RGH Developments

Rocky Acres Subdivision
Stormwater Management Report

Prepared by:

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Date: April 2021

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April 23, 2021

RGH Developments
190 Pauline Tom Avenue
Kingston, ON
K7K 0G1

Regarding: Rocky Acres Subdivision
Stormwater Management Report

Dear Mr. Haynes

The enclosed report details the existing drainage conditions and provides recommendations for stormwater management and drainage for the proposed Rocky Acres Subdivision located in the Town of Gananoque.

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 27 single-detached lots and 2 semi-detached lots (4 units) for a total of 31 units. The development will include a new street with two connections to Garfield Street.

It is recommended that storm sewers and storm sewer services be installed along the proposed street with a connection to Maple Street storm sewers through an easement.

Development of the Rocky Acres Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. It is recommended that an oil grit separator be installed at the outlet to the Maple Street storm sewer to mitigate any adverse water quality effects that site run-off may have on downstream works.

Stormwater management details are contained in this Report along with recommended maintenance procedures.

Detailed subdivision and stormwater facility drawings are required.

This Report demonstrates that adequate stormwater management controls are available for the proposed development

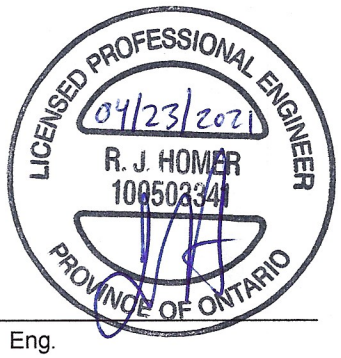
If you have any inquiries or wish to discuss further, please contact this office.

Sincerely,

FOREFRONT Engineering Inc.

Kyle Nielissen, P.Eng.
Project Manager
Kyle.Nielissen@Forefronteng.ca

FOREFRONT Signatures



Report Prepared By:

Jeff Homer, P. Eng.

Report Review By:

Kyle Nielissen, P. Eng.

Table of Contents

Statement of Qualifications and Limitations
Letter of Transmittal

Page

1. Introduction 2

2. Existing Site Conditions 3

3. Proposed Development 4

3.1 Drainage Plan 4
3.2 Water Quantity 4
3.1 Analysis 4
3.1.1 Rational Method 5
3.1.2 Design Storm Events 5
3.1.3 Hydrology 5
3.1.4 Pre-Development Flows 7
3.1.5 Post-Development Flows 7
3.2 Water Quality 8
3.2.1 Oil Grit Separator 8
3.3 Maintenance 9
3.4 Quality Control (Short Term) 9

4. Conclusions 9

Appendices

Appendix A

- Concept Plan
- Figure 2 – Pre-Development Catchment Areas
- Figure 3 – Post-Development Catchment Areas
- Figure 4 – Gananoque West Ward Storm Sewer Catchment Areas

Appendix B

- MTO Gananoque IDF Look Up Curve
- Composite Runoff Coefficient Calculations
- Storm Sewer Design Sheets
  - Rocky Acres Subdivision
  - Existing Storm Sewer Design Sheet to Gananoque River
  - Proposed Storm Sewer Design Sheet to Gananoque River
- Rational Method Calculations
- OGS Calculations

1. Introduction

Forefront has assembled relevant supporting information for the proposed residential development at Part of Lots 2 and 71, Part of Old Kingston Road, Registered Plan 86 in the Town of Gananoque in the County of Leeds.

The proposed Rocky Acres Subdivision is located in the Town of Gananoque east of Garfield Street and west of Maple Street. The property is bounded by existing residential dwellings to the north, east, west and south. The property includes frontage on Garfield Street.

Figure 1: Site Location

The subject site is currently zoned Residential within the Town of Gananoque. The property is currently vacant with no existing structures.

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 27 single-detached lots and 2 semi-detached lots (4 units) for a total of 31 units. The development will include a new street with two connections to Garfield Street.

It is recommended that storm sewers and storm sewer services be installed along the proposed street with a connection to Maple Street storm sewers.

Development of the Rocky Acres Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This Report proposes a plan to address stormwater management concerns and minimize impacts on the natural drainage and environment.

Refer to Appendix A, **Concept Plan** for the proposed development plan.

2. Existing Site Conditions

The subject site and surrounding affected drainage area total approximately 2.81 hectares.

The existing topography of the site drains towards Maple Street. Rock outcrops are visible on the surface, suggesting relatively shallow bedrock. The subject site is currently vacant with no existing structures.

The subject site drains north easterly in a shallow depression to a buried pipe located adjacent to 180 Maple Street North. Drainage from the site and developed lands to the north is directed to an existing storm sewer and catch basin system along Maple Street North that eventually outlets from an existing 900mm diameter storm sewer on River Street to the Gananoque River (**Outlet 1**).

Drainage from lands to the southwest of the development, including Garfield Street, is collected by the King Street West storm sewer system and outlets direct to the St. Lawrence River near the intersection of King Street West and Elm Street (**Outlet 2**).

In order to service the proposed Rocky Acres Subdivision, existing downstream storm sewers were reviewed to both the Gananoque River (**Outlet 1**) and the St. Lawrence River (**Outlet 2**).

The Gananoque River outlet (**Outlet 1**) is within the Gananoque Intake Protection Zone 2 (IPZ-2). The Cataraqui Source Protection Plan approved in 2014 and effective as of 2015 recommends that developed areas within the IPZ-2 be designed for an ‘enhanced’ level of stormwater treatment.

Please refer to Appendix A, **Figure 2**: Pre-Development Catchment Areas and **Figure 4**: Gananoque West Ward Storm Sewer Catchment Areas for existing condition details.

3. Proposed Development

The proposed Rocky Acres Subdivision fronts Garfield Street, is approximately 2.81 ha, consisting of 27 single-detached lots and 2 semi-detached lots (4 units) for a total of 31 units. The development will include a new street with two connections to Garfield Street.

Quality controls are proposed for this development. Quantity control is not anticipated to be required as the storm sewer system from Maple Street out to the Gananoque River outlet (**Outlet 1**) has adequate capacity for the uncontrolled peak flow. Further to this, the Gananoque River outlet is in close proximity to the St. Lawrence River. Peak flows from downstream developed area will precede peak flows from upstream undeveloped areas.

Please refer to Appendix A, **Figure 3**: Post-Development Catchment Areas for proposed condition details.

3.1 Drainage Plan

The proposed storm sewer system is to be sized to convey the minor event and connect to the existing 600mm storm sewer system on Maple Street North conveying drainage to **Outlet 1**.

