Sixteen Mile Creek
Fluvial Geomorphology Assessment and Critical Redside Dace Habitat Delineation

Scoped Subwatershed Study
9094 Regional Road 25
Halton Hills, ON

Prepared for:
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1 Introduction

GEO Morphix Ltd. (GEO Morphix) was retained to complete a fluvial geomorphology assessment, which included erosion hazard and erosion mitigation assessments for a portion of Sixteen Mile Creek to support a proposed commercial development at 9094 Regional Road 25 in Halton Hills, Ontario (herein referred to as the "subject site"). The subject site is bounded by Regional Road 25 to the northeast, 5 Side Road to the southeast, and agricultural fields to the northwest and southwest (**Appendix G1**). Existing land use consists of a golf driving range. The main tributary of Sixteen Mile Creek flows in a generally west to south orientation, while a low order drainage feature flows generally north to south and confluences with the main tributary approximately midway though the subject site.

The following activities were completed as part of the assessment:

- Review available background reports and mapping regarding tributary form and function and controlling factors related to fluvial geomorphology (i.e., watershed/subwatershed studies, geology, topography, provincial LiDAR data, conceptual development plans)
- Refine tributary reaches delineated in previous studies based on a desktop assessment and field observations
- Conduct field reconnaissance using standard, industry-accepted tools such as the rapid geomorphic assessment (RGA) to evaluate channel stability and the rapid stream assessment technique (RSAT) to evaluate existing instream and riparian conditions
- Delineate the extent of the erosion hazard on a reach basis using field observations, empirical modelling, and historical aerial photography, as appropriate
- Complete one (1) detailed geomorphic field assessment to support the determination of an erosion threshold or flow target for the stormwater management (SWM) design
- Calculate an appropriate erosion threshold and complete an erosion exceedance analysis through a comparison of post- to pre-development hydrology modelling prepared by C.F. Crozier and Associates Inc. (Crozier)

Online aquatic species at risk mapping available from Fisheries and Oceans Canada (DFO) indicates that the main tributary of the Sixteen Mile Creek tributary contains critical habitat for Redside Dace (*Clinostomus elongatus*). This species is listed as endangered under the provincial *Endangered Species Act, 2007* (ESA) and the federal *Species at Risk Act, 2002* (SARA). DFO defines critical Redside Dace habitat as the meander belt width and a 30 m vegetated riparian area on either side of the meander belt. Therefore, the study also includes delineation of the extent of regulated Redside Dace habitat along the western tributary.

2 Background Review and Desktop Assessment

The subject site is located within the headwaters of the middle Sixteen Mile Creek watershed, which originates at the north end of the Halton Region on the Niagara escarpment (Gore & Storrie Ltd et al., 1996). The whole of the Sixteen Mile Creek watershed covers around 360 km^2 and flows through Halton Hills, Milton, and Oakville into Lake Ontario. Watershed health is generally stressed, especially towards the downstream extent of the watershed.

The tributary of Sixteen Mile Creek that flows through the western portion of the subject site was evaluated as part of the Sixteen Mile Creek Subwatershed Planning Study Areas 2 and 7 (Philips Engineering et al. (2000) and the Functional Stormwater and Environmental Management Strategy (FSEMS) for the Highway 401 Industrial/Business Park Secondary Plan Area (Philips Engineering Ltd (2000). The geomorphological assessment was completed at a broad scale, and included descriptions of channel length, sinuosity, gradient and stream order as well as bankfull channel and substrate characterization. The northern limit of the study coincided with 5 Side Road; however, the reach naming convention used the current study was adapted from Philips Engineering et al. (2000) for consistency.

2.1 Surficial Geology and Physiology

Surficial geology and physiography function as constraints to channel development and tendency. These factors determine the nature and quantity of available sediment and its type. Secondary variables that affect the channel include land use and riparian vegetation. These factors are explored not only for insight into existing conditions but also for potential future changes related to a proposed activity.

The subject site is situated within the South Slope physiographic region and the drumlinized till plains physiographic landform (Chapman and Putnam, 2007). The South Slope region is characterized by gently sloping glacial till plain deposits (Chapman and Putnam, 1984). Published surficial geology mapping indicates that the majority of the subject lands are dominated by clay to silt textured till, though the main tributary of the Sixteen Mile Creek passes through modern alluvial deposits, comprised of clay, silt, sand and gravel (OGS, 2010).

Soil Engineers Ltd. (2025) completed a geotechnical investigation in support of the proposed development and drilled 15 boreholes (BHs) across the site. Of these, BHs 5, 7 and 8 are proximal to the western tributary. In general, a shallow layer of topsoil (0.13 m to 0.20 m in depth) was underlain by silty clay till that ranged in thickness from 4.6 m to 6.6 m. In the northern portion of the site (BH 5), the till was underlain by a 0.5 m deposit of compact, fine-grained sand. BH 7, which was located near the confluence of the low order drainage feature with the western tributary, the till deposit was underlain by loose silt. These borehole records are generally consistent with published mapping and field observations, which are documented in **Section 3.2** of this report.

2.2 Site History

A series of historical aerial photographs were reviewed to determine changes to the channel and surrounding land use and land cover over time. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. Aerial photographs and satellite images from 1946 to 2024 were retrieved to complete the historical assessment and inform the meander belt width delineation. Specifically, aerial photographs for the years 1946 (1:20,000), 1960 (1:25,000) and 1974 (1:25,000) from the National Air Photo Library and an orthoimage from 1999 (1:20,000) from the Ministry of Natural Resources were reviewed. Recent satellite imagery from 2004, 2014, 2016, 2021, and 2024 was retrieved from Google Earth Pro. Historical aerial imagery is provided in **Appendix G2** for reference.

The subject site consisted of agricultural lands in 1946. The planform of the western tributary was faintly visible within the valley, with a rural residence or farm outbuilding on the tablelands east of the channel. The woodlot in the southwestern portion of the subject site appeared to be significantly reduced in extent and fragmented when compared to existing conditions. The upstream portion of the tributary was previously realigned, and the woodlot to the west of the subject site was not present. Similarly, significant portions of the channel downstream of 5 Side Road were also historically straightened. There was limited change in land use within and upstream of the subject site between 1946 and 1974. The channel planform for the length of tributary within the subject lands was clearly visible in the 1960 image and was relatively straight. By 1974, the extent of the southwestern woodlot within the subject site had expanded within the valley, partially obscuring the channel planform. Downstream of 5 Side Road, the channel planform remained relatively straight in imagery from both 1960 and 1974.

In 1999, woody vegetation had further expanded within the southwest woodlot and the woodlot to the northwest of the subject site. Where the channel planform was visible, channel sinuosity had slightly increased compared to previous years. By 2004, a driving range was built east of the tributary on the subject site, and the Granite Ridge Golf Course was operating upstream of the subject site. The golf course introduced several irrigation/open water features that drain downstream through the subject site. South of 5 Side Road, construction of a realigned natural corridor was underway to facilitate development. Google Earth Pro imagery showed the woody vegetation gradually expanding northwards from the southwest woodlot. Where the planform was visible in recent aerial imagery, there was limited change in 2024 when compared to previous years.

In summary, the tributary of Sixteen Mile Creek within the subject lands, as well as upstream and downstream, was historically straightened to facilitate agricultural land uses. There were limited changes to the channel planform within the subject site, except for a minor increase in sinuosity in years when the planform was visible. The lack of overall change in channel planform in the upstream portion of the reach (where the channel planform was consistently visible) suggests limited erosion potential along this reach.

3 Tributary Characteristics

3.1 Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. They are studied semi-independently, as each is expected to function in a manner at least slightly different from adjoining reaches. This method allows for a meaningful characterization of a given watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.

Reaches are typically delineated based on changes in the following:

- Channel/feature planform
- Channel/feature gradient
- Physiography
- Land cover (land use or vegetation)
- Flow, due to tributary inputs
- Soil type and surficial geology
- Certain types of anthropogenic modifications

This follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), and the Toronto and Region Conservation Authority (TRCA) (2004). Reaches are first delineated as a desktop exercise using available data and information such as aerial photography, topographic data, and surficial geology and physiography maps. The results are then verified in the field.

As noted in **Section 2**, the reach naming convention was adapted from previous planning level studies completed for lands to the south. Reach **N-2-C** extended downstream of the subject site, south of 5 Side Road. Philips Engineering et al. (2000) delineated a single reach along the tributary that extended from a confluence downstream of Highway 401 upstream through the subject lands. The tributary was subdivided further as part of the current study based on tributary confluences, changes in land use/cover and channel characteristics observed during site specific field work.

Reach N-2-D extended upstream from 5 Side Road in a northerly direction through a woodlot. **Reach N-2-Da** extended upstream of **Reach N-2-D** and entered the subject site from the northwest through a swale with wetland characteristics. A low order drainage feature, **Reach N-2-D2** confluences with the tributary approximately midway through the subject site. This feature was poorly defined and characterized as a headwater drainage feature (HDF). Reach delineation is graphically presented in **Appendix G1**.

3.2 General Reach Observations

Field investigations were completed in August and October 2025, and included the following observations on a reach basis:

- Descriptions of riparian conditions

- Estimates of bankfull channel dimensions, where feasible
- Determination of bed and bank material composition and structure
- Confirmation of valley form (i.e., unconfined, partially confined, confined)
- Observations of erosion, scour, or deposition
- Collection of photographs to document the western tributary, riparian areas, adjacent land use, and disturbances such as crossing structures

These observations and measurements are summarized in **Table 1**. Field descriptions are supplemented and supported with representative photographs in **Appendix G3**. Field sheets, including those completed for reach characterization and rapid assessments, are provided in **Appendix G4**.

Table 1: General reach characteristics

Reach Name	Avg. Bankfull Width (m)	Avg. Bankfull Depth (m)	Bed Substrate	Bank Materials	Valley Type	Dominant Riparian Conditions	Notes
N-2-C*	1.96	0.21	Clay/silt to gravel	Clay/silt	Partially confined	Wide, continuous buffer of shrubs and mature trees	Few undercuts, two rooted knickpoints
N-2-D	1.24	0.14	Clay/silt to gravel	Clay/silt	Partially confined	Wide, continuous buffer of shrubs and mature trees	Various undercuts; two minor knickpoints
N-2-Da**	0.51	0.14	Clay/silt		Unconfined	Cattails/herbaceous vegetation and was flanked by agricultural fields	Swale with wetland characteristics

** Bankfull channel dimensions based on cross-sections surveyed as part of detailed geomorphological assessment*
*** Dimensions reflect low flow channel width rather than bankfull channel width due to historical channel modifications, poor feature definition and wetland characteristics*

Reach N-2-C flowed south via piped flow under 5 Side Road before entering a forested woodlot between two residential properties. The reach was partially confined, with a floodplain, and the riparian area consisted of grasses, shrubs, and fragmented sections of tree cover. The bed and banks throughout the reach were predominantly comprised of clay to silt textured material that overlaid glacial till. Riffles were absent along this reach, while pools and runs dominated throughout. Average bankfull width and depth were 1.96 m and 0.21 m, respectively, based on cross-section survey data. The tributary flowed in a southeast orientation before discharging to a constructed natural corridor downstream.

Reach N-2-D was partially confined within a relatively shallow valley, with contact at the valley wall occurring in two locations along the left (east) bank. Riparian vegetation was comprised of trees and shrubs, though there was one small clearing containing herbaceous vegetation at the upstream extent of the reach. Watercress was present along the reach and seeps were identified, suggesting potential groundwater inputs to the tributary. Bank substrates generally consisted of clay and silt, whereas bed substrates ranged from clay and silt to gravel. The reach contained predominantly runs and no riffles were observed. Average bankfull width and depth were 1.24 m and 0.14 m, respectively; however, a few deeper pools measured between 0.18 and 0.34 m in depth. Undercuts ranged from 0.19 m to 0.34 m. Water was present in the tributary at the time of the August assessment, with an average wetted width and depth of 0.81 m and 0.05 m, respectively, but velocity could not be estimated due to imperceptible flow. During the site visit in October, the average wetted width and depth were 0.99 m and 0.25 m, respectively.

Reach N-2-Da consisted of an unconfined, poorly defined swale with wetland characteristics. Bed and bank substrates consisted of clay and silt. Vegetation heavily encroached the feature and was mainly composed of cattails and other herbaceous vegetation. Watercress was also present along the reach. The reach lacked a well-defined channel and bankfull indicators were absent. A narrow low-flow channel was discernible amongst the instream vegetation and ranged in width from 0.41 m to 0.62 m. Average wetted width and depth at the time of the August assessment were 0.24 m and 0.04 m, respectively, though the reach was not flowing. During the October site visit, the average wetted width and depth were 0.8 m and 0.07 m, respectively. The adjacent land use consisted of agricultural fields.

3.3 Rapid Geomorphological Assessments

Rapid assessments were completed to identify dominant geomorphic processes, document stream health, and identify any areas of concern regarding erosion or instability. Channel instability was objectively quantified through the application of the Ontario Ministry of the Environment's (2003) Rapid Geomorphic Assessment (RGA). Observations were quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, channel widening, and planimetric adjustment. The index produces values that indicate whether a channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40), or adjusting (score >0.41).

The Rapid Stream Assessment Technique (RSAT) can also be employed to provide a broader view of the system as it considers the ecological function of a given watercourse (Galli, 1996). Observations are made of channel stability, channel scouring or sediment deposition, instream and riparian habitats, and water quality. The RSAT score ranks the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

Reaches were also classified according to a modified Downs (1995) Channel Evolution Model. The Downs (1995) model describes the successional stages of a channel because of perturbation, namely hydromodification. Understanding the current stage of the system is beneficial as this allows one to predict how the channel will continue to evolve or respond to an alteration to the system. A summary of the reach classifications and rapid assessment scores is provided in **Table 2**.

Rapid geomorphologic assessment tools were not applied to **Reach N-2-Da** as this reach consisted of a poorly defined swale with wetland characteristics. Similarly, rapid assessment tools were not applied to **Reach N-2-D2** as this feature consists of an HDF. Additional field assessments following TRCA and Credit Valley Conservation (CVC) (2014) HDF guidelines are being conducted by others.

Table 2: Summary of rapid assessment results

Reach	RGA (MOE, 2003)			RSAT (Galli, 1996)			Downs (1995)
	Score	Condition	Dominant Systematic Adjustment	Score	Condition	Limiting Feature(s)	
N-2-C	0.15	In regime	Evidence of Widening	30	Good	Physical instream habitat, riparian habitat conditions	s/m
N-2-D	0.27	In transition/ stress	Evidence of widening	29	Good	Physical instream habitat	m
N-2-Da	N/A – swale/wetland			N/A – swale/wetland			s

Reach N-2-C was evaluated to be in regime with an RGA score of 0.15. The dominant mode of systematic adjustment was evidence of widening due to fallen trees and exposed mature tree roots in some sections. Stream health was evaluated to be good but was limited by the lack of riffle geomorphic units and relatively poor canopy cover.

N-2-D was in transition/stress with a score of 0.29. The main mode of systematic adjustment was evidence of widening, as there was large organic debris and numerous exposed tree roots throughout the reach. There were few leaning trees, but several fallen trees of various ages. Stream health was evaluated as good, limited mainly by physical instream habitat due to a lack of riffles and generally shallow pools.

3.4 Detailed Geomorphological Assessment

A detailed geomorphological assessment was completed on **Reach N-2-C** downstream of the subject site. The detailed assessment location was selected as it is located downstream of proposed stormwater outlets and upstream of a realigned and naturalized corridor constructed in the early 2000's as part of downstream development. The location of this site is indicated in **Appendix G1.**

The following activities were completed along an approximately 150 m length of the reach:

- Complete a topographic survey of the channel bed long profile and water level to determine channel bed gradient and water surface slope at the measured discharge
- Conduct detailed topographic surveys of seven channel cross-sections to document average bankfull channel geometry
- Collect detailed observations at each surveyed cross-section location including riparian vegetation type and cover, bank material composition and structure, bank height/angle, bank substrate shear strength, presence of undercutting, and bank root density
- Sample bed material at each surveyed cross-section following a modified Wolman (1954) pebble count technique or collect a substrate sample for laboratory particle size analysis

The results of the detailed assessment are summarized below in **Table 3**. A summary of the detailed assessment is available in **Appendix G5**.

Table 3: Detailed assessment summary for Reach N-2-C

Channel parameter	N-2-C
Bankfull Conditions	
Average bankfull width (m)	1.96
Average bankfull depth (m)	0.21
Bankfull gradient (%)	0.75
D_{50} (mm)*	< 2
D_{84} (mm)*	< 2
Manning's n roughness coefficient	0.048

** Grain size distribution will be refined once laboratory results are available*

4 Erosion Hazard Delineation

4.1 Methodology

Most watercourses in southern Ontario have a natural tendency to develop and maintain a meandering planform provided there are no topographical or spatial constraints. When defining the limits of an erosion hazard for a watercourse, unconfined and confined systems are assessed differently (TRCA, 2004 and MNR, 2002). Unconfined systems are those with streams in open areas (i.e., valleys not apparent) or with valley walls at a sufficient distance that the channel cannot reasonably be expected to contact due to migration under existing or future hydrologic scenarios. In this type of setting, the extent of the erosion hazard is delineated by the meander belt width, which is defined as the lateral extent that a channel has historically occupied and will likely occupy in the future.

