

Hydrology & Hydraulics Technical Report

Quinte Conservation Authority

For the

Marsh Creek Flood Hazard Mapping

May 22, 2026



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1 Introduction

Quinte Conservation Authority (QCA) has partnered with Prince Edward County (the County) along with provincial and federal partners to lead the *Marsh Creek Floodplain Mapping Update*.

With acquired funding through the federal Flood Hazard Identification Mapping Program (FHIMP) and the County, QCA has undertaken a leadership role in the production of updated mapping for Marsh and Macaulay Creeks that are the main channels that route through Picton's urban setting.

The objective is to provide a floodplain mapping update that will allow QCA and County staff to make informed planning and regulation decisions. Jewell Engineering Inc. (Jewell) is pleased to support this initiative through the technical analysis and reporting described herein.

The driving forces for this project include climate change, improved modelling techniques and software programs, improved data acquisition tools, land use changes, and updated infrastructure that can dramatically influence flood behaviour and floodplain extents.

The need for accurate, detailed floodplain mapping that factors in climate change forecasting has become increasingly evident as flood damages become the largest cost to the Canadian economy out of any other natural hazard. Updated floodplain maps are needed to protect human life, property, and infrastructure from the damaging effects of flooding that is occurring with increased frequency.

The funds deployed by the federal and local governments to complete this updated floodplain mapping provide a dual benefit; it protects the local community from potential flood hazards *and* reduces the dependence on provincial and federal funds associated with the Disaster Financial Assistance Arrangements (DFAA) administered by Public Safety Canada.

Marsh Creek was previously mapped in 1983, making the data no longer current. The findings herein will replace the historic flood limits. Flood Hazard Maps are provided in **Appendix B**.

2 Background

Previous studies (see list below) were authored that have relevance to the *Marsh Creek Floodplain Mapping Update*.

- *1983 Marsh Creek Watershed Management Study* prepared by Cumming-Cockburn & Associates Limited (CCL)
- *2017 Delhi Park Stormwater Management Report* prepared by Jewell Engineering Inc. (Jewell)
- *2020 Picton Harbour Master Drainage Plan* prepared by Jewell
- *2023 Macaulay Dam; Dam Safety Report and Public Safety Assessment* prepared by KGS Group (KGS)

A summary of relevant findings from each of the above reports is provided below.

2.1 Marsh Creek Watershed Management Study

After the heavy rainfall in July of 1980, Cumming-Cockburn & Associates Limited (CCL) was hired later that year to prepare a watershed management study. As CCL states in their report:

“The objectives of the study were twofold: First, flood and fill line mapping was to be produced for designated reaches along Marsh and Macaulay Creeks, and, second, structural means for reducing potential flood damages were to be developed.”

The study produced the flood limits that have been referenced by QCA to date.

Notable findings of the report include:

- Rainfall events are expected to be more severe than snowmelt events,
- The hydrologic modeling platform was TR-20 with checks using ILLUDAS,
- The hydraulic modeling platform was HEC-2,
- The watershed was subdivided into 11 catchments,
- CCL’s Regulatory storm was the Timmins event with a peak flow of 31.1 m³/s at the watershed outlet. CCL applied a 1% AEP peak flow of 25.5 m³/s.
- CCL estimated the July 1980 storm to have a peak flow of 8.3 m³/s, well below their modeling values for the Regulatory event. According to *Table 4-1* of the CCL report, the 1980 event would be closest to a 5-yr return period since CCL’s 5- and 25-yr peak flows at the watershed outlet were 7.6 and 16.0 m³/s, respectively.

2.2 Delhi Park Stormwater Management Report

An updated design for the Delhi Park stormwater management (SWM) facility was investigated and prepared by Jewell in 2017. QCA and PEC initiated an Environmental Assessment process to review options for remedial stormwater quality treatment for two large storm sewer outlets that drain to Marsh Creek.

The relevant information from the Delhi Park investigation is the catchment areas used in the design, since they should be consistent with the Marsh Creek hydrology update. The catchments in the 2017

report refer to previous storm sewer design sheets that were prepared by Van Meer Limited. The time of concentration in these sheets was used as an input into the current hydrologic modeling of the respective Marsh Creek sub-catchment.

2.3 Picton Harbour Master Drainage Plan

The *Picton Harbour Master Drainage Plan (MDP)* was prepared by Jewell for QCA and PEC. The focus of the MDP was stormwater controls with focus on remedial quality treatment for Picton Harbour.

The MDP and the floodplain update have similarities in that they both outlet to Picton Harbour and focus on the urban areas of Picton. The Marsh Creek sub-catchments were drawn individually from the MDP and the MDP information has limited relevance to the flood hazard limits. However, the findings of the flood hazard mapping update provide current summaries of hydraulic performance at each of the motor vehicle crossings. Potential upgrades may be of interest for County staff and could be useful in the County's asset management plans.

2.4 Macaulay Dam: Dam Safety Report and Public Safety Assessment

The *Dam Safety Report* for the Macaulay Dam was recently prepared by KGS. The survey and outlet information for the Macaulay Dam outlet was utilized in this flood hazard mapping update. The peak flows and hydraulic model referenced in the KGS report were reviewed by Jewell staff and not selected for this analysis. The peak flows and hydraulic model for the Macaulay Dam and the Macaulay channel were modeled separately by Jewell using the methodologies and modeling approach that will be described in **Sections 4 and 5**.

A regional frequency analysis was used by KGS. No hydrologic model was utilized in the KGS project. The hydraulic model used by KGS was HEC-RAS Version 6.4.1.

3 Study Area

The study area for the Marsh Creek floodplain mapping update was outlined by QCA at the beginning of the project. It is identified in **Appendix A**.

The study area includes two main channels:

- 1) Marsh Creek
- 2) Macaulay Creek.

The confluence of the two creeks occurs just upstream of York Street. The combined flows of the two channels form the downstream stretch of the Marsh Creek channel that dictates the flood hazard between York Street and Picton Harbour.

Between York Street and Picton Harbour, there are residential and commercial properties on each side of the main channel that may be susceptible to the flood hazard. There is a flood berm along the west side of the channel between York and Bridge Street that has some protection for the properties up until its crest elevation assuming the backflow valves are operating correctly.

Upstream of York Street, the *Marsh Creek* main channel has no influence on habitable dwellings, meaning its risk to life and property is relatively low. However, this portion of Marsh Creek traverses a large cemetery area and public parkland, so the understanding of the flood conditions should be well understood to protect visitors and the local properties.

Upstream of York Street, the *Macaulay Creek* main channel drains through backyards of properties along York Street. It crosses Church Street that is an urban arterial road, and Lalor Street that provides access to the cemetery and park lands. There is also a potential spill upstream of Pitt Street that could affect residential properties. In extreme flood conditions, a 2nd spill could occur upstream of Church Street.

Existing and future build-out conditions were considered. Guidance for future development was obtained from the maps of the Official Plan, the Base 31 development plans available on the PEC website, and the zoning shape files received from the County.

4 Hydrology

The hydrology assessment was prepared for several nodes of interest throughout the watershed. Various methodologies were applied and compared to determine representative peak flows. Each methodology was carefully considered prior to the selection of the peak flows for use in the hydraulic model, including potential spring-melt conditions.

The Marsh Creek watershed is within *Zone 3 of Flood Hazard Criteria Zones for Ontario Conservation Authorities*. Based on the *2002 Ontario MNR Technical Guidelines*, the flood standard is the 1% AEP or Timmins event; whichever produces the greater peak flow.

Based on *Ontario Regulation 41/24*, the flood standard is the 1% AEP storm event. However, the Timmins storm is included in case the Regulations change in the future.

The detailed hydrologic analysis for the purpose of quantifying the peak flow rates is described below.

4.1 Data Sources

Data collection is an integral component of the hydrologic assessment. A description of each primary data source applied in the analysis is provided below.

4.1.1 LiDAR, Catchment Areas & Terrain

The Marsh Creek watershed has a total area of 5.6 km². The total watershed and its sub-catchments are identified in **Appendix C**.

Catchment areas were delineated using topographic information from the following sources:

- 1) Elevation data was provided in LiDAR format and datum CGVD 2013. The LiDAR source is the East Ontario – Belleville/Prince Edward 2022 data set – NRCan/MNR and meets the “High” flood risk category as defined in the Federal Airborne LiDAR Data Acquisition Guideline Appendix 2 – Flood Mapping; Ministry of Natural Resources and Forestry and or NRCan. The LiDAR elevations are used to create the terrain surface in the hydraulic model at a 0.5m resolution.
- 2) Jewell completed topographic and bathymetric survey and performed inspections within the study area to confirm elevations that may not be identified in LiDAR such as pipe outlets and culverts of interest. The local survey supplements the LiDAR data in the hydraulic model. Refer to **Section 5.2** for further discussion.
- 3) The LiDAR was validated with local survey at eight (8) spot elevations (see **Table 4-1**). After conversions from the local datum to datum CGVD2013, the LiDAR compares well with the local survey and is considered suitable for flood mapping purposes.
- 4) NRCan’s Station Report at *Station 67U159* located along Bridge Street in Picton suggests an approximate conversion of -0.352m from datum CGVD 28 to CGVD 2013. Jewell’s survey confirms that this vertical difference is a reasonable conversion value, although preference is

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given to the datum difference of -0.391m since this was taken using site-specific GPS survey whereas the NRCan difference is intended as an estimate only.

Table 4-1: LiDAR & Local Survey Elevation-Datum Comparisons

Point #:	Location / Description:	LiDAR (2013)	Jewell (28)	Difference	Jewell (2013)	Difference
		(1)	(2)	= (1) - (2)	(3)	= (1) - (3)
1	Bridge St CL Road @ east culvert	76.76	77.16	-0.40	76.77	0.009
2	York St CL Road @ west culvert	76.25	76.65	-0.40	76.26	0.009
3	Church St NE CL	91.98	92.41	-0.43	92.02	0.039
4	Lalor St NE CL	76.24	76.62	-0.38	76.23	-0.011
5	Dog Park Culv 1 - 400m US York St	77.10	77.50	-0.40	77.11	0.009
6	Dog Park Culv 2 - 575m US York St	77.44	77.81	-0.37	77.42	-0.021
7	Cemetery Culv 1	77.10	77.49	-0.39	77.10	-0.001
8	Cemetery Culv 2	77.99	78.35	-0.36	77.96	-0.031
Average				-0.391	Average (absolute)	0.016

**All units in meters.*

4.1.2 Soils and Land Cover

Soils information was obtained from the Soil Survey Complex database produced by the *Ontario Ministry of Agriculture, Food and Agribusiness* in cooperation with the *Ontario Ministry of Natural Resources*.

The soils are predominantly classified as Hydrologic Soils Groups (HSG) B. The HSG classification for soils is used to identify drainage characteristics for various soil types. An excerpt from Chapter 8 of the *1997 MTO Drainage Management Manual* that describes drainage characteristics for each HSG is provided below. A soils map is provided in **Appendix D**.

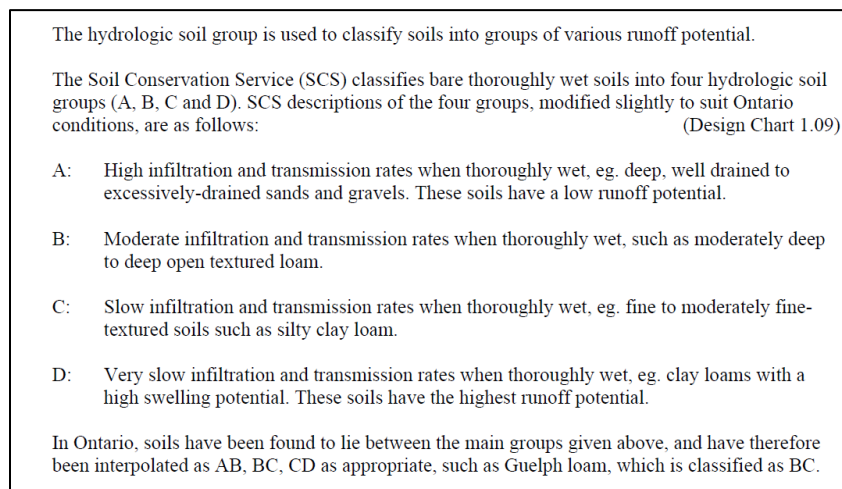


Figure 4-1: Excerpt from 1997 MTO DMM Describing Hydrologic Soils Group Classifications

The soils data is used to develop Curve Numbers (CNs) that are a key modelling parameter used in the Soil Conservation Service (now known as the *National Resources Conservation Service*) methodology for estimating the proportion of precipitation that will run off the lands and the portion that will infiltrate. CNs are a function of soil type, land cover, slope, and land use. The higher the CN – the greater the proportion of precipitation that is expected to run off the lands. CNs are representative of the pervious portion of the watershed. Jewell followed the guidance in the *HEC-HMS Technical Reference Manual* and the *MTO Design Chart 1.09* to determine CNs for the discretized catchments.

Land cover information was initially obtained from the Ontario Land Cover Compilation (OLCC), a database owned by *Land Information Ontario*, and provided by the *Ontario Ministry of Natural Resources*. Street Maps and Official Plan zoning were used to update the land coverage for the urban components of the watershed. Modifications to land cover were also made on the GIS layer using aerial imagery. A land cover map is provided in **Appendix D**.

The Marsh Creek sub-catchments were assessed based on their individual soils group and land cover characteristics. A summary table that includes the soils group and land cover breakdown for each sub-catchment is included in **Appendix D**.

4.1.3 Meteorological Inputs

Environment and Climate Change Canada (ECCC) intensity-duration frequency (IDF) curves for data collected at the Trenton Airport station is the best available data record. Jewell reviewed the station data from Kingston, Belleville, and Trenton. Other local stations did not have sufficient length of record for consideration. The Trenton Airport station was selected since it yields the longest record of data while having the closest proximity to Marsh Creek. The rainfall data is summarized in **Appendix E-1**.

An SCS distribution was selected with varying durations investigated. The 6-, 12-, and 24-hr durations were simulated. The 12-hr SCS storm was selected since it compared very closely to RFFA values that will be discussed in Section 4.2.2. The 12-hr also produced the highest regulatory flow at the bottom end of the system, meaning it not only compared the best to RFFA results but was also most conservative.

The Timmins storm is a historical event that produced 193mm. The Ontario MNR believes the Timmins storm could theoretically occur within the Marsh Creek watershed. It was therefore included in this analysis. The Timmins tabular rainfall is obtained from *MTO Design Chart 1.04* and reproduced in **Table 4-2** below.

Table 4-2: Excerpt of Design Chart 1.04 from MTO Drainage Manual – Timmins Hourly Rainfall Depths

Design Chart 1.04: Timmins Storm

	Depth		Percent of 12 hour
	(mm)	(inches)	
1st hour	15	0.6	8
2nd hour	20	0.8	10
3rd hour	10	0.4	6
4th hour	3	0.1	1
5th hour	5	0.2	3
6th hour	20	0.8	10
7th hour	43	1.7	23
8th hour	20	0.8	10
9th hour	23	0.9	12
10th hour	13	0.5	6
11th hour	13	0.5	7
12th hour	8	0.3	4
	193	7.6	100

A reduction to the Timmins hyetograph is not applicable since the Marsh Creek watershed is smaller than the minimum area for a reduction to be applied.

An important consideration in the precipitation data is the potential impacts on rainfall depths due to climate change. The methodology, rainfall depths, and peak flow results associated with the climate change scenario are discussed further in **Section 4.6**.

In recent experience, Jewell participated in discussions with ECCC staff regarding precipitation statistics and the approach used to assess rainfall depths beyond the 1% AEP rainfall depth. As part of these discussions, Jewell acquired and reviewed the ECCC precipitation statistics tool. This review confirmed Jewell's in-house spreadsheet is consistent with the ECCC methodology. Jewell's in-house precipitation tool was used to calculate the 0.5% AEP (200-yr) and 0.3% AEP (350-yr) events since these return period events are not included in the standard ECCC IDF curves. The spreadsheet calculates the precipitation frequency curve using a Gumbel distribution. See **Appendix G**.

4.1.4 Water Survey of Canada Stream Flows

There is no *Water Survey of Canada (WSOC)* stream flow gauge for Marsh Creek. However, WSOC stream flow gauge data for other locations of interest are applied in the Regional Flood Frequency Analysis (see **Section 4.3**). The WSOC flow data is a reliable source that is maintained and monitored by ECCC. The data used from the WSOC flow gauge portal is the *Annual Maximum Instantaneous Peak Discharge*.

4.2 Index Flood Method

While the Index Flood Method is considered a generally useful methodology, it should not be the only tool applied in the FFA. This is because the Index Flood Method is based on data for large regions across the province and its results can vary greatly depending on local rainfall data, soil types, storage areas, wetland coverage, among other characteristics. Therefore, the Index Flood Method will be used as an approximation only.

Jewell employed the Index Flood Analysis following the methodology established by the Ontario Ministry of Natural Resources to estimate design flows and assess the hydrology of the contributing drainage area.

The Index Flood method relates the annual peak instantaneous flow determined for 247 stream gauges across Ontario to drainage area. Twelve regions across the province were identified as having similar characteristics and a regression curve was developed for each region (see **Figure 4-2**). The subject watershed is within Region 1.

The 2-yr flows are resolved directly from the equation using the constant and exponent from **Table 4-3**. Other return period flows may be derived from the 2-yr flow by multiplying with the factors provided in **Table 4-4**.

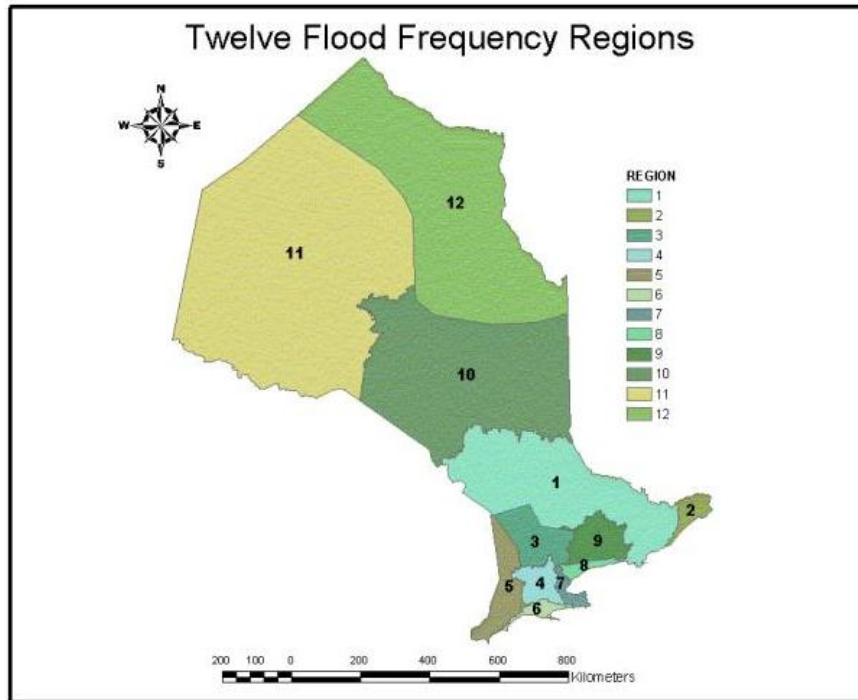


Figure 4-2: Excerpt of Flood Frequency Regions from *User Guide for Ontario Flow Assessment Tool (OFAT)*

Equation: Index Flood Method

$$Q_2 = CA^n$$

Where:

Q_2 = 2-year return period (3 Parameter Log Normal) flood

A = Drainage Area (km^2)

C = constant

n = exponent (slope of the line)

Table 4-3: Table of Constant (C) and Exponent (n) for use in the Modified Index Flood Equation (Ministry of Natural Resources and Forestry, 2020)

Region	Constant (C)	Exponent n
1(a)	0.22 ($A < 60 \text{ km}^2$)	1.000
1 (b)	0.73 ($A > 60 \text{ km}^2$)	0.707
2	0.51	0.896
3	0.20	0.957
4	0.71	0.842
5	0.45	0.775
6	0.41	0.806
7	1.13	0.696
8	0.73	0.785
9	0.40	0.810
10	0.28	0.849
11	0.38	0.706
12	0.59	0.765

Table 4-4: Ratio of Various Flood Frequencies to Q₂ (Ministry of Natural Resources and Forestry, 2020)

Region	Q _{1.25} /Q ₂	Q ₂ /Q ₂	Q ₅ /Q ₂	Q ₁₀ /Q ₂	Q ₂₀ /Q ₂	Q ₅₀ /Q ₂	Q ₁₀₀ /Q ₂	Q ₂₀₀ /Q ₂	Q ₅₀₀ /Q ₂
1	0.95	1.00	1.24	1.43	1.62	1.86	2.04	2.23	2.48
2	0.94	1.00	1.29	1.52	1.74	2.04	2.25	2.45	2.72
3	0.93	1.00	1.33	1.62	1.89	2.25	2.54	2.82	3.19
4	0.93	1.00	1.32	1.57	1.80	2.13	2.37	2.60	2.92
5	0.94	1.00	1.27	1.50	1.74	2.06	2.34	2.62	2.96
6	0.91	1.00	1.43	1.78	2.13	2.60	2.96	3.33	3.84
7	0.94	1.00	1.27	1.47	1.66	1.90	2.07	2.24	2.47
8	0.92	1.00	1.43	1.85	2.30	2.96	3.46	4.00	4.77
9	0.94	1.00	1.27	1.50	1.72	2.02	2.26	2.49	2.80
10	0.95	1.00	1.20	1.35	1.48	1.64	1.77	1.90	2.07
11	0.93	1.00	1.33	1.62	1.90	2.32	2.67	3.05	3.55
12	0.94	1.00	1.22	1.38	1.52	1.68	1.80	1.90	2.05

Table 4-5: Limitation of Application of Index Flood Method Based on Drainage Area (Ministry of Natural Resources and Forestry, 2020)

Region	Minimum (km ²)	Maximum (km ²)
1	0.11	9270
2	76.1	3816
3	86.0	3960
4	2.5	5910
5	14.2	4300
6	5.2	697
7	63.5	293
8	4.9	800
9	24.3	1520
10	18.6	11900
11	0.7	24200
12	4250	94300

The Index Flood Method for Region 1 yields a 1% AEP peak flow of 2.8 m³/s. This is well below the 1% AEP peak flow from the HEC-HMS model and Regional Flood Frequency Analysis that are discussed in the following sections. The Index Flood Method would underestimate the Regulatory peak flow and was therefore not selected for any of the current hydraulic modeling.

4.3 Regional Flood Frequency Analysis

A Regional Flood Frequency Analysis was implemented to provide confidence in the hydrologic model results given the absence of a local flow gauge.

From discussions with ECCC's Senior Engineer in recent and similar FHIMP projects, and the 2002 Ontario MNR *Technical Guide – River and Stream Systems: Flooding Hazard Limit* document, it is understood that the Three Parameter Log Normal is the preferred distribution to be applied in flood flow statistics. The **Consolidated Frequency Analysis V3.1 (CFA)** was used to complete the analysis since HEC-SSP only offers a two-parameter log normal option.

In addition to the CFA program, the Index Flood Method was considered along with direct comparisons to a single station analysis for a hydrologically similar urban watershed.

Each of the three FFA type analysis is described below.

A summary of the twelve (12) WSOC flow gauges investigated in the Regional FFA is provided in **Table 4-6**.

Table 4-6: WSOC Flow Gauge Stations Selected for Regional Flood Frequency Analysis

WSOC Flow Gauge Station:		Drainage Area (km ²)
Name	ID	
Rawdon Creek	02HK008	93
Mayhew Creek	02HK011	33
Cold Creek	02HK007	161
West Cataraqui	02HM009	5.0
Ancaster	02HB021	9.1
Consecon	02HE002	119
Shelter Valley	02HD010	63.8
Wilton	02HM004	105
Black Creek	02HE004	41.2
Millhaven	02HM011	144
Wilmot	02HD009	80.7
Ganaraska	02HD012	242

The simplest method to estimate peak flow based on the statistical flow gauge results is the sole relationship between drainage area and peak flow. This could be done using the data summarized in **Figure 4-3** and would follow a similar methodology to the Index Flood Method.

Jewell's concern with applying this simplistic approach is that solely focusing on drainage area assumes that the characteristics across each watershed in the region are the same. It neglects parameters that may differ among watersheds within the same region.

A more thorough approach is to assess drainage area and additional parameters to project their cumulative influence on the 1% AEP peak flow. This approach was customized by Jewell for the local region using the twelve gauges referenced above.

The 1% AEP statistical return period results for each stream flow gauge are presented in **Tables 4-7 and 4-8**.

In addition to the 1% AEP return period result for each of the twelve regional stream flow gauges, **Tables 4-7 and 4-8** includes hydrologic data values associated with their respective watersheds. These values include drainage area, lake and wetland coverage, mean watershed slope, and channel slope.

Table 4-7: Regional Flow Gauge Data - Part 1

Station:	Marsh	Rawdon	Mayhew	Cold	West Cataraqui	Ancaster	Consecon	Shelter Valley
		1	2	3	4	5	6	7
Drainage Area (km2)	5.6	93	33	161	5.0	9.1	119	63.8
Q100 / Drainage Area	N_A	0.21	0.50	0.24	2.35	0.70	0.46	1.01
1% AEP (CFA)	N_A	19.6	16.5	39.4	11.7	6.44	54.2	64.6
Land Cover:								
Lakes and wetlands	7.6	30.3	26.5	16.3	6.6	3.2	29.4	8.2
Treed	50.1	31.3	20.4	22.3	3.6	9.9	13.4	27.5
Crop and improved	6.4	35.8	45.5	57.8	8.7	32.9	55.8	59.7
Urban	35.9	2.0	7.4	3.6	81.1	53.9	1.4	4.4
Bedrock / gravel	0.0	0.6	0.1	0.1	0.0	0.0	0.1	0.1
Mean Slope (%)	7.4	3.7	6.6	6.5	2.2	3.4	1.6	8.5
Channel Slope (%)	1.7	0.3	0.9	0.7	0.6	0.6	0.1	1.1
Channel Length	4.3	22.1	10.2	30.5	6.2	6.2	29.8	20.8

Table 4-8: Regional Flow Gauge Data - Part 2

Station:	Marsh	Wilton	Black Creek	Millhaven	Wilmot	Ganaraska
		8	9	10	11	12
Drainage Area (km2)	5.6	105	41.2	144	80.7	242
Q100 / Drainage Area	N_A	0.36	0.52	0.27	0.95	0.64
1% AEP (CFA)	N_A	37.6	21.3	38.6	76.3	155.0
Land Cover:						
Lakes and wetlands	7.6	12.4	15.8	15.8	7.2	9
Treed	50.1	20.0	25.1	25.1	19.1	29
Crop and improved	6.4	63.6	55.6	55.6	65.4	58
Urban	35.9	3.5	3.5	3.5	6.9	3
Bedrock / gravel	0.0	0.4	0.0	0.0	1.4	0
Mean Slope (%)	7.4	3.0	1.6	4.1	6.4	7.1
Channel Slope (%)	1.7	0.2	0.5	0.2	1.1	0.6
Channel Length	4.3	42.7	15.2	48.1	23.5	39.6

The statistical 1% AEP results, when correlated to their individual watershed characteristics, can be used to determine the sensitivity of each parameter on the stream flow gauge result. With twelve flow gauges included across the region, the influence (if any) of each parameter is calculated.

The influence of each parameter is evident in a scatter plot of the data versus the *unit rate* of the 1% AEP statistical flows. A heavily influential parameter will show a steeper slope in the line of best fit (see **Figures 4-4 to 4-7**) and in the slope of the regression equation.

4.3.1 Parameter #1: Drainage Area

The first parameter investigated is drainage area. **Figure 4-4** indicates smaller drainage areas tend to generate a higher 1% AEP peak flow when measured on a unit area basis. It shows that Marsh Creek is small relative to most WSOC stations. Therefore, on a unit area basis, Marsh Creek is expected to produce an above-average peak flow rate. The unit flow rate for Marsh Creek, based solely on drainage area, would be 0.64 m³/s per square kilometer.

4.3.2 Parameter #2: Lake & Wetland Coverage

The 2nd parameter investigated is the lakes and wetlands coverage. **Figure 4-5** shows a strong correlation between low lake and wetlands coverage and higher unit flow rates.

Marsh Creek has 7.6% lake and wetland coverage that is below the regional average of 15.1%. This lesser lake and wetland coverage is expected to increase the 1% AEP unit peak flow rate per unit drainage area from 0.64 to 0.68 m³/s per square kilometer. This equates to an increase in 1% AEP peak flow rate of 7%.

4.3.3 Parameter #3: Mean Slope for Overland/Shallow Concentrated Flow

The 3rd parameter investigated is the mean slope. The mean slope represents the slope of the catchment that would be comprised of overland sheet flow and shallow concentrated flow before surface water enters the main channel. It has a large impact on the time of concentration for each watershed. **Figure 4-6** indicates a correlation between higher mean slopes and higher unit flow rates.

Marsh Creek has a 7.4% mean slope that is above the regional average of 4.6%. This higher slope would be expected to individually increase the 1% AEP unit peak flow rate from 0.64 to 0.68 m³/s per square kilometer. This equates to an increase in 1% AEP peak flow rate of 5%.

4.3.4 Parameter #4: Channel Slope

The 4th parameter investigated is the channel slope. This represents the average slope of the main channel throughout the watershed area. It has a large impact on the routing of the watershed. **Figure 4-7** indicates a strong correlation between channel slope and unit peak flow rate, with steeper main channels slopes having faster runoff routing that produces higher runoff rates.

Marsh Creek has a 1.7% average channel slope that is nearly three times greater than the regional average of 0.6%. This higher slope would be expected to individually increase the 1% AEP unit peak flow

rate from 0.64 to 1.21 m³/s per square kilometer. This equates to a large increase in 1% AEP peak flow rate of 88%.

4.3.5 Parameter #5: Urbanization

Urbanization only applies to areas of the watershed currently developed or zoned for future development. Parameter #5 is best investigated with the flow gauge results for the urban area that may be considered a hydrologically similar watershed. It is discussed in Section 4.3.7.

4.3.6 Combination of Parameters

The base value is measured based on drainage area (Parameter #1) and is 0.64 m³/s. The chart in Figure 4-5 suggests the less than average lake and wetland coverage would increase the 1% AEP unit peak flow rate by 0.04 m³/s per square kilometer to (0.68 – 0.64). Similarly, the chart in Figure 4-6 suggests that the steeper than average mean slope would increase the 1% AEP unit peak flow rate by 0.04 m³/s per square kilometer (0.68 – 0.64). Figure 4-7 suggests the steeper than average channel slope would increase the 1% AEP unit peak flow rate by 0.56 m³/s per square kilometer (1.20 – 0.64). The net increase (0.04 + 0.04 + 0.56 = 0.64) yields the 0.64 m³/s per square kilometer increase to account for catchment specific parameters. 0.64 added to 0.64 is 1.28 m³/s per square kilometer. Therefore, the 1% AEP estimate for non-urban portions of the watershed is the total non-urban area are multiplied by 1.28.

The same cumulative impacts of Parameters #1, #2, #4, and #5 are applied for the urban portions of the Marsh Creek watershed. Parameter #3 was omitted from the urban areas since the shallow mean slope of the Little West Branch Cataraqui watershed would skew the data by suggesting an adjustment for lower and slower runoff when, in reality, the hardened surfaces may shallow the mean slope for construction purposes, but the net result would be runoff with faster and greater quantities.

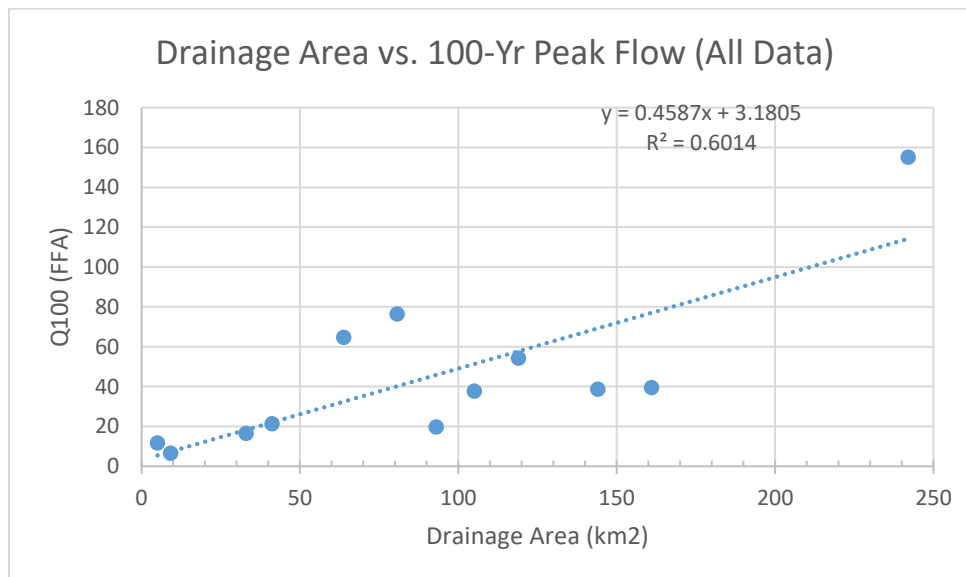


Figure 4-3: Drainage Area vs. 1% AEP Peak Flow

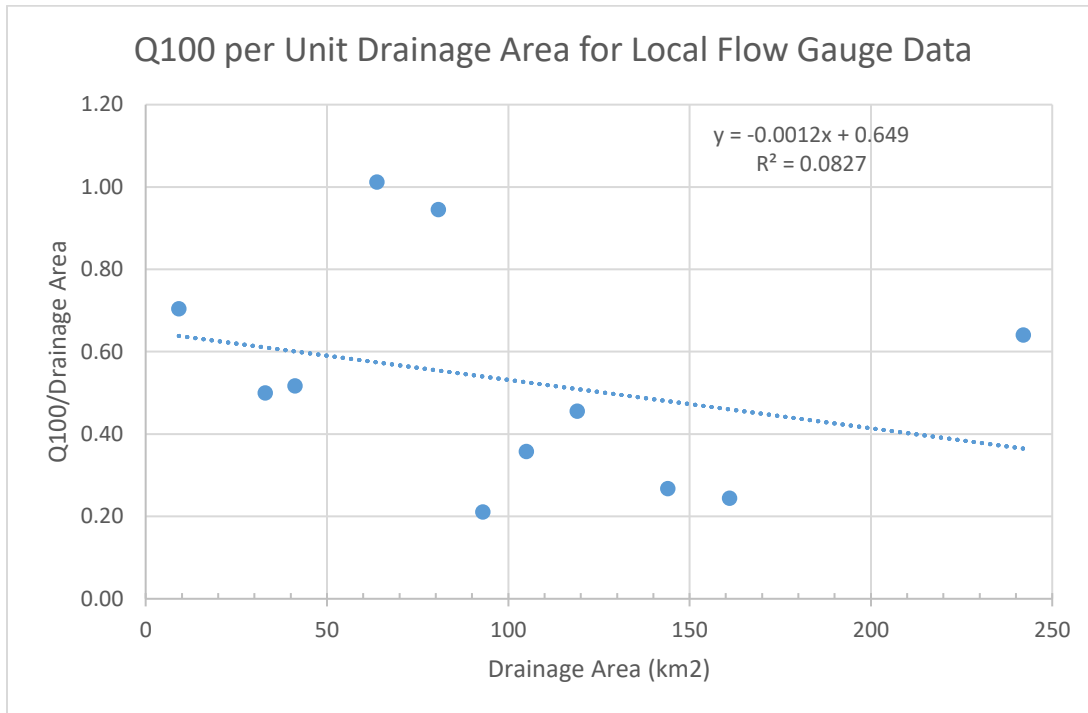


Figure 4-4: 1% AEP Per Unit Drainage Area

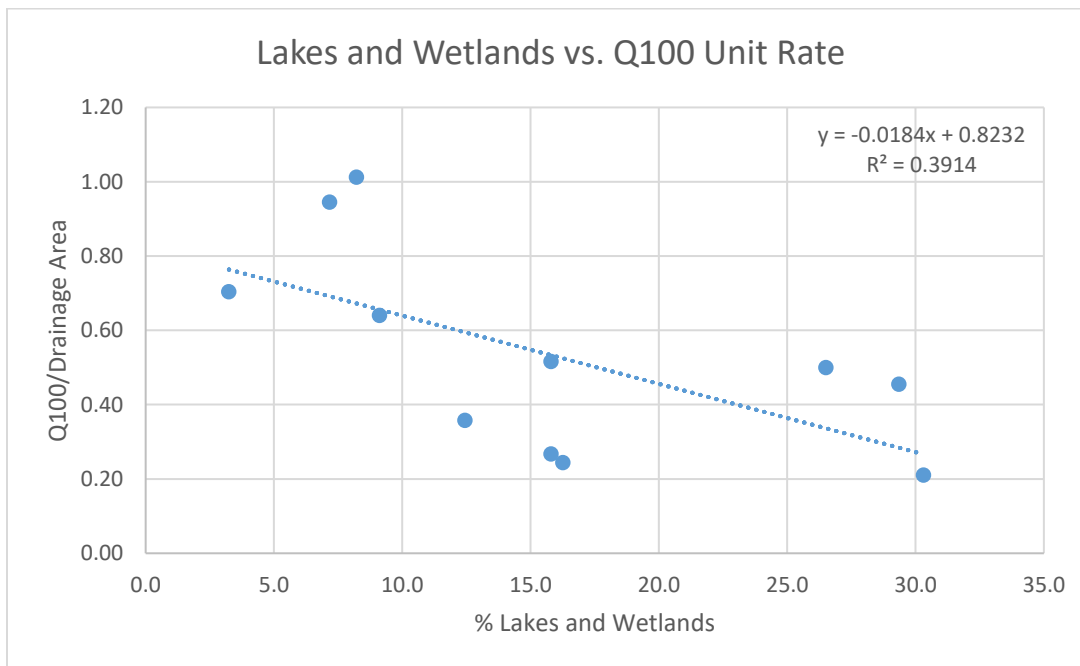


Figure 4-5: Lakes and Wetlands Coverage vs. 1% AEP Unit Rate

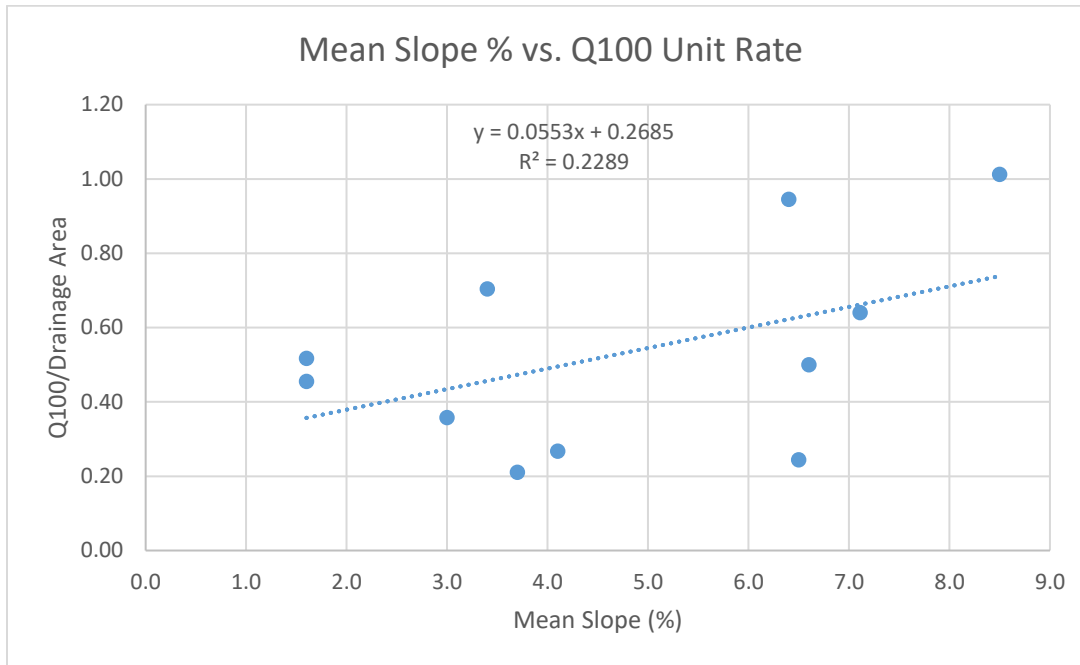


Figure 4-6: Mean Slope vs. 1% AEP Unit Rate

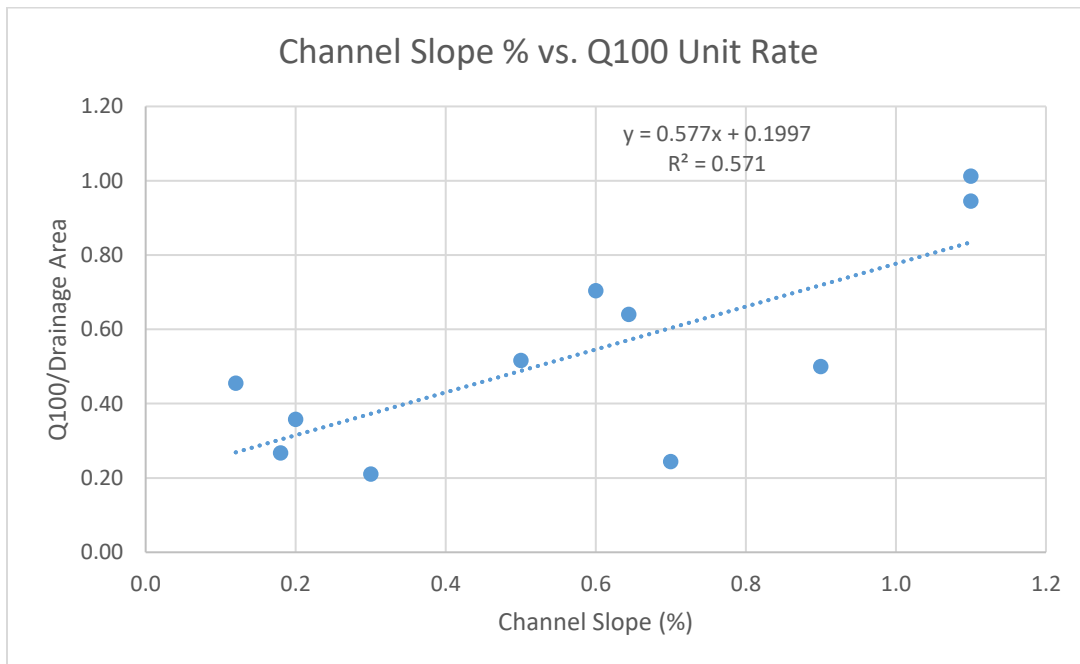


Figure 4-7: Channel Slope vs. 1% AEP Unit Rate

4.3.7 Hydrologically Similar Watersheds

Most local WSOC flows gauges do not have significant urban components, meaning urbanization typically does not have significant impact on their results. However, for Marsh Creek, approximately 23% of its watershed is within the urban area.

In the context of urbanized watersheds, the flow gauge at West Branch Little Cataraqui Creek was considered a hydrologically similar watershed in the context of its significant urban component, albeit at a much higher urbanization coverage of 81%.

In a review of the Little Cataraqui Creek gauge, the impervious cover yields a clear spike in the peak flow rate on a per unit area basis relative to other regional flow results. To quantify this impact, its watershed characteristics were analyzed using the same regional data as presented in Parameters #1 - #4. The expected 1% AEP peak flow based on regional statistics was compared to the 1% AEP peak flow from its flow gauge. The difference, after accounting for the portion of the watershed that is urbanized vs. natural, can be attributed to the surface hardening with the development across the watershed. Ultimately, the analysis of the Little Cataraqui Creek gauge vs. the regional statistics indicated an expected 4.5x increase in peak flow from urban areas relative to unimproved or 'pre-existing' areas. This value was applied for the purpose of the urban area factor increase applied to the Marsh Creek watershed.

Little Cataraqui Creek is one of the few flow gauges across the province that has a similar watershed size to Marsh Creek while having a significant urban component. Fortunately, Little Cataraqui Creek is located within the City of Kingston, meaning its watershed is relatively near to Marsh Creek and its rainfall would be similar due to the proximity to the influences of Lake Ontario.

For added support, in the spirit of a weight of evidence approach, publications of expected peak flow increase with urban developments were reviewed. The 2002 document titled *Hydrologic Impacts Due to Development: The Need for Adequate Runoff Detention and Stream Protection*, published by the Michigan Department of Environmental Quality, identifies peak flows for a previously undeveloped catchment is expected to increase by two to five times after development. The value of 4.5 obtained from the review of regional data and local flow statistics compares well with this publication and suggests our assessment is realistic yet conservative.

4.3.8 RFFA - Peak Flow Summary

The flood frequency analysis yields 1% AEP peak flows based on local and hydrologically similar watersheds. A summary of the 1% AEP peak flows based on the FFA, after accounting for local watershed characteristics, is provided in **Table 4-9**. Node locations are presented visually in **Appendix C**.

Table 4-9: RFFA 1% AEP Peak Flow Summary at Nodes of Interest

Marsh Creek:		
Node	1% AEP	Node Description / Location
A-1	1.2	Confluence of upstream tributaries forming main Marsh Creek channel
B-1	1.7	Confluence with West Tributary #1
C-1	2.2	Cemetery Culv. #1 (just upstream of urban areas)
D-1	7.8	Dog Park Culv. #1
E	15.7	York Street / Confluence with Macaulay Creek
F	15.7	Bridge Street
Macaulay Creek:		
Node	1% AEP	Node Description / Location
A-2	4.0	Macaulay Dam
B-2	4.4	County Road 22 (Church Street)
C-2	4.7	Lalor Street

4.4 Rainfall-Runoff Modeling

HEC-HMS version 4.12 was applied for hydrologic modeling simulations. HEC-HMS is the preferred software by ECCC for flood hazard mapping applications.

Notable input parameters for the HEC-HMS model include:

- Precipitation – intensity, duration and frequency as well as distribution.
- Catchment area.
- Percent imperviousness – runoff volume, time to peak and peak flow increase with percent imperviousness.
- Soil conditions – these determine how much and how quickly water will be removed from runoff through infiltration. This may be expressed as a curve number, or by a runoff coefficient or using an infiltration model such as Horton’s Infiltration.
- Slope – peak flows increase with slope.
- Initial abstraction – depth of precipitation input that is subtracted from the model and does not contribute to runoff.
- Basin lag or time to peak.

4.4.1 Hydrologic Input Summary

A hydrology input summary is provided in **Tables 4-10 and 4-11**. It summarizes the area, curve number, time of concentration and initial abstraction applied for each sub-catchment in the model. The input

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summary is shown for antecedent moisture condition (AMC) II conditions as this setting was applied for the peak flows in the hydraulic modeling.

