UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

Upper Canada Planning & Engineering Ltd.
3-30 Hannover Drive
St. Catharines, ON
L2W 1A3
Phone 905-688-9400
Fax 905-688-5274

FUNCTIONAL SERVICING REPORT

McLEOD ROAD - FRUITBELT
City of Niagara Falls
March 2023

INTRODUCTION

The proposed residential development of McLeod Road – Fruitbelt is located at the western boundary of City of Niagara Falls. The subject lands are located at 9304 McLeod Road and adjoining property located immediately west to it. The subject lands have fronting on McLeod Road on the north side and Beechwood Road on the west side. The site is located directly south of Mcleod Road and east of Beechwood Road. The subject lands were historically used for agricultural activity with a residential building fronting on to the McLeod Road. There is an existing ditch that traverses along the eastern boundary of the subject lands from north to south.

The proposed 22.92 hectare development shall consist of approximately 217 single family lots, 53 reverse frontage street townhouse units, 85 street town units, 68 back to back town units and 72 townhouse condominium units. The proposed development will be provided with full urban services including sanitary and storm sewers, watermain, asphalt road with concrete curb and gutters.

The objectives of this study are as follows:

1. Identify domestic water service needs for the site.
2. Identify sanitary servicing needs for the site.
3. Identify stormwater management needs for the site.

WATER SERVICING

There is an existing a 500mm diameter Regional watermain on north side of the McLeod Road and a 300mm diameter PVC Municipal watermain on south side of McLeod Road till the Matteo Drive.

It is proposed to extend the existing 300mm diameter municipal watermain on McLeod westerly to the western limit of the site and construct a looped 150mm diameter watermain to provide both domestic water supply and fire protection for the proposed development. It is proposed to construct fire hydrants within the proposed development to provide adequate fire protection for the proposed units. The spacing and location of the proposed fire hydrants will be determined through detailed design.

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SANITARY SERVICING

There is an existing 250mm dia. sanitary sewer with stub, located adjacent to the subject lands. The existing sanitary sewer conveys the sanitary flows from the Forestview Estates to the existing 375mm dia. sanitary sewer on the east of the Garner Road and ultimately to 525mm diameter truck sanitary sewer located at the intersection of Garner Road and Warren Woods Avenue. The existing 250mm dia. sanitary sewer has been designed and constructed to service the subject lands. It is proposed to construct sanitary sewer network on subject lands to collect future sanitary flows from the proposed development and convey it to the existing 250mm dia. sanitary sewer. A preliminary calculation sheet is attached in Appendix A for reference.

The existing 250mm dia. sanitary sewer located on adjoining property was designed with the expected future population of 1345 people (50.7 ppha) of the subject lands. The future population for the proposed development on the subject lands will be 1476 people (64.4 ppha). The future sanitary flows from the subject lands will be approximately 24.60 L/s and that will occupy additional 4.7% of the available capacity in the existing 250mm dia. sanitary sewer. As the existing sanitary sewer was designed with this site in consideration, it is expected that this will be an acceptable addition to the current capacity.

STORMWATER MANAGEMENT

The proposed site is located within the head water of north branch of Thompson Creek. Upper Canada Consultants had recently reviewed the “Thompson Creek North Branch Stormwater Master Plan Update”. The stormwater management strategy for the subject site is proposed to align with the updated Stormwater Master Plan.

The following will serve as a summary of the stormwater management plan for the subject lands that has been prepared by Upper Canada Consultants (UCC) and enclosed within this report as Appendix C.

The subject lands discharges peak stormwater flows to one of the tributaries of the Thompson Creek that traverses along the east boundary of the subject lands.

Based on the proposed outlet to the existing ditch, the following stormwater management criteria have been identified for the subject lands.

- The receiving ditch has been identified as Type 2 fish habitat. Based on this fish habitat, the corresponding MECP Level of Protection for stormwater management quality practices is Normal. In addition, staff at the Region of Niagara and the NPCA have brought forth concerns regarding the possibility of dissolved stormwater contaminants (e.g. road salts) being conveyed through the SWMF and ultimately outletting to the PSW.

- The site outlet to an existing ditch that would be negatively impacted by the increased stormwater peak flows.

Based on the above policies and site-specific considerations, the following stormwater management criteria have been established for the proposed stormwater management facility.

- Stormwater quality controls are to be provided to Enhanced protection levels (80% TSS removal) in accordance with MECP Guidelines.

- Stormwater quantity controls were to be provided to restricts future stormwater flows to existing levels.

- Downstream erosion protection is to be provided in accordance with MECP Guidelines.

It is proposed to construct a stormwater management wet pond facility to provide both stormwater quality and quantity controls for the proposed and future development lands. To provide stormwater quality improvements to MECP Enhanced levels (80% TSS removal), a wet pond facility servicing total drainage area of approximately 19.39 hectares with an overall imperviousness of 64.3% will be required to provide a permanent pool volume of 3,374 m^3 The preliminary wet pond can provide approximately 4,995 m^3 of permanent pool storage. Therefore, there is adequate permanent pool volume to provide 80% TSS removal. Wet pond calculations can be found in Appendix B for reference.

To provide the required downstream erosion controls, the proposed wet pond must detain the 25mm design storm flows and slowly release them over a period of at least 24 hours. As shown in the calculations in Appendix B, the proposed outlet control structure for the proposed wet pond facility consisting of 150mm diameter reverse slope pipe functioning as an orifice and a ditch inlet weir structure will provide a total drawdown time of 54.8 hours for the 25mm design storm event.

Table 1. Impacts of Wet Pond Facility on Future Peak Flows

Design Storm	Peak Flow (m^3/s)		
	Existing	Future with SWM	Change*
5 Year	0.102	0.081	-20.6%
100 Year	0.399	0.299	-25.1%

Note: *indicates the percent change between existing conditions and future conditions with stormwater management controls in place.

As shown in the above table, the proposed wet pond facility can adequately restrict the future flows to below existing levels into the existing ditch for the 5 year and 100 year design storm events.

Therefore, the proposed wet pond facility can provide the required stormwater quality and quantity controls in accordance with MECP guidelines. Detailed calculations can be found in the enclosed SWM Report in Appendix C.

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CONCLUSION AND RECOMMENDATIONS

Therefore, based on the above comments and design calculations provided for this site, the following summarizes the serving for this site:

1. The existing 300mm diameter municipal watermain on the McLeod Road will be extended to the west boundary of the subject site and will have sufficient capacity to provide both domestic and fire protection water supply.

2. The existing 250mm diameter sanitary sewer on the adjoining property will have adequate capacity for the proposed development.

3. Stormwater quantity and erosion controls can be provided by the proposed wet pond facility up to and including 100 year design storm event.

4. Stormwater quality controls can be provided to MECP Enhaced protections levels (80% TSS Removal) by the proposed wet pond facility.

Based on the above and the accompanying calculations, there exists adequate municipal servicing for this development. We trust the above comments and enclosed calculations are satisfactory for approval. If you have any questions or require additional information, please do not hesitate to contact our office.

Prepared By:

Keyur Prajapati, E.I.T.,
December 8, 2022

LICENSED PROFESSIONAL ENGINEER
A. S. KEANE
100109861
PROVINCE OF ONTARIO

Reviewed By:

Adam Keane, P.Eng.
March 20, 2023

Encl.

APPENDICES

APPENDIX A

Preliminary Sanitary Sewer Calculation

UPPER CANADA CONSULTANTS
3-30 HANNOVER DRIVE
ST.CATHARINES, ON, L2W 1A3

DESIGN FLOWS		**SEWER DESIGN**
RESIDENTIAL:	320 LITRES/PERSON/DAY (NIAGARA FALLS AVERAGE DAILY FLOW)	PIPE ROUGHNESS: 0.013 FOR MANNING'S EQUATION
INFILTRATION RATE:	0.18 LITRES/HECTARE (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 LITRES/HECTARE)	PIPE SIZES: 1.016 IMPERIAL EQUIVALENT FACTOR
POPULATION / UNIT:	3.0 PERSONS	PERCENT FULL: TOTAL PEAK FLOW / CAPACITY
MUNICIPALITY:	CITY OF NIAGARA FALLS	PEAKING FACTOR = when P<1710, PF=4.5
PROJECT :	McLEOD ROAD - FRUITBELT	P>1710, PF=5/((P/1000)^0.2)
PROJECT NO:	2054	

S A N I T A R Y   S E W E R   D E S I G N   S H E E T

LOCATION			**AREA**		**POPULATION**			**ACCUMULATED PEAK FLOW**				**DESIGN FLOW**					
Description	**From M.H**	**To M.H.**	**Increment (hectares)**	**Accumulated (hectares)**	**Population Density (persons/hectare)**	**Population Increment**	**Total Population Served (P)**	**Peaking Factor (PF)**	**Flow (L/s)**	**Infiltration Flow L/s**	**Total Peak Flow (L/s)**	**Pipe Length (m)**	**Pipe Diameter (mm)**	**Pipe Slope (%)**	**Full Flow Velocity (m/s)**	**Full Flow Capacity (L/s)**	**Percent Full**
FORESTVIEW ESTATES SANITARY																	
Original Design Condition																	
Expected Future Development: 16.40 hectares (pop. of 984 persons) of residential land and 10.13 hectares (equivalent pop. of 361 persons) of light industrial land																	
EXPECTED FUTURE DEV.	STUB	S14	26.53	26.53	50.7	1345	1345	4.50	22.42	4.78	27.19		250	0.28	0.6	32.83	82.8%
EMILY BLVD.	S20	S127	10.65	37.18	57.7	615	1960	4.37	31.73	6.69	38.42		300	0.22	0.6	47.32	81.2%
Proposed Condition																	
Proposed Future Development: 22.92 hectares (Proposed 492 dwellings equivalent pop. of 1476 persons) of proposed residential land																	
PROPSED FUTURE DEV.	STUB	S14	22.92	22.92	64.4	1476	1476	4.50	24.60	4.13	28.73		250	0.28	0.6	32.83	87.5%
EMILY BLVD.	S20	S127	10.65	33.57	57.7	615	2091	4.31	33.41	6.04	39.45		300	0.22	0.6	47.32	83.4%

APPENDIX B

Stormwater Management Facility Calculations

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, ON, L2W 1A3
PROJECT NAME: **McLeod Road - Fruitbelt**
PROJECT NO.: **2054**

PROPOSED WET POND CALCULATIONS

Quality Requirements
Drainage Area (ha) = 19.39
Enhanced (m3/ha) = 214
Perm Pool (m3/ha) = 174
Perm Pool Vol (m3) = 3,374
Active Vol (m3) 776
25mm MOE Volume = 2,841
Water Level Elev. = 179.85 m

