

Fluvial Geomorphology Assessment Report

Regional Road 25 from 5 Side Road to 10 Side Road

North Halton Coordinated MCEA Study

Halton Hills, ON

Prepared for: HDR Corporation

Prepared by: Onterris Canada Inc.

September 2026

Version 6.0

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Version Control

Version	Date	Issue Type	Filename	Description
V1.0	15-Sep-2025	Final	36105 North Halton EA - Geomorphology Report - RR25 2025-09-15 F V1.0.docx	Issued to client
V2.0	20-Oct-2025	Revised Final	36105 North Halton EA - Geomorphology Report - RR25 2025-10-20 V2.0.docx	Issued to client
V3.0	03-Mar-2026	Revised Final	36105 North Halton EA - Geomorphology Report - RR25 2026-03-03 F V3.0.docx	Issued to client
V4.0	05-Mar-2026	Revised Final	36105 North Halton EA - Geomorphology Report - RR25 2026-03-05 F V4.0.docx	Issued to client
V5.0	31-Jul-2026	Revised Final	36105 North Halton EA - Geomorphology Report - RR25 2026-07-31 F V5.0.docx	Issued to client
V6.0	02-Sep-2026	Revised Final	36105 North Halton EA - Geomorphology Report - RR25 2026-09-02 F V6.0	Issued to client

