Appendix J

Short Term Erosion Monitoring Memos – Short Term Monitoring Memo (Part 1 of 3)

Report

18 December 2023

To	Daniel McCreery	**Contact No.**	
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From	Jeff Doucette	**Project No.**	11209954
Project Name	City of Toronto-Yellow Creek MP		
Subject	Short-Term Erosion Monitoring		

Dear Mr. McCreery,

1. Introduction

1.1 Purpose of this report

The Yellow Creek Geomorphic Systems Master Plan (YCGSMP) project comprises a comprehensive investigation of the factors that have contributed to substantial stream bed, bank, and erosion control infrastructure damage within the Yellow Creek channel. The Study Area for this project includes the aboveground reach of Yellow Creek within the Vale of Avoca between Mount Pleasant Cemetery and the crossing at Mount Pleasant Road (**Figure 1**).

The investigation will guide the development of a long-term rehabilitation plan for Yellow Creek that will protect Toronto Water infrastructure while minimizing riparian ecosystem impacts and enhancing aquatic habitat. Work on the YCGSMP will take into consideration past and concurrent erosion control projects, assessments, and designs. The project will be completed in accordance with the Municipal Class Environmental Assessment (MCEA) process for Schedule B projects, with the integration of methodologies from the MNR *Adaptive Management of Stream Corridors* (2002) protocol.

The assessments and investigations conducted as part of the YCGSMP will identify Toronto Water infrastructure locations that cross beneath the channel, run parallel to the channel, or are within an eroding bank, to determine the amount of protection (depth of cover, lateral distance, toe protection, extent of exposure), the rate of change, and forecast how much time will elapse before the current degree of protection is lost and the infrastructure will either be exposed and/or potentially fail. The goal of the assessment is to identify High Risk sites along the project watercourse and prioritize the sites for restoration. Based on the results, conceptual restoration plans for High Priority sites will be developed.

As part of the YCGSMP process, which is to be developed over several years, short-term erosion monitoring of Yellow Creek is essential to ensure that the priority list is updated as site conditions evolve, maintenance needs are met, and to document successful and unsuccessful restoration approaches. The following technical memo presents the results of the short-term monitoring program that was implemented by GHD within the Study Area between May 2020 and June 2023, as well as any implications of these results on the YCGSMP.

1.2 Scope and limitations

1.3 Scope of work

In conjunction with the City, GHD developed a short-term erosion monitoring plan for Yellow Creek within the Study Area. The monitoring occurred at six-month intervals during the YCGSMP study to identify changes along the watercourse. The monitoring plan has produced results which can be compared to the results obtained in the risk assessment that was completed as part of initial project work for the YCGSMP.

Elements of the monitoring plan include general field reconnaissance to identify potential areas of erosion concern; and an assessment of overall channel stability using rapid geomorphic assessment techniques; and monumented monitoring sites to gauge channel erosion through installation of erosion pins and cross-section monitoring. Detailed cross section surveys were performed at each monitoring station to establish baseline condition and monitor change, as well as monumented photographic records. **Figure 1** shows the locations of the six monitoring cross sections, as well as the reach delineations.

1.4 Limitations

This report: has been prepared by GHD for City of Toronto and may only be used and relied on by City of Toronto for the purpose agreed between GHD and City of Toronto as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than City of Toronto arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

2. General Field Reconnaissance

During the monitoring period, the Study Area was walked multiple times per year. It was observed that bank erosion, particularly channel widening and degradation, was an ongoing process, however alterations to the channel were not drastic within the three-year period. A photo appendix showing monumented photographs of the monitoring cross section stations is provided in **Appendix A**.

3. Rapid Geomorphic Assessment Results

The watercourse within the Study Area was divided into four (4) reaches based on channel gradient, form and dominant geomorphic processes. Baseline conditions for Reach 1 had previously been collected on September 3, 2018. Baseline conditions for Reach 2, 3 and 4 were characterized on April 4, 2020. A rapid geomorphic assessment was repeated on each reach on July 14, 2021, and again on June 15, 2023. Results were compared to baseline conditions to document any geomorphic adjustment during the short-term erosion monitoring period.

The reaches were located as per the following descriptions and are shown in **Figure 1**:

– Reach 1 spanned from the upstream outfall to the St Clair Avenue East bridge.

– Reach 2 spanned from the St Clair Avenue East bridge to approximately even with the southern boundary of David A. Balfour Park.
– Reach 3 spanned from the southern boundary of David A. Balfour Park to the CPR rail line overpass.
– Reach 4 spanned from CPR rail line overpass to the downstream channel inlet.

