Fluvial Geomorphology Assessment and Meander Belt Width Delineation

Tributary of Boyne River

Melancthon, Ontario

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Disclaimer

This report presents professional opinions and findings of a scientific and technical nature based on the knowledge and information available at the time of preparation. This document is prepared solely for the Client, and the later interpretations, suggestions, recommendations, and opinions expressed in the report pertaining only to the Project being completed for the Client.

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1 Introduction

GEO Morphix Ltd. (GEO Morphix) was retained to complete a fluvial geomorphology assessment for a tributary of Boyne River in support of a proposed development site at 476420 3rd Line, in Melancthon, Ontario (herein referred to as the "subject property" and shown in **Appendix A**). The objective of the assessment is to support the delineation of erosion hazard limits for the subject watercourse. The results of the assessment will be used to support the planning and design of site development activities.

It is understood that the Nottawasaga Valley Conservation Authority (NVCA) requested the completion of a meander belt width assessment to inform the developable limit within the property. The following tasks were completed to address the objectives of the assessment:

- Review available study reports and data records for the site (including watershed/subwatershed studies, geology, historical aerials, and topography) to assist in the general characterization of channel and watershed conditions for the subject watercourse, as well as to guide the field studies
- Complete rapid geomorphic field assessments at the subject watercourse to further characterize existing channel conditions, with a plan to use standard, industry-accepted tools such as the rapid geomorphic assessment (RGA) and rapid stream assessment technique (RSAT) to evaluate existing instream and riparian conditions (i.e., evidence of ongoing channel processes, active erosion/deposition, or potential channel/slope instability)
- Delineate the meander belt width and erosion hazard for the subject watercourse based on the results of the desktop analyses, field assessments, and, if required, empirical modelling approaches

2 Background Review and Desktop Assessment

2.1 Subwatershed

The subject property is situated within the Boyne River Subwatershed. This subwatershed generally flows west to east through a gently rolling landscape, ultimately draining into the Nottawasaga River, east of Alliston, Ontario. The subject property is among the headwaters of Boyne River, which are marked by wetlands and agricultural drains (Nottawasaga Valley Conservation Authority, 2023). The subject watercourse enters the western limits of the subject property and flows into a pond. Immediately downstream of the pond, the watercourse transitions into the McKibbon Drain, which flows northeasterly to exit the subject property, and cross 3rd Line.

2.2 Surficial Geology and Physiology

Surficial geology and physiography mapping was reviewed to assess the geologic and biophysical controls on channel morphology, recognizing that surficial geology and physiography function as constraints to channel development and tendency. These factors determine the nature and quantity of the availability and type of sediment. Secondary variables that affect the channel include land use and riparian vegetation. These factors are explored as they not only offer insight into existing conditions, but also potential changes that could be expected in the future as they relate to a proposed activity.

The subject property is situated within the Dundalk Till plain physiographic region and the Kame Moraines physiographic landform. The Dundalk Till plain region commonly has <2 feet of surficial silt deposits found at the surface (Chapman and Putnam, 2007). Published surficial geology mapping indicates that the subject lands are dominated by ice-contact stratified deposits comprised of sand, gravel, minor silt, clay, and till to the north, whereas till deposits comprised of clay to silt-textured till derived from glaciolacustrine deposits or shale, are present in a small area in the southeast of the subject property (OGS, 2010).

2.3 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. Specifically, aerial photographs and satellite images from 1938 (1:20,000), 1969 (1:35,000), 1981 (1:50,000), and 1995 (1:50,000) were retrieved from the National Air Photo Library (NAPL), while satellite imagery for 2010 was retrieved from the Southwestern Ontario Orthophotography Project, 2014 and 2019 imagery were obtained from Google Earth Pro, and 2023 imagery was retrieved from Dufferin County. The review and assessment of this information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. Historical aerial photographs are provided in **Appendix B** for reference.

In 1938, the subject property and surrounding areas were primarily used for agricultural purposes, with scattered woodlots and wetlands throughout. The channel enters the western limits of the study area with a natural meandering channel planform and mature riparian corridor for approximately 250 m before transitioning into a straightened agricultural drain (McKibbon Drain) that flows north-east for approximately 670 m before existing the subject property. No development or residential dwellings appear to be situated within the subject property.

Between 1938 and 1969 little to no surrounding land use changes are noted. The forested area within the subject property appears to have matured and become denser. Within the subject property, an online pond appears between the transitioning zone where the natural tributary of Boyne River meets the McKibbon Drain. At the downstream extent of the pond, a road crossing was constructed, which is connected to the 3rd Line. Channel planform appears to be maintained with meandering upstream of the pond, and a straight planform downstream of the pond. Riparian vegetation matures throughout the entire subject property.

Through to 1995, Chipwoods Park is constructed within the subject property. The subject property is almost entirely covered in forest between 1969 and 1981. During this time frame, a dam is constructed east of 3rd Line. Between 1981 and 1995, a small offline pond is constructed on site, north of Chipwoods lane, west of 3rd Line. No changes to channel planform are evident due to the heavy tree cover. The riparian vegetation corridor is enlarged due to the increase in forested area within the property. In the northeastern portion of the subject property, the vegetation appears to transition to wetland conditions based on the present riparian vegetation. Although, this is difficult to confirm with black-and-white imagery.

By 2010, riparian vegetation in the northeast portion of the subject property was confirmed to be primarily wetland, while the southwest portion remained forested. McKibbon Drain is evident in the aerial image and continues to exhibit a straightened channel planform. Upstream of the online pond, the channel is still not visible due to heavy tree cover. In general, no major changes in land cover are noted for the surrounding areas. Between 2010 and 2023, little to no changes are present within the subject property or surrounding areas. This includes little to no changes in channel planform or riparian vegetation and corridor.

3 Watercourse 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 that is at least slightly different from adjoining reaches. This method allows for a meaningful characterization of a watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.

Channel reaches are delineated based on changes in channel planform, channel gradient, physiography; land cover (land use or vegetation); flow, due to tributary inputs; soil type and surficial geology; and certain types of channel modifications by humans.

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

Five channel reaches were delineated within the subject property, described herein as **Reaches TBR-1**, **Reach TBR-2**, **Reach TBR-3**, **Reach TBR-4**, and **Reach TBR-5**. The channel on the subject property begins approximately at the southwest corner of the property, with **Reach TBR-1**. The unconfined channel flows generally northeast through the Chipwoods trailer park, and then through a mix of forested and grassed vegetation, and then is conveyed via CSP beneath 3 Line, Melancthon. Reach delineation mapping is provided in **Appendix A**.

3.2 General Reach Observations

Field investigations were completed along **Reaches TBR-1**, **Reach TBR-2**, **Reach TBR-3**, **Reach TBR-4**, and **Reach TBR-5** on July 23, 2024, and included the following:

- Descriptions of riparian conditions
- Estimates of bankfull channel dimensions
- Determination of bed and bank material composition and structure
- Observations of erosion, scour, or deposition
- Collection of photographs to document the watercourses, riparian areas and/or valley, surrounding land use, and channel disturbances such as crossing structures

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

Table 1. Summary of General Reach Characteristics

Reach Name	Average Bankfull Width (m)	Average Bankfull Depth (m)	Riffle Substrate	Pool Substrate	Bank Material	Dominant Riparian Condition	Notes
TBR-1	Geometries inconsistent due to backwater effect from downstream pond (**TBR-2**)*		No riffles observed	Clay/silt	Clay/silt	Moderately encroaching Grasses, shrubs and herbaceous vegetation with mature trees beyond	Loamy and saturated bed and bank substrate; wet floodplain area; backwatering condition from TBR-2 pond
TBR-2	Pond						
TBR-3	2.52	0.23	Sand, gravel, cobble	Clay/silt	Clay/silt	Grasses and mature trees extending 4-10 channel widths, not encroaching	Trailer Park residences adjacent, foot bridge crossings
TBR-4	2.66	0.71	Cobble	Clay/silt, sand	Clay/silt	Mature trees (forest) extending >10 channel widths, not encroaching	Many exposed tree roots, iron staining on channel substrate
TBR-5	0.66	0.25	No riffles observed	Clay/silt, sand	Clay/silt, sand, gravel	Grasses extending >10 channel widths with heavy channel encroachment	Evidence of groundwater from iron staining on bed

** Geometries for **TBR-1** are unreliable due to backwater effect from downstream pond*

In general, the channel at **Reach TBR-1** was unconfined and had defined, regular meanders through a wide, flat, saturated area of loamy soil with grassy and herbaceous riparian vegetation, bordered by cedar forest (>30-year-old trees), with trailer park residences beyond. Rooted emergent vegetation grew within the stream, covering about 20% of the reach. Watercress was also observed. Bed material sorting was good, with both the bed and bank materials being clay/silt. Bed material was loose, and sediment depth was measured to be 0.44 m deep in one instance. Channel morphology was comprised of runs and pools; no riffles were observed. The channel was stable, with no signs of erosion or undercutting. The channel was heavily impacted by backwater conditions because of the downstream pond. At the downstream extent of the reach, the channel opened into a pond, comprising **Reach TBR-2**, which showed heavy sedimentation and no evidence of erosion along the margines. The pond outlets downstream of a gravel road through a CSP of diameter 0.46 m, and which is elevated 0.61 m, marking the beginning of **Reach TBR-3**. The scour pool created by this culvert was 0.52 m deep.

Reach TBR-3 was an unconfined, low gradient channel of irregular meanders set within a mature cedar forest interspersed with trailer park residences and grassy riparian vegetation. Riparian vegetation extended an average of 4-10 channel widths. Instream vegetation covered only 2% of the reach and consisted of rooted emergent vegetation. Some watercress was identified. Channel bed material differed between riffles and pools, with riffles ranging sand to cobble, and pools containing mainly silt/clay, however bed morphology was primarily runs, with sand to gravel sized material. Banks were made of silt/clay with angles mostly 30-60 degrees. The reach exhibited erosion along 5-30% of its length. Only one location showed undercutting, with a measurement of 0.19 m at maximum. Notably, several small wooden foot bridges crossed the stream (a total of four at the time of assessment). One of which – a larger older one – showed some exposed bridge footings, which may be attributed to its construction rather than bank erosion. At the downstream extent of the reach, extensive channel alteration was observed as it was evident that an artificial pond was created by building a dam (of soil and reinforced with wood and U-posts). A gazebo was placed adjacent to the pond, and several fish were observed. Flows are conveyed by a CSP measuring 0.73 m in diameter and was elevated 0.46 m on the downstream side. The man-made dam marks the reach break between reaches **TBR-3** and **TBR-4**.

At the initiation of **Reach TBR-4**, extensive erosion was noted at the CSP outfall. The scour pool measured 0.34 m deep and was bordered by undercut banks (measuring 0.26 m) and exposed roots. From here the reach was relatively straight (i.e., low sinuosity with the occasional, irregular meander) and unconfined. Riparian vegetation became a mature, continuous, cedar forest extending >10 channel widths. No instream vegetation was observed. Average wetted width was 1.59 m, average wetted depth was 0.07 m. The reach primarily showed riffle and run morphology, however, pools, riffles, and runs were all observed and displayed different bed substrate. Grain size for pools was comprised of clay/silt, and sand, riffles were primarily cobbles and runs (non-riffle or pool) ranged from clay/silt to cobble. Banks were made of clay/silt, with angles of 30-60 degrees. 30 to 60% of the bank network showed signs of erosion. Older leaning and fallen trees were frequent throughout the reach, with some instream woody debris present in the channel, however only two woody debris jams were observed (over the span of approximately 180 metres). Some iron staining on bed substrate possibly indicate the presence of groundwater.

Reach TBR-5 begins at the edge of the cedar forest where the canopy opens and riparian vegetation becomes mixed, with the amount of grasses increasing moving downstream. Vegetation was comprised of a mixture of trees, shrubs, herbaceous vegetation, and primarily grasses. Rooted emergent instream vegetation was observed and covered approximately 10% of the reach. The reach was sinuous with some irregular meanders. Channel morphology was comprised of runs with some pools. Measured wetted width averaged 0.78 m, and wetted depth averaged 0.16 m, with pools as deep as 0.57 m. Both bed and bank substrate ranged from clay/silt to gravel. Due to the low bank heights, and flat meadow-type land use, the surrounding ground showed saturation and some seepage and functioned like a wetland in areas. The banks were 60-90 degrees with undercutting occurring below water level for much of the reach, measuring usually

about 0.2 m. Groundwater indicators such as watercress, seepage, and iron staining were all observed.

3.3 Rapid Geomorphological Assessment Tools

Rapid assessments were completed to identify dominant geomorphic processes, document stream health, and to 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 by employed to provide a broader view of the system as it considers the ecological function of the 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 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.

The results of these assessments are summarized in **Table 2** below.