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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 Regional Road 25. 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

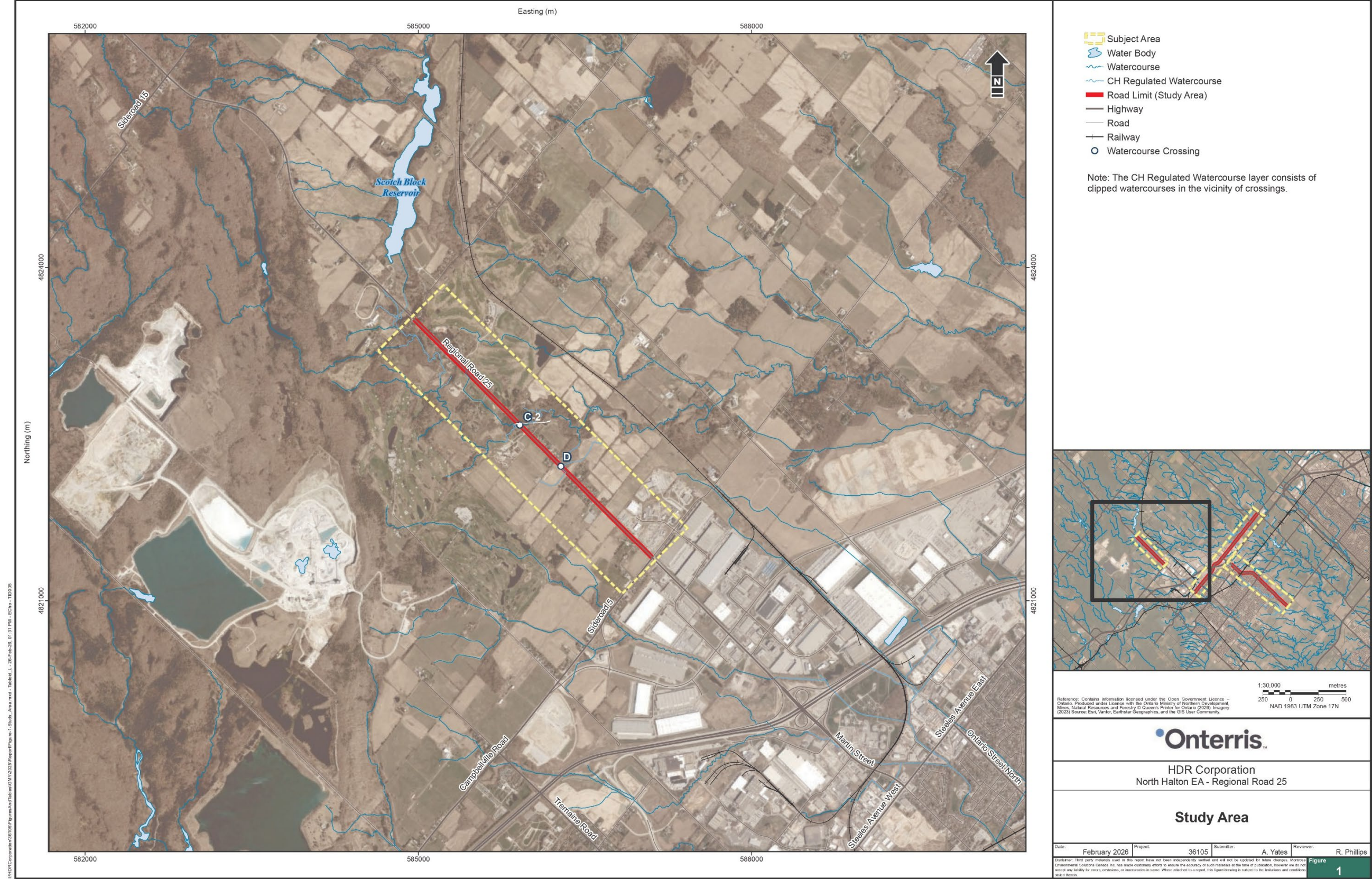
The fluvial geomorphology studies will contribute to the project's technical investigations for the watercourse crossings of James Snow Parkway, Regional Road 25, and Steeles Avenue within the study areas to document the existing crossing and watercourse conditions, to assess future crossing alternatives, 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 Regional Road 25 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 Regional Road 25 from 5 Side Road northwestward to 10 Side Road. Two watercourses cross James Snow Parkway within the study area: Crossing ID C-2, which crosses Regional Road 25 just northwest of the access road to Chudleigh's Entertainment Farm; and Crossing ID D, which crosses Regional Road 25 about 475 metres southeast of the access road to Chudleigh's Entertainment Farm.