Following MNR (2002), the meander belt width can be applied, at minimum, based on 20 times the bankfull channel width. Alternatively, the meander belt width can be determined through a detailed geomorphological study that examines the largest channel meanders observed in historical and recent aerial photographs. The meander belt width can then be graphically defined using orthorectified aerial imagery by determining the channel centerline and the channel's central tendency (i.e., meander belt axis). In cases where the channel is not discernible in aerial photographs or the channel has been substantially modified, empirical models can be used to estimate the meander belt width.

Confined systems, in contrast, are those where a watercourse is contained within a defined valley where valley walls may constrain meander bend migration. Partially confined systems are those where meander bends are adjacent to only one valley wall and the watercourse is therefore restricted in migration and floodplain occupation on one side of the valley system. In these settings, where the channel is positioned within 15 m of a valley slope, the erosion hazard is generally defined by the toe erosion allowance, stable slope allowance, and erosion access allowance. In some instances, a meander belt width may also apply in partially confined systems (i.e., where the channel is greater than 15 m from the valley slope toe).

The MNR (2002) outlines several approaches for establishing an appropriate toe erosion allowance where watercourses are confined by valley walls and located within 15 m of the toe of slope, which are as follows:

1) calculating the average annual recession rate based on a minimum of 25 years of record
2) applying a 15 m toe erosion allowance measured inland horizontally and perpendicular to the toe of the watercourse slope
3) soil types and hydraulic processes
4) use of a study that applies accepted geotechnical and engineering principles based on a minimum of 25 years of record

LiDAR and topographic survey data were used to evaluate the degree of reach confinement. **Reach N-2-Da** was characterized as unconfined, while **Reach N-2-D** was characterized as partially confined (i.e., portions of the tributary are positioned within 15 m of the toe of slope). Erosion hazard delineation was not completed for **Reach N-2-D2** as this feature consists of an HDF.

As noted above, the approach to erosion hazard delineation is based on floodplain confinement and valley form. Because **Reach N-2-D** is considered critical habitat for Redside Dace by DFO, a meander belt width was calculated for this reach despite its confinement. Refer to **Section 5** for additional details on Redside Dace habitat delineation.

4.2 Meander Belt Width Assessment

Typically, the preferred approach for delineating meander belt widths includes measuring maximum meander amplitudes over a minimum 25-year period. No natural meanders were present along Reaches **N-2-D** and **N-2-Da** due to historical straightening. Meander amplitudes measured along Reach **N-2-D** as part of rapid field assessments were notably small (i.e., 2.2 m and 3.7 m). Therefore, a suite of empirical models was used to calculate meander belt widths for **Reaches N-2-D and N-2-Da.** Where possible, feature/bankfull dimensions collected during field reconnaissance were used in the equations summarized below.

The empirical relations from Williams (1986) were modified to include channel area and width, and applied using the bankfull channel dimensions such that:

$$B_w = 18A^{0.65} + W_b \quad \text{[Eq. 1]}$$

$B_w = 4.3{W_b}^{1.12} + W_b$ [Eq. 2]

where Bw is meander belt width (m), A is bankfull cross-sectional area (m^2), and W_b is bankfull channel width (m). An additional 20% buffer, or factor of safety, was applied to the computed belt width values to provide an envelope versus a fit line and limit issues of under-prediction.

The Ward et al. (2002) channel width and drainage area models were also used to determine a meander belt width (ft):

$B_w = 6{W_b}^{1.12}$ [Eq. 3]

$B_w = 120DA^{0.43}$ [Eq. 4]

where DA is the drainage area (square miles). The resulting value was then converted to the metric system (m). A 20% factor of safety was not applied to the Ward et al. (2002) channel width value due to the approach used in the modelling (i.e., hazard envelope rather than a linear relationship). A 20% factor of safety is included in the Ward et al. (2002) drainage area equation.

Lastly, meander belt widths were also calculated based on TRCA's (2004) empirical model:

$B_w = -14.827 + 8.319\ln(\rho g Q S * DA)$ [Eq. 5]

where ρ is water density (1000 kg/m^3), g is acceleration due to gravity (9.8 m/s^2), Q is discharge (m^3/s), S is channel slope (m/m), and DA is drainage area (km^2). Reach gradients were determined using topographic survey data. Drainage areas and 2-year flows were provided by Crozier (2025). **Table 4** provides a summary of the input parameters used in the empirical modelling exercise and **Table 5** provides a summary of the modelled belt widths.

Table 4: Input parameters for modelled meander belt widths

Reach	Avg. Bankfull Width (m)	Avg. Bankfull Depth (m)	2-year Discharge (m^3/s)	Slope (m/m)	Drainage Area (km^2)
N-2-D	1.24	0.14	1.92	0.010	1.88
N-2-Da	0.51*	0.14*	1.02	0.010	1.26

** Dimensions reflect low flow channel width rather than bankfull width due to historical channel modifications, poor feature definition and wetland characteristics*

Table 5: Modelled meander belt widths

Reach	Modified Williams (1986) Area*	Modified Williams (1986) Width*	Ward et al. (2002) Width	Ward et al. (2002) Drainage Area*	TRCA (2004)**	Recommended Meander Belt Width (m)
N-2-D	8	8	9	32	42	32
N-2-Da	4	3	3	27	34	27

** Includes 20% factor of safety*
*** Includes one standard error (8.63 m) as factor of safety*

Modelled meander belt widths for **Reach N-2-D** range from 8 to 42 m. Meander belt widths based on modified Williams (1986) equations and the Ward et al. (2002) width equation are not recommended as they are relatively small. Instead, a meander belt width of 32 m is recommended and is graphically represented in **Appendix G6**. The meander belt width along **Reach N-2-D** was determined to inform the extent of critical Redside Dace habitat (refer to **Section 5**). Because this reach is partially confined, the ultimate extent of the erosion hazard is defined by the toe erosion allowance and the stable slope allowance.

Modelled meander belt widths for Reach **N-2-Da** range from 4 to 34 m. This reach contained a poorly defined channel and lacked true bankfull indicators due to historical modification and existing wetland characteristics. The modelled belt widths based on feature width and depth are nominal. A meander belt width of 27 m is recommended for this reach and is considered conservative due to the limited channel form and erosion observed in the field, and the lack of planform adjustment visible in historical aerial imagery. Refer to **Appendix G6** for the extent of the meander belt width along this reach.

4.3 Toe Erosion Allowance Recommendation

Recent and historical imagery for **Reach N-2-D** was reviewed to determine whether a meander migration assessment could be completed at meander bends in contact with valley walls. Due to tree cover, limited meander form, and the relatively small size of the channel, the channel planform could not be accurately digitized. Therefore, MNR (2002) was reviewed to recommend a suitable toe erosion allowance (refer to **Table 6**, below).

Table 6: Toe Erosion Allowance Guide (adapted from MNR, 2002)

Material Type	Evidence of Active Erosion	No Evidence of Active Erosion		
		Bankfull Channel Width		
		< 5 m	30 m	> 30 m
1. Hard Rock (Granite)	0 – 2 m	0 m	0 m	1 m
2. Soft Rock (Shale, Limestone) Cobbles, Boulders	2 – 5 m	0 m	1 m	2 m
3. Stiff/Hard Cohesive Soils (Clays, Clay Silt), Coarse Granular (Gravels), Tills	5 – 8 m	1 m	2 m	4 m
4. Soft/Firm Cohesive Soil, loose granular, (sand, silt) Fill	8 – 15 m	1 – 2 m	5 m	7 m

Reach N-2-D contained channel banks comprised of clay and silt based on field observations collected by GEO Morphix. BH 8, as described by Soil Engineers Ltd (2025), contained topsoil underlain by stiff to hard silty clay till. These materials fall within the 5-8 m toe erosion allowance range (**Table 6**). A toe erosion allowance of 5 m is recommended for **Reach N-2-D** and is to be applied from the channel bank where it is positioned within 15 m of the eastern slope. This recommendation is to be reviewed in tandem with the geotechnical slope stability assessment conducted by Soil Engineers Ltd (2026).

5 Critical Redside Dace Habitat Delineation

The Redside Dace is a small, colourful minnow that prefers clear, cool, flowing water (Scott and Crossman, 1973). In Canada, this species largely occurs in the western end of the Lake Ontario basin within the Greater Toronto Area; however, populations are also located in the drainage basins of Lake Erie, Lake Huron and Lake Simcoe. Redside Dace typically occupy relatively small watercourses, with widths ranging from 5-10 m and substrates ranging from silt to boulders (COSEWIC, 2017). Riparian vegetation (preferably grasses and shrubs) is an important habitat component as this species largely feeds on terrestrial insects by jumping out of the water (COSEWIC, 2017, Scott and Crossman, 1973, MNRF 2016). The Redside Dace is considered a coolwater species, with preferred temperatures usually less than 24°C and dissolved oxygen concentrations equal to or greater than 7mg/L (RDRT, 2010). This species also prefers clear water and is sensitive to turbidity; however, it has been found in some streams of moderate turbidity (RDRT, 2010).

During most of the year, including the winter, they are located in mid-water positions of pools that range from 0.11 m to 1 m deep (COSEWIC, 2017); although DFO (2024) notes that pool depths greater than 0.6 m with little current act as important overwintering refugia. In the spring, adults move upstream from overwintering habitat to find suitable spawning habitat (MNRF, 2016). Spawning occurs on riffles with fine gravel substrates in late May when water temperature reaches 16-18°C. Non-adhesive eggs are typically deposited in nests constructed by other species such as Creek Chub (*Semotilus atromaculatus*) and Common Shiner (*Luxilus cornutus*) (COSEWIC, 2017). These species likely improve egg survivorship by providing protection from predators and the removal of debris from the nest. In the summer, this species prefers wetted stream widths of 0.5 m to 20 m and depths of 0.1 m to 2 m. Undercut banks and instream structures such as boulders and woody debris are used for cover (DFO, 2024).

Field observations indicate that critical habitat for Redside Dace is not present along **Reach N-2-Da** as the reach lacked riffle-pool sequences, contained predominantly fine-grained substrates (i.e., clay and silt), relatively shallow flow conditions and lacked instream structures. It is assumed that **Reach N-2-D** contains critical habitat for Redside Dace as although the reach contained predominantly pools and runs, the bankfull channel was better defined and contained suitable instream structures such as undercut banks and woody debris. In addition, there is no fish passage barrier at the 5 Side Road culvert that would otherwise prevent Redside Dace occupation of this reach. The critical habitat status of both reaches will be confirmed through consultation with DFO as the project progresses.

As noted previously, DFO defines critical habitat as the meander belt width and a 30 m vegetated riparian area on either side of the meander belt. As the definition does not account for differences in valley setting, where the meander belt width overlaps with the valley toe of slope, the 30 m riparian area is applied from the toe of slope as this represents the extent the tributary can physically or effectively migrate. To delineate the extent of regulated habitat in proximity to proposed development on the east side of Reach **N-2-D**, the toe of slope was delineated using topographic survey data. The 30 m vegetated riparian area was then applied from a combination of the 32 m meander belt width and toe of slope. Refer to **Appendix G6** for the extent of critical Redside Dace habitat along the tributary.

6 Erosion Threshold Analysis

In support of the proposed SWM plan, an erosion threshold was calculated for **Reach N-2-C**. The application of erosion threshold analysis for evaluating the effectiveness of stormwater management facilities in mitigating changes in downstream erosion potential is a concept developed with support by a co-author of the present report (P. Villard) and detailed in guidelines prepared on behalf of CVC and the TRCA and in Villard and Parish (2003).

Erosion thresholds are used to determine the magnitude of flow required to potentially entrain and transport bed and/or bank material (Garcia, 2008; Villard and Parish, 2003). As such, they are used to inform channel restoration designs and erosion mitigation strategies in channels influenced by changes in upstream land use. An erosion threshold is often expressed as a critical discharge or shear stress. Changes in the magnitude, duration, and frequency of discharge may alter the pattern and rates of channel erosion. Erosion thresholds are defined by assessing the morphology of the channel and the characteristics and condition of the bed and bank materials.

It is understood that under post-development conditions, the majority of overland drainage from the proposed development will be directed to on-site SWM infrastructure in the form of rooftop storage and underground storage tanks. This infrastructure will outlet to **Reach N-2-D**, before flowing downstream of 5 Side Road into **Reach N-2-C**. **Reach N-2-C** was selected for assessment as it will receive flow from the proposed SWM outlet and is upstream of a previously restored channel.

6.1 Methodology

Threshold targets are determined using different methods that are dependent on channel and sediment characteristics. For example, thresholds for non-cohesive sediments are commonly estimated using a shear stress approach, similar to that of Miller et al. (1977), which is based on a modified Shields' curve. A velocity approach can also be applied. For cohesive materials, a method such as that described by Komar (1987), or empirically derived values such as those compiled by Fischenich (2001), Chow (1959) or Julien (1994), could be applied.

An erosion threshold is quantified based on the bed and bank materials and local channel geometry, in the form of a critical discharge. Theoretically, above this discharge, entrainment and transport of sediment can occur. To determine this discharge, the velocity, U, or Shear Stress, τ, is calculated at various depths for a representative cross-section until the average velocity or shear stress slightly exceeds the critical threshold of the bed material. The velocity is determined using Manning's approach, where Manning's n value is visually estimated through a method described by Acrement and Schneider (1989) or calculated using the Limerino (1970) approach. A Manning's n value of 0.045 was used for the assessment. The velocity is mathematically represented as:

$$U = \frac{1}{n} d^{2/3} S^{1/2} \qquad \text{[Eq. 6]}$$

where d is depth of water, S is the channel slope, and n is the Manning's roughness.

The shear stress is determined using the depth-slope product, which can be applied to the bed of open channels containing fluid undergoing steady flows. The shear stress is mathematically represented as:

$$\tau = d \rho g S_{bed} \qquad \text{[Eq.7]}$$

Where τ is shear stress, d is the water depth, ρ is water density, g is acceleration due to gravity, and S_{bed} is the channel bed slope.

Because only 75% of bed shear stress and velocities apply to channel banks in uniform cross sections (Chow, 1959), the erosion threshold is scaled appropriately for these materials.

6.2 Results

The banks within **Reach N-2-C** were characterized as predominantly consisting of silt loam, based on the criteria of Julien (1994), as this soil type most closely matches observations made during field assessments. The Ontario Soil Survey Complex identifies two soil types within the reach, Chinguacousy silt loam and Jeddo clay loam. Brooke and Guelph loams developed in Halton Till and generally have clay loam to silty loam textures (OMAFRA, 2019; Gillespie et al., 1971).

A critical velocity approach was taken using the criteria of Fischenich (2001) for the silt loam bank materials. This material is estimated to have a critical velocity of 0.53 m/s, which was used to determine the threshold discharges for this reach. Threshold discharge is an estimate of the discharge at which sediment entrainment begins to occur. Manning's roughness value of 0.035 was adopted for the critical discharge calculations, based on the framework described by Acrement and Schneider (1989). Based on critical velocity of 0.53 m/s, the critical discharge for the bank materials within **Reach N-2-C** was predicted to be 0.144 m^3/s.

The bed within **Reach N-2-C** was comprised of fine materials. These materials were classified as alluvial loamy clay based on the criteria of Julien (1994). Based on a critical velocity of 0.76 m/s for these materials, the critical discharge for the bed within **Reach N-2-C** was predicted to be 0.181 m^3/s.

The more conservative of the bed and bank estimates is adopted as the erosion threshold discharge, thus the erosion threshold for **Reach N-2-C** is 0.144 m^3/s. The results from the erosion threshold analysis are shown in **Table 7**.

Table 7: Preliminary erosion threshold results for Reach N-2-C

Channel parameter	N-2-C	
Average bankfull channel width (m)	1.61	
Average bankfull channel depth (m)	0.21	
Channel gradient (%)	0.79	
D_{50} (mm)	<0.075	
D_{84} (mm)	0.207	
Manning's n roughness coefficient	0.035	
Drainage Area (ha)*	400.5	
Bankfull discharge (m^3/s)**	0.286	
Average bankfull velocity (m/s)**	0.82	
Erosion Threshold	**Bed**	**Banks**
Material	Alluvial Loamy Clay	Silty loam
Reference	Julien (1994)	Fischenich (2001)
Critical velocity (m/s)	0.76	0.53
Apparent bed shear stress (N/m^2)	--	2.15-2.39
Critical depth (m)	0.18	0.16
Critical discharge (m^3/s)	0.181	0.144
Unitary erosion threshold ($m^3/s/ha$)*	0.00045	0.00036
Limiting erosion threshold (m^3/s)	**0.144**	
Limiting unitary threshold ($m^3/s/ha$)*	**0.00036**	

*Drainage area from OWIT
**Based on Manning's equation and select representative cross-sections used in erosion threshold modelling

7 Erosion Mitigation Analysis

Using the results of the erosion threshold analysis described above and the site-wide hydrological simulation modelling provided by Crozier (2026) for existing, interim, and proposed conditions, an erosion exceedance analysis was completed to evaluate the potential for changes in erosion potential within the receiving watercourses. The erosion exceedance modelling was completed with our in-house erosion exceedance model. The most relevant erosion exceedance indices are summarized below:

1) Cumulative time of exceedance (t_{ex})
2) Cumulative effective volume (CEV)
3) Cumulative effective work/stream power index (CEWI)

These indices were developed in response to limitations of traditional peak flow-based stormwater design (Villard and Parish, 2003; Villard and Ness, 2006). They have been applied in various southern Ontario jurisdictions, including Conservation Halton (CH), TRCA, CVC. As a product, these indices provide an evaluation of the number of events and the duration and magnitude of sediment transport (Villard and Ness, 2006). We note that the most relevant indicator is the cumulative effective stream power (CEWI) as it reflects both the duration and magnitude of erosion exceedance events.

