Grimsby Anaerobic Digestion Site Expansion

Stormwater Management Report

Project Location:
424 Sobye Road,
Grimsby, ON, L3M 0K8

Prepared For:
1414229 Ontario Limited (o/a Escarpment Renewables)
424 Sobye Road, Grimsby, ON, L3M 0K8

Prepared by:
GRIT Engineering Inc.
133 Regent Street, Stratford, Ontario

October 31, 2023

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PASSION, DETERMINATION, RESOLVE

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1.0 Introduction

GRIT Engineering Inc. (GRIT) was retained by 1414229 Ontario Limited (c/o Escarpment Renewables) to review the private stormwater management for a proposed anaerobic digestion site expansion to satisfy the site plan approval and Renewable Energy Application (REA) amendment requirements set forth by the Town of Grimsby, Region of Niagara, and the Ministry of the Environment, Conservation and Parks (MECP).

The subject Site (Site) is located at 424 Sobye Road in the Town of Grimsby, Ontario, is approximately 10.50 hectare in size, and zoned Agriculture A(H). The site is surrounded by existing Agriculture A(H) to the south, east and west, Sobye Road to the north, and Agriculture SC(H) north of Sobye Road. Refer to Figure 1 for a site location map.

This Stormwater Management (SWM) Report will provide the necessary background and proposed design information to address the Site Plan Approval (SPA) and REA amendment requirements for the Site. This report is to be read in conjunction with all other submitted documents, including the design drawings – provided separately – containing the proposed design and construction details.

1.1 Previous and Concurrent Studies

The following background documents provide context and form the base for the stormwater management design.

- Design and Operations Report (GHD, March 31, 2022),
- Surface Water Assessment Report (GHD, January 25, 2022), and
- Hydrogeological Assessment Report (GHD, January 24, 2022).

2.0 Design Requirements for Approval

The Town of Grimsby, as part of SPA, and the MECP, as part of the REA amendment, require the proposed development to meet the following design requirements.

<u>Stormwater Management Requirements (Town of Grimsby/Niagara Peninsula Conservation Authority)</u>

In accordance with the Niagara Peninsula Conservation Authority (NPCA) Stormwater Management Guidelines (March 2010), the stormwater requirements are as follows:

- *Require that post-development runoff flows from a site are controlled to a level that matches or is below the pre-development flows for the 2, 5, 25 and 100-year design storm events. (7.1.4. Water Quantity), and*
- *The NPCA will typically require that a Normal level of stormwater quality control be implemented as the minimum acceptable standard regardless of the condition of the receiving watercourse. (7.1.2. Water Quality-Surface).*

Stormwater Management Requirements (MECP)

In accordance with the May 10, 2022 letter addressed to Escarpment Renewables from the MECP, the stormwater requirements are as follows:

- *Please provide the details and function of these two (2) stormwater ponds, and demonstrate (via calculations and tables) how they meet the recommended design practices of the MECP publication "Stormwater Management Planning and Design Manual" (2003, Publication #4329e) for both quality control and quantity control for the expansion and increased imperviousness of the site and operational phase of the site.*
- *Please provide further details on how the sediment pond will be converted back to stormwater management pond(s), that meets the recommended design practices of the MECP publication "Stormwater Management Planning and Design Manual" (2003, Publication #4329e) or alternatively provide an appropriate re-design of the stormwater management pond(s), as applicable.*
- *For the temporary sediment pond during the construction phase, please provide details demonstrating (via calculations and tables) how the sediment pond meets the recommended practices of the Erosion & Sediment Control Guidelines for Urban Construction [December 2006], guidance document that best suits the Greater Golden Horseshoe Area Conservation Authorities, which includes the Niagara Peninsula Conservation Authority.*
- *Please further discuss in the Stormwater Management Plan how secondary construction requirements have been met - per Section 3: Secondary Containment in the "Guidelines for environmental protection measures at chemical and waste storage facilities" and demonstrate (via calculations and tables) whether during a large catastrophic worst case scenario spill, the capacity of the stormwater ponds can handle both the spill volume and the 100-year storm event volume.*

3.0 Stormwater Management Design

3.1 Design Approach

Calculation Method

The contributing drainage area from the subject site to the ultimate outlet is approximately 5.79 hectares. AutoDesk Storm and Sanitary Analysis 2023 (Version 13.5.255.0) has been used to complete the modelling using the United States' Environmental Protection Agency's Stormwater Management Model (EPA SWMM) hydrology engine and the SCS Curve Number method for infiltration. Modelling was completed using rainfall intensity duration frequency (IDF) curves and runoff coefficient parameters for the Niagara Region to calculate the post-development peak flow rates and confirm that they conform to the allowable pre-development release rate. The Hydrogeological Assessment Report by GHD and referenced in Section 1.1 states that the existing soil composition is silty clay with a hydraulic conductivity between $1.6x10^{-5}$ cm/s

and 7.2x120^{-8} cm/s and acts as an aquitard. Therefore, a Hydraulic Soil Group 'D' has been used in the SWM modelling to establish the SCS Curve Numbers for the existing soils and land cover.

Table 3.1: Niagara Region IDF Parameters

IDF Coefficients (Grimsby)			
Storm Frequency	a	b	c
2-year	603.25	6.00	0.79
5-year	785.59	6.00	0.79
10-year	953.64	7.00	0.79
25-year	1119.02	7.00	0.79
50-year	1301.80	8.00	0.80
100-year	1426.13	8.00	0.80

Design Methodology

The SWM design for the development achieves the following design goals and requirements:

- Review of the existing drainage, overland flow route patterns, and site characteristics to determine the allowable outlets,
- Confirmation of the allowable peak flow rates for the 2, 5, 10, 25, 50, and 100-year design storm events,
- Calculation of the post-development runoff coefficients and peak flow rates for the 2, 5, 10, 25, 50, and 100-year design storm events,
- Calculation of the required on-site stormwater storage volume and the Stormwater Management Facility (SWMF) ponding elevations, and secondary containment storage volumes, and
- Review, evaluation, and recommendation of stormwater quality control techniques and structures to meet the *Enhanced* level (80%) of Total Suspended Solids (TSS) removal.

3.2 Pre-Development Conditions

In the pre-development condition, the 10.50 hectare Site was an agricultural farm field. Approximately 3.94 hectares of the Site were developed into an Anaerobic Digestion Facility under REA 8541-9HSGG3, October 1, 2014. The facility includes various holding tanks; buildings; concrete and gravel driving and parking areas; grassed areas; and two stormwater retention ponds.

A review of the pre-development drainage patterns for the site – see Figure 2 – determined that the site comprises one main drainage catchment.

- **Catchment 101** is the subject portion of the site and drains overland from the northwest to the southeast. Minor flows are directed to the on-site private storm sewers that outlet the retention ponds or overland to the retention ponds. Major flows are conveyed overland to the retention ponds.

The east pond flows to the west pond via three 450mm diameter culverts. The west pond outlets at grade to the southwest via a weir where the flows ultimately join with a tributary to Spring Creek located south of the Site. See Figure 2 for the pre-development catchment area, site characteristic analysis, drainage, and overland flow patterns. Table 3.2 below defines the existing site characteristics.

Table 3.2: Existing Site Characteristics

Catchment Number	Area (ha)	Percent Impervious (%)	Flow Length (m)	Overland Slope (%)	Composite SCS Curve Number	Composite Manning's Pervious n	Composite Manning's Impervious n
101	3.94	63%	194.93	0.5%	90.38	0.250	0.015

Pre-development modelling for the 2 through 100-year design storms using a 3-hour Chicago Distribution and a one-minute time step was completed using the catchment characteristics above to establish the post-development runoff rates. See Appendix A for the calculated Chicago Distribution Hyetographs for all design storm events. Table 3.3. below summarizes the pre-development flows, and Table 3.4 below summarizes the runoff volumes for the catchment for all design storms.

Table 3.3: Pre-Development Runoff Rates

Catchment Number	2-Year Flow (L/S)	5-Year Flow (L/S)	10-Year Flow (L/S)	25-Year Flow (L/S)	50-Year Flow (L/S)	100-Year Flow (L/S)
101	189.23	279.26	354.28	450.91	511.10	586.83

Table 3.4: Pre-Development Runoff Volume

Catchment Number	2-Year Volume (m^3)	5-Year Volume (m^3)	10-Year Volume (m^3)	25-Year Volume (m^3)	50-Year Volume (m^3)	100-Year Volume (m^3)
101	774.80	1,098.92	1,397.41	1,699.84	1,905.27	2,122.53

See Appendix B for the full EPA SWMM pre-development modelling output results.

3.3 Post-Development Conditions

Based on the Design and Operations Report (GHD, March 31, 2022), all existing facility structures will remain except the current biogas storage building. The facility will be upgraded with a new organic pre-processing building, new digester tanks, digestate/biogas storage tanks, Renewable Natural Gas (RNG) upgrading equipment and processing equipment. New asphalt and gravel drive aisles, parking areas, and grassed

areas will be constructed. Under post-development conditions, the total contributing drainage area increases from 3.94 to 5.79 hectares and is split into two catchments.

- **Catchment 201** comprises the majority of existing Catchment 101 with new asphalt and gravel ground cover, four new buildings, and grassed areas within the area of Catchment 101. The minor flows are directed to private storm sewers and overland to the existing retention ponds. The major flows are directed overland to the existing retention ponds. The drainage pattern generally matches the existing drainage pattern.
- **Catchment 202** comprises the new digester and storage tanks, three buildings, gravel parking and drive areas, secondary containment and new retention area, and grassed areas. Minor flows are directed to private storm sewers and overland to the new retention area. Major flows are directed overland to the new retention area. The new retention area is designed for the runoff from rainfall events and the secondary containment. The retention area does not have a direct gravity outlet rather, it will be pumped to the east pond after the east and west ponds drawdown to ultimately outlet in the same location as the existing retention ponds. See Section X.X for additional information on the secondary containment and new retention area.

See Figure 3 for the post-development catchment areas, site characteristic analysis, drainage, and overland flow patterns, and the engineering drawings by GRIT – provided separately – for the proposed grading and servicing. Table 3.5 below defines the proposed site characteristics for the site.

Table 3.5: Proposed Site Characteristics

Catchment Number	Area (ha)	Percent Impervious (%)	Flow Length (m)	Overland Slope (%)	Composite SCS Curve Number	Composite Manning's Pervious n	Composite Manning's Impervious n
201	3.54	55%	317.16	0.75%	89.61	0.250	0.015
202	2.25	48%	234.52	0.75%	88.40	0.250	0.015

Post-development modelling for the 2 through 100-year design storms using a 3-hour Chicago Distribution and a one-minute time step was completed using the catchment characteristics above to establish the post-development runoff rates. See Appendix A for the calculated Chicago Distribution Hyetographs for all design storm events. Table 3.6. below summarizes the post-development flows, and Table 3.7 below summarizes the runoff volumes for the catchment for all design storms.

Table 3.6: Post-Development Runoff Rates

Catchment Number	2-Year Flow (L/S)	5-Year Flow (L/S)	10-Year Flow (L/S)	25-Year Flow (L/S)	50-Year Flow (L/S)	100-Year Flow (L/S)
201	136.89	200.05	251.46	317.48	358.20	409.61
202	89.98	129.30	159.92	201.09	225.32	257.47

Table 3.7: Post-Development Runoff Volume

Catchment Number	2-Year Volume (m^3)	5-Year Volume (m^3)	10-Year Volume (m^3)	25-Year Volume (m^3)	50-Year Volume (m^3)	100-Year Volume (m^3)
201	618.54	913.66	1,175.51	1,441.97	1,623.50	1,815.64
202	360.60	533.03	694.67	859.68	972.76	1,092.59

See Appendix B for the full EPA SWMM post-development modelling output results.

3.4 Quantity Control Summary

Control of the post-development 2 through 100-year design storm events to the pre-development level is provided separately for each post-development catchment. **Catchment 201** is controlled by the existing retention ponds and existing outlet controls. No modifications to the quantity control portion of the existing retention ponds are proposed. The post-development flow rates and runoff volumes from Catchment 201 are less than in the pre-development condition. As the flows are reduced in post-development, the catchment is considered overcontrolled and will improve the downstream receiver by reducing the intensity of the outlet flows and minimizing the risk of erosion in the receiver. Therefore, the existing retention ponds are sufficient to meet the post to pre flow requirement. See Table 3.8 and Table 3.9 below for a comparison of the pre and post-development flows and runoff volume.

Table 3.8: Post-Development Runoff Rate Comparison

Catchment Number	2-Year Flow (L/S)	5-Year Flow (L/S)	10-Year Flow (L/S)	25-Year Flow (L/S)	50-Year Flow (L/S)	100-Year Flow (L/S)
101	189.23	279.26	354.28	450.91	511.10	586.83
201	136.89	200.05	251.46	317.48	358.20	409.61
Reduction	**52.34**	**79.21**	**102.82**	**133.43**	**152.90**	**177.22**

Table 3.9: Post-Development Runoff Volume Comparison

Catchment Number	2-Year Volume (m^3)	5-Year Volume (m^3)	10-Year Volume (m^3)	25-Year Volume (m^3)	50-Year Volume (m^3)	100-Year Volume (m^3)
101	774.80	1,098.92	1,397.41	1,699.84	1,905.27	2,122.53
201	618.54	913.66	1,175.51	1,441.97	1,623.50	1,815.64
Reduction	**156.26**	**185.26**	**221.89**	**257.87**	**281.77**	**306.88**

Catchment 202 is controlled by the proposed retention area designed to provide storage for the runoff volume and secondary containment. The proposed retention area does not have an outflow during the storm events it has been sized to accommodate the entire runoff for the 100-year storm on top of the secondary containment volume. After a rainfall event, the retention area will be inspected to confirm that no spills have occurred and will be pumped to the east pond once the east and west ponds have emptied, where the runoff will outlet through the existing outlet controls in the west pond. See the Operation and Maintenance Report by GHD for how runoff that mixes with a spill will be handled.

Section 3.6 discussed the available volume in the proposed retention area in conjunction with the secondary containment volume requirements and demonstrates compliance with the volume requirements.

3.5 Quality Controls

To meet the recommended stormwater management quality control criteria, as noted in Section 2, an ADS FD-5HC Oil Grit Separator (OGS), or approved substitution, has been sized and selected for the site. The OGS provides 82.0% removal of TSS, which exceeds the required 80% TSS removal. The OGS will be installed between the proposed retention area and the east pond. As the flow from the existing outlet controls is unknown, the OGS is sized for a maximum flow of 136.89 L/s, which is the flow from Catchment 201 in the 2-year design storm event. See Appendix C for the OGS sizing summary and typical details.

3.6 Secondary Containment

The secondary containment volume is sized per Section 3 of the *Guidelines for Environmental Protection Measures at Chemical and Waste Storage Facilities* to provide a minimum impoundment volume equal to the greater of:

- 110% of the volume of the largest tank
- 100% of the volume of the largest tank plus the greater of 10% of the volume of the largest tank or 10% of the aggregate volume of all remaining tanks.

Based on the Design and Operations Report (GHD, March 31, 2022), The existing digesters and storage tanks are constructed below grade. The liquid receiving tanks are also constructed below grade, and the unloading area is sloped to drains connected to the storage tanks. Therefore, any spill that occurs will drain into the tanks and be contained.

The new digesters and digestate storage tanks are mostly above grade. Each tank is proposed to be installed 1.8m below grade, with the remainder above grade. Secondary containment is required for the net volume of the tanks above grade.

Based on the Design and Operations Report, there will be four (4) digesters and two (2) digestate storage tanks. Below is a breakdown of the volume of secondary containment that is required.