Table 2. Summary of Rapid Assessment Results

Reach	RGA (MOE, 2003)			RSAT (Galli, 1996)			Downs Channel Evolution Model (1995)	River Styles Framework
	Score	Condition	Dominant Systematic Adjustment	Score	Condition	Limiting Feature(s)		
TBR-1	0.067	In Regime	Evidence of widening and Aggradation	34	Good	Riparian Habitat Condition	S - Stable	Meandering
TBR-2	Pond*							
TBR-3	0.203	In Regime	Evidence of Degradation	37	Excellent	Riparian Habitat Condition	S - Stable	Straight
TBR-4	0.381	In Transition	Evidence of Widening	29	Good	Channel Stability	M – Lateral Migration	Straight
TBR-5	0.127	In Regime	Evidence of Widening	34	Good	Riparian habitat Condition	U - Undercutting	Straight

**Note, rapids assessments are designed to assess channel stability for large alluvial systems. Ponds typically lack dynamic flow and channel characteristics that RGA/RSATs are designed to assess. Therefore, Reach TBR-2 (the online pond) was not eligible for a rapid assessment.*

An RGA score of 0.067 was determined for **Reach TBR-1**, indicating the reach is in a regime with aggradation as the dominant process of adjustment. Siltation was found in the pools along this reach. The RSAT score was 34, indicating that the reach was in good health overall. The riparian area was predominantly wooded with localized gaps, along with moderate canopy coverage made riparian habitat conditions the limiting factor for this reach. **Reach TBR-1** was classified as stable based on Downs (1995) classification and exhibited a meandering river style framework.

Reach TBR-3 was assigned an RGA score of 0.203, indicating the reach is in transition, with degradation as the dominant process of adjustment. This is evidenced by exposed bridge footings, elevated storm sewer outfalls, and scour pools downstream of the storm sewer outlets. An RSAT score of 37 was determined, indicating that this reach was in excellent health. The limiting factor for **Reach TBR-3** was a wide forested riparian buffer that is predominantly mature trees. This reach was classified as stable based on Downs (1995) classification and exhibited a straight river style framework.

Reach TBR-4 was determined to have an RGA score of 0.381, indicating the reach was in transition with evidence of widening as the dominant process of adjustment. Fallen and leaning trees were noted, along with exposed tree roots, large organic debris, and basal scour along more than 50% of the reach. The RSAT score was 29 for **Reach TBR-4**, indicating the reach was in good health. The limiting feature was channel stability, indicated by fallen trees, exposed roots, highly erodible bottom bank material with areas of unstable banks. The reach was classified as lateral migration based on Downs (1995) classification and exhibited a straight river style framework.

An RGA score of 0.127 was assigned to **Reach TBR-5**, indicating the reach was in regime, with evidence of widening as the dominant process of adjustment. Large organic debris, along with basal scour along >50% of the reach indicated the widening process. An RSAT score of 34 was determined for **Reach TBR-5**, indicating that the reach was in good health. The limiting feature was riparian habitat due to low canopy coverage. The reach was classified as undercutting based on Downs (1995) classification and exhibited a straight river style framework.

4 Erosion Hazard Assessment

Most watercourses in southern Ontario have a natural tendency to develop and maintain a meandering planform, provided that 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., valley not apparent) or with valley walls that are positioned at a sufficient distance where the channel cannot reasonably be expected to contact as a result of migration. In this type of setting, a meander belt width assessment is used to estimate the lateral extent that a channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential erosion hazard to a feature or proposed activity in vicinity of a watercourse.

Confined systems, in contrast, are those where a watercourse is contained within a defined valley where meander bend migration may be constrained by valley walls. In this setting, a 100-year migration rate or a toe erosion allowance is provided, in conjunction to a slope stability assessment provided by a geotechnical engineer, to estimate the lateral extent a channel could occupy in the future. This type of erosion hazard application is only applied to where the channel is positioned within 15 m of the valley slope toe. The erosion hazard is defined by the toe erosion allowance, stable slope allowance, and erosion access allowance.

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. Where the channel is positioned within 15 m of the valley slope toe, the erosion hazard is defined by the toe erosion allowance, stable slope allowance, and erosion access allowance. Where the channel is positioned greater than 15 m of the valley slope toe, the erosion hazard can be defined by the meander belt width, as well as the stable slope allowance and erosion access allowance.

Within the subject property, all reaches that require an erosion hazard assessment (**Reaches TBR-1, TBR-3, TBR-4**, and **TBR-5**) were characterized as unconfined. **Reach TBR-2** (pond feature) was delineated for map completeness. Due to the depositional nature of this pond feature and the lack of erosion along the pond margins, no erosion hazard is required.

4.1 Meander Belt Width Delineation

The conventional method to estimate a meander belt width relies on a series of georeferenced or orthorectified aerial imagery to complete a historical aerial overlay analysis. The channel's meander belt axis is initially determined on a reach-by-reach basis, and the lateral limits of the meander belt, as defined by the channel's maximum meander amplitude and an appropriate factor of safety, is then used to delineate the meander belt.

As identified in **Section 2.3**, the tributary of Boyne River and the McKibbon Drain are surrounded and covered by heavy vegetation and mature trees, making it difficult to review the channel planform. Therefore, a historical aerial overlay analysis could not be completed to delineate channel migration and determine the meander belt within the subject property. To supplement the conventional method, a suite of empirical equations was used to calculate the meander belt width for the unconfined portion of the subject reaches. These models are scientifically defensible and have been verified in past projects as suitable for use in southern Ontario. Average bankfull channel dimensions measured during field reconnaissance were used to inform both the Williams (1986) and Ward et al. (2002) channel width models.

The relevant empirical equations/models are summarized below, noting that a summary of the results is provided in Error! Reference source not found.

The empirical relations from Williams (1986) are described as follows and were modified to include channel width:

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

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

where *Bw* is meander belt width (m), *A* is bankfull cross-sectional area (m^2), and *Wb* is bankfull channel width (m), with the understanding that a 20% buffer, or factor of safety, was applied to the computed belt widths to address issues of under prediction.

The Ward et al. (2002) drainage area models are outlined as:

$$B_w = 120DA^{0.43} \quad \text{[Eq. 3]}$$

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. The TRCA (2004) empirical model is described as follows:

$$B_w = -14.827 + 8.319\ln(\rho gQS * DA) \quad \text{[Eq. 4]}$$

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), noting that:

- The TRCA meander belt width values were determined using drainage areas provided by the Ontario Watershed Information Tool
- 2-year discharge was calculated using the Index Flood Method (Moin & Shaw, 1985) as documented in the User Guide for the Ontario Flow Assessment Tool (OFAT) (MNR, 2020)
- The channel slope was calculated using publicly available LiDAR data provided by the Ministry of Natural Resources (2022)
- One standard error was added to the calculated belt width following TRCA (2004) guidelines, where no change in hydrologic regime is anticipated

Table 3. Summary of Meander Belt Width Estimates

Meander Belt Width (m)					
Reach	Williams (1986) Channel Area*	Williams (1986) Channel Width*	Ward et al. (2002) Drainage Area	TRCA (2004)**	Recommended MBW
TBR-1	N/A	N/A	20.0	N/A	20
TBR-3	18.0	17.5	20.5	15.5	20
TBR-4	19.0	18.5	21.5	16.0	20
TBR-5	7.5	4.0	28	18.0	20

** Includes a 20% factor of safety*
***Includes 1 standard error (8.63), no change in hydrologic regime anticipated*
*N/A – Williams (1986) method could not be adopted for **TBR-1** given that bankfull geometries are distorted by pond backwatering effect; TRCA method also not applicable for **TBR-1**, as a channel slope of 0% was calculated based on available topographic data*

Based on the results from the empirical modeling exercise, as displayed in **Appendix A**, a conservative meander belt width of 20 m is recommended for all reaches within the subject property. This considers that the meander belt width estimate using the Ward et al. (2002) drainage area model is suitable, as the channel has undergone historical straightening modifications, and therefore channel geometries may not reflect the natural characteristics of a given reach.

5 Summary

GEO Morphix was retained to complete a fluvial geomorphology assessment for a tributary of Boyne River in support of a proposed development site at 476420 3rd Line, in Melancthon, Ontario. The objective of the assessment was to support the delineation of the erosion hazard limits for the subject watercourse. The results of the assessment will ultimately be used to support the planning and design of site development activities.

The key results of the assessment for the tributary of Boyne River (delineated in the study as **Reaches TBR-1, TBR-2, TBR-3, TBR-4,** and **TBR-5**) are summarized as follows:

The results of the desktop assessment showed that **Reach TBR-1** was generally left unmodified, exhibiting a meandering channel planform, with a large woody riparian corridor, although significant backwater effects have occurred because of the downstream dam feature. **Reach TBR-2** was dammed between 1938 and 1969 due to the construction of Chipwoods Park. **Reaches TBR-3**, **TBR-4**, and **TBR-5** were previously modified/straightened (prior to 1938) as the McKibbon Drain and have since remained straight and stable with a marsh/wetland riparian corridor.

The results of the field assessment confirmed the following channel characteristics:

- All reaches within the subject property are identified as unconfined.
- The channel banks were comprised mostly of fine-grained sediment (clay and silt), with some sand noted downstream. In general, channel banks were vegetated with grasses throughout the entirety of the subject property, with trees as the dominant vegetation along **Reach TBR-4**.
- Minor to moderate erosion was noted along reaches that exhibited a defined bankfull channel.

- All reaches within the subject property were determined through the RGA assessment to be in regime, with the exception of **Reach TBR-4** which was determined to be in transition. Based on the RSAT assessment, all reaches were noted as in good health, with **Reach TBR-3** in excellent condition.

The results of the erosion hazard delineation showed that:

- Based on the results from the empirical modeling exercise, a meander belt width estimate of 20 m (relating to the modelled calculations from Ward et al. [2002]) was recommended for all unconfined Reaches (**Reaches TBR-1, TBR-3, TBR-4,** and **TBR-5**) within the subject property.
- Of note, **Reach TBR-2**, is an online pond, therefore not requiring an erosion hazard delineation due to the depositional nature of pond features and the lack of erosion observed on site.

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

Respectfully submitted,

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Matilda Oja, M.Sc., EPt
Geomatics / Remote Sensing Technician

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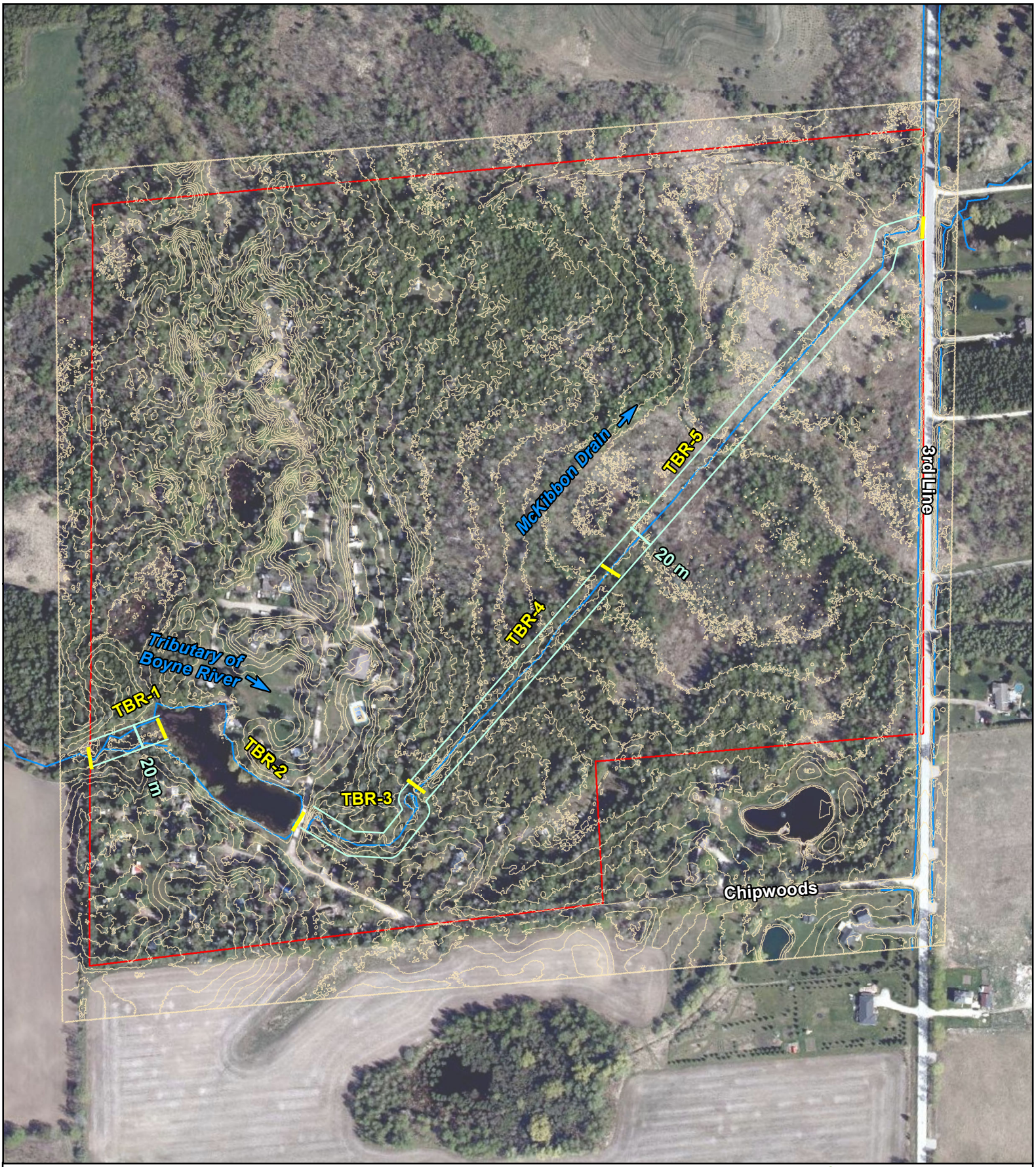
Appendix A
Study Area and Meander Belt Width Delineation