Major flow for the site will be conveyed by overland surface drainage within the right of way and diverted westerly to Garfield Street directed to King Street West and **Outlet 2**.

For stormwater quality control for the subject site, enhanced protection (80% suspended solids removal) is required as the site is within the Gananoque Intake Protection Zone 2.

Storm sewers and a storm sewer connection to the existing 600mm storm sewer on Maple Street North are proposed to convey the minor event. An approximate drainage area of 2.81 ha is directed towards Maple Street. An oil grit separator sized for enhanced protection is proposed at the site discharge point prior to flow entering the 600mm diameter Maple Street storm sewer from the subject site.

Lot level conveyance controls and further details will be provided during detailed design of the grading and drainage of these areas, these details will be depicted on the final engineering drawings.

3.2 Water Quantity

Urbanization leads to an increase in impermeable surfaces (roof tops and parking areas). The resultant increased peak flows increase the risk to life, environment and property damage. Water quantity control is generally required when there will be downstream quantity impacts.

Consistent with general stormwater management practices, stormwater quality is proposed for the site. Quantity control is not recommended as the site outlets directly to Lake Ontario. Minor storm sewer systems will be designed for the 5-year design event. Overland flow paths are to convey the 100-year storm event.

3.1 Analysis

The Rational Method will be utilized to design the proposed drainage conveyances onsite.

3.1.1 Rational Method

The rational method calculates the peak flow rate at a specific location in a catchment due to the runoff contributed from the entire upstream catchment area. The rational method is represented by then following equation:

$$Q = 2.78AIR$$

where Q = Design flow in L/s,
A = area in hectares
I = rainfall intensity in mm/hr, and
R = runoff coefficient.

A minimum time of concentration of 15 minutes is proposed onsite given the calculated times of concentration for the site is less than 15 minutes.

3.1.2 Design Storm Events

Quality Event

The Ministry of Environment Stormwater Management Manual refers to a 12.5mm to 25mm 4 hour Chicago storm event for sizing quality treatment facilities in Ontario that are not included in table 3.2 of the manual.

The following formula has been developed for a 25mm- 4 hr Chicago Design storm for this area:

$$I_{25mm} = \frac{498}{(t_c+9.7)^{0.825}}$$

Minor Event and Major Event

Storm sewers are proposed along the proposed street. The storm sewer will be designed for the 5-year design storm and provide surcharge protection for all major flow events. The storm sewer shall be designed using Manning's equation and intensities based on the MTO IDF curve for the area. Refer to Appendix B for IDF curve details.

The proposed storm sewer system is to be sized to convey the minor event and connect to the existing 600mm storm sewer system on Maple Street North conveying drainage to **Outlet 1**.

Major flow for the site will be conveyed by overland surface drainage within the right of way and diverted westerly to Garfield Street directed to King Street West and **Outlet 2**.

3.1.3 Hydrology

Runoff Coefficients

The runoff coefficient (C) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well vegetated areas (forest, flat land). Coefficients were assigned based on surface cover and soil conditions as follows:

Urban			
Land Use & Topography	**Runoff Coefficients**		
Asphalt, concrete, roof areas	0.9		
Grassed area, parkland	0.25		
Commercial	0.8		
Industrial	0.7		
Residential			
Single family (<400 m^2)	0.4		
Single family (>400 m^2)	0.5		
Semi-detached	0.5		
Townhouses	0.6		
Apartments	0.6		
Institutions	0.55		
Rural			
	Soil Texture		
Land Use & Topography	**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	0.3	0.45	0.6
Hilly 10-30% Slopes	0.4	0.65	0.7
Pasture			
Flat 0-5% Slopes	0.1	0.28	0.4
Rolling 5-10% Slopes	0.15	0.35	0.45
Hilly 10-30% Slopes	0.22	0.4	0.55
Woodlands and Cutover			
Flat 0-5% Slopes	0.08	0.25	0.35
Rolling 5-10% Slopes	0.12	0.3	0.42
Hilly 10-30% Slopes	0.18	0.35	0.52
Bare Rock	**Coverage**		
	30%	50%	70%
Flat 0-5% Slopes	0.4	0.55	0.75
Rolling 5-10% Slopes	0.5	0.65	0.8
Hilly 10-30% Slopes	0.55	0.7	0.85
Lakes and Wetlands	0.05		
Note: Values are a combination of the City of Kingston Subdivision Guidelines and Ministry of Transportation Design Chart 1.07			

To reflect the unique hydrologic properties within each sub-catchment, a variety of surface cover types were defined. Refer to the composite runoff coefficient calculations in Appendix B for further details. A runoff coefficient of 0.25 is to be used for grassed and soft landscape surfaces, and 0.9 is proposed for asphalt and roof tops.

3.1.4 Pre-Development Flows

Runoff coefficients and catchment characteristics were assigned for the existing catchments and are summarized in Table 3-1 below.

Table 3-1 Existing Conditions

Hydrologic Units - Existing Conditions										
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Width (m)	Average Grade (%)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)
E1	Site to Outlet 1	0.25	2.81	160	100	1.0	8.22	5.63	**15**	1.97

A minimum time of concentration of 15 minutes is recommended for all catchments.

Results shown in Table 3-2 quantify the pre-development peak rate of surface runoff that has been routed through the drainage system, eventually discharging to outlets downstream. Results are grouped by outlet location for all the rainfall events.

Table 3-2 Peak Flows in Pre-Development Conditions

Peak Flows in Pre-Development Conditions (LPS)			
Description	**2 Year Design Storm**	**5 Year Design Storm**	**100 Year Design Storm**
	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)
Site to Outlet 1	107	137	237

3.1.5 Post-Development Flows

The development of this site will have a minor increase the imperviousness of the site and hence the runoff. Runoff coefficients and catchment characteristics were assigned for the proposed catchments and are detailed in Table 3-3. Refer to the subdivision storm sewer design sheet in Appendix B for the calculated time of concentration.

Table 3-3 Proposed Conditions

Hydrologic Units - Proposed Conditions								
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Width (m)	Average Grade (%)	Tc Proposed	Indiv. 2.78 AC (ha)
P1	Minor to Outlet 1 / Major to Outlet 2	0.50	2.81	160	100	0.5	**19.5**	3.93

Results shown in Table 3-4 quantify the peak rate of surface runoff calculated with the rational method and assigned catchment characteristics. The post-development uncontrolled flow rates are calculated.

