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Appendix K

Storm Drainage and Low Impact Development Review Memorandum

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Technical Memorandum

Storm Drainage and Low Impact Development Review

Date:	January 19, 2022	**Project No.:**	300052314.0000
Project Name:	Warden Avenue and Kennedy Road Environmental Assessment Studies Between Major Mackenzie Drive and Elgin Mills Road		
Client Name:	Regional Municipality of York		
Submitted To:	Jennifer Vandermeer, P.Eng.		
Submitted By:	Harold Faulkner, P.Eng. and H.T. Lam, OALA, CSLA		
Reviewed By:	Jennifer Vandermeer, P.Eng.		

1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by the Regional Municipality of York (Region) to provide storm drainage and Low Impact Development (LID) design services in support of the Class Environmental Assessment (EA) Studies for the proposed improvements to Warden Avenue from Major Mackenzie Drive to Elgin Mills Road and Kennedy Road from Major Mackenzie Drive to Elgin Mills Road. The purpose of this memorandum is to provide a review of existing drainage conditions and summarize the constraints and stormwater management requirements resulting from the proposed improvements to Warden Avenue and Kennedy Road. The drainage impacts associated with the proposed improvements to these road corridors will be further assessed as part of the Storm Drainage Assessment being completed for these EAs. This memorandum also provides information on potential LID design methodologies that are being considered for these two road improvement projects. The Study Areas are illustrated on Figure 1. The Study Areas shown includes lands within 500 m of the subject roads, but road improvements will be limited to the right-of-way (ROW) along the roads and will not extend into private property.

2.0 Storm Drainage Considerations

2.1 Background Review

A subwatershed study (North Markham Future Urban Areas Subwatershed Study, City of Markham, Amec Foster Wheeler Environment and Infrastructure – FUA SWS) was completed in 2019 and forms the basis of this review memo. The relevant stormwater management design criteria documents are listed below:

- York Region Road Design Guidelines, York Region Transportation Services, December 2020;
- TRCA Stormwater Management Criteria, Toronto and Region Conservation Authority, August 2012;
- Stormwater Management Planning and Design Manual, Ontario Ministry of Environment, March 2003; and
- Low Impact Development Stormwater Management Planning and Design Guide, Credit Valley Conservation & Toronto and Region Conservation Authority, 2010.

2.2 Topography and Drainage

The Study Areas are characterized by gently sloped topography with slopes generally being southwards towards the watercourse valleys. Along Warden Avenue the ground elevations range from 229 masl at Elgin Mills Road down to 210 masl at Major Mackenzie Drive E. Along Kennedy Road, ground elevations range from 225 masl near Elgin Mills Rd down to 205 masl at Major Mackenzie Drive.

The Study Areas are located in the Rouge River watershed within the jurisdiction of the Toronto and Region Conservation Authority (TRCA) and occupies portions of the Berczy Creek, Bruce Creek and Robinson Creek subwatersheds. Warden Avenue is within the Bruce and Berczy Creek subwatersheds; Kennedy Road is within the Bruce and Robinson Creek subwatersheds.

Along Warden Avenue a tributary of Bruce Creek crosses approximately 825 m north of Major Mackenzie Drive flowing southeast and the main branch of Berczy Creek flows across Warden Avenue just south of Major Mackenzie Drive. Along Kennedy Road there are no watercourse crossings except for Bruce Creek, which crosses just north of Elgin Mills Road. Both roads include other road crossing culverts which are not associated with watercourses.

The FUA SWS includes catchment area plans associated with a PCSWMM hydrologic model, which will be useful in determining the external and internal catchment areas draining to and within the right-of-way (ROW).

2.3 Conveyance

Conveyance of ROW runoff and external areas draining to the ROW is currently via roadside ditches. Urbanization of the subject roads will result in this system being replaced with a storm sewer system. Storm sewers are to be designed to York Region standards to convey the 10-year storm, using York Region intensity-duration-frequency rainfall curves. Runoff from storms exceeding the 10-year storm will be conveyed overland within the ROW.

