411 Main St.
Wellington, Ontario
12 Trees Residential

Stormwater Management Report

Part of Lot 69-A, Registered Plan 8
Village of Wellington
Prince Edward County

July 2020

AINLEY GRAHAM & ASSOCIATES

CONSULTING ENGINEERS AND PLANNERS
COLLINGWOOD · BARRIE · BELLEVILLE · KINGSTON · OTTAWA

File No. 19629-1

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1.0 INTRODUCTION

1.1 General

Ainley Group has been retained to undertake engineering services necessary to provide detailed design of stormwater management requirements for the proposed 12 Trees Residential development concept.

The proposed development is located on Wellington Main Street, located 80m east of the Wellington Main Street and Carla Court intersection and 80m west of the Wellington Main Street and MacDonald Street intersection. The property is bounded to the north by Wellington Main Street and to the east, and west by existing residential development. The development site is represented in **Figure 1**.

The proposal will incorporate the development of 9 single detached units and 8 semi-detached units.

1.2 Criteria

This report has been prepared with consideration of the Ministry of Environment's Stormwater Management Planning and Design Manual (2003).

The stormwater management is subject to the following;

- Quantity control mitigation measures to ensure post development discharge rates do not exceed pre-development rates, and,
- Quality control mitigation measures to provide 'level 2', treatment of the 25mm quality rainfall event.

The subject site lies with the Quinte Conservation Authority Region, quantity mitigation is subject to the 100-year storm, as outlined in Ontario Regulation 319/09 Quinte Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses.

1.3 Property Description

The subject site is approximately 1.2 hectares (ha) in size and has an approximate 83m frontage along Wellington Main Street. Topography in the area has a slight slope (~3%) from Wellington Main Street towards Lake Ontario in the south.

The site is in the Village of Wellington, in Prince Edward County. The soils mapping for the site indicates that the soil is comprised of Ameliasburg Clay Loam (good drainage), with 0.3m to 0.9m of soil over bedrock.

1.4 Existing Conveyance

The site currently sheet drains from Wellington Main Street into Lake Ontario. There is curb-and-gutter along Wellington Main Street that collects any drainage to the road.

2.0 HYDROLOGY

2.1 Model Selection

Flow calculations for the pre and post development conditions were carried out using the SWMHYMO computer program. This program is a complex hydrologic model used for the simulation and management of stormwater runoff in either small or large rural and urban areas.

2.2 Model Parameters

The SWMHYMO model has been developed with consideration of the parameters interpreted from air photos, Ontario Soils Mapping, topographic information, and the designer's knowledge of the site based on visual observations. The soils within the subject site have been identified as Soil Group 'C', with a Curve Number of 70 and Runoff Coefficient of 0.35. Supporting documentation is enclosed in **Appendix A**.

The site has been divided into three different catchment areas (1, 2, 3) to reflect the site geometry and allow the drainage requirements of each area to be more accurately modelled.

An estimate of the contributing site impervious cover for each catchment area has been prepared for use in the SWMHYMO modeling. It has been estimated that Catchment Area 1 will be approximately 50% impervious, with 50% directly connected. Catchment Areas 2 and 3 will both be approximately 27% impervious, with 0% directly connected. Supporting Calculations for the estimate of impervious cover are included in **Appendix A**.

2.3 Post Development

The post development SWMHYMO model was developed to evaluate the runoff rate and volume generated by the 25mm and 100-year events from the contributing catchment areas as outlined on **Figure 2**. The SWMHYMO output is included in **Appendix B**. A summary of the post-development flows is as follows:

Catchment Area 1:
- Post-development Quality event (25mm Event): 0.037m^3/s
- Post-development Quantity event (100-year Storm Event): 0.250m^3/s

Catchment Area 2:
- Post-development Quality event (25mm Event): 0.002m^3/s
- Post-development Quantity event (100-year Storm Event): 0.015 m^3/s

Catchment Area 3:
- Post-development Quality event (25mm Event): 0.002m^3/s
- Post-development Quantity event (100-year Storm Event): 0.017 m^3/s

3.0 QUANTITY MEASURES

Drainage of the site will be handled by an urban cross section including curb, a main outlet drainage swale, and rear yard swales.

As all three catchment areas of the subject site will drain to Lake Ontario, quantity control mitigation is not required. However, conveyance of the quantity event (100-year Storm) needs to be provided. Conveyance of these flows is proposed to be through a grassed swale in each catchment area. For design purposes, Catchment Area 2 and 3 are considered identical, with the higher peak flow rate used. The proposed minimum dimensions of these swales are shown in **Appendix C**.

