Rossmore Subdivision

Stormwater Management Report

County Road 28
Rossmore, Ontario
Prince Edward County

Part of Lots 63 to 77,
Registered Plan No. 3,
Village of Rossmore,
Ameliasburgh Ward
Municipality of Prince Edward

March 2014
(Preliminary October 2013)

AINLEY GRAHAM & ASSOCIATES

CONSULTING ENGINEERS AND PLANNERS
COLLINGWOOD · BARRIE · BELLEVILLE · OTTAWA

File No. 13549-1

Ainley GROUP CONSULTING ENGINEERS PLANNERS

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 General

The Ainley Group has been retained by 1470757 Ontario Inc. to undertake engineering services necessary for the completion of a preliminary stormwater management study to support the planning application for the proposed residential subdivision as outlined on **Figure 1**.

The proposed development is located near the north east intersection of Highway #62 and County Road #28 in the Village of Rossmore. The development site is bound by Highway #62 to the west, county Road #28 to the south, existing residential and agricultural land to the east and the Bay of Quinte and a Provincially Significant Wetland to the north. The Site location is outlined on **Figure 2**.

The proposal will incorporate the development of 44 single residential units.

1.2 Criteria

This report has been prepared with consideration of the Ministry of Environment's Stormwater Management Planning and Design Manual (2003) and the Bay of Quinte Remedial Action Plan (2006)

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 1', or enhanced, treatment of the 25mm quality rainfall event.

As the subject area lies within the Quinte Conservation Authority Region, stormwater is subject to the regional 100 year event, as outlined in Ontario Regulation 319/09 Quinte Conservation Authority: Regulation, Interference with Wetlands and Alterations to Shorelines and Watercourses.

1.3 Background

The existing site comprises an approximate area of 20.88ha and is mostly undeveloped with the exception of an existing single residential property located near the east limits. This existing residence will be incorporated into the subdivision.

Site topography is generally flat with a slight northeasterly fall of +/- 1.5% towards the Bay of Quinte.

The regulated flood line along the abutting portion of the Bay of Quinte is 75.8m plus 0.2m (wave uprush). At the time of preparation of this report detailed topographic surveying had not been completed, however, utilizing Google Earth it was determined that the shore line elevation is approximately 75.3m and the edge of the existing tree line (proposed edge of developed lands) is approximately 78.9m. The proposed development is well above the regulated level of 75.8m plus wave uprush. No impacts to the proposed drainage of the development are anticipated. During detailed design the flood line can be verified. The elevations are outlined on **Figure 3**.

At the time of preparation of this report we were not aware of any background stormwater reports or master drainage plans outlining requirements for the area.

2.0 QUANTITY MEASURES

As the development site lies directly adjacent to the Bay of Quinte the need to provide quantity controls is not warranted. Accordingly it is proposed to surface drain the entire development area through a combination of sheet flow and open ditches to key conveyance points where runoff will discharge directly to the Bay of Quinte without any quantity control measures.

The engineering design drawings will be required to incorporate a typical open ditch rural cross section to allow for conveyance of all road drainage and concentrated runoff from the residential lots.

The engineering design should also incorporate typical lot grading with the encouragement of front to back grading on all lots backing onto the Bay of Quinte to reduce concentrated drainage. **Figure 3** outlines the recommended drainage patterns; however, these are subject to change through detailed design.

3.0 QUALITY MEASURES

As the lands fall within the Bay of Quinte Watershed the need to provide quality control mitigation measures to provide 'level 1', or enhanced, treatment of the 25mm quality rainfall event is required. The following outlines the hydrologic and hydraulic review for quality mitigation.

3.1 Model Selection

Flow calculations for the pre-development 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.

3.2 Rainfall Distribution

A quality 4 hour 25mm event was applied to evaluate quality control peak runoff rates and storage volume requirements.

3.3 Model Parameters

The SWMHYMO model has been developed with consideration of the parameters interpreted from air photos, Soils Investigation (Rowan 2012), topographic information and the designer's knowledge of the site based on visual observations.

Documentation to support the model parameters is enclosed in **Appendix B**.

A copy of the SWMHYMO input file is enclosed in **Appendix C**.

A copy of the SWMHYMO output file is enclosed in **Appendix D**.

3.4 Quality Treatment

Due to the anticipated low imperviousness levels at the two key drainage locations (11.3% and 12.7%) it is not recommended to implement a wet-pond or wetland facility, instead it is proposed to achieve quality treatment through a treatment train approach applying the following measures;

- Reduced lot grading,
- Grassed Swales,
- Vegetated Filter Strips, and
- Corridor Buffer Strips.