Legend

- Reach Break and Label
- Watercourse
- 0.5 m Contour
- Meander Belt Width
- Approximate Study Area

Study Area and Meander Belt Width Delineation

476420 3rd Line

Melancthon, Ontario

GEO MORPHIX™

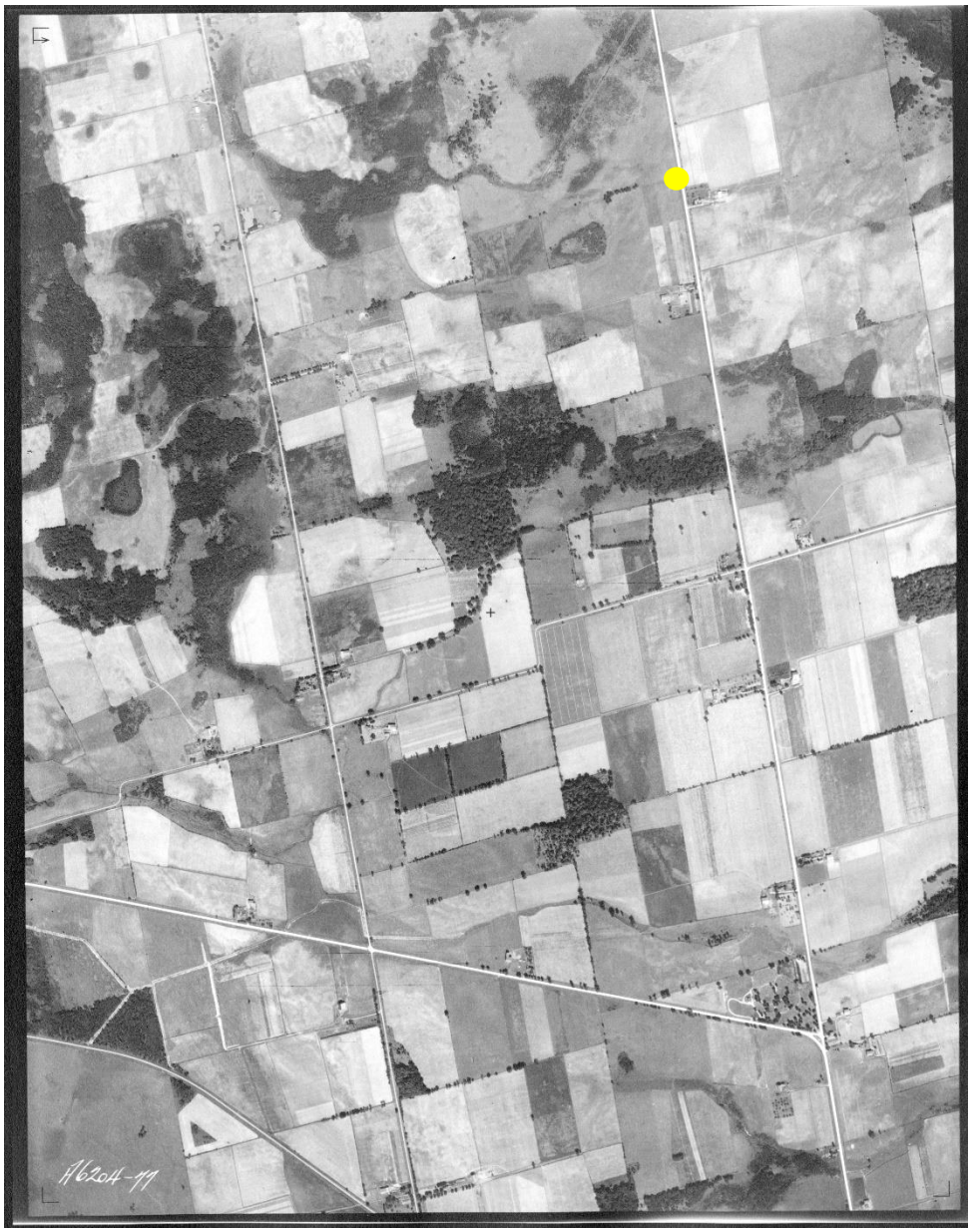
N

0 60 120

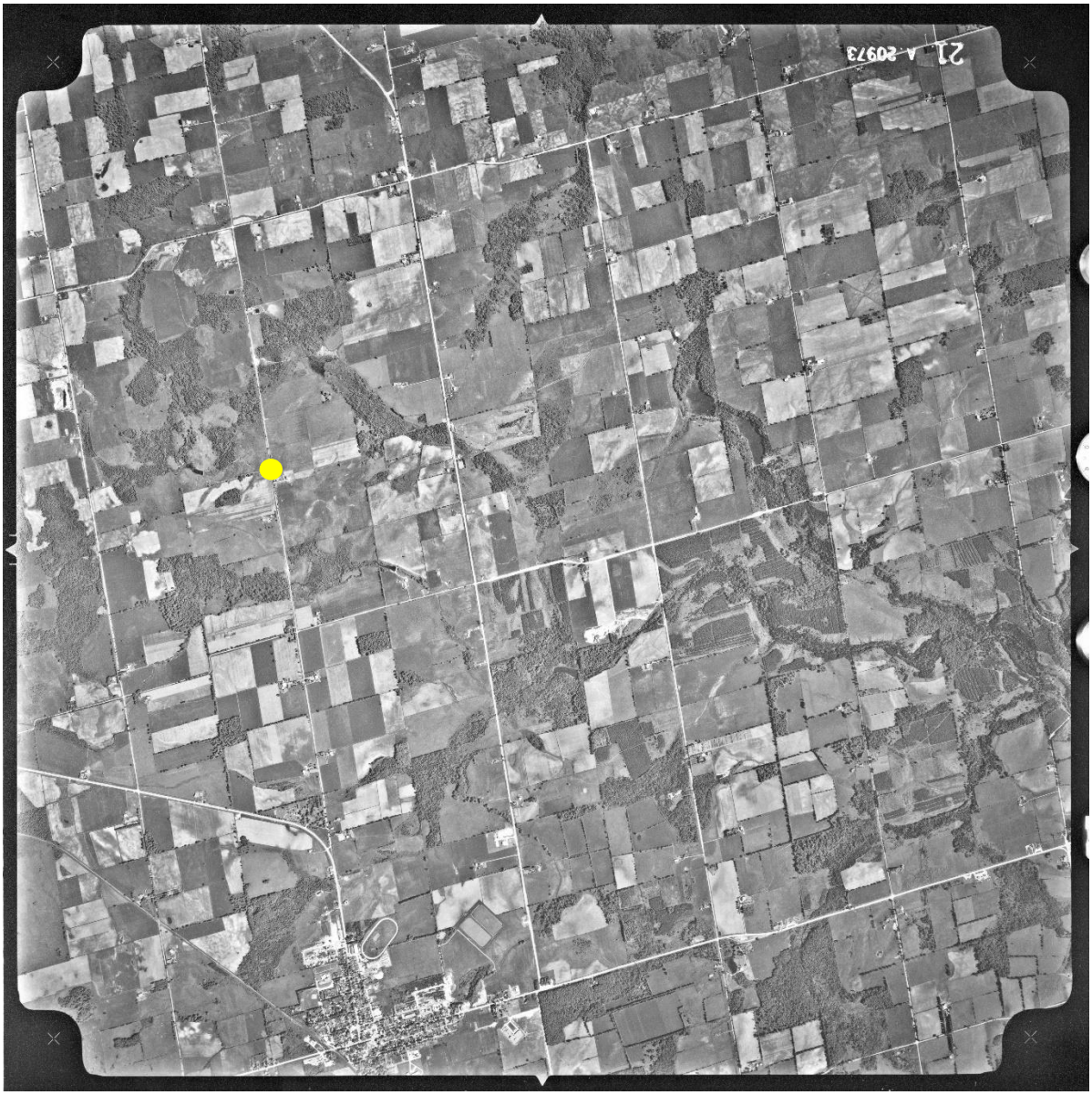
Metres

Imagery: NVCA, 2023. Watercourse: Crozier, 2024.
0.5 m Contour: MNR, 2022 (Interpolated from LiDAR).
Approximate Study Area, MBW, Reach Break and Label: GEO Morphix Ltd.
Print Date: May 2025. PN24060. Drawn By: M.O., K.W.

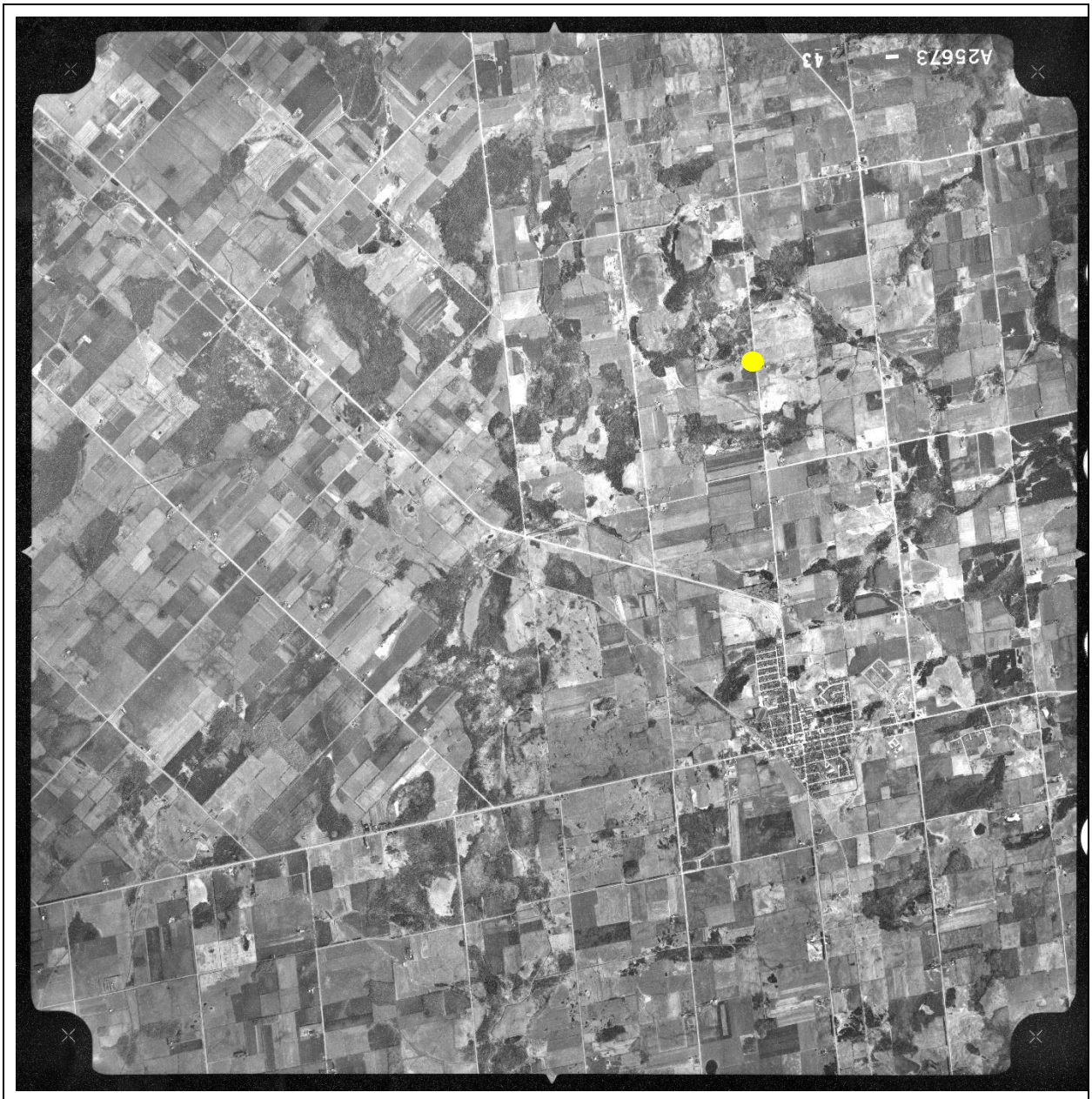
Appendix B
Historical Aerial Photographs