Table 4-10: Hydrology Input Summary – Marsh Creek

Catchment	Area (km ²)	CN AMC II	% Imp.	Length (m)	Slope (m/m)	Lag Time (min)
Marsh Creek Main Channel Sub-Catchments:						
1	0.056	58.0	6.3	262	0.10	17.8
2	0.023	61.1	6.6	317	0.11	25.7
3	0.017	61.0	12.1	228	0.14	19.5
4	0.021	61.0	0.0	234	0.15	19.5
5	0.168	61.3	35.4	605	0.01	64.0
6	0.147	54.3	0.0	681	0.07	48.8
7	0.147	57.6	1.3	511	0.10	32.6
8	0.047	60.6	6.3	336	0.20	29.3
9	0.065	42.9	0.0	309	0.08	19.5
10	0.139	57.7	5.1	231	0.27	12.3
11	0.219	62.0	5.5	413	0.01	103.2
12	0.265	39.3	43.4	0	N_A	21.5
13	0.061	49.6	39.7	361	0.09	19.5
14	0.138	61.0	16.0	471	0.12	19.6
15	0.146	61.1	40.3	530	0.03	31.4
16	0.487	55.1	49.7	0	N_A	21.5
17	0.050	61.0	34.7	301	0.06	21.8
18	0.156	61.1	21.8	595	0.08	22.3
19	0.072	61.0	60.5	347	0.05	27.4
20	<u>0.499</u>	58.1	56.4	0	N_A	27.4
2.92						

Table 4-11: Hydrology Input Summary - Macaulay Creek and Downstream of Confluence Point

Catchment	Area (km ²)	CN AMC II	% Imp.	Length (m)	Slope (m/m)	Lag Time (min)
Macaulay Creek Sub-Catchments:						
21	0.685	61.5	4.6	904	0.02	44.0
22	1.307	63.5	5.7	1167	0.03	56.1
23	0.271	61.0	15.9	592	0.10	28.1
24	0.048	61.0	2.7	314	0.18	12.0
25	0.094	61.0	12.1	200	0.24	14.1
26	0.037	61.0	42.1	67	0.18	12.0
27	0.028	61.2	42.0	114	0.10	12.0
28	0.056	61.0	39.6	160	0.09	12.0
29	0.006	61.0	58.5	54	0.07	12.0
30	0.028	61.0	35.2	298	0.09	15.9
31	<u>0.058</u>	61.0	41.7	471	0.05	21.4
2.62						
Downstream of Marsh and Macaulay Confluence						
32	0.080	61.0	52.9	384	0.05	21.1
Total	5.62					

4.4.2 Loss Method

Jewell selected the curve number loss method since it accounts for both land cover and hydrologic soils group information. It was also selected because of the reputable sources available for this information. Attribute tables in the hydrologic modeling software were used to connect each land cover sub-area to its corresponding soil type. The attribute tables are combined with the soil and land cover layers to produce detailed weighted curve numbers applied to each sub-catchment.

AMC II per Chapter 8 of the MTO Drainage Manual was applied for antecedent moisture conditions (AMC) in the rainfall-runoff events. Saturated soil conditions (AMC III) were applied for spring melt conditions.

4.4.3 Lag Time / Time of Concentration

Several time of concentration (T_c) methods were tested, including the TR-55, Kirpich, Airport, and SCS Lag Time methods. Ultimately, the TR-55 method was selected since it best represents the local travel

time by utilizing the detailed LiDAR and sub-catchment delineations to determine respective combinations of overland flow, shallow concentrated flow, and channel flow for each sub-catchment.

An example of the detailed TR-55 method is provided in **Figure 4-8**, where green represents the overland flow, yellow represents shallow concentrated flow, and blue represents the channel flow. The flow paths are identified by the user along with the relevant Manning's n values. The built-in software is then set up to calculate the TR-55 time of concentration value.

The alternative methods, including Kirpich, SCS Lag Time, and Airport, were completed manually. The Kirpich, SCS Lag Time, and TR-55 provided generally comparable Tc values (some higher, some lower depending on the sub-catchment). This was expected considering they are each a reputable method. The SCS lag time method would be the next preferred method after TR-55 since, in our opinion, it is the next best method for applying catchment specific inputs. Kirpich would be least preferred since it only uses slope and flow path length. The alternative methods confirmed that the TR-55 time of concentration values are within a reasonable value range.

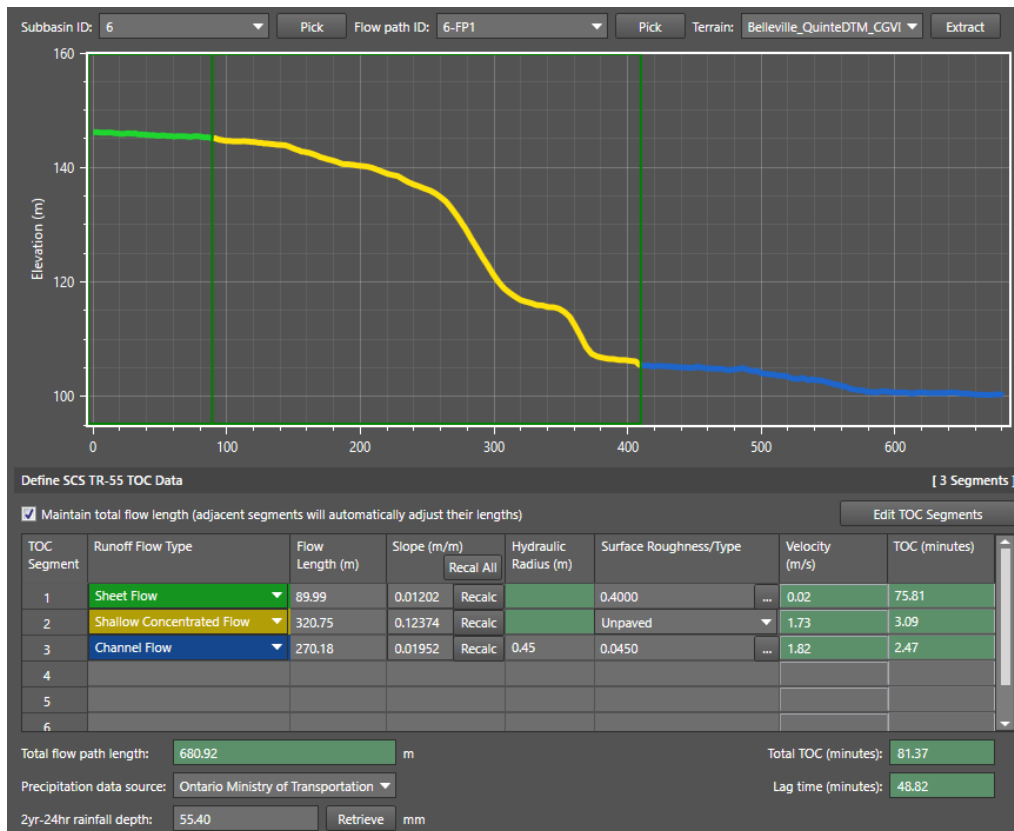


Figure 4-8: Example Time of Concentration Calculation for TR-55 Method

4.4.4 Channel Routing

Channel routing was completed using the Muskingum-Cunge method. This routing method allows the user to input a cross-section to represent ground surface data for the channel and overbank areas.

Cross-sections were obtained from the terrain data and then simplified into an eight-point cross-section. The Muskingum-Cunge method was also selected for the 1D model since it incorporates Manning's n values to represent expected roughness for the channel and overbank areas. The applied Manning's n values are based on the design charts in the *MTO Drainage Manual*. For the 2D model at the Macaulay Creek portion of the study area, the 2D flow area naturally routes the flows.

4.5 Snowmelt Events

The *2002 Ontario MNR Technical Guidelines* recommend the event duration be less than the time of concentration. Due to the small watershed size and steep slopes, the time of concentration for the full watershed is well below 24 hours. The 1-day duration is the minimum for a snowmelt plus rain event. On this basis, the snowmelt plus rain would be dismissed as the system routing is not long enough to govern the hydrologic peak flows. Nevertheless, due diligence for the snowmelt scenario was assessed as described below.

Snowmelt events were modeled with a similar modeling approach as the rainfall events; however appropriate adjustments were made to reflect the spring snowmelt condition. This included conversion of the CNs to an AMC III condition to account for saturated and/or frozen ground conditions, in addition to extended model times to reflect the longer durations and runoff volume of the snowmelt runoff periods relative to single event rainfall storms.

The snowmelt modeling was based on the degree day method following Meteorological Services of Canada (MSC) snowmelt equations for Ontario as indicated in the *2002 Ontario MNR Technical Guide*. Both the 1-day and 3-day snowmelt periods were simulated for the 1% AEP storm.

Combinations of rain and snow melt events are accounted for in the rain plus snowmelt depth, duration, and frequency values published by the engineering climate services branch of the MSC. The charts include a range of durations for rain plus snow events (see **Appendix E-2**). For rain plus snow events, with the 1-day rain plus snow produces $2.7 \text{ m}^3/\text{s}$ at the bottom end of the system and the 3-day rain plus snow produces $3.1 \text{ m}^3/\text{s}$. These values are much less than the rain only event for the 1% AEP, 12-hr rainfall from the ECCC IDF curves and are not expected to govern in a Regulatory event as evidenced by the historic record event that occurred in July of 1980.

Most WSOC flow gauge results indicate that return period floods occur in the spring snowmelt condition. Based on the site-specific modeling results and review of relevant engineering literature, Marsh Creek can be considered an exception since its relatively small and steep watershed is more sensitive to shorter, high-intensity hyetographs relative to longer, less intense runoff events that characterize snow melt periods and can last days or weeks. Smaller watersheds generally have shorter routing times that make them less sensitive to slower runoff events.

The historical Marsh Creek report also found that the basin is more likely to experience its 1% AEP peak flow rate in a rainfall-driven event rather than a snowmelt event. This is consistent with the *2002 Ontario MNR Technical Guide*. The findings are also consistent with the observations noted by residents and the historic event that occurred in July of 1980.

4.6 Climate Change

The technical requirements to address climate change were provided by ECCC project partners in past FHIMP projects in a technical memorandum titled *Incorporating Climate Change in Floodplain Mapping under the Flood Hazard Identification and Mapping Program*.

Per the memorandum, the hourly rainfall that corresponds to the regulatory storm was adjusted using the mean annual temperature change obtained from the federal climate data portal for the Town of Picton. The Ontario MNR's recommendation of obtaining the value for the 50th percentile of the mean annual temperature change based on the CMIP5, RCP 4.5 scenario was followed.

The year 2071 was selected since this is the furthest projected date in the Excel download from the federal climate data portal. The mean annual temperature change for the year 2071 is an increase of 3.2 degrees Celsius. An excerpt from the technical memo defining the equation used to convert historic rainfall intensity and temperature change to the future estimated rainfall intensity is provided in Equation 2 below.

Equation 2: Estimation of Future Rainfall Intensity (Environment and Climate Change Canada)

$$R_p = R_c \times 1.07^{\Delta T}$$

Where:

R_p = Future estimated rainfall intensity (mm/h)

R_c = Historic estimated rainfall intensity (mm/h)

T = Temperature (°C)

There is a 25% projected rainfall increase due to climate change (see **Table 4-12**).

Table 4-12: Future Estimated Rainfall Intensities for 1% AEP (Regulatory) Storm

Time		Historic Intensity (Rc)	Percent of 12 hour	Future Estimated Intensity (Rp)	% Increase in Intensity
Hour	Minute	mm	mm	mm	
0.5	60	1.21	1.3%	1.50	25%
1	120	1.21	1.3%	1.50	25%
1.5	180	1.21	1.3%	1.50	25%
2	240	1.21	1.3%	1.50	25%
2.5	300	1.45	1.5%	1.80	25%
3	360	1.45	1.5%	1.80	25%
3.5	420	1.93	2.0%	2.40	25%
4	480	1.93	2.0%	2.40	25%
4.5	540	2.90	3.0%	3.59	25%
5	600	3.86	4.0%	4.79	25%
5.5	660	5.79	6.0%	7.19	25%
6	720	43.43	45.0%	53.92	25%
6.5	780	8.69	9.0%	10.78	25%
7	840	3.86	4.0%	4.79	25%
7.5	900	2.90	3.0%	3.59	25%
8	960	2.90	3.0%	3.59	25%
8.5	1020	1.69	1.8%	2.10	25%
9	1080	1.69	1.8%	2.10	25%
9.5	1140	1.69	1.8%	2.10	25%
10	1200	1.69	1.8%	2.10	25%
10.5	1260	0.97	1.0%	1.20	25%
11	1320	0.97	1.0%	1.20	25%
11.5	1380	0.97	1.0%	1.20	25%
12	1440	0.97	1.0%	1.20	25%
Total		96.50	100%	119.8	25%

4.7 Presentation of Peak Flows

The maximum peak flows for Marsh and Macaulay Creek are summarized in **Tables 4-13 and 4-14**. A node location description is provided in **Table 4-15** with node locations identified visually in **Appendix C**.

The peak flow rates in the table below were applied in the hydraulic model to identify the flood hazard limits. Peak rates were selected after review of a variety of hydrologic modeling scenarios (see **Tables 4-16 to 4-19**). The Timmins event was obtained using the SCS CN method since its peak flows for historic events can only be calculated using rainfall-runoff software programs.

The Regulatory peak flows shown below correspond to a 1% AEP storm with a 12-hr, SCS distribution.

Table 4-13: Summary of Regulatory Peak Flows for Marsh Creek

Node	Peak Flow (m ³ /s)	
	1% AEP	Timmins
A-1	1.2	1.6
B-1	1.7	3.1
C-1	2.2	4.5
D-1	7.8	9.0
E	15.7	21.1
F	15.7	21.4

Table 4-14: Summary of Regulatory Peak Flows for Macaulay Creek

Node	Peak Flow (m ³ /s)	
	1% AEP	Timmins
A-2	4.0	8.5
B-2	4.4	9.9
C-2	4.7	11.1

The peak flows are different between the Jewell HEC-HMS model and the 1983 model results because Jewell completed an independent study with a different modeling platform. Some differences could be the 1983 report used a drainage area of 6.3 km² whereas a detailed review of LiDAR confirms the catchment area is 11% less at 5.6 km². Also, the 1983 work used a rainfall source with only 14 years of data, which would not be accepted by today's standards.

In 2026, we have four decades of local flow gauge and rainfall data at twelve relatively near locations that were taken into consideration in the RFFA. Model input methodologies were selected to build a model that followed model input values per technical guidance while maintaining a good fit with the RFFA results. The 1983 report would not have benefited from this level of information, and their findings suggest the 1983 model overestimated flows by showing a 5-yr peak flow of 7.6 m³/s and 25-yr peak flow of 16 m³/s. Interpolating yields a 15-yr flow of 11.8 m³/s although the 1980 event was estimated at a 15-yr rainfall with corresponding peak flow of 8.3 m³/s. So, the 1983 published modeling overestimated the calibration event by 42%.

With the updated ECCC IDF data, the 1980 event would have been a 25-yr storm. The Jewell 25-yr peak flow is 11.6 m³/s, still above the 8.3 m³/s. This suggests the Jewell model is also conservative, but the results are acceptable since 1) the 1980 event was a 6-hr duration and it is expected the peak flow

would have a minor increase for a 12-hr storm and 2) the 100-yr modeling result is in line with the weight of evidence from the local flow gauge data captured in the RFFA, including an urban flow gauge in Kingston to check the implications of the urbanized areas of Picton.

Table 4-15: Node Description and Location Summary

Marsh Creek:		
Node	Contributing Area (km ²)	Node Description / Location
A-1	0.29	Confluence of upstream tributaries forming main Marsh Creek channel
B-1	0.69	Confluence with West Tributary #1
C-1	1.11	Cemetery Culv. #1 (just upstream of urban areas)
D-1	2.20	Dog Park Culv. #1
E	5.38	York Street / Confluence with Macaulay Creek
F	5.62	Bridge Street
Macaulay Creek:		
Node	Contributing Area (km ²)	Node Description / Location
A-2	1.83	Macaulay Dam
B-2	2.24	County Road 22 (Church Street)
C-2	2.46	Lalor Street

Table 4-16: Comparison of Marsh Creek Peak Flows from Alternative Sources

Node	Contributing Area (km ²)	HMS - Rainfall		RFFA	1980 Historic Event	1983 Report		1% AEP - Rain w. Snowmelt	
		1% AEP	Timmins	1% AEP		1% AEP	Timmins	1-Day	3-Day
A-1	0.29	1.2	1.6	1.2	0.3	1.2	1.0	0.2	0.2
B-1	0.69	1.7	3.1	1.7	1.2	4.8	4.1	0.2	0.3
C-1	1.11	2.2	4.5	2.2	1.3	5.3	5.1	0.5	0.7
D-1	2.20	7.8	9.0	7.8	1.4	6.1	6.8	1.1	1.3
E	5.38	15.9	21.1	15.7	8.3	25.5	31.1	2.7	3.0
F	5.62	15.9	21.4	15.7	8.3	25.5	31.1	2.7	3.1

Table 4-17: Comparison of Macaulay Creek Peak Flows from Alternative Sources

Node	Contributing Area (km ²)	HMS - Rainfall		RFFA	1980 Historic Event	1983 Report		1% AEP - Rain w. Snowmelt	
		1% AEP	Timmins	1% AEP		1% AEP	Timmins	1-Day	3-Day
A-2	1.83	4.0	8.5	4.0	2.6	12.2	15.2	1.1	1.3
B-2	2.24	4.4	9.9	4.4	3.0	12.5	16.1	1.3	1.5
C-2	2.46	4.7	11.1	4.7	3.4	9.6	7.7	1.4	1.6

Table 4-18: Marsh Creek Peak Flow Summary for All Storm Events

HMS ID	River Station	Annual Exceedance Probability (%)								Timmins	1% AEP + Climate Change
		50	20	10	4	2	1	0.5	0.3		
Node A-1	2967	0.37	0.54	0.69	0.88	1.03	1.18	1.34	1.44	1.62	1.65
J3	2749	0.37	0.56	0.71	0.94	1.13	1.33	1.55	1.69	2.12	1.98
J4	2268	0.37	0.59	0.77	1.06	1.29	1.56	1.84	2.02	2.78	2.42
Node B-1	1863	0.38	0.61	0.81	1.12	1.37	1.66	1.99	2.21	3.14	2.69
J6B	1614	0.43	0.72	0.97	1.36	1.68	2.05	2.45	2.70	4.19	3.29
Node C-1	1339	0.46	0.77	1.02	1.43	1.77	2.15	2.59	2.89	4.47	3.55
Dog Park Culv. 2	1028	2.57	3.61	4.36	5.47	6.33	7.25	8.23	8.82	8.61	10.00
Node D-1	901	2.77	3.88	4.68	5.86	6.78	7.78	8.82	9.46	9.02	10.71
J10	722	3.02	4.31	5.25	6.24	7.26	9.39	10.07	10.84	10.09	12.32
Node E	443	5.51	8.03	9.40	10.95	13.03	15.86	17.26	18.51	20.17 (21.11)	21.36
Node F	278	5.60	7.89	9.92	11.58	13.72	15.93	17.82	19.11	20.61 (21.39)	21.54

*12-Hr, SCS Distribution for AEP (Return Period) Storms

Table 4-19: Macaulay Creek Peak Flow Summary for All Storm Events

HMS ID	Annual Exceedance Probability (%)								Timmins	1% AEP + Climate Change
	50	20	10	4	2	1	0.5	0.3		
Node A-2	0.47	1.07	1.59	2.45	3.18	3.99	4.85	5.41	8.52	6.57
Node B-2	0.57	1.22	1.78	2.73	3.52	4.40	5.33	5.93	9.86	7.19
Node C-2	1.25	1.86	2.35	3.10	3.78	4.70	5.68	6.30	11.08	7.60

5 Hydraulics

The hydraulic analysis was prepared using **HEC-RAS version 6.6**. The hydrology results from the HEC-HMS model were applied in the HEC-RAS model to delineate flood hazard limits. The Marsh Creek floodplain is characterized by a steep profile with narrow flood limits in the upper reach of its main channel, followed by a large natural storage area in the vicinity of Delhi Park, York Street and Bridge Street. The east branch of the Marsh Creek watershed, defined by Macaulay Creek, is characterized by the Macaulay Dam, potential spills through urban areas in extreme storms, and flood limits within the rear-yards of several residential properties. This section describes the following as they relate to Marsh and Macaulay Creek:

- modeling approach,
- survey data and cross-sections,
- bridge/culvert crossings,
- profile plots,
- storage impacts,
- spill locations, and
- the flood control structure.

5.1 1D & 2D Modeling

Recent hydraulic model software advancements give flexibility in the modeling approach. The FHIMP guidelines outline when the application of a 1D or 2D model is generally preferred.

1D model advantages: include more conventional output tables, cross section outputs, water surface profile plots, and efficient run times. They are suitable for areas that generally flow in the direction of the main channel, although spill areas can be accounted for with lateral structures.

2D model advantages: include more detailed flow behaviour in urban areas, the ability to account for and quantify storage impacts, and dynamic output result displays.

For enhanced understanding of the flood behaviour and preferred modeling approach in Marsh Creek, detailed 1D and 2D models were prepared for the full study area. A review of the model performance and flood characteristics was then completed to select the model output for use in the flood maps.

5.1.1 Floodplain Maps – 1D Extents

The 1D results were selected for the full Marsh Creek main channel. This covers *Station 0 + 085 to 2+967* on the floodplain maps.

The 1D results were also selected for the smaller Marsh Creek tributaries, referred to as *Tributaries 1 and 3* on the floodplain maps.

5.1.2 Floodplain Maps – 2D Extents

The 2D results were selected for the Macaulay Creek channel.

The 2D results were also selected for the potential spill locations, referred to as *Spill 1* and *Spill 2* on the flood maps.

A subject of interest is the storage area that occurs in the vicinity of Delhi Park, York Street, and Bridge Street (see **Section 5.5**). On one hand, this storage imposed by the York and Bridge Street crossings can be significant. On the other hand, there is provincial direction that discourages the reliance on flood storage at road crossings and flood berms for flood protection downstream.

Jewell's opinion is that the consideration of storage should occur on a case-by-case basis. In this case, potential changes to the Bridge Street or York Street culvert, or future developments within the Delhi Park area, could theoretically adjust the storage impacts and have an unintended impact on peak flows at Node E and F (York Street and Bridge Street). **To avoid potential unintended impacts, this storage is not included in the final output results.**

5.2 Survey Data, Cross Sections, & 2D Flow Areas

Local topographic survey was obtained for the local crossings, including detailed cross sections upstream and downstream of each crossing. Topographic survey data for the culvert crossings is summarized in **Appendix J**.

The cross sections cut and applied in the 1D hydraulic model along the Marsh Creek main channel are shown in the Flood Limit Maps in **Appendix B**.

The 2D flow area for Macaulay Creek is defined by a dense base mesh of hexagonal polygons to capture the flow movement. Mesh improvements were applied for added density in locations of the main channel, culvert crossings, and potential spill locations to enhance the output results. An example of the 2D flow area set up is provided in **Figure 5-1**.

Cross sections are not needed for the 2D flow area. However, representative cross sections and their corresponding water levels are extracted from the output results and shown on the flood maps along the Macaulay Creek channel to maintain a traditional mapping style.

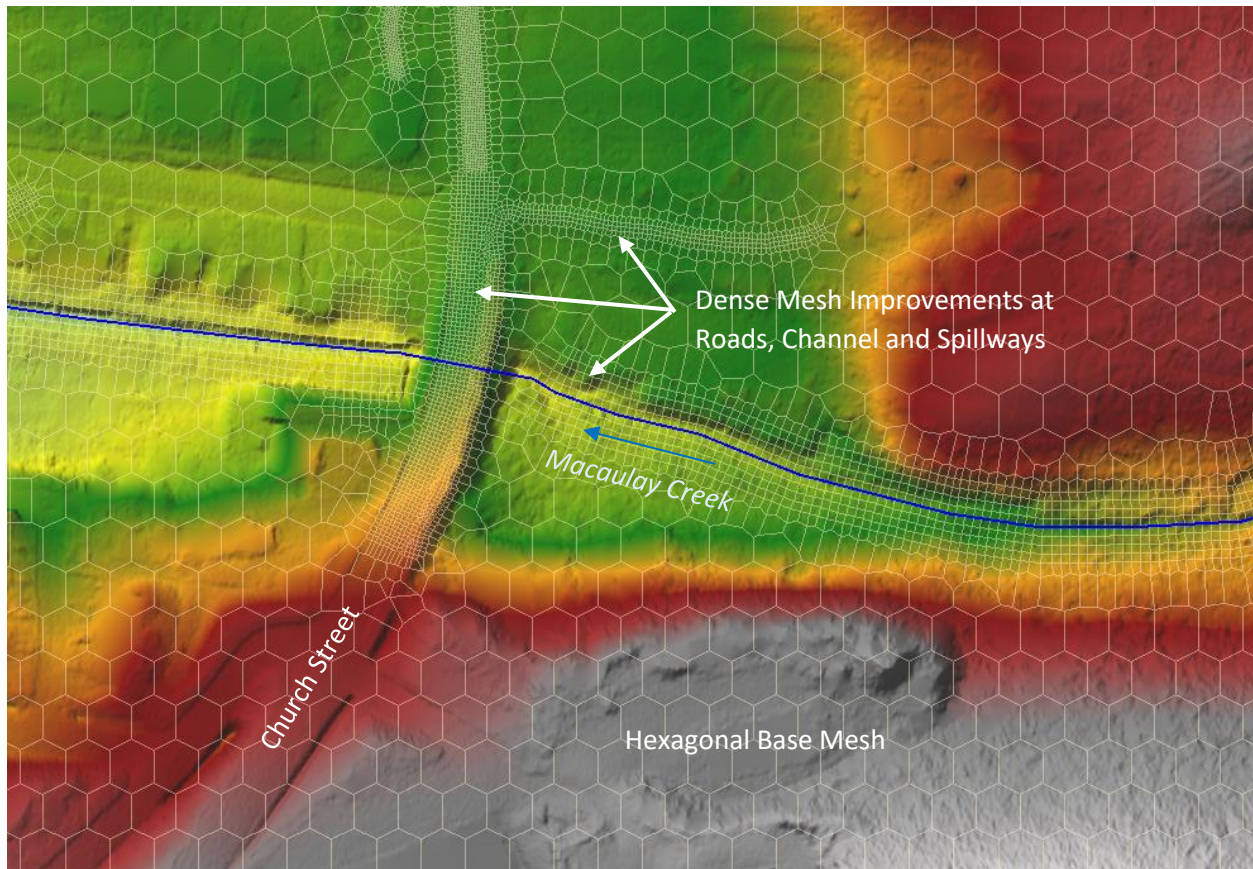


Figure 5-1: Example of Mesh Set-Up for 2D Flow Area at Macaulay Creek

5.3 Culvert & Bridge Crossings

The hydraulic model simulates the effects of culvert and bridge crossings on the water surface elevations at each crossing. There are **five (5) motor vehicle crossings** along the Marsh and Macaulay Creek main channels.

1. County Road 22 (Church Street)
2. Pitt Street
3. Lalor Street
4. York Street
5. Bridge Street

There are an additional six (6) crossings included in the hydraulic model within the green space upstream (south) of Bridge Street that contains Delhi Park, Prince Edward Dog Park, two pedestrian bridges, and the Glenwood Cemetery.

The vehicle crossings are of interest because motor vehicles have safe access limitations that are dependent on flow depths and velocities over the roadway. When flow depths and velocities get too extreme, the flood hazard can take away safe access and present a flood risk.

For the pedestrian crossings, there is less risk as we assume visitors will not be seeking to use the green space areas during major flood conditions.

This subsection summarizes the existing crossing configurations, hydraulic performance, and the maximum water surface elevation at each motor vehicle crossing.

5.3.1 Crossing #1: County Road 22 (Church Street)

County Road 22 is the first crossing along the Macaulay Creek system (upstream to downstream).

It is a single 1.6m span x 1.0m rise CSP arch culvert (see **Figure 5-2**).

A summary of the crossing performance is provided in **Table 5-1**.

The culvert has excellent flow capacity when compared to standard culvert sizing guidelines such as the *Ontario Ministry of Transportation Highway Drainage Design Standards*. The culvert has sufficient capacity to convey up to the 1% AEP storm with negligible overtopping.

In the flow-stage hydrograph at Church Street, there is a significant head difference between the 1% AEP headwater and tailwater elevations, suggesting the crossing operates under inlet-controlled conditions. The crossing is far enough upstream of Picton Harbour that its tailwater influence has no meaningful influence at this crossing.

Figure 5-3 demonstrates the flood pattern in the most extreme (Timmins) event.

Since the County Road 22 (Church Street) road profile continues lower moving further north, its relief flow over the road does not follow the main Macaulay Creek channel. Rather, it first spills over the parking lot at 23 Church Street (currently Macaulay Heritage Building) before overtopping Church Street. In the Timmins event, 3.4 m³/s of the relief flow is conveyed along the local road allowance along Church Street and Union Street before ultimately draining and pooling as part of the municipal road drainage. The remainder of the weir flow overtops York Street and makes its way back to the Macaulay Creek main channel.

Table 5-1: Church Street Culvert - Hydraulic Performance Summary

Church Street:				
Corrugated Steel Pipe Arch Culvert				
1.6m span x 1.0m rise opening				
¹ Spill Point = 91.67				
See Appendix J for detailed survey summary.				
Parameter	Unit	Storm:		
		1% AEP	Timmins	² Climate Change
Q _{peak}		4.4	9.9	7.0
Q _{culvert}	m ³ /s	4.1	4.0	3.9
Q _{weir}		0.3	5.9	3.1
¹ Peak Water Level	m	91.76	91.99	91.92
Relief Flow Depth		0.03	0.15	0.11
Velocity	m/s	1.30	2.78	2.35
D*V Product	m ² /s	0.02	0.27	0.16

¹Datum CGVD 2013.

²Climate change rainfall increases applied to 1% AEP storm.

³Maximum depth and velocity do not occur at same location. D*V measured along Church Street profile line.



Figure 5-2: Church Street Culvert Looking Upstream

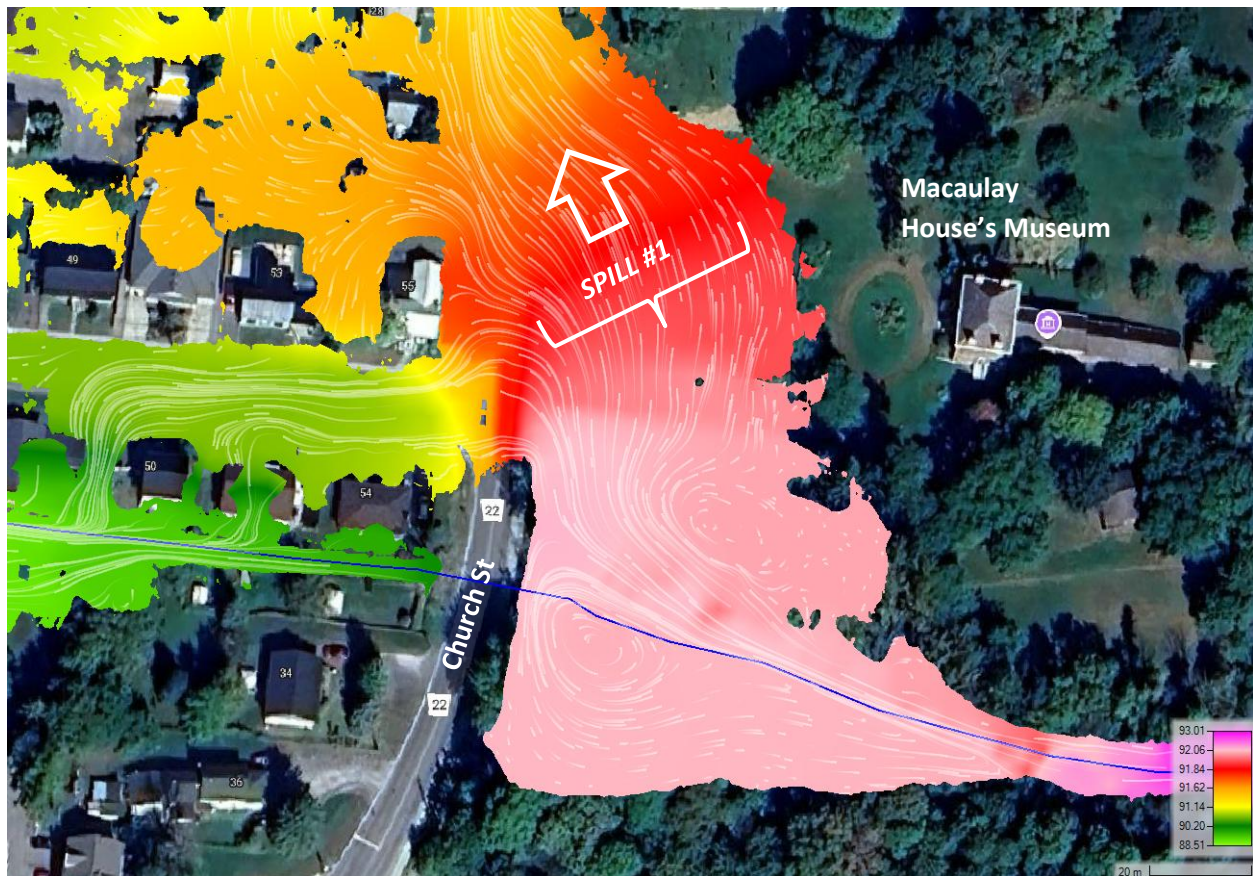


Figure 5-3: Spill #1 at Church Street in Timmins Event; Water Level Display in meters

5.3.2 Crossing #2: Pitt Street

The Pitt Street crossing is a 1.6m diameter CSP (see **Figure 5-4**) located 230m downstream (west) of the County Road 22 crossing.

The Pitt Street culvert is unusually long since it runs underneath the parking lot of the property at 19 Pitt Street (currently Jehovah's Witness Hall).

Flows exceeding the culvert capacity overflow onto the parking lot before overtopping Pitt Street.

The road sag (low point) of Pitt Street is near the intersection of Pitt Street and York Street. Spills would flow towards the private properties on the north side of York Street as shown in **Figure 5-5**. Spills over Pitt Street would simultaneously follow the York Street road allowance as also shown in Figure 5-5.

Table 5-2 shows no safe access concerns in the 1% AEP event. The relief flow depth at the deepest point is above 0.30m in the Timmins event (0.38m).



Figure 5-4: Pitt Street Culvert Looking Upstream

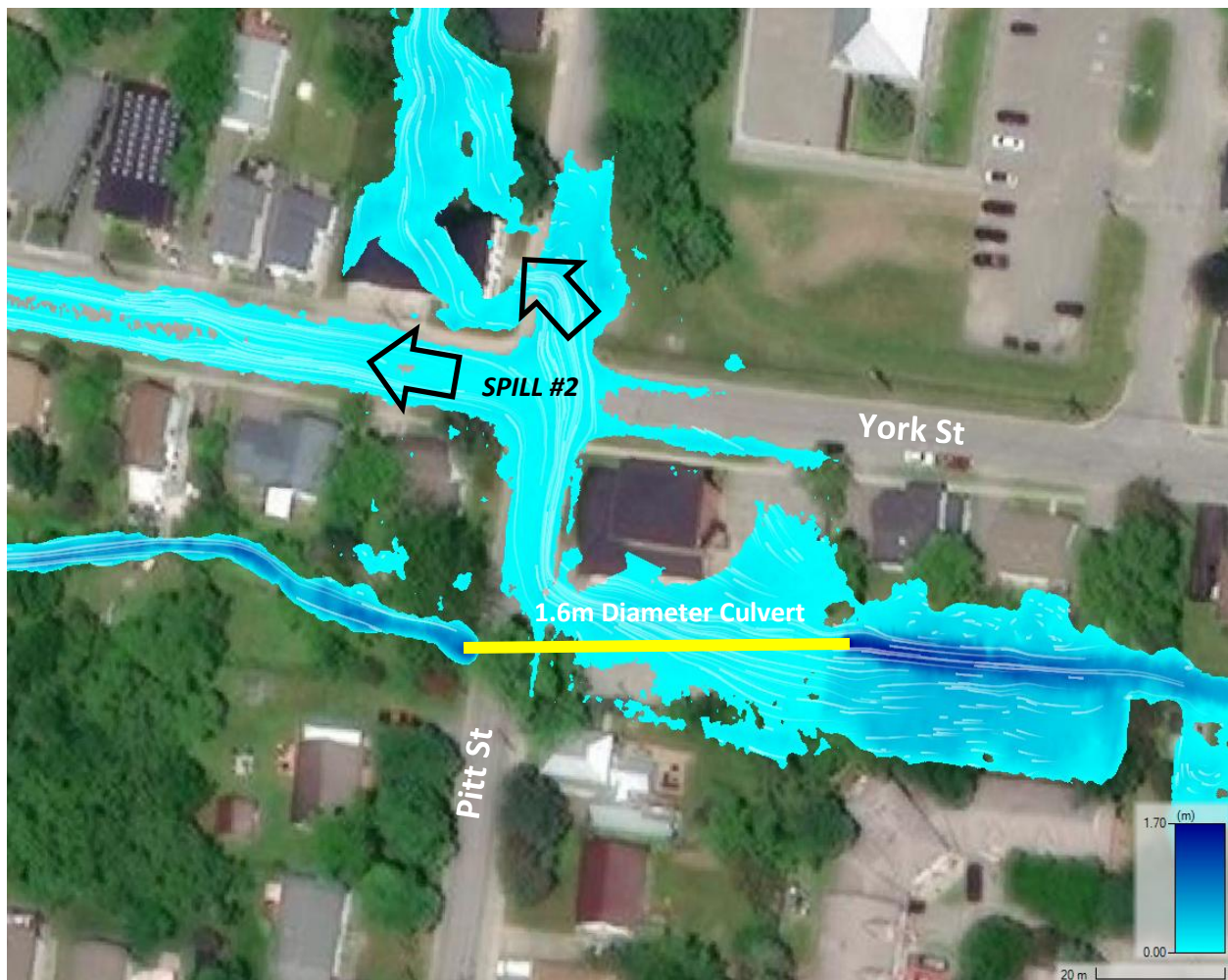


Figure 5-5: Spill #2 at Pitt Street – Snapshot Before Timmins Peak to Illustrate Location of Spill Divergence (Depth, m)

Table 5-2: Pitt Street - Hydraulic Performance Summary

Pitt Street:				
Corrugated Steel Pipe Culvert				
Round 1.6m diameter steel pipe				
¹ Road sag = 86.52				
See Appendix J for detailed survey summary.				
Parameter	Unit	Storm:		
		1% AEP	Timmins	² Climate Change
Q _{peak}		4.6	10.6	7.3
Q _{culvert}	m ³ /s	3.8	4.4	4.5
Q _{weir}		0.8	6.2	2.8
¹ Peak Water Level	m	86.63	86.90	86.82
Relief Flow Depth		0.11	0.38	0.30
Velocity	m/s	1.0	3.1	2.7
³ D*V Product	m ² /s	0.03	0.60	0.27

¹Datum CGVD 2013. Water level varies across Pitt St and shown at location of greatest relief flow depth.

²Climate change rainfall increases applied to 1% AEP storm.

³Maximum depth and velocity do not occur at same location. D*V measured along Pitt Street profile line.

5.3.3 Crossing #3: Lalor Street

Lalor Street is an access road to the green space area associated with Delhi Park and Cemetery lands. It is a short distance (15m) upstream of the Marsh Creek main channel.

The Lalor Street crossing is comprised of a 1.8m span x 1.3m rise CSP arch culvert (see **Figure 5-6**).

Outlet control conditions govern at this crossing due to the tailwater influence from the downstream end of the Marsh Creek system. This is evident with the minimal head difference between the headwater and tailwater elevations in both the 1% AEP and Timmins events. The tailwater (downstream boundary condition) was defined in the model as the peak water level at Cross Section 387 of the Marsh Creek main channel for the corresponding storm event.

A freeze-frame of the dynamic output near bank full flow of Marsh and Macaulay Creek is presented in **Figure 5-7** to demonstrate the natural flow paths and confluence of the two channels before the Lalor Street crossing is swallowed by the backwater impacts of the Bridge and York Street crossings in major storm events.

Safe access is expected to be limited in the 1% AEP event at Lalor Street to emergency vehicles only.



Figure 5-6: Lalor Street Culvert Looking Upstream

Table 5-3: Lalor Street - Hydraulic Performance Summary

Lalor Street:				
Corrugated Steel Pipe Arch Culvert				
1.8m span x 1.3m rise opening				
¹ Road sag = 76.21				
See Appendix J for detailed survey summary.				
Parameter	Unit	Storm:		
		1% AEP	Timmins	² Climate Change
Q _{peak}		4.7	11.1	7.2
Q _{culvert}	m ³ /s	0.9	³ N_A	³ N_A
Q _{weir}		6.4	³ N_A	³ N_A
¹ Peak Water Level	m	76.59	77.06	77.09
Relief Flow Depth		0.38	0.85	0.88
Velocity	m/s	0.65	0.71	0.70
D*V Product	m ² /s	0.25	0.60	0.62

¹Datum CGVD 2013.

²Climate change rainfall increases applied to 1% AEP storm.

³Minimal culvert and weir flow since tailwater influence from Marsh Creek main channel governs peak water level.

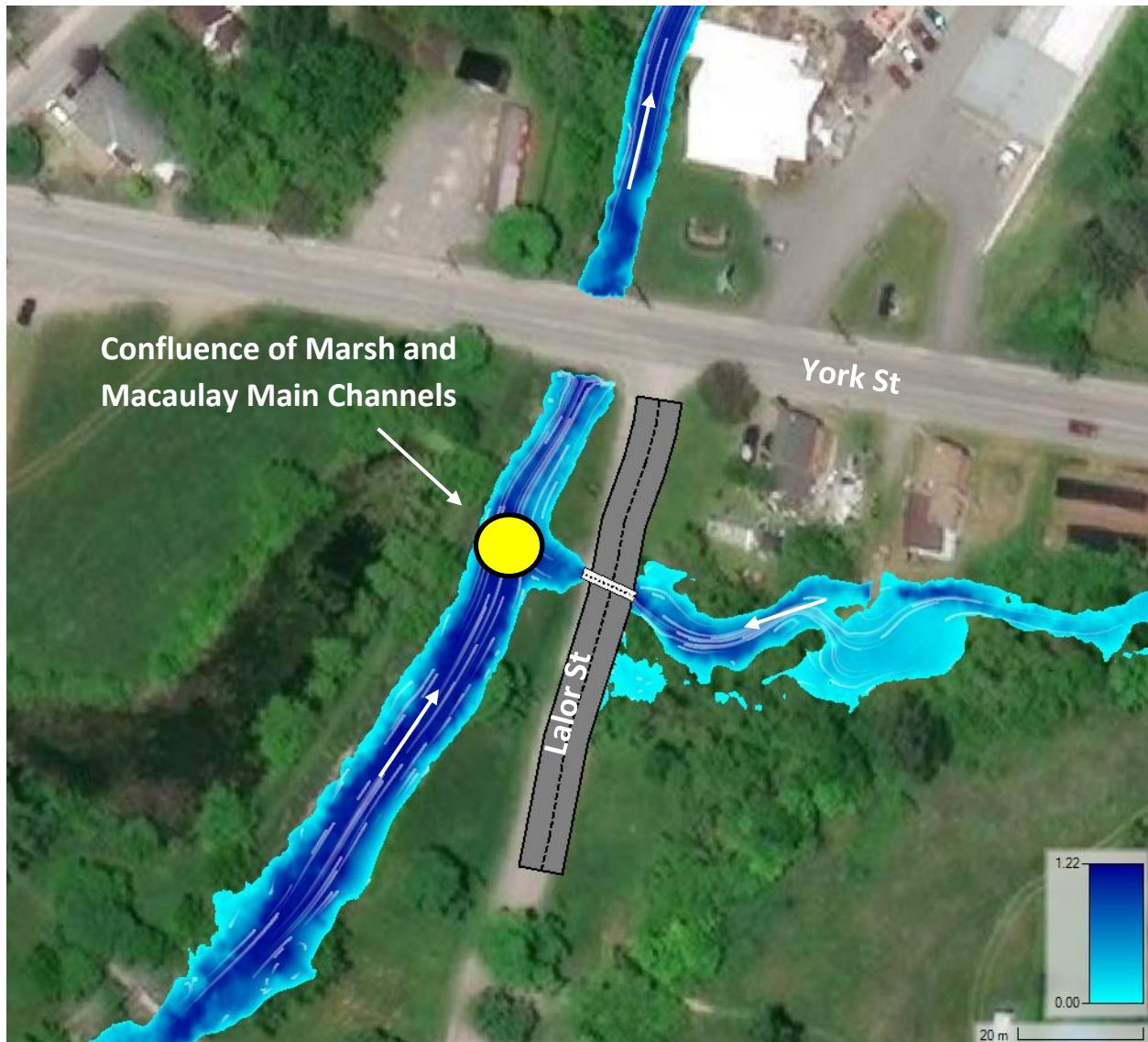


Figure 5-7: Lalor Street Crossing Location and Confluence of Marsh and Macaulay Creek Upstream of York Street – Snapshot of Depth, in m, Taken Before 1% AEP Peak to Show Bank Full Flow to Identify Confluence Location

5.3.4 Crossing #4: York Street

York Street is located immediately downstream of the confluence of the Marsh and Macaulay Creek main channels. It is comprised of two (2) 2.85m span x 1.95m rise CSP arch culverts. Due to the tailwater influence of the Picton Harbour the base of the culverts is partially submerged in a standard setting (see **Figure 5-8**).

In addition to the Picton Harbour tailwater, the culvert at Crossing #5: Bridge Street would create a backwater that would further increase the tailwater at the York Street crossing in a major storm event. These downstream influences create an outlet-controlled setting where the difference in water level upstream and downstream of York Street is near the same elevation for an extreme event such as the Timmins or climate change scenarios. This is evident in the water surface elevations on the flood maps at this location.

Safe access is not anticipated in the 1% AEP, Timmins, or climate change events (see **Table 5-4**).

Figure 5-9 demonstrates the flow patterns at this location in an extreme event such as the Timmins storm.



