



April 19, 2023
File: LD-00209

VIA EMAIL

St. Clair Region Conservation Authority
205 Mill Pond Crescent
Strathroy, ON N7G 3P9

Attention: **Girish Sankar**
 Director of Water Resources

gsankar@scrca.on.ca

Reference: **Flood Hazard Assessment**
 Proposed Townhouse Development
 MN 101 Hull Road, Strathroy-Caradoc

Introduction

As requested, LDS Consultants Inc. (LDS) has undertaken a topographic survey and detailed analysis for the encroachment of a proposed residential development into the St. Clair Region Conservation Authority's (SCRCA) regulated area. This encroachment occurs on the southern part of the subject property, adjacent to Hull Road. The flooding proposed by SCRCA results from a backwater effect occurring upstream at **a culvert spanning Kittridge Avenue**. There is also a culvert crossing **Hull Road**, which will be analyzed for complete flood line mapping with the reach of the Stokeman Drain surrounding the subject property. A Key Plan is provided in **Figure 1**, appended.

A large single-family residential lot currently occupies the subject property. The property is approximately 1.24 hectares in area. Existing residential land and the Stokeman Drain bound the site. The Stokeman Drain flows in a southern direction. The existing flooding, assumed to be the SCRCA-regulated limit, encroaches 0.18 hectares onto the subject property. The drain crosses Hull Road (west of the site) through a box culvert and Kittridge Avenue (to the south) through an existing box culvert.

Background Information

LDS undertook a topographic survey to establish existing grades throughout the site, along the Hull Road Right-of-Way (ROW) and at the downstream culvert crossing at Kitteridge Avenue. Online tools were used to characterize the watershed's hydrologic properties and assess the backwater effects under the local 250-year design storm event along the Stokeman Drain. In addition to the topographic information collected for the site, and the regulatory flood elevation provided by SCRCA, LDS also reviewed and incorporated relevant information from the following documents:

- Strathroy Area Two Zone Flood Line Mapping Study, prepared by Fenco Maclaren Inc. for the St. Clair Region Conservation Authority, dated January 1995;
- Ontario Watershed Information Tool (OWIT), Ministry of Natural Resources and Forestry.

To assist in preparing this report, LDS conducted a pre-consultation with the planning and regulatory staff from the SCRCA in the Fall of 2019. As a result, SCRCA confirmed that the regulatory flood elevation along the Stokeman Drain is 226.23 m for the regulatory storm event (Fenco Maclaren Inc., 1994). Based on LDS' consultation with SCRCA, it is understood that engineering review and analysis are required to demonstrate and confirm that the site has safe access appropriate for the nature of the development and the natural hazard.

Existing Conditions

The subject site is within the south-central portion of the Stokeman Drain watershed (See Location Plan, **Figure 1**). The upstream watershed catchment area comprises mainly agricultural land, with part of the region consisting of infrastructure and residential/commercial development. A pond provides storage at the Cuddy Woods Conservation Area, attenuating flows generated by the watershed north of Second Street and Highway 402. LDS's desktop investigation confirmed that peak flow attenuation for the Hurricane Hazel event is provided by the available storage capacity in the existing pond near Second Street, allowing for the exclusion of a portion of the Stokeman Drain watershed north of Second Street for this flood line analysis. Therefore, per the pre-consultation meeting, this analysis will quantify the flood limit caused by the catchment area south of Second Street.

The drain's watershed extends approximately 2700 m upstream from a 4900 mm by 2000 mm culvert underneath Kittridge Avenue downstream of the property. The drainage area upstream of the culvert crossing comprises multiple ownerships and encompasses an area of approximately 311 hectares. The Stokeman Drain discharges into the Sydenham River about 800 m downstream of the Kittridge culvert. The catchment area boundary and location plan for this culvert are in **Appendix A**.

Soils within the watershed area can generally be described as consisting of sand. The Hull Road culvert crossing watershed is like the condition described above. However, its watershed omits the land between Hull Road and Kittridge Avenue East. The characteristics of both local watersheds and Drain are described in the table below.

Table 1 - Hydrologic Properties for the Stokeman Drain Watershed

Parameter	Hull Road Culvert	Kittridge Avenue Culvert
Flow Length (m)	2500	2700
Average Slope (%)	0.60	0.60
Channel Bottom Width (m)	3.50	3.50
Channel Side Slopes (H:V)	2:1	2:1
Curve Number	67	69
Time to Peak (hrs)	1.40	1.55

Model documentation from the hydrologic model is attached in **Appendix B**.

