

Fluvial Geomorphology Assessment Report

James Snow Parkway from Britannia Road to just south of Highway 401
North Halton Coordinated MCEA Study
Milton, ON

Prepared for: HDR Corporation

Prepared by: Onterris Canada Inc.

July 2026

Version 5.0

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1 Introduction

Halton Region is undertaking the North Halton Coordinated Municipal Class Environmental Assessment (MCEA) Study for transportation corridor improvements for the following three (3) corridors (Figure 1):

1. James Snow Parkway (Regional Road 4) from Britannia Road (Regional Road 6) to just south of Highway 401
2. Regional Road 25 from 5 Side Road to 10 Side Road
3. Steeles Avenue (Regional Road 8) from Regional Road 25 to Trafalgar Road (Regional Road 3)

The focus area of this report is James Snow Parkway. Each of the subject transportation corridors for James Snow Parkway, Regional Road 25, and Steeles Avenue cross natural watercourses and therefore require fluvial geomorphological assessments to provide recommendations to mitigate potential impacts of the preliminary design on natural channel processes, and to identify opportunities for restoration. Specifically, Conservation Halton's complete application checklist for Environmental Assessments includes requirements to identify and assess erosion hazards including lateral migration and vertical downcutting (e.g., meander belt and scour analyses) and to verify that the preferred alternative will allow for natural functions and sediment transport that minimize risks to infrastructure.

HDR Corporation retained Onterris Canada Inc., formerly Montrose Environmental Solutions Canada Inc. (Montrose) to complete a fluvial geomorphic assessment of watercourse crossings as part of the North Halton Coordinated MCEA Study.

1.1 Scope

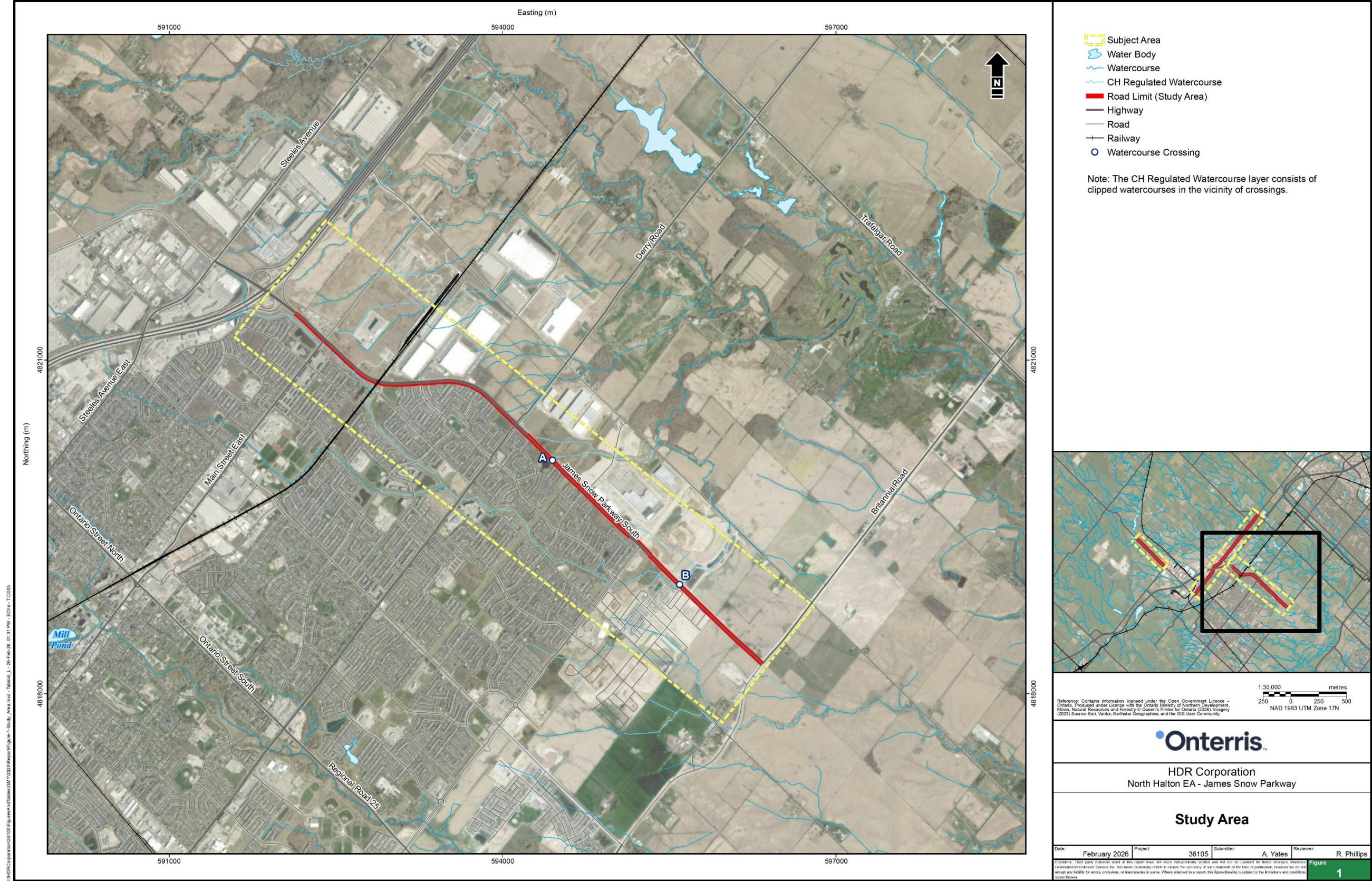
The fluvial geomorphology studies will contribute to the project's technical investigations for the watercourse crossings of James Snow Parkway, Regional Road 25, and Steeles Avenue within the study areas to document the existing crossing and watercourse conditions, to assess future crossing alternatives, and to provide conceptual plan recommendations to accommodate future upgrades to the each of the transportation corridor.

