

Appendix B

Stormwater Impact Assessment and Conceptual Stormwater Management Design Memorandum



To:

Date: March 6, 2023Project #: 60683946From: Anya YiReview by: Kosta Paliouras

CC:

Greenhouse Road Reconstruction and Extension Project Memo

Subject: **Draft Stormwater Impact Assessment and Conceptual Stormwater Management (SWM) Design**

1. Introduction

AECOM Canada Ltd. (AECOM) has been retained by Woolwich Township (Township) to complete the Municipal Class Environmental Assessment (EA) study for the reconstruction of Greenhouse Road from Highway 7 (Victoria Street North) to the Metrolinx Rail Corridor, in Breslau. This includes the extension of Greenhouse Road south of Kramp Road to the Metrolinx Corridor, with a turnaround area at the southerly end of the Greenhouse Road extension. The study is evaluating various alternatives for the cross section of the road extension. The intent of the project is to fully urbanize Greenhouse Road in this area to service existing and future development within the Breslau Settlement Area.

The study is being conducted in accordance with Schedule 'B' requirements of the Municipal Engineers Association "Municipal Class Environmental Assessment" manual (as recently amended in 2015) which is approved under the Ontario Environmental Assessment Act.

The purpose of the following technical memorandum is to provide a stormwater management (SWM) impact assessment and a preliminary SWM design in support of the EA process. Please note that a detailed SWM design will be further refined through the detailed design stage of the Project.

The following tasks have been completed for the SWM impact assessment and a draft SWM design:

- Confirm SWM criteria based on the Grand River Conservation Authority (GRCA) and Ministry of Environment, Conservation, and Parks (MECP) requirements
- Update the existing SWM Model from Ariss Glen Development SWM Facility Design for both the Greenhouse Road existing and proposed road cross section (the preferred alternative road design) conditions
- Identify the impacts based on the model results of existing and proposed conditions
- Develop conceptual SWM design options to satisfy SWM criteria

1.1 Study Area

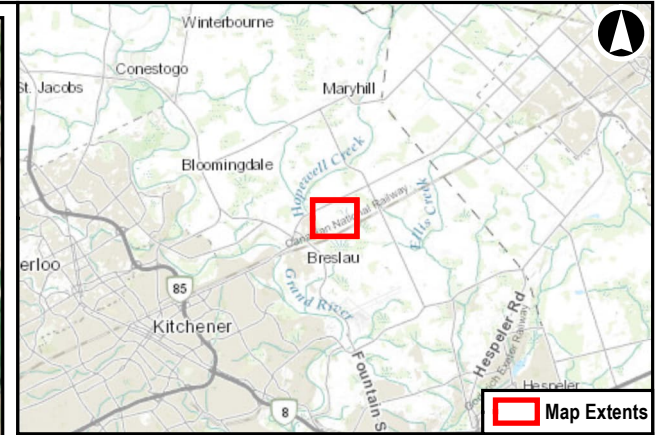
The Study Area consists of Greenhouse Road, between Highway 7 (Victoria Street North) and the Canadian National Railway (CN Rail) – Metrolinx Rail Corridor, and is a local road to the northeast of the Breslau community in the Township of Woolwich (**Figure 1**).

The existing section of Greenhouse Road (Highway 7 to approximately 75 meters (m) south of Kramp Road [Seagrams]) is approximately 860 m in length with an existing 7.6+/- m pavement width within a 26+/- m wide right-of-way. The new extension of Greenhouse Road, between approximately 75 m south of Kramp Road (Seagrams) and the CN Rail – Metrolinx Rail Corridor, is proposed to be constructed within a 26+/- m right-of-way (currently 20+/- meters as identified in the Hopewell Crossing Draft Plan), and is approximately 340 m in length.

