February 14, 2025

CBM Aggregates, a division of St. Marys Cement Inc. (Canada)
55 Industrial Street,
Toronto, ON M4G 3W9

Attn: David Hanratty (VCNA)
Director of Land, Resource & Environment

Re: **Fluvial Geomorphic Assessment at Credit River and Tributary System in Caledon, Ontario**
Proposed CBM Caledon Pit/Quarry Project
GEO Morphix Ltd. Project No. PN24061 – Report Version 1.0

1.0 INTRODUCTION

GEO Morphix Ltd. (GEO Morphix) was retained by CBM Aggregates, a division of St. Marys Cement Inc. (Canada) (CBM), to conduct technical services to support the regulatory approvals for the Caledon Pit/Quarry licence application (the Project). The technical services involved the completion of a fluvial geomorphic assessment in the receiving surface water environment of the proposed Caledon Pit/Quarry, specific to the tributary and mainstem channel system of the Credit River near Charleston Side Road.

The purpose of this report is to present the methods and results of the fluvial geomorphic study at the subject channels of the Credit River and tributary system. A summary of the study objectives and reporting structure is presented immediately below. A description of the methods and results of the assessment follows.

Project Overview and Study Objectives

With reference to Figure 1, the proposed conditions for the Project include the discharge of pumped water from the planned pit/quarry operations (i.e., surplus water that is not managed directly at the site – estimated to be 18 L/s on an average annual basis as described in WSP [2023]) to a location on the southeast side of the Osprey Valley Golf Course (OVGC). The surplus water will, in turn, be directed to one or more of the storage ponds at the OVGC, and, depending on the time of year and available storage capacity, relied on for irrigation purposes or returned to the receiving environment. This considers that, under existing conditions, permitted water takings at OVGC (primarily obtained/pumped from the Credit River at a location immediately north of Pond 3 – East and used mainly for golf course irrigation), coupled with local runoff and groundwater inputs, are managed through the on-site pond system, noting the following, relevant drainage conditions and water management practices:

- The network of ponds in the central portion of the site are relied on to convey the managed water from generally north to south (i.e., water is directed in series from Pond 3 – East through to Pond 4 – South), with the understanding that water above and beyond the storage capacity of the ponds is allowed to passively drain to an unnamed tributary of the Credit River (described herein as "Tributary 4") at a location immediately downgradient of Pump House A (i.e., surplus water from Pond 4 – South collects at a wet well structure at the pumphouse, and, under overflow/bypass conditions, drains to Tributary 4 via a culvert).

- The ponds at the far east side of the site (described herein as the "East Ponds") have no connection to the existing water management network/infrastructure in the central part of the site and serve to capture and convey local runoff to the Credit River by way of a small outlet channel (also an unnamed tributary of the Credit River and described herein as the "East Ponds Outlet Channel"), recognizing that water from the ponds drain to the outlet channel via a culvert, as well as through other surface and subsurface flow paths (i.e., flows have been shown to overtop the outlet berm and also enter the downstream channel through subsurface pathways in the berm).

It also considers that, based on site observations and discussions with CBM to date, the proposed conditions for the Project include two conveyance path alternatives to direct the discharge waters from the Caledon Pit/Quarry to the Credit River:

1. Tributary 4 via the network of ponds and related water management infrastructure (existing or planned) in the central portion of the OVGC site.
2. The East Ponds and associated East Ponds Outlet Channel on the east side of the OVGC site via the installation of new water management infrastructure at the golf course facility (to direct water to the East Ponds from the central part of the site).

The regulatory review of the licence application for the Project has been ongoing in recent years. As part of this review process, the Credit Valley Conservation Authority (CVC) has communicated concerns that the proposed discharge activities from the Caledon Pit/Quarry have the potential to increase rates of erosion-sedimentation at the mainstem channel of the Credit River and/or channels of the contributing tributaries.

Based on the above, GEO Morphix was tasked to complete a fluvial geomorphic study at the subject channels of the Credit River and tributary system (specifically Tributary 4 and the East Ponds Outlet Channel, given that each feature was identified as a potential conveyance path alternative) to assess the potential for Project-related effects on characteristic erosion-sedimentation processes, and, where appropriate, to identify suitable mitigation measures. The results of the geomorphic assessment will be used to address the comments from CVC, and, as part of this, to inform the discharge capacity and control requirements at the subject receiving channels, as well as to comment on the preferred conveyance path alternative.

Reporting Structure

The remaining part of this report has been organized into three main sections. The methods and results are described in Section 2.0 and Section 3.0, respectively, while a summary and discussion are outlined in Section 4.0.

2.0 METHODS

As illustrated on Figure 2, the fluvial geomorphic studies were conducted at the following locations of the Credit River and tributary system:

- Unnamed tributary of the Credit River that is described herein as Tributary 4.
- Unnamed tributary of the Credit River that is described herein as the East Ponds Outlet Channel.
- Credit River from a location approximately 100 m upstream of the confluence with Tributary 4 to a location approximately 100 m downstream of the confluence with the East Ponds Outlet Channel.

The studies included the completion of an existing conditions assessment, as well as an erosion threshold assessment. The methodology for these studies is detailed below.

Existing Conditions Assessment

The existing conditions assessment involved the completion of desktop- and field-based studies to characterize the past and present channel morphology (including erosion-sedimentation patterns and associated bed and bank stability) in the subject receiving environment. Each component of the existing conditions assessment is outlined below.

The desktop analyses comprised a review of available study reports and data records for the site to assist in the general characterization of channel and watershed conditions at the subject watercourses, as well as to guide or inform the field studies (e.g., selection of representative channel units for the detailed geomorphic assessment) and the erosion threshold assessment. The relevant materials for the desktop review included the following:

- Mapping and imagery for the subject watersheds (i.e., soils and geological information, LiDAR and other topographic mapping, and historical and recent aerial photographs/imagery) that were obtained through publicly available sources.
- Flow estimates (e.g., average monthly flows, return period flow rates, etc.) for the subject channels that were obtained from WSP.
- Past environmental studies and reporting for the Project that were obtained from WSP.

The field studies involved the completion of rapid and detailed geomorphic assessments between July 23 and July 25, 2024, as well as other cursory level, visual inspections on June 17 and July 18, 2024 (to support the planning and implementation of the detailed field work, and, in the case of the July 18 visit, to observe high flow conditions at the subject channels following the major rainfall event on July 16). The specific field activities included the following at each of the subject channels:

- Completion of a Rapid Geomorphic Assessment (MOE, 2003) and Rapid Stream Assessment Technique (Galli, 1996) to evaluate channel stability and stream 'health', respectively.

- Completion of rapid-based habitat sketch maps and related observation logs in accordance with Newson and Newson (2000) to document the presence of, or variations to, channel bedform features (e.g., riffles and/or nick points, etc.), meander bend patterns/sequences, areas of active channel and valley slope erosion, channel substrate types and flow patterns, woody debris and other instream structures, and riparian vegetation.

- Detailed measurements of channel geometry and hydraulics, including bankfull width and depth, side and channel slope, channel entrenchment heights, pool and riffle flow depths, vegetation rooting depths, and flow velocity, noting that the various measurements of channel geometry were obtained through the completion of a targeted topographic survey (using RTK GPS survey equipment) at several representative channel cross-sections and profile units, while the flow velocity measurements were obtained via the floating ball method at a similar set of locations.

- Detailed characterization of bed and bank materials via the completion of a modified Wolman (1954) pebble count technique at the identified cross-section locations, supplemented, where needed, with the sampling of the fine-grained component of the substrate and subsequent testing of this material at an accredited laboratory for grain size distribution (i.e., bed and bank materials were sampled at discrete locations using an Ekman dredge sampler, and, in turn, the samples were issued to the laboratory for physical analysis).

Following the completion of the field investigations, the full set of field data was compiled and summarized to facilitate the characterization of existing channel conditions and associated controls on channel morphology at the watercourse network, and, as part of this, to develop several detailed desktop analyses. The topographic survey data, in particular, was used, in combination with other key measurements and standard coefficients, to estimate bankfull flow characteristics (e.g., discharge, average velocity, stream power, tractive force, and flow competency) at the subject channels. The same information was relied on to derive erosion thresholds for the receiving environment (described in the section below).

Erosion Threshold Assessment

The erosion thresholds for the subject channels (i.e., flow rates that would be expected to maintain physical stability at the subject channels) were quantified, in the form of a "critical discharge", based on the observed substrate (bed and bank) materials and channel geometry. The derivation of the critical discharge estimates involved the calculation of flow velocity, U, and shear stress, t, values under a range of flow rates and associated depths for a representative cross section, and, in turn, the comparison of these values against the assumed threshold for the bed and bank materials (i.e., the theoretical flow velocity or shear stress that would be expected to result in entrainment and transport of sediment based on Julien [1998], Fischenich [2001], Chow [1959], and others). The results of the comparison were then used to determine the point at which a given flow condition at the channel (using velocity and shear stress as the proxy) was shown to "exceed" the threshold of the substrate.

The flow velocity estimates were determined using a Manning's approach; mathematically represented as:

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

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

The shear stress estimates were determined using the depth-slope product; mathematically represented as:

$$t = d\rho g S_{bed} \quad \text{[Eq. 2]}$$

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

The erosion thresholds for the subject channels were determined for both bed and bank materials, noting the following:

- The lower of the two erosion threshold values was adopted at a given location to maintain a conservative and limiting estimate.
- The erosion threshold estimates at the banks were scaled by a factor of 0.75 in accordance with Chow (1959) to account for the inferred reduction in shear stress and velocity at the channel margins.

For added context to assess the potential for Project-related effects on characteristic erosion-sedimentation processes at the subject channels, the erosion threshold estimates were compared against the characteristic flow conditions for the local surface water system. The flow information for each of the watercourses were provided by WSP and included estimates of mean, minimum, and maximum monthly flow rates, as well as flood flow conditions under the 2-year, 5-year, and 10-year return period events, with the understanding that the flow estimates at each of the subject channels were derived by pro-rating flow records (i.e., daily discharge data) from local Water Survey of Canada stream gauge stations.

3.0 RESULTS

Existing Conditions Assessment

The detailed results from the existing conditions assessment at the subject channels are presented in Appendices A, B, and C. This includes the documented records of observed channel morphology in Appendix A (photographs) and Appendix B (field measurements and sketches), as well as a detailed summary of the characteristic geomorphology and hydrotechnical conditions in Appendix C.

With reference to Photographs 1 through 4 (embedded below), the key findings from the existing conditions assessment are listed below for each of the subject channels:

- The observed channel morphology at the **Credit River** (from approximately 100 m upstream of the confluence with Tributary 4 to a location approximately 100 m downstream of the confluence with the East Ponds Outlet Channel) demonstrated mostly alluvial controls and included the following attributes:
    - Channel features were well-defined (i.e., incised channel with prominent bed and banks) with low to moderate entrenchment relative to the surrounding terrain;
    - Channel planform was characterized by a moderate, irregular meander pattern with partial valley confinement;
    - Bed form included alternating riffle-pool sequences (or run and pool features) for the bulk of the surveyed section;
    - Channel gradient was minor (<0.5%) for the majority of the surveyed section;
    - Channel geometry was broad and largely trapezoidal with:

        - average bankfull widths ranging from 14.19 m to 14.70 m;
        - average bankfull depths varying from 0.66 m to 1.02 m; and
        - bank angles ranging from 15 to 90°.
    - Erosion and/or depositional features at the channel included undercutting of banks (on the order of 0.10 m to 0.82 m) for the majority of the surveyed section, as well as discrete instances of leaning trees and valley wall contact;
    - Instream controls included instances of woody debris (of moderate densities);
    - Bank materials were composed of mostly fine-grained sediment (i.e., silty/sandy clay with instances of small to large cobbles), while bed materials comprised sands (ranging from very fine to very coarse sand) and small to large cobbles;
    - Surface flows were generally low to moderate (i.e., water levels were below bankfull – albeit notably higher during the site visit on July 18 that followed the major rainfall event) and exhibited a visible surface current; and
    - Riparian zone spanned more than 10 channel widths and consisted of a continuous cover of mature and well-established vegetation (including trees and shrubs).

- The observed channel morphology at the **East Ponds Outlet Channel** (a short, section of channel approximately 33 m in length) showed mostly alluvial controls and included the following attributes:
    - Channel features were well-defined with moderate entrenchment relative to the surrounding terrain;
    - Channel planform was straight and confined;
    - Bed form was mostly flat;
    - Channel gradient was low (<1.0%);
    - Channel geometry was narrow and mostly trapezoidal with:
        - average bankfull widths of 2.53 m;
        - average bankfull depths of 0.31 m; and
        - bank angles of 40 to 70°.
    - Erosion and/or depositional features at the channel included:
        - A knickpoint at the upstream extent of the channel (located immediately downstream from the berm at the East Ponds where flows were conveyed from the upstream pond to the downstream channel via a degraded, 0.3 m diameter culvert, as well as by way of throughflow and overflow at the berm itself [as observed both in June and July, 2024]);
        - Undercutting of the banks on both sides of the channel for approximately 60% of the surveyed length; and
        - A small, vegetated island (sand deposit) immediately upstream of the confluence with the Credit River (likely indicative of backwater effects / dispositional influences from the mainstem channel).
    - Instream controls included some woody debris and vegetation encroachment;
    - Bank materials were composed of silt and fine to medium sand with small to large cobbles, while bed materials consisted of medium to very coarse sand with cobbles;
    - Surface flows were generally low at the channel; and
    - Riparian zone spanned between 4 and 10 channel widths and consisted of a dense cover of mature cedar trees.

- The observed channel morphology at **Tributary 4** (section that extends from the golf course limits near Pumphouse A to the confluence with the Credit River) demonstrated alluvial and wetland controls and included the following attributes:
    - Channel features were largely ill-defined (i.e., absence of discernible bed and/or banks) except for at the downstream-most extent of the watercourse (~ 75 m length of channel) that supported incised conditions;
    - Channel planform (or primary flow path of the watercourse) was characterized by a moderate and irregular meandering pattern;
    - Bed form (where present) was mostly flat;
    - Channel or valley gradient was low (<1.0%);
    - Channel geometry (where present) was narrow and mostly trapezoidal with:
        - average bankfull widths of 2.89 m;
        - average bankfull depths of 0.20 m; and

    - bank angles of 15 to 45°.
  - Erosion and depositional features were mostly absent;
  - Instream controls included moderate to high density woody debris, heavy vegetation encroachment, and rooted emergent aquatic vegetation;
  - Bank materials (where present) were composed of clays with silts and sands (ranging from very fine to coarse sand) and occasional gravels, while bed materials consisted of fine to medium sand with small to large cobbles;
  - Surface flows were largely discontinuous (the watercourse was characterized by dry channel conditions and/or a series of mostly isolated ponded features at the time of the field visits in June and July, 2024) except for at the downstream-most extent of the watercourse that supported flowing conditions (albeit nominal in magnitude); and
  - Riparian zone spanned over 10 channel widths and comprised a dense cover of trees, shrubs, and low-lying vegetation.

Photograph 01: Credit River near confluence with Tributary 4 (June 2024).

Photograph 02: East Ponds Outlet Channel near confluence point with Credit River (June 2024).

Photograph 03: Tributary 4 at a location downgradient of the OVGC access road (June 2024).

Photograph 04: Tributary 4 near confluence point with Credit River (June 2024).

A summary of the key characteristics at the subject channels is provided in Table 1 and includes field-surveyed (or -inferred) channel dimensions and conditions, desktop-based hydraulic and catchment area calculations, and pebble count derived grain sizes.

Table 1. Summary of Observed and Derived Geomorphic and Hydrotechnical Conditions at Subject Channels

Geomorphic and Hydrotechnical Parameters at Selected Cross-Section Location	Subject Channel			
	Tributaries of Credit River		Mainstem of Credit River	
	East Ponds Outlet Channel (2)	Tributary 4 (3)	Credit River at East Ponds Outlet Channel	Credit River at Tributary 4
Catchment Area (ha) (1)	16	229	15,051	14,759
Surveyed Channel Gradient (%)	0.71	0.96	0.38	0.30
Surveyed Bankfull Width (m)	2.53	2.89	14.19	14.70
Surveyed Bankfull Depth (m)	0.31	0.20	1.02	0.66
Bed material – Calculated D_{50} (mm) (4)	10.8	<2mm	26.2	27.9
Bank material – Observed	Silty sand with small to large cobbles	Silty clay with fine to medium sand	Silty/sandy clay with small to large cobbles	Silty/sandy clay
Inferred Manning's n	0.045	0.045	0.045	0.045
Field Measured Flow (m^3/s) (5)	0.021	No Flow (Standing)	0.547	0.450
Calculated Bankfull Discharge (m^3/s)	0.41	0.44	14.75	8.95
Calculated Bankfull Velocity (m/s)	0.71	0.75	1.02	0.92

(1) Catchment areas at the subject channels were estimated based on the Ontario Watershed Information Tool (OWIT), noting that the estimated catchment area for Tributary 4 does not account for the seasonal/intermittent drainage from the irrigation ponds at OVGC.
(2) Calculated hydraulic conditions at East Ponds Outlet Channel (as well as the surveyed channel gradient) were estimated based on the channel length located downstream of the knick point and berm.
(3) Surveyed channel dimensions and calculated hydraulic conditions at Tributary 4 were estimated at the location that included discernible bed and banks (i.e., incised channel at the downstream-most extent of the watercourse).
(4) The full suite of available pebble count results on a reach-specific scale were used to generate the reported bed material values for each of the subject channels (i.e., calculated D_{50} values). The laboratory-based grain size results were used, for descriptive purposes, to provide a more fulsome characterization of the fine-grained component of the sampled substrate (or, in case of sites/samples dominated by fines, relied on to infill for the calculated D_{50} values where pebble count analyses were not possible or practical).
(5) Field measured flows were obtained from July 23 to July 25, 2024.

The results of the erosion threshold assessment are presented in Tables 2 and 3. This includes the estimated erosion thresholds for each of the subject channels (Table 2), as well as a comparison of the threshold values with the characteristic flow conditions to provide a means of assessing the channel capacity to accommodate added flow contributions from the Project or other (Table 3).

Table 2. Summary of Erosion Threshold Results at Subject Channels

Geomorphic and Hydraulic Parameters at Selected Cross-Section Location	Subject Channel							
	Tributaries of Credit River				Mainstem of Credit River			
	East Ponds Outlet Channel		Tributary 4		Credit River at East Ponds Outlet Channel		Credit River at Tributary 4	
	Bed	Bank	Bed	Bank	Bed	Bank	Bed	Bank
Critical Velocity or Shear Stress	0.45 m/s	0.34 m/s	0.46 m/s	7.18 N/m^2	0.76 m/s	0.53 m/s	0.76 m/s	7.18 N/m^2
Critical Discharge (m^3/s)	0.100	0.100	0.134	0.149	3.859	3.153	3.668	2.284
Erosion Threshold (m^3/s)	**0.100**		**0.134**		**3.153**		**2.284**	
Notes on Critical Discharge Estimates	Critical velocities of 0.34 m/s and 0.45 m/s were based on Julien (1998) for "medium sand" and "firm sandy loam", respectively; each of which corresponded to a critical discharge of 0.100 m^3/s. For the purposes of maintaining conservative estimates, the observed cobbles at the channel (present as a minor component at both the bed and banks) were not considered in the erosion threshold calculations.		Critical velocity of 0.46 m/s at the bed was based on Fischenich (2001) for a "fine to medium sand" and resulted in a critical discharge of 0.134 m^3/s. Critical shear stress of 7.18 N/m^2 at the banks was based on Chow (1959) for "fairly compact sandy clays" and resulted in a critical discharge of 0.149 m^3/s. For the purposes of maintaining conservative estimates, the observed cobbles at the channel bed (present as a minor component at most locations) were not considered in the erosion threshold calculations.		Critical velocity of 0.76 m/s at the bed was based on Fischenich (2001) for "small cobbles" and resulted in a critical discharge of 3.859 m^3/s. Critical velocity of 0.53 m/s at the banks was based on Julien (1998) for "sandy-loamy clay" and resulted in a critical discharge of 3.153 m^3/s. For the purposes of maintaining conservative estimates, the observed cobbles at the channel banks (present on a variable basis) were not considered in the erosion threshold calculations.		Critical velocity of 0.76 m/s at the bed was based on Fischenich (2001) for "small cobbles"; corresponding to a critical discharge of 3.668 m^3/s. Critical shear stress of 7.18 N/m^2 at the banks was based on Chow (1959) for "fairly compact sandy clays"; corresponding to a critical discharge of 2.284 m^3/s. For the purposes of maintaining conservative estimates, the observed cobbles at the channel banks (present on a variable basis) were not considered in the erosion threshold calculations.	

Table 3. Comparison of Erosion Threshold Results with Characteristic Flow Conditions at Subject Channels

Characteristic Flow Rate	Existing Flow at Channel (m^3/s)	Proportion of Flow at Channel Relative to Critical Discharge (%)	Proportion of Flow at Channel Relative to Critical Discharge (m^3/s)
East Ponds Outlet Channel (ET 0.100 m^3/s)			
Field-Measured Flow	0.021	21%	-0.079
Min Monthly Flow	0.001	1%	-0.099
Max Monthly Flow	0.004	4%	-0.096
2-Year Flow	0.068	68%	-0.032
5-Year Flow	0.127	127%	+0.027
10-Year Flow	0.157	157%	+0.057
Tributary 4 (ET 0.134 m^3/s)			
Field-Measured Flow	No Flow (Standing)	N/A	N/A
Min Monthly Flow	0.014	10%	-0.12
Max Monthly Flow	0.052	39%	-0.082
2-Year Flow	0.525	392%	+0.39
5-Year Flow	0.914	682%	+0.78
10-Year Flow	1.196	893%	+1.06
Credit River at East Ponds Outlet Channel (ET 3.153 m^3/s)			
Field-Measured Flow	0.547	17%	-2.61
Min Monthly Flow	0.939	30%	-2.21
Max Monthly Flow	3.410	108%	+0.26
2-Year Flow	11.405	362%	+8.25
5-Year Flow	21.362	672%	+18.21
10-Year Flow	29.469	935%	+26.32
Credit River at Tributary 4 (ET 2.284m^3/s)			
Field-Measured Flow	0.450	18%	-1.83
Min Monthly Flow	0.921	40%	-1.36
Max Monthly Flow	3.343	146%	+1.06
2-Year Flow	11.236	492%	+8.95
5-Year Flow	21.046	921%	+18.76
10-Year Flow	29.033	1,271%	+26.75

The key findings from the comparison of the erosion threshold estimates with the characteristic flow conditions are presented below:

- **Mainstem of Credit River** – The characteristic flow rates at the mainstem of the Credit River were shown to be lower than the estimated erosion thresholds for flow rates up to and including the minimum monthly flows (at both areas of interest at the river – downstream of each of the

confluence points with the subject tributary channels). This suggests that, under existing conditions, channel stability at the Credit River can be maintained under low to moderate flows, but sediment entrainment and transport is inferred under seasonally higher flow rates (e.g., spring freshet) and larger flood flow conditions. To that end, the capacity of the channel to accommodate additional flow volumes from the Project or other would be expected to align to this same flow regime. However, for added context, it is important to point out that the preliminary estimates of average annual pump rates from the Project (i.e., 18 L/s as described in WSP [2023]) represent less than 1% of the maximum monthly flow and 2-year flood event at the Credit River, meaning that, even under high flow events, the supplementary flows (assuming some or all would passively drain from OVGC to the receiving environment) would serve to provide little to no added risk of heightened rates of channel erosion.

- **Tributaries of Credit River** – The characteristic flow rates at the East Ponds Outlet Channel and Tributary 4 were shown to be lower than the estimated erosion thresholds for flow rates up to and including the maximum monthly flows, and, in the case of the East Ponds Outlet Channel, the 2-year flow event. This suggests that, under existing conditions, channel stability at the subject tributaries of the Credit River can be maintained under a wide range of low to high flow conditions, and, because of this, the capacity of the respective channels to accommodate additional discharge volumes during similar types of flow periods would be expected to follow suit. Similar to the identified comparisons for the mainstem of the Credit River, the estimated average annual pump rate from the Project represents less than 3% and 2% of the respective 2-year event and 5-year event at Tributary 4, meaning that, under larger flood flow events, the supplementary flows would be equally inconsequential from the standpoint of added erosion risks. In contrast, for the East Ponds Outlet Channel, the estimated average annual pump rate from the Project represents approximately 26% and 14% of the respective 2-year event and 5-year event.

4.0 SUMMARY OF RESULTS AND DISCUSSION

Based on a review of the results from the fluvial geomorphology study at subject channels of the Credit River and tributary system, Project-related effects on the characteristic erosion-sedimentation processes in the receiving environment are expected to be negligible. This considers that the subject channels were shown to be relatively stable under existing conditions, noting some evidence of active erosion processes (widening and degradation) at the East Ponds Outlet. It also considers that, based on the derived erosion thresholds and the preliminary estimates of average annual pump rates from the Project, the subject channels include sufficient capacity to accommodate an increase in flows (while still maintaining channel stability) under a relatively wide range of runoff conditions.

Further to the above, the results review suggested that Tributary 4 would serve as the preferred conveyance path to direct the discharge waters from the Caledon Pit/Quarry to the Credit River (via the OVGC). This was based on the following inferences and observations:

- The existing irrigation infrastructure/network at the OVGC site, coupled with the associated passive drainage processes, could be relied on to manage the discharge waters from the proposed Caledon Pit/Quarry (through a new or amended PTTW), with the understanding that, given the expected water demands at the golf facility, the storage and taking practices at the irrigation ponds could serve to reduce the actual quantity of water directed to the Credit River (i.e., some or all of the pumped water could be re-purposed for irrigation depending on the time of year), and, as part of that, further limit any added risk of increased rates, however negligible, of downstream erosion-sedimentation processes.
- Channel stability at Tributary 4 was shown to be especially prominent, with specific consideration of the low gradient of the channel and associated wetland influences, the dense/heavy vegetation cover at the banks and overbank zone, the strong connection to the floodplain, and the absence of erosion and depositional features.
- The estimated erosion threshold at Tributary 4 was shown to be slightly higher than the associated value at the East Ponds Outlet Channel.