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 Regional Road 25 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 Regional Road 25)

Montrose Crossing ID	HDR Crossing ID	Transportation Corridor	Watercourse Name	Drainage Area (km ²) ^(a)	Watercourse Condition	Crossing Type
C-2	25-1158180 BR01	Regional Road 25	Middle Sixteen Mile Creek	40.2	Natural Corridor	Major
D	N/A	Regional Road 25	Unnamed Tributary, Middle Branch	0.4	Natural, agricultural US, Woodlot DS	Minor

(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 Regional Road 25 transportation corridor from 5 Side Road to 10 Side Road, including watercourse Crossings C-2 and D.**

Regional Road 25 is a major north-south two-lane arterial rural 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 Regional Road 25 involves providing active transportation facilities, improving traffic operations at intersections through physical and operational modifications, and localized improvements to provide a continuous centre turn lane along Regional Road 25.

This **fluvial geomorphology assessment report** summarizes the findings and recommendations of the geomorphic assessment for watercourse crossings of **Regional Road 25** within the North Halton Coordinated MCEA study area. The report also includes geomorphic review of the preliminary design and recommendations for detailed design.

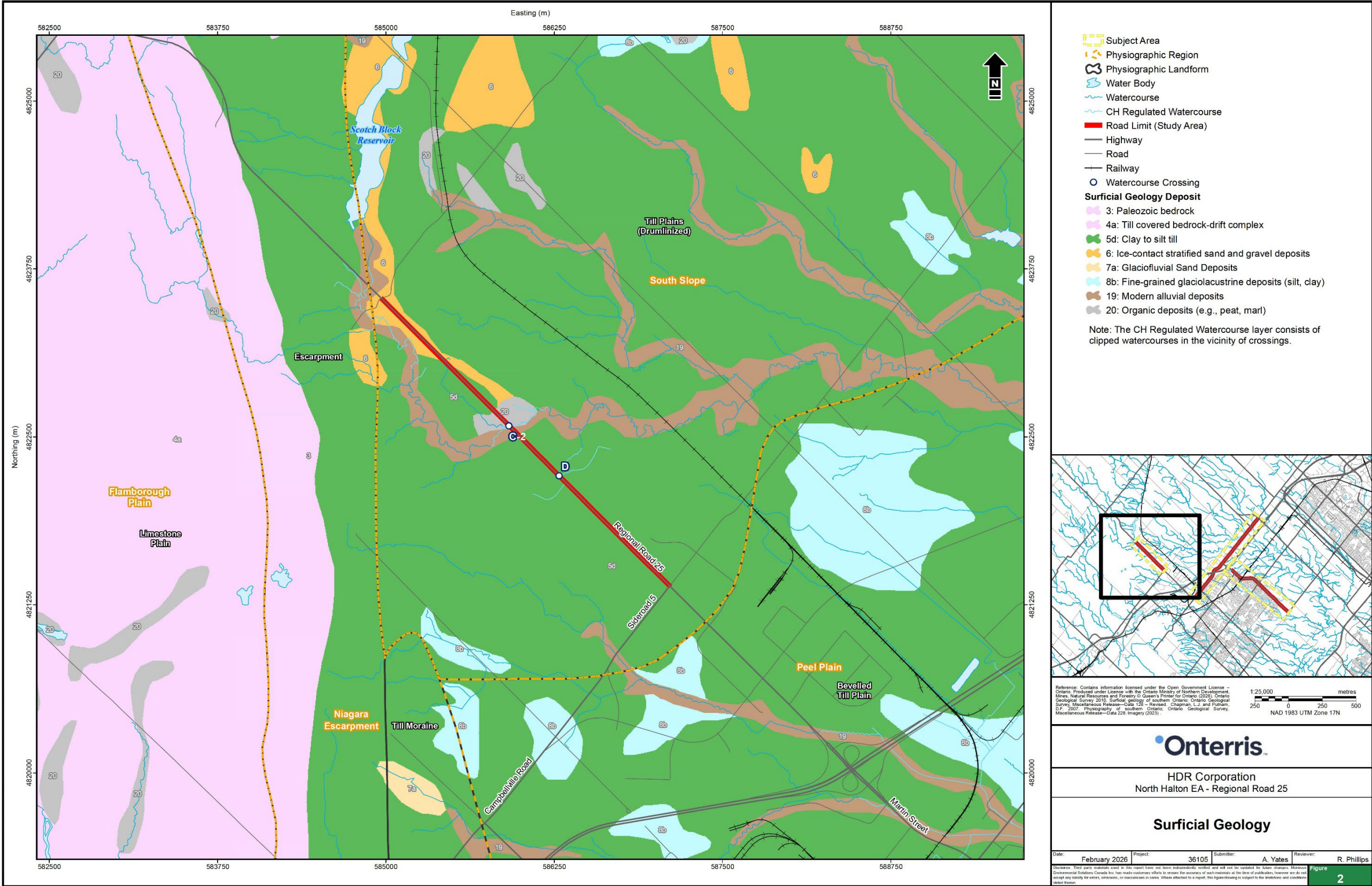
2 Study Area

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.