Existing road-crossing culverts are to be assessed for condition and conveyance capacity. Based on York Region standards, the required storm frequency will be determined using the 2008 MTO Highway Drainage Design Standards (WC tables for urban arterial roads). Where feasible, existing culverts can be extended as needed to accommodate the proposed road design. Culverts are to be located, surveyed and inspected.

The subject portion of Warden Avenue includes an existing road-crossing culvert regulated by the TRCA. The FUA SWS describes a HEC-RAS hydraulic model prepared for the Rouge River Watershed, which includes this portion of the Bruce River Tributary that crosses Warden Avenue. This model should be updated as part of the EAs to determine the impacts of the proposed ROW and potential culvert changes on the regional floodplain.

2.4 Quantity Control

Road improvements are expected to result in increased impervious area within the ROW, thereby increasing the rate of storm runoff from the existing condition. York Region standards require stormwater quantity control to reduce the proposed runoff peak flow rates to existing rates or lower for events up to and including the 100-year storm.

A hydrologic PCSWMM model was established in the SWS to estimate the anticipated runoff increases and storage volumes required for mitigation. This model was based on the Rouge River Hydrology Study and is to be refined and updated as the design process progresses.

The FUA SWS identifies potential locations for end-of-pipe stormwater management facilities within the adjacent development lands. There may be an opportunity to utilize these facilities for ROW quantity control; however, further review of the modeling and preliminary design of the adjacent lands is required to confirm. Quantity controls will be necessary within the ROW if the runoff cannot be accommodated within the end-of-pipe facilities, through low impact development features as described in Section 3.0.

Unitary quantity control volumes and discharge rates are provided in Table 4.1.19 of the FUA SWS Phase 2 Report:

Subwatershed	100-Year Unitary Volume (m^3/impervious ha)	Unitary Discharge (m^3/s/ha)
Berczy Creek	-	-
Bruce Creek	800	0.015
Robinson & Eckardt Creeks	1100	0.0085

In addition to quantity controls for storm return period peak flows, erosion control will also be required to mitigate increased erosion potential at key locations along receiving watercourses. Unitary erosion control volumes and discharge rates are provided in Table 4.1.19 of the FUA SWS Phase 2 Report:

Subwatershed	Unitary Volume (m^3/impervious ha)	Unitary Discharge (m^3/s/ha)
Berczy Creek	500	0.001
Bruce Creek	500	0.001
Robinson & Eckardt Creeks	300	0.001

2.5 Quality Control

Section 4.4.2 of the FUA SWS Phase 2 Report specifies the stormwater quality control criteria. Stormwater quality treatment will be required to an Enhanced level per the 2003 MOE SWM Planning & Design Manual. This requires a minimum total suspended solids (TSS) removal of 80%.

The FUA SWS also identifies Redside Dace habitat within the subject subwatersheds. Therefore, stormwater management facilities in affected areas should attempt to have outflow temperatures less than 24 degrees C, dissolved oxygen levels above 7 mg/L, TSS levels less than 25 mg/L above background conditions, as per the Guidance for Development Activities in Redside Dace Protected Habitat (OMNRF, March 2016).

Generally, the quality control requirements are determined based on drainage area and imperviousness. These factors will be determined at the design stage, based on preferred road design criteria.

As with the quantity control review, there may be an opportunity to utilize future stormwater management facilities within adjacent lands for ROW quality control; however, further review of the modeling and preliminary design of the adjacent lands is required to confirm. Quality controls will be necessary within the ROW if the runoff cannot be accommodated within the end-of-pipe facilities, such as oil/grit separators or LID measures such as bioswales or infiltration trenches. Options for LID measures are further discussed in Section 3.0. A combination of measures is likely required, with underground features providing a thermal mitigation benefit.

3.0 Low Impact Development Measures

Low Impact Development Best Management Practices (LID BMPs) can provide stormwater management benefits, including erosion control, quality control, temperature mitigation and water balance. Typically LID features are infiltration-based and include infiltration trenches, bioswales, vegetated swales, etc. located within the boulevards. These measures are to be implemented where it is determined they will be functional and will achieve the desired goal or protection. Implementation of LID features is dependent on soil type and groundwater levels.