3.1 Methods

Two rapid assessment tools, a Rapid Geomorphic Assessment (RGA) and a Rapid Stream Assessment Technique (RSAT) were used to assess the watercourse. The RGA documents observed indicators of channel instability (MOE, 2003) by quantifying observations using an index that identifies channel sensitivity. Sensitivity is based on evidence of aggradation, degradation, channel widening and planimetric form adjustment. The index produces values that indicate whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21 0.40) or in adjustment (score >0.41). The classifications resulting from the assessment are defined as:

In regime – The watercourse form is adjusted to the flow and sediments conveyed by the system.

In transition/stress – The watercourse is showing signs of form adjustment in response to changes in the flow and/or sediment conveyed by the system.

In adjustment – The watercourse form is actively undergoing adjustment as a result of changes in the flow and/or sediment conveyed by the system.

The RSAT offers a slightly different approach by using an index to quantify overall stream health and includes the consideration of biological indicators. Observations concerning channel stability, channel scouring/sediment deposition, physical instream habitat, water quality, and riparian habitat conditions are used in an index to produce values that indicate whether the channel is in poor (<13), fair (13-24), good (25-34), or excellent (35-42) condition.

The Downs (1995) classification system was also used as an indicator of morphological adjustment. This classification scheme categorizes channels based on adjustment processes and changes in channel form. For example, streams are characterized as stable, laterally migrating, enlarging, undercutting, aggrading, or recovering. Field observations and rapid assessment results are shown in **Table 2**.

3.2 Rapid Assessment Results

All four reaches consistently fell within the RGA category of “In Adjustment” throughout the monitoring period. Widening and degradation were the dominant forms of adjustment. The RSAT of all reaches produced a condition of “Fair” with the limiting factor of channel instability. The Down’s classification consistently showed lateral migration and enlarging of the channel due to observations of erosion channel banks and scoured bed. While individual bank erosion sites may have continued to erode throughout the monitoring period, the general condition and processes within the Yellow Creek system remained the same.

Table 1 Rapid Assessment Summary

Date (MM/DD/YYYY)	RGA			RSAT			Downs Classification
	Score	Condition	Dominant form of Adjustment	Score	Condition	Limiting Factor	
Reach 1							
09/03/2018	0.62	In Adjustment	Widening and degradation	15.5	Fair	Channel stability	M- lateral migration E - enlarging
07/14/2021	0.62	In Adjustment	Widening and degradation	16	Fair	Channel stability	M- lateral migration E - enlarging

Date (MM/DD/YYYY)	RGA			RSAT			Downs Classification
	Score	Condition	Dominant form of Adjustment	Score	Condition	Limiting Factor	
06/15/2023	0.69	In Adjustment	Widening and degradation	17	Fair	Channel stability	M- lateral migration E - enlarging
Reach 2							
04/01/2020	0.62	In Adjustment	Widening and degradation	17	Fair	Channel stability	M- lateral migration E - enlarging
07/14/2021	0.50	In Adjustment	Widening and degradation	17.5	Fair	Channel stability	M- lateral migration E - enlarging
06/15/2023	0.62	In Adjustment	Widening and degradation	17.5	Fair	Channel stability	M- lateral migration E - enlarging
Reach 3							
04/01/2020	0.53	In Adjustment	Widening and degradation	18	Fair	Channel stability	M- lateral migration E - enlarging
07/14/2021	0.58	In Adjustment	Widening and degradation	17	Fair	Channel stability	M- lateral migration E - enlarging
06/15/2023	0.58	In Adjustment	Widening and degradation	18	Fair	Channel stability	M- lateral migration E - enlarging
Reach 4							
04/01/2020	0.53	In Adjustment	Widening and degradation	18	Fair	Channel stability	M- lateral migration E - enlarging
07/14/2021	0.57	In Adjustment	Widening and degradation	17	Fair	Channel stability	M- lateral migration E - enlarging
06/15/2023	0.60	In Adjustment	Widening and degradation	17	Fair	Channel stability	M- lateral migration E - enlarging

4. Channel Morphology Adjustments

Six monitoring cross sections, identified as M1, M2, M3, M4, M5 and M6, were surveyed at six-month intervals through the short-term monitoring program. Erosion pins were also installed at four of the cross sections on one bank. The erosion pins were each installed such that 20 cm of the pin was exposed. The cross-sections were visited for survey purposes on:

– April 24, 2020 (installation)
– October 28, 2020
– May 19, 2021

– October 20, 2021
– June 27, 2022

Table 2 Erosion Pin Exposure

Erosion Pin Location	Exposure (cm)					Maximum Change Between Monitoring Visits	Overall Change
	24-Apr-20	28-Oct-20	19-May-21	20-Oct-21	27-Jun-22		
M1 (RB)	20.0	23.0	24.0	32.0	Missing	-8.0	unknown
M2 (LB)	20.0	20.0	21.6	28.0	28.0	-6.4	-8.0
M5 (RB)	20.0	21.0	22.5	25.0	27.0	-2.5	-7.0
M6 (LB)	20.0	20.0	21.0	18.0	Missing	-3.0	unknown

Note – All values are in centimetres;
- *A negative change indicates the bank is receding, while a positive change indicates the bank is aggrading.*

Erosion pin measurements at four of the six cross sections indicated that banks were overall receding since 2020. This coincides with visual observations of the four reaches showing signs of widening as the dominant form of adjustment. Where the erosion pin was missing during the final monitoring event, it was assumed that the pin was dislodged by high storm flows, and therefore the final measurement and overall change could not be determined.

The 2020 to 2022 cross section surveys are shown in **Appendix B**. The graph for M1 shows an average lateral receding of the right bank over the full height of the bank of 0.33 m between April 2020 and June 2022, while the left bank and channel bed have remained relatively constant based on the survey. However, the erosion pin on the left bank indicates that erosion has occurred on that bank as well. It appears that the June 2022 survey may be slightly off the survey line of the previous surveys given that the armourstone block at the toe of the right bank appears to be shifted. This could indicate that the erosion as shown by the survey on the right bank is also exaggerated, however observations at the site and the loss of the right bank erosion pin suggest that the measured erosion is real.

The photographs facing downstream at M1 show two large trees that have fallen into the creek on the right bank due to slope failure sometime between October 2020 and May 2021. This indicates that active toe erosion was occurring between M1 and M2 on the unprotected section of bank.

The cross-section for M2 shows the right bank receding to a greater extent than the left bank between monitoring surveys. The channel bed at M2 shows minor deviations, however, maintains the same general shape between April 2020 and June 2022.

The M3 cross section appears to be relatively consistent on both bed and banks throughout the monitoring period, however the photographs of the left bank (west bank) show changes on the failed slope. Woody debris has been removed and underlying filter cloth was exposed during one visit. It appears that material is being eroded from the toe of slope by the creek and then additional material slides down the slope to replace the lost material. Erosion can be seen on the toe of slope on the right bank in the October 2021 cross section. This was when the underlying filter cloth was most exposed on the bank (Photo 43, Appendix A). The filter cloth was subsequently covered by sediment in June 2022 (Photo 58, Appendix A). The monitoring cross sections are deceiving in that they do not show net overall change on the slope failure, however material is being removed from the bank by periodic storm events creating greater instability.

M4 shows widening on both the left and right banks, with the greater recession occurring on the right. The cross-section graph shows the left bank has receded laterally an average of 0.50 m over the full bank height between April 2020 and June 2022. This is an approximate erosion rate of 0.25 m/yr which is very similar to the estimated rate based on the rate determined from historical aerials between 1978 and 2005 of 0.26 m/yr as reported as part of Phase 2 of the Geomorphic System Master Plan. A higher rate of 0.53 m/yr was determined from an aerial photograph taken in 2018 and a topographic survey in 2019. This was either a more rapid period of change or potentially a result of inaccuracies in the georectification of the 2018 image. Overall, the observations support the use of an average rate of 0.39 m/yr in the Phase 2 assessment as a suitably conservative rate for the hazard delineation. Changes within the

channel bed appear to be shifting of the cobble bar, with the greatest difference between April 2020 and June 2022 being approximately 0.6 m of accretion. Note that the change on the right bank in the June 2022 cross section appears to be a result of less survey points collected at that location and does not indicate failure of the bank.