Digester Tank:
Diameter = 18m
Total Height = 13.5m
Embedded Depth = 1.8m
Net Height = 13.5m - 1.8m = 11.7m
Area = 254m^2
Volume = 254m^2 x 11.7m = 2,971.8m^3
Number of Tanks = 4

Digestate Storage Tank:
Diameter = 32m
Total Height = 10m
Embedded Depth = 1.8m
Net Height = 10m - 1.8m = 8.2m
Area = 804m^2
Volume = 804m^2 x 8.2m = 6,592.8m^3
Number of Tanks = 2

Containment Volume Required
Largest Tank Volume = 6,592.8m^3
10% of aggregate volume
4 x 2,971.8m^3 = 11,887.20m^3
6,592.8m^3 + ((11,887.20m^3 + 6,592.8m^3) x 10%)
= **8,440.80m^3**

The proposed secondary containment area for the new tanks is in the proposed retention area, which acts as a combination stormwater management pond and secondary containment located east of the proposed tanks. "Visual inspection and continuous tank level monitoring will identify if a spill had occurred. Provided there is no evidence of impact to water collected in the containment area, it will be manually discharged to the stormwater ponds. Alternatively, the accumulated water will be used in the digestion process by mixing with incoming feedstock to achieve desired solids content and reduce the need to import water. This will be done on an as-needed basis." (Design and Operations Report, GHD, March 31, 2022).

The area around the new tanks will be graded to convey spills to catch basins and sewers that discharge to the new secondary containment area. The area around the tanks is not part of the secondary containment area; however, the area might temporarily hold some of the spill while the catch basins and sewers convey the spill to the secondary containment storage. The secondary containment area and the area around the tanks will have an underlying layer of clay that is considered an aquitard per the Hydrogeological Assessment Report by GHD; therefore, the underlying soils are impermeable. For operational uses, the surface material of both areas will be gravel. Table 3.10 below summarizes the required and available storage in the proposed retention area.

Table 3.10: Required and Available Storage

Containment Storage Required (m^3)	100-year Storage Required (m^3)	Total Required Storage (m^3)	Available Storage (m^3)
8,440.80	1,092.59	9,533.39	10,719.80

Figure 3 illustrates the required secondary containment storage and 100-year design storm storage location.

3.7 Erosion & Sedimentation Control

Erosion and sediment controls are proposed for the site design as illustrated on GRIT Engineering Drawing C300, and further detailed on C500 – provided separately. The proposed measures include sediment control fencing, silt socks and silt sacks in all catch basins to be installed before any construction and maintained regularly by the contractor until the development is complete with the final surface and the vegetation is stabilized with mature growth.

4.0 Design Summary

The stormwater management requirements for Quantity and Quality Controls are based on the Town of Grimsby, Niagara Peninsula Conservation Authority, and MECP design guidelines and are summarized in Section 2. The design and calculations in Section 3 and the Figures and Appendices demonstrate compliance with the above requirements. We trust this report satisfies the Municipality's requirements. If there are any questions regarding the report, please do not hesitate to contact our office.

5.0 Statement of Conditions and Limitations

This document was prepared for *1414229 Ontario Limited* (the Client), and the *Town of Grimsby* and has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the engineering profession currently practicing in the same or similar locality, under the same or similar conditions, subject to the time limits and financial, physical, or other constraints applicable to the Services.

The recommendations and conclusions provided in this document are applicable only to the specific site, development, design objectives, and purposes that are described in the text and are based on the information that was available and provided to GRIT Engineering Inc. at the time this document was prepared. This document is not intended to be exhaustive in scope and it shall be recognized that the passage of time may alter the opinions, recommendations, and conclusions that are contained in this document. The design is limited to the documents reference and any other drawings or documents prepared by GRIT Engineering Inc. provided separately. GRIT Engineering Inc. accepts no responsibility or liability for the accuracy of any information provided by others.

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Yours respectfully,

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Founder & CEO

Figures

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Legend

Project:

GRIMSBY ANAEROBIC DIGESTION
SITE EXPANSION

Figure Title:

SITE LOCATION
TOWN OF GRIMSBY

Figure No:

FIGURE 1

SOBYE ROAD

N

cb1
tg=191.705
nw inv=191.19
se inv=191.21

mw
192.384

ex.
bldg

ex.
bldg

ex.
scale

ex.
septic
tank

ex.
electrical
area

ex.
solids
storage
bldg

cb2
tg=191.700
150ø plastic
e inv=191.13

cb3
tg=191.661
150ø plastic
e inv=191.06

cb8
tg=191.573
150ø plastic
sw inv=191.08

mw
191.720

cb4
tg=191.651
150ø plastic
ne inv=191.09
150ø plastic
e inv=191.07

ex.
tanks

ex.
tanks

ex.
tanks

ex.
bldg

ex.
tanks

ex.
tanks

ex.
tanks

cb5
tg=191.675
150ø plastic
e inv=191.09

mw
192.425
mw
192.338

cb6
tg=191.652
150ø plastic
e inv=191.07

ex.
600mmø
strm

mw
192.332

cb7
tg=191.682
150ø plastic
e inv=191.10

ex. stormwater
retention pond

ex.
450mmø
strm

ex. stormwater
retention pond

mw
191.686

mw
191.682

mw
191.52

EXISTING OVERFLOW
WEIR ELEV=191.00+/-

1 : 1000 METRIC

0 20 40 60

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Legend

CATCHMENT BOUNDARY

CATCHMENT PARAMETER

ID#
AREA

EX. OVERLAND FLOW ROUTE

EX. STORM SEWER

Project:
GRIMSBY ANAEROBIC DIGESTION
SITE EXPANSION

Figure Title:
PRE-DEVELOPMENT
CATCHMENT FIGURE

Figure No:
FIGURE 2

SOBYE ROAD

N

tg=191.705
cb1 nw inv=191.19
se inv=191.21

mw 192.384

NEW PARKING

EXISTING SEPTIC BED LOCATION

RESERVE SEPTIC BED LOCATION

GRASS

WEIGH SCALE

OFFICE BUILDING

NEW GRAVEL

ex. septic tank

DICB 6

ex. electrical area

PROPOSED DIGESTER

PROPOSED PUMP BUILDING 2 (GROSS AREA = 1344ft 2)

PROPOSED DIGESTER

PROPOSED DIGESTER

PROPOSED STORAGE TANK

NEW GRAVEL ACCESS

GRAVEL

NEW GRAVEL

PROPOSED PUMP BUILDING 2 (GROSS AREA = 1344ft 2)

PROPOSED DIGESTER

202

2.25ha

PROPOSED BUILDING

100-YEAR PONDING ELEVATION = 189.55m

SECONDARY CONTAINMENT PONDING ELEVATION = 191.26m

100-YEAR + SECONDARY CONTAINMENT PONDING ELEVATION = 191.52m

mw 191.720

FUTURE DEVELOPEMENT

PROPOSED BUILDING (GROSS AREA = 3185ft 2)

ex. tanks

EXISTING STORAGE TANK

ex. tanks

GRASS

PROPOSED STORAGE TANK

CB 8

300 mmØ PVC

mw 192.332

NEW GRAVEL

CBMH 5

375 mmØ PVC

ASPHALT

CB 4

PROPOSED BUILDING (GROSS AREA = 24,000ft 2)

ex. bldg

ex. tanks

EXISTING STORAGE TANK

ex. tanks

ex. tanks

ex. tanks

ex. tanks

mw 192.425

mw 192.338

300 mmØ PVC

CBMH 2

CBMH 3

300 mmØ PVC

300 mmØ PVC

PROPOSED BUILDING (GROSS AREA = 7680ft 2)

STMH 1

375 mmØ PVC

6.0m WIDE GRAVEL ACCESS

201

3.54ha

GRASS

ex. 450mmø stm

ex. 450mmø stm

OGS 10

300 mmØ PVC

300 mmØ PVC

CBMH 9

WATER FROM STORMWATER MANAGEMENT DETENTION AREA IS TO BE PUMPED FROM CBMH9 THROUGH OGS10 TO THE EXISTING STORMWATER MANAGEMENT PONDS AFTER THE PONDS HAVE NATURALLY DRAWN DOWN.

mw 191.528

mw 191.682

mw 191.686

1 : 1000 METRIC

0 20 40 60

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Legend

CATCHMENT BOUNDARY

CATCHMENT PARAMETER

ID#
AREA

PROPOSED PONDING ELEVATION

PROPOSED OVERLAND FLOW ROUTE

PROPOSED STORM SEWER

PROPOSED SWALE 0.2%

EX. STORM SEWER

EX. SANITARY SEWER EX. MH

EX. WATERMAIN EX. VALVE EX. FH

Project:
GRIMSBY ANAEROBIC DIGESTION SITE EXPANSION

Figure Title:
POST-DEVELOPMENT CATCHMENT FIGURE

Figure No:
FIGURE 3

Appendix A

Chicago Distribution Hyetographs

GRIT ENGINEERING INC

Storm Water Management

Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	**603.250**	**6.000**	**0.790**
5-Year	785.590	6.000	0.790
10-Year	953.640	7.000	0.790
25-Year	1119.020	7.000	0.790
50-Year	1301.800	8.000	0.800
100-Year	1426.130	8.000	0.800

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

Before the peak:

$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

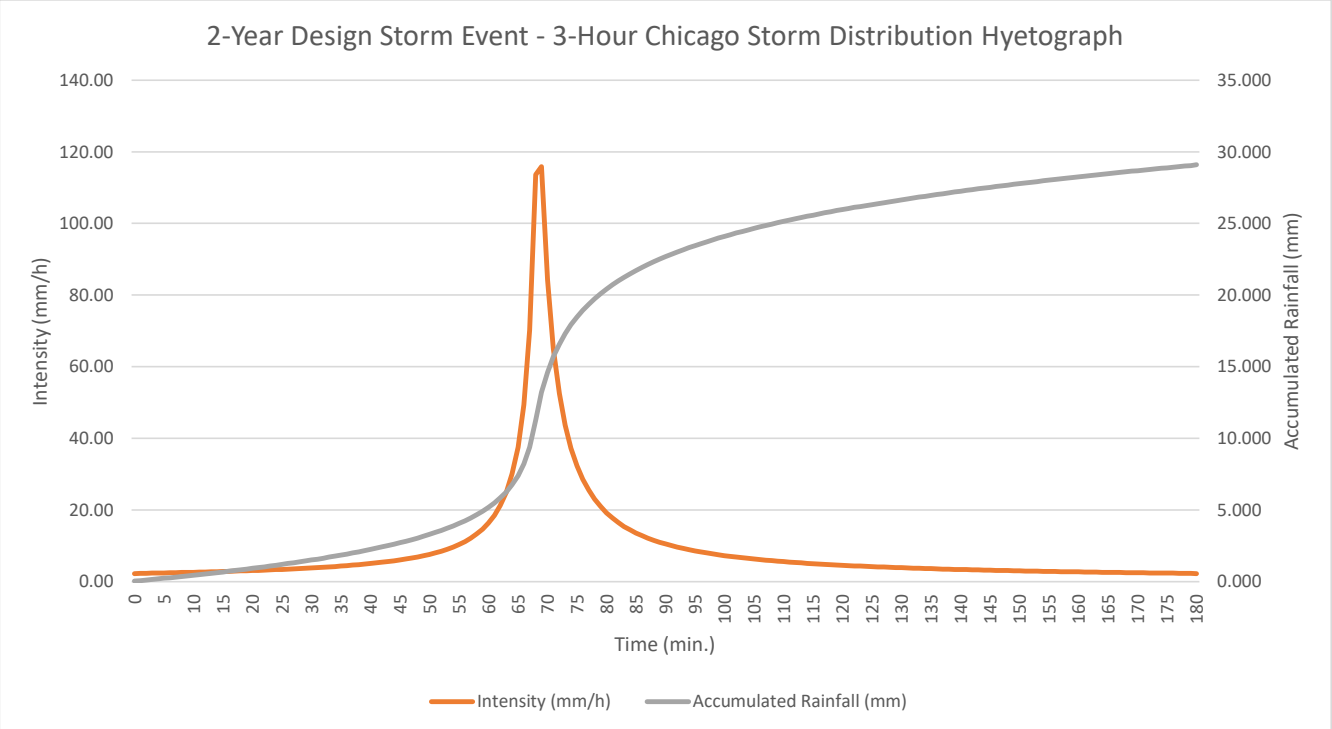
After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

Storm Parameters

Rainfall Duration=	3:00	hours
Rainfall Duration=	180	minutes
Starting Time=	0:00	
Time Step=	0:01	
r=	0.38	
t_d=	1	

t_d*r=	0.38	
t_d*(1-r)=	0.62	
i_p=	129.7	Peak Rainfall Intensity (mm/h)
t_b=	68.4	Time Before Peak (min.)
t_a=	111.6	Time After Peak (min.)
Total Rainfall Depth=	29.09	mm



2-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00	2.29	0.038	0.038
67.4	1	0:01	2.32	0.039	0.077
66.4	2	0:02	2.35	0.039	0.116
65.4	3	0:03	2.38	0.040	0.156
64.4	4	0:04	2.41	0.040	0.196
63.4	5	0:05	2.44	0.041	0.237
62.4	6	0:06	2.48	0.041	0.278
61.4	7	0:07	2.51	0.042	0.320
60.4	8	0:08	2.55	0.043	0.362
59.4	9	0:09	2.59	0.043	0.405
58.4	10	0:10	2.63	0.044	0.449
57.4	11	0:11	2.67	0.044	0.494
56.4	12	0:12	2.71	0.045	0.539
55.4	13	0:13	2.75	0.046	0.585
54.4	14	0:14	2.80	0.047	0.631
53.4	15	0:15	2.84	0.047	0.679
52.4	16	0:16	2.89	0.048	0.727
51.4	17	0:17	2.94	0.049	0.776
50.4	18	0:18	2.99	0.050	0.826
49.4	19	0:19	3.05	0.051	0.877
48.4	20	0:20	3.10	0.052	0.928
47.4	21	0:21	3.16	0.053	0.981
46.4	22	0:22	3.22	0.054	1.035
45.4	23	0:23	3.29	0.055	1.090
44.4	24	0:24	3.35	0.056	1.145
43.4	25	0:25	3.42	0.057	1.202
42.4	26	0:26	3.49	0.058	1.261
41.4	27	0:27	3.57	0.060	1.320
40.4	28	0:28	3.65	0.061	1.381
39.4	29	0:29	3.73	0.062	1.443
38.4	30	0:30	3.82	0.064	1.507
37.4	31	0:31	3.92	0.065	1.572
36.4	32	0:32	4.01	0.067	1.639
35.4	33	0:33	4.12	0.069	1.708
34.4	34	0:34	4.23	0.070	1.778
33.4	35	0:35	4.34	0.072	1.851
32.4	36	0:36	4.47	0.074	1.925
31.4	37	0:37	4.60	0.077	2.002
30.4	38	0:38	4.74	0.079	2.081
29.4	39	0:39	4.89	0.081	2.162
28.4	40	0:40	5.05	0.084	2.246
27.4	41	0:41	5.22	0.087	2.333
26.4	42	0:42	5.41	0.090	2.424
25.4	43	0:43	5.61	0.093	2.517
24.4	44	0:44	5.82	0.097	2.614
23.4	45	0:45	6.06	0.101	2.715
22.4	46	0:46	6.31	0.105	2.820
21.4	47	0:47	6.60	0.110	2.930
20.4	48	0:48	6.90	0.115	3.045
19.4	49	0:49	7.24	0.121	3.166
18.4	50	0:50	7.62	0.127	3.293
17.4	51	0:51	8.05	0.134	3.427
16.4	52	0:52	8.52	0.142	3.569
15.4	53	0:53	9.06	0.151	3.720
14.4	54	0:54	9.67	0.161	3.881