1.2 Background Information

The following background information has been reviewed:

- Relevant design standards, and guidelines:
 - Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS), Region of Waterloo, January 2018
 - Ontario Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design (SWMP) Manual (MOE, 2003)
 - GRCA Policies and Procedures for Compliance with the Development, Interface with Wetlands and Alterations to Shorelines and Watercourses Regulation Ontario Regulation 150/06, Grand River Conservation Authority (GRCA), August 2009
 - Provincial Policy Statement Under the Planning Act (Ontario, 2020)
- Available background data and information:
 - Report on Geotechnical Investigation, Reconstruction of Greenhouse Road, between Victoria Street and 80m south of Kramp Road, Breslau Township of Woolwich, ON. Prepared by Sirati & Partners Consultants Ltd., February 2021
 - Comprehensive Environmental Impact Study for Proposed Mixed Use Development – Ariss Glen Developments & Thomasfield Homes - Woolwich Township (Breslau) DRAFT. Prepared for Thomasfield Homes by Natural Resource Solutions Inc., March 2011
 - Stormwater Management Facility Design Report – Proposed Hopewell Crossing Development Township of Woolwich (Breslau) Draft Plan of Subdivision 30T-11701 Final Submission. Prepared for Ariss Glen Development by AECOM Canada Ltd., June 2018
 - Environmental Impact Study Terms of Reference for Greenhouse Road Reconstruction Project – Breslau (Memorandum). Prepared by AECOM Canada Ltd. for Grand River Conservation Authority, November 30, 2022
 - Greenhouse Road Reconstruction and Extension Project Municipal Class Environmental Assessment – Phase 1: Problem or Opportunity Statement. Prepared by AECOM Canada Ltd. The Township of Woolwich, December 2022
 - GRCA GIS layers including watercourse, water body, regulatory floodplain, wetlands etc.
 - Updated survey base plan (AECOM, September 2022)
 - Google base imagery map



- Legend**
- Road Reconstruction
 - Road Extension
 - EA Alternatives Study Area
 - Watercourse
 - Constructed Drain
 - Railway
 - Waterbody
 - Parcel

**GREENHOUSE ROAD RECONSTRUCTION AND
EXTENSION PROJECT MUNICIPAL CLASS EA**

EA ALTERNATIVES STUDY AREA

0 50 100 150 200 250 300
Metres

Datum: NAD 1983 UTM Zone 17N

Jan, 2023	PN#: 60683946	1:5,500 * when printed 11"x17"
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Figure 1

AECOM

Data Sources: LID
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2. Stormwater Management Criteria

Below are the design criteria, based on those regulations noted above:

- **Quantity Control:** The proposed conditions peak flows rates of 2-year to 100-year design storm events are to be controlled to pre-development levels or less.
- **Quality Control:** Water quality treatment will be required and shall conform to Provincial requirements (Stormwater Management Planning and Design Manual, MOE, 2003). Enhanced level of protection for the long-term removal of 80% of Total Suspended Solids (TSS).
- **Water balance:** Retaining stormwater on-site to minimize changes in water balance. Achieve the same level of the annual volume of overland runoff allowable from the development site under pre-development conditions.
- **Erosion Control:** Soil erosion and sediment movement must be minimized and controlled in accordance with the latest requirements of the GRCA. Temporary erosion and sediment control for construction must be provided on-site.

3. Study Site Conditions

3.1 Existing Conditions Drainage

The project site is located within the Hopewell Creek subwatershed and is under the jurisdiction of the GRCA. Under existing conditions, two (2) watercourse crossings exist within the Study Area that connects the wetlands located west and east of Greenhouse Road.

- **Crossing #1:** Located close to the intersection of Greenhouse Road and Highway 7 (Victoria Street North). The watercourse is a tributary of Hopewell Creek and crosses Greenhouse Road through twin 400 mm circular corrugated steel pipe (CSP) culverts that are aligned perpendicular to Greenhouse Road to the west (**Table 1**).

Upstream drainage to Crossing #1 includes the Belgian Nursery property, Grobe Nursery property, Breslau Wetland Provincially Significant Wetland (PSW) Complex, and green space areas. The total drainage area is approximately 59 ha. Downstream of Crossing #1, flow discharges into a small wetland, continuing north, under Highway 7 (Victoria Street North), and eventually outlets to Hopewell Creek, approximately 725 m north of Highway 7 (Victoria Street North).