Figure 5-8: York Street Culvert Looking Downstream

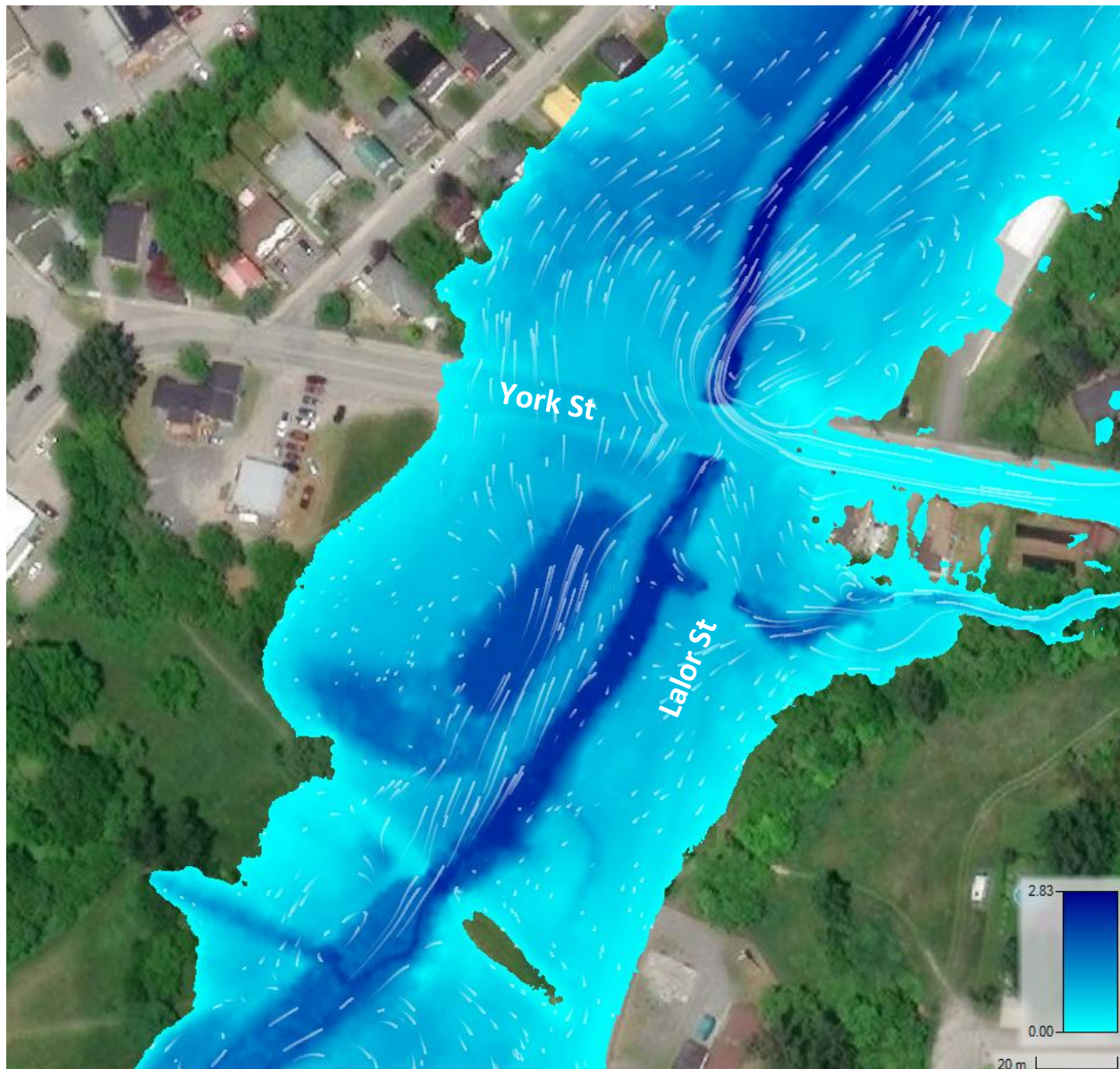


Figure 5-9: Flood Depth, in m, at York Street Near Peak of an Extreme (Timmins) Storm Event

Table 5-4: York Street - Hydraulic Performance Summary

York Street:				
Corrugated Steel Pipe Arch Open Footing Culvert				
Two (2) 2.85m span x 1.95m rise openings				
¹ Road sag = 76.09				
<i>See Appendix J for detailed survey summary.</i>				
Parameter	Unit	Storm:		
		1% AEP	Timmins	² Climate Change
Q _{peak}	m ³ /s	15.9	21.1	21.4
Q _{culvert}		2.0	0.7	0.9
Q _{weir}		13.9	20.4	20.5
¹ Peak Water Level	m	76.54	76.97	76.98
Relief Flow Depth		0.45	0.88	0.89
Velocity	m/s	0.67	0.35	0.35
D*V Product	m ² /s	0.30	0.31	0.31

¹Datum CGVD 2013.

²Climate change rainfall increases applied to 1% AEP storm.

5.3.5 Crossing #5: Bridge Street

Bridge Street is the final crossing before the Picton Harbour outlet. It includes two (2) concrete box culverts (see **Figure 5-10**). It is directly connected to Picton Harbour on its downstream end.

The Bridge Street road profile is relatively high given that the low point of the road is 1.36m higher than the obvert. This means a significant headwater depth is available on the upstream side of the crossing prior to road overtopping. The greater headwater depth means greater culvert flow capacity since it creates a driving head between the upstream and downstream side. The available headwater depth helps protect Bridge Street from overtopping even in larger return period events such as the 1% AEP storm.

The disadvantage of the elevated road profile at Bridge Street is that it creates a backwater area on its upstream (south) side. This contributes to the outlet-controlled condition at York Street and the high flood elevations at the residential and commercial properties in the area between Bridge and York Street. The wide flood extents and flow patterns upstream of Bridge Street are evident in **Figure 5-11**.

Safe access is expected to be available at Bridge Street in the 1% AEP, Timmins, and climate change scenarios (see **Table 5-5**).



Figure 5-10: Bridge Street Culvert Looking Downstream

Table 5-5: Bridge Street Culvert - Hydraulic Performance Summary

Bridge Street:				
Concrete open footing box culvert				
1.94m span & 1.64m span x 1.29m rise openings				
¹ Road sag = 76.74				
See Appendix J for detailed survey summary.				
Parameter	Unit	Storm:		
		1% AEP	Timmins	² Climate Change
Q _{peak}		15.9	21.4	21.5
Q _{culvert}	m ³ /s	15.9	19.1	18.4
Q _{weir}		0.0	2.3	3.1
¹ Peak Water Level	m	76.46	76.93	76.94
Relief Flow Depth		0.00	0.19	0.20
Velocity	m/s	0.00	0.44	0.58
D*V Product	m ² /s	0.00	0.08	0.12

¹Datum CGVD 2013.

²Climate change rainfall increases applied to 1% AEP storm.

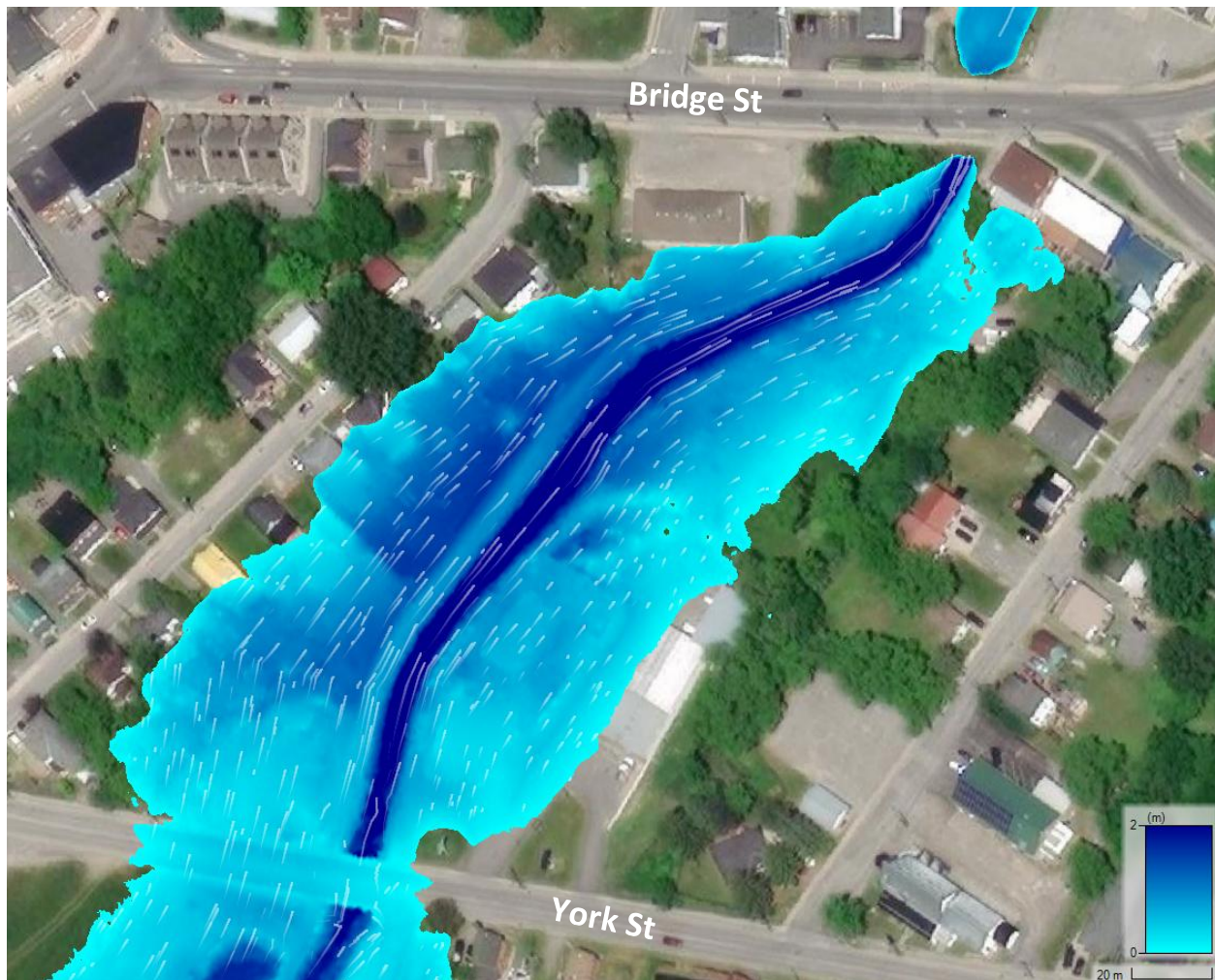


Figure 5-11: Wide Flood Extents and Flow Patterns Upstream of Bridge Street in 1% AEP Event (Depth, m)

5.4 Spill Areas

There are two (2) spill areas within the study area. Both are within the Macaulay Creek portion of the study area.

The first spill that would occur is upstream of the Church Street crossing. This spill location was identified in **Figure 5-3** as part of the description for Crossing #1.

The spill would become engaged for peak flows exceeding the capacity of the Church Street culvert. This peak flow would be exceeded at the Church Street location in return period events greater than the 1% AEP. Therefore, it would occur in the 0.5% AEP, the 0.3% AEP, the Timmins event, and the climate change scenario.

The second spill that would occur is upstream of the Pitt Street crossing. This spill location was identified in **Figure 5-5** as part of the description for Crossing #2.

The spill would become engaged for peak flows exceeding the capacity of the Pitt Street culvert. Similar to the Church Street spill, the culvert capacity would be exceeded in return period events greater than the 1% AEP. Therefore, it would occur in the 0.5% AEP, the 0.3% AEP, the Timmins event, and the climate change scenario.

The peak flow at the spill locations for the 1% AEP and Timmins events is summarized in **Table 5-6**.

Table 5-6: Spill Quantities in 1% AEP and Timmins Events

Spill Location	1% AEP	Timmins
#1: Church Street	0.25	3.4
#2: Pitt Street	0.27	5.2

Flow rates in m³/s.

Since the spills are created by road crossings, the spill quantities were reinserted immediately downstream as directed by QCA.

5.5 Storage Impacts

The potential attenuation of flows from storage imposed by culvert crossings were conservatively not included in the hydraulic modeling used to identify the flood limits. This means potential attenuation of flows imposed by the culvert crossings at York Street and Bridge Street are not relied upon and that uncontrolled flows are maintained downstream of the crossings.

Storage from the Macaulay Dam is included, although its attenuation influence is minimal. The Macaulay Dam is considered a flood control structure and therefore discussed in **Section 5.6**.

5.6 Flood Control Structure(s)

The Marsh Creek watershed has one flood control structure: the Macaulay Dam.

It is 530m upstream of County Road 22 (Church Street) and 250m south of County Road 8 (Union Street).

The Macaulay Dam was investigated in the *Dam Safety Report* prepared by KGS. The outlet structure information was obtained from the KGS DSR and applied for consistency between their work and the Marsh Creek Floodplain Mapping Update. After a review of the KGS report and modeling, Jewell opted to prepare separate hydrology and hydraulic analysis to route the Macaulay Dam reservoir and its downstream channel to Marsh Creek.

The attenuation offered by the Macaulay Dam is minor (see **Table 5-7**). The attenuation could be increased by making the reservoir substantially larger and adjusting its outlet control. This would increase the storage within the reservoir along with its driving head on the outlet structure. Although this could provide flood mitigation in theory, we caution that it could provide a net increase in flood risk in the event of a dam breach. With more storage and more driving head within the reservoir, a dam breach has more risk than in its current operating condition. Considerations in improving flow attenuation from the Macaulay Dam would be construction costs, loss of usable trail land, and a review of the net increase or decrease in flood risk (dam breach flood risk versus existing flood risk).

Table 5-7: Macaulay Dam Hydraulic Performance Summary

Macaulay Dam	1% AEP	Timmins
Inflow	3.97	8.50
Outflow	3.92	8.47
Q _{attenuation} (%)	1.2%	0.4%
Q _{pipe}	1.00	1.23
Q _{overtopping}	2.92	6.90
Water Level (m)	104.20	104.46
Storage (m ³)	5,400	6,930

Flow rates in m³/s.

Water level in datum CGVD 2013.

5.7 Profile Plots

Profile plots for the Marsh and Macaulay Creek main channels are displayed in **Figures 5-12 and 5-13**.

The intent is to demonstrate the change in slope of the main channel as it traverses the watershed. The blue inundation areas represent approximations of the 1% AEP water levels. The Timmins event is included for the Marsh Creek Profile Plot to demonstrate the flat water surface profile in the vicinity of Bridge Street, York Street and Delhi Park that is largely the result of the backwater from the Bridge Street crossing in extreme storm conditions.

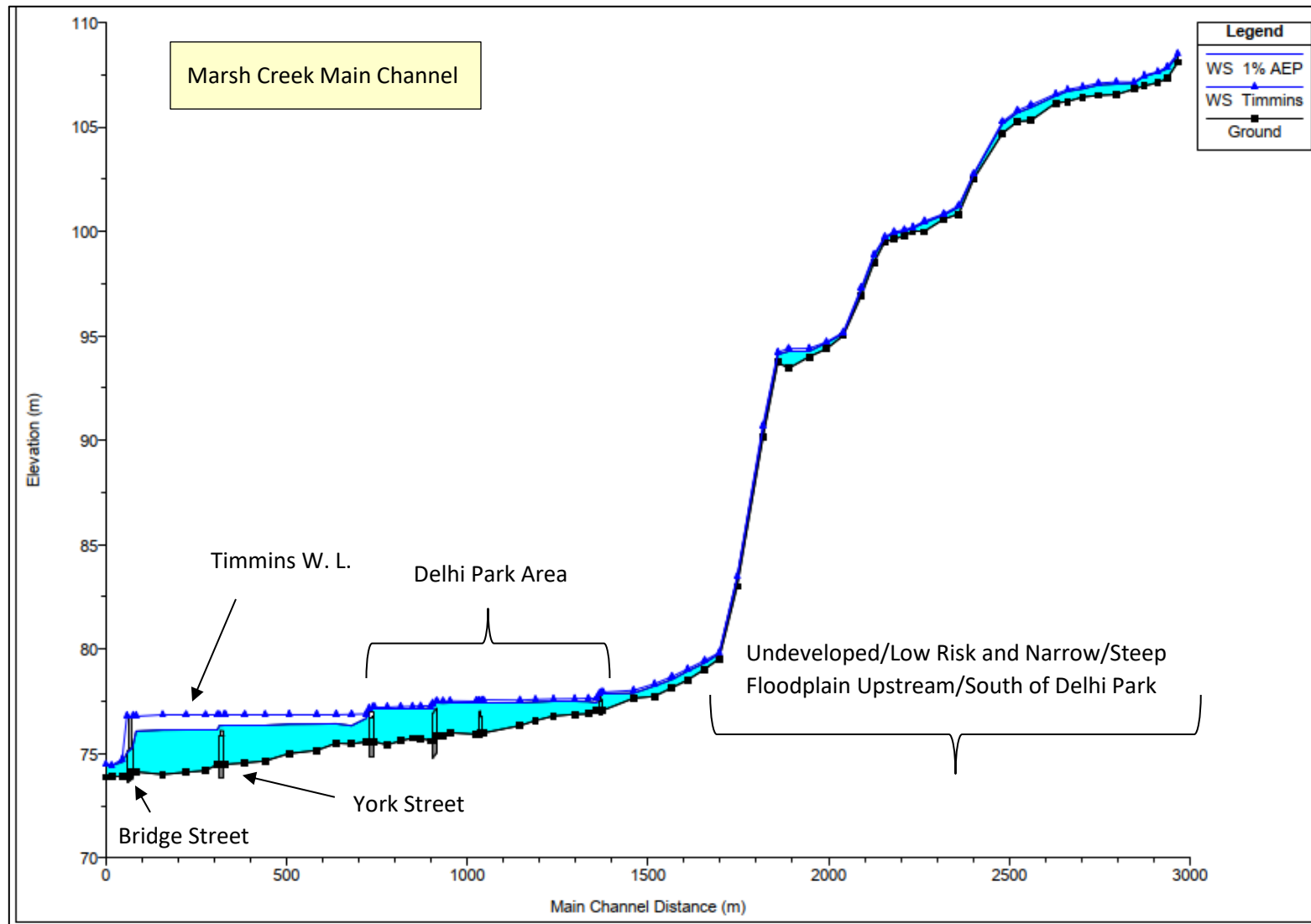


Figure 5-12: Profile Plot of Marsh Creek Main Channel

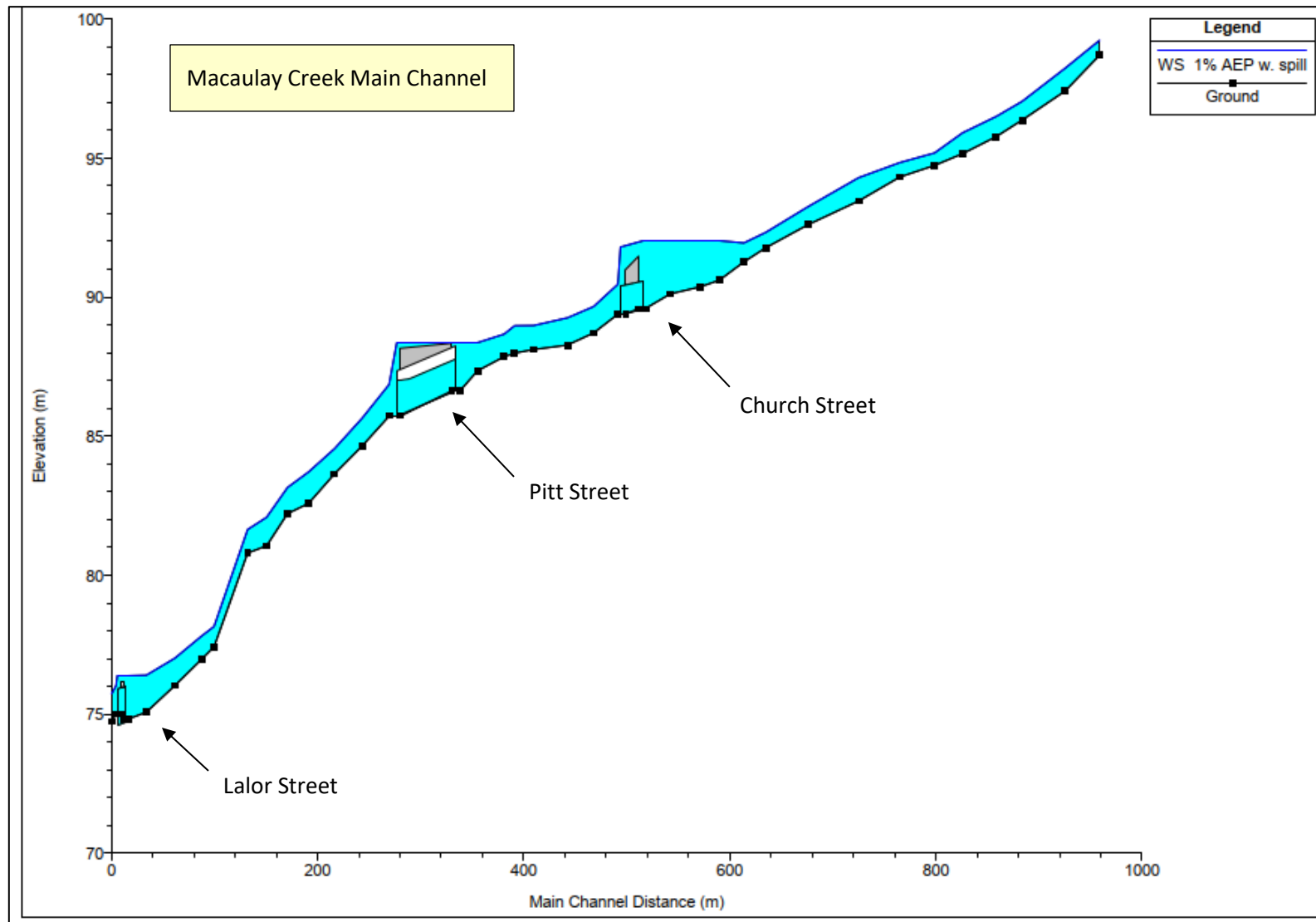


Figure 5-13: Profile Plot of Macaulay Creek Main Channel

6 Sensitivity Analysis

The flood hazard limits are derived from two separate modelling tools. Firstly, the peak flow rates are developed from hydrologic models, which estimate peak flows at various points of interest within the study area. Secondly, the hydraulic models incorporate the peak flows and estimate the water surface elevations within the study area.

The two models, in concert, serve as simplified predictive tools that emulate the watershed response to given precipitation events and estimate the resulting area of land that would be inundated by the flooding. The models have very simplistic inputs that attempt to represent the complex watershed conditions including slope, soils, land cover, land use, storage and surface roughness.

The objective for this sensitivity analysis is to attempt to answer the question – can we rely on the modelling results? That question is further refined to – how accurate is the estimate of the floodplain limits?

In this section, both uncertainty in the data and sensitivity of the model to the data and modelling techniques are explored.

6.1 Hydrologic Modelling

6.1.1 Precipitation

Some hydrologic inputs have large uncertainties. An example is the precipitation depth. While many years of precipitation records are available at the selected precipitation station, uncertainty in the data arises from the method of collection, the maintenance of the gauge and siting of stations. It is reported that standard TB3 tipping bucket rain gauges underreport the precipitation depth by 3.5% and total depth gauges such as the Geonor T-200B underreport 4.7%. Older Type B rain gauges underreport by just 0.6% against the standard WMO pit gauge¹. This would represent systematic losses in the data collection.

Return period precipitation depths are derived statistically from the data and estimates of return period depths are subject to the selection of statistical method and the period of record.

Precipitation used in the current study is the data directly from the ECCC Intensity Duration Frequency (IDF) curves. ECCC reports the 95% confidence (equivalent to 2 standard deviations) for the precipitation intensities. As an example, the 1-hr intensities are reported with (+ / -) values in mm/h. These vary from 2.3mm to 10mm, or 11.7% to 20.4% of the stated intensities for the 2-yr to 100-yr respectively. While some estimates of confidence is provided for the statistical intensities, there is no direct statement within the station report on the confidence of the total depth estimates for return period. Specific to the Marsh

¹ Field Accuracy of Canadian Rain Measurements, Kenneth A. Devine and Eva Mekis, Atmosphere-Ocean, 2008

Creek watershed, the 1% AEP value was measured against a range of rainfall increase and decreases to determine its sensitivity.

The model is considered sensitive to rainfall volumes. This is useful knowledge because the climate change influence on rainfall projections is significant at a 25% increase. As **Figure 6-1** suggests, a 25% increase in rainfall translates to a 35% increase peak flow. Therefore, the expected climate change impacts are significant and closes the gap between the existing 1% AEP peak flow and the Timmins storm.

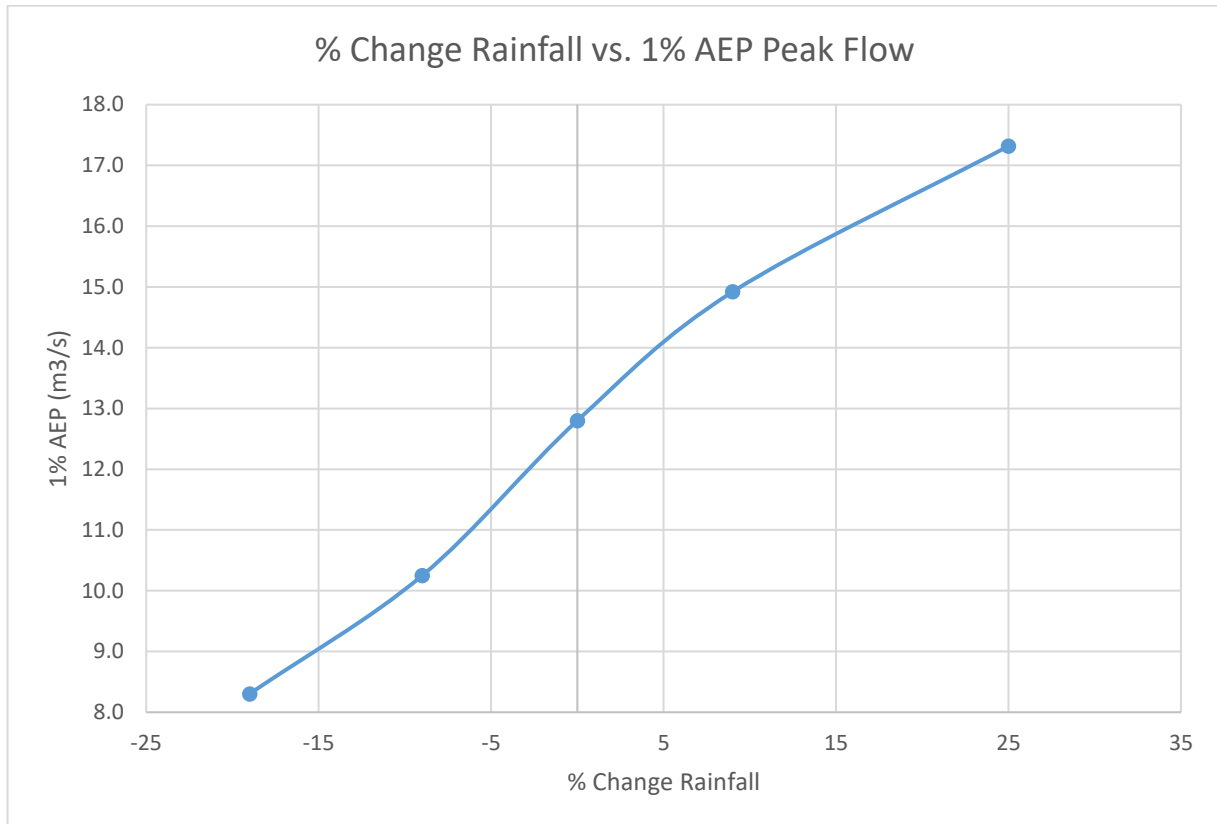


Figure 6-1: Sensitivity of Peak Runoff Rates to Rainfall Volume

6.1.2 Curve Number

The sensitivity analysis for the CN was completed to determine the impact this value has on peak flows. **Figure 6-2** shows a comparison of CN values to the resulting peak flows in the hydrology model. As expected, there is a strong correlation between CN and peak flows values. With a 30% increase in CN, there is approximately a 39% increase in peak flow. Similarly, for a 30% decrease in CN, there is approximately a 16% reduction in peak flow. It is interesting that the model demonstrates some stability in the vicinity of the applied CNs, with the CN impact on peak flow becoming more sensitive as one deviates from the selected values.

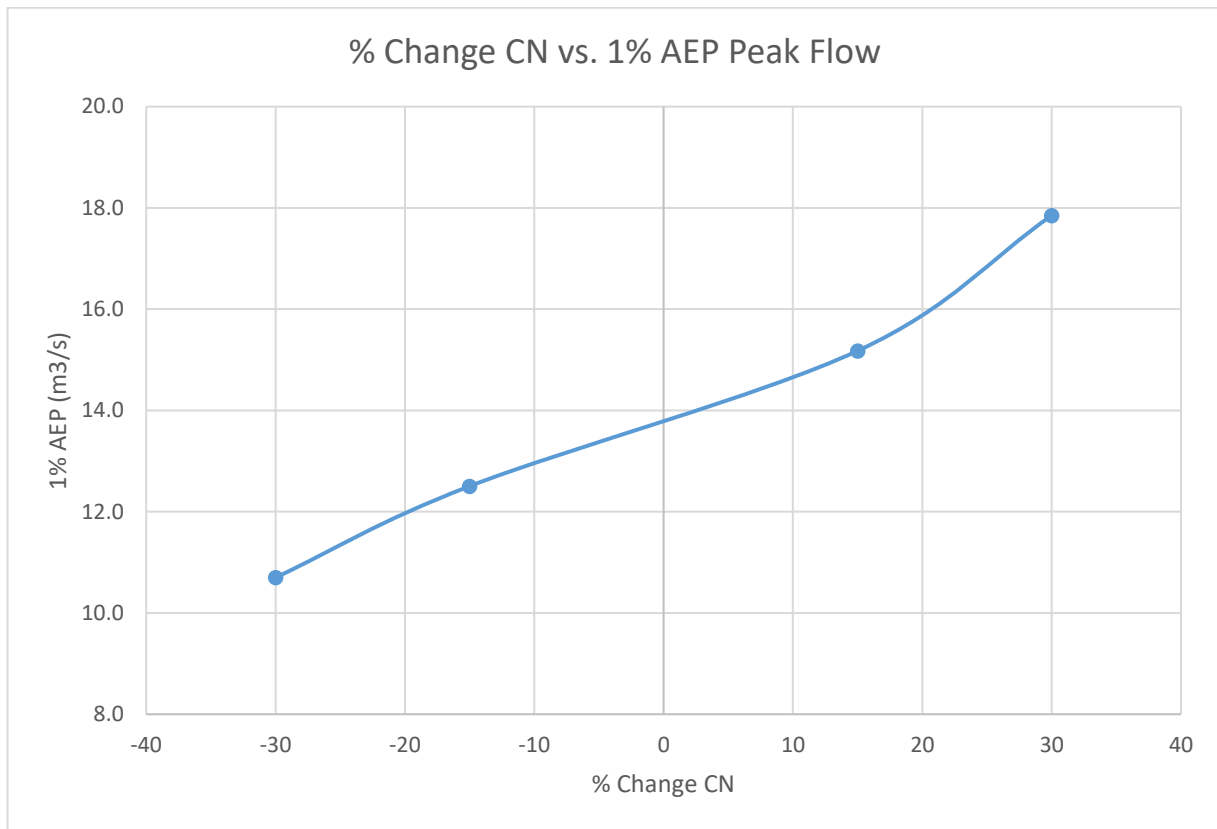


Figure 6-2: Sensitivity of Peak Runoff Rates to CN

6.1.3 Lag Time

The lag time has moderate sensitivity impacts on the peak flow results. **Figure 6-3** shows a comparison of lag time values to the resulting peak flows. With a 30% increase in lag time, there is a 13% decrease in peak flow. For a 30% decrease in lag time, there is a 38% increase in peak flow.

It is interesting that similar to the CN sensitivity, the model demonstrates some stability in the vicinity of the applied lag times, with the lag time impact on peak flow becoming more sensitive as the deviation from the selected values increases.

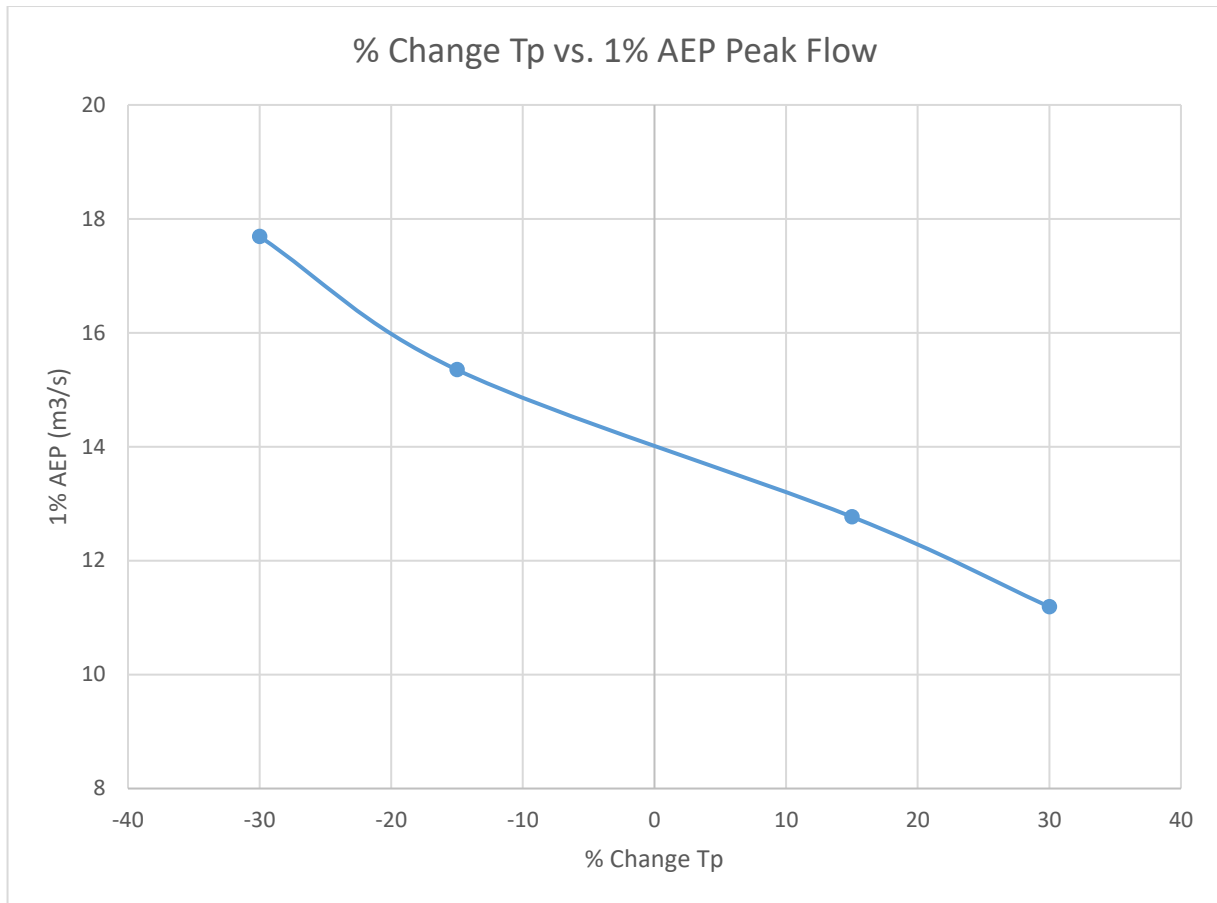


Figure 6-3: Sensitivity of Peak Runoff Rates to Lag Time

6.2 Hydraulic Modeling

6.2.1 Manning's n

The hydraulic model requires inputs for Manning's n values. The *HEC-RAS User's Manual* and *MTO Drainage Management Manual* provide ranges of roughness coefficient values for varying surface cover such as crop overbank areas, treed areas, and channel bottoms for natural watercourses. Mid-range, high, and low Manning's values were tested in different simulations to determine the effect of these values on the floodplain limits. Mid-range values were selected and applied in the regulatory floodplain mapping. A comparison of water levels at different cross sections for low, mid, and high-range values varied no more than 10cm, meaning the Manning's values have a minor influence on water level results.

Table 6-1: Manning's n Values Applied in Hydraulic Model Sensitivity Tests

Land Cover	Low	Medium	High
Swamp	0.035	0.045	0.06
Clear open water	0.028	0.032	0.035
Community infrastructure	0.035	0.05	0.12
Tree upland	0.05	0.07	0.09
Marsh	0.035	0.045	0.06
Deciduous treed	0.05	0.07	0.09
Mixed treed	0.05	0.07	0.09
Coniferous treed	0.05	0.07	0.09
Agriculture and undifferentiated rural	0.035	0.05	0.07
Plantations - treed cultivated	0.035	0.05	0.07
Hedge rows	0.04	0.05	0.07
Sand gravel mine tailings extraction	0.017	0.025	0.033

6.2.2 Storage from Bridge Street to Delhi Park

While flood limits on a map are a useful tool, it is helpful for the technical team to understand the drainage system which they regulate. Flow gauge and watershed statistics across the region suggest a strong correlation between storage areas and peak flow attenuation. For this reason, Jewell investigated the potential storage imposed by the crossings near the downstream end of the system. Although this storage is conservatively ignored in the hydraulic model used to produce the flood maps, it is recommended to be understood to make informed watershed management decisions.

To investigate this potential storage area, a 2D model was employed separate from the 1D model. The 2D model encompasses the full study area and accounts for volume throughout the natural storage location. It includes the impacts of the Bridge Street and York Street crossings, and accounts for the two Macaulay Creek spills. It utilizes the same HEC-HMS peak inflow rates as the 1D model.

6.2.2.1 1% AEP Storm

In the 1% AEP storm, the consequential storage is located upstream of York Street. The 1% AEP inflow to the crossing storage upstream of York Street is 15.9 m³/s and the outflow from the York Street crossing is 12.7 m³/s. There is 7,850 m³ of crossing storage utilized upstream of York Street that provides some attenuation of the peak flows that would occur downstream at Bridge Street. The storage impacts are summarized in **Table 6-2**.

The storage *between Bridge Street and York Street* offers minimal attenuation in the 1% AEP storm since most of the attenuation has already occurred upstream of York Street. This is evident by the difference in peak flow between the York and Bridge Street crossings.

6.2.2.2 Timmins Storm

In the Timmins storm, there is minimal difference in water level between York Street and Bridge Street. This is because the Bridge Street crossing has a higher road sag than York Street, and the higher Timmins flows inundate both crossings due to the overtopping that occurs at Bridge Street.

The percent flow attenuation in the Timmins event is much less than in the 1% AEP event since the Timmins event overtops the roadways and does not experience the same impact from the culvert openings as is experienced in the 1% AEP event.

Table 6-2: Potential Storage Impacts for 1% AEP and Timmins Events

Storage Area	1% AEP	Timmins
Inflow with spills	15.9	20.6
Outflow	12.7	19.2
Q _{attenuation} (%)	20%	7%
2D Water Level (m)	76.46	76.94
Active Storage (m ³)	7,850	39,430

Flow rates in m³/s.

6.2.3 Water Level at Picton Harbour

The tailwater elevation for the routing in the hydraulic model is the water level imposed by the Picton Harbour.

The FHIMP guidelines reference the “annual maximum” for lake level usage in hydraulic modeling. For Picton Harbour, which is directly connected to the Bay of Quinte and Lake Ontario.

The NRCan website records water levels in Lake Ontario. For the full history, the month with the highest average water level is June. Between 2015 – 2024, slightly higher water levels have been recorded.

To identify the sensitivity of the model to the Picton Harbour (Lake Ontario) water level, the historical seasonal high based on 1918 - 2024 (June) record, updated seasonal high based on 2015-2024 (June) record, and the Lake Ontario 1% AEP water level were simulated (see **Table 6-3**). The lake level is the immediate tailwater elevation for the crossing at Bridge Street. Therefore, a comparison of headwater vs. tailwater of the Bridge Street crossing identifies the influence of the lake level on the flood elevations upstream of Bridge Street. The sensitivity is summarized in **Table 6-4** and **Figure 6-4**.

The June seasonal high from 2015 – 2024 was selected as the annual maximum for modeling purposes.

The tailwater has limited impact on the water level at Bridge Street during its seasonal high-water level. There is a 0.4m increase in the 1% AEP Lake Ontario water level were to occur at the same time as the 1% AEP for the Marsh Creek catchment. Since these are mutually exclusive events, the 1% AEP Lake Ontario water level was simulated for information purposes only, and the annual maximum was applied.

Table 6-3: Three Tailwater Alternatives for Picton Harbour Water Level

	Lake Ontario Water Level		
	IGLD 85	CGVD 28	CGVD 2013
Historical Seasonal High 1918 - 2024	75.06	75.012	74.67
Seasonal High (June) from 2015 - 2024	75.23	75.182	74.84
1% AEP	76.03	75.982	75.64

Table 6-4: Picton Harbour Water Level Setting vs. Bridge Street 1% AEP Water Level

	Lake Ontario Water Level (CGVD 2013)	Bridge Street 1% AEP Headwater (CGVD 2013)
Historical Seasonal High 1918 - 2024	74.67	76.46
Seasonal High (June) from 2015 - 2024	74.84	76.46
1% AEP	75.64	76.84

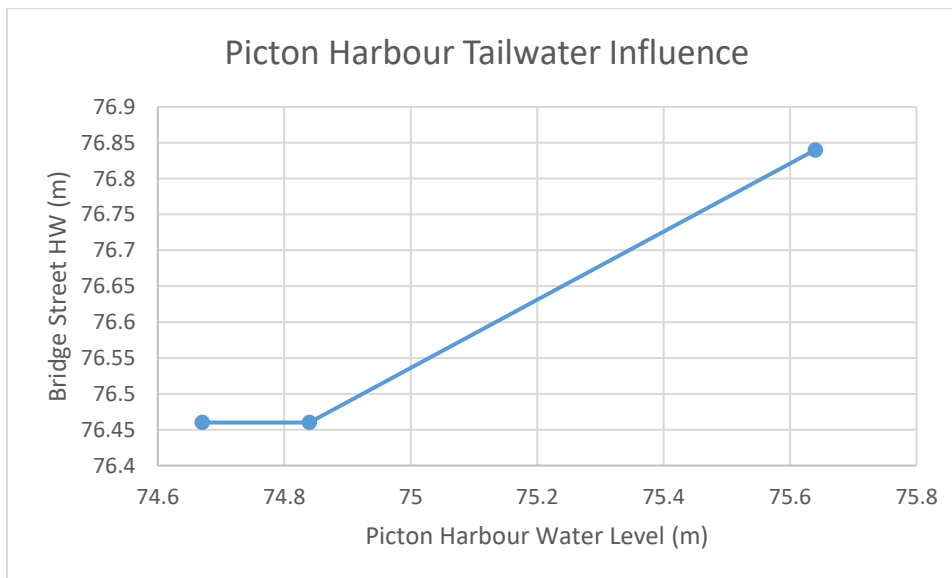


Figure 6-4: Picton Harbour Water Level vs. 1% AEP Headwater Level at Bridge Street

7 Flood Hazard Limit Delineation

It is important to note that the historic flood limit was delineated using the Timmins as the Regulatory event. Based on current Ontario Regulations, the 1% AEP is defined as the Regulatory storm in lieu of the Timmins event.

Flood Hazard Maps are provided in **Appendix B**.

Three mapping sets are provided:

1. 2026 1% AEP flood limits,
2. Map overlay of 50% AEP, 10% AEP, 1% AEP, 0.5% AEP, and Timmins storms, and
3. 2026 regulatory flood limits (1% AEP) vs. historic regulatory flood limits (old Timmins).

8 Flood Hazard Mitigation

The current hydrologic and hydraulic analysis can be used to identify potential opportunities for flood mitigation. A high-level review of potential mitigation opportunities is discussed below.

8.1 Low-Lying Area Bridge Street to Delhi Park

There are limited opportunities for meaningful flood hazard mitigation. The primary area of interest is the low-lying area from Bridge Street to Delhi Park.

The flood limits within the low-lying area are influenced by the culvert crossings at Bridge Street and York Street. However, each of these culverts have good flow capacity. In major storms, such as the 1% AEP (Regulatory event) and Timmins storms, culverts are not expected to convey the full flow and overtopping of the road is accepted for relief flow.

If the road is lowered to lower the flood water levels, then the depth over the road may be increased. If the culvert capacities are increased, it may be a high cost for minimal improvement (lowering) of water levels.

The Bridge Street centerline elevation is relatively high. This helps protect traffic from the flood hazard. However, it contributes to the flood hazard upstream of Bridge Street. If the County is to pursue culvert improvements, it is recommended that they have the hydraulics assessed along with a cost-benefit for their preferred culvert size.

Based on recent projects and the existing culvert sizes at Bridge Street, Jewell estimates an upsizing of the culverts for potential improvements would have a material cost of \$400,000, a contractor cost of \$350,000, and another \$150,000 for engineering, design and approvals. These estimates are high-level and combine for a total of \$900,000. With standard contingencies a budget of more than \$1,000,000 would be expected.

8.2 Macaulay Dam Modifications

Another area investigated for flood mitigation was the Macaulay Dam. The Macaulay Dam offers minimal flow attenuation for the 1% AEP (Regulatory) event in its current condition. Some meaningful flow attenuation could be achieved by reducing the Macaulay Dam outflow control and raising the elevation of the dam to impose a deeper reservoir for more storage volume. While this could work in theory, it is not recommended since a failure or breach of the reservoir could be a greater risk than the uncontrolled 1% AEP storm. No cost estimate is assigned since this alternative is not recommended.

8.3 Floodproofing and Regulatory Measures

There are approximately nineteen (19) buildings within the Regulatory Flood Limit. An additional eleven (11) buildings are within the flood limit for the Timmins storm. The Quinte Conservation *Regulations Policy Document* includes *Appendix E – Floodproofing Guidelines* is a useful reference for floodproofing measures. With the small watershed size and short times to peak, flood forecasting abilities are limited.

9 Conclusions

The Flood Hazard Identification Mapping Program has provided the opportunity for Quinte Conservation Authority, in partnership with Prince Edward County and the provincial and federal partners, to complete the *2026 Marsh Creek Floodplain Mapping Update*.

The finer details of this report provide an overview of the rigorous testing of the hydrology and hydraulics that have been completed to ensure reliable flood hazard limits are presented in the 2026 Marsh Creek flood maps. The current mapping will allow QCA and County staff to make informed planning and regulation decisions to mitigate the flood risk to life and property, with emphasis on the urban core throughout the Town of Picton.

Table 9-1 summarizes the Regulatory (1% AEP) peak flow for the full watershed for the 12-hr, SCS distribution rainfall event. The Timmins peak flow is also included.

Table 9-1: Full Watershed Peak Flow Summary at Bridge Street (m³/s)

1% AEP	Timmins
15.9	21.4

Table 9-2 summarizes the number of existing buildings within the flood limit for the 1% AEP and Timmins events. It is recommended that the findings of this mapping update be used as a tool to assist QCA and County staff in their goal to protect life and property from the flood hazard.

Table 9-2: Estimate of Buildings within Flood Hazard Limit

1% AEP	Timmins
19	30

We commend QCA staff and the project partners for their efforts in preparing the *2026 Marsh Creek Floodplain Mapping Update* that will benefit the local community within the Town of Picton for many years to come.

Prepared by:

Elliott Fledderus, P. Eng.

Jewell Engineering Inc.