Time of exceedance, average effective discharge, and cumulative effective volume can be calculated from the discharge record and the estimated erosion threshold value (i.e., critical discharge). The cumulative time of exceedance is simply the summed duration of time where discharge exceeds the established erosion threshold. The cumulative time of exceedance simply quantifies the duration that the threshold is exceeded but does not provide information on the work or erosive force of flows when streamflow is above the erosion threshold (TRCA, 2012). The average effective discharge represents the average magnitude of discharge exceeding the erosion threshold during a given erosion event, whereas the cumulative effective volume (CEV) represents the total discharge volume that exceeds the erosion threshold throughout the modelled discharge record.

For more relevant indicators, namely the cumulative effective work index, channel hydraulic information is required. Our model applies discharge to a characteristic cross-section. Using Manning's approach, the discharge at each time step in the continuous hydrological model is converted into a velocity, depth of flow, shear stress, and/or stream power. These parameters are calculated based on field measurements of slope, cross-sectional geometry and channel roughness. This provides analysis that is site-appropriate and specific.

The post- and pre-development hydrological modelling reflects changes to the hydrological regime resulting from SWM measures being implemented within the catchment. Flow data was provided by Crozier (2026) in 5-minute increments for synthetic 25 mm, 2-year, 5-year, 10-year, 25-year, 50-year, 100-year storm events, as well as the regional event. The hydrological modeling was analyzed to calculate the aforementioned erosion indices to identify changes in the erosive potential within **Reach N-2-C** following development. The interim conditions represent development solely in Phase 1, while the rest of the study area remains undeveloped. The proposed conditions demonstrate the full buildout of the study area. A full series of post- and pre-development hydrographs, overlain with the respective erosion threshold and bankfull discharge values, are provided in **Appendix G7**, for reference.

7.1 Methodology

To calculate erosion indices, both velocity and shear stress were calculated at each model time step. Through an iterative process, water depth and velocity were calculated for each discharge passing through a representative cross-section from each of the subject reaches. For this process, the cross-section is divided into floodplain and bankfull sections. The cross-section is further broken into panels. Velocity, U, is calculated for each panel using Manning's approach. This is a conservative approach as it allows dissipation of flood energy in the floodplain.

The total discharge, $Q_{T,}$ at each time step is based on the summation of the discharge of all panels, Q_i, such that:

$$Q_{T=} \sum Q_i \qquad \text{[Eq. 8]}$$

Q_i is discharge through a panel (which is set at 10 percent of the cross-section).

Q_i is defined as:

$$Q_i = U_i w_i d_i \qquad \text{[Eq. 9]}$$

where, w_i and d_i are the width and the depth of each panel. The discharge for each panel was then summed to give a total discharge. This is more accurate than using average cross-sectional dimensions of a simple trapezoidal channel, as the bed is usually irregular, and a panel approach more accurately represents the true cross-sectional area.

For each event, the discharge is converted into a maximum depth and average velocity. The maximum depth is used to calculate the maximum bed shear stress, $\tau_{o_{\max}}$ based on:

$\tau_{o_{\max}} = d_{\max}\rho g S_{\text{bed}}$ [Eq. 10]

where $d_{\max}$ is the maximum water depth, ρ is water density, g is the acceleration due to gravity, and S_{bed} is the channel bed slope.

Cumulative total work, ϖ_{tot} is defined as:

$\varpi_{\text{tot}} = \sum \tau_{0_{\max}} . U_{\text{avg}} . \Delta t$ [Eq. 11]

where, U_{avg} is average velocity (Q_{tot}/A_{tot}, where A_{tot} is wetted area), while the cumulative effective work index (ϖ_{eff}) is defined by:

$\varpi_{\text{eff}} = \sum \tau - \tau_{cr} . U . \Delta t, \varpi < 0 = 0$ [Eq. 12]

where, τ_{cr} is the critical shear stress.

Time of exceedance t_{ex} defined as:

$t_{\text{ex}} = \sum \Delta t \ \text{ for } (Q_T > Q_{\text{threshold}})$ [Eq. 13]

where, $Q_{\text{threshold}}$ is the discharge at the erosion threshold.

The cumulative effective discharge volume (CEV) is defined as:

$\text{CEV} = \sum Q$ (for $Q > Q_{threshold}$) [Eq. 14]

Similarly, the cumulative effective discharge (CED) is defined as:

$\text{CED} = \text{CEV}/t_{ex}$ [Eq. 15]

7.2 Results

Erosion exceedance modelling results indicate that the proposed interim SWM strategy will have a minor influence on erosion potential within the receiving watercourse. The event-based hydrological modelling results indicate minor changes in key erosion indices for all storm events along the assessed reach. **Table 8** and **Table 9** summarize the results of the erosion exceedance assessment at **Reach N-2-C** derived from the event-based modelled streamflow data for interim and proposed conditions provided by Crozier (2026).

Table 8: Reach N-2-C erosion exceedance assessment results for the proposed interim condition

Reach N-2-C				
Parameter		**CEV (m^3)**	**ϖ_{eff} (N/m)**	**t_{ex} (hrs)**
25mm Event	**(PRE)**	7,818	92	5.8
	(POST)	7274	89	5.9
	Change (%)	**-7.0**	**-3.9**	**2.9**
2-year Event	**(PRE)**	31,512	306	16.8
	(POST)	30,924	310	17.2
	Change (%)	**-1.9**	**1.1**	**2.5**
5-year Event	**(PRE)**	61,139	516	18.0

Reach N-2-C				
Parameter		**CEV (m^3)**	**ω_{eff} (N/m)**	**t_{ex} (hrs)**
	(POST)	60,805	520	18.4
	Change (%)	**-0.5**	**0.8**	**2.3**
10-year Event	**(PRE)**	82,516	646	18.8
	(POST)	82,304	650	19.3
	Change (%)	**-0.3**	**0.6**	**2.7**
25-year Event	**(PRE)**	111,464	808	19.7
	(POST)	111,373	811	20.2
	Change (%)	**-0.1**	**0.4**	**2.5**
50-year Event	**(PRE)**	134,266	927	20.4
	(POST)	134,261	930	20.8
	Change (%)	**0.0**	**0.3**	**2.0**
100-year Event	**(PRE)**	161,256	1,061	21.2
	(POST)	161,369	1,064	21.6
	Change (%)	**0.1**	**0.3**	**2.0**
Regional Event	**(PRE)**	359,123	1,794	18.4
	(POST)	360,942	1,814	20.2
	Change (%)	**0.5**	**1.1**	**9.5**

A review of the pre- and post-development hydrographs for the interim condition indicates that the post-development hydrographs are attenuated with peak-flow reductions. The largest changes in key erosion indices were observed for the 25mm storm event where CEV decreased by 7% and CEWI 3.9%. All other synthetic storm events under interim conditions demonstrated minor changes in CEV and CEWI (i.e., ±2%). Overall, the results for the interim condition indicate minimal changes in erosion potential, with almost all key indices remaining within ±5% of pre-development conditions.

Given that the cumulative effective work index is the most relevant indicator of erosion potential, and predicted changes generally remain within the ±5% threshold for significance, the interim condition results suggest that the proposed interim SWM strategy will not result in a measurable change in erosion potential within the receiving watercourse.

Table 9: Reach N-2-C erosion exceedance assessment results for the proposed ultimate condition

Reach N-2-C				
Parameter		**CEV (m^3)**	**ω_{eff} (N/m)**	**t_{ex} (hrs)**
25mm Event	**(PRE)**	7,818	92	5.8
	(POST)	6,830	85	6.1
	Change (%)	**-12.6**	**-8.4**	**5.8**
2-year Event	**(PRE)**	31,512	306	16.8
	(POST)	30,377	310	17.5
	Change (%)	**-3.6**	**1.2**	**4.5**
5-year Event	**(PRE)**	61,139	516	18.0

Reach N-2-C				
Parameter		**CEV (m^3)**	**ω_{eff} (N/m)**	**t_{ex} (hrs)**
	(POST)	60,388	521	18.8
	Change (%)	**-1.2**	**1.0**	**4.2**
10-year Event	**(PRE)**	82,516	646	18.8
	(POST)	81,954	651	19.5
	Change (%)	**-0.7**	**0.8**	**4.0**
25-year Event	**(PRE)**	111,464	808	19.7
	(POST)	111,081	812	20.4
	Change (%)	**-0.3**	**0.6**	**3.8**
50-year Event	**(PRE)**	134,266	927	20.4
	(POST)	134,014	931	21.2
	Change (%)	**-0.2**	**0.4**	**3.7**
100-year Event	**(PRE)**	161,256	1,061	21.2
	(POST)	161,172	1,064	21.8
	Change (%)	**-0.1**	**0.3**	**3.1**
Regional Event	**(PRE)**	359,123	1,794	18.4
	(POST)	362,302	1,830	20.3
	Change (%)	**0.9**	**2.0**	**10.4**

Erosion exceedance modelling results for the proposed ultimate condition are similar to those of the interim condition and suggest that minor changes in erosion potential within the receiving watercourse. The analysis indicates that CEV decreases across all modelled events from the 25 mm to 100-year storms, with reductions ranging from approximately -12.6% to -0.1%. The greatest reduction in CEV was observed for the 25 mm event at 12.6%, whereas the regional event saw a minor increase in CEV of 0.9%. Conversely, CEWI exhibits minor increases across all events (excluding the 25mm [-8.4%]), generally ranging from approximately 3.1% to 10.4%.

Despite these variations, the cumulative effective work index remains within the ±5% of pre-development conditions for all events with the exception of the 25mm event, indicating that the predicted changes are not expected to result in measurable changes in erosion potential. The observed reductions in discharge volume, combined with modest increases in exceedance duration, suggest that the proposed SWM strategy effectively attenuates peak flows while maintaining overall erosion conditions comparable to pre-development levels.

Accordingly, the results of the erosion exceedance analysis indicate that the proposed SWM plan for both the proposed interim and ultimate conditions will maintain long-term channel stability. It is expected that erosion potential within the receiving watercourse will be effectively maintained.

8 Summary

GEO Morphix was retained to complete a fluvial geomorphology assessment as part of the Scoped SWS being undertaken for proposed development at 9094 Regional Road 25 in the Town of Halton Hills. The study focused on the tributary of Sixteen Mile Creek in the western portion of the subject site. The following provides a summary of key findings and recommendations:

- Tributary reaches within the subject lands have been significantly impacted by past agricultural land uses and lacked natural riffle and pool morphology and particularly along **Reach N-2-Da**, a well-defined bankfull channel.

- Rapid geomorphological assessments were completed along Reaches **N-2-D** and **N-2-C** and the results indicated that **Reach N-2-D** was in transition, while **N-2-C** was in regime.

- Meander belt widths of 27 m (**N-2-Da**) and 32 m (**N-2-D**) were delineated based on field observations, a review of aerial imagery, and empirical modelling.

- A 5 m toe erosion allowance was recommended for **Reach N-2-D** and was to be applied from the channel bank where it is within 15 m of the valley slope. This is to be reviewed in tandem with the geotechnical slope stability assessment prepared by Soil Engineers Ltd (2026).

- The western tributary of Sixteen Mile Creek is mapped as critical habitat for Redside Dace by DFO. Based on field observations, Redside Dace habitat is not present along **Reach N-2-Da** as it lacked riffle-pool sequences, contained fine-grained sediments (i.e., clay and silt) and shallow flow conditions. Consultation with DFO will be completed to confirm the extent of critical habitat as the project proceeds.

- The extent of critical Redside Dace habitat was delineated for **Reach N-2-D** based on the meander belt width and toe of slope, as this reach was partially confined by a defined valley.

- A detailed geomorphological assessment was conducted along **Reach N-2-C** in support of the erosion mitigation assessment as this reach is located downstream of proposed stormwater outlets and upstream of the constructed natural heritage system south of 5 Side Road.

- Erosion threshold and erosion exceedance analyses conducted for proposed interim and proposed conditions indicate that post-development hydrographs are attenuated with minor changes in key erosion indices, such that no measurable increase in erosion potential is expected and long-term channel stability will be maintained within the receiving watercourse.

We trust this report meets your current requirements. Should you have any questions, please contact the undersigned.

Respectfully submitted,

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Appendix G1
Reach Delineation and Erosion Mitigation Assessment Figures

Legend

- Reach Break and ID
- Watercourse
- Headwater Drainage Feature
- 1 m Contour
- Detailed Assessment Location
- Approximate Study Area

Reach Delineation
Scoped Subwatershed Study

9094 Regional Road 25

Halton Hills, Ontario

GEO MORPHIX™

0 55 110

Metres

Imagery: Google Earth, 2023.
Reach Break and ID and Approximate Study Area, Detailed Assessment: GEO Morphix Ltd., 2025.
Watercourse: MNRF, 2024.1 m Contour: Crozier, 2025.
Print Date: October 2025. PN25111. Drawn By: S.S.O., G.U., M.O.

Legend

- Reach Break and ID
- Modelling Node
- Watercourse
- Headwater Drainage Feature
- Detailed Assessment Location
- Approximate Study Area
- Waterbody