Quality Orifice
Diameter (m) = 0.150
Cd = 0.65
Invert (m) = 179.85

Outlet Weir
Perimeter Length (m) = 0.60
Inlet Elevation (m) = 180.45

Overflow Spillway
Length (m) = 2.50
Slopes (X:1) = 3.00
Invert (m) = 181.05

Outflow Pipe Orifice
Diameter (m) = 0.300
Cd = 0.65
Invert (m) = 179.85
Obvert (m) = 180.15
Top of Pipe (m) = 180.25

Pond Drawdown Time Calculation (MOE, 2003)
MOE Equation 4.11 Drawdown Coefficient 'C2' = 1,891
MOE Equation 4.11 Drawdown Coefficient 'C3' = 5,816
MOE Equation 4.11 Drawdown Time (h) = **54.8**

Elevation	Increment Depth (m)	Active Depth (m)	Surface Area (m2)	Average Surface Area (m2)	Increment Volume (m3)	Permanent Volume (m3)	Active Volume (m3)	Quality Orifice (m3/s)	Ditch Inlet (m3/s)	Max Pipe Orifice (m3/s)	Overflow Spillway (m3/s)	Total Outflow (m3/s)	Average Discharge (m3/s)
178.35		-1.50	2,110			0							
	0.30			2,345	703								
178.65		-1.20	2,579			703							
	0.30			2,820	846								
178.95		-0.90	3,062			1,549							
	0.30			3,309	993								
179.25		-0.60	3,557			2,542							
	0.30			3,810	1,143								
179.55		-0.30	4,064			3,685							
	0.30			4,367	1,310								
179.85		0.00	4,670			4,995							
179.85		0.00	5,830				0	0.000	0.000	0.000	0.000	0.000	
	0.30			6,103	1,831								0.011
180.15		0.30	6,376				1,831	0.023	0.000	0.064	0.000	0.023	
	0.30			6,656	1,997								0.029
180.45		0.60	6,936				3,828	0.036	0.000	0.129	0.000	0.036	
	0.30			7,223	2,167								0.103
180.75		0.90	7,511				5,995	0.046	0.168	0.170	0.000	0.170	
	0.30			7,805	2,341								0.187
181.05		1.20	8,099				8,336	0.053	0.475	0.204	0.000	0.204	
	0.30			8,456	2,537								0.661
181.35		1.50	8,813				10,873	0.060	0.874	0.232	0.886	1.118	

Notes

1. Quality Orifice flow is the orifice controlling for the 24 hour detention period and uses an orifice formula.
2. Pipe Orifice flow is calcuated using an orifice formula on the pipe from the ditch inlet to the outlet and uses the total head on the orifice.
3. Overflow Weir flow is calculated using a trapezondial weir to convey outflow for less frequent storms through the embankment with an emergency spillway.
4. Total Outflow is calculated by adding the Overflow Spillway with the lowest of Quality Orifice plus Ditch Inlet or Max Pipe Orifice.

APPENDIX C

Stormwater Management Plan. McLeod Road – Fruitbelt (UCC, 2022)

PRELIMINARY STORMWATER MANAGEMENT PLAN

McLEOD ROAD – FRUITBELT

CITY OF NIAGARA FALLS

Prepared by:

Upper Canada Consultants
30 Hannover Drive, Unit 3
St. Catharines, Ontario
L2W 1A3

December 2022

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REFERENCES

1. Stormwater Management Planning and Design Manual
   Ontario Ministry of Environment and Energy (March 2003)

2. Stormwater Quality Best Management Practices
   Ontario Ministry of Environment and Energy (June 1991)

3. MTO Drainage Management Technical Guidelines
   Ontario Ministry of Transportation (November 1989)

4. Winter Maintenance Policy Plan
   City of Niagara Falls (March 2017)

5. Engineering Design Guidelines Manual
   City of Niagara Falls (Amended January 2012)

STORMWATER MANAGEMENT PLAN

McLEOD ROAD - FRUITBELT

CITY OF NIAGARA FALLS

1.0 INTRODUCTION

1.1 Study Area

The proposed development of McLeod Road – Fruitbelt is located in the City of Niagara Falls at the western limit of the City of Niagara Falls. The subject lands are located at 9305 McLeod Road and lands located immediately west to it. As shown in Figure 1, Site Location Plan, the subject property is situated south of McLeod Road and east of Beechwood Road. The subject lands are approximately 22.92 ha in size. There is a reconstructed watercourse (tributary to Thompson Creek) that traverses along the east boundary of the subject lands and separates the subject lands on east side with the neighboring property known as Forestview Estates.

The location of the proposed development has been identified as the headwater for the Thompson Creek Watershed, therefore, no additional flows will be conveyed through the subject property other than flows created by the site. Flows generated by the site are to be reduce below existing levels and will not have adverse effects to the downstream flows. The drainage areas and development contributing to this stormwater management plan consist of strictly the development site and the individual residential lots fronting McLeod Road and Beechwood Road.

1.2 Objectives

The objectives of this study are as follows:

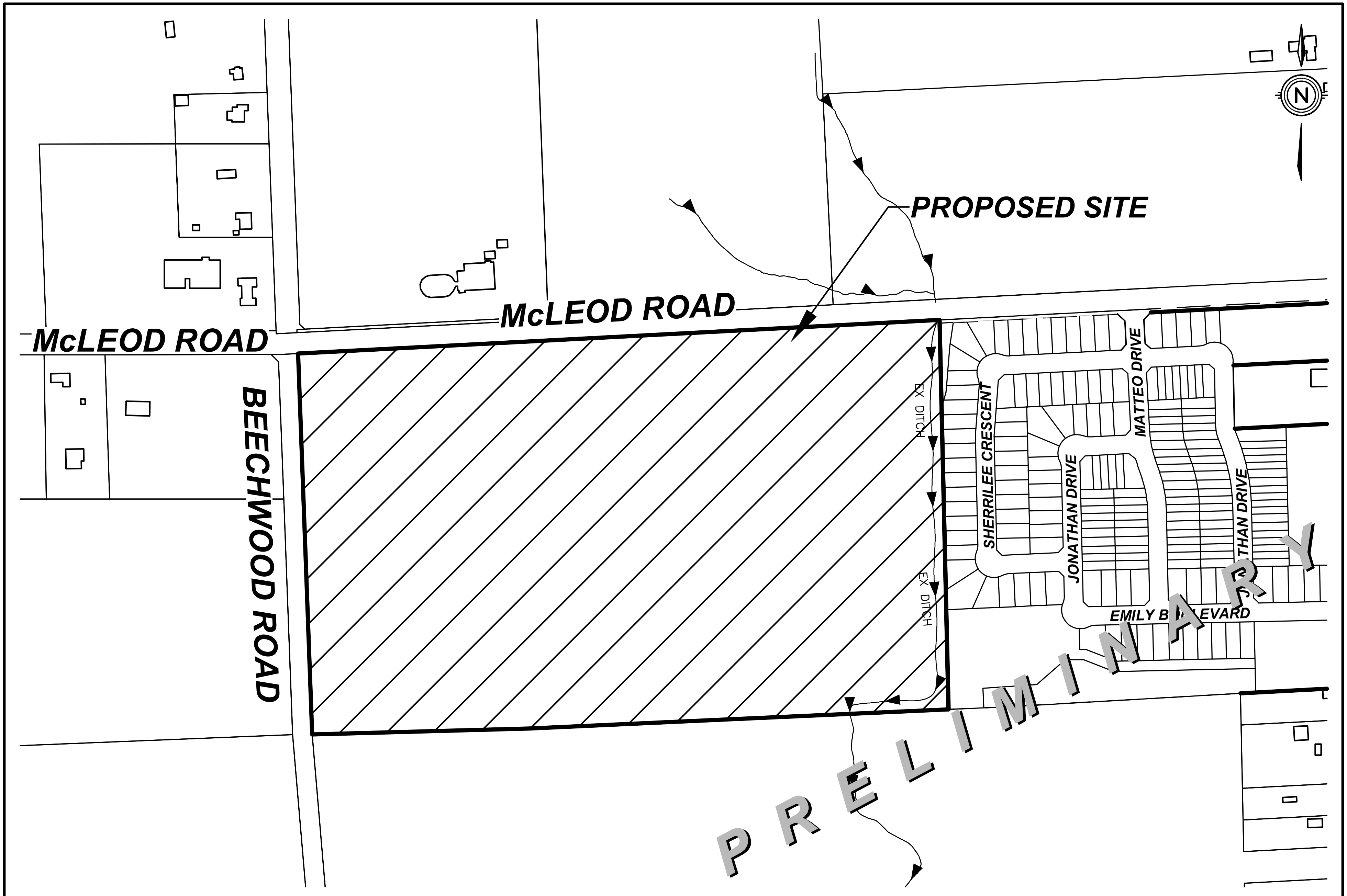
1. Establish specific criteria for the management of stormwater from this site.

2. Determine the impact of this development on the peak flows of from this site.

3. Investigate alternatives for controlling the quantity and quality of stormwater from this site.

4. Recommend a comprehensive plan for the management of stormwater during and after construction.

5. Establish land requirements as part of draft plan of subdivision.



UPPER CANADA CONSULTANTS *ENGINEERS / PLANNERS*	**SITE LOCATION PLAN** *CITY OF NIAGARA FALLS* **MCLEOD ROAD - FRUITBELT**	DATE	2022-12-08
		SCALE	1:5000 m
		REF No.	2054
		DWG No.	FIGURE 1

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1.3 Existing and Future Conditions

a) Existing Conditions

The site is presently vacant agricultural lands and a single residential unit had been demolished recently. The topography of the site conveys flows overland from north to south with three drainage outlets located at the southern portion of the property, which converge and convey flows overland ultimately to tributaries of Thompson Creek.

The native soils in the development areas of these sites consist mainly of lacustrine heavy clays. This soil type in the development and valley areas are classified as imperfectly drained and variably drained, respectively. This soil is classified in the Soil Conservation Service (SCS) classification method as belonging to hydrologic soil group C.

b) Future Conditions

This stormwater management plan will consider the proposed development along with future development of the existing properties fronting McLeod Road and Beechwood Road. The proposed 21.53 hectare development shall consist of approximately 221 single family lots, 129 street town units, 70 back to back town units and 72 Townhouse Condominium units. The remaining 1.38 hectares is comprised of the existing ditch located along the east boundary of the subject lands. The proposed development will be provided with full urban services including sanitary and storm sewers, watermains, asphalt road with concrete curb and gutters.