Table 3-4 Uncontrolled Peak Flows in Post Development Conditions

Uncontrolled Peak Flows in Post Development (LPS)				
Description	**25mm Quality Event**	**2 Year Design Storm**	**5 Year Design Storm**	**100 Year Design Storm**
	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)	Peak Flow Q (LPS)
Minor to Outlet 1 / Major to Outlet 2	121	179	237	395

As noted above, the proposed storm sewer is to be sized to convey the minor storm event. Drainage from catchment area P1 is to be conveyed to an oil grit separator prior to outletting to the 600mm diameter storm sewer on Maple Street towards **Outlet 1**. The major overland flow for catchment area P1 is to be maintained within the right of way and directed south towards Garfield Street and out to King Street West to **Outlet 2**.

The existing and future drainage areas and storm sewer from Maple Street North to River Street were reviewed as part of the analysis. Detailed calculations demonstrate that the storm sewer is capable of conveying the uncontrolled minor event peak flow out to Gananoque River (**Outlet 1**). Refer to Appendix B Existing and Proposed Storm Sewer Design Sheets for further details.

Refer to the Rational Method Calculations for the 25mm-4 hour, 2 year, 5 year and 100 year event in Appendix B for the peak flow calculations.

Note, the King Street West storm sewer system was analysed from Garfield Street to Outlet 2 as part of the storm sewer review and the results are available upon request. The King Street West storm sewer system was found to have insufficient capacity for the proposed development.

3.2 Water Quality

The Stormwater Management Planning and Design Manual by the Ministry of the Environment, Conservation, and Parks (MECP) describes various levels of protection of water quality based on a general relationship between the end-of-pipe stormwater management facilities long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life.

Based on the characteristics of the receiving watercourse, Level 1 or Enhanced Protection (corresponding to the end-of-pipe storage volumes required for the long-term removal of 80% of suspended solids) is required. Stormwater management measures will be implemented to provide in excess of 80% long-term removal of suspended solids.

3.2.1 Oil Grit Separator

The proposed storm sewer network will outlet to an oil grit separator. The proposed oil grit separator will provide in excess of 82% suspended solids removal.

A Contech precast concrete CDS Model PMSU3020_6m Oil and Grit Separator is proposed for quality control from catchment area P1.

Refer to Appendix B: Echelon Environmental Sizing Report and Cumulative Volume Calculations for further details.

3.3 Maintenance

The oil grit separator will separate the oils and sediment from runoff onsite and will require annual maintenance and pumper truck access.

Periodic maintenance inspection of the facilities is the responsibility of the Owner. A summary of observations during inspection of the facility over the course of the year should be provided. These observations should include comments on the:

- hydraulic operation of the facilities (detention time, evidence or occurrence of overflows)
- occurrence of obstructions at the inlet and outlet
- evidence of spills and oil/grease contamination
- frequency of trash build-up
- measured sediment depths in the facilities
- maintenance and operational control undertaken during the year
- recommendations for inspection and maintenance program for the coming year

The pipe system will require routine periodic maintenance including hydro vacuuming, flushing and debris removal annually. Removal of accumulated sediment will be required.

3.4 Quality Control (Short Term)

Silt fencing is to be provided at all side slopes and down gradient locations to ensure sediment and erosion control during construction. Other control devices such as straw bales will also be provided where drainage is concentrated. Sediment and erosion management measures also serve to provide a limit to the grading operations.

Straw bale filters are to be provided in overland swale systems.

The timeframe for land to remain exposed before it is stabilized with sod, mulch, or hydroseeding is to be minimized. Topsoil is to be stockpiled away from watercourses and wetlands. Rock check dams or straw bale filters are to be provided in overland swale and ditch systems.

Inspection of the sediment control works should be undertaken before and after all rainfall (and snowmelt) events. Maintenance is to be undertaken as required to ensure the proper operation of all sediment and erosion controls. Inspection and maintenance are the Owner’s responsibility.

4. Conclusions

It is recommended that the Rocky Acres Subdivision proceed with the mitigation measures detailed in this report to address stormwater quality and quantity and erosion concerns on site.

The development is to be designed in accordance with the Ministry of the Environment, Conservation, and Parks, Town of Gananoque Public Works, and CRCA guidelines.

Stormwater runoff within the Rocky Acres Subdivision is to be directed to an oil grip separator prior to flow discharging to the storm sewer on Maple Street.

Appendix A

Concept Plan
Figure 2: Pre-development Catchment Areas
Figure 3: Post-development Catchment Areas
Figure 4: Gananoque West Ward Storm Sewer Catchment Areas

0 12.5 25 m H=1:500

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

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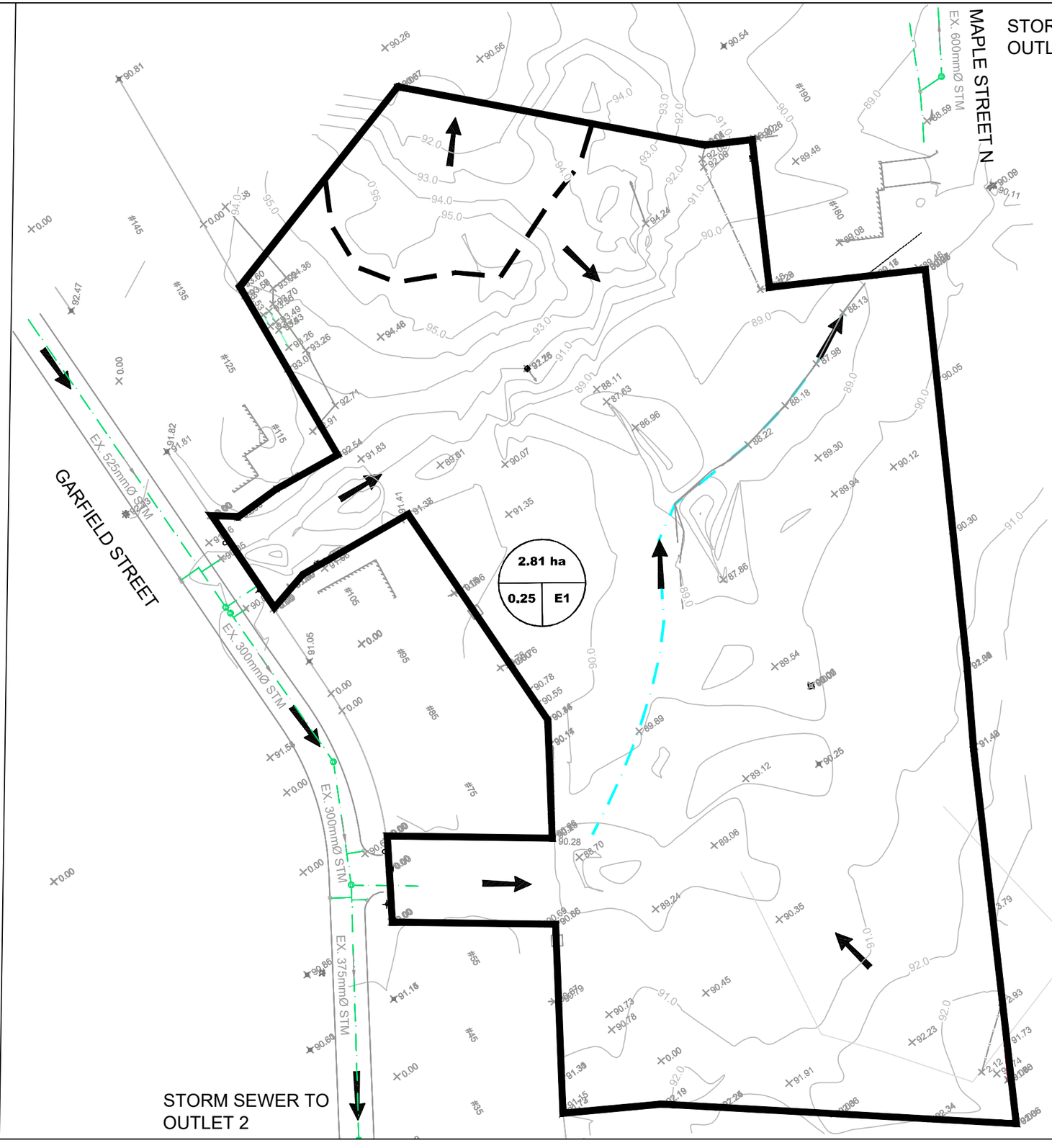
Client
RGH DEVELOPMENTS