Backwater Effect Analysis

As discussed previously, the Kittridge Avenue culvert crossing and impacts associated with the proposed access road is the primary drainage element being investigated for this study. LDS used the topographic survey and OWIT to gather essential information on the contributing drainage area. LDS conducted a topographic survey to measure the culvert and adequately describe the hydraulic element's essential features.

Figure 3 details the proposed flood limit and property boundary, which falls within the existing SCRCA-regulated flood line. Our analysis has determined that the current flood elevation is overestimated for the subject portion of the Stokeman Drain corridor.

The table below summarizes the model inputs used to estimate the backwater effects of the Kitteridge culvert downstream of the subject property.

Table 2 - Hydraulic Characteristics of Kittridge Avenue Culvert Crossing

Parameter	Value	Notes
Size (Span x Height)	4900 mm x 2000 mm	Field Measurement by LDS
Length	18 m	Field Measurement by LDS
Upstream Invert	233.08 m	Field Measurement by LDS
Downstream Invert	222.89 m	Field Measurement by LDS
Slope	1.05 %	Calculated by Culvert Master

Material	Concrete	Field Observation by LDS
Flow Rate	9.179 m ³ /s	Calculated by SWMHYMO
Backwater Elevation	225.77 m	Calculated by Culvert Master

Figure 3 in Appendix A depicts the regulatory backwater elevation created by the 4.9 m x 2 m culvert downstream at Kittridge Avenue along the Stokeman Drain and the adjacent backwater elevation caused by the Hull Road culvert crossing. The backwater elevations are calculated as follows:

- upstream (north) side of the existing culvert is Elev. 225.77 m asl;
- adjacent (west) side of the proposed access road is Elev. 226.34 m asl.

The analysis demonstrated by this report illustrates that the proposed regulatory flood elevation upstream of the Kittridge culvert crossing does not fall within the site limits and has no adverse effects on safe access or impose a flood hazard on the subject property. The Hull Road culvert crossing backwater flood elevation does not impact the subject property. The higher flood elevation proposed by the SCRCA report likely needs to account for Hull Road acting as a weir and controlling any flood waters from occurring north of the road.

Based on LDS's professional engineering opinion, the calculated flow rate for the regulatory 250-year design storm event appears to be very close numerically to the flow rate generated by the Hurricane Hazel design storm event. The flow rate calculated for the regulatory 250-year design storm event suits this assessment. The past report (Fenco Maclaren Inc., 1995) had higher flow rates, reaching up to 24.1 m³/s, possibly due to measurement errors or inaccurate assumptions. However, the current study (LDS, 2023) has lower flow rates, around 9.2 m³/s, due to more advanced and accurate measuring techniques. Additionally, the present study factors in potential changes in the environment, such as changes in rainfall and terrain, which helps to ensure more accurate results.

Conclusion and Recommendations

The analysis completed by LDS yields the following conclusions:

- The hazard flood assessment has re-evaluated the subject property's floodplain based on existing conditions; and,
- The proposed flood limit based on hydrologic and hydraulic computations demonstrates that the site has safe access appropriate for the nature of the development and the natural hazard.

We trust this letter report to be complete and meet with your acceptance. However, should you have any questions concerning the findings presented herein, please do not hesitate to contact the undersigned.

Sincerely,

LDS CONSULTANTS INC.