<u>Reduced Lot Grading</u>
Reduced lot grading is effective when grades are less than 2% and soil percolation rates are greater than 15mm/hr (MOE SWM 4.5.4).

The subject lands have an existing slope of 1.5% and soils were tested to have a range of 25min/cm to 45min/cm (24mm/hr to 13.3mm/hr). As these rates are within proximity to the recommended range it has been deemed appropriate to apply reduced lot grading as part of a 'treatment train' approach for quality treatment.

The detailed grading plan should incorporate a grading design that ensures minimum grades are achieved.

The SWMHYMO model has been adjusted to reflect an additional 0.5mm of initial abstraction due to the recommended reduced lot grading of 1.5% (based on existing grade) as supported by Section 4.9.1 of the MOE design manual.

Grassed Swales

It is proposed to utilize the rural open ditch road section to increase pollutant removal. To increase the effectiveness of the ditching they should be designed with a flat bottom to increase contact area.

A typical 1.5m flat bottom swale with side slopes of 5:1 have been evaluated to provide a velocity of 0.56m/s and 0.46m/s for the central and western catchments respectively. These velocities are within proximity to the recommended rates for quality treatment outlined in Section 4.5.9 of the MOE design manual. It should also be noted that the velocities would be peak flows within the ditches just prior to discharge into the filter strips (outlined below) and during detailed design further review can be performed to reduce velocities further within the swales.

Calculations are enclosed in **Appendix E**.

To further enhance the swales, check dams are recommended throughout the open ditch at 200m intervals (or at aesthetically preferred locations adjacent to property lines).

Filter Strips

Filter strips are typically applied to small catchment areas (2ha) however as this development has an overall low imperviousness it is anticipated that filter strips will have a positive effect on quality treatment as part of the overall 'treatment train'.

Utilizing MOE equation 4.4 the following parameters are recommended for the level spreader portion of the filter strips;

Q (m^3/s)	Coefficient	H (m)	L (m)
0.074	2.3	0.05	2.88
0.039	2.3	0.05	1.52

As the lengths recommended in the above table are short, it is suggested that during detailed design the length be maximized to increase contact area and reduce velocities.

The vegetation portion of the filter strip should consist of existing vegetation located along the edge of the development area on the site.

The recommended location for the filter strip is outlined on **Figure 3**.

Corridor Buffer Strip

The subject development is required to provide a 30m setback from the provincially significant wetland. Section 4.5.13 of the MOE design manual outlines that maintaining riparian buffers will help to provide filtration of pollutants, provide shade and bank stability and reduce overland runoff.

It is anticipated that the 30m buffer will greatly help to improve stormwater quality.

4.0 MAINTENANCE

As all of the recommended quality measures are passive options the need for routine maintenance is not anticipated.
It is recommended that the swales and filter strip be monitored during the construction process until full vegetation has established and areas of concern (ex. Erosion) be rectified.

5.0 EROSION AND SEDIMENTATION CONTROL

An erosion and sediment control strategy should be implemented as part the detailed engineering drawings in order to minimize the transfer of silt off site during construction. The following measures are recommended:

- Environmental fencing and straw bales
- 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

6.0 CONCLUSIONS AND RECOMMENDATIONS

- Quantity control is not required due to the development's proximity to the Bay of Quinte,

- Quality control is to be provided through a 'treatment train' approach utilizing the following;

    - Reduced lot grading (to be outlined on detailed grading plans),
    - Flat bottom grassed swales within the rural ROW, including check dams,
    - Filter strips at main outlet locations of concentrated flows (the length of the strip should be maximized during detailed design based on final grading plans),
    - Corridor buffer strip utilizing existing riparian vegetation.