The geomorphic assessment included the following tasks:

- completing a background review
- undertaking field reconnaissance, Rapid Geomorphic Assessment (RGA), and substrate characterization at major and moderate watercourses
- undertaking erosion hazard delineation
- investigating geomorphic impacts and recommending mitigation strategies for the preliminary design of the preferred solution

Two potential watercourse crossings were identified within the James Snow Parkway (Regional Road 4) study area at the project outset. Individual watercourse crossings are shown on Figure 1 and listed in Table 1 below.

Figure 1 Study Area



The study area for this project runs along James Snow Parkway from Britannia Road northwestward to just south of Highway 401. Two watercourses cross James Snow Parkway within the study area: Crossing ID A, which crosses James Snow Parkway between Derry Road and Clark Boulevard; and Crossing ID B, which crosses northwest of the James Snow Parkway / Whitlock Avenue intersection.

1.1.1 Watercourse Crossing Inventory

Montrose completed a review of the study areas to identify the expected number and size of watercourse crossings that require fluvial geomorphology assessments. Table 1 lists the crossings for the James Snow Parkway transportation corridor. A review of existing background information and studies related to these fluvial systems provides context for field surveys and analysis (Section 2).

Table 1 Inventory of Watercourse Crossings within the Study Area (Focus Area James Snow Parkway)

Montrose Crossing ID	HDR Crossing ID	Transportation Corridor	Watercourse Name	Drainage Area (km ²) ^(a)	Watercourse Condition	Crossing Type
A	N/A	James Snow Parkway	Unnamed Tributary, East Branch	0.2	Natural, SWM Upstream, Agricultural Downstream	Minor
B	04-1068770 BR01	James Snow Parkway	Centre Tributary, East Branch	7.7	Natural, agricultural	Moderate

Note:

(a) Ontario Watershed Information Tool

1.2 Purpose

A separate fluvial geomorphology assessment report was prepared for each of the three transportation corridors of the North Halton Coordinated MCEA Study. **The following report focuses on the James Snow Parkway (Regional Road 4) transportation corridor from Britannia Road (Regional Road 6) to Highway 401, including watercourse Crossings A and B.**

James Snow Parkway is a major north-south arterial road in Halton Region. In order to support future travel demand and a transportation system that is safe, continuous, connected, and coordinated for all users and abilities, the recommended solution for James Snow Parkway includes improving active transportation facilities, improving traffic operations at intersections through physical and operational modifications, and widening James Snow Parkway to six lanes to provide additional travel lanes and opportunities for transit supportive infrastructure.

This **fluvial geomorphology assessment report** summarizes the findings and recommendations of the geomorphic assessment for watercourse crossings of **James Snow Parkway** within the North Halton Coordinated MCEA study area. The report also includes a geomorphic review of the preliminary design and recommendations for detailed design.

