Stantec

Memo

To:	Steve Brown Waterloo	From:	Carrie Curtis and Trevor Chandler Waterloo
File:	Silver Lake Environmental Assessment Addendum 161413464	Date:	August 17, 2017

Reference: Surface Water Resources Status Memo
Hydrology, Hydraulics and Fluvial Geomorphology

1.0 Project Context

Stantec Consulting Ltd. has been retained by the City of Waterloo to complete a Class Environmental Assessment (Class EA) Addendum for Silver Lake and Laurel Creek Rehabilitation in Waterloo Park. The primary objective of the project is to identify preferred rehabilitation options for Silver Lake and Laurel Creek.

This technical memorandum summarizes the review of surface water resources information related to the Class EA Addendum.

2.0 Background

The Laurel Creek Watershed Study (GRCA and City of Waterloo, 1992) reported erosion and sedimentation problems throughout the Laurel Creek watershed. "Priority" erosion sites, that required restoration, were identified throughout the City but none of these sites were located within Waterloo Park.

In 1995, the City of Waterloo Completed a Class Environmental Assessment (EA) entitled "A Rehabilitation Plan for Silver Lake and Laurel Creek in Waterloo Park. This was prepared to develop and explore alternatives to address the water quality issues, including sediment accumulation, in Silver Lake. As part of the EA, an Implementation Plan was developed, however, many of the recommendations of the plan were not implemented including the following:

- The creation of a wetland at the mouth of Silver Lake to address polishing of animal display area runoff;
- Restoration and naturalizing of Laurel Creek and associated floodplain areas; and
- Integrating pathways and boardwalks along Laurel Creek.

In addition, it does not appear that as-recorded drawings of the constructed elements were completed and as such, the constructed condition of work within the Lake is unknown. Remedial measures that do appear to be incorporated include the construction of low flow outlets designed to convey sediment downstream of Silver Lake. However, these outlets have not functioned as intended and sediment accumulation has remained an issue within the Lake.

Additional issues identified in the Environmental Assessment included erosion and undercutting of upstream gabion baskets, inadequate drainage within Waterloo Park, frequent washouts of pedestrian bridges and inadequate maintenance access to the outlet at Caroline Street.

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Hydrology, Hydraulics and Fluvial Geomorphology

The EA indicated that the principle geomorphic impacts to the watercourses in Waterloo Park were related to the straightening of sections of Laurel Creek, bank protection (gabions) and the removal or disturbance of riparian vegetation. Recommended approaches to restore these impacts ranged from: Do Nothing, Enhancement, and Naturalization. Enhancement involved local "spot repairs", such as rock weirs added to enhance pool-riffle morphology, and gabion removal. Naturalization involved the re-design of sections of Laurel creek, to re-establish a meandering channel planform, pool-riffle morphology, and riparian vegetation.

The geomorphology of Waterloo's creeks was further assessed in 2001 (Parish Geomorphic, 2002). The watercourses in Waterloo Park were found to be in generally good condition, although channel widening was noted in the section of Laurel Creek downstream of University Avenue, and deposition dominated the lower section of the creek near Silver Lake. Sections of disturbed channel were observed but were not identified as "priority" restoration sites.

The Waterloo Park Masterplan (City of Waterloo, 2009) recommended improving the ecological function of Laurel Creek. This was to be achieved by naturalizing the channel, specifically the straightened section of Laurel Creek adjacent to University of Waterloo Parking Lot "C". Naturalization would involve substantial modification to the creek, such as incorporating meanders, pool-riffle bed morphology, and creek banks that consist of native sediments and vegetation.

MTE Consultants Inc. were commissioned to complete a Baseline Inventory Summary Report for Silver Lake/Laurel Creek (June 2013), referred as 2013 MTE Report in this memo, to provide an update to the condition of the Lake and watercourse prior to the further development of any detailed remedial strategies. Baseline data was collected including hydrologic, hydraulic, environmental and fluvial information.

As part of the 2013 MTE Report, several baseline components were completed and include the following related to hydrology/hydraulics:

- Completion of a topographic survey (completed by the City of Waterloo);
- Completion of water quality monitoring;
- Completion of flow monitoring data utilized to update the previous hydraulic model up to the 100-year event;
- Sediment sampling and bathymetric survey to determine sediment accumulation rates and volume; and
- Development of potential rehabilitation options and interim measures.

The geomorphology and stability of the creeks in Waterloo Park was assessed as part of the Baseline Inventory (MTE, 2013). The creeks in the Park were regarded as generally stable, although restoration opportunities were identified where the channel was disturbed by anthropogenic activities, such as dams, weirs, bank hardening, and bridge crossings. Six anthropogenic disturbances were observed in Laurel Creek and potential remedial measures presented, which involve spot repairs to restore the channel.