10 References

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Marsh Creek Flood Hazard Mapping Update

Appendix A:
Study Area



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Appendix B:
Flood Hazard Maps (See Separate Attachment)



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Appendix C:
Catchment Areas

MARSH CREEK
SUBCATCHMENT
GROUPS

LIDAR PROJECT CONTROL DATUM:
HORIZONTAL DATUM: NAD 83 CSRS
(EPOCH 2010.0)
VERTICAL DATUM: CGVD 2013



LEGEND

SUBCATCHMENTS

ONT TRAIL NETWORK

RAIL NETWORK

CONSESSIONS

PICTON URBAN BOUNDARY

WATER BODIES

RIVER NETWORK

PRIMARY TRIBUTARY

SECONDARY TRIBUTARY

ROAD NETWORK

MAJOR HIGHWAY

MINOR HIGHWAY

COUNTY HIGHWAY

LOCAL ROAD

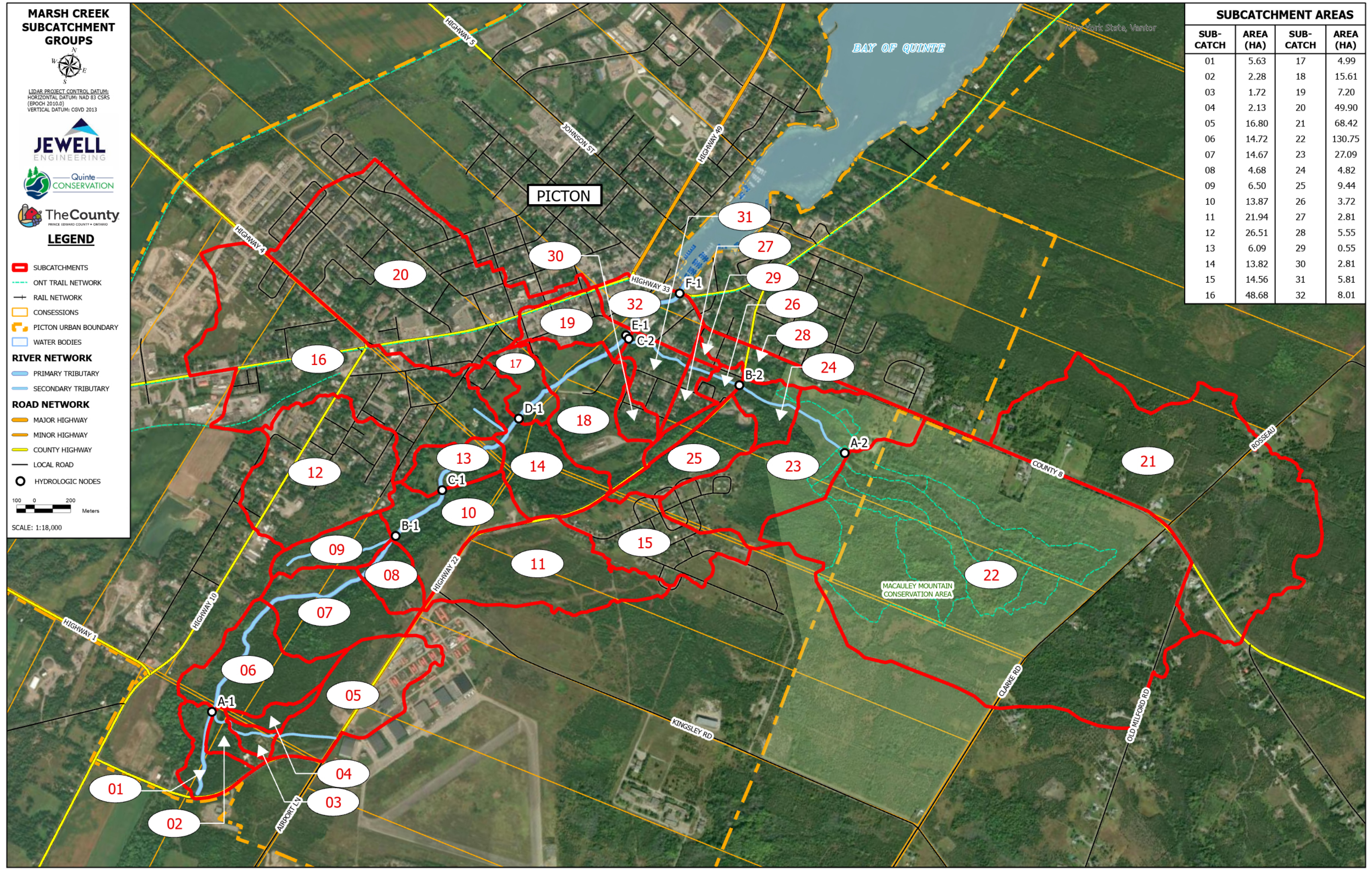
HYDROLOGIC NODES

100 0 200
Meters

SCALE: 1:18,000

SUBCATCHMENT AREAS

SUB-CATCH	AREA (HA)	SUB-CATCH	AREA (HA)
01	5.63	17	4.99
02	2.28	18	15.61
03	1.72	19	7.20
04	2.13	20	49.90
05	16.80	21	68.42
06	14.72	22	130.75
07	14.67	23	27.09
08	4.68	24	4.82
09	6.50	25	9.44
10	13.87	26	3.72
11	21.94	27	2.81
12	26.51	28	5.55
13	6.09	29	0.55
14	13.82	30	2.81
15	14.56	31	5.81
16	48.68	32	8.01





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Appendix D:
Soil and Land Cover Maps

MARSH CREEK SOIL GROUPS



LIDAR PROJECT CONTROL DATUM:
HORIZONTAL DATUM: NAD 83 CSRS
(EPOCH 2010.0)
VERTICAL DATUM: CGVD 2013

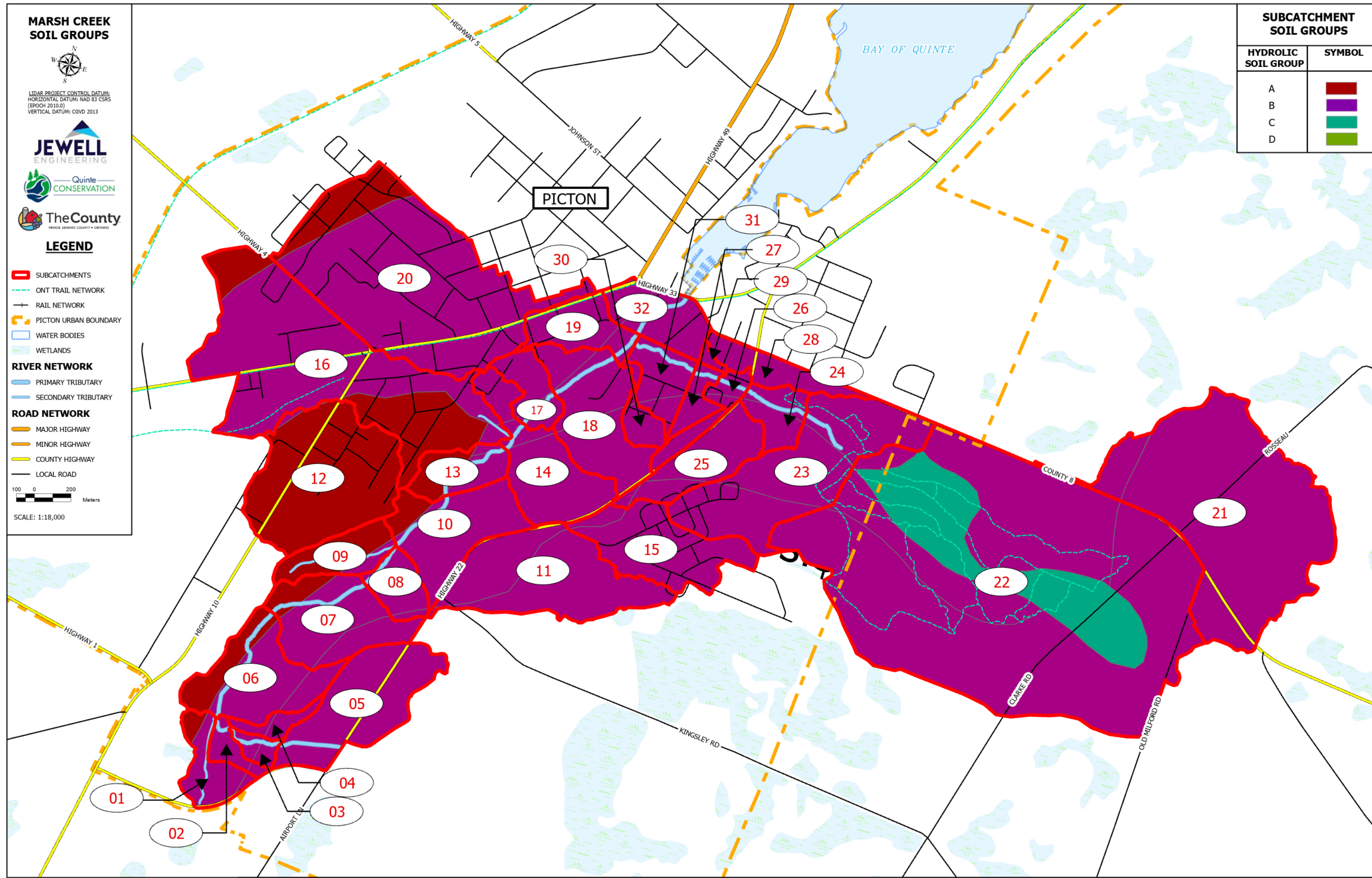


LEGEND

- SUBCATCHMENTS
 - ONT TRAIL NETWORK
 - RAIL NETWORK
 - PICTON URBAN BOUNDARY
 - WATER BODIES
 - WETLANDS
 - RIVER NETWORK**
 - PRIMARY TRIBUTARY
 - SECONDARY TRIBUTARY
 - ROAD NETWORK**
 - MAJOR HIGHWAY
 - MINOR HIGHWAY
 - COUNTY HIGHWAY
 - LOCAL ROAD
- 100 0 200 Meters
SCALE: 1:18,000

SUBCATCHMENT SOIL GROUPS

HYDROLOGIC SOIL GROUP	SYMBOL
A	
B	
C	
D	



Subbasin ID	HSG			
	A	B	C	D
1	14	86	0	0
2	0	100	0	0
3	0	100	0	0
4	0	100	0	0
5	0	100	0	0
6	31	69	0	0
7	15	85	0	0
8	0	100	0	0
9	83	17	0	0
10	13	87	0	0
11	0	100	0	0
12	99	1	0	0
13	52	48	0	0
14	0	100	0	0
15	0	100	0	0
16	27	73	0	0
17	0	100	0	0
18	0	100	0	0
19	0	100	0	0
20	13	87	0	0
21	0	100	0	0
22	0	81	19	0
23	0	100	0	0
24	0	100	0	0
25	0	100	0	0
26	0	100	0	0
27	0	100	0	0
28	0	100	0	0
29	0	100	0	0
30	0	100	0	0
31	0	100	0	0
32	0	100	0	0

MARSH CREEK LAND COVER GROUPS



LIDAR PROJECT CONTROL DATUM:
HORIZONTAL DATUM: NAD 83 CSRS
(EPOCH 2010.0)
VERTICAL DATUM: CGVD 2013



LEGEND

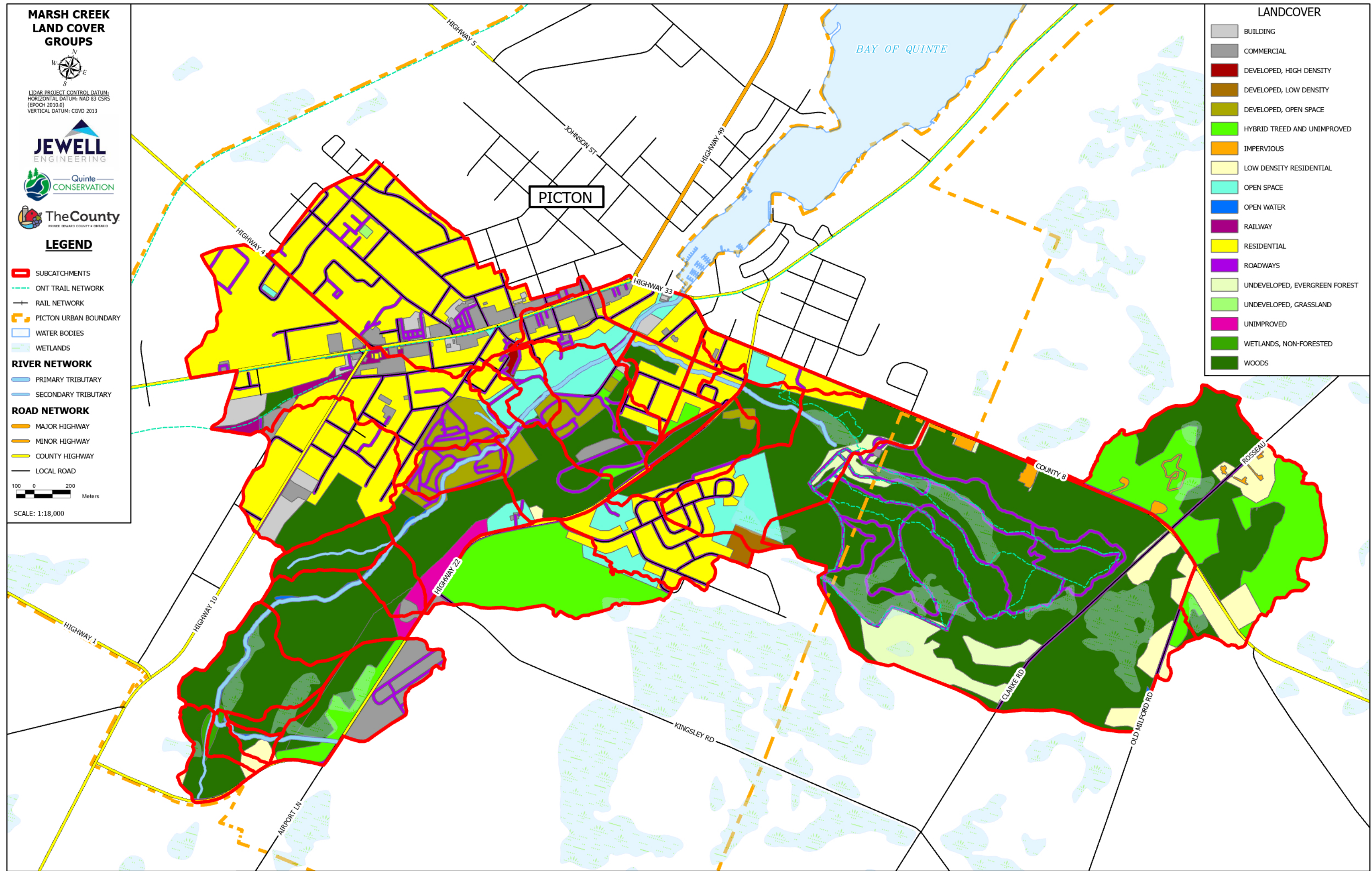
- SUBCATCHMENTS
- ONT TRAIL NETWORK
- RAIL NETWORK
- PICTON URBAN BOUNDARY
- WATER BODIES
- WETLANDS
- RIVER NETWORK**
 - PRIMARY TRIBUTARY
 - SECONDARY TRIBUTARY
- ROAD NETWORK**
 - MAJOR HIGHWAY
 - MINOR HIGHWAY
 - COUNTY HIGHWAY
 - LOCAL ROAD

100 0 200
Meters

SCALE: 1:18,000

LANDCOVER

- BUILDING
- COMMERCIAL
- DEVELOPED, HIGH DENSITY
- DEVELOPED, LOW DENSITY
- DEVELOPED, OPEN SPACE
- HYBRID TREED AND UNIMPROVED
- IMPERVIOUS
- LOW DENSITY RESIDENTIAL
- OPEN SPACE
- OPEN WATER
- RAILWAY
- RESIDENTIAL
- ROADWAYS
- UNDEVELOPED, EVERGREEN FOREST
- UNDEVELOPED, GRASSLAND
- UNIMPROVED
- WETLANDS, NON-FORESTED
- WOODS



Sub-basin ID

[illegible]

Sub-basin ID

[illegible]

Sub-basin ID

Land Cover	21	22	23	24	25	26	27	28	29	30
Woods	36	76	48	90	75	36	0	0	0	42
Low Density Residential	13	4	0	0	0	0	0	0	0	0
WetLands, Non-Forested	0	0	0	0	0	0	0	0	0	0
Roadways	3	9	8	1	8	27	18	14	29	20
Open Water	0	0	0	0	0	0	0	0	0	0
Hybrid Treed and Unimproved	45	0	0	0	0	0	22	0	0	0
Unimproved	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	1	3	0
Residential	0	0	17	3	9	37	60	62	68	31
Open Space	0	0	18	2	3	0	0	23	0	4
Developed, Open Space	0	0	0	4	6	0	0	0	0	0
Railway	0	0	0	0	0	0	0	0	0	0
Building	0	0	0	0	0	0	0	0	0	3
Developed, Low Density	0	0	3	0	0	0	0	0	0	0
Developed, High Density	0	0	0	0	0	0	0	0	0	0
Undeveloped, Grassland	0	0	0	0	0	0	0	0	0	0
Undeveloped, Evergreen Forest	0	8	5	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
Impervious	2	1	0	0	0	0	0	0	0	0

Sub-basin ID

Land Cover	31	32
Woods	20	0
Low Density Residential	0	0
WetLands, Non-Forested	0	0
Roadways	16	16
Open Water	0	0
Hybrid Treed and Unimproved	0	0
Unimproved	0	0
Commercial	0	10
Residential	64	56
Open Space	0	11
Developed, Open Space	0	0
Railway	0	0
Building	0	7
Developed, Low Density	0	0
Developed, High Density	0	0
Undeveloped, Grassland	0	0
Undeveloped, Evergreen Forest	0	0
Other	0	0
Impervious	0	0



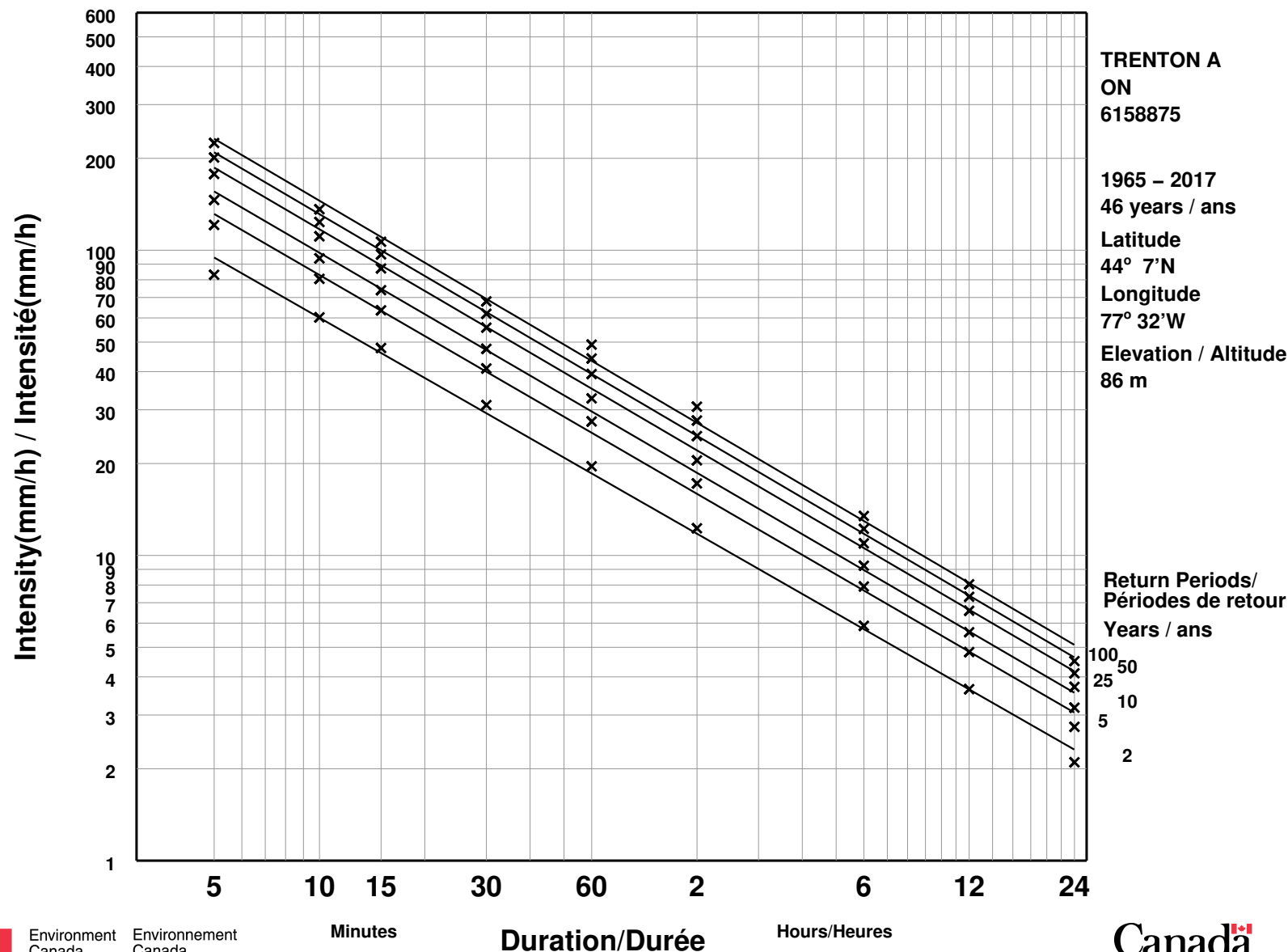
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Appendix E-1:
Trenton 'A' ECCC IDF's

Short Duration Rainfall Intensity–Duration–Frequency Data

2022/10/31

Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée





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Appendix E-2:
Trenton 'A' – Rain Plus Snowmelt MSC Frequency Values

RASM2013A 03/2015

Processed 2016-01-27

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 1 - Eastern Canada Forested Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

TOTAL %				START		MAX							
YR	DAYS	VALID	FLAG	MAX	1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY	
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY	SNPK							
1935	168	62	0 **										
1936	121	44	0 **										
1937	91	33 **	M/D	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	
12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4							
			.1MM	13	13	13	13	13	13	13	13	13	
13	13	13	13	13	13								
1938	211	77 **	M/D	1/24	1/24	1/23	1/22	1/22	1/22	1/22	1/24	1/23	
1/22	1/22	1/22	1/22	1/22	1/22								
			.1MM	266	310	344	358	358	358	358	468	503	
516	516	516	516	516	516								
1939	170	62 **	M/D	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	
6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1								
			.1MM	371	670	670	670	670	670	670	670	670	
670	670	670	670	670	670								
1940	151	55 **	M/D	4/ 8	4/ 7	4/ 6	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1		
4/ 1	4/ 1	4/ 1	4/ 1	4/ 1	4/ 1								
			.1MM	267	371	445	525	661	710	784	884		
915	915	923	923	923	923								
1941	240	88 **	M/D	1/22	4/ 6	4/ 6	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1		
4/ 1	3/31	3/25	3/22	3/16	3/15								
			.1MM	183	331	471	585	695	830	935	1055		
1120	1143	1331	1554	1632	1689								
1942	273	100	M/D	2/16	2/16	2/15	3/ 8	3/ 4	3/ 4	3/ 5	3/ 4		
2/28	2/28	2/28	2/28	2/15	2/15								

			.1MM	340	424	443	458	497	576	620	704
775	854	982	1019	1426	1462	701					
1943	272	100	M/D	3/16	3/15	3/14	3/14	3/13	3/11	3/10	3/10
3/10	3/10	3/10	2/28	2/20	2/19						
			.1MM	379	464	529	586	636	697	848	906
906	906	906	948	1434	1555	782					
1944	274	100	M/D	2/ 5	3/12	3/12	3/12	2/23	2/23	3/ 6	3/ 6
3/ 6	3/ 6	2/22	2/23	2/22	2/17						
			.1MM	160	188	188	188	237	257	316	365
365	365	437	622	626	655	252					
1945	273	100	M/D	3/15	3/14	3/13	3/12	3/12	3/10	3/ 9	3/ 9
2/26	3/ 6	3/ 1	2/24	2/21	2/15						
			.1MM	261	355	440	524	529	564	579	583
584	653	948	1178	1405	1444	978					
1946	271	99	M/D	3/ 6	3/ 6	3/ 6	3/ 6	3/ 4	3/ 3	3/ 2	3/ 2
3/ 2	3/ 2	3/ 2	3/ 2	2/13	2/13						
			.1MM	223	386	607	653	772	830	940	986
986	986	986	986	1145	1145	727					
1947	273	100	M/D	3/24	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1	4/ 1	3/31
3/29	3/29	3/23	3/20	3/13	3/10						
			.1MM	272	466	543	613	748	844	873	901
932	961	1314	1420	1770	1932	1354					
1948	274	100	M/D	3/19	3/19	3/19	3/19	3/18	3/15	3/15	3/15
3/15	3/15	3/ 8	3/ 7	2/27	2/24						
			.1MM	463	639	821	904	944	1072	1254	1337
1337	1337	1421	1429	1478	1656	964					
1949	273	100	M/D	2/14	2/14	2/13	2/12	2/12	2/12	2/12	2/12
2/12	2/ 9	2/ 9	12/28	12/28	12/21						
			.1MM	249	373	493	559	623	623	662	706
715	722	832	961	961	1045	406					
1950	273	100	M/D	3/ 8	12/11	3/25	3/24	3/24	3/23	3/22	3/21
3/21	3/21	3/21	3/ 8	3/ 5	2/28						
			.1MM	303	363	415	535	649	738	832	886
886	886	886	1076	1229	1242	535					
1951	273	100	M/D	1/ 3	1/ 2	1/ 2	1/ 2	12/31	12/31	12/31	12/31
1/ 2	1/ 2	12/31	12/23	12/22	12/22						
			.1MM	407	623	666	666	669	669	669	669
740	792	796	873	897	927	369					
1952	274	100	M/D	11/ 7	11/ 6	11/ 6	11/ 6	11/ 6	11/ 6	11/ 4	11/ 3
11/ 3	3/10	3/ 9	1/17	1/12	1/13						
			.1MM	438	616	695	755	845	845	859	868
868	922	1000	1405	1715	1789	904					
1953	273	100	M/D	12/ 5	1/10	12/ 3	1/10	1/10	1/10	1/10	1/10
1/10	1/10	2/ 6	12/25	12/23	12/16						
			.1MM	184	227	241	296	371	410	410	410
420	420	446	485	664	747	216					
1954	273	100	M/D	2/16	2/15	2/15	2/15	2/15	2/15	2/15	2/14
2/14	2/14	2/ 8	2/ 2	2/ 2	1/25						
			.1MM	295	506	616	730	825	1016	1075	1124
1124	1124	1172	1271	1271	1490	731					

1955	273	100	M/D	3/22	2/27	2/26	3/29	3/29	2/23	2/22	2/21
2/20	2/20	2/17	2/10	2/ 6	2/10						
			.1MM	193	316	355	381	381	399	487	576
620	620	679	827	896	915	426					
1956	274	100	M/D	1/11	1/10	1/10	1/ 9	1/ 9	1/10	1/ 9	2/ 7
1/ 3	1/ 3	1/ 3	2/ 6	2/ 7	1/28						
			.1MM	152	287	317	345	345	356	384	434
469	499	539	655	693	717	362					
1957	273	100	M/D	1/22	1/21	1/20	1/20	1/20	1/20	1/20	1/20
1/20	1/20	2/23	2/ 7	1/21	1/20						
			.1MM	454	597	630	630	630	630	630	630
630	630	720	787	872	959	387					
1958	273	100	M/D	2/27	2/27	2/27	2/24	2/24	2/27	2/27	2/27
2/27	2/24	2/24	2/24	2/24	2/24						
			.1MM	161	236	290	376	452	522	612	686
740	827	990	1274	1447	1447	749					
1959	273	100	M/D	4/ 1	4/ 1	4/ 1	3/31	3/31	3/30	3/30	3/30
3/27	3/25	3/20	3/15	3/15	3/ 5						
			.1MM	261	466	650	785	861	936	936	936
956	1040	1333	1549	1624	1920	1258					
1960	274	100	M/D	2/10	4/ 3	4/ 2	3/31	3/30	3/30	3/30	3/28
3/28	3/28	3/27	3/17	3/17	3/17						
			.1MM	339	464	568	674	847	990	1085	1215
1310	1349	1424	1471	1546	1546	1223					
1961	273	100	M/D	2/25	2/24	2/23	2/22	2/22	2/22	2/19	2/18
2/18	2/17	2/13	2/ 9	2/ 9	2/22						
			.1MM	324	439	709	807	871	871	882	1055
1119	1138	1241	1295	1295	1437	733					
1962	273	100	M/D	11/23	3/25	3/25	3/24	3/23	3/22	3/21	3/20
3/19	3/18	3/13	3/10	3/ 6	2/26						
			.1MM	241	290	393	477	512	607	696	765
810	854	1209	1337	1375	1577	1245					
1963	273	100	M/D	3/ 6	3/25	3/25	3/24	3/24	3/23	3/22	3/20
3/20	3/19	3/17	3/12	3/ 6	3/ 3						
			.1MM	273	485	653	769	841	900	905	977
1049	1077	1263	1375	1648	1667	986					
1964	274	100	M/D	1/ 9	1/ 9	1/20	1/18	1/18	1/18	1/ 3	1/ 2
1/ 2	1/ 2	1/ 9	1/ 3	1/ 2	1/ 3						
			.1MM	310	310	319	352	397	404	486	495
495	495	719	888	905	987	594					
1965	273	100	M/D	2/ 7	2/ 7	2/10	2/ 7	2/ 7	2/ 7	2/ 6	2/ 6
2/ 6	2/ 6	2/ 6	1/24	1/24	2/ 7						
			.1MM	315	369	569	675	735	949	988	988
988	988	988	1192	1192	1669	864					
1966	273	100	M/D	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/26
2/25	2/25	2/28	2/25	2/ 9	2/ 9						
			.1MM	389	548	627	687	794	933	933	972
985	985	1233	1285	1381	1446	772					
1967	273	100	M/D	3/27	3/26	3/25	3/24	3/24	3/23	3/22	3/22
3/20	3/20	3/14	3/10	3/ 6	3/ 3						

			.1MM	148	267	332	396	459	503	558	558
567	567	666	837	846	885	678					
1968	274	100	M/D	2/ 2	2/ 1	3/16	3/15	1/29	1/28	1/27	1/27
1/27	3/ 9	1/19	1/14	1/14	1/14						
			.1MM	267	451	459	516	590	618	643	643
643	747	827	968	968	968	707					
1969	273	100	M/D	1/24	1/23	1/22	1/29	1/30	1/29	1/24	1/23
1/23	1/23	1/18	1/17	1/17	1/17						
			.1MM	405	481	490	522	569	622	814	889
954	1008	1144	1259	1259	1259	414					
1970	273	100	M/D	12/11	12/10	12/10	12/ 8	12/ 8	12/ 8	3/20	3/19
3/18	3/18	3/13	3/13	3/ 4	3/ 4						
			.1MM	237	448	512	571	635	674	762	830
849	849	884	909	1158	1183	720					
1971	273	100	M/D	4/13	4/12	4/11	4/10	4/ 9	4/ 9	4/ 9	4/ 9
4/ 7	4/ 7	4/ 1	3/29	3/29	3/20						
			.1MM	282	437	542	652	815	884	990	1021
1118	1149	1438	1555	1555	1603	1349					
1972	274	100	M/D	12/15	12/15	2/13	2/13	2/13	3/17	3/16	3/15
3/15	3/15	3/21	3/15	3/12	3/15						
			.1MM	355	355	386	386	386	445	609	649
663	663	804	1087	1176	1318	747					
1973	273	100	M/D	2/ 2	2/ 1	2/ 1	12/31	12/31	12/30	12/30	12/ 6
12/ 6	12/26	12/21	12/12	12/12	12/ 6						
			.1MM	349	364	364	385	545	548	548	562
562	624	799	979	1222	1425	446					
1974	273	100	M/D	3/30	3/30	3/30	3/30	3/30	1/21	1/21	1/20
1/20	1/18	1/18	1/18	1/18	12/25						
			.1MM	293	487	542	542	542	603	717	768
768	781	781	781	781	910	330					
1975	273	100	M/D	1/25	12/16	12/16	2/20	1/25	2/18	2/17	2/17
2/17	2/17	12/16	12/16	12/16	1/25						
			.1MM	181	190	214	237	306	366	422	422
422	454	477	541	728	729	264					
1976	274	100	M/D	1/26	3/19	3/19	2/18	2/17	2/16	2/15	2/15
2/18	2/18	2/13	2/15	2/10	2/13						
			.1MM	224	335	459	469	501	591	688	711
785	832	1111	1374	1548	1610	705					
1977	273	100	M/D	3/13	3/12	3/12	3/11	3/10	3/ 9	3/ 8	3/ 7
3/ 6	3/ 4	3/ 3	2/24	3/ 4	2/27						
			.1MM	376	574	757	911	1076	1208	1252	1284
1348	1599	1816	2122	2259	2390	1654					
1978	273	100	M/D	1/26	1/25	1/24	4/10	4/ 9	4/ 7	4/ 7	4/ 6
4/ 5	4/ 4	3/30	3/26	3/20	3/14						
			.1MM	450	520	543	579	616	718	859	953
1069	1194	1597	1829	2271	2463	1804					
1979	273	100	M/D	12/31	12/31	12/30	3/ 3	3/ 1	3/ 1	3/ 1	2/28
2/27	2/23	2/21	2/21	2/21	2/21						
			.1MM	293	515	518	550	631	711	784	814
850	855	1245	1245	1245	1245	709					

1980	274	100	M/D	3/21	3/20	3/20	3/19	3/17	3/17	3/16	3/16
3/14	3/14	3/ 8	3/ 5	3/ 5	2/22						
			.1MM	730	887	1003	1051	1163	1279	1281	1281
1282	1282	1457	1461	1461	1560	537					
1981	273	100	M/D	2/20	2/19	2/19	2/18	2/17	2/16	2/16	2/15
2/15	2/15	2/10	2/ 7	2/ 1	1/26						
			.1MM	433	811	988	1107	1242	1388	1454	1468
1468	1468	1628	1629	1709	1838	921					
1982	273	100	M/D	1/ 4	1/ 3	3/11	1/ 1	3/17	3/17	3/11	3/11
3/11	3/12	3/11	3/11	3/ 5	3/ 4						
			.1MM	327	329	423	484	505	583	669	704
807	889	1193	1225	1241	1255	911					
1983	273	100	M/D	12/24	12/23	12/23	12/23	3/27	12/19	12/19	12/19
12/19	12/19	12/14	12/14	3/27	11/28						
			.1MM	139	177	177	177	182	214	214	214
214	214	273	273	296	395	119					
1984	274	100	M/D	12/12	12/12	12/12	2/11	2/11	2/11	2/11	12/ 6
12/ 6	12/ 5	2/ 3	12/ 4	12/ 4	11/15						
			.1MM	510	635	742	769	854	854	854	943
1050	1083	1140	1257	1263	1457	631					
1985	273	100	M/D	2/23	2/23	2/22	2/22	2/22	2/22	2/22	2/22
2/22	2/22	2/22	2/22	2/18	2/13						
			.1MM	451	648	845	903	950	950	950	1090
1118	1118	1297	1922	2023	2082	997					
1986	273	100	M/D	1/20	1/19	1/18	1/17	1/17	1/17	3/13	3/13
3/11	3/10	3/11	3/10	3/ 2	3/ 2						
			.1MM	382	547	660	712	741	785	885	885
990	1118	1294	1525	1573	1573	1015					
1987	273	100	M/D	3/ 1	3/ 1	4/ 2	4/ 2	4/ 2	4/ 2	3/ 1	3/ 1
2/28	2/28	2/23	2/23	2/23	2/ 7						
			.1MM	334	408	494	494	494	494	622	687
732	732	770	770	770	851	434					
1988	274	100	M/D	12/20	12/19	12/19	3/ 7	3/ 6	3/ 6	3/ 6	3/ 6
3/ 6	3/ 7	3/ 6	3/ 6	2/15	2/15						
			.1MM	225	284	284	325	383	401	403	447
447	447	548	646	799	862	603					
1989	273	100	M/D	12/20	3/25	3/24	3/24	3/24	3/24	3/24	3/24
3/24	3/18	3/14	3/11	3/ 4	3/14						
			.1MM	178	220	275	283	283	283	283	283
283	285	520	531	559	596	266					
1990	273	100	M/D	2/22	2/22	2/22	2/22	12/31	12/31	12/31	1/17
1/17	1/ 9	1/ 4	12/31	12/31	12/31						
			.1MM	337	359	359	359	382	405	405	429
513	543	736	973	1091	1175	436					
1991	273	100	M/D	3/ 2	3/ 1	3/ 1	3/ 1	3/ 2	3/ 1	3/ 1	3/ 1
3/ 1	3/ 1	2/20	2/18	2/18	2/ 3						
			.1MM	343	470	470	506	567	694	694	694
694	694	754	922	922	1022	288					
1992	274	100	M/D	3/26	3/26	3/25	3/26	3/25	3/25	3/25	3/25
3/25	3/25	3/17	3/17	3/ 5	3/ 5						

			.1MM	225	447	492	562	608	608	608	608
608	608	620	620	924	924	275					
1993	273	100	M/D	1/ 4	1/ 3	1/ 3	1/ 3	12/31	12/30	12/29	12/28
12/28	12/28	3/16	12/16	12/11	12/11						
			.1MM	423	477	477	477	559	646	805	838
838	838	988	1256	1277	1277	723					
1994	273	100	M/D	1/28	3/21	3/21	3/21	3/21	3/21	3/21	3/21
3/21	3/20	3/13	3/10	3/ 5	3/ 4						
			.1MM	207	323	447	586	633	666	750	820
857	874	1071	1197	1323	1352	889					
1995	273	100	M/D	11/28	3/ 6	3/ 6	11/25	11/25	11/25	11/25	11/25
11/25	11/25	2/27	11/28	11/25	11/25						
			.1MM	280	333	365	396	396	396	396	396
396	396	411	529	765	790	237					
1996	274	100	M/D	1/19	1/18	1/17	1/16	1/16	1/16	1/17	1/16
1/16	1/16	1/16	1/16	1/16	1/16						
			.1MM	399	555	779	843	843	843	881	945
945	945	1145	1145	1467	1488	372					
1997	273	100	M/D	2/21	3/25	3/25	3/25	3/25	3/25	3/25	3/25
3/25	3/25	2/18	2/18	2/18	3/ 1						
			.1MM	297	381	550	711	901	985	1024	1093
1093	1093	1167	1232	1356	1492	880					
1998	273	100	M/D	3/19	3/18	3/18	2/17	2/17	2/17	2/17	2/17
2/12	2/11	2/10	2/ 2	1/30	1/23						
			.1MM	163	323	329	409	426	426	426	426
509	563	614	648	668	714	347					
1999	273	100	M/D	1/18	1/22	1/22	1/21	1/20	1/18	1/18	1/17
1/17	1/17	1/17	1/17	1/18	1/18						
			.1MM	247	396	521	529	549	731	856	900
900	900	900	1206	1430	1627	1053					
2000	274	100	M/D	2/25	2/24	2/23	2/23	2/22	2/21	2/21	2/21
2/21	2/21	2/21	2/ 9	2/21	2/21						
			.1MM	197	382	538	578	591	594	594	594
594	594	594	647	708	708	410					
2001	273	100	M/D	11/26	11/25	11/25	11/25	11/25	11/25	3/18	3/17
3/15	3/13	3/10	3/13	3/10	3/ 8						
			.1MM	483	532	532	532	532	532	558	566
582	712	896	1149	1334	1396	1091					
2002	273	100	M/D	3/ 3	3/ 2	3/ 2	3/ 2	1/ 6	3/ 3	3/ 3	3/ 2
3/ 2	3/ 2	3/ 2	2/19	2/15	2/ 8						
			.1MM	211	280	280	280	294	377	488	558
558	558	572	697	889	1017	279					
2003	242	89 **	M/D	3/20	3/20	3/19	3/18	3/17	3/16	3/15	3/15
3/15	3/12	3/ 8	3/ 8	3/17	3/15						
			.1MM	289	451	500	599	729	779	803	803
803	805	871	871	996	1207						
2004	274	100	M/D	3/ 5	3/ 4	3/ 3	3/ 2	3/ 1	2/29	2/28	2/28
2/29	2/28	2/20	2/19	2/19	2/ 9						
			.1MM	269	373	485	637	726	827	849	849
858	881	1012	1107	1107	1169	828					

2005	273	100		M/D	12/ 7	2/14	2/14	2/14	2/12	2/12	2/12	2/ 8
2/ 7	2/ 7	2/ 3		12/ 4	12/ 7	2/ 6						
				.1MM	271	420	462	462	470	470	470	573
649	691	737		745	783	857	344					
2006	273	100		M/D	3/ 9	12/23	12/23	12/23	12/23	12/23	12/23	12/23
12/23	12/23	12/23		12/23	12/ 4	11/28						
				.1MM	207	277	417	476	500	582	582	582
582	582	602		644	678	760	356					
2007	273	100		M/D	3/14	3/13	3/12	3/11	3/11	3/10	3/10	3/10
3/10	3/13	3/10		3/ 3	3/ 2	2/22						
				.1MM	227	388	474	558	596	622	622	622
622	645	862		896	1099	1119	814					
2008	274	100		M/D	12/23	3/31	4/ 4	4/ 4	4/ 3	3/31	3/31	3/31
3/31	3/31	3/26		3/19	3/15	3/14						
				.1MM	398	411	479	669	749	842	994	1183
1248	1248	1428		1621	1849	1877	1315					
2009	272	100		M/D	2/11	2/11	2/10	3/ 6	3/ 6	3/ 6	3/ 5	3/ 5
3/ 5	3/ 5	2/25		2/22	2/11	2/10						
				.1MM	386	562	616	659	754	893	899	899
899	899	1181		1189	1316	1812	892					
2010	243	89 **		M/D	12/26	12/25	12/25	12/25	12/25	12/25	12/25	12/25
12/25	12/25	12/13		12/ 9	12/ 9	12/ 9						
				.1MM	353	450	504	504	504	504	568	572
572	572	647		831	900	900						
2011	270	99		M/D	3/ 5	3/10	3/10	3/10	3/ 9	3/ 5	3/ 5	3/ 5
3/ 5	3/ 4	3/ 4		2/27	2/27	2/17						
				.1MM	477	578	656	747	775	909	1083	1161
1253	1289	1735		1965	1965	2153	881					
2012	274	100		M/D	1/23	1/16	1/16	2/27	1/23	1/23	1/17	1/16
1/16	1/16	1/17		1/16	1/16	1/16						
				.1MM	188	192	192	214	253	253	355	380
380	380	504		540	540	596	81					
2013	242	89 **		M/D	1/13	1/12	1/11	1/10	1/ 9	1/ 8	1/ 8	1/ 6
1/ 5	1/ 4	12/31		1/11	1/ 6	1/ 4						
				.1MM	271	445	523	578	593	621	621	650
665	702	734		773	900	952						
2014	273	100		M/D	2/21	2/21	2/20	2/19	3/31	3/30	3/29	3/28
3/27	3/27	3/21		3/19	3/11	3/10						
				.1MM	323	411	495	537	598	691	758	908
914	914	993		1239	1438	1504	881					
2015	273	100		M/D	1/ 4	1/ 3	4/ 1	3/30	3/30	3/29	3/29	3/26
3/25	3/25	3/20		3/14	3/ 9	3/ 9						
				.1MM	208	276	313	452	510	526	526	580
677	736	862		1087	1357	1416	1074					
2016	118	43 **		M/D	1/26	1/26	1/26	12/30	12/29	12/29	12/29	12/29
12/30	12/29	12/29		12/29	1/ 2	12/29						
				.1MM	140	140	140	160	170	170	170	170
182	192	192		243	250	383						

				1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY						
	MEAN EXTREME	(MM)	30.6	42.2	50.0	55.8	61.5	67.4	73.0	77.3	
80.2	83.1	96.6	109.3	121.0	129.7						
	STD. DEV.	(MM)	10.8	14.0	17.5	19.4	21.8	24.5	25.5	27.0	
27.9	28.9	34.0	38.0	41.0	44.1						
	YEARS ANALYSED		71	71	71	71	71	71	71	71	
71	71	71	71	71	71						
	MAX EXTREME	(MM)	73.0	88.7	100.3	110.7	124.2	138.8	145.4	146.8	
146.8	159.9	181.6	212.2	227.1	246.3						
	YEAR		1980	1980	1980	1981	1981	1981	1981	1981	
1981	1977	1977	1977	1978	1978						

** NOTE ** VALUE IN FLAG INDICATES YEAR NOT INCLUDED IN ANALYSIS BASED ON % DAYS OPERATIONAL (<90.0%)

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 1 - Eastern Canada Forested Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

RETURN PERIOD VALUES (MM) WITH 50%

CONFIDENCE LIMITS

RETURN PERIOD

YEARS		1 DAY	2 DAY	3 DAY	4
DAY	5 DAY				
2		28.82+/- 0.79	39.88+/- 1.03	47.14+/- 1.29	
52.62+/- 1.43	57.96+/- 1.60				
5		38.37+/- 1.34	52.28+/- 1.74	62.63+/- 2.17	
69.78+/- 2.40	77.20+/- 2.69				

10		44.70+/- 1.81	60.49+/- 2.34	72.88+/- 2.93
81.14+/- 3.24	89.94+/- 3.64			
25		52.70+/- 2.44	70.87+/- 3.16	85.83+/- 3.95
95.49+/- 4.37	106.04+/- 4.90			
50		58.63+/- 2.91	78.56+/- 3.78	95.44+/- 4.72
106.14+/- 5.23	117.98+/- 5.87			
100		64.51+/- 3.39	86.20+/- 4.40	104.98+/- 5.50
116.71+/- 6.09	129.84+/- 6.83			

RETURN PERIOD

YEARS		6 DAY	7 DAY	8 DAY	9
DAY	10 DAY				

2		63.41+/- 1.80	68.83+/- 1.87	72.87+/- 1.98
75.66+/- 2.05	78.31+/- 2.12			
5		85.05+/- 3.03	91.36+/- 3.15	96.72+/- 3.34
100.29+/- 3.45	103.86+/- 3.57			
10		99.38+/- 4.09	106.27+/- 4.26	112.52+/- 4.51
116.60+/- 4.66	120.78+/- 4.83			
25		117.48+/- 5.51	125.12+/- 5.74	132.48+/- 6.08
137.20+/- 6.28	142.15+/- 6.51			
50		130.91+/- 6.60	139.09+/- 6.87	147.29+/- 7.27
152.49+/- 7.51	158.01+/- 7.79			
100		144.24+/- 7.69	152.97+/- 8.00	161.98+/- 8.47
167.67+/- 8.75	173.75+/- 9.08			

RETURN PERIOD

YEARS		15 DAY	20 DAY	25 DAY	30
DAY					

2		90.97+/- 2.50	103.03+/- 2.79	114.24+/- 3.01
122.45+/- 3.24				
5		121.04+/- 4.21	136.63+/- 4.70	150.45+/- 5.07
161.39+/- 5.45				
10		140.95+/- 5.68	158.88+/- 6.35	174.42+/- 6.84
187.18+/- 7.36				
25		166.10+/- 7.66	186.99+/- 8.56	204.72+/- 9.23
219.76+/- 9.92				
50		184.76+/- 9.17	207.84+/-10.24	227.19+/-11.04
243.93+/-11.87				
100		203.29+/-10.68	228.53+/-11.93	249.49+/-12.86
267.92+/-13.83				

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 1 DAYS ACCUMULATION

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 2 DAYS ACCUMULATION

METEOROLOGICAL SERVICE OF CANADA

RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 2 - Western North America Mountain Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

TOTAL %				START	MAX							
YR	DAYS	VALID	FLAG	MAX	1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY	SNPK						
1935	168	62	0 **									
1936	121	44	0 **									
1937	90	33 **	M/D	12/10	12/10	12/10	12/10	12/10	12/10	12/10	12/10	12/10
12/10	12/10	12/10	12/10	12/10	12/10							
			.1MM	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13							
1938	211	77 **	M/D	1/24	1/24	1/24	1/24	3/13	3/12	3/12	3/12	3/12
3/12	3/12	3/ 5	3/ 2	3/ 2	3/ 2							
			.1MM	265	278	278	278	400	489	508	508	508
508	508	594	626	626	626							
1939	170	62 **	M/D	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1
6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1							
			.1MM	623	724	724	724	724	724	724	724	724
724	724	724	724	724	724							
1940	151	55 **	M/D	4/ 8	4/ 7	4/ 6	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1	4/ 1
4/ 1	4/ 1	4/ 1	4/ 1	4/ 1	4/ 1							
			.1MM	339	463	532	610	728	750	818	934	934
934	934	934	934	934	934							
1941	240	88 **	M/D	4/ 6	4/ 6	4/ 6	4/ 5	4/ 3	4/ 3	4/ 2	4/ 1	4/ 1
4/ 1	4/ 1	3/25	3/23	3/15	3/15							
			.1MM	266	477	634	777	936	1094	1220	1373	1373
1373	1373	1580	1719	1802	1802							
1942	273	100	M/D	3/16	3/16	3/15	3/15	3/15	3/15	3/11	3/11	3/11
3/ 8	3/ 8	3/ 3	2/28	2/28	2/16							
			.1MM	444	580	621	621	621	621	720	720	720
953	1089	1312	1538	1538	1965	773						
1943	271	99	M/D	12/29	12/28	12/27	12/27	12/27	12/24	12/23	3/10	3/10
3/10	3/10	3/11	3/10	2/20	2/19							
			.1MM	434	571	622	663	663	700	750	822	822
824	824	974	1094	1315	1475	888						
1944	274	100	M/D	3/12	3/12	3/12	3/12	3/12	3/12	3/12	3/ 6	3/ 6
3/ 6	3/ 6	3/ 6	2/27	2/23	2/23							