Of note, the East Ponds Outlet Channel could still serve as a potentially viable option to receive and convey supplementary flows from the Caledon Pit/Quarry and OVGC (given that the channel was shown to support relatively stable conditions [albeit with some evidence of active erosion] and demonstrated a suitable level of capacity to accommodate additional flows). However, the implementation of this alternative would likely require alterations to one or both of the outlet structure/berm and channel to improve the physical stability and drainage capacity of the outlet area and the installation of new water management infrastructure at the OVGC (to direct water to the East Ponds from the central or other part of the site).

Staying on the topic of potential mitigation requirements and assuming that pump rates from the Project remain generally in line with the preliminary estimates from WSP (2023), there is no evidence to suggest that channel protection measures would be required at Tributary 4, or, for that matter, the Credit River, to accommodate the additional flow inputs. However, in the interest of maintaining channel stability in the receiving environment, and as part of this, appropriately managing the discharge of pumped water to OVGC, the implementation of the following general mitigation plan is recommended at the Tributary 4 and Credit River system:

- During typical/normal flow conditions (i.e., periods of low to moderate flow rates), the total flows at Tributary 4 and the Credit River (including any supplementary flows that are allowed to passively drain from the OVGC site) should be maintained at or below the erosion threshold limits for the subject channels; and
- During comparatively higher flow events (when flow rates could theoretically exceed the estimated critical discharge limit), the total flows at Tributary 4 and the Credit River (including, again, any supplementary flows that are allowed to passively drain from the OVGC site) should be maintained within 5% of the estimated flow rates under existing conditions, recognizing that this upper bound (of 5%) is expected to be well within the range of natural variation for a given flow event.

CLOSURE

We trust that the content of this technical memorandum meets your current requirements. However, should you have any questions or comments, please direct them to the undersigned.

Respectfully submitted,

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REFERENCES

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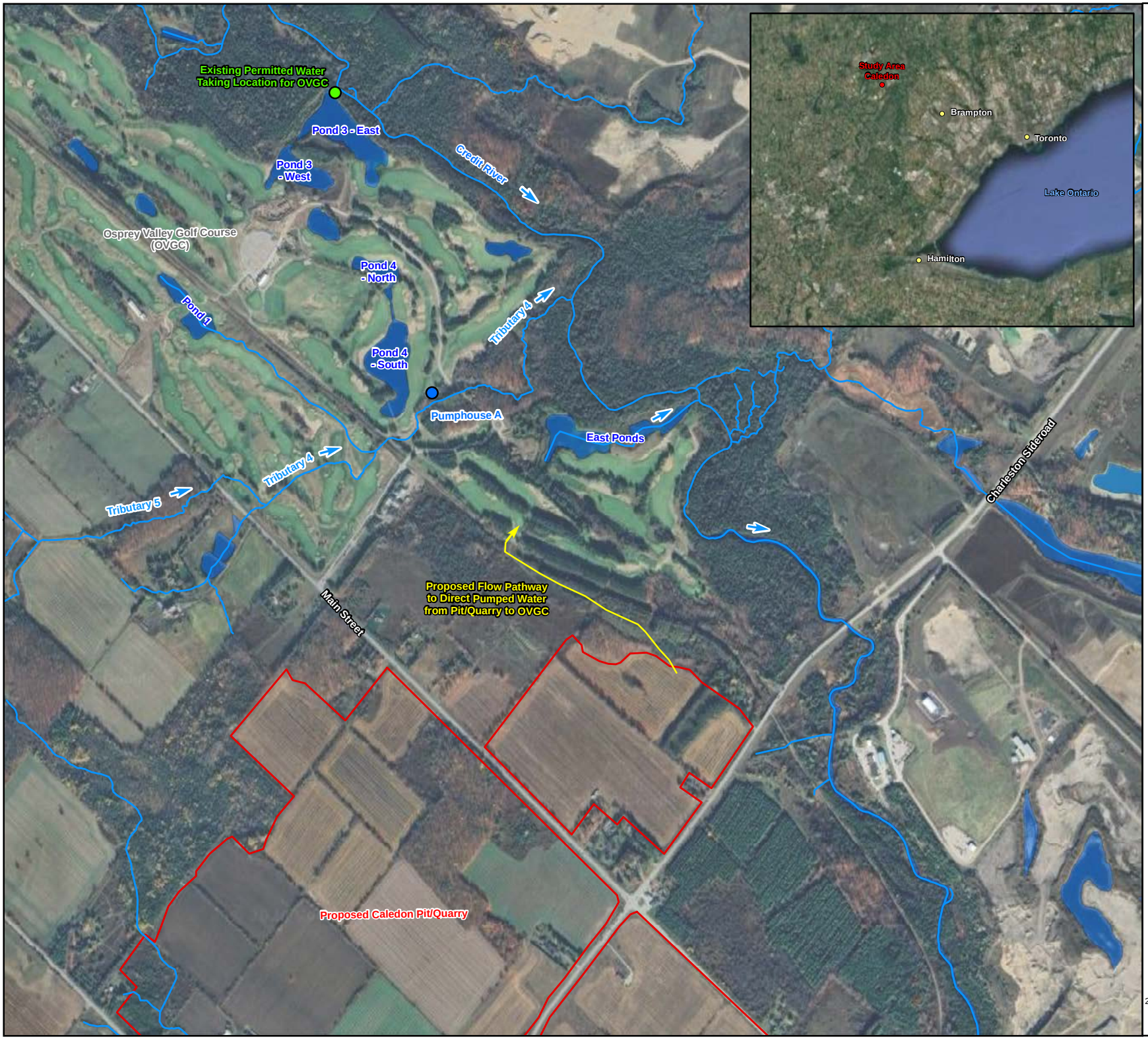
Figures



GEO MORPHIX™

Figure 1

Study Area for Fluvial Geomorphology Assessment

Proposed Caledon Pit/Quarry

Caledon, Ontario

Legend

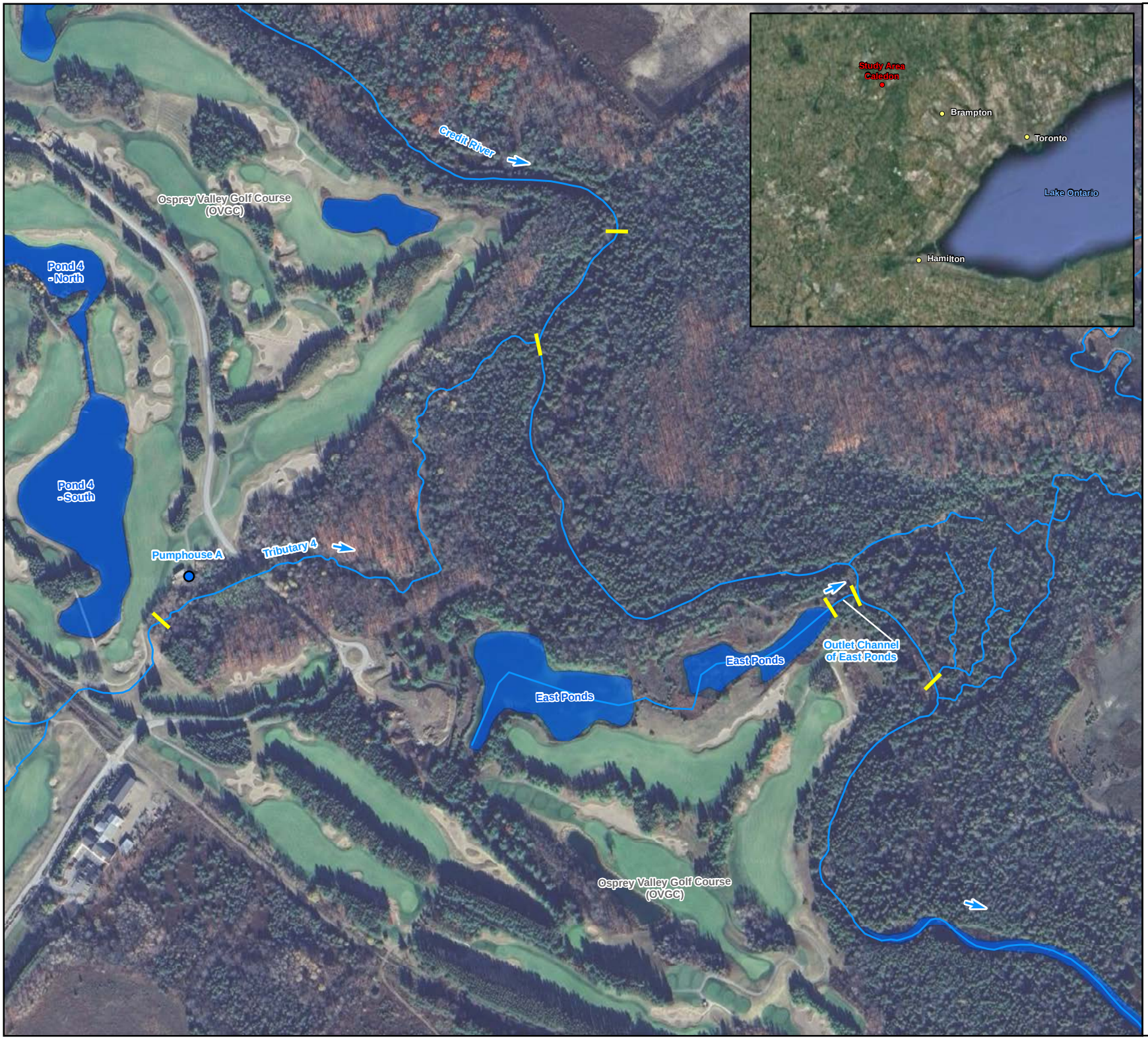
- Watercourse
- Property Limits of Proposed Caledon Pit/Quarry
- Waterbody

N

0 210 420

Metres

Imagery: Google Earth, 2022. Watercourse: CVC, 2022. Waterbody: MNRF, 2024/GEO Morphix Ltd., 2024. Approximate Study Area and Limit of Extraction: Digitized from Golder, 2023. PN24061.
Drawn By: A.F., M.O. Print Date: Setpember 2024.



GEO MORPHIX™

Figure 2

Spatial Limits for Detailed Geomorphic Assessments

Proposed Caledon Pit/Quarry

Caledon, Ontario

Legend

- Approximate Limits for Detailed Geomorphic Assessments
- Watercourse
- Waterbody

N

0 80 160

Metres

Imagery: Google Earth, 2022. Watercourse: CVC, 2022. Waterbody: MNRF, 2024/GEO Morphix Ltd., 2024. Reach Break and ID: GEO Morphix Ltd., 2024., 2023. PN24061.
Drawn By: A.F., M.O. Print Date: September 2024.

Appendix A
Reach Photographs

Photo 1
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel - facing downstream at the upstream portion of the reach. Heavy encroachment of vegetation into the channel was observed throughout the upstream extent.

Photo 2
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel – facing upstream within the upstream extent. A knickpoint and culvert were identified immediately downstream of the East Ponds berm.

Photo 3
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel – facing downstream. Undercutting was observed along the left bank.

Photo 4
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel – Bed materials consisted predominantly of medium to very coarse sand.

Photo 5
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel – Bank materials consisted predominantly of silt and fine to medium sand, with small to large cobbles.

Photo 6
East Ponds Outlet Channel, Caledon, ON
July 24, 2024

East Ponds Outlet Channel – facing upstream at the confluence with the Credit River. A small vegetated island was present at the confluence.

Photo 7 Tributary 4, Caledon, ON July 23, 2024	
	Tributary 4 – facing downstream at the upstream extent. A high density of woody debris was found throughout the channel.
Photo 8 Tributary 4, Caledon, ON July 23, 2024	
	Tributary 4 – facing downstream. Heavy encroachment is observed throughout, with no observed evidence of erosion-sedimentation features.

Photo 9
Tributary 4, Caledon, ON
July 23, 2024

Tributary 4 – the channel was poorly-defined and dry at time of assessment with the upstream extent, with some ponded water found within pools.

Photo 10
Tributary 4, Caledon, ON
July 23, 2024

Tributary 4 – bed materials along the downstream extent consisted of fine to medium sand and scattered small to large cobbles.

Photo 11
Tributary 4, Caledon, ON
July 23, 2024

Tributary 4 – bank materials along the downstream extent consisted of silty-clays and very fine to coarse sand.

Photo 12
Tributary 4, Caledon, ON
July 23, 2024

Tributary 4 – facing downstream near the confluence with the Credit River at the downstream extent. The channel widened and small to large cobbles were apparent along the bed.

Photo 13 Credit River, Caledon, ON July 25, 2024	
	Credit River – taken downstream of the confluence with Tributary 4, facing downstream.
Photo 14 Credit River, Caledon, ON July 25, 2024	
	Credit River – facing the left bank. Undercutting and exposed roots were observed downstream of the confluence with Tributary 4.

Photo 15
Credit River, Caledon, ON
July 25, 2024

Credit River – facing upstream. The Credit River flows through an open meadow located between the confluence with Tributary 4 and the East Ponds outlet channel.

Photo 16
Credit River, Caledon, ON
July 25, 2024

Credit River – facing upstream, downstream of the confluence with the East Ponds outlet channel .

Photo 17 Credit River, Caledon, ON July 25, 2024	
	Credit River – facing the left bank, downstream of the confluence with the East Ponds outlet channel. Valley wall contact was observed.
Photo 18 Credit River, Caledon, ON July 25, 2024	
	Credit River – facing the right bank, upstream of the confluence with the East Ponds outlet channel. Bank materials consisted of fairly compact silty/sandy clays with small to large cobbles.

Appendix B
Field Sheets

GEO MORPHIX™

General Site Characteristics

Project Number: 24061

Date:	2024-07-24	**Stream:**	East Ponds Trib
Time:	11:15	**Reach:**	East Ponds Outlet Channel
Weather:	22° CLOUDY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CREDIT 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		

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

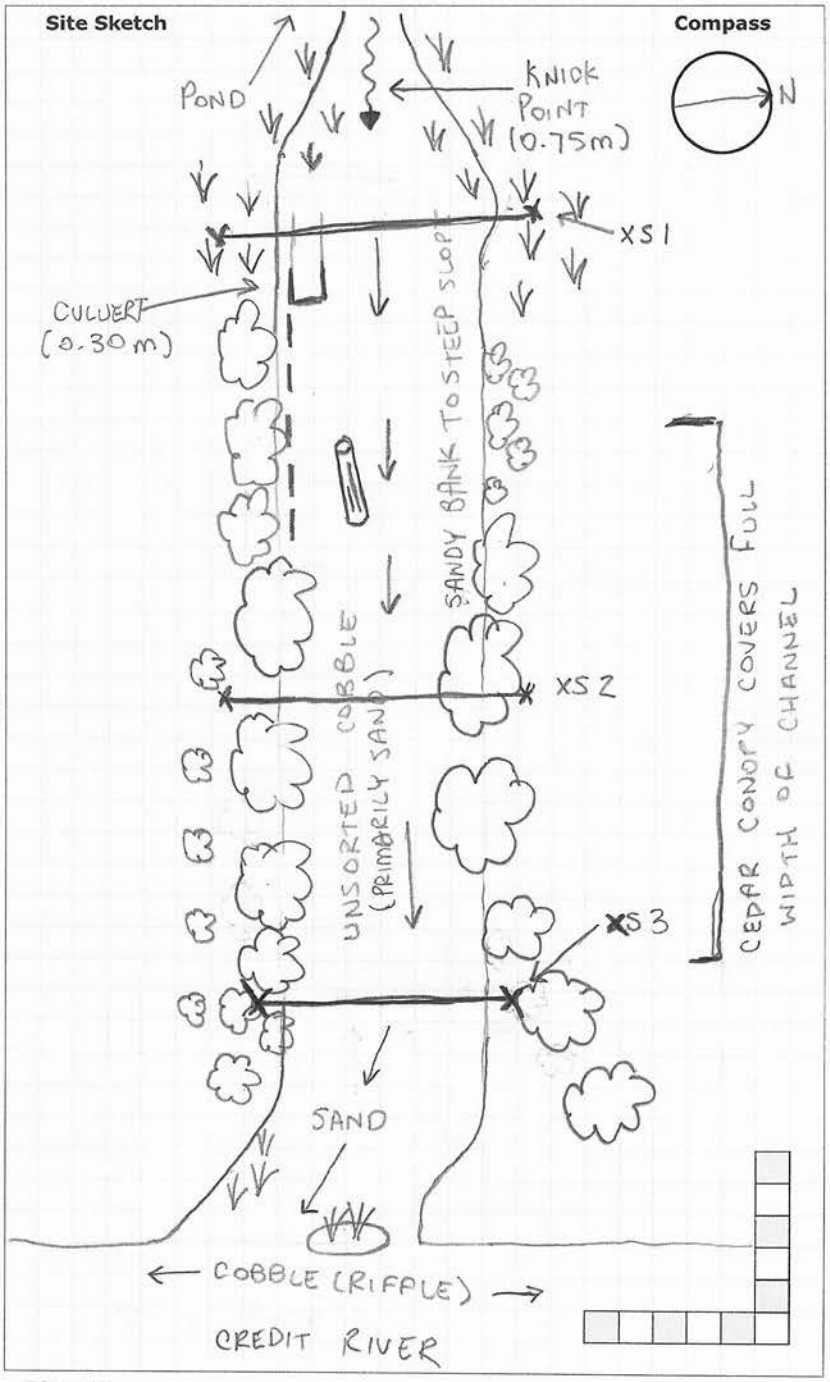
Substrate

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: CULVERT = 0.30 m

KNICK = 0.75 m

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Assessment Long Profile (Level) Project Code: 24061

Date:	2024-07-24	**Reach:**	East Ponds Outlet Channel
Time:	11:15	**Location:**	OUGC
Weather:	22° CLOUDY	**Watershed/Subwatershed:**	CREDIT RIVER
Field Staff:	EF MK	**Rain in last 24 hours:**	☐ None ☐ Yes: Amount _____ mm

Top	Middle	Bottom	Angle	Water	XS	Notes
1002	0865	0740	252	0740		
0980	0843	0715	252	0746		
0982	0852	0723	251.5	0786		
1025	0900	0772	251	0802		
1042	0918	0792	251	0879		
1085	0960	0838	252	0945		
1610	1488	1365	252	1396		
1606	1487	1370	252	1381		
1589	1579	1363	252	1392		
1597	1490	1382	252	1403		
1610	1510	1408	252.5	1409	XS 1	
1596	1500	1402	253	1410		
1602	1510	1422	252.5	1418		
1638	1551	1466	252	1422		
1631	1552	1476	250	1415		
1592	1522	1452	250	1419		
1589	1525	1462	249	1424		
1597	1541	1486	249	1442		
1596	1546	1496	249	1415	XS 2	
1601	1559	1515	248.5	1434		
1599	1565	1529	246	1425		
1588	1560	1530	249	1432		
1588	1566	1546	243	1428		
1587	1578	1554	242	1432		
1596	1582	1569	236	1438	XS 3	
1585	1576	1568	222	1432		
1609	1605	1600	182.5	1429		
1623	1612	1602	121	1442		
1648	1628	1610	118	1432		
1625	1595	1562	132	1431		

Survey Direction

☒ Upstream to Downstream

☐ Downstream to Upstream

Cross-sections

No. of Cross-sections Surveyed: 3

Monitoring Cross-sections: ☒ No ☐ Yes

XS ID: _____ / _____ / _____

Erosion Pin Installed: ☒ No ☐ Yes

XS ID: _____ / _____ / _____

Velocity & Sediment Transport

☐ Velocity 0.1125 m/s **Method:**

☐ Discharge _____ m^3/s _____

Sed. Transport (Table 21): ☐ Suspended

☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Valley Type (Table 2)

☒ Confined ☐ Partially ☐ Unconfined

Channel Zone (Table 4)

☐ Headwater ☒ Transfer ☐ Deposition

Land Use (Table 1)

FORESTED

Vegetation

Aquatic Vegetation: _____

Coverage of Reach: _____%

☐ In Stream ☐ Margins ☐ On Bank

Riparian Vegetation: ☐ No ☒ Yes

Extent of Riparian Cover:

☐ Fragment ☐ None ☒ Continuous

Riparian Cover (channel widths):

☐ 1-4 ☒ 4-10 ☐ >10

Age Class of Riparian Vegetation:

Immature Established Mature

☐ (<5 yrs) ☐ (5-30 yrs) ☒ (>30 yrs)

Extent of Encroachment:

☐ None ☐ Minimal ☐ Moderate

☒ Heavy ☐ Extreme

Density of Woody Debris:

☐ Low ☒ Moderate ☐ High

Blockage(s) in Channel:

☐ Infrastructure ☐ Dam ☐ LWD

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS 1
Time:	2:00	**Reach:**	East Ponds Outlet Channel
Weather:	22° SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CREDIT RIVER

X	Y	NOTE			Notes
1.75	1991	LB PIN			
2.0	2140				
2.15	2282				
2.4	2482				
2.65	2640				
2.9	2788				
3.1	2980				
3.35	3091				
3.5	3231	BF			
3.75	3384				
3.95	3532				
4.10	3617				
4.25	3656	WE			
4.45	3730				
4.65	3743				
4.8	3749				
4.95	3746				
5.12	3670	WE			
5.20	3516				
5.4	3428				
5.65	3348				
5.85	3250				
6.1	3132				
6.4	3076				
6.95	2952				

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

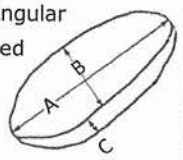
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
	1			1.2			3			SAND	
	1.9			4			4.6				
	0.9			5.3			4				
3	2.2	0.5	2.9	2.2	1.4	4	2.4	0.6			
	1.1			3.5			4.6				
	1.4			3			1.2				
	0.9			3			2.3				
4	3.8	0.3	5.8	3.8	2.3	3.7	3	0.5			
	0.8			2.4			2.9				
	1			4.3			1.1				

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 10 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.152 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS1

Distance 1.0 m Time 6.83 s V 0.146 m/s

Distance 1.0 m Time 6.44 s V 0.155 m/s

Distance 1.0 m Time 6.41 s V 0.156 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

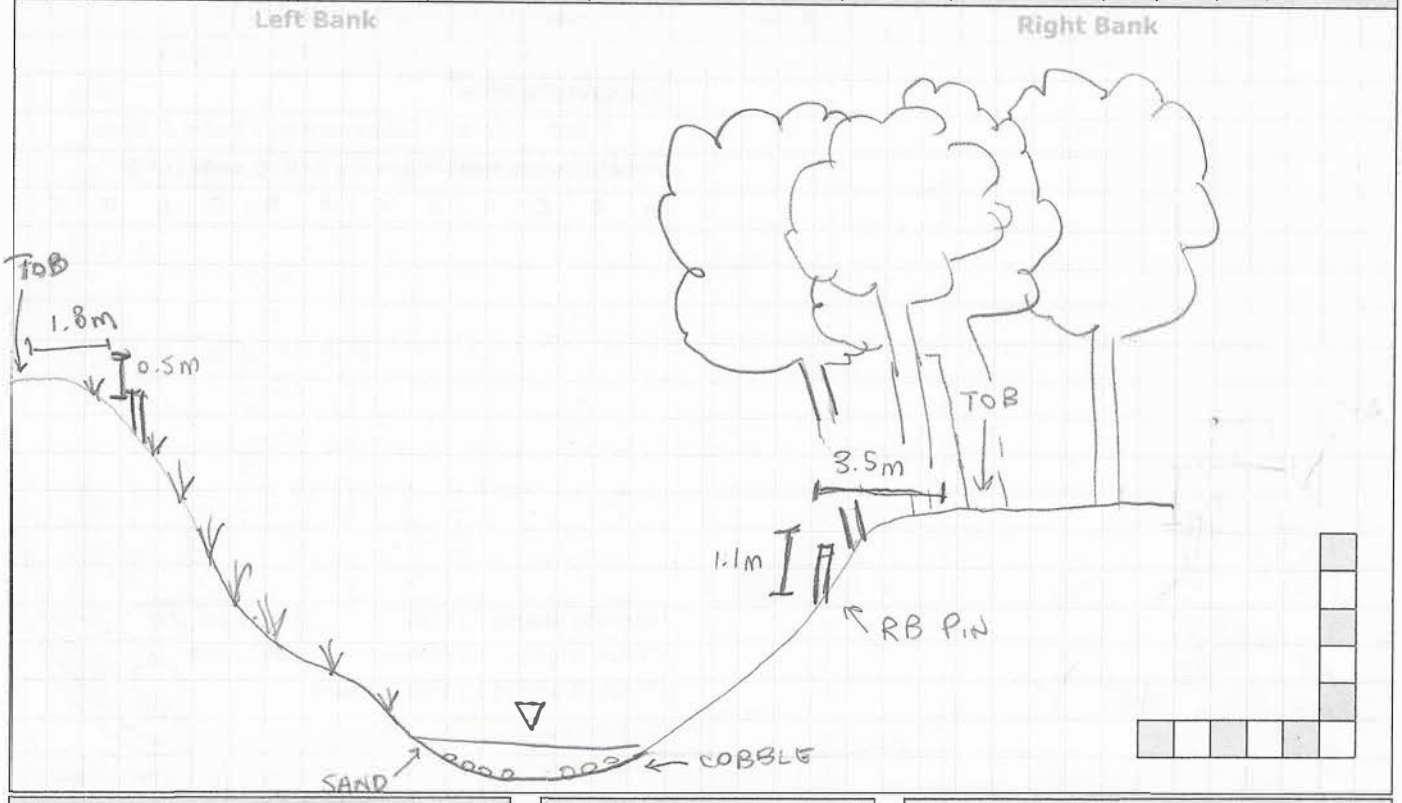
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS1
Time:	2:00	**Reach:**	East Ponds Outlet Channel
Weather:	22oC Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble	
☐ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder	
Bank Height:	2.0	m
Bank Angle:	50	°
Root Depth:	1.0	m
Root Density:	10	%
Undercut:	0	m
Erosion Pin:	/	m
Torvane:	0.25	kg/cm²
Penetrometer:	2.25	kg/cm²
Foot Used:	☐ Yes ☒ No	

Features

	Station location
	Monumented XS
	Monumented photo
	Undercut bank
	Eroded bank/slope
	Bank stabilization
	Fence
	Grasses
	Leaning tree
	Tree
	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble	
☐ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder	
Bank Height:	2.1	m
Bank Angle:	40	°
Root Depth:	1.0	m
Root Density:	15	%
Undercut:	0	m
Erosion Pin:	/	m
Torvane:	0.25	kg/cm²
Penetrometer:	1.75	kg/cm²
Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS 2
Time:	1:15	**Reach:**	East Ponds Outlet Channel
Weather:	22° CLOUDY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CREDIT RIVER