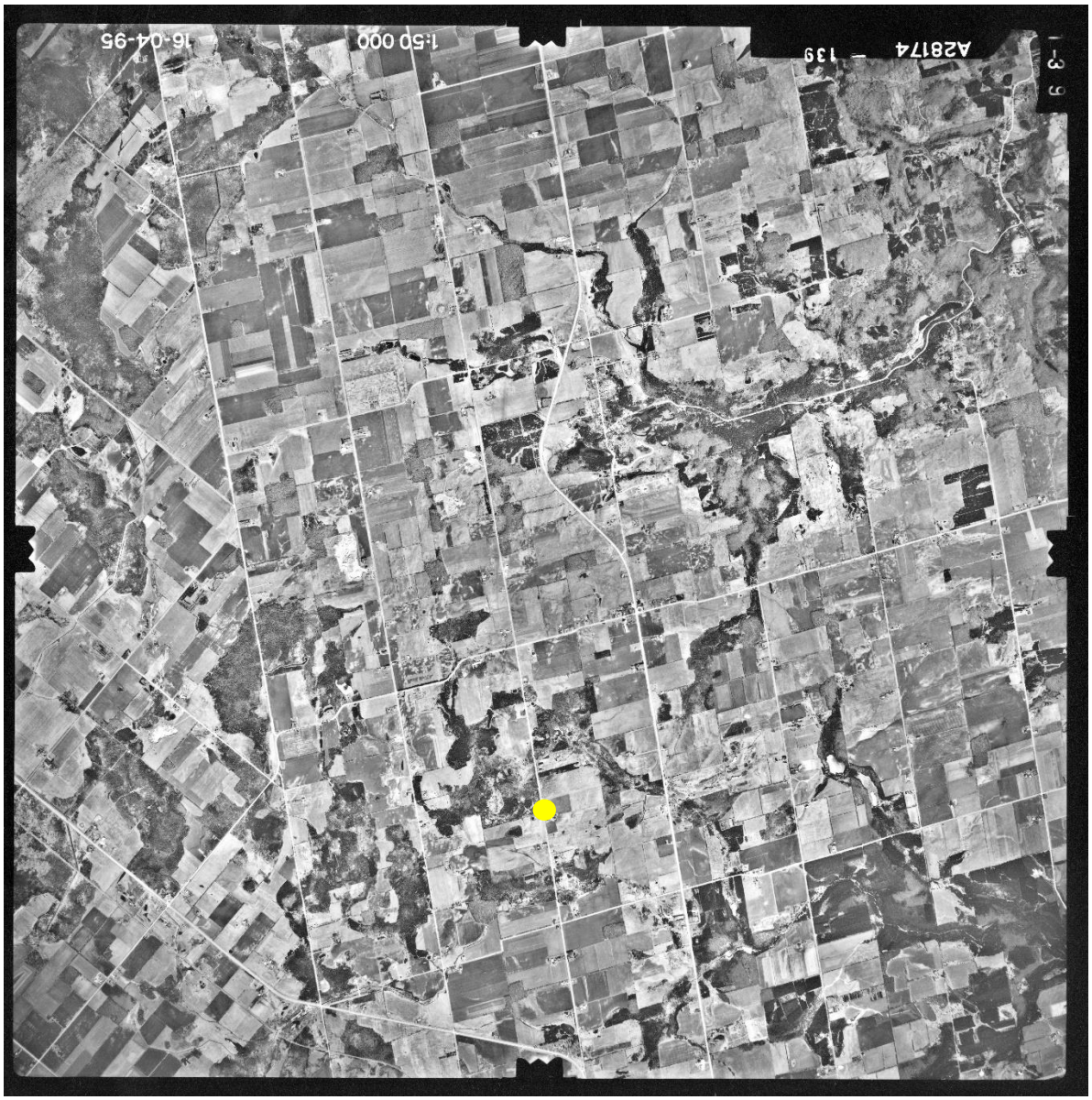
Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 1938
Scale: 1:20,000
Source: National Air Photo Library



Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 1969
Scale: 1:35,000
Source: National Air Photo Library



Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 1981
Scale: 1:50,000
Source: National Air Photo Library



Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 1995
Scale: 1:20,000
Source: National Air Photo Library

Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 2010
Scale: 20 cm
Source: Southwestern Ontario Orthophotography Project

Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 2014
Scale: Orthorectified Image
Source: Googe Earth Pro

Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 2019
Scale: Orthorectified Image
Source: Googe Earth Pro

Location: Melancthon, ON
Yellow Point: 3rd Line and Chipwoods
Year: 2023
Scale: 20 cm
Source: Dufferin County

Appendix C
Photographic Record

Photo 1
Reach TBR-1, Tributary of Boyne River, Melancthon, Ontario

Photograph taken at the upstream extent of **Reach TBR-1**. A narrow flow path observed through a wetted floodplain/corridor area. Blue arrow denotes flow direction.

Photo 2
Reach TBR-1, Tributary of Boyne River, Melancthon, Ontario

Riparian vegetation within the wetted corridor consisted of grasses, forbs and shrubs on hummocky, saturated terrain. Cedar forest bordered the corridor on both sides.

Photo 2
Reach TBR-1, Tributary of Boyne River, Melancthon, Ontario

The instream vegetation found was predominantly watercress. It covered about 20% of the reach.

Photo 3
Reach TBR-1, Tributary of Boyne River, Melancthon, Ontario

Substrate consisted of a soft/loose loamy soil (organic-rich clay and sand) with rootlets.

Photo 4
Reach TBR-1, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream at a meander bend in the flow path. Wetted surface area expands further downstream. The blue arrow denotes flow direction.

Photo 5
Reach TBR-2, Tributary of Boyne River, Melancthon, Ontario

Photo taken where **Reach TBR-1** enters a pond. This is the upstream extent of **Reach TBR-2.** The blue arrow denotes the direction of flow from the stream into the pond.

Photo 6
Reach TBR-2, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing the upstream extent of the pond. Note moderate algae growth is visible. No erosion observed along the edge of the pond.

Photo 7
Reach TBR-2, Tributary of Boyne River, Melancthon, Ontario

Photograph taken of the outlet from the pond into the downstream extent of the watercourse/drain.

Photo 8
Reach TBR-3, Tributary of Boyne River, Melancthon, Ontario

Photograph taken of the raised culvert at the upstream extent of **Reach TBR-3.** The culvert outlets into a pool with a depth of 0.52m.

Photo 9
Reach TBR-3, Tributary of Boyne River, Melancthon, Ontario

Photograph taken at the upstream extent of **Reach TBR-3,** facing downstream. The substrate ranged from sand to small cobbles.

Photo 10
Reach TBR-3, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream of a constructed bridge across the channel. Note some bank erosion is visible around the exposed bridge footings.

Photo 11
Reach TBR-3, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream, demonstrating a meander bend. The meander amplitude was 7.98 m. Note the surrounding land use at this extent was residential.

Photo 12
Reach TBR-3, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing the downstream extent of the reach, ending in an artificial pond. Note the pond drains into a culvert located at the downstream extent of the pond.

Photo 13
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph taken at the upstream extent of the **Reach TBR-4**. Note the slightly perched culvert at the pedestrian crossing.

Photo 14
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream. The substrate ranged from silt to small cobbles.

Photo 15
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph taken of the left bank, showing exposed tree roots and undercutting. The undercuts in this channel were 0.19 m on average.

Photo 16
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph showing iron staining on the cobble. Evidence of groundwater.

Photo 17
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream of a fallen tree in the channel.

Photo 18
Reach TBR-4, Tributary of Boyne River, Melancthon, Ontario

Photograph facing downstream, showing a riffle. The riffle length was 12.15m.

Photo 19
Reach TBR-5, Tributary of Boyne River, Melancthon, Ontario

Photograph taken facing downstream at the upstream extent of **Reach TBR-5.** The vegetation changes from primarily established trees to herbaceous plants.

Photo 20
Reach TBR-5, Tributary of Boyne River, Melancthon, Ontario

Photograph showing the open canopy and change in riparian vegetation along reach.

Photo 21
Reach TBR-5, Tributary of Boyne River, Melancthon, Ontario

Photograph showing evidence of groundwater. Iron staining is visible.

Photo 22
Reach TBR-5, Tributary of Boyne River, Melancthon, Ontario

Photograph taken of the culvert at the downstream extent, facing upstream toward subject property.

Appendix D
Field Observations

GEO MORPHIX™

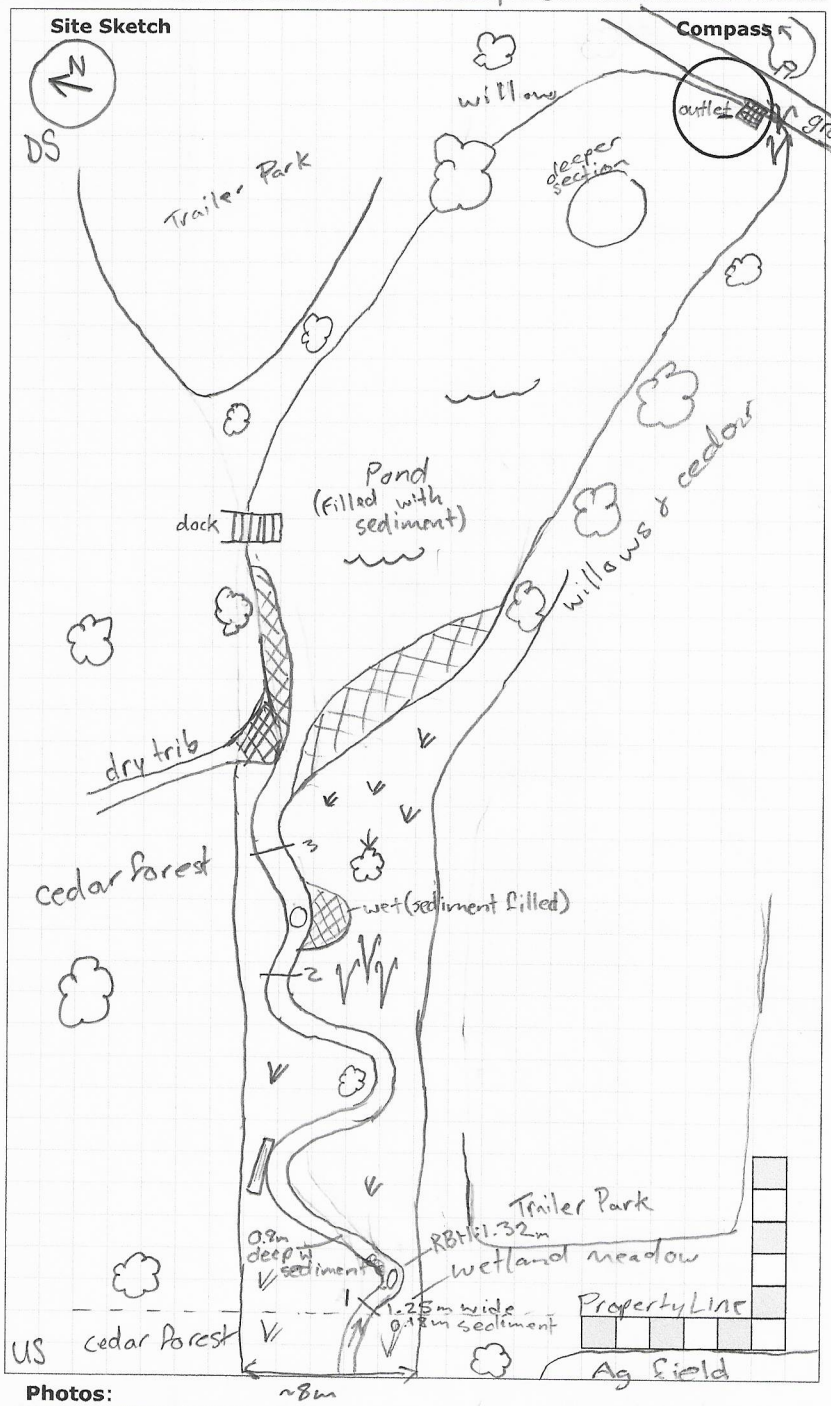
General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib of Byone River
Time:		**Reach:**	TBR-1 & TBR-2
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

Features		Monitoring	
	Reach break	-o-o-o-	Long-profile
	Station location		Monumented XS
x—x	Cross-section		Monumented photo
→	Flow direction		Monumented photo direction
~→	Riffle		Sediment sampling
	Pool		Erosion pins
	Sediment bar	8 8	Scour chains
//////	Eroded bank/slope	**Additional Symbols**	
-----	Undercut bank	watercress	
XXXXXX	Bank stabilization	cattails	
	Leaning tree		
x-x-x	Fence		
	Culvert/outfall		
	Swamp/wetland		
	Grasses		
	Tree		
	Instream log/tree		
	Woody debris		
	Beaver dam		
	Vegetated island		

Site Sketch



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

Photos:

Notes: US

Substrate: fines. Outlet of pond is metal box grate that is partially blocked/clogged with vegetation, causing a large change in water level elevation DS of the road.