The southern portion of Lots 10-12 are not included in the three catchment areas. Conveyance of quantity flows in this area will be through sheet drainage directly to Lake Ontario.

4.0 QUALITY MEASURES

Quality control for the proposed development site will be provided through a 'treatment train', including;

- Roof leaders to rear yards, and
- Vegetated contact through swales before flowing to Level 2 receiver.

To meet the requirements of treatment for a Level 2 receiver, the proposed swales were designed to meet the requirements of Section 4.5.9 of the SWM Planning and Design Manual. The swales must be able to convey the peak flow from the 25mm quality event at a velocity of less than 0.5m/s. The proposed minimum dimensions of the swales are shown in **Appendix C.** The swales for Catchment Areas 2 and 3 meet the 0.5m/s velocity requirement under the peak flow of the 100-year event, which is much greater than the peak flow of the 25mm event.

5.0 EROSION AND SEDIMENTATION CONTROL

An erosion and sediment control strategy will be implemented as per the plan included in the drawing package in order to minimize the transfer of silt off site during construction. The following measures will also be incorporated into the strategy as required:

- Environmental fencing and geotextile
- Regular inspection of the erosion and sediment control devices
- Removal & disposal of the erosion and sediment control devices after the site has been stabilized
- All exposed earth to be re-vegetated within thirty days after construction has been completed.

6.0 CONCLUSIONS AND RECOMMENDATIONS

- Quantity control mitigation measures are not required due to proximity to Lake Ontario. Conveyance to Lake Ontario will be provided by a swale in each catchment area.
- Quality control will be provided through a low impact development treatment train approach consisting of grassed swales and roof leaders.
- Silt fencing and geotextile will be in place during construction.

We trust that the above meets your guidelines and ask that you contact the undersigned, should you have any queries.

Sincerely,
AINLEY GRAHAM & ASSOCIATES LIMITED

Ben Lange, B. Eng.
EIT

Adam Wilson, P. Eng.
Senior Engineer

LICENSED PROFESSIONAL ENGINEER
July 13/20
A. J. WILSON
100121298
PROVINCE OF ONTARIO

Figure 1 – 12 Trees Residential Development Site

Figure 2 – Catchment Areas

APPENDIX A

Model Parameters

Design Chart 1.07: Runoff Coefficients (Continued)

- Rural

Land Use & Topography[3]	Soil Texture		
	Open Sand Loam	Loam or Silt Loam	Clay Loam or Clay
CULTIVATED			
Flat 0 - 5% Slopes	0.22	0.35	0.55
Rolling 5 - 10% Slopes	0.30	0.45	0.60
Hilly 10- 30% Slopes	0.40	0.65	0.70
PASTURE			
Flat 0 - 5% Slopes	0.10	0.28	0.40
Rolling 5 - 10% Slopes	0.15	0.35	0.45
Hilly 10- 30% Slopes	0.22	0.40	0.55
WOODLAND OR CUTOVER			
Flat 0 - 5% Slopes	0.08	0.25	0.35
Rolling 5 - 10% Slopes	0.12	0.30	0.42
Hilly 10- 30% Slopes	0.18	0.35	0.52
BARE ROCK	COVERAGE[3]		
	30%	50%	70%
Flat 0 - 5% Slopes	0.40	0.55	0.75
Rolling 5 - 10% Slopes	0.50	0.65	0.80
Hilly 10- 30% Slopes	0.55	0.70	0.85
LAKES AND WETLANDS	0.05		

[2] Terrain Slopes

[3] Interpolate for other values of % imperviousness

Sources: American Society of Civil Engineers - ASCE (1960)
U.S. Department of Agriculture (1972)

Design Chart 1.08: Hydrologic Soil Groups (Continued)

- Based on Soil Texture

Sands, Sandy Loams and Gravels	
- overlying sand, gravel or limestone bedrock, very well drained	A
- ditto, imperfectly drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium to Coarse Loams	
- overlying sand, gravel or limestone, well drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium Textured Loams	
- shallow, overlying limestone bedrock	B
- overlying medium textured subsoil	BC
Silt Loams, Some Loams	
- with good internal drainage	BC
- with slow internal drainage and good external drainage	C
Clays, Clay Loams, Silty Clay Loams	
- with good internal drainage	C
- with imperfect or poor external drainage	C
- with slow internal drainage and good external drainage	D

Source: U.S. Department of Agriculture (1972)

