# Fluvial Geomorphology and Erosion Hazard Assessment

## 1086 Antochi Lane
## Manotick, Ontario

Prepared for:
1910753 Ontario Inc.
c/o Cavanagh Developments
6900 Sunset Blvd
Greely, Ontario
K4P 1C2

June 22, 2023
PN23057

GEO MORPHIX
Geomorphology
Earth Science
Observations

| | |
|---|---|
| Report Prepared by: | GEO Morphix Ltd.<br>36 Main Street North<br>PO Box 205<br>Campbellville, ON L0P 1B0 |
| Report Prepared for: | 1910753 Ontario Inc.<br>c/o Cavanagh Developments<br>6900 Sunset Blvd<br>Greely, Ontario<br>K4P 1C2 |
| Report Title: | Fluvial Geomorphology and Erosion Hazard Assessment<br>1086 Antochi Lane<br>Manotick, Ontario |
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| Approval Date: | June 22, 2023 |

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## Appendices

# 1 Introduction

GEO Morphix Ltd. ("GEO Morphix") has been retained to complete an erosion hazard assessment in support of the proposed redevelopment at 1086 Antochi Lane, Manotick, Ontario. The subject lands currently consist of a private road and eight single residential units. The Rideau River is adjacent and east of the subject lands, flowing from south to north. Based on measurements using a Google Earth Pro 2023 image, residences with rear yards facing the River are positioned approximately 15 m from the channel bank (**Appendix A**).

GEO Morphix previously reviewed the following documents prepared in support of the redevelopment:

- 1086 Antochi Lane Residential Development Environmental Impact Statement and Tree Conservation Report (Muncaster Environmental Planning Inc., dated February 9, 2023)
- Geotechnical Investigation, Proposed Residential Development, 1086 Antochi Lane, Ottawa Ontario (GEMTEC Consulting Engineers and Scientists Limited, dated February 7, 2023)
- 1086 Antochi Lane, Adequacy of Public Services and Conceptual Stormwater Management (Novatech, dated February 3, 2023)

Our office prepared a Letter of Opinion (dated March 16,2023), indicating that a fluvial geomorphology assessment was not required as the above studies, and more specifically the geotechnical investigation, adequately addressed the erosion hazard associated with the Rideau River. The Environmental Impact Statement (EIS) included a constraint map that showed the 100-year floodplain, Rideau Valley Conservation Authority (RVCA) Regulation limit and the 30 m setback from controlled water elevation (per Parks Canada). The geotechnical investigation included a slope stability assessment following MNR (2001) guidelines. The report noted that a minimum toe erosion allowance of 5 to 8 m was required where the bank/slope materials were composed of coarse granular (gravels) tills. Given the existing bank armouring (rip rap), a 5 m toe erosion allowance was determined. A stable slope allowance of 2.5 m was also applied.

Novatech prepared a plan that illustrates constraints to development (refer to Drawing No. 120061-CONS in **Appendix B**). As demonstrated in the plan, the proposed development respects the erosion hazard limit delineated by GEMTEC Consulting Engineers and Scientists Limited (2023). The 30 m setback from the controlled water elevation is the governing constraint to the development as currently proposed.

The City of Ottawa has confirmed via email (dated Match 16, 2023) that a fluvial geomorphology assessment is required in support of the redevelopment. To complete the fluvial geomorphology and erosion hazard assessment and address the City of Ottwa's concerns, GEO Morphix completed the following tasks:

- Review available background reports and mapping (e.g., watershed/subwatershed reporting, geology, and topography) related to channel form and function and controlling factors related to fluvial geomorphology
- Conduct a desktop assessment of watercourse/shoreline conditions
- Review recent and historical aerial photographs of the site to understand historical changes in channel form and function over time
- Complete site reconnaissance to understand general property and watercourse characteristics and confirm results of the desktop-assessment using standard, industry accepted tools including the Rapid Geomorphic Assessment (RGA) (MOE, 2003) and Rapid Stream Assessment Technique (Galli, 1996), as appropriate
- Delineate the erosion hazard associated with the Rideau River

This report summarizes findings of the desktop- and field-based geomorphological assessment and should be reviewed in combination with the previously completed geotechnical investigation (GEMTEC Consulting Engineers and Scientists Limited, 2023).

# 2 Background Review and Desktop Assessment

## 2.1 Background Information

The subject property is located within the Rideau River watershed, which drains a large catchment area of approximately 4,000 km$^2$ (RVCA, 2022). Headwaters originate south of Ottawa in the South and Central Frontenac regions. Land use within the watershed is dominated by agriculture, forest, and wetlands (RVCA, 2022).

Local to the subject site, the Rideau River flows from south to north adjacent to the eastern property boundary. Directly upstream of the subject site, the Rideau River splits into two branches and converges approximately 5 km downstream. The study site is located on the west bank of the southern branch. Additionally, a dam is located approximately 1.2 km downstream of the subject site. A map of the study area is provided in **Appendix A**, for reference.

Land use within and surrounding the subject property is primarily residential and commercial development, and active agriculture east of the Rideau River. Multiple residential properties are located along both banks of the Rideau River.

## 2.2 Surficial Geology and Physiology

Surficial geology and physiography act 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 resides entirely within the Ottawa Valley Clay Plains physiographic region (Chapman and Putman, 2007). This region is characterized by relatively thick deposits of sensitive marine clay, overlaying relatively thin, commonly reworked glacial till and glaciofluvial deposits (Chapman and Putman, 1984). Published surficial geology mapping indicates that deposits within the subject property have offshore marine deposits composed of clay, silty clay and silt overlain by thin sands (OGS, 2010). This is generally consistent with surficial materials documented in a test pit and two boreholes recovered by GEMTEC, where topsoil was underlain by silty clay, silty sand, as well as glacial till. In general, fine-grained bank sediments such as silt and clay are relatively resistant to erosion when compared to sandy deposits, for example.

## 2.3 Historical Assessment

A series of historical aerial photographs were reviewed to determine changes to the channel and surrounding land use and land cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. Various aerial satellite images from 1954 to 2021 were retrieved to complete the historical assessment and inform delineation of the erosion hazard. With the exception of the 1954 image, all aerials were retrieved from GEO Ottawa (https://maps.ottawa.ca/geoottawa/). The 1954 image was retrieved from the University of Toronto Map and Data Library. Select images are provided in **Appendix C** for reference.

In 1954, the predominant land use was agriculture. Overall, natural riparian vegetation appeared limited with cultivation to the channel edge in many locations. The existing dam structure is also visible in 1954. In 1976, surrounding land use remained primarily agriculture; however, several rural dwellings and relatively small subdivisions were constructed along both banks of the Rideau River in vicinity of the subject property. The natural riparian zone was narrow and discontinuous, with trees and shrubs visible along the channel banks. There was no significant change to the channel planform between 1954 and 1976.

