115	3.5%
	Easement (pipe storage only)	MH6	MH2		0.00	0.00	0.51	0.00	nil	0.00	0.00	nil	10.00	88.00	0.00	1200	0.013	0.20	1741.70	1.54	26.00	0.28		0.052	0.000	-0.052	0.0%
	Bird Blvd	MH2	MH1		0.00	0.56	0.45	0.00	0.00	0.28	0.78	0.45	10.45	86.00	67.08	1200	0.013	0.21	1786.94	1.58	26.67	0.28	0.000	0.056	-0.115	-0.171	3.8%
	Bird Blvd	MH1	MH9		0.00	0.56	0.45	0.00	nil	0.28	0.78	0.28	10.73	85.00	66.30	1200	0.013	0.20	1741.70	1.54	26.47	0.29	0.000	0.053	-0.171	-0.224	3.8%
300	Stonehaven Dr	MH9	MH8		0.61	1.63	0.45	0.27	0.16	0.71	1.97	0.00	11.02	84.00	165.48	375	0.013	0.39	110.45	1.00	0.00	0.00	0.000	0.000	-0.224	-0.224	149.8%
205	Stonehaven Dr	MH9	MH8		0.11	1.74	0.68	0.07	nil	0.78	2.17	0.00	11.02	84.00	182.28	375	0.013	0.39	110.45	1.00	96.71	1.61	0.000	0.381	-0.224	-0.605	165.0%
	Stonehaven Dr	MH8	MH7		0.00	1.74	0.45	0.00	nil	0.78	2.17	1.61	12.63	78.00	169.26	375	0.013	0.76	152.42	1.38	14.50	0.18	0.000	0.110	-0.605	-0.716	111.0%
500	Stonehaven Dr	MH10	MH7		0.40	0.40	0.30	0.12	nil	0.12	0.33	nil	10.00	88.00	29.04	525	0.013	0.31	240.29	1.11	25.90	0.39		0.080	0.000	-0.080	12.1%
400	Orchard Rd	MH7	Ex. MH		0.20	2.34	0.45	0.09	0.12	0.99	2.75	0.18	12.81	77.00	211.75	600	0.013	0.52	443.91	1.57	23.20	0.25	0.000	0.121	-0.716	-0.836	

Calculate Average C value for development (Areas 200, 201, 202, 205)
Total A = 0.85 ha
C avg = 0.52

Calculate Average C value for all Areas U/S of MH8
Total A = 1.74 ha
C avg = 0.45

RUNOFF COEFFICIENT 'C'	
PARKS AND PAYGROUNDS	- 0.20
RESIDENTIAL - SINGLE AND DUPLEX	- 0.50 and 0.55
- ROW HOUSING	- 0.65
- APARTMENTS	- 0.65 and 0.70
COMMERCIAL AND INDUSTRIAL	- 0.90 and 0.70
DENSLEY BUILT, PAVED	- 0.90

STORM SEWER DESIGN SHEET
CITY OF BURLINGTON

FLOW Q = 2.78CiA where Q = PEAK FLOW IN LITRES PER SECOND (l/s)
A = AREA IN HECTARES (ha)
C = RUNOFF COEFFICIENT
i = RAINFALL INTENSITY (mm/hr)
RETURN PERIOD 5 YEARS