- Silt fencing and straw bale barriers will be required 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

Adam Wilson, P.Eng.
Senior Engineer

APPENDIX A

Figures

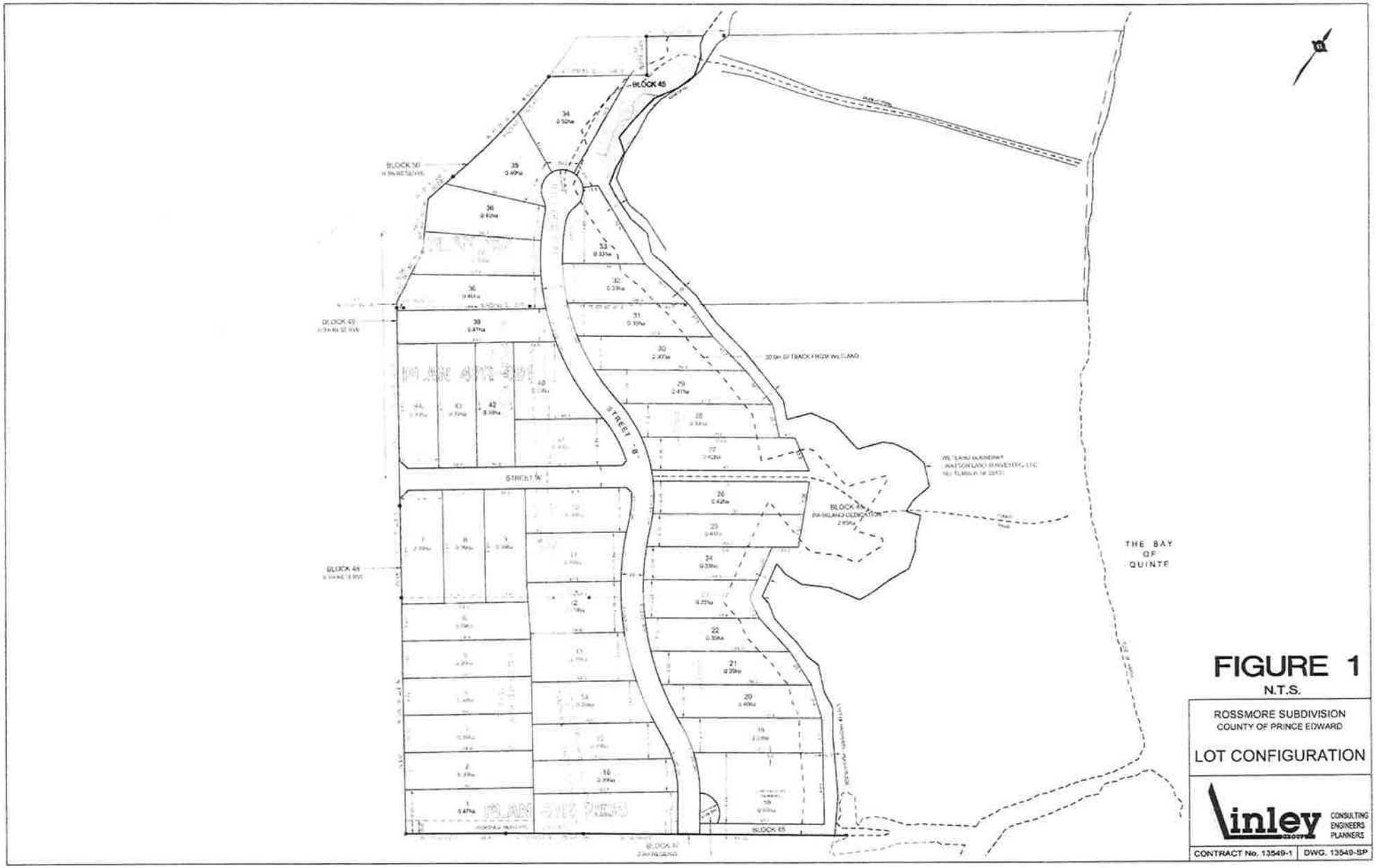


FIGURE 1

N.T.S.