X	Y	Note			Notes
1.75	1045	LB PIN			
2.0	1232				
2.25	1396				
2.5	1522				
2.75	1722				
3.0	1907				
3.25	2069				
3.5	2214				
3.75	2300				
4.0	2512				
4.2	2648	BF			
4.4	2872				
4.45	3006				
4.71	3068	WE			
5	3167				
5.2	3156				
5.45	3180				
5.6	3172				
5.9	3165				
6.15	3146				
6.4	3075	WE			
6.5	3024				
6.55	2838				
6.65	2749				
6.8	2636	BF			
7.05	2470				
7.25	2362				
7.45	2256				
7.65	2068				
7.85	1952				
8.15	1889				
8.35	1800				
8.5	1720				
8.75	1625				
9.0	1542				
9.25	1465				
9.47	1392				

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

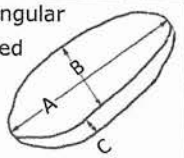
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
1			3			4.3			SAND		
2			1			2.3					
1.1			3.2			2					
11	7.2	1.1	5.4	5.3	1	11	8	6.5			
0.6			7			4					
1.1			3.3			4.3					
5			1.1			3					
4	2.8	2	11.3	8	2	2.2	2.1	0.8			
5.1			2.9			1.8					
7.3			10			0.9					

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 30 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☒ Obsv ☐ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☒ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: 1.0 %

Velocity

☒ Measured 0.048 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 2

Distance 0.5 m Time 9.64 s V 0.052 m/s

Distance 0.5 m Time 10.88 s V 0.048 m/s

Distance 0.5 m Time 11.44 s V 0.043 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

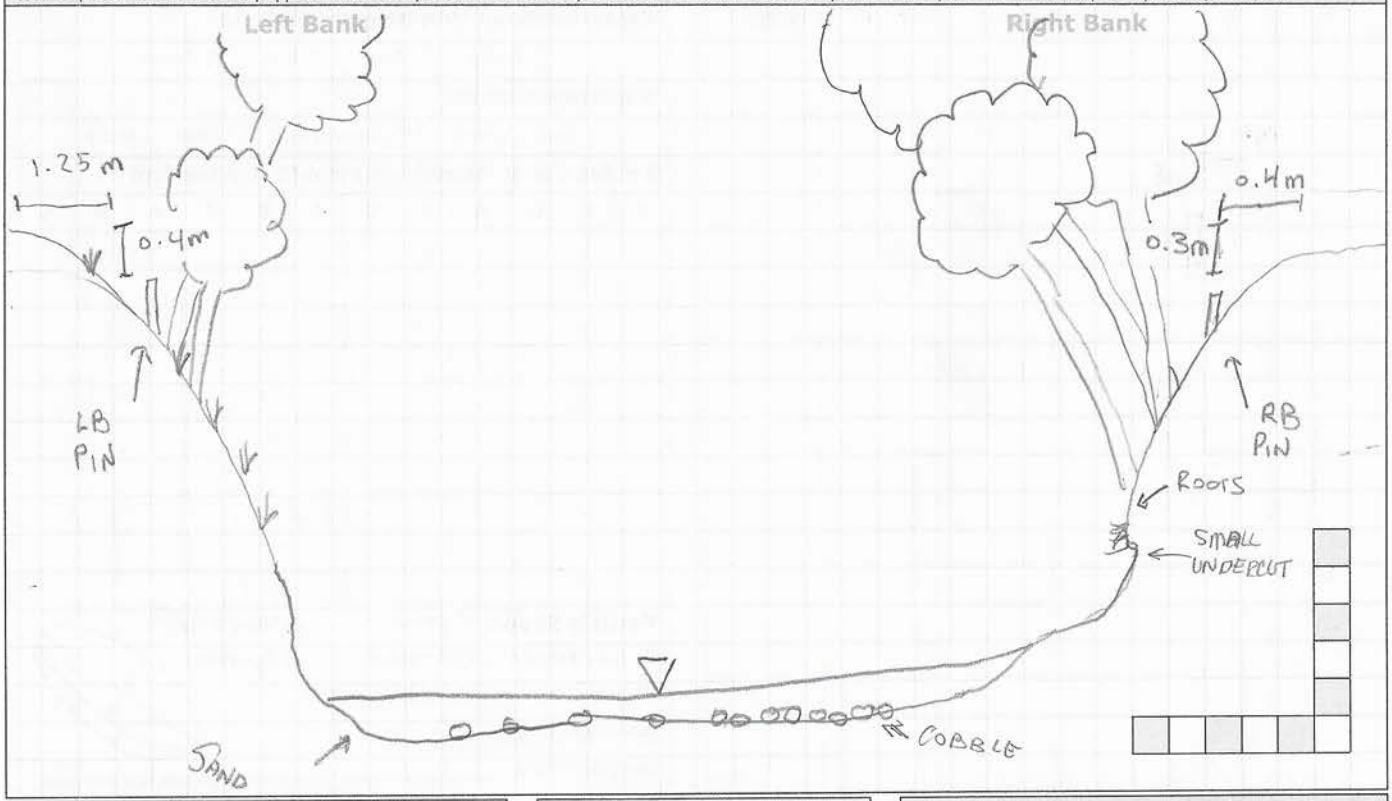
GEO MORPHIX™

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS2
Time:	1:15	**Reach:**	East Ponds Outlet Channel
Weather:	22°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble			Monumented XS	☐ Till	☒ Small Cobble	
☐ Clay	☒ Large Cobble			Monumented photo	☐ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder			Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder			Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	2.25	m		Bank stabilization	Bank Height:	1.95	m
Bank Angle:	50	°		Fence	Bank Angle:	45	°
Root Depth:	1.0	m		Grasses	Root Depth:	1.0	m
Root Density:	10	%		Leaning tree	Root Density:	10	%
Undercut:	0	m		Tree	Undercut:	0	m
Erosion Pin:	1	m		Woody Debris	Erosion Pin:	0.04	m
Torvane:	0.25	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	2	kg/cm²		Erosion pin	Penetrometer:	2.5	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS 3
Time:	12:30	**Reach:**	East Ponds Outlet Channel
Weather:	22° CLOUDY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CREDIT RIVER

X	Y	Note			Notes
1.75	1286	LB PIN			
2.0	1375				
2.25	1612				
2.5	1732				
2.75	1869				
3.0	2123	BF			
3.1	2295				
3.25	2498				
3.3	2511				
3.42	2582	WE			
3.65	2662				
3.9	2704				
4.05	2708				
4.3	2740				
4.55	2750				
4.8	2736				
5.05	2749				
5.3	2752				
5.55	2600	WE			
5.65	2423	BF			
5.75	2288				
5.85	2083				
6.0	2002				
6.25	1900				
6.4	1793				
6.7	1662				
6.9	1565				
7.1	1436				
7.34	1329	RB PIN			

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

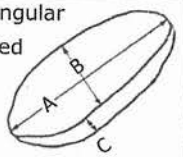
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
6.3			8.3								
5			5								
5.2			SAND								
6.5	3.4	3.2									
7											
5.3											
4.8											
7	5	1.5									
6.2											
8.3											

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 40 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☒ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.025 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 3

Distance 0.50 m Time 20.25 s V 0.025 m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

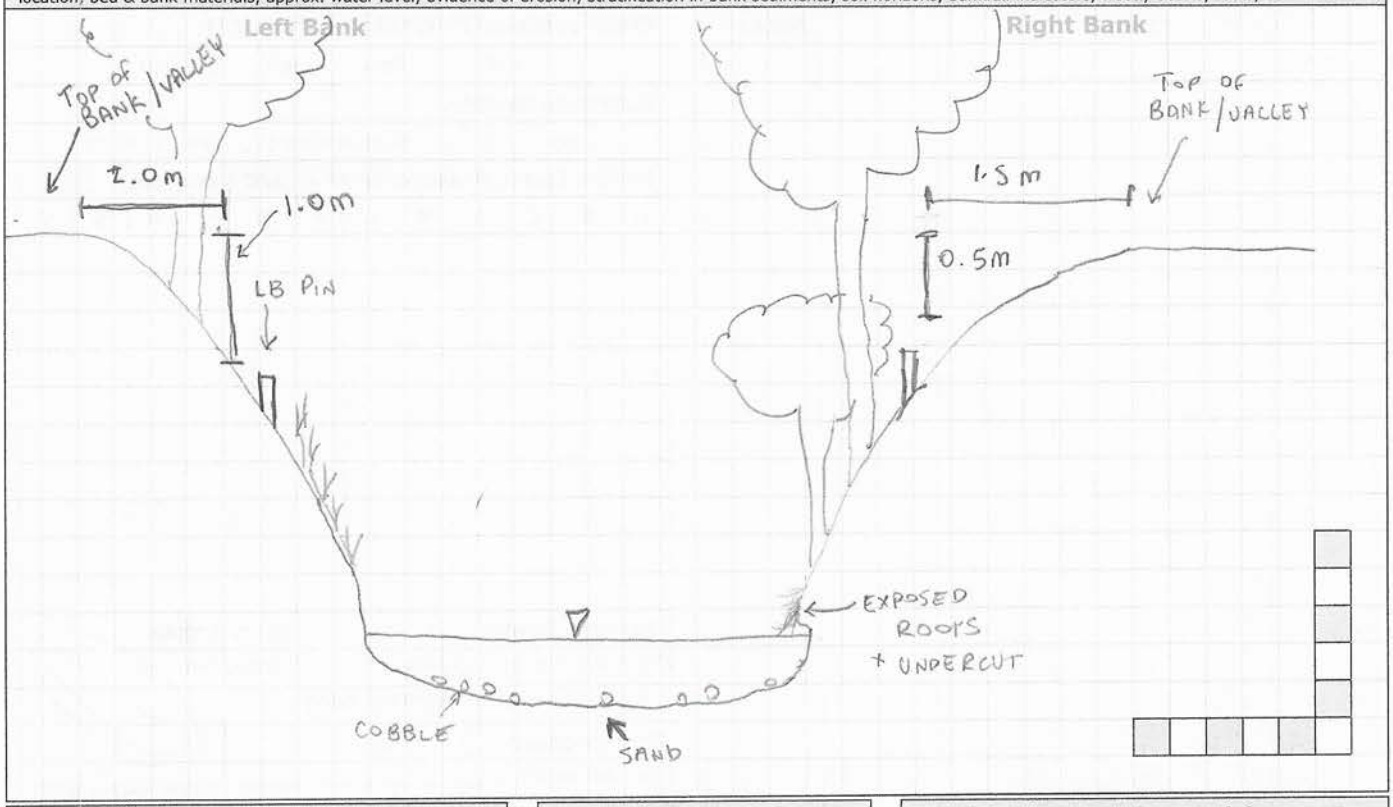
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS3
Time:	12:30	**Reach:**	East Ponds Outlet Channel
Weather:	22°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble			Monumented XS	☐ Till	☒ Small Cobble	
☐ Clay	☒ Large Cobble			Monumented photo	☐ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder		------	Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder		#####	Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	2.0	m	XXXXX	Bank stabilization	Bank Height:	2.5	m
Bank Angle:	55	°	-*-*-*	Fence	Bank Angle:	70	°
Root Depth:	1.0	m	VVV	Grasses	Root Depth:	1.0	m
Root Density:	15	%		Leaning tree	Root Density:	10	%
Undercut:	0	m		Tree	Undercut:	0.06	m
Erosion Pin:	/	m	* * *	Woody Debris	Erosion Pin:	/	m
Torvane:	0.25	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	1.5	kg/cm²		Erosion pin	Penetrometer:	2.5	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

General Site Characteristics

Project Number: 24061

Date:	2024-07-23	**Stream:**	Trib H
Time:	10:15	**Reach:**	TRIB H
Weather:	Sunny 25°C	**Location:**	ON GC
Field Staff:	JV EF	**Watershed/Subwatershed:**	CREDIT 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	IV InstreamVeg
Bank stabilization	
Leaning tree	
Fence	
Culvert/outfall	
Swamp/wetland	
Grasses	
Tree	
Instream log/tree	
Woody debris	
Beaver dam	
Vegetated island	

Flow Type

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

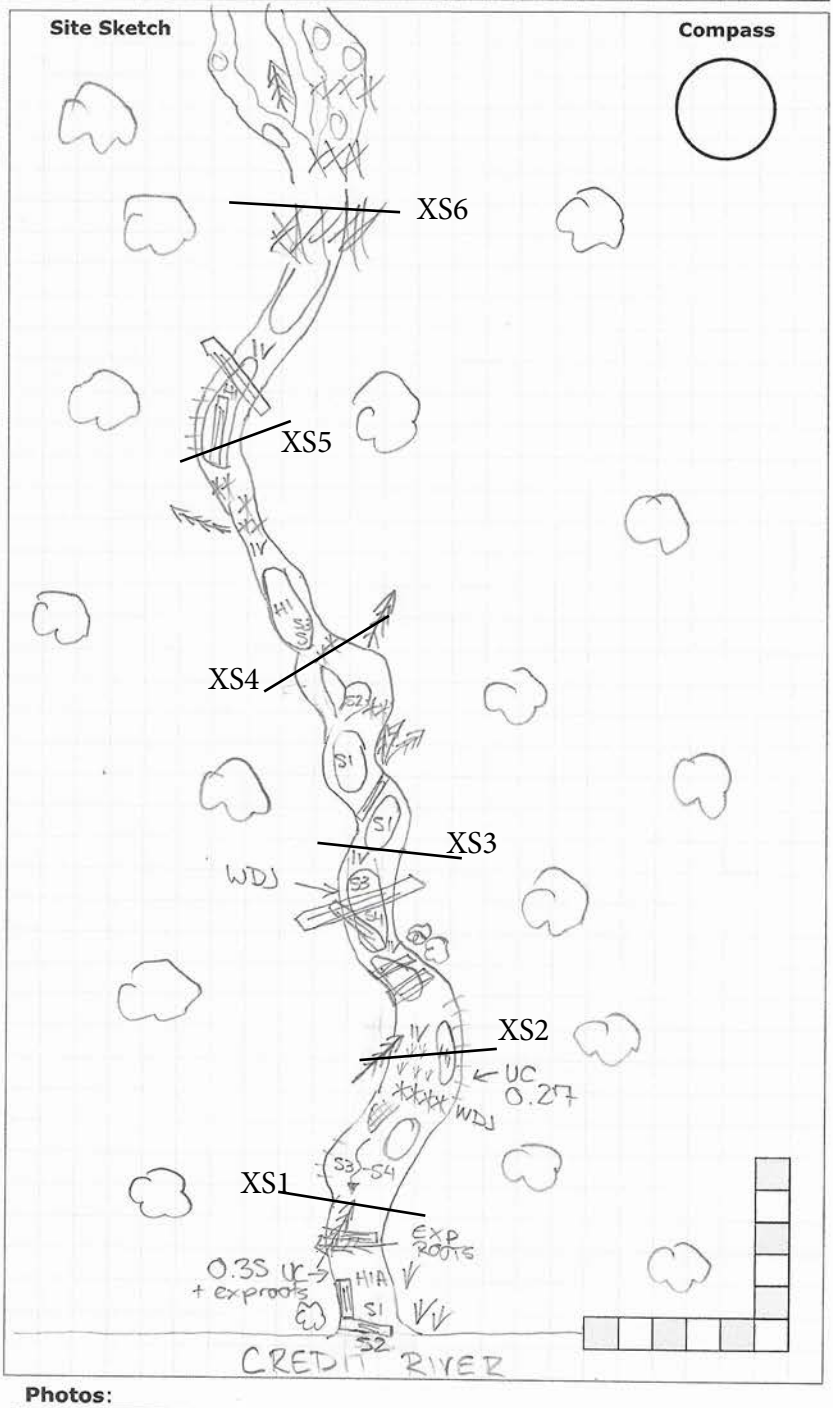
Substrate

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

Other

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

Site Sketch



Photos:

Notes: Intermittent pooling only flow that occurs

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Assessment Long Profile (Level) Project Code: 24061

Date:	2024-07-23	**Reach:**	Trib 4
Time:	11:15	**Location:**	OVGC
Weather:	Sunny 25°C	**Watershed/Subwatershed:**	CREDIT RIVER
Field Staff:	JV EF	**Rain in last 24 hours:**	☐ None ☐ Yes: Amount _____ mm

Top	Middle	Bottom	Angle	Water	XS	Notes
1989	1914	1843	128	1690		
2001	1937	1855	127	1605		
1957		1841	129.5	1585		
1873		1768	131	1590		
1743		1653	133	1595		
1805	1767	1735	131	1590		
1739	1708	1677	128	1595		
1691	1667	1643	122	1590		
1647	1628	1610	114	1590		
1572	1556	1542	85	1534	XS1	LBF 1230 RBF 922
1504	1488	1474	46	1470		
1638	1614	1592	24	1468		
1585	1555	1525	13	1465	XS2	LBF 1113 RBF 1224
1541	1505	1468	5	1428		
1690	1648	1587	11	1425		
1572	1512	1451	6	1426		
1556	1488	1489	4	1412		
1736	1664	1590	358	1444		
1726	1648	1569	353	1400		
1461	1374	1286	352	1349		
1401	1311	1222	347	1275	\	
1442	1352	1262	341	1295		
2425	2349	2371	83	2275		
2419	2349	2282	86	2235		
2350	2290	2229	88	2232		
2330	2275	2223	89	2222		
2268	2208	2159	85	2175	XS3	LBF 1950 RBF 1800
2301	2264		79	2175		
2342	2303	2268	72	2175	XS4	LBF 1938 RBF 1780
2186	2158	2133	46	2135		
2147	2125	2105	31	2079		
2181	2150	2123	17	2095		
2225	2195	2165	328	2097		
2105	2067	2029	306	2052		
2147	2101	2058	302	—		
2125	2075	2025	289	2012		
2159	2098	2038	282	2009	XS5	LBF 1992 RBF 1836
2138	2063	1995	273	1970		
2080	2005	1925	271	1952		

TP1
TP1 + 1m
TP2

Survey Direction
☐ Upstream to Downstream
☒ Downstream to Upstream

Cross-sections
No. of Cross-sections Surveyed: 6
Monitoring Cross-sections: ☒ No ☐ Yes
XS ID: _____ / _____ / _____
Erosion Pin Installed: ☐ No ☐ Yes
XS ID: _____ / _____ / _____

Velocity & Sediment Transport
☒ Velocity 0.256 m/s **Method:**
☐ Discharge _____ m^3/s _____
Sed. Transport (Table 21): ☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation
Percentage of Bed Active: _____ %

Valley Type (Table 2)
☐ Confined ☐ Partially ☒ Unconfined

Channel Zone (Table 4)
☐ Headwater ☒ Transfer ☐ Deposition

Land Use (Table 1)
Forested

Vegetation
Aquatic Vegetation: rooted emergent
Coverage of Reach: 50 %
☒ In Stream ☐ Margins ☐ On Bank
Riparian Vegetation: ☐ No ☒ Yes
Extent of Riparian Cover:
☐ Fragment ☐ None ☒ Continuous
Riparian Cover (channel widths):
☐ 1-4 ☐ 4-10 ☒ >10
Age Class of Riparian Vegetation:
Immature Established Mature
☐ (<5 yrs) ☐ (5-30 yrs) ☒ (>30 yrs)
Extent of Encroachment:
☐ None ☐ Minimal ☐ Moderate ☒ Heavy ☐ Extreme
Density of Woody Debris:
☐ Low ☐ Moderate ☒ High
Blockage(s) in Channel:
☐ Infrastructure ☐ Dam ☒ LWD

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

GEO MORPHIX

Detailed Assessment Long Profile (Level)

Project Code: 24061

Date:	2024-07-23	**Reach:**	Trib 4
Time:	11:15	**Location:**	OVGC
Weather:	Sunny 25°C	**Watershed/Subwatershed:**	CR
Field Staff:	JV EF	**Rain in last 24 hours:**	☐ None ☐ Yes: Amount _____ mm

Top	Middle	Bottom	Angle	Water	XS	Notes
2129		1976	78	1969		still a point
2104	2041		79	1969		
2128	2072	2019	88	1968		
2103		1999	92	1955		
2098	2053	2010	93	1955		
2115	2080	2046	89	1960		
2090	2059	2030	78	1954		
1946	1926	1906	58	1875		
2130	2116	2101	39	1880		
2074	1968	1955	0	1875	XS6	LBF 1757 RBF 1710
2019	1997	1975	329	1880		
1565	1478	1395	186	—		not a point
1700	1657	1615	126	—		"
2177	2137	2097	12	1990		
2034	2001	1967	2	1978		
2041	2011	1983	346	1977		
2082	2054	2025	335	1978		
2020	1994		302			
2061	2021		287	1963		
2000	1946	1894	282	—		
1994	1934	1873	287	1892		
	1945	1875	292	1892		
2050	1945	1890	289	1875		
1955	1884	1793	287	1835		

TP2 +2.15m

TP3 TP3 +7m

Survey Direction

☐ Upstream to Downstream

☐ Downstream to Upstream

Cross-sections

No. of Cross-sections Surveyed: 6

Monitoring Cross-sections: ☒ No ☐ Yes

XS ID: _____ / _____ / _____

Erosion Pin Installed: ☒ No ☐ Yes

XS ID: _____ / _____ / _____

Velocity & Sediment Transport

☐ Velocity _____ m/s **Method:**

☐ Discharge _____ m^3/s _____

Sed. Transport (Table 21): ☐ Suspended

☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Valley Type (Table 2)

☐ Confined ☐ Partially ☐ Unconfined

Channel Zone (Table 4)

☐ Headwater ☐ Transfer ☐ Deposition

Land Use (Table 1)

Vegetation

Aquatic Vegetation: _____

Coverage of Reach: _____ %

☐ In Stream ☐ Margins ☐ On Bank

Riparian Vegetation: ☐ No ☐ Yes

Extent of Riparian Cover:

☐ Fragment ☐ None ☐ Continuous

Riparian Cover (channel widths):

☐ 1-4 ☐ 4-10 ☐ >10

Age Class of Riparian Vegetation:

Immature Established Mature

☐ (<5 yrs) ☐ (5-30 yrs) ☐ (>30 yrs)

Extent of Encroachment:

☐ None ☐ Minimal ☐ Moderate

☐ Heavy ☐ Extreme

Density of Woody Debris:

☐ Low ☐ Moderate ☐ High

Blockage(s) in Channel:

☐ Infrastructure ☐ Dam ☐ LWD

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS1
Time:	2:42	**Reach:**	TRIB 4
Weather:	26° SUNNY	**Location:**	OVGC
Field Staff:	EF JU	**Watershed/Subwatershed:**	CREDIT RIVER

X	Y	NOTE			Notes
1.75	1950	LB			
2.1	1995				
2.4	2065				
2.59	2115	BF			
2.8	2185				
2.9	2210				
3.1	2255				
3.25	2330				
3.3	2355				
3.5	2392				
3.6	2405	WE			
3.9	2423				
4	2428				
4.2	2412				
4.4	2397				
4.7	2398				
4.86	2427				
5.1	2440				
5.3	2445				
5.65	2417				
5.8	2402				
6	2385				
6.2	2415				
6.5	2456				
6.8	2399	WE			
7.0	2345				
7.3	2318				
7.6	2249				
7.8	2229				
7.9	2195				
7.15	2041				
7.35	1888				
7.45	1820				
8.7	1753				
9.15	1708				
9.5	1688				
9.8	1679				
10.32	1663	RB			

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

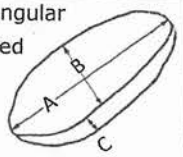
Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
3			2.1			SILT/SAND			2.7		
1.8			4.6						0.4		
4.8									0.2		
3.4	2.3	1.4	2.7	2.2	1	13	8	4.6	5.6	4.6	3.4
3.4			2.0						1.6		
3.7			4.0						2.4		
0.9			3.2						1.9		
3	1.8	1	2.8	2.4	1.7	1.1	0.4	0.4	6.1	3.8	3
3.3			2.6			↓	→				
3			3.7								

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded

Embededness: 30 %

Subpavement: _____



[Pebble ABC axis guide]

Sorting (Table 20): ☒ Well ☐ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.156 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS1

Distance 1.0 m Time 5.73 s V 0.175 m/s

Distance 1.0 m Time 6.67 s V 0.150 m/s

Distance 1.0 m Time 6.90 s V 0.145 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