Geotechnical investigations for Warden Avenue and Kennedy Road were prepared by Golder Associates Ltd. August 6 and August 30, 2021, respectively. These reports identified the existing subsurface soils to be mostly silty sand, which are considered to generally exhibit a relatively high potential for infiltration.

The depth to water table varies with topography ranging from surface to 5 m below existing ground along Warden Avenue, and 1 m to 9 m below existing ground along Kennedy Road. MECP design criteria for infiltration measures typically require a minimum 1 m vertical separation between the bottom of the infiltration feature and the seasonally high groundwater level.

Location-specific percolation rates and high groundwater elevations should be determined to complete a more detailed design of proposed LID infiltration measures. This information will also determine where functional infiltration-based LID measures are achievable. The geotechnical and borehole investigations shall be the guidance towards specific LID designs and locations during the detailed design process.

3.1 LID Design Options

There are several design alternatives that have been installed as pilot projects throughout York Region and municipalities, including the use of Credit Valley Conservation Authority (CVC) and TRCA staff as teaching tools and monitoring for their performance and success rates. LID uses cost-effective construction and building methods to store, filter and infiltrate rainwater and snow melt to the ground. LIDs mimic nature while cleaning and cooling surface water and evapotranspiration to manage localized flood risks while reducing stress to municipal stormwater infrastructure. Some of the more prevalent designs include:

1. **Box Trench Design** - this is a variable depth linear design to capture surface water quantity to hold, filter and infiltrate through a below ground perforated pipe system that is connected lineally. Pavement runoff may be collected through a series of catch basin inlets along the sides of the roadway and redirected into these units. They are also open to the sky to collect any precipitation and adjacent surface runoff. Each section shall have a small Hickenbottom structure to manage the water levels. These structures shall be planted with wet tolerant plant material and species pre-selected by theTRCA.

2. **Vegetated/Bio Swale Design** - this is a linear or meander application of water collection and conveyance from paved surfaces to larger bioretention and rain gardens. The effectiveness of this design is dependent on the size of the rain event and flow rates. This design will capture lower rates and flow volumes, allowing surface water (and contaminants) to filter through plant material and absorption media before infiltrating into the local subgrades.

3. **Bioretention and Rain Garden Design** - this is a stormwater infiltration practice that collects and treats runoff from paved surfaces utilizing the natural properties of vegetation and soil to trap and filter contaminants. This design requires a large surface area to be effective.

4. **Underground Storage Tanks** - retains stormwater during peak flows and discharges it to the municipal storm sewer system

5. **Infiltration Trenches and Soakaways** - below ground clear stone infrastructure designed to capture precipitation and surface water for a timed release to the surrounding soils and / or into municipal stormwater management systems.

6. **Permeable Pavement** - a porous urban surface that infiltrates precipitation and surface water, storing it in its granular base while slowly allowing water to infiltrate into the subsoil below. This option is dependent on the local subsoil material.

7. **Above-Ground Rainwater Harvesting Tanks** - a gravity fed system that collects precipitation from upper level impervious surfaces such as building roofs and directed into rain barrels and storage tanks for reuse.

All options will be investigated and considered for implementation. As the design process progresses, some features may be ruled out if they do not achieve the desired goals or fit within the project limits.