Design Chart 1.09: Soil/Land Use Curve Numbers

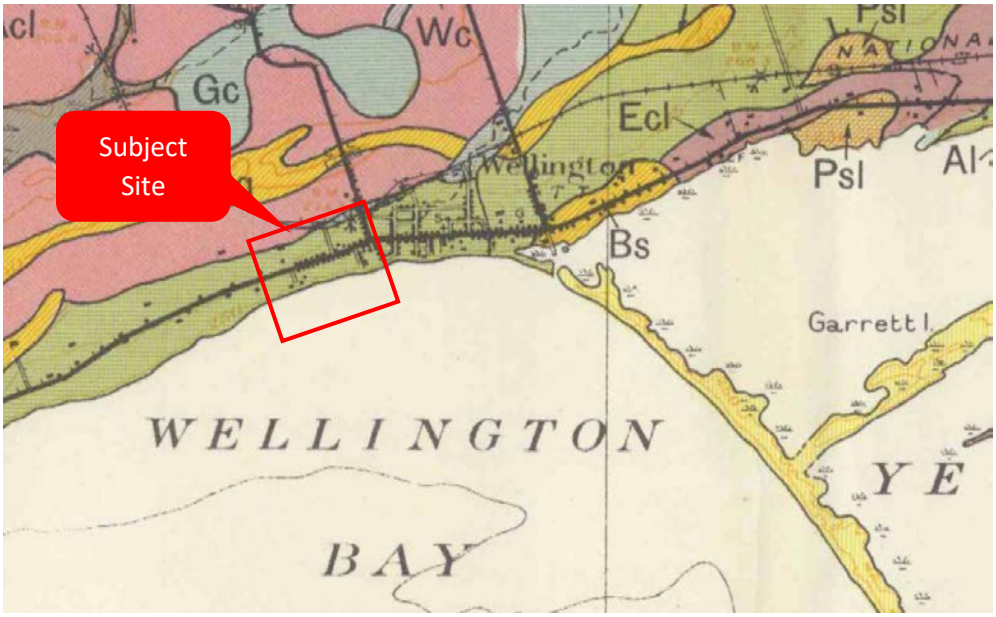
Land Use	Treatment or Practice	Hydrologic Condition[4]	Hydrologic Soil Group			
			A	B	C	D
Fallow	Straight row	---	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	" and terraced	Poor	66	74	8	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	" and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes[2] or rotation meadow	Straight row	Poor	66	77	85	89
	" "	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	"	Good	55	69	78	83
	" and terraced	Poor	63	73	80	83
	" and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
	Contoured	Good	39	61	74	80
	"	Poor	47	67	81	88
	"	Fair	25	59	75	83
		Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		---	59	74	82	86
		---	72	82	87	89
		---	74	84	90	92

For average anticedent soil moisture condition (AMC II)
[2] Close-drilled or broadcast.

[4] The hydrologic condition of cropland is good if a good crop rotation practice is used; it is poor if one crop is grown continuously.

Source: U.S. Department of Agriculture (1972)

Soil Classification
(Ontario Soil Survey Report Prince Edward County)



Good
AMELIASBURG
Clay loam Acl—25,200 loam Al —25,600
Undulating to rolling
Stony
Alkaline
One to three feet of soil over bedrock. 5,000 acres imperfectly drained phase (Ac-i) occur in depressional areas.

	CN	C
Softscape	70	0.35
Hardscape	98	0.95

Catchment 1

Location	Area (m2)	Area (ha)	Softscape	Hardscape	% Impervious
Lot 1-8	1760.32	0.18	802.72	958	54.40%
9	332.00	0.03	232.40	100	30.00%
12	301.40	0.03	150.70	151	50.00%
13	189	0.02	132.30	57	30.00%
EP Lands	550	0.06	512.50	38	6.82%
Parkette	342	0.03	288.00	54	15.79%
Street A	2171	0.22	697.06	1474	67.89%
Total	5645.63	0.56	2815.68	2829.95	50.13%

Average CN

	A	CN	A*CN	
Total Area	0.56			
Impervious Area	0.2829952	98	27.73	
Pervious Area	0.2815683	70	19.71	
		SUM	**47.44**	**84**

Average RC

	A	C	A*C	
Total Area	0.56			
Impervious Area	0.2829952	0.95	0.27	
Pervious Area	0.2815683	0.35	0.10	
		SUM	**0.37**	**0.65**

Catchment 2

Location	Area (m2)	Area (ha)	Softscape	Hardscape	% Impervious
Lot 1-4	1158.00	0.12	825.20	333	28.74%
13	652.80	0.07	456.96	196	30.00%
EP Lands	120.00	0.01	120.00	0	0.00%
Total	1930.80	0.19	1402.16	528.64	27.38%