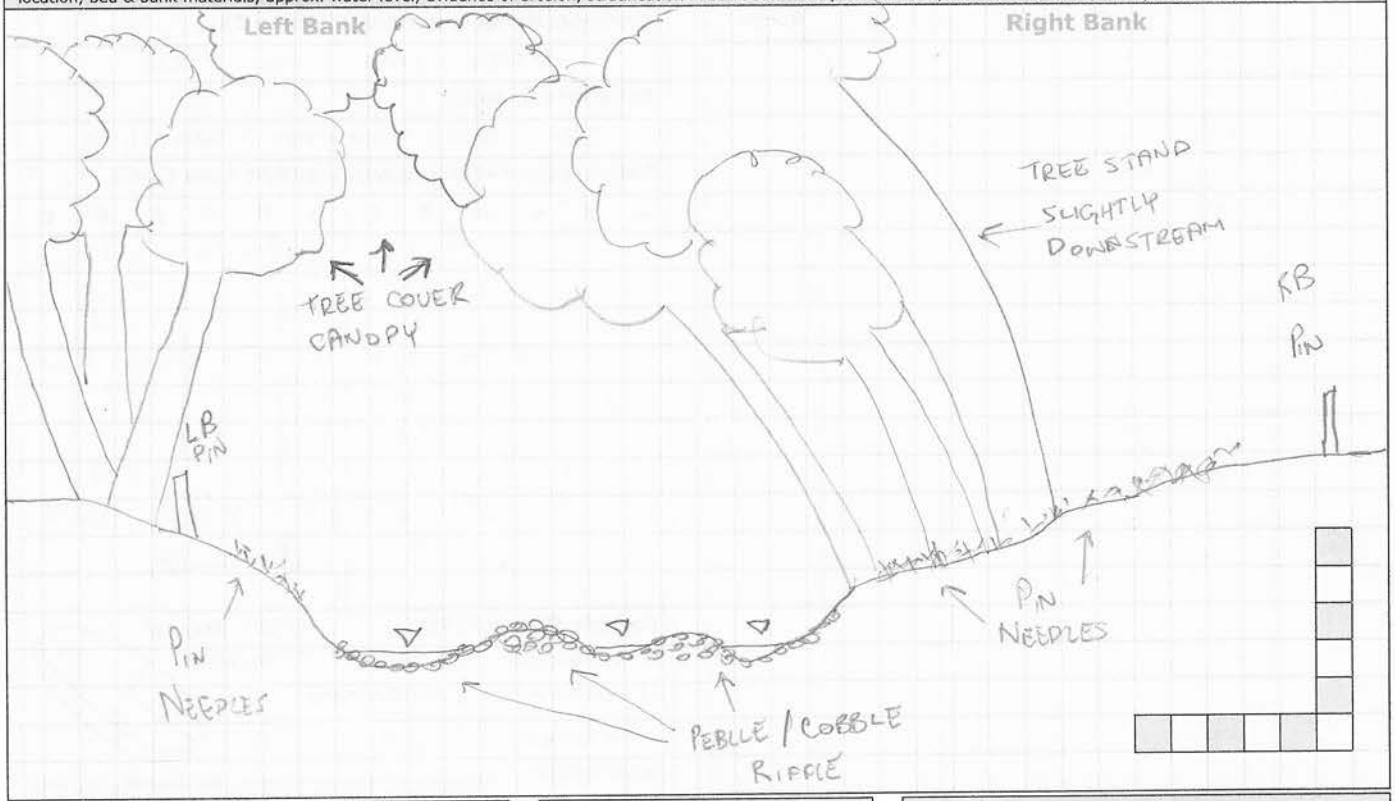
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS1
Time:	2:42	**Reach:**	TRIB 4
Weather:	26°C SUNNY	**Location:**	OVGG
Field Staff:	JV EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.49	m	
Bank Angle:	25	°	
Root Depth:	0.30	m	
Root Density:	15	%	
Undercut:	X	m	
Erosion Pin:	X	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
XXXXX	Bank stabilization
x-x-x	Fence
VVV	Grasses
	Leaning tree
	Tree
x x x	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.55	m	
Bank Angle:	30	°	
Root Depth:	0.30	m	
Root Density:	15	%	
Undercut:	X	m	
Erosion Pin:	X	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS 2
Time:	3:25	**Reach:**	TRIB 4
Weather:	26° SUNNY	**Location:**	OVGC
Field Staff:	EP JV	**Watershed/Subwatershed:**	CREDIT RIVER

X	Y	NOTE			Notes
1.75	2080	LB			
2.2	2122				
2.27	2195	BF			
2.5	2345				
2.78	2499				
2.96	2570	WE			
3.12	2639				
3.3	2650				
3.5	2675				
3.8	2655				
4.06	2648				
4.4	2665				
4.6	2622				
4.9	2583				
5.1	2565				
5.4	2560				
5.6	2550				
5.8	2468				
6.0	2454				
6.1	2450				
6.3	2480				
6.5	2590				
6.7	2578				
6.9	2580				
7.1	2543				
7.15	2590				
7.5	2560				
7.6	2503				
7.75	2380	BF			
7.9	2332				
8	2320				
8.3	2342				
8.6	2277				
8.8	2250				
9	2230				
9.2	2150				
9.4	2010				
9.6	1940				
9.95	1890	RB			

Cross-sectional Morphology (Table 22)

☐ Riffle ☒ Pool ☐ Run ☐ Other

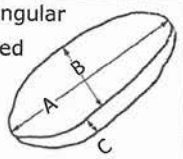
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			1.2			0.5			SAMP		
			1.1			2.5					
			0.4			2					
			3.6	3.4	2.0	4	3	1.7			
			0.6			3.4					
			1.6			2.6					
			.2			0.3					
			6.4	4.6	1.4	3.8	3	2.2			
			1.2			0.3					
			1.5			1.9					

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 75 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☒ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☐ Measured _____ m/s Method: TOO SLOW

☐ Estimated _____ m/s XS ID: _____

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

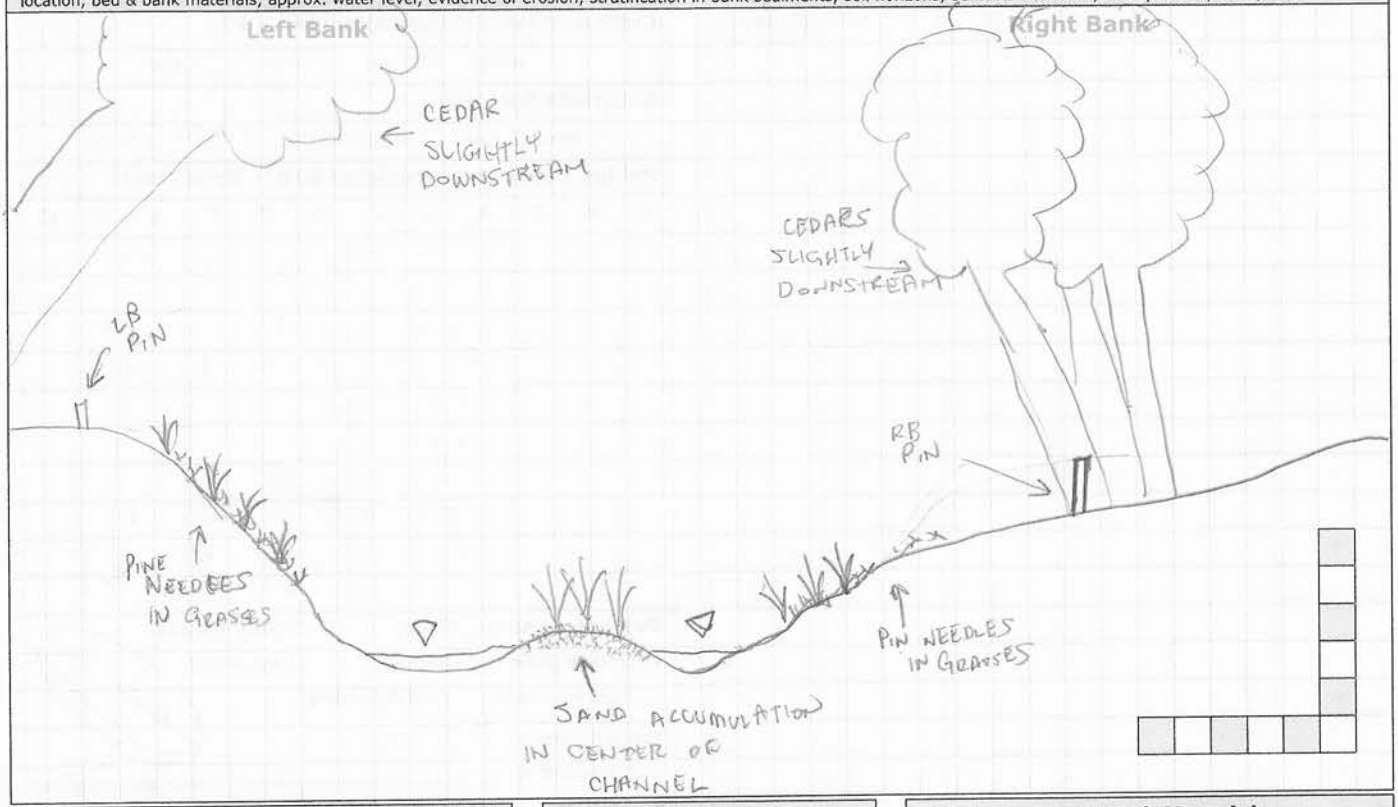
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS2
Time:	3:25	**Reach:**	TRIB 4
Weather:	Sunny 26°C	**Location:**	OVGC
Field Staff:	JV EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☒ Sand	☐ Large Boulder		
Bank Height:	0.58	m	
Bank Angle:	35	°	
Root Depth:	0.15	m	
Root Density:	15	%	
Undercut:	x	m	
Erosion Pin:	x	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
XXXXX	Bank stabilization
x-x-x	Fence
VVV	Grasses
	Leaning tree
	Tree
x x x	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☒ Sand	☐ Large Boulder		
Bank Height:	0.58	m	
Bank Angle:	45	°	
Root Depth:	0.15	m	
Root Density:	15	%	
Undercut:	x	m	
Erosion Pin:	x	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number:

Date:	2024-07-23	**Cross-section:**	XS 3
Time:	4:10	**Reach:**	TRIB 4
Weather:	Sunny 26°C	**Location:**	OVGC
Field Staff:	JJ EF	**Watershed/Subwatershed:**	CR

X	Y				Notes
1.75	1977	LB			
2.1	1895				
2.4	1932				
2.6	1883				
2.75	1785				
2.87	1860				
3.03	2030				
3.2	2045				
3.4	2050	BF			
3.62	2062				
3.72	2220				
3.85	2320	NE			
3.9	2385				
4.1	2364				
4.3	2302				
4.5	2346				
4.7	2296				
4.9	2270				
5.1	2225				
5.3	2203				
5.5	2112				
5.65	2047				
5.78	1954	BF			
5.9	1890				
6.1	1842				
6.4	1837				
6.8	1796				
7.0	1732				
7.3	1663				
7.7	1480	RB			
7.79	1445	RB			

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

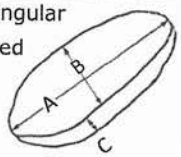
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SILT/FINES /Sand											
3	2.1	1.1	7.4	2.8	2	2.1	1.2	0.9	2.7	1.7	1.4
1.6	0.6	0.6	3.4	2.9	1.4	0.8	0.5	0.5	2.0	1.2	1.2

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 80 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☒ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☐ Measured _____ m/s Method: Too SLOW

☐ Estimated _____ m/s XS ID: _____

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

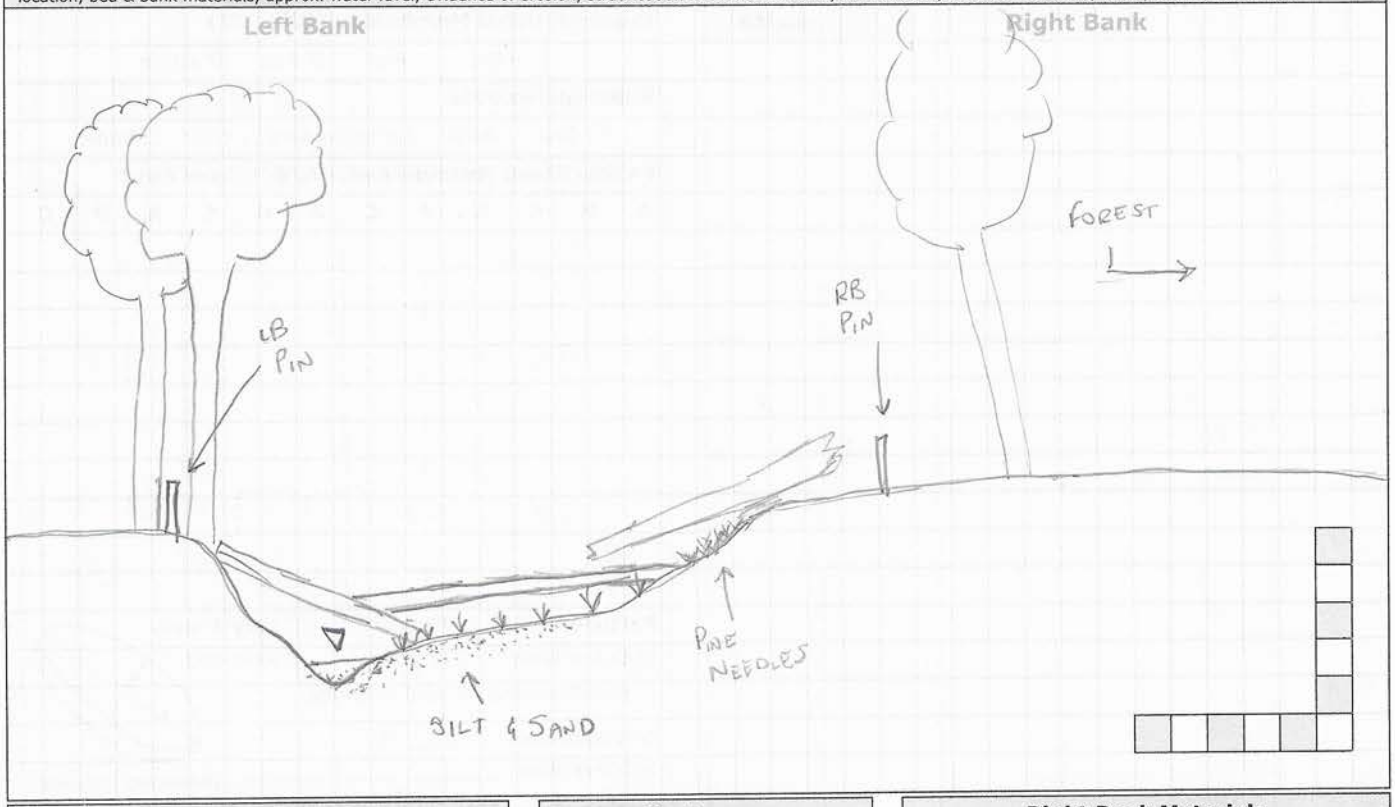
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS3
Time:	4:10	**Reach:**	TRIB 4
Weather:	Sunny 26°C	**Location:**	OVGC
Field Staff:	JV EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel	☒ ORGANICS	
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.43	m	
Bank Angle:	40	°	
Root Depth:	0.30	m	
Root Density:	40	%	
Undercut:	1	m	
Erosion Pin:	1	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Features

- Station location
- Monumented XS
- Monumented photo
- Undercut bank
- Eroded bank/slope
- Bank stabilization
- Fence
- Grasses
- Leaning tree
- Tree
- Woody Debris
- Sediment sample
- Erosion pin
- Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel	☒ ORGANICS	
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.45	m	
Bank Angle:	30	°	
Root Depth:	0.27	m	
Root Density:	40	%	
Undercut:	1	m	
Erosion Pin:	1	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number:

Date:	2024-07-23	**Cross-section:**	XS 4
Time:	4:45	**Reach:**	TRIB 4
Weather:	Sunny 26°C	**Location:**	OVGC
Field Staff:	JV EF	**Watershed/Subwatershed:**	CT

x	y				Notes
1.75	1802				
2.1	1889				
2.2	1890	BF			
2.4	1998				
2.46	1999				
2.8	2038				
3.0	2083				
3.3	2110				
3.5	2043				
3.7	2104				
3.8	2123	WE			
3.9	2170				
4.1	2205				
4.24	2223				
4.34	2258				
4.5	2250				
4.6	2260	← LOG			
5.07	2155				
5.2	2138				
5.4	2005				
5.6	1902				
5.8	1782	BF			
6.1	1719				
6.4	1648				
6.65	1689	RB			

Cross-sectional Morphology (Table 22)

☐ Riffle ☒ Pool ☐ Run ☐ Other

Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

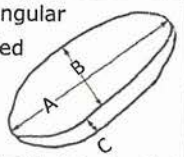
Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
2			0.4			2.4			Silt	Sand	
1			0.5			2.1					
1.4			1			1.2					
3	2.4	1.6	4.5	2.6	2.4	4.4	3.4	1.3			
0.9			4.3			1.3					
1			1.5			0.5					
1			0.8			0.4					
3.8	2.9	2.1	4.1	3	1.6	3.2	2.8	1.7			
1			1.7			0.4					
0.6			1			0.7					

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded

Embededness: 25 %

Subpavement: _____



[Pebble ABC axis guide]

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☐ Measured _____ m/s Method: NO FLOW

☐ Estimated _____ m/s XS ID: _____

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

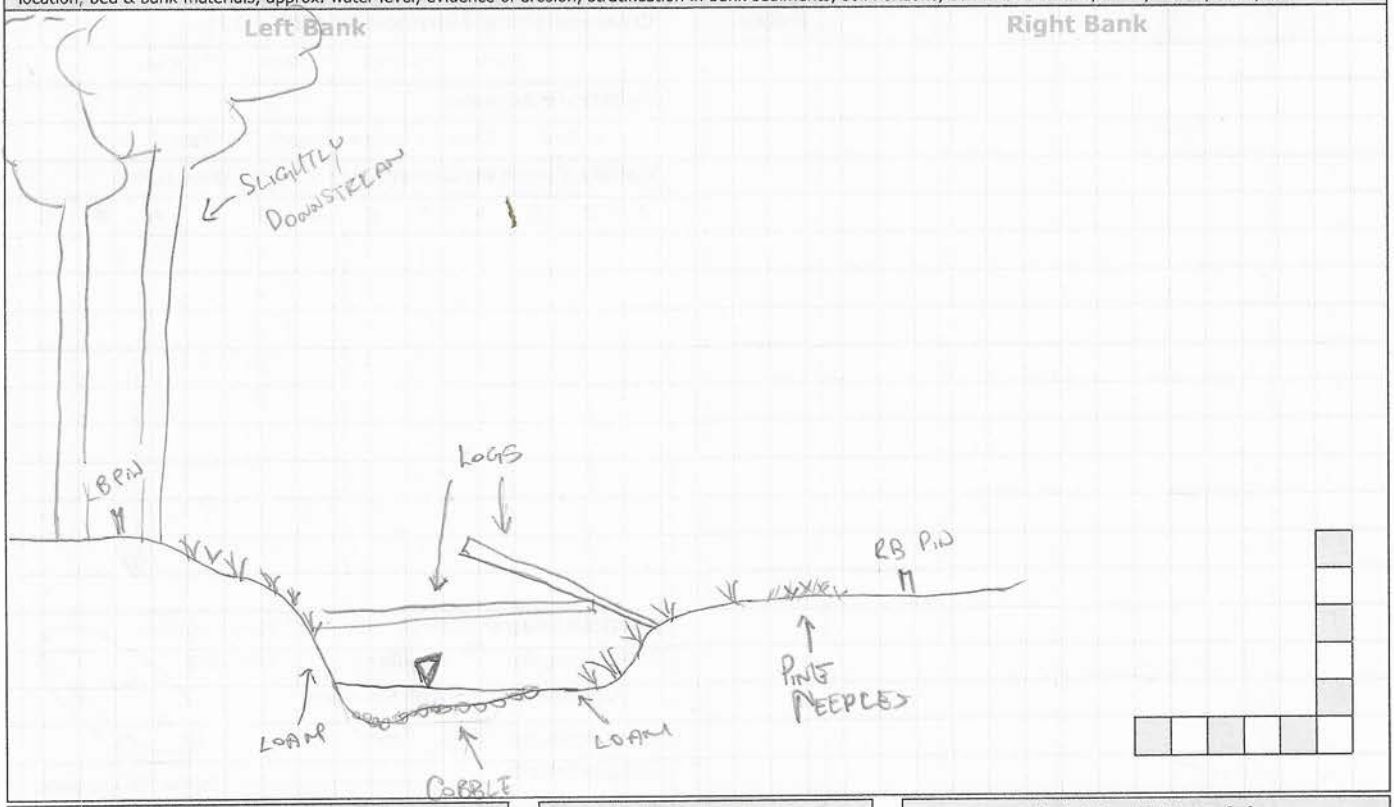
GEO MORPHIX™

Bank Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS4
Time:	4:45	**Reach:**	TRIB 4
Weather:	Sunny 26°C	**Location:**	OV GC
Field Staff:	JV EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder	
Bank Height:	0.48	m
Bank Angle:	35	°
Root Depth:	0.20	m
Root Density:	15	%
Undercut:	X	m
Erosion Pin:	1	m
Torvane:	Taken at	kg/cm²
Penetrometer:	representative XS5	kg/cm²
Foot Used:	☐ Yes ☐ No	

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
#####	Eroded bank/slope
XXXXX	Bank stabilization
--*	Fence
VVV	Grasses
	Leaning tree
	Tree
* * *	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder	
☐ Sand	☐ Large Boulder	
Bank Height:	0.57	m
Bank Angle:	20	°
Root Depth:	0.20	m
Root Density:	15	%
Undercut:	X	m
Erosion Pin:	1	m
Torvane:	Taken at	kg/cm²
Penetrometer:	representative XS5	kg/cm²
Foot Used:	☐ Yes ☐ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: PN24061

Date:	2024-07-24	**Cross-section:**	XS5
Time:	9:18	**Reach:**	Tr.64
Weather:	Sunny 22°C	**Location:**	OVGC
Field Staff:	MK EE	**Watershed/Subwatershed:**	CR

X	Y				Notes
1.75	1756				
2.10	1805				
2.50	1842				
2.80	1898				
3.20	1997	BF			
3.40	2008				
3.50	2065				
3.60	2088				
3.80	2065	WE			
3.90	2176				
4.00	2149				
4.13	2065	WE			
4.25	1998				
4.40	1960				
4.70	1935				
4.90	1924				
5.20	1901	BF			
5.40	1828				
5.70	1812				
6.00	1786				
6.18	1778				

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

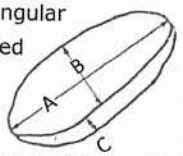
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
Fines											

Particle Shape: ☐ Platy ☐ Very Angular ☐ Sub-angular ☐ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: _____ %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☐ Measured _____ m/s Method: _____

☐ Estimated _____ m/s XS ID: Stagnant

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

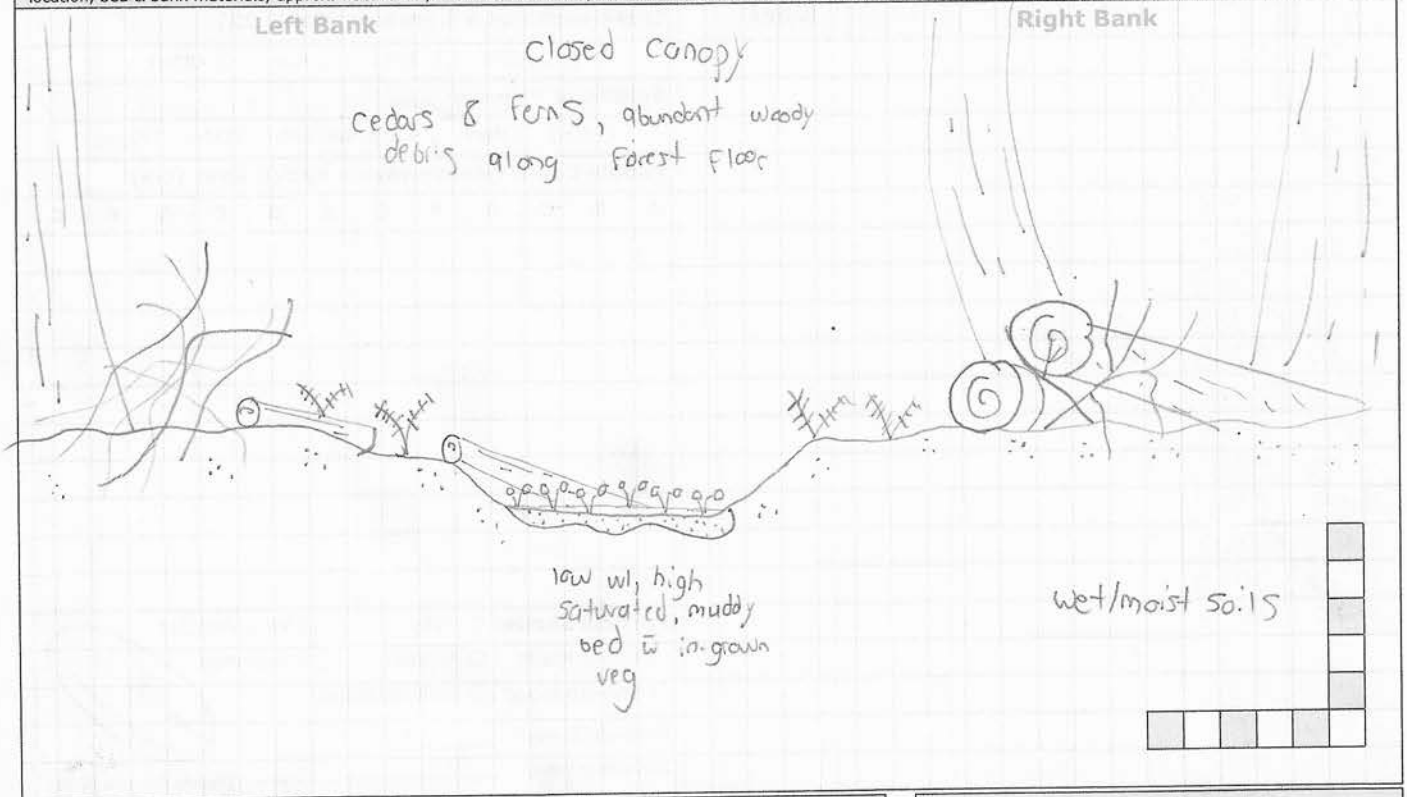
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS5
Time:	9:18	**Reach:**	TRIB 4
Weather:	Sunny, 22°C	**Location:**	OVGC
Field Staff:	MK EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.33	m	
Bank Angle:	15	°	
Root Depth:	0.15	m	
Root Density:	10	%	
Undercut:	0	m	
Erosion Pin:	N/D	m	
Torvane:	0.25	kg/cm²	
Penetrometer:	0.25	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
XXXXX	Bank stabilization
--*	Fence
WWW	Grasses
	Leaning tree
	Tree
* * *	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.31	m	
Bank Angle:	15	°	
Root Depth:	0.15	m	
Root Density:	10	%	
Undercut:	0	m	
Erosion Pin:	N/D	m	
Torvane:	0.25	kg/cm²	
Penetrometer:	0.25	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Additional Notes

-

Photos: UPLIT

Version #4
Last edited: 21/02/2023

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

Detailed Cross-Section Characteristics

Project Number: 24061

GEO MORPHIX

Date:	2024-07-24	**Cross-section:**	XS6
Time:	9:52 AM	**Reach:**	TRIB 4
Weather:	Sunny 22°C	**Location:**	OVGC
Field Staff:	MK EF	**Watershed/Subwatershed:**	CR

X	Y				Notes
1.75	1031				
2.20	1083				
2.50	1083				
2.78	1182	BF			
3.00	1295				
3.15	1318				
3.30	1311	WE			
3.50	1340				
3.60	1400	WE			
3.75	1474				
3.90	1621				
4.10	1549				
4.30	1538				
4.50	1510				
4.60	1380	WE			
4.75	1371				
4.88	1288	BF			
5.10	1252				
5.25	1243				
5.45	1212				
5.70	1170				
5.99	1143				