			.1MM	161	230	230	230	281	364	364	375
375	375	509	606	716	778	325					
1945	273	100	M/D	3/15	3/14	3/14	3/13	3/12	3/12	3/10	3/10
3/10	3/10	3/ 2	2/26	2/21	2/21						
			.1MM	363	468	572	661	734	734	738	738
738	738	1092	1295	1471	1471	1029					
1946	271	99	M/D	3/ 6	3/ 6	3/ 6	3/ 5	3/ 4	3/ 3	3/ 2	3/ 2
3/ 2	3/ 2	3/ 2	3/ 2	2/13	2/13						
			.1MM	300	528	712	724	878	917	1035	1035
1035	1035	1035	1035	1171	1171	798					
1947	273	100	M/D	4/ 6	4/ 5	4/ 5	4/ 4	4/ 2	4/ 2	4/ 1	4/ 1
4/ 1	3/29	3/24	3/22	3/13	3/11						
			.1MM	340	663	799	857	946	1082	1164	1199
1199	1206	1543	1734	1927	2158	1522					
1948	274	100	M/D	3/19	3/19	3/19	3/18	3/16	3/15	3/15	3/15
3/15	3/15	3/ 7	3/ 7	2/26	2/24						
			.1MM	536	794	1008	1013	1048	1276	1490	1490
1490	1490	1519	1519	1545	1710	1005					
1949	273	100	M/D	2/24	2/14	2/13	2/12	2/12	2/12	2/12	2/ 9
2/ 9	2/ 9	2/12	2/ 6	12/28	12/28						
			.1MM	248	365	456	522	572	572	575	614
614	616	930	1023	1152	1201	457					
1950	273	100	M/D	3/ 8	3/27	3/26	3/25	3/24	3/23	3/22	3/21
3/21	3/21	3/21	3/ 8	3/ 8	3/ 5						
			.1MM	332	446	533	678	833	908	1000	1032
1036	1036	1128	1136	1460	1465	713					
1951	273	100	M/D	1/ 3	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2
1/ 2	1/ 2	1/ 2	12/23	12/23	12/23						
			.1MM	480	703	710	710	710	710	710	710
779	834	834	911	911	941	400					
1952	274	100	M/D	11/ 7	3/10	11/ 6	2/ 1	11/ 6	11/ 6	11/ 6	11/ 6
11/ 6	11/ 6	3/10	3/ 4	1/13	1/13						
			.1MM	404	592	638	689	834	895	895	895
895	895	1454	1519	1599	1608	923					
1953	273	100	M/D	12/ 5	1/14	1/13	1/13	1/11	1/10	1/10	1/10
1/10	1/10	1/10	12/29	12/23	12/17						
			.1MM	233	244	302	302	310	485	485	485
485	495	495	498	732	810	269					
1954	273	100	M/D	2/16	2/15	2/15	2/15	2/15	2/15	2/15	2/14
2/14	2/14	2/14	2/14	2/14	1/25						
			.1MM	284	551	669	812	918	1124	1203	1224
1224	1224	1272	1308	1358	1508	757					
1955	273	100	M/D	12/17	2/28	2/27	2/26	2/26	2/26	2/23	2/22
2/21	2/20	2/20	12/14	12/ 9	2/21						
			.1MM	284	398	523	538	538	538	551	632
725	737	737	915	991	1098	426					
1956	274	100	M/D	1/10	1/10	1/ 9	1/ 9	1/ 9	3/29	3/29	3/29
1/ 3	1/ 3	1/ 3	2/ 6	2/ 8	2/ 6						
			.1MM	181	347	375	375	375	412	412	412
457	457	470	546	658	836	447					

1957	273	100	M/D	1/22	1/21	1/20	1/20	1/20	1/20	1/20	1/20
1/20	1/20	2/25	2/23	2/25	2/14						
			.1MM	536	710	743	743	743	743	743	743
743	743	834	984	1038	1047	502					
1958	273	100	M/D	3/22	3/21	3/20	3/19	3/18	3/17	3/17	3/15
3/14	3/14	2/24	3/ 3	2/27	2/24						
			.1MM	142	267	373	461	550	600	617	669
749	765	816	1113	1415	1609	965					
1959	273	100	M/D	4/ 1	4/ 1	4/ 1	3/31	3/31	3/31	3/30	3/30
3/30	3/30	3/24	3/19	3/15	3/ 6						
			.1MM	346	635	821	1002	1166	1304	1375	1375
1375	1375	1573	1915	2029	2126	1579					
1960	274	100	M/D	4/ 3	4/ 3	4/ 2	4/ 1	3/30	3/30	3/30	3/28
3/28	3/27	3/27	3/17	3/17	3/17						
			.1MM	416	602	726	842	1087	1272	1379	1552
1658	1660	1660	1673	1673	1673	1465					
1961	273	100	M/D	2/25	2/24	2/23	2/22	2/22	2/22	2/22	2/18
2/18	2/18	2/13	2/13	2/13	2/23						
			.1MM	344	489	792	872	930	994	994	1125
1183	1246	1363	1363	1363	1521	801					
1962	273	100	M/D	11/23	3/25	3/26	3/25	3/24	3/24	3/22	3/21
3/20	3/20	3/14	3/12	3/12	2/28						
			.1MM	279	400	601	783	870	887	977	1075
1133	1150	1387	1580	1580	1674	1463					
1963	273	100	M/D	3/26	3/25	3/25	3/24	3/24	3/23	3/23	3/21
3/20	3/19	3/17	3/12	3/ 6	3/ 6						
			.1MM	365	693	910	1054	1189	1230	1235	1252
1319	1347	1584	1633	1875	1875	1277					
1964	274	100	M/D	1/ 9	1/ 9	1/ 9	1/20	1/20	1/18	1/ 3	1/ 3
3/ 1	3/ 1	1/ 9	1/ 3	1/ 3	1/ 3						
			.1MM	329	329	329	407	407	429	475	475
478	478	758	824	904	995	594					
1965	273	100	M/D	2/ 7	4/ 6	2/10	2/ 7	2/ 7	2/ 7	2/ 6	2/ 6
2/ 6	2/ 6	2/ 7	1/24	2/10	2/ 7						
			.1MM	340	358	570	653	695	938	940	940
940	940	941	1097	1186	1727	911					
1966	273	100	M/D	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/26
2/26	2/26	2/28	2/28	2/26	2/26						
			.1MM	368	537	615	657	767	901	901	904
904	904	1198	1378	1381	1381	786					
1967	273	100	M/D	12/ 6	3/27	3/26	3/26	3/25	3/24	3/23	3/22
3/22	3/22	3/14	3/10	3/10	3/ 3						
			.1MM	203	369	522	584	634	684	696	728
728	728	758	962	962	964	757					
1968	274	100	M/D	2/ 2	2/ 1	3/16	3/16	3/15	3/15	3/15	3/15
3/10	3/ 9	3/ 9	3/ 9	3/ 9	3/ 9						
			.1MM	290	479	561	645	671	671	671	671
731	876	960	1015	1015	1015	711					
1969	273	100	M/D	1/24	1/23	1/29	1/29	1/30	1/29	1/24	1/23
1/23	1/23	1/18	1/18	1/18	1/18						

			.1MM	380	441	458	489	505	558	793	855
905	936	1062	1131	1131	1131	489					
1970	273	100	M/D	12/11	12/10	12/10	12/ 8	12/ 8	3/21	3/20	3/19
3/19	3/19	3/20	3/19	3/19	3/19						
			.1MM	234	445	495	565	615	694	783	841
883	883	1098	1364	1364	1364	941					
1971	273	100	M/D	4/13	4/12	4/11	4/10	4/ 9	4/ 9	4/ 9	4/ 9
4/ 9	4/ 7	4/ 2	3/29	3/29	3/20						
			.1MM	373	592	718	852	1080	1140	1266	1477
1477	1593	1779	1951	1951	1964	1730					
1972	274	100	M/D	12/15	4/13	4/11	4/11	4/10	4/ 9	4/ 9	4/ 9
4/ 9	4/ 9	4/ 1	3/29	3/21	3/16						
			.1MM	364	484	667	854	915	917	917	917
917	917	1163	1268	1606	1845	1169					
1973	273	100	M/D	2/ 2	12/12	12/12	1/15	12/31	12/30	12/30	12/ 6
12/ 6	1/14	12/21	12/30	12/30	12/ 6						
			.1MM	349	366	366	393	507	510	510	550
550	559	656	925	1070	1244	562					
1974	273	100	M/D	2/22	3/30	3/30	3/30	3/30	3/30	3/30	1/20
1/20	1/18	1/18	3/16	3/16	12/25						
			.1MM	280	466	584	721	721	721	721	768
768	781	781	782	782	874	333					
1975	273	100	M/D	3/19	3/18	2/22	3/16	2/20	2/19	2/18	2/17
2/17	2/17	2/17	2/17	2/23	2/18						
			.1MM	337	444	516	525	542	573	638	694
694	715	728	786	1107	1307	339					
1976	274	100	M/D	3/20	3/19	3/19	3/19	3/19	3/19	3/19	3/19
2/18	2/18	2/15	2/15	2/10	2/21						
			.1MM	293	453	585	585	640	640	640	640
752	849	1131	1487	1636	1781	866					
1977	273	100	M/D	3/13	3/12	3/11	3/10	3/ 9	3/ 9	3/ 8	3/ 8
3/ 5	3/ 4	2/27	2/23	3/ 4	2/27						
			.1MM	471	768	983	1221	1398	1486	1499	1499
1561	1918	2043	2279	2415	2540	1743					
1978	273	100	M/D	1/26	1/25	4/11	4/11	4/11	4/10	4/ 7	4/ 7
4/ 5	4/ 4	3/31	3/27	3/21	3/20						
			.1MM	450	503	756	853	914	964	1066	1163
1300	1443	1939	2169	2543	2606	2096					
1979	273	100	M/D	3/ 4	12/31	3/ 3	3/ 3	3/ 3	3/ 3	3/ 2	3/ 1
3/ 1	3/ 1	2/23	2/21	2/21	2/21						
			.1MM	307	538	564	640	708	811	864	937
975	975	1193	1297	1297	1297	804					
1980	274	100	M/D	3/21	3/20	3/20	3/19	3/17	3/17	3/16	3/16
3/16	3/16	3/10	3/10	3/10	2/22						
			.1MM	831	1053	1146	1166	1292	1385	1387	1387
1387	1387	1544	1544	1544	1611	643					
1981	273	100	M/D	2/20	2/19	2/18	2/17	2/16	2/16	2/16	2/16
2/16	2/16	2/10	2/ 2	2/ 1	1/26						
			.1MM	540	983	1136	1318	1493	1589	1589	1589
1589	1589	1727	1763	1807	1976	1045					

1982	273	100	M/D	1/ 4	1/ 3	3/11	3/11	3/11	3/20	3/19	3/18
3/17	3/11	3/11	3/11	3/11	3/ 4						
			.1MM	336	338	483	523	523	560	682	688
813	870	1353	1552	1703	1733	1095					
1983	273	100	M/D	12/24	12/23	12/23	12/23	12/23	12/23	3/27	3/27
3/27	12/15	12/14	12/14	12/14	11/28						
			.1MM	205	214	214	214	214	214	249	249
249	284	378	378	388	503	148					
1984	274	100	M/D	12/12	2/13	2/13	2/11	2/11	2/11	2/11	2/11
2/11	12/ 6	2/ 3	12/ 4	1/24	11/15						
			.1MM	510	633	757	870	995	1038	1038	1038
1038	1119	1291	1317	1349	1570	782					
1985	273	100	M/D	2/23	2/23	2/22	2/22	2/22	2/22	2/22	2/22
2/22	2/22	2/22	2/22	2/22	2/13						
			.1MM	481	712	941	979	996	996	996	1179
1183	1183	1378	2024	2097	2136	1080					
1986	273	100	M/D	1/20	1/19	1/18	1/17	1/17	1/17	3/13	3/19
3/18	3/17	3/13	3/10	3/10	3/10						
			.1MM	395	610	751	770	770	781	824	972
1056	1068	1478	1701	1701	1701	1192					
1987	273	100	M/D	4/ 4	3/ 7	4/ 2	4/ 2	4/ 2	4/ 2	3/ 1	3/ 1
2/28	2/28	2/23	2/28	2/23	3/ 6						
			.1MM	358	443	510	510	510	510	622	836
877	877	878	891	892	976	540					
1988	274	100	M/D	11/29	11/28	11/28	11/28	11/28	11/28	11/28	11/28
11/28	11/29	11/28	3/ 6	11/28	11/28						
			.1MM	440	442	442	442	442	442	442	442
442	442	544	740	921	921	660					
1989	273	100	M/D	12/20	3/25	3/25	3/24	3/24	3/24	3/24	3/24
3/24	3/18	3/14	3/14	3/ 4	3/14						
			.1MM	210	252	319	352	352	352	352	352
352	354	590	590	618	635	331					
1990	273	100	M/D	2/22	1/17	1/17	1/17	1/17	1/17	1/17	1/17
1/17	1/17	1/ 4	12/31	12/31	12/31						
			.1MM	329	401	401	401	403	403	405	540
618	618	750	960	1099	1178	436					
1991	273	100	M/D	12/29	2/ 3	2/ 3	2/ 3	2/ 3	3/ 1	3/ 1	3/ 1
3/ 1	3/ 1	12/17	2/18	1/14	2/ 3						
			.1MM	258	352	352	352	352	358	364	364
364	364	470	592	606	742	353					
1992	274	100	M/D	3/26	3/26	3/25	3/26	3/26	3/25	3/25	3/25
3/25	3/25	3/25	2/18	3/ 5	3/ 5						
			.1MM	263	464	478	555	606	620	620	620
620	624	624	719	1087	1142	396					
1993	273	100	M/D	1/ 4	1/ 4	1/ 3	1/ 3	1/ 3	12/31	12/30	12/29
12/29	12/29	12/22	12/17	12/16	12/29						
			.1MM	527	739	793	793	793	842	895	1044
1044	1044	1075	1210	1383	1505	828					
1994	273	100	M/D	2/20	3/22	3/22	3/21	3/21	3/21	3/21	3/21
3/21	3/21	3/21	3/13	3/ 7	3/13						

			.1MM	217	346	531	687	705	705	777	838
889	926	1030	1270	1347	1374	916					
1995	273	100	M/D	3/ 7	3/ 6	3/ 6	3/ 5	3/ 5	3/ 5	3/ 6	3/ 6
3/ 5	3/ 5	2/27	2/27	11/25	11/25						
			.1MM	304	397	423	431	431	431	520	585
593	593	612	612	739	789	434					
1996	274	100	M/D	1/19	1/18	1/17	1/16	1/16	1/16	1/17	1/17
1/16	1/16	1/16	1/16	1/16	1/16						
			.1MM	401	621	880	944	944	944	964	1048
1112	1112	1325	1325	1651	1657	569					
1997	273	100	M/D	2/21	3/28	3/27	3/25	3/25	3/25	3/25	3/25
3/25	3/25	2/18	2/18	2/18	3/ 1						
			.1MM	332	476	720	831	1091	1161	1161	1188
1188	1188	1222	1252	1361	1575	945					
1998	273	100	M/D	3/26	3/26	2/17	2/17	2/17	2/17	2/19	2/18
2/17	2/17	2/11	2/11	2/11	2/18						
			.1MM	266	268	292	370	403	403	482	558
683	691	787	812	812	832	425					
1999	273	100	M/D	1/23	1/22	1/22	1/22	1/22	1/18	1/18	1/17
1/17	1/17	1/18	1/17	1/18	1/18						
			.1MM	322	468	610	610	610	752	894	905
905	905	912	1174	1381	1578	1071					
2000	274	100	M/D	2/24	2/24	2/23	2/23	2/23	2/23	2/23	2/23
2/23	2/23	2/23	2/ 9	2/23	2/23						
			.1MM	229	435	636	636	636	636	636	636
636	636	636	666	750	750	451					
2001	273	100	M/D	11/26	11/25	4/ 4	4/ 3	4/ 2	4/ 1	3/31	3/31
3/30	3/29	3/23	3/18	3/13	3/12						
			.1MM	512	532	608	727	787	839	895	934
959	972	1109	1454	1713	1758	1482					
2002	273	100	M/D	3/ 3	3/ 8	3/ 8	3/ 8	1/ 6	2/15	3/ 3	3/ 2
3/ 2	3/ 2	3/ 2	2/19	2/15	2/10						
			.1MM	191	298	298	298	341	407	490	558
558	558	572	753	965	1018	315					
2003	242	89 **	M/D	3/20	3/20	3/20	3/18	3/17	3/17	3/16	3/16
3/16	3/16	3/ 8	3/17	3/17	3/16						
			.1MM	293	512	600	647	821	909	932	932
932	932	972	1007	1117	1335						
2004	274	100	M/D	3/ 5	3/ 4	3/ 3	3/ 2	3/ 1	2/29	2/29	2/29
2/29	2/29	2/29	2/19	2/29	2/20						
			.1MM	315	438	576	784	876	994	994	994
994	1000	1090	1143	1248	1283	890					
2005	273	100	M/D	12/31	2/14	2/14	2/14	2/14	2/14	2/14	2/ 8
2/ 7	2/ 7	2/ 6	12/12	12/ 7	12/ 4						
			.1MM	326	442	462	462	462	462	462	596
664	684	688	761	1051	1071	421					
2006	273	100	M/D	3/ 9	1/17	12/23	12/23	12/23	12/23	12/23	1/11
1/11	1/11	1/ 4	12/23	12/25	12/23						
			.1MM	246	404	449	472	472	527	533	619
619	619	776	889	1008	1309	434					

2007	273	100	M/D	3/14	3/13	3/12	3/11	3/10	3/10	3/10	3/10
3/10	3/13	3/10	3/ 3	3/ 2	2/22						
			.1MM	335	566	657	742	754	755	755	755
755	779	967	992	1155	1167	870					
2008	274	100	M/D	12/23	3/31	4/ 5	4/ 4	4/ 3	4/ 3	4/ 1	3/31
3/31	3/31	3/26	3/19	3/15	3/14						
			.1MM	418	496	655	870	951	1005	1164	1447
1502	1502	1628	1815	2006	2012	1451					
2009	272	100	M/D	2/11	12/27	3/ 6	3/ 6	3/ 6	3/ 6	3/ 5	3/ 5
3/ 5	3/ 5	2/25	2/25	2/11	2/10						
			.1MM	446	665	733	766	836	959	965	965
965	965	1250	1250	1474	1896	916					
2010	243	89 **	M/D	1/25	1/24	1/24	1/24	1/24	1/24	1/19	1/18
1/17	1/16	1/14	1/14	1/ 1	12/27						
			.1MM	366	714	714	714	714	714	726	764
792	798	944	944	948	1007						
2011	270	99	M/D	3/ 5	3/10	3/10	3/10	3/10	3/ 5	3/ 5	3/ 5
3/ 5	3/ 4	3/ 4	2/28	2/28	2/17						
			.1MM	520	636	711	786	786	962	1157	1232
1307	1312	1811	2000	2000	2204	932					
2012	274	100	M/D	1/23	1/16	3/ 1	2/29	2/27	2/27	1/17	1/16
1/16	1/16	1/17	1/13	1/13	1/16						
			.1MM	188	206	221	241	290	312	369	394
394	394	518	595	595	626	104					
2013	242	89 **	M/D	1/13	1/12	1/11	1/10	1/ 9	1/ 9	1/ 9	1/ 6
1/ 6	1/ 6	1/ 6	1/11	1/ 6	1/ 6						
			.1MM	410	664	725	758	760	760	760	778
778	778	786	981	1034	1034						
2014	273	100	M/D	4/ 4	2/21	1/11	1/11	3/31	3/30	3/29	3/28
3/28	3/28	3/27	3/19	3/11	3/10						
			.1MM	377	437	531	585	702	804	859	1039
1075	1138	1144	1379	1471	1623	989					
2015	273	100	M/D	4/ 2	4/ 2	4/ 1	3/31	3/30	3/30	3/30	3/30
3/26	3/25	3/20	3/15	3/10	3/ 9						
			.1MM	281	482	510	538	711	711	711	711
841	913	989	1073	1377	1425	1084					
2016	118	43 **	M/D	1/ 9	1/ 8	1/ 8	1/ 8	1/ 8	1/ 8	1/ 9	1/ 9
1/ 8	12/31	12/29	1/ 8	1/ 8	12/29						
			.1MM	190	202	202	202	202	202	204	224
236	263	285	412	412	494						

				1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY						
	MEAN	EXTREME	(MM)	34.8	49.4	59.5	65.9	71.9	77.3	81.8	86.7
89.9	92.3	106.8	119.5	131.2	140.9						
	STD. DEV.		(MM)	11.5	16.5	20.4	23.4	27.2	30.0	31.2	32.5
33.0	34.8	39.5	43.3	44.4	46.5						

	YEARS ANALYSED		71	71	71	71	71	71	71	71	71
71	71	71	71	71	71						
	MAX EXTREME	(MM)	83.1	105.3	114.6	131.8	149.3	158.9	158.9	158.9	
165.8	191.8	204.3	227.9	254.3	260.6						
	YEAR		1980	1980	1980	1981	1981	1981	1981	1981	
1960	1977	1977	1977	1978	1978						

** NOTE ** VALUE IN FLAG INDICATES YEAR NOT INCLUDED IN ANALYSIS BASED ON % DAYS OPERATIONAL (<90.0%)

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 2 - Western North America Mountain Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

RETURN PERIOD VALUES (MM) WITH 50%

CONFIDENCE LIMITS

RETURN PERIOD

YEARS		1 DAY	2 DAY	3 DAY	4
DAY	5 DAY				
2		32.94+/- 0.84	46.72+/- 1.21	56.16+/- 1.50	
62.10+/- 1.72	67.42+/- 2.00				
5		43.11+/- 1.42	61.33+/- 2.04	74.18+/- 2.52	
82.80+/- 2.90	91.50+/- 3.37				
10		49.84+/- 1.92	71.00+/- 2.76	86.10+/- 3.40	
96.50+/- 3.91	107.44+/- 4.55				
25		58.35+/- 2.59	83.22+/- 3.72	101.17+/- 4.59	
113.81+/- 5.27	127.58+/- 6.14				
50		64.66+/- 3.10	92.29+/- 4.45	112.36+/- 5.49	
126.66+/- 6.31	142.53+/- 7.34				
100		70.92+/- 3.61	101.29+/- 5.19	123.45+/- 6.40	
139.41+/- 7.35	157.36+/- 8.55				

RETURN PERIOD YEARS	6 DAY	7 DAY	8 DAY	9
DAY	10 DAY			

2	72.35+/- 2.20	76.63+/- 2.29	81.33+/- 2.39
84.47+/- 2.42	86.60+/- 2.55		
5	98.84+/- 3.71	104.18+/- 3.85	110.07+/- 4.02
113.61+/- 4.08	117.33+/- 4.30		
10	116.37+/- 5.01	122.42+/- 5.21	129.11+/- 5.43
132.91+/- 5.51	137.67+/- 5.81		
25	138.53+/- 6.75	145.47+/- 7.02	153.16+/- 7.33
157.28+/- 7.42	163.38+/- 7.83		
50	154.96+/- 8.08	162.57+/- 8.40	171.00+/- 8.77
175.37+/- 8.88	182.45+/- 9.37		
100	171.28+/- 9.41	179.54+/- 9.79	188.71+/-10.21
193.32+/-10.35	201.38+/-10.91		

RETURN PERIOD YEARS	15 DAY	20 DAY	25 DAY	30
DAY				

2	100.35+/- 2.90	112.39+/- 3.18	123.92+/- 3.26
133.25+/- 3.41			
5	135.25+/- 4.88	150.67+/- 5.36	163.18+/- 5.49
174.34+/- 5.75			
10	158.37+/- 6.60	176.01+/- 7.23	189.16+/- 7.42
201.55+/- 7.77			
25	187.56+/- 8.89	208.02+/- 9.75	222.00+/-10.00
235.93+/-10.47			
50	209.23+/-10.64	231.78+/-11.67	246.36+/-11.97
261.43+/-12.53			
100	230.73+/-12.40	255.35+/-13.59	270.54+/-13.94
286.74+/-14.60			

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 1 DAYS ACCUMULATION

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 2 DAYS ACCUMULATION

METEOROLOGICAL SERVICE OF CANADA

RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 3 - Western Canada Mountain Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

TOTAL %			START		MAX							
YR	DAYS	VALID	FLAG	MAX	1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY	SNPK						
1935	168	62	0 **									
1936	121	44	0 **									
1937	90	33 **	M/D	12/10	12/10	12/10	12/10	12/10	12/10	12/10	12/10	12/10
12/10	12/10	12/10	12/10	12/10	12/10							
			.1MM	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13							
1938	211	77 **	M/D	1/24	1/24	3/17	3/16	3/16	3/13	3/13	3/12	
3/12	3/12	3/ 5	3/ 2	3/ 2	3/ 2							
			.1MM	242	242	359	431	431	456	581	649	
649	649	735	751	751	751							
1939	170	62 **	M/D	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1
6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1							
			.1MM	724	724	724	724	724	724	724	724	724
724	724	724	724	724	724							
1940	148	54 **	M/D	4/ 8	4/ 7	4/ 7	4/ 6	4/ 4	4/ 4	4/ 3	4/ 2	
4/ 1	4/ 1	4/ 2	4/ 1	4/ 1	4/ 1							
			.1MM	312	411	503	552	621	712	720	769	
861	861	1063	1252	1252	1252							
1941	240	88 **	M/D	4/ 6	4/ 6	4/ 6	4/ 6	4/ 6	4/ 5	4/ 4	4/ 3	
4/ 2	4/ 1	3/27	3/23	3/23	3/15							
			.1MM	234	410	569	744	934	1050	1158	1308	
1408	1533	1615	1783	1783	1854							
1942	273	100	M/D	3/16	3/16	3/16	3/16	3/16	3/16	3/15	3/15	
3/15	3/ 8	3/ 6	3/ 1	2/28	2/16							
			.1MM	422	597	730	770	829	856	882	882	
882	1022	1312	1527	1613	1770	840						
1943	271	99	M/D	12/29	12/28	12/27	12/27	12/27	12/24	12/23	12/23	
12/23	12/23	3/13	3/12	3/10	3/10							
			.1MM	434	571	622	650	650	690	723	751	
751	751	1065	1266	1406	1419	1005						
1944	273	100	M/D	2/ 5	3/23	3/23	3/23	3/12	3/12	3/12	3/ 6	
3/ 6	3/24	3/12	3/ 6	3/ 6	3/ 6							
			.1MM	152	188	188	188	222	287	287	316	
316	330	475	607	704	799	361						
1945	273	100	M/D	3/16	3/15	3/14	3/13	3/12	3/12	3/12	3/12	
3/12	3/12	3/ 2	2/26	2/21	2/21							
			.1MM	372	705	788	855	911	911	911	911	
911	911	1198	1381	1537	1537	1094						
1946	271	99	M/D	3/ 7	3/ 6	3/ 6	3/ 6	3/ 4	3/ 3	3/ 2	3/ 2	
3/ 2	3/ 4	3/ 2	3/ 2	3/ 2	2/13							

			.1MM	281	538	732	745	857	881	986	999
999	1002	1132	1132	1132	1232	847					
1947	273	100	M/D	4/ 6	4/ 5	4/ 5	4/ 4	4/ 5	4/ 2	4/ 1	4/ 2
4/ 1	4/ 1	3/24	3/22	3/13	3/11						
			.1MM	462	811	946	988	1058	1193	1257	1305
1370	1370	1664	1892	2017	2306	1656					
1948	274	100	M/D	3/19	3/19	3/19	3/19	3/19	3/15	3/15	3/15
3/15	3/15	3/ 9	3/ 7	2/27	2/24						
			.1MM	489	832	1032	1135	1135	1256	1456	1559
1559	1559	1566	1574	1582	1749	1060					
1949	273	100	M/D	3/22	3/21	3/21	3/21	2/12	2/12	1/15	1/15
1/15	1/15	2/12	2/ 6	12/28	12/28						
			.1MM	396	513	513	513	529	529	570	603
603	603	856	932	1165	1198	496					
1950	273	100	M/D	12/12	3/27	3/26	3/25	3/24	3/23	3/22	3/21
3/21	3/25	3/21	3/23	3/21	3/ 8						
			.1MM	314	475	548	679	811	869	941	957
957	1049	1328	1367	1455	1639	839					
1951	273	100	M/D	1/ 3	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2
1/ 2	1/ 2	1/ 2	1/ 2	12/23	12/23						
			.1MM	495	693	696	696	696	696	696	696
745	795	803	872	880	949	413					
1952	274	100	M/D	11/ 7	3/10	11/ 6	11/ 6	11/ 6	11/ 6	11/ 6	11/ 6
11/ 6	11/ 6	3/10	3/10	3/10	3/ 4						
			.1MM	404	587	623	649	781	889	939	939
939	939	1338	1490	1716	1830	976					
1953	273	100	M/D	12/ 5	1/23	1/15	1/14	1/13	1/10	1/10	1/10
1/10	1/15	1/10	1/10	1/10	1/10						
			.1MM	233	247	309	358	399	465	465	579
579	614	884	884	930	1133	364					
1954	273	100	M/D	2/21	2/15	2/15	2/15	2/15	2/16	2/15	2/14
2/14	2/14	2/14	2/14	2/14	1/25						
			.1MM	303	524	619	734	817	1039	1300	1307
1307	1307	1358	1381	1414	1546	841					
1955	273	100	M/D	12/17	2/28	2/27	2/27	2/26	2/26	2/26	2/26
2/21	2/21	2/26	2/21	2/26	2/21						
			.1MM	284	356	466	524	539	552	552	557
614	673	861	995	1069	1203	462					
1956	274	100	M/D	1/10	1/10	1/ 9	1/ 9	3/31	3/30	3/29	3/29
3/29	3/29	3/22	2/24	2/12	2/ 7						
			.1MM	233	409	437	437	455	488	559	559
559	559	575	610	676	821	414					
1957	273	100	M/D	1/22	1/21	1/20	1/20	1/20	1/20	1/20	1/20
1/20	1/20	2/25	2/25	2/25	2/25						
			.1MM	567	725	758	758	758	758	758	758
758	758	788	1020	1078	1078	516					
1958	273	100	M/D	3/26	3/25	3/21	3/23	3/22	3/21	3/20	3/19
3/18	3/18	3/14	3/14	3/ 3	2/27						
			.1MM	166	258	330	415	531	630	712	784
851	907	1049	1049	1292	1519	1096					

1959	273	100	M/D	4/ 2	4/ 1	4/ 1	3/31	4/ 1	4/ 1	3/31	4/ 1
3/31	3/30	3/25	3/20	3/15	3/15						
			.1MM	342	660	823	973	1149	1310	1460	1624
1774	1825	1942	2234	2378	2378	1738					
1960	274	100	M/D	4/ 3	4/ 3	4/ 2	3/31	3/30	3/30	3/30	3/28
3/28	3/28	3/28	3/28	3/28	3/28						
			.1MM	459	655	754	875	1176	1372	1456	1642
1726	1726	1812	1812	1812	1812	1608					
1961	273	100	M/D	2/25	2/24	2/23	2/22	2/23	2/22	2/22	2/18
2/18	2/18	2/17	2/13	2/13	2/23						
			.1MM	335	478	773	837	912	975	992	1045
1086	1184	1344	1434	1434	1606	872					
1962	273	100	M/D	3/29	3/28	3/27	3/26	3/25	3/24	3/24	3/22
3/21	3/20	3/15	3/12	3/12	2/28						
			.1MM	409	584	725	908	1058	1124	1124	1208
1287	1328	1461	1621	1628	1715	1525					
1963	273	100	M/D	3/26	3/25	3/25	3/24	3/25	3/24	3/23	3/23
3/21	3/20	3/17	3/12	3/ 6	3/ 6						
			.1MM	399	776	974	1091	1202	1319	1344	1344
1352	1405	1660	1696	1925	1925	1353					
1964	274	100	M/D	1/ 9	1/24	1/23	1/23	1/21	1/20	1/20	1/18
1/18	1/18	1/18	1/ 6	1/ 3	1/ 3						
			.1MM	298	341	425	425	517	724	724	732
732	732	806	1038	1139	1213	594					
1965	273	100	M/D	4/ 7	4/ 7	4/ 6	4/ 5	4/ 5	2/ 7	2/ 7	2/ 7
2/ 7	2/ 7	2/ 7	1/24	2/10	2/ 7						
			.1MM	342	507	635	686	713	835	835	835
835	835	838	977	1080	1549	940					
1966	273	100	M/D	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28
2/28	2/28	2/28	2/28	2/28	2/28						
			.1MM	351	495	554	579	678	792	792	792
792	792	1030	1461	1461	1461	798					
1967	273	100	M/D	12/ 6	3/27	3/27	3/26	3/26	3/25	3/24	3/24
3/22	3/22	3/22	3/11	3/11	3/11						
			.1MM	216	350	482	606	711	744	777	777
794	794	794	968	968	968	761					
1968	274	100	M/D	2/ 2	2/ 1	3/16	3/16	3/16	3/15	3/15	3/15
3/15	3/15	3/ 9	3/ 9	3/ 9	3/ 9						
			.1MM	259	434	496	639	804	817	817	817
817	817	1064	1123	1123	1123	768					
1969	273	100	M/D	1/24	1/23	1/29	1/29	11/28	11/28	1/24	1/23
1/23	1/23	1/18	1/18	1/18	11/15						
			.1MM	365	409	415	431	439	494	752	796
829	846	951	1007	1007	1045	517					
1970	273	100	M/D	4/ 8	12/10	4/ 6	12/ 8	12/ 8	4/ 3	4/ 2	4/ 1
4/ 1	4/ 1	3/25	3/20	3/19	3/19						
			.1MM	252	423	484	526	559	600	727	769
769	769	1026	1446	1487	1487	1049					
1971	273	100	M/D	4/13	4/12	4/11	4/10	4/ 9	4/13	4/12	4/11
4/10	4/ 9	4/ 7	4/ 1	3/29	3/29						

			.1MM	374	557	658	766	957	1134	1317	1417
1525	1716	1860	2095	2140	2140	1919					
1972	274	100	M/D	12/15	4/13	4/13	4/11	4/13	4/12	4/11	4/10
4/10	4/10	4/ 3	3/30	3/30	3/21						
			.1MM	364	495	648	803	1034	1151	1342	1384
1384	1384	1451	1649	1649	1943	1378					
1973	273	100	M/D	2/ 2	2/ 1	1/17	1/16	1/15	1/17	1/17	1/16
1/15	1/14	1/14	1/14	12/30	1/ 4						
			.1MM	349	364	458	530	547	577	684	756
773	780	780	1144	1228	1290	644					
1974	273	100	M/D	1/27	1/26	3/30	3/30	3/30	3/30	3/30	3/30
1/20	1/20	1/18	3/16	3/16	12/25						
			.1MM	263	436	527	735	798	798	798	798
805	814	829	833	833	913	348					
1975	273	100	M/D	3/19	3/18	3/17	3/16	3/16	3/16	3/16	3/12
2/17	2/17	3/ 6	2/17	2/23	2/18						
			.1MM	508	592	634	641	641	641	641	692
705	712	733	753	1258	1390	367					
1976	274	100	M/D	12/14	3/19	3/19	3/19	3/20	3/19	3/19	3/19
3/19	3/19	3/12	2/15	2/10	2/25						
			.1MM	408	419	533	533	664	797	898	898
898	898	1030	1274	1384	1753	844					
1977	273	100	M/D	3/13	3/13	3/12	3/11	3/10	3/ 9	3/ 9	3/ 9
3/ 9	3/ 4	3/ 4	2/24	3/ 4	2/27						
			.1MM	483	763	1031	1211	1410	1556	1655	1655
1655	1725	2103	2331	2477	2580	1756					
1978	273	100	M/D	1/26	4/11	4/11	4/11	4/11	4/11	4/11	4/11
4/11	4/10	4/ 5	3/31	3/26	3/21						
			.1MM	450	505	778	853	940	1036	1161	1279
1431	1465	1878	2338	2468	2831	2165					
1979	273	100	M/D	3/ 4	12/31	3/ 3	3/ 3	3/ 3	3/ 3	3/ 3	3/ 2
3/ 1	3/ 1	2/23	3/ 1	2/23	2/21						
			.1MM	320	485	536	592	642	721	803	839
897	913	1084	1290	1439	1567	933					
1980	274	100	M/D	3/21	3/20	3/20	3/20	3/20	3/17	3/17	3/17
3/17	3/16	3/10	3/10	3/10	3/10						
			.1MM	838	1039	1176	1189	1287	1360	1374	1472
1514	1516	1611	1653	1653	1653	709					
1981	273	100	M/D	2/20	2/19	2/18	2/17	2/16	2/16	2/16	2/16
2/16	2/11	2/10	2/ 1	1/27	1/26						
			.1MM	597	1064	1213	1435	1582	1582	1582	1582
1582	1674	1720	1800	1802	1960	1055					
1982	273	100	M/D	3/31	3/30	3/29	3/31	3/30	3/29	3/29	3/29
3/26	3/25	3/20	3/16	3/11	3/11						
			.1MM	460	585	615	862	987	1017	1017	1017
1019	1196	1474	1705	2144	2166	1251					
1983	273	100	M/D	12/24	12/24	12/23	12/23	12/23	12/23	3/28	3/27
3/27	3/27	12/14	12/14	12/14	11/28						
			.1MM	179	276	285	285	285	285	301	324
324	324	449	449	459	574	162					

1984	274	100	M/D	12/12	12/12	12/12	2/11	2/11	2/11	2/11	2/11
2/11	2/11	2/11	2/ 3	2/ 3	11/15						
			.1MM	510	597	706	793	892	1000	1066	1168
1246	1246	1274	1452	1480	1515	916					
1985	273	100	M/D	2/23	2/22	2/22	2/22	2/22	2/22	2/22	2/22
2/22	2/22	2/22	2/22	2/22	2/22						
			.1MM	449	673	876	899	903	903	903	1106
1110	1110	1281	1849	1946	2110	1109					
1986	273	100	M/D	3/26	3/25	3/25	3/25	3/23	3/23	3/23	3/19
3/19	3/18	3/13	3/10	3/10	3/10						
			.1MM	508	688	823	842	930	948	948	1088
1224	1287	1653	1854	1854	1854	1319					
1987	273	100	M/D	4/ 4	4/ 3	4/ 2	4/ 2	4/ 2	4/ 2	3/ 1	3/ 1
2/28	2/28	2/28	2/28	2/28	3/ 7						
			.1MM	397	434	510	510	510	510	557	735
776	776	776	992	992	1112	641					
1988	274	100	M/D	11/29	3/24	3/23	3/23	3/23	3/23	3/23	3/23
3/23	3/16	3/12	3/ 6	3/ 6	3/ 6						
			.1MM	459	551	732	732	732	732	732	732
732	755	757	1043	1043	1043	660					
1989	273	100	M/D	3/27	3/26	3/25	3/24	3/24	3/24	3/24	3/24
3/24	3/18	3/14	3/14	3/ 4	3/14						
			.1MM	227	329	435	453	453	453	453	453
453	455	644	644	672	673	431					
1990	273	100	M/D	2/22	3/11	3/10	3/ 9	3/ 9	3/ 9	3/ 9	3/ 9
1/17	1/17	1/17	2/22	1/ 4	12/31						
			.1MM	307	422	485	487	487	487	487	487
572	581	684	834	960	1155	440					
1991	273	100	M/D	3/ 2	3/ 1	3/ 1	3/ 1	3/ 2	3/ 1	3/ 1	3/ 1
3/ 1	3/ 1	2/20	2/18	2/18	2/ 3						
			.1MM	335	470	470	490	526	661	667	667
667	667	732	899	932	1116	394					
1992	274	100	M/D	3/26	3/26	3/25	3/26	3/26	3/25	3/25	3/25
3/26	3/25	3/25	2/19	3/ 6	3/ 5						
			.1MM	288	473	487	534	605	619	619	619
619	633	633	698	1125	1185	430					
1993	273	100	M/D	1/ 4	1/ 4	1/ 3	3/27	3/26	3/25	3/24	12/29
12/29	3/24	3/16	3/16	3/16	3/ 8						
			.1MM	542	728	782	806	823	908	986	996
996	1032	1231	1320	1411	1500	995					
1994	273	100	M/D	2/20	2/20	3/21	3/21	3/21	3/21	3/21	3/21
3/21	3/21	3/21	3/21	3/15	3/13						
			.1MM	261	320	451	603	608	608	663	705
740	761	1213	1390	1491	1579	972					
1995	273	100	M/D	11/28	3/ 6	3/ 6	11/25	11/25	11/25	3/ 7	3/ 6
3/ 6	3/ 5	2/27	2/27	11/27	11/25						
			.1MM	292	338	364	396	396	396	533	604
618	626	631	645	706	790	466					
1996	274	100	M/D	2/20	1/18	1/17	1/16	1/16	1/16	1/17	1/17
1/16	1/16	1/16	1/16	1/16	1/16						

			.1MM	412	581	838	902	902	902	904	988
1052	1052	1245	1245	1548	1554	676					
1997	273	100	M/D	2/21	3/28	3/27	3/25	3/25	3/25	3/25	3/25
3/25	3/25	3/21	3/25	3/21	3/ 9						
			.1MM	308	435	662	766	1020	1080	1080	1193
1377	1432	1436	1526	1530	1556	1041					
1998	273	100	M/D	3/26	2/25	2/24	2/25	2/24	2/25	2/24	2/24
2/17	2/17	2/17	2/11	2/11	2/25						
			.1MM	271	317	344	455	482	485	512	512
569	662	830	908	908	1003	467					
1999	273	100	M/D	1/23	1/22	1/22	1/22	1/22	1/18	1/18	1/18
1/18	1/18	1/18	1/18	1/18	1/18						
			.1MM	423	551	668	668	668	797	914	914
914	914	932	1129	1284	1438	1071					
2000	274	100	M/D	2/24	2/23	2/23	2/23	2/23	2/23	2/23	2/23
2/23	2/23	2/23	2/ 9	2/23	2/23						
			.1MM	216	421	610	651	651	651	651	651
651	651	651	666	778	778	466					
2001	273	100	M/D	11/26	11/25	4/ 6	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1
3/31	3/30	3/30	3/21	3/15	3/12						
			.1MM	523	543	723	912	1070	1164	1206	1241
1280	1290	1290	1650	1746	1922	1646					
2002	273	100	M/D	2/20	3/ 8	3/ 8	3/ 8	1/ 6	2/15	3/ 3	3/ 2
3/ 2	3/ 2	3/ 2	2/19	2/15	2/10						
			.1MM	226	315	315	315	334	412	490	558
558	558	572	790	970	1018	318					
2003	242	89 **	M/D	3/20	3/20	3/20	3/20	3/18	3/17	3/17	3/16
3/16	3/16	3/16	3/17	3/17	3/16						
			.1MM	268	484	626	695	724	866	935	944
944	944	944	1033	1108	1348						
2004	274	100	M/D	3/ 5	3/ 4	3/ 3	3/ 2	3/ 1	2/29	2/29	2/29
2/29	2/29	2/29	2/19	2/29	2/29						
			.1MM	423	530	651	881	951	1045	1045	1045
1045	1045	1122	1144	1272	1317	896					
2005	273	100	M/D	12/31	2/14	2/14	2/14	2/14	2/14	2/14	2/ 8
12/23	12/22	12/30	12/12	12/ 7	12/ 4						
			.1MM	388	441	461	461	461	461	461	573
630	645	671	774	1064	1084	483					
2006	273	100	M/D	1/17	1/17	12/23	12/23	12/23	12/23	1/12	1/11
1/11	1/11	1/ 4	1/ 4	12/25	12/23						
			.1MM	232	404	412	432	432	487	529	699
699	699	828	838	1044	1322	448					
2007	273	100	M/D	3/14	3/13	3/12	3/11	3/10	3/10	3/10	3/10
3/10	3/10	3/ 2	3/ 2	3/ 2	2/22						
			.1MM	514	763	832	897	909	909	909	909
909	911	1066	1074	1158	1170	873					
2008	274	100	M/D	12/23	4/ 7	4/ 6	4/ 5	4/ 4	4/ 3	4/ 3	4/ 1
3/31	3/31	3/26	3/26	3/15	3/14						
			.1MM	385	655	832	962	1155	1215	1215	1395
1657	1657	1735	1735	2096	2102	1541					

2009	272	100	M/D	2/11	12/27	3/ 6	3/ 6	3/ 6	3/ 6	3/ 5	3/ 5
3/ 5	3/ 6	2/25	2/25	2/11	2/10						
			.1MM	482	639	711	733	789	910	916	916
916	954	1176	1264	1470	1823	931					
2010	243	89 **	M/D	1/25	1/24	1/24	1/24	1/24	1/24	1/24	1/24
1/18	1/17	1/14	1/14	1/14	12/31						
			.1MM	476	799	823	823	823	823	823	823
846	860	979	979	979	1007						
2011	270	99	M/D	3/ 5	3/10	3/10	3/10	3/10	3/ 5	3/ 5	3/ 5
3/10	3/10	3/ 5	2/28	2/28	2/17						
			.1MM	486	611	668	726	726	929	1098	1155
1368	1377	1864	2045	2045	2195	932					
2012	274	100	M/D	1/23	1/16	3/ 1	2/29	2/29	2/27	1/17	1/16
1/16	1/23	1/17	1/13	1/13	1/ 6						
			.1MM	192	202	257	277	277	328	369	394
394	396	497	601	601	623	116					
2013	242	89 **	M/D	1/13	1/12	1/11	1/10	1/ 9	1/ 9	1/ 9	1/ 6
1/ 6	1/ 6	1/ 6	1/11	1/ 6	1/ 6						
			.1MM	389	714	758	776	778	778	778	796
796	796	804	1014	1052	1052						
2014	273	100	M/D	4/ 7	4/ 7	4/ 7	4/ 6	4/ 4	4/ 4	4/ 3	4/ 2
3/31	3/31	3/27	3/27	3/19	3/11						
			.1MM	351	653	734	785	1075	1155	1178	1248
1318	1398	1689	1689	1876	2059	1091					
2015	273	100	M/D	4/ 3	4/ 2	4/ 2	4/ 1	3/30	3/30	3/30	3/30
3/30	3/30	3/25	3/21	3/14	3/ 9						
			.1MM	298	537	606	620	713	782	785	873
900	900	1080	1127	1271	1451	1103					
2016	118	43 **	M/D	1/ 9	1/ 8	1/ 8	1/ 8	1/ 8	1/ 8	1/ 9	1/ 9
1/ 8	12/31	12/29	1/ 8	1/ 8	12/29						
			.1MM	207	219	219	219	219	219	221	241
253	263	285	424	424	489						

				1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY						
	MEAN EXTREME	(MM)	37.1	52.6	62.6	69.1	76.3	82.7	87.7	92.4	
95.8	98.3	112.9	126.7	137.1	147.6						
	STD. DEV.	(MM)	11.9	17.4	20.9	23.7	27.9	30.1	31.8	33.3	
35.8	37.0	41.2	44.9	45.9	47.9						
	YEARS ANALYSED		71	71	71	71	71	71	71	71	
71	71	71	71	71	71						
	MAX EXTREME	(MM)	83.8	106.4	121.3	143.5	158.2	158.9	165.5	165.5	
177.4	191.8	210.3	233.8	254.3	283.1						
	YEAR		1980	1981	1981	1981	1981	1981	1977	1977	
1959	1977	1977	1978	1978	1978						