GEO MORPHIX

Reach Characteristics Project Number: 24060

Date:	2024-07-23	**Field Staff:**	CT KC	**Watershed/Subwatershed:**	Boyne River
Time:	10:14	**Stream:**	Tributary of Boyne river	**UTM (Upstream):**	
Weather:	27°C sun	**Reach:**	TBR-1 US of Pond	**UTM (Downstream):**	

Land Use (Table 1): 1/7 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 13 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location:_____ Photo:_____

Riparian Vegetation

Dominant Type (Table 6): All | **Encroachment** (Table 7): 3

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 %**: 20

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): 2

Channel Characteristics

Sinuosity Type (Table 9): 3 | **Sinuosity Degree** (Table 10): 3

Gradient (Table 11): 1 | **# of Channels** (Table 12): 1

Entrenchment (Table 13): 1 | **Bank Failure** (Table 14): 1

Down's Model (Table 15): S | **Bankfull Indicators** (Table 18): 5

Sed Sorting (Table 20): very well sorted | **Sediment Transport Observed?** ☐ Yes ☐ No ☒ Not Visible

Transport Mode (Table 21): 3 | **% of Bed Active**: 0

Geomorphic Units (Table 22): 8 | **Mass Movement** (Table 23): N/A

Riffle-Pool Spacing (m): / | **% Riffles**: / | **% Pools**:

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)	☒	☐	☐	☐	☐	☐	☐

	BH				
Bankfull Width (m)	~~1.0~~	1.2	1.2	**Wetted Width (m)**	8.5	1.64	2.89
Bankfull Depth (m)	0.4	0.6	0.44	**Wetted Depth (m)**	0.3	0.36	0.2 / 0.64 with Sediment
Undercuts (m)	/	/	/	**Velocity (m/s)**	0.478	0.133	0.11
Pool Depth (m)	/	/	/	**Velocity Estimate Method**	WB	WB	WB
Riffle Length (m)	/	/	/	**Meander Amplitude (m)**	5.33		

Notes: Riparian veg: directly adjacent to channel → grasses + weeds (1-4 channel widths) then forest surrounding that
Instream veg: watercress
substrate: clay/silt, really loamy and saturated
stable channel, no undercutting/erosion
channel morphology: primarily runs, no riffles

Upon review of photographs with field staff, bankfull channel not discernible due to backwater effects from downstream pond

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): _____ Checked by: KW Completed by: KC

GEO MORPHIX™

Rapid Geomorphic Assessment

Project Number: 24060

Date:	2024-07-23	**Stream:**	tnb of Bayne River
Time:	10:14	**Reach:**	TBR-1
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Bayne River

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	0.167
Evidence of Degradation (DI)	1	Exposed bridge footing(s) n/a		✓	0
	2	Exposed sanitary / storm sewer / pipeline / etc.		✓	
	3	Elevated storm sewer outfall(s)		✓	
	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	10	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		✓	1/10
	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		✓	
	6	Outflanked gabion baskets / concrete walls / etc.		✓	
	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		✓	
		Sum of indices =	1	9	0.1
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		✓	0
	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 =			0

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.067

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: KW Completed by: CT

GEO MORPHIX™

Rapid Stream Assessment Technique Project Number: 24060

Date:	2024-07-23	**Stream:**	trib of Boyne River
Time:	10:14	**Reach:**	TBR1 (US of pond)
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Boyne River

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: _____ Completed by: CT

GEO MORPHIX™

Date:	2024-07-23	PN:	24060	Location:	Chipwoods, Melancthon, 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) = 34	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: KW Completed by: CT

GEO MORPHIX™

General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-3
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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		watercress
	Bank stabilization		wooden bridge
	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

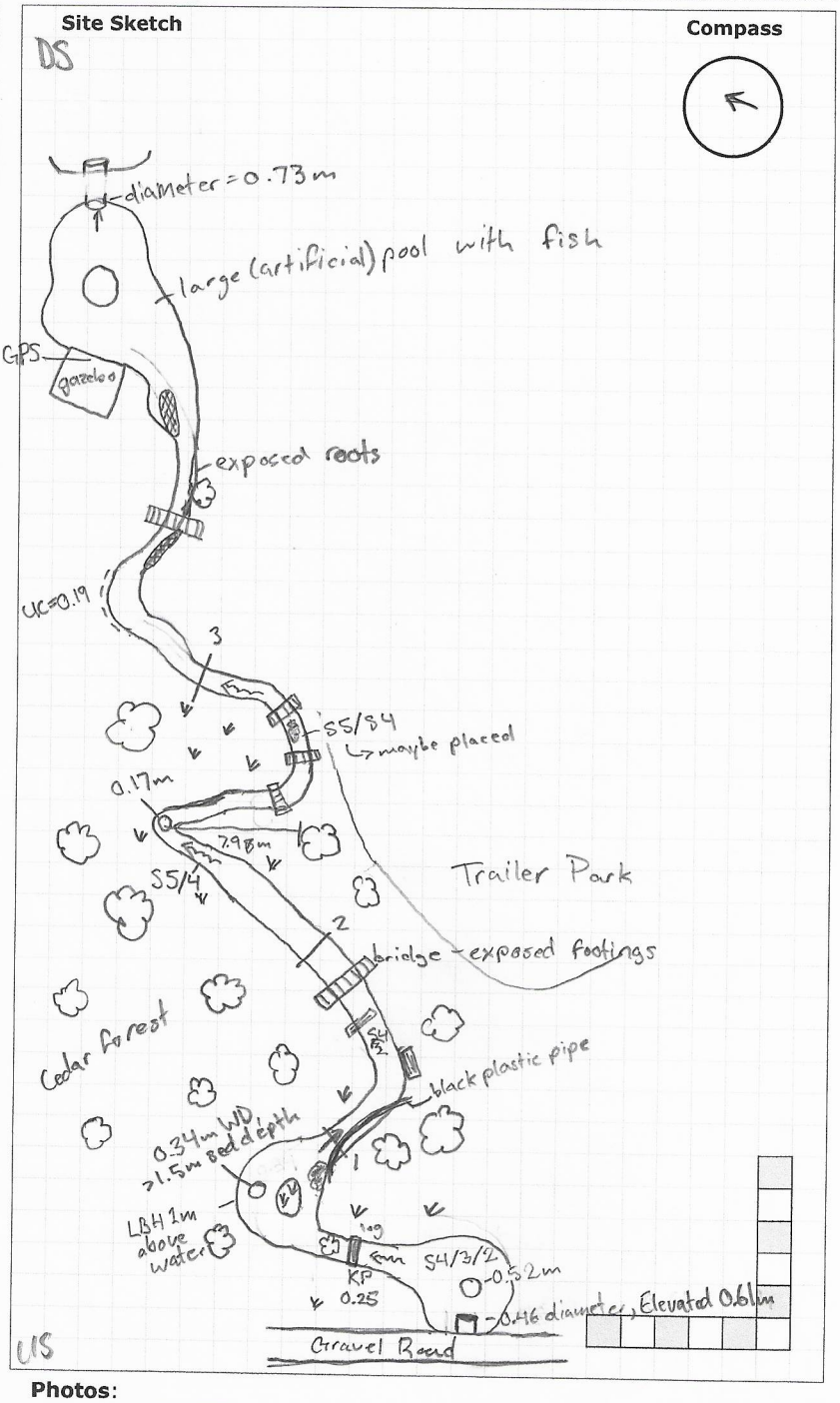
Substrate

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



Photos:

Notes: GPS pt 009 @ pool w gazebo

Sand, gravel, small cobbles as bed material.
Loamy soil as banks (sand + clay + organics)

GEO MORPHIX

Reach Characteristics Project Number: 24060

Date:	2024-07-23	**Field Staff:**	CT KC	**Watershed/Subwatershed:**	Boyne River
Time:	10:57	**Stream:**	Tributary of Boyne River	**UTM (Upstream):**	
Weather:	27°C sun	**Reach:**	TBR-3 (DS of Pond)	**UTM (Downstream):**	

Land Use (Table 1): 1/7 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 13 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location:_____ Photo:_____

Riparian Vegetation

Dominant Type (Table 6): 1/3 | **Encroachment** (Table 7): 1

Coverage	Channel Widths	Age (yrs)
☐ None	☐ 1 - 4	☐ Immature (<5)
☐ Fragmented	☒ 4 - 10	☐ Established (5-30)
☒ Continuous	☐ > 10	☒ Mature (>30)

Aquatic & Instream Vegetation

Type (Table 8): 1 | **Reach Coverage %**: 2%

Woody Debris	WD Density
☐ In Cutbank	☒ Low
☒ In Channel	☐ Mod
☐ Not Present	☐ High

WDJ/50m: 0

Water Quality

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

Channel Characteristics

Sinuosity Type (Table 9): 2 | **Gradient** (Table 11): 1 | **Entrenchment** (Table 13): 1 | **Down's Model** (Table 15): S | **Sed Sorting** (Table 20): moderately sorted | **Transport Mode** (Table 21): 3 | **Geomorphic Units** (Table 22): 8 | **Riffle-Pool Spacing (m):** /

Sinuosity Degree (Table 10): 3 | **# of Channels** (Table 12): 1 | **Bank Failure** (Table 14): 1 | **Bankfull Indicators** (Table 18): 5

Bank Angle: ☐ 0 – 30 | ☒ 30 – 60 | ☐ 60 – 90 | ☐ Undercut

Bank Erosion: ☐ < 5% | ☒ 5 – 30% | ☐ 30 – 60% | ☐ 60 – 100%

Sediment Transport Observed? ☐ Yes ☐ No ☒ Not Visible

% of Bed Active: 0 | **Mass Movement** (Table 23): 3/4 | **% Riffles**: / | **% Pools**:

(Table 19)	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
Bank	☒	☐	☐	☐	☐	☐	☒
Riffle	☐	☒	☒	☒	☐	☐	☐
Pool	☒	☐	☐	☐	☐	☐	☒
Bed (if no riffle-pool morphology)	☐	☒	☒	☐ BH 0.38	☐	☐ 0.26	☐ 0.22

Bankfull Width (m)	2.90	2.57	2.09	**Wetted Width (m)**	1.67	1.97	1.11
Bankfull Depth (m)	0.27	0.2	0.22	**Wetted Depth (m)**	0.11	0.06	0.08
Undercuts (m)	/	/	0.19	**Velocity (m/s)**	0.133	0.326	0.26
Pool Depth (m)	0.52	0.34	0.17	**Velocity Estimate Method**	WB	WB	WB
Riffle Length (m)				**Meander Amplitude (m)**	7.98		

Notes:

surrounding land: residential trailer park + forest, riparian veg: primarily forest + grass through residential yards, multiple manmade crossings (bridges) - some erosion around bridge parts (photos R0046564-69)
minimal in stream veg: some watercress
stable channel, primarily mins, no undercutting

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): _____ Checked by: KW Completed by: KC

GEO MORPHIX

Rapid Geomorphic Assessment

Project Number: 24060

Date:	2024-07-23	**Stream:**	tnb of Boyne River
Time:	10:57	**Reach:**	TBR-3
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Boyne River