13.4	55	0:55	10.37	0.173	4.054
12.4	56	0:56	11.19	0.187	4.241
11.4	57	0:57	12.15	0.203	4.443
10.4	58	0:58	13.29	0.222	4.665
9.4	59	0:59	14.68	0.245	4.909
8.4	60	1:00	16.38	0.273	5.182
7.4	61	1:01	18.51	0.309	5.491
6.4	62	1:02	21.27	0.354	5.845
5.4	63	1:03	24.95	0.416	6.261
4.4	64	1:04	30.05	0.501	6.762
3.4	65	1:05	37.54	0.626	7.388
2.4	66	1:06	49.37	0.823	8.210
1.4	67	1:07	70.19	1.170	9.380
0.4	68	1:08	113.71	1.895	11.275
0.6	69	1:09	115.87	1.931	13.207
1.6	70	1:10	84.18	1.403	14.610
2.6	71	1:11	65.05	1.084	15.694
3.6	72	1:12	52.47	0.874	16.568
4.6	73	1:13	43.68	0.728	17.296
5.6	74	1:14	37.25	0.621	17.917
6.6	75	1:15	32.37	0.539	18.456
7.6	76	1:16	28.56	0.476	18.932
8.6	77	1:17	25.51	0.425	19.357
9.6	78	1:18	23.03	0.384	19.741
10.6	79	1:19	20.97	0.349	20.091
11.6	80	1:20	19.24	0.321	20.411
12.6	81	1:21	17.77	0.296	20.707
13.6	82	1:22	16.50	0.275	20.982
14.6	83	1:23	15.40	0.257	21.239
15.6	84	1:24	14.43	0.241	21.480
16.6	85	1:25	13.58	0.226	21.706
17.6	86	1:26	12.83	0.214	21.920
18.6	87	1:27	12.15	0.203	22.122
19.6	88	1:28	11.54	0.192	22.315
20.6	89	1:29	10.99	0.183	22.498
21.6	90	1:30	10.50	0.175	22.673
22.6	91	1:31	10.04	0.167	22.840
23.6	92	1:32	9.63	0.160	23.001
24.6	93	1:33	9.25	0.154	23.155
25.6	94	1:34	8.89	0.148	23.303
26.6	95	1:35	8.57	0.143	23.446
27.6	96	1:36	8.27	0.138	23.584
28.6	97	1:37	7.99	0.133	23.717
29.6	98	1:38	7.73	0.129	23.846
30.6	99	1:39	7.48	0.125	23.970
31.6	100	1:40	7.26	0.121	24.091
32.6	101	1:41	7.04	0.117	24.209
33.6	102	1:42	6.84	0.114	24.323
34.6	103	1:43	6.65	0.111	24.434
35.6	104	1:44	6.47	0.108	24.541
36.6	105	1:45	6.31	0.105	24.647
37.6	106	1:46	6.15	0.102	24.749
38.6	107	1:47	6.00	0.100	24.849
39.6	108	1:48	5.85	0.098	24.946
40.6	109	1:49	5.72	0.095	25.042
41.6	110	1:50	5.59	0.093	25.135
42.6	111	1:51	5.46	0.091	25.226
43.6	112	1:52	5.34	0.089	25.315
44.6	113	1:53	5.23	0.087	25.402

45.6	114	1:54	5.13	0.085	25.488
46.6	115	1:55	5.02	0.084	25.571
47.6	116	1:56	4.92	0.082	25.653
48.6	117	1:57	4.83	0.080	25.734
49.6	118	1:58	4.74	0.079	25.813
50.6	119	1:59	4.65	0.078	25.890
51.6	120	2:00	4.57	0.076	25.966
52.6	121	2:01	4.49	0.075	26.041
53.6	122	2:02	4.41	0.074	26.115
54.6	123	2:03	4.34	0.072	26.187
55.6	124	2:04	4.26	0.071	26.258
56.6	125	2:05	4.20	0.070	26.328
57.6	126	2:06	4.13	0.069	26.397
58.6	127	2:07	4.06	0.068	26.465
59.6	128	2:08	4.00	0.067	26.531
60.6	129	2:09	3.94	0.066	26.597
61.6	130	2:10	3.88	0.065	26.662
62.6	131	2:11	3.83	0.064	26.725
63.6	132	2:12	3.77	0.063	26.788
64.6	133	2:13	3.72	0.062	26.850
65.6	134	2:14	3.67	0.061	26.911
66.6	135	2:15	3.62	0.060	26.972
67.6	136	2:16	3.57	0.059	27.031
68.6	137	2:17	3.52	0.059	27.090
69.6	138	2:18	3.48	0.058	27.148
70.6	139	2:19	3.43	0.057	27.205
71.6	140	2:20	3.39	0.056	27.261
72.6	141	2:21	3.35	0.056	27.317
73.6	142	2:22	3.31	0.055	27.372
74.6	143	2:23	3.27	0.054	27.427
75.6	144	2:24	3.23	0.054	27.480
76.6	145	2:25	3.19	0.053	27.534
77.6	146	2:26	3.15	0.053	27.586
78.6	147	2:27	3.12	0.052	27.638
79.6	148	2:28	3.08	0.051	27.689
80.6	149	2:29	3.05	0.051	27.740
81.6	150	2:30	3.01	0.050	27.790
82.6	151	2:31	2.98	0.050	27.840
83.6	152	2:32	2.95	0.049	27.889
84.6	153	2:33	2.92	0.049	27.938
85.6	154	2:34	2.89	0.048	27.986
86.6	155	2:35	2.86	0.048	28.034
87.6	156	2:36	2.83	0.047	28.081
88.6	157	2:37	2.80	0.047	28.128
89.6	158	2:38	2.77	0.046	28.174
90.6	159	2:39	2.75	0.046	28.220
91.6	160	2:40	2.72	0.045	28.265
92.6	161	2:41	2.69	0.045	28.310
93.6	162	2:42	2.67	0.044	28.354
94.6	163	2:43	2.64	0.044	28.398
95.6	164	2:44	2.62	0.044	28.442
96.6	165	2:45	2.60	0.043	28.485
97.6	166	2:46	2.57	0.043	28.528
98.6	167	2:47	2.55	0.042	28.571
99.6	168	2:48	2.53	0.042	28.613
100.6	169	2:49	2.51	0.042	28.655
101.6	170	2:50	2.48	0.041	28.696
102.6	171	2:51	2.46	0.041	28.737
103.6	172	2:52	2.44	0.041	28.778

104.6	173	2:53	2.42	0.040	28.818
105.6	174	2:54	2.40	0.040	28.858
106.6	175	2:55	2.38	0.040	28.898
107.6	176	2:56	2.36	0.039	28.937
108.6	177	2:57	2.34	0.039	28.976
109.6	178	2:58	2.32	0.039	29.015
110.6	179	2:59	2.31	0.038	29.053
111.6	180	3:00	2.29	0.038	29.092

GRIT ENGINEERING INC

Storm Water Management

Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	603.250	6.000	0.790
5-Year	**785.590**	**6.000**	**0.790**
10-Year	953.640	7.000	0.790
25-Year	1119.020	7.000	0.790
50-Year	1301.800	8.000	0.800
100-Year	1426.130	8.000	0.800

Storm Parameters

Rainfall Duration=	3:00	hours
Rainfall Duration=	180	minutes
Starting Time=	0:00	
Time Step=	0:01	
r=	0.38	
t_d=	1	

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

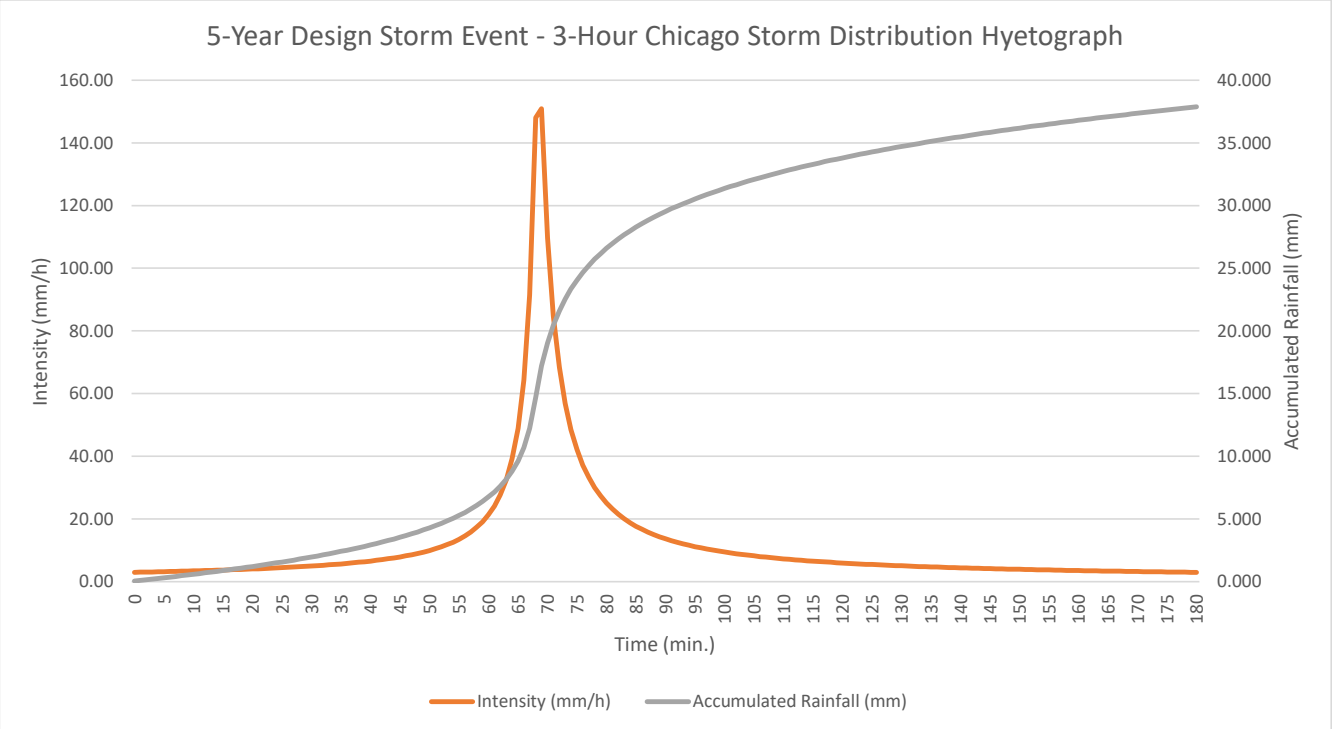
Before the peak:

$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

t_d*r=	0.38	
t_d*(1-r)=	0.62	
i_p=	168.9	Peak Rainfall Intensity (mm/h)
t_b=	68.4	Time Before Peak (min.)
t_a=	111.6	Time After Peak (min.)
Total Rainfall Depth=	37.88	mm



5-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00	2.98	0.050	0.050
67.4	1	0:01	3.02	0.050	0.100
66.4	2	0:02	3.06	0.051	0.151
65.4	3	0:03	3.10	0.052	0.203
64.4	4	0:04	3.14	0.052	0.255
63.4	5	0:05	3.18	0.053	0.308
62.4	6	0:06	3.23	0.054	0.362
61.4	7	0:07	3.27	0.055	0.416
60.4	8	0:08	3.32	0.055	0.472
59.4	9	0:09	3.37	0.056	0.528
58.4	10	0:10	3.42	0.057	0.585
57.4	11	0:11	3.47	0.058	0.643
56.4	12	0:12	3.53	0.059	0.702
55.4	13	0:13	3.58	0.060	0.761
54.4	14	0:14	3.64	0.061	0.822
53.4	15	0:15	3.70	0.062	0.884
52.4	16	0:16	3.77	0.063	0.947
51.4	17	0:17	3.83	0.064	1.010
50.4	18	0:18	3.90	0.065	1.075
49.4	19	0:19	3.97	0.066	1.142
48.4	20	0:20	4.04	0.067	1.209
47.4	21	0:21	4.12	0.069	1.278
46.4	22	0:22	4.20	0.070	1.348
45.4	23	0:23	4.28	0.071	1.419
44.4	24	0:24	4.37	0.073	1.492
43.4	25	0:25	4.46	0.074	1.566
42.4	26	0:26	4.55	0.076	1.642
41.4	27	0:27	4.65	0.078	1.719
40.4	28	0:28	4.75	0.079	1.798
39.4	29	0:29	4.86	0.081	1.880
38.4	30	0:30	4.98	0.083	1.963
37.4	31	0:31	5.10	0.085	2.048
36.4	32	0:32	5.23	0.087	2.135
35.4	33	0:33	5.36	0.089	2.224
34.4	34	0:34	5.51	0.092	2.316
33.4	35	0:35	5.66	0.094	2.410
32.4	36	0:36	5.82	0.097	2.507
31.4	37	0:37	5.99	0.100	2.607
30.4	38	0:38	6.17	0.103	2.710
29.4	39	0:39	6.37	0.106	2.816
28.4	40	0:40	6.57	0.110	2.925
27.4	41	0:41	6.80	0.113	3.039
26.4	42	0:42	7.04	0.117	3.156
25.4	43	0:43	7.30	0.122	3.278
24.4	44	0:44	7.58	0.126	3.404
23.4	45	0:45	7.89	0.131	3.536
22.4	46	0:46	8.22	0.137	3.673
21.4	47	0:47	8.59	0.143	3.816
20.4	48	0:48	8.99	0.150	3.966
19.4	49	0:49	9.43	0.157	4.123
18.4	50	0:50	9.93	0.165	4.288
17.4	51	0:51	10.48	0.175	4.463
16.4	52	0:52	11.10	0.185	4.648
15.4	53	0:53	11.80	0.197	4.844
14.4	54	0:54	12.59	0.210	5.054

13.4	55	0:55	13.51	0.225	5.279
12.4	56	0:56	14.57	0.243	5.522
11.4	57	0:57	15.82	0.264	5.786
10.4	58	0:58	17.31	0.289	6.075
9.4	59	0:59	19.11	0.319	6.393
8.4	60	1:00	21.33	0.355	6.749
7.4	61	1:01	24.11	0.402	7.150
6.4	62	1:02	27.70	0.462	7.612
5.4	63	1:03	32.49	0.541	8.153
4.4	64	1:04	39.14	0.652	8.806
3.4	65	1:05	48.89	0.815	9.621
2.4	66	1:06	64.29	1.072	10.692
1.4	67	1:07	91.40	1.523	12.215
0.4	68	1:08	148.09	2.468	14.684
0.6	69	1:09	150.90	2.515	17.198
1.6	70	1:10	109.62	1.827	19.026
2.6	71	1:11	84.71	1.412	20.437
3.6	72	1:12	68.33	1.139	21.576
4.6	73	1:13	56.88	0.948	22.524
5.6	74	1:14	48.50	0.808	23.333
6.6	75	1:15	42.15	0.702	24.035
7.6	76	1:16	37.19	0.620	24.655
8.6	77	1:17	33.22	0.554	25.208
9.6	78	1:18	29.99	0.500	25.708
10.6	79	1:19	27.31	0.455	26.163
11.6	80	1:20	25.05	0.418	26.581
12.6	81	1:21	23.14	0.386	26.966
13.6	82	1:22	21.49	0.358	27.325
14.6	83	1:23	20.05	0.334	27.659
15.6	84	1:24	18.80	0.313	27.972
16.6	85	1:25	17.69	0.295	28.267
17.6	86	1:26	16.70	0.278	28.545
18.6	87	1:27	15.82	0.264	28.809
19.6	88	1:28	15.03	0.251	29.060
20.6	89	1:29	14.32	0.239	29.298
21.6	90	1:30	13.67	0.228	29.526
22.6	91	1:31	13.08	0.218	29.744
23.6	92	1:32	12.54	0.209	29.953
24.6	93	1:33	12.04	0.201	30.154
25.6	94	1:34	11.58	0.193	30.347
26.6	95	1:35	11.16	0.186	30.533
27.6	96	1:36	10.77	0.179	30.712
28.6	97	1:37	10.40	0.173	30.886
29.6	98	1:38	10.06	0.168	31.053
30.6	99	1:39	9.75	0.162	31.216
31.6	100	1:40	9.45	0.157	31.373
32.6	101	1:41	9.17	0.153	31.526
33.6	102	1:42	8.91	0.148	31.675
34.6	103	1:43	8.66	0.144	31.819
35.6	104	1:44	8.43	0.141	31.959
36.6	105	1:45	8.21	0.137	32.096
37.6	106	1:46	8.00	0.133	32.230
38.6	107	1:47	7.81	0.130	32.360
39.6	108	1:48	7.62	0.127	32.487
40.6	109	1:49	7.44	0.124	32.611
41.6	110	1:50	7.27	0.121	32.732
42.6	111	1:51	7.11	0.119	32.851
43.6	112	1:52	6.96	0.116	32.967
44.6	113	1:53	6.81	0.114	33.080