- **Crossing #2:** located approximately 250 m south of the end of existing Greenhouse Road, and approximately 80 m north of the CNR – Metrolinx crossing. The watercourse is a tributary of Waterloo-Guelph Airport Creek (WGAC) and crosses the trail (future Greenhouse Road extension) through a 450 mm CSP culvert to the east (**Table 1**).

Upstream drainage to Crossing #2 includes a new residential subdivision with Phase 1 of the Hopewell Crossing development and a small wetland area. A SWM pond is included in the new development area, which outflow discharges to the small wetland and then crosses the existing trail (future Greenhouse Road extension) to the east. The total drainage area is approximately 25 ha. Downstream of Crossing #2, water in the channel connects to the WGAC and then flows south under the CNR.

Table 1: Summary of Crossings

ID	Watercourse	Location	Culvert Material	Culvert Size (mm)
Crossing #1	Tributary to Hopewell Creek	125 m south of Highway 7 (Victoria Street North)	Twin CSP	400
Crossing #2	Tributary of Airport Creek	80 m North of CNR – Metrolinx Crossing	CSP	450

3.2 Topography, Soil, and Groundwater Condition

The land in the Study Area is relatively flat, with a local plateau along Greenhouse Road (at elevation 326 m) and a large wetland to the east (elevation approximately 321 m) within a localized low area. The elevation at the location close to Crossing #2 is approximately 321.6 m.

Based on the Geotechnical Report, below the pavement structure, fill material was encountered in all the boreholes, except BH5, extending to depths ranging from 1.5 m to 2.3 m. The fill material consists of sandy silt, silty sand, and sand and gravel.

During and upon completion of drilling, water entering the open boreholes was observed in all boreholes except BH4, resulting in soil cave-in of the boreholes. The soil cave-in depth in the boreholes ranged from 2.4 m to 4.6 m. The accumulated groundwater (short-term) was encountered at an approximate depth ranging from 0.9 m to 5.0 m below the existing pavement surface.

3.3 Proposed Conditions

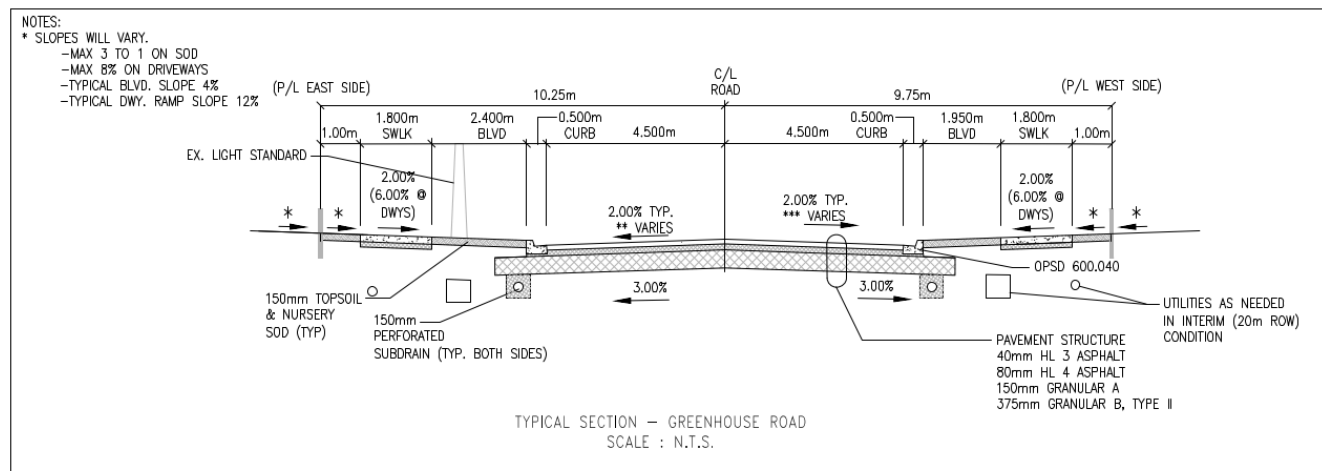
Three (3) alternatives are proposed at this EA stage:

- **Alternative #1:** Two-lane urbanized cross-section with sidewalks on both sides of the road, including culvert upgrade south of Kramp Road.
- **Alternative #2:** Two-lane urbanized cross-section with multi-use pathway on one side of the road, including culvert upgrade south of Kramp Road.
- **Alternative #3:** Two-lane urbanized cross-section with sidewalks on both sides of the road and bike lanes within the roadway width, including culvert upgrade south of Kramp Road.