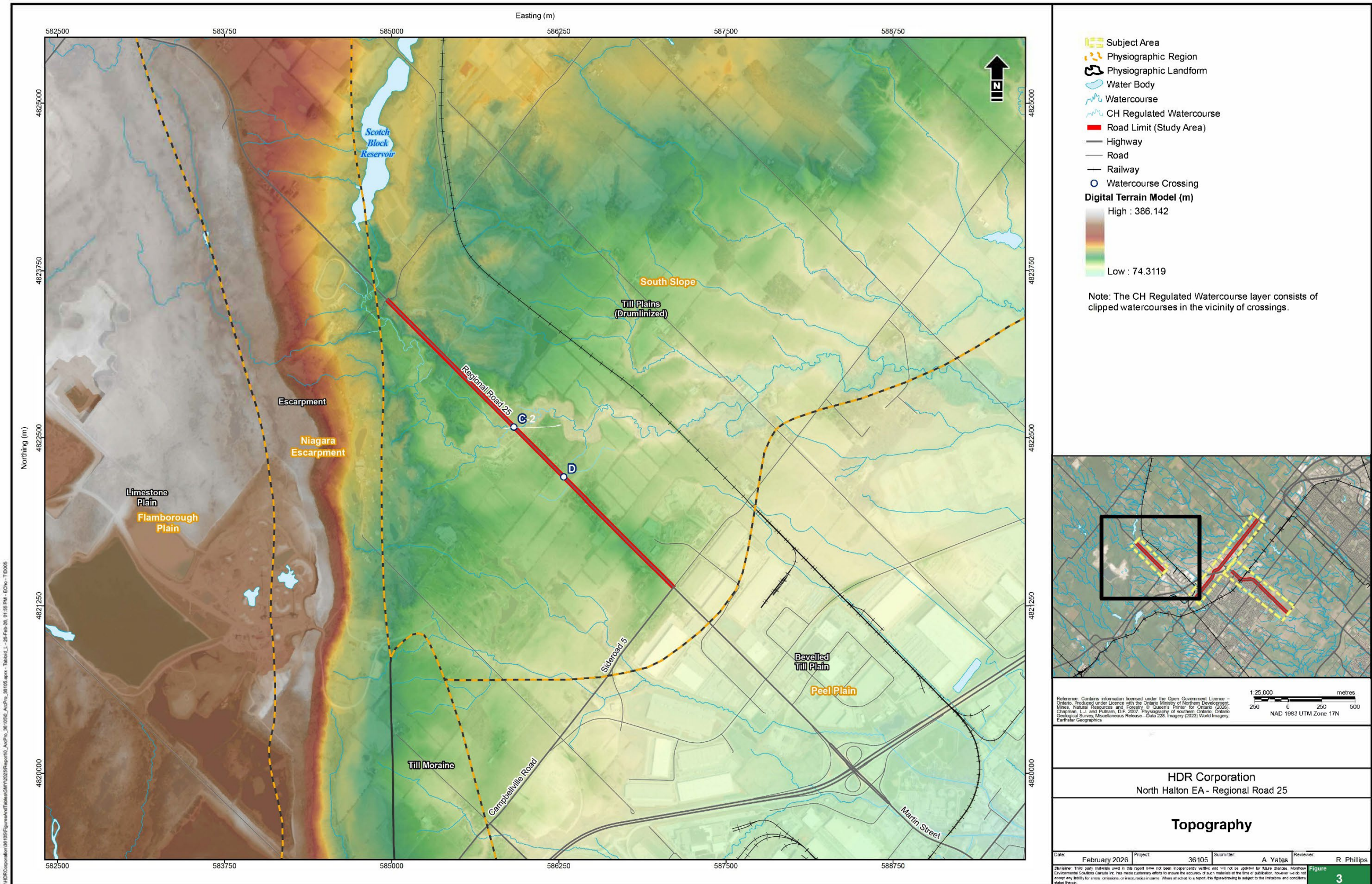
The study area is located east of the Niagara Escarpment. North of the Peel Plain, the RR25 transportation corridor is located within the South Slope physiographic region which in this area is a drumlinized till plain composed of clay and silt till. A local deposit of organic deposits (peat or marl) is mapped near Crossing C-2. Middle Sixteen Mile Creek in the vicinity of Crossing C-2 runs through a riverine corridor of alluvial deposits, where the fluvial system has incised and reworked the upland glacial materials. Minor watercourses and headwater drainage features within the study area, including Crossing D, 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 Regional Road 25 is primarily characterized by clay to silt till, especially in the southwestern half of the study area. Moving northwest along Regional Road 25, the geological character shifts to modern alluvial deposits approaching Crossing ID C-2, to organic deposits like peat and marl at and just northwest of Crossing ID C-2, and back to clay to silt till. The final several hundred metres of the study area is characterized by ice-contact stratified sand and gravel deposits.