2.0 STORMWATER MANAGEMENT CRITERIA

New developments are required to provide stormwater management in accordance with provincial and municipal policies including:

- Stormwater Quality Guidelines for New Development (MECP/MNR, May 1991)
- Stormwater Management Planning and Design Manual (MECP, March 2003)

The site currently outlets to three different outlets located on the southern boundary of the subject property, which convey flows south to a tributary of Thompsons Creek and ultimately the Welland River. This drainage system is considered a Type 2 fish habitat. Based on this fish habitat, the corresponding MECP Level of Protection for stormwater management quality practices is Normal.

In addition, staff at the Region of Niagara and the NPCA have brought forth concerns regarding the possibility of dissolved stormwater contaminants (e.g. road salts) being conveyed through the SWMF and ultimately outletting to the PSW.

Based on the above policies and site specific considerations, the following stormwater management criteria have been established for this site.

a. Stormwater **quality** controls are to be provided for the more frequent storm events to provide Enhanced Protection in accordance with MECP guidelines.

b. Additional Stormwater **quality** controls are not required in reference to concerns brought forth regarding road salt. Within the City of Niagara Falls Winter Maintenance Policy Plan (March 8, 2017), Section 5 of the plan states “Salt is not used within residential areas”. The City of Niagara Falls only applies road salt on Class 2 and 3 roadways (Arterial/Collector and Collector/Transit Roadways). Within residential areas, the City of Niagara Falls spreads sand, the provide Enhanced Protection proposed for the SWMF shall allow the sand (suspended solid) adequate settling time.

c. Stormwater **quantity** controls are to be provided as follows:

   i. Erosion control to be provided in accordance with MECP guidelines. The guidelines require the storm runoff from a 25mm rainfall event to be detained for 24 hours.

   ii. Quantity controls will be provided to control future site peak flows to existing levels at the existing outlet for various storm events up to the 100 year design storm event.

3.0 STORMWATER ANALYSIS

Stormwater flows and volumes for the existing and future conditions were estimated using the MIDUSS computer modelling program. This program was selected because it is applicable to an urban drainage area like the study area. This program is relatively easy to use and modify for the future drainage conditions and control facilities, and it readily allows for the use of design storm hyetographs for the various return periods being investigated.

3.1 Design Storms

Design storm hyetographs were developed using a 4 hour Chicago distribution based on the City of Niagara Falls Intensity-Duration Frequency (IDF) Curves. The 25mm rainfall data is a generic design storm for the purpose of generating 25mm of rainfall over a 4 hour Chicago distribution. Table 1 summarizes the rainfall data.

Table 1. Rainfall Data

Design Storm (Return Period)	Distribution Parameters			Duration (minutes)
	Chicago Design Storm Parameters			
	a	b	c	
25mm	512.00	6.00	0.800	240
5 Year	719.50	6.34	0.769	240
100 Year	1264.60	7.72	0.781	240

3.2 Existing Conditions

The existing conditions were modelled to establish the stormwater peak flows and volumes prior to any development in this subwatershed. The existing drainage area for this subwatershed are shown on Figure 2. This area was determined from field investigations and recent topographic surveys. Existing drainage area A1, B1 and C1 ouletting to the Outlet A, B and C respectively as shown in Figure 2. Input parameters for the computer model for the existing conditions are shown in Table 2. Table 3 shows the stormwater peak flows and volumes generated by the various design storm events.

3.3 Proposed Conditions

It is proposed to convey stormwater from the proposed development to the existing ditch at the south-east end of the property ultimately draining to Outlet A. The proposed drainage area for the development are shown in Figure 3, were modelled to establish the stormwater peak flows and volumes once development has been completed within the associated drainage areas. A general imperviousness value of 64.3% has been assumed for the future residential development within the associated drainage area to determine the capacity of future stormwater management facility.

Proposed drainage area A10 will collect and convey the future stormwater flows from the proposed future development on the subject lands to the Outlet A. Drainage area A11 will collect future stormwater from the backyards of the proposed development fronting on the McLeod Road, and along the existing ditch on the subject lands including the existing ditch on the subject lands to Outlet A. The future stormwater flows from the proposed development of the area C10, fronting on the Beechwood Road will drain to the existing roadside ditch on the east of the Beechwood Road to Outlet C.

The future stormwater flows from the proposed future development on the subject lands to the area A10 and C10 will be from the backyards of the proposed developments. Therefore, future stormwater flows from the proposed drainage areas A10 and C10 are considered uncontrolled and does not require quantity control. Input parameters for the computer model for proposed development conditions are shown in Table 2. The results of this modelling are shown in Table 3 for the various design storm events.

Table 2. Hydrologic Parameters

Subcatchment No.	Area (ha)	Length (m)	Slope (%)	Impervious (%)	SCS CN
Existing Conditions					
A1	15.89	325.5	1.0	1.5	74
B1	5.72	195.3	1.0	1.0	74
C1	2.29	123.6	1.0	4.4	74
	23.9	**Total Area**			
Future Conditions					
A10	3.71	157.3	1.0	5.75	74
A11	19.39	359.5	1.0	64.3	74
C10	0.79	72.6	1.0	12.8	74
	23.9	**Total Area**			

The future stormwater flows from the Outlet B will be directed to Outlet A. Therefore, there will be no future stormwater flows from the proposed development on the subject lands to Outlet B. However, there will be increased stormwater flows at Outlet A. As shown in Table 3, the future peak flows to the Outlet A are increased above existing levels in the 5 and 100 year design storm event. Therefore, stormwater management quantity controls are required for the future stormwater flows discharging from the site to Outlet A. Also, the future peak flows to the Outlet C are reduced below the existing levels and hence does not require quantity control. The detailed MIDUSS modelling output files have been enclosed in Appendix B for reference.

Table 3. Peak Flow and Volume Comparisons

Design Storm	Peak Flow (m^3/s)			Volume (m^3)		
	Existing	Future	Change	Existing	Future	Change
Outlet A						
5 Year	0.102	1.999	+1859.8%	1,464	5,492	+4,028
100 Year	0.399	3.257	+716.3%	3,860	9,475	+5,615
Outlet B						
5 Year	0.047	0	-100%	519	0	-519
100 Year	0.182	0	-100%	1377	0	-1377
Outlet C						
5 Year	0.024	0.017	-29.2%	228	97	-131
100 Year	0.091	0.041	-54.9%	581	226	-355

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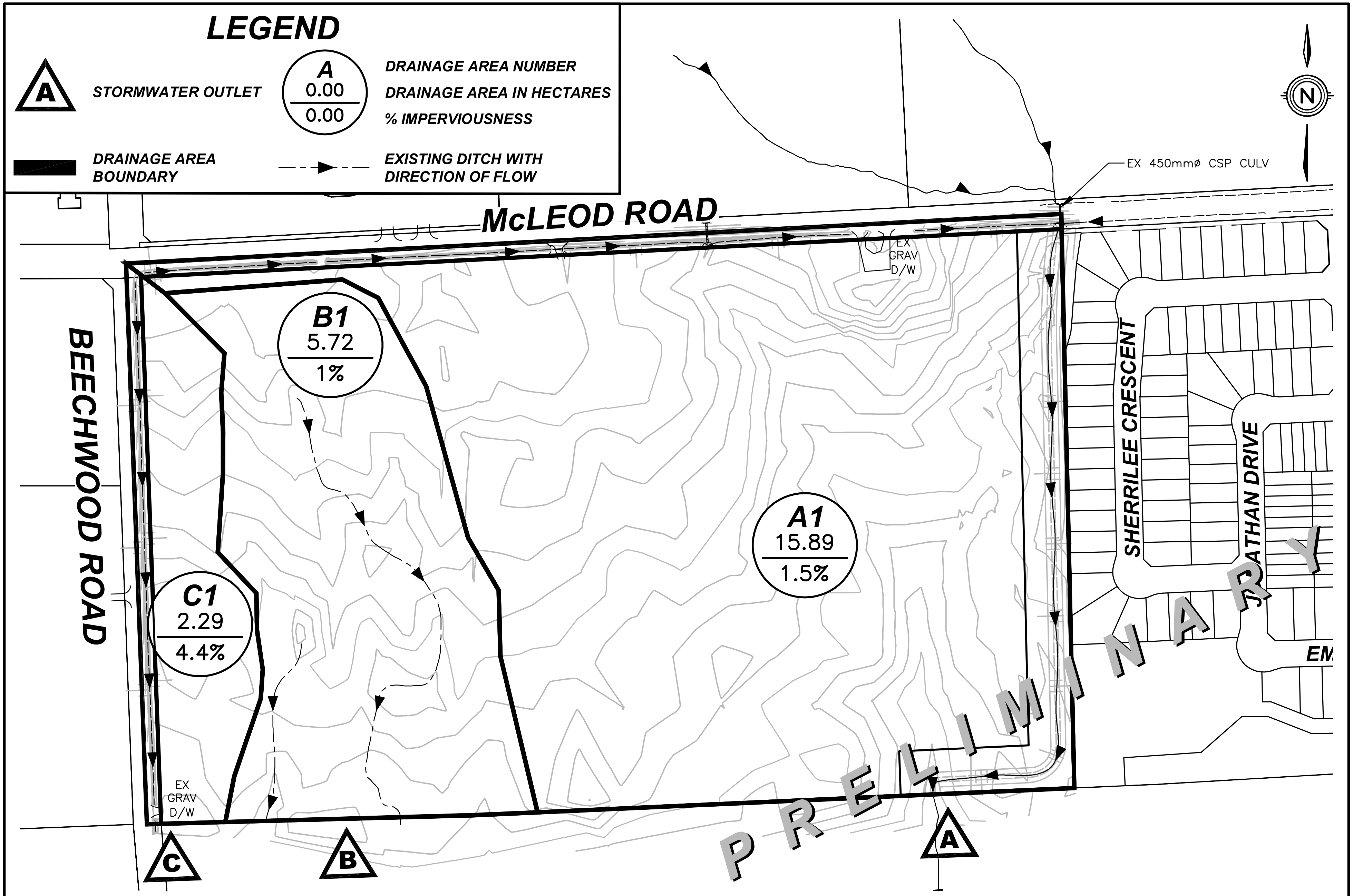

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EXISTING STORM DRAINAGE AREAS
CITY OF NIAGARA FALLS
MCLEOD ROAD - FRUITBELT