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☐ Run ☒ Other

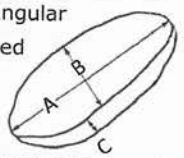
Substrate Sample: Comp

☒ Bed ☒ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
Fines											

Particle Shape: ☐ Platy ☐ Very Angular ☐ Sub-angular ☒ Angular ☐ Rounded ☐ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: _____ %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☐ Measured _____ m/s Method: Stagnant

☐ Estimated _____ m/s XS ID: _____

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Distance _____ m Time _____ s V _____ m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

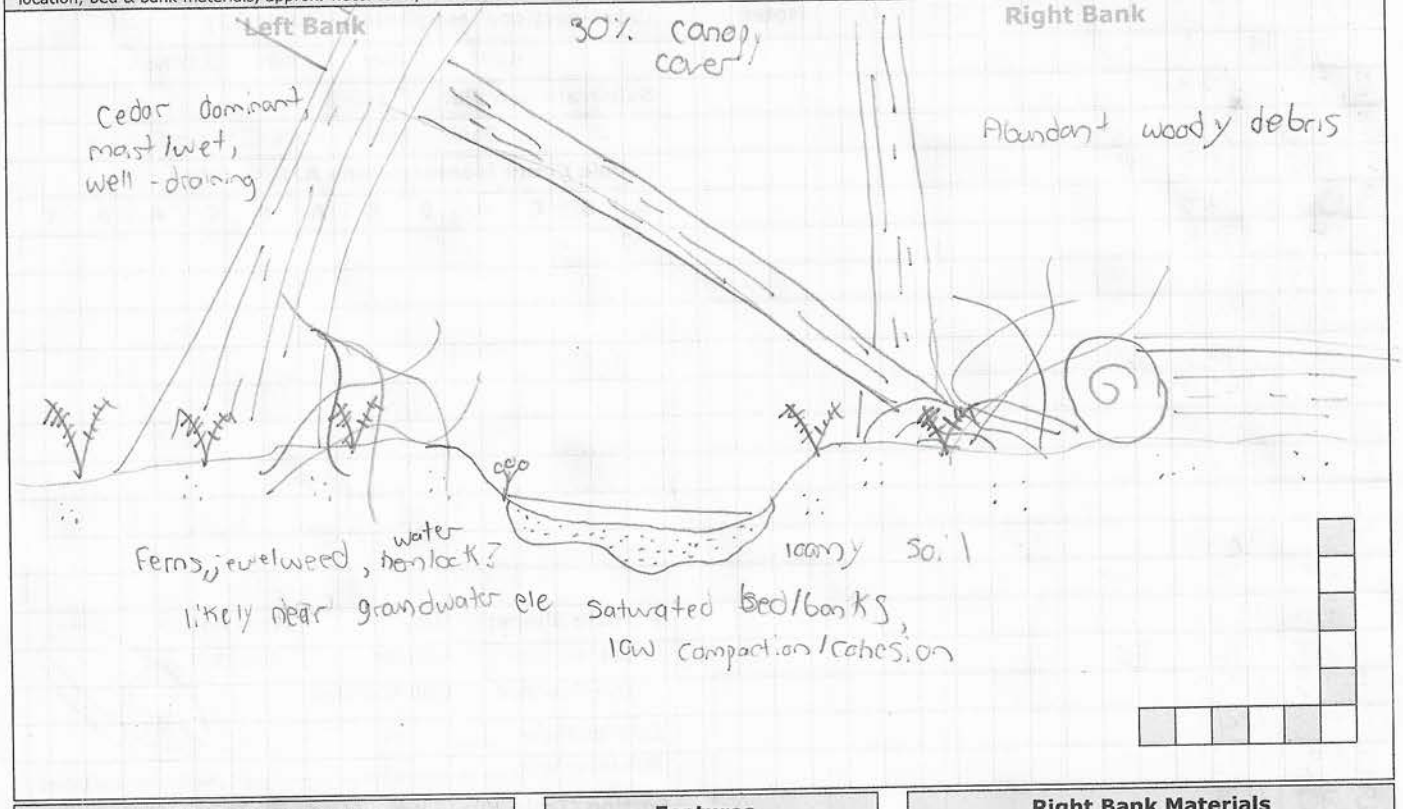
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS6
Time:	9:52	**Reach:**	TRIB 4
Weather:	Sunny 22°C	**Location:**	OVGC
Field Staff:	MK EF	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.46	m	
Bank Angle:	20	°	
Root Depth:	0.80	m	
Root Density:	15	%	
Undercut:	0	m	
Erosion Pin:	N/D	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
XXXXX	Bank stabilization
-x-x-x	Fence
	Grasses
	Leaning tree
	Tree
	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☐ Sand	☐ Large Boulder		
Bank Height:	0.40	m	
Bank Angle:	25	°	
Root Depth:	0.20	m	
Root Density:	15	%	
Undercut:	0	m	
Erosion Pin:	N/D	m	
Torvane:	Taken at	kg/cm²	
Penetrometer:	representative XS5	kg/cm²	
Foot Used:	☐ Yes ☐ No		

Additional Notes

Photos: UDLRT

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Assessment Long Profile (Total Station) **Project Code:** PN24061

Date:	2024-07-25	**Reach:**	/
Time:	/	**Location:**	OVGC
Weather:	23°c Sunny	**Watershed/Subwatershed:**	CR
Field Staff:	MW EF	**Rain in last 24 hours:**	☐ None ☐ Yes: Amount _____ mm

Point No.		Code	Notes
		RTK	
		(-0.18m adjustment)	

Survey Direction
☐ Upstream to Downstream
☒ Downstream to Upstream

Cross-sections
No. of Cross-sections Surveyed: 8
Monitoring Cross-sections: ☒ No ☐ Yes
XS ID: _____ / _____ / _____
Erosion Pin Installed: ☒ No ☐ Yes
XS ID: _____ / _____ / _____

Velocity & Sediment Transport
☐ Velocity _____ m/s **Method:**
☐ Discharge _____ m^3/s _____
Sed. Transport (Table 21): ☒ Suspended
☒ Saltation ☐ Sliding ☐ Rolling
Percentage of Bed Active: 5 %

Valley Type
☐ Confined ☒ Partially ☐ Unconfined

Channel Zone
☐ Headwater ☒ Transfer ☐ Deposition

Land Use
Forest (golf course adjacent)

Vegetation
Aquatic Vegetation: N/A
Coverage of Reach: / %
☐ In Stream ☐ Margins ☐ On Bank
Riparian Vegetation: ☐ No ☒ Yes
Extent of Riparian Cover: (localized gap /meadow)
☐ Fragment ☐ None ☒ Continuous
Riparian Cover (channel widths):
☐ 1-4 ☐ 4-10 ☒ >10
Age Class of Riparian Vegetation:
Immature Established Mature
☐ (<5 yrs) ☒ (5-30 yrs) ☒ (>30 yrs)
Extent of Encroachment:
☐ None ☒ Minimal ☐ Moderate
☐ Heavy ☐ Extreme
Density of Woody Debris:
☐ Low ☒ Moderate ☐ High
Blockage(s) in Channel:
☐ Infrastructure ☐ Dam ☒ LWD

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

GEO MORPHIX™

General Site Characteristics

Project Number: 24061

Date:	2024-07-25	**Stream:**	CREDIT RIVER
Time:		**Reach:**	CREDIT RIVER
Weather:	23°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CREDIT 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		

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

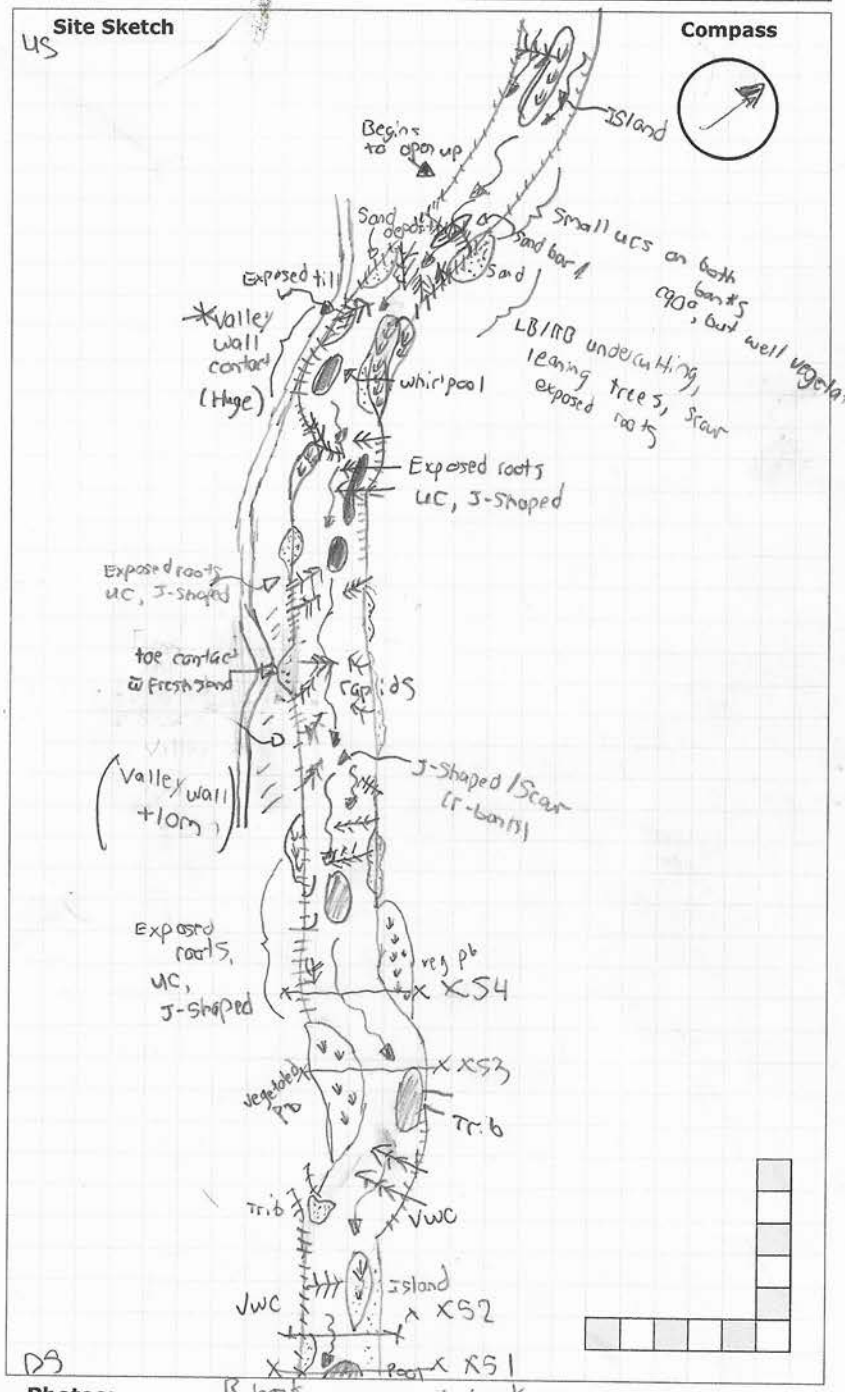
Substrate

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:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

General Site Characteristics

Project Number: 24061

Date:	2024-07-25	**Stream:**	CREDIT RIVER
Time:	/	**Reach:**	CREDIT RIVER
Weather:	23°C SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

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

Flow Type

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

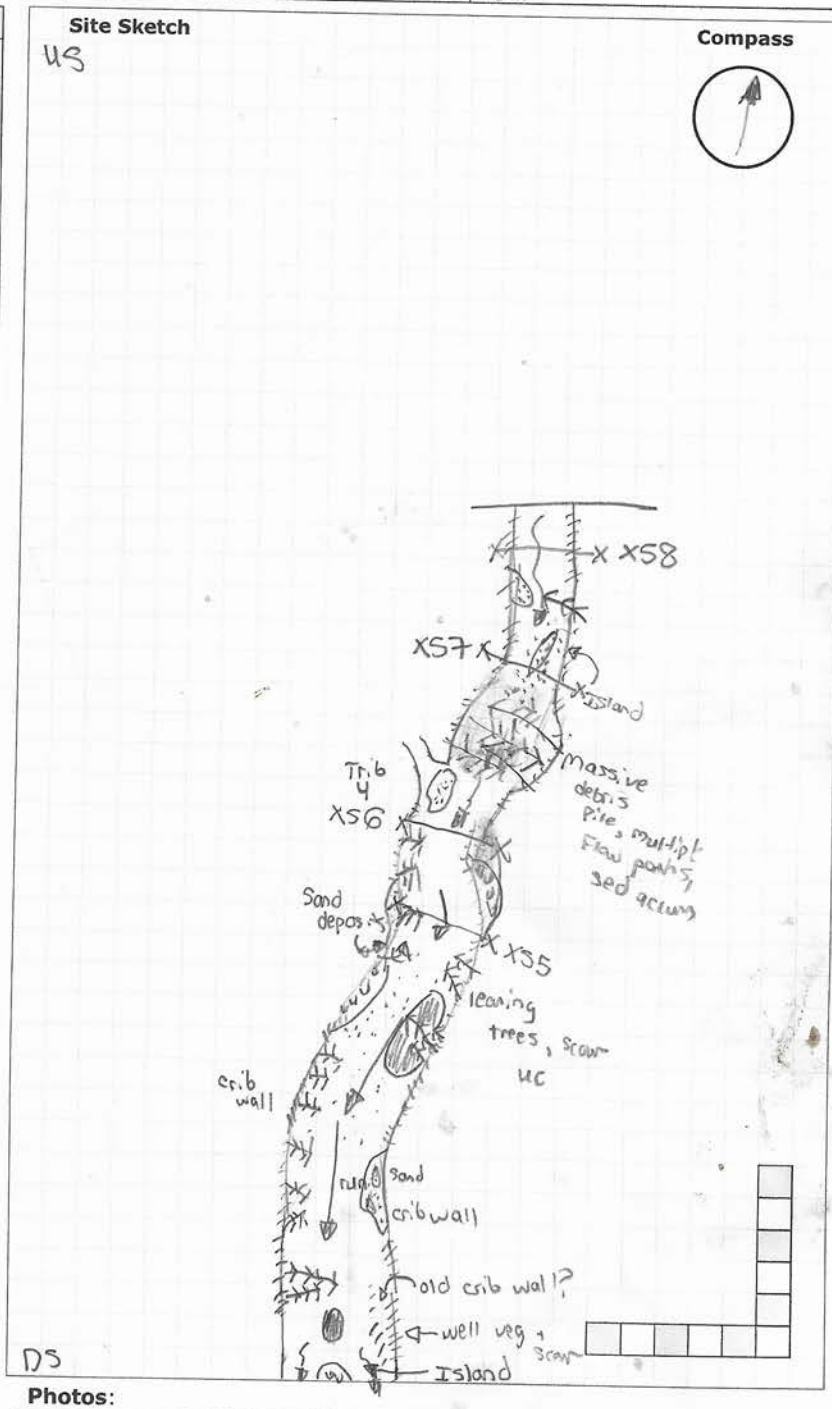
Substrate

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

Other

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

Site Sketch



Photos:

Notes:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS 1
Time:	4:17	**Reach:**	CREDIT RIVER DS
Weather:	24° CLOUDY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	NOTE			Notes
1.75	1155	LB PIN	15.8	1202	
2.1	1265		16.2	1048	
2.3	1503		16.6	0949	
2.72	1600		16.8	0895	RB PIN
2.9	2859				
3.2	2990				
3.5	3070				
3.8	3068				
4.2	3044				
4.6	3075				
5.0	3180				
5.4	3160				
5.8	3312				
6.2	3355				
6.6	3347				
7.0	3395				
7.4	3365				
8.0	3287				
8.4	3232				
8.8	3190				
9.2	3130				
9.6	3108				
10.0	3040				
10.4	2980				
10.8	2889				
11.2	2850				
11.6	2790				
12.0	2705				
12.4	2575				
12.6	2505	WE			
13.0	2482				
13.4	2435				
13.8	2426				
14.2	2394				
14.6	2400				
15.0	2390				
15.26	2340				
15.30	1659	BF			
15.50	1405				

Cross-sectional Morphology (Table 22)

☐ Riffle ☒ Pool ☐ Run ☐ Other

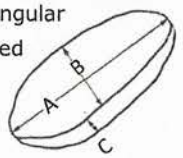
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
1.1			1.1			SAND					
2.4			5								
1			2								
2.4	2.2	0.5	1.8	1	0.9						
0.8			6								
6.5			5.3								
2.4			2.9								
2	1.5	0.8	4.1	3	2						
1.2			3.5								
1.2			2.5								

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 30 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.512 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS1

Distance 1.0 m Time 2.09 s V 0.479 m/s

Distance 1.0 m Time 1.72 s V 0.581 m/s

Distance 1.0 m Time 2.10 s V 0.476 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

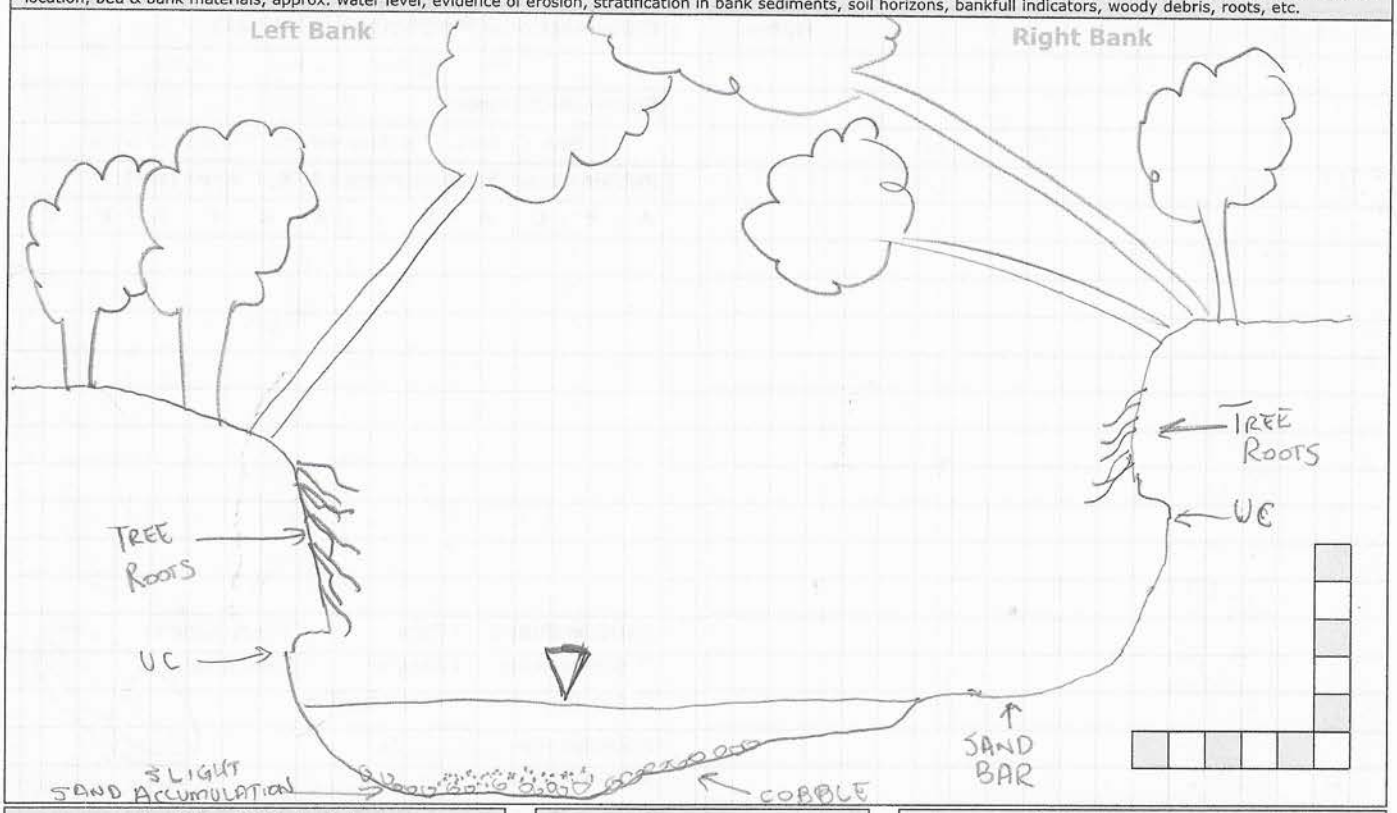
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS1
Time:	11:17	**Reach:**	CREDIT RIVER DS
Weather:	24°C Cloudy	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble			Monumented XS	☐ Till	☒ Small Cobble	
☒ Clay	☒ Large Cobble			Monumented photo	☐ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder		------	Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder		#####	Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	2.2	m		Bank stabilization	Bank Height:	2.2	m
Bank Angle:	90	°	-*-*-	Fence	Bank Angle:	90	°
Root Depth:	1.5	m		Grasses	Root Depth:	1.5	m
Root Density:	35	%		Leaning tree	Root Density:	35	%
Undercut:	0.82	m		Tree	Undercut:	0.33	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.5	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	2.0	kg/cm²		Erosion pin	Penetrometer:	2	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS 2
Time:	3:00	**Reach:**	CREDIT RIVER DS
Weather:	24° CLOUDY	**Location:**	OWGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	NOTE	X	Y	Notes
1.75	1545		16.2	3432	
2.2	1580		16.6	3405	
2.6	1588		17.0	3350	
3.0	1600		17.4	3312	
3.4	1610		17.8	3227	
3.7	1690		18.2	3050	
4.0	1875		18.6	2818	
4.12	2040		19.02	2648	WE
4.15	2678		19.1	2492	
4.5	2840		19.5	2480	
4.85	3055		19.92	2029	BF
5.1	3160		20.0	1712	
5.5	3215		20.2	1518	
5.9	3258		20.5	1021	
6.3	3300		20.75	0918	
6.7	3245		21.10	0921	
7.1	3225		21.40	0908	
7.5	3220				
7.9	3125				
8.3	3089				
8.7	3060				
9.1	2985				
9.5	2986				
9.9	2952				
10.3	2872				
10.7	2798				
11.1	2800				
11.5	2829				
11.8	2852				
12.2	2888				
12.6	2942				
13	2980				
13.4	3030				
13.8	3110				
14.2	3202				
14.6	3298				
15	3372				
15.4	3382				
15.8	3398				

Cross-sectional Morphology (Table 22)

☐ Riffle ☒ Pool ☒ Run ☐ Other

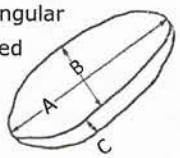
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
1			2.9			4			4		
1.5			3.1			2.9			1.5		
2			1			3.1			2.8		
3.5	2.5	1.6	4.4	3	2	3.4	3	1	5	5	1
8.5			1.6			3.8			1.6		
4			1.2			1			1.2		
4.3			1.5			2.5			1.8		
3	1.8	1.2	4.5	3.6	1	9	6.3	1.5	1.4	1.1	0.5
2.2			6			2			4		
2.6			4.6			8			3.5		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 10 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☐ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.715 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 2

Distance 1.0 m Time 1.50 s V 0.667 m/s

Distance 1.0 m Time 1.22 s V 0.820 m/s

Distance 1.0 m Time 1.52 s V 0.658 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

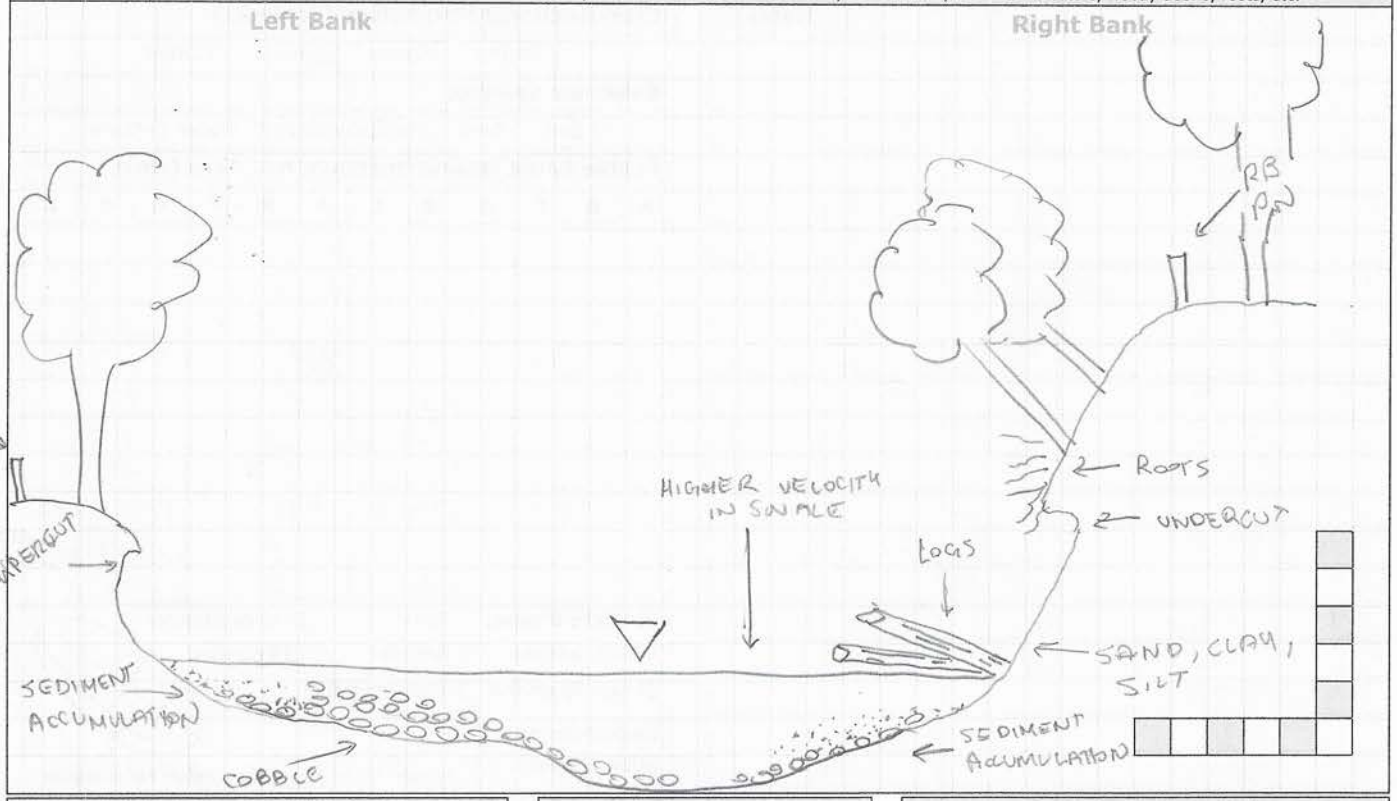
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-24	**Cross-section:**	XS2
Time:	3:00	**Reach:**	CREDIT RIVER DS
Weather:	Cloudy 24°C	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☒ Small Cobble			Monumented XS	☐ Till	☒ Small Cobble	
☒ Clay	☒ Large Cobble			Monumented photo	☒ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder		------	Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder		#####	Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	2.0	m		Bank stabilization	Bank Height:	2.75	m
Bank Angle:	90	°		Fence	Bank Angle:	70	°
Root Depth:	1.0	m		Grasses	Root Depth:	1.5	m
Root Density:	30	%		Leaning tree	Root Density:	35	%
Undercut:	0.10	m		Tree	Undercut:	0.65	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.5	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	2	kg/cm²		Erosion pin	Penetrometer:	2.5	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 3
Time:	9:50	**Reach:**	CREDIT RIVER
Weather:	18° SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	NOTE	x	y	Notes
1.75	0667	LB PIN	16.65	2234	
2.00	0728		17.05	2233	
2.30	0860		17.50	2248	
2.60	1029		18.00	2191	
2.90	1128		18.40	2104	
3.10	1178		18.75	1986	
3.50	1226		18.92	1965	
3.70	1235		19.00	1636	
4.00	1439	BF	19.20	1528	
4.30	1572		19.55	1446	
4.65	1651		20.00	1418	
5.10	1682		20.55	1362	
5.50	1641		21.10	1286	
5.90	1615		21.70	1258	
6.35	1542		22.40	1232	
6.75	1516		23.00	1210	
7.10	1507		23.75	1199	
7.55	1504		24.50	1217	
8.00	1530		25.25	1241	
8.45	1552		26.00	1188	
8.65	1569		27.00	1199	
8.82	1611		27.75	1299	
8.90	1804	WE	28.50	1379	
9.30	1930		29.25	1409	
9.75	2176		30.00	1431	
10.10	2301		30.70	1391	
10.55	2411		31.30	1337	
11.00	2617		31.90	1226	
11.50	2607		32.40	1086	
12.00	2530		32.90	0945	
12.45	2416		33.35	0860	
12.90	2365		33.71	0751	RB PIN
13.40	2418				
13.90	2351				
14.40	2205				
14.80	2177				
15.30	2090				
15.75	2093				
16.20	2152				