DATE June 20/17 (revised April 2020)
DESIGN SAH
CHECKED
PROJECT 105842

Proposed Design with SWM

Table 2

PROJECT NAME: **Halton District School Board Lands**

LOCATION				AREA			TOTAL (A X C)					RAINFALL INTENSITY			Q	SEWER DESIGN					PROFILE						
AREA NO.	STREET	FROM	TO	DIMENSIONS	DELTA HEC.	TOTAL HEC.	RUNOFF C	INCR. AxC	SECTION AxC	SEWER AxC	DELTA 2.78AxC	TIME ENTRY mm SECTION	TIME ENTRY mm ACCUM.	INTENSITY mm/hr	l/sec	SIZE mm	n	SLOPE %	CAP. l/sec	VEL. m/sec	LENGTH m	TIME OF FLOW	DROP MH	FALL IN SEWER	INVERT ELEV. U.S.	INVERT ELEV. D.S.	Q/Qcap (%)
Storm Sewer in Park																										
203	Park	CB1	CBMH2		0.14	0.14	0.15	0.02	nil	0.02	0.06	nil	10.00	88.00	5.28	250	0.013	0.49	41.72	0.85	0.00	0.00		0.000	153.850	153.850	12.7%
201	Park	CB1	CBMH2		0.09	0.23	0.18	0.02	nil	0.04	0.11	0.00	10.00	88.00	9.68	250	0.013	0.49	41.72	0.85	46.66	0.91	0.000	0.229	153.850	153.621	23.2%
204	Park	CBMH2	Ex St		0.14	0.37	0.15	0.02	nil	0.06	0.17	0.91	10.91	84.00	14.28	250	0.013	0.55	44.18	0.90	0.00	0.00	0.000	0.000	153.621	153.621	32.3%
202	Park	CB2	Ex St		0.11	0.47	0.18	0.02	nil	0.08	0.22	0.00	10.91	84.00	18.48	250	0.013	0.55	44.18	0.90	34.00	0.63	0.000	0.187	153.621	153.434	41.8%
200	Bird Blvd (New)	MH4	MH2		0.56	0.56	0.18	0.10	nil	0.10	0.28	nil	10.00	88.00	24.64	1200	0.013	0.25	1945.27	1.72	46.15	0.45		0.115	0.000	-0.115	1.3%
	Easement (pipe storage only)	MH6	MH2		0.00	0.00	0.51	0.00	nil	0.00	0.00	nil	10.00	88.00	0.00	1200	0.013	0.20	1741.70	1.54	26.00	0.28		0.052	0.000	-0.052	0.0%
	Bird Blvd	MH2	MH1		0.00	0.56	0.45	0.00	0.00	0.10	0.28	0.45	10.45	86.00	24.08	1200	0.013	0.21	1786.94	1.58	26.67	0.28	0.000	0.056	-0.115	-0.171	1.3%
	Bird Blvd	MH1	MH9		0.00	0.56	0.45	0.00	nil	0.10	0.28	0.28	10.73	85.00	23.80	1200	0.013	0.20	1741.70	1.54	26.47	0.29	0.000	0.053	-0.171	-0.224	1.4%
300	Stonehaven Dr	MH9	MH8		0.61	1.63	0.45	0.27	0.08	0.45	1.25	0.00	11.02	84.00	105.00	375	0.013	0.39	110.45	1.00	0.00	0.00	0.000	0.000	-0.224	-0.224	95.1%
205	Stonehaven Dr	MH9	MH8		0.11	1.74	0.18	0.02	nil	0.47	1.31	0.00	11.02	84.00	110.04	375	0.013	0.39	110.45	1.00	96.71	1.61	0.000	0.381	-0.224	-0.605	99.6%
	Stonehaven Dr	MH8	MH7		0.00	1.74	0.45	0.00	nil	0.47	1.31	1.61	12.63	78.00	102.18	375	0.013	0.76	152.42	1.38	14.50	0.18	0.000	0.110	-0.605	-0.716	67.0%
500	Stonehaven Dr	MH10	MH7		0.40	0.40	0.15	0.06	nil	0.06	0.17	nil	10.00	88.00	14.96	525	0.013	0.31	240.29	1.11	25.90	0.39		0.080	0.000	-0.080	6.2%
400	Orchard Rd	MH7	Ex. MH		0.20	2.34	0.45	0.09	0.06	0.62	1.72	0.18	12.81	77.00	132.44	600	0.013	0.52	443.91	1.57	23.20	0.25	0.000	0.121	-0.716	-0.836	

2.34

0.18 = C value required in development until MH9 to MH8 is not above capacity

a) Calculate Average C value for all Areas U/S of MH8 based upon capacity of MH9 to MH8 Restricted flow required at ST MH8

Total A = 1.74 ha
C avg = 0.27

b) Calculate Average C value originally allowed into MH 9 to MH8
Amount previously allowed into MH9 from Dwg MDR-299

A = 1.62 ha
Cavg = 0.33
A*C = 0.54 (0.86ha * C=0.45 + 0.76ha * C=0.20)
Current designed area into MH9 = 1.74 ha
Allowable C = 0.31

Therefore the total area of 1.74 ha is to be restricted to C=0.27 (governing value)
which equates to the new development being restricted to C=0.18 which corresponds to a pre-development level.