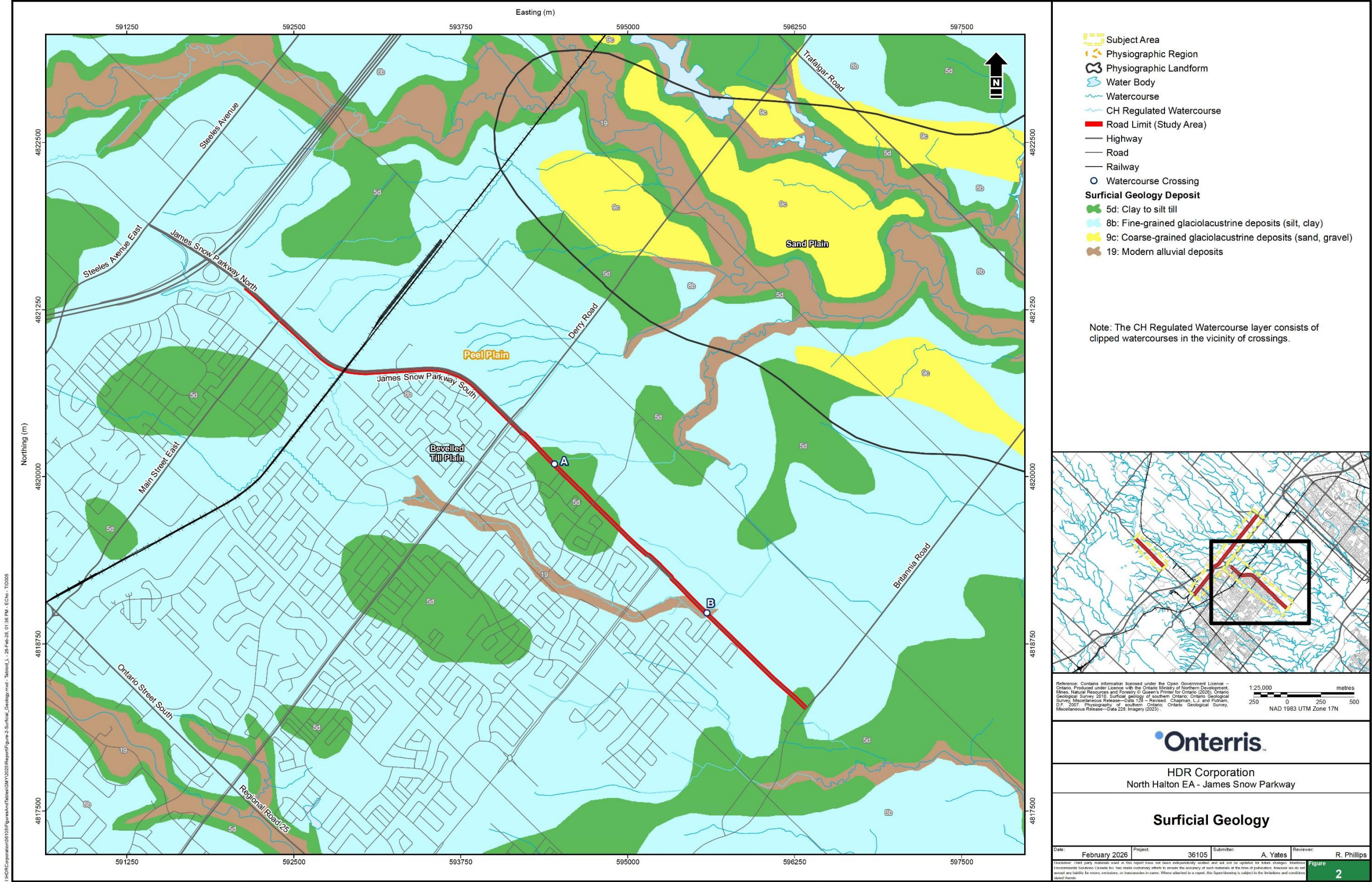
2 Study Area

2.1 Physiography and Surficial Geology

The surficial geology of the southern Ontario region is shaped by a legacy of bedrock erosion and sediment deposition, following continental glaciations over geological timescales and post glacial incision by fluvial processes over the last 10,000 years. The resulting stream and river drainage networks including their sediments and slope profiles are conditioned by this glacial and post glacial history. The physiography and surficial geology of the North Halton Coordinated MCEA study area is presented in Figure 2. Local topography, valleylands, watercourses, and crossing locations within the study area are presented in Figure 3.

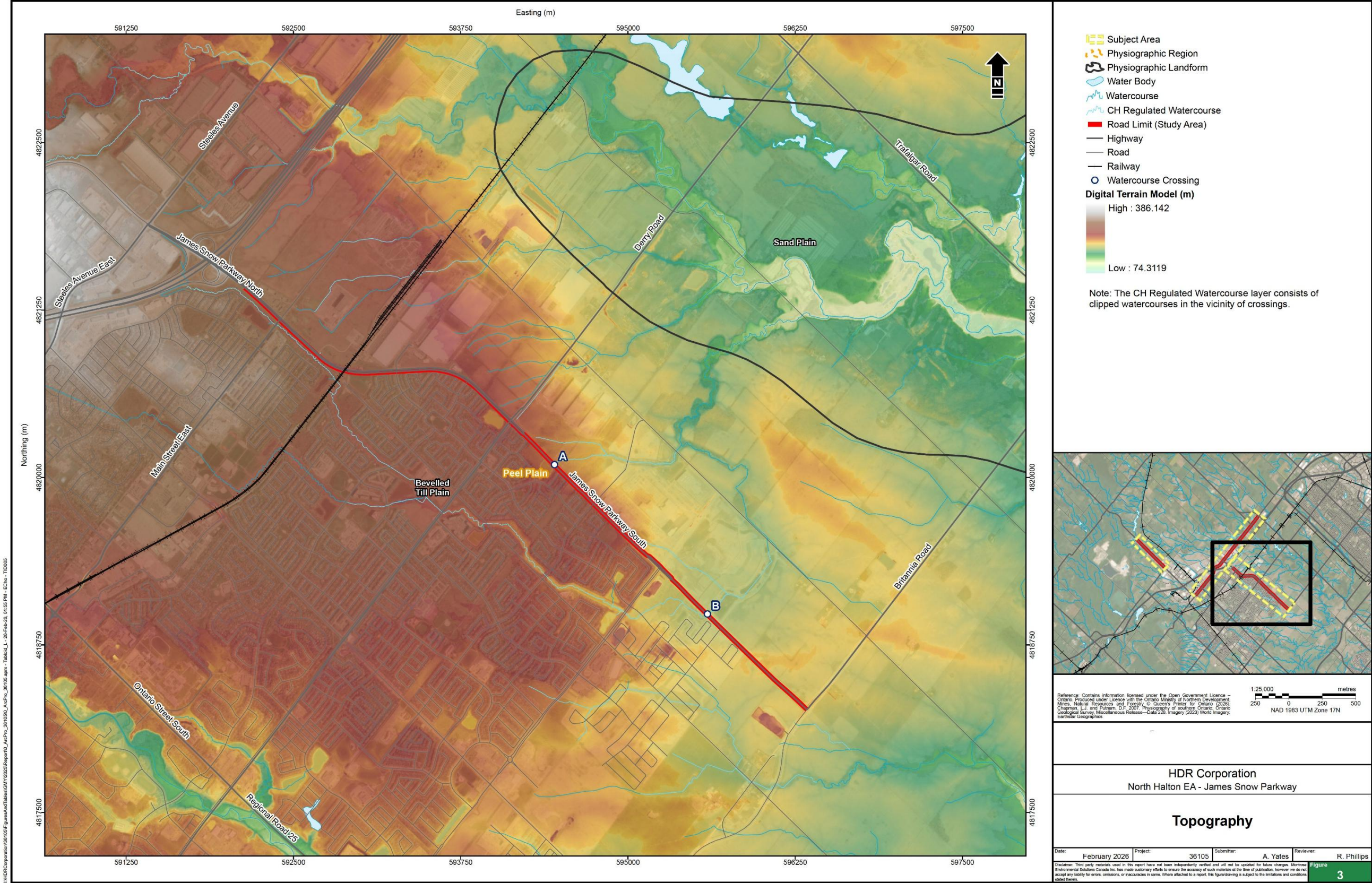
The study area is located east of the Niagara Escarpment. The James Snow Parkway corridor is located within the Peel Plain physiographic region (Figure 2) which is characterized by relatively flat plains of fine-grained glaciolacustrine deposits (Chapman and Putnam 1984). In this region soils are often clayey and poorly drained. Along the James Snow Parkway corridor, the glaciolacustrine deposits plain is punctuated with pockets of clay to silt till. All but the most minor watercourses within the study area run through riverine corridors of alluvial deposits, where the fluvial systems have incised and reworked the upland glacial materials. Minor watercourses and headwater drainage features tend to be the most impacted and decoupled from the glacial legacy due to a history of realignments, impoundments, and ploughing to accommodate over two centuries of agricultural and transportation land uses.