Project
ROCKY ACRES DEVELOPMENT

Drawing
CONCEPT PLAN

Drawn by:	Checked by:	Project No.
CGD	JH	
Designed by:	Approved by:	Drawing No.
KMN	KMN	CP
Date: APRIL 2021		
Scale: 1:500		



0 20 40 m H=1:1000

MAJOR FLOW ARROW

CATCHMENT AREA IN HECTARES
##.##ha
#.## ##
RUNOFF COEFFICIENT
CATCHMENT AREA ID

Benchmark

No.	Revision/Issue	Date

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Client
RGH DEVELOPMENTS

Project
ROCKY ACRES SUBDIVISION

Drawing
PRE-DEVELOPMENT
CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.2
Date: APRIL 2021		
Scale: 1:1000		

MINOR EVENT TO OUTLET 1

EX.MH11
T/G 88.77
N. INV. 87.04
S. INV. 87.07

MAPLE STREET N

EX. 600mmØ STM

EX.MH11

33m - 450mmØ @ 0.80%

MH9

3.0m EASEMENT

49m - 450mmØ @ 2.32%

MH8

OGS

MH5

26m - 300mmØ @ 0.30%

29m - 300mmØ @ 0.48%

MH6

34m - 450mmØ @ 0.45%

MH4

31m - 250mmØ @ 0.50%

MH7

0.82 ha | 0.50 | P1D

0.49 ha | 0.50 | P1A

0.70 ha | 0.50 | P1C

0.80 ha | 0.50 | P1B

101m - 450mmØ @ 0.45%

STREET 'A'

RYCB1

41m - 300mmØ @ 0.30%

MH3

MH1

49m - 375mmØ @ 0.30%

MH2

15m - 375mmØ @ 0.35%

51m - 300mmØ @ 0.30%

RYCB2

GARFIELD STREET

EX. 525mmØ STM

EX. 300mmØ STM

EX. 300mmØ STM

EX. 375mmØ STM

MAJOR EVENT TO OUTLET 2

0 20 40 m H=1:1000

MAJOR FLOW ARROW

CATCHMENT AREA IN HECTARES
##.##ha
#.## ##
RUNOFF COEFFICIENT
CATCHMENT AREA ID

Benchmark

No.	Revision/Issue	Date

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Client
RGH DEVELOPMENTS

Project
ROCKY ACRES SUBDIVISION

Drawing
POST-DEVELOPMENT CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.3

Date: APRIL 2021
Scale: 1:1000

GANANOQUE RIVER OUTLET (OUTLET 1)

ST. LAWRENCE RIVER OUTLET (OUTLET 2)

EX. STM MAIN

MAJOR FLOW ARROW

CATCHMENT AREA IN HECTARES

##.##ha

#.## ##

RUNOFF COEFFICIENT

CATCHMENT AREA ID

0 80 160 m H=1:4000

Benchmark

No.	Revision/Issue	Date

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Client: RGH DEVELOPMENTS

Project: ROCKY ACRES SUBDIVISION

Drawing: GANANOQUE WEST WARD STORM SEWER CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
JH	JH	
Designed by:	Approved by:	Drawing No.
		FIG.4
Date: APRIL 2021		
Scale: 1:4000		

Appendix B

MTO Gananoque Look Up Curve
Composite Runoff Coefficient Calculations
Storm Sewer Design Sheets
    Rocky Acres Subdivision
    Existing Storm Sewer Design Sheet to Gananoque River
    Proposed Storm Sewer Design Sheet to Gananoque River
Rational Method Calculations
OGS Calculations

Ontario IDF CURVE LOOKUP

Active coordinate

44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Retrieved: Thu, 08 Apr 2021 12:50:57 GMT