Average CN

	A	CN	A*CN	
Total Area	0.19			
Impervious Area	0.052864	98	5.18	
Pervious Area	0.140216	70	9.82	
		SUM	**15.00**	**78**

Average RC

	A	C	A*C	
Total Area	0.19308			
Impervious Area	0.052864	0.95	0.05	
Pervious Area	0.140216	0.35	0.05	
		SUM	**0.10**	**0.51**

Catchment 3

Location	Area (m2)	Area (ha)	Softscape	Hardscape	% Impervious
Lot 5-8	1158.00	0.12	825.20	333	28.74%
9	885.00	0.09	619.5	266	30.00%
EP Lands	237.50	0.02	237.50	0	0.00%
Total	2280.50	0.23	1682.20	598.30	26.24%

Average CN

	A	CN	A*CN	
Total Area	0.23			
Impervious Area	0.05983	98	5.86	
Pervious Area	0.16822	70	11.78	
		SUM	**17.64**	**77**

Average RC

	A	C	A*C	
Total Area	0.22805			
Impervious Area	0.05983	0.95	0.06	
Pervious Area	0.16822	0.35	0.06	
		SUM	**0.12**	**0.51**

APPENDIX B

SWMHYMO Output

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

SSSSS   W   W   M   M   H   H   Y   Y   M   M    OOO         222     000    11   77777 =========
S       W W W   MM MM   H   H    Y Y    MM MM   O   O          2    0   0   11   7   7
SSSSS   W W W   M M M   HHHHH     Y     M M M   O   O          2    0   0   11       7 Ver4.05.0
    S    W W    M   M   H   H     Y     M   M   O   O        222    0   0   11      7  APR 2017
SSSSS    W W    M   M   H   H     Y     M   M    OOO         2      0   0   11     7   =========
                                                             2      0   0   11    7    # 2196493
      StormWater Management HYdrologic Model                  222     000    11    7    =========

*********************************************************************************************
*************************************  SWMHYMO Ver4.05.0  ************************************
******************  A single event and continuous hydrologic simulation model  ******************
******************     based on the principles of HYMO and its successors      ******************
******************                OTTHYMO-83 and OTTHYMO-89.                   ******************
*********************************************************************************************
****************** Distributed by:  J.F. Sabourin and Associates Inc.          ******************
******************                  Ottawa,  Ontario: (613) 836-3884           ******************
******************                  Gatineau, Quebec: (819) 243-6858           ******************
******************                  E-Mail: swmhymo@jfsa.com                   ******************
*********************************************************************************************

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++ Licensed user: Ainley Group                                 ++++++++++++++++++
++++++++++++++++++                Belleville           SERIAL#:2196493         ++++++++++++++++++
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

*********************************************************************************************
******************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            ******************
******************           Maximum value for ID numbers  :     11            ******************
******************           Max. number of rainfall points: 105408            ******************
******************           Max. number of flow points    : 105408            ******************
*********************************************************************************************

*********************************************************************************************
*************************************  SWMHYMO Ver4.05.0  ************************************
******************  A single event and continuous hydrologic simulation model  ******************
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*********************************************************************************************

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++ Licensed user: Ainley Group                                 ++++++++++++++++++
++++++++++++++++++                Belleville           SERIAL#:2196493         ++++++++++++++++++
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

*********************************************************************************************
******************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            ******************
******************           Maximum value for ID numbers  :     11            ******************
******************           Max. number of rainfall points: 105408            ******************
******************           Max. number of flow points    : 105408            ******************
*********************************************************************************************


*******************************  D E T A I L E D   O U T P U T  *******************************
*********************************************************************************************
*                 RUN DATE: 2020-07-13     TIME: 09:57:31     RUN COUNTER: 000001            *
*********************************************************************************************
* Input   file: V:\19629-1\SWM\SWMHYMO\12 Trees - 100yr.dat                                  *
* Output  file: V:\19629-1\SWM\SWMHYMO\12 Trees - 100yr.out                                  *
* Summary file: V:\19629-1\SWM\SWMHYMO\12 Trees - 100yr.sum                                  *
* User comments:                                                                             *
* 1:_________________________________________________________________________________________*
* 2:_________________________________________________________________________________________*
* 3:_________________________________________________________________________________________*
*********************************************************************************************