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

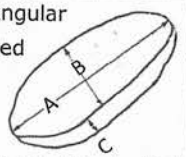
Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
2.9			6.8			3.1			SAND		
11			11.5			1.3					
10.8			3.1			5					
14.4	8	4.1	6	4.8	2.1	8.5	6	1.8			
9.1			3.8			6.4					
3.4			4			0.8			7.4		
8.2			3.7			0.7			4		
7	5.9	2.8	3.9	3	3	3.9	5.2	1	4.1	3	2.8
5			6.3			0.6			4.1		
7			2.6			16			2.2		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded

Embededness: 15 %

Subpavement: _____



[Pebble ABC axis guide]

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.743 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 3

Distance 1.0 m Time 1.46 s V 0.685 m/s

Distance 1.0 m Time 1.30 s V 0.769 m/s

Distance 1.0 m Time 1.29 s V 0.775 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

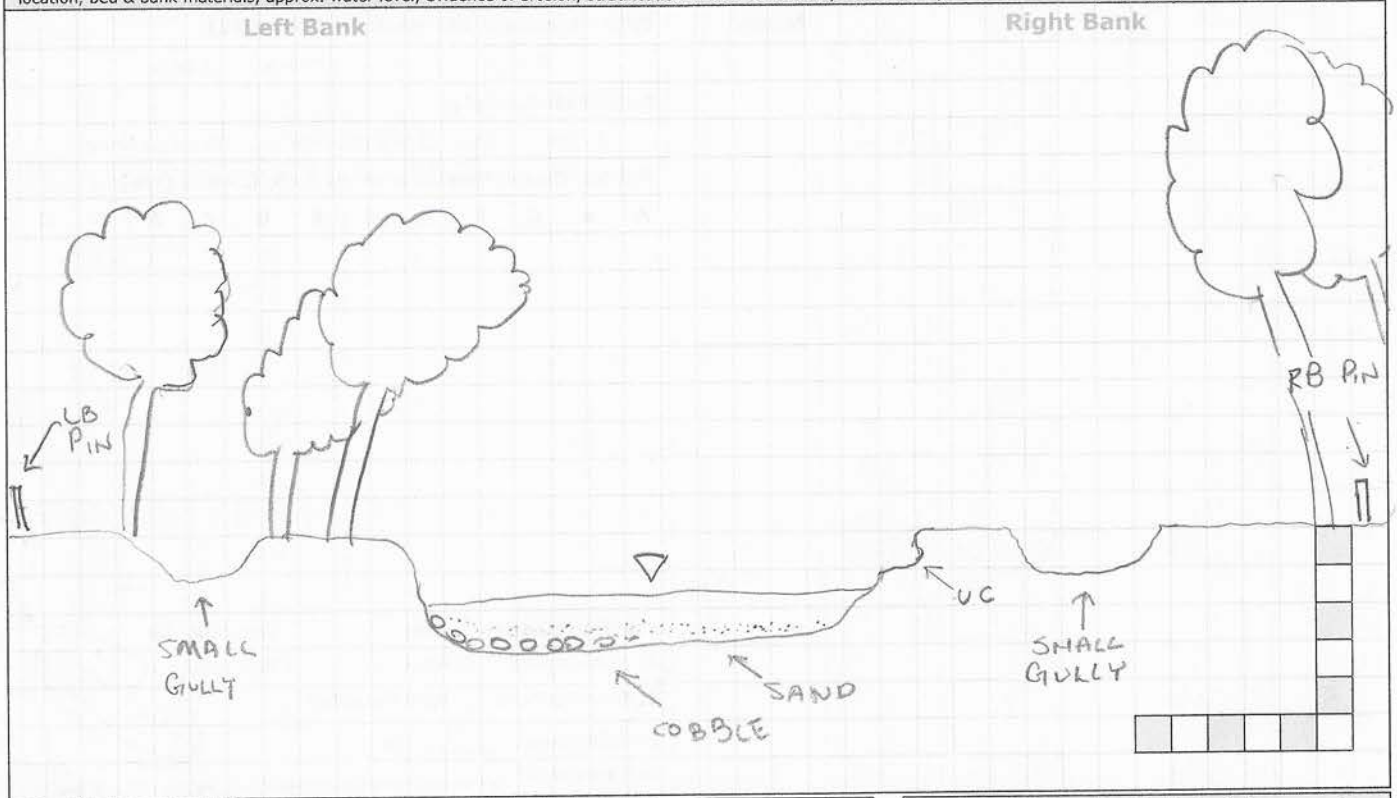
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS3
Time:	9:50	**Reach:**	CREDIT RIVER
Weather:	23°C SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☒ Sand	☐ Large Boulder		
Bank Height:	1.35	m	
Bank Angle:	15	°	
Root Depth:	0.80	m	
Root Density:	15	%	
Undercut:	0	m	
Erosion Pin:	/	m	
Torvane:	0.50	kg/cm²	
Penetrometer:	0.75	kg/cm²	
Foot Used:	☐ Yes ☒ No		

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
	Bank stabilization
-x-x-x	Fence
	Grasses
	Leaning tree
	Tree
	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel		
☐ Till	☐ Small Cobble		
☒ Clay	☐ Large Cobble		
☒ Silt	☐ Small Boulder		
☒ Sand	☐ Large Boulder		
Bank Height:	1.35	m	
Bank Angle:	20	°	
Root Depth:	0.50	m	
Root Density:	40	%	
Undercut:	0.20	m	
Erosion Pin:	/	m	
Torvane:	0.5	kg/cm²	
Penetrometer:	1.75	kg/cm²	
Foot Used:	☐ Yes ☒ No		

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 4
Time:	11:00	**Reach:**	CREDIT RIVER
Weather:	20° SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	Note	x	y	Notes
1.75	1312	LB PIN	16.95	2684	
2.10	1348		17.30	2610	
2.45	1398		17.70	2511	
2.80	1419		18.10	2379	
3.20	1500		18.44	2322	
3.60	1548		18.55	1662	BF
4.00	1568		18.60	1602	
4.40	1569		18.85	1500	
4.80	1578		18.98	1389	
5.20	1609		19.30	1286	
5.60	1642		19.75	1199	
6.00	1659		20.10	1160	RB PIN
6.40	1613				
6.80	1617				
7.20	1560				
7.60	1519				
8.00	1527				
8.40	1513				
9.00	1531				
9.35	1542				
9.45	1695				
9.55	1782				
9.80	1838				
10.05	1941				
10.38	1995	WE			
10.80	2027				
11.25	2066				
11.65	2118				
12.05	2186				
12.50	2270				
12.95	2331				
13.40	2352				
13.85	2480				
14.30	2520				
14.75	2566				
15.20	2640				
15.65	2700				
16.05	2733				
16.50	2716				

Cross-sectional Morphology (Table 22)

☐ Riffle ☐ Pool ☒ Run ☐ Other

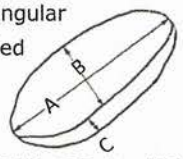
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			1.5			3			7.2		
			9			1.2			6.8		
			6.3			2.3			5		
			15	13.5	9.1	4	2.4	1.5	3.5	2	0.9
			4.5			3			6.1		
			10			4.3			6		
			10.9			1			8		
			4.9	3.3	1.6	6	5.5	2	2	1.9	0.7
6.8			6.9			8			4.5		
5.9			9.5			11			2		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 20 %

Subpavement: _____

Sorting (Table 20): ☐ Well ☐ Moderate ☒ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.758 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 4

Distance 1.0 m Time 1.68 s V 0.595 m/s

Distance 1.0 m Time 1.10 s V 0.909 m/s

Distance 1.0 m Time 1.30 s V 0.769 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

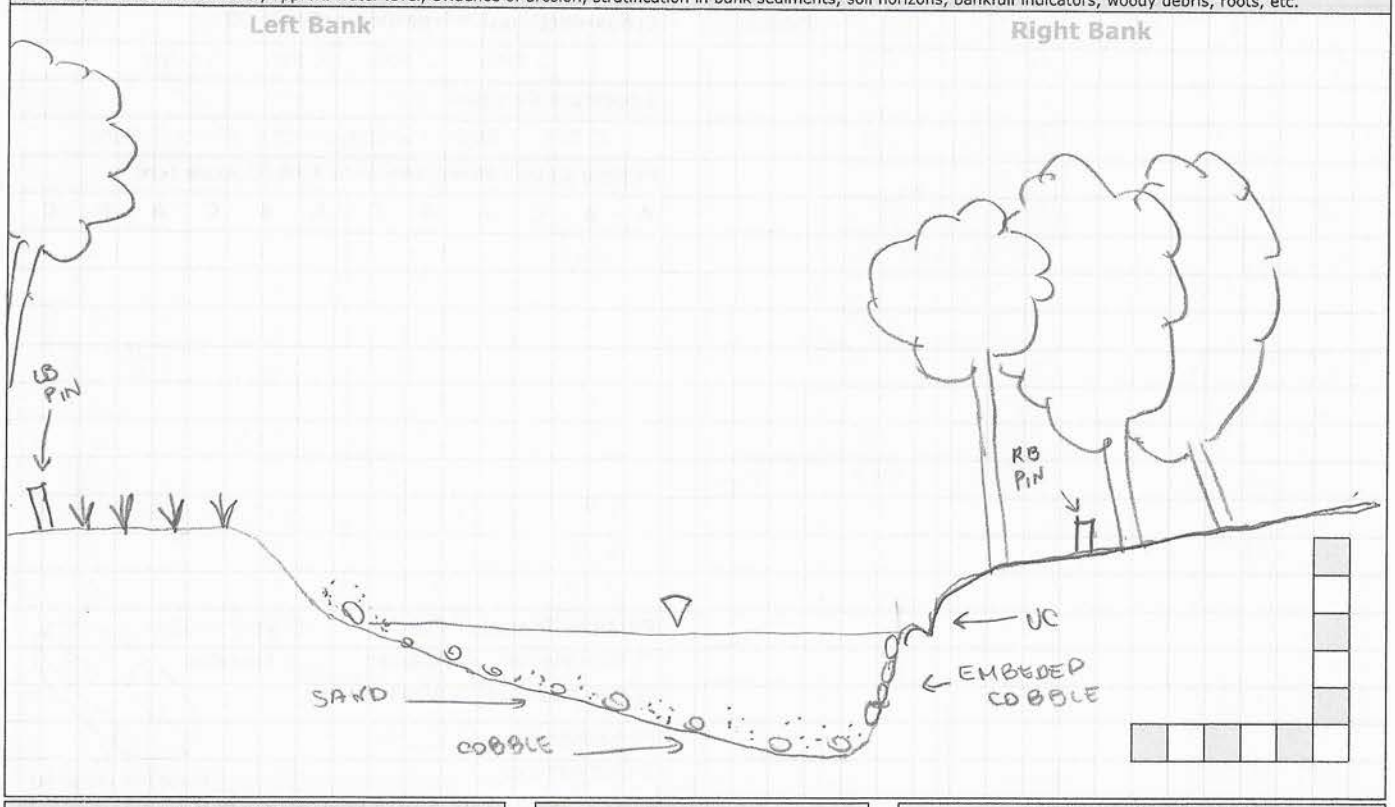
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS4
Time:	11:00	**Reach:**	CREDIT RIVER
Weather:	23°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble			Monumented XS	☐ Till	☒ Small Cobble	
☒ Clay	☐ Large Cobble			Monumented photo	☒ Clay	☒ Large Cobble	
☒ Silt	☐ Small Boulder			Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder			Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	1.50	m		Bank stabilization	Bank Height:	1.60	m
Bank Angle:	30	°		Fence	Bank Angle:	90	°
Root Depth:	0.70	m		Grasses	Root Depth:	1.0	m
Root Density:	35	%		Leaning tree	Root Density:	35	%
Undercut:	0	m		Tree	Undercut:	0.15	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.5	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	1.5	kg/cm²		Erosion pin	Penetrometer:	1.5	kg/cm²
Foot Used:	☐ Yes ☐ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 5
Time:	3:12	**Reach:**	CREDIT RIVER
Weather:	23° SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	NOTE			Notes
1.75	0962	LB PIN			
2.10	0965				
2.58	1059	BF			
2.65	1311				
2.72	1449				
3.30	1545				
3.80	1610				
4.15	1627				
4.60	1727				
5.00	1739				
5.50	1740				
6.00	1760				
6.50	1760				
7.00	1771				
7.50	1772				
8.00	1731				
8.50	1768				
9.00	1769				
9.50	1787				
10.00	1805				
10.50	1821				
11.00	1839				
11.50	1829				
12.00	1825				
12.50	1799				
13.00	1735				
13.50	1702				
14.00	1682				
14.50	1619				
15.00	1655				
15.50	1608				
15.91	1410	WE			
16.20	1405				
16.48	1428				
16.56	1191				
16.70	1041				
17.00	0995				
17.50	1029	RB PIN			

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

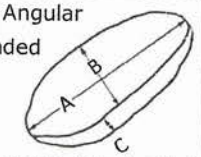
Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			7.3			1.8			5		
			2			2.3			7		
			1.4			2.9			2		
			5	3.3	2.5	3	2.3	2	2.2	1.8	0.8
			1.4			2			4.3		
4			1			8			5		
2			3			10.5			2		
14	10	1.3	4.8	3	0.5	2.4	2	1	2	1.9	1
1.1			2			6.5			2.3		
2.1			2.6			11			2.7		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded

Embededness: 10 %

Subpavement: TILL



[Pebble ABC axis guide]

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.637 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 5

Distance 1.0 m Time 1.90 s V 0.526 m/s

Distance 1.0 m Time 1.71 s V 0.585 m/s

Distance 1.0 m Time 1.25 s V 0.8 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

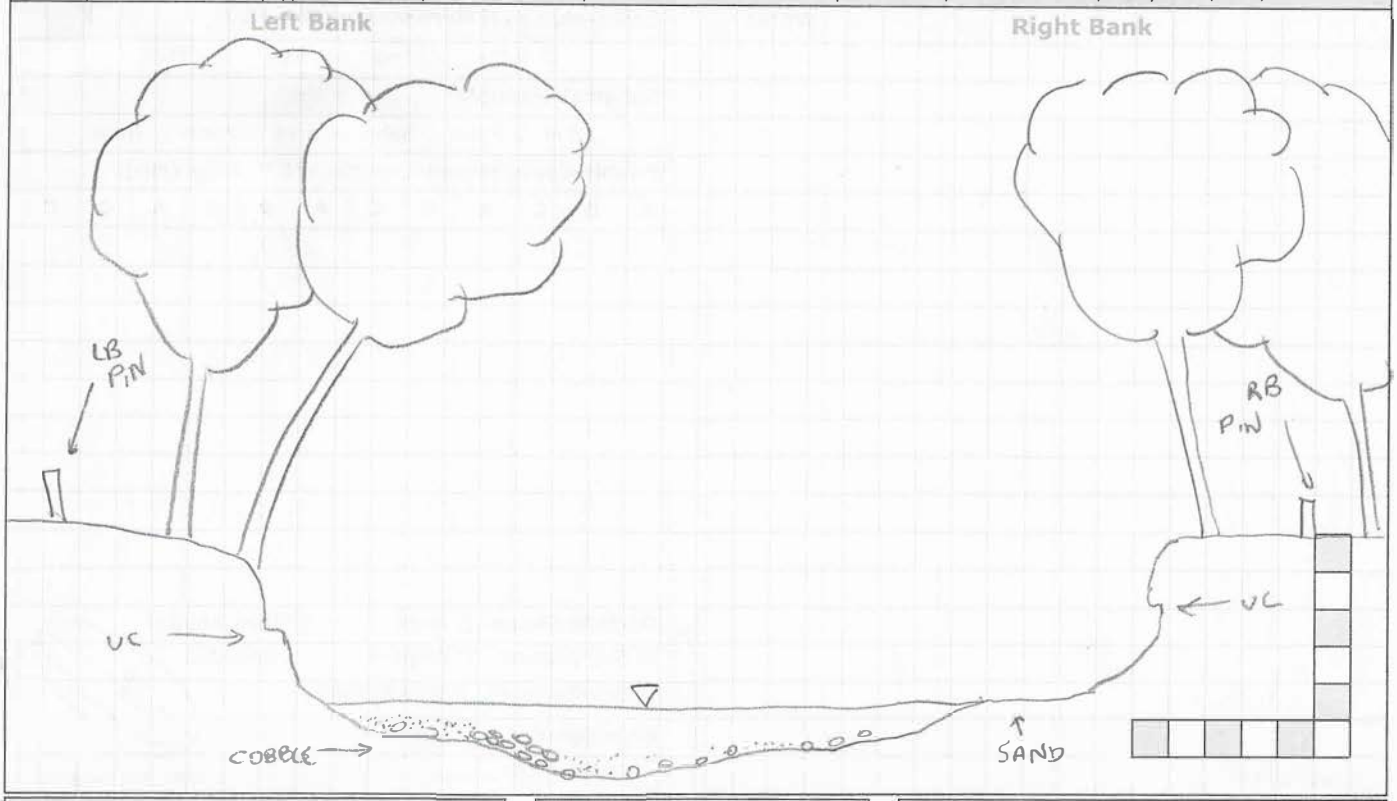
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS5
Time:	3:12	**Reach:**	CREDIT RIVER
Weather:	23°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble			Monumented XS	☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble			Monumented photo	☑ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder			Undercut bank	☒ Silt	☐ Small Boulder	
☑ Sand	☐ Large Boulder			Eroded bank/slope	☑ Sand	☐ Large Boulder	
Bank Height:	0.66	m		Bank stabilization	Bank Height:	0.63	m
Bank Angle:	85	°		Fence	Bank Angle:	80	°
Root Depth:	0.50	m		Grasses	Root Depth:	0.50	m
Root Density:	20	%		Leaning tree	Root Density:	10	%
Undercut:	0.04	m		Tree	Undercut:	0.08	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.25	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	1.0	kg/cm²		Erosion pin	Penetrometer:	0.75	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX™

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 6
Time:	2:35	**Reach:**	CREDIT RIVER
Weather:	22° SUNNY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	

X	Y	NOTE			Notes
1.75	0805	LB PIN			
2.20	0867				
2.60	0990	BF			
2.80	1170				
3.30	1275				
3.62	1360	WE			
4.10	1455				
4.60	1486				
5.20	1547				
5.70	1580				
6.20	1575				
6.70	1610				
7.20	1631				
7.80	1678				
8.30	1720				
8.90	1723				
9.60	1740				
10.20	1775				
10.80	1821				
11.30	1856				
11.90	1838				
12.50	1863				
13.10	1782				
13.70	1713				
14.20	1678				
14.60	1650				
14.90	1452				
15.00	1107				
15.30	1042				
15.66	1021	RB PIN			

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

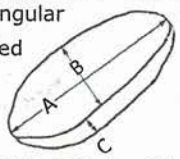
Substrate Sample:

☐ Bed ☒ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			6.6			3.6			3.5		
			3.1			3.2			2.4		
			2.2			9.3			3.2		
			4.6	2.2	1.8	4.4	3.3	1.6	2.5	2.4	1
			2			3			10		
			3			4.5			6.5		
			4			3.3			9.1		
4	3	1.5	3.4	3.2	1.9	2.6	2.4	0.5	2.4	2.2	0.9
			3.2			4			3.1		
			9.4			3.1			4.2		

Particle Shape: ☐ Platy ☐ Very Angular
☒ Sub-angular ☐ Angular ☐ Rounded
☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 10 %

Subpavement: TILL

Sorting (Table 20): ☒ Well ☐ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.633 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 6 C

Distance 1.0 m Time 1.73 s V 0.578 m/s

Distance 1.0 m Time 1.58 s V 0.633 m/s

Distance 1.0 m Time 1.45 s V 0.689 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

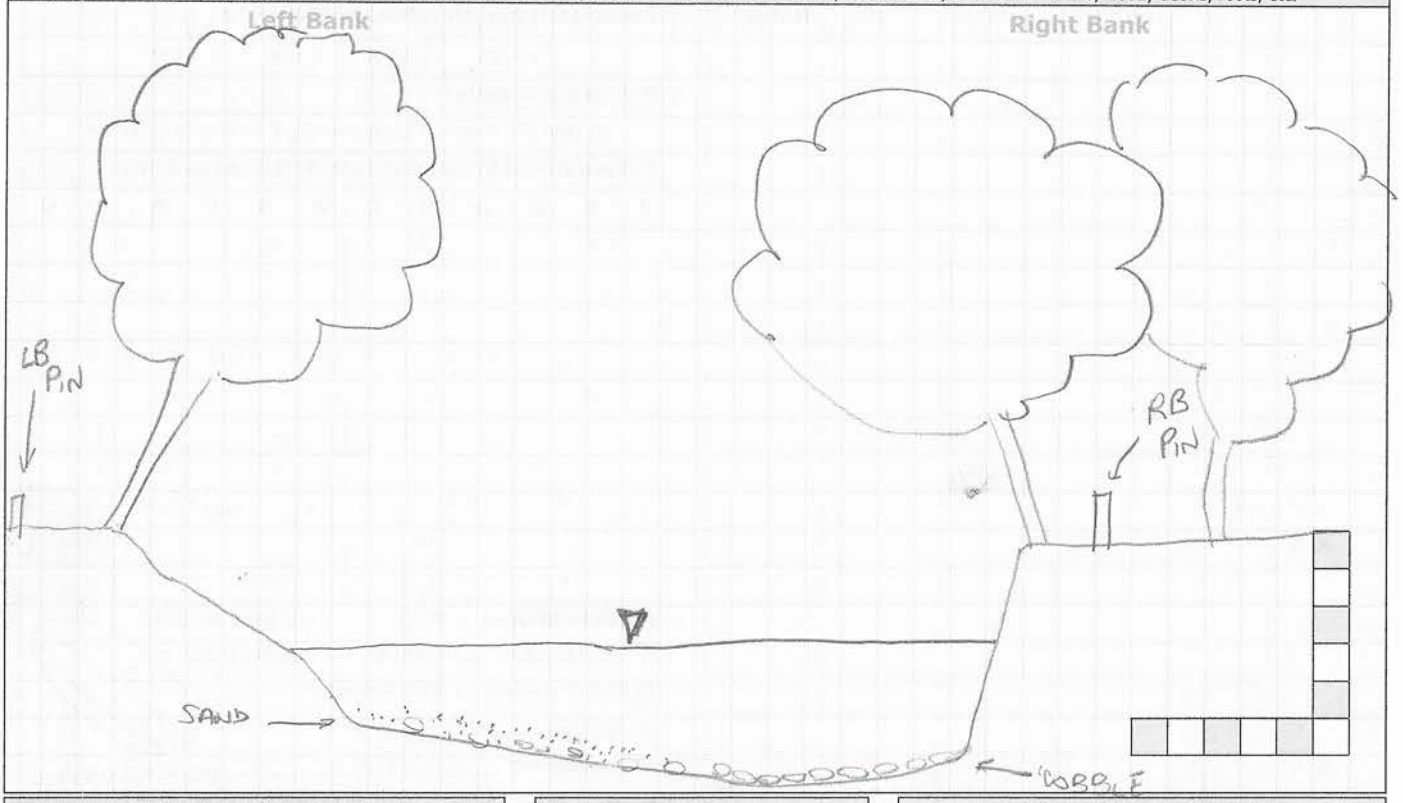
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS6
Time:	2:35	**Reach:**	CREDIT RIVER
Weather:	22°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder	
Bank Height:	0.8	m
Bank Angle:	25	°
Root Depth:	0.50	m
Root Density:	10	%
Undercut:	0	m
Erosion Pin:	/	m
Torvane:	0.25	kg/cm²
Penetrometer:	0.5	kg/cm²
Foot Used:	☐ Yes ☒ No	

Features

	Station location
	Monumented XS
	Monumented photo
------	Undercut bank
//////	Eroded bank/slope
XXXXX	Bank stabilization
x-x-x	Fence
VVV	Grasses
	Leaning tree
	Tree
	Woody Debris
	Sediment sample
	Erosion pin
	Scour/bed chain