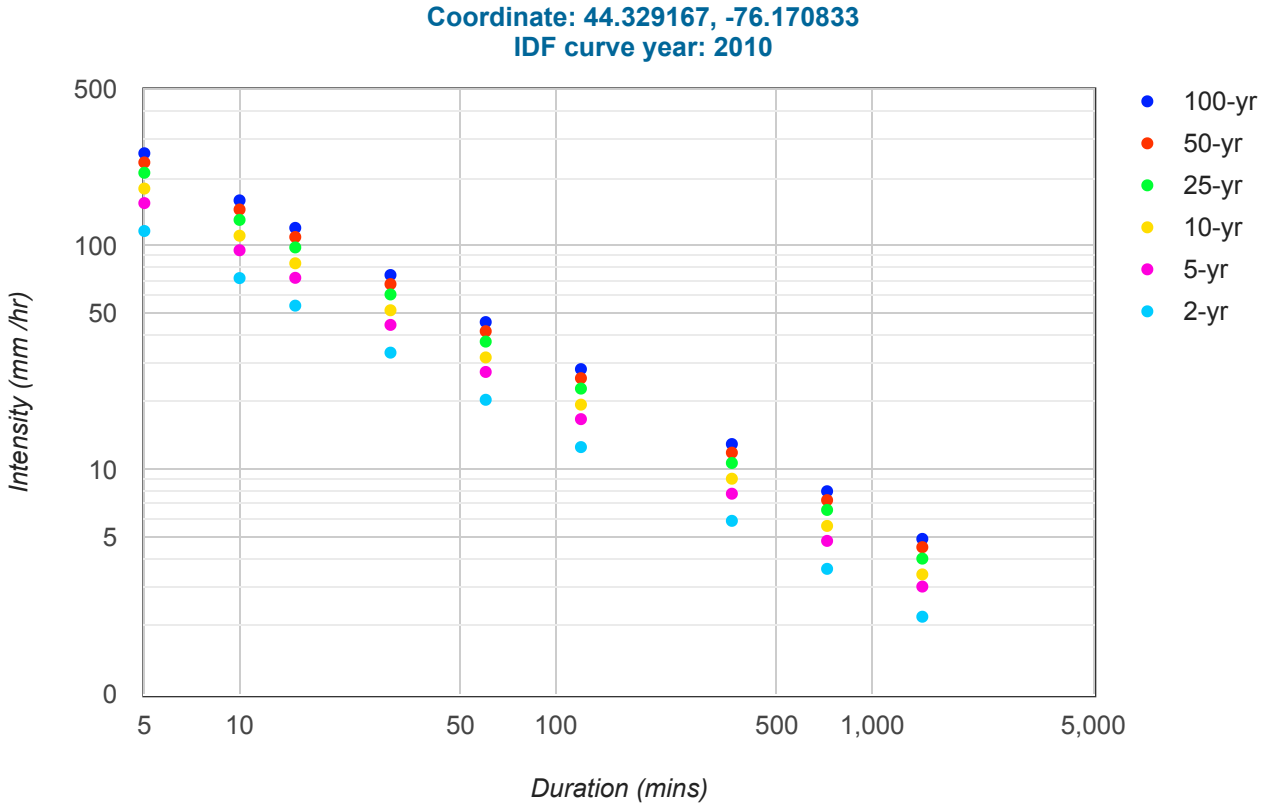
Location summary

These are the locations in the selection.

IDF Curve: 44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 44° 19' 45" N, 76° 10' 15" W (44.329167,-76.170833)

Retrieved: Thu, 08 Apr 2021 12:50:57 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	20.5	27.3	31.7	37.3	41.5	45.6
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	116.4	71.7	54.0	33.3	20.5	12.6	5.9	3.6	2.2
5-yr	155.1	95.5	71.9	44.3	27.3	16.8	7.8	4.8	3.0
10-yr	180.1	110.9	83.5	51.5	31.7	19.5	9.1	5.6	3.4
25-yr	211.9	130.5	98.3	60.6	37.3	23.0	10.7	6.6	4.0
50-yr	235.7	145.2	109.4	67.4	41.5	25.6	11.9	7.3	4.5
100-yr	259.0	159.5	120.2	74.0	45.6	28.1	13.0	8.0	4.9

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	9.7	12.0	13.5	16.6	20.5	25.3	35.2	43.3	53.4
5-yr	12.9	15.9	18.0	22.2	27.3	33.6	46.8	57.7	71.1
10-yr	15.0	18.5	20.9	25.7	31.7	39.1	54.4	67.0	82.5
25-yr	17.7	21.8	24.6	30.3	37.3	46.0	64.0	78.8	97.1
50-yr	19.6	24.2	27.3	33.7	41.5	51.1	71.2	87.7	108.0
100-yr	21.6	26.6	30.0	37.0	45.6	56.2	78.2	96.3	118.7

Terms of Use

Composite Runoff Coefficients			
Rocky Acres Subdivsion			
Hydrologic Units - Existing Conditions			
Drainage Area No.	**Total Area (ha)**	**Runoff Coefficient -C**	**Description**
EX1			
Grass / Rock Outcrop	2.8100	0.25	
Total	**2.81**	**0.25**	

Hydrologic Units - Proposed Conditions			
Drainage Area No.	**Total Area (ha)**	**Runoff Coefficient -C**	**Description**
P1			
Grass	1.710	0.25	
Asphalt/Concrete	0.505	0.90	
Building	0.591	0.90	
Total	**2.81**	**0.50**	

Weighted Product Equation

$$C_{weighted} = \frac{C_1 * A_1 + C_2 * A_2 + C_3 * A_3 \ldots + C_n * A_n}{A_1 + A_2 + A_3 \ldots A_n}$$

PROPOSED STORM SEWER DESIGN SHEET (ROCKY ACRES SUBDIVISION)

CLIENT
PROJECT NAME — Rocky Acres Subdivision — Min. V = 0.75 m/s — DESIGN FREQUENCY 5 100
DATE — April 2021 — Max. V = 6 m/s — RAINFALL STATIONS Gananoque MTO - Look Up
DESIGNED 'n' 0.013

LOCATION: ROCKY ACRES SUBDIVISION — DRAINAGE AREA = 2.81 ha — RUNOFF 3 7 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	R = 0.15 ha	R = 0.35 ha	R = 0.40 ha	R = 0.50 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	100 Year Indiv. 2.78AC ha	100 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	100 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)
0.51	Street A	P1A	RYCB1	MH1				0.510	0.708	0.708			15.0	70		49	HDPE	300	300	40	0.30%	53	0.75	0.89	0.93	0.85	229	0.23	0.120
0.40	Street A	P1B	RYCB2	MH1				0.400	0.556	0.556			15.0	70		39	HDPE	300	300	50	0.30%	53	0.75	1.11	0.73	0.82	190	0.19	0.150
0.20	Street A	P1B	MH1	MH2				0.200	0.278	1.542			16.1	67		103	HDPE	450	375	50	0.30%	96	0.87	0.96	1.08	0.87	375	0.38	0.150
0.20	Street A	P1B	MH2	MH3				0.200	0.278	1.819			17.1	65		118	HDPE	450	375	15	0.35%	104	0.94	0.27	1.14	0.94	375	0.38	0.053
0.70	Street A	P1C	MH3	MH4				0.700	0.972	2.792			17.3	64		180	HDPE	450	450	100	0.45%	191	1.20	1.39	0.94	1.37	346	0.35	0.450
	Street A		MH4	OGS						2.792			18.7	62		172	HDPE	450	450	23	0.45%	191	1.20	0.32	0.90	1.36	332	0.33	0.104
0.40	Street A	P1D	MH7	MH6				0.400	0.556	0.556			15.0	70		39	HDPE	250	250	33	0.50%	42	0.86	0.64	0.92	0.97	189	0.19	0.165
0.20	Street A	P1D	MH6	MH5				0.200	0.278	0.833			15.6	68		57	HDPE	300	300	29	0.40%	61	0.87	0.56	0.93	0.98	228	0.23	0.116
0.20	Street A	P1D	MH5	OGS				0.200	0.278	1.111			16.2	67		74	HDPE	375	375	26	0.30%	96	0.87	0.50	0.77	0.96	247	0.25	0.078
	Easement		OGS	MH8						3.903			19.0	61		238	HDPE	375	450	55	2.30%	432	2.72	0.34	0.55	2.78	237	0.24	1.265
	Easement		MH8	MH9						3.903			19.4	60		236	HDPE	450	450	13	0.80%	255	1.60	0.14	0.92	1.82	341	0.34	0.104
	Maple Street		MH9	EX.MH11						3.903			19.5	60		234	HDPE	450	450	35	0.80%	255	1.60	0.36	0.92	1.82	339	0.34	0.280