In addition to the above reports, additional studies, analysis and construction elements have been completed which provide further influence on the existing conditions and potential future design concepts. This include the following:

- LRT construction including the Laurel Creek Culvert construction (Structure 4 – Laurel Creek Culvert Hydraulic Design Report, AECOM August, 2014;
- Various City of Waterloo Park initiatives (Central Promenade, trail network design, etc.); and
- Completion of some of the recommendations from the MTE Report including replacement of the central pedestrian bridge crossing and connection of the splash pad discharge to the sanitary system.

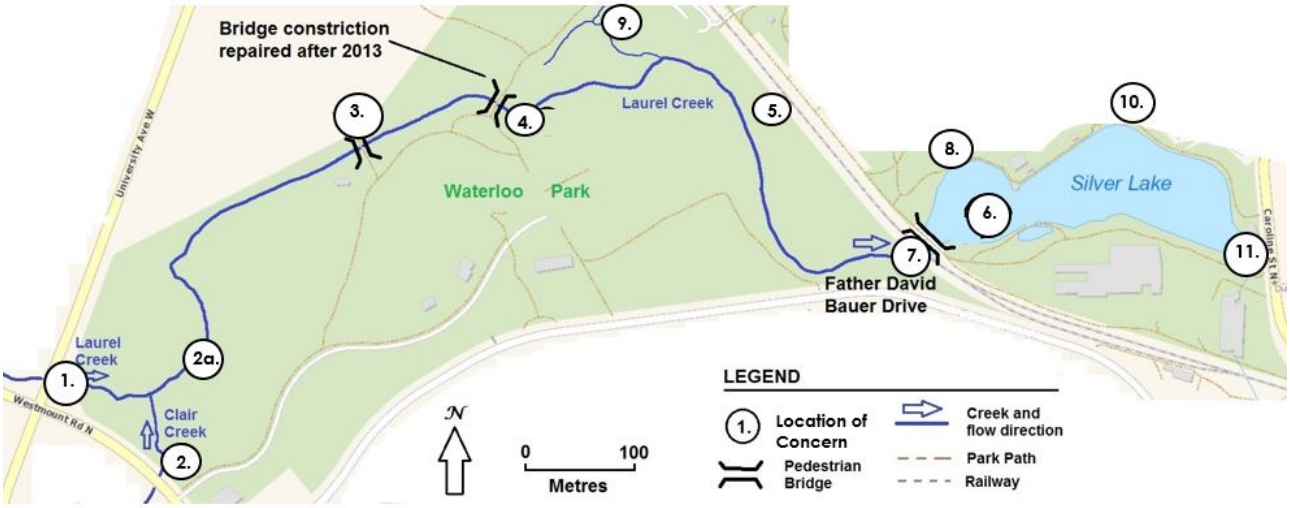
3.0 2017 Conditions

As part of the 2017 Environmental Assessment Update, additional background information has been collected and reviewed to date. This includes the following:

- Review of the above additional reports and drawings;
- Site Reconnaissance of 2017 conditions to confirm current conditions and observe any changes from previous reports;
- Undertaking of supporting studies (hydrogeological, geomorpholical, aquatic and terrestrial habitat, etc.); and
- Review of additional City of Waterloo initiatives, studies and reports to identify opportunities and constraints in conjunction with the surface water objectives of the overall Environmental Assessment update.

The site reconnaissance, completed May 26, 2017, revealed that many of the same conditions exist from the 2013 assessment, with the additional complexity of the added culvert/bridge structure and LRT tracks. Sediment has continued to accumulate within the Lake and the accumulation has extended into the newly installed triple box culvert for the rail crossing.

Figure 1: Areas of Concern Identified during the Field Work



4.0 Fluvial Geomorphology

Field reconnaissance of the disturbed areas was conducted in 2017 and are discussed in greater detail below.

Overall the watercourses were observed to be in good (stable) condition. Small-scale anthropogenic disturbances to the watercourses were observed and are reported below. These disturbances were considered to be caused by local effects. "Spot repairs" to these disturbances would likely be appropriate to restore channel function.

4.1 CLAIR CREEK

Clair Creek flows for approximately 80 m within Waterloo Park, between Westmount Road North and its confluence with Laurel Creek. One disturbance was observed in Clair Creek.

- **Eroded Outfall (Figure 1 - Location 2)**

Bank erosion has undermined a concrete stormwater outfall (approx. 1000 mm dia.) and associated gabion bank protection (Photo 1). The site is located approximately 20 m downstream of the Westmount Road culvert along the right (downstream-facing) bank (Figure 1). The erosion at this site is assumed to be recent as it was not identified in previous reporting.