45.6	114	1:54	6.67	0.111	33.192
46.6	115	1:55	6.54	0.109	33.301
47.6	116	1:56	6.41	0.107	33.407
48.6	117	1:57	6.29	0.105	33.512
49.6	118	1:58	6.17	0.103	33.615
50.6	119	1:59	6.06	0.101	33.716
51.6	120	2:00	5.95	0.099	33.815
52.6	121	2:01	5.84	0.097	33.913
53.6	122	2:02	5.74	0.096	34.008
54.6	123	2:03	5.65	0.094	34.102
55.6	124	2:04	5.55	0.093	34.195
56.6	125	2:05	5.46	0.091	34.286
57.6	126	2:06	5.38	0.090	34.376
58.6	127	2:07	5.29	0.088	34.464
59.6	128	2:08	5.21	0.087	34.551
60.6	129	2:09	5.13	0.086	34.636
61.6	130	2:10	5.06	0.084	34.721
62.6	131	2:11	4.98	0.083	34.804
63.6	132	2:12	4.91	0.082	34.885
64.6	133	2:13	4.84	0.081	34.966
65.6	134	2:14	4.78	0.080	35.046
66.6	135	2:15	4.71	0.079	35.124
67.6	136	2:16	4.65	0.077	35.202
68.6	137	2:17	4.59	0.076	35.278
69.6	138	2:18	4.53	0.075	35.354
70.6	139	2:19	4.47	0.074	35.428
71.6	140	2:20	4.41	0.074	35.502
72.6	141	2:21	4.36	0.073	35.574
73.6	142	2:22	4.30	0.072	35.646
74.6	143	2:23	4.25	0.071	35.717
75.6	144	2:24	4.20	0.070	35.787
76.6	145	2:25	4.15	0.069	35.856
77.6	146	2:26	4.10	0.068	35.924
78.6	147	2:27	4.06	0.068	35.992
79.6	148	2:28	4.01	0.067	36.059
80.6	149	2:29	3.97	0.066	36.125
81.6	150	2:30	3.92	0.065	36.191
82.6	151	2:31	3.88	0.065	36.255
83.6	152	2:32	3.84	0.064	36.319
84.6	153	2:33	3.80	0.063	36.383
85.6	154	2:34	3.76	0.063	36.445
86.6	155	2:35	3.72	0.062	36.507
87.6	156	2:36	3.69	0.061	36.569
88.6	157	2:37	3.65	0.061	36.630
89.6	158	2:38	3.61	0.060	36.690
90.6	159	2:39	3.58	0.060	36.749
91.6	160	2:40	3.54	0.059	36.808
92.6	161	2:41	3.51	0.058	36.867
93.6	162	2:42	3.48	0.058	36.925
94.6	163	2:43	3.44	0.057	36.982
95.6	164	2:44	3.41	0.057	37.039
96.6	165	2:45	3.38	0.056	37.095
97.6	166	2:46	3.35	0.056	37.151
98.6	167	2:47	3.32	0.055	37.207
99.6	168	2:48	3.29	0.055	37.261
100.6	169	2:49	3.26	0.054	37.316
101.6	170	2:50	3.23	0.054	37.370
102.6	171	2:51	3.21	0.053	37.423
103.6	172	2:52	3.18	0.053	37.476

104.6	173	2:53	3.15	0.053	37.529
105.6	174	2:54	3.13	0.052	37.581
106.6	175	2:55	3.10	0.052	37.633
107.6	176	2:56	3.08	0.051	37.684
108.6	177	2:57	3.05	0.051	37.735
109.6	178	2:58	3.03	0.050	37.785
110.6	179	2:59	3.00	0.050	37.835
111.6	180	3:00	2.98	0.050	37.885
		3:01			

GRIT ENGINEERING INC

Storm Water Management

Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	603.250	6.000	0.790
5-Year	785.590	6.000	0.790
10-Year	**953.640**	**7.000**	**0.790**
25-Year	1119.020	7.000	0.790
50-Year	1301.800	8.000	0.800
100-Year	1426.130	8.000	0.800

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

Before the peak:

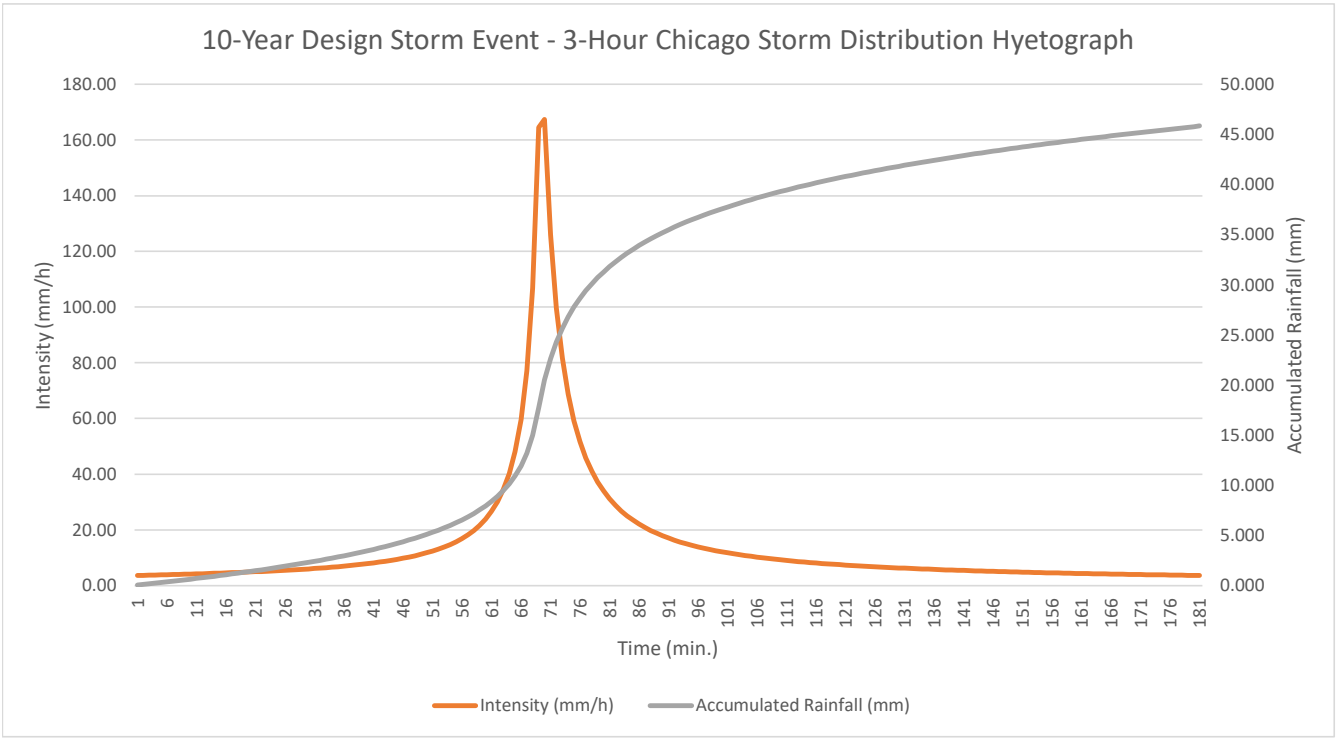
$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

Storm Parameters

Rainfall Duration=	3:00	hours	t_d*r=	0.38	
Rainfall Duration=	180	minutes	t_d*(1-r)=	0.62	
Starting Time=	0:00		i_p=	184.5	Peak Rainfall Intensity (mm/h)
Time Step=	0:01		t_b=	68.4	Time Before Peak (min.)
r=	0.38		t_a=	111.6	Time After Peak (min.)
t_d=	1		Total Rainfall Depth=	45.83	mm



10-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00	3.66	0.061	0.061
67.4	1	0:01	3.71	0.062	0.123
66.4	2	0:02	3.76	0.063	0.186
65.4	3	0:03	3.81	0.064	0.249
64.4	4	0:04	3.86	0.064	0.314
63.4	5	0:05	3.92	0.065	0.379
62.4	6	0:06	3.97	0.066	0.445
61.4	7	0:07	4.03	0.067	0.512
60.4	8	0:08	4.09	0.068	0.581
59.4	9	0:09	4.15	0.069	0.650
58.4	10	0:10	4.21	0.070	0.720
57.4	11	0:11	4.28	0.071	0.791
56.4	12	0:12	4.35	0.072	0.864
55.4	13	0:13	4.42	0.074	0.937
54.4	14	0:14	4.49	0.075	1.012
53.4	15	0:15	4.57	0.076	1.088
52.4	16	0:16	4.64	0.077	1.166
51.4	17	0:17	4.73	0.079	1.245
50.4	18	0:18	4.81	0.080	1.325
49.4	19	0:19	4.90	0.082	1.406
48.4	20	0:20	4.99	0.083	1.489
47.4	21	0:21	5.08	0.085	1.574
46.4	22	0:22	5.18	0.086	1.661
45.4	23	0:23	5.29	0.088	1.749
44.4	24	0:24	5.39	0.090	1.839
43.4	25	0:25	5.51	0.092	1.930
42.4	26	0:26	5.63	0.094	2.024
41.4	27	0:27	5.75	0.096	2.120
40.4	28	0:28	5.88	0.098	2.218
39.4	29	0:29	6.02	0.100	2.318
38.4	30	0:30	6.16	0.103	2.421
37.4	31	0:31	6.31	0.105	2.526
36.4	32	0:32	6.47	0.108	2.634
35.4	33	0:33	6.64	0.111	2.745
34.4	34	0:34	6.82	0.114	2.859
33.4	35	0:35	7.01	0.117	2.976
32.4	36	0:36	7.22	0.120	3.096
31.4	37	0:37	7.43	0.124	3.220
30.4	38	0:38	7.66	0.128	3.347
29.4	39	0:39	7.90	0.132	3.479
28.4	40	0:40	8.17	0.136	3.615
27.4	41	0:41	8.45	0.141	3.756
26.4	42	0:42	8.75	0.146	3.902
25.4	43	0:43	9.08	0.151	4.053
24.4	44	0:44	9.44	0.157	4.210
23.4	45	0:45	9.82	0.164	4.374
22.4	46	0:46	10.24	0.171	4.545
21.4	47	0:47	10.70	0.178	4.723
20.4	48	0:48	11.21	0.187	4.910
19.4	49	0:49	11.77	0.196	5.106
18.4	50	0:50	12.39	0.206	5.312
17.4	51	0:51	13.08	0.218	5.530
16.4	52	0:52	13.86	0.231	5.761
15.4	53	0:53	14.73	0.246	6.007
14.4	54	0:54	15.73	0.262	6.269

13.4	55	0:55	16.88	0.281	6.551
12.4	56	0:56	18.21	0.304	6.854
11.4	57	0:57	19.78	0.330	7.184
10.4	58	0:58	21.63	0.361	7.544
9.4	59	0:59	23.86	0.398	7.942
8.4	60	1:00	26.60	0.443	8.385
7.4	61	1:01	30.02	0.500	8.886
6.4	62	1:02	34.41	0.573	9.459
5.4	63	1:03	40.19	0.670	10.129
4.4	64	1:04	48.13	0.802	10.931
3.4	65	1:05	59.56	0.993	11.924
2.4	66	1:06	77.13	1.285	13.209
1.4	67	1:07	106.80	1.780	14.989
0.4	68	1:08	164.57	2.743	17.732
0.6	69	1:09	167.31	2.788	20.521
1.6	70	1:10	125.94	2.099	22.620
2.6	71	1:11	99.61	1.660	24.280
3.6	72	1:12	81.64	1.361	25.641
4.6	73	1:13	68.75	1.146	26.786
5.6	74	1:14	59.11	0.985	27.772
6.6	75	1:15	51.69	0.861	28.633
7.6	76	1:16	45.82	0.764	29.397
8.6	77	1:17	41.08	0.685	30.081
9.6	78	1:18	37.18	0.620	30.701
10.6	79	1:19	33.93	0.566	31.266
11.6	80	1:20	31.18	0.520	31.786
12.6	81	1:21	28.83	0.481	32.267
13.6	82	1:22	26.80	0.447	32.713
14.6	83	1:23	25.03	0.417	33.130
15.6	84	1:24	23.47	0.391	33.522
16.6	85	1:25	22.10	0.368	33.890
17.6	86	1:26	20.87	0.348	34.238
18.6	87	1:27	19.78	0.330	34.568
19.6	88	1:28	18.79	0.313	34.881
20.6	89	1:29	17.90	0.298	35.179
21.6	90	1:30	17.08	0.285	35.464
22.6	91	1:31	16.34	0.272	35.736
23.6	92	1:32	15.66	0.261	35.997
24.6	93	1:33	15.04	0.251	36.248
25.6	94	1:34	14.47	0.241	36.489
26.6	95	1:35	13.94	0.232	36.721
27.6	96	1:36	13.44	0.224	36.945
28.6	97	1:37	12.98	0.216	37.162
29.6	98	1:38	12.56	0.209	37.371
30.6	99	1:39	12.16	0.203	37.574
31.6	100	1:40	11.79	0.196	37.770
32.6	101	1:41	11.43	0.191	37.961
33.6	102	1:42	11.11	0.185	38.146
34.6	103	1:43	10.80	0.180	38.326
35.6	104	1:44	10.50	0.175	38.501
36.6	105	1:45	10.23	0.170	38.671
37.6	106	1:46	9.97	0.166	38.837
38.6	107	1:47	9.72	0.162	38.999
39.6	108	1:48	9.48	0.158	39.157
40.6	109	1:49	9.26	0.154	39.312
41.6	110	1:50	9.05	0.151	39.462
42.6	111	1:51	8.85	0.147	39.610
43.6	112	1:52	8.65	0.144	39.754
44.6	113	1:53	8.47	0.141	39.895