The Greenhouse Road reconstruction component (north of Kramp Road) is included with all the above alternatives. Alternative #1 is the preferred solution (preliminary cross-section is shown in **Figure 2**), which includes a two-lane urbanized 20 m cross-section with sidewalks on both sides of the road, with the east boulevard being demolished and re-designed in the future to the full 26 m right-of-way width when the road is widened. There will be a proposed storm (STM) sewer on the roadway, within the southbound lanes (west portion) of the road.

The proposed Greenhouse Road reconstruction and extension increases the paving area and results in the increase in imperviousness of the road drainage area and surface runoff will increase accordingly. To mitigate the impacts of the proposed works on stormwater quality and quantity and meet applicable design criteria as described in **Section 2**, SWM design options are proposed and will be described in **Section 5**.

Figure 2. Preliminary Cross Section of the Preferred Solution (Alternative #1)



4. Hydrologic and Hydraulic Assessment

4.1 Hydrological Model Update

AECOM completed SWM Facility Design for the proposed Hopewell Crossing Development in 2018. A hydrologic/hydraulic computer model (PCSWMM) was developed and used to support the design. For this Greenhouse Road Reconstruction and Extension Project, the existing PCSWMM model was updated to include details of Greenhouse road drainage for existing conditions.

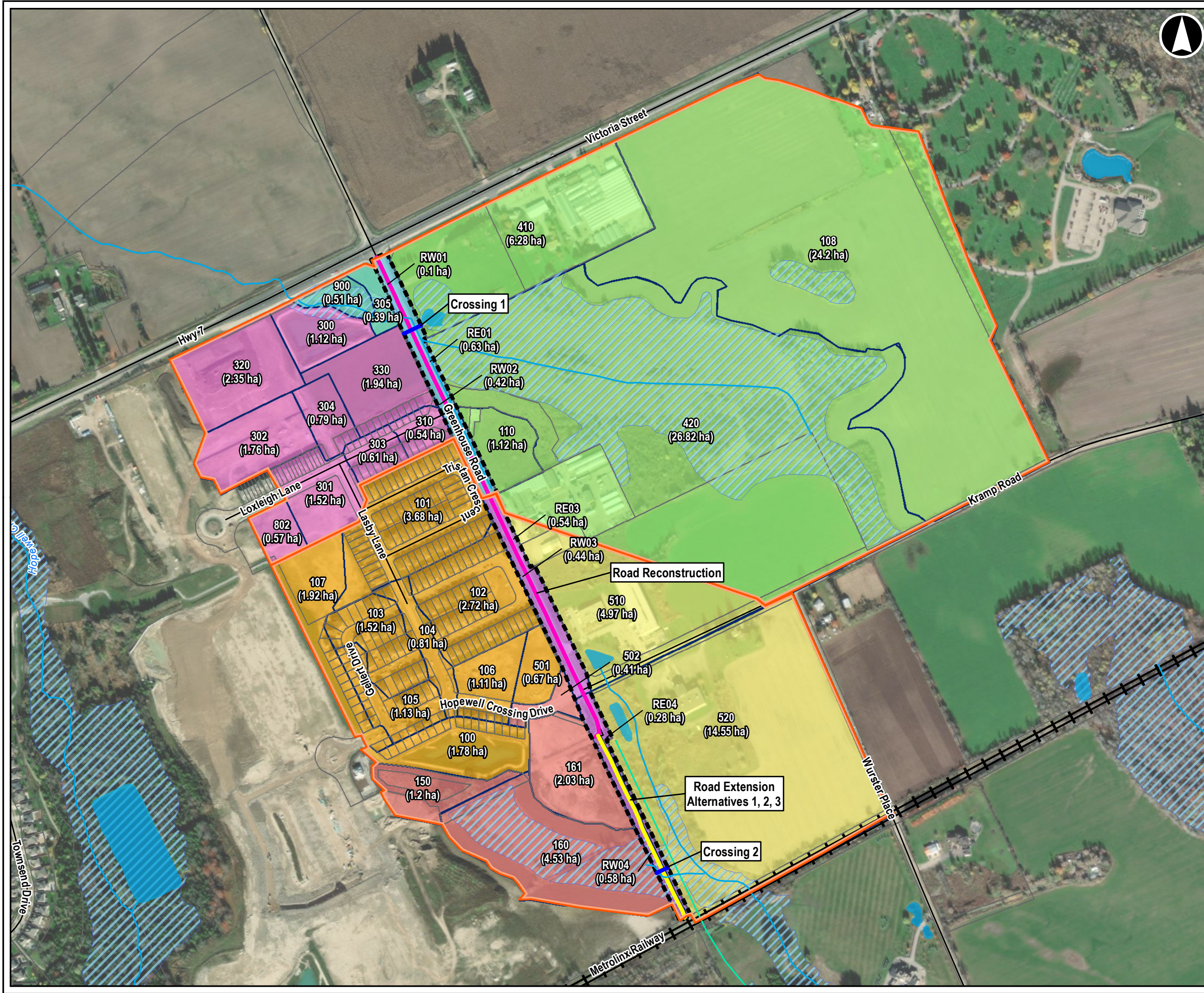
The 2018 PCSWMM model (Proposed-With East Wetland_20180517_KitchenerIDF.inp) was taken and updates include:

- Re-delineate road drainage for the existing Greenhouse Road and extension to the CN Rail – Metrolinx Corridor
- Update road drainage parameters
- Revise upstream drainage of Crossing #1 to existing conditions

The updated PCSWMM model subcatchments are shown in **Figure 3**. Same as the 2018 model, Manning roughness coefficients of 0.012 and 0.25, 1.5 mm and 3.0 mm of depression storage were used for impervious and pervious areas. Other modeling subcatchment parameters are provided in **Table 2**.

Table 2: Summary of Subcatchment Parameters

Subcatchment ID	Location	Area (ha)	Flow Length (m)	Slope (%)	Impervious (%) *	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit
RW1	Road Drainage of Crossing #1	0.100	48	2	44 (66) *	139.64	8.76	0.367
RW2		0.418	152	2	37 (65) *	139.64	8.76	0.367
RE1		0.635	200	2	33 (48) *	139.64	8.76	0.367
400	Upstream Drainage of Crossing #1	6.26	157	2.7	46	169	6.6	0.366
420		26.69	297	1.4	42	169	6.6	0.366
108		24.20	310	2.3	4	169	6.6	0.386
110		1.12	114	3.2	10.4	169	6.6	0.366
900	Downstream Wetland Drainage of Crossing #1	0.51	98	0.6	2	160	7.3	0.366
305		0.38	95	3.2	61.3	135	9.2	0.4
RW3	Road Drainage of Crossing #2	0.443	180	2	38 (56) *	139.64	8.76	0.367
RW4		0.582	105	2	14 (17) *	139.64	8.76	0.367
RE3		0.545	180	2	33 (47) *	139.64	8.76	0.367
RE4		0.278	105	2	19 (24) *	139.64	8.76	0.367
150, 160	Upstream Wetland Drainage of Crossing #2	5.86	80, 179	1.2, 1.7	6, 8	169	6.6	0.366
161	Upstream Drainage of Crossing #2	2.15	134	4.3	79.5	135	9.2	0.4
100 – 107, 501	Upstream Residential Drainage of Crossing #2	15.34	27 - 179	0.8 - 5.4	6 - 79.9	135	9.2	0.4
Note: *, Numbers in parentheses are parameters under proposed conditions that are changed								