Similarly, there was limited change to the channel planform between 1976 and 2002. This could be due, in part, to the presence of the dam downstream. Redevelopment occurred within the subject site in 1991 through the establishment of several residences in a similar orientation to current conditions; however, no changes to the channel banks could be discerned in the imagery.

From 2002 to 2021 there was again, no discernable change to the planform, indicating that the channel bank along the subject site has remained relatively stable. The surrounding land use continued to shift from rural/agricultural to residential development; however, no significant changes along the river upstream or downstream of the subject site were observed.

Further to the qualitative overall assessment above, the channel bank along the property was digitized using GEO Ottawa imagery for the years 1976, 2002, 2011 and 2021, encompassing 45 years of record. Although a 1954 aerial image is available from the University of Toronto, the shoreline was not digitized due to the resolution of the image and georeferencing considerations (i.e., inadequate control points). As shown in **Appendix D**, the channel bank appears to have been modified/infilled when 1976 and 2002 channel bank positions are compared, but has remained relatively stable over the period examined.

# 3 Watercourse Characteristics

## 3.1 Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. Reaches 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.

Reaches are typically delineated based on changes in the following:

- Channel planform
- Channel gradient
- Physiography
- Land cover (land use or vegetation)
- Flow, due to tributary inputs
- Soil type and surficial geology
- Historical channel modifications

Reach delineation follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), and the Toronto and Region Conservation Authority (2004) as well as others. Due to the scale of the watercourse in comparison to the subject site, no formal reaches were delineated as the section of assessed watercourse adjacent to the development is substantially too small to be considered a reach. A full assessment of the Rideau River at the reach scale is beyond the scope of the current study. This does not invalidate the assessment.

## 3.2 General Reach Observations

A field investigation was completed on May 17, 2023, and included the following:

- Descriptions of riparian conditions
- Determination 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

Due to the scale of the watercourse and neighbouring private properties, observations were collected from the channel bank along the perimeter of the subject site. Field descriptions are supplemented and supported with representative photographs, included in **Appendix E**. Field sheets, including those completed for reach characterization and rapid assessments, are provided in **Appendix F**.

The watercourse was located in an unconfined setting and located adjacent to a section of relatively calm water (most likely backwater influenced by the downstream dam). Riparian vegetation within the subject site was composed of primarily manicured grass, with trees and shrubs denoting individual boundaries between residences and located along the channel bank. Very few leaning trees were observed, and one portion of channel bank with exposed tree roots was identified. The bank materials along a 5 m section of the downstream extent were composed of fine sediments (i.e., > 2mm in diameter). Rip rap (10-20 cm in diameter) was present along the remaining bank. The rip rap extended 1-2 m into the water and 1-2 m up the banks along the majority of the channel bank extent. Erosion blankets were observed under the cobble at several locations. There was no evidence of bank slumping, and erosion was observed at <5% of the shoreline assessed in the field. This section of the Rideau River is impacted by the downstream dam structure and as such, behaves similar to a shoreline with limited erosion potential.

The channel width was estimated using Google Earth Pro, and is approximately 42 m wide. Bank height ranged from 0.50-1.25 m from the wetted edge. Local topography was relatively flat within rear yards of private residences, and a minor slope was observed towards the river.

These findings are consistent with the field assessment conducted by GEMTEC Consulting Engineers and Scientists Limited (2023), who collected visual observations and surveyed 4 cross sections along the channel bank. The surveyed slope height ranged from 0.7 to 1.3 m and had inclinations ranging from 4° to 79°. No evidence of overall slope stability (i.e., rotational failure) was observed.

## 3.3 Rapid Geomorphological Assessment Tools

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) was also employed to provide a broader view of the system as it considers the ecological function of the watercourse (Galli, 1996). Observations were 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.

These observations and measurements are summarized below in **Table 2**. Note that the scale of the channel and effects of the downstream dam precluded the measurement of certain channel parameters (e.g., bankfull and wetted channel width and depth, presence/absence and dimensions of riffles and pools, channel substrate characteristics/longitudinal sorting).

### Table 1. Summary of rapid assessment results

| Reach | RGA (MOE, 2003) | | | RSAT (Galli, 1996) | | |
|---|---|---|---|---|---|---|
| | Score | Condition | Dominant Systematic Adjustment | Score | Condition | Limiting Feature(s) |
| **RR-1** | 0.062 | In Regime | Widening | 31 | Good | Riparian Habitat Condition |

The channel was assigned an RGA score of 0.06, indicating that the reach was in regime. The dominant systematic adjustment was evidence of widening. This was due to the few observations of leaning trees and exposed tree roots. The RSAT resulted in a score of 31, or 'good'. The limiting factor was the riparian habitat conditions due to the large scale of the channel and the relatively narrow riparian corridor.

## 4 Erosion Hazard Delineation

Most watercourses in Ontario have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential erosion hazard to proposed activities adjacent to a given watercourse.

When defining the meander belt width or erosion hazard for a creek system, unconfined and confined valley systems are assessed differently. Confined systems are those where the watercourse is contained within a defined valley, where contact between the watercourse and a valley wall is possible. The erosion hazard for confined systems can be defined based on a toe erosion allowance and stable slope allowance. In contrast, unconfined systems are those with poorly defined valleys or slopes well-outside where the channel could realistically migrate. Unconfined systems are generally found within glaciated plains with flat or gently rolling topography.

Based on the desktop assessment and field reconnaissance, this portion of the Rideau River is unconfined. There are no steep or significant valley slopes on either side of the watercourse. The erosion hazard for an unconfined system can be defined by delineating the meander belt width (MNR, 2002 and TRCA, 2004). Due to the size of the Rideau River, a meander belt width assessment is not an appropriate method for delineating the erosion hazard. As noted previously, this section of the Rideau River is impacted by the downstream dam structure and as such, behaves similar to a shoreline with limited erosion potential.

A more appropriate approach is to delineate the erosion hazard following MNR (2002) guidelines, where the erosion hazard is comprised of three main components: 1) the toe erosion allowance; 2) the stable slope allowance; and 3) the erosion access allowance. As noted previously, the channel bank along the subject site has been largely lined with erosion control blanket and 10 – 20 cm diameter rip rap. Where the channel bank native materials were visible near the

downstream limit of the property, they were characterized as clay and silt. MNR (2002) guidelines note that for stiff/hard cohesive coil (clays, clay silt) and coarse granular (gravels) tills, a 5 to 8 m erosion access is to be applied. Given the limited evidence of erosion and the presence of rip rap along the channel bank, a 5 m toe erosion allowance is recommended. This is consistent with recommendations provided by GEMTEC (2023) and considers site-specific observations collected by GEO Morphix.