---------------------------------------------------------------------------------------------
R0001:C00001----------------------------------------------------------------------------------
*#*************************************************************************
*#  Project Name: [12 Trees Residential]    Project Number: [19629-1]
*#  Date        : 08-07-2020
*#  Modeller    : [Ben Lange]
*#  Company     : Ainley Group
*#  License #   :  2196493
*#*************************************************************************
--------------------
| START            | Project  dir.:V:\19629-1\SWM\SWMHYMO\
-------------------- Rainfall dir.:V:\19629-1\SWM\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 0001
    NSTORM=   0
---------------------------------------------------------------------------------------------
R0001:C00002----------------------------------------------------------------------------------
*
***************************************************************************
***************************************************************************
*
* Quantity - 100-yr Event
*
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 960.833
| Ptotal= 48.48 mm |                          B=   1.500
--------------------                          C=    .725
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  1.00 hrs
                        Storm time step    =  2.00 min
                        Time to peak ratio =   .33

                    The CORRELATION coefficient is = .9996688

                     TIME        ENTERED            COMPUTED
                    (min)        (mm/hr)             (mm/hr)
                       5.         265.80              247.34
                      10.         163.70              163.55
                      15.         123.30              125.88
                      30.          76.00               78.77
                      60.          46.80               48.50
                     120.          28.80               29.60
                     360.          13.40               13.43
                     720.           8.20                8.14
                    1440.           5.10                4.93

       TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN
      hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr
       0:02  15.614|   0:12  30.296|   0:22 153.958|   0:32  36.141|   0:42  22.356|   0:52  16.732
       0:04  17.138|   0:14  38.966|   0:24  88.719|   0:34  31.940|   0:44  20.892|   0:54  15.973
       0:06  19.067|   0:16  56.852|   0:26  63.597|   0:36  28.720|   0:46  19.634|   0:56  15.290
       0:08  21.600|   0:18 121.266|   0:28  50.225|   0:38  26.166|   0:48  18.541|   0:58  14.673
       0:10  25.098|   0:20 387.435|   0:30  41.876|   0:40  24.086|   0:50  17.582|   1:00  14.111

---------------------------------------------------------------------------------------------
R0001:C00003----------------------------------------------------------------------------------
*Catchment 1
*
*Post Development
--------------------------
| CALIB STANDHYD         |   Area    (ha)=     .56
| 02:1B100      DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
--------------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .28           .28
     Dep. Storage     (mm)=        .60          4.00
     Average Slope     (%)=       3.10          3.10
     Length            (m)=     156.40        156.40
     Mannings n          =        .013          .250

     Max.eff.Inten.(mm/hr)=     387.43         47.30
                over (min)        1.00         20.00
     Storage Coeff.  (min)=       1.38 (ii)    20.30 (ii)
     Unit Hyd. Tpeak (min)=       1.00         20.00
     Unit Hyd. peak  (cms)=        .87           .06
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .25           .02            .250 (iii)
     TIME TO PEAK    (hrs)=        .33           .72            .333
     RUNOFF VOLUME    (mm)=      47.88         21.31          34.597
     TOTAL RAINFALL   (mm)=      48.48         48.48          48.485
     RUNOFF COEFFICIENT   =        .99           .44            .714

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  84.0    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.

---------------------------------------------------------------------------------------------
R0001:C00004----------------------------------------------------------------------------------
*
*Catchment 2
*
*Post Development
--------------------------
| CALIB STANDHYD         |   Area    (ha)=     .19
| 04:2B100      DT= 1.00 |   Total Imp(%)=   27.00   Dir. Conn.(%)=    1.00
--------------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05           .14
     Dep. Storage     (mm)=        .60          4.00
     Average Slope     (%)=       2.70          2.70
     Length            (m)=     136.30        136.30
     Mannings n          =        .013          .250

     Max.eff.Inten.(mm/hr)=     387.43         69.70
                over (min)        1.00         17.00
     Storage Coeff.  (min)=       1.33 (ii)    16.88 (ii)
     Unit Hyd. Tpeak (min)=       1.00         17.00
     Unit Hyd. peak  (cms)=        .90           .07
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .00           .02            .015 (iii)
     TIME TO PEAK    (hrs)=        .33           .65            .650
     RUNOFF VOLUME    (mm)=      47.77         21.08          21.347
     TOTAL RAINFALL   (mm)=      48.48         48.48          48.485
     RUNOFF COEFFICIENT   =        .99           .43            .440

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  78.0    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.