Erosion Mitigation Assessment

9094 Regional Road 25

Halton Hills, Ontario

GEO MORPHIX™

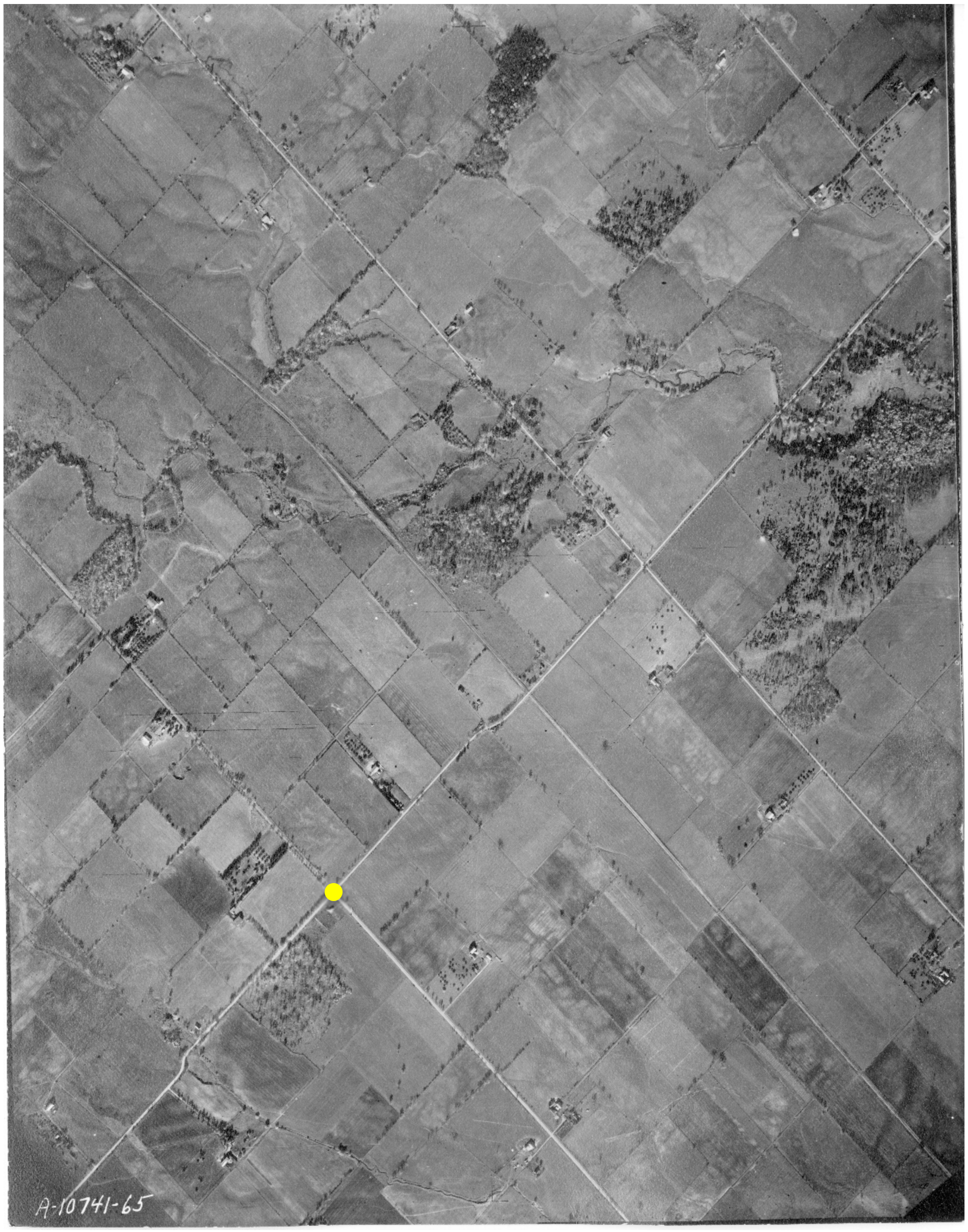
N

0 55 110

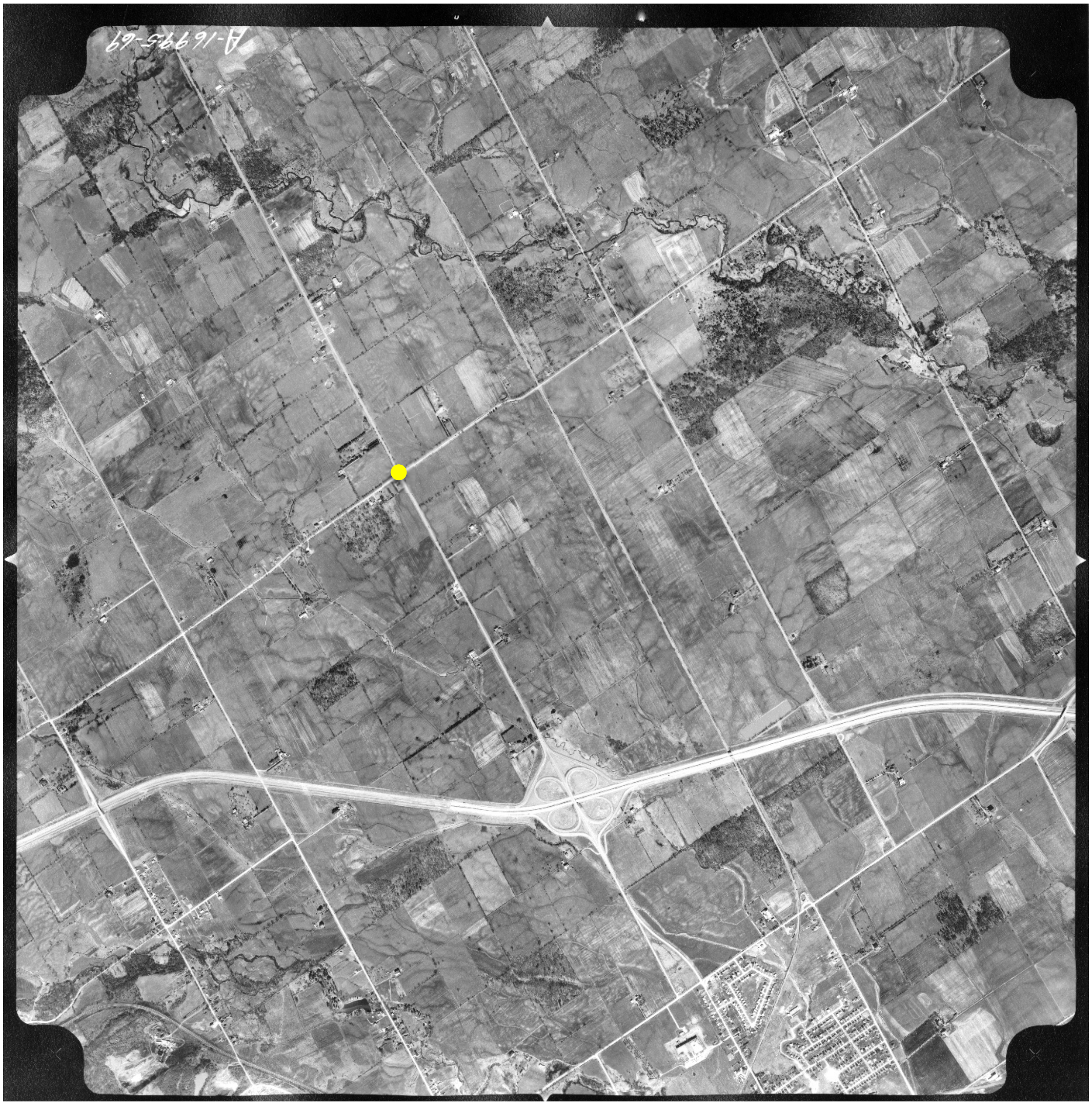
Metres

Hillshade: MNRF, 2023. Modelling Node, Detailed Assessment, Reach Break and ID and Approximate Study Area: GEO Morphix Ltd., 2025.Wetland, Waterbody and Watercourse: MNRF, 2024. Print Date: March 2026. PN25111. Drawn By: C.G., M.O., S.S.O.

Appendix G2
Historical Aerial Photographs



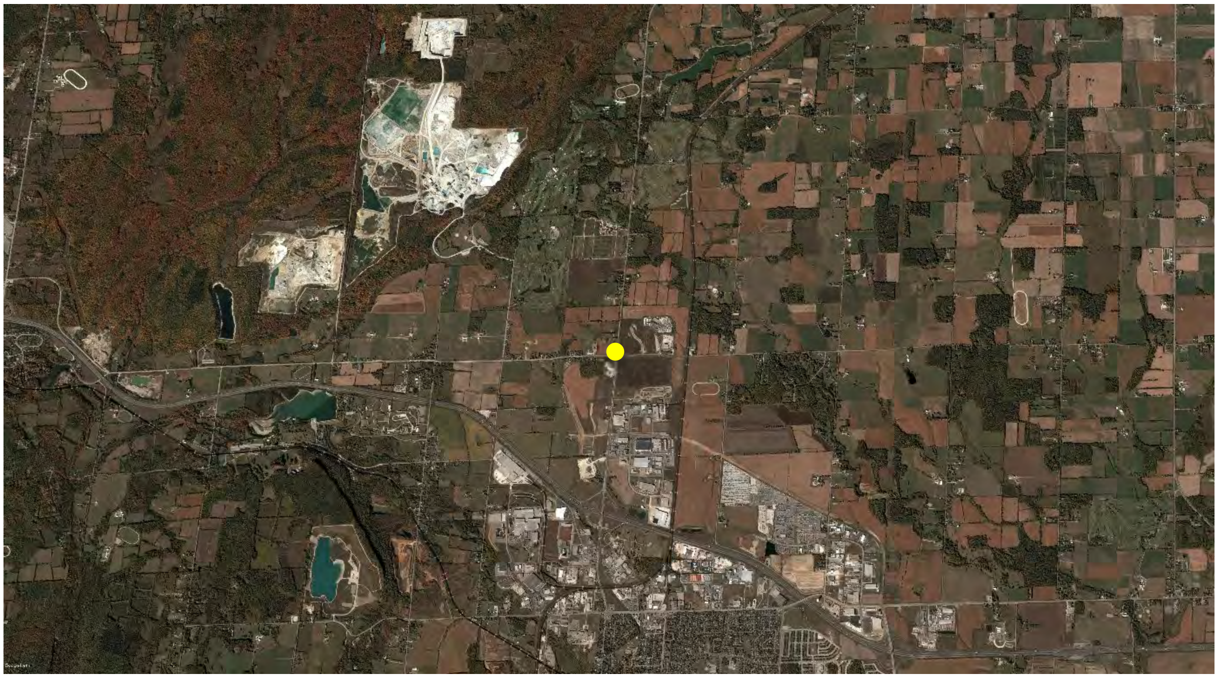
Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 1946
Scale: 1:20,000
Source: National Air Photo Library



Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 1960
Scale: 1:25,000
Source: National Air Photo Library

Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 1974
Scale: 1:25,000
Source: National Air Photo Library

Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 1999
Scale: 1:20,000
Source: Ministry of Natural Resources



Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 2004
Source: Google Earth Pro

Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 2014
Source: Google Earth Pro

Location: Halton Hills, ON
Yellow dot: 5 Side Road and Regional Road 25
Year: 2024
Source: Google Earth Pro

Appendix G3
Photographic Record

GEO | MORPHIX™

Photo 1 **Tributary of Sixteen Mile Creek, Halton Hills** **Reach N-2-D**	 Photo of **Reach N-2-D** facing downstream. Watercress (circled) was frequently observed throughout the reach.
Photo 2 Tributary of Sixteen Mile Creek **Reach N-2-D**	 The bed and bank substrate in **Reach N-2-D** was primarily comprised of clay- and silt-textured materials.

Photo 3
Tributary of Sixteen Mile Creek
Reach N-2-D

Photo of **Reach N-2-D** facing downstream. Woody debris and fallen trees of various ages were common throughout the reach.

Photo 4
Tributary of Sixteen Mile Creek
Reach N-2-D

Photo of **Reach N-2-D** facing downstream. Undercutting was present along the left bank (indicated by arrow).

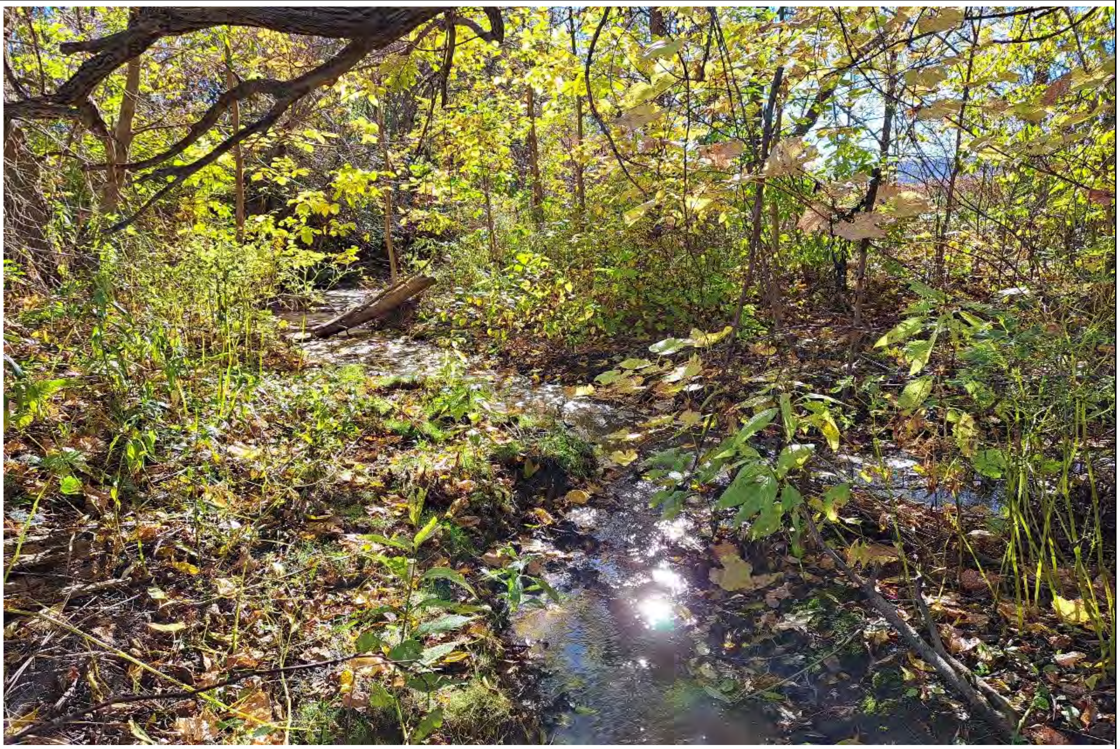
Photo 5
Tributary of Sixteen Mile Creek
Reach N-2-Da

Photo of **Reach N-2-Da** facing downstream. Watercress was prevalent throughout the reach.

Photo 6
Tributary of Sixteen Mile Creek
Reach N-2-Da

Vegetation was mainly comprised of wetland-type plants that encroached into the low-flow channel. Agricultural fields flanked the reach.

Photo 8 Tributary of Sixteen Mile Creek **Reach N-2-C**	 Photo of **Reach N-2-C** facing downstream. Woody debris and fallen trees were found throughout the reach.
Photo 9 Tributary of Sixteen Mile Creek **Reach N-2-C**	 Photo of **Reach N-2-C** facing downstream. Riparian vegetation consisted of grasses, shrubs, and mature trees.

Photo 10 Tributary of Sixteen Mile Creek **Reach N-2-C**	 Photo of **Reach N-2-C** facing downstream at the confluence with an adjacent tributary. The reach had an average bankfull width and depth of 1.96 m and 0.21 m, respectively.

Appendix G4
Field Observations

GEO MORPHIX™

Reach Characteristics Project Number: 25111

Date:	2025-10-16	**Field Staff:**	CG AM	**Watershed/Subwatershed:**	16 Mile Creek
Time:	9:00	**Stream:**	16 mile W Branch	**UTM (Upstream):**	
Weather:	sunny 9°C	**Reach:**	N-2-C	**UTM (Downstream):**	

Land Use (Table 1): 1/2/5/9/7 **Valley Type** (Table 2): 2 **Channel Type** (Table 3): 12 **Channel Zone** (Table 4): 2 **Flow Type** (Table 5): 1 ☐ Evidence of Groundwater Location: N/A Photo: N/A

Riparian Vegetation

- Dominant Type (Table 6): 1-4
- Encroachment (Table 7): 2
- Coverage: ☐ None ☐ Fragmented ☑ Continuous
- Channel Widths: ☐ 1 - 4 ☐ 4 - 10 ☑ > 10
- Age (yrs): ☐ Immature (<5) ☑ Established (5-30) ☑ Mature (>30)

Aquatic & Instream Vegetation

- Type (Table 8): 1
- Reach Coverage %: 5
- Woody Debris: ☐ In Cutbank ☑ In Channel ☐ Not Present
- WD Density: ☑ Low ☐ Mod ☐ High
- WDJ/50m: 1.5

Water Quality

- Odour (Table 16): 1
- Turbidity (Table 17): 1

Channel Characteristics

- Sinuosity Type (Table 9): 1
- Sinuosity Degree (Table 10): 1
- Gradient (Table 11): 1
- # of Channels (Table 12): 1
- Entrenchment (Table 13): 1
- Bank Failure (Table 14): 1/2/6
- Down's Model (Table 15): S/m
- Bankfull Indicators (Table 18): 1/3/5
- Sed Sorting (Table 20): PS
- Sediment Transport Observed? ☐ Yes ☑ No ☐ Not Visible
- Transport Mode (Table 21): 3
- % of Bed Active: /
- Geomorphic Units (Table 22): 5/8
- Mass Movement (Table 23): 4
- Riffle-Pool Spacing (m):
- % Riffles: N/A
- % Pools: NA
- Bank Angle: ☐ 0 – 30 ☑ 30 – 60 ☐ 60 – 90 ☑ Undercut
- Bank Erosion: ☐ < 5% ☑ 5 – 30% ☐ 30 – 60% ☐ 60 – 100%

(Table 19)	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
Bank	☑	☑	☐	☐	☐	☐	☐
Riffle	☐	☐	☐	☐	☐	☐	☐
Pool	☑	☐	☐	☐	☐	☐	☐
Bed (if no riffle-pool morphology)	☑	☐	☑	☐	☐	☐	☐

Bankfull Width (m), Bankfull Depth (m), Undercuts (m), Pool Depth (m), Riffle Length (m): See Detailed Assessment Summary

Wetted Width (m), Wetted Depth (m), Velocity (m/s), Velocity Estimate Method, Meander Amplitude (m): See Detailed Assessment Summary

Notes:
↳ Flowing water was present throughout the reach
↳ Some watercress and cattails present
↳ US portion of reach near 5 Side Road not included in this evaluation due to access restrictions

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: CG

GEO MORPHIX

Rapid Geomorphic Assessment

Project Number: 25111

Date:	2025-10-16	**Stream:**	16 Mile W
Time:	9:15	**Reach:**	N-2-C
Weather:	9°C sunny	**Location:**	Milton ON
Field Staff:	CG AM	**Watershed/Subwatershed:**	16 mile Creek

Process	No.	Geomorphological Indicator – Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		✓	1/6
	2	Coarse materials in riffles embedded — No riffles	~~✓~~		
	3	Siltation in pools	✓		
	4	Medial bars		✓	
	5	Accretion on point bars		✓	
	6	Poor longitudinal sorting of bed materials		✓	
	7	Deposition in the overbank zone		✓	
		Sum of indices =	1	5	0.17
Evidence of Degradation (DI)	1	Exposed bridge footing(s) — N/A			0/6
	2	Exposed sanitary / storm sewer / pipeline / etc.		✓	
	3	Elevated storm sewer outfall(s) — N/A			
	4	Undermined gabion baskets / concrete aprons / etc. — N/A			
	5	Scour pools downstream of culverts / storm sewer outlets — N/A			
	6	Cut face on bar forms		✓	
	7	Head cutting due to knickpoint migration		✓	
	8	Terrace cut through older bar material		✓	
	9	Suspended armour layer visible in bank		✓	
	10	Channel worn into undisturbed overburden / bedrock		✓	
		Sum of indices =	0	6	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	✓		2/7
	2	Occurrence of large organic debris		✓	
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends		✓	
	5	Basal scour on both sides of channel through riffle — N/A			
	6	Outflanked gabion baskets / concrete walls / etc. — N/A			
	7	Length of basal scour >50% through subject reach		✓	
	8	Exposed length of previously buried pipe / cable / etc.		✓	
	9	Fracture lines along top of bank		✓	
	10	Exposed building foundation — N/A			
		Sum of indices =	2	5	0.27
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		✓	1/7
	2	Single thread channel to multiple channel		✓	
	3	Evolution of pool-riffle form to low bed relief form		✓	
	4	Cut-off channel(s)		✓	
	5	Formation of island(s)		✓	
	6	Thalweg alignment out of phase with meander form		✓	
	7	Bar forms poorly formed / reworked / removed	✓		
		Sum of indices =	1	6	0.14