DATE	2022-12-07
SCALE	1:3500 m
REF No.	2054
DWG No.	FIGURE 2

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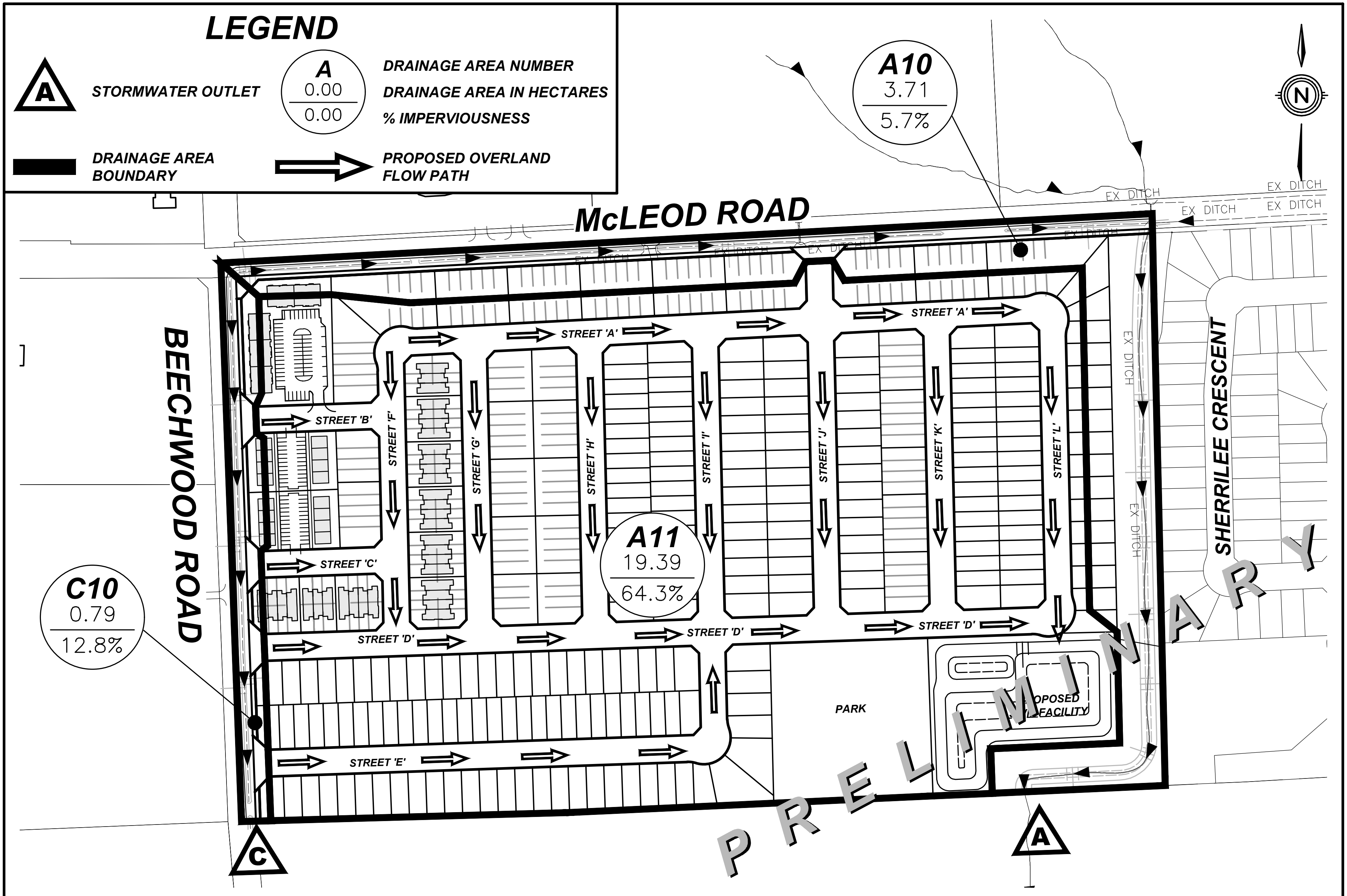

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

PROPOSED STORM DRAINAGE AREAS
CITY OF NIAGARA FALLS
MCLEOD ROAD - FRUITBELT

DATE	2023-03-17
SCALE	1:3500 m
REF No.	2054
DWG No.	FIGURE 3

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4.0 STORMWATER MANAGEMENT ALTERNATIVES

4.1 Screening of Stormwater Management Alternatives

A variety of stormwater management alternatives are available to control the quality of stormwater, most of which are described in the Stormwater Management Planning and Design Manual (MECP, March 2003). Alternatives for the proposed and ultimate developments were considered in the following broad categories: lot level, vegetative, infiltration, and end-of-pipe controls. General comments on each category are provided below. Individual alternatives for the proposed development are listed in Table 4 with comments on their effectiveness and applicability to the proposed outlet.

a) Lot Level Controls

Lot level controls are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

b) Vegetative Alternatives

Vegetative stormwater management practices are not generally suitable as the primary control facility for quality control. They are generally used enhance stormwater quality in conjunction with other types of control facilities.

c) Infiltration Alternatives

Where soils are suitable, infiltration techniques can be very effective in providing quantity and quality control. However, the very small amount of surface area on this site dedicated to permeable surfaces such as greenspace and landscaping make this an impractical option. Therefore, infiltration techniques will not be considered for this development.

d) End-of-Pipe Alternatives

Surface storage techniques can be very effective in providing quality and quantity control. Dry facilities are effective practices for stormwater erosion and flood control for large drainage areas.

Wet facilities are effective practices for stormwater erosion, quality and quantity control for large drainage areas.

Table 4. Evaluation of Stormwater Management Practices

McLeod Road - Fruitbelt	Criteria for Implementation of Stormwater Management Practices (SWMP)					Technical Effectiveness (10 high)	Recommend Implementation Yes / No	Comments
	Topography	**Soils**	**Bedrock**	**Groundwater**	**Area**			
Site Conditions	***Variable 1 to 3%***	***Silty Sand ±13.3mm/hr***	***At Considerable Depth***	***At Considerable Depth***	***± 12.60ha***			
Lot Level Controls								
Lot Grading	<5%	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Leaders to Surface	nlc	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Ldrs.to Soakaway Pits	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	6	No	Unsuitable site conditions
Sump Pump Fdtn. Drains	nlc	nlc	nlc	nlc	nlc	2	No	Unsuitable site conditions
Vegetative								
Grassed Swales	< 5 %	nlc	nlc	nlc	nlc	7	Yes	Quality/quantity benefits
Filter Strips(Veg. Buffer)	< 10 %	nlc	nlc	>.5m Below Bottom	< 2 ha	5	No	Unsuitable site conditions
Infiltration								
Infiltration Basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 5 ha	2	No	Unsuitable site conditions
Infiltration Trench	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 2 ha	4	No	Unsuitable site conditions
Rear Yard Infiltration	< 2.0 %	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	7	No	Unsuitable site conditions
Perforated Pipes	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	4	No	Unsuitable site conditions
Pervious Catch basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	3	No	Unsuitable site conditions
Sand Filters	nlc	nlc	nlc	>.5m Below Bottom	< 5 ha	5	No	High maintenance/poor aesthetics
Surface Storage								
Dry Ponds	nlc	nlc	nlc	nlc	> 5 ha	7	No	No quality control
Wet Ponds	nlc	nlc	nlc	nlc	> 5 ha	9	Yes	Very effective quality control
Wetlands	nlc	nlc	nlc	nlc	> 5 ha	9	No	Very effective quality control
Other								
Oil/Grit Separator	nlc	nlc	nlc	nlc	<2 ha	3	No	Limited benefit/area too large

Reference: Stormwater Management Practices Planning and Design Manual - 1994
nlc - No Limiting Criteria

4.2 Selection of Stormwater Management Alternatives

Stormwater management alternatives were screened based on technical effectiveness, physical suitability for this site, and their ability to meet the stormwater management criteria established for proposed and future development areas. The following stormwater management alternatives are recommended for implementation on the proposed development:

- **Lot grading** to be kept as flat as practical in order to slow down stormwater and encourage infiltration.

- **Roof leaders to be discharged to the ground surface** in order to slow down stormwater and encourage infiltration.

- **Grassed swales** to be used to collect rear lot drainage. Grassed swales tend to filter sediments and slow down the rate of stormwater.

- A **wet pond facility** to be constructed to provide stormwater quality enhancement for frequent storms and quantity controls up to and including the 100 year design storm event.

5.0 STORMWATER MANAGEMENT PLAN

5.1 Proposed Stormwater Management Facility

5.1.1 Stormwater Quality

The stormwater drainage outlet for the proposed development is existing ditch on the subject land that outlets to Outlet A, which has been identified by the Mniistry of natural Resources watercourse evaluation as an Important fish habitat. Additionally, as per the recommendation from the Region of Niagara and NPCA the Enhanced protection (80% TSS Removal) will be provided to the receiving existing ditch.

Based on Table 3.2 of SWMP & Design Manual, the water quality storage requirement is approximately 214m^3/ha for *Enhanced* protection for developments with 65% impervious areas. The drainage area requiring stormwater quality improvement draining to the proposed facility is 19.39 hectares. The storage volumes required for this proposed facility are shown in Table 5.

Table 5. Stormwater Quality Volume Calculations

Total Water Quality Volume = 19.39 ha x 214 m^3/ha = 4,150 m^3	Reference: Table 3.2, SWMP & Design Manual (MECP 2003)
Permanent Pool Volume = 19.39 ha x 174 m^3/ha = 3,374 m^3	**Extended Detention Volume** = 19.39 ha x 40 m^3/ha = 776 m^3

5.1.2 Stormwater Quantity Control

As shown in the previous Table 3, stormwater management quantity controls are required to reduce future peak flows from the development area to existing levels up to and including the 100-year design storm event. The stormwater peak flows from the proposed development shall be reduced to the existing levels by providing stormwater quantity storage. It is proposed to construct a control structure outlet to reduce the peak stormwater flows outletting from the proposed facility.

5.1.3 Stormwater Management Facility Configuration

It is proposed to construct a two-stage outlet to provide the required stormwater quantity controls. The first stage of control consists of a reverse slope pipe acting as an orifice to control future stormwater flows generated from frequent storm events. The second stage of control consists of an outlet weir which provides an outlet for flows exceeding the required extended detention volume. An emergency spillway will provide an outlet for major storm events.

The proposed bottom elevation of the facility is 178.35m, and the permanent pool water level is 179.85m for a water depth of 1.50m. The configuration of the facility provides 4,995m^3 of permanent pool volume, which is more than the required 4,150m^3. The proposed top of pond is at an elevation of 181.35m, providing a total active storage volume of 10,873m^3.

Based on the proposed configuration of the proposed facility, it was determined that a 150mm diameter reverse slope pipe, functioning as an orifice with an invert of 179.85m within the ditch inlet, provides 54.8 hours of detention which is greater than the minimum 24 hours required in accordance with MECP guidelines. A stage-storage-discharge relationship was determined for the facility and is included in Appendix A.