45.6	114	1:54	8.29	0.138	40.033
46.6	115	1:55	8.12	0.135	40.169
47.6	116	1:56	7.96	0.133	40.301
48.6	117	1:57	7.81	0.130	40.432
49.6	118	1:58	7.66	0.128	40.559
50.6	119	1:59	7.52	0.125	40.685
51.6	120	2:00	7.38	0.123	40.808
52.6	121	2:01	7.25	0.121	40.928
53.6	122	2:02	7.12	0.119	41.047
54.6	123	2:03	7.00	0.117	41.164
55.6	124	2:04	6.88	0.115	41.278
56.6	125	2:05	6.77	0.113	41.391
57.6	126	2:06	6.66	0.111	41.502
58.6	127	2:07	6.56	0.109	41.612
59.6	128	2:08	6.45	0.108	41.719
60.6	129	2:09	6.35	0.106	41.825
61.6	130	2:10	6.26	0.104	41.929
62.6	131	2:11	6.17	0.103	42.032
63.6	132	2:12	6.08	0.101	42.133
64.6	133	2:13	5.99	0.100	42.233
65.6	134	2:14	5.91	0.098	42.332
66.6	135	2:15	5.83	0.097	42.429
67.6	136	2:16	5.75	0.096	42.525
68.6	137	2:17	5.67	0.094	42.619
69.6	138	2:18	5.60	0.093	42.712
70.6	139	2:19	5.52	0.092	42.804
71.6	140	2:20	5.45	0.091	42.895
72.6	141	2:21	5.38	0.090	42.985
73.6	142	2:22	5.32	0.089	43.074
74.6	143	2:23	5.25	0.088	43.161
75.6	144	2:24	5.19	0.086	43.248
76.6	145	2:25	5.13	0.085	43.333
77.6	146	2:26	5.07	0.084	43.418
78.6	147	2:27	5.01	0.083	43.501
79.6	148	2:28	4.95	0.083	43.584
80.6	149	2:29	4.90	0.082	43.665
81.6	150	2:30	4.84	0.081	43.746
82.6	151	2:31	4.79	0.080	43.826
83.6	152	2:32	4.74	0.079	43.905
84.6	153	2:33	4.69	0.078	43.983
85.6	154	2:34	4.64	0.077	44.060
86.6	155	2:35	4.59	0.077	44.137
87.6	156	2:36	4.54	0.076	44.213
88.6	157	2:37	4.50	0.075	44.287
89.6	158	2:38	4.45	0.074	44.362
90.6	159	2:39	4.41	0.073	44.435
91.6	160	2:40	4.37	0.073	44.508
92.6	161	2:41	4.32	0.072	44.580
93.6	162	2:42	4.28	0.071	44.651
94.6	163	2:43	4.24	0.071	44.722
95.6	164	2:44	4.20	0.070	44.792
96.6	165	2:45	4.16	0.069	44.862
97.6	166	2:46	4.13	0.069	44.930
98.6	167	2:47	4.09	0.068	44.998
99.6	168	2:48	4.05	0.068	45.066
100.6	169	2:49	4.02	0.067	45.133
101.6	170	2:50	3.98	0.066	45.199
102.6	171	2:51	3.95	0.066	45.265
103.6	172	2:52	3.91	0.065	45.330

104.6	173	2:53	3.88	0.065	45.395
105.6	174	2:54	3.85	0.064	45.459
106.6	175	2:55	3.82	0.064	45.523
107.6	176	2:56	3.78	0.063	45.586
108.6	177	2:57	3.75	0.063	45.648
109.6	178	2:58	3.72	0.062	45.710
110.6	179	2:59	3.69	0.062	45.772
111.6	180	3:00	3.66	0.061	45.833
		3:01			

Storm Water Management

Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	603.250	6.000	0.790
5-Year	785.590	6.000	0.790
10-Year	953.640	7.000	0.790
25-Year	**1119.020**	**7.000**	**0.790**
50-Year	1301.800	8.000	0.800
100-Year	1426.130	8.000	0.800

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

Before the peak:

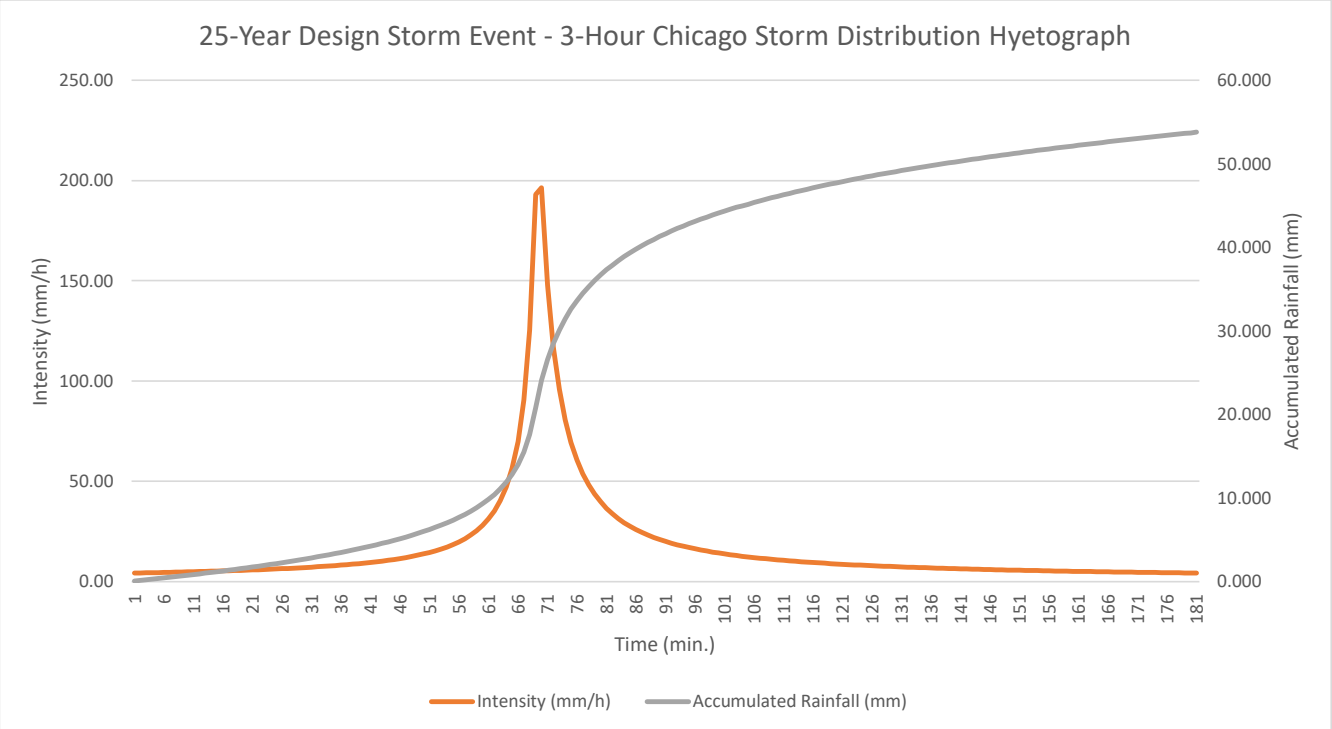
$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

Storm Parameters

Rainfall Duration=	3:00	hours	t_d*r=	0.38	
Rainfall Duration=	180	minutes	$t_d*(1-r)$=	0.62	
Starting Time=	0:00		i_p=	216.5	Peak Rainfall Intensity (mm/h)
Time Step=	0:01		t_b=	68.4	Time Before Peak (min.)
r=	0.38		t_a=	111.6	Time After Peak (min.)
t_d=	1		Total Rainfall Depth=	53.78	mm



25-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00	4.30	0.072	0.072
67.4	1	0:01	4.36	0.073	0.144
66.4	2	0:02	4.41	0.074	0.218
65.4	3	0:03	4.47	0.075	0.292
64.4	4	0:04	4.54	0.076	0.368
63.4	5	0:05	4.60	0.077	0.445
62.4	6	0:06	4.66	0.078	0.522
61.4	7	0:07	4.73	0.079	0.601
60.4	8	0:08	4.80	0.080	0.681
59.4	9	0:09	4.87	0.081	0.762
58.4	10	0:10	4.95	0.082	0.845
57.4	11	0:11	5.02	0.084	0.929
56.4	12	0:12	5.10	0.085	1.014
55.4	13	0:13	5.18	0.086	1.100
54.4	14	0:14	5.27	0.088	1.188
53.4	15	0:15	5.36	0.089	1.277
52.4	16	0:16	5.45	0.091	1.368
51.4	17	0:17	5.54	0.092	1.460
50.4	18	0:18	5.64	0.094	1.554
49.4	19	0:19	5.75	0.096	1.650
48.4	20	0:20	5.85	0.098	1.748
47.4	21	0:21	5.97	0.099	1.847
46.4	22	0:22	6.08	0.101	1.949
45.4	23	0:23	6.20	0.103	2.052
44.4	24	0:24	6.33	0.106	2.157
43.4	25	0:25	6.46	0.108	2.265
42.4	26	0:26	6.60	0.110	2.375
41.4	27	0:27	6.75	0.112	2.488
40.4	28	0:28	6.90	0.115	2.603
39.4	29	0:29	7.06	0.118	2.720
38.4	30	0:30	7.23	0.121	2.841
37.4	31	0:31	7.41	0.123	2.964
36.4	32	0:32	7.60	0.127	3.091
35.4	33	0:33	7.80	0.130	3.221
34.4	34	0:34	8.01	0.133	3.354
33.4	35	0:35	8.23	0.137	3.492
32.4	36	0:36	8.47	0.141	3.633
31.4	37	0:37	8.72	0.145	3.778
30.4	38	0:38	8.99	0.150	3.928
29.4	39	0:39	9.28	0.155	4.082
28.4	40	0:40	9.58	0.160	4.242
27.4	41	0:41	9.91	0.165	4.407
26.4	42	0:42	10.27	0.171	4.579
25.4	43	0:43	10.66	0.178	4.756
24.4	44	0:44	11.07	0.185	4.941
23.4	45	0:45	11.52	0.192	5.133
22.4	46	0:46	12.02	0.200	5.333
21.4	47	0:47	12.56	0.209	5.542
20.4	48	0:48	13.15	0.219	5.761
19.4	49	0:49	13.81	0.230	5.992
18.4	50	0:50	14.53	0.242	6.234
17.4	51	0:51	15.35	0.256	6.490
16.4	52	0:52	16.26	0.271	6.761
15.4	53	0:53	17.29	0.288	7.049
14.4	54	0:54	18.46	0.308	7.356

13.4	55	0:55	19.81	0.330	7.687
12.4	56	0:56	21.37	0.356	8.043
11.4	57	0:57	23.21	0.387	8.430
10.4	58	0:58	25.38	0.423	8.853
9.4	59	0:59	28.00	0.467	9.319
8.4	60	1:00	31.21	0.520	9.840
7.4	61	1:01	35.23	0.587	10.427
6.4	62	1:02	40.37	0.673	11.100
5.4	63	1:03	47.17	0.786	11.886
4.4	64	1:04	56.48	0.941	12.827
3.4	65	1:05	69.89	1.165	13.992
2.4	66	1:06	90.51	1.508	15.500
1.4	67	1:07	125.32	2.089	17.589
0.4	68	1:08	193.11	3.219	20.807
0.6	69	1:09	196.32	3.272	24.079
1.6	70	1:10	147.78	2.463	26.542
2.6	71	1:11	116.88	1.948	28.490
3.6	72	1:12	95.80	1.597	30.087
4.6	73	1:13	80.67	1.344	31.432
5.6	74	1:14	69.36	1.156	32.588
6.6	75	1:15	60.65	1.011	33.599
7.6	76	1:16	53.76	0.896	34.495
8.6	77	1:17	48.20	0.803	35.298
9.6	78	1:18	43.63	0.727	36.025
10.6	79	1:19	39.81	0.664	36.689
11.6	80	1:20	36.59	0.610	37.299
12.6	81	1:21	33.83	0.564	37.862
13.6	82	1:22	31.45	0.524	38.386
14.6	83	1:23	29.37	0.489	38.876
15.6	84	1:24	27.55	0.459	39.335
16.6	85	1:25	25.93	0.432	39.767
17.6	86	1:26	24.49	0.408	40.175
18.6	87	1:27	23.21	0.387	40.562
19.6	88	1:28	22.05	0.367	40.930
20.6	89	1:29	21.00	0.350	41.280
21.6	90	1:30	20.05	0.334	41.614
22.6	91	1:31	19.18	0.320	41.933
23.6	92	1:32	18.38	0.306	42.240
24.6	93	1:33	17.65	0.294	42.534
25.6	94	1:34	16.98	0.283	42.817
26.6	95	1:35	16.35	0.273	43.089
27.6	96	1:36	15.77	0.263	43.352
28.6	97	1:37	15.24	0.254	43.606
29.6	98	1:38	14.74	0.246	43.852
30.6	99	1:39	14.27	0.238	44.090
31.6	100	1:40	13.83	0.230	44.320
32.6	101	1:41	13.42	0.224	44.544
33.6	102	1:42	13.03	0.217	44.761
34.6	103	1:43	12.67	0.211	44.972
35.6	104	1:44	12.32	0.205	45.177
36.6	105	1:45	12.00	0.200	45.377
37.6	106	1:46	11.69	0.195	45.572
38.6	107	1:47	11.40	0.190	45.762
39.6	108	1:48	11.13	0.185	45.948
40.6	109	1:49	10.87	0.181	46.129
41.6	110	1:50	10.62	0.177	46.306
42.6	111	1:51	10.38	0.173	46.479
43.6	112	1:52	10.15	0.169	46.648
44.6	113	1:53	9.94	0.166	46.814

45.6	114	1:54	9.73	0.162	46.976
46.6	115	1:55	9.53	0.159	47.135
47.6	116	1:56	9.34	0.156	47.290
48.6	117	1:57	9.16	0.153	47.443
49.6	118	1:58	8.99	0.150	47.593
50.6	119	1:59	8.82	0.147	47.740
51.6	120	2:00	8.66	0.144	47.884
52.6	121	2:01	8.51	0.142	48.026
53.6	122	2:02	8.36	0.139	48.165
54.6	123	2:03	8.22	0.137	48.302
55.6	124	2:04	8.08	0.135	48.437
56.6	125	2:05	7.94	0.132	48.569
57.6	126	2:06	7.82	0.130	48.700
58.6	127	2:07	7.69	0.128	48.828
59.6	128	2:08	7.57	0.126	48.954
60.6	129	2:09	7.46	0.124	49.078
61.6	130	2:10	7.35	0.122	49.201
62.6	131	2:11	7.24	0.121	49.321
63.6	132	2:12	7.13	0.119	49.440
64.6	133	2:13	7.03	0.117	49.557
65.6	134	2:14	6.93	0.116	49.673
66.6	135	2:15	6.84	0.114	49.787
67.6	136	2:16	6.74	0.112	49.899
68.6	137	2:17	6.65	0.111	50.010
69.6	138	2:18	6.57	0.109	50.120
70.6	139	2:19	6.48	0.108	50.228
71.6	140	2:20	6.40	0.107	50.334
72.6	141	2:21	6.32	0.105	50.440
73.6	142	2:22	6.24	0.104	50.544
74.6	143	2:23	6.16	0.103	50.646
75.6	144	2:24	6.09	0.101	50.748
76.6	145	2:25	6.02	0.100	50.848
77.6	146	2:26	5.95	0.099	50.947
78.6	147	2:27	5.88	0.098	51.045
79.6	148	2:28	5.81	0.097	51.142
80.6	149	2:29	5.75	0.096	51.238
81.6	150	2:30	5.68	0.095	51.332
82.6	151	2:31	5.62	0.094	51.426
83.6	152	2:32	5.56	0.093	51.519
84.6	153	2:33	5.50	0.092	51.610
85.6	154	2:34	5.44	0.091	51.701
86.6	155	2:35	5.39	0.090	51.791
87.6	156	2:36	5.33	0.089	51.880
88.6	157	2:37	5.28	0.088	51.968
89.6	158	2:38	5.23	0.087	52.055
90.6	159	2:39	5.17	0.086	52.141
91.6	160	2:40	5.12	0.085	52.227
92.6	161	2:41	5.07	0.085	52.311
93.6	162	2:42	5.03	0.084	52.395
94.6	163	2:43	4.98	0.083	52.478
95.6	164	2:44	4.93	0.082	52.560
96.6	165	2:45	4.89	0.081	52.641
97.6	166	2:46	4.84	0.081	52.722
98.6	167	2:47	4.80	0.080	52.802
99.6	168	2:48	4.76	0.079	52.881
100.6	169	2:49	4.71	0.079	52.960
101.6	170	2:50	4.67	0.078	53.038
102.6	171	2:51	4.63	0.077	53.115
103.6	172	2:52	4.59	0.077	53.191