The toe erosion allowance is one component of the erosion hazard and is to be applied from the toe of slope. The ultimate extent of the erosion hazard limit includes the stable slope allowance, as defined in the geotechnical investigation undertaken by GEMTEC (2023). GEMTEC noted that a formal erosion access allowance was not required given the relatively low height of the slope (i.e., small equipment could likely be used for any slope repairs) and access to the slope was provided between residential dwellings/blocks in the development plan. Based on field observations, GEO Morphix does not have concerns with this approach, particularly given that the limited local topographic relief and the property is located within a regulated area.

Residences with rear yards facing the Rideau River are approximately 15 from the channel bank. As noted previously, the 30 m setback from the controlled water elevation is the governing constraint to the proposed development. This 30 m distance from the channel is approximately twice the distance of residences to the channel bank in existing conditions. Should an 8 m toe erosion allowance have been applied following MNR guidelines (2001), the extent of the erosion hazard would still fall well within the 30 m setback from the controlled water elevation. It is not suggested or recommended that an 8 m toe erosion allowance be applied, but to only demonstrate that all constraints to development are considered and that the erosion hazard is adequately addressed.

# 5 Proposed Storm Sewer Outfall

Under existing conditions, the subject lands drain to the Rideau River. The conceptual stormwater management plan prepared by Novatech (2023) indicated that a single storm sewer outfall to the Rideau River would be required and would be armored with rip rap. No hydraulic stone sizing was provided; however, this will be completed as part of detailed design.

No erosion concerns are anticipated to result from the stormwater outfall due to the small size of the drainage area associated with the proposed redevelopment and the relatively large size of the Rideau River. The only other infrastructure proposed along the shoreline were potential floating dock systems, which is assumed to be acceptable.

# 6 Summary

A desktop assessment, field investigation and erosion hazard assessment were completed for the subject property. The historical assessment revealed that there were no significant changes to riparian vegetation or channel planform between 1964 and 2021 in vicinity of the subject property. This was further reflected in the historical position of the channel bank, which was reviewed in further detail by digitizing its position for the years 1976, 2002, 2011 and 2021. When the channel bank position in 1976 was compared to more recent aerial imagery, minor infilling/modification of the shoreline was apparent; however, the shoreline has remained relatively stable during the period of record.

Rapid geomorphological assessments were completed for the watercourse adjacent to the subject site on May 17, 2023. The watercourse is situated within an unconfined valley and showed limited evidence of active erosion. The banks were largely composed of rip rap and a narrow band of

woody vegetation between property lines. A toe erosion allowance of 5 m is recommended for this portion of the Rideau River and is consistent with the geotechnical investigation conducted by GEMTEC (2023) following MNR guidelines (2002). The toe erosion allowance should be applied with the stable slope allowance determined by GEMTEC (2023) to delineate the full extent of the hazard.

With regard to the storm sewer outfall, given the size of the Rideau River's drainage area in comparison to the limited area of the proposed development, no impacts are anticipated to result from stormwater discharge to the Rideau River. Potential local erosion can be adequately addressed through erosion protection measures at the outfall. It is recommended that configuration of the outfall and erosion protection measures be confirmed at detailed design, along with the completion of hydraulic stone sizing for any proposed outfall treatments.

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

Respectfully submitted,


Paul Villard, Ph.D., P.Geo., CAN-CISEC, EP, CERP
Director, Principal Geomorphologist

Suzanne St Onge, M.Sc.
Senior Environmental Scientist

# 7 References


Chapman, L.J., and Putnam, D.F. 1984: Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Toronto, ON.

Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228.

GEMTEC Consulting Engineers and Scientists Limited. 2023. Geotechnical Investigation Proposed Residential Development 1086 Antochi Lane, Ottawa, Ontario

Ministry of Natural Resources and Forestry (MNRF). 2002. Technical Guide – River and Stream Systems: Erosion Hazard Limit.

Montgomery, D.R. and J.M. Buffington. 1997. Channel-reach morphology in mountain drainage basins. Geological Society of America Bulletin, 109 (5): 596-611.

Novatech. 2023. 1086 Antochi Lane, Adequacy of Public Services and Conceptual Stormwater Management Report.

Ontario Geological Survey (OGS). 2010. Surficial geology of Southern Ontario. Ontario Geological Survey. Miscellaneous Release – Data 128-REV.

Rideau Valley Conservation Authority (RVCA). 2022. 2022 Annual Report.

Richards, C., Haro, R.J., Johnson, L.B. and Host, G.E. 1997. Catchment and reach-scale properties as indicators of macroinvertebrate species traits. Freshwater Biology, 37: 219-230.

Toronto and Region Conservation Authority (TRCA). 2004. Belt Width Delineation Procedures.