Overland flows from the subject lands and external drainage area shall be directed to the proposed stormwater management facility through the proposed internal roadways. The preliminary foot print of the proposed wet pond facility is shown in Figure 4.

A sediment forebay was designed to minimize the transport of heavy sediment through the facility to the Gavora Ditch and to localize future maintenance activities. Calculations for the forebay sizing follow MECP Guidelines and are shown in Table 6.

Table 3. Ultimate Stormwater Management Facility Forebay Sizing

a) Forebay Settling Length (MOE SWMP&D, Equation 4.5)

$$Settling\ Length = \sqrt{\left(\frac{r \times Q}{V_s}\right)}$$

r =	5.8	:1	(Length:Width Ratio)
Q_p =	0.026	m^3/s	(25mm Storm Pond Discharge)
V_s =	0.0003	m/s	(Settling Velocity)

Settling Length = **22.48** **m**

b) Dispersion Length (MOE SWMP&D, Equation 4.6)

$$Dispersion\ Length = \frac{8 \times Q}{D \times V_f}$$

Q =	1.961	m^3/s	(5 Yr Stm Sew Design Inflow)
D =	1.50	m	(Depth of Forebay)
V_f =	0.5	m/s	(Desired Velocity)

Dispersion Length = **20.92** **m**

c) Minimum Forebay Deep Zone Bottom Width (MOE SWMP&D), Equation 4.7)

$$Width = \frac{Min. Forebay\ Length}{8}$$

22.48 m (minimum required length)

Width = **2.81** **m** (minimum required width)

d) Average Velocity of Flow

$$Average\ Velocity = \frac{Q}{A}$$

Q =	1.103	m^3/s	(25mm Storm Design Inflow)
A =	15.75	m^2	(Cross Sectional Area)
D =	1.50	m	(Depth of Forebay)
W =	6.00	m	(Proposed Bottom Width)
SS =	3	:1	(Side Slopes - Minimum)

Average Velocity = **0.07** **m/s**

Is this Acceptable? **Yes** (Maximum velocity of flow = 0.15 m/s)

c) Cleanout Frequency

Is this Acceptable? **Yes**

L =	35.0	m	(Proposed Bottom Length)
ASL =	2.5	m^3/ha	(Annual Sediment Loading)
A =	19.39	ha	(Drainage Area)
FRC =	80	%	(Facility Removal Efficiency)
FV =	652.5	m^3	(Forebay Volume)

Cleanout Frequency = **10.8** **Years**

Is this Acceptable? **Yes** (10 Year Minimum Cleanout Frequency)

Table 7 summarizes the peak flows discharging to and from the proposed wet pond facility in the 5 and 100 year design storm event. As shown in the below table, the maximum wet pond elevation reaches 180.93m, with utilized active storage volume of 7,425 m^3 for the 100 year design storm event.

Table 7. Stormwater Management Wet Pond Facility Characteristics

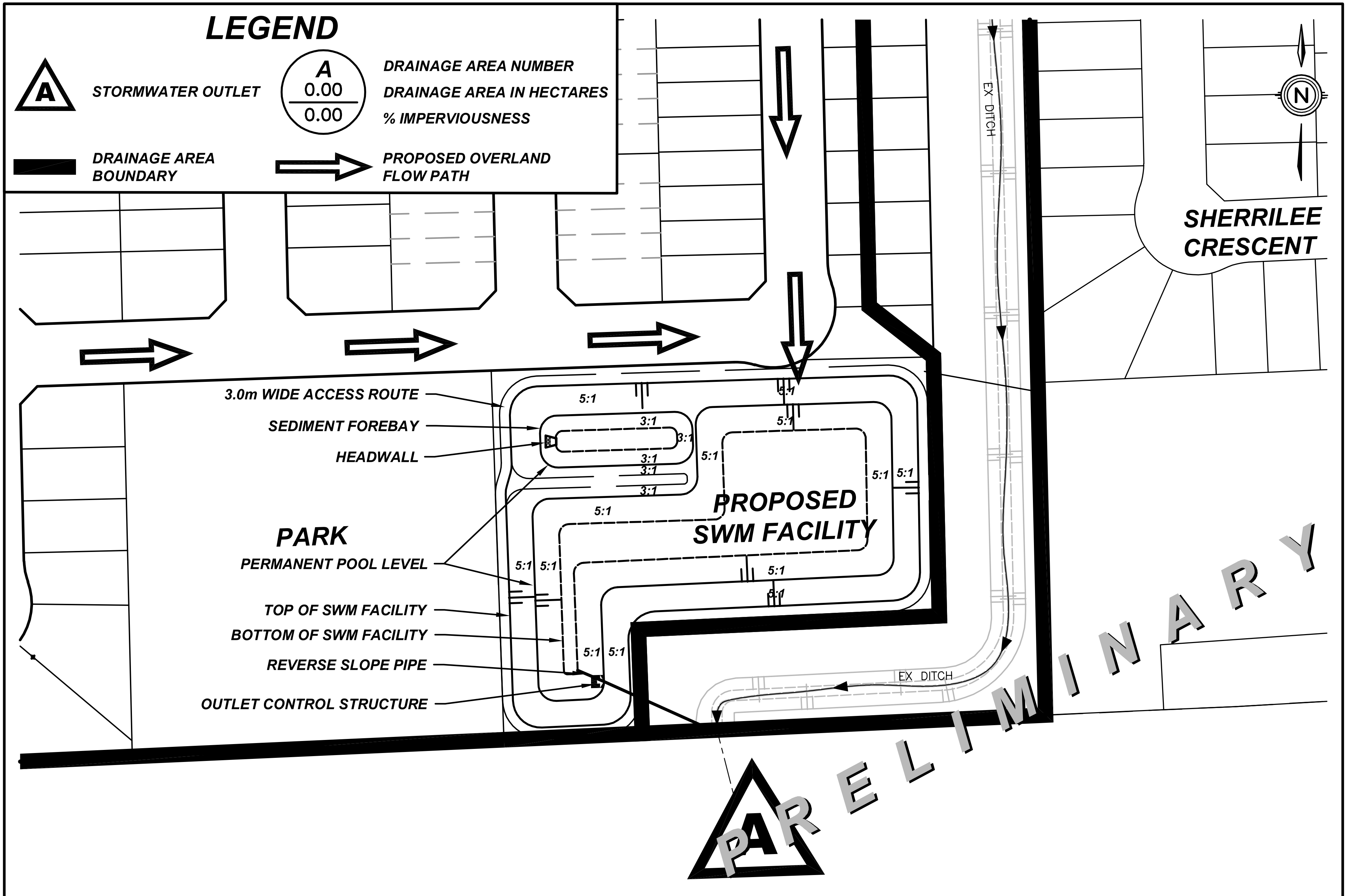
Design Storm (Return Period)	Peak Flows (m^3/s)		Maximum Elevation (m)	Maximum Volume (m^3)
	Inflow	Outflow		
5 Year	1.960	0.066	180.52	4,321
100 Year	3.257	0.189	180.92	7,301

Table 8. Impacts of Wet Pond Facility on Future Peak Flows at Outlet A

Design Storm	Peak Flow (m^3/s)		
	Existing	Future with SWM	Change*
5 Year	0.102	0.081	-20.6%
100 Year	0.399	0.299	-25.1%

Note: *indicates the percent change between existing conditions and future conditions with stormwater management controls in place.

As shown in Table 8 above, the proposed stormwater management facility can provide adequate stormwater quantity controls to reduce future peak stormwater flows below existing levels to Outlet A up to and including the 100 year design storm event.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

PROPOSED SWM FACILITY
CITY OF NIAGARA FALLS
MCLEOD ROAD - FRUITBELT

DATE	2022–12–07
SCALE	1:1500 m
REF No.	2054
DWG No.	FIGURE 4

DRAWING FILE: F:\2054\SWM\2054_CP-10.dwg PLOTTED: Dec 07, 2022 – 3:14pm PLOTTED BY: keyur

6.0 SEDIMENT AND EROSION CONTROL

Sediment and erosion controls are required during construction. The proposed extended detention facilities can be used for this purpose. Therefore, the proposed constructed wet pond facilities should be constructed prior to development of the remainder of the site. Runoff from the site can then be directed to the facility for sediment control during construction. Following construction, the accumulated sediments will be removed from the facilities and disposed at an appropriate dumping location.

The following additional erosion and sediment controls will also be implemented during construction:

- Install silt control fencing along the limits of construction where overland flows will flow beyond the limits of the development or into a downstream watercourse.

- Re-vegetate disturbed areas as soon as possible after grading works have been completed.

- Lot grading and siltation controls plans will be provided with sediment and erosion control measures to the appropriate agencies for approval during the final design stage.

7.0 STORMWATER MANAGEMENT FACILITY MAINTENANCE

7.1 Wet Pond Facility

Maintenance is a necessary and important aspect of urban stormwater quality and quantity measures such as constructed wetlands. Many pollutants (i.e. nutrients, metals, bacteria, etc.) bind to sediment and therefore removal of sediment on a scheduled basis is required.

The wet pond for this development is subject to frequent wetting and deposition of sediments as a result of frequent low intensity storm events. The purpose of the wet pond is to improve post development sediment and contaminant loadings by detaining the 'first flush' flow for a 24-hour period. For the initial operation period of the stormwater management facility, the required frequency of maintenance is not definitively known and many of the maintenance tasks will be performed on an 'as required' basis. For example, during the home construction phase of the development there will be a greater potential for increased maintenance frequency, which depends on the effectiveness of sediment and erosion control techniques employed.

Inspections of the wet pond will indicate whether or not maintenance is required. Inspections should be made after every significant storm during the first two years of operation or until all development is completed to ensure the wet pond is functioning properly. This may translate into an average of six inspections per year. Once all building activity is finalized, inspections shall be performed annually. The following points should be addressed during inspections of the facility.

a) Standing water above the inlet storm sewer invert a day or more after a storm may indicate a blockage in the reverse slope pipe or orifice. The blockage may be caused by trash or sediment and a visual inspection would be required to determine the cause.

b) The vegetation around the wet pond should be inspected to ensure its function and aesthetics. Visual inspections will indicate whether replacement of plantings are required. A decline in vegetation habitat may indicate that other aspects of the constructed wet pond are operating improperly, such as the detention times may be inadequate or excessive.

c) The accumulation of sediment and debris at the wet pond inlet sediment forebay or around the high-water line of the wet pond should be inspected. This will indicate the need for sediment removal or debris clean up.

d) The wet pond has been created by excavating a detention area. The integrity of the embankments should be periodically checked to ensure that it remains watertight and the side slopes have not sloughed.