Figure 2 Surficial Geology



The physiography and surficial geology of the study area along James Snow Parkway is primarily characterized by fine-grained glaciolacustrine deposits such as silt and clay, with two exceptions. A 500-metre area surrounding and southeast of Watercourse Crossing ID A is characterized by clay to silt till. A very narrow area around Watercourse Crossing ID B is characterized by modern alluvial deposits.

Figure 3 Topography



Terrain elevation varies throughout the study area. The southernmost section of James Snow Parkway between Britannia Road and Louis St. Laurent Avenue is at a low to mid elevation. From the Louis St. Laurent Avenue intersection northwestward, James Snow Parkway is at a high elevation.

Note: “low” and “high” elevations as described above are relative. There is around a 312-metre difference between the lowest and highest elevations in the area surrounding the project area.

2.2 Background Review

Relevant background studies referenced in preparation of this report, including previous experience by staff from Montrose, include:

- Milton Urban Expansion Conceptual Fisheries Compensation Plan, Derry Green Corporate Business Park (April 2013) – AMEC
- Sixteen Mile Creek, Areas 2 and 7 Subwatershed Update Study, Town of Milton (May 2015) - AMEC
- Conceptual Channel Design, Centre Tributary (Reach BP-4-C) Milton Phase 3 East Lands, SIS Area 5B-C (April 2022) – GEO Morphix Ltd.

2.2.1 Milton Urban Expansion Conceptual Fisheries Compensation Plan, Derry Green Corporate Business Park (AMEC 2013)

The Milton Urban Expansion Conceptual Fisheries Compensation Plan (AMEC 2013) outlined the assessment and management of fish habitat impacts throughout the Derry Green Development Area. A field geomorphic assessment was conducted in 2007. Reach BP-2-B (downstream of Crossing A on James Snow Parkway, Figure 1) was a swale with an RSAT score of 8.5 and an RGA score of 0.03. It was ranked a ‘low geomorphic constraint’ system; however, the reach had a “high” net ranking due to its location within a high constraint terrestrial feature. A high constraint ranking indicated the watercourse must be protected/enhanced and remain open in its existing form and location.

2.2.2 Sixteen Mile Creek, Areas 2 & 7 Subwatershed Update Study (AMEC 2015)

The Sixteen Mile Creek, Areas 2 & 7 Subwatershed Update Study (AMEC 2015) provided an update to the 2000 Subwatershed Study and included management recommendations for the Boyne Survey lands and the Derry Green lands. A field geomorphic assessment was conducted including rapid and detailed geomorphic assessments as well as headwater drainage feature assessments. Results are shown in Table 3. Reach BP-4-C and BP-3-B (located at Crossing B, Figure 1) were ranked “medium geomorphic constraint” systems; however, they had a “high” net ranking with rehabilitation potential. These reaches have been subjected to historical alteration and the permanent flowing condition is attributed to an artificial low flow condition rather than a natural baseflow condition sustained by groundwater. These reaches may be realigned as part of future development, including watercourse enhancements and maintaining baseflow conditions through implementation of infiltration best management practices.

Table 2 Sixteen Mile Creek, Areas 2 & 7 Subwatershed Update Study (2015) Geomorphic Assessment Results

Parameter	Reach BP-2-B (Crossing A)	Reach BP-4-C (Crossing B)	Reach BP-3-B (Crossing B)
Location in relation to James Snow Parkway	Downstream	Upstream/Downstream	Downstream
Rapid Geomorphic Assessment Stability Index	0.03 (In Regime)	0.25 (Transitional)	Not assessed
Rapid Stream Assessment Technique Score	8.5 (Swale)	24 (Moderate)	Not assessed
Meander Belt Width (m) *including 20% factor of safety	18 m	33.6 m	24 m
Geomorphic constraint ranking	Low	Medium	Medium
Net constraint ranking	High	High (rehabilitation potential)	High (rehabilitation potential)

2.2.3 Conceptual Channel Design, Centre Tributary (Reach BP-4-C) Milton Phase 3 East Lands, SIS Area 5B-C (GEO Morphix 2022)

GEO Morphix completed the conceptual design for the East Branch of Sixteen Mile Creek (Centre Tributary) situated on the Boyne Phase 3 Survey Lands (Area 5B-C) located at the southwest corner of Louis St. Laurent Avenue and James Snow Parkway. Within this area the tributary passes through the Centre Tributary Natural Heritage System Unit (NHSU). The channel upstream and downstream of the NHSU were impacted by historical agricultural activities. Reach BP-4-C (Crossing B) had an average bankfull width of 2.0 m and bankfull depths ranged from 0.5 to 1.0 m.

The SUS and SIS ranked Reach BP-4-C as high constraint within the NHSU requiring it to remain in its existing condition. The channel upstream and downstream of the NHSU were classified as medium-high constraint requiring them to remain open, but they were identified for potential realignment providing their function was maintained.