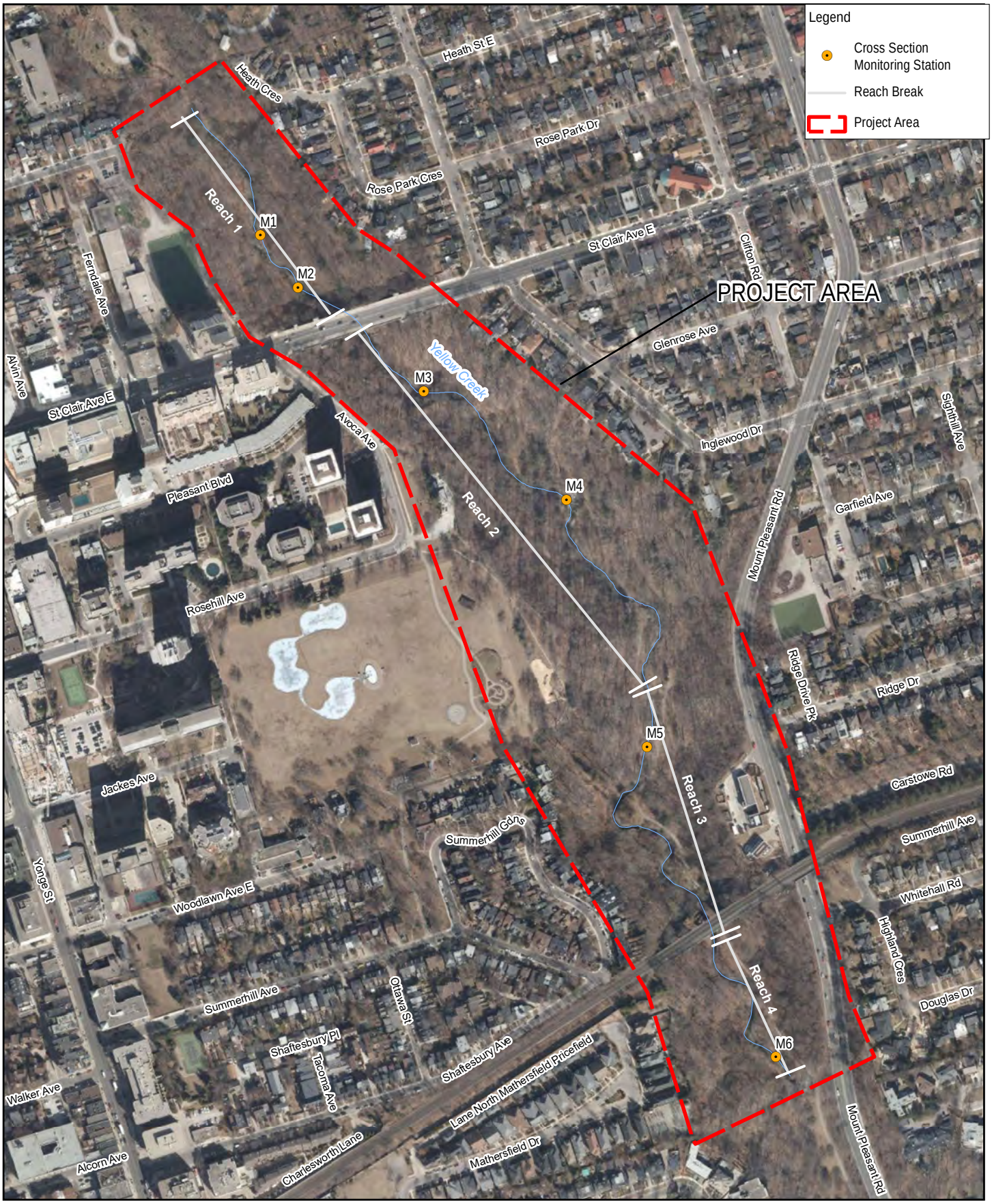
M5 was generally stable if the June 2022 survey is not considered. The June 2022 survey appears to be missing survey detail within the channel bed and the survey was shifted as shown by the shift in the stationary armourstone wall on the right bank. Minor erosion was noted on the bed of the channel which is significant given that this location is the approximate location of the watermain below the creek. Bed degradation was on the order of a couple of centimetres over 1.5 years which supports the long-term rate of 0.012 m/yr as estimated in the Phase 2 assessment based on 1966 as-built drawings and a 2020 survey. The erosion indicated by the erosion pin was an expansion of the scour under the low right bank. The erosion pin can be seen in the undercut on the left side of Photo 97 in Appendix A.

M6 was relatively stable. The June 2022 cross section again appears to be shifted slightly and does not represent shifting of the right bank since that bank was a stable grouted quarried block wall. Is interesting to note that the loosely stacked block wall on the left bank does not appear to have shifted during the monitoring period. The erosion scar behind the block wall also does not appear to have expanded during the 2 year period.

5. Summary

The Study Area was visited multiple times per year during the short-term monitoring program period. It was observed that bank erosion and degradation, was an ongoing process at some locations. Rates of change were relatively low except for the known erosion of the outside bed at M4 and significant erosion of the right bank at M1. Overall, the results of the monitoring support the findings of the hazard assessment completed in Phase 2 of the Geomorphic System Master Plan. Existing quarried block walls at the monitoring sites remained stable through the monitoring period.