---------------------------------------------------------------------------------------------
R0001:C00005----------------------------------------------------------------------------------
*
*Catchment 3
*
*Post Development
--------------------------
| CALIB STANDHYD         |   Area    (ha)=     .23
| 06:3B100      DT= 1.00 |   Total Imp(%)=   26.00   Dir. Conn.(%)=    1.00
--------------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .06           .17
     Dep. Storage     (mm)=        .60          4.00
     Average Slope     (%)=       3.30          3.30
     Length            (m)=     156.60        156.40
     Mannings n          =        .013          .250

     Max.eff.Inten.(mm/hr)=     387.43         63.68
                over (min)        1.00         18.00
     Storage Coeff.  (min)=       1.36 (ii)    17.85 (ii)
     Unit Hyd. Tpeak (min)=       1.00         18.00
     Unit Hyd. peak  (cms)=        .88           .06
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .00           .02            .017 (iii)
     TIME TO PEAK    (hrs)=        .33           .67            .667
     RUNOFF VOLUME    (mm)=      47.75         20.25          20.526
     TOTAL RAINFALL   (mm)=      48.48         48.48          48.485
     RUNOFF COEFFICIENT   =        .98           .42            .423

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    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.

---------------------------------------------------------------------------------------------
R0001:C00006----------------------------------------------------------------------------------
*********************************************************************************
--------------------
| FINISH           |
--------------------
---------------------------------------------------------------------------------------------
*********************************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2020-07-13     at 09:57:31
=============================================================================================
```

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

 SSSSS   W   W   M   M   H   H   Y   Y   M   M    OOO          222     000    11   77777 =========
 S       W W W   MM MM   H   H    Y Y    MM MM   O   O           2    0   0   11   7   7
 SSSSS   W W W   M M M   HHHHH     Y     M M M   O   O           2    0   0   11       7 Ver4.05.0
     S    W W    M   M   H   H     Y     M   M   O   O         222    0   0   11      7  APR 2017
 SSSSS    W W    M   M   H   H     Y     M   M    OOO          2      0   0   11     7   =========
                                                                2      0   0   11    7    # 2196493
       StormWater Management HYdrologic Model                   222     000    11    7    =========

 ***************************************************************************************************
 *************************************  SWMHYMO Ver4.05.0  *****************************************
 *****************  A single event and continuous hydrologic simulation model  *****************
 *****************     based on the principles of HYMO and its successors       *****************
 *****************                 OTTHYMO-83 and OTTHYMO-89.                   *****************
 ***************************************************************************************************
 ***************** Distributed by:  J.F. Sabourin and Associates Inc.           *****************
 *****************                  Ottawa,  Ontario: (613) 836-3884            *****************
 *****************                  Gatineau, Quebec: (819) 243-6858            *****************
 *****************                  E-Mail: swmhymo@jfsa.com                    *****************
 ***************************************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++++++++++ Licensed user: Ainley Group                                  +++++++++++++++++
 +++++++++++++++++                Belleville           SERIAL#:2196493          +++++++++++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************************************
 *****************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *****************
 *****************           Maximum value for ID numbers  :     11             *****************
 *****************           Max. number of rainfall points: 105408             *****************
 *****************           Max. number of flow points    : 105408             *****************
 ***************************************************************************************************

 ***************************************************************************************************
 *************************************  SWMHYMO Ver4.05.0  *****************************************
 *****************  A single event and continuous hydrologic simulation model  *****************
 *****************     based on the principles of HYMO and its successors       *****************
 *****************                 OTTHYMO-83 and OTTHYMO-89.                   *****************
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 +++++++++++++++++                Belleville           SERIAL#:2196493          +++++++++++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************************************
 *****************           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *****************
 *****************           Maximum value for ID numbers  :     11             *****************
 *****************           Max. number of rainfall points: 105408             *****************
 *****************           Max. number of flow points    : 105408             *****************
 ***************************************************************************************************


 *******************************  D E T A I L E D   O U T P U T  *******************************
 ***************************************************************************************************
 *                 RUN DATE: 2020-07-13     TIME: 10:02:36     RUN COUNTER: 000002                 *
 ***************************************************************************************************
 * Input   file: V:\19629-1\SWM\SWMHYMO\12 Trees - 25mm.dat                                        *
 * Output  file: V:\19629-1\SWM\SWMHYMO\12 Trees - 25mm.out                                        *
 * Summary file: V:\19629-1\SWM\SWMHYMO\12 Trees - 25mm.sum                                        *
 * User comments:                                                                                  *
 * 1:______________________________________________________________________________________________*
 * 2:______________________________________________________________________________________________*
 * 3:______________________________________________________________________________________________*