The bankfull discharge for the design was defined as 0.26 m³/s, which is equivalent to the modelled 1.05-year flow and the accepted approach outlined under the SIS (David Schaeffer Engineering Ltd., et al. 2018). A meander belt width of 20 m was defined in the SIS for the proposed realigned watercourse, which included a factor of safety. The conceptual design was split into three design reaches. Design Reach 3 extends from NHSU 290 m to James Snow Parkway and has an overall gradient of 0.18%. Bankfull width and depth range from 1.7 to 2.3 m and 0.35 to 0.50 m, respectively. The design is riffle-pool morphology and addresses floodplain storage and wetland replication requirements. The channel corridor is 35 m wide, and the estimated meander belt width of Design Reach 3 is 13 m.

2.3 Historic Photograph Assessment

A georeferenced 1954 aerial photograph was obtained from the University of Toronto Library. Aerial photographs from 1976, 1985, and 1988 were acquired from the National Air Photo Library and geo-rectified for use in the historic channel and erosion hazard risk assessment. Publicly available satellite imagery from 2015 to 2024 was also reviewed and was verified using publicly available Ontario LiDAR (MNR 2023a). Historic photographs and recent satellite imagery are included in Appendix A. An overlay of historic channel traces from each photograph year are presented in Appendix B.

An error assessment of common ground control points (GCP) was completed for the historical aerial imagery to support interpretation of historical channel delineation. The average distance error for all GCPs between all year comparisons was 7.1 m, with most of the data falling between 1.8 and 12.4 m. While lateral migration rates were not evaluated for this current study, these results indicate an average error of 0.3 m/year, with the majority of the data between 0.0 and 0.6 m/year. The maximum GCP discrepancy measured was 23.0 m (1.1 m/year). These GCP comparisons were collected for the entire study area (i.e., 3 combined transportation corridors), and were averaged across all years of comparison. A more detailed break down of distance and rate errors across year-to-year comparisons is provided in Appendix B.

2.3.1 Overview

In the earliest available historic photograph (1954), land use within the study area was predominantly agricultural. James Snow Parkway had not been established in 1954. Surrounding land use remained agricultural in 1976 and 1988. By 2015, James Snow Parkway had been constructed, and residential development had occurred in the area to the west. Development surrounding James Snow Parkway has continued from 2015 to present.

Crossing A: Unnamed Tributary, East Branch

In 1954, no watercourse was visible. In the 1976 image, a small poorly defined channel could be distinguished downstream of the existing James Snow Parkway. By 2015, there was a stormwater pond upstream of the crossing and a swale with a narrow riparian corridor through farmland downstream. Conditions remain similar at present; however, the reach further downstream has been realigned.

Crossing B: Centre Tributary, East Branch

The watercourse at Crossing B was a straightened channel through farmland prior to the construction of James Snow Parkway. In the 2015 imagery, the channel remained a straightened channel. In 2023, the channel was realigned, and a meandering planform was constructed with floodplain wetlands.

3 Existing Geomorphic Conditions

3.1 Drainage Area and Hydrological Flows

Watercourse drainage areas at road crossings were obtained using the Ontario Watershed Information Tool (OWIT; MNRF 2023b). Drainage areas are provided in Table 3.

A preliminary flow assessment for the purpose of the erosion hazard assessment was completed using the Unified Ontario Flood Method (UOFM; Sehgal 2016; MTO 2023). The UOFM is a regression-based method for estimating peak discharge and flood frequencies in Ontario, using drainage area and other parameters including lake attenuation index and mean annual precipitation. Estimated existing peak flow rates in the vicinity of the road crossings are provided in Table 3.

Table 3 Existing Drainage Area and Peak Flow Rates

Crossing	Drainage Area ^(a) at Crossing (km ²)	Discharge ^(b) at Crossing (m ³ /s)					
		2-year	5-year	10-year	25-year	50-year	100-year
A	0.2	0.2	0.4	0.5	0.7	0.8	0.9
B	7.7	3.6	5.5	7.3	9.4	10.9	12.5

(a) Ontario Watershed Information Tool

(b) Estimated discharge using Unified Ontario Flood Method (UOFM)

3.1.1 Hydraulic Modelling

Detailed review of existing hydraulic modelling was not deemed necessary as Crossing A is a pond outlet and Crossing B is a relatively new natural channel design (reviewed in Section 2.2). HDR completed a hydraulic assessment of Crossing B and recommendations are summarized in (Section 5.2 – Table 9).

3.2 Reach Delineation

Reaches were delineated based on differences in channel planform, valley form, riparian vegetation, flows, channel modification, and land use. Reaches are lengths of channel that display similarity with respect to valley and stream network setting, planform, floodplain materials, and land use/cover. Reach length will vary with channel scale, since the morphology of low-order watercourses will vary over a smaller distance than those of higher-order watercourses. At the reach scale, the characteristics of the watercourse corridor impose a direct influence on channel form, function, and processes.

Where applicable, reach breaks delineated as part of previous studies were confirmed and re-used as part of the current study. For the purposes of this study reach names consisting of the crossing number followed by another number, starting with 1 at the downstream-most reach walked, and increasing upstream (e.g., Crossing A downstream of James Snow Parkway = A-1). Road crossings

often serve as reach breaks due to impacts from the crossing structure or changes in land use on either side of the road that impact channel morphology. Reach breaks are presented in Appendix B. Reach names are presented in Table 4.

Table 4 Reach Names

Crossing	Watercourse	Location ^(a)	Reach Name	Previous Study Reach Name	Notes
A	Unnamed Tributary, East Branch	Downstream	A-1	BP-2-B ^(b,c)	N/A
		Upstream	A-2	N/A	Pond
B	Centre Tributary, East Branch	Downstream	B-1	BP-4-C ^(c, d) , BP-3-B ^(c)	N/A
		Upstream	B-2	BP-4-C ^(c, d)	Reach breaks added at upstream woodlot and James Snow Parkway

N/A – not applicable

(a) Location in relation to James Snow Parkway

(b) Source: AMEC (2013)

(c) Source: AMEC (2015)

(d) Source: GEO Morphix Ltd. (2022)

3.3 Geomorphic Field Assessment

Montrose completed a geomorphic field assessment of the 2 watercourse crossings on December 6, 2023, May 1, 2024, and May 31, 2024. The purpose of the geomorphic assessment is to characterize channel form and processes and identify any erosion hazards within the study area. The field assessment was completed only within properties where there was permission to enter and did not extend the full reach length.