ROSSMORE SUBDIVISION
COUNTY OF PRINCE EDWARD

LOT CONFIGURATION

Vinley GROUP CONSULTING ENGINEERS PLANNERS

CONTRACT No. 13549-1 | DWG. 13549-SP

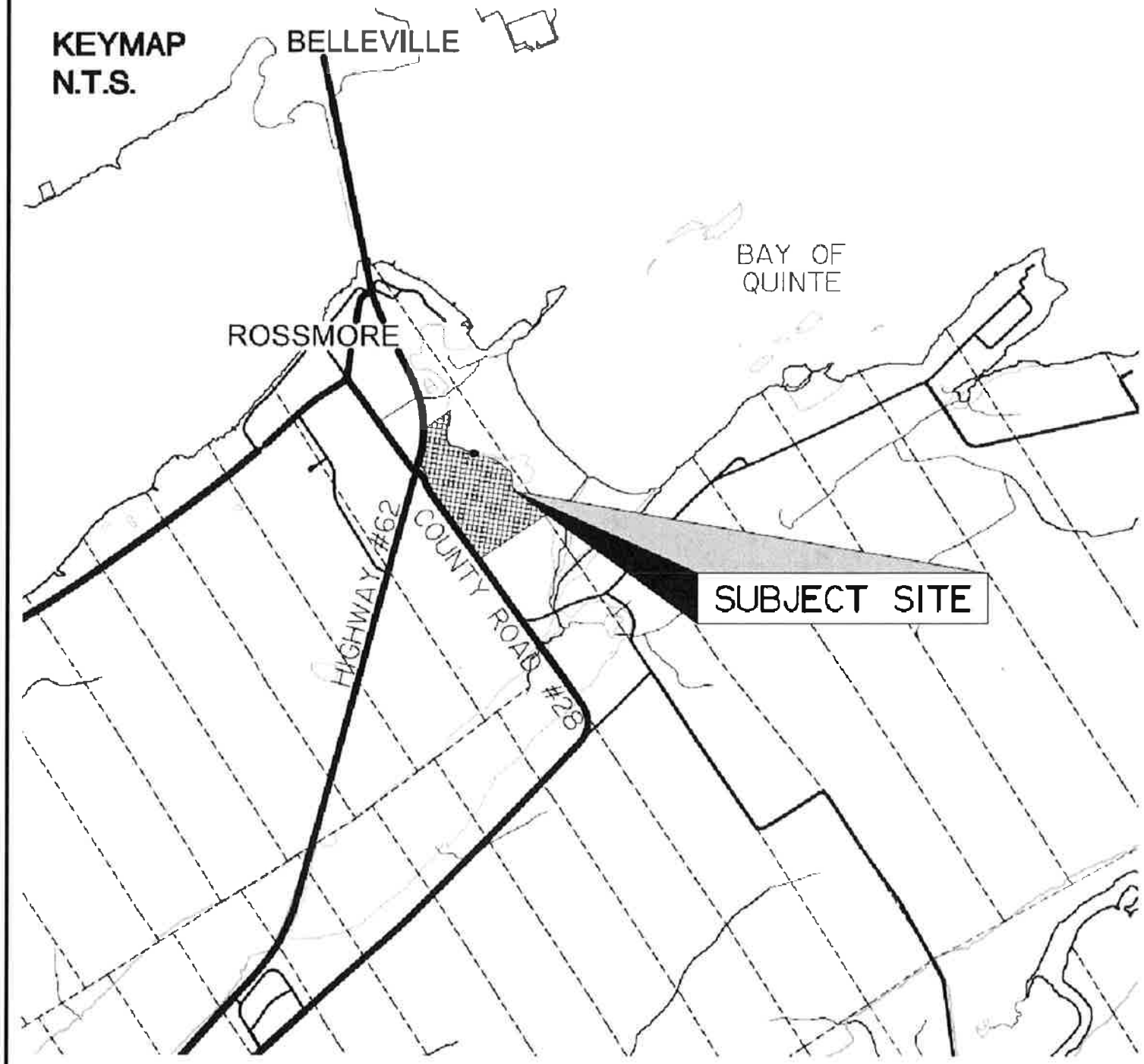


FIGURE 2

N.T.S.