Right Bank Materials

☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder	
Bank Height:	0.8	m
Bank Angle:	80	°
Root Depth:	0.10	m
Root Density:	10	%
Undercut:	0	m
Erosion Pin:	/	m
Torvane:	0.25	kg/cm²
Penetrometer:	1	kg/cm²
Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 7
Time:	4:17	**Reach:**	CREDIT RIVER
Weather:	23° CLOUDY	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

X	Y	NOTE			Notes
1.75	1430	LB PIN			
2.05	1451				
2.40	1570				
2.90	1655				
3.40	1725				
3.55	1815	BF			
3.60	1975				
3.87	2125	WE			
4.50	2279				
5.50	2292				
6.50	2405				
7.50	2383				
8.50	2400				
9.25	2390				
9.87	2113	WE (ISLAND)			
9.94	2010				
10.75	1999				
11.40	2070				
11.69	2120	WE			
12.50	2305				
13.50	2225				
14.50	2255				
15.50	2221				
16.50	2249				
17.50	2250				
18.50	2261				
19.50	2455				
20.50	2600				
21.50	2540				
22.30	2302				
22.82	2090	WE			
23.30	1952	BF			
24.00	1855				
24.90	1805				
25.60	1815				
26.47	1785	RB PIN			

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

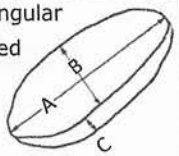
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			2			1			3.2		
			3			2.5			6		
			1.5			1.8			2		
			4.3	3.5	1.6	5	2.8	1.5	2.9	2.5	1.6
			9			5.1			3.1		
3			7.1			4.9			3.5		
1.5			7.5			6			2		
4.2	3.2	1	3	1.6	1.5	3.1	2	1	2.9	2	0.9
1			5.4			3			3.1		
3.9			4			4.2			0.5		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 10 %

Subpavement: TILL

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.736 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 7

Distance 1.0 m Time 1.16 s V 0.862 m/s

Distance 1.0 m Time 1.33 s V 0.752 m/s

Distance 1.0 m Time 1.68 s V 0.595 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

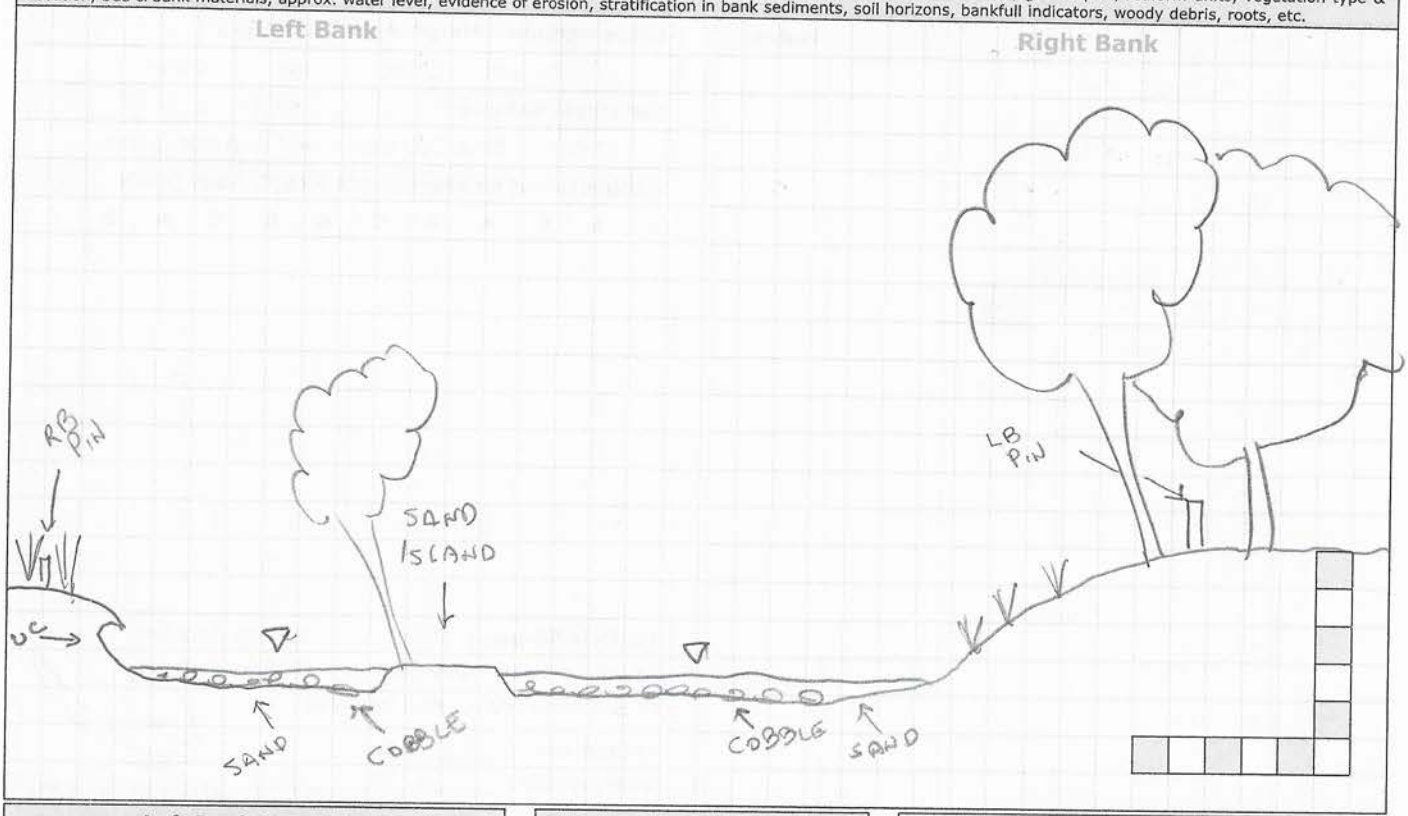
GEO MORPHIX

Bank Characteristics

Project Number: 24061

Date:	2024-07-23	**Cross-section:**	XS7
Time:	4:17	**Reach:**	Credit River
Weather:	23°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble			Monumented XS	☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble			Monumented photo	☒ Clay	☐ Large Cobble	
☒ Silt	☐ Small Boulder			Undercut bank	☒ Silt	☐ Small Boulder	
☒ Sand	☐ Large Boulder			Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	0.90	m		Bank stabilization	Bank Height:	0.85	m
Bank Angle:	25	°		Fence	Bank Angle:	15	°
Root Depth:	0.20	m		Grasses	Root Depth:	0.20	m
Root Density:	15	%		Leaning tree	Root Density:	15	%
Undercut:	0.10	m		Tree	Undercut:	0	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.25	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	1.75	kg/cm²		Erosion pin	Penetrometer:	0.25	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

GEO MORPHIX

Detailed Cross-Section Characteristics **Project Number:** 24061

Date:	2024-07-25	**Cross-section:**	XS8
Time:	4:55	**Reach:**	CREDIT RIVER
Weather:	23° SUNNY	**Location:**	DUGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

x	Y	NOTE			Notes
1.75	1345	LB PIN			
2.30	1400				
2.65	1467	BF			
2.95	1628				
3.15	1725	WE			
3.60	1863				
4.15	1881				
4.75	1910				
5.25	1999				
5.95	2063				
6.50	2069				
7.00	2040				
7.60	2020				
8.20	2008				
8.80	2005				
9.40	2020				
10.00	1980				
10.60	1909				
11.20	1923				
11.80	1928				
12.50	1880				
12.60	1373				
12.85	1192				
13.10	1026				
13.40	0924				
13.70	0930	RB PIN			

Cross-sectional Morphology (Table 22)

☒ Riffle ☐ Pool ☐ Run ☐ Other

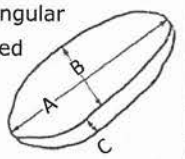
Substrate Sample:

☐ Bed ☐ Bank ☐ Subpavement ☐ Water ☐ None

Pebble Count Measurements A/B/C Axes (cm):

A	B	C	A	B	C	A	B	C	A	B	C
SAND			4			2.7			7.1		
			2			6			7		
			3.6			11.8			4.1		
			3	2.2	0.8	6.3	5	3	3.2	2.1	1
			3.1			7.5			4.5		
2.5			2.1			11.1			3.4		
0.6			2.7			7.5			3		
9.9	9	4	7.5	7	4.8	3	2.5	1	8.6	3	1.8
6			2.6			7.7			3.6		
5.4			2.1			5.5			5.2		

Particle Shape: ☐ Platy ☐ Very Angular ☒ Sub-angular ☐ Angular ☐ Rounded ☒ Sub-Rounded ☐ Well Rounded



[Pebble ABC axis guide]

Embededness: 10 %

Subpavement: TILL

Sorting (Table 20): ☐ Well ☒ Moderate ☐ Poor ☐ Very poor

Sediment Transport

☐ Obsv ☒ Not Obsv ☐ Not Visible - Reason: _____

If Observed (Table 21):

☐ Suspended ☐ Sliding ☐ Rolling ☐ Saltation

Percentage of Bed Active: _____ %

Velocity

☒ Measured 0.950 m/s Method: WB

☐ Estimated _____ m/s XS ID: XS 8

Distance 1.0 m Time 1.24 s V 0.806 m/s

Distance 1.0 m Time 0.95 s V 1.052 m/s

Distance 1.0 m Time 1.01 s V 0.990 m/s

Discharge

☐ Estimated _____ m^3/s Method: _____

☐ Measured _____ m^3/s XS ID: _____

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Depth _____ m Width _____ m V_{60} _____ m/s

Use V_{60} if Depth < 0.75 m and V_{20} / V_{80} if Depth > 0.75 m

Version #3
Last edited: 21/02/2023

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

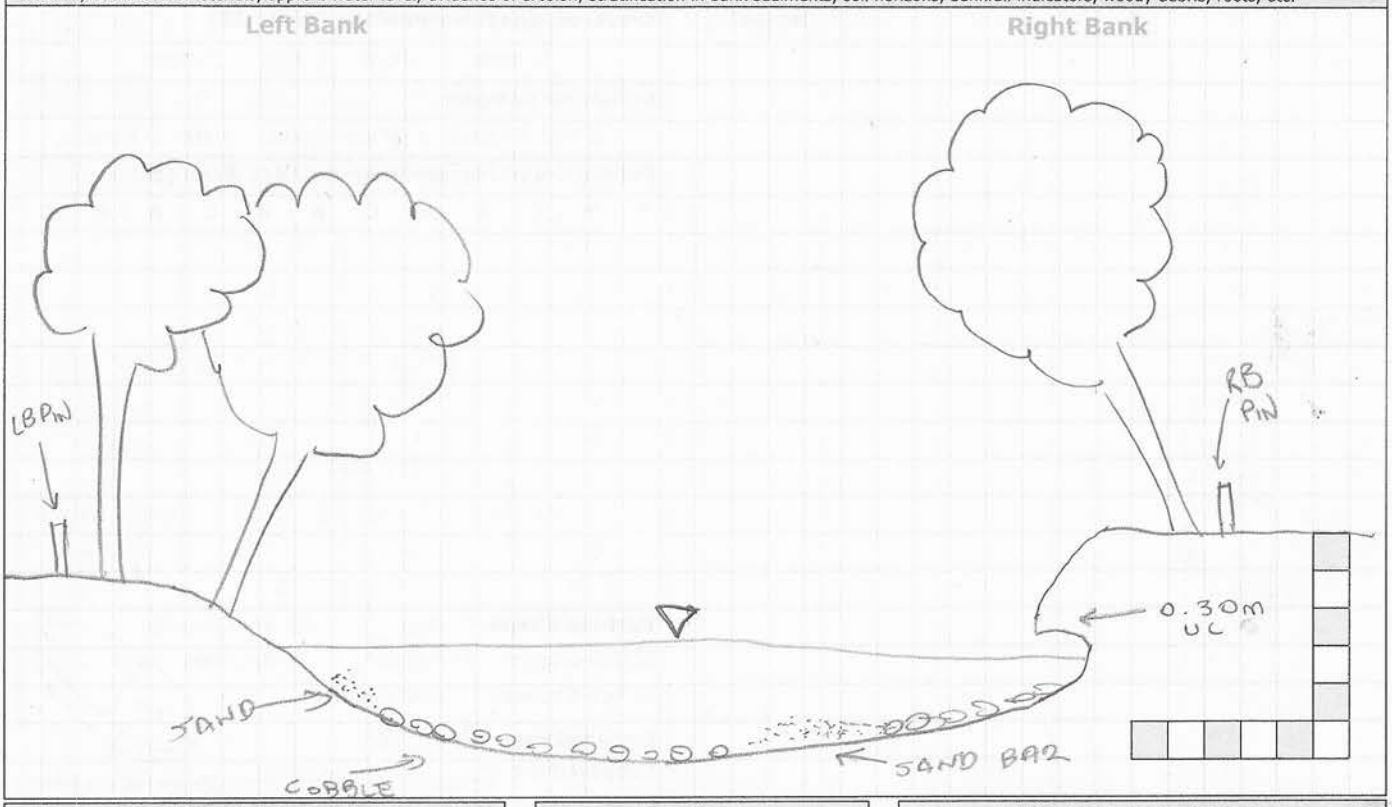
GEO MORPHIX™

Bank Characteristics

Project Number: 24061

Date:	2024-07-25	**Cross-section:**	XS 8
Time:	4:55	**Reach:**	CREDIT RIVER
Weather:	23°C Sunny	**Location:**	OVGC
Field Staff:	EF MK	**Watershed/Subwatershed:**	CR

Sketch (Viewed Downstream) Include: measurements, bank slope, evidence of geomorphic processes/adjustments, geomorphic/bedform units, vegetation type & location, bed & bank materials, approx. water level, evidence of erosion, stratification in bank sediments, soil horizons, bankfull indicators, woody debris, roots, etc.



Left Bank Materials			Features		Right Bank Materials		
☐ Bedrock	☐ Gravel			Station location	☐ Bedrock	☐ Gravel	
☐ Till	☐ Small Cobble			Monumented XS	☐ Till	☐ Small Cobble	
☒ Clay	☐ Large Cobble			Monumented photo	☐ Clay	☐ Large Cobble	
☐ Silt	☐ Small Boulder		------	Undercut bank	☐ Silt	☐ Small Boulder	
☐ Sand	☐ Large Boulder		//////	Eroded bank/slope	☒ Sand	☐ Large Boulder	
Bank Height:	0.75	m	XXXXX	Bank stabilization	Bank Height:	0.85	m
Bank Angle:	20	°	-x-x-x	Fence	Bank Angle:	10	°
Root Depth:	0.10	m	VVV	Grasses	Root Depth:	0.50	m
Root Density:	10	%		Leaning tree	Root Density:	30	%
Undercut:	0	m		Tree	Undercut:	0.30	m
Erosion Pin:	/	m		Woody Debris	Erosion Pin:	/	m
Torvane:	0.25	kg/cm²		Sediment sample	Torvane:	0.25	kg/cm²
Penetrometer:	1	kg/cm²		Erosion pin	Penetrometer:	2	kg/cm²
Foot Used:	☐ Yes ☒ No			Scour/bed chain	Foot Used:	☐ Yes ☒ No	

Additional Notes

Photos:

Version #4
Last edited: 21/02/2023

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

Appendix C
Detailed Field Assessment Summaries

Detailed Geomorphological Assessment Summary

East Ponds Outlet Channel

Project Number:	PN24061	Date:	2024-07-24
Client:	Votorantim Cimentos	Length Surveyed (m):	30.8
Location:	Caledon, ON	# of Cross-Sections:	3

Reach Characteristics

Drainage Area:	0.162 km^2	Dominant Riparian Vegetation Type:	Coniferous Trees
Geology/Soils:	Glaciofluvial Deposits	Extent of Riparian Cover:	Continuous
Surrounding Land Use:	Forest / Golf Course	Width of Riparian Cover:	4-10 Channel Widths
Valley Type:	Confined	Age Class of Riparian Vegetation:	Established - Mature
Dominant Instream Vegetation Type:	Not Applicable	Extent of Encroachment into Channel:	Minimal
Portion of Reach with Vegetation:	Not Applicable	Density of Woody Debris:	Low

Hydrology

Measured Discharge (m^3/s):	0.01	Calculated Bankfull Discharge (m^3/s):	0.68
Modelled 2-year Discharge (m^3/s):	Not modelled	Calculated Bankfull Velocity (m/s):	0.86
Modelled 2-year Velocity (m/s):	Not modelled		

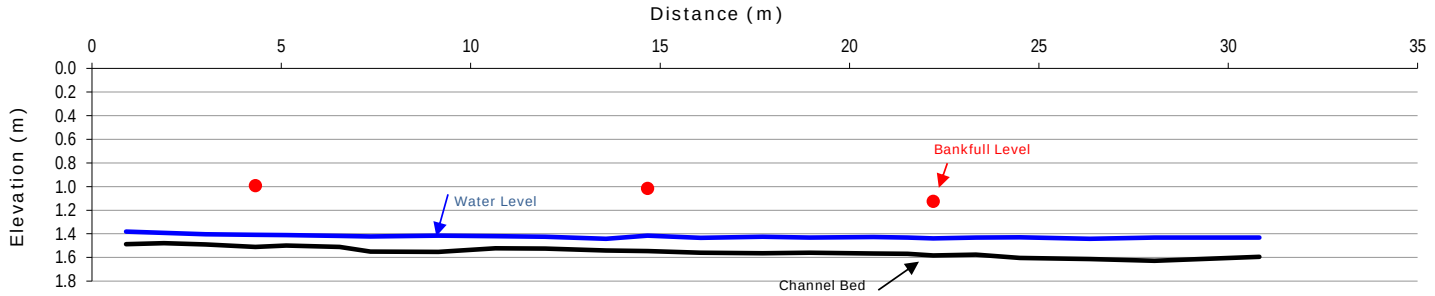
Profile Characteristics

Bankfull Gradient (%):	0.71
Channel Bed Gradient (%):	0.14
Riffle Gradient (%):	
Riffle Length (m):	No Riffle Morphology
Riffle-Pool Spacing (m):	

Planform Characteristics

Sinuosity:	1.10
Meander Belt Width (m):	
Radius of Curvature (m):	Not Applicable
Meander Amplitude (m):	
Meander wavelength (m):	

Longitudinal Profile



Bank Characteristics

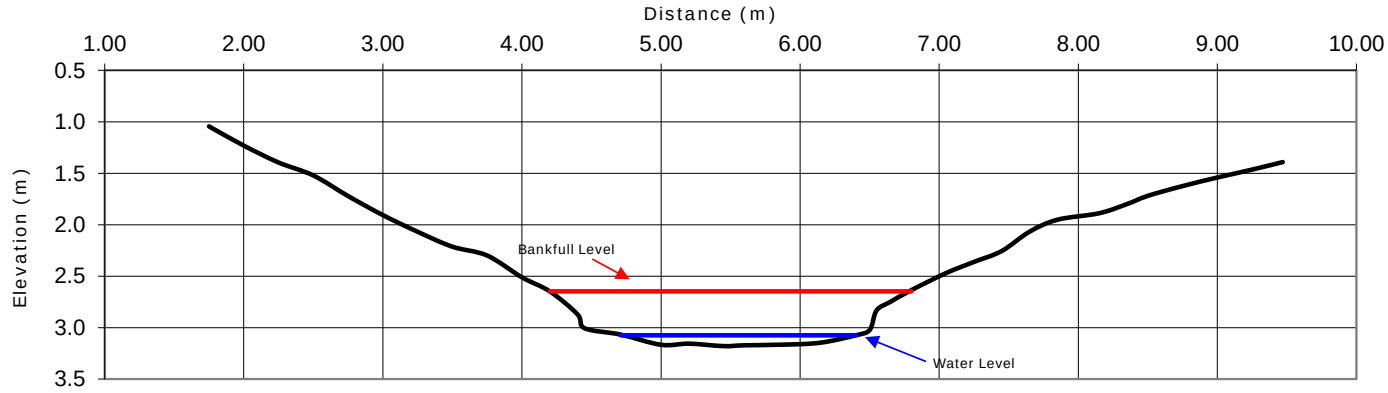
	Minimum	Maximum	Average		Minimum	Maximum	Average
Bank Height (m):	1.95	2.50	2.13				
Bank Angle (deg):	40	70	52	Torvane Value (kg/cm^2):	0.3	0.3	0.3
Root Depth (m):	1.00	1.00	1.00	Penetrometer Value (kg/cm^3):	1.5	2.5	2.1
Root Density (%):	10	15	12	Bank Material (range):		Sand, Silt, Cobbles	
Bank Undercut (m):	0	0.06	0.02				

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	2.35	2.65	2.53
Average Bankfull Depth (m):	0.27	0.35	0.31
Bankfull Width/Depth (m/m):	7.5	9.6	8.2
Wetted Width (m):	0.87	2.13	1.56
Average Water Depth (m):	0.05	0.10	0.07
Wetted Width/Depth (m/m):	19.1	25.6	22.1
Entrenchment (m):		Entrenched	
Entrenchment Ratio (m/m):		(ER < 1.4)	
Maximum Water Depth (m):	0.11	3.75	1.34
Manning's *n*:		0.045	

Photograph at cross section 2 (looking upstream)

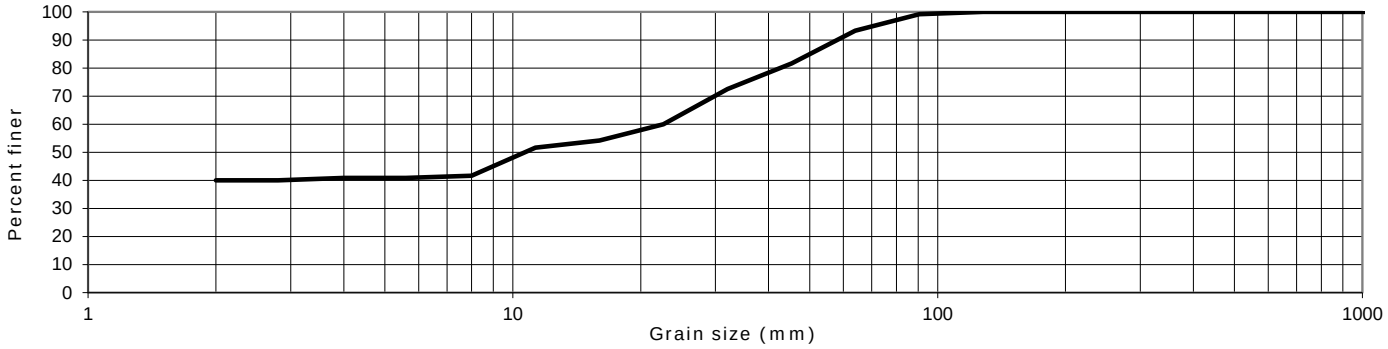
Representative Cross-Section #2



Substrate Characteristics

Particle Size (mm)			
D_{10}:	<2.0	Subpavement:	Till
D_{50}:	10.8	Particle shape:	Sub-angular, Sub-rounded
D_{84}:	49.0	Embeddedness (%):	10 - 40
		Particle range:	Sand - Cobbles

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		Tractive Force at Bankfull (N/m^2):	21.63
for D_{50}:	0.59	Tractive Force at 2-year flow (N/m^2):	Not modelled
for D_{84}:	1.18	Critical Shear Stress (D_{50}) (N/m^2):	7.83
Unit Stream Power at Bankfull (W/m^2):	18.57		

General Field Observations

Channel Description

The East Ponds Outlet Channel is a minor, ~35m tributary of the Credit River in Caledon, ON which conveys flows from the southeast side of the Osprey Valley Golf Course (OVGC) through a series of inline ponds, and into the mainstem of the Credit River. During the time of assessment, water was observed overtopping the banks of the nearest upstream inline pond, permitting flow through the subject reach, with no flow observed from the outflanked tile drain. The subject reach consisted of a straight channel within a confined, forested valley with a prominent knickpoint (~0.75m) at the upstream extent, revealing the exposed tile. Channel bed morphology was notably homogeneous downstream of the knickpoint and was planar in profile; however, channel substrates became gradually finer downstream, with materials consisting of sand and small to large cobbles (Embeddedness: 10-40%; D_{50}: 10.8 mm). The channel exhibited multiple indicators suggestive of aggradation, widening and degradation. Aggradation processes were supported by the observed sediment accumulation at the downstream extent, but was ultimately secondary to widening and degradational processes. These processes were evidenced by the persistent scour and exposed roots observed along the toe of the valley wall, as well as the exposed tile drainage.