 ***************************************************************************************************

-----------------------------------------------------------------------------------------------------
R0001:C00001-----------------------------------------------------------------------------------------
*#****************************************************************************
*#  Project Name: [12 Trees Residential]    Project Number: [19629-1]
*#  Date        : 08-07-2020
*#  Modeller    : [Ben Lange]
*#  Company     : Ainley Group
*#  License #   :  2196493
*#****************************************************************************
--------------------
| START             | Project  dir.:V:\19629-1\SWM\SWMHYMO\
-------------------- Rainfall dir.:V:\19629-1\SWM\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 0001
    NSTORM=   0
-----------------------------------------------------------------------------------------------------
R0001:C00002-----------------------------------------------------------------------------------------
*
******************************************************************************
******************************************************************************
*
* Quality - 25mm Event
*
--------------------
| READ STORM        |  Filename: V:\19629-1\SWM\SWMHYMO\25mm.STM
| Ptotal=  25.00 mm|  Comments: Twenty-Five mm Four Hour Chicago Storm
--------------------
       TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN|   TIME    RAIN
      hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr|  hh:mm   mm/hr
       0:10   2.071|   0:50   3.382|   1:30  50.214|   2:10   5.194|   2:50   3.252|   3:30   2.476
       0:20   2.266|   1:00   4.175|   1:40  13.366|   2:20   4.466|   3:00   3.010|   3:40   2.346
       0:30   2.524|   1:10   5.696|   1:50   8.286|   2:30   3.949|   3:10   2.799|   3:50   2.233
       0:40   2.880|   1:20  10.777|   2:00   6.295|   2:40   3.560|   3:20   2.622|   4:00   2.136

-----------------------------------------------------------------------------------------------------
R0001:C00003-----------------------------------------------------------------------------------------
*Catchment 1
*
*Post Development
-------------------------
| CALIB STANDHYD        |   Area    (ha)=     .56
| 02:1B25       DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
-------------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .28          .28
     Dep. Storage     (mm)=       .60         4.00
     Average Slope     (%)=      3.10         3.10
     Length            (m)=    156.40       156.40
     Mannings n           =      .013         .250

     Max.eff.Inten.(mm/hr)=     50.21         4.36
               over (min)       3.00        52.00
     Storage Coeff.  (min)=      3.13 (ii)   52.22 (ii)
     Unit Hyd. Tpeak (min)=      3.00        52.00
     Unit Hyd. peak  (cms)=       .36          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=       .04          .00          .037 (iii)
     TIME TO PEAK    (hrs)=      1.50         2.52         1.500
     RUNOFF VOLUME    (mm)=     24.40         6.35        15.375
     TOTAL RAINFALL   (mm)=     25.00        25.00        24.996
     RUNOFF COEFFICIENT   =       .98          .25          .615

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  84.0    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.

-----------------------------------------------------------------------------------------------------
R0001:C00004-----------------------------------------------------------------------------------------
*
*Catchment 2
*
*Post Development
-------------------------
| CALIB STANDHYD        |   Area    (ha)=     .19
| 04:2B25       DT= 1.00 |   Total Imp(%)=   27.00   Dir. Conn.(%)=    1.00
-------------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .05          .14
     Dep. Storage     (mm)=       .60         4.00
     Average Slope     (%)=      2.70         2.70
     Length            (m)=    136.30       136.30
     Mannings n           =      .013         .250

     Max.eff.Inten.(mm/hr)=     50.21         6.86
               over (min)       3.00        42.00
     Storage Coeff.  (min)=      3.01 (ii)   42.32 (ii)
     Unit Hyd. Tpeak (min)=      3.00        42.00
     Unit Hyd. peak  (cms)=       .41          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=       .00          .00          .002 (iii)
     TIME TO PEAK    (hrs)=      1.48         2.28         2.283
     RUNOFF VOLUME    (mm)=     24.40         6.49         6.671
     TOTAL RAINFALL   (mm)=     25.00        25.00        24.996
     RUNOFF COEFFICIENT   =       .98          .26          .267

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  78.0    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.

-----------------------------------------------------------------------------------------------------
R0001:C00005-----------------------------------------------------------------------------------------
*
*Catchment 3
*
*Post Development
-------------------------
| CALIB STANDHYD        |   Area    (ha)=     .23
| 06:3B25       DT= 1.00 |   Total Imp(%)=   26.00   Dir. Conn.(%)=    1.00
-------------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .06          .17
     Dep. Storage     (mm)=       .60         4.00
     Average Slope     (%)=      3.30         3.30
     Length            (m)=    156.60       156.40
     Mannings n           =      .013         .250

     Max.eff.Inten.(mm/hr)=     50.21         6.14
               over (min)       3.00        45.00
     Storage Coeff.  (min)=      3.08 (ii)   45.10 (ii)
     Unit Hyd. Tpeak (min)=      3.00        45.00
     Unit Hyd. peak  (cms)=       .40          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=       .00          .00          .002 (iii)
     TIME TO PEAK    (hrs)=      1.48         2.35         2.350
     RUNOFF VOLUME    (mm)=     24.40         6.15         6.334
     TOTAL RAINFALL   (mm)=     25.00        25.00        24.996
     RUNOFF COEFFICIENT   =       .98          .25          .253

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    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.

-----------------------------------------------------------------------------------------------------
R0001:C00006-----------------------------------------------------------------------------------------
******************************************************************************
--------------------
| FINISH            |
--------------------
-----------------------------------------------------------------------------------------------------
*****************************************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2020-07-13     at 10:02:36
=====================================================================================================
```