# Appendix A
# Study Area


GEO MORPHIX™

# Study Area

1086 Antochi Lane
Rideau River

Manotick, Ontario

## Legend

Study Area

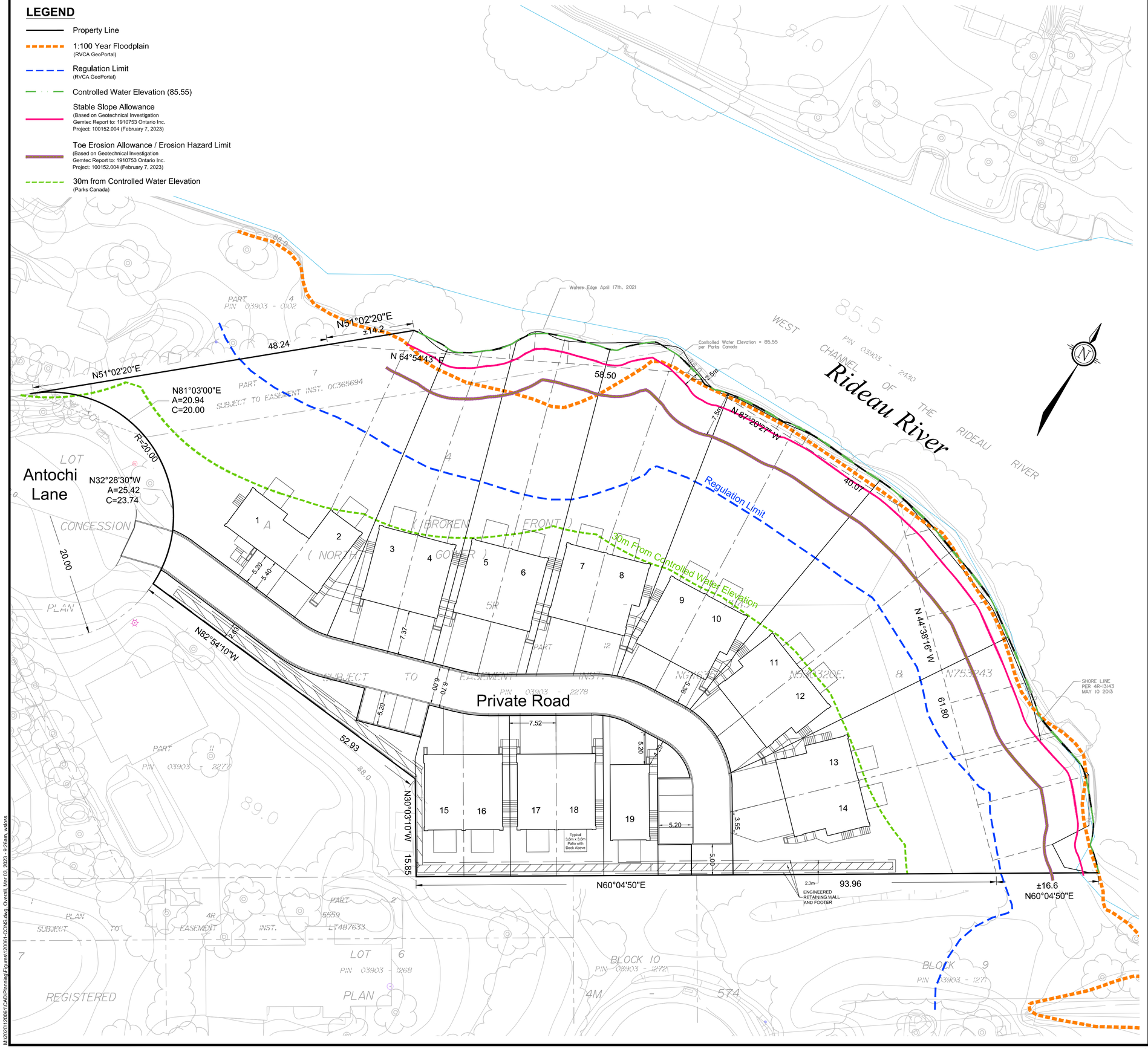
0 10 20
Metres

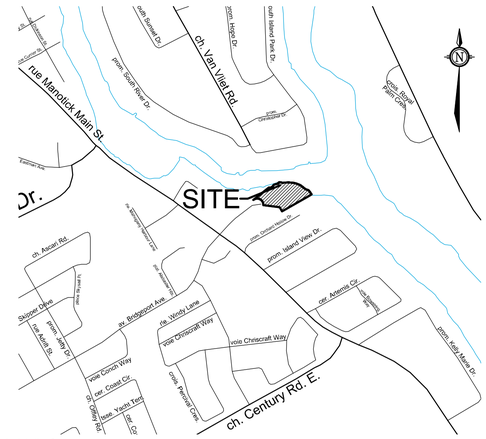
Imagery: City of Ottawa, 2021.
Study Area: Novatech, 2023.
Print Date: June 2023. PN23057.
Drawn By: M.O., S.S.O.

# Appendix B
# Constraints Plan

## LEGEND

- Property Line
- 1:100 Year Floodplain (RVCA GeoPortal)
- Regulation Limit (RVCA GeoPortal)
- Controlled Water Elevation (85.55)
- Stable Slope Allowance (Based on Geotechnical Investigation Gemtec Report to: 1910753 Ontario Inc. Project: 100152.004 (February 7, 2023))
- Toe Erosion Allowance / Erosion Hazard Limit (Based on Geotechnical Investigation Gemtec Report to: 1910753 Ontario Inc. Project: 100152.004 (February 7, 2023))
- 30m from Controlled Water Elevation (Parks Canada)




KEY MAP
NOT TO SCALE

# CONSTRAINTS PLAN

## 1086 Antochi Lane

SCALE 1:300

| No. | REVISION | DATE | BY |
|---|---|---|---|
| 2 | REVISED TO ADD REFERENCE TO GEMTEC GEOTECHNICAL REPORT | MAR 03/23 | JI |
| 1 | ISSUED FOR SUBMISSION | MAR 01/23 | JI |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ISSUED
MARCH, 2023