Cross Section 3 - Facing Downstream

Detailed Geomorphological Assessment Summary

Credit River at East Ponds Outlet Channel

Project Number:	PN24061	Date:	2024-07-25
Client:	Votorantim Cimentos	Length Surveyed (m):	403.4
Location:	Caledon, ON	# of Cross-Sections:	8

Reach Characteristics

Drainage Area:	150.51 km^2	Dominant Riparian Vegetation Type:	Coniferous Trees
Geology/Soils:	Glaciofluvial and Organic Deposits	Extent of Riparian Cover:	Continuous
Surrounding Land Use:	Forest / Golf Course	Width of Riparian Cover:	>10 Channel Widths
Valley Type:	Partially Confined	Age Class of Riparian Vegetation:	Established - Mature
Dominant Instream Vegetation Type:	N/A	Extent of Encroachment into Channel:	Minimal
Portion of Reach with Vegetation:	N/A	Density of Woody Debris:	Moderate

Hydrology

Estimated Discharge (m^3/s):	0.547	Estimated Bankfull Discharge (m^3/s):	14.75
Modelled 2-year Discharge (m^3/s):	11.32	Estimated Bankfull Velocity (m/s):	1.02
Modelled 2-year Velocity (m/s):	1.46		

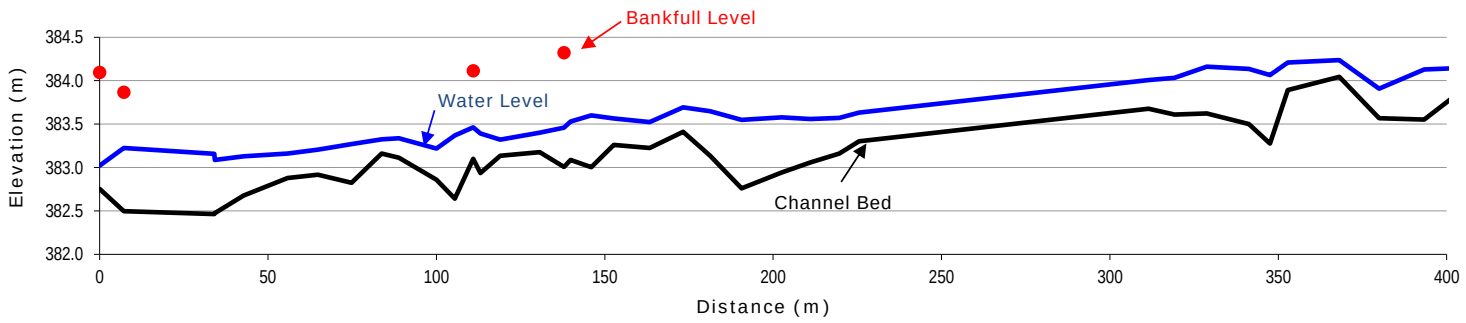
Profile Characteristics

Bankfull Gradient (%):	0.20
Channel Bed Gradient (%):	0.38
Riffle Gradient (%):	0.50
Riffle Length (m):	96.42
Riffle-Pool Spacing (m):	176.03

Planform Characteristics

Sinuosity:	1.18
Meander Belt Width (m):	See Report
Radius of Curvature (m):	150.2
Meander Amplitude (m):	201.5
Meander Wavelength (m):	627.9

Longitudinal Profile



Bank Characteristics

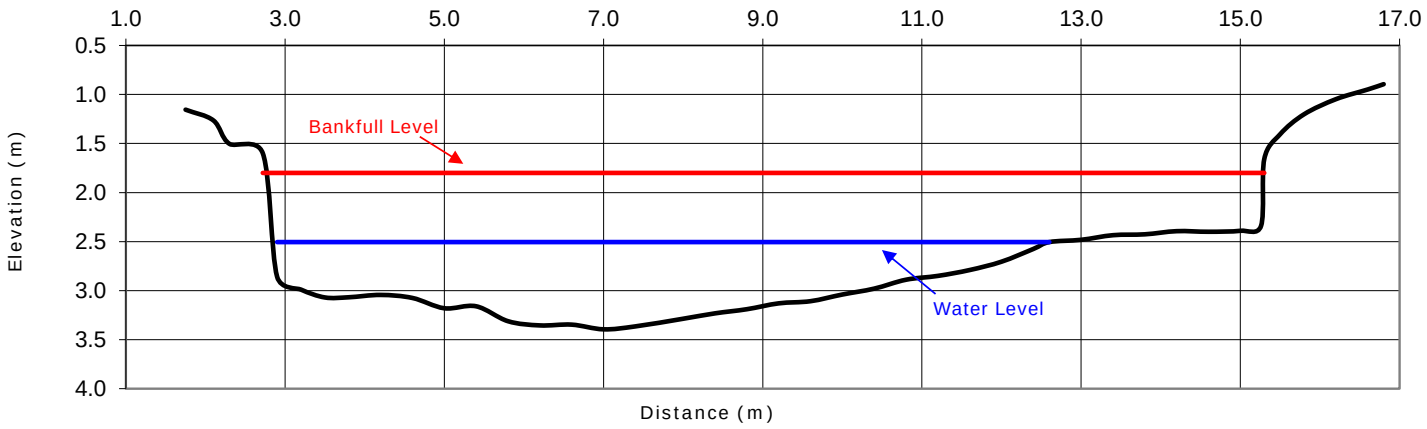
	Minimum	Maximum	Average		Minimum	Maximum	Average
Bank Height (m):	1.35	2.75	1.87	Penetrometer Value (kg/cm3):	0.25	2.5	1.4
Bank Angle (deg):	15	90	62	Bank Material (range):	Clay, Silt, Sand, Cobbles		
Root Depth (m):	0.50	1.50	1.06				
Root Density (%):	15	40	33				
Bank Undercut (m):	0.00	0.82	0.28				

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	12.58	15.80	14.19
Average Bankfull Depth (m):	0.52	1.23	1.02
Bankfull Width/Depth (m/m):	12.0	32.3	22.7
Wetted Width (m):	8.06	14.87	10.66
Average Water Depth (m):	0.42	0.55	0.46
Wetted Width/Depth (m/m):	17.6	33.9	23.5
Entrenchment Ratio (m/m):	1.4 - 2.2 (Moderately Entrenched)		
Maximum Water Depth (m):	0.74	0.89	0.81
Manning's *n*:		0.045	

Photograph at cross section 1 (looking downstream)

Representative Cross-Section #1

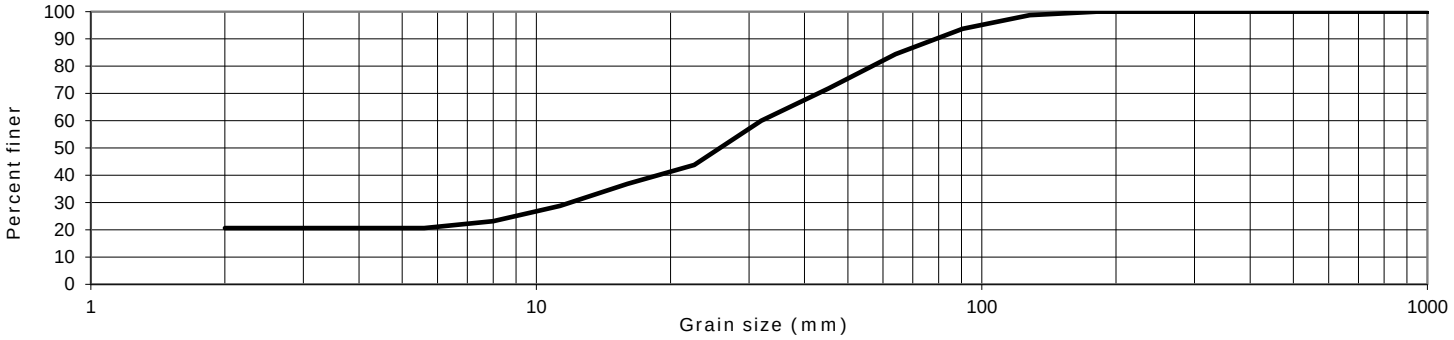


Substrate Characteristics

Particle Size (mm)	
D_{10}:	<2
D_{50}:	26.2
D_{84}:	63.5

Subpavement:	Till
Particle Shape:	Subrounded - Subangular
Embeddedness (%):	10 to 30
Particle Range (riffle):	Clay, Silt, Sand, Cobbles
Particle Range (pool):	Clay, Silt, Sand, Cobbles

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		Tractive Force at Bankfull (N/m^2):	20.47
for D_{50}:	0.89	Tractive Force at 2-year flow (N/m^2):	17.43
for D_{84}:	1.33	Critical Shear Stress (D_{50}) (N/m^2):	19.08
Unit Stream Power at Bankfull (W/m^2):	26.84		

General Field Observations

Channel Description

The assessed stretch of channel consisted of ~400m of the Credit River in Caledon, ON, receiving inputs from the East Ponds Outlet Channel originating from the Osprey Valley Golf Course (OVGC). The Credit River was characterized by a meandering channel set within a forested corridor. Dominant riparian vegetation consisted of coniferous trees which provided good cover over the channel and stability to the loosely consolidated, sandy-silt banks. Channel bed morphology demonstrated notable heterogeneity and was characterized by an alternating riffle-pool sequence featuring abundant micro-habitats/refugia. Widening processes were evidenced by fallen and leaning trees, as well as bank scour, while evidence of planimetric form adjustment was observed by an occasionally misaligned thalweg in straight sections of channel. Significant valley wall contact was observed along both banks, particularly upstream from the confluence with the East Ponds Outlet Channel. Despite steady inputs of sand and silt due to the described bank scour, aggredational processes were less significant as stream conditions were sufficient in preventing the formation of in-channel bars and embedment of larger substrates that would otherwise be

Cross Section 2 - Facing Upstream

Detailed Geomorphological Assessment Summary

Reach __Trib 4____

Project Number:	PN 24061	Date:	2024-07-23
Client:	Votorantim Climentos	Length Surveyed (m):	98.5
Location:	Caledon, ON	# of Cross-Sections:	6

Reach Characteristics

Drainage Area:	228.5 ha	Dominant Riparian Vegetation Type:	Coniferous trees
Geology/Soils:	Glaciofluvial deposits	Extent of Riparian Cover:	Continuous
Surrounding Land Use:	Golf course/forested	Width of Riparian Cover:	>10 channel widths
Valley Type:	Unconfined	Age Class of Riparian Vegetation:	Mature
Dominant Instream Vegetation Type:	Rooted emergent	Extent of Encroachment into Channel:	Heavy
Portion of Reach with Vegetation:	50%	Density of Woody Debris:	High

Hydrology

Measured Discharge (m^3/s):	Stagnant water	Calculated Bankfull Discharge (m^3/s):	0.44
Modelled 2-year Discharge (m^3/s):	Data not available	Calculated Bankfull Velocity (m/s):	0.75
Modelled 2-year Velocity (m/s):	Data not available		

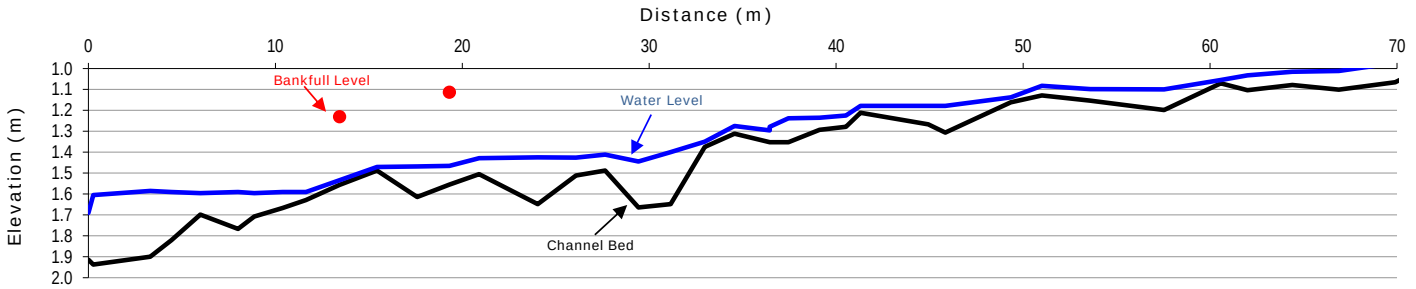
Profile Characteristics

Bankfull Gradient (%):	0.57
Channel Bed Gradient (%):	0.96
Riffle Gradient (%):	N/A
Riffle Length (m):	N/A
Riffle-Pool Spacing (m):	N/A

Planform Characteristics

Sinuosity:	1.34
Meander Belt Width (m):	Not modelled
Radius of Curvature (m):	80.2
Meander Amplitude (m):	157
Meander wavelength (m):	259

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	0.31	0.58	0.45
Bank Angle (deg):	15	45	27
Root Depth (m):	0.15	0.80	0.30
Root Density (%):	10	N/A	18
Bank Undercut (m):	0	0	0.00

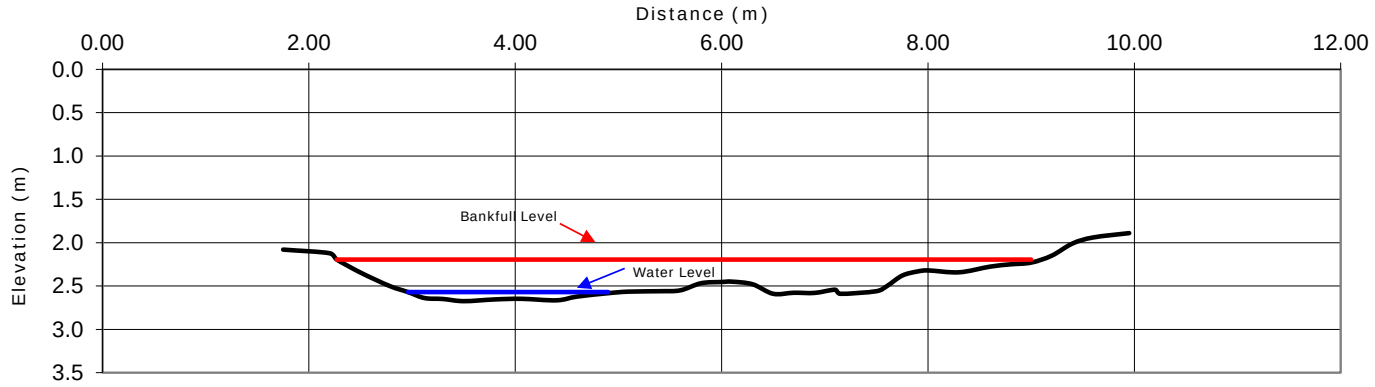
	Minimum	Maximum	Average
Torvane Value (kg/cm^2):	0.3	0.3	0.3
Penetrometer Value (kg/cm^3):	0.3	0.3	0.3
Bank Material (range):			

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	2.25	6.73	2.89
Average Bankfull Depth (m):	0.12	0.30	0.20
Bankfull Width/Depth (m/m):	13	23	19
Wetted Width (m):	0.00	3.20	1.04
Average Water Depth (m):	0.01	0.08	0.05
Wetted Width/Depth (m/m):	6	276	60
Entrenchment (m):		Low entrenchment	
Entrenchment Ratio (m/m):		(ER > 2.2)	
Maximum Water Depth (m):	0.05	0.15	0.08
Manning's *n*:		0.045	

Photograph at cross section 5 (looking downstream)

Representative Cross-Section #5

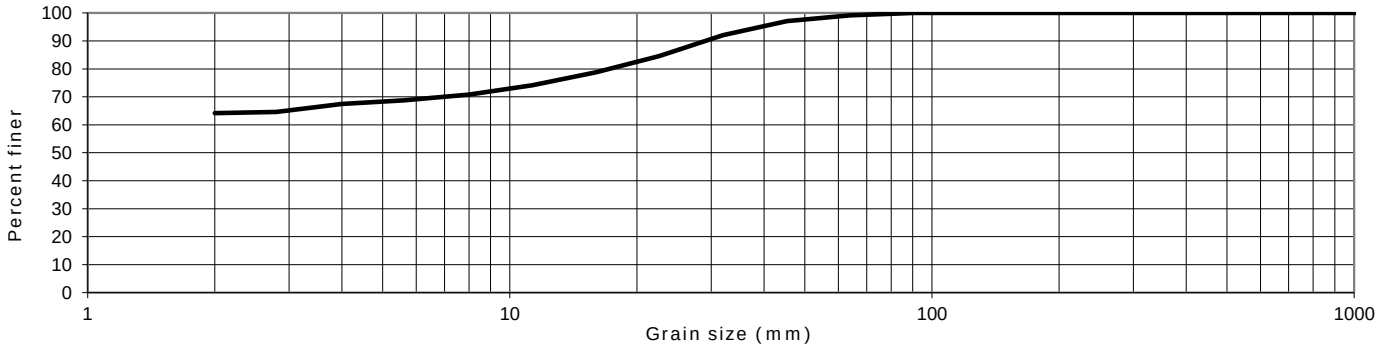


Substrate Characteristics

Particle Size (mm)	
D_{10}:	<2
D_{50}:	2.0
D_{84}:	22.6

Subpavement:	Till
Particle shape:	Sub-angular
Embeddedness (%):	20-80
Particle range (riffle):	N/A
Particle Range (pool):	Sand - cobbles

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		Tractive Force at Bankfull (N/m^2):	19.01
for D_{50}:	0.27	Tractive Force at 2-year flow (N/m^2):	Data not available
for D_{84}:	0.83	Critical Shear Stress (D_{50}) (N/m^2):	1.46
Unit Stream Power at Bankfull (W/m^2):	14.24		

General Field Observations

Channel Description

Tributary 4 flows unconfined northwest through a golf course before discharging to the Credit River upstream of the East Ponds Outlet Channel. At time of assessment, the channel was predominantly dry with some flow occurring within isolated pools. The riparian zone was continuous, spanning over 10 channel widths and consists of mature vegetation. Heavy encroachment of vegetation into the channel was observed, along with a high density of woody debris. Rooted emergent aquatic vegetation was also present at time of assessment. Bank angles range from 15-45, with no undercutting observed. The right and left bank consisted primarily of very fine to medium sand, with a small percentage of coarse sand, gravel and small stones. The bed was composed of medium to very coarse sand, with small to large cobbles observed throughout the extent of the channel.

Cross Section 3 - Facing Downstream

Detailed Geomorphological Assessment Summary

Credit River at Tributary 4

Project Number:	PN24061	Date:	2024-07-25
Client:	Votorantim Cimentos	Length Surveyed (m):	450.0
Location:	Caledon, ON	# of Cross-Sections:	8

Reach Characteristics

Drainage Area:	147.5 km^2	Dominant Riparian Vegetation Type:	Coniferous Trees
Geology/Soils:	Glaciofluvial and Organic Deposits	Extent of Riparian Cover:	Continuous
Surrounding Land Use:	Forest / Golf Course	Width of Riparian Cover:	>10 Channel Widths
Valley Type:	Partially Confined	Age Class of Riparian Vegetation:	Established - Mature
Dominant Instream Vegetation Type:	N/A	Extent of Encroachment into Channel:	Minimal
Portion of Reach with Vegetation:	N/A	Density of Woody Debris:	Moderate

Hydrology

Estimated Discharge (m^3/s):	0.450	Estimated Bankfull Discharge (m^3/s):	8.95
Modelled 2-year Discharge (m^3/s):	11.32	Estimated Bankfull Velocity (m/s):	0.92
Modelled 2-year Velocity (m/s):	1.46		

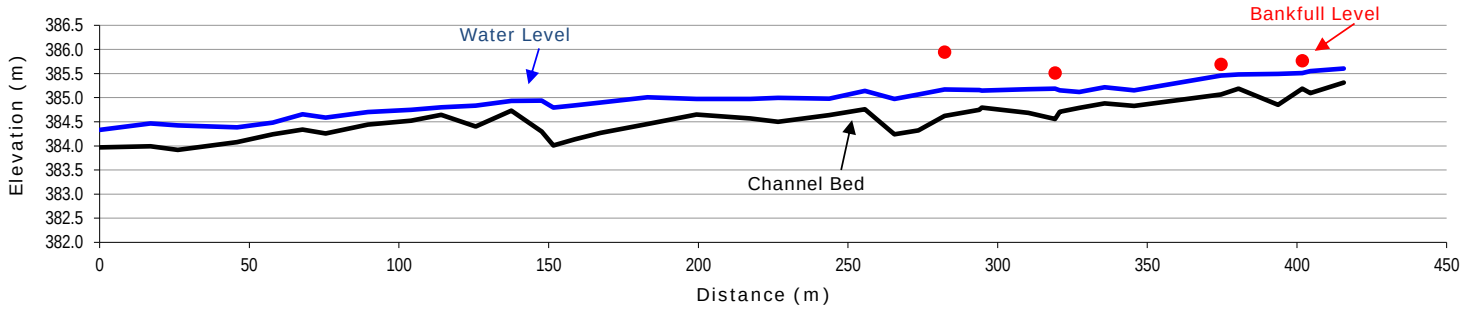
Profile Characteristics

Bankfull Gradient (%):	0.08
Channel Bed Gradient (%):	0.30
Riffle Gradient (%):	0.50
Riffle Length (m):	113.42
Riffle-Pool Spacing (m):	93.27

Planform Characteristics

Sinuosity:	1.13
Meander Belt Width (m):	See Report
Radius of Curvature (m):	133.1
Meander Amplitude (m):	116.6
Meander Wavelength (m):	557.2

Longitudinal Profile



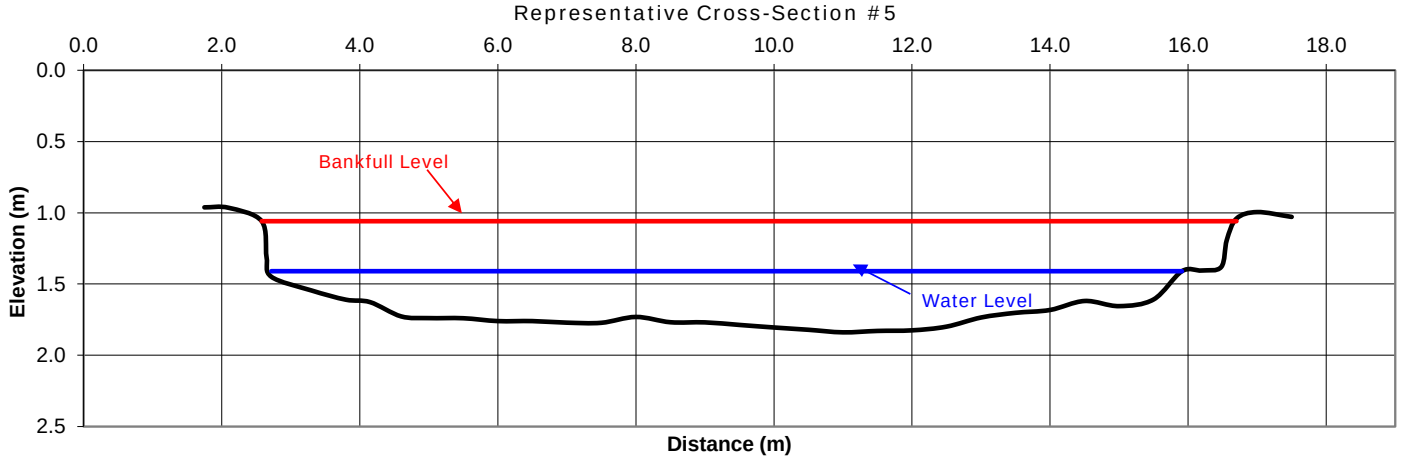
Bank Characteristics

	Minimum	Maximum	Average		Minimum	Maximum	Average
Bank Height (m):	0.63	0.90	0.78	Penetrometer Value (kg/cm3):	0.25	2.5	1.4
Bank Angle (deg):	15	85	50	Bank Material (range):		Clay, Silt, Sand	
Root Depth (m):	0.10	0.50	0.33				
Root Density (%):	10	30	15				
Bank Undercut (m):	0.00	0.30	0.07				

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	10.30	20.40	14.70
Average Bankfull Depth (m):	0.37	0.75	0.66
Bankfull Width/Depth (m/m):	22.3	54.9	22.3
Wetted Width (m):	9.35	18.95	13.19
Average Water Depth (m):	0.17	0.30	0.25
Wetted Width/Depth (m/m):	37.5	109.5	57.9
Entrenchment Ratio (m/m):	1.4 - 2.2 (Moderately Entrenched)		
Maximum Water Depth (m):	0.43	0.50	0.47
Manning's *n*:		0.045	

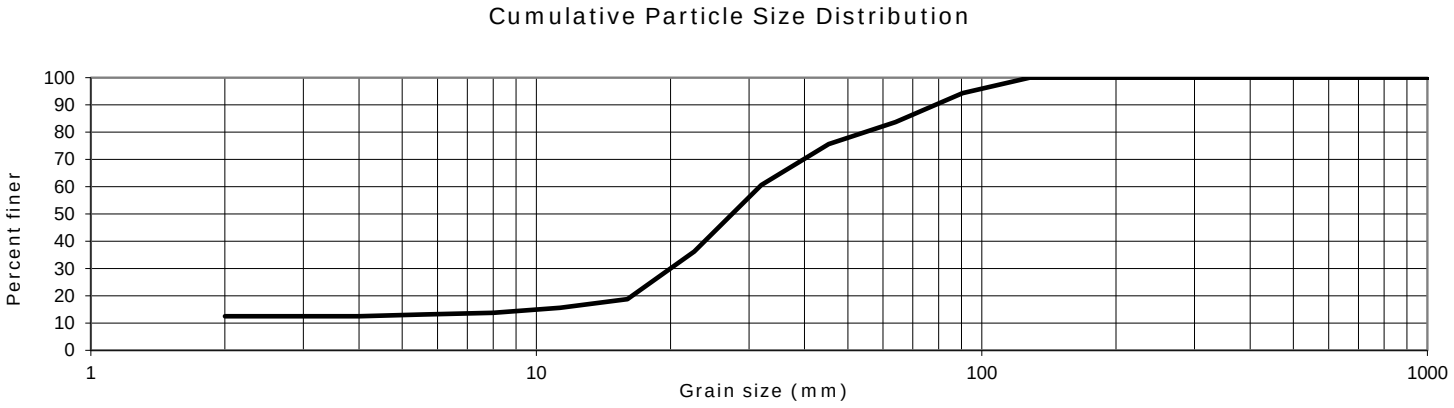
Photograph at cross section 5 (looking downstream)



Substrate Characteristics

Particle Size (mm)	
D_{10}:	<2
D_{50}:	27.9
D_{84}:	64.6

Subpavement:	Till
Particle Shape:	Subrounded - Subangular
Embeddedness (%):	10 to 30
Particle Range (riffle):	Clay, Silt, Sand, Cobbles
Particle Range (pool):	Clay, Silt, Sand, Cobbles



Channel Thresholds

Flow Competency (m/s):		Tractive Force at Bankfull (N/m^2):	19.40
for D_{50}:	0.91	Tractive Force at 2-year flow (N/m^2):	17.43
for D_{84}:	1.34	Critical Shear Stress (D_{50}) (N/m^2):	20.32
Unit Stream Power at Bankfull (W/m^2):	23.03		

General Field Observations

Channel Description

The assessed stretch of channel consisted of ~450m of the Credit River in Caledon, ON, receiving inputs from Tributary 4 from the Osprey Valley Golf Course (OVGC). The Credit River at Tributary 4 was characterized by a meandering channel set within an expansive, forested corridor, with localized pockets of meadow habitat. Dominant riparian vegetation consisted of coniferous trees which provided good cover over the channel and stability to the loosely consolidated, sandy-silt banks. Channel bed morphology demonstrated notable heterogeneity and was characterized by an alternating riffle-pool sequence featuring abundant micro-habitats/refugia. Widening processes were evidenced by fallen and leaning trees, as well as bank scour, while evidence of planimetric form adjustment was observed by an occasionally misaligned thalweg in straight sections of channel, and formation of several islands. The upstream extent of the channel was marked by a debris jam resulting in multiple flow paths and sediment accumulation. Aggradational processes within the channel were limited due to sufficient flow conditions allowing for transport of the fine sediment input from the eroded/undercut banks.

Cross Section 6 - Facing Upstream