Grass cutting is a maintenance activity that is done solely for aesthetic purposes. It is recommended that grass cutting be eliminated. It should be noted that municipal by-laws may require regular grass maintenance for weed control.

Trash removal is an integral part of maintenance and an annual clean-up, usually in the spring, is a minimum requirement. After this, trash removal is performed as required basis on observation of trash build-up during inspections.

To ensure long term effectiveness, the sediment that accumulates in the forebay area should be removed periodically to ensure that sediment in not deposited throughout the facility. For sediment removal operations, typical grading/excavating equipment should be used to remove sediment from the inlet forebay and detention areas. Care should be taken to ensure that limited damage occurs to existing vegetation and habitat.

Generally, the sediment which is removed from the detention pond will not be contaminated to the point that it would be classified as hazardous waste. However, the sediment should be tested to determine the disposal options.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, the following conclusions are offered:

- Infiltration techniques are not suitable for this site as the primary control facility due to the low soil infiltration rates and the large drainage area for this development.
- Roof water leaders shall discharge to grade to enhance future infiltration levels.
- The proposed stormwater management facility will provide stormwater quality and quantity controls for the approximately 19.39 hectare catchment area.
- Various lot level vegetative stormwater management practices can be implemented to enhance stormwater quality.
- This report was prepared in accordance with the provincial guidelines contained in “Stormwater Management Planning and Design Manual, March 2003”.

The above conclusions lead to the following recommendations:

- That the stormwater management criteria established in this report be accepted.
- That a stormwater management wet pond facility be constructed to provide stormwater quality protection to MECP Enhanced Protection levels and quantity controls up to and including the 100 year design storm event, as outlined in this report.
- That additional lot level controls and vegetative stormwater management practices as described previously in this report be implemented.
- That sediment and erosion controls during construction as described in this report be implemented.

Prepared By:

Keyur Prajapati, E.I.T.
December 8, 2022

Reviewed By:

Adam Keane, P. Eng.
December 8, 2022

APPENDICES

APPENDIX A

Stormwater Management Facility Calculations

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, ON, L2W 1A3
PROJECT NAME: **McLeod Road - Fruitbelt**
PROJECT NO.: **2054**

PROPOSED WET POND CALCULATIONS

Quality Requirements

Drainage Area (ha) = 19.39
Enhanced (m3/ha) = 214
Perm Pool (m3/ha) = 174
Perm Pool Vol (m3) = 3,374
Active Vol (m3) 776
25mm MOE Volume = 2,841
Water Level Elev. = 179.85 m

Quality Orifice

Diameter (m) = 0.150
Cd = 0.65
Invert (m) = 179.85

Outlet Weir

Perimeter Length (m) = 0.60
Inlet Elevation (m) = 180.45

Overflow Spillway

Length (m) = 2.50
Slopes (X:1) = 3.00
Invert (m) = 181.05

Outflow Pipe Orifice

Diameter (m) = 0.300
Cd = 0.65
Invert (m) = 179.85
Obvert (m) = 180.15
Top of Pipe (m) = 180.25

Pond Drawdown Time Calculation (MOE, 2003)

MOE Equation 4.11 Drawdown Coefficient 'C2' = 1,891
MOE Equation 4.11 Drawdown Coefficient 'C3' = 5,816
MOE Equation 4.11 Drawdown Time (h) = **54.8**

Elevation	Increment Depth (m)	Active Depth (m)	Surface Area (m2)	Average Surface Area (m2)	Increment Volume (m3)	Permanent Volume (m3)	Active Volume (m3)	Quality Orifice (m3/s)	Ditch Inlet (m3/s)	Max Pipe Orifice (m3/s)	Overflow Spillway (m3/s)	Total Outflow (m3/s)	Average Discharge (m3/s)
178.35		-1.50	2,110			0							
	0.30			2,345	703								
178.65		-1.20	2,579			703							
	0.30			2,820	846								
178.95		-0.90	3,062			1,549							
	0.30			3,309	993								
179.25		-0.60	3,557			2,542							
	0.30			3,810	1,143								
179.55		-0.30	4,064			3,685							
	0.30			4,367	1,310								
179.85		0.00	4,670			4,995							
179.85		0.00	5,830				0	0.000	0.000	0.000	0.000	0.000	
	0.30			6,103	1,831								0.011
180.15		0.30	6,376				1,831	0.023	0.000	0.064	0.000	0.023	
	0.30			6,656	1,997								0.029
180.45		0.60	6,936				3,828	0.036	0.000	0.129	0.000	0.036	
	0.30			7,223	2,167								0.103
180.75		0.90	7,511				5,995	0.046	0.168	0.170	0.000	0.170	
	0.30			7,805	2,341								0.187
181.05		1.20	8,099				8,336	0.053	0.475	0.204	0.000	0.204	
	0.30			8,456	2,537								0.661
181.35		1.50	8,813				10,873	0.060	0.874	0.232	0.886	1.118	

Notes

1. Quality Orifice flow is the orifice controlling for the 24 hour detention period and uses an orifice formula.
2. Pipe Orifice flow is calcuated using an orifice formula on the pipe from the ditch inlet to the outlet and uses the total head on the orifice.
3. Overflow Weir flow is calculated using a trapezondial weir to convey outflow for less frequent storms through the embankment with an emergency spillway.
4. Total Outflow is calculated by adding the Overflow Spillway with the lowest of Quality Orifice plus Ditch Inlet or Max Pipe Orifice.

APPENDIX B

MIDUSS Output Files

B-1. Existing Conditions

```
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            24   144    10.000        are MAXDT MAXHYD & DTMIN values
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 35     COMMENT
       4     line(s) of comment
        STORMWATER MANAGEMENT PLAN
        MCLEOD ROAD FRUITBELT
        CITY OF NIAGARA FALLS
        EXISTING CONDITIONS
 35     COMMENT
       3     line(s) of comment
        ***********
        25mm STORM EVENT
        ***********
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      512.000     Coefficient  a
        6.000     Constant  b    (min)
         .800     Exponent  c
         .450     Fraction to peak  r
      240.000     Duration ó  240 min
               25.035 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015     Manning "n"
       98.000     SCS Curve No or C
         .100     Ia/S Coefficient
         .518     Initial Abstraction
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A1 to Outlet A
        ***********
  4     CATCHMENT
        1.000     ID No.ó 99999
       15.890     Area in hectares
      325.500     Length (PERV) metres
        1.000     Gradient (%)
        1.530     Per cent Impervious
      325.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .023       .000       .000       .000 c.m/s
               .098       .805       .109     C perv/imperv/total
 15     ADD RUNOFF
               .023       .023       .000       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .4344443E+03 c.m
 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area B1 to Outlet B
        ***********
  4     CATCHMENT
        2.000     ID No.ó 99999
        5.720     Area in hectares
      195.300     Length (PERV) metres
        1.000     Gradient (%)
        1.000     Per cent Impervious
      195.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .009       .000       .000       .000 c.m/s
               .098       .806       .105     C perv/imperv/total
 15     ADD RUNOFF
               .009       .009       .000       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
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 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area C1 to Outlet C
        ***********
  4     CATCHMENT
        3.000     ID No.ó 99999
        2.290     Area in hectares
      123.600     Length (PERV) metres
        1.000     Gradient (%)
        4.410     Per cent Impervious
      123.600     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .010       .000       .000       .000 c.m/s
               .098       .797       .129     C perv/imperv/total
 15     ADD RUNOFF
               .010       .010       .000       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
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       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        5-YEAR STORM EVENT
        ***********
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      719.500     Coefficient  a
        6.340     Constant  b    (min)
         .769     Exponent  c
         .450     Fraction to peak  r
      240.000     Duration ó  240 min
               41.683 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015     Manning "n"
       98.000     SCS Curve No or C
         .100     Ia/S Coefficient
         .518     Initial Abstraction
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A1 to Outlet A
        ***********
  4     CATCHMENT
        1.000     ID No.ó 99999
       15.890     Area in hectares
      325.500     Length (PERV) metres
        1.000     Gradient (%)
        1.530     Per cent Impervious
      325.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1       Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
               .102       .000       .000       .000 c.m/s
               .211       .869       .221     C perv/imperv/total
 15     ADD RUNOFF
               .102       .102       .000       .000 c.m/s
 27     HYDROGRAPH DISPLAY
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       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area B1 to Outlet B
        ***********
  4     CATCHMENT
        2.000     ID No.ó 99999
        5.720     Area in hectares
      195.300     Length (PERV) metres
        1.000     Gradient (%)
        1.000     Per cent Impervious
      195.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1       Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
               .047       .000       .000       .000 c.m/s
               .211       .871       .218     C perv/imperv/total
 15     ADD RUNOFF
               .047       .047       .000       .000 c.m/s
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       5     is # of Hyeto/Hydrograph chosen
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       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area C1 to Outlet C
        ***********
  4     CATCHMENT
        3.000     ID No.ó 99999
        2.290     Area in hectares
      123.600     Length (PERV) metres
        1.000     Gradient (%)
        4.410     Per cent Impervious
      123.600     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1       Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
               .024       .000       .000       .000 c.m/s
               .211       .856       .239     C perv/imperv/total
 15     ADD RUNOFF
               .024       .024       .000       .000 c.m/s
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       5     is # of Hyeto/Hydrograph chosen
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       3     line(s) of comment
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```
          100-YEAR STORM EVENT
          ************
   2      STORM
              1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       1264.600      Coefficient  a
          7.720      Constant  b    (min)
           .781      Exponent  c
           .450      Fraction to peak  r
        240.000      Duration ó  240 min
                   68.280 mm     Total depth
   3      IMPERVIOUS
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .015      Manning "n"
         98.000      SCS Curve No or C
           .100      Ia/S Coefficient
           .518      Initial Abstraction
  35      COMMENT
         3     line(s) of comment
          ***********
          Area A1 to Outlet A
          ***********
   4      CATCHMENT
          1.000      ID No.ó 99999
         15.890      Area in hectares
        325.500      Length (PERV) metres
          1.000      Gradient (%)
          1.530      Per cent Impervious
        325.500      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         74.000      SCS Curve No or C
           .100      Ia/S Coefficient
          8.924      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                 .399       .000       .000       .000 c.m/s
                 .347       .920       .356     C perv/imperv/total
  15      ADD RUNOFF
                 .399       .399       .000       .000 c.m/s
  27      HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .3860197E+04 c.m
  14      START
         1     1=Zero; 2=Define
  35      COMMENT
         3     line(s) of comment
          ***********
          Area B1 to Outlet B
          ***********
   4      CATCHMENT
          2.000      ID No.ó 99999
          5.720      Area in hectares
        195.300      Length (PERV) metres
          1.000      Gradient (%)
          1.000      Per cent Impervious
        195.300      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         74.000      SCS Curve No or C
           .100      Ia/S Coefficient
          8.924      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                 .182       .000       .000       .000 c.m/s
                 .347       .901       .353     C perv/imperv/total
  15      ADD RUNOFF
                 .182       .182       .000       .000 c.m/s
  27      HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .1377293E+04 c.m
  14      START
         1     1=Zero; 2=Define
  35      COMMENT
         3     line(s) of comment
          ***********
          Area C1 to Outlet C
          ***********
   4      CATCHMENT
          3.000      ID No.ó 99999
          2.290      Area in hectares
        123.600      Length (PERV) metres
          1.000      Gradient (%)
          4.410      Per cent Impervious
        123.600      Length (IMPERV)
           .000      %Imp. with Zero Dpth
              1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
         74.000      SCS Curve No or C
           .100      Ia/S Coefficient
          8.924      Initial Abstraction
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                 .091       .000       .000       .000 c.m/s
                 .347       .909       .372     C perv/imperv/total
  15      ADD RUNOFF
                 .091       .091       .000       .000 c.m/s
  27      HYDROGRAPH DISPLAY
         5     is # of Hyeto/Hydrograph chosen
          Volume  =  .5813172E+03 c.m
  20      MANUAL
```