R.J. Burnside & Associates Limited

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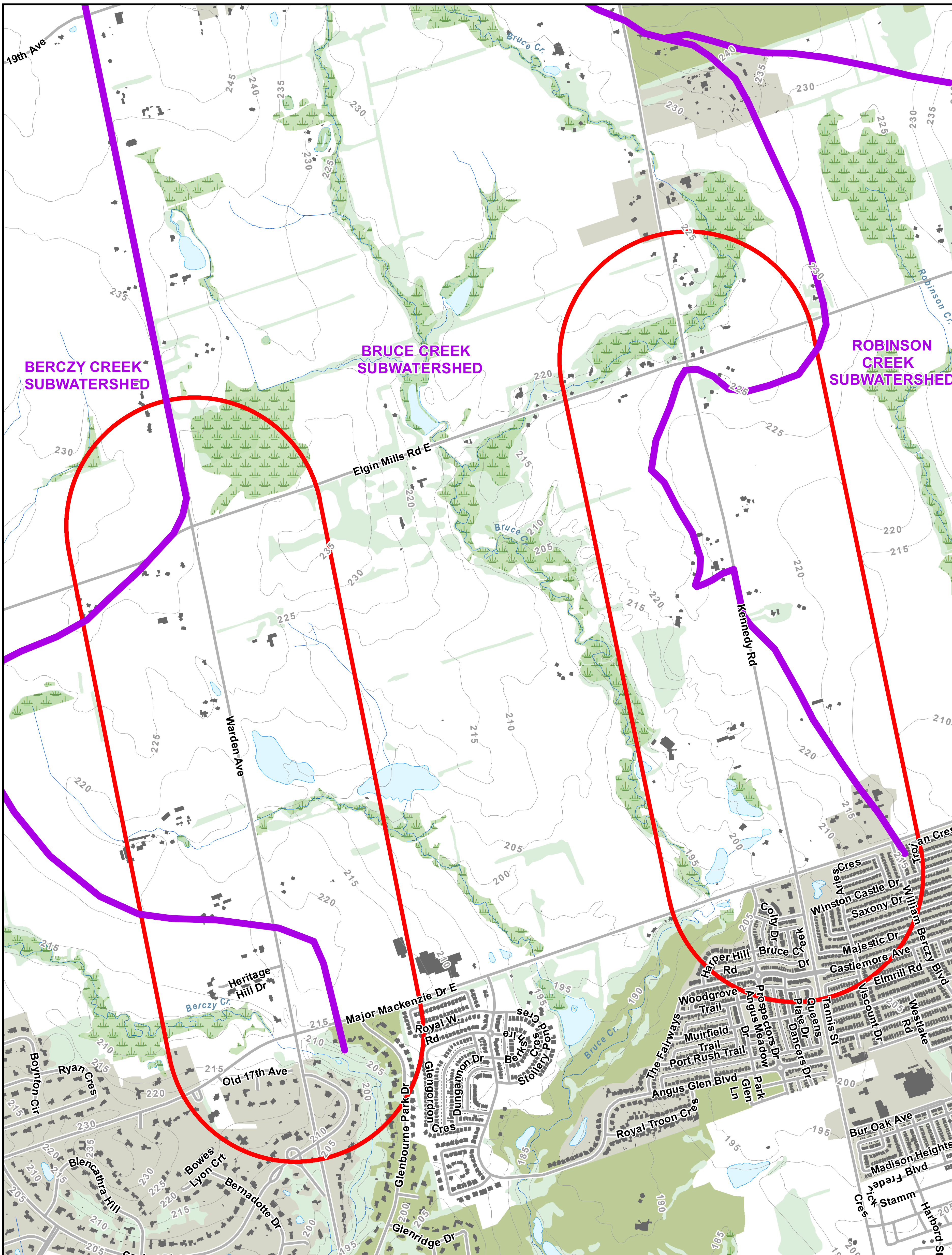
HF/HL:js



LEGEND

- STUDY AREAS
- SUBWATERSHED BOUNDARY
- BUILDING
- ROADWAY
- CONTOUR (5m intervals - masl)
- WATERCOURSE
- WETLAND
- OPEN WATER
- WOODED AREA
- BUILT-UP AREA: IMPERVIOUS
- BUILT-UP AREA: PERVIOUS

Sources:
1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

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Client / Report

CITY OF MARKHAM
MARKHAM, ONTARIO

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
STORM DRAINAGE AND LOW IMPACT DEVELOPMENT REVIEW

Figure Title

STUDY AREAS

Drawn	Checked	Date	Figure No.
SK	HF	December 2021	1
Scale		Project No.	
1:15,000		300052314	

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