Figure 3



Terrain elevation along the studied portion of Regional Road 25 is relatively flat and low, particularly compared to the Niagara Escarpment just west of the study area. Elevation varies between around 100 and 150 metres throughout the study area.

2.2 Background Review

None of the background studies reviewed for the North Halton Coordinated MCEA study were located within the Regional Road 25 transportation corridor.

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 (GeoHub 2023). 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 and Regional Road 25 had been established. By 1976, residential homes were constructed along Regional Road 25 in the vicinity of the Crossings C and D. Land use remained similar in 1988. The area surrounding Regional Road 25 has remained relatively undeveloped with natural wooded riparian buffers remaining around the watercourses at present.

Crossing C-2: Middle Sixteen Mile Creek

The culvert at Crossing C-2 was constructed prior to 1954. Changes in channel planform between 1954 and present were difficult to detect due to tree cover but were likely due to a combination of channel migration and modification associated with the armouring along the road embankment upstream of Regional Road 25. Migration within the valley further upstream and downstream is evident over time.

Crossing D: Unnamed Tributary, Middle Branch

In the 1954 image, the crossing structure could not be seen, and no channel was visible upstream of Regional Road 25. Downstream of the crossing the watercourse could not be distinguished through the forested area but there appeared to be a channel coming from the forest to the confluence with Middle Sixteen Mile Creek. By 1976, a depression/small channel was visible in the upstream farm field. Downstream of the crossing and forest there appeared to be a depression associated with a farm path/crossing in 1976 and 1988. Conditions remain similar at present. In the 2023 image a channel can be seen within the forest downstream of the crossing, but the connection to the culvert is unclear. Depressions can also be seen within the upstream and downstream farm fields.

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 2023). Drainage areas are provided in Table 2.

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 2.

Table 2 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
C-2	40.2	9.2	13.1	16.9	20.8	23.7	26.6
D	0.4	0.4	0.6	0.9	1.1	1.3	1.5

Notes:

(a) Ontario Watershed Information Tool

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

3.1.1 Hydraulic Modelling

Hydraulic modelling was provided by HDR for Crossing C-2. Existing peak flow rates from the model upstream of the crossing structure (model section 50.26) are provided in Table 3. Modelling was not available for Crossing D.

HDR completed a hydraulic assessment of Crossing C-2 and recommendations are summarized in (Section 5.2 – Table 10).

Table 3 Modelled Existing Peak Flow Rates at Crossing C-2

Crossing	Discharge at Crossing (m ³ /s) ^(a)						
	2-year	5-year	10-year	25-year	50-year	100-year	Regional
C-2	-	19.33	23.86	30.88	37.37	42.63	235.16

Note:

(a) Hydraulic model: HEC-2 FOAK5.DAT

3.1.1.1 Modelled Velocities

Existing channel velocities modelled in the vicinity of Crossing C-2 were compared to permissible values (Fischenich 2001) for the observed channel substrate and boundary condition. Permissible velocity indicates stability thresholds for the channel boundary material and when regularly exceeded channel erosion tends to occur, and higher exceedances during higher frequency flood events (e.g., Q2, Q5) will have negative impacts on long-term geomorphic stability.

Modelled existing channel velocities in the vicinity of Crossing C-2 ranged from 0.5-3.73 m/s across all flow events (Table 4). Permissible velocities for the natural bed material (D_{50} 2.8 cm) based on Fischenich (2001) range from 0.76 to 1.52 m/s. Velocities at sections approximately 50 m upstream and 50 m downstream of the crossing are generally within permissible ranges. Modelled velocities at the culvert inlet and outlet were above the permissible velocity values for representative sediment transport under most flow/flood events, including most frequent events (e.g. Q5), which indicates a higher erosion risk and need for erosion mitigation at the crossing.