PROJECT No.
120061

DRAWING No.
120061-CONS

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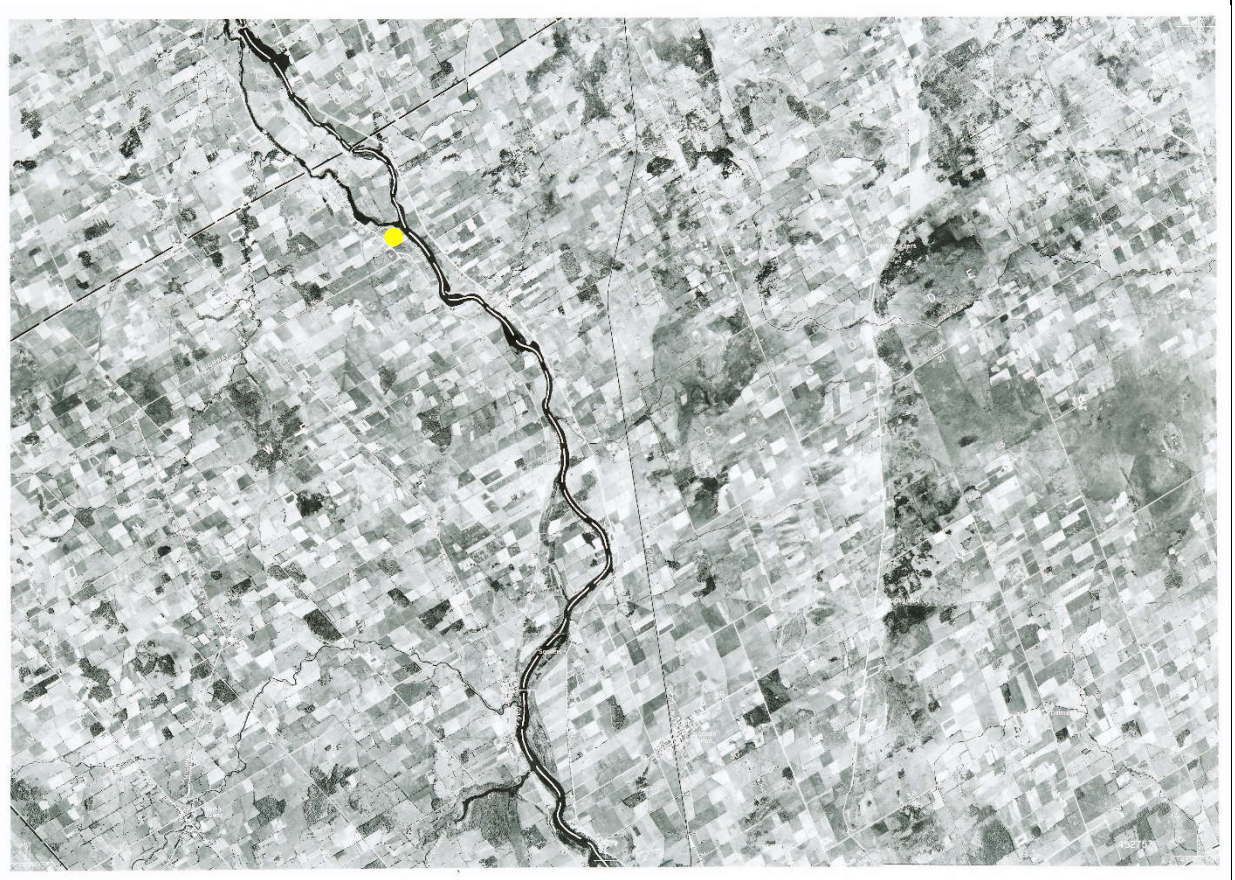
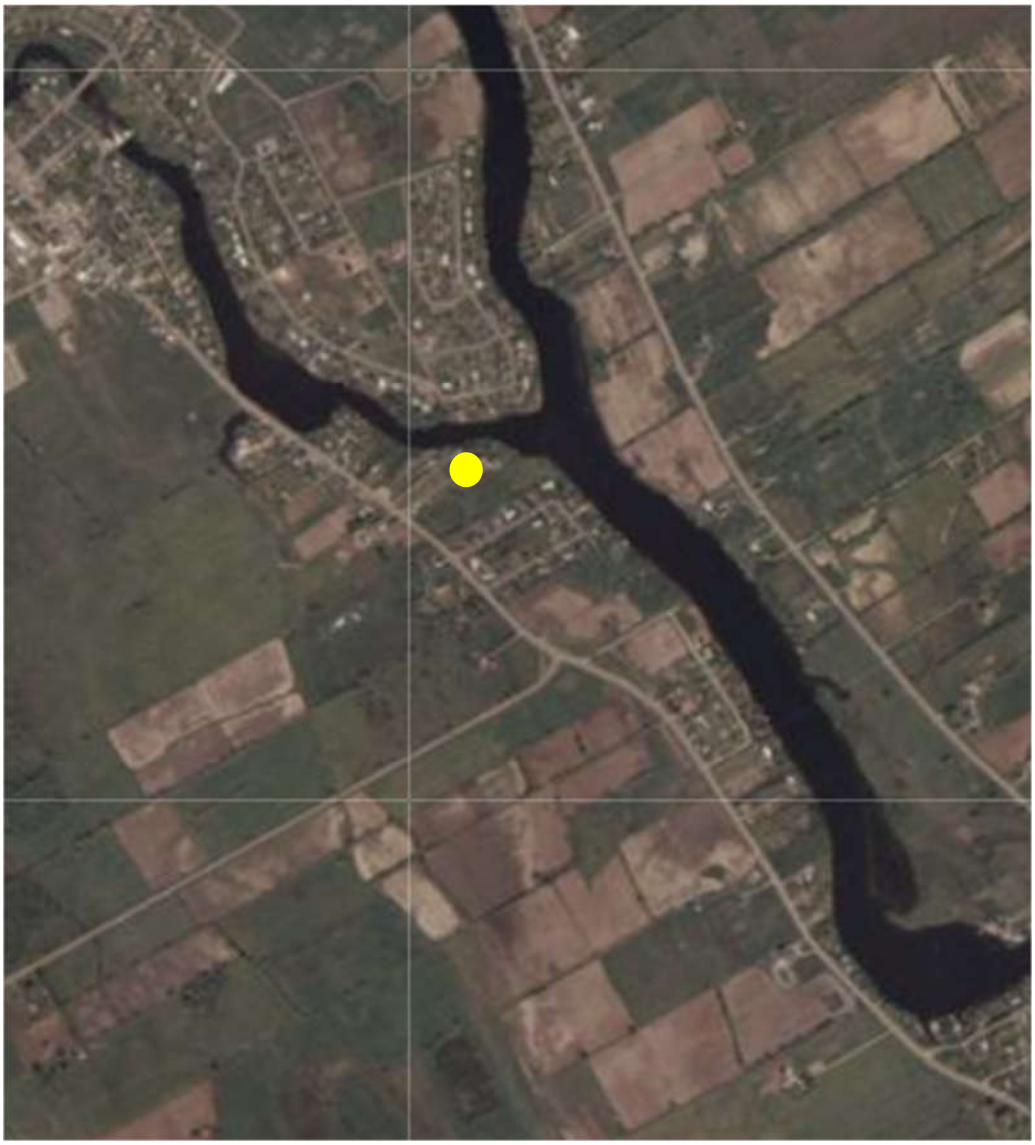
# Appendix C
# Historical Aerial Photographs