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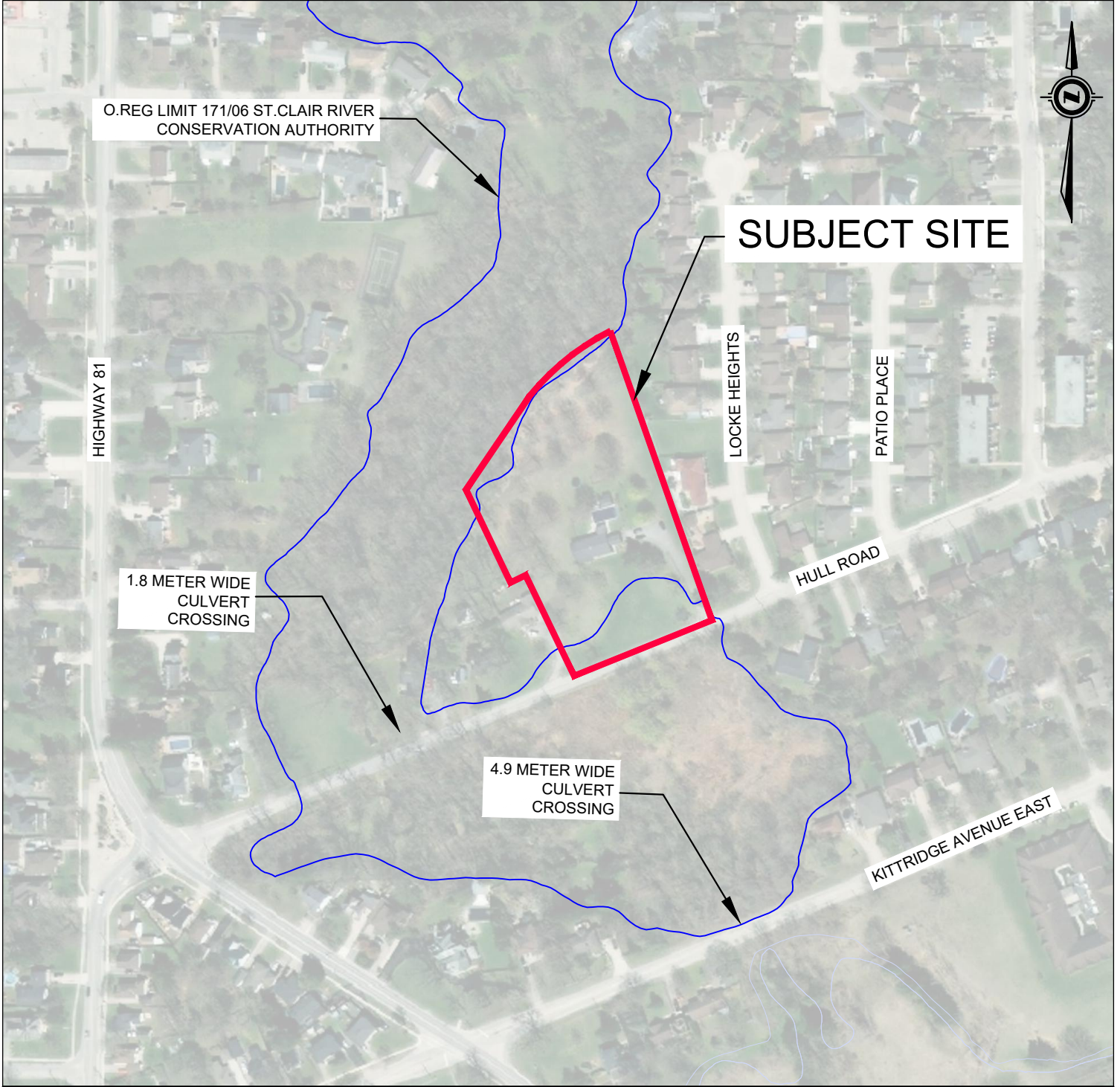


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Attachments:

- Appendix A – Figures
- Appendix B – Hydrologic Model
- Appendix C – Supporting Calculations
- Appendix D – Photographs

APPENDIX A
FIGURES



O.REG LIMIT 171/06 ST. CLAIR RIVER
CONSERVATION AUTHORITY

SUBJECT SITE

HIGHWAY 81

LOCKE HEIGHTS

PATIO PLACE

1.8 METER WIDE
CULVERT
CROSSING

HULL ROAD

4.9 METER WIDE
CULVERT
CROSSING

KITTRIDGE AVENUE EAST

Z:\LD-00209 - HULL ROAD, STRATHROY\DETAIL DESIGN\REPORTS\FLOODLINE DRAWINGS\LD-00209 LOCATION PLAN(1).DWG
2023-01-13 2:30:54 PM by: LUKE JESSON



MN 101 HULL ROAD, STRATHROY-CARADOC
GOLD LEAF PROPERTIES INC.