Ainley GROUP CONSULTING ENGINEERS PLANNERS

ROSSMORE SUBDIVISION DEVELOPMENT
PROPERTY SITE LOCATION

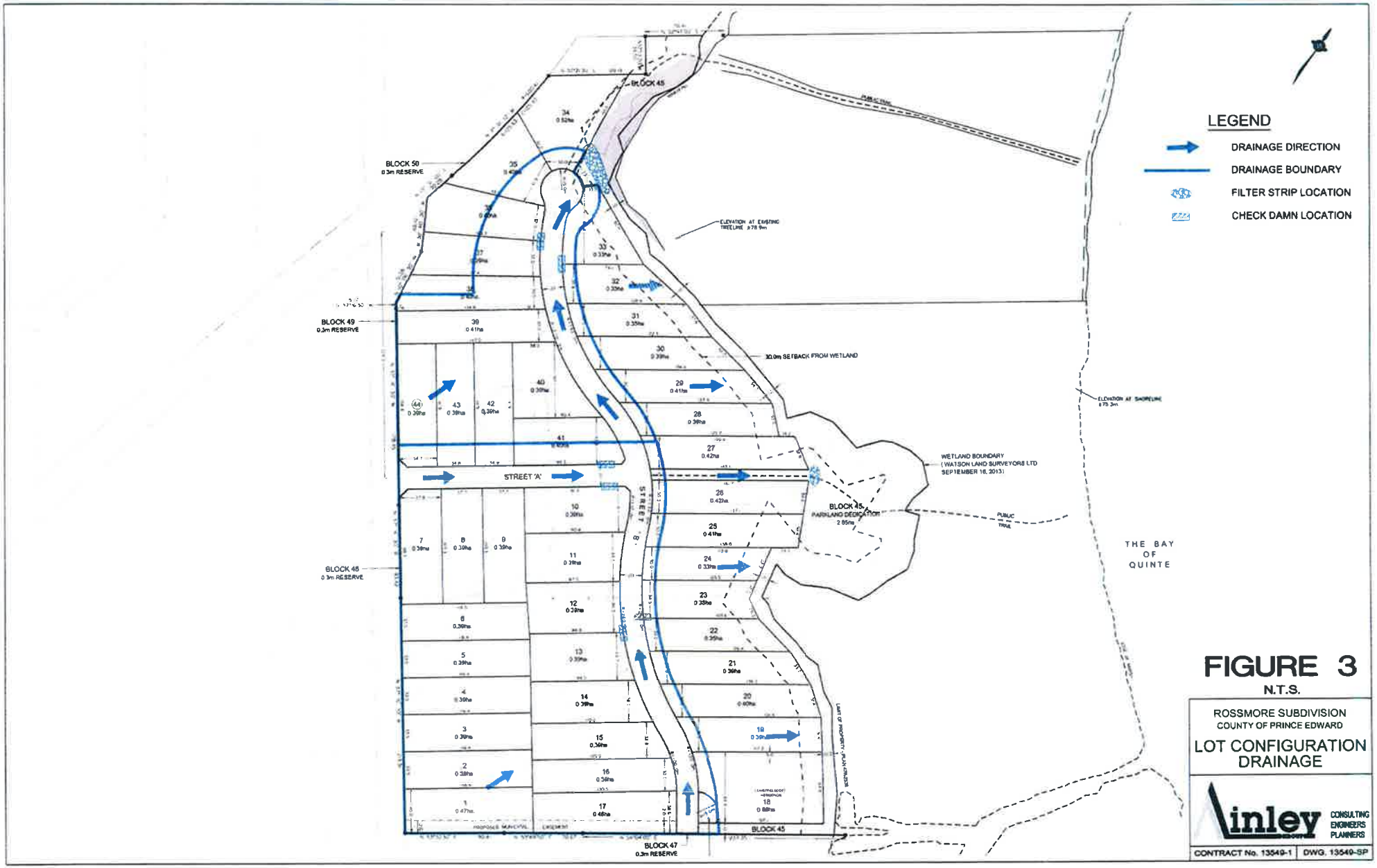


FIGURE 3

N.T.S.

ROSSMORE SUBDIVISION
COUNTY OF PRINCE EDWARD

LOT CONFIGURATION
DRAINAGE

Vinley CONSULTING ENGINEERS PLANNERS

CONTRACT No. 13549-1 | DWG. 13549-SP

APPENDIX B

Model Parameters

Estimate of Impervious Cover - central area					CN	
Total Area			**8.25**	ha	58	Direclty Connected or not
	#units	**Area (m2)**				
Driveway	30	60	*1800.00*	m2	98	y
Rural (all)	15	232	*3480.00*	m2	98	y (50%)
Rural (partial)	1	232	*116.00*			n
			5396.00	m2		
	Length (m)	**Width (m)**				
Road	560	7	*3920.00*	m2	98	y
Total			3920.00	m2		
		Total Impervious =	*9316.00*	m2		
			11.29	%		
		Directly Connected Impervious	7460.00	m2		
			9.04	%		

Average CN

	A	CN	A*CN
Total Area	8.25		
Impervious Area	0.9316	98	91.30
Pervious Area	7.3184	58	424.47
		SUM	**515.76**

63

Estimate of Impervious Cover - western area					CN	
Total Area			**3.6**	ha	58	Direclty Connected or not
	#units	**Area (m2)**				
Driveway	14	60	*840.00*	m2	98	y
Rural (all)	6	232	*1392.00*	m2	98	y (50%)
Rural (partial)	4	232	*464.00*			n
			2696.00	m2		
	Length (m)	**Width (m)**				
Road	270	7	*1890.00*	m2	98	y
Total			1890.00	m2		
		Total Impervious =	*4586.00*	m2		
			12.74	%		
		Directly Connected Impervious	3426.00	m2		
			9.52	%		