APPENDIX C

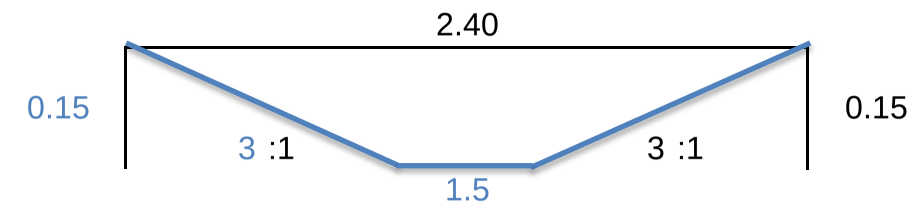
Swale Design Sheet

Hydraulic Capacity Check - Quanitity

CATCHMENT 1 OUTLET DRAINAGE DITCH

Swale Capacity/Velocity Calculation V = 1/n * (A/P)^0.667 * (S)^0.5			
Channel Bottom Width	1.5	m	
Channel Side Slopes (X : 1)	3	to 1	
Flow Depth	0.15		
Manning's n	0.035	Grass	
Slope (%)	2.4	%	
Calculated Area	0.29	m^2	
Calculated Wetted Perimeter	2.45	m	
Calculated Width Required	2.40		
Velocity Calculated	1.07	m/s	
Q Peak	0.314	m^3/s	
Required Q Peak	0.250	m^3/s	100-yr
Flow Depth during Required Event	0.130	m	
Velocity during Required Event	0.990	m/s	

Inputs

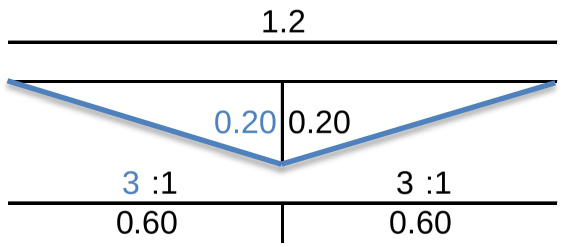


Hydraulic Capacity Check

CATCHMENT 2&3 BACKYARD SWALE

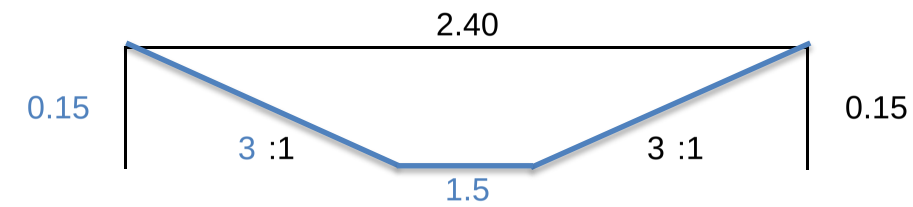
Inputs

Swale Capacity/Velocity Calculation V = 1/n * (A/P)^0.667 * (S)^0.5		
Flow Depth	0.20 m	
Manning's n	0.035	
Average Swale Slope (%)	3 %	
Calculated Area	0.12 m²	
Calculated Wetted Perimeter	1.26 m	
Velocity Calculated	1.03 m/s	
Q Peak	0.124 m³/s	
Required Q Peak	0.017 m³/s	100-yr
Flow Depth during Required Event	0.090 m	
Velocity during Required Event	0.140 m/s	



Hydraulic Capacity Check - Quality

CATCHMENT 1 OUTLET DRAINAGE DITCH

Swale Capacity/Velocity Calculation V = 1/n * (A/P)^0.667 * (S)^0.5			
Channel Bottom Width	1.5	m	
Channel Side Slopes (X : 1)	3	to 1	
Flow Depth	0.15		
Manning's n	0.035	Grass	
Slope (%)	2.4	%	
Calculated Area	0.29	m^2	
Calculated Wetted Perimeter	2.45	m	
Calculated Width Required	2.40		
Velocity Calculated	1.07	m/s	
Q Peak	0.314	m^3/s	
Required Q Peak	0.037	m^3/s	25-yr
Flow Depth during Required Event	0.040	m	
Velocity during Required Event	0.491	m/s	

Inputs