Figures



Paper Size ANSI A

0 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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GHD

CITY OF TORONTO
YELLOW CREEK GEOMORPHIC SYSTEMS
MASTER PLAN SHORT-TERM EROSION MONITORING

PROJECT LOCATION

Project No. 11209954
Revision No. -
Date Aug 15, 2023

FIGURE 1

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Print date: 15 Aug 2023 - 12:42

Data source: City of Toronto.

Appendices

Appendix A

Photographic Inventory

Photo 1 April 24, 2020. M1, west bank.

Photo 2 October 28, 2020. M1, west bank.

Photo 3 May 19, 2021. M1, west bank.

Photo 4 October 20, 2021. M1, west bank.

Photo 5 June 27, 2022. M1, west bank.

Photo 6 April 24, 2020. M1, east bank.

Photo 7 October 28, 2020. M1, east bank.

Photo 8 May 19, 2021. M1, east bank.

Photo 9 October 20, 2021. M1, east bank.

Photo 10 June 27, 2022. M1, east bank.

Photo 11 April 24, 2020. M1, facing upstream.

Photo 12 October 28, 2020. M1, facing upstream.

Photo 13 May 19, 2021. M1, facing upstream.

Photo 14 October 20, 2021. M1, facing upstream.

Photo 15 June 27, 2022. M1, facing upstream.

Photo 16 April 24, 2020. M1, facing downstream.

Photo 17 October 28, 2020. M1, facing downstream.

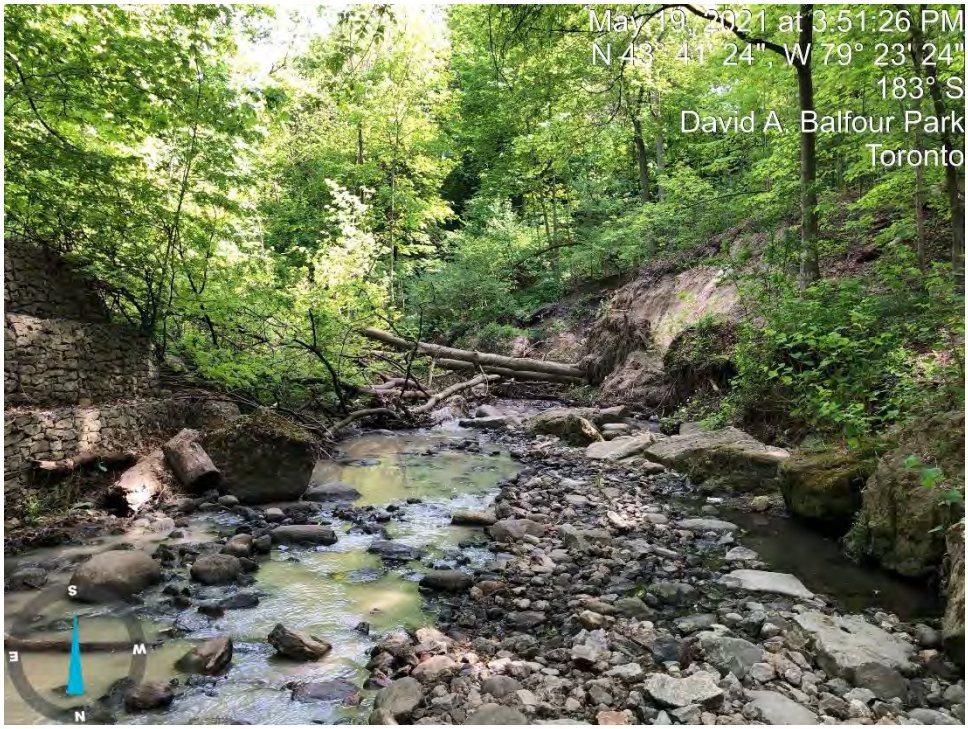

Photo 18 May 19, 2021. M1, facing downstream. Note 2 trees had fallen from the right bank downstream of the cross section.

Photo 19 October 20, 2021. M1, facing downstream.

Photo 20 June 27, 2022. M1, facing downstream.

Photo 21 April 24, 2020. M2, west bank.

Photo 22 October 28, 2020. M2, west bank.

Photo 23 May 19, 2021. M2, west bank.

Photo 24 October 20, 2021. M2, west bank.

Photo 25 June 27, 2022. M2, west bank.

Photo 26 April 24, 2020. M2, east bank.

Photo 27 October 28, 2020. M2, east bank.

Photo 28 May 19, 2021. M2, east bank.

Photo 29 October 20, 2021. M2, east bank.

Photo 30 June 27, 2022. M2, east bank.