Photo 1. Eroded bank, Clair Creek at Westmount Rd. N.

4.2 LAUREL CREEK

The creek has a length of 1,600 m within Waterloo Park. Approximately 1,100 m of the creek is free-flowing and the remaining 500 m consists of Silver Lake and related backwater. There were several disturbances observed in Laurel Creek, which are described below.

- **Historic Dam (Figure 1 – Location 3)**

A concrete dam reported as a "historic dam" (MTE 2013) was observed again in 2017 (Figure 1). The historic dam, which also functions as a pedestrian bridge, consists of three concrete openings that are each 2 m wide. The channel width is 6 m and the flow is constricted through the opening (Photo 2). There is a deep scour pool (water depth >1.5 m) immediately downstream of the dam/constriction.

Removal of the historic dam was considered to offer minimal benefits (MTE, 2013), although doing so would restore (increase) channel width, which would improve flow conveyance and reduce erosion potential. Based on the 2017 field assessment of this site, the recommendation to remove or modify the historic dam to restore channel width is considered appropriate.

Photo 2. Historic dam, Laurel Creek.

- **Gabion Basket Walls (Figure 1 – Location 3)**

Gabion baskets line both sides of Laurel Creek and extend downstream from the historic dam for 70 m. The gabions were likely necessary to protect the banks from erosion caused by the dam and flow constriction. The gabions are up to 2.5 m in height, resulting in locally entrenched conditions, which further aggravates erosion. Sections of the gabion along the right bank are sagging/collapsing (Photo 3). Gabions on both banks at the dam structure are failing as well (Photo 4).

Removal of the gabions and reshaping of the banks would improve stream conditions and the riparian buffer, and should occur in conjunction with the removal of the dam (MTE, 2013). Removal of the historic dam would alleviate the constriction and erosion potential, and bank protection would likely not be required. Based on the 2017 field assessment of this site, this restoration approach is considered appropriate and is recommended

Photo 3. Gabions downstream of historic dam.

Photo 4. Failing gabions at historic dam

- **Mid-channel Bar (Figure 1 – Location 4)**

Mid-channel bars have been observed in the creek for many years (e.g., Parish, 2002). These bars can cause problems by altering flow vectors that erode both sides of the channel along the bar. The mid-channel bars that were observed in 2001 (Parish, 2002) were not observed in 2017, indicating that the bar sediments were reworked by flows and that the disturbance to the channel is not permanent.

A large mid-channel bar was observed in 2017 at Site 3, at a sharp bend in the channel (Figure 1). The bar was not indicated in previous reporting and likely developed recently (Photo 5). Restorative measures are not considered necessary as the bar does not appear to be affecting Park infrastructure and the creek may restore itself without intervention. This site should be monitored and restored if bank erosion poses a permanent hazard to infrastructure or channel stability.

Photo 5. Mid-channel bar deposition.

- **Weir Remnants (Figure 1 – Location 5)**

Concrete was observed in the channel at the location of a former weir (Figure 1; Photo 6). The 2013 report by MTE recommended that the concrete be removed, and the adjacent banks reshaped to transition the creek upstream and downstream of the existing weir location. These modifications were recommended to improve stream conditions (flow conveyance) at this location. The 2017 field assessment indicated that the weir remnants created a local constriction and that its removal, as previously recommended would relieve this constriction.

Photo 6. Remnant concrete weir structure.

- **Pedestrian Bridges**

One of the pedestrian bridges across Laurel Creek was identified as an erosion site (MTE, 2013). The field inspection of this bridge in 2017 indicated that it has been modified (widened) to remove the constriction and no longer affects channel stability (Photo 7). No restoration is required at this site.

Photo 7. Appropriately-sized pedestrian bridge.

- **Large Woody Debris**

Large woody debris was observed at several sites along the creek, and was causing localized bank erosion (MTE,2013). Woody debris was observed in 2017 but was not considered to be causing bank erosion or channel disturbance (Photo 8). No woody debris was observed in the narrow (2 m) openings at the historic dam. Based on the field inspection in 2017, only a few local points require action to address large woody debris at this time, although monitoring should continue.

Photo 8. Woody debris along Laurel Creek.

- **Bank Erosion and Channel Incision**

Localized bank erosion was observed at several locations in Laurel Creek upstream of Silver Lake (MTE, 2013). Localized repairs were considered only temporary solutions since the cause of the erosion would likely remain. It was recommended that bank repairs be combined with other channel alterations, such as improving channel-floodplain connection to reduce erosion potential.