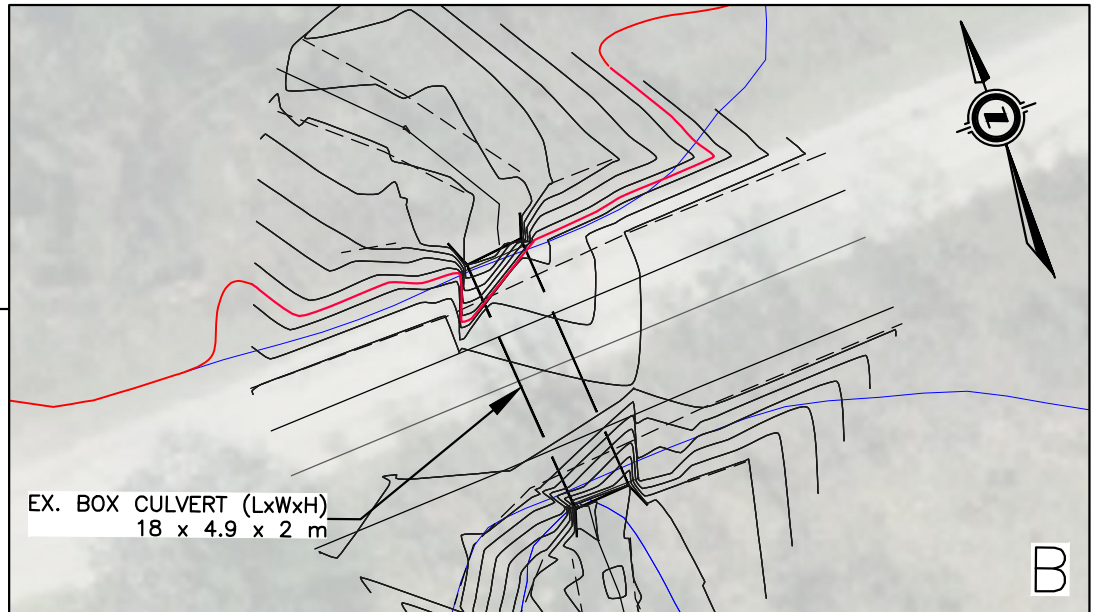
LOCATION PLAN

PROJECT: LD-00209




SCALE: N.T.S.

FIGURE 1

21-UD-00209 - HULL ROAD, STRATHROY-CARADOC, DESIGN REPORTS/FLOOD LINE HAZARD ASSESSMENT/ANIMATIONS/UD-00209 REPORT FIGURES/FIG 4



LEGEND:

	PROPOSED FLOOD LIMIT		SCRCA REGULATED AREA
	SUBJECT PROPERTY LIMIT		

MN 101 HULL ROAD, STRATHROY-CARADOC
GOLD LEAF PROPERTIES INC.