** NOTE ** VALUE IN FLAG INDICATES YEAR NOT INCLUDED IN ANALYSIS BASED ON % DAYS OPERATIONAL (<90.0%)

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 3 - Western Canada Mountain Basin

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

RETURN PERIOD VALUES (MM) WITH 50%

CONFIDENCE LIMITS

RETURN PERIOD

YEARS		1 DAY	2 DAY	3 DAY	4
DAY	5 DAY				
2		35.12+/- 0.88	49.74+/- 1.27	59.12+/- 1.54	
65.25+/- 1.74	71.69+/- 2.05				
5		45.68+/- 1.48	65.08+/- 2.15	77.61+/- 2.59	
86.22+/- 2.93	96.32+/- 3.45				
10		52.67+/- 2.00	75.24+/- 2.90	89.86+/- 3.50	
100.10+/- 3.96	112.62+/- 4.65				
25		61.50+/- 2.69	88.07+/- 3.91	105.33+/- 4.71	
117.64+/- 5.34	133.22+/- 6.27				
50		68.06+/- 3.22	97.59+/- 4.68	116.81+/- 5.64	
130.66+/- 6.39	148.50+/- 7.51				
100		74.56+/- 3.75	107.04+/- 5.45	128.20+/- 6.57	
143.58+/- 7.45	163.67+/- 8.75				

RETURN PERIOD

YEARS		6 DAY	7 DAY	8 DAY	9
DAY	10 DAY				
2		77.71+/- 2.21	82.45+/- 2.33	86.90+/- 2.44	
89.89+/- 2.63	92.21+/- 2.72				
5		104.33+/- 3.73	110.51+/- 3.93	116.31+/- 4.12	

121.50+/- 4.42	124.95+/- 4.58			
10		121.96+/- 5.03	129.09+/- 5.30	135.79+/- 5.56
142.43+/- 5.97	146.62+/- 6.19			
25		144.24+/- 6.78	152.57+/- 7.15	160.40+/- 7.50
168.87+/- 8.05	174.00+/- 8.34			
50		160.76+/- 8.12	169.98+/- 8.56	178.65+/- 8.97
188.49+/- 9.64	194.32+/- 9.98			
100		177.16+/- 9.46	187.27+/- 9.97	196.77+/-10.45
207.96+/-11.23	214.49+/-11.63			

RETURN PERIOD

YEARS	15 DAY	20 DAY	25 DAY	30
DAY				
2	106.16+/- 3.02	119.29+/- 3.30	129.52+/- 3.37	
139.76+/- 3.52				
5	142.53+/- 5.09	158.99+/- 5.55	170.12+/- 5.68	
182.09+/- 5.92				
10	166.61+/- 6.87	185.27+/- 7.50	197.00+/- 7.67	
210.12+/- 8.00				
25	197.03+/- 9.27	218.48+/-10.12	230.96+/-10.35	
245.54+/-10.79				
50	219.60+/-11.09	243.12+/-12.10	256.16+/-12.38	
271.81+/-12.91				
100	242.00+/-12.92	267.58+/-14.10	281.17+/-14.42	
297.89+/-15.04				

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 1 DAYS ACCUMULATION
METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 4 - Southern Ontario

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6
NOTE : MODIFIED GUMBEL 12/82

TOTAL %	START		MAX									
YR	DAYS	VALID	FLAG	MAX	1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY	SNPK						

1935	168	62	0 **									
1936	121	44	0 **									
1937	92	34 **	M/D	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4
12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4	12/ 4						
			.1MM	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13							
1938	213	78 **	M/D	1/24	1/23	1/22	1/22	1/22	1/24	1/24	1/23	
1/22	1/22	1/22	1/22	1/22	1/ 2							
			.1MM	262	292	312	322	322	341	483	513	
533	533	533	533	533	584							
1939	175	64 **	M/D	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	
6/ 1	2/ 2	1/29	1/29	1/29	1/29							
			.1MM	213	389	389	389	389	389	389	389	
389	411	568	598	674	684							
1940	148	54 **	M/D	4/16	4/ 7	4/ 7	4/ 7	4/ 4	4/ 4	4/ 4	4/ 1	
4/ 8	4/ 7	4/ 2	4/ 1	4/ 1	4/ 1							
			.1MM	243	289	345	396	476	532	583	644	
701	777	1071	1183	1183	1183							
1941	240	88 **	M/D	1/22	4/ 6	4/ 6	4/ 6	4/ 6	4/ 4	4/ 3	4/ 3	
4/ 2	4/ 1	3/27	3/22	3/21	3/13							
			.1MM	159	258	375	502	613	690	801	912	
993	1074	1227	1472	1488	1686							
1942	273	100	M/D	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/15	
3/ 8	3/ 8	3/ 8	3/ 3	2/27	2/16							
			.1MM	434	526	566	596	652	734	769	795	
920	1012	1255	1405	1518	1669	744						
1943	273	100	M/D	3/16	3/15	3/15	3/14	3/13	3/12	3/10	3/10	
3/10	3/10	3/10	3/10	3/10	2/19							
			.1MM	381	457	502	543	578	619	761	807	
827	853	1026	1152	1205	1296	791						
1944	274	100	M/D	3/ 6	3/ 6	3/11	3/11	3/12	3/12	3/ 6	3/ 6	
3/ 6	3/ 6	3/ 6	2/23	2/22	2/17							
			.1MM	157	167	193	193	211	258	325	360	
360	360	472	512	644	715	240						
1945	273	100	M/D	3/15	3/14	3/13	3/12	3/11	3/10	3/ 9	3/ 8	
3/ 8	3/ 6	3/ 1	2/25	2/21	2/15							
			.1MM	208	309	370	426	456	481	507	527	
544	583	884	1129	1354	1416	950						
1946	271	99	M/D	3/ 8	3/ 7	3/ 6	3/ 6	3/ 4	3/ 4	3/ 2	3/ 1	
3/ 1	3/ 4	3/ 1	3/ 1	3/ 1	2/12							
			.1MM	207	297	476	525	588	636	674	729	
778	813	955	955	955	1143	670						
1947	273	100	M/D	3/24	3/13	4/ 4	4/ 3	4/ 2	4/ 1	4/ 5	4/ 4	
4/ 3	4/ 2	3/29	3/23	3/19	3/13							
			.1MM	198	317	398	454	529	611	779	863	
919	995	1193	1467	1625	1906	1427						
1948	274	100	M/D	3/19	3/19	3/19	3/19	3/19	3/19	3/18	3/15	
3/15	3/15	3/14	3/ 7	3/ 7	2/24							
			.1MM	414	511	659	760	842	966	1017	1117	

1199	1323	1363	1411	1411	1571	887						
1949	273	100	M/D	1/18	2/13	2/12	2/12	2/12	2/12	2/12	2/ 8	
2/ 8	2/ 6	1/ 5	1/27	12/28	1/18							
			.1MM	233	357	474	574	604	604	608	651	
681	752	832	928	1116	1256	473						
1950	273	100	M/D	3/ 8	12/11	4/ 1	1/10	3/24	3/23	3/22	3/27	
3/26	3/25	3/20	3/21	3/19	3/ 5							
			.1MM	249	319	364	433	455	505	560	668	
768	829	1072	1092	1123	1418	558						
1951	273	100	M/D	1/ 3	1/ 2	1/ 2	1/ 1	1/ 1	12/31	12/29	12/29	
12/29	1/ 1	12/22	12/23	12/22	12/ 7							
			.1MM	337	525	579	620	630	640	645	655	
655	681	804	875	900	951	344						
1952	274	100	M/D	11/ 7	11/ 6	11/ 6	11/ 6	11/ 6	11/ 6	11/ 6	11/ 4	
11/ 4	11/ 4	3/10	3/ 9	3/ 4	2/27							
			.1MM	434	612	667	723	794	856	856	876	
876	876	1266	1387	1521	1573	871						
1953	273	100	M/D	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	
1/10	1/10	1/ 2	12/29	12/23	12/17							
			.1MM	200	225	255	296	336	469	486	486	
486	486	536	572	737	776	271						
1954	273	100	M/D	2/16	2/15	2/15	2/15	2/16	2/15	2/15	2/14	
2/14	2/15	2/15	2/14	2/14	2/ 2							
			.1MM	251	403	469	555	661	814	925	981	
1017	1040	1409	1520	1568	1627	765						
1955	273	100	M/D	12/17	4/ 1	3/31	3/30	3/29	3/29	3/29	3/29	
3/25	3/24	3/20	2/19	3/ 9	2/ 9							
			.1MM	287	303	405	486	547	547	547	547	
563	614	806	879	990	1044	439						
1956	274	100	M/D	1/11	2/24	1/ 9	1/ 9	3/ 1	1/ 9	1/ 9	1/ 9	
2/24	2/24	2/24	2/24	2/10	2/ 5							
			.1MM	88	167	217	223	243	248	299	299	
329	349	431	549	606	745	327						
1957	273	100	M/D	1/22	1/21	1/20	1/20	1/20	1/20	1/20	1/20	
2/22	2/22	2/25	2/22	2/16	2/13							
			.1MM	380	470	538	538	538	538	538	538	
545	545	710	904	913	990	463						
1958	273	100	M/D	2/27	3/26	3/25	3/24	3/23	3/22	3/21	3/20	
3/19	3/18	3/14	3/ 8	3/ 3	2/26							
			.1MM	132	203	285	341	427	502	568	624	
660	721	873	997	1185	1437	1007						
1959	273	100	M/D	3/ 6	3/ 5	4/ 1	3/31	4/ 1	3/31	4/ 1	4/ 1	
3/31	3/30	3/25	3/20	3/15	3/13							
			.1MM	238	362	499	590	715	807	952	1088	
1179	1230	1357	1595	1758	1783	1157						
1960	274	100	M/D	2/10	2/10	2/ 9	2/ 8	3/30	3/30	3/29	3/28	
3/27	3/27	4/ 1	3/27	3/22	3/17							
			.1MM	335	380	406	449	538	617	678	754	
810	861	1280	1651	1667	1743	1402						
1961	273	100	M/D	2/25	2/24	2/23	2/22	2/22	2/22	2/22	2/18	

2/17	2/18	2/17	2/13	2/ 8	2/22						
			.1MM	264	320	531	625	655	706	747	826
866	907	1103	1187	1258	1343	712					
1962	273	100	M/D	11/23	11/22	3/24	3/24	3/22	3/22	3/21	3/20
3/18	3/17	3/12	3/ 8	3/ 5	2/26						
			.1MM	222	247	289	333	381	425	465	505
547	603	839	985	1035	1280	948					
1963	273	100	M/D	3/ 6	3/25	3/25	3/24	3/25	3/25	3/24	3/23
3/22	3/21	3/16	3/12	3/ 6	3/ 3						
			.1MM	249	343	458	564	648	793	900	961
977	1033	1305	1384	1669	1705	972					
1964	274	100	M/D	1/25	1/24	1/23	1/22	1/21	1/20	1/19	1/18
1/18	1/17	1/18	1/ 6	1/ 2	1/ 3						
			.1MM	296	332	393	423	479	591	636	666
672	677	743	1024	1126	1177	586					
1965	273	100	M/D	2/10	2/ 7	2/10	2/ 7	2/ 7	2/ 7	2/ 6	2/ 5
2/ 7	2/ 7	2/ 5	2/ 6	2/ 7	2/ 7						
			.1MM	292	337	517	639	674	864	885	890
890	920	981	1116	1223	1527	789					
1966	273	100	M/D	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/26
2/26	2/26	2/28	2/27	2/24	2/24						
			.1MM	390	505	556	612	665	769	785	815
831	831	1062	1301	1352	1352	730					
1967	273	100	M/D	12/ 6	12/ 5	12/ 5	3/24	3/23	3/22	3/21	3/20
3/20	3/20	3/13	3/10	3/ 3	2/27						
			.1MM	185	233	233	271	301	317	322	343
343	343	442	575	645	672	454					
1968	274	100	M/D	2/ 2	2/ 1	1/31	1/30	1/29	1/28	1/27	1/27
1/27	1/27	3/ 8	1/14	1/14	1/14						
			.1MM	223	352	378	452	566	594	609	615
615	615	805	882	893	893	688					
1969	273	100	M/D	1/24	1/23	1/22	1/21	1/20	1/19	1/24	1/23
1/22	1/21	1/17	1/17	1/17	1/17						
			.1MM	407	468	508	538	544	574	787	848
888	919	1094	1211	1211	1227	411					
1970	273	100	M/D	12/10	12/10	12/ 9	12/ 8	12/ 8	12/ 8	12/ 7	3/19
3/18	3/17	3/12	3/ 4	3/ 3	3/ 3						
			.1MM	226	419	455	528	554	564	574	599
645	681	732	790	1027	1032	590					
1971	273	100	M/D	4/13	4/12	4/11	4/10	4/ 9	4/ 9	4/ 9	4/ 9
4/ 9	4/ 8	4/ 2	3/29	3/27	3/20						
			.1MM	218	340	437	523	678	729	820	932
1018	1064	1268	1524	1562	1587	1342					
1972	274	100	M/D	12/15	12/15	12/15	2/12	2/12	12/15	3/16	3/15
3/15	12/ 6	3/21	3/16	3/16	3/15						
			.1MM	364	364	364	368	368	414	494	520
525	618	678	898	1005	1194	665					
1973	273	100	M/D	2/ 2	12/12	12/12	12/12	12/31	12/31	12/30	12/ 6
12/ 6	12/ 6	1/19	12/31	12/12	12/ 6						
			.1MM	328	366	381	381	485	501	504	567

582	582	649	886	1076	1262	472					
1974	273	100	M/D	3/30	3/30	3/30	3/30	3/30	3/30	1/21	1/20
1/20	1/20	1/18	1/14	1/14	12/25						
			.1MM	269	413	484	604	604	604	668	719
759	774	858	898	898	934	351					
1975	273	100	M/D	1/25	1/ 9	1/ 8	1/ 7	1/25	1/24	1/23	1/ 3
1/ 3	1/ 1	12/27	12/22	1/ 6	1/ 1						
			.1MM	147	180	228	261	299	315	330	374
374	389	507	624	705	817	210					
1976	274	100	M/D	1/26	3/20	3/19	3/19	2/15	2/16	2/15	2/15
2/13	2/12	2/12	2/15	2/10	2/13						
			.1MM	246	322	418	418	455	513	642	685
704	759	1049	1229	1448	1504	635					
1977	273	100	M/D	3/13	3/12	3/11	3/10	3/10	3/ 9	3/10	3/ 9
3/ 8	3/ 4	3/ 3	3/ 4	3/ 4	3/ 2						
			.1MM	308	455	585	713	834	936	1021	1123
1173	1252	1617	1805	2093	2270	1482					
1978	273	100	M/D	1/26	4/19	4/18	4/18	4/17	4/17	4/16	4/15
4/13	4/11	4/ 7	4/ 4	3/30	3/26						
			.1MM	475	573	681	780	863	946	1013	1082
1165	1313	1654	1986	2320	2446	1830					
1979	273	100	M/D	12/31	12/31	12/30	12/30	12/30	3/ 1	3/13	3/ 3
3/ 1	3/ 4	2/28	2/23	2/23	2/21						
			.1MM	252	433	436	437	437	439	510	524
571	665	972	1240	1434	1580	856					
1980	274	100	M/D	3/21	3/21	3/20	3/19	3/17	3/17	3/17	3/17
3/17	3/17	3/14	3/ 9	3/ 4	3/ 4						
			.1MM	657	766	871	920	995	1104	1123	1198
1265	1344	1381	1534	1563	1563	572					
1981	273	100	M/D	2/23	2/19	2/19	2/20	2/19	2/18	2/17	2/16
2/15	2/15	2/10	2/ 7	2/ 1	1/25						
			.1MM	358	647	736	915	1221	1283	1347	1446
1483	1511	1780	1820	1951	2056	819					
1982	273	100	M/D	1/ 4	1/ 3	1/ 4	1/ 1	12/31	12/31	12/31	12/31
3/17	3/16	3/11	3/11	3/ 7	3/ 1						
			.1MM	306	333	345	521	563	563	602	602
694	736	1079	1203	1229	1316	816					
1983	273	100	M/D	12/24	12/24	12/23	12/23	12/23	12/23	12/23	12/23
12/23	12/23	12/11	12/10	12/10	11/28						
			.1MM	149	250	265	265	265	265	265	265
265	265	322	339	339	444	107					
1984	274	100	M/D	12/12	12/12	12/12	12/12	12/12	12/12	12/ 6	12/ 6
12/ 6	12/ 6	2/10	12/ 4	2/ 2	11/15						
			.1MM	521	608	715	779	790	790	808	895
1002	1065	1162	1319	1342	1485	726					
1985	273	100	M/D	2/23	2/23	2/22	2/21	2/21	2/21	2/21	2/22
2/21	2/21	2/22	2/22	2/18	2/22						
			.1MM	401	550	686	740	772	809	822	877
930	963	1091	1564	1737	1956	1010					
1986	273	100	M/D	3/19	1/19	1/18	1/17	3/15	1/17	3/13	3/19

3/11	3/10	3/15	3/10	3/ 5	3/ 2							
			.1MM	359	444	492	560	598	657	757	763	
871	996	1282	1679	1696	1781	1142						
1987	273	100	M/D	4/ 4	4/ 4	4/ 3	4/ 2	4/ 1	4/ 1	4/ 1	3/ 1	
2/28	2/27	2/22	2/21	2/21	2/ 7							
			.1MM	323	472	503	558	577	577	577	632	
685	708	772	831	831	850	479						
1988	274	100	M/D	11/29	11/28	11/28	11/26	11/26	11/26	11/29	11/29	
2/15	2/14	2/15	2/19	2/15	2/15							
			.1MM	452	457	457	463	463	463	472	479	
522	527	537	643	881	951	552						
1989	273	100	M/D	3/27	3/14	3/25	3/24	3/23	3/23	3/21	3/20	
3/20	3/23	3/13	3/ 9	3/ 4	3/14							
			.1MM	130	204	268	301	336	336	337	355	
355	359	593	623	662	705	315						
1990	273	100	M/D	2/22	2/21	2/21	2/21	2/19	2/19	2/16	2/16	
1/17	12/31	1/ 4	12/31	12/31	12/31							
			.1MM	307	344	368	368	387	387	443	468	
497	503	618	900	1009	1102	345						
1991	273	100	M/D	3/ 2	3/ 1	3/ 1	3/ 1	3/ 2	3/ 1	3/ 1	3/ 1	
3/ 1	3/ 1	2/20	2/18	2/18	2/ 5							
			.1MM	355	454	454	474	579	678	678	678	
678	678	801	928	928	1030	293						
1992	274	100	M/D	3/27	3/26	3/25	3/25	3/25	3/24	3/24	3/24	
3/24	3/20	3/17	3/17	3/ 4	3/ 1							
			.1MM	200	357	444	482	520	534	534	534	
534	557	620	620	763	826	250						
1993	273	100	M/D	1/ 4	1/ 4	1/ 3	1/ 3	1/ 3	12/31	12/30	12/29	
12/28	12/28	12/22	12/17	12/13	12/13							
			.1MM	387	573	665	671	674	750	805	923	
950	956	1026	1234	1378	1381	653						
1994	273	100	M/D	1/28	3/21	3/21	3/21	3/21	3/21	3/21	3/21	
3/21	3/21	3/19	3/13	3/10	3/ 4							
			.1MM	198	277	376	492	521	556	606	656	
698	744	995	1148	1260	1420	885						
1995	273	100	M/D	11/28	3/ 7	3/ 6	3/ 5	3/ 4	3/ 4	3/ 5	3/ 4	
3/ 4	2/27	2/23	2/17	2/15	11/24							
			.1MM	256	267	327	364	368	368	370	374	
374	387	426	554	664	739	323						
1996	274	100	M/D	1/19	1/18	1/17	1/16	1/16	1/14	1/16	1/17	
1/16	1/16	1/13	1/13	1/16	1/13							
			.1MM	439	539	702	786	786	808	824	916	
1001	1001	1284	1300	1520	1593	421						
1997	273	100	M/D	3/25	3/25	3/25	3/25	3/25	3/25	3/25	3/25	
3/25	3/25	3/20	3/14	3/ 9	3/ 4							
			.1MM	334	367	482	620	751	813	845	949	
1067	1074	1120	1228	1339	1396	823						
1998	273	100	M/D	3/18	3/18	3/17	3/17	3/15	3/15	3/17	3/18	
3/18	3/17	3/15	3/15	3/ 2	2/25							
			.1MM	134	267	297	302	305	311	311	360	

448	478	486	486	515	557	305					
1999	273	100	M/D	1/18	1/22	1/22	1/21	1/18	1/18	1/18	1/17
1/16	1/16	1/16	1/16	1/18	1/18						
			.1MM	230	293	383	414	434	589	679	708
736	736	740	1006	1170	1379	1025					
2000	274	100	M/D	2/25	2/24	2/23	2/23	2/22	2/22	2/21	2/20
2/19	2/19	2/15	2/ 9	2/20	2/15						
			.1MM	148	276	371	464	532	570	587	598
606	606	633	662	725	760	411					
2001	273	100	M/D	11/26	11/25	11/24	11/24	11/24	11/21	11/21	11/21
11/21	3/13	3/10	3/18	3/13	3/ 8						
			.1MM	462	523	538	538	538	545	545	545
545	611	789	1032	1293	1372	1074					
2002	273	100	M/D	3/ 3	3/ 2	3/ 1	2/28	2/28	3/ 1	3/ 2	3/ 1
2/28	2/28	2/17	2/17	2/ 7	2/ 7						
			.1MM	229	361	379	382	382	392	433	451
453	453	545	617	725	797	295					
2003	242	89 **	M/D	3/20	3/20	3/19	3/17	3/17	3/16	3/15	3/15
3/15	3/12	3/ 8	3/ 2	3/18	2/20						
			.1MM	250	341	380	454	544	607	651	651
651	672	737	776	843	1054						
2004	274	100	M/D	3/ 5	3/ 5	3/ 4	3/ 2	3/ 1	3/ 1	2/29	2/28
2/27	2/27	2/21	2/19	2/19	2/10						
			.1MM	292	362	414	490	575	645	712	768
796	813	936	1048	1072	1094	786					
2005	273	100	M/D	12/23	2/14	2/14	2/12	2/12	2/12	2/12	2/12
2/ 7	2/ 6	2/ 1	12/ 4	12/ 4	12/ 4						
			.1MM	263	391	391	417	417	417	417	417
465	516	626	787	801	839	323					
2006	273	100	M/D	11/28	1/ 4	12/23	12/23	12/22	12/23	12/22	12/22
1/ 4	1/ 3	12/22	12/23	12/22	12/16						
			.1MM	152	189	255	289	315	363	389	405
418	424	614	800	843	854	373					
2007	273	100	M/D	3/ 2	3/22	3/22	3/21	3/10	3/10	3/10	3/10
3/10	3/13	3/10	3/10	2/28	2/27						
			.1MM	165	241	307	356	390	445	445	445
452	522	842	842	1035	1053	705					
2008	274	100	M/D	12/23	12/22	12/22	4/ 4	4/ 4	4/ 3	3/31	3/31
3/31	3/30	3/25	3/19	3/15	3/11						
			.1MM	381	423	423	503	639	732	844	965
1101	1139	1290	1359	1680	1777	1185					
2009	272	100	M/D	2/11	2/11	2/10	2/ 9	3/ 7	3/ 6	3/ 5	3/ 4
3/ 4	3/ 5	2/25	2/25	2/11	2/10						
			.1MM	312	481	541	552	620	742	809	820
820	847	1156	1244	1298	1748	1025					
2010	243	89 **	M/D	1/25	1/24	1/24	1/22	1/22	1/20	1/19	1/18
1/17	1/16	1/13	1/13	1/ 1	12/27						
			.1MM	347	683	683	707	707	720	740	752
771	796	870	870	895	966						
2011	270	99	M/D	3/ 5	3/ 4	3/10	3/10	3/10	3/ 5	3/ 5	3/ 4

3/ 5	3/ 4	3/ 4	2/28	2/25	2/24							
			.1MM	425	472	498	561	593	820	948	995	
1042	1089	1475	1755	1973	1984	875						
2012	274	100	M/D	1/23	3/ 1	2/29	2/28	2/27	2/27	2/27	2/25	
2/25	2/25	2/19	2/13	2/13	2/13							
			.1MM	168	195	215	227	294	303	303	310	
310	310	403	446	446	467	99						
2013	242	89 **	M/D	1/13	1/12	1/12	1/11	1/10	1/ 9	1/ 8	1/ 7	
1/ 6	1/ 5	12/31	1/11	1/ 6	1/ 4							
			.1MM	338	435	501	561	606	664	692	713	
753	767	793	803	995	1017							
2014	273	100	M/D	4/ 7	4/ 6	2/19	4/ 4	4/ 3	4/ 2	4/ 1	3/31	
3/30	3/29	3/25	3/19	3/14	3/10							
			.1MM	315	386	438	708	752	805	870	962	
1027	1054	1198	1457	1620	1747	897						
2015	273	100	M/D	1/ 4	4/ 2	4/ 2	4/ 1	3/30	3/30	3/29	3/29	
3/26	3/25	3/21	3/16	3/11	3/ 8							
			.1MM	178	317	371	417	502	555	595	604	
632	766	909	1086	1310	1404	1058						
2016	118	43 **	M/D	1/26	1/25	1/25	1/25	12/30	12/29	1/ 2	1/ 1	
12/30	12/30	12/29	12/29	1/ 2	12/29							
			.1MM	82	107	107	107	108	118	134	139	
169	194	204	257	295	364							

				1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY						
	MEAN EXTREME	(MM)	28.9	38.0	44.6	50.3	55.3	60.6	65.2	69.5	
73.2	76.9	93.5	107.9	118.8	128.6						
	STD. DEV.	(MM)	10.9	12.5	14.0	16.1	18.3	20.6	22.2	24.6	
26.6	28.1	33.2	37.6	41.0	43.3						
	YEARS ANALYSED		71	71	71	71	71	71	71	71	
71	71	71	71	71	71						
	MAX EXTREME	(MM)	83.8	106.4	121.3	143.5	158.2	158.9	165.5	165.5	
177.4	191.8	210.3	233.8	254.3	283.1						
	YEAR		1980	1981	1981	1981	1981	1981	1977	1977	
1959	1977	1977	1978	1978	1978						

** NOTE ** VALUE IN FLAG INDICATES YEAR NOT INCLUDED IN ANALYSIS BASED ON % DAYS OPERATIONAL (<90.0%)

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 4 - Southern Ontario

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

RETURN PERIOD VALUES (MM) WITH 50%

CONFIDENCE LIMITS

RETURN PERIOD

YEARS		1 DAY	2 DAY	3 DAY	4
DAY	5 DAY				
2		27.10+/- 0.80	35.97+/- 0.92	42.25+/- 1.03	
47.63+/- 1.18	52.32+/- 1.35				
5		36.73+/- 1.35	47.03+/- 1.55	54.62+/- 1.73	
61.83+/- 1.99	68.52+/- 2.27				
10		43.11+/- 1.82	54.35+/- 2.09	62.81+/- 2.34	
71.24+/- 2.68	79.24+/- 3.06				
25		51.17+/- 2.45	63.61+/- 2.82	73.16+/- 3.15	
83.11+/- 3.62	92.79+/- 4.13				
50		57.15+/- 2.94	70.47+/- 3.37	80.84+/- 3.77	
91.93+/- 4.33	102.84+/- 4.94				
100		63.08+/- 3.42	77.29+/- 3.93	88.46+/- 4.39	
100.67+/- 5.04	112.82+/- 5.75				

RETURN PERIOD

YEARS		6 DAY	7 DAY	8 DAY	9
DAY	10 DAY				
2		57.21+/- 1.51	61.58+/- 1.63	65.42+/- 1.81	
68.85+/- 1.95	72.30+/- 2.06				
5		75.40+/- 2.55	81.18+/- 2.74	87.20+/- 3.05	
92.32+/- 3.28	97.10+/- 3.47				
10		87.45+/- 3.44	94.16+/- 3.70	101.61+/- 4.12	
107.86+/- 4.44	113.51+/- 4.69				
25		102.67+/- 4.64	110.56+/- 5.00	119.83+/- 5.55	
127.50+/- 5.98	134.26+/- 6.32				
50		113.96+/- 5.55	122.73+/- 5.98	133.34+/- 6.64	
142.07+/- 7.16	149.64+/- 7.56				
100		125.16+/- 6.46	134.80+/- 6.96	146.76+/- 7.73	
156.52+/- 8.34	164.92+/- 8.81				

RETURN PERIOD YEARS DAY	15 DAY	20 DAY	25 DAY	30
2	88.08+/- 2.44	101.74+/- 2.76	112.09+/- 3.01	
121.47+/- 3.18				
5	117.44+/- 4.11	134.95+/- 4.65	148.37+/- 5.08	
159.70+/- 5.35				
10	136.87+/- 5.55	156.94+/- 6.28	172.39+/- 6.86	
185.01+/- 7.23				
25	161.43+/- 7.48	184.73+/- 8.46	202.74+/- 9.24	
217.00+/- 9.74				
50	179.65+/- 8.95	205.34+/-10.13	225.25+/-11.06	
240.73+/-11.66				
100	197.73+/-10.43	225.80+/-11.80	247.60+/-12.88	
264.28+/-13.58				

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 1 DAYS ACCUMULATION

** WARNING ** : 100 YEAR VALUES IN 1981 BASED ON 5 DAYS ACCUMULATION

** WARNING ** : 100 YEAR VALUES IN 1981 BASED ON 6 DAYS ACCUMULATION

METEOROLOGICAL SERVICE OF CANADA

RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 5 - Modification of Model 4

CRITICAL PERIOD : 1ST OF MONTH10 (PRECEDING YEAR) TO THE END OF MONTH 6

NOTE : MODIFIED GUMBEL 12/82

TOTAL %				START		MAX						
YR	DAYS	VALID	FLAG	MAX	1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY	SNPK						
1935	168	62	0	**								
1936	121	44	0	**								
1937	90	33	**	M/D	12/10	12/10	12/10	12/10	12/10	12/10	12/10	12/10
12/10	12/10	12/10	12/10	12/10	12/10	12/10						
			.1MM	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13						

1938	211	77	**	M/D	1/24	3/12	3/16	3/16	3/13	3/13	3/12	3/12
3/12	3/12	3/ 5		3/ 2	3/ 2	3/ 2						
				.1MM	253	265	309	350	381	492	575	616
616	616	702		722	722	722						
1939	170	62	**	M/D	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1	6/ 1
6/ 1	6/ 1	6/ 1		6/ 1	6/ 1	6/ 1						
				.1MM	660	724	724	724	724	724	724	724
724	724	724		724	724	724						
1940	151	55	**	M/D	4/ 8	4/ 7	4/ 7	4/ 6	4/ 4	4/ 4	4/ 3	4/ 1
4/ 1	4/ 1	4/ 2		4/ 1	4/ 1	4/ 1						
				.1MM	335	455	532	592	694	771	780	875
952	952	1020		1131	1131	1131						
1941	240	88	**	M/D	4/ 6	4/ 6	4/ 6	4/ 5	4/ 4	4/ 3	4/ 2	4/ 1
4/ 1	4/ 1	3/25		3/23	3/16	3/15						
				.1MM	274	488	682	822	954	1137	1260	1411
1464	1464	1594		1769	1802	1840						
1942	273	100		M/D	3/16	3/16	3/16	3/15	3/15	3/15	3/15	3/11
3/ 8	3/ 8	3/ 4		2/28	2/28	2/16						
				.1MM	429	622	730	761	761	761	761	847
899	1092	1385		1588	1588	1900	816					
1943	271	99		M/D	12/29	12/28	12/27	12/27	12/27	12/24	12/23	12/23
12/23	12/23	3/12		3/10	3/10	2/19						
				.1MM	434	571	622	653	653	693	733	764
764	764	1072		1219	1315	1356	967					
1944	274	100		M/D	3/12	3/12	3/12	3/12	3/12	3/12	3/12	3/ 6
3/ 6	3/ 6	3/12		3/ 6	3/ 6	3/ 6						
				.1MM	156	217	217	217	255	329	329	349
349	349	465		597	679	765	350					
1945	273	100		M/D	3/15	3/15	3/14	3/13	3/12	3/12	3/12	3/12
3/12	3/12	3/ 2		2/26	2/21	2/21						
				.1MM	365	566	667	749	813	813	813	813
813	813	1148		1339	1504	1504	1062					
1946	271	99		M/D	3/ 6	3/ 6	3/ 6	3/ 6	3/ 4	3/ 3	3/ 2	3/ 2
3/ 2	3/ 2	3/ 2		3/ 2	2/13	2/13						
				.1MM	301	532	735	748	887	916	1028	1041
1041	1041	1113		1113	1157	1230	829					
1947	273	100		M/D	4/ 6	4/ 5	4/ 5	4/ 4	4/ 5	4/ 2	4/ 1	4/ 2
4/ 1	4/ 1	3/24		3/22	3/13	3/11						
				.1MM	354	674	808	855	998	1069	1141	1259
1331	1331	1502		1833	1867	2242	1594					
1948	274	100		M/D	3/19	3/19	3/19	3/19	3/19	3/16	3/15	3/15
3/15	3/15	3/ 9		3/ 7	2/27	2/24						
				.1MM	516	782	1016	1065	1065	1263	1485	1533
1533	1533	1542		1550	1559	1726	1036					
1949	273	100		M/D	2/24	2/14	2/13	2/12	2/12	2/12	2/12	2/ 9
2/ 9	2/ 6	2/12		2/ 6	12/28	12/28						
				.1MM	241	361	452	518	558	558	558	589
589	600	909		991	1152	1192	478					
1950	273	100		M/D	3/ 8	3/27	3/26	3/25	3/24	3/23	3/22	3/21
3/21	3/24	3/21		3/23	3/21	3/ 8						

			.1MM	320	445	520	663	817	882	966	986
986	1031	1302	1325	1429	1623	790					
1951	273	100	M/D	1/ 3	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2	1/ 2
1/ 2	1/ 2	1/ 2	12/23	12/23	12/23						
			.1MM	464	677	680	680	680	680	680	680
740	801	809	878	886	949	413					
1952	274	100	M/D	11/ 7	11/ 6	11/ 6	2/ 1	11/ 6	11/ 6	11/ 6	11/ 6
3/19	3/18	3/10	3/10	3/ 4	3/ 4						
			.1MM	404	582	627	661	811	907	907	907
918	943	1400	1575	1677	1689	923					
1953	273	100	M/D	12/ 5	1/14	1/15	1/14	1/13	1/10	1/10	1/10
1/10	1/10	1/10	1/10	12/24	1/10						
			.1MM	233	290	343	404	453	519	519	633
633	672	672	672	834	961	333					
1954	273	100	M/D	2/16	2/15	2/15	2/15	2/15	2/15	2/15	2/14
2/14	2/14	2/14	2/14	2/14	1/25						
			.1MM	271	536	647	788	888	1086	1268	1277
1277	1277	1328	1352	1393	1526	811					
1955	273	100	M/D	12/17	2/28	2/27	2/27	2/26	2/26	2/26	2/26
2/21	2/21	2/21	12/14	12/ 9	2/21						
			.1MM	284	387	503	574	589	602	602	607
677	748	766	934	991	1143	435					
1956	274	100	M/D	1/10	1/10	1/ 9	3/ 3	3/ 2	3/29	3/29	3/29
3/29	3/ 2	2/24	2/24	2/12	2/ 7						
			.1MM	182	341	369	381	426	490	490	490
490	506	623	694	767	938	477					
1957	273	100	M/D	1/22	1/21	1/20	1/20	1/20	1/20	1/20	1/20
1/20	1/20	2/25	2/25	2/25	2/25						
			.1MM	517	687	720	720	720	720	720	720
720	720	800	1047	1105	1105	535					
1958	273	100	M/D	3/23	3/22	3/21	3/20	3/19	3/18	3/18	3/18
3/17	3/14	3/14	3/ 4	2/27	2/24						
			.1MM	140	281	402	502	585	667	718	768
809	840	941	1072	1376	1656	1050					
1959	273	100	M/D	4/ 1	4/ 1	3/31	3/31	4/ 1	3/31	3/31	3/30
3/30	3/30	3/25	3/19	3/15	3/15						
			.1MM	345	638	821	996	1187	1370	1450	1512
1512	1556	1699	2021	2172	2172	1678					
1960	274	100	M/D	4/ 3	4/ 3	4/ 2	4/ 1	3/30	3/30	3/30	3/28
3/28	3/28	3/28	3/28	3/28	3/28						
			.1MM	410	595	715	827	1075	1260	1362	1534
1637	1637	1757	1757	1757	1757	1553					
1961	273	100	M/D	2/25	2/24	2/23	2/22	2/23	2/22	2/22	2/18
2/18	2/18	2/14	2/13	2/13	2/23						
			.1MM	331	474	767	836	930	999	1019	1072
1121	1235	1347	1396	1396	1570	835					
1962	273	100	M/D	11/23	3/25	3/26	3/25	3/25	3/24	3/24	3/22
3/21	3/20	3/15	3/12	3/12	2/28						
			.1MM	279	405	608	791	944	1025	1025	1127
1218	1268	1431	1620	1620	1714	1511					

1963	273	100	M/D	3/26	3/25	3/25	3/24	3/24	3/24	3/23	3/23
3/21	3/20	3/17	3/12	3/ 6	3/ 6						
			.1MM	376	704	920	1063	1195	1290	1321	1321
1330	1385	1643	1680	1909	1909	1335					
1964	274	100	M/D	1/ 9	1/ 9	1/ 9	1/20	1/20	1/20	1/18	1/18
3/ 1	3/ 1	1/ 9	1/ 6	1/ 3	1/ 3						
			.1MM	316	316	316	405	448	448	457	457
478	478	731	782	904	987	594					
1965	273	100	M/D	2/ 7	4/ 6	2/10	2/ 7	2/ 7	2/ 7	2/ 7	2/ 7
2/ 7	2/ 7	2/ 7	1/24	2/10	2/ 7						
			.1MM	327	448	539	625	656	892	892	892
892	892	895	1037	1147	1658	923					
1966	273	100	M/D	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28
2/28	2/28	2/28	2/28	2/28	2/28						
			.1MM	355	515	586	617	721	845	845	845
845	845	1118	1407	1407	1407	786					
1967	273	100	M/D	12/ 6	3/27	3/26	3/26	3/25	3/24	3/24	3/22
3/22	3/22	3/22	3/11	3/11	3/11						
			.1MM	216	368	520	657	697	737	737	758
758	758	758	968	968	968	761					
1968	274	100	M/D	2/ 2	2/ 1	3/16	3/16	3/15	3/15	3/15	3/15
3/15	3/10	3/ 9	3/ 9	3/ 9	3/ 9						
			.1MM	279	459	552	706	719	719	719	719
719	861	1004	1063	1063	1063	733					
1969	273	100	M/D	1/24	1/23	1/29	1/29	1/28	1/29	1/24	1/23
1/23	1/23	1/18	1/18	1/18	1/18						
			.1MM	366	419	434	454	459	510	766	818
858	878	996	1052	1052	1052	502					
1970	273	100	M/D	12/11	12/10	12/10	12/ 8	12/ 8	3/21	3/20	3/19
3/19	3/19	3/20	3/19	3/19	3/19						
			.1MM	223	434	474	544	584	655	744	793
824	824	1021	1434	1443	1443	1009					
1971	273	100	M/D	4/13	4/12	4/11	4/10	4/ 9	4/12	4/11	4/ 9
4/ 9	4/ 9	4/ 3	3/29	3/29	3/29						
			.1MM	370	593	715	847	1078	1145	1267	1495
1630	1630	1782	2066	2066	2066	1844					
1972	274	100	M/D	12/15	4/13	4/13	4/11	4/11	4/11	4/10	4/10
4/10	4/10	4/ 2	3/30	3/22	3/18						
			.1MM	364	516	682	883	1048	1175	1227	1227
1227	1227	1369	1543	1706	1862	1306					
1973	273	100	M/D	2/ 2	2/ 1	1/17	1/16	1/15	1/17	1/16	1/16
1/15	1/14	1/14	1/14	12/30	12/24						
			.1MM	349	364	456	538	558	575	657	683
703	713	713	1077	1190	1251	605					
1974	273	100	M/D	2/22	3/30	3/30	3/30	3/30	3/30	3/30	1/21
1/20	1/20	1/18	1/18	1/18	12/25						
			.1MM	270	444	555	739	739	739	739	765
816	816	829	829	829	858	348					
1975	273	100	M/D	3/19	3/18	3/17	2/22	2/22	2/20	2/18	2/17
2/17	2/17	2/17	2/17	2/23	2/18						

			.1MM	428	531	582	592	601	603	628	684
735	744	744	794	1223	1380	352					
1976	274	100	M/D	12/14	3/19	3/19	3/19	3/19	3/19	3/19	3/19
3/19	2/25	2/15	2/15	2/10	2/24						
			.1MM	302	456	578	578	638	787	787	787
787	817	1057	1407	1541	1768	913					
1977	273	100	M/D	3/13	3/12	3/11	3/10	3/10	3/ 9	3/ 9	3/ 9
3/ 6	3/ 4	3/ 4	2/23	3/ 4	2/27						
			.1MM	460	765	985	1228	1413	1590	1590	1590
1628	1884	2069	2325	2456	2573	1756					
1978	273	100	M/D	1/26	4/11	4/11	4/11	4/11	4/11	4/10	4/ 7
4/ 5	4/ 4	3/31	3/28	3/21	3/20						
			.1MM	450	494	763	855	961	1078	1118	1140
1272	1409	1893	2182	2435	2679	2149					
1979	273	100	M/D	3/ 4	12/31	3/ 3	3/ 3	3/ 3	3/ 3	3/ 3	3/ 2
3/ 1	3/ 1	2/23	2/23	2/21	2/21						
			.1MM	299	517	550	618	678	775	874	918
980	996	1174	1360	1451	1526	883					
1980	274	100	M/D	3/21	3/20	3/20	3/20	3/20	3/17	3/17	3/17
3/16	3/16	3/10	3/10	3/10	2/24						
			.1MM	792	1019	1171	1187	1246	1378	1395	1454
1456	1456	1602	1602	1602	1604	686					
1981	273	100	M/D	2/20	2/19	2/18	2/17	2/16	2/16	2/16	2/16
2/16	2/16	2/10	2/ 2	2/ 1	1/26						
			.1MM	524	953	1104	1287	1458	1589	1589	1589
1589	1589	1727	1763	1807	1976	1046					
1982	273	100	M/D	3/31	3/30	3/29	3/29	3/29	3/26	3/25	3/24
3/24	3/22	3/17	3/12	3/11	3/ 4						
			.1MM	351	495	532	532	532	534	733	799
799	867	1291	1646	1803	1833	1194					
1983	273	100	M/D	12/24	12/24	12/23	12/23	12/23	12/23	12/23	12/23
12/23	12/23	12/14	12/14	12/14	11/28						
			.1MM	198	276	285	285	285	285	285	285
285	285	449	449	459	574	161					
1984	274	100	M/D	12/12	2/13	2/13	2/13	2/11	2/11	2/11	2/11
2/11	2/11	2/ 3	2/ 3	1/24	11/15						
			.1MM	510	619	739	871	962	1093	1162	1162
1162	1162	1385	1385	1430	1534	871					
1985	273	100	M/D	2/23	2/23	2/22	2/22	2/22	2/22	2/22	2/22
2/22	2/22	2/22	2/22	2/22	2/22						
			.1MM	463	688	911	938	943	943	943	1126
1130	1130	1319	1930	2049	2134	1103					
1986	273	100	M/D	3/26	3/25	1/18	3/23	3/23	3/23	3/23	3/19
3/19	3/18	3/13	3/10	3/10	3/10						
			.1MM	417	636	733	761	851	851	851	1065
1156	1233	1620	1824	1824	1824	1289					
1987	273	100	M/D	4/ 4	3/ 7	4/ 2	4/ 2	4/ 2	4/ 2	3/ 1	3/ 1
2/28	2/28	2/28	2/28	2/28	3/ 7						
			.1MM	375	451	510	510	510	510	592	809
850	850	850	958	958	1069	606					

1988	274	100	M/D	11/29	3/24	3/23	3/23	3/23	3/23	3/23	3/23
3/23	3/16	3/12	3/ 6	3/ 6	3/ 6						
			.1MM	453	462	674	674	674	674	674	674
674	701	703	1029	1029	1029	660					
1989	273	100	M/D	12/20	3/26	3/25	3/24	3/24	3/24	3/24	3/24
3/24	3/18	3/14	3/14	3/ 4	3/14						
			.1MM	210	251	370	392	392	392	392	392
392	394	618	618	646	653	371					
1990	273	100	M/D	2/22	1/17	1/17	1/17	1/17	1/17	1/17	1/17
1/17	1/17	1/ 4	12/31	12/31	12/31						
			.1MM	315	388	388	388	390	390	392	523
654	665	701	900	1035	1177	436					
1991	273	100	M/D	12/29	2/ 3	2/ 3	2/ 3	2/ 3	2/ 3	2/ 3	2/ 3
2/ 3	2/ 3	12/17	2/ 3	1/14	2/ 3						
			.1MM	258	354	377	377	377	377	377	377
377	377	470	605	606	767	377					
1992	274	100	M/D	3/26	3/26	3/25	3/26	3/26	3/25	3/25	3/25
3/26	3/25	3/25	2/18	3/ 6	3/ 5						
			.1MM	256	444	458	519	606	620	620	620
620	634	634	703	1111	1181	426					
1993	273	100	M/D	1/ 4	1/ 4	1/ 3	1/ 3	3/25	3/24	3/23	12/29
12/29	12/29	3/16	3/16	3/16	12/29						
			.1MM	508	710	764	764	817	912	916	985
985	985	1158	1258	1338	1448	923					
1994	273	100	M/D	2/20	3/22	3/22	3/21	3/21	3/21	3/21	3/21
3/21	3/21	3/21	3/14	3/15	3/13						
			.1MM	219	347	532	688	694	694	757	808
850	876	1178	1307	1411	1503	957					
1995	273	100	M/D	3/ 7	3/ 6	3/ 6	3/ 5	3/ 5	3/ 5	3/ 7	3/ 6
3/ 5	3/ 5	2/27	2/27	11/25	11/25						
			.1MM	300	385	411	419	419	419	521	606
614	614	633	633	721	790	454					
1996	274	100	M/D	2/20	1/18	1/17	1/16	1/16	1/16	1/17	1/17
1/16	1/16	1/16	1/16	1/16	1/16						
			.1MM	408	611	861	925	925	925	936	1020
1084	1084	1287	1287	1593	1599	623					
1997	273	100	M/D	2/21	3/28	3/27	3/25	3/25	3/25	3/25	3/25
3/25	3/25	3/21	3/14	3/ 9	3/ 1						
			.1MM	321	479	730	832	1094	1166	1166	1282
1282	1282	1286	1310	1416	1557	974					
1998	273	100	M/D	3/26	2/25	2/24	2/24	2/24	2/21	2/20	2/19
2/17	2/17	2/12	2/11	2/11	2/18						
			.1MM	271	334	367	367	367	389	459	541
618	722	794	835	835	883	445					
1999	273	100	M/D	1/23	1/23	1/22	1/22	1/22	1/18	1/18	1/18
1/18	1/18	1/18	1/18	1/18	1/18						
			.1MM	323	461	595	595	595	720	857	857
857	857	875	1095	1283	1466	1071					
2000	274	100	M/D	2/24	2/24	2/23	2/23	2/23	2/23	2/23	2/23
2/23	2/23	2/23	2/ 9	2/23	2/23						