3.3.1 Rapid Geomorphic Assessment and Rapid Stream Assessments

3.3.1.1 Methodology

Montrose assessed geomorphic conditions using the RGA and the Rapid Stream Assessment Technique (RSAT). Results of the RGA and RSAT are presented in Tables 5 and 6.

The RGA (MOE 2003) is used to evaluate dominant geomorphic processes. Field observations are evaluated using an indexed rating for channel sensitivity based on aggradation, degradation, channel widening, and lateral adjustment. The combined indices are used to provide an indication of current channel stability, with designations of In Regime, Stressed/Transitional, or In Adjustment. The RGA is applied on a per reach basis (i.e., a defined length of channel with relatively uniform characteristics).

The RSAT (Galli 1996) uses a broad, qualitative approach to assess overall health and function of a reach from a more biological and water quality perspective. The indicators assessed in the RSAT technique are scored on a scale of 1 to 10 (with 10 being the better score), and cumulative scores produce an overall indication of stream health (<20 Low, 20 to 35 Moderate, >35 High). This approach is useful for assessing geomorphic conditions because in general the physical and biological features of a healthy stream also indicate geomorphic function.

3.3.1.2 Results

A reach summary table describing existing geomorphic site conditions is provided in Appendix C. The table includes bankfull widths observed onsite. A photographic inventory is provided in Appendix D.

3.3.2 Stream Crossing Assessments

The stream crossing assessment collects data specific to the channel and crossing structure within the vicinity of the road crossing. Information recorded includes crossing type, material, shape, dimensions, structural condition, as well as an assessment of potential issues relating to the channel near the crossing (e.g., bank erosion, bed scour, debris trapping, and fish passage). Crossing A is a stormwater pond outlet and therefore was not evaluated for RGA and RSAT. Table 7 summarizes existing watercourse crossing conditions within the study area.

Table 5 Summary of Rapid Geomorphic Assessment Scores

Reach	Factor Value				Stability Index	Condition	Dominant Process
	Aggradation	Degradation	Widening	Planimetric Adjustment			
A-1	N/A (HDF)						
A-2	N/A (pond)						
B-1	N/A – No PTE (recently realigned channel)						
B-2	N/A (recently realigned channel)						

N/A – Not applicable

HDF – Headwater drainage feature

PTE – Permission to enter

Table 6 Summary of Rapid Stream Assessment Technique (RSAT) Scores

Reach	Factor Value						Overall Score	Condition
	Channel Stability	Scour/ Deposition	Instream Habitat	Water Quality	Riparian Condition	Biological Indicators		
Maximum Score	11	8	8	8	7	8	50	
A-1	N/A (pond)							
A-2	N/A (HDF)							
B-1	N/A (recently realigned channel)							
B-2	N/A (no PTE)							

N/A – Not applicable

HDF – Headwater drainage feature

PTE – Permission to enter

Table 7 Crossing Assessment Results

Structure				Local Bankfull Dimensions		Opening Width: Channel Width	Gradient	Flow Restriction	Appendix D Photos
Crossing	Type	Opening Width (m)	Estimate Skew Angle ^(a) (°)	Width (m)	Depth (m)				
A	Circular concrete pipe	1.4	N/A	N/A – poorly defined		N/A (effectively ~1)	Low	Pond outlet. Channel choked with reeds downstream.	3, 4
B	Bridge	20.6	0	2.0 – 2.7	0.4	Ratio: 7.6; bridge wider than bankfull channel	Low	Wetland/pond-like upstream	5, 8, 9

N/A – Not applicable

(a) Skew angles measured between alignment of the crossing structures and road centreline. The skew angle is 0° where the crossing structuring is perpendicular to the road centreline

4 Erosion Hazard Assessment

4.1 Methodology

Watercourses within the study area have undergone extensive historic modification. Most open reaches have been historically straightened or have modified floodplains. Erosion hazard limits were therefore assessed using multiple lines of evidence, including historic and current planform observations, empirical meander belt relations, meander amplitudes, and multiples of channel bankfull width. A 20% factor of safety was considered in the absence of measurable 100-year erosion limits. These were used to assess the erosion hazard at each crossing. Erosion hazards are discussed further in Section 5 with respect to crossing recommendations. Crossing A is a stormwater outfall; therefore, erosion hazards were not assessed.

4.2 Results

Results of the erosion hazard assessment are presented in Table 8.

Table 8 Recommended Erosion Hazard Widths at Watercourse Crossings

Crossing	Valley Considerations and Historic Observations	Low Risk: Empirical MBW ^(a) (m)	Moderate Risk: MA + 20% FS (m)	High Risk: 3 x BFW (m)	Existing Crossing Span (m)	Recommended Erosion Hazard Width (m)		Erosion Risk at Crossing
						Existing Urban Corridor ^(b)	Unmanaged Natural Corridor	
A	N/A							
B	Designed channel corridor 35 m wide. Original meander belt width 20 m, estimated design meander belt 13 m.	9 to 70 Average 31	13	2.7 x 3 = 8.1	20.6	N/A	31	Low

Notes:

MBW – Meander belt width

MA – Meander amplitude

FS – Factor of safety

BFW – Bankfull width

N/A – Not applicable

(a) Sources: PARISH (2004) ($=8.32 \ln(Aw * 9806 * Q_{bf} * S)$ 14.83), Williams (1986) ($=4.3W^{1.12}$, $=18Ac^{0.65}$, $=148D^{1.52}$), Ward et al. (2002) ($=6W^{1.12}$), Bridge (1993) ($=59.9D^{1.8}$), Annable (1996) ($=35.2 * Q_{bf}^{0.53}$) Where: Aw = drainage area, D = bankfull depth, W = bankfull width, Q_{bf} = bankfull or 2 year discharge rate, S = slope.