Average CN

	A	CN	A*CN
Total Area	3.6		
Impervious Area	0.4586	98	44.94
Pervious Area	3.1414	58	182.20
		SUM	**227.14**

63

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 Conservation Service Curve Numbers (Continued)

Land Use or Surface	Hydrologic Soil Group						
	A	[redacted]	B	BC	C	CD	D
Fallow (special cases only)	77	82	86	89	91	93	94
Crop and other improved land	66** (62)	70** (68)	74	78	82	84	86 AMC I
Pasture & other unimproved land	58* (38)	[redacted] (51)	65	71	76	79	81
Woodlots and forest	50* (30)	[redacted] (44)	58	65	71	74	77
Impervious areas (paved)							98
Bare bedrock draining directly to stream by surface flow							98
Bare bedrock draining indirectly to stream as groundwater (usual case)							70
Lakes and wetlands							50

Notes

(i) All values are based on AMC II except those marked by * (AMC III) or ** (mean of AMC II and AMC III).

(ii) Values in brackets are AMC II and are to be used only for special cases.

(iii) Table is not applicable to frozen soils or to periods in which snowmelt contributes to runoff.

$$CN_{Avg} = \frac{62 + 54}{2} = 58$$


28
62
Pidgeon Ct
Bay Breeze St
Yuill Crescent
Yuill Crescent
Bay Breeze St
62
28
62
28
Mississauga Rd
Mississauga Rd
200 m
500 ft

APPENDIX C

SWMHYMO Input

```
00001> 2
00002> * October 2013 ------ FILE:  13549-1
00003> *
00004> * Rossmore Subdivision
00005> *
00006> START                0.0 HR
00007> *
00008> ***************************************************************************
00009> ***************************************************************************
00010> *
00011> * Quality Event
00012> *
00013> READ STORM           STORM_FILENAME="25MM.STM"
00014> *
00015> ***************************************************************************
00016> ***************************************************************************
00017> *
00018> * Central Area
00019> *
00020> CALIB STANDHYD       ID=1 NHYD=100 DT=2 A=8.25HA XIMP=.09 TIMP=.113 DWF=0 LOSS=2
00021>                      CN*=63 IA=3.0 SLOPE=1.5 LGP=110 MNP=.25 SCP=0 IAimp=0.6
00022>                      SLPI=1.5 LGI=500 MNI=.013 SCI=0 RAIN=-1
00023> *
00024> ***************************************************************************
00025> *
00026> * Western Area
00027> *
00028> CALIB STANDHYD       ID=1 NHYD=100 DT=2 A=3.6HA XIMP=.095 TIMP=.127 DWF=0 LOSS=2
00029>                      CN*=63 IA=3.0 SLOPE=1.5 LGP=110 MNP=.25 SCP=0 IAimp=0.6
00030>                      SLPI=1.5 LGI=270 MNI=.013 SCI=0 RAIN=-1
00031> *
00032> ***************************************************************************
00033> *
00034> FINISH
```