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =		0.15
In Regime	**In Transition/Stress**	**In Adjustment**
☑ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Version #3
Last edited: 10/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: CG

GEO MORPHIX

Rapid Stream Assessment Technique **Project Number:** 25111

Date:	2025-10-16	**Stream:**	16 Mile W
Time:	9:15	**Reach:**	N-2-C
Weather:	9°C sunny	**Location:**	Milton ON
Field Staff:	CG AM	**Watershed/Subwatershed:**	16 Mile Creek

Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☒ 8	☐ 9 ☐ 10 ☐ 11
Channel Scouring/ Sediment Deposition	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☒ 7 ☐ 8

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: CG

GEO MORPHIX™

Date:	2025-10-16	PN:	25111	Location:	Milton ON

Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☒ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☒ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☒ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 30	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: CC

General Site Characteristics

Project Number: 25111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:51	**Reach:**	N-2-D
Weather:	19.5°C, Sun & Cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Features		Monitoring	
(symbol)	Reach break	(symbol)	Long-profile
(symbol)	Station location	(symbol)	Monumented XS
(symbol)	Cross-section	(symbol)	Monumented photo
(symbol)	Flow direction	(symbol)	Monumented photo direction
(symbol)	Riffle	(symbol)	Sediment sampling
(symbol)	Pool	(symbol)	Erosion pins
(symbol)	Sediment bar	(symbol)	Scour chains
(symbol)	Eroded bank/slope	**Additional Symbols**	
(symbol)	Undercut bank	ER	exposed roots
(symbol)	Bank stabilization		
(symbol)	Leaning tree		
(symbol)	Fence		
(symbol)	Culvert/outfall		
(symbol)	Swamp/wetland		
(symbol)	Grasses		
(symbol)	Tree		
(symbol)	Instream log/tree		
(symbol)	Woody debris		
(symbol)	Beaver dam		
(symbol)	Vegetated island		

Flow Type

H1	Standing water	H1A	Back water
H2	Scarcely perceptible flow		
H3	Smooth surface flow		
H4	Upwelling		
H5	Rippled		
H6	Unbroken standing wave		
H7	Broken standing wave		
H8	Chute		
H9	Free fall	H9A	Dissipates below free fall

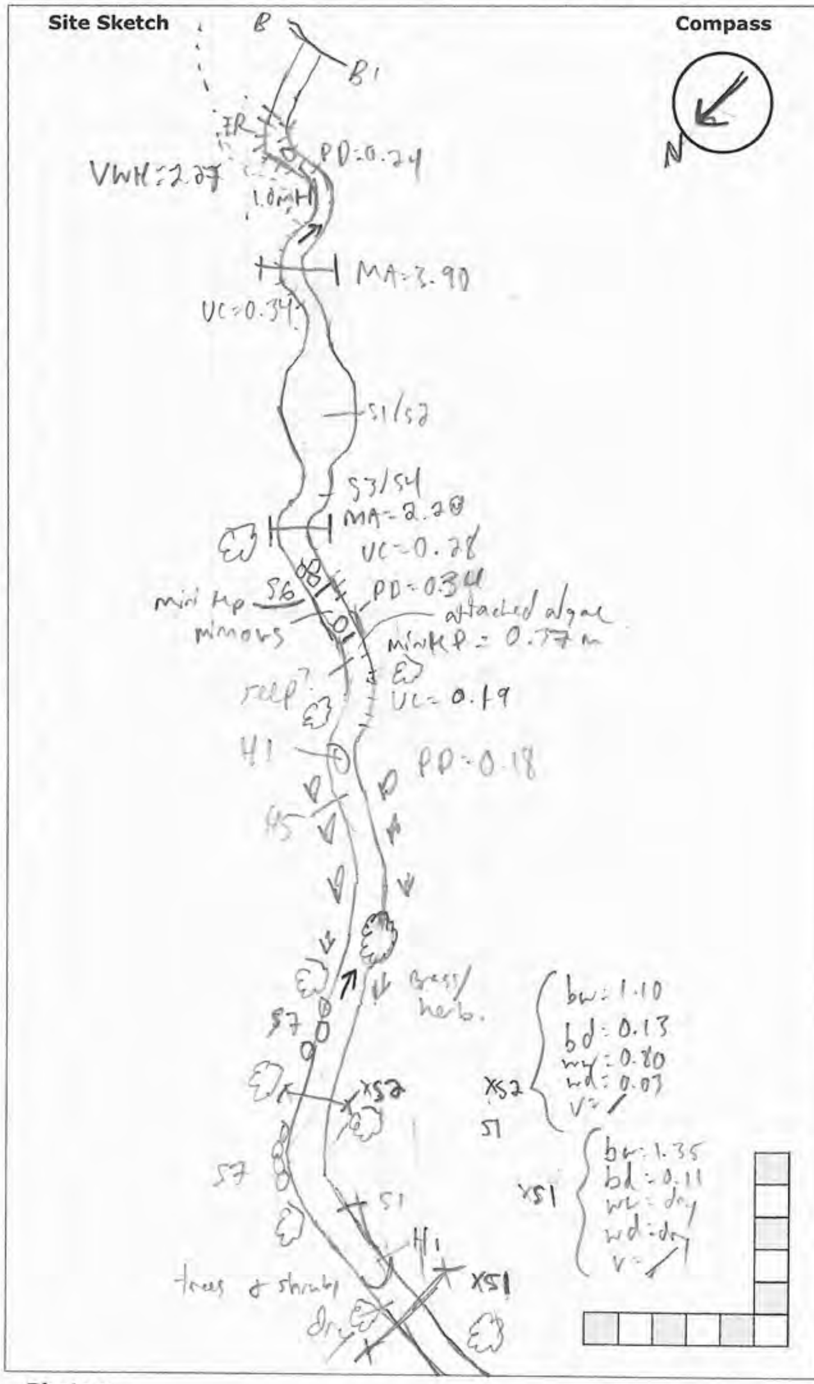
Substrate

S1	Silt	S6	Small boulder
S2	Sand	S7	Large boulder
S3	Gravel	S8	Bimodal
S4	Small cobble	S9	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	EP	Erosion pin
BS	Backsight	RB	Rebar
DS	Downstream	US	Upstream
WDJ	Woody debris jam	TR	Terrace
VWC	Valley wall contact	FC	Flood chute
BOS	Bottom of slope	FP	Flood plain
TOS	Top of slope	KP	Knick point

Site Sketch **Compass**



Photos:

Notes: water clear. watercress throughout

Version #4
Last edited: 21/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

GEO MORPHIX™

General Site Characteristics

Project Number: 25111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:51	**Reach:**	N-2-D
Weather:	19.5c, sun & cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Features	**Monitoring**
Reach break	Long-profile
Station location	Monumented XS
Cross-section	Monumented photo
Flow direction	Monumented photo direction
Riffle	Sediment sampling
Pool	Erosion pins
Sediment bar	Scour chains
Eroded bank/slope	**Additional Symbols**
Undercut bank	ER exposed roots
Bank stabilization	
Leaning tree	
Fence	
Culvert/outfall	
Swamp/wetland	
Grasses	
Tree	
Instream log/tree	
Woody debris	
Beaver dam	
Vegetated island	

Flow Type

H1	Standing water	H1A	Back water
H2	Scarcely perceptible flow		
H3	Smooth surface flow		
H4	Upwelling		
H5	Rippled		
H6	Unbroken standing wave		
H7	Broken standing wave		
H8	Chute		
H9	Free fall	H9A	Dissipates below free fall

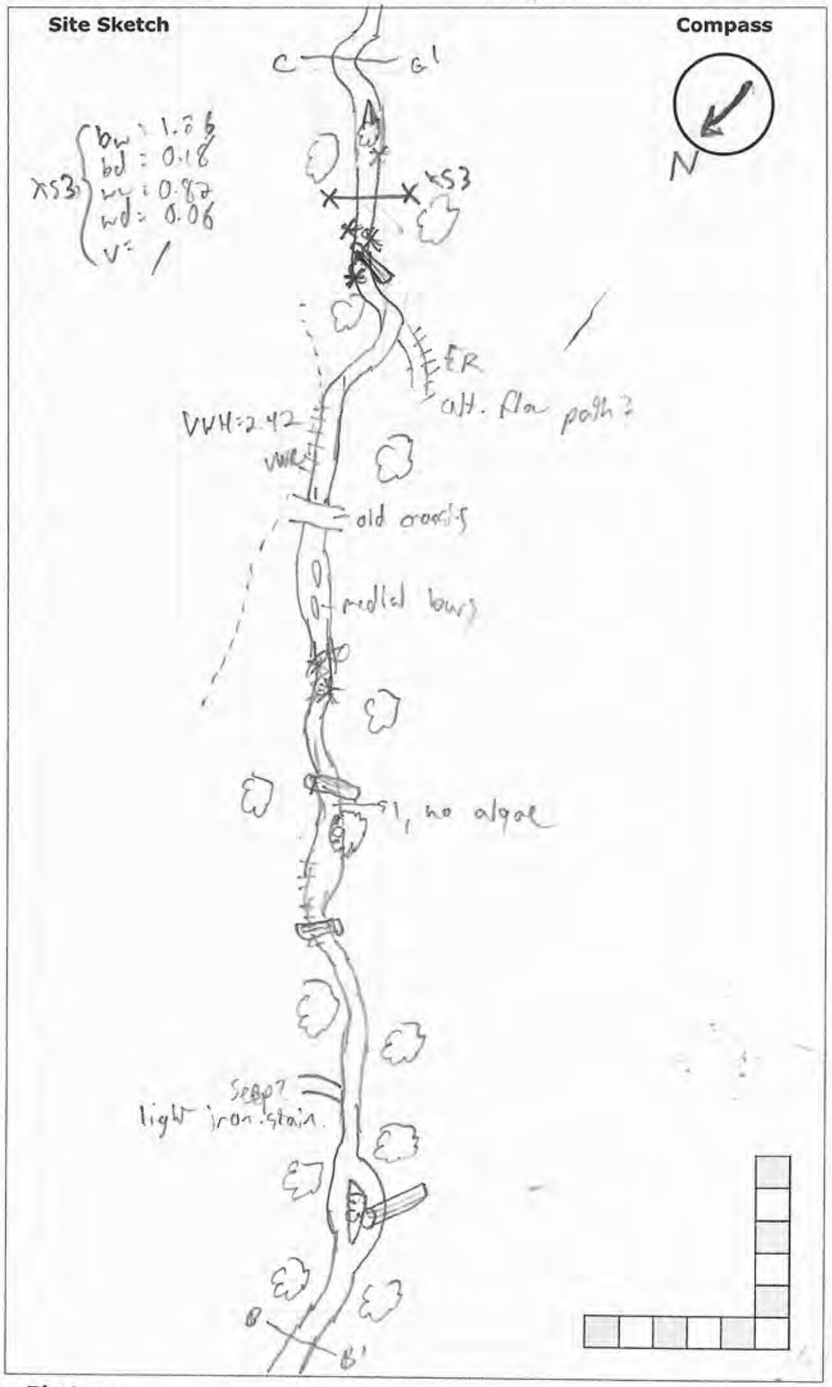
Substrate

S1	Silt	S6	Small boulder
S2	Sand	S7	Large boulder
S3	Gravel	S8	Bimodal
S4	Small cobble	S9	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	EP	Erosion pin
BS	Backsight	RB	Rebar
DS	Downstream	US	Upstream
WDJ	Woody debris jam	TR	Terrace
VWC	Valley wall contact	FC	Flood chute
BOS	Bottom of slope	FP	Flood plain
TOS	Top of slope	KP	Knick point

Site Sketch **Compass**



Photos:

Notes: watercress throughout. Exposed roots throughout.

Version #4
Last edited: 21/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

GEO MORPHIX™

General Site Characteristics — Project Number: 25111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:51	**Reach:**	N-2-D
Weather:	19.5°C, sun & cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Features	Monitoring
Reach break	Long-profile
Station location	Monumented XS
Cross-section	Monumented photo
Flow direction	Monumented photo direction
Riffle	Sediment sampling
Pool	Erosion pins
Sediment bar	Scour chains
Eroded bank/slope	**Additional Symbols**
Undercut bank	
Bank stabilization	
Leaning tree	
Fence	
Culvert/outfall	
Swamp/wetland	
Grasses	
Tree	
Instream log/tree	
Woody debris	
Beaver dam	
Vegetated island	

Flow Type

H1	Standing water	H1A	Back water
H2	Scarcely perceptible flow		
H3	Smooth surface flow		
H4	Upwelling		
H5	Rippled		
H6	Unbroken standing wave		
H7	Broken standing wave		
H8	Chute		
H9	Free fall	H9A	Dissipates below free fall

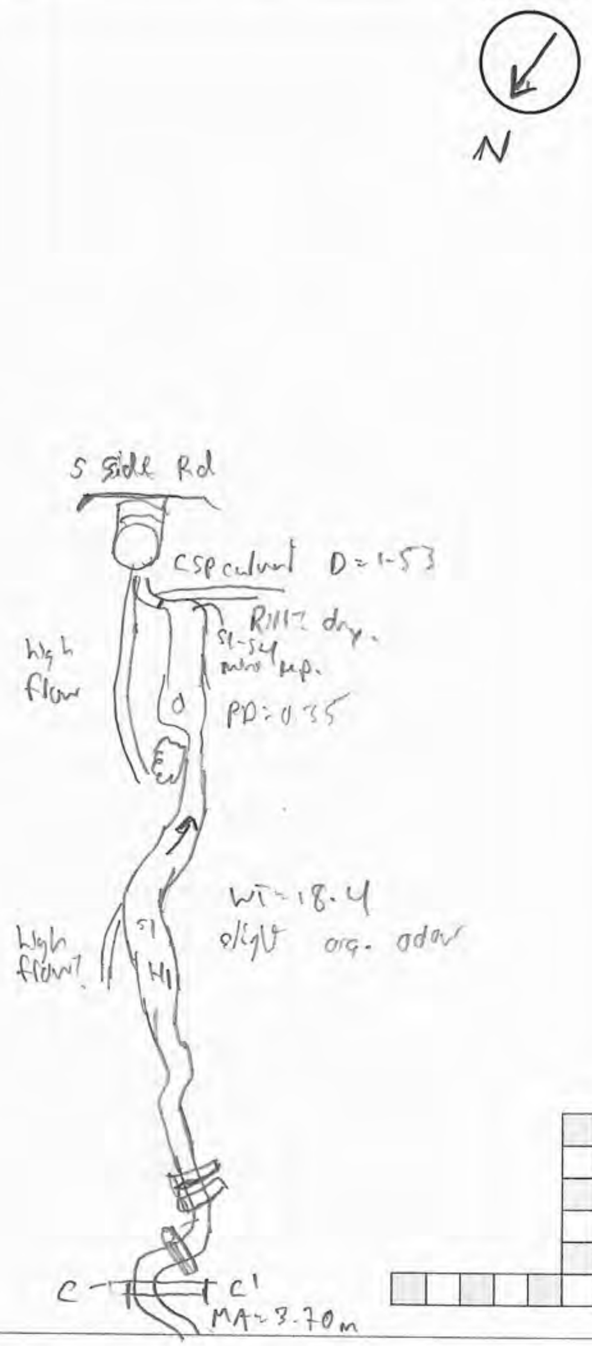
Substrate

S1	Silt	S6	Small boulder
S2	Sand	S7	Large boulder
S3	Gravel	S8	Bimodal
S4	Small cobble	S9	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	EP	Erosion pin
BS	Backsight	RB	Rebar
DS	Downstream	US	Upstream
WDJ	Woody debris jam	TR	Terrace
VWC	Valley wall contact	FC	Flood chute
BOS	Bottom of slope	FP	Flood plain
TOS	Top of slope	KP	Knick point

Site Sketch — **Compass**



Photos:

Notes:

Version #4
Last edited: 21/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

GEO MORPHIX™

Reach Characteristics

Project Number:

Date:	2025-08-14	**Field Staff:**	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek
Time:	9:51	**Stream:**	Trib. Sixteen Mile Creek	**UTM (Upstream):**	
Weather:	19.5°C, sun & cloud	**Reach:**	N-2-D	**UTM (Downstream):**	

Land Use (Table 1): 1 | **Valley Type** (Table 2): 3 | **Channel Type** (Table 3): 12 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location: throughout *watercress Photo: ✓