104.6	173	2:53	4.55	0.076	53.267
105.6	174	2:54	4.52	0.075	53.343
106.6	175	2:55	4.48	0.075	53.417
107.6	176	2:56	4.44	0.074	53.491
108.6	177	2:57	4.40	0.073	53.565
109.6	178	2:58	4.37	0.073	53.637
110.6	179	2:59	4.33	0.072	53.710
111.6	180	3:00	4.30	0.072	53.781
		3:01			

Storm Water Management
Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	603.250	6.000	0.790
5-Year	785.590	6.000	0.790
10-Year	953.640	7.000	0.790
25-Year	1119.020	7.000	0.790
50-Year	**1301.800**	**8.000**	**0.800**
100-Year	1426.130	8.000	0.800

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

Before the peak:

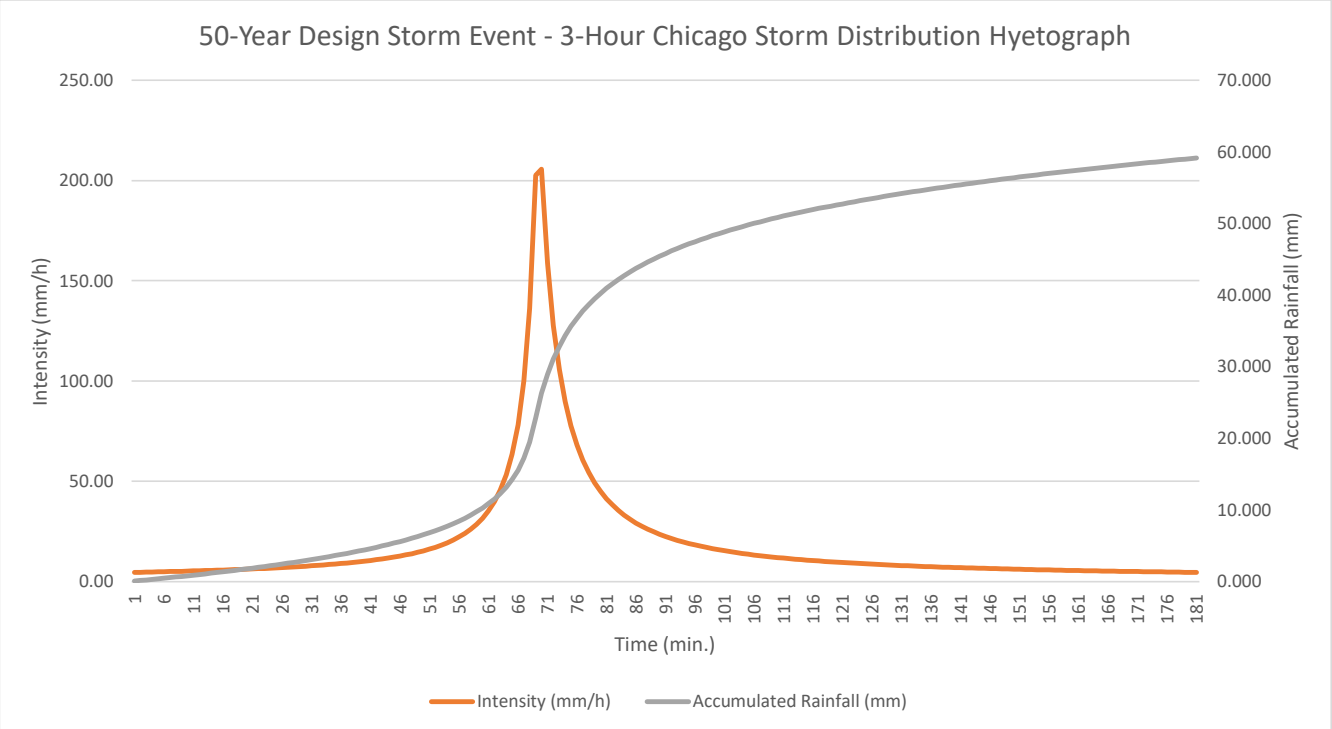
$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

Storm Parameters

Rainfall Duration=	3:00	hours	t_d*r=	0.38	
Rainfall Duration=	180	minutes	$t_d*(1-r)$=	0.62	
Starting Time=	0:00		i_p=	224.5	Peak Rainfall Intensity (mm/h)
Time Step=	0:01		t_b=	68.4	Time Before Peak (min.)
r=	0.38		t_a=	111.6	Time After Peak (min.)
t_d=	1		Total Rainfall Depth=	59.15	mm



50-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00	4.62	0.077	0.077
67.4	1	0:01	4.68	0.078	0.155
66.4	2	0:02	4.74	0.079	0.234
65.4	3	0:03	4.81	0.080	0.314
64.4	4	0:04	4.88	0.081	0.396
63.4	5	0:05	4.95	0.082	0.478
62.4	6	0:06	5.02	0.084	0.562
61.4	7	0:07	5.10	0.085	0.647
60.4	8	0:08	5.17	0.086	0.733
59.4	9	0:09	5.25	0.088	0.820
58.4	10	0:10	5.33	0.089	0.909
57.4	11	0:11	5.42	0.090	1.000
56.4	12	0:12	5.51	0.092	1.091
55.4	13	0:13	5.60	0.093	1.185
54.4	14	0:14	5.69	0.095	1.280
53.4	15	0:15	5.79	0.097	1.376
52.4	16	0:16	5.89	0.098	1.474
51.4	17	0:17	6.00	0.100	1.574
50.4	18	0:18	6.11	0.102	1.676
49.4	19	0:19	6.23	0.104	1.780
48.4	20	0:20	6.35	0.106	1.886
47.4	21	0:21	6.47	0.108	1.994
46.4	22	0:22	6.60	0.110	2.104
45.4	23	0:23	6.74	0.112	2.216
44.4	24	0:24	6.88	0.115	2.331
43.4	25	0:25	7.03	0.117	2.448
42.4	26	0:26	7.19	0.120	2.568
41.4	27	0:27	7.35	0.122	2.690
40.4	28	0:28	7.52	0.125	2.815
39.4	29	0:29	7.70	0.128	2.944
38.4	30	0:30	7.89	0.132	3.075
37.4	31	0:31	8.09	0.135	3.210
36.4	32	0:32	8.31	0.138	3.349
35.4	33	0:33	8.53	0.142	3.491
34.4	34	0:34	8.77	0.146	3.637
33.4	35	0:35	9.02	0.150	3.787
32.4	36	0:36	9.29	0.155	3.942
31.4	37	0:37	9.57	0.160	4.102
30.4	38	0:38	9.88	0.165	4.266
29.4	39	0:39	10.20	0.170	4.436
28.4	40	0:40	10.55	0.176	4.612
27.4	41	0:41	10.93	0.182	4.794
26.4	42	0:42	11.33	0.189	4.983
25.4	43	0:43	11.77	0.196	5.179
24.4	44	0:44	12.25	0.204	5.384
23.4	45	0:45	12.76	0.213	5.596
22.4	46	0:46	13.32	0.222	5.818
21.4	47	0:47	13.94	0.232	6.051
20.4	48	0:48	14.62	0.244	6.294
19.4	49	0:49	15.37	0.256	6.550
18.4	50	0:50	16.20	0.270	6.820
17.4	51	0:51	17.13	0.285	7.106
16.4	52	0:52	18.17	0.303	7.409
15.4	53	0:53	19.35	0.323	7.731
14.4	54	0:54	20.70	0.345	8.076

13.4	55	0:55	22.24	0.371	8.447
12.4	56	0:56	24.03	0.400	8.848
11.4	57	0:57	26.13	0.435	9.283
10.4	58	0:58	28.61	0.477	9.760
9.4	59	0:59	31.60	0.527	10.286
8.4	60	1:00	35.25	0.587	10.874
7.4	61	1:01	39.80	0.663	11.537
6.4	62	1:02	45.59	0.760	12.297
5.4	63	1:03	53.19	0.887	13.184
4.4	64	1:04	63.51	1.058	14.242
3.4	65	1:05	78.15	1.302	15.545
2.4	66	1:06	100.19	1.670	17.214
1.4	67	1:07	136.21	2.270	19.485
0.4	68	1:08	202.64	3.377	22.862
0.6	69	1:09	205.68	3.428	26.290
1.6	70	1:10	158.73	2.646	28.935
2.6	71	1:11	127.61	2.127	31.062
3.6	72	1:12	105.77	1.763	32.825
4.6	73	1:13	89.75	1.496	34.321
5.6	74	1:14	77.58	1.293	35.614
6.6	75	1:15	68.09	1.135	36.749
7.6	76	1:16	60.51	1.009	37.757
8.6	77	1:17	54.35	0.906	38.663
9.6	78	1:18	49.24	0.821	39.484
10.6	79	1:19	44.96	0.749	40.233
11.6	80	1:20	41.33	0.689	40.922
12.6	81	1:21	38.21	0.637	41.559
13.6	82	1:22	35.51	0.592	42.151
14.6	83	1:23	33.15	0.553	42.703
15.6	84	1:24	31.08	0.518	43.221
16.6	85	1:25	29.24	0.487	43.709
17.6	86	1:26	27.60	0.460	44.169
18.6	87	1:27	26.13	0.435	44.604
19.6	88	1:28	24.80	0.413	45.017
20.6	89	1:29	23.60	0.393	45.411
21.6	90	1:30	22.51	0.375	45.786
22.6	91	1:31	21.52	0.359	46.145
23.6	92	1:32	20.60	0.343	46.488
24.6	93	1:33	19.77	0.329	46.817
25.6	94	1:34	19.00	0.317	47.134
26.6	95	1:35	18.28	0.305	47.439
27.6	96	1:36	17.62	0.294	47.732
28.6	97	1:37	17.00	0.283	48.016
29.6	98	1:38	16.43	0.274	48.290
30.6	99	1:39	15.90	0.265	48.554
31.6	100	1:40	15.39	0.257	48.811
32.6	101	1:41	14.92	0.249	49.060
33.6	102	1:42	14.48	0.241	49.301
34.6	103	1:43	14.07	0.234	49.536
35.6	104	1:44	13.68	0.228	49.764
36.6	105	1:45	13.31	0.222	49.985
37.6	106	1:46	12.96	0.216	50.201
38.6	107	1:47	12.62	0.210	50.412
39.6	108	1:48	12.31	0.205	50.617
40.6	109	1:49	12.01	0.200	50.817
41.6	110	1:50	11.73	0.195	51.012
42.6	111	1:51	11.46	0.191	51.203
43.6	112	1:52	11.20	0.187	51.390
44.6	113	1:53	10.95	0.183	51.573

45.6	114	1:54	10.72	0.179	51.751
46.6	115	1:55	10.50	0.175	51.926
47.6	116	1:56	10.28	0.171	52.098
48.6	117	1:57	10.08	0.168	52.266
49.6	118	1:58	9.88	0.165	52.430
50.6	119	1:59	9.69	0.161	52.592
51.6	120	2:00	9.51	0.158	52.750
52.6	121	2:01	9.33	0.156	52.906
53.6	122	2:02	9.16	0.153	53.058
54.6	123	2:03	9.00	0.150	53.209
55.6	124	2:04	8.85	0.147	53.356
56.6	125	2:05	8.70	0.145	53.501
57.6	126	2:06	8.55	0.143	53.643
58.6	127	2:07	8.41	0.140	53.784
59.6	128	2:08	8.28	0.138	53.922
60.6	129	2:09	8.15	0.136	54.057
61.6	130	2:10	8.02	0.134	54.191
62.6	131	2:11	7.90	0.132	54.323
63.6	132	2:12	7.78	0.130	54.452
64.6	133	2:13	7.67	0.128	54.580
65.6	134	2:14	7.56	0.126	54.706
66.6	135	2:15	7.45	0.124	54.830
67.6	136	2:16	7.34	0.122	54.953
68.6	137	2:17	7.24	0.121	55.073
69.6	138	2:18	7.14	0.119	55.192
70.6	139	2:19	7.05	0.117	55.310
71.6	140	2:20	6.96	0.116	55.426
72.6	141	2:21	6.87	0.114	55.540
73.6	142	2:22	6.78	0.113	55.653
74.6	143	2:23	6.69	0.112	55.765
75.6	144	2:24	6.61	0.110	55.875
76.6	145	2:25	6.53	0.109	55.984
77.6	146	2:26	6.45	0.108	56.091
78.6	147	2:27	6.37	0.106	56.197
79.6	148	2:28	6.30	0.105	56.302
80.6	149	2:29	6.23	0.104	56.406
81.6	150	2:30	6.16	0.103	56.509
82.6	151	2:31	6.09	0.101	56.610
83.6	152	2:32	6.02	0.100	56.711
84.6	153	2:33	5.95	0.099	56.810
85.6	154	2:34	5.89	0.098	56.908
86.6	155	2:35	5.83	0.097	57.005
87.6	156	2:36	5.76	0.096	57.101
88.6	157	2:37	5.70	0.095	57.196
89.6	158	2:38	5.64	0.094	57.290
90.6	159	2:39	5.59	0.093	57.383
91.6	160	2:40	5.53	0.092	57.476
92.6	161	2:41	5.48	0.091	57.567
93.6	162	2:42	5.42	0.090	57.657
94.6	163	2:43	5.37	0.089	57.747
95.6	164	2:44	5.32	0.089	57.835
96.6	165	2:45	5.27	0.088	57.923
97.6	166	2:46	5.22	0.087	58.010
98.6	167	2:47	5.17	0.086	58.096
99.6	168	2:48	5.12	0.085	58.182
100.6	169	2:49	5.08	0.085	58.266
101.6	170	2:50	5.03	0.084	58.350
102.6	171	2:51	4.99	0.083	58.433
103.6	172	2:52	4.94	0.082	58.515

104.6	173	2:53	4.90	0.082	58.597
105.6	174	2:54	4.86	0.081	58.678
106.6	175	2:55	4.81	0.080	58.758
107.6	176	2:56	4.77	0.080	58.838
108.6	177	2:57	4.73	0.079	58.917
109.6	178	2:58	4.69	0.078	58.995
110.6	179	2:59	4.66	0.078	59.073
111.6	180	3:00	4.62	0.077	59.150
		3:01			

GRIT ENGINEERING INC

Storm Water Management
Chicago Storm Hyetograph Creation

Project	Grimsby Anaerobic Digestion Site Expansion
Project Number	GE22-0178-1
Client	1414229 Ontario Limited
Address	242 Sobye Road, Grimsby
Date	Thursday, October 12, 2023

Rainfall Parameters

Niagara Region IDF			
Rainfall Event	A	B	C
2-Year	603.250	6.000	0.790
5-Year	785.590	6.000	0.790
10-Year	953.640	7.000	0.790
25-Year	1119.020	7.000	0.790
50-Year	1301.800	8.000	0.800
100-Year	**1426.130**	**8.000**	**0.800**

Hyetograph Formulas

$$i_p = \frac{A}{(\Delta t + B)^c} = \text{peak rainfall intensity}$$

Before the peak:

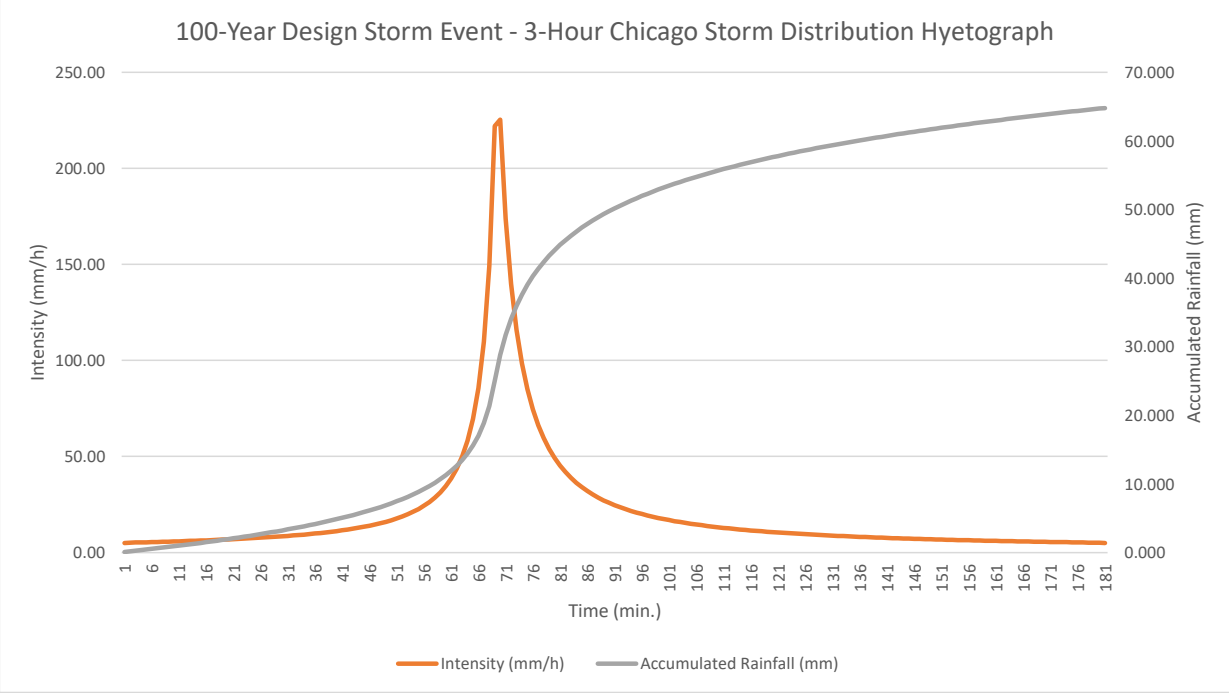
$$i_b = \frac{A[((1-c)t_b/r) + B]}{[t_b/r + B]^{1+c}}$$

After the peak:

$$i_a = \frac{A[((1-c)t_a/(1-r)) + B]}{[t_a/(1-r) + B]^{1+c}}$$

Storm Parameters

Rainfall Duration=	3:00	hours	t_d*r=	0.38	
Rainfall Duration=	180	minutes	t_d*(1-r)=	0.62	
Starting Time=	0:00		i_p=	245.9	Peak Rainfall Intensity (mm/h)
Time Step=	0:01		t_b=	68.4	Time Before Peak (min.)
r=	0.38		t_a=	111.6	Time After Peak (min.)
t_d=	1.0		Total Rainfall Depth=	64.80	mm



100-Year Design Storm Event - 3-Hour Chicago Storm Distribution Hyetograph

t_b OR t_a	Time (min.)	Time (h:m)	Intensity (mm/h)	Rainfall Depth (mm)	Accumulated Rainfall (mm)
68.4	0	0:00:00	5.06	0.084	0.084
67.4	1	0:01:00	5.13	0.085	0.170
66.4	2	0:02:00	5.20	0.087	0.256
65.4	3	0:03:00	5.27	0.088	0.344
64.4	4	0:04:00	5.34	0.089	0.433
63.4	5	0:05:00	5.42	0.090	0.524
62.4	6	0:06:00	5.50	0.092	0.615
61.4	7	0:07:00	5.58	0.093	0.708
60.4	8	0:08:00	5.67	0.094	0.803
59.4	9	0:09:00	5.75	0.096	0.899
58.4	10	0:10:00	5.84	0.097	0.996
57.4	11	0:11:00	5.94	0.099	1.095
56.4	12	0:12:00	6.03	0.101	1.196
55.4	13	0:13:00	6.13	0.102	1.298
54.4	14	0:14:00	6.24	0.104	1.402
53.4	15	0:15:00	6.35	0.106	1.508
52.4	16	0:16:00	6.46	0.108	1.615
51.4	17	0:17:00	6.57	0.110	1.725
50.4	18	0:18:00	6.70	0.112	1.836
49.4	19	0:19:00	6.82	0.114	1.950
48.4	20	0:20:00	6.95	0.116	2.066
47.4	21	0:21:00	7.09	0.118	2.184
46.4	22	0:22:00	7.23	0.121	2.305
45.4	23	0:23:00	7.38	0.123	2.428
44.4	24	0:24:00	7.54	0.126	2.553
43.4	25	0:25:00	7.70	0.128	2.682
42.4	26	0:26:00	7.87	0.131	2.813
41.4	27	0:27:00	8.05	0.134	2.947
40.4	28	0:28:00	8.24	0.137	3.084
39.4	29	0:29:00	8.44	0.141	3.225
38.4	30	0:30:00	8.65	0.144	3.369
37.4	31	0:31:00	8.87	0.148	3.517
36.4	32	0:32:00	9.10	0.152	3.668
35.4	33	0:33:00	9.34	0.156	3.824
34.4	34	0:34:00	9.60	0.160	3.984
33.4	35	0:35:00	9.88	0.165	4.149
32.4	36	0:36:00	10.17	0.170	4.318
31.4	37	0:37:00	10.49	0.175	4.493
30.4	38	0:38:00	10.82	0.180	4.674
29.4	39	0:39:00	11.18	0.186	4.860
28.4	40	0:40:00	11.56	0.193	5.053
27.4	41	0:41:00	11.97	0.200	5.252
26.4	42	0:42:00	12.42	0.207	5.459
25.4	43	0:43:00	12.90	0.215	5.674
24.4	44	0:44:00	13.42	0.224	5.898
23.4	45	0:45:00	13.98	0.233	6.131
22.4	46	0:46:00	14.60	0.243	6.374
21.4	47	0:47:00	15.27	0.255	6.629
20.4	48	0:48:00	16.02	0.267	6.895
19.4	49	0:49:00	16.84	0.281	7.176
18.4	50	0:50:00	17.75	0.296	7.472
17.4	51	0:51:00	18.77	0.313	7.785
16.4	52	0:52:00	19.91	0.332	8.116
15.4	53	0:53:00	21.20	0.353	8.470
14.4	54	0:54:00	22.67	0.378	8.848
13.4	55	0:55:00	24.36	0.406	9.254
12.4	56	0:56:00	26.32	0.439	9.693
11.4	57	0:57:00	28.62	0.477	10.170

10.4	58	0:58:00	31.34	0.522	10.692
9.4	59	0:59:00	34.62	0.577	11.269
8.4	60	1:00:00	38.62	0.644	11.912
7.4	61	1:01:00	43.60	0.727	12.639
6.4	62	1:02:00	49.95	0.832	13.472
5.4	63	1:03:00	58.27	0.971	14.443
4.4	64	1:04:00	69.57	1.160	15.602
3.4	65	1:05:00	85.61	1.427	17.029
2.4	66	1:06:00	109.76	1.829	18.859
1.4	67	1:07:00	149.22	2.487	21.346
0.4	68	1:08:00	221.99	3.700	25.045
0.6	69	1:09:00	225.32	3.755	28.801
1.6	70	1:10:00	173.89	2.898	31.699
2.6	71	1:11:00	139.80	2.330	34.029
3.6	72	1:12:00	115.87	1.931	35.960
4.6	73	1:13:00	98.32	1.639	37.599
5.6	74	1:14:00	84.99	1.417	39.015
6.6	75	1:15:00	74.59	1.243	40.259
7.6	76	1:16:00	66.29	1.105	41.363
8.6	77	1:17:00	59.54	0.992	42.356
9.6	78	1:18:00	53.95	0.899	43.255
10.6	79	1:19:00	49.26	0.821	44.076
11.6	80	1:20:00	45.28	0.755	44.830
12.6	81	1:21:00	41.86	0.698	45.528
13.6	82	1:22:00	38.90	0.648	46.177
14.6	83	1:23:00	36.32	0.605	46.782
15.6	84	1:24:00	34.04	0.567	47.349
16.6	85	1:25:00	32.03	0.534	47.883
17.6	86	1:26:00	30.23	0.504	48.387
18.6	87	1:27:00	28.62	0.477	48.864
19.6	88	1:28:00	27.17	0.453	49.317
20.6	89	1:29:00	25.86	0.431	49.748
21.6	90	1:30:00	24.66	0.411	50.159
22.6	91	1:31:00	23.57	0.393	50.552
23.6	92	1:32:00	22.57	0.376	50.928
24.6	93	1:33:00	21.66	0.361	51.289
25.6	94	1:34:00	20.81	0.347	51.636
26.6	95	1:35:00	20.03	0.334	51.969
27.6	96	1:36:00	19.30	0.322	52.291
28.6	97	1:37:00	18.63	0.310	52.601
29.6	98	1:38:00	18.00	0.300	52.901
30.6	99	1:39:00	17.41	0.290	53.192
31.6	100	1:40:00	16.86	0.281	53.473
32.6	101	1:41:00	16.35	0.272	53.745
33.6	102	1:42:00	15.87	0.264	54.010
34.6	103	1:43:00	15.41	0.257	54.267
35.6	104	1:44:00	14.98	0.250	54.516
36.6	105	1:45:00	14.58	0.243	54.759
37.6	106	1:46:00	14.19	0.237	54.996
38.6	107	1:47:00	13.83	0.231	55.226
39.6	108	1:48:00	13.49	0.225	55.451
40.6	109	1:49:00	13.16	0.219	55.670
41.6	110	1:50:00	12.85	0.214	55.884
42.6	111	1:51:00	12.55	0.209	56.094
43.6	112	1:52:00	12.27	0.205	56.298
44.6	113	1:53:00	12.00	0.200	56.498
45.6	114	1:54:00	11.74	0.196	56.694
46.6	115	1:55:00	11.50	0.192	56.886
47.6	116	1:56:00	11.26	0.188	57.073
48.6	117	1:57:00	11.04	0.184	57.257
49.6	118	1:58:00	10.82	0.180	57.438
50.6	119	1:59:00	10.61	0.177	57.615

51.6	120	2:00:00	10.42	0.174	57.788
52.6	121	2:01:00	10.22	0.170	57.959
53.6	122	2:02:00	10.04	0.167	58.126
54.6	123	2:03:00	9.86	0.164	58.290
55.6	124	2:04:00	9.69	0.162	58.452
56.6	125	2:05:00	9.53	0.159	58.611
57.6	126	2:06:00	9.37	0.156	58.767
58.6	127	2:07:00	9.22	0.154	58.920
59.6	128	2:08:00	9.07	0.151	59.071
60.6	129	2:09:00	8.93	0.149	59.220
61.6	130	2:10:00	8.79	0.146	59.367
62.6	131	2:11:00	8.65	0.144	59.511
63.6	132	2:12:00	8.52	0.142	59.653
64.6	133	2:13:00	8.40	0.140	59.793
65.6	134	2:14:00	8.28	0.138	59.931
66.6	135	2:15:00	8.16	0.136	60.067
67.6	136	2:16:00	8.04	0.134	60.201
68.6	137	2:17:00	7.93	0.132	60.333
69.6	138	2:18:00	7.83	0.130	60.464
70.6	139	2:19:00	7.72	0.129	60.592
71.6	140	2:20:00	7.62	0.127	60.719
72.6	141	2:21:00	7.52	0.125	60.845
73.6	142	2:22:00	7.43	0.124	60.968
74.6	143	2:23:00	7.33	0.122	61.091
75.6	144	2:24:00	7.24	0.121	61.211
76.6	145	2:25:00	7.15	0.119	61.331
77.6	146	2:26:00	7.07	0.118	61.448
78.6	147	2:27:00	6.98	0.116	61.565
79.6	148	2:28:00	6.90	0.115	61.680
80.6	149	2:29:00	6.82	0.114	61.793
81.6	150	2:30:00	6.74	0.112	61.906
82.6	151	2:31:00	6.67	0.111	62.017
83.6	152	2:32:00	6.59	0.110	62.127
84.6	153	2:33:00	6.52	0.109	62.235
85.6	154	2:34:00	6.45	0.108	62.343
86.6	155	2:35:00	6.38	0.106	62.449
87.6	156	2:36:00	6.31	0.105	62.555
88.6	157	2:37:00	6.25	0.104	62.659
89.6	158	2:38:00	6.18	0.103	62.762
90.6	159	2:39:00	6.12	0.102	62.864
91.6	160	2:40:00	6.06	0.101	62.965
92.6	161	2:41:00	6.00	0.100	63.065
93.6	162	2:42:00	5.94	0.099	63.164
94.6	163	2:43:00	5.88	0.098	63.262
95.6	164	2:44:00	5.83	0.097	63.359
96.6	165	2:45:00	5.77	0.096	63.455
97.6	166	2:46:00	5.72	0.095	63.550
98.6	167	2:47:00	5.66	0.094	63.645
99.6	168	2:48:00	5.61	0.094	63.738
100.6	169	2:49:00	5.56	0.093	63.831
101.6	170	2:50:00	5.51	0.092	63.923
102.6	171	2:51:00	5.46	0.091	64.014
103.6	172	2:52:00	5.41	0.090	64.104
104.6	173	2:53:00	5.37	0.089	64.193
105.6	174	2:54:00	5.32	0.089	64.282
106.6	175	2:55:00	5.27	0.088	64.370
107.6	176	2:56:00	5.23	0.087	64.457
108.6	177	2:57:00	5.19	0.086	64.544
109.6	178	2:58:00	5.14	0.086	64.629
110.6	179	2:59:00	5.10	0.085	64.714
111.6	180	3:00:00	5.06	0.084	64.799
		3:01:00			

Appendix B

Pre-Development Stormwater Management Modelling

2-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	2yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.115	29.092
Evaporation Loss	0.000	0.000
Infiltration Loss	0.026	6.607
Surface Runoff	0.077	19.653
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.021	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.077	0.775
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.077	0.775
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	9.69728
Impervious Rainfall Intensity (mm/hr):	9.69728
Slope (%):	0.50000
Computed TOC (minutes):	73.24

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	29.09	0.00	0.00	6.61	19.65	189.23	0.676	0	01:13:14

Analysis began on: Tue Oct 3 17:07:45 2023
Analysis ended on: Tue Oct 3 17:07:54 2023
Total elapsed time: 00:00:09

5-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	5yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.149	37.884
Evaporation Loss	0.000	0.000
Infiltration Loss	0.028	7.183
Surface Runoff	0.110	27.871
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.024	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.110	1.099
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.110	1.099
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	12.62806
Impervious Rainfall Intensity (mm/hr):	12.62806
Slope (%):	0.50000
Computed TOC (minutes):	65.90

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	37.88	0.00	0.00	7.18	27.87	279.26	0.736	0	01:05:53

Analysis began on: Tue Oct 3 17:09:29 2023
Analysis ended on: Tue Oct 3 17:09:38 2023
Total elapsed time: 00:00:09

10-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	10yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.181	45.832
Evaporation Loss	0.000	0.000
Infiltration Loss	0.030	7.558
Surface Runoff	0.140	35.445
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.022	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.140	1.398
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.140	1.398
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	15.27739
Impervious Rainfall Intensity (mm/hr):	15.27739
Slope (%):	0.50000
Computed TOC (minutes):	61.06

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	45.83	0.00	0.00	7.56	35.44	354.28	0.773	0	01:01:03