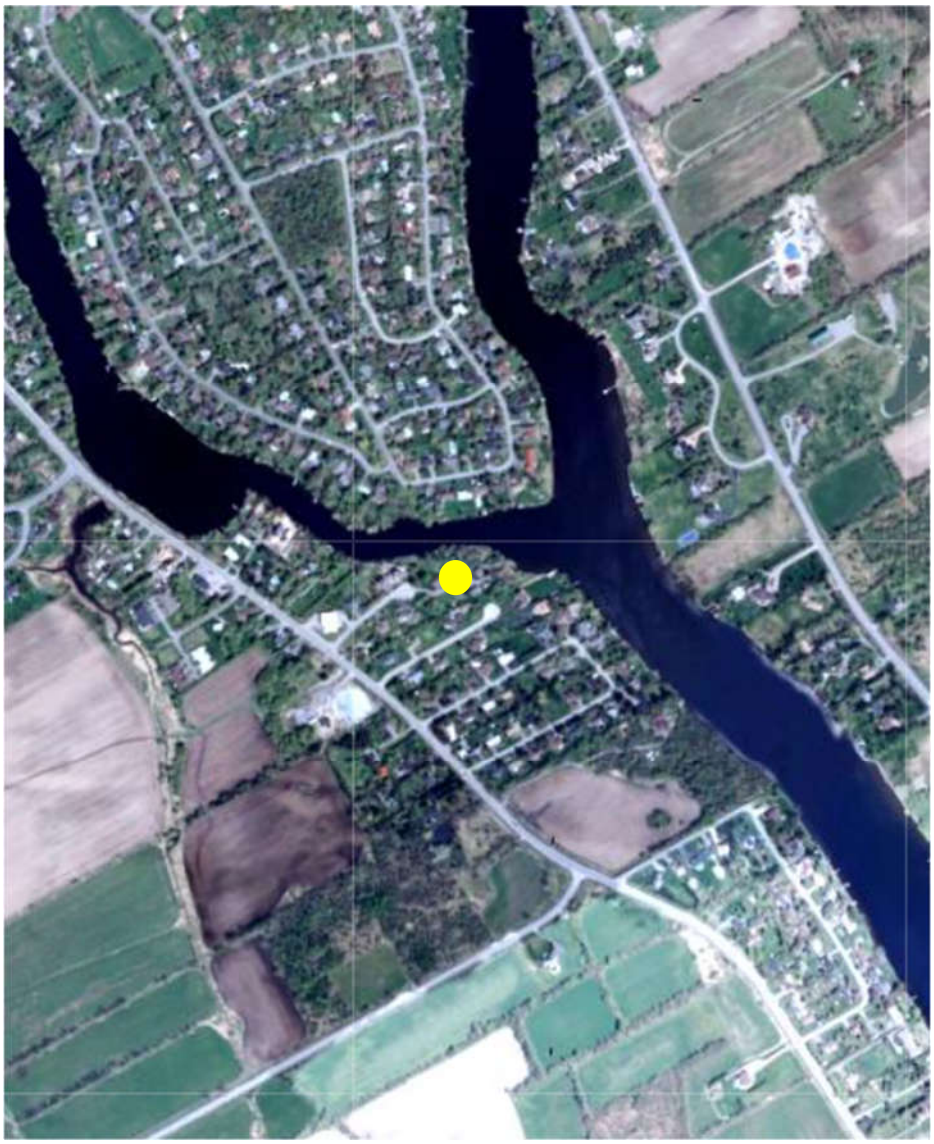


**Location:** 1086 Antochi Lane, Manotick (Yellow Dot)
**Year:** 1954
**Source:** University of Toronto Map and Data Library

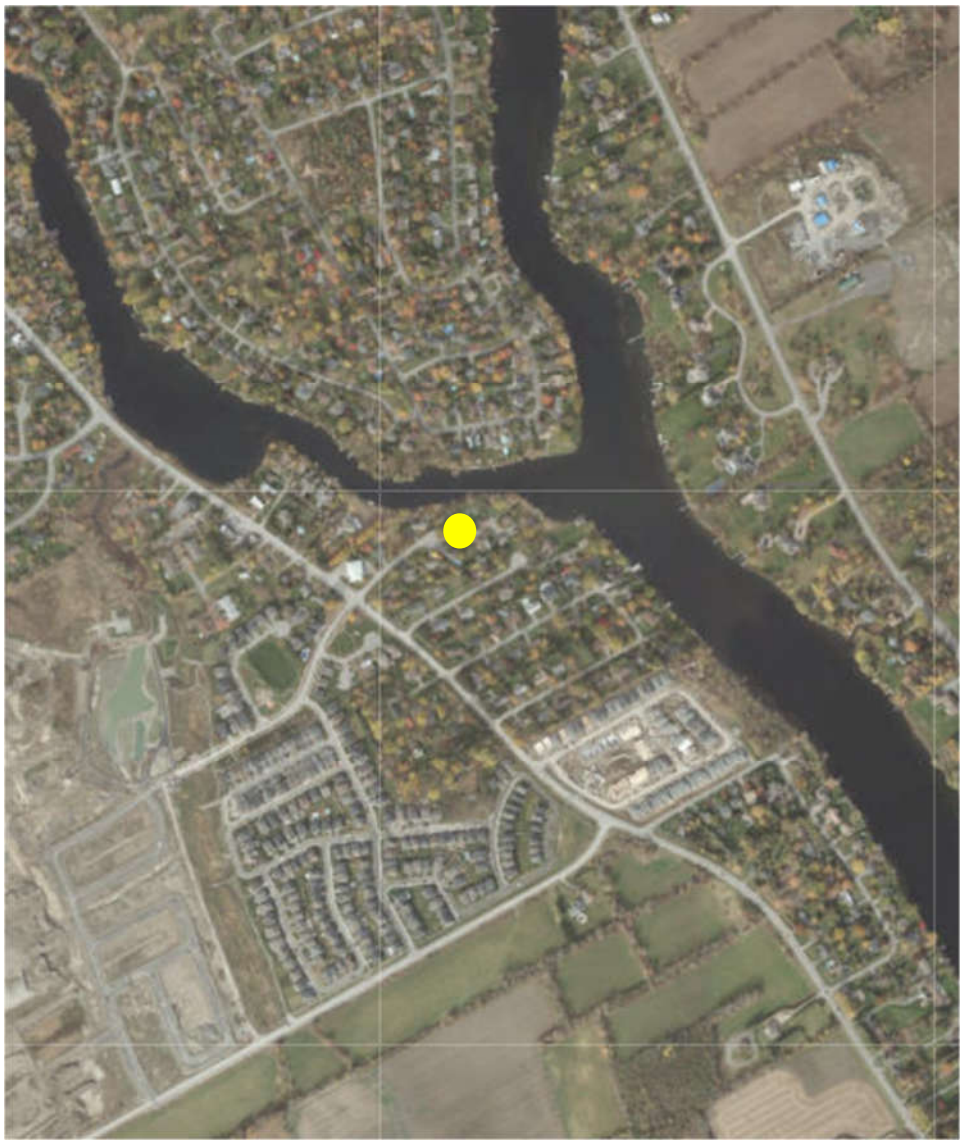


**Location:** 1086 Antochi Lane, Manotick  (Yellow Dot)
**Year:** 1976
**Source:** GEO Ottawa

**Location:** 1086 Antochi Lane, Manotick (Yellow Dot)
**Year:** 2005
**Source:** GEO Ottawa



**Location:** 1086 Antochi Lane, Manotick  (Yellow Dot)
**Year:** 2008
**Source:** GEO Ottawa



**Location:** 1086 Antochi Lane, Manotick (Yellow Dot)
**Year:** 2021
**Source:** GEO Ottawa

# Appendix D
# Historical Channel Position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# Historical Assessment

1086 Antochi Lane

Manotick, Ontario

## Legend

**Historical Channel Bank Position**

- 1976
- 2002
- 2011
- 2021

N

0 10 20

Metres

Imagery: City of Ottawa, 2021. Approximate Property Parcel: City of Ottawa/GEO Morphix Ltd., 2023. Historical Bank Tracings: GEO Morphix Ltd., 2023. Print Date: June 2023. PN23057. Drawn By: M.O., S.S.O.