B-2. Future Conditions without SWM

```
        Output File (4.7) FUT.OUT      opened 2022-12-08  11:08
        Units used are defined by G =     9.810
            24   144    10.000        are MAXDT MAXHYD & DTMIN values
        Licensee: UPPER CANADA CONSULTANTS
 35     COMMENT
       4     line(s) of comment
        STORMWATER MANAGEMENT PLAN
        MCLEOD ROAD FRUITBELT
        CITY OF NIAGARA FALLS
        FUTURE CONDITIONS
 35     COMMENT
       3     line(s) of comment
        ***********
        25mm STORM EVENT
        ***********
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      512.000     Coefficient  a
        6.000     Constant  b    (min)
         .800     Exponent  c
         .450     Fraction to peak  r
      240.000     Duration ó  240 min
                25.035 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015     Manning "n"
       98.000     SCS Curve No or C
         .100     Ia/S Coefficient
         .518     Initial Abstraction
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A10
        ***********
  4     CATCHMENT
       10.000     ID No.ó 99999
        3.710     Area in hectares
      157.300     Length (PERV) metres
        1.000     Gradient (%)
        5.750     Per cent Impervious
      157.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               .020       .000       .000       .000 c.m/s
               .098       .806       .139     C perv/imperv/total
 15     ADD RUNOFF
               .020       .020       .000       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .1291531E+03 c.m
  9     ROUTE
         .000     Conduit Length
         .000     No Conduit defined
         .000     Zero lag
         .000     Beta weighting factor
         .000     Routing timestep
            0     No. of sub-reaches
               .020       .020       .020       .000 c.m/s
 17     COMBINE
       1     Junction Node No.
               .020       .020       .020       .020 c.m/s
 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A11
        ***********
  4     CATCHMENT
       11.000     ID No.ó 99999
       19.390     Area in hectares
      359.500     Length (PERV) metres
        1.000     Gradient (%)
       64.300     Per cent Impervious
      359.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              1.103       .000       .020       .020 c.m/s
               .098       .807       .554     C perv/imperv/total
 15     ADD RUNOFF
              1.103      1.103       .020       .020 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .2680132E+04 c.m
  9     ROUTE
         .000     Conduit Length
         .000     No Conduit defined
         .000     Zero lag
         .000     Beta weighting factor
         .000     Routing timestep
            0     No. of sub-reaches
              1.103      1.103      1.103       .020 c.m/s
 17     COMBINE
       1     Junction Node No.
              1.103      1.103      1.103      1.123 c.m/s
 35     COMMENT
       3     line(s) of comment
        ***********
        Flow at Outlet A
        ***********
 18     CONFLUENCE
       1     Junction Node No.
              1.103      1.123      1.103       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .2808600E+04 c.m
 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area C10
        ***********
  4     CATCHMENT
       12.000     ID No.ó 99999
         .790     Area in hectares
       72.600     Length (PERV) metres
        1.000     Gradient (%)
       12.780     Per cent Impervious
       72.600     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1        Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
               .009       .000      1.103       .000 c.m/s
               .098       .796       .188     C perv/imperv/total
 15     ADD RUNOFF
               .009       .009      1.103       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .3708568E+02 c.m
 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        5-YEAR STORM EVENT
        ***********
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      719.500     Coefficient  a
        6.340     Constant  b    (min)
         .769     Exponent  c
         .450     Fraction to peak  r
      240.000     Duration ó  240 min
                41.683 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015     Manning "n"
       98.000     SCS Curve No or C
         .100     Ia/S Coefficient
         .518     Initial Abstraction
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A10
        ***********
  4     CATCHMENT
       10.000     ID No.ó 99999
        3.710     Area in hectares
      157.300     Length (PERV) metres
        1.000     Gradient (%)
        5.750     Per cent Impervious
      157.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
        8.924     Initial Abstraction
            1        Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
               .039       .000      1.103       .000 c.m/s
               .211       .860       .248     C perv/imperv/total
 15     ADD RUNOFF
               .039       .039      1.103       .000 c.m/s
 27     HYDROGRAPH DISPLAY
       5     is # of Hyeto/Hydrograph chosen
        Volume  =  .3839060E+03 c.m
  9     ROUTE
         .000     Conduit Length
         .000     No Conduit defined
         .000     Zero lag
         .000     Beta weighting factor
         .000     Routing timestep
            0     No. of sub-reaches
               .039       .039       .039       .000 c.m/s
 17     COMBINE
       1     Junction Node No.
               .039       .039       .039       .039 c.m/s
 14     START
       1     1=Zero; 2=Define
 35     COMMENT
       3     line(s) of comment
        ***********
        Area A11
        ***********
  4     CATCHMENT
       11.000     ID No.ó 99999
       19.390     Area in hectares
      359.500     Length (PERV) metres
        1.000     Gradient (%)
       64.300     Per cent Impervious
      359.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       74.000     SCS Curve No or C
         .100     Ia/S Coefficient
```

```
      8.924     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            1.960       .000       .039       .039 c.m/s
             .211       .866       .632     C perv/imperv/total
 15     ADD RUNOFF
            1.960      1.960       .039       .039 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .5109208E+04 c.m
  9     ROUTE
       .000     Conduit Length
       .000     No Conduit defined
       .000     Zero lag
       .000     Beta weighting factor
       .000     Routing timestep
          0     No. of sub-reaches
            1.960      1.960      1.960       .039 c.m/s
 17     COMBINE
      1     Junction Node No.
            1.960      1.960      1.960      1.999 c.m/s
 35     COMMENT
      3     line(s) of comment
       ***********
       Flow at Outlet A
       ***********
 18     CONFLUENCE
      1     Junction Node No.
            1.960      1.999      1.960       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .5491800E+04 c.m
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area C10
       ***********
  4     CATCHMENT
     12.000     ID No.ó 99999
       .790     Area in hectares
     72.600     Length (PERV) metres
      1.000     Gradient (%)
     12.780     Per cent Impervious
     72.600     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     74.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.924     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .017       .000      1.960       .000 c.m/s
             .211       .866       .295     C perv/imperv/total
 15     ADD RUNOFF
             .017       .017      1.960       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9698585E+02 c.m
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       *************
       100-YEAR STORM EVENT
       *************
  2     STORM
          1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
   1264.600     Coefficient  a
      7.720     Constant  b    (min)
       .781     Exponent  c
       .450     Fraction to peak  r
    240.000     Duration ó  240 min
           68.280 mm     Total depth
  3     IMPERVIOUS
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .015     Manning "n"
     98.000     SCS Curve No or C
       .100     Ia/S Coefficient
       .518     Initial Abstraction
 35     COMMENT
      3     line(s) of comment
       ***********
       Area A10
       ***********
  4     CATCHMENT
     10.000     ID No.ó 99999
      3.710     Area in hectares
    157.300     Length (PERV) metres
      1.000     Gradient (%)
      5.750     Per cent Impervious
    157.300     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     74.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.924     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .131       .000      1.960       .000 c.m/s
             .347       .904       .379     C perv/imperv/total
 15     ADD RUNOFF
             .131       .131      1.960       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9604528E+03 c.m
  9     ROUTE
       .000     Conduit Length
       .000     No Conduit defined
       .000     Zero lag
       .000     Beta weighting factor
       .000     Routing timestep
          0     No. of sub-reaches
```

```
             .131       .131       .131       .000 c.m/s
 17     COMBINE
      1     Junction Node No.
             .131       .131       .131       .131 c.m/s
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area A11
       ***********
  4     CATCHMENT
     11.000     ID No.ó 99999
     19.390     Area in hectares
    359.500     Length (PERV) metres
      1.000     Gradient (%)
     64.300     Per cent Impervious
    359.500     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     74.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.924     Initial Abstraction
          1       Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
            3.257       .000       .131       .131 c.m/s
             .347       .920       .716     C perv/imperv/total
 15     ADD RUNOFF
            3.257      3.257       .131       .131 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9475032E+04 c.m
  9     ROUTE
       .000     Conduit Length
       .000     No Conduit defined
       .000     Zero lag
       .000     Beta weighting factor
       .000     Routing timestep
          0     No. of sub-reaches
            3.257      3.257      3.257       .131 c.m/s
 17     COMBINE
      1     Junction Node No.
            3.257      3.257      3.257      3.353 c.m/s
 35     COMMENT
      3     line(s) of comment
       ***********
       Flow at Outlet A
       ***********
 18     CONFLUENCE
      1     Junction Node No.
            3.257      3.353      3.257       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .1043460E+05 c.m
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area C10
       ***********
  4     CATCHMENT
     12.000     ID No.ó 99999
       .790     Area in hectares
     72.600     Length (PERV) metres
      1.000     Gradient (%)
     12.780     Per cent Impervious
     72.600     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     74.000     SCS Curve No or C
       .100     Ia/S Coefficient
      8.924     Initial Abstraction
          1       Option  1=Trianglr;  2=Rectanglr;  3=SWM  HYD;  4=Lin.
Reserv
             .041       .000      3.257       .000 c.m/s
             .346       .909       .418     C perv/imperv/total
 15     ADD RUNOFF
             .041       .041      3.257       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .2256910E+03 c.m
 20     MANUAL
```