APPENDIX D

SWMHYMO Output

```
00001> ================================================================================
00002>
00003>    SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    *********
00004>    S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
00005>    SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
00006>        S  W W W  M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
00007>    SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9    *********
00008>                                                          9   9  9   9   # 2196493
00009>          StormWater Management HYdrologic Model          999    999    *********
00010>
00011> ********************************************************************************
00012> ************************** SWMHYMO Ver/4.05  ***********************************
00013> *********  A single event and continuous hydrologic simulation model  *********
00014> *********     based on the principles of HYMO and its successors      *********
00015> *********               OTTHYMO-83 and OTTHYMO-89.                    *********
00016> ********************************************************************************
00017> *********  Distributed by:  J.F. Sabourin and Associates Inc.          *********
00018> *********                   Ottawa,  Ontario: (613) 836-3884           *********
00019> *********                   Gatineau, Quebec: (819) 243-6858           *********
00020> *********                   E-Mail: swmhymo@jfsa.com                   *********
00021> ********************************************************************************
00022>
00023> ********************************************************************************
00024> *********  Licensed user: Ainley Group                                 *********
00025> *********                 Belleville              SERIAL#:2196493      *********
00026> ********************************************************************************
00027>
00028> ********************************************************************************
00029> *********             ****** PROGRAM ARRAY DIMENSIONS ******             *********
00030> *********             Maximum value for ID numbers  :   10              *********
00031> *********             Max. number of rainfall points: 105408            *********
00032> *********             Max. number of flow points    : 105408            *********
00033> ********************************************************************************
00034>
00035>
00036> **********************   D E T A I L E D   O U T P U T   **********************
00037> ********************************************************************************
00038> *         DATE: 2014-03-10      TIME: 09:11:29      RUN COUNTER: 000289         *
00039> ********************************************************************************
00040> * Input   filename: Z:\13549-~1\ENGINE~1\STORMW~1\swmhymo\quality.dat           *
00041> * Output  filename: Z:\13549-~1\ENGINE~1\STORMW~1\swmhymo\quality.out           *
00042> * Summary filename: Z:\13549-~1\ENGINE~1\STORMW~1\swmhymo\quality.sum           *
00043> * User comments:                                                              *
00044> * 1:_____________________________________________________________________     *
00045> * 2:_____________________________________________________________________     *
00046> * 3:_____________________________________________________________________     *
00047> ********************************************************************************
00048>
00049> --------------------------------------------------------------------------------
00050> 001:0001--------------------------------------------------------------------------
00051> * October 2013 ------ FILE:  13549-1
00052> *
00053> * Rossmore Subdivision
00054> *
00055> --------------------
00056> | START            |  Project dir.: Z:\13549-~1\ENGINE~1\STORMW~1\swmhymo\
00057> --------------------  Rainfall dir.: Z:\13549-~1\ENGINE~1\STORMW~1\swmhymo\
00058>    TZERO =   .00 hrs on        0
00059>    METOUT=   2 (output = METRIC)
00060>    NRUN  = 001
00061>    NSTORM=   0
00062> --------------------------------------------------------------------------------
00063> 001:0002--------------------------------------------------------------------------
00064> *
00065> ********************************************************************************
00066> ********************************************************************************
00067> *
00068> * Quality Event
00069> *
00070> --------------------
00071> | READ STORM       |    Filename: 25 mm 4 hr
00072> | Ptotal= 25.00 mm |    Comments: 25 mm 4 hr
00073> --------------------
00074>              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00075>              hrs    mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00076>              .17    2.071 |   1.17   5.696 |   2.17   5.194 |   3.17   2.799
00077>              .33    2.266 |   1.33  10.777 |   2.33   4.466 |   3.33   2.622
00078>              .50    2.524 |   1.50  50.214 |   2.50   3.949 |   3.50   2.476
00079>              .67    2.880 |   1.67  13.366 |   2.67   3.560 |   3.67   2.346
00080>              .83    3.382 |   1.83   8.286 |   2.83   3.252 |   3.83   2.233
00081>             1.00    4.175 |   2.00   6.295 |   3.00   3.010 |   4.00   2.136
00082>
00083> --------------------------------------------------------------------------------
00084> 001:0003--------------------------------------------------------------------------
00085> *
00086> ********************************************************************************
00087> ********************************************************************************
00088> *
00089> * Central Area
00090> *
00091> ---------------------
00092> | CALIB STANDHYD    |   Area    (ha)=    8.25
00093> | 01:000100 DT= 2.00 |   Total Imp(%)=   11.30   Dir. Conn.(%)=    9.00
00094> ---------------------
00095>                                IMPERVIOUS    PERVIOUS (i)
00096>      Surface Area     (ha)=         .93          7.32
00097>      Dep. Storage     (mm)=         .60          3.00
00098>      Average Slope     (%)=        1.50          1.50
00099>      Length            (m)=      500.00        110.00
00100>      Mannings n            =        .013          .250
00101>
00102>      Max.eff.Inten.(mm/hr)=       50.21          5.04
00103>                over (min)         8.00         54.00
00104>      Storage Coeff.  (min)=        7.83 (ii)    54.45 (ii)
00105>      Unit Hyd. Tpeak (min)=        8.00         54.00
00106>      Unit Hyd. peak  (cms)=         .14          .02
00107>                                                          *TOTALS*
00108>      PEAK FLOW         (cms)=         .07          .02          .074 (iii)
00109>      TIME TO PEAK      (hrs)=        1.57         2.57         1.567
00110>      RUNOFF VOLUME      (mm)=       24.40         2.91         4.843
00111>      TOTAL RAINFALL     (mm)=       25.00        25.00        24.996
00112>      RUNOFF COEFFICIENT    =         .98          .12          .194
00113>       *** WARNING: For areas with impervious ratios below
00114>                    20%, this routine may not be applicable.
00115>
00116>         (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00117>             CN* =  63.0    Ia = Dep. Storage  (Above)
00118>        (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00119>             THAN THE STORAGE COEFFICIENT.
00120>       (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00121>
00122> --------------------------------------------------------------------------------
00123> 001:0004--------------------------------------------------------------------------
00124> *
00125> ********************************************************************************
00126> *
00127> * Western Area
00128> *
00129> ---------------------
00130> | CALIB STANDHYD     |   Area    (ha)=    3.60
00131> | 01:000100 DT= 2.00 |   Total Imp(%)=   12.70   Dir. Conn.(%)=    9.50
00132> ---------------------
00133>                                IMPERVIOUS    PERVIOUS (i)
00134>      Surface Area     (ha)=         .46          3.14
00135>      Dep. Storage     (mm)=         .60          3.00
00136>      Average Slope     (%)=        1.50          1.50
00137>      Length            (m)=      270.00        110.00
00138>      Mannings n            =        .013          .250
00139>
00140>      Max.eff.Inten.(mm/hr)=       50.21          5.17
00141>                over (min)         6.00         52.00
00142>      Storage Coeff.  (min)=        5.41 (ii)    51.59 (ii)
00143>      Unit Hyd. Tpeak (min)=        6.00         52.00
00144>      Unit Hyd. peak  (cms)=         .20          .02
00145>                                                          *TOTALS*
00146>      PEAK FLOW         (cms)=         .04          .01          .039 (iii)
00147>      TIME TO PEAK      (hrs)=        1.53         2.50         1.533
00148>      RUNOFF VOLUME      (mm)=       24.40         2.94         4.981
00149>      TOTAL RAINFALL     (mm)=       25.00        25.00        24.996
00150>      RUNOFF COEFFICIENT    =         .98          .12          .199
00151>       *** WARNING: For areas with impervious ratios below
00152>                    20%, this routine may not be applicable.
00153>
00154>         (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00155>             CN* =  63.0    Ia = Dep. Storage  (Above)
00156>        (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00157>             THAN THE STORAGE COEFFICIENT.
00158>       (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00159>
00160> --------------------------------------------------------------------------------
00161> 001:0005--------------------------------------------------------------------------
00162> *
00163> ********************************************************************************
00164> *
00165>      FINISH
00166> --------------------------------------------------------------------------------
00167> ********************************************************************************
00168>     WARNINGS / ERRORS / NOTES
00169>     -------------------------
00170>  001:0003 CALIB STANDHYD
00171>       *** WARNING: For areas with impervious ratios below
00172>                    20%, this routine may not be applicable.
00173>  001:0004 CALIB STANDHYD
00174>       *** WARNING: For areas with impervious ratios below
00175>                    20%, this routine may not be applicable.
00176>   Simulation ended on 2014-03-10     at 09:11:30
00177> ********************************************************************************
00178>
00179>
```