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Stormwater Management
Rational Method
City of Burlington (IDF Curves from Dwg S-IDF)

Project: Halton District School Board Lands **Table 3**
Location: Burlington, On
Date: June 26/17 (April 2020 is same as April 2018 calc's)
Job No. 105842

Design Criteria

Calculate Total Storage needed

Area =	1.74	hectares
Predevelopment C =	0.27	
IDF Curve =	5	year
Predevelopment Tc =	10.97	minutes
a =	697.40	
b =	5.00	
c =	0.76	
I =	83.9763	mm/hr
Outflow Restriction =	0.110	cms
Post Development C =	0.45	

Calculation of Critical Storage Volume

Rainfall Duration (min)	Rainfall Intensity (mm/hr)	Peak Runoff (m^3/s)	Storm Runoff (m^3)	Release Flow (m^3)	Required Storage (m^3)	
5	120.08	0.26	78	33	45	
10	88.09	0.19	115	66	49	*
15	70.71	0.15	138	99	40	
20	59.63	0.13	156	132	24	
30	46.11	0.10	181	197	-17	
40	38.06	0.08	199	263	-65	
50	32.65	0.07	213	329	-116	
60	28.74	0.06	225	395	-170	
70	25.76	0.06	235	461	-225	
80	23.41	0.05	244	526	-282	
90	21.50	0.05	253	592	-340	
100	19.92	0.04	260	658	-398	
110	18.58	0.04	267	724	-457	
120.00	17.44	0.04	273	790	-517	

** IDF Curve Parameters (a,b,c) from City of Burlington IDF Curves, Dwg No. S-IDF*

Required On Site Storage = 49 m^3
for the 5 Yr Storm

IBI GROUP

Stormwater Management
Rational Method
City of Burlington (IDF Curves from Dwg S-IDF)

Project: Halton District School Board Lands **Table 4**
Location: Burlington, On
Date: June 26/17 (April 2020 same as April 11/18 calc's)
Job No. 105842

Design Criteria

Calculate Total Storage needed for 100 yr event

Area =	1.74	hectares
Predevelopment C =	0.27	
IDF Curve =	100	year
Predevelopment Tc =	10.97	minutes
a =	1114.20	
b =	5.00	
c =	0.76	
I =	135.28	mm/hr
Outflow Restriction =	0.110	cms restricted to 5 year level
Post Development C =	0.56	(C value of 0.45 multiplied by 1.25 to account for 100 yr antecede cond'ns per City Std S-3D)

Calculation of Critical Storage Volume

Rainfall Duration (min)	Intensity (mm/hr)	Peak Runoff (m^3/s)	Storm Runoff (m^3)	Release Flow (m^3)	Required Storage (m^3)	
5	193.18	0.53	158	33	125	
10	141.89	0.39	231	66	166	
15	113.99	0.31	279	99	180	
20	96.19	0.26	314	132	182	*
30	74.46	0.20	364	197	167	
40	61.50	0.17	401	263	138	
50	52.79	0.14	431	329	102	
60	46.49	0.13	455	395	60	
70	41.69	0.11	476	461	15	
80	37.90	0.10	495	526	-32	
90	34.83	0.09	511	592	-81	
100	32.27	0.09	526	658	-132	
110	30.11	0.08	540	724	-184	
120.00	28.26	0.08	553	790	-236	

** IDF Curve Parameters (a,b,c) from City of Burlington IDF Curves, Dwg No. S-IDF*

Required On Site Storage = 182 m^3
for the 100 Yr Storm

Project: Halton District School Board Lands
Location: Burlington, On
Date: April 30/20
Job No. 105842