Process	No.	Geomorphological Indicator	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		✓	1/8
	2	Coarse materials in riffles embedded		✓	
	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	7	0.125
Evidence of Degradation (DI)	1	Exposed bridge footing(s)	✓		3/10
	2	Exposed sanitary / storm sewer / pipeline / etc.		✓	
	3	Elevated storm sewer outfall(s) – could have been installed that way?	✓		
	4	Undermined gabion baskets / concrete aprons / etc.		✓	
	5	Scour pools downstream of culverts / storm sewer outlets	✓		
	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 =	3	7	0.3
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		✓	1/10
	2	Occurrence of large organic debris		✓	
	3	Exposed tree roots – only a few occurances	✓		
	4	Basal scour on inside meander bends		✓	
	5	Basal scour on both sides of channel through riffle – vegetated banks		✓	
	6	Outflanked gabion baskets / concrete walls / etc.		✓	
	7	Length of basal scour >50% through subject reach		✓	
	8	Exposed length of previously buried pipe / cable / etc. – pipe was unlikely buried		✓	
	9	Fracture lines along top of bank		✓	
	10	Exposed building foundation		✓	
		Sum of indices =	1	9	0.1
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 – artificial pond installed causing sedimentation DS	✓		
	4	Cut-off channel(s)		✓	
	5	Formation of island(s) – near US	✓		
	6	Thalweg alignment out of phase with meander form		✓	
	7	Bar forms poorly formed / reworked / removed – not present/n/a		✓	
		Sum of indices =	2	5	0.286

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.203

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: KW Completed by: CT

GEO MORPHIX

Rapid Stream Assessment Technique Project Number: 24060

Date:	2024-07-23	**Stream:**	tnb of Boyne River
Time:	10:57	**Reach:**	TBR-3 (DS of Pond)
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Boyne River

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: _____ Completed by: CT

GEO MORPHIX™

Date:	2024-07-23	PN:	24060	Location:	Chipwoods, Melancthon, 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) = 37	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: KW Completed by: CT

GEO MORPHIX™

General Site Characteristics

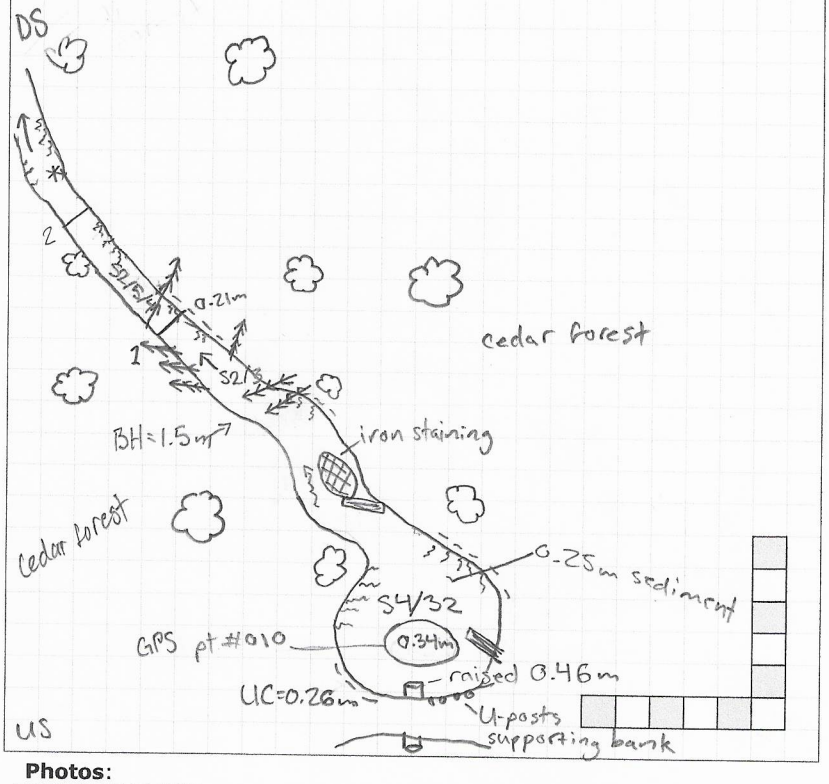
Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	DS of Artificial Pond / TBR-4
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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	exposed roots	
	Bank stabilization		
	Leaning tree		
	Fence		
	Culvert/outfall		
	Swamp/wetland		
	Grasses		
	Tree		
	Instream log/tree		
	Woody debris		
	Beaver dam		
	Vegetated island		

Site Sketch

Compass



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

Photos:

Notes:

Banks = clay, gravel, sand
Bed = large cobbles - sand

GEO MORPHIX™

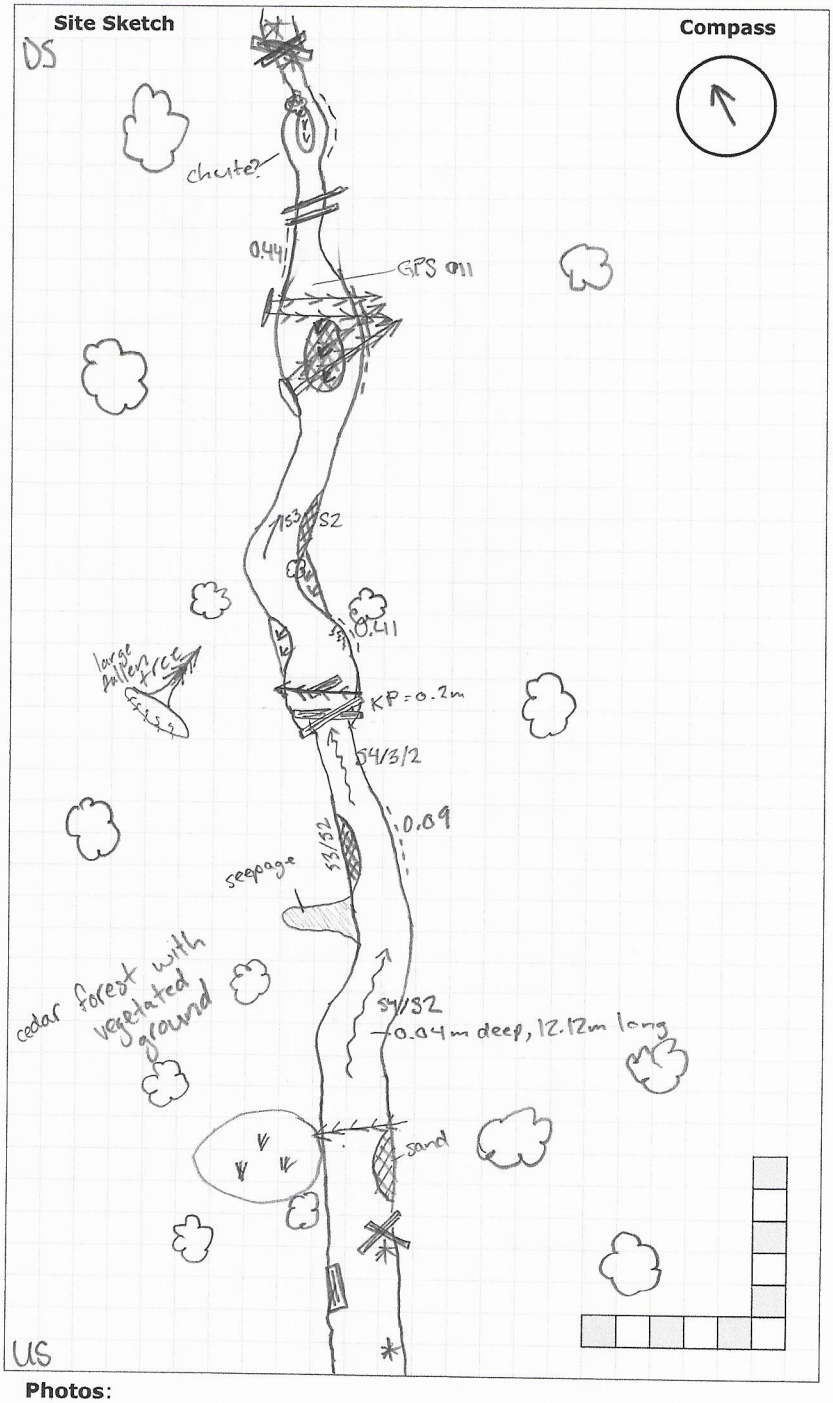
General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-4 (cedar forest)
Weather:	27°C sun	**Location:**	Chipwoods, Melanethon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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		watercress
	Bank stabilization		
	Leaning tree		
	Fence		
	Culvert/outfall		
	Swamp/wetland		
	Grasses		
	Tree		
	Instream log/tree		
	Woody debris		
	Beaver dam		
	Vegetated island		

Site Sketch



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

Photos:

Notes: Redside dace possibly spotted @ pt 011

Bed: gravel, sand, small cobbles

GEO MORPHIX™

Reach Characteristics Project Number: 240600

Date:	2024-07-23	**Field Staff:**	CT KC	**Watershed/Subwatershed:**	Bayne River
Time:	11:44	**Stream:**	Tributary of Bayne River	**UTM (Upstream):**	
Weather:	27°C sun	**Reach:**	TBR-4 (DS of artificial pool)	**UTM (Downstream):**	

Land Use (Table 1): 1 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 11 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location: DS of artificial pond Photo: R0046705

Riparian Vegetation

Dominant Type (Table 6): 1
Encroachment (Table 7): 1

Coverage	Channel Widths	Age (yrs)
☐ None	☐ 1 - 4	☐ Immature (<5)
☐ Fragmented	☐ 4 - 10	☐ Established (5-30)
☑ Continuous	☑ > 10	☑ Mature (>30)

Aquatic & Instream Vegetation

Type (Table 8): N/A
Reach Coverage %: 0

Woody Debris	WD Density
☐ In Cutbank	☐ Low
☑ In Channel	☑ Mod
☐ Not Present	☐ High

WDJ/50m: 1

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): m
Sed Sorting (Table 20):
Transport Mode (Table 21): 3
Geomorphic Units (Table 22): 5/6/8
Riffle-Pool Spacing (m):

Sinuosity Degree (Table 10): 1
# of Channels (Table 12): 1
Bank Failure (Table 14): 2
Bankfull Indicators (Table 18): 5/7
Sediment Transport Observed? ☐ Yes ☐ No ☑ Not Visible
% of Bed Active: 0
Mass Movement (Table 23): 3/4
% Riffles:
% Pools:

Bank Angle	Bank Erosion
☐ 0 – 30	☐ < 5%
☑ 30 – 60	☐ 5 – 30%
☐ 60 – 90	☑ 30 – 60%
☐ Undercut	☐ 60 – 100%

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

Bankfull Width (m)	2.33	2.94	2.71
Bankfull Depth (m)	0.32	0.18	0.21
Undercuts (m)	0.26	0.21	0.09
Pool Depth (m)	0.34		
Riffle Length (m)	12.15		

Bank height (m)	1.34	0.82	0.60
Wetted Width (m)	1.65	1.50	1.61
Wetted Depth (m)	0.07	0.09	0.05
Velocity (m/s)	0.289	0.150	0.565
Velocity Estimate Method	WB	WB	WB
Meander Amplitude (m)	4.5		

Notes:

Riparian veg: forest / small weeds / shrubs
Evidence of groundwater: iron staining on cobbles in channel (R0046705)
NO in stream vegetation
Some undercutting, a lot of exposed tree roots
Good riffle/pool morphology, riffle substrate very well sorted cobbles
Possible redside dace spotting

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): _____ Checked by: KW Completed by: KC

GEO MORPHIX™

Rapid Geomorphic Assessment

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib of Boyne River
Time:	11:44	**Reach:**	TBR-4
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Boyne River

Process	No.	Geomorphological Indicator	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		✓	2/7
	2	Coarse materials in riffles embedded		✓	
	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 =	2	5	0.286
Evidence of Degradation (DI)	1	Exposed bridge footing(s) – n/a (yes if there)			2/7
	2	Exposed sanitary / storm sewer / pipeline / etc. – n/a (yes if there)			
	3	Elevated storm sewer outfall(s)	✓		
	4	Undermined gabion baskets / concrete aprons / etc. – n/a (yes if there)			
	5	Scour pools downstream of culverts / storm sewer outlets	✓		
	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 =	2	5	0.286
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	✓		4/6
	2	Occurrence of large organic debris	✓		
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends – n/a (no meanders)			
	5	Basal scour on both sides of channel through riffle		✓	
	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. – n/a			
	9	Fracture lines along top of bank		✓	
	10	Exposed building foundation – n/a			
		Sum of indices =	4	2	0.667
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	0.286

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.381

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: KW Completed by: CT

GEO MORPHIX

Rapid Stream Assessment Technique Project Number: 24060

Date:	2024-07-23	**Stream:**	trib of Bayne River
Time:	11:44	**Reach:**	TBR-4 (Cedar forest)
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Bayne River

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: KW Completed by: CT

GEO MORPHIX™

Date:	2024-07-23	PN:	240160	Location:	Chipwood, Mclanchan, 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) = 29	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: KW Completed by: CT