(b) Applies where meander amplitude is N/A

Crossing A: Unnamed Tributary, East Branch

Erosion hazard assessment is not applicable for crossing, as it is stormwater pond outlet pipe and outfall.

Crossing B: Centre Tributary, East Branch

Theoretical meander belt widths ranged from 9 to 69 m. The upstream meander amplitude plus a 20% factor of safety is 13 m. The unmanaged natural corridor width is estimated to be 31 m based on the average empirical meander belt width. A 31 m erosion hazard width is a more conservative estimate than the design belt widths of 13 m and 20 m estimated in the channel design brief (GEO Morphix 2022), but it falls within the designed realignment corridor of 35 m.

4.3 Scour Hazards

The CVC (2019) Fluvial Geomorphic Guidelines: Factsheet VI: Scour Analysis provides guidelines for scour assessment studies, which may be applied to the current study area. CVC defines scour assessment as the technical and professional evaluation of the long-term risks due to potential vertical erosion and/or degradation of stream and river channels. A variety of rational and empirical methods are available to quantify the potential scour of a watercourse in anticipation of new infrastructure and hazard delineation. CVC (2019a) aims to guide such evaluations.

Following the completion of the North Halton Coordinated MCEA Study, the following additional assessment is recommended based on CVC guidelines:

- Scour assessment to identify the scour hazard limit at each watercourse crossing for which alterations to the crossing structure or watercourse are proposed.
- Where engineering to the 100-year scour hazard limit is not practical or feasible with respect to impacting adjacent land uses and/or habitats, hazard mitigation and management plans will be required to the satisfaction of the conservation authority and other stakeholders.

It is recommended that this assessment be completed by a qualified engineer and/or geoscientist at detailed design.

5 Crossing Recommendations

5.1 Principles of Crossing Design and Crossing Design Guidance

Fluvial geomorphic recommendations regarding the proposed roadway improvements and crossing structure alterations have been developed based on the results of the desktop assessment, field investigation results, and geomorphic analysis to provide a geomorphic review of the preliminary design. A review of the proposed crossing extensions, skew, and adjacent works is provided to address risks associated with erosion hazards surrounding the channels. The fluvial geomorphic review involved the evaluation of the following criteria:

- **Valley setting:** Watercourses with wide, flat floodplains and low valley setting tend to migrate laterally across the floodplain over time. Watercourses within the study area occupy a variety of valley settings, and are unconfined, partially confined, and entrenched. Many reaches have modified floodplains.
- **Channel size:** The potential for lateral channel movement and erosion for the watercourses within the study area generally increases with channel size. At James Snow Parkway there is one moderate watercourse crossing (Crossing B) and one minor watercourse crossing (Crossing A).
- **RGA:** The RGA score provides a measure of the channel stability. The RGA was not applicable for the James Snow Parkway crossings. Crossing A was a stormwater pond outlet with a poorly defined channel downstream. Crossing B was a recently constructed natural channel design.
- **Erosion hazard limit:** The erosion hazard is assessed based on several conceptual and technical approaches depending on the watercourse context (e.g., natural, rural, urban) and available information (e.g., historic, topographic), including:
- **Meander belt width (MBW):** The MBW represents a conservative approach for crossing span recommends and considers the long-term migratory tendencies of the watercourse. Where it is not possible for the crossing to accommodate the MBW, alternative criteria are evaluated.
- **Meander geometry:** Crossings are typically evaluated in terms of their relationship to the meander amplitude to ensure that channel processes and functions can be maintained within the crossing. Current or historic meander amplitudes could be measured in watercourses with natural planforms.
- **100-year migration rate:** Migration rates are typically estimated using historical aerial photography. Due to historical channel straightening, 100-year migration rates could not be estimated. A 20% factor of safety was considered in the absence of measurable 100-year erosion limits.

Where a new crossing is proposed, a collective evaluation of all these factors is used to direct the development of new structural design parameters (span, length, and skew) that are appropriate from a fluvial geomorphic perspective. This process is also informed by local and regional conservation authority guidelines. The CVC's Fluvial Geomorphic Guidelines (CVC 2015) states that a well-designed crossing:

- spans the stream and banks
- does not change water velocity
- has natural substrate
- creates no noticeable change in river form
- preferably structures include bridges, open bottom arches, or culverts that span and are embedded below the streambed

The CVC's Technical Guidelines for Watercourse Crossings (CVC 2019b) provides the following additional geomorphic guidance under Section 6: Design Principles:

- The crossing design should respect the fluvial geomorphic process in the watercourse in order to minimize the negative impacts on the aquatic and terrestrial environment.
- The span of crossings should be selected based on detailed fluvial geomorphic analyses. Abutments, piers and other bridge components should be located outside of the 100-year local erosion hazard. Determination of the local erosion hazard is separate from the procedure of determining meander belt and scour potential at a specific site. The 100-year local erosion hazard will determine the extent at which the crossing infrastructure should be placed in order to avoid future channel realignment or unnecessary hardening of the channel or banks.
- Generally, a geomorphic study is required to determine the crossing opening. However, for the watercourses that are less than 4 m wide, the crossing opening of three times the bankfull channel can be adopted without undertaking a geomorphic study.
- Where the existing bridge abutments interfere with the erosion hazard, a fluvial geomorphic assessment must be completed in order to identify if the abutment needs removal or relocation.
- It is recognized that larger crossings may require piers in the watercourse. This must be specified early in the process. In some cases, as early as during the environmental assessment.
- For new crossings, the footing depths are based on the scour depth as identified by a fluvial geomorphologist. Provide the method used, results of the analyses and the input parameters used to determine the type and depth of footings.
- The replacement or new construction of a crossing must be an open footing culvert or bridge, unless there is a compelling reason why a closed bottom culvert would provide greater social, economic and environmental benefits.