EXISTING STORM SEWER DESIGN SHEET - GANANOQUE RIVER OUTLET (OUTLET 1)

CLIENT
PROJECT NAME — Rocky Acres Subdivision — Min. V = 0.75 m/s — DESIGN FREQUENCY 5 100
DATE — April 2021 — Max. V = 6 m/s — RAINFALL STATIONS Gananoque MTO - Look Up
DESIGNED 'n' 0.013

LOCATION: ROCKY ACRES SUBDIVISION — DRAINAGE AREA = 19.13 ha — RUNOFF 3 7 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	R = 0.25 ha	R = 0.30 ha	R = 0.40 ha	R = 0.50 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	100 Year Indiv. 2.78AC ha	100 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	100 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)
2.81	Maple Street	From Site	Inlet	EX.MH11	**2.81**				1.951	1.9514			20.0	59		116													
0.50	Maple Street	EXT.1	EX.MH11	EX.MH10			0.500		0.556	2.507			20.0	59		149	Conc.	525	600	56	0.25%	307	1.09	0.86	0.48	1.07	292	0.29	0.140
1.29	Second Street	EXT.2	EX.MH10	EX.MH9			1.290		1.433	3.940			20.9	58		227	Conc.	525	600	92	0.40%	388	1.37	1.12	0.59	1.43	329	0.33	0.368
	Second Street		EX.MH9	EX.MH8					0.000	3.940			22.0	56		220	Conc.	525	600	93	0.40%	388	1.37	1.13	0.57	1.42	324	0.32	0.372
2.48	Elm Street	EXT.3	EX.MH8	EX.MH7			2.480		2.756	6.696			23.1	54		363	Conc.	600	675	128	0.50%	594	1.66	1.28	0.61	1.74	379	0.38	0.640
1.60	Elm Street	EXT.4	EX.MH7	EX.MH6			1.600		1.778	8.474			24.4	52		445	Conc.	675	750	75	0.30%	610	1.38	0.91	0.73	1.51	475	0.48	0.225
	Third Street		EX.MH6	EX.MH5					0.000	8.474			25.3	51		435	Conc.	675	750	92	0.35%	659	1.49	1.03	0.66	1.59	443	0.44	0.322
4.27	Third Street	EXT.5	EX.MH5	EX.MH4		4.270			3.558	12.032			26.3	50		601	Conc.	750	750	96	0.45%	747	1.69	0.95	0.80	1.88	509	0.51	0.432
	Oak Street		EX.MH4	EX.MH3					0.000	12.032			27.3	49		589	Conc.	750	900	98	0.30%	992	1.56	1.05	0.59	1.62	497	0.50	0.294
3.03	Oak Street	EXT.6	EX.MH3	EX.MH2			3.030		3.367	15.399			28.3	48		735	Conc.	825	900	105	0.30%	992	1.56	1.12	0.74	1.70	574	0.57	0.315
	Fourth Street		EX.MH2	EX.MH1					0.000	15.399			29.4	47		717	Conc.	825	900	88	0.30%	992	1.56	0.94	0.72	1.70	566	0.57	0.264
3.15	River Street	EXT.7	EX.MH1	OUTLET			3.150		3.500	18.899			30.4	46		863	Conc.	900	900	63	0.30%	992	1.56	0.67	0.87	1.75	647	0.65	0.189

PROPOSED STORM SEWER DESIGN SHEET - GANANOQUE RIVER OUTLET (OUTLET 1)

CLIENT
PROJECT NAME — Rocky Acres Subdivision — Min. V = 0.75 m/s — DESIGN FREQUENCY 5 100
DATE — April 2021 — Max. V = 6 m/s — RAINFALL STATIONS Gananoque MTO - Look Up
DESIGNED 'n' 0.013

LOCATION: ROCKY ACRES SUBDIVISION — DRAINAGE AREA = 19.13 ha — RUNOFF 3 7 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	R = 0.15 ha	R = 0.35 ha	R = 0.40 ha	R = 0.50 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	100 Year Indiv. 2.78AC ha	100 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	100 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)
2.81	From Site	P1	MH1	MH2				**2.810**	3.903	3.903			19.5	60		235													
0.50	Maple Street	EXT.1	EX.MH11	EX.MH10			0.500		0.556	4.458			19.5	60		268	Conc.	600	600	56	0.25%	307	1.09	0.86	0.87	1.22	434	0.43	0.140
1.29	Second Street	EXT.2	EX.MH10	EX.MH9			1.290		1.433	5.892			20.4	59		345	Conc.	600	600	92	0.40%	388	1.37	1.12	0.89	1.55	439	0.44	0.368
	Second Street		EX.MH9	EX.MH8					0.000	5.892			21.5	57		334	Conc.	600	600	93	0.40%	388	1.37	1.13	0.86	1.54	429	0.43	0.372
2.48	Elm Street	EXT.3	EX.MH8	EX.MH7			2.480		2.756	8.647			22.6	55		475	Conc.	675	675	128	0.50%	594	1.66	1.28	0.80	1.84	456	0.46	0.640
1.60	Elm Street	EXT.4	EX.MH7	EX.MH6			1.600		1.778	10.425			23.9	53		554	Conc.	750	750	75	0.30%	610	1.38	0.91	0.91	1.56	560	0.56	0.225
	Third Street		EX.MH6	EX.MH5					0.000	10.425			24.8	52		542	Conc.	750	750	92	0.35%	659	1.49	1.03	0.82	1.66	515	0.52	0.322
4.27	Third Street	EXT.5	EX.MH5	EX.MH4		4.270			4.151	14.576			25.8	51		737	Conc.	750	750	96	0.45%	747	1.69	0.95	0.99	1.93	606	0.61	0.432
	Oak Street		EX.MH4	EX.MH3					0.000	14.576			26.8	49		721	Conc.	825	900	98	0.30%	992	1.56	1.05	0.73	1.70	566	0.57	0.294
3.03	Oak Street	EXT.6	EX.MH3	EX.MH2			3.030		3.367	17.943			27.8	48		866	Conc.	900	900	105	0.30%	992	1.56	1.12	0.87	1.76	651	0.65	0.315
	Fourth Street		EX.MH2	EX.MH1					0.000	17.943			28.9	47		845	Conc.	900	900	88	0.30%	992	1.56	0.94	0.85	1.75	637	0.64	0.264
3.15	River Street	EXT.7	EX.MH1	OUTLET			3.150		3.500	21.443			29.9	46		990	Conc.	900	900	63	0.30%	992	1.56	0.67	1.00	1.78	733	0.73	0.189