# Appendix E
# Photographic Record

| | |
|---|---|
| **Photo 1**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Photograph taken at the downstream extent of the subject lands. Bank was unaltered along an approximately 5 m section. |
| **Photo 2**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Photograph taken at the downstream extent of the subject lands. The remainder of the bank was composed of 10-20 cm rip rap. |

| | |
|---|---|
| **Photo 3**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Erosion blanket observed at several locations along the bank under the rip rap. |
| **Photo 4**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Photograph taken facing downstream, bank materials extended approximately 1-3 m into the water, and 1-2 m up the channel banks. |

| | |
|---|---|
| **Photo 5**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Between property lines, vegetation extended to the water edge. Mature and immature vegetation was well established along the banks. |
| **Photo 6**<br>**Rideau River**<br>**1086 Antochi Lane, Manotrick** |  |
| | Photograph taken facing upstream at the upstream extent of the subject lands. A majority of the shoreline was composed of rip rap. Private docks were present at the shoreline of most residences. |

# Appendix F
# Field Observations

GEO MORPHIX

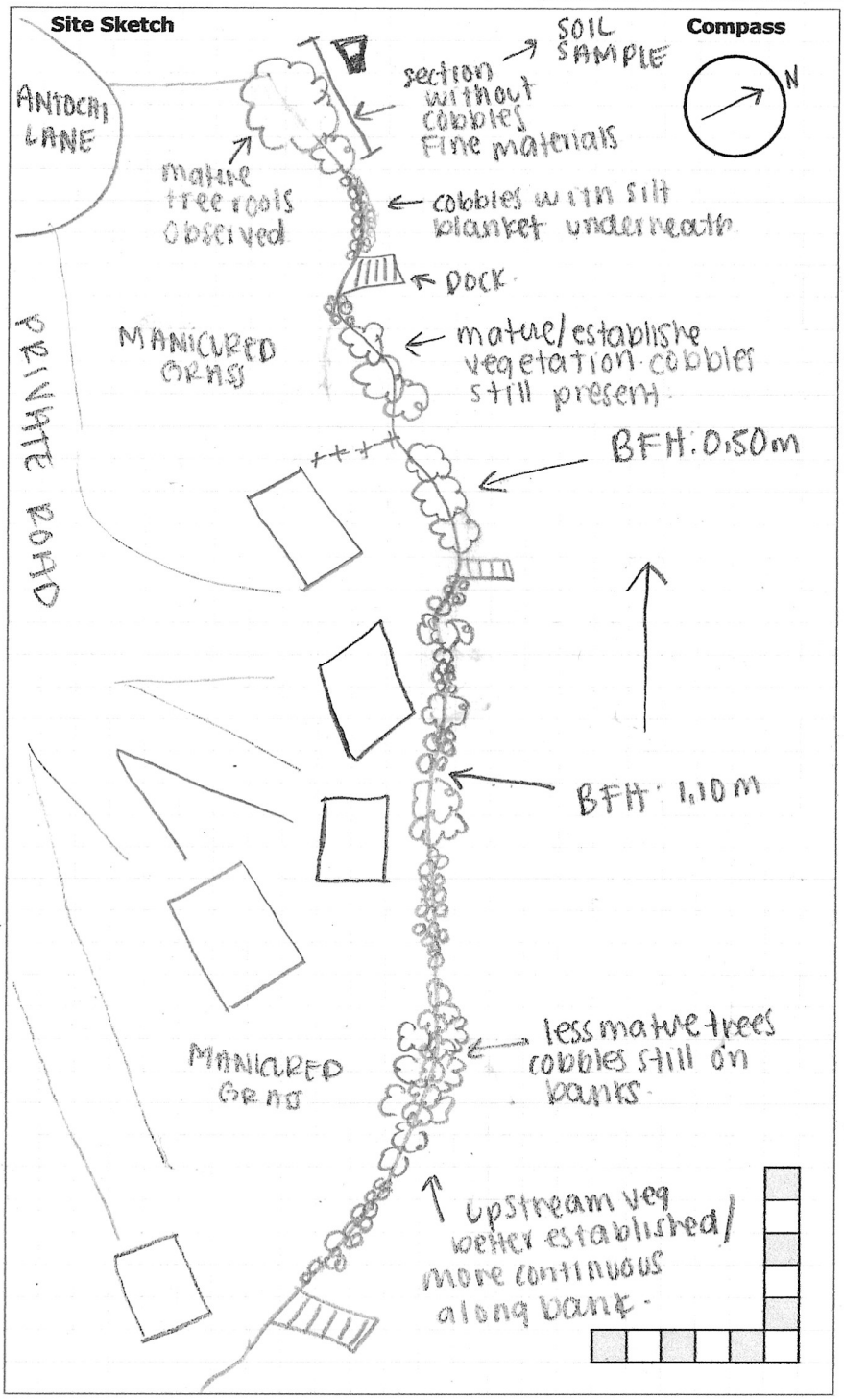
## General Site Characteristics

**Project Number:** 22057

| | | | |
|---|---|---|---|
| **Date:** | 2023-05-17 | **Stream:** | Rideau River |
| **Time:** | 9:15am | **Reach:** | RR1 |
| **Weather:** | 10°C, cloudy | **Location:** | Antochi Lane |
| **Field Staff:** | KM, KS | **Watershed/Subwatershed:** | Rideau 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**




**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:** Entire shoreline composed of angular cobbles (10-20cm diameter). Bank vegetation well established where present. No signs of active erosion.

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX™

## Reach Characteristics  Project Number: 23057

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | 17-05-23 | **Field Staff:** | KM KS | **Watershed/Subwatershed:** | RIDEAU RIVER |
| **Time:** | 9:15 AM | **Stream:** | RIDEAU RIVER | **UTM (Upstream):** | |
| **Weather:** | 10°C, CLOUDY | **Reach:** | | **UTM (Downstream):** | |

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

### Riparian Vegetation

**Dominant Type** (Table 6): 1, 2
**Encroachment** (Table 7): 2

| 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 %**: N/A

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

WDJ/50m: N/A

### Water Quality

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

### Channel Characteristics

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

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

**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 NM | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Pool NM | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Bed (if no riffle-pool morphology) NM | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Bankfull Width (m)** | NM | | | **Wetted Width (m)** | NM | | |
| **Bankfull Depth (m)** | NM | | | **Wetted Depth (m)** | NM | | |
| **Undercuts (m)** | N/A | | | **Velocity (m/s)** | NM | | |
| **Pool Depth (m)** | NM | | | **Velocity Estimate Method** | N/A | | |
| **Riffle Length (m)** | NM | | | **Meander Amplitude (m)** | NM | | |