Legend

- Road Reconstruction
- Road Extension - Alternatives 1, 2, 3
- Limits of Alternatives
- Watercourse
- Constructed Drain
- Railway
- Waterbody
- Parcel
- Drainage Crossing
- Crossing Location

Wetland Significance

- Evaluated-Provincial

Subcatchments

- Road Drainage to Crossing 1
- Upstream Drainage of Crossing 1
- Downstream Wetland Drainage of Crossing 1
- Downstream Residential Drainage of Crossing 1
- Road Drainage to Crossing 2
- Upstream Residential Drainage of Crossing 2
- Upstream Wetland Drainage of Crossing 2
- Downstream Drainage of Crossing 2

GREENHOUSE ROAD RECONSTRUCTION AND EXTENSION PROJECT MUNICIPAL CLASS EA

UPDATED PCSWMM MODEL SUBCATCHMENTS

0 50 100 150 200 250 300
Metres

Datum: NAD 1983 UTM Zone 17N

Jan, 2023	PN#: 60683946	1:6,000 * when printed 11"x17"
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Figure 3

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Data Sources: LIO
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4.2 Model Simulations and Results

4.2.1 Design Storm

Intensity Duration Frequency (IDF) curves from City of Kitchener's Development Manual were used to create a 3-hour Chicago design storm distribution. Varies of rainfall Intensity (I) shall be determined by: $I = A / (T_c + B)^C$, where T_c is time of concentration and A, B, C design storm IDF parameters and total rainfall depths for the 3-hour Chicago design storms are presented in **Table 3**.

Table 3: Design Storm Parameters and Total 3-hour Rainfall

Return Period	A	B	C	3-hour Total Rainfall (mm)
2-year	743	6	0.7989	34.3
5-year	1593	11	0.8789	47.3
10-year	2221	12	0.9080	56.3
25-year	3158	15	0.9355	68.3
50-year	3886	16	0.9495	77.7
100-year	4688	17	0.9624	87.1

4.2.2 Modeling Results

Hydrologic and hydraulic simulations were conducted for the 2-year to 100-year design storm events and modeling results are provided in **Table 4**. Peak runoff rates from road drainage areas (subcatchments RW01, RW02, RW03, RW04, RE01, RE03, and RE04) under the proposed condition are increased due to increases in imperviousness areas.

Table 4: Summary of Modeling Results – Road Subcatchments

Model ID	Location	Condition	Simulated Peak Flow Rate (m³/s)					
			2-year	5-year	10-year	25-year	50-year	100-year
RW01	Road Drainage at Crossing #1	EX	0.01	0.02	0.03	0.03	0.04	0.04
		PR	0.02	0.03	0.04	0.04	0.05	0.06
RW02		EX	0.05	0.06	0.08	0.09	0.11	0.13
		PR	0.06	0.09	0.11	0.13	0.15	0.17
RE01		EX	0.06	0.08	0.10	0.12	0.14	0.17
		PR	0.08	0.11	0.14	0.17	0.2	0.22
RW03	Road Drainage at Crossing #2	EX	0.05	0.07	0.08	0.10	0.12	0.13
		PR	0.07	0.09	0.12	0.14	0.16	0.18
RW04		EX	0.03	0.04	0.05	0.07	0.08	0.10
		PR	0.03	0.04	0.06	0.08	0.09	0.11
RE03		EX	0.05	0.07	0.09	0.11	0.13	0.15
		PR	0.07	0.1	0.12	0.14	0.17	0.19
RE04		EX	0.02	0.02	0.03	0.04	0.05	0.06
		PR	0.02	0.03	0.04	0.05	0.06	0.07
Sub Total	Crossing #1	EX	0.12	0.16	0.21	0.24	0.29	0.34
		PR	0.16	0.23	0.29	0.34	0.40	0.45
	Crossing #2	EX	0.15	0.20	0.25	0.32	0.38	0.44
		PR	0.19	0.26	0.34	0.41	0.48	0.55