PROPOSED CONDITIONS FLOOD LIMIT

PROJECT: LD-00209 SCALE: N.T.S. FIGURE 4

APPENDIX B
HYDROLOGIC MODEL

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00001> =====
00002>
00003> SSSSS W W M M H H Y Y M M O O 999 999 =====
00004> S W W M M M H H Y Y M M O O 9 9 9 9
00005> SSSSS W W M M M H H H Y Y M M O O ## 9 9 9 9 Ver 4.05
00006> S W W M M M H H Y Y M M O O 9999 9999 Sept 2011
00007> SSSSS W W M M H H Y Y M M O O 9 9 9 =====
00008> 9 9 9 # 4058874
00009> StormWater Management Hydrologic Model 999 999 =====
00010>
00011> *****
00012> ***** SWMMHYM Ver/4.05 *****
00013> ***** A single event and continuous hydrologic simulation model *****
00014> ***** based on the principles of HYMO and its successors *****
00015> ***** OTHYMO-83 and OTHYMO-89. *****
00016> *****
00017> ***** Distributed by: J.F. Sabourin and Associates Inc. *****
00018> ***** Ottawa, Ontario: (613) 836-3884 *****
00019> ***** Gatineau, Quebec: (819) 243-6858 *****
00020> ***** E-Mail: swmhymo@jfsa.Com *****
00021> *****
00022>
00023> *****
00024> ***** Licensed user: Land Development Solutions *****
00025> ***** London SERIAL#:4058874 *****
00026> *****
00027> *****
00028> *****
00029> ***** PROGRAM ARRAY DIMENSIONS *****
00030> ***** Maximum value for ID numbers : 10 *****
00031> ***** Max. number of rainfall points: 105408 *****
00032> ***** Max. number of flow points : 105408 *****
00033> *****
00034>
00035> ***** D E T A I L E D O U T P U T *****
00036> *****
00037> *****
00038> * DATE: 2023-01-13 TIME: 12:57:55 RUN COUNTER: 000356 *
00039> *****
00040> * Input filename: C:\SWMMHY-1\LD-00209\230113.dat *
00041> * Output filename: C:\SWMMHY-1\LD-00209\230113.out *
00042> * Summary filename: C:\SWMMHY-1\LD-00209\230113.sum *
00043> * User comments: *
00044> * 1: *
00045> * 2: *
00046> * 3: *
00047> *****
00048>
00049> -----
00050> 001:0001-----
00051> *****
00052> *# Project Name: [MN 101 HULL ROAD, STRATHROY-CARADOC] Project Number: [LD-0
00053> *# Date : 13-01-2023
00054> *# Modeller : [LJ]
00055> *# Company : LDS Consultants Inc.
00056> *# License # : 4058874
00057> *# *****
00058> -----
00059> | START | Project dir.: C:\SWMMHY-1\LD-00209\
00060> ----- Rainfall dir.: C:\SWMMHY-1\LD-00209\
00061> TZERO = .00 hrs on 0
00062> METOUT= 2 (output = METRIC)
00063> NRUN = 001
00064> NSTORM= 0
00065> -----
00066> 001:0002-----
00067> *# *****
00068> *#
00069> *# 250-year
00070> *# =====
00071> *#
00072> *# *****
00073> -----
00074> | CHICAGO STORM | IDF curve parameters: A=3048.220
00075> | Ptotal= 86.60 mm | B= 10.030
00076> | | C= .888
00077> used in: INTENSITY = A / (t + B)^C
00078>
00079> Duration of storm = 3.00 hrs
00080> Storm time step = 5.00 min
00081> Time to peak ratio = .33
00082>
00083> TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN
00084> hrs mm/hr | hrs mm/hr | hrs mm/hr | hrs mm/hr
00085> .08 5.146 | .83 43.789 | 1.58 19.207 | 2.33 7.218
00086> .17 5.748 | .92 106.492 | 1.67 16.378 | 2.42 6.730
00087> .25 6.505 | 1.00 274.730 | 1.75 14.228 | 2.50 6.302
00088> .33 7.486 | 1.08 136.493 | 1.83 12.548 | 2.58 5.925
00089> .42 8.799 | 1.17 76.628 | 1.92 11.204 | 2.67 5.589
00090> .50 10.637 | 1.25 50.754 | 2.00 10.107 | 2.75 5.289
00091> .58 13.366 | 1.33 36.943 | 2.08 9.197 | 2.83 5.020
00092> .67 17.763 | 1.42 28.579 | 2.17 8.431 | 2.92 4.776
00093> .75 25.782 | 1.50 23.067 | 2.25 7.779 | 3.00 4.554
00094>
00095> -----
00096> 001:0003-----
00097> *# *****
00098> *#
00099> *# KITTRIDGE AVENUE CULVERT
00100> *# *****
00101> *#
00102> -----
00103> | CALIB NASHYD | Area (ha)= 311.00 Curve Number (CN)=69.00
00104> | 01:c101 DT= 1.00 | Ia (mm)= 5.000 # of Linear Res. (N)= 3.00
00105> | | U.H. Tp(hrs)= 1.550
00106>
00107> Unit Hyd Qpeak (cms)= 7.664
00108>
00109> PEAK FLOW (cms)= 9.179 (l)
00110> TIME TO PEAK (hrs)= 2.333
00111> RUNOFF VOLUME (mm)= 34.021
00112> TOTAL RAINFALL (mm)= 86.599
00113> RUNOFF COEFFICIENT = .393
00114>
00115> (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00116>
00117>
00118> 001:0004-----
00119> *# *****
00120> *#
00121> *# HULL ROAD CULVERT
00122> *# *****
00123> *#
00124> -----
00125> | CALIB NASHYD | Area (ha)= 194.00 Curve Number (CN)=67.00
00126> | 02:c102 DT= 1.00 | Ia (mm)= 4.000 # of Linear Res. (N)= 3.00
00127> | | U.H. Tp(hrs)= 1.400