Analysis began on: Tue Oct 3 17:10:31 2023
Analysis ended on: Tue Oct 3 17:10:39 2023
Total elapsed time: 00:00:08

25-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	25yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.212	53.782
Evaporation Loss	0.000	0.000
Infiltration Loss	0.031	7.845
Surface Runoff	0.170	43.110
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.024	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.170	1.700
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.170	1.700
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	17.92722
Impervious Rainfall Intensity (mm/hr):	17.92722
Slope (%):	0.50000
Computed TOC (minutes):	57.27

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	53.78	0.00	0.00	7.85	43.11	450.91	0.802	0	00:57:16

Analysis began on: Tue Oct 3 17:11:34 2023
Analysis ended on: Tue Oct 3 17:11:42 2023
Total elapsed time: 00:00:08

50-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	50yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.233	59.150
Evaporation Loss	0.000	0.000
Infiltration Loss	0.032	8.004
Surface Runoff	0.191	48.320
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.023	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.191	1.905
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.191	1.905
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	19.71656
Impervious Rainfall Intensity (mm/hr):	19.71656
Slope (%):	0.50000
Computed TOC (minutes):	55.14

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	59.15	0.00	0.00	8.00	48.32	511.10	0.817	0	00:55:08

Analysis began on: Tue Oct 3 17:12:24 2023
Analysis ended on: Tue Oct 3 17:12:33 2023
Total elapsed time: 00:00:09

100-Year Pre-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PreDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-02-2023 00:00:00
Ending Date OCT-04-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 1
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	100yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C101	39430.20	202.28	63.00	0.5000	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
Outlet	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.255	64.798
Evaporation Loss	0.000	0.000
Infiltration Loss	0.032	8.147
Surface Runoff	0.212	53.827
Final Surface Storage	0.011	2.839
Continuity Error (%)	-0.024	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.212	2.122
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.212	2.122
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C101

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	3272.34	D	98.00
50 - 75% grass cover, Fair	14852.80	D	84.00
Paved parking & roofs	8111.36	D	98.00

Gravel roads	13193.70	D	91.00
Composite Area & Weighted CN	39430.20		90.38

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C101

Flow length (m):	194.93
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	21.59933
Impervious Rainfall Intensity (mm/hr):	21.59933
Slope (%):	0.50000
Computed TOC (minutes):	53.16

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
C101	64.80	0.00	0.00	8.15	53.83	586.83	0.831	0	00:53:09

Analysis began on: Tue Oct 3 17:13:18 2023
Analysis ended on: Tue Oct 3 17:13:27 2023
Total elapsed time: 00:00:09

Appendix C

Post-Development Stormwater Management Modelling

2-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	2yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.168	29.092
Evaporation Loss	0.000	0.000
Infiltration Loss	0.050	8.686
Surface Runoff	0.099	17.144
Final Surface Storage	0.019	3.266
Continuity Error (%)	-0.017	

Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.099	0.992
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.099	0.992
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	9.69728
Impervious Rainfall Intensity (mm/hr):	9.69728
Slope (%):	0.75000
Computed TOC (minutes):	95.80

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	9.69728
Impervious Rainfall Intensity (mm/hr):	9.69728
Slope (%):	0.75000
Computed TOC (minutes):	88.10

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	29.09	0.00	0.00	8.08	17.84	136.89	0.613	0	01:35:47
C202	29.09	0.00	0.00	9.65	16.04	89.98	0.551	0	01:28:05

Analysis began on: Tue Oct 3 16:54:02 2023
Analysis ended on: Tue Oct 3 16:54:08 2023
Total elapsed time: 00:00:06

5-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	5yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.219	37.884
Evaporation Loss	0.000	0.000
Infiltration Loss	0.056	9.623
Surface Runoff	0.145	25.001
Final Surface Storage	0.019	3.267
Continuity Error (%)	-0.019	

Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.145	1.447
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.145	1.447
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	12.62806
Impervious Rainfall Intensity (mm/hr):	12.62806
Slope (%):	0.75000
Computed TOC (minutes):	86.19

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	12.62806
Impervious Rainfall Intensity (mm/hr):	12.62806
Slope (%):	0.75000
Computed TOC (minutes):	79.26

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	37.88	0.00	0.00	8.90	25.82	200.05	0.682	0	01:26:11
C202	37.88	0.00	0.00	10.77	23.71	129.30	0.626	0	01:19:15

Analysis began on: Tue Oct 3 16:57:44 2023
Analysis ended on: Tue Oct 3 16:57:53 2023
Total elapsed time: 00:00:09

10-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	10yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.265	45.832
Evaporation Loss	0.000	0.000
Infiltration Loss	0.059	10.254
Surface Runoff	0.187	32.319
Final Surface Storage	0.019	3.268
Continuity Error (%)	-0.018	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.187	1.870
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.187	1.870
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	15.27739
Impervious Rainfall Intensity (mm/hr):	15.27739
Slope (%):	0.75000
Computed TOC (minutes):	79.86

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	15.27739
Impervious Rainfall Intensity (mm/hr):	15.27739
Slope (%):	0.75000
Computed TOC (minutes):	73.44

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	45.83	0.00	0.00	9.44	33.22	251.46	0.725	0	01:19:51
C202	45.83	0.00	0.00	11.53	30.90	159.92	0.674	0	01:13:26

Analysis began on: Tue Oct 3 16:58:38 2023
Analysis ended on: Tue Oct 3 16:58:48 2023
Total elapsed time: 00:00:10

25-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	25yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.311	53.782
Evaporation Loss	0.000	0.000
Infiltration Loss	0.062	10.748
Surface Runoff	0.230	39.775
Final Surface Storage	0.019	3.269
Continuity Error (%)	-0.019	

Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.230	2.302
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.230	2.302
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	17.92722
Impervious Rainfall Intensity (mm/hr):	17.92722
Slope (%):	0.75000
Computed TOC (minutes):	74.91

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	17.92722
Impervious Rainfall Intensity (mm/hr):	17.92722
Slope (%):	0.75000
Computed TOC (minutes):	68.89

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	53.78	0.00	0.00	9.86	40.75	317.48	0.758	0	01:14:54
C202	53.78	0.00	0.00	12.14	38.24	201.09	0.711	0	01:08:53

Analysis began on: Tue Oct 3 16:59:32 2023
Analysis ended on: Tue Oct 3 16:59:42 2023
Total elapsed time: 00:00:10

50-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	50yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.342	59.150
Evaporation Loss	0.000	0.000
Infiltration Loss	0.064	11.026
Surface Runoff	0.260	44.866
Final Surface Storage	0.019	3.269
Continuity Error (%)	-0.019	

Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.260	2.596
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.260	2.596
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	19.71656
Impervious Rainfall Intensity (mm/hr):	19.71656
Slope (%):	0.75000
Computed TOC (minutes):	72.11

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	19.71656
Impervious Rainfall Intensity (mm/hr):	19.71656
Slope (%):	0.75000
Computed TOC (minutes):	66.32

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	59.15	0.00	0.00	10.10	45.88	358.20	0.776	0	01:12:06
C202	59.15	0.00	0.00	12.48	43.27	225.32	0.731	0	01:06:18

Analysis began on: Tue Oct 3 17:01:05 2023
Analysis ended on: Tue Oct 3 17:01:16 2023
Total elapsed time: 00:00:11

100-Year Post-Development

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.5.302 (Build 0)

****
Project Description
****
File Name ..... GE22-0178-1 - PostDev.SPF

****
Analysis Options
****
Flow Units ..... LPS
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Storage Node Exfiltration.. None
Starting Date OCT-03-2023 00:00:00
Ending Date OCT-05-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:01:00
Dry Time Step 01:00:00

****
Element Count
****
Number of rain gages 1
Number of subbasins 2
Number of nodes 2
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
Rain Gage-01	100yr3hr Niagara	INTENSITY	1.00

****
Subbasin Summary
****

Subbasin ID	Total Area m²	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
C201	35385.75	111.57	55.00	0.7500	Rain Gage-01
C202	22481.27	95.86	48.00	0.7500	Rain Gage-01

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
201out	OUTFALL	0.00	0.00	0.00	
202out	OUTFALL	0.00	0.00	0.00	

Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.375	64.798
Evaporation Loss	0.000	0.000
Infiltration Loss	0.065	11.280
Surface Runoff	0.291	50.261
Final Surface Storage	0.019	3.269
Continuity Error (%)	-0.019	

Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.291	2.909
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.291	2.909
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Composite Curve Number Computations Report
****

Subbasin C201

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	7466.82	D	98.00

50 - 75% grass cover, Fair	16971.71	D	84.00
Paved parking & roofs	2454.82	D	98.00
Gravel roads	8492.40	D	91.00
Composite Area & Weighted CN	35385.75		89.61

Subbasin C202

Soil/Surface Description	Area (m²)	Soil Group	CN
Paved parking & roofs	4107.63	D	98.00
50 - 75% grass cover, Fair	12559.90	D	84.00
Paved parking & roofs	113.37	D	98.00
Gravel roads	5700.36	D	91.00
Composite Area & Weighted CN	22481.26		88.40

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin C201

Flow length (m):	317.16
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	21.59933
Impervious Rainfall Intensity (mm/hr):	21.59933
Slope (%):	0.75000
Computed TOC (minutes):	69.53

Subbasin C202

Flow length (m):	234.52
Pervious Manning's Roughness:	0.25000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (mm/hr):	21.59933
Impervious Rainfall Intensity (mm/hr):	21.59933
Slope (%):	0.75000
Computed TOC (minutes):	63.94

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff LPS	Runoff Coefficient	Time of Concentration days	hh:mm:ss
C201	64.80	0.00	0.00	10.32	51.31	409.61	0.792	0	01:09:31
C202	64.80	0.00	0.00	12.80	48.60	257.47	0.750	0	01:03:56

Analysis began on: Tue Oct 3 17:03:30 2023
Analysis ended on: Tue Oct 3 17:03:41 2023
Total elapsed time: 00:00:11

Appendix D

Stormwater Quality Control Oil Grit Separator Sizing

ADS OGS Sizing Summary

Project Name:	424 Sobye Road
Consulting Engineer:	GRIT Engineering
Location:	Grimsby, ON
Sizing Completed By:	C. Neath

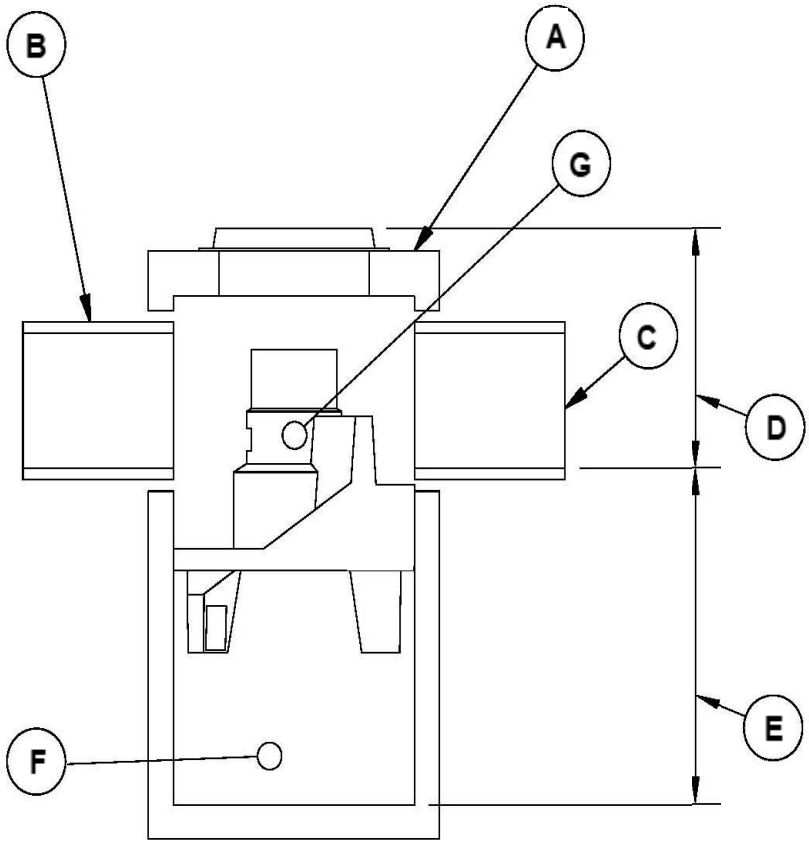
Email: cody.neath@ads-pipe.com

Treatment Requirements		
Treatment Goal:	Enhanced (MOE)	
Selected Parameters:	80% TSS	90% Volume
Selected Unit:	**FD-5HC**	

Site Details	
Site Area:	3.54 ha
% Impervious:	54%
Rational C:	0.63
Rainfall Station:	Niagara Falls, ONT
Particle Size Distribution:	Fine
Peak Flowrate:	136.89 L/s

Summary of Results		
Model	**TSS Removal**	**Volume Treated**
FD-4HC	78.0%	>90%
FD-5HC	82.0%	>90%
FD-6HC	84.0%	>90%
FD-8HC	89.0%	>90%
FD-10HC	92.0%	>90%

FD-5HC Specification	
Unit Diameter (A):	1,500 mm
Inlet Pipe Diameter (B):	300 mm
Outlet Pipe Diameter (C):	300 mm
Height, T/G to Outlet Invert (D):	2000 mm
Height, Outlet Invert to Sump (E):	1780 mm
Sediment Storage Capacity (F):	1.29 m³
Oil Storage Capacity (G):	1,135 L
Recommended Sediment Depth for Maintenance:	475 mm
Max. Pipe Diameter:	600 mm
Peak Flow Capacity:	566 L/s



Site Elevations:	
Rim Elevation:	100.00
Inlet Pipe Elevation:	98.00
Outlet Pipe Elevation:	98.00

Notes:

Removal efficiencies are based on NJDEP Test Protocols and independently verified.

All units supplied by ADS have numerous local, provincial, and international certifications (copies of which can be provided upon request). The design engineer is responsible for ensuring compliance with applicable regulations.

Project Name:	424 Sobye Road
Consulting Engineer:	GRIT Engineering
Location:	Grimsby, ON

Net Annual Removal Efficiency Summary: FD-5HC

Rainfall Intensity[1]	Fraction of Rainfall[1]	FD-5HC Removal Efficiency[2]	Weighted Net-Annual Removal Efficiency
mm/hr	%	%	%
0.50	0.0%	98.1%	0.0%
1.00	11.2%	92.0%	10.3%
1.50	18.6%	88.6%	16.4%
2.00	13.3%	86.2%	11.4%
2.50	2.9%	84.4%	2.5%
3.00	1.5%	83.0%	1.2%
3.50	8.9%	81.8%	7.3%
4.00	5.6%	80.8%	4.6%
4.50	1.0%	80.0%	0.8%
5.00	5.5%	79.2%	4.3%
6.00	4.3%	77.8%	3.3%
7.00	4.4%	76.7%	3.4%
8.00	3.5%	75.8%	2.6%
9.00	2.1%	75.0%	1.6%
10.00	2.3%	74.2%	1.7%
20.00	9.9%	69.6%	6.9%
30.00	2.7%	67.0%	1.8%
40.00	1.1%	65.2%	0.7%
50.00	0.6%	63.9%	0.4%
100.00	0.5%	59.9%	0.3%
150.00	0.1%	57.7%	0.0%
200.00	0.0%	56.2%	0.0%
		Total Net Annual Removal Efficiency:	81.7%
		Total Runoff Volume Treated:	99.9%

Notes:

(1) Rainfall Data: 1965:1990, HLY03, Niagara Falls, ONT, 6135638.

(2) Based on third party verified data and appoximating the removal of a PSD similar to the STC Fine distribution

(3) Rainfall adjusted to 5 min peak intensity based on hourly average.