Table 5: Summary of Modeling Results – Water Level at Crossings and Wetlands

Model ID	Location	Condition	Simulated Maximum Water Level (m)					
			2-year	5-year	10-year	25-year	50-year	100-year
GreenhouseMarsh	Wetland upstream of Crossing #1 (east of the road)	EX	321.31	321.40	321.48	321.58	321.66	321.74
		PR	321.31	321.41	321.48	321.59	321.66	321.74
Hwy7_015	Wetland downstream of Crossing #1 (west of the road)	EX	321.05	321.08	321.11	321.17	321.20	321.21
		PR	321.05	321.08	321.11	321.17	321.20	321.21
J4	Outlet Junction of Crossing #1 (west of the road)	EX	321.29	321.36	321.41	321.46	321.50	321.54
		PR	321.29	321.37	321.41	321.46	321.50	321.54
Randall_020	Wetland upstream of Crossing #2 (west of the road)	EX	321.08	321.13	321.15	321.19	321.21	321.24
		PR	321.09	321.13	321.15	321.19	321.21	321.24
Randall_010	Outlet Junction of Crossing #2 (east of the road)	EX	320.76	320.85	320.89	320.91	320.95	321.02
		PR	320.77	320.86	320.89	320.91	320.95	321.02

Results in **Table 4** and **Table 5** show that compared to the existing condition, peak flow rates to Crossing #1 and Crossing #2 are both increased due to the increase of the impervious area of the proposed road. However, water levels at wetlands and crossing downstream junctions have no change in wetland downstream of Crossing #1, and only a 0.01 m increase at other locations with 2-, 5- and 25-year storm events. The results indicate that the proposed Greenhouse Road reconstruction and extension work would have little impact on wetlands.

The increase of peak flow rates to each water crossing due to the increase in the impervious area of the proposed road will need stormwater management for quantity/quality control, which is described in **Section 5**.

5. Stormwater Management

Due to the increase in the impervious area of the proposed Greenhouse Road reconstruction and extension, stormwater controls are required, in accordance with the design criteria described in **Section 2**. The following options are proposed:

- SWM Option #1: proposed CB shields and enhanced grass swale with check dam
- SWM Option #2: proposed CB shields, the permeable pavement on sidewalks, and infiltration trench

As presented in **Table 4**, peak flow rates to Crossing #1 and Crossing #2 are increased compared to existing conditions due to the proposed road development. Storm water quantity storage is required to control peak flow under proposed conditions to match or lessen that under existing conditions. The total required storage is 130 m³ for Crossing #1 and 160 m³ for Crossing #2 respectively.

SWM Option #1:

The proposed enhanced grass swale with check dams will provide storage for quantity requirement and infiltration for water balance. CB shields and grass swale treatment train system will provide sufficient TSS removal requirements.

SWM Option #2:

If enhanced grass swale is not feasible, the permeable pavement on sidewalks, and infiltration trench would be another SWM option to provide storage for quantity requirement and also infiltration for water balance. The treatment train system of CB shields, the permeable pavement, and the infiltration trench will provide sufficient TSS removal requirements.

Detailed calculations of the proposed SWM options will be completed in the detailed design stage of the Project.

6. Conclusions and Recommendations

Based on the modeling results for the preferred solution (Alternative #1), the following conclusions are drawn for the SWM impact assessment along Greenhouse Road:

- As presented in **Table 4**, peak flow rates to Crossing #1 and Crossing #2 are increased compared to existing conditions due to the proposed road development. SWM storage is required to control peak flow under proposed conditions to match or lessen that under existing conditions. The total required storage is 130 m³ for Crossing #1 and 160 m³ for Crossing #2.
- Two SWM options with Low Impact Development (LID) design are proposed to provide storage, and infiltration for SWM design requirements as outlined in **Section 2**.
 - SWM Option #1: Proposed CB shields and enhanced grass swale with check dams
 - SWM Option #2: Proposed CB shields, permeable pavement on sidewalks, and infiltration trench

Detailed calculations of the proposed SWM options will be completed in the detailed design stage of the Project. At that time, the approach for the SWM design will be confirmed.