IBI

Table 5

Pipe Storage

From	To	Ponding Elev (m)	Length of Ponding (m)	Pipe Size (mm)	Pipe Area (m2)	Storage Volume (m3)
MH8 (control MH)	MH9/5	154.97	96.71	375	0.110	10.7
MH9/5	MH1	154.97	26.47	1200	1.131	29.9
MH1	MH2	154.97	26.70	1200	1.131	30.2
MH2	MH4	154.97	29.12	1200	1.131	32.9
CBMH1	CBMH2	154.97	46.66	250	0.049	2.3
CBMH2	Storm	154.97	34.00	250	0.049	1.7
MH2	MH6	154.97	28.85	1200	1.131	32.6
					Total	**140.3**

Manhole/CB Storage

MH/CB	Ponding elev (m)	Lid Elev (m)	Lowest Invert (m)	Depth of Ponding (m)	MH Size (mm)	MH/CB Area (m2)	Storage Volume (m3)
MH8 (control MH)	154.97	155.06	153.01	1.96	1200 dia	1.131	2.2
MH9/5	154.97	155.47	153.46	1.51	2400 dia	4.524	6.8
MH1	154.97	155.68	153.51	1.46	3000 dia	7.069	10.3
MH2	154.97	155.71	153.60	1.37	3000 dia	7.069	9.7
MH4	154.97	155.81	153.71	1.26	2400 dia	4.524	5.7
MH6	154.97	156.13	153.71	1.26	2400 dia	4.524	5.7
CBMH1	154.97	155.74	153.85	1.12	1200 dia	1.131	1.3
CBMH2	154.97	155.16	153.62	1.35	1200 dia	1.131	1.5
						Total	**43.2**

Therefore the total pipe/structure storage to elev. 154.97 is approximately = 184 m3

Req'd for 5 year storm = 49.00 m3

Req'd for 100 year storm = 182.00 m3

Therefore the system provides underground storage for the 100 year storm event.

Project: Halton District School Board Lands
Location: Burlington, On
Date: April 23/20
Job No. 105842

IBI

Table 6

Orifice Calculations

Assume Orifice is at MH8

Orifice Invert Elev (m)	100 yr Ponding Elev (m)	Head h (m)	Orifice Size (mm)	Orifice Area A (m^2)	Qr (m^3/s)	Q req'd (m^3/s)
153.01	154.97	1.86	197	0.030	0.110	0.110

assuming 1200mm dia pipe is full
at U/S end

note: $Q=KA\sqrt{2gh}$

K = the coeff. of contraction = 0.60
A = area (in sq. meters)
g = gravity (9.81m/sq. s)
h = head (in meters)

Therefore an orifice size of approximately 200mm diameter is required.

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

APPENDIX B

STORMWATER MANAGEMENT CALCULATIONS

3228 South Service Road, Suite 105, East Wing Burlington, Ontario L7N 3H8
Tel. (905) 631-6978 info@sla.on.ca

BENCH MARK NOTE:

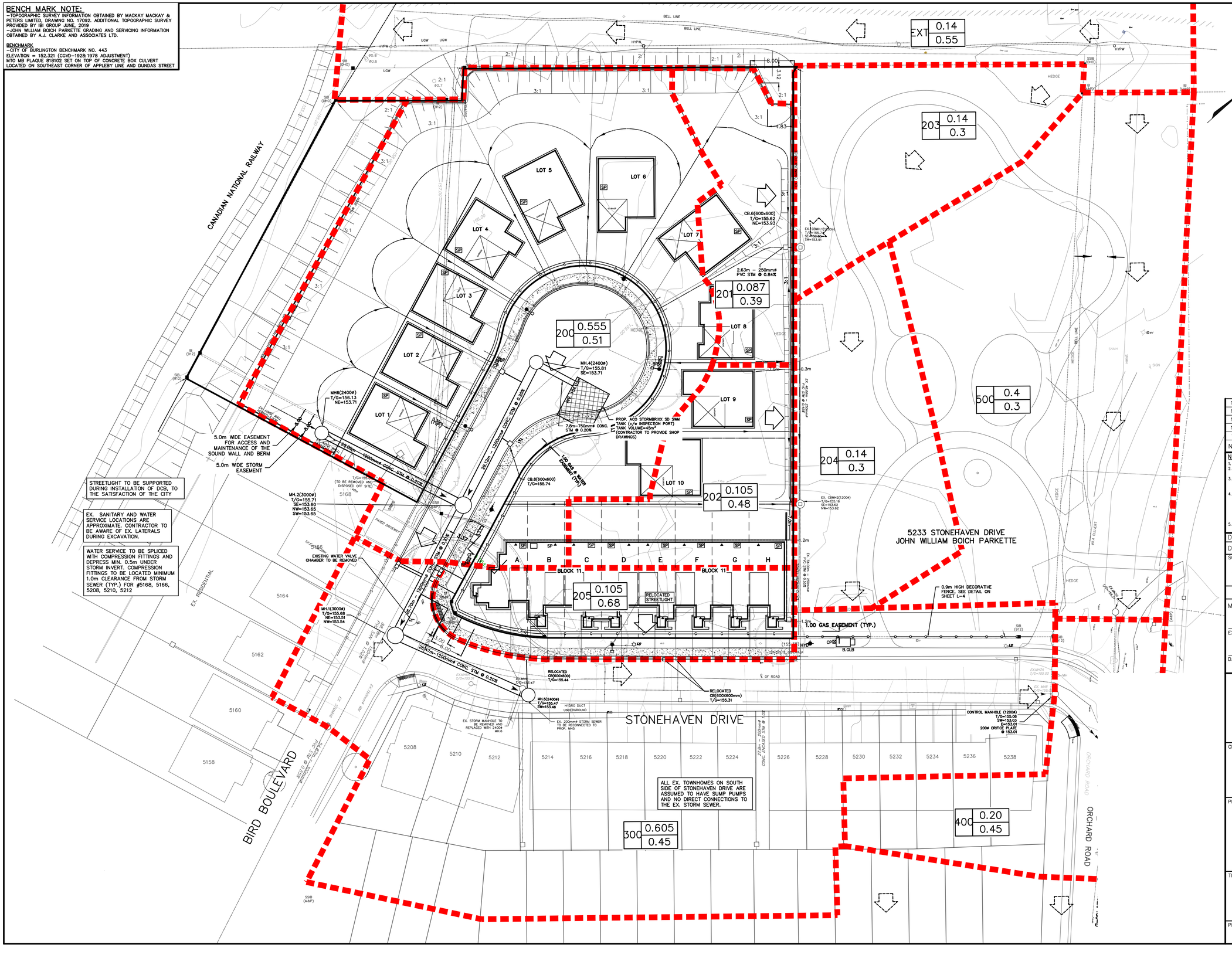
–TOPOGRAPHIC SURVEY INFORMATION OBTAINED BY MACKAY MACKAY & PETERS LIMITED, DRAWING NO. 17092. ADDITIONAL TOPOGRAPHIC SURVEY PROVIDED BY IBI GROUP JUNE, 2019
–JOHN WILLIAM BOICH PARKETTE GRADING AND SERVICING INFORMATION OBTAINED BY A.J. CLARKE AND ASSOCIATES LTD.

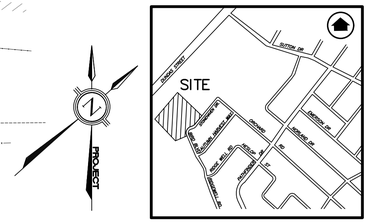
BENCHMARK
–CITY OF BURLINGTON BENCHMARK NO. 443
ELEVATION = 152.321 (CGVD–1928:1978 ADJUSTMENT)
MTO MB PLAQUE 818102 SET ON TOP OF CONCRETE BOX CULVERT LOCATED ON SOUTHEAST CORNER OF APPLEBY LINE AND DUNDAS STREET

STREETLIGHT TO BE SUPPORTED DURING INSTALLATION OF DCB, TO THE SATISFACTION OF THE CITY

EX. SANITARY AND WATER SERVICE LOCATIONS ARE APPROXIMATE. CONTRACTOR TO BE AWARE OF EX. LATERALS DURING EXCAVATION.