Table 4 Modelled Existing Channel Velocities at Crossing C-2

Existing Channel Velocity (m/s) ^(a)					
Section		50.35	50.275	50.26	50.22
Location		Upstream	Culvert inlet	Culvert outlet	Downstream
Flow Event	5-year	1.34	2.26	2.76	1.04
	10-year	1.00	2.36	3.21	1.11
	25-year	0.72	2.72	3.49	1.23
	50-year	0.68	3.45	3.73	1.32
	100-year	0.50	2.79	1.02	1.39
	Regional	0.80	1.30	3.23	2.28

Note:

(a) Hydraulic model: HEC-2 FOAK5.DAT

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 C-2 downstream of Regional Road 25 = C-2-1). 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 5.

Table 5 Reach Names

Crossing	Watercourse	Location ^(a)	Reach Name	Previous Study Reach Name	Notes
C	Middle Sixteen Mile Creek	Downstream	C-2-1	N/A	N/A
		Upstream	C-2-2	N/A	N/A
D	Unnamed Tributary, Middle Branch	Downstream	D-1	N/A	N/A
		Upstream	D-2	N/A	N/A

N/A – not applicable

(a) Location in relation to Regional Road 25

3.3 Geomorphic Field Assessment

Montrose completed a geomorphic field assessment of the 2 watercourse crossings on December 6, 2023, 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 6 and 7.

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. Pebble counts were completed at major and moderate crossings (based on channel size) to characterize bed substrate. The median grain size (D_{50}) is provided in Appendix C. 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). The watercourse at Crossing D was poorly defined and therefore was not evaluated for RGA and RSAT. Table 8 summarizes existing watercourse crossing conditions within the study area.

Table 6 Summary of Rapid Geomorphic Assessment Scores

Reach	Factor Value				Stability Index	Condition	Dominant Process
	Aggradation	Degradation	Widening	Planimetric Adjustment			
C-2-1	0.29	0.00	0.43	0.29	0.25	Transitional	Widening
C-2-2	0.14	0.14	0.50	0.29	0.27	Transitional	Widening
D-1	N/A (HDF)						
D-2	N/A (HDF)						

N/A – Not applicable

HDF – Headwater drainage feature

Table 7 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	
C-2-1	7	6	5	7	5	5	35	Moderate
C-2-2	7	6	6	7	4	5	35	Moderate
D-1	N/A (HDF)							
D-2	N/A (HDF)							

N/A – Not applicable

HDF – Headwater drainage feature

Table 8 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)				
C-2	Concrete box	7.07	0	5.0 – 6.5	0.8 – 1.5	Ratio: 1.3; culvert wider than bankfull channel	Low	Channel skewed to culvert upstream and downstream. Sand bar inside culvert	1,5,6
D	Concrete box (old, spalling)	1	0	N/A (poorly defined)		N/A (effectively <1)	N/A	Grasses upstream and downstream	10,11

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.

4.2 Results

Results of the erosion hazard assessment are presented in Table 9.

Table 9 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	
C-2	Upstream reach confined/armoured along road embankment. Moderately defined valley with variable bottom width approximately 60 to 150 m.	Average 66 (28 to 114)_	42	5.4 x 3 = 16.2	7.07	N/A	66	High
D	Unconfined valley. Headwater drainage feature.	Average 14 (8.5 to 24.4)	N/A	2 x 3 = 6	~1	N/A	14	High

MBW – Meander belt width

MA – Meander amplitude

FS – Factor of safety

BFW – Bankfull width

N/A – Not applicable

(a) Sources: PARISH (2004) ($=8.32 \ln(Aw*9806*Qbf*S)$ 14.83), Williams (1986) ($=4.3W1.12$, $=18Ac0.65$, $=148D1.52$), Ward et al. (2002) ($=6W1.12$), Bridge (1992) ($=59.9D1.8$), Annable (1996) ($=35.2*Qbf0.53$) Where: Aw = drainage area, D = bankfull depth, W = bankfull width, Qbf = bankfull or 2 year discharge rate, S = slope.