APPENDIX E

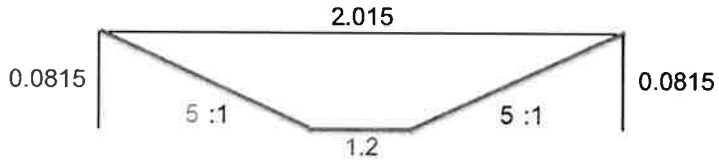
Quality Swale Design

Hydraulic Capacity Check
25mm discharge - Central Area

Swale Capacity/Velocity Calculation V = 1/n * (A/P)^0.667 * (S)^0.5	
Channel Bottom Width	1.2 m
Channel Side Slopes (X : 1)	5 to 1
Flow Depth	0.0815
Manning's n	0.035
Slope (%)	1.5 %
Calculated Area	0.13101125 m²
Calculated Wetted Perimeter	2.03 m
Calculated Width Required	2.02
Velocity Calculated	0.56 m/s
Q Peak	0.074 m³/s

Required = 0.074 m³/s

Inputs



Hydraulic Capacity Check
25mm discharge - Western Area

Swale Capacity/Velocity Calculation V = 1/n * (A/P)^0.667 * (S)^0.5	
Channel Bottom Width	1.2 m
Channel Side Slopes (X : 1)	5 to 1
Flow Depth	0.057
Manning's n	0.035
Slope (%)	1.5 %
Calculated Area	0.084645 m²
Calculated Wetted Perimeter	1.78 m
Calculated Width Required	1.77
Velocity Calculated	0.46 m/s
Q Peak	0.039 m³/s

Required = 0.039 m³/s

Inputs