WATER SERVICE TO BE SPLICED WITH COMPRESSION FITTINGS AND DEPRESS MIN. 0.5m UNDER STORM INVERT. COMPRESSION FITTINGS TO BE LOCATED MINIMUM 1.0m CLEARANCE FROM STORM SEWER (TYP.) FOR #5168, 5166, 5208, 5210, 5212





LEGEND:

- PROPOSED STORM MANHOLE
- EXISTING STORM MANHOLE
- PROPOSED CATCH BASIN
- PROPOSED CATCH BASIN MANHOLE
- PROPOSED DOUBLE CATCH BASIN
- CATCHMENT AREA NUMBER
- 3 | 0.15ha | 0.80 — AREA (ha) / RUN OFF COEFFICIENT
- PROP. OVERLAND FLOW
- EX. OVERLAND FLOW
- PROP. STORM DRAINAGE AREA

REGIONAL
DESIGN OF WATER &/OR WASTEWATER SERVICES APPROVED SUBJECT TO DETAIL CONSTRUCTION CONFORMING TO HALTON REGION STANDARDS & SPECIFICATIONS & LOCATION APPROVAL FROM LOCAL MUNICIPALITY.

LEGISLATIVE AND PLANNING SERVICES

DATE

NO.	DATE	BY	REVISIONS
15	AUG 2024	AP	REVISED PER PHASE 1 (TOWNHOUSE BLOCK A TO H)
14	MAR 2023	AK	REVISED UCP & ISSUED FOR FINAL APPROVAL.
13	NOV 2022	SD	UPDATED HYDRO LAYOUT.
12	FEB 2022	AK	REVISED PER CITY COMMENTS.
11	NOV 2021	AK	REVISED PER FORESTRY COMMENTS.

NOTES TO CONTRACTOR:

1. CONTRACTORS AND SUBCONTRACTORS SHALL NOT SCALE FROM THIS DRAWING.
2. ANY INCONSISTENCIES AND OMISSIONS FOUND ON THE DRAWINGS MUST BE REPORTED TO THE ENGINEER FOR CLARIFICATION BEFORE COMMENCING THE WORK.
3. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR MUST CHECK AND VERIFY ALL DIMENSIONS AND ELEVATIONS AND REPORT ALL FINDINGS TO THE ENGINEER. ONCE CONSTRUCTION HAS COMMENCED, THE CONTRACTOR ACCEPTS RESPONSIBILITY FOR ALL DIMENSIONS, ELEVATIONS, AND SITE CONDITIONS.
4. THE POSITIONS OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVER–GROUND UTILITIES AND STRUCTURES ARE NOT NECESSARILY SHOWN ON THE DRAWINGS. WHERE SHOWN ON THE DRAWING, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM THEMSELVES OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
5. ALL DRAWINGS REMAIN THE PROPERTY OF THE ENGINEER AND SHALL NOT BE REPRODUCED, REUSED, OR REVISED WITHOUT THE WRITTEN CONSENT OF S. LLEWELLYN AND ASSOCIATES LIMITED.

DESIGN		CHK'D	SL	DATE
DRAWN		CHK'D	SL	Aug. 12, 24

SCALE 1:300 (0 5 10 20 30)

APPROVALS

MUNICIPAL

EXECUTIVE DIRECTOR OF CAPITAL WORKS

DATE

STAMP

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

CLIENT

CITY OF BURLINGTON

PROJECT NAME

BASINGSTOKE ENTERPRISES LTD.
STONEHAVEN SUBDIVISION
5209 STONEHAVEN DRIVE
REGION OF HALTON FILE No.: 24T–17001/DB–1011
MUNICIPAL FILE No.: 510–01/17

TITLE

STORM DRAINAGE AREA PLAN

PROJECT No. 21052

DRAWING No. SHEET 7 of 27

100-Year Storm - Modified Rational Method

Stormwater Storage Volume and Orifice Sizing

Determination of required storage volume under preliminary conditions to control the 100-year proposed conditions runoff to the allowable flow rate.

Storage volume calculated using the Modified Rational Method.