Riparian Vegetation

Dominant Type (Table 6): 1/2	**Coverage**	**Channel Widths**	**Age (yrs)**
	☐ None	☐ 1 - 4	☐ Immature (<5)
	☐ Fragmented	☐ 4 - 10	☐ Established (5-30)
Encroachment (Table 7): 2	☑ Continuous	☑ > 10	☑ Mature (>30)

Aquatic & Instream Vegetation

Type (Table 8): 6	**Woody Debris**	**WD Density**	**WDJ/50m:** 0
	☑ In Cutbank	☐ Low	
	☑ In Channel	☑ Mod	
Reach Coverage %: 5%	☐ Not Present	☐ High	

Water Quality

Odour (Table 16)	**Turbidity** (Table 17)
6	1/2

*minor organic occasionally

Channel Characteristics

Sinuosity Type (Table 9)	2	**Sinuosity Degree** (Table 10)	2/3	**Bank Angle**	**Bank Erosion**
				☐ 0 – 30	☐ < 5%
Gradient (Table 11)	1/2	**# of Channels** (Table 12)	1/2	☑ 30 – 60	☑ 5 – 30%
				☐ 60 – 90	☐ 30 – 60%
Entrenchment (Table 13)	1	**Bank Failure** (Table 14)	1/2	☑ Undercut	☐ 60 – 100%
Down's Model (Table 15)	M	**Bankfull Indicators** (Table 18)	3/5/6		
Sed Sorting (Table 20)	MS	**Sediment Transport Observed?**	☐ Yes ☑ No ☐ Not Visible		
Transport Mode (Table 21)	3	**% of Bed Active**	0		
Geomorphic Units (Table 22)	5/8	**Mass Movement** (Table 23)	/		
Riffle-Pool Spacing (m):	/	**% Riffles:**	0	**% Pools:**	>5

(Table 19)	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
Bank	☑	☐	☐	☐	☐	☐	☐
Riffle	☐	☐	☐	☐	☐	☐	☐
Pool	☑	☐	☐	☐	☐	☐	☐
Bed (if no riffle-pool morphology)	☑	☑	☑	☐	☐	☐	☐

Bankfull Width (m)	1.35	1.10	1.26
Bankfull Depth (m)	0.11	0.13	0.18
Undercuts (m)	0.19	0.28	0.34
Pool Depth (m)	0.18	0.34	0.24
Riffle Length (m)	/	/	/

Wetted Width (m)	/	0.80	0.82
Wetted Depth (m)	/	0.03	0.06
Velocity (m/s)	/	/	/
Velocity Estimate Method	/	/	/
Meander Amplitude (m)	2.20	3.70	/

Notes: Dry @ U/s extent. Deepens towards d/s extent. Unable to measure flow or water was standing. 2x Mini head-cut points.

Photos:

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

GEO MORPHIX

Rapid Geomorphic Assessment **Project Number:** 28111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:51	**Reach:**	N-2-D
Weather:	19.5°C, sun/cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Process	No.	Geomorphological Indicator – Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		✓	1/6
	2	Coarse materials in riffles embedded N/A			
	3	Siltation in pools	✓		
	4	Medial bars		✓	
	5	Accretion on point bars		✓	
	6	Poor longitudinal sorting of bed materials		✓	
	7	Deposition in the overbank zone		✓	
		Sum of indices =	1	5	0.17
Evidence of Degradation (DI)	1	Exposed bridge footing(s) N/A			1/5
	2	Exposed sanitary / storm sewer / pipeline / etc. N/A			
	3	Elevated storm sewer outfall(s) N/A			
	4	Undermined gabion baskets / concrete aprons / etc. N/A			
	5	Scour pools downstream of culverts / storm sewer outlets N/A			
	6	Cut face on bar forms		✓	
	7	Head cutting due to knickpoint migration	✓		
	8	Terrace cut through older bar material		✓	
	9	Suspended armour layer visible in bank		✓	
	10	Channel worn into undisturbed overburden / bedrock		✓	
		Sum of indices =	1	4	0.2
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	✓		3/7
	2	Occurrence of large organic debris	✓		
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends		✓	*occurred @ one bend
	5	Basal scour on both sides of channel through riffle N/A			
	6	Outflanked gabion baskets / concrete walls / etc. N/A			
	7	Length of basal scour >50% through subject reach		✓	
	8	Exposed length of previously buried pipe / cable / etc.		✓	
	9	Fracture lines along top of bank		✓	
	10	Exposed building foundation N/A			
		Sum of indices =	3	4	0.43
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)	✓		2/7
	2	Single thread channel to multiple channel		✓	
	3	Evolution of pool-riffle form to low bed relief form		✓	
	4	Cut-off channel(s)		✓	
	5	Formation of island(s)		✓	
	6	Thalweg alignment out of phase with meander form		✓	
	7	Bar forms poorly formed / reworked / removed	✓		
		Sum of indices =	2	5	0.29

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =		0.27
In Regime	**In Transition/Stress**	**In Adjustment**
☐ **0.00 - 0.20**	☑ **0.21 - 0.40**	☐ **0.41**

Version #3
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO Checked by: NBS Completed by: [signature]

GEO MORPHIX™

Rapid Stream Assessment Technique **Project Number:** 25111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:51	**Reach:**	N-2-D
Weather:	19.5°C, sun/cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☑ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

Category	Poor	Fair	Good	Excellent
Channel Scouring/ Sediment Deposition	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☑ 6	☐ 7 ☐ 8

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO Checked by: NBS Completed by: SL

GEO MORPHIX™

Date:	2025-08-14	PN:	25111	Location:	Halton Hills

Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☑ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☑ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☑ 6 ☐ 7

Total overall score (0–42) = 29	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO Checked by: NBJ Completed by: SC

GEO MORPHIX™

General Site Characteristics

Project Number: 25111

Date:	2025-08-14	**Stream:**	Trib. Sixteen Mile Creek
Time:	9:11	**Reach:**	N-2-Da
Weather:	19.5°C, sun + cloud	**Location:**	Halton Hills
Field Staff:	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek

Features	Monitoring
Reach break	Long-profile
Station location	Monumented XS
Cross-section	Monumented photo
Flow direction	Monumented photo direction
Riffle	Sediment sampling
Pool	Erosion pins
Sediment bar	Scour chains
Eroded bank/slope	**Additional Symbols**
Undercut bank	cattails
Bank stabilization	ER exposed roots
Leaning tree	
Fence	
Culvert/outfall	
Swamp/wetland	
Grasses	
Tree	
Instream log/tree	
Woody debris	
Beaver dam	
Vegetated island	

Flow Type

H1	Standing water	H1A	Back water
H2	Scarcely perceptible flow		
H3	Smooth surface flow		
H4	Upwelling		
H5	Rippled		
H6	Unbroken standing wave		
H7	Broken standing wave		
H8	Chute		
H9	Free fall	H9A	Dissipates below free fall

Substrate

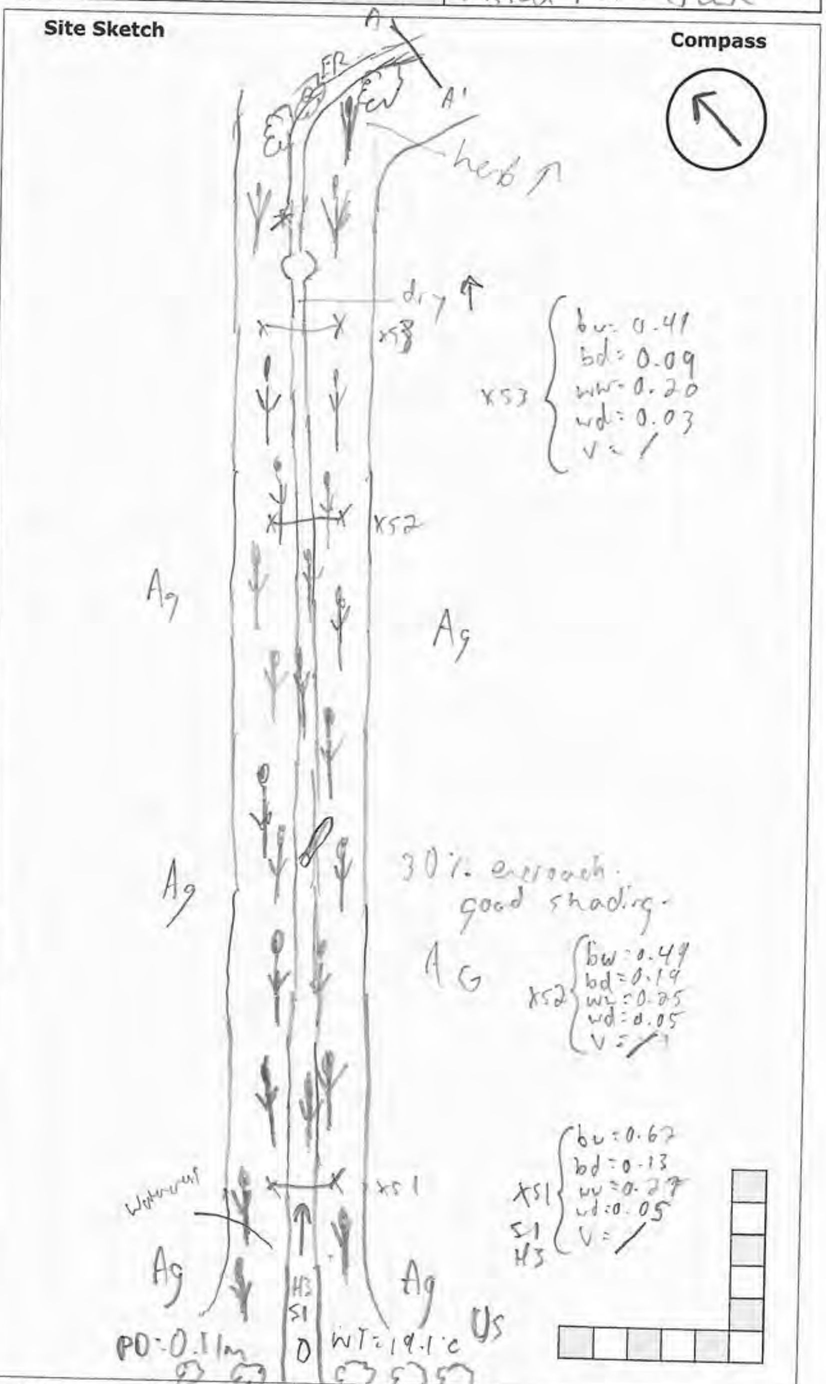
S1	Silt	S6	Small boulder
S2	Sand	S7	Large boulder
S3	Gravel	S8	Bimodal
S4	Small cobble	S9	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	EP	Erosion pin
BS	Backsight	RB	Rebar
DS	Downstream	US	Upstream
WDJ	Woody debris jam	TR	Terrace
VWC	Valley wall contact	FC	Flood chute
BOS	Bottom of slope	FP	Flood plain
TOS	Top of slope	KP	Knick point

Site Sketch

Compass



Photos:

Notes: watercourse throughout

Version #4
Last edited: 21/02/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

GEO MORPHIX™

Reach Characteristics

Project Number: 25111

Date:	2025-08-14	**Field Staff:**	NBS SL	**Watershed/Subwatershed:**	Sixteen Mile Creek
Time:	9:11	**Stream:**	Trib Sixteen Mile Creek	**UTM (Upstream):**	
Weather:	NBS SL	**Reach:**	N-2-Da	**UTM (Downstream):**	

Land Use (Table 1): 3 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 11 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location: ______ Photo: ______ Watercress

Riparian Vegetation

- **Dominant Type** (Table 6): 4
- **Encroachment** (Table 7): 4
- **Coverage:** ☐ None ☐ Fragmented ☑ Continuous
- **Channel Widths:** ☑ 1 - 4 ☐ 4 - 10 ☐ > 10
- **Age (yrs):** ☑ Immature (<5) ☐ Established (5-30) ☐ Mature (>30)

Aquatic & Instream Vegetation

- **Type** (Table 8): 1
- **Reach Coverage %:** 25
- **Woody Debris:** ☐ In Cutbank ☐ In Channel ☑ Not Present
- **WD Density:** ☑ Low ☐ Mod ☐ High
- **WDJ/50m:** 0

Water Quality

- **Odour** (Table 16): 1
- **Turbidity** (Table 17): 1

Channel Characteristics

- **Sinuosity Type** (Table 9): 1
- **Gradient** (Table 11): 1
- **Entrenchment** (Table 13): 1
- **Down's Model** (Table 15): 5
- **Sed Sorting** (Table 20): WS
- **Transport Mode** (Table 21): 3
- **Geomorphic Units** (Table 22): 8
- **Riffle-Pool Spacing (m):** /
- **Sinuosity Degree** (Table 10): 1
- **# of Channels** (Table 12): 1
- **Bank Failure** (Table 14): 1
- **Bankfull Indicators** (Table 18): 3/5
- **Sediment Transport Observed?** ☐ Yes ☑ No ☐ Not Visible
- **% of Bed Active:** 0
- **Mass Movement** (Table 23): /
- **% Riffles:** 0 **% Pools:** <5
- **Bank Angle:** ☐ 0 – 30 ☐ 30 – 60 ☐ 60 – 90 ☐ Undercut
- **Bank Erosion:** ☐ < 5% ☐ 5 – 30% ☐ 30 – 60% ☐ 60 – 100%

(Table 19)	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
Bank	☑	☐	☐	☐	☐	☐	☐
Riffle	☐	☐	☐	☐	☐	☐	☐
Pool	☑	☐	☐	☐	☐	☐	☐
Bed (if no riffle-pool morphology)	☑	☐	☐	☐	☐	☐	☐

Low-flow channel ~~Bankfull~~ Width (m)	0.62	0.49	0.41
Bankfull Depth (m)	0.13	0.19	0.09
Undercuts (m)	/	/	/
Pool Depth (m)	0.11	/	/
Riffle Length (m)	/	/	/

Wetted Width (m)	0.27	0.25	0.20
Wetted Depth (m)	0.05	0.05	0.03
Velocity (m/s)	/	/	/
Velocity Estimate Method	/	/	/
Meander Amplitude (m)	/	/	/

Notes:

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): ________ Checked by: SSO Completed by: NBS

Appendix G5
Detailed Geomorphological Assessment Data Summary

Detailed Geomorphological Assessment Summary

Reach N-2-C

Project Number:	PN25111	**Date:**	2025-10-16
Client:	Halton Hills Limited Partnership c/o Rice Group	**Length Surveyed (m):**	146.5
Location:	Milton, ON	**# of Cross-Sections:**	7

Reach Characteristics

Drainage Area:	401 km^2	**Dominant Riparian Vegetation Type:**	Grasses, shrubs, trees
Geology/Soils:	Clay to silt textured till	**Extent of Riparian Cover:**	continuous
Surrounding Land Use:	Agricultural, Commercial, Park, Forest	**Width of Riparian Cover:**	>10 channel widths
Valley Type:	Confined	**Age Class of Riparian Vegetation:**	Established to mature
Dominant Instream Vegetation Type:	Grasses, watercress	**Extent of Encroachment into Channel:**	Minimal
Portion of Reach with Vegetation:	~5%	**Density of Woody Debris:**	Low

Hydrology

		Estimated Bankfull Discharge (m^3/s):	0.35
Estimated Discharge (m^3/s):	0.004	**Estimated Bankfull Velocity (m/s):**	0.87

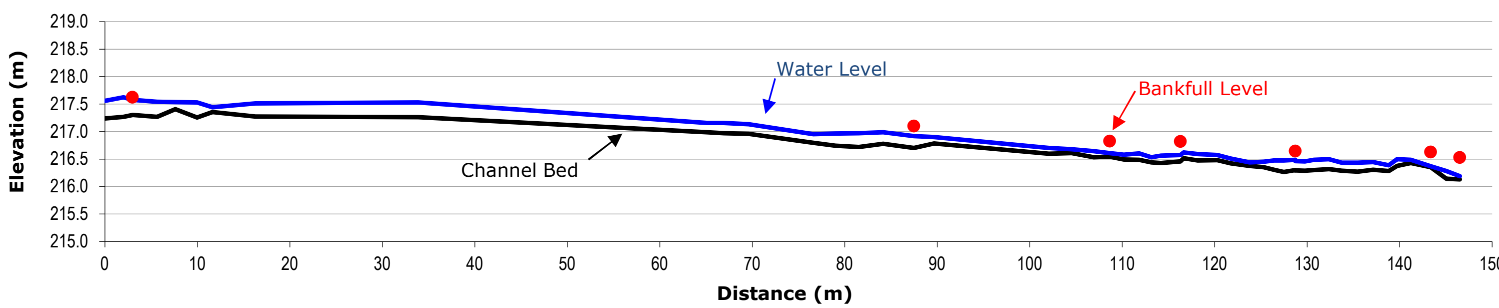
Profile Characteristics

Bankfull Gradient (%):	0.75
Channel Bed Gradient (%):	0.80
Riffle Gradient (%):	N/A
Riffle Length (m):	N/A
Riffle-Pool Spacing (m):	N/A