RATIONAL METHOD CACULATIONS

Project: Rocky Acres Subdivision

Date: April 2021

Hydrologic Units - Existing Conditions											2 Year Design Storm		5 Year Design Storm		100 Year Design Storm	
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Width (m)	Average Grade (%)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)
E1	Outlet 1	0.25	2.81	160	100	1.0	8.22	5.63	**15.0**	1.97	54.5	107	69.85	137	120.27	237

Hydrologic Units - Proposed Conditions											25mm Quality Event		2 Year Design Storm		5 Year Design Storm		100 Year Design Storm	
Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Width (m)	Average Grade (%)	Tc (Bransby Williams) (when C = >0.4)	Tc (Kirpich Method) (C<0.4)	Tc Proposed	Indiv. 2.78 AC (ha)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)	Intensity I (mm/hr)	Peak Flow Q (LPS)
P1	Minor to Outlet 1 / Major to Outlet 2	0.50	2.81	160	100	0.5	9.45	7.35	**19.5**	3.93	30.78	121	45.5	179	60.20	237	100.48	395

Rational Method Calculations

Formula:

Q (LPS) = 2.78* C * I * A

Where:

Q = Peak runoff rate, LPS

C = Composite runoff coefficient

I = Rainfall intensity, mm/hr,
MTO Gananoque IDF Look Up Curve (Quantity Event)

t_c = Time of Concentration, (15 minute minimum)

Kirpich Method $0.0192[L^{0.77}/S_{(m/m)}^{0.385}]$

Airport Method $3.26(1.1 - C)* L^{0.5}/ S_w^{0.33}$

A = Drainage area, ha

25mm - 4 hr (Quality Event)

$$I_{(25mm)} = \frac{498}{(tc + 9.7)^{0.825}}$$

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: Rocky Acres Subdivision
Location: Ganaoque, ON
OGS #: 1

Engineer: **Forefront Engineering INC**
Contact: Jeff Homer, P.Eng
Report Date: 14-Apr-21

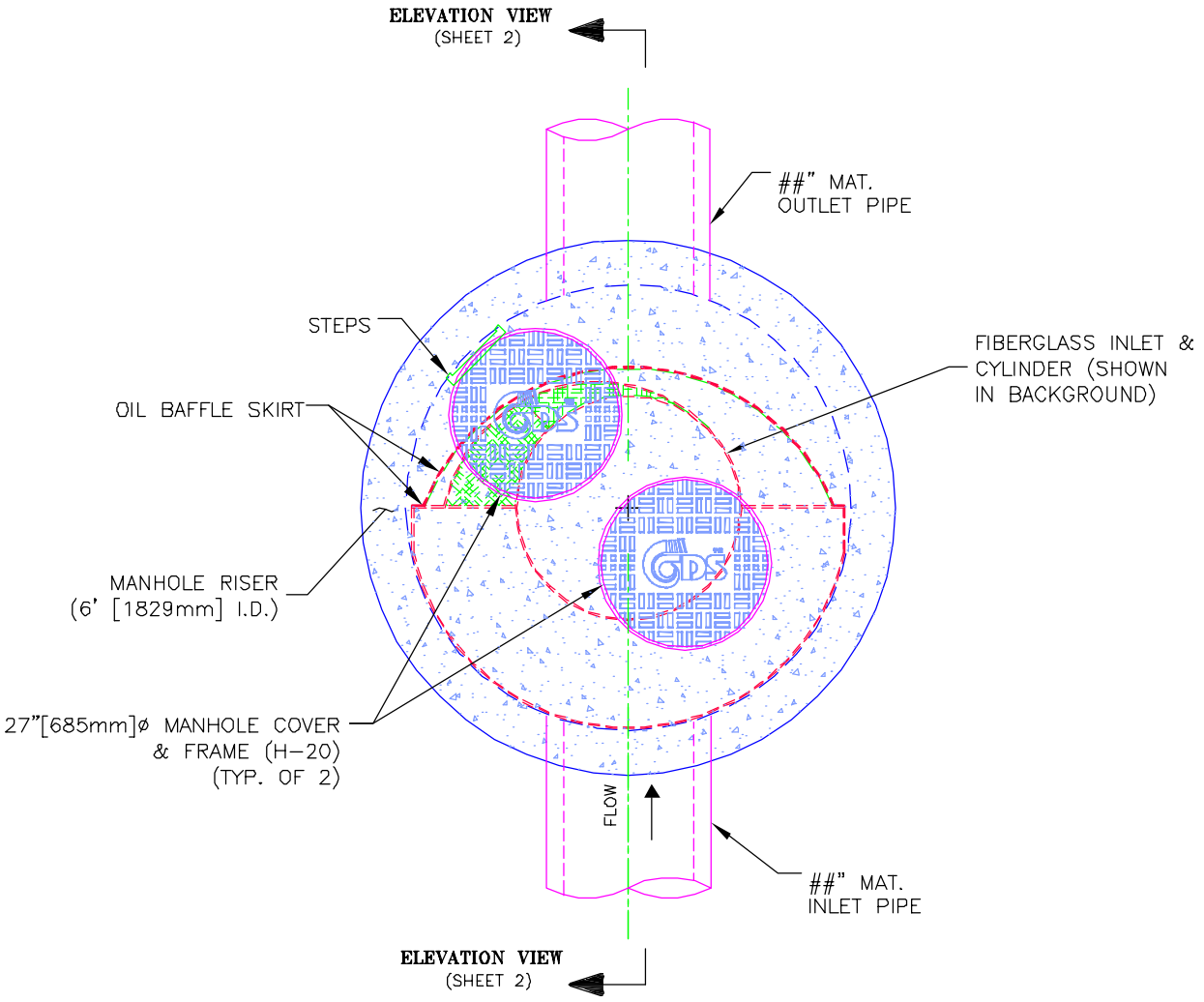
Area	2.75	ha	**Rainfall Station #**	214	
Weighted C	0.50		**Particle Size Distribution**	FINE	
CDS Model	3020		**CDS Treatment Capacity**	57	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
1.0	10.8%	20.7%	3.8	3.8	6.7	96.9	10.5
1.5	10.1%	30.8%	5.7	5.7	10.0	96.0	9.7
2.0	9.1%	39.9%	7.6	7.6	13.3	95.0	8.6
2.5	7.0%	46.9%	9.4	9.4	16.7	94.1	6.6
3.0	6.9%	53.9%	11.3	11.3	20.0	93.1	6.4
3.5	4.5%	58.4%	13.2	13.2	23.3	92.2	4.2
4.0	4.5%	62.9%	15.1	15.1	26.7	91.2	4.1
4.5	4.1%	67.0%	17.0	17.0	30.0	90.3	3.7
5.0	3.8%	70.8%	18.9	18.9	33.3	89.3	3.4
6.0	5.7%	76.5%	22.7	22.7	40.0	87.4	4.9
7.0	4.5%	81.0%	26.4	26.4	46.7	85.5	3.9
8.0	3.6%	84.5%	30.2	30.2	53.4	83.6	3.0
9.0	2.3%	86.8%	34.0	34.0	60.0	81.7	1.8
10.0	1.9%	88.7%	37.8	37.8	66.7	79.7	1.5
15.0	6.1%	94.8%	56.7	56.6	100.0	70.2	4.3
20.0	2.6%	97.5%	75.5	56.6	100.0	52.6	1.4
25.0	2.0%	99.4%	94.4	56.6	100.0	42.1	0.8
30.0	0.4%	99.9%	113.3	56.6	100.0	35.1	0.2
35.0	0.1%	100.0%	132.2	56.6	100.0	30.1	0.0
40.0	0.0%	100.0%	151.1	56.6	100.0	26.3	0.0
45.0	0.0%	100.0%	170.0	56.6	100.0	23.4	0.0
50.0	0.0%	100.0%	188.9	56.6	100.0	21.1	0.0
							88.8