(b) Applies where meander amplitude is N/A

Crossing C-2: Middle Sixteen Mile Creek

Theoretical meander belt widths ranged from 28 to 114 m. The upstream meander amplitude plus a 20% factor of safety is 36 m. The unmanaged natural corridor width is estimated to be 66 m based on the average empirical meander belt width. Within the Regional Road 25 right-of-way the channel is confined along the road embankment upstream of the crossing; however, the unmanaged natural corridor limit is recommended for potential realignment.

Crossing D: Unnamed Tributary, Middle Branch

The tributary at Crossing D is a headwater drainage feature and was poorly defined at the crossing. It was mapped as a CH regulated watercourse; therefore, a hazard assessment was completed. The empirical meander belt widths ranged from 8.5 to 24.4 m. The unmanaged natural corridor width is estimated to be 14 m based on the average empirical meander belt width. Meander amplitudes could not be measured due to tree cover and the small size of the watercourse. The average of three times the bankfull width is 6 m. The recommended erosion hazard width is 14 m based on the unmanaged natural corridor width.

4.3 Scour Hazards

The CVC (2019a) 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. Middle Sixteen Mile Creek is a major watercourse that crosses Regional Road 25 at Crossing C-2. Crossing D was considered minor and lacked a defined channel.
- **RGA:** The RGA score provides a measure of the channel stability. Reaches upstream and downstream of Crossing C-2 were Transitional and are in the process of widening. The RGA was not applicable for Crossing D.
- **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 Regional Road 25 transportation corridor, Segment 1 from 5 Side Road to Chudleigh's Entertainment Farm Access will maintain 2 lanes of traffic with the addition of a continuous centre turn lane, paved shoulders with painted buffers on both sides, and a multi-use path on the west side. Segment 2 from Chudleigh's Entertainment Farm Access to 10 Side Road will maintain 2 lanes of traffic with localized improvements and paved shoulders. No structural modifications are proposed to Crossing C. Subsequent to the fluvial geomorphic assessment, Crossing D was determined to require a culvert extension to accommodate the centre-turning lane and multi-use path. Further fluvial geomorphic assessment and erosion mitigation works will be required in the subsequent detailed design phase.

Montrose reviewed the following design materials provided by HDR:

- Draft Roll Plan: North Halton Coordinated EA Study – Regional Road 25 (5 Side Road to 10 Side Road) – Plan, Public Information Centre #2 – December 2024
- AutoCAD file of Draft Roll Plan
- Transverse Crossing Hydraulic Summary provided March 23, 2025
- North Halton Coordinated Environmental Assessment – Watercourse Crossings Evaluation, May 26, 2025
- PowerPoint: North Halton Coordinated MCEA Study – Meeting with Conservation Halton #4, Preliminary Drainage Recommendations, July 10, 2025
- Hydraulic model: HEC-2 FOAK5.DAT

Table 10 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 10 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
C-2	High	25-1158180 BR01	Does not meet MTO freeboard and clearance criteria. Regional storm overtops road. Assuming no extension required, preliminary assessment: Cannot alleviate Regional overtopping: 10 m: 0.8 m freeboard for 100-year 12 m: 1 m freeboard for 100-year Maintain existing structure, no extension required to support proposed roadway improvements. Minimal benefit in reducing roadway overtopping with larger structure span	Maintaining existing crossing does not address high long-term erosion risk. This management strategy is to be acknowledged and accepted by Region and CH. High risk requires maintenance of hard engineering erosion controls. Lack of implementation for recommended levels of erosion control assumes acceptance of risk by owner and stakeholders.	No additional improvements required. Opportunities to address existing hydraulic deficiencies may not be feasible without significant adverse impacts (for example to wetlands, driveway entrances due to road profile adjustments, significant woodlands and property impacts). The Region is currently undertaking some minor works at this crossing consisting of minor and limited concrete patch repairs to address erosion at the inlet and outlet by installing rock protection.

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
D	High	N/A	N/A	Extending existing crossing does not address high long-term erosion risk. This management strategy is to be acknowledged and accepted by Region and CH. High risk requires maintenance of hard engineering erosion controls. Lack of implementation for recommended levels of erosion control assumes acceptance of risk by owner and stakeholders. Further fluvial geomorphic assessment and erosion mitigation works will be required in the subsequent detailed design phase.	N/A

N/A – Not applicable

5.2.1 Review of Proposed Hydraulic Conditions

Proposed hydraulic modelling was not reviewed for the Regional Road 25 crossings.