Planform Characteristics

Sinuosity:	1.03
Meander Belt Width (m):	Not Calculated
Meander Amplitude (m):	Not Calculated

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	0.35	0.78	0.53
Bank Angle (deg):	25	90	45
Root Depth (m):	0.30	0.30	0.30
Root Density (%):	15	70	49
Bank Undercut (m):	0.00	0.05	0.00

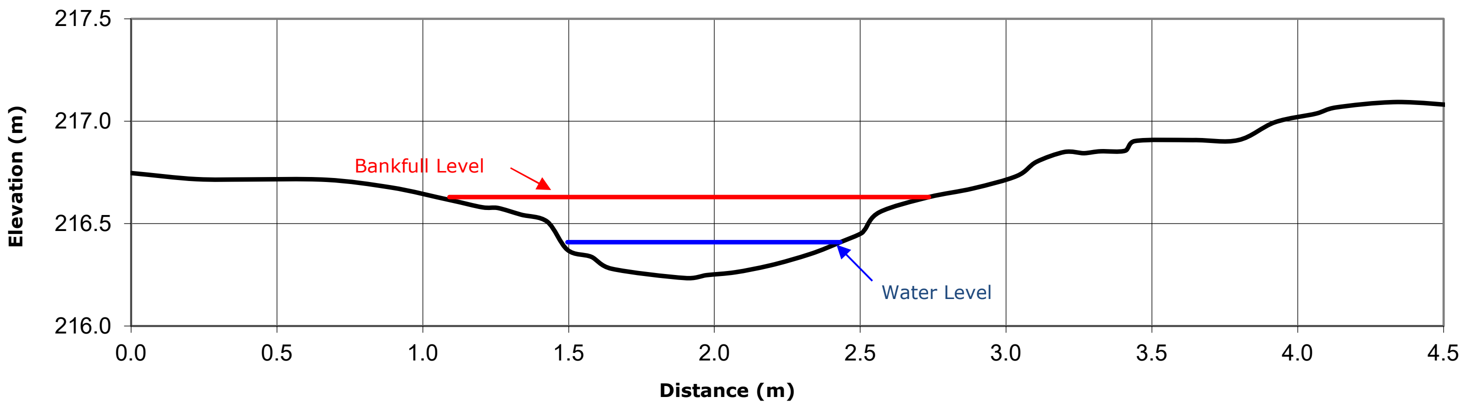
Bank Material (range): Clay to Silt Loam

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	1.35	3.32	1.90
Average Bankfull Depth (m):	0.18	0.26	0.21
Bankfull Width/Depth (m/m):	5	17	9
Wetted Width (m):	0.63	2.05	1.01
Average Water Depth (m):	0.02	0.20	0.08
Wetted Width/Depth (m/m):	9	36	17
Entrenchment Ratio (m/m):	>2.2 (Slight/Low Entrenchment)		
Maximum Water Depth (m):	0.04	0.34	0.16
Manning's *n*:		0.035	

Photograph at cross section 6 (looking downstream)

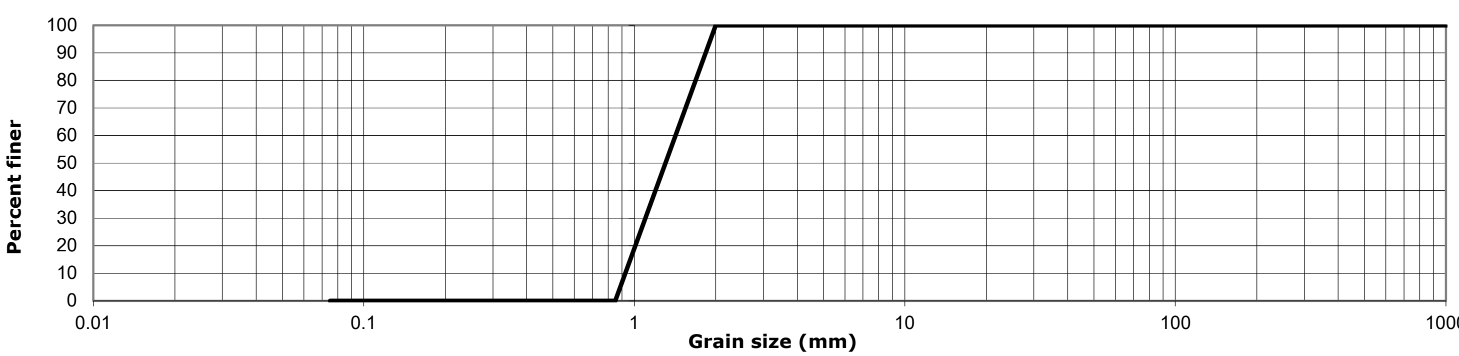
Representative Cross-Section 6



Substrate Characteristics

Particle Size (mm)		**Subpavement:**	Glacial till
D_{10} :	<2 mm	**Particle Shape:**	Sub-angular, sub-rounded
D_{50} :	<2 mm	**Embeddedness (%):**	N/A
D_{84} :	<2 mm	**Particle Range (riffle):**	N/A
		Particle Range (pool):	Clay to silt

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):			
for D_{50}:	N/A	**Tractive Force at Bankfull (N/m^2):**	N/A
for D_{84}:	N/A	**Critical Shear Stress (D_{50}) (N/m^2):**	N/A
Unit Stream Power at Bankfull (W/m^2):	13		

General Field Observations

Channel Description

The subject reach was characterized by a straight channel set within a partially confined wooded and grassy valley. Dominant riparian vegetation consisted of mature trees and established shrubs, which provided limited cover over the channel. Channel bed morphology was characterized by pool and run geomorphic units. The channel exhibited evidence of systematic widening. For example channel banks were generally vegetated with some mature roots exposed and multiple leaning/fallen trees observed. The channel also displayed multiple indicators associated with good channel health. For example the channel was characterized by a variable bed morphology (i.e., pools and runs) with diverse flow conditions and habitat refuge potential.

Long Profile - Facing Downstream

Appendix G6
Meander Belt Width and Critical Redside Dace Habitat Delineation

Legend

- Reach Break and ID
- Watercourse
- Headwater Drainage Feature
- 0.5 m Contour
- Staked Top of Bank (CH)
- Approximate Toe of Slope
- Approximate Study Area
- Meander Belt Width
- Meander Belt Width (Beyond Toe of Slope)
- 30 m Redside Dace Vegetated Riparian Area (from Meander Belt Width)
- 30 m Redside Dace Habitat Area (from Toe of Slope)

Meander Belt Width and Critical Redside Dace Habitat Delineation

9094 Regional Road 25

Halton Hills, Ontario

GEO MORPHIX™

N

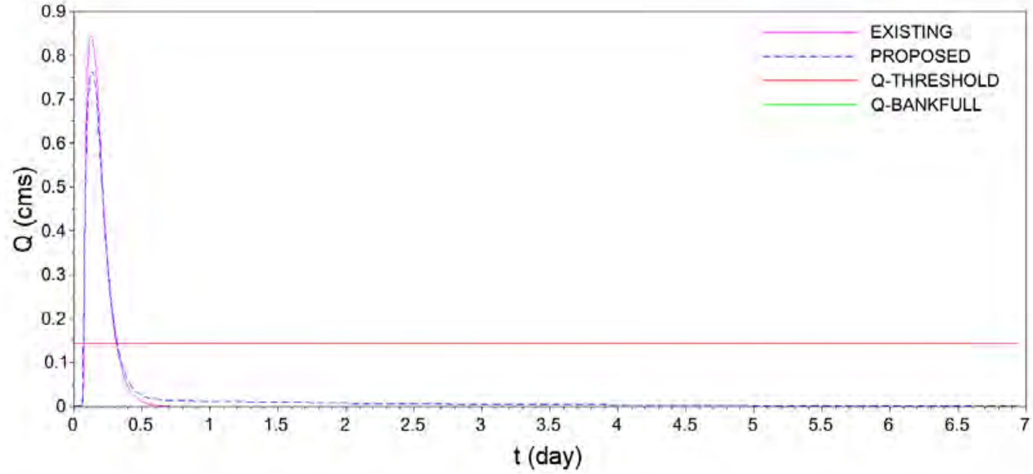
0 40 80

Metres

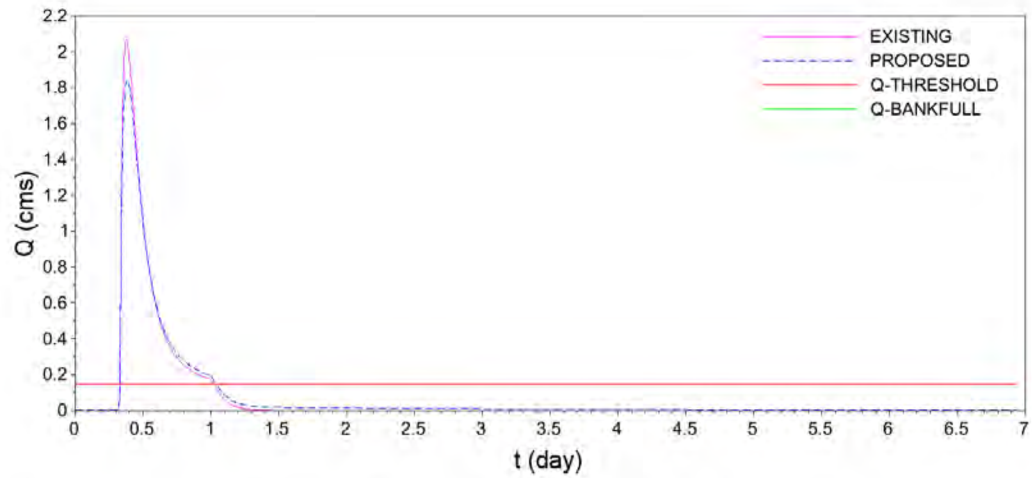
Imagery: Google Earth, 2023. MBW: GEO Morphix Ltd., 2025. Reach Break, ID and Approximate Study Area, Toe of Slope, MBW, RSD: GEO Morphix Ltd., 2025. Watercourse: MNRF, 2024.1 m Contour: Crozier, 2025. 0.5 m Contour: MNR, 2023 (LiDAR). Staked Top of Bank: Conservation Halton, 2025. Print Date: February 2026. PN25111. Drawn By: S.S.O., G.U., M.O.

Appendix G7
Hydrographs

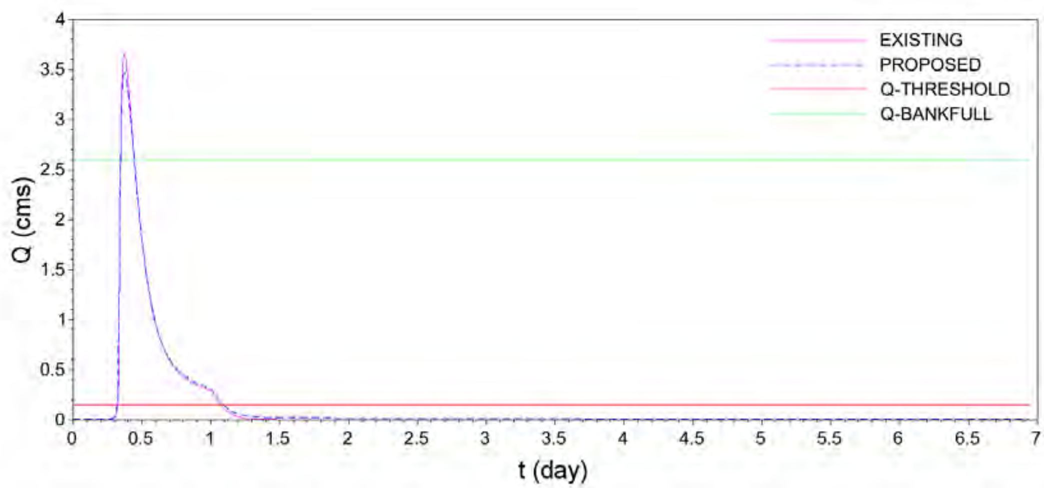
Representative Hydrographs



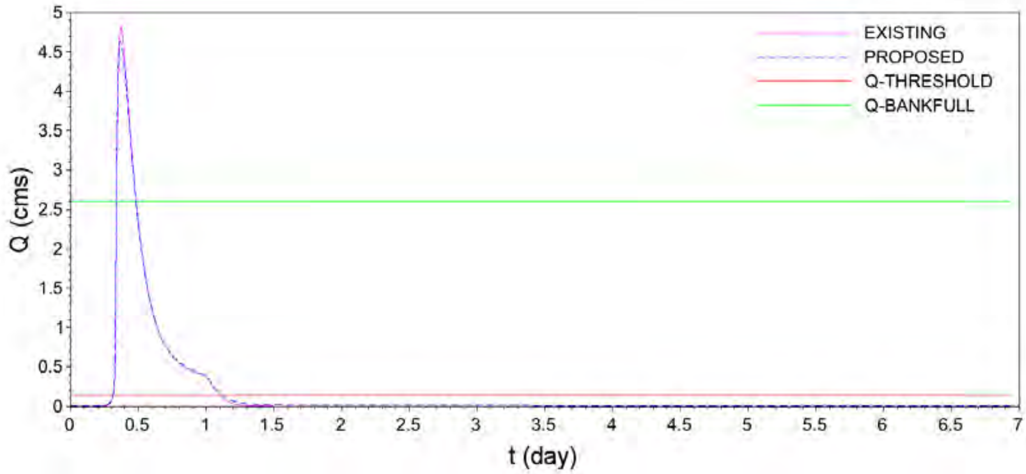
N-2-C Interim Conditions (25mm Storm Event)



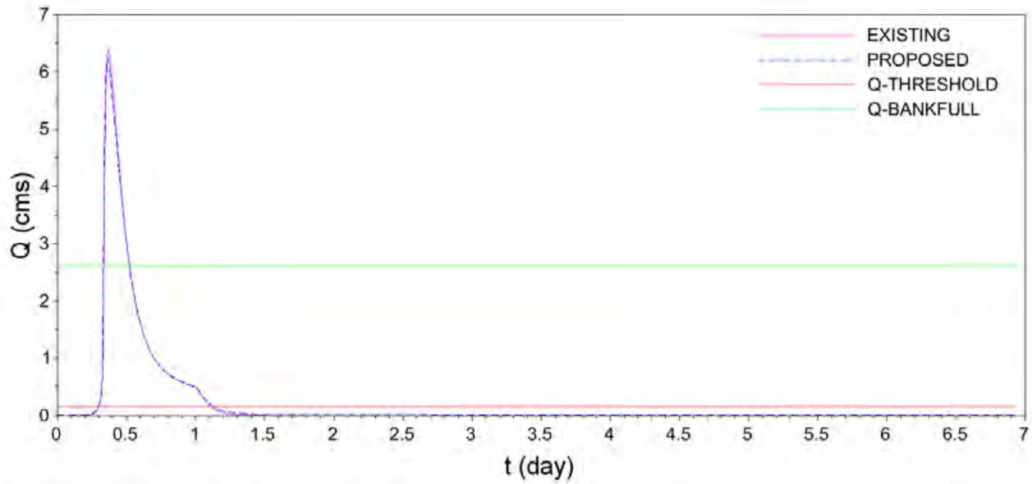
N-2-C Interim Conditions (2-year Storm Event)



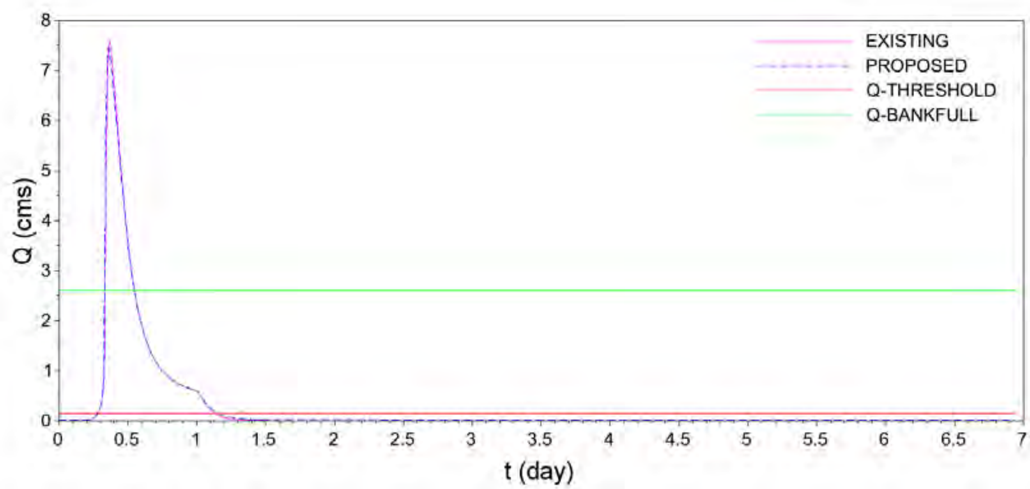
N-2-C Interim Conditions (5-year Storm Event)