			.1MM	226	429	629	647	647	647	647	647
647	647	647	666	774	774	463					
2001	273	100	M/D	11/26	11/25	4/ 5	4/ 4	4/ 3	4/ 3	4/ 2	4/ 1
3/31	3/30	3/30	3/21	3/15	3/12						
			.1MM	514	534	626	818	933	1000	1051	1093
1140	1153	1153	1561	1678	1860	1585					
2002	273	100	M/D	2/20	3/ 8	3/ 8	3/ 8	1/ 6	2/15	3/ 3	3/ 2
3/ 2	3/ 2	3/ 2	2/19	2/15	2/10						
			.1MM	204	310	310	310	346	412	490	558
558	558	572	768	970	1018	318					
2003	242	89 **	M/D	3/20	3/20	3/20	3/19	3/17	3/17	3/16	3/16
3/16	3/16	3/ 8	3/17	3/17	3/16						
			.1MM	281	494	636	645	786	929	940	940
940	940	980	1027	1118	1344						
2004	274	100	M/D	3/ 5	3/ 4	3/ 3	3/ 2	3/ 1	2/29	2/29	2/29
2/29	2/29	2/29	2/19	2/29	2/29						
			.1MM	370	489	624	835	920	1033	1033	1033
1033	1033	1112	1144	1284	1305	896					
2005	273	100	M/D	12/31	2/14	2/14	2/14	2/14	2/14	2/14	2/ 8
2/ 7	2/ 7	2/ 7	12/12	12/ 7	12/ 4						
			.1MM	370	434	454	454	454	454	454	581
640	660	662	774	1064	1084	459					
2006	273	100	M/D	3/ 9	1/17	12/23	12/23	12/23	12/23	12/23	1/11
1/11	1/11	1/ 4	12/23	12/25	12/23						
			.1MM	239	404	429	449	449	504	510	678
678	678	811	836	1033	1321	447					
2007	273	100	M/D	3/14	3/13	3/12	3/11	3/10	3/10	3/10	3/10
3/10	3/13	3/10	3/ 3	3/ 2	2/22						
			.1MM	344	580	664	743	755	755	755	755
755	819	993	1006	1158	1170	873					
2008	274	100	M/D	12/23	4/ 6	4/ 5	4/ 4	4/ 4	4/ 3	4/ 1	3/31
3/31	3/31	3/26	3/19	3/15	3/14						
			.1MM	402	508	667	873	1021	1094	1159	1433
1582	1582	1677	1760	2037	2043	1482					
2009	272	100	M/D	2/11	12/27	3/ 6	3/ 6	3/ 6	3/ 6	3/ 5	3/ 5
3/ 5	3/ 6	2/25	2/25	2/11	2/10						
			.1MM	431	663	728	750	808	938	944	944
944	991	1225	1298	1443	1834	928					
2010	243	89 **	M/D	1/25	1/24	1/24	1/24	1/24	1/24	1/24	1/18
1/17	1/17	1/14	1/14	1/ 1	12/27						
			.1MM	490	825	825	825	825	825	825	852
869	869	998	998	1002	1045						
2011	270	99	M/D	3/ 5	3/10	3/10	3/10	3/10	3/ 5	3/ 5	3/ 5
3/10	3/10	3/ 4	2/28	2/28	2/17						
			.1MM	501	613	680	745	745	927	1114	1182
1329	1329	1836	2012	2012	2204	932					
2012	274	100	M/D	1/23	1/16	3/ 1	2/29	2/27	2/27	1/17	1/16
1/16	1/16	1/17	1/13	1/13	1/ 6						
			.1MM	188	206	240	260	272	322	369	394
394	394	512	601	601	623	111					

2013	242	89	**	M/D	1/13	1/12	1/11	1/10	1/ 9	1/ 9	1/ 9	1/ 6
1/ 6	1/ 6	1/ 6		1/11	1/ 6	1/ 6						
				.1MM	436	698	748	770	772	772	772	790
790	790	798		1004	1046	1046						
2014	273	100		M/D	4/ 7	4/ 7	4/ 6	4/ 4	4/ 4	4/ 3	4/ 2	4/ 1
3/31	3/30	3/27		3/20	3/15	3/10						
				.1MM	375	545	607	827	998	1025	1111	1175
1294	1391	1618		1705	1833	2048	1044					
2015	273	100		M/D	4/ 3	4/ 2	4/ 2	4/ 1	3/30	3/30	3/30	3/30
3/26	3/25	3/21		3/16	3/10	3/ 9						
				.1MM	300	585	608	625	787	810	810	810
912	984	1061		1098	1378	1439	1092					
2016	118	43	**	M/D	1/ 9	1/ 8	1/ 8	1/ 8	1/ 8	1/ 8	1/ 9	1/ 9
1/ 8	12/31	12/29		1/ 8	1/ 8	12/29						
				.1MM	199	211	211	211	211	211	213	233
245	263	285		419	419	492						

				1 DAY	2 DAY	3 DAY	4 DAY	5 DAY	6 DAY	7 DAY	8 DAY
9 DAY	10 DAY	15 DAY	20 DAY	25 DAY	30 DAY						
	MEAN	EXTREME	(MM)	34.7	50.2	60.5	67.6	74.0	80.2	84.5	89.7
92.8	95.6	110.2	123.9	134.1	144.4						
	STD. DEV.	(MM)	11.1	15.6	19.5	22.6	27.0	30.6	31.8	33.0	
34.4	35.5	40.1	44.1	44.6	47.1						
	YEARS ANALYSED		71	71	71	71	71	71	71	71	71
71	71	71	71	71	71						
	MAX EXTREME	(MM)	83.8	106.4	121.3	143.5	158.2	159.0	165.5	165.5	
177.4	191.8	210.3	233.8	254.3	283.1						
	YEAR		1980	1981	1981	1981	1981	1977	1977	1977	
1959	1977	1977	1978	1978	1978						

** NOTE ** VALUE IN FLAG INDICATES YEAR NOT INCLUDED IN ANALYSIS BASED ON % DAYS OPERATIONAL (<90.0%)

METEOROLOGICAL SERVICE OF CANADA
RAIN+SNOWMELT DEPTH, DURATION, FREQUENCY VALUES
PREPARED BY THE ENGINEERING CLIMATE SERVICES

UNIT

STATION : TRENTON A

STATION NUMBER 6158875

LATITUDE: 44.12N LONGITUDE: 77.53W ELEVATION (M): 86

ARCHIVE: DLY04 (01/01/1935 - 31/12/2013) DLY02 (01/01/2014 - 26/01/2016)

SNOWMELT MODEL 5 - Modification of Model 4

CRITICAL PERIOD : 1ST OF MONTH 10 (PRECEDING YEAR) TO THE END OF MONTH 6
NOTE : MODIFIED GUMBEL 12/82

RETURN PERIOD VALUES (MM) WITH 50%

CONFIDENCE LIMITS

RETURN PERIOD

YEARS		1 DAY	2 DAY	3 DAY	4
DAY	5 DAY				
2		32.91+/- 0.81	47.67+/- 1.15	57.29+/- 1.44	
63.86+/- 1.66	69.60+/- 1.98				
5		42.71+/- 1.37	61.47+/- 1.93	74.56+/- 2.42	
83.88+/- 2.80	93.43+/- 3.33				
10		49.19+/- 1.85	70.61+/- 2.61	86.00+/- 3.26	
97.13+/- 3.78	109.21+/- 4.50				
25		57.38+/- 2.50	82.16+/- 3.52	100.45+/- 4.40	
113.87+/- 5.10	129.14+/- 6.07				
50		63.46+/- 2.99	90.72+/- 4.21	111.17+/- 5.27	
126.29+/- 6.10	143.93+/- 7.27				
100		69.50+/- 3.48	99.23+/- 4.90	121.81+/- 6.14	
138.61+/- 7.11	158.61+/- 8.46				

RETURN PERIOD

YEARS		6 DAY	7 DAY	8 DAY	9
DAY	10 DAY				
2		75.20+/- 2.24	79.30+/- 2.33	84.24+/- 2.42	
87.14+/- 2.52	89.80+/- 2.61				
5		102.20+/- 3.78	107.36+/- 3.93	113.38+/- 4.08	
117.52+/- 4.25	121.17+/- 4.39				
10		120.08+/- 5.10	125.94+/- 5.30	132.67+/- 5.51	
137.63+/- 5.74	141.95+/- 5.93				
25		142.68+/- 6.88	149.41+/- 7.15	157.05+/- 7.43	
163.04+/- 7.74	168.19+/- 8.00				
50		159.44+/- 8.23	166.83+/- 8.56	175.13+/- 8.88	
181.89+/- 9.26	187.67+/- 9.57				
100		176.08+/- 9.59	184.11+/- 9.97	193.09+/-10.35	
200.60+/-10.79	207.00+/-11.14				

RETURN PERIOD

YEARS		15 DAY	20 DAY	25 DAY	30
DAY					
2		103.64+/- 2.95	116.62+/- 3.24	126.80+/- 3.28	
136.63+/- 3.45					

5	139.11+/- 4.96	155.60+/- 5.45	166.25+/- 5.52
178.21+/- 5.82			
10	162.60+/- 6.70	181.40+/- 7.37	192.36+/- 7.45
205.74+/- 7.86			
25	192.27+/- 9.04	214.01+/- 9.93	225.36+/-10.05
240.52+/-10.60			
50	214.28+/-10.82	238.20+/-11.88	249.84+/-12.03
266.33+/-12.68			
100	236.14+/-12.60	262.21+/-13.84	274.13+/-14.01
291.94+/-14.77			

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 1 DAYS ACCUMULATION

** WARNING ** : 100 YEAR VALUES IN 1980 BASED ON 2 DAYS ACCUMULATION



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Appendix F:
Federal Climate Data Portal: ΔT Adjustment

time	rcp26_tg_mean_p10	rcp26_tg_mean_p50	rcp26_tg_mean_p90	rcp45_tg_mean_p10	rcp45_tg_mean_p50	rcp45_tg_mean_p90	rcp85_tg_mean_p10	rcp85_tg_mean_p50	rcp85_tg_mean_p90	rcp26_tg_mean_delta7100_p10	rcp26_tg_mean_delta7100_p50	rcp26_tg_mean_delta7100_p90	rcp45_tg_mean_delta7100_p10	rcp45_tg_mean_delta7100_p50	rcp45_tg_mean_delta7100_p90	rcp85_tg_mean_delta7100_p10	rcp85_tg_mean_delta7100_p50	rcp85_tg_mean_delta7100_p90
1/1/1951	6.9	7	7.2	6.9	7	7.2	6.9	7	7.2	-0.6	-0.3	-0.1	-0.6	-0.3	-0.1	-0.6	-0.3	-0.1
1/1/1961	7	7.1	7.2	7	7.1	7.2	7	7.1	7.2	-0.5	-0.3	-0.1	-0.5	-0.3	-0.1	-0.5	-0.3	-0.1
1/1/1971	7.2	7.3	7.5	7.2	7.3	7.5	7.2	7.3	7.5	0	0	0	0	0	0	0	0	0
1/1/1981	7.5	7.7	7.9	7.5	7.7	7.9	7.5	7.7	7.9	0.2	0.3	0.4	0.2	0.4	0.5	0.2	0.3	0.5
1/1/1991	7.9	8	8.4	7.8	8.1	8.4	7.9	8.2	8.4	0.5	0.7	1	0.5	0.8	1	0.6	0.8	1
1/1/2001	8.2	8.4	9	8.2	8.6	9	8.2	8.7	9	0.8	1.2	1.6	0.7	1.2	1.6	0.9	1.3	1.6
1/1/2011	8.3	8.8	9.5	8.4	9	9.7	8.5	9.2	9.8	1	1.4	2.1	1.1	1.7	2.3	1.3	1.8	2.4
1/1/2021	8.5	9.2	10	8.8	9.3	10.2	8.9	9.6	10.3	1.2	1.8	2.6	1.4	2	2.9	1.7	2.2	3
1/1/2031	8.5	9.4	10.3	9.1	9.7	10.8	9.4	10.2	11.3	1.3	2	2.9	1.7	2.4	3.4	2.2	2.8	3.9
1/1/2041	8.6	9.4	10.6	9.2	10.1	11.3	10.1	10.9	12.2	1.3	2.1	3.3	1.8	2.8	4	2.8	3.5	4.8
1/1/2051	8.6	9.4	10.8	9.3	10.3	11.8	10.8	11.6	13.3	1.2	2.1	3.4	1.9	2.9	4.5	3.4	4.2	6
1/1/2061	8.6	9.4	10.8	9.4	10.4	12.2	11.4	12.4	14.2	1.2	2.1	3.4	2	3.2	4.8	4.1	5	6.8
1/1/2071	8.6	9.4	10.7	9.5	10.6	12.1	11.8	13.1	15.1	1.2	2.1	3.3	2.2	3.3	4.7	4.6	5.7	7.7



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Appendix G:
Gumbel Distribution Precipitation Frequency Curve

Calculate Precipitation Frequency Curve using Gumbel

Year	Depth (mm)	Rank	q_i	p_i	T_p est	$(x-u)/a$	p theor	T_p theor
1988	28	48	0.9884	0.0116	1.0	-1.2771	0.0277	1.0
1976	30.2	47	0.9676	0.0324	1.0	-1.1158	0.0473	1.0
1991	32.8	46	0.9468	0.0532	1.1	-0.9251	0.0803	1.1
1975	34.3	45	0.9260	0.0740	1.1	-0.8151	0.1044	1.1
1989	34.7	44	0.9052	0.0948	1.1	-0.7857	0.1115	1.1
1994	34.8	43	0.8845	0.1155	1.1	-0.7784	0.1133	1.1
1971	35.1	42	0.8637	0.1363	1.2	-0.7564	0.1188	1.1
1978	36.6	41	0.8429	0.1571	1.2	-0.6464	0.1483	1.2
1982	39	40	0.8221	0.1779	1.2	-0.4704	0.2018	1.3
1985	39.7	39	0.8013	0.1987	1.2	-0.4190	0.2186	1.3
2001	40.4	38	0.7805	0.2195	1.3	-0.3677	0.2359	1.3
1968	40.9	37	0.7598	0.2402	1.3	-0.3310	0.2485	1.3
1984	42.2	36	0.7390	0.2610	1.4	-0.2357	0.2820	1.4
1987	42.4	35	0.7182	0.2818	1.4	-0.2210	0.2873	1.4
1992	42.8	32	0.6559	0.3441	1.5	-0.1917	0.2978	1.4
1992	42.8	32	0.6559	0.3441	1.5	-0.1917	0.2978	1.4
1992	42.8	32	0.6559	0.3441	1.5	-0.1917	0.2978	1.4
1965	43.9	31	0.6351	0.3649	1.6	-0.1110	0.3271	1.5
1966	45.7	30	0.6143	0.3857	1.6	0.0210	0.3756	1.6
2016	46.2	29	0.5935	0.4065	1.7	0.0577	0.3891	1.6
1972	47.2	28	0.5727	0.4273	1.7	0.1310	0.4160	1.7
2008	47.6	27	0.5520	0.4480	1.8	0.1604	0.4266	1.7
1970	48	26	0.5312	0.4688	1.9	0.1897	0.4373	1.8
1981	48.2	25	0.5104	0.4896	2.0	0.2044	0.4426	1.8
1990	50	24	0.4896	0.5104	2.0	0.3364	0.4895	2.0
2003	50.2	23	0.4688	0.5312	2.1	0.3511	0.4946	2.0
1973	53.6	22	0.4480	0.5520	2.2	0.6004	0.5778	2.4
1997	53.9	21	0.4273	0.5727	2.3	0.6224	0.5847	2.4
2005	54.1	20	0.4065	0.5935	2.5	0.6371	0.5893	2.4
1969	54.9	19	0.3857	0.6143	2.6	0.6958	0.6073	2.5
1979	55.8	18	0.3649	0.6351	2.7	0.7618	0.6270	2.7
1993	56	17	0.3441	0.6559	2.9	0.7764	0.6313	2.7
2010	59.1	16	0.3234	0.6766	3.1	1.0038	0.6932	3.3
1980	60	15	0.3026	0.6974	3.3	1.0698	0.7096	3.4
2007	62.1	14	0.2818	0.7182	3.5	1.2238	0.7452	3.9
1983	63.3	13	0.2610	0.7390	3.8	1.3118	0.7639	4.2
1995	64.9	12	0.2402	0.7598	4.2	1.4292	0.7870	4.7

1986	65.6	11	0.2195	0.7805	4.6	1.4805	0.7965	4.9
2017	66.3	10	0.1987	0.8013	5.0	1.5319	0.8056	5.1
1967	69.6	9	0.1779	0.8221	5.6	1.7739	0.8439	6.4
2006	69.9	8	0.1571	0.8429	6.4	1.7959	0.8471	6.5
2000	71.6	7	0.1363	0.8637	7.3	1.9206	0.8637	7.3
1977	72.1	6	0.1155	0.8845	8.7	1.9572	0.8683	7.6
2009	75.8	5	0.0948	0.9052	10.6	2.2286	0.8979	9.8
2002	78.8	4	0.0740	0.9260	13.5	2.4486	0.9172	12.1
2014	79.4	3	0.0532	0.9468	18.8	2.4926	0.9206	12.6
2012	80.6	2	0.0324	0.9676	30.8	2.5806	0.9271	13.7
2004	123.7	1	0.0116	0.9884	85.9	5.7416	0.9968	312.1

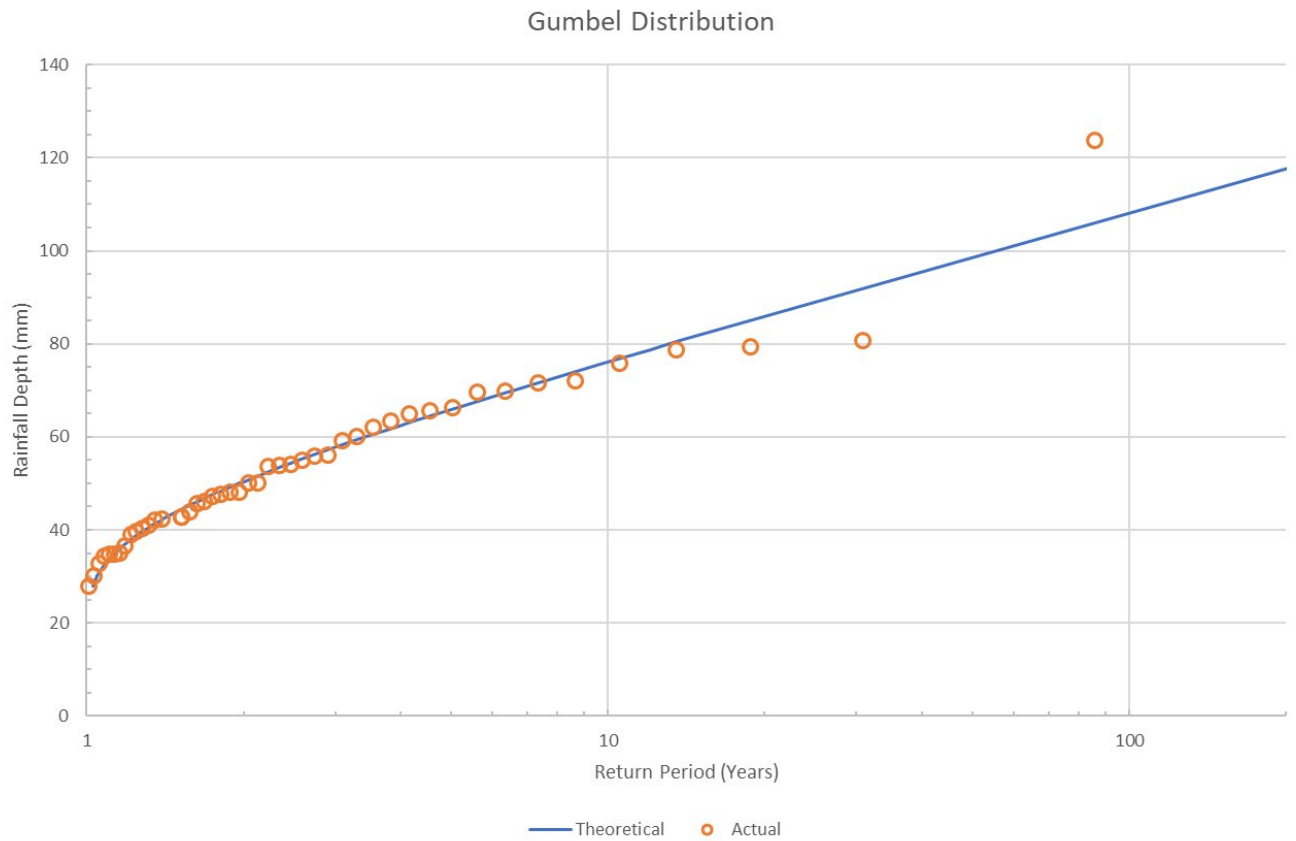
$$Z\ Score = \frac{x - \mu}{\sigma}$$

Return Period (Yr)	Depth (mm)
0.98	50
	98.62

3.9019

Number of Obs (n) = 48

Min	28
Max	123.7
Average	53.2833
Std Dev	17.4875
Alpha	13.6350
mu	45.4132



Note: Theoretical values represent 24-hr duration for comparison purposes.



Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update

Appendix H:
Regional Frequency Analysis Output - CFA

02HM009 – WEST BRANCH LITTLE CATARAQUI CREEK

Snow

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Cataraqui Creek

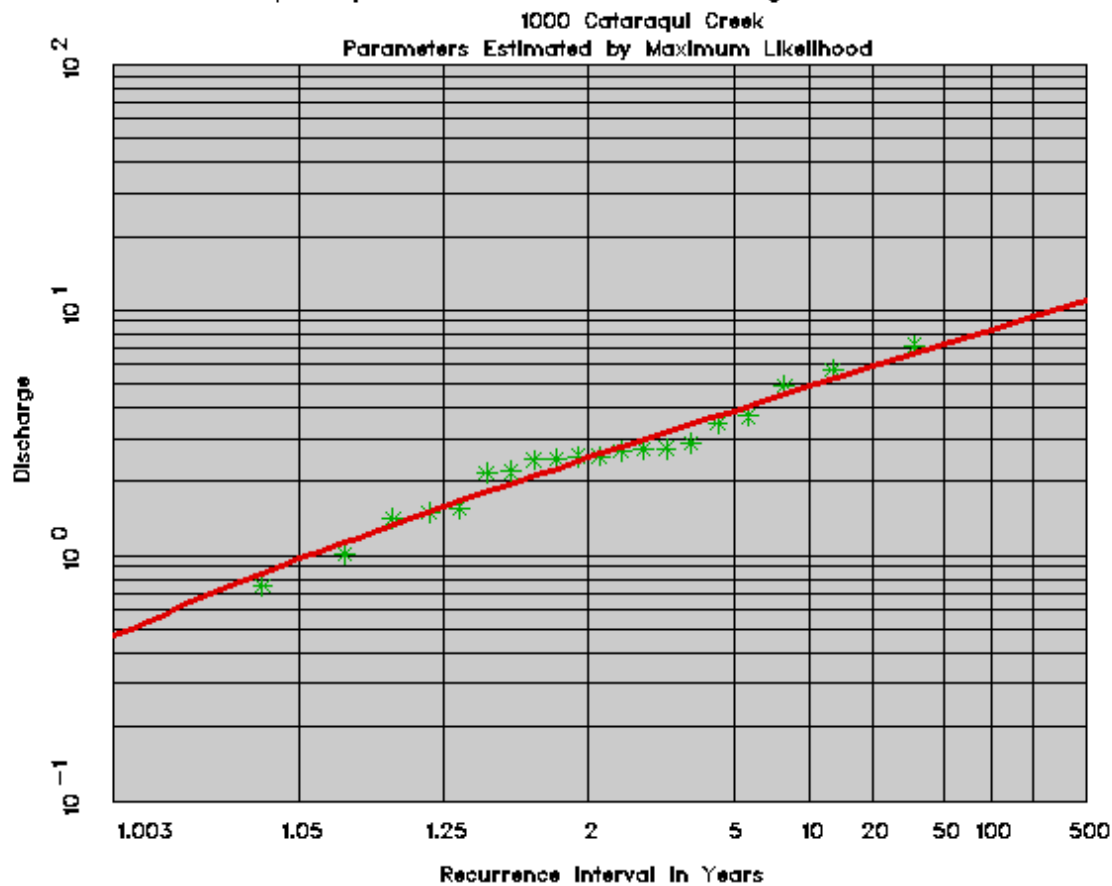
	SAMPLE STATISTICS				
	MEAN	S.D.	C.U	C.S.	C.K.
X SERIES	2.827	1.575	.557	1.411	5.765
LN X SERIES	.902	.546	.605	-.186	4.000
LN(X-A) SERIES	1.012	.487	.481	-.008	3.909
X(MIN)=	.751			TOTAL SAMPLE SIZE=	20
X(MAX)=	7.190			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	.671			NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= -.253 M= 1.012 S= .487

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.470
1.050	.952	.970
1.250	.800	1.57
2.000	.500	2.50
5.000	.200	3.89
10.000	.100	4.89
20.000	.050	5.88
50.000	.020	7.24
100.000	.010	8.30
200.000	.005	9.41
500.000	.002	10.9

Flood Frequency – Three Parameter Lognormal Distribution



Rainfall

FREQUENCY ANALYSIS – THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Cataragui Creek West Branch

SAMPLE STATISTICS

	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	3.350	2.350	.701	1.052	4.230
LN X SERIES	.908	.904	.996	-1.127	5.031
X(MIN)=	.160				
X(MAX)=	9.460				
LOWER OUTLIER LIMIT OF X=	.241				
				TOTAL SAMPLE SIZE=	31
				NO. OF LOW OUTLIERS=	1
				NO. OF ZERO FLOWS=	0

AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS

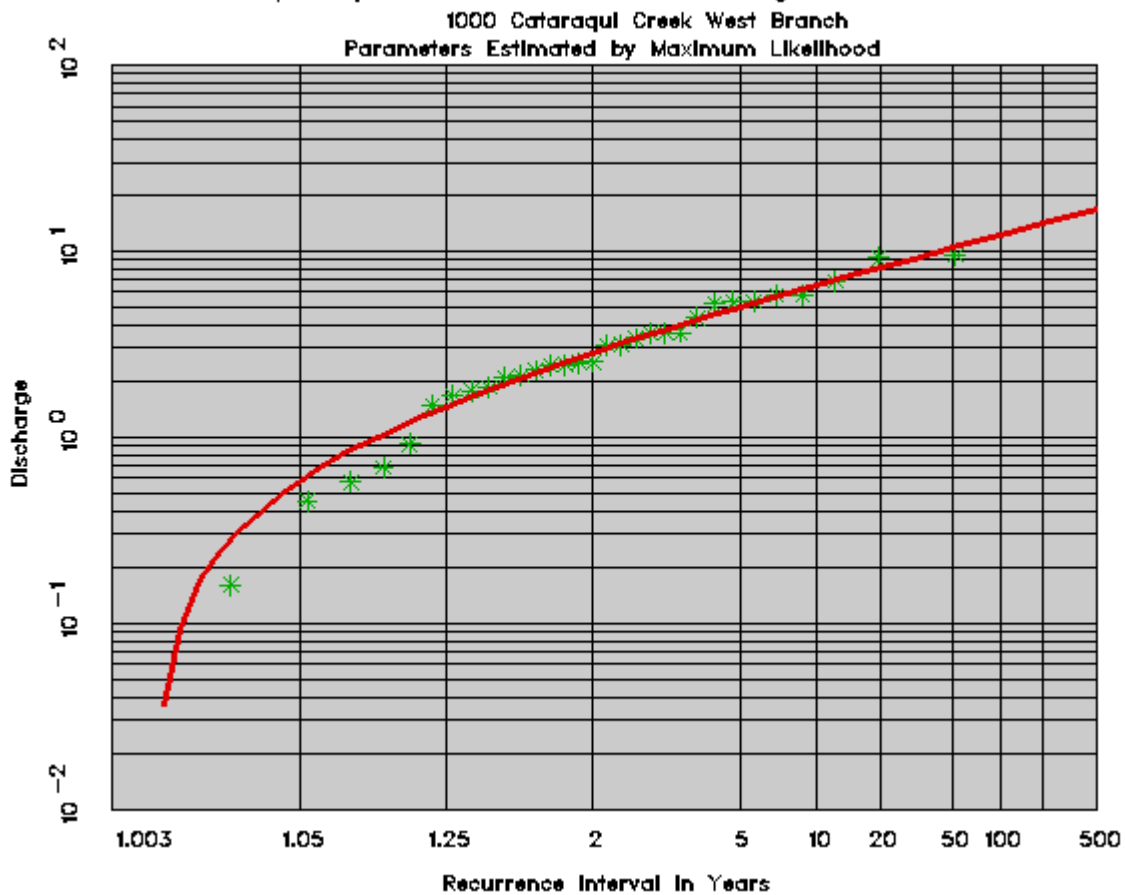
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	3.456	2.313	.669	1.093	4.295
LN X SERIES	.999	.760	.761	-.624	3.560
LN(X-A) SERIES	1.370	.513	.375	-.053	2.970

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
 PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
 $A = -1.002$ $M = 1.344$ $S = .529$

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	-
1.050	.952	.580
1.250	.800	1.45
2.000	.500	2.83
5.000	.200	4.98
10.000	.100	6.55
20.000	.050	8.16
50.000	.020	10.4
100.000	.010	12.1
200.000	.005	14.0
500.000	.002	16.6

Flood Frequency – Three Parameter Lognormal Distribution



Combined Flow

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Cataraqui Creek West Branch

SAMPLE STATISTICS					
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	3.805	2.253	.592	.895	3.789
LN X SERIES	1.142	.686	.600	-.818	4.352

X(MIN)=	.454	TOTAL SAMPLE SIZE=	32
X(MAX)=	9.460	NO. OF LOW OUTLIERS=	1
LOWER OUTLIER LIMIT OF X=	.530	NO. OF ZERO FLOWS=	0

AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS					
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	3.913	2.204	.563	.958	3.851
LN X SERIES	1.205	.598	.496	-.412	3.510
LN(X-A) SERIES	1.475	.452	.306	-.025	2.997

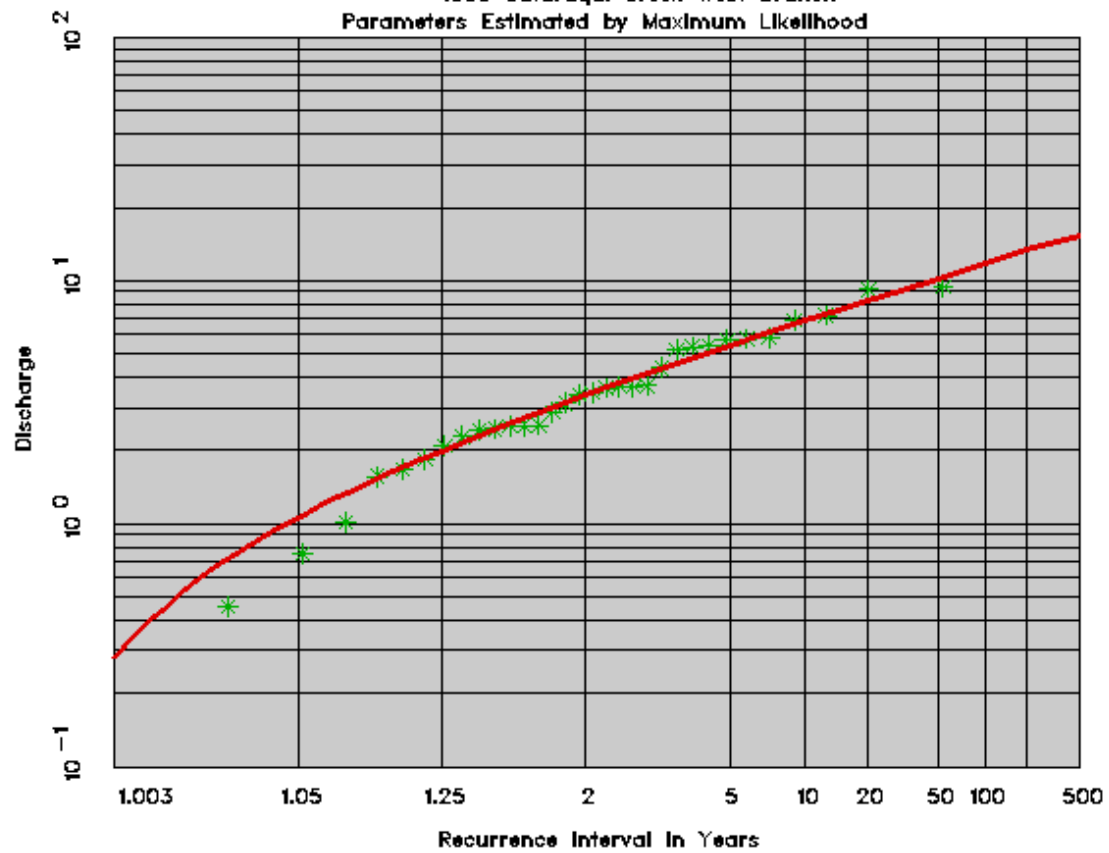
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
A= -.905 M= 1.453 S= .465

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.280
1.050	.952	1.06
1.250	.800	1.99
2.000	.500	3.37
5.000	.200	5.42
10.000	.100	6.85
20.000	.050	8.28
50.000	.020	10.2
100.000	.010	11.7
200.000	.005	13.3
500.000	.002	15.4

Flood Frequency – Three Parameter Lognormal Distribution

1000 Cataragui Creek West Branch
Parameters Estimated by Maximum Likelihood



02HB021 – ANCASTER CREEK

Snow

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Ancaster Creek

	SAMPLE STATISTICS				
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	1.539	.839	.545	1.520	9.451
ZERO FLOW IN SERIES - LN X SERIES CANNOT BE COMPUTED					

X(MIN)=	.000	TOTAL SAMPLE SIZE=	26
X(MAX)=	4.540	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	.356	NO. OF ZERO FLOWS=	1

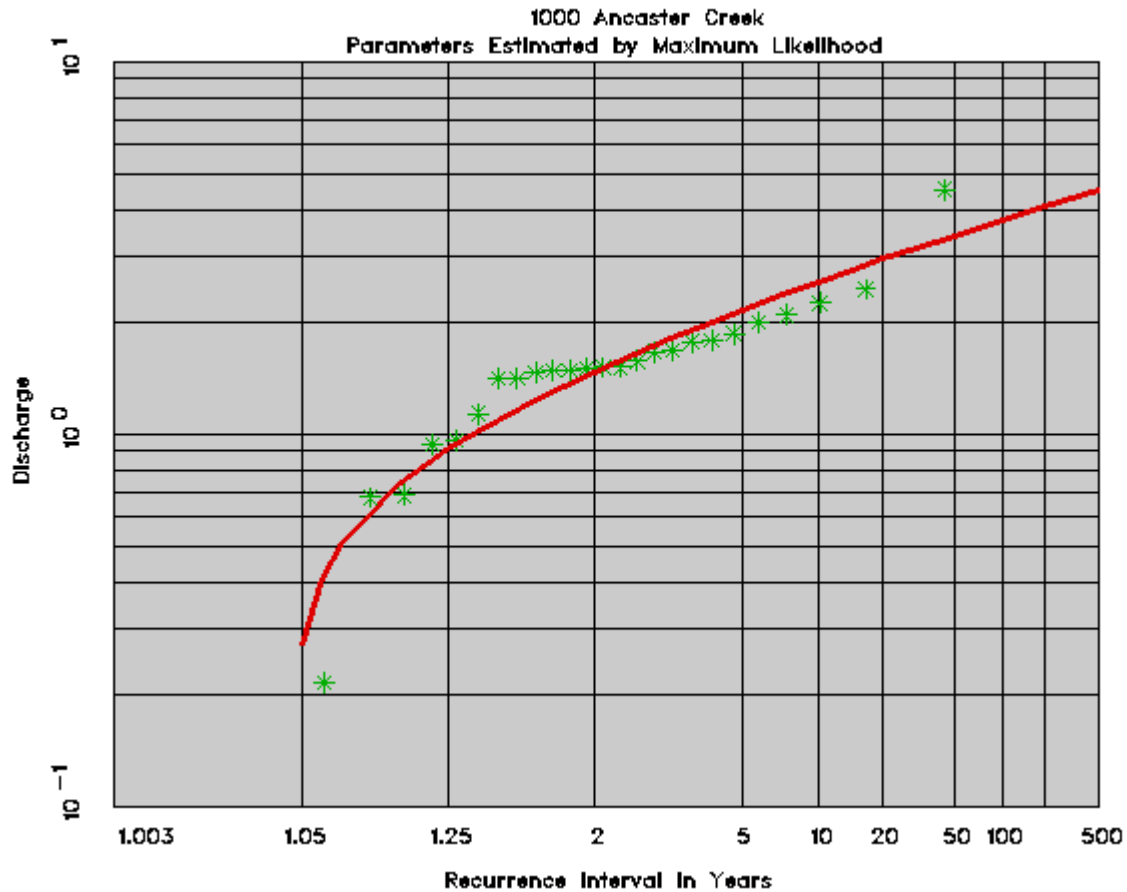
	AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS				
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	1.601	.795	.496	1.949	10.874
LN X SERIES	.347	.556	1.600	-1.493	8.633
LN(X-A) SERIES	.980	.265	.271	.181	6.326

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= -1.158 M= .980 S= .265

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	-
1.050	.952	.270
1.250	.800	.910
2.000	.500	1.47
5.000	.200	2.15
10.000	.100	2.56
20.000	.050	2.95
50.000	.020	3.42
100.000	.010	3.76
200.000	.005	4.10
500.000	.002	4.54

Flood Frequency – Three Parameter Lognormal Distribution



Rainfall

FREQUENCY ANALYSIS – THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Ancaster Creek Rainfall

SAMPLE STATISTICS					
	MEAN	S.D.	C.U	C.S.	C.K.
X SERIES	2.071	1.475	.712	2.932	15.391
LN X SERIES	.549	.602	1.097	.049	4.113
LN(X-A) SERIES	.538	.608	1.131	.028	4.100
X(MIN)=	.490	TOTAL SAMPLE SIZE= 29			
X(MAX)=	8.410	NO. OF LOW OUTLIERS= 0			
LOWER OUTLIER LIMIT OF X=	.373	NO. OF ZERO FLOWS= 0			

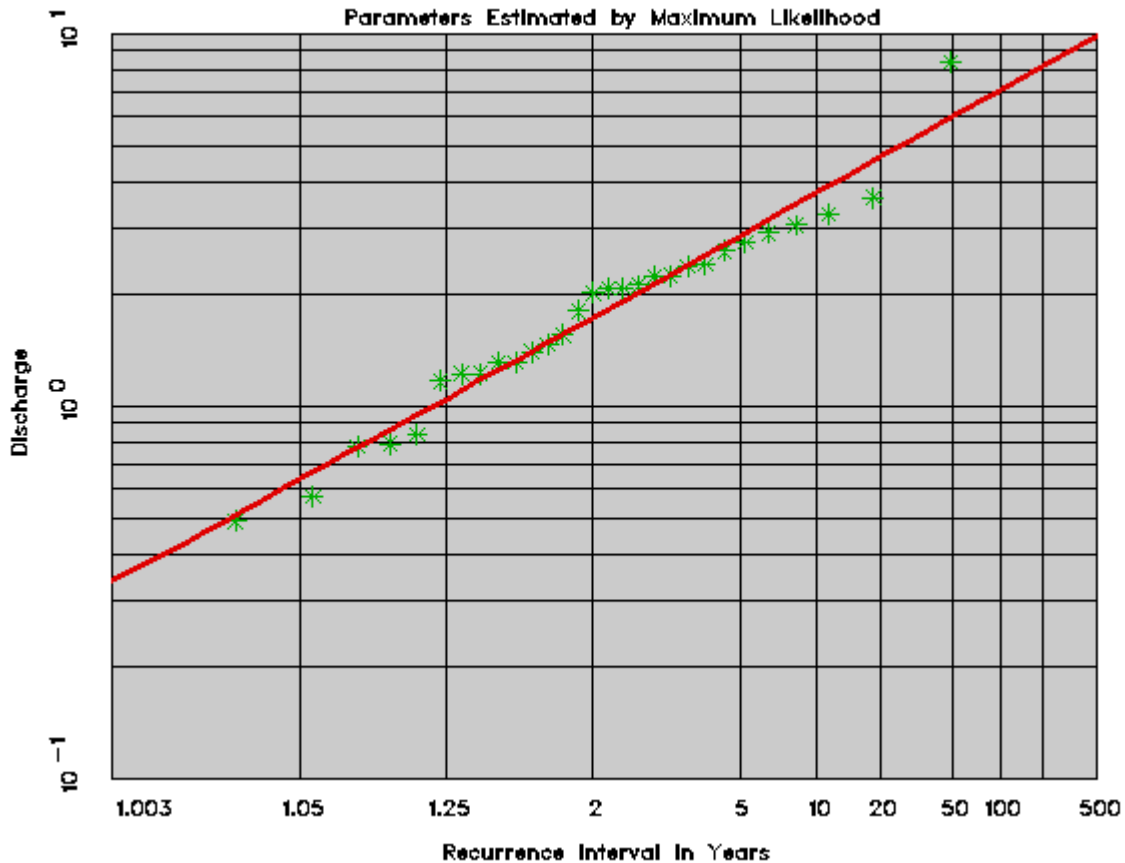
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
 3LN PARAMETERS: A= .016 M= .538 S= .608

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.340
1.050	.952	.640
1.250	.800	1.04
2.000	.500	1.73
5.000	.200	2.87
10.000	.100	3.75
20.000	.050	4.67
50.000	.020	5.99
100.000	.010	7.07
200.000	.005	8.22
500.000	.002	9.88

Flood Frequency – Three Parameter Lognormal Distribution

1000 Ancaster Creek Rainfall
 Parameters Estimated by Maximum Likelihood



Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Ancaster Creek

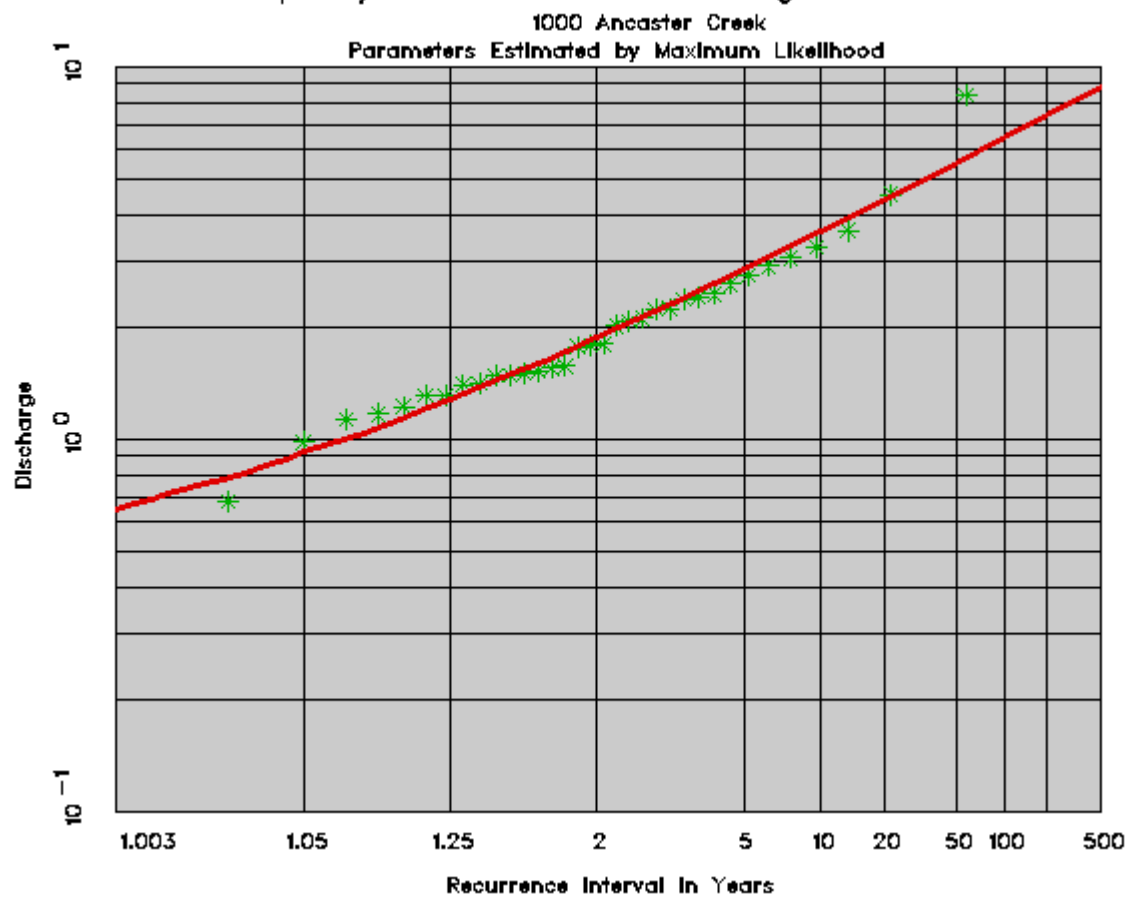
SAMPLE STATISTICS					
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	2.180	1.374	.630	3.082	15.891
LN X SERIES	.653	.478	.732	.734	5.060
LN(X-A) SERIES	.412	.598	1.452	.217	4.796
X(MIN)=	.680			TOTAL SAMPLE SIZE=	34
X(MAX)=	8.410			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	.550			NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= .362 M= .412 S= .598

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.650
1.050	.952	.920
1.250	.800	1.27
2.000	.500	1.87
5.000	.200	2.86
10.000	.100	3.61
20.000	.050	4.40
50.000	.020	5.52
100.000	.010	6.44
200.000	.005	7.41
500.000	.002	8.81