GEO MORPHIX™

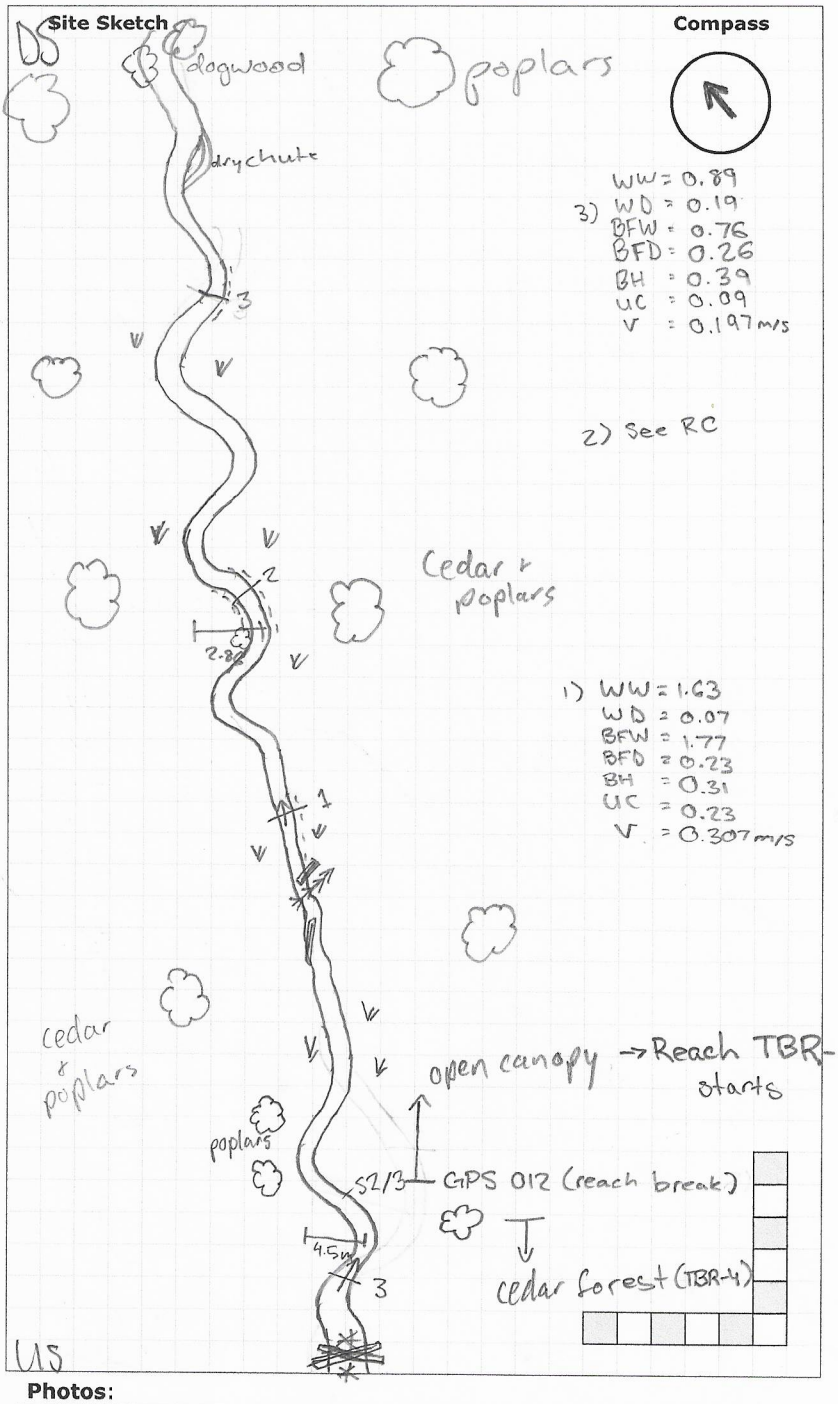
General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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		

Site Sketch



Compass

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

Photos:

Notes:

Canopy opens, riparian veg becomes varied combination (dogwood, spotted joe-pye weed, grasses, jewelweed, raspberry etc.). Bed is sand, bank is clay + sand (loam + organics). Channel narrows in TBR-5, and undercutting is frequent = 80-90° banks

GEO MORPHIX™

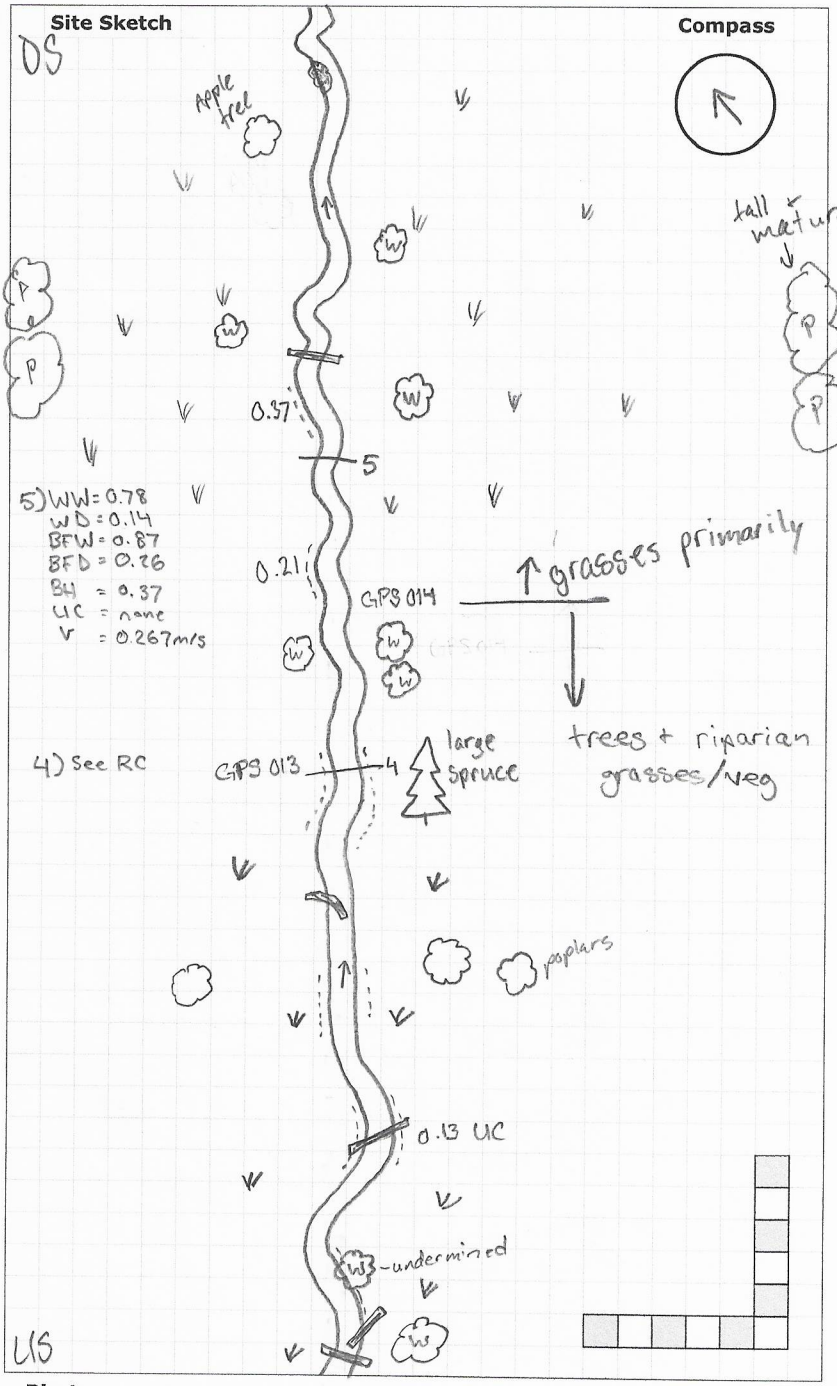
General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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	W	willow tree
	Bank stabilization		watercress
	Leaning tree	P	poplars
	Fence		
	Culvert/outfall		
	Swamp/wetland		
	Grasses		
	Tree		
	Instream log/tree		
	Woody debris		
	Beaver dam		
	Vegetated island		

Site Sketch



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		
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Substrate			
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Other			
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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

Photos:

Notes: Amount of grasses + forbs increases.

Veg: grasses, spotted joe-pye weed, dogwood, willows intermixed

GEO MORPHIX™

General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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	watercress	
	Bank stabilization	willow tree	
	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
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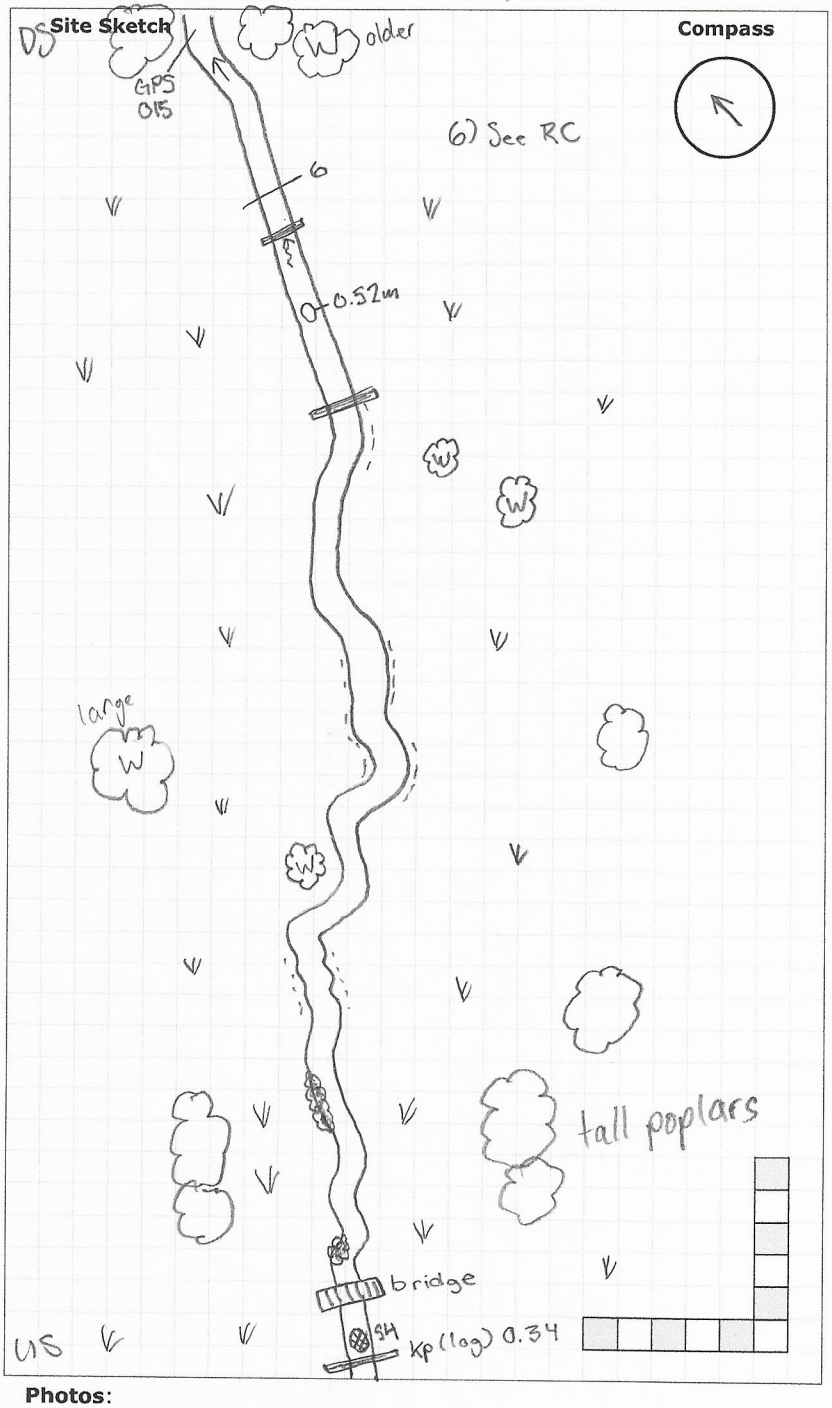
Site Sketch



Compass

Photos:

Notes: @DS channel entered a stand of older willows. Bed substrate remains sand. Bank is sand/clay/organics. Undercutting along banks is frequent and channel is narrow and crowded by grasses.