Bank erosion was observed in 2017 at several locations between University Avenue and the remnant weir structure at Site 4 (Figure 1), along the outside of bends and along straight sections of channel (Photo 9). Trees and other vegetation provide a dense root mat which appears to protect the banks

Photo 9. Tree roots protecting bank from scour.

in many areas. Channel modifications in areas of erosion are recommended to increase resistance to erosion (e.g., stone bank toe; vegetative plantings) and to reduce the erosive potential of the flow (e.g., structures to control flow vectors; improve channel-floodplain connection).

4.3 SILVER LAKE

Silver Lake has been a feature of Waterloo since the 1800's (Totten Sims Hubicki, 1995).

- **Sedimentation (Figure 1 – Location 6)**

Extensive sediment deposition was observed in the upstream portion of Silver Lake (Figure 1). This material appeared to consist mainly of fluvial sand and silt that fall out of suspension as creek flows enter the lake (Photo 10). Controlling sedimentation will involve removing sediment (by dredging) and by preventing sediment from entering the lake (MTE, 2013). Several remedial measures have been recommended to reduce bank erosion upstream of Silver Lake and to modify Silver Lake to reduce or eliminate its capacity to retain sediment (MTE, 2013).

Photo 10. Bar deposition, upstream end of Silver Lake.

- **Surface Erosion and Rills (Figure 1 – Location 10)**

Overland flow over bare soil has caused surficial erosion and rill development on Park lands adjacent to Silver Lake. This erosion was not observed previously and contributes additional sediment to the lake (Figure 1; Photo 11). The site appears to have heavy foot traffic. Measures to reduce sediment loading from overland flow would likely involve a combination of reducing the force of the flows that cause erosion and to increase the resistance of the ground surface to erosion.

Photo 11. Rill development on Waterloo Park lands.

- **Silver Lake Outlet (Figure 1 – Location 11)**

A minor leak was identified at the armourstone outlet structure and the road/access ramp was cracked (MTE, 2013; Figure 1). The outlet structure and access ramp were inspected in 2017 and are in poor condition and need repair (Photo 12) if the outlet is to continue in its present function.

Photo 12. Armourstone outlet structure, Silver Lake.

5.0 Hydrology and Hydraulics

In addition to geomorphologic components, the site reconnaissance and assessment also included review related to hydraulics and hydrology.

Specific items of note identified in the site reconnaissance include the following and correlate to the locations identified on Figure 1 and associated photos below.

- **Eroded Outfall (Figure 1 - Location 1)**

Erosion behind the headwall at the University Avenue crossing.

Photo 13. Bank erosion at Laurel Creek at University Avenue.

- **Debris Accumulation (Figure 1 – Location 2 and 2a)**

Significant erosion immediately downstream of Westmount Road along the Clair Creek tributary. In addition, there is significant debris accumulation within the creek.

Photo 14. Debris accumulation – Laurel Creek.

Photo 15. Debris accumulation – Clair Creek.

- **Gabion Basket Walls (Figure 1 - Location 3)**

Undermining of gabion wall near the pedestrian crossing and overflow culvert near the former band shelter as identified in previous reports. The overflow channel is also damaged and of reduced capacity in its current condition.

Photo 16 Undermined gabions.

Photo 17. Undermined gabions.

Photo 18 Overflow culverts near historic dam

- **Pedestrian Bridge (Figure 1 - Location 4)**

The primary pedestrian crossing between the east and west sides of the park was replaced following the 2013 MTE Report as recommended. This new crossing appears to be functioning appropriately with stable banks and no signs of erosion. The former structure in this location was often washed out due to its lack of capacity.

Photo 19. Appropriately-sized pedestrian bridge.

- **Weir Remnants (Figure 1 - Location 5)**

Remnants of the former dam remain in the same damaged condition as identified in the 2013 MTE Baseline Report. This was recommended for removal in the previous report.

Photo 20. Remnant weir structure, Laurel Creek.

- **Sedimentation (Figure 1 - Location 6)**

The box culvert appears to be accumulating sediment. The culvert was to be designed to accommodate the Regional storm.

Photo 21. Sediment deposition in Silver Lake, downstream of LRT tracks.

- **LRT Crossing (Figure 1 – Location 7)**

The LRT construction has significantly modified the entrance to the park along Father David Bauer Drive where Laurel Creek transitions into Silver Lake. As previously mentioned, a triple box culvert has been added for the rail crossing to accommodate for dual tracks in place of the previous wood trestle bridge carrying a single railway track.

The tracks have also been modified within the corridor to accommodate the dual track and associated catenary systems. In addition, significant fencing lines the tracks and prevents crossing of the tracks along its length within the Park. This limits the ability to implement some of the recommendations made in previous reports.

Photo 22. LRT tracks at Silver Lake (south side of crossing