Flood Frequency – Three Parameter Lognormal Distribution



02HE004 - BLACK CREEK

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Black Creek

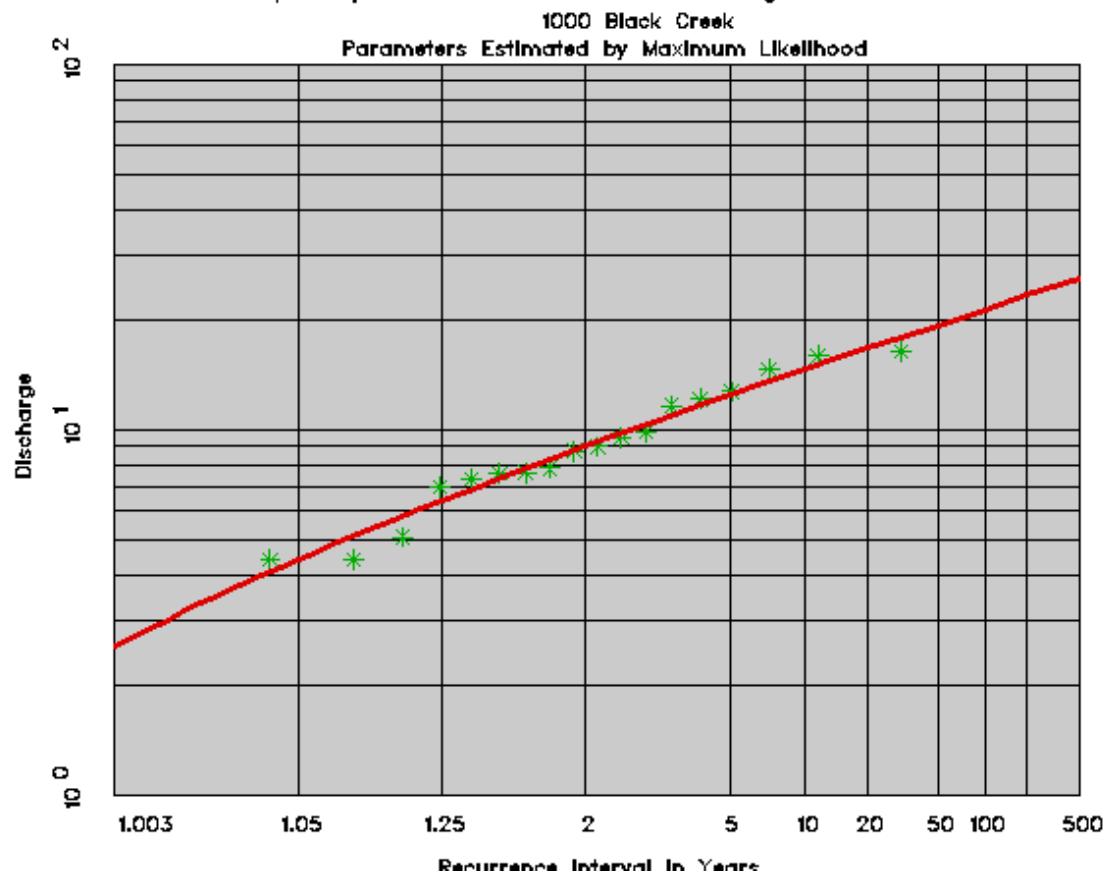
SAMPLE STATISTICS					
	MEAN	S.D.	C.U	C.S.	C.K.
X SERIES	9.529	3.676	.386	.486	3.021
LN X SERIES	2.181	.401	.184	-.237	3.038
LN(X-A) SERIES	2.387	.326	.137	-.095	2.948
X(MIN)=	4.400			TOTAL SAMPLE SIZE=	18
X(MAX)=	16.400			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	3.472			NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= -1.900 M= 2.387 S= .326

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	2.54
1.050	.952	4.42
1.250	.800	6.37
2.000	.500	8.98
5.000	.200	12.4
10.000	.100	14.6
20.000	.050	16.7
50.000	.020	19.3
100.000	.010	21.3
200.000	.005	23.3
500.000	.002	25.9

Flood Frequency – Three Parameter Lognormal Distribution



02HM011 - MILLHAVEN CREEK

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Millhaven Creek

SAMPLE STATISTICS					
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	14.720	6.366	.432	1.308	4.984
LN X SERIES	2.609	.398	.153	.365	3.142
LN(X-A) SERIES	2.255	.559	.248	-.041	3.249
X(MIN)=	6.240			TOTAL SAMPLE SIZE=	31
X(MAX)=	33.400			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	4.871			NO. OF ZERO FLOWS=	0

Press <RETURN> to continue , <CTRL> P to obtain hard copy_

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= 3.660 M= 2.255 S= .559

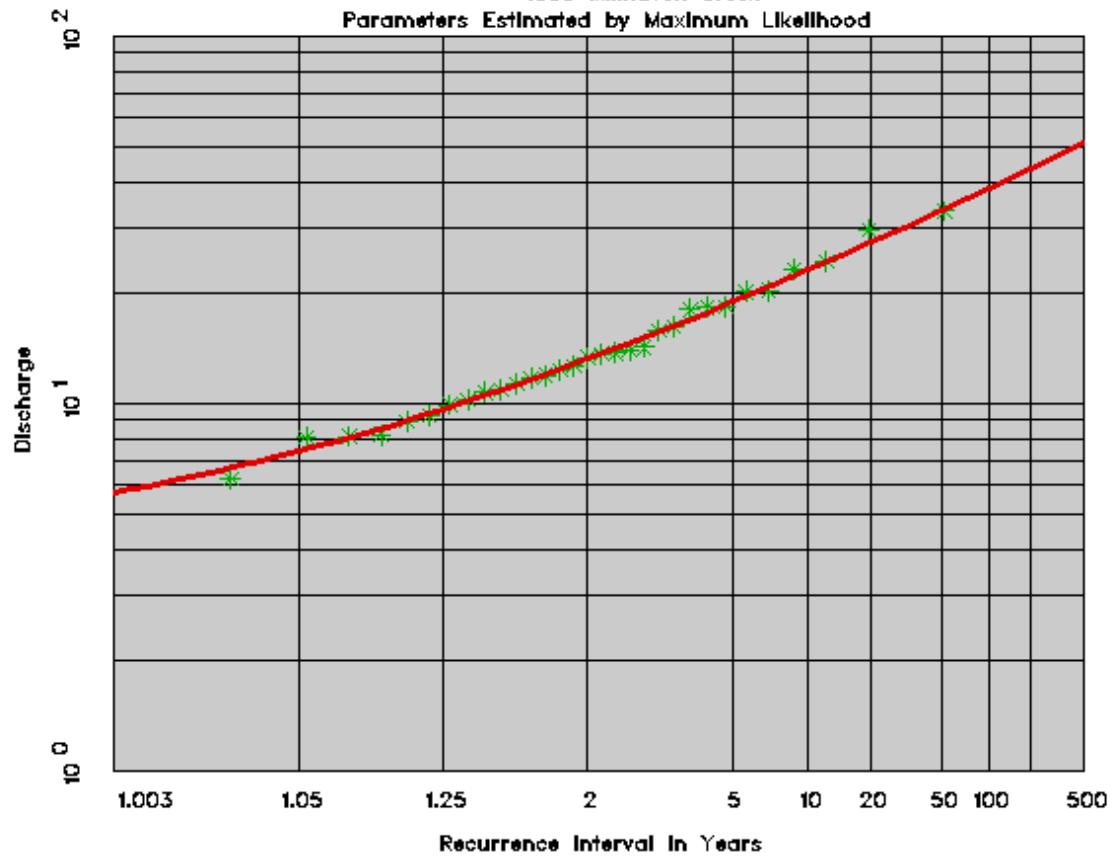
FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	5.71
1.050	.952	7.41
1.250	.800	9.62
2.000	.500	13.2
5.000	.200	18.9
10.000	.100	23.2
20.000	.050	27.5
50.000	.020	33.7
100.000	.010	38.6
200.000	.005	43.8
500.000	.002	51.2

Flood Frequency – Three Parameter Lognormal Distribution

1000 Millhaven Creek

Parameters Estimated by Maximum Likelihood



02HE002 - CONSECON CREEK

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 1000 Consecon Creek

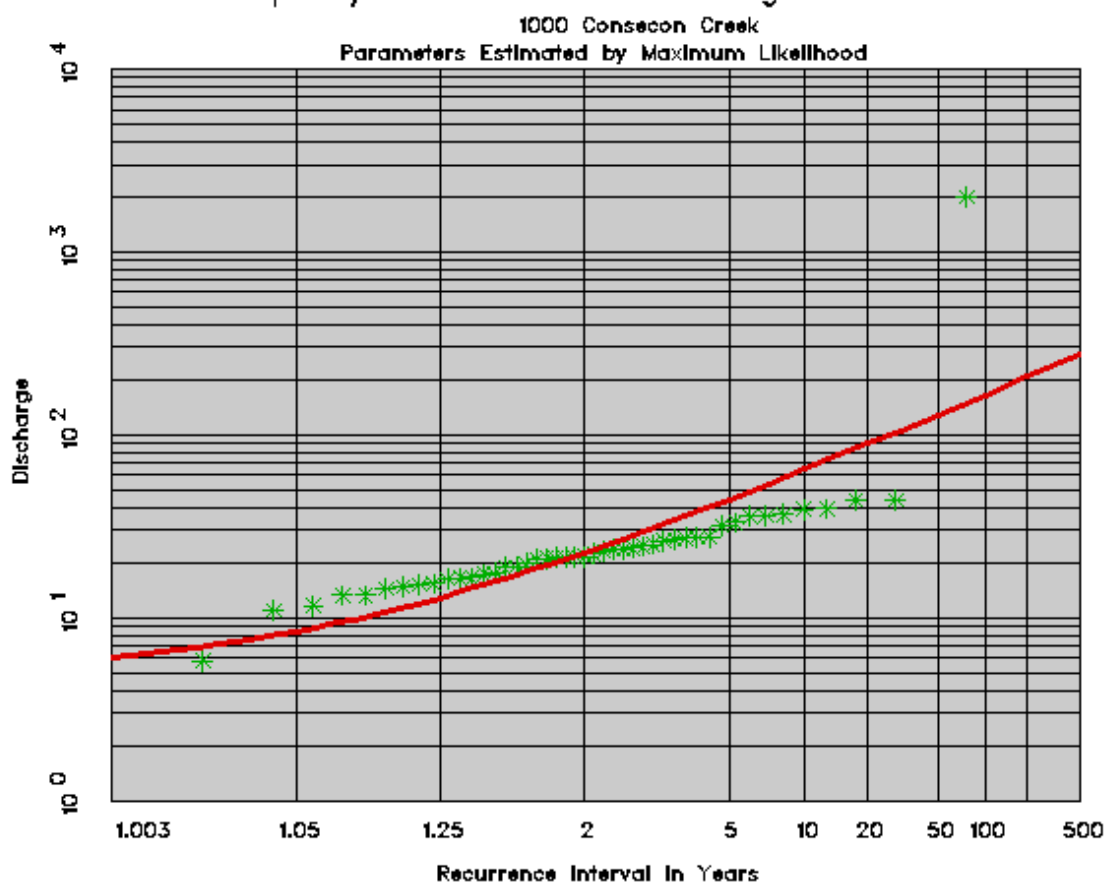
	SAMPLE STATISTICS				
	MEAN	S.D.	C.U	C.S.	C.K.
X SERIES	66.878	292.722	4.377	6.699	48.128
LN X SERIES	3.171	.786	.248	4.059	26.561
LN(X-A) SERIES	2.888	.940	.325	2.327	18.490
X(MIN)=	5.800			TOTAL SAMPLE SIZE=	45
X(MAX)=	1986.000			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	2.798			NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= 4.677 M= 2.888 S= .940

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	6.03
1.050	.952	8.42
1.250	.800	12.8
2.000	.500	22.6
5.000	.200	44.3
10.000	.100	64.5
20.000	.050	88.9
50.000	.020	128
100.000	.010	164
200.000	.005	207
500.000	.002	273

Flood Frequency – Three Parameter Lognormal Distribution



02HM004 – WILTON CREEK

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 100 Wilton Creek

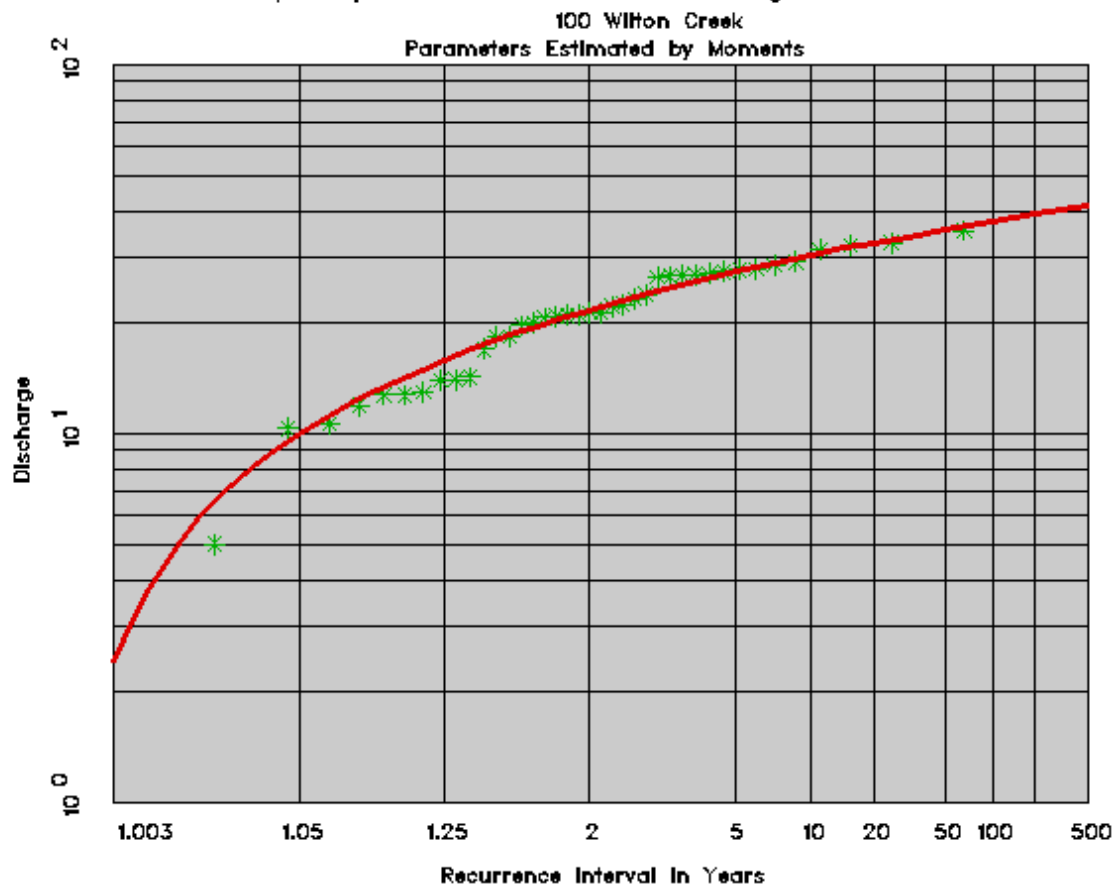
		SAMPLE STATISTICS			
		MEAN	S.D.	C.U.	C.S.
					C.K.
X SERIES		21.438	7.219	.337	-.166
LN X SERIES		2.997	.404	.135	-1.228
X(MIN)=	5.000				
X(MAX)=	35.500				
LOWER OUTLIER LIMIT OF X=	6.809				
		TOTAL SAMPLE SIZE=		39	
		NO. OF LOW OUTLIERS=		1	
		NO. OF ZERO FLOWS=		0	

SOLUTION OBTAINED VIA MOMENTS
DISTRIBUTION IS UPPER BOUNDED AT A= .8303E+03
PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
A= 830.335 M= 6.695 S= .009

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	2.41
1.050	.952	10.0
1.250	.800	15.8
2.000	.500	21.6
5.000	.200	27.4
10.000	.100	30.5
20.000	.050	32.9
50.000	.020	35.7
100.000	.010	37.6
200.000	.005	39.3
500.000	.002	41.3

Flood Frequency – Three Parameter Lognormal Distribution



02HD012 – GANARASKA RIVER

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 100 Ganaraska River

	MEAN	S.D.	C.U	C.S.	C.K.
X SERIES	51.991	29.179	.561	2.085	10.428
LN X SERIES	3.822	.514	.134	.039	3.463
LN(X-A) SERIES	3.761	.546	.145	-.045	3.423

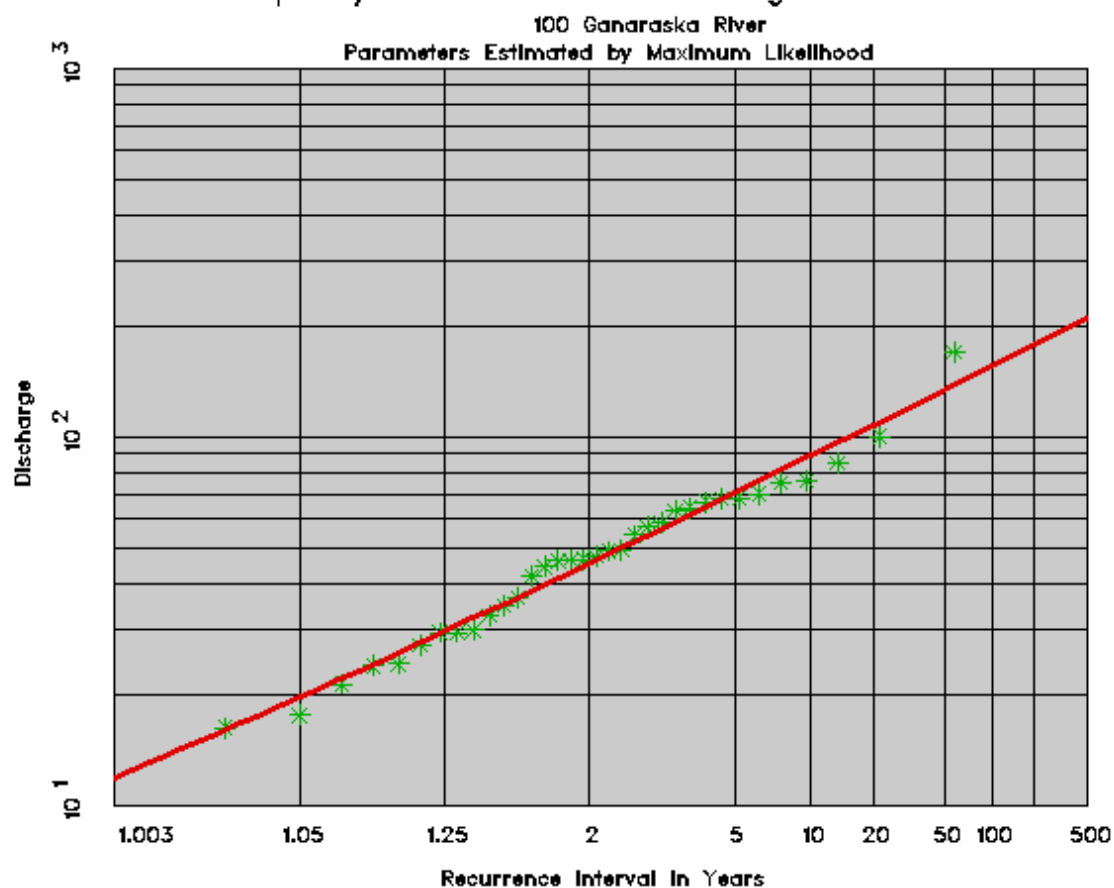
X(MIN)=	16.200	TOTAL SAMPLE SIZE=	34
X(MAX)=	170.000	NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	11.909	NO. OF ZERO FLOWS=	0

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= 2.344 M= 3.761 S= .546

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	11.9
1.050	.952	19.6
1.250	.800	29.5
2.000	.500	45.3
5.000	.200	70.4
10.000	.100	88.9
20.000	.050	108
50.000	.020	134
100.000	.010	155
200.000	.005	178
500.000	.002	209

Flood Frequency – Three Parameter Lognormal Distribution



02HD009 – WILMOT CREEK

Combined

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION 100 Wilmot Creek

	SAMPLE STATISTICS				
	MEAN	S.D.	C.U.	C.S.	C.K.
X SERIES	24.014	13.357	.556	1.273	4.536
LN X SERIES	3.041	.528	.174	.109	2.893
LN(X-A) SERIES	2.914	.598	.205	-.064	3.004
X(MIN)=	6.570			TOTAL SAMPLE SIZE=	43
X(MAX)=	62.200			NO. OF LOW OUTLIERS=	0
LOWER OUTLIER LIMIT OF X=	5.001			NO. OF ZERO FLOWS=	0

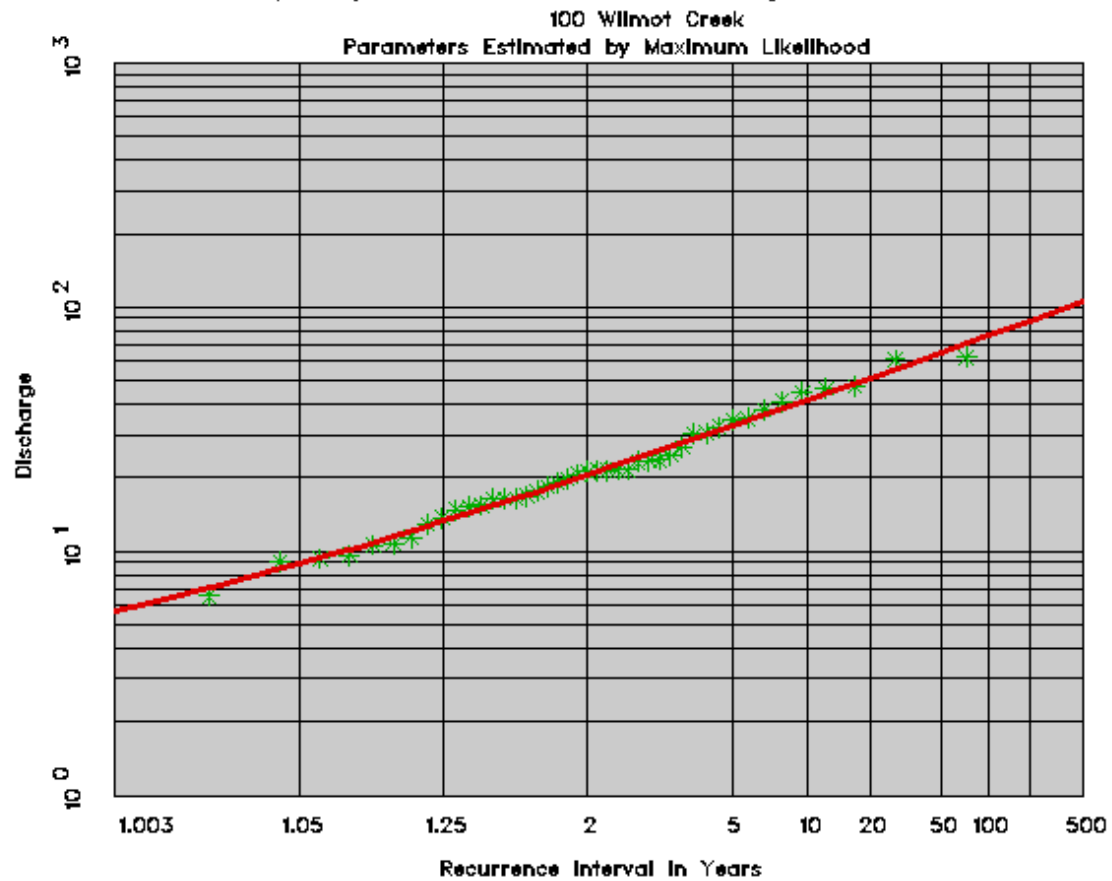
SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD
3LN PARAMETERS: A= 2.143 M= 2.914 S= .598

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	5.71
1.050	.952	8.94
1.250	.800	13.3
2.000	.500	20.6
5.000	.200	32.6
10.000	.100	41.8
20.000	.050	51.5
50.000	.020	65.1
100.000	.010	76.3
200.000	.005	88.2
500.000	.002	105

R = (RETURN) (PERIOD) (EXCEEDANCE PROBABILITY) FLOOD

Flood Frequency – Three Parameter Lognormal Distribution



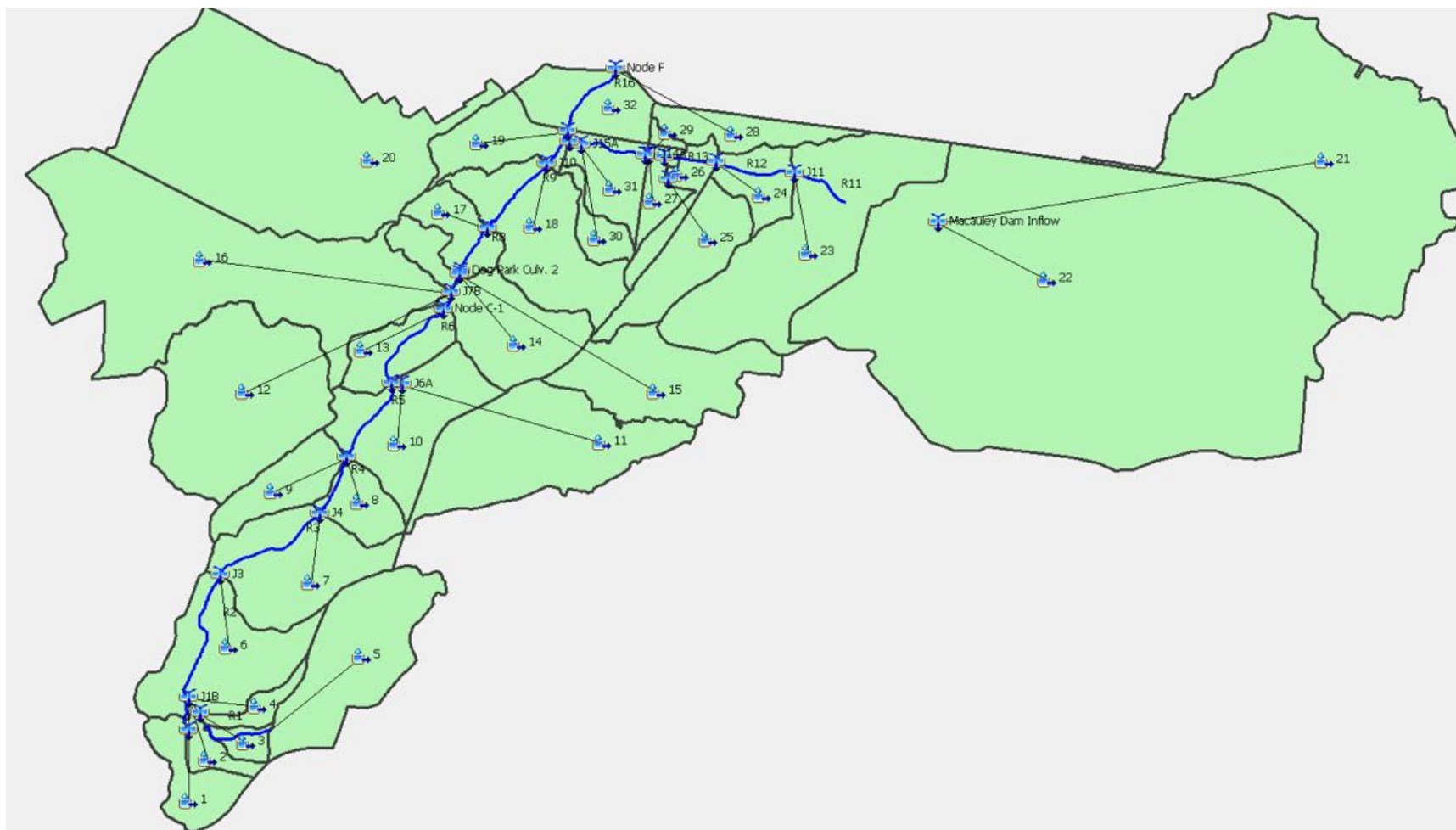


Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update

Appendix I:
HEC-HMS Schematic



Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update





Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update

Appendix J:
Culvert Crossing Survey Data Sheets

CULVERT DATA

Structure ID	MARSH-1	Survey Date	7/3/2025
Location	Bridge Street	Year of Construction	N/A
UTM Coordinates	44.008656, -77.136721	Year of Latest Repair	N/A
Shape and Material	Double Concrete Box Culvert	Conversion to CGVD28	+0.393m

A. Specifications

Road Data

Top of Road Elevation @ Structure 76.77 m

Road Sag Elevation 76.74 m

Upstream Data

Top of Culvert Opening 75.28 m

Measured Span 1.94 m

Creek Invert Elevation 73.60 m

Downstream Data

Top of Culvert Opening 75.29 m

Measured Span 2.01 m

Creek Invert Elevation 73.58 m

Opening Data

Width of Opening (Average Span) 1.58 m

Height of Opening 1.29 m

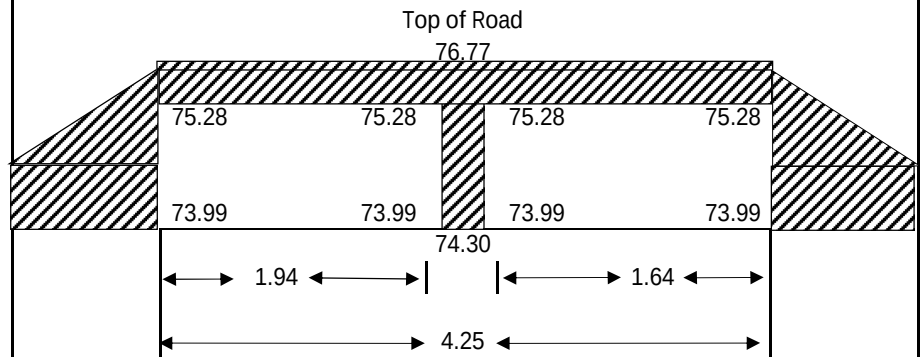
Length of Opening 21.31 m

Average Culvert Slope 0.1 %

Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Date of Photo: 7/3/2025

Downstream:



Date of Photo: 7/3/2025

D. Benchmark

Description 67U159 Geodetic Bench Mark South East Corner of The Box Culvert

Coordinates 4875059, 328730.6

Elevation 76.006

CULVERT DATA

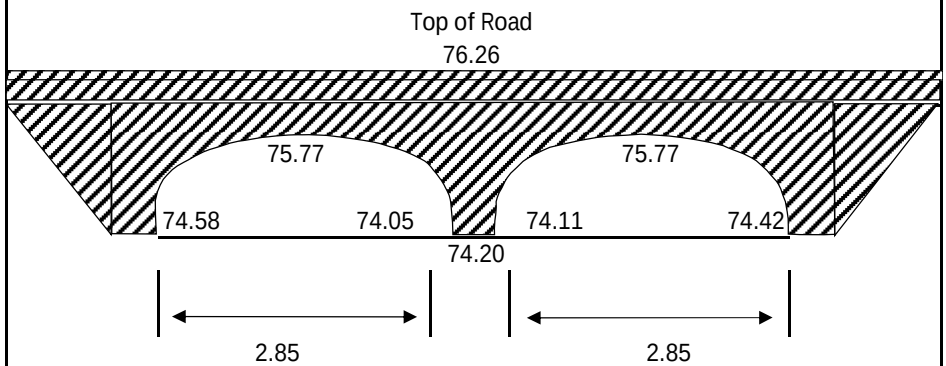
Structure ID	MARSH-2	Survey Date	7/3/2025
Location	York Street	Year of Construction	N/A
UTM Coordinates	44.006933, -77.138549	Year of Latest Repair	N/A
Shape and Material	Arch CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road DataTop of Road Elevation @ Structure 76.26 mRoad Sag Elevation 76.09 mUpstream DataTop of Culvert Opening 75.77 mMeasured Span 2.85 mCreek Invert Elevation 74.20 mDownstream DataTop of Culvert Opening 75.73 mMeasured Span 2.85 mCreek Invert Elevation 74.18 mOpening DataWidth of Opening 2.85 mHeight of Opening 1.95 mLength of Opening 13.2 mAverage Culvert Slope 0.2 %Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:

Date of Photo: 7/3/2025

Downstream:

Date of Photo: 7/3/2025

D. Benchmark

Description Cross Cut On Curb of Lalor StreetCoordinates N/E 4874819, 328579.9Elevation 76.359

BRIDGE DATA

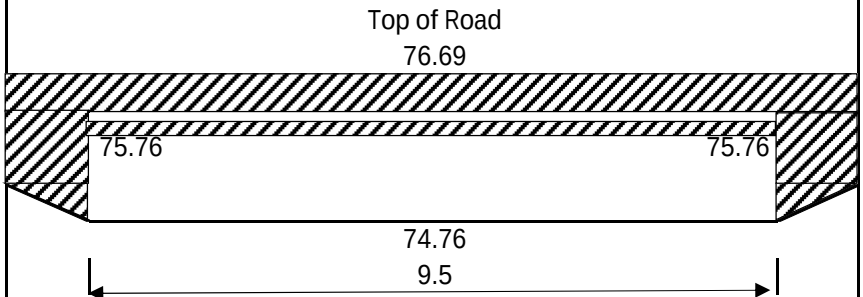
Structure ID	MARSH-3	Survey Date	7/3/2025
Location	Pedestrian Bridge - 130m US York ST	Year of Construction	N/A
UTM Coordinates	44.006045, -77.139164	Year of Latest Repair	N/A
Shape and Material	Simply Supported Wooden Bridge	Conversion to CGVD28	+0.393m

A. Specifications

Road DataTop of Road Elevation 76.69 mRoad Sag Elevation 76.61 mUpstream DataUnderside of Structure Elevation 75.76 mBottom of Structure Elevation 74.61 mCreek Invert Elevation 74.61 mDownstream DataUnderside of Structure Elevation 75.76 mBottom of Structure Elevation 74.51 mCreek Invert Elevation 74.51 mOpening DataWidth of Opening 9.5 mHeight of Opening 2.0 mLength of Opening 3.0 mAverage Culvert Slope 3.3 %Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Downstream:

Date of Photo: 10/6/2025Date of Photo: 10/6/2025

D. Benchmark

Description South East Corner of Concrete Base For Plaque H Angus Leneup In ParkCoordinates 4874717, 328536.7Elevation 76.69

CULVERT DATA

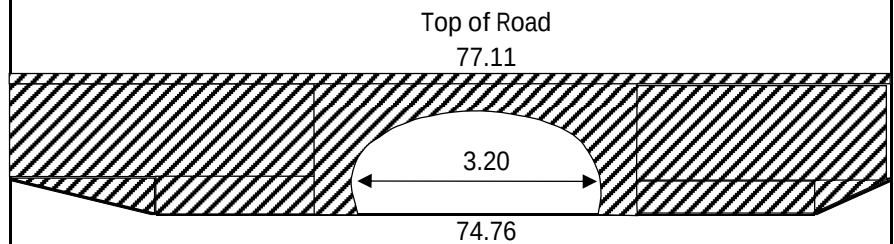
Structure ID	MARSH-4	Survey Date	7/4/2025
Location	Pedestrian Bridge - 400m US York St	Year of Construction	N/A
UTM Coordinates	44.004006, -77.141468	Year of Latest Repair	N/A
Shape and Material	CSPA	Conversion to CGVD28	+0.393m

A. Specifications

Road DataTop of Road Elevation 77.11 mRoad Sag Elevation 76.45 mUpstream DataTop of Culvert Opening 76.93 mMeasured Span 3.20 mCreek Invert Elevation 74.76 mDownstream DataTop of Culvert Opening 76.98 mMeasured Span 3.20 mCreek Invert Elevation 75.11 mOpening DataWidth of Opening 3.2 mHeight of Opening 1.5 mLength of Opening 10.9 mAverage Culvert Slope -0.5 %Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:

Date of Photo: 10/6/2025

Downstream:

Date of Photo: 7/4/2025

D. Benchmark

Description 3/4" Rebar North Side of CulvertCoordinates 4874563, 328306.5Elevation 77.228

CULVERT DATA

Structure ID	MARSH-5	Survey Date	7/4/2025
Location	Pedestrian Bridge -- 575m US York St	Year of Construction	N/A
UTM Coordinates	44.002710, -77.142576	Year of Latest Repair	N/A
Shape and Material	CSPA	Conversion to CGVD28	+0.393m

A. Specifications

Road Data

Top of Road Elevation	77.42 m
Road Sag Elevation	76.97 m

Upstream Data

Top of Culvert Opening	77.13 m
Measured Span	3.20 m
Creek Invert Elevation	75.45 m

Downstream Data

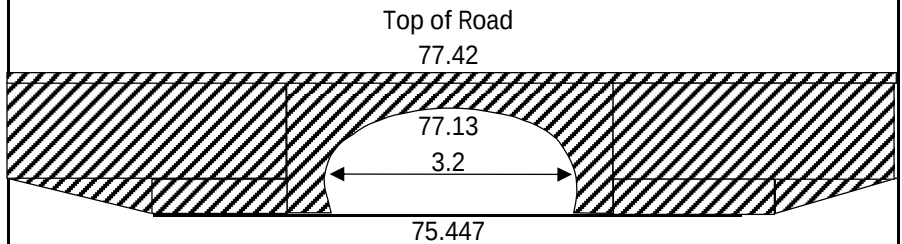
Top of Culvert Opening	76.86 m
Measured Span	3.20 m
Creek Invert Elevation	75.51 m

Opening Data

Width of Opening	3.2 m
Height of Opening	1.4 m
Length of Opening	10.8 m
Average Culvert Slope	2.5 %
Skew Angle	0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Date of Photo: 10/6/2025

Downstream:



Date of Photo: 10/6/2025

D. Benchmark

Description	3/4" Rebar North Side of Culvert
Coordinates	4874415, 328210.5
Elevation	78.571

CULVERT DATA

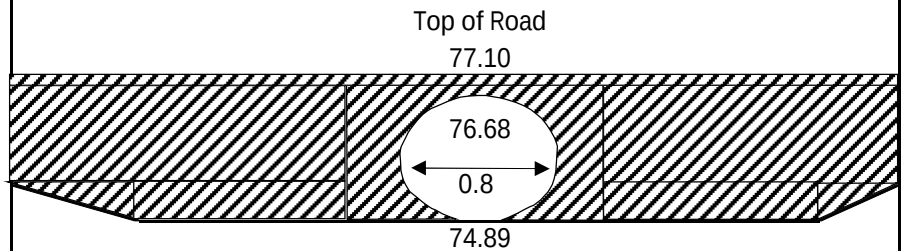
Structure ID	MARSH-6	Survey Date	7/4/2025
Location	Pedestrian Bridge - Cemetary Culv 1	Year of Construction	N/A
UTM Coordinates	44.001640, -77.143125	Year of Latest Repair	N/A
Shape and Material	CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road DataTop of Road Elevation 77.10 mRoad Sag Elevation 77.00 mUpstream DataTop of Culvert Opening 76.69 mMeasured Span 0.80 mCreek Invert Elevation 75.89 mDownstream DataTop of Culvert Opening 76.68 mMeasured Span 0.80 mCreek Invert Elevation 75.71 mOpening DataWidth of Opening 0.8 mHeight of Opening 0.8 mLength of Opening 6.3 mAverage Culvert Slope 2.9 %Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:

Date of Photo: 10/6/2025

Downstream:

Date of Photo: 7/4/2025

D. Benchmark

Description	South Corner of Concrete Pad on Building North of Culvert
Coordinates	4874322, 328153.5
Elevation	78.287

CULVERT DATA

Structure ID	MARSH-7	Survey Date	7/4/2025
Location	Pedestrian Trail - Cemetary Culv 2	Year of Construction	N/A
UTM Coordinates	43.999452, -77.145202	Year of Latest Repair	N/A
Shape and Material	CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road Data

Top of Road Elevation 77.96 m

Road Sag Elevation 77.70 m

Upstream Data

Top of Culvert Opening 77.42 m

Measured Span 0.60 m

Creek Invert Elevation 76.82 m

Downstream Data

Top of Culvert Opening 77.59 m

Measured Span 0.60 m

Creek Invert Elevation 76.98 m

Opening Data

Width of Opening 0.6 m

Height of Opening 0.6 m

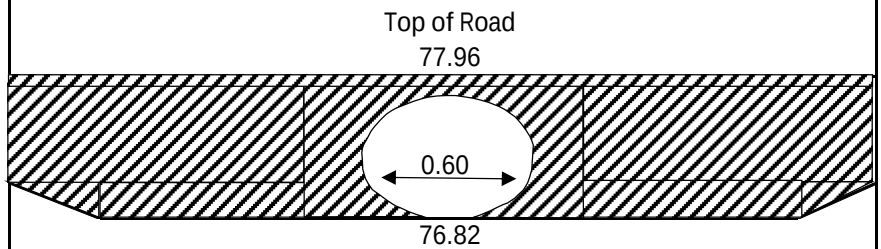
Length of Opening 6.1 m

Average Culvert Slope -2.8 %

Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Date of Photo: 10/6/2025

Downstream:



Date of Photo: 10/6/2025

D. Benchmark

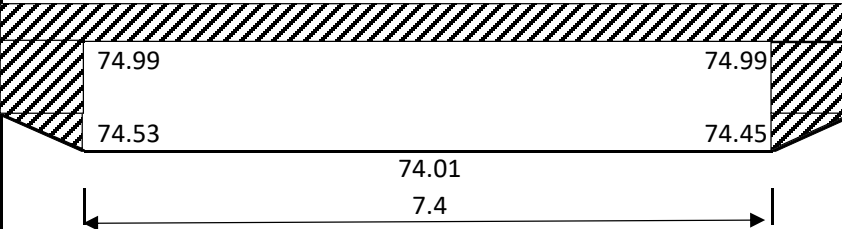
Description 3/4" Rebar 0.5m West of Road At Culvert

Coordinates 4874052, 328005.8

Elevation 77.520

BRIDGE DATA

Structure ID	MARSH-8	Survey Date	7/3/2025
Location	Pedestrian Bridge - 130m US Bridge St	Year of Construction	N/A
UTM Coordinates	<u>44.007807, -77.137775</u>	Year of Latest Repair	N/A
Shape and Material	Simply Supported Wooden Bridge	Conversion to CGVD28	+0.393m

A. Specifications		B. Sketch - Upstream	
<u>Road Data</u>			
Top of Road Elevation	<u>75.41</u> m		
Road Sag Elevation	<u>75.41</u> m		
<u>Upstream Data</u>			
Underside of Structure Elevation	<u>74.99</u> m		
Bottom of Structure Elevation	<u>74.51</u> m		
Creek Invert Elevation	<u>74.01</u> m		
<u>Downstream Data</u>			
Underside of Structure Elevation	<u>74.99</u> m		
Bottom of Structure Elevation	<u>74.51</u> m		
Creek Invert Elevation	<u>73.96</u> m		
<u>Opening Data</u>			
Width of Opening	<u>7.4</u> m		
Height of Opening	<u>1.0</u> m		
Length of Opening	<u>3.0</u> m		
Average Culvert Slope	<u>1.7</u> %		
Skew Angle	<u>0</u> °		
*Elevations in Datum CGVD2013			

Upstream:

Downstream:

Date of Photo: 8/13/2025Date of Photo: N/A

D. Benchmark

Description	South East Corner Bolt of Light Post Base On East End of Bridge
Coordinates	4874961, 328637.7
Elevation	76.073

CULVERT DATA

Structure ID	MAC-1	Survey Date	7/3/2025
Location	Lalor Street	Year of Construction	N/A
UTM Coordinates	44.006549, -77.138354	Year of Latest Repair	N/A
Shape and Material	CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road Data

Top of Road Elevation 76.26 m

Road Sag Elevation 76.21 m

Upstream Data

Top of Culvert Opening 75.97 m

Measured Span 1.80 m

Creek Invert Elevation 74.79 m

Downstream Data

Top of Culvert Opening 75.87 m

Measured Span 1.80 m

Creek Invert Elevation 74.79 m

Opening Data

Width of Opening 1.8 m

Height of Opening 1.3 m

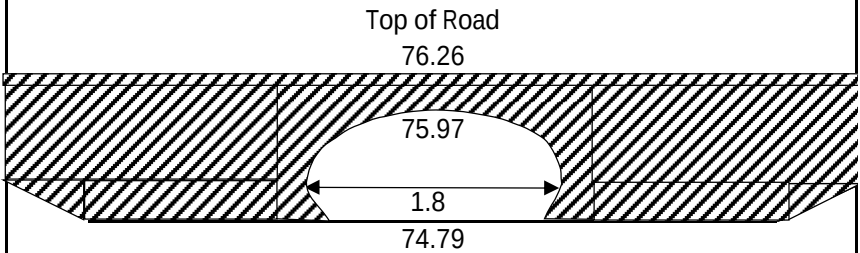
Length of Opening 8.3 m

Average Culvert Slope 1.2 %

Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Date of Photo: 7/3/2025

Downstream:



Date of Photo: 7/3/2025

D. Benchmark

Description Cross Cut On Curb of Lalor Street

Coordinates 4874819, 328579.9

Elevation 76.359

CULVERT DATA

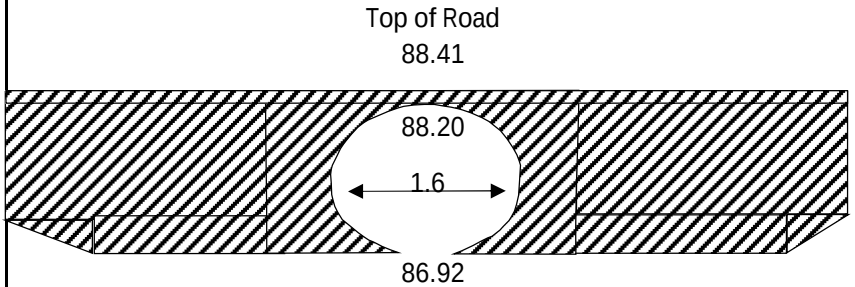
Structure ID	MAC-2	Survey Date	7/3/2025
Location	Pitt Street	Year of Construction	N/A
UTM Coordinates	44.006205, -77.135141	Year of Latest Repair	N/A
Shape and Material	CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road DataTop of Road Elevation 88.41 mRoad Sag Elevation 88.52 mUpstream DataTop of Culvert Opening 88.20 mMeasured Span 1.60 mCreek Invert Elevation 86.92 mDownstream DataTop of Culvert Opening 84.76 mMeasured Span 1.60 mCreek Invert Elevation 85.43 mOpening DataWidth of Opening 1.6 mHeight of Opening 1.6 mLength of Opening 57.0 mAverage Culvert Slope 2.6 %Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Downstream:

Date of Photo: 10/6/2025Date of Photo: 7/3/2025

D. Benchmark

Description Cut Cross in Sidewalk East Side of Pitt StreetCoordinates 4874774, 328836.5Elevation 87.898

CULVERT DATA

Structure ID	MAC-3	Survey Date	7/3/2025
Location	Church Street (Cty Rd 22)	Year of Construction	N/A
UTM Coordinates	44.006038, -77.132396	Year of Latest Repair	N/A
Shape and Material	CSP	Conversion to CGVD28	+0.393m

A. Specifications

Road Data

Top of Road Elevation 92.11 m

Road Sag Elevation 91.67 m

Upstream Data

Top of Culvert Opening 90.53 m

Measured Span 1.60 m

Creek Invert Elevation 89.61 m

Downstream Data

Top of Culvert Opening 92.11 m

Measured Span 1.60 m

Creek Invert Elevation 89.21 m

Opening Data

Width of Opening 1.6 m

Height of Opening 1.0 m

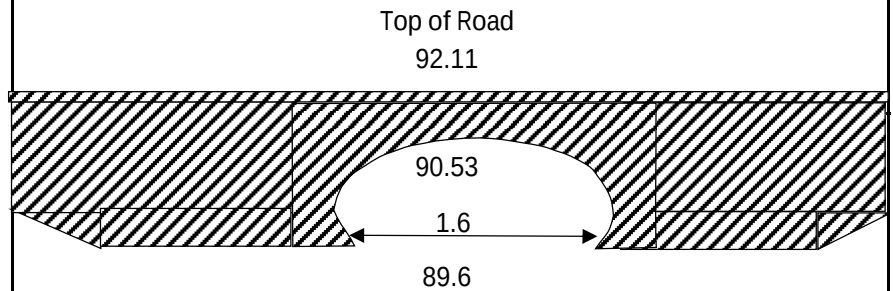
Length of Opening 22.1 m

Average Culvert Slope 1.8 %

Skew Angle 0 °

*Elevations in Datum CGVD2013

B. Sketch - Upstream



Upstream:



Date of Photo: 7/3/2025

Downstream:



Date of Photo: 7/3/2025

D. Benchmark

Description Cut Cross on Downstream Side on North East Side of Concrete Pad

Coordinates 4874758.1, 329043.6

Elevation 90.448



Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update

Appendix K:
Public Information Centre Comments and Responses

Marsh Creek Floodplain Mapping Update

Public Information Center – Sign-In Sheet

Name	Email
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No follow-up comments received following PIC. It is assumed all public questions and comments were addressed in-person at the event.



Hydrology & Hydraulics Technical Report
Marsh Creek Flood Hazard Mapping Update