5.2.2 Erosion Risk Assessment Recommendations for Watercourse Crossings

Crossing C-2: Middle Sixteen Mile Creek

The existing Middle Sixteen Mile Creek culvert at Regional Road 25 (7.07 m span) is larger than the average bankfull channel width upstream and downstream (5.4 m), for an opening width to channel width ratio of 1.3. The existing crossing structure does not span three times the bankfull width (16.2 m), the meander amplitude (with a 20% buffer = 42 m) or the unmanaged natural corridor width of 66 m. This risk appears to have been partially mitigated by the riprap bank protection lining the channel/road embankment upstream of the crossing; however, there is exposed sheet pile and bed scour directly upstream of the culvert. The channel is confined along the road embankment resulting in swift flows and erosive pressure along the toe of the embankment. Using the risk assessment framework described above, the existing crossing is classified as having a **high erosion risk**.

The existing crossing is perpendicular to the upstream channel and to the roadway. Extension of the crossing upstream would require realignment. Any extension or replacement of the crossing structure must consider the existing channel profile and channel tie-in requirements upstream and/or downstream.

The preliminary design for the Regional Road 25 transportation corridor does not include any structural modifications to Crossing C-2. The crossing will remain a high long-term erosion risk, which requires maintenance of hard engineering erosion controls (e.g. armourstone, riprap). It was noted that the Region is currently undertaking some minor works at this crossing consisting of minor concrete patch repairs and installing rock protection to address erosion at the inlet and outlet.

Crossing D: Unnamed Tributary, Middle Branch

The existing Unnamed Tributary Middle Branch culvert inlet at Regional Road 25 (~1 m span) is narrower than the bankfull channel width (2 m) where the channel is more defined in the downstream forest. It does not span three times the bankfull width (6 m) or the unmanaged natural corridor width of 14 m. Using the risk assessment framework described above, the existing crossing is classified as having a **high erosion risk**.

The existing crossing is perpendicular to Regional Road 25 but skewed to the headwater drainage feature. There were no signs of erosion at the crossing, but the culvert is old and deteriorating (i.e., concrete spalling) and should be replaced.

Subsequent to the fluvial geomorphic assessment, Crossing D was determined to require a culvert extension to accommodate the centre-turning lane and multi-use path. Further fluvial geomorphic assessment and erosion mitigation works will be required in the subsequent detailed design phase.

With the proposed extension the crossing will remain a high long-term erosion risk, which requires hard engineering erosion controls (e.g. armourstone, riprap). Lack of implementation for recommended levels of erosion control assumes acceptance of risk by owner and stakeholders.

5.2.3 Recommendations for Detailed Design

Both crossings were classified as **high erosion risk** (long-term, as defined in Section 5.1.1) and therefore require hard engineering erosion controls (e.g. armourstone, riprap) to mitigate this risk. At Crossing C-2, scour noted at the culvert inlet should be addressed and the existing erosion controls (riprap and sheet pile) should be repaired or replaced at detailed design. Erosion protection should also be installed at the culvert outlet to mitigate the high erosion risk at this crossing. The extent of erosion control works, and stone sizing should be confirmed at detailed design.

Given the evaluation of erosion risk, erosion mitigation works at Crossing D are also recommended at detailed design.

5.3 Conclusion

This fluvial geomorphology assessment baseline report summarizes the findings and recommendations of the geomorphic assessment of the watercourses within the Regional Road 25 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, both existing crossing structures are **high risk from long-term erosion hazards** due to the small culvert spans relative to the bankfull channel and natural corridor widths. No increases in span are proposed at either of the crossings; therefore, the crossings will remain high risk with respect to erosion hazards, which will require additional management with erosion controls through detailed design and future monitoring and maintenance.

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