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Mount Hope Storm Rainfall Information		
City/Town/Region:	**Burlington**	
Return Period:	**100**	Years
A =	**1114.200**	
B =	**5.000**	
C=	**0.760**	
Tc =	**10.97**	minutes
	658.2	seconds

Area of site being investigated (ha) =	**1.74**	(Site Area)
Composite Runoff Coeff. (C) =	**0.56**	("C" - 0.45 x 1.25 to account for 100-yr antecedent conditions per City Std S-3D)
Release Rate - Q_{ALLOW} (m^3/s) =	**0.110**	(Allowable Flow Rate)

Flows from Lot area calculated from area indicated above

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

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	193.626	0.0000538	0.524	0.0	0.5241	157.22	52.70	104.52
10	600	142.277	0.0000395	0.385	0.0	0.3851	231.06	69.20	161.86
15	900	114.335	0.0000318	0.309	0.0	0.3095	278.52	85.70	192.82
20	1200	96.500	0.0000268	0.261	0.0	0.2612	313.43	102.20	211.23
25	1500	84.014	0.0000233	0.227	0.0	0.2274	341.10	118.70	222.40
30	1800	74.726	0.0000208	0.202	0.0	0.2023	364.06	135.20	228.86
35	2100	67.515	0.0000188	0.183	0.0	0.1827	383.75	151.70	232.05
40	2400	61.734	0.0000171	0.167	0.0	0.1671	401.02	168.20	232.82
45	2700	56.983	0.0000158	0.154	0.0	0.1542	416.43	184.70	231.73
50	3000	53.001	0.0000147	0.143	0.0	0.1435	430.37	201.20	229.17
55	3300	49.610	0.0000138	0.134	0.0	0.1343	443.12	217.70	225.41
60	3600	46.682	0.0000130	0.126	0.0	0.1264	454.87	234.20	220.67

Max. required storage volume = 232.82 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

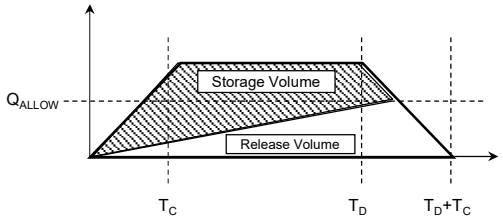
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)$ Q_{ALLOW}

Storage Volume = Runoff Volume - Release Volume



Pipe Storage

From	To	Ponding Elev (m)	Length of Pipe (m)	Pipe Size (mm)	Pipe Area (m^2)	Storage Volume (m^3)
MH8	MH9/5	154.97	95.96	375	0.110	10.6
MH9/5	MH1	154.97	26.47	1200	1.131	29.9
MH1	MH2	154.97	26.70	1200	1.131	30.2
MH2	MH4	154.97	29.12	1200	1.131	32.9
CBMH1	CBMH2	154.97	46.66	250	0.049	2.3
CHBM2	STM SEWER	154.97	34.00	250	0.049	1.7
MH2	MH6	154.97	28.85	1200	1.131	32.6
TANK	MH4	154.97	7.80	750	0.442	3.4
					Total	**143.7**

Structure Storage

Structure	Ponding Elev (m)	Lid Elev (m)	Lowest Invert (m)	Depth of Ponding (m)	Structure Size (mm)	Structure Area (m^2)	Storage Volume (m^3)
MH8	155.06	155.06	153.01	2.05	1200	1.131	2.3
MH9/5	155.06	155.47	153.46	1.60	2400	4.524	7.2
MH1	155.06	155.68	153.51	1.55	3000	7.069	11.0
MH2	155.06	155.71	153.60	1.46	3000	7.069	10.3
MH4	155.06	155.81	153.71	1.35	2400	4.524	6.1
MH6	155.06	156.13	153.71	1.35	2400	4.524	6.1
CBMH1	155.06	155.74	153.85	1.21	1200	1.131	1.4
CBMH2	155.06	155.16	153.62	1.44	1200	1.131	1.6
						Total	**46.0**

Tank Storage

Footprint Area (m^2)	Bottom Elevation (m)	Top Elevation (m)	Depth (m)	Void Ratio	Storage Volume (m^3)
51.48	154.02	154.94	0.92	0.97	45.89
				Total	**45.9**

TOTAL	***235.6***
Require	233
Need	-2.6