B-3. Future Conditions with SWM

```
         Output File (4.7) SWM.OUT      opened 2022-12-08  11:09
         Units used are defined by G =     9.810
             24   144    10.000        are MAXDT MAXHYD & DTMIN values
         Licensee: UPPER CANADA CONSULTANTS
  35     COMMENT
        4     line(s) of comment
         STORMWATER MANAGEMENT PLAN
         MCLEOD ROAD FRUITBELT
         CITY OF NIAGARA FALLS
         SWM CONDITIONS
  35     COMMENT
        3     line(s) of comment
         ***********
         25mm STORM EVENT
         ***********
   2     STORM
             1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       512.000      Coefficient  a
         6.000      Constant  b    (min)
          .800      Exponent  c
          .450      Fraction to peak  r
       240.000      Duration ó  240 min
                  25.035 mm     Total depth
   3     IMPERVIOUS
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015      Manning "n"
        98.000      SCS Curve No or C
          .100      Ia/S Coefficient
          .518      Initial Abstraction
  35     COMMENT
        3     line(s) of comment
         ***********
         Area A10
         ***********
   4     CATCHMENT
        10.000      ID No.ó 99999
         3.710      Area in hectares
       157.300      Length (PERV) metres
         1.000      Gradient (%)
         5.750      Per cent Impervious
       157.300      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        74.000      SCS Curve No or C
          .100      Ia/S Coefficient
         8.924      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .020        .000        .000        .000 c.m/s
                .098        .806        .139     C perv/imperv/total
  15     ADD RUNOFF
                .020        .020        .000        .000 c.m/s
  27     HYDROGRAPH DISPLAY
        5     is # of Hyeto/Hydrograph chosen
         Volume  =  .1291531E+03 c.m
   9     ROUTE
          .000      Conduit Length
          .000      No Conduit defined
          .000      Zero lag
          .000      Beta weighting factor
          .000      Routing timestep
             0      No. of sub-reaches
                .020        .020        .020        .000 c.m/s
  17     COMBINE
        1     Junction Node No.
                .020        .020        .020        .020 c.m/s
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         ***********
         Area A11
         ***********
   4     CATCHMENT
        11.000      ID No.ó 99999
        19.390      Area in hectares
       359.500      Length (PERV) metres
         1.000      Gradient (%)
        64.300      Per cent Impervious
       359.500      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        74.000      SCS Curve No or C
          .100      Ia/S Coefficient
         8.924      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
               1.103        .000        .020        .020 c.m/s
                .098        .807        .554     C perv/imperv/total
  15     ADD RUNOFF
               1.103       1.103        .020        .020 c.m/s
  27     HYDROGRAPH DISPLAY
        5     is # of Hyeto/Hydrograph chosen
         Volume  =  .2680132E+04 c.m
  10     POND
        6 Depth - Discharge - Volume sets
         179.850        .000          .0
         180.150       .0230      1831.0
         180.450       .0360      3828.0
         180.750        .170      5995.0
         181.050        .204      8336.0
         181.350       1.118     10873.0
         Peak Outflow    =      .026 c.m/s
         Maximum Depth   =   180.218 metres
         Maximum Storage =     2285. c.m
               1.103       1.103        .026        .020 c.m/s
  17     COMBINE
        1     Junction Node No.
               1.103       1.103        .026        .032 c.m/s
  35     COMMENT
        3     line(s) of comment
         ***********
         Flow at Outlet A
         ***********
  18     CONFLUENCE
        1     Junction Node No.
               1.103        .032        .026        .000 c.m/s
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         ***********
         Area C10
         ***********
   4     CATCHMENT
        12.000      ID No.ó 99999
          .790      Area in hectares
        72.600      Length (PERV) metres
         1.000      Gradient (%)
        12.780      Per cent Impervious
        72.600      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        74.000      SCS Curve No or C
          .100      Ia/S Coefficient
         8.924      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin.
Reserv
                .009        .000        .026        .000 c.m/s
                .098        .796        .188     C perv/imperv/total
  15     ADD RUNOFF
                .009        .009        .026        .000 c.m/s
  27     HYDROGRAPH DISPLAY
        5     is # of Hyeto/Hydrograph chosen
         Volume  =  .3708568E+02 c.m
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         ***********
         5-YEAR STORM EVENT
         ***********
   2     STORM
             1      1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       719.500      Coefficient  a
         6.340      Constant  b    (min)
          .769      Exponent  c
          .450      Fraction to peak  r
       240.000      Duration ó  240 min
                  41.683 mm     Total depth
   3     IMPERVIOUS
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015      Manning "n"
        98.000      SCS Curve No or C
          .100      Ia/S Coefficient
          .518      Initial Abstraction
  35     COMMENT
        3     line(s) of comment
         ***********
         Area A10
         ***********
   4     CATCHMENT
        10.000      ID No.ó 99999
         3.710      Area in hectares
       157.300      Length (PERV) metres
         1.000      Gradient (%)
         5.750      Per cent Impervious
       157.300      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        74.000      SCS Curve No or C
          .100      Ia/S Coefficient
         8.924      Initial Abstraction
             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin.
Reserv
                .039        .000        .026        .000 c.m/s
                .211        .860        .248     C perv/imperv/total
  15     ADD RUNOFF
                .039        .039        .026        .000 c.m/s
  27     HYDROGRAPH DISPLAY
        5     is # of Hyeto/Hydrograph chosen
         Volume  =  .3839060E+03 c.m
   9     ROUTE
          .000      Conduit Length
          .000      No Conduit defined
          .000      Zero lag
          .000      Beta weighting factor
          .000      Routing timestep
             0      No. of sub-reaches
                .039        .039        .039        .000 c.m/s
  17     COMBINE
        1     Junction Node No.
                .039        .039        .039        .039 c.m/s
  14     START
        1     1=Zero; 2=Define
  35     COMMENT
        3     line(s) of comment
         ***********
         Area A11
         ***********
   4     CATCHMENT
        11.000      ID No.ó 99999
        19.390      Area in hectares
       359.500      Length (PERV) metres
         1.000      Gradient (%)
        64.300      Per cent Impervious
       359.500      Length (IMPERV)
          .000      %Imp. with Zero Dpth
             1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250      Manning "n"
        74.000      SCS Curve No or C
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        .100     Ia/S Coefficient
       8.924     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             1.960       .000       .039       .039 c.m/s
              .211       .866       .632     C perv/imperv/total
 15     ADD RUNOFF
             1.960      1.960       .039       .039 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .5109208E+04 c.m
 10     POND
      6 Depth - Discharge - Volume sets
       179.850        .000         .0
       180.150       .0230      1831.0
       180.450       .0360      3828.0
       180.750        .170      5995.0
       181.050        .204      8336.0
       181.350       1.118     10873.0
       Peak Outflow    =      .066 c.m/s
       Maximum Depth   =   180.518 metres
       Maximum Storage =     4321. c.m
             1.960      1.960       .066       .039 c.m/s
 17     COMBINE
      1     Junction Node No.
             1.960      1.960       .066       .081 c.m/s
 35     COMMENT
      3     line(s) of comment
       ***********
       Flow at Outlet A
       ***********
 18     CONFLUENCE
      1     Junction Node No.
             1.960       .081       .066       .000 c.m/s
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area C10
       ***********
  4     CATCHMENT
      12.000     ID No.ó 99999
        .790     Area in hectares
      72.600     Length (PERV) metres
       1.000     Gradient (%)
      12.780     Per cent Impervious
      72.600     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      74.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.924     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .017       .000       .066       .000 c.m/s
              .211       .866       .295     C perv/imperv/total
 15     ADD RUNOFF
              .017       .017       .066       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9698585E+02 c.m
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       *************
       100-YEAR STORM EVENT
       *************
  2     STORM
           1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
    1264.600     Coefficient  a
       7.720     Constant  b    (min)
        .781     Exponent  c
        .450     Fraction to peak  r
     240.000     Duration ó  240 min
              68.280 mm     Total depth
  3     IMPERVIOUS
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
 35     COMMENT
      3     line(s) of comment
       ***********
       Area A10
       ***********
  4     CATCHMENT
      10.000     ID No.ó 99999
       3.710     Area in hectares
     157.300     Length (PERV) metres
       1.000     Gradient (%)
       5.750     Per cent Impervious
     157.300     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      74.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.924     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .131       .000       .066       .000 c.m/s
              .347       .904       .379     C perv/imperv/total
 15     ADD RUNOFF
              .131       .131       .066       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9604528E+03 c.m
  9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
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        .000     Routing timestep
           0     No. of sub-reaches
              .131       .131       .131       .000 c.m/s
 17     COMBINE
      1     Junction Node No.
              .131       .131       .131       .131 c.m/s
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area A11
       ***********
  4     CATCHMENT
      11.000     ID No.ó 99999
      19.390     Area in hectares
     359.500     Length (PERV) metres
       1.000     Gradient (%)
      64.300     Per cent Impervious
     359.500     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      74.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.924     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin.
Reserv
             3.257       .000       .131       .131 c.m/s
              .347       .920       .716     C perv/imperv/total
 15     ADD RUNOFF
             3.257      3.257       .131       .131 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .9475032E+04 c.m
 10     POND
      6 Depth - Discharge - Volume sets
       179.850        .000         .0
       180.150       .0230      1831.0
       180.450       .0360      3828.0
       180.750        .170      5995.0
       181.050        .204      8336.0
       181.350       1.118     10873.0
       Peak Outflow    =      .189 c.m/s
       Maximum Depth   =   180.917 metres
       Maximum Storage =     7301. c.m
             3.257      3.257       .189       .131 c.m/s
 17     COMBINE
      1     Junction Node No.
             3.257      3.257       .189       .299 c.m/s
 35     COMMENT
      3     line(s) of comment
       ***********
       Flow at Outlet A
       ***********
 18     CONFLUENCE
      1     Junction Node No.
             3.257       .299       .189       .000 c.m/s
 14     START
      1     1=Zero; 2=Define
 35     COMMENT
      3     line(s) of comment
       ***********
       Area C10
       ***********
  4     CATCHMENT
      12.000     ID No.ó 99999
        .790     Area in hectares
      72.600     Length (PERV) metres
       1.000     Gradient (%)
      12.780     Per cent Impervious
      72.600     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      74.000     SCS Curve No or C
        .100     Ia/S Coefficient
       8.924     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin.
Reserv
              .041       .000       .189       .000 c.m/s
              .346       .909       .418     C perv/imperv/total
 15     ADD RUNOFF
              .041       .041       .189       .000 c.m/s
 27     HYDROGRAPH DISPLAY
      5     is # of Hyeto/Hydrograph chosen
       Volume  =  .2256910E+03 c.m
 20     MANUAL
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