Removal Efficiency Adjustment[2] = 6.5%
Predicted Net Annual Load Removal Efficiency = 82.3%
Predicted Annual Rainfall Treated = 98.2%

1 - Based on 44 years of hourly rainfall data from Canadian Station 6104175, Kingston ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

PLAN VIEW

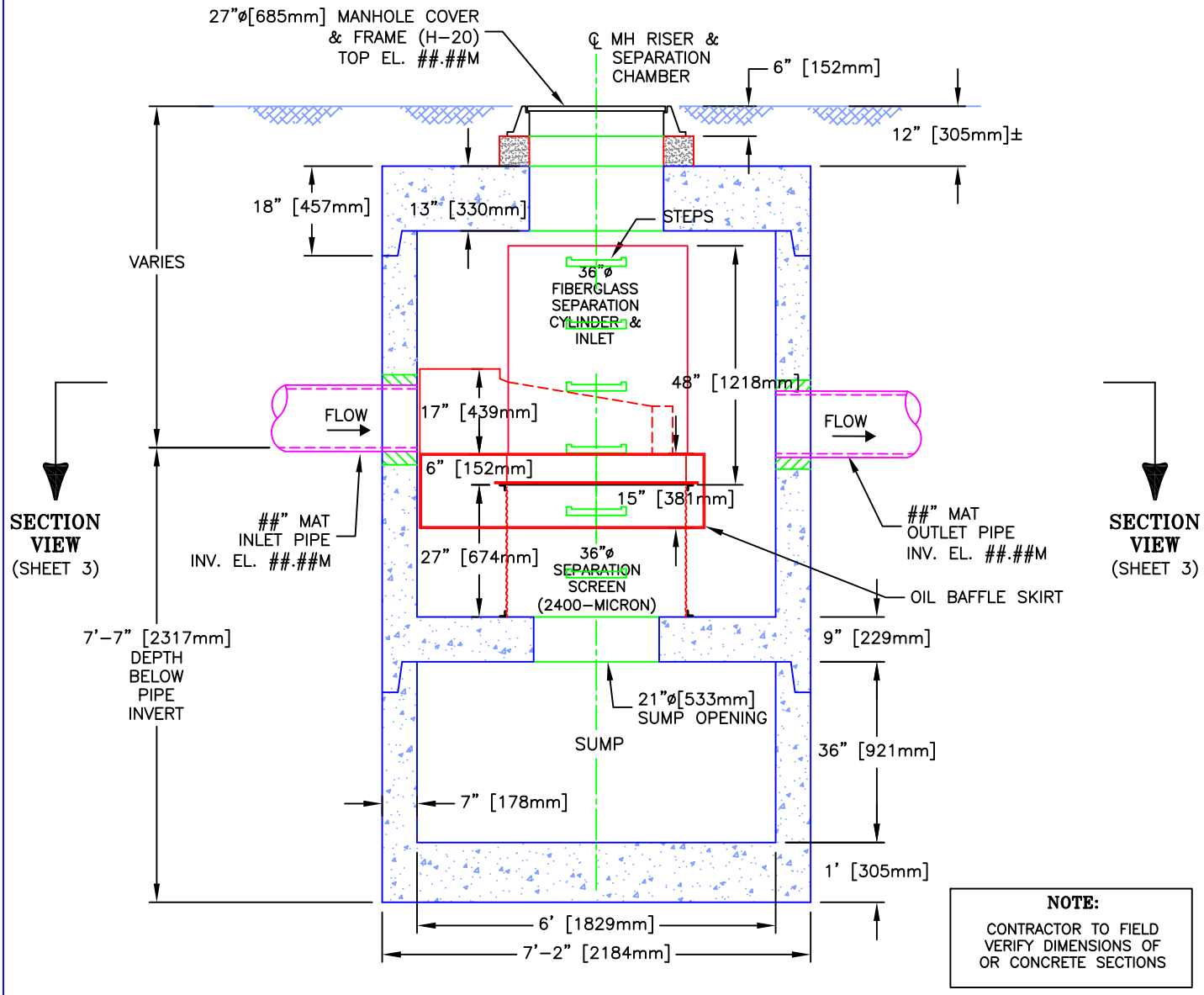


CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 2.5'
		DATE ##/##/##	SHEET 1
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



NOTE:
CONTRACTOR TO FIELD VERIFY DIMENSIONS OF OR CONCRETE SECTIONS

CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET 2
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955