GEO MORPHIX™

General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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	watercress	
	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		
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H5	Rippled		
H6	Unbroken standing wave		
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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
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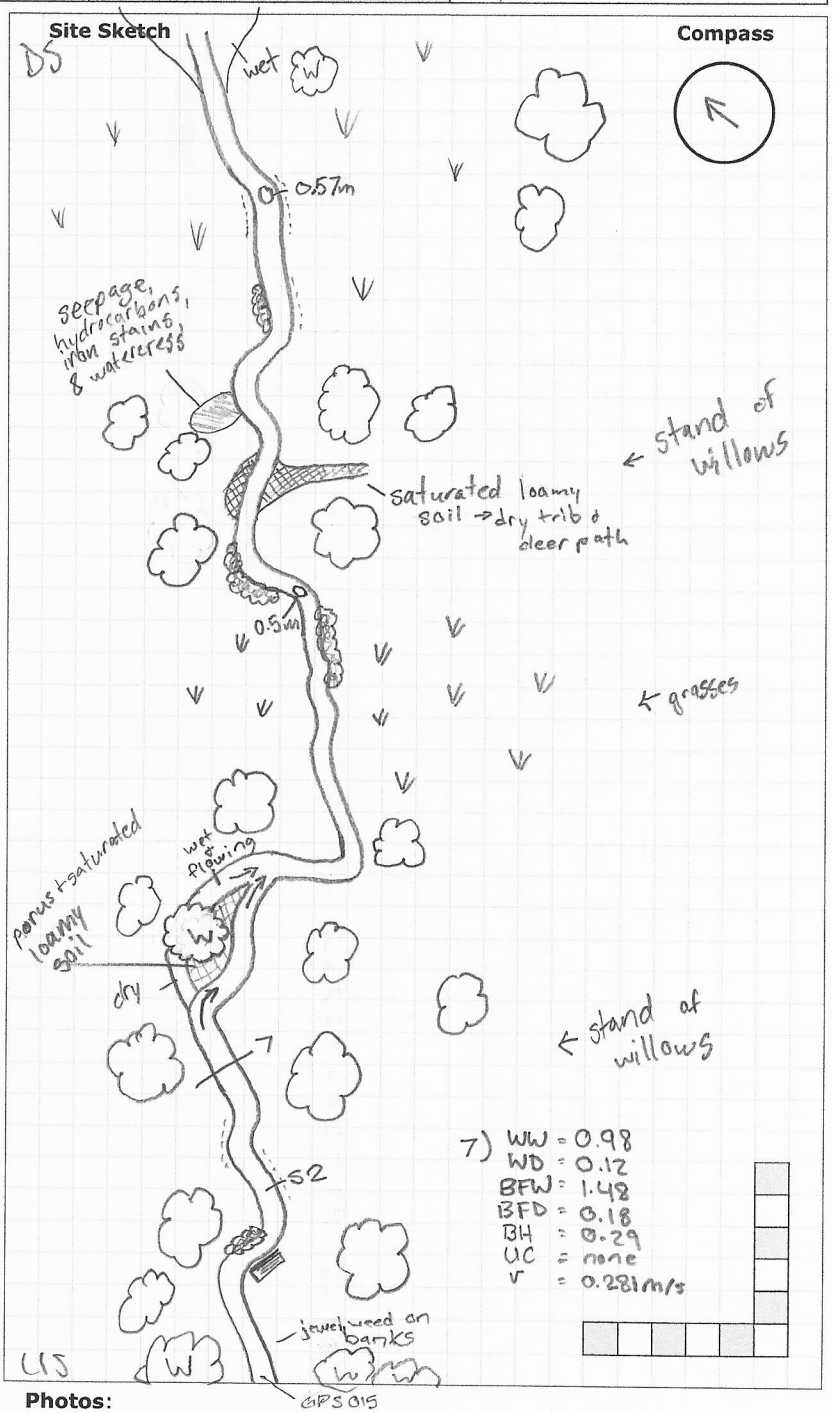
Site Sketch



Compass

Photos:

Notes: Channel gets deeper in DS section. Undercutting common, narrow channel. Loamy/organics in banks. Sand & organics bed

GEO MORPHIX™

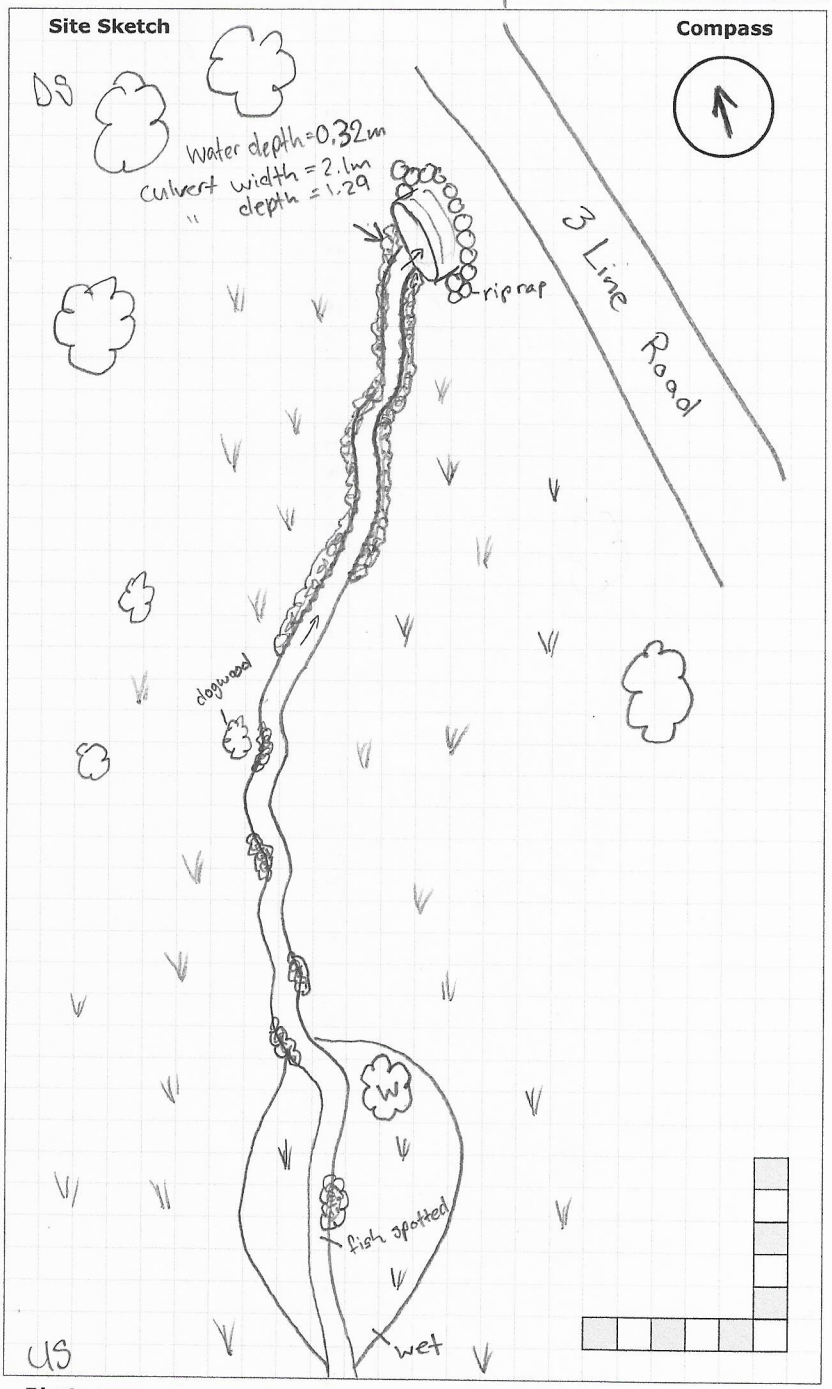
General Site Characteristics

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib to Byone River
Time:		**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	Chipwoods, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Byone River

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	Watercress	
	Bank stabilization		
	Leaning tree		
	Fence		
	Culvert/outfall		
	Swamp/wetland		
	Grasses		
	Tree		
	Instream log/tree		
	Woody debris		
	Beaver dam		
	Vegetated island		

Site Sketch



Flow Type

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

Substrate

S1	Silt	**S6**	Small boulder
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S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
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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

Photos:

Notes: Watercress increased. Channel narrow with frequent undercutting. Sand build up in culvert. (see photos)

GEO MORPHIX™

Reach Characteristics Project Number: 240660

Date:	2024-07-23	**Field Staff:**	CT KC	**Watershed/Subwatershed:**	Boyne River
Time:	12:51	**Stream:**	Tributary of Boyne River	**UTM (Upstream):**	
Weather:	27°C sun	**Reach:**	TBR-5 (open canopy)	**UTM (Downstream):**	

Land Use (Table 1): 1 (meadow) | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 12 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Evidence of Groundwater Location: under willow trees | Photo: 20240723-143500.JPG

Riparian Vegetation

Dominant Type (Table 6): 3 | **Encroachment** (Table 7): 4

Coverage	Channel Widths	Age (yrs)
☐ None	☐ 1 - 4	☐ Immature (<5)
☐ Fragmented	☐ 4 - 10	☐ Established (5-30)
☑ Continuous	☑ > 10	☑ Mature (>30)

Aquatic & Instream Vegetation

Type (Table 8): 1 | **Reach Coverage %**: 10

Woody Debris	WD Density
☐ In Cutbank	☑ Low
☑ In Channel	☐ Mod
☐ Not Present	☐ High

WDJ/50m: 0

Water Quality

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

Channel Characteristics

Sinuosity Type (Table 9): 3 | **Sinuosity Degree** (Table 10): 3 | **Gradient** (Table 11): 1 | **# of Channels** (Table 12): 1 | **Entrenchment** (Table 13): 1 | **Bank Failure** (Table 14): 2 | **Down's Model** (Table 15): U | **Bankfull Indicators** (Table 18): 517 | **Sed Sorting** (Table 20): well sorted | **Sediment Transport Observed?** ☐ Yes ☐ No ☑ Not Visible | **Transport Mode** (Table 21): 3 | **% of Bed Active**: 0 | **Geomorphic Units** (Table 22): 8 | **Mass Movement** (Table 23): 314 | **Riffle-Pool Spacing (m)**: | **% Riffles**: | **% Pools**:

	Bank Angle	Bank Erosion
	☐ 0 – 30	☐ < 5%
	☐ 30 – 60	☐ 5 – 30%
	☑ 60 – 90	☑ 30 – 60%
	☐ Undercut	☐ 60 – 100%

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

	XS) 2	4	6
Bankfull Width (m)	0.59	1.0	0.39
Bankfull Depth (m)	0.19	0.23	0.33
Undercuts (m)	0.21	0.21	0.25
Pool Depth (m)	0.52	0.50	0.57
Riffle Length (m)			

Bank Height(m)	2	4	6
Wetted Width (m)	0.37 / 0.83	0.36 / 1.18	0.41 / 0.34
Wetted Depth (m)	0.11	0.14	0.24
Velocity (m/s)	0.332	0.391	0.242
Velocity Estimate Method	WB	WB	WB
Meander Amplitude (m)	2.86		

Notes:

land use / riparian veg: meadow with grasses, spotted joe pye weed, dogwood, raspberry, open canopy, encroaching heavily on channel, minimal in stream vegetation

channel narrower than previous reaches stays defined throughout property, even in wetland section towards the end

evidence of groundwater - seepage through soil, iron staining

Photos:

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): _____ Checked by: KW Completed by: KC

GEO MORPHIX™

Rapid Geomorphic Assessment

Project Number: 24060

Date:	2024-07-23	**Stream:**	trib of Boyne River
Time:	12:51	**Reach:**	TBR-5
Weather:	27°C sun	**Location:**	chipwoods, Melancthon, ON
Field Staff:	CT KL	**Watershed/Subwatershed:**	Boyne River

Process	No.	Geomorphological Indicator	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar			1/7
	2	Coarse materials in riffles embedded			
	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	6	0.143
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			0
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	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 =			
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.			2/9
	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			
	6	Outflanked gabion baskets / concrete walls / etc.			
	7	Length of basal scour >50% through subject reach - UC >50%			
	8	Exposed length of previously buried pipe / cable / etc.			
	9	Fracture lines along top of bank - would be too vegetated to see, but unlikely			
	10	Exposed building foundation - n/a			
		Sum of indices =	2	7	0.222
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s) - only 1			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 - no bars			
		Sum of indices =	1	6	0.143

Notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.127

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: KW Completed by: CT

GEO MORPHIX™

Rapid Stream Assessment Technique Project Number: 24060

Date:	2024-07-23	**Stream:**	Tributary of Boyne River
Time:	12:51	**Reach:**	TBR-5 (open canopy)
Weather:	overcast 27°C	**Location:**	Chipwood, Melancthon, ON
Field Staff:	CT KC	**Watershed/Subwatershed:**	Boyne River

Category	Poor	Fair	Good	Excellent
some undercutting	• < 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
undercuts around 0.25m bank heights ~0.35-0.45 m Channel Stability	• 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
no riffle)	• > 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
Channel Scouring/ Sediment Deposition	• 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
no point bars	• 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

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Senior staff sign-off (if required): _____ Checked by: KW Completed by: KC

GEO MORPHIX™

Date:	2024-07-23	PN:	24060	Location:	Chipwoods, Milanthon, 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)
no riffles velocity relatively quick but pretty uniform throughout no riffles	• 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
no riffles	• 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
no riffles	• 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
meadow/ forest 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) = 34	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

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