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00128>
00129> Unit Hyd Qpeak (cms)= 5.293
00130>
00131> PEAK FLOW (cms)= 5.992 (i)
00132> TIME TO PEAK (hrs)= 2.750
00133> RUNOFF VOLUME (mm)= 32.848
00134> TOTAL RAINFALL (mm)= 86.599
00135> RUNOFF COEFFICIENT = .379
00136>
00137> (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00138>
00139> -----
00140> 001:0005-----
00141> FINISH
00142> -----
00143> *****
00144> ***** WARNINGS / ERRORS / NOTES *****
00145> *****
00146> Simulation ended on 2023-01-13 at 12:57:56
00147> =====
00148>
00149>

```

APPENDIX C
SUPPORTING CALCULATIONS

Parameters				Comments	
SWMHYMO Catchment Type		NASHYD	NASHYD	Pre-Dev (<20% impervious)	
Soil Type		Sand	Sand		
Soil Group		A	A		
Catchment		C101	C202		
Area	ha	194	311	Based on Servicing Standards 2021, Strathroy-Caradoc.	
H1	m	257.37	257.37		
H2	m	223.62	223.10		
Length	m	2500	2700		
Slope	%	0.63	0.63		
Width	m	776	1152		
RC	Location	0.44	0.40		
CN	Location	67	69		
IA	mm	4	5		
Tc	min	126	139		
Tp	min	84	93		
Tp	hrs	1.40	1.55		
All the above parameters were taken from Ontario Watershed Information Tool and available topographic information.					
Q	m3/s	5.99	9.18	From SWMHYMO	

Calculating Coefficients						
Catchment	C201			C202		
	RC	CN	Area (0 to 1)	RC	CN	Area (0 to 1)
Land Use						
Agriculture	0.22	77	0.39	0.22	77	0.51
Residential/Town	0.6	61	0.59	0.6	61	0.47
Woods	0.08	25	0.02	0.08	25	0.02
Water	0.05	50	0.00	0.05	50	0.00
Weighted RC	0.44	67	1.00	0.40	69	1.00

Culvert Calculator Report

Worksheet-Hull Road

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	226.96 m	Headwater Depth/Height	2.24
Computed Headwater Elev.	226.34 m	Discharge	5.9920 m ³ /s
Inlet Control HW Elev.	225.77 m	Tailwater Elevation	225.77 m
Outlet Control HW Elev.	226.34 m	Control Type	Outlet Control

Grades			
Upstream Invert	223.65 m	Downstream Invert	223.55 m
Length	20.18 m	Constructed Slope	0.4955 %

Hydraulic Profile			
Profile	Pressure Profile	Depth, Downstream	2.22 m
Slope Type	N/A	Normal Depth	N/A m
Flow Regime	N/A	Critical Depth	1.04 m
Velocity Downstream	2.77 m/s	Critical Slope	0.4557 %

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.80 m
Section Size	1800 x 1200 mm	Rise	1.20 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	226.34 m	Upstream Velocity Head	0.39 m
Ke	0.20	Entrance Loss	0.08 m

Inlet Control Properties			
Inlet Control HW Elev.	225.77 m	Flow Control	Submerged
Inlet Type	90° headwall w 3/4 inch chamfers	Area Full	2.2 m ²
K	0.51500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	1
C	0.03750	Equation Form	2
Y	0.79000		

Culvert Calculator Report

Worksheet-Kittridge Ave E

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	226.30 m	Headwater Depth/Height	1.35
Computed Headwater Elev:	225.77 m	Discharge	9.1790 m ³ /s
Inlet Control HW Elev.	225.70 m	Tailwater Elevation	225.70 m
Outlet Control HW Elev.	225.77 m	Control Type	Outlet Control

Grades			
Upstream Invert	223.08 m	Downstream Invert	222.89 m
Length	18.00 m	Constructed Slope	1.0556 %

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	2.81 m
Slope Type	N/A	Normal Depth	0.45 m
Flow Regime	N/A	Critical Depth	0.71 m
Velocity Downstream	0.94 m/s	Critical Slope	0.2608 %

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.90 m
Section Size	4900 x 2000 mm	Rise	2.00 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	225.77 m	Upstream Velocity Head	0.04 m
Ke	0.50	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	225.70 m	Flow Control	N/A
Inlet Type	90 and 15° wingwall flares	Area Full	9.8 m ²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	2
C	0.04000	Equation Form	1
Y	0.80000		

APPENDIX D
PHOTOGRAPHS













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