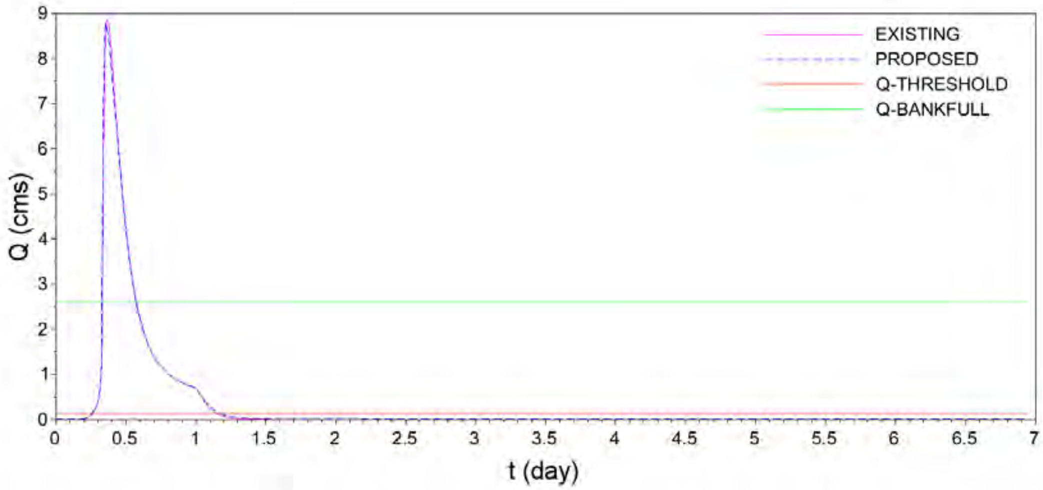
N-2-C Interim Conditions (10-year Storm Event)



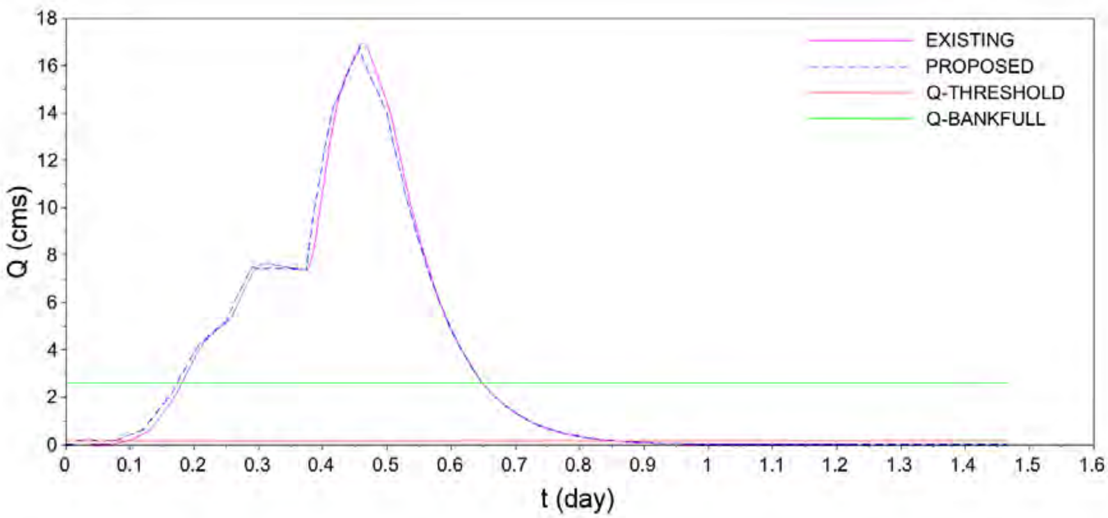
N-2-C Interim Conditions (25-year Storm Event)



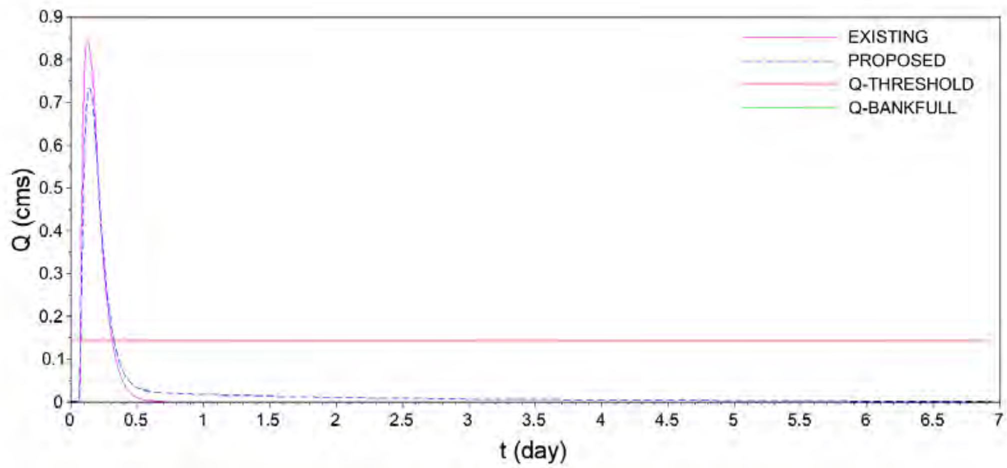
N-2-C Interim Conditions (50-year Storm Event)



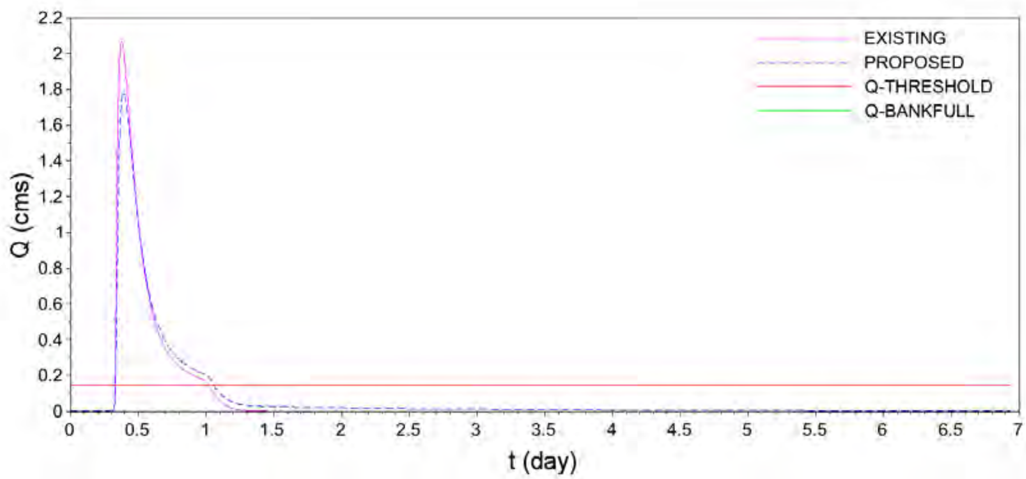
N-2-C Interim Conditions (100-year Storm Event)



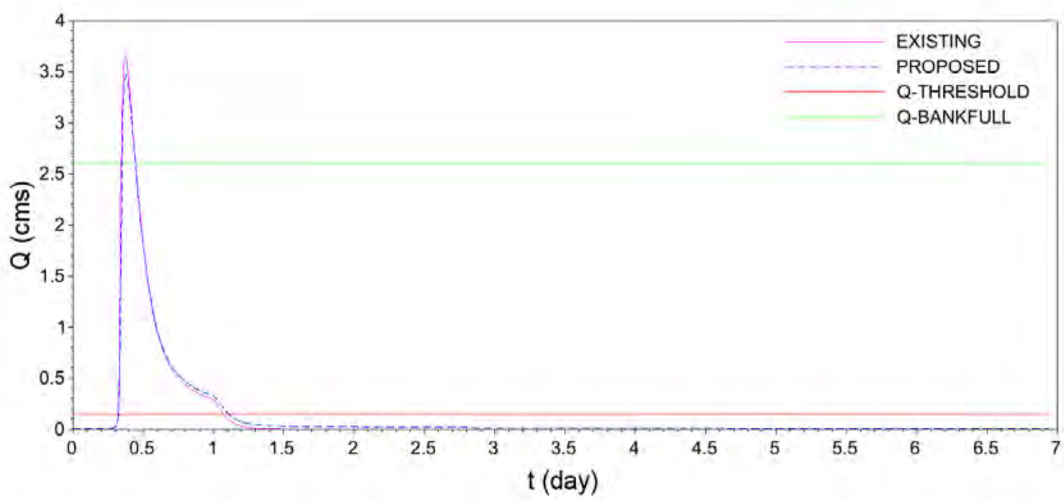
N-2-C Interim Conditions (Regional Storm Event)



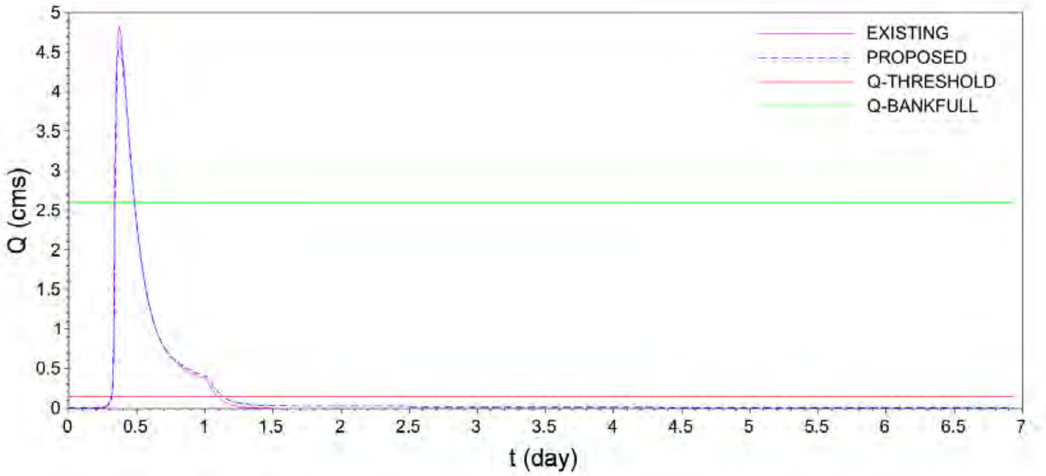
N-2-C Proposed Conditions (25mm Storm Event)



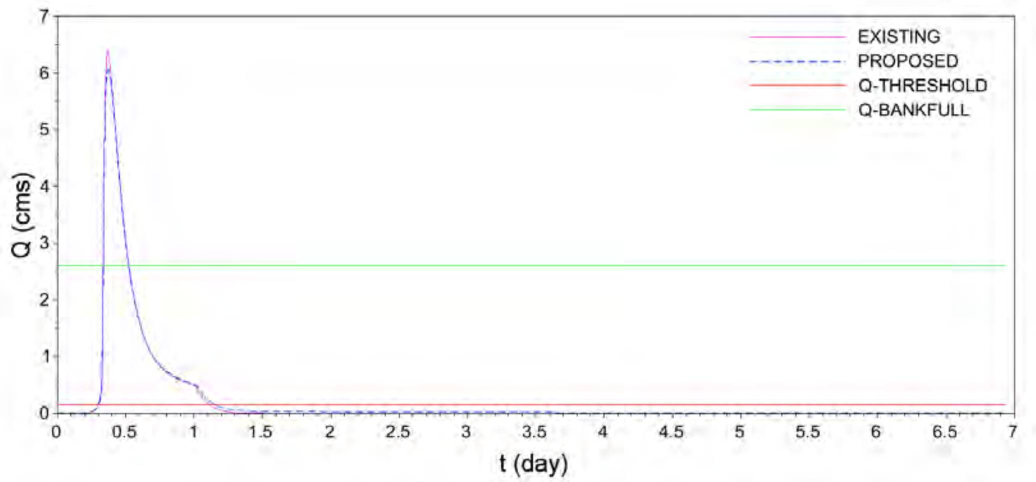
N-2-C Proposed Conditions (2-year Storm Event)



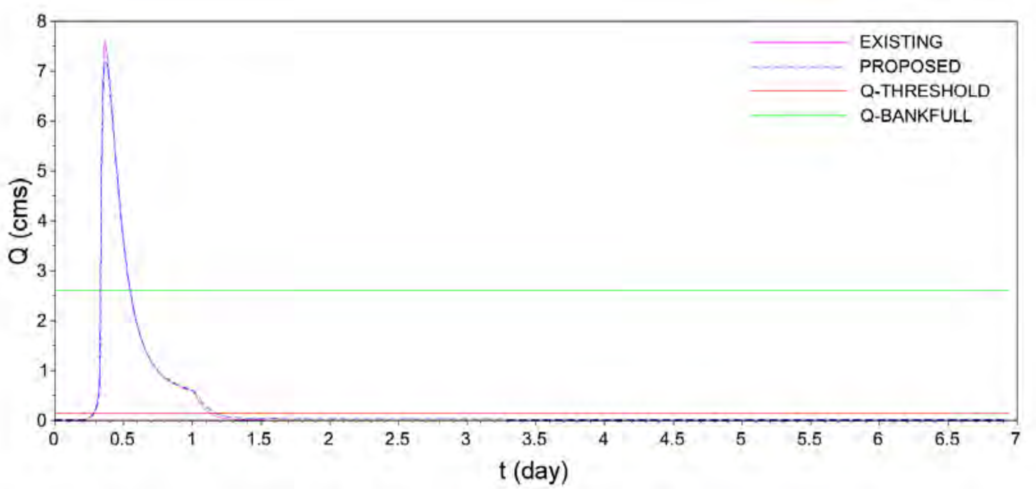
N-2-C Proposed Conditions (5-year Storm Event)



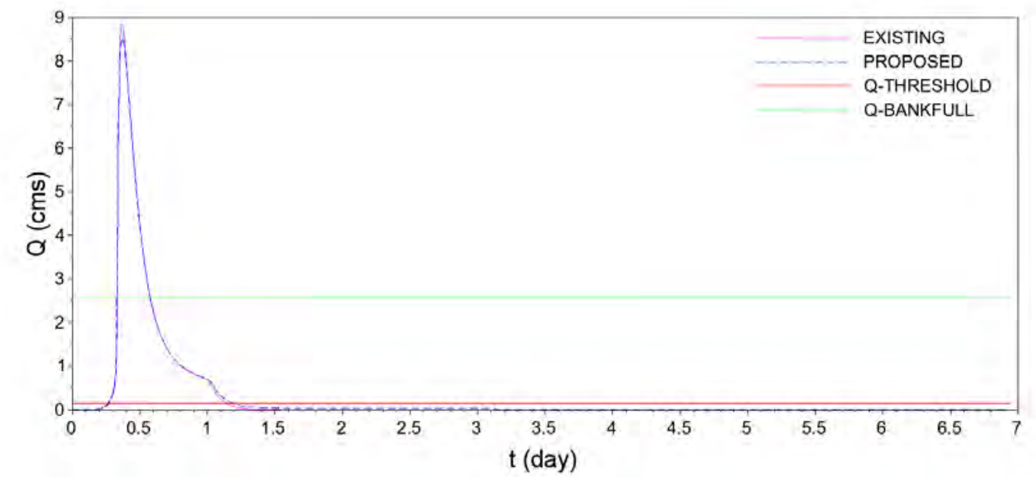
N-2-C Proposed Conditions (10-year Storm Event)



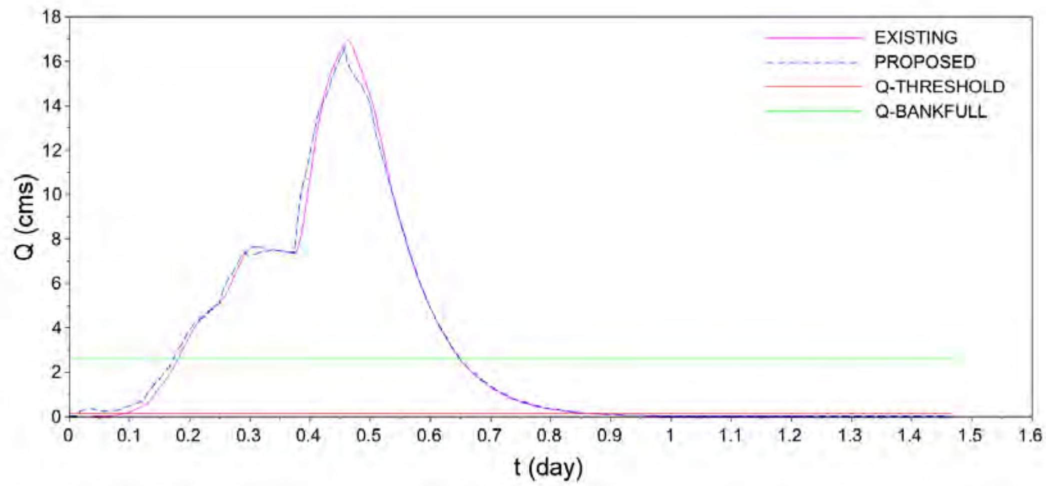
N-2-C Proposed Conditions (25-year Storm Event)



N-2-C Proposed Conditions (50-year Storm Event)



N-2-C Proposed Conditions (100-year Storm Event)



N-2-C Proposed Conditions (Regional Storm Event)