**Notes:** BANK HEIGHT 0.50-1.25 M FROM WE, ANGULAR COBBLE 2-5m WIDTH, EROSION BLANKET BENEATH COBBLE FOR ENTIRE SITE LENGTH. TOPOGRAPHY FLAT IN BACKYARDS, MINOR SLOPE

NOTE! N/A → NOT PRESENT
NM → NOT MEASURED DUE TO WATERBODY SCALE/PERMITTED ACCESS

**Photos:**

Version #4
Last edited: 04/04/2023

Senior staff sign-off (if required): SSD  Checked by: SSD  Completed by: KS/KM

GEO MORPHIX™

## Rapid Geomorphic Assessment

**Project Number:** 23057

| | | | |
|---|---|---|---|
| **Date:** | 2023-05-17 | **Stream:** | Rideau River |
| **Time:** | 9:15am | **Reach:** | RR1 |
| **Weather:** | 10°C cloudy | **Location:** | Antochi Lane |
| **Field Staff:** | KM / KS | **Watershed/Subwatershed:** | Rideau River |

| Process | No. | Geomorphological Indicator | Present? Yes | Present? No | Factor Value |
|---|---|---|---|---|---|
| Evidence of Aggradation (AI) | 1 | Lobate bar | | X | 0/5 |
| | 2 | Coarse materials in riffles embedded | NM | NM | |
| | 3 | Siltation in pools | | X | |
| | 4 | Medial bars | | X | |
| | 5 | Accretion on point bars | | X | |
| | 6 | Poor longitudinal sorting of bed materials | NM | NM | |
| | 7 | Deposition in the overbank zone | | X | |
| | | Sum of indices = | 0 | 5 | 0 |
| Evidence of Degradation (DI) | 1 | Exposed bridge footing(s) | N/A | N/A | 0/7 |
| | 2 | Exposed sanitary / storm sewer / pipeline / etc. | | X | |
| | 3 | Elevated storm sewer outfall(s) | N/A | N/A | |
| | 4 | Undermined gabion baskets / concrete aprons / etc. | | X | |
| | 5 | Scour pools downstream of culverts / storm sewer outlets | N/A | N/A | |
| | 6 | Cut face on bar forms | | X | |
| | 7 | Head cutting due to knickpoint migration | | X | |
| | 8 | Terrace cut through older bar material | | X | |
| | 9 | Suspended armour layer visible in bank | | X | |
| | 10 | Channel worn into undisturbed overburden / bedrock | | X | |
| | | Sum of indices = | 0 | 7 | 0 |
| Evidence of Widening (WI) | 1 | Fallen / leaning trees / fence posts / etc. | X | | 2/8 |
| | 2 | Occurrence of large organic debris | | X | |
| | 3 | Exposed tree roots | X | | |
| | 4 | Basal scour on inside meander bends | | X | |
| | 5 | Basal scour on both sides of channel through riffle | | X | |
| | 6 | Outflanked gabion baskets / concrete walls / etc. | N/A | N/A | |
| | 7 | Length of basal scour >50% through subject reach | | X | |
| | 8 | Exposed length of previously buried pipe / cable / etc. | | X | |
| | 9 | Fracture lines along top of bank | | X | |
| | 10 | Exposed building foundation | N/A | N/A | |
| | | Sum of indices = | 2 | 10 | 0.25 |
| Evidence of Planimetric Form Adjustment (PI) | 1 | Formation of chute(s) | | X | 0/10 |
| | 2 | Single thread channel to multiple channel | | X | |
| | 3 | Evolution of pool-riffle form to low bed relief form DAM DS → | NM | NM | |
| | 4 | Cut-off channel(s) | | X | |
| | 5 | Formation of island(s) | | X | |
| | 6 | Thalweg alignment out of phase with meander form | | X | |
| | 7 | Bar forms poorly formed / reworked / removed | | X | |
| | | Sum of indices = | 0 | 6 | .0 |

**Notes:** ANGULAR RIPRAP ON EROSION BLANKET COVERED BANK THROUGHOUT. SPATIAL SCALE OF SITE SMALLER THAN A REACH BASED ON SCALE OF RIDEAU RIVER. NOTE

| Stability Index (SI) = (AI+DI+WI+PI)/4 = | | | 0.062 |
|---|---|---|---|
| **In Regime** | **In Transition/Stress** | | **In Adjustment** |
| ☐ **0.00 - 0.20** | ☐ **0.21 - 0.40** | | ☐ **0.41** |

N/A - NOT PRESENT. NM → NOT MEASURED DUE TO LARGE SCALE.

Version #3
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO Checked by: SSO Completed by: KS/KM

GEO MORPHIX

## Rapid Stream Assessment Technique  Project Number: 23057

| | | | |
|---|---|---|---|
| **Date:** | 2023-05-17 | **Stream:** | Rideau River |
| **Time:** | 9:15am | **Reach:** | RR1 |
| **Weather:** | 10°C, cloudy | **Location:** | Antorhi Lane |
| **Field Staff:** | KM / KS | **Watershed/Subwatershed:** | Rideau River |

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

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO  Checked by: SSO  Completed by: KM/KS

* NOTE NIA → Not present
NM → Not measured due to large scale/ permitted access

GEO MORPHIX

| Date: | 2023-05-17 | PN: | 23057 | Location: | Rideau River |
|---|---|---|---|---|---|

| Category | Poor | Fair | Good | Excellent |
|---|---|---|---|---|
| | • 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) |
| DAM → DS | • 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.<br>• 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<br>• Relatively diverse velocity and depth of flow | • Riffles, runs and pool habitat present<br>• Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water) |
| NM<br>Physical Instream Habitat | • Riffle substrate composition: predominantly gravel with high amount of sand<br>• < 5% cobble | • Riffle substrate composition: predominantly small cobble, gravel and sand<br>• 5-24% cobble | • Riffle substrate composition: good mix of gravel, cobble, and rubble material<br>• 25-49% cobble | • Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand<br>• > 50% cobble |
| NM | • 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 |
| DAM DS | • 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 |
| N/A | • 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<br>• TDS: > 150 mg/L | • Grey colour<br>• TDS: 101-150 mg/L | • Slightly grey colour<br>• TDS: 50-100 mg/L | • Clear flow<br>• 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) = | Poor (<13) | Fair (13-24) | Good (25-34) | Excellent (>35) |
|---|---|---|---|---|

Version #2
Last edited: 10/02/2023

Senior staff sign-off (if required): SSO Checked by: SSO Completed by: KM/KS