5.1.1 Erosion Risk Assessment Framework for Existing Crossings

To assess the erosion risk of existing crossings, a risk-based assessment method was applied using the following categories:

- **No Risk:** spans the natural corridor MBW

- **Low Risk:** spans the meander amplitude plus 20% factor of safety or the average of three times the bankfull width and the natural corridor MBW (if meander amplitude could not be measured)
- **Moderate Risk:** spans three times the bankfull width
- **High Risk:** spans the bankfull channel width or less

For both the moderate- and high-risk span options, erosion control treatment will need to be considered at detailed design. Results of the erosion risk assessment are included in Section 5.2.2.

5.2 Geomorphic Impact Assessment of the Preliminary Design

As part of planned improvement to the James Snow Parkway transportation corridor, James Snow Parkway is proposed to be widened to six lanes, following a best fit approach, with sidewalk and boulevard cycle track on both sides. No structural modifications are proposed to Crossings A or B.

Montrose reviewed the following design materials provided by HDR:

- Draft Roll Plan: North Halton Coordinated MCEA Study – James Snow Parkway (Britania Rd to Highway 401) – Plan, Public Information Centre #2 – December 2024
- AutoCAD file of Draft Roll Plan
- Transverse Crossing Hydraulic Summary provided March 23, 2025
- North Halton Coordinated MCEA Study – Watercourse Crossings Evaluation, May 26, 2025
- PowerPoint: North Halton Coordinated MCEA Study – Meeting with Conservation Halton #4, Preliminary Drainage Recommendations, July 10, 2025

Table 9 summarizes the preliminary design analysis and recommendations provided by HDR and Montrose's review of the preliminary design. The following sections provide a risk assessment of the existing crossings and geomorphic impact assessment of the preliminary design.

Table 9 Crossing Recommendations Summary

Montrose Crossing ID	Erosion Risk at Crossing	HDR Crossing ID	HDR Hydraulic Analysis and Recommendations	Montrose Review of HDR Concepts	HDR Preliminary Recommended Alternative Design
A	N/A	N/A	N/A	No fluvial geomorphic input needed at this crossing.	N/A
B	Low	04-1068770 BR01	Meets MTO freeboard criteria. Regional storm does not overtop road. Maintain existing bridge structure, no extension required to support proposed roadway improvements.	Recently constructed natural channel design. Existing bridge has a low erosion risk. No work required.	No additional improvements required. The existing structure accommodates the proposed roadway improvements and meets hydraulic requirements.

N/A – Not applicable

5.2.1 Review of Proposed Hydraulic Conditions

Hydraulic modelling was not reviewed for the James Snow Parkway crossings as Crossing A does not require fluvial geomorphic input and Crossing B has a low erosion risk and does not require replacement. No structural modifications to the crossings are proposed.

5.2.2 Erosion Risk Assessment Recommendations for Watercourse Crossings

Crossing A: Unnamed Tributary, East Branch

No fluvial geomorphic input is needed for this crossing. The pond outlet is located approximately 25 m from the road shoulder.

The preliminary design for the James Snow Parkway transportation corridor does not include any structural modifications to Crossing A.

Crossing B: Centre Tributary, East Branch

The existing Centre Tributary, East Branch bridge at James Snow Parkway (20.6 m span) is larger than the bankfull channel width (2.7 m), for an opening width to channel width ratio of 7.6. Thus the existing crossing spans more than three times the bankfull width, and the upstream meander amplitude (with a 20% buffer), but does not span the recommended erosion hazard width of 31 m. Using the risk assessment framework described above, the existing crossing has a **low erosion risk**.

The existing bridge is perpendicular to James Snow Parkway and inline with the channel planform. The upstream and downstream channel is a recently constructed natural channel design with floodplain wetlands. There is riverstone lining the sinuous channel through the crossing. The existing bridge is wider than the road width and may be able to accommodate road widening without structural alteration.

The preliminary design for the James Snow Parkway transportation corridor does not include any structural modifications to the bridge at Crossing B. The erosion risk at the bridge will remain low.

5.2.3 Recommendations for Detailed Design

No structural modifications are proposed to either of the James Snow Parkway crossings. Crossing A did not require any fluvial geomorphic input. The risk assessment for Crossing B indicated a low erosion risk, therefore, erosion mitigation is not required.

5.3 Conclusion

This fluvial geomorphology assessment baseline report summarizes the findings and recommendations of the geomorphic assessment of the watercourses within the James Snow Parkway transportation corridor of the North Halton Coordinated MCEA study area. The geomorphic assessment includes a background review and historical assessment, field reconnaissance, and erosion hazard assessment. The assessment provides an understanding of the existing conditions of area watercourses in terms of function, stability, and the interactions with road crossings within the study area.

The desktop assessment indicated that watercourses within the area have a history of agricultural and urban modification. The erosion assessment took this into consideration by estimating erosion hazards using multiple lines of evidence, taking into consideration historic, current, and potential future site conditions. Based on an erosion risk framework, Crossing B is at **low risk from long-term erosion hazards**, and Crossing A is a stormwater pond outlet that does not require a geomorphic hazard assessment. No structural modifications are proposed at either of the James Snow Parkway crossings. It is expected that Crossing B will remain at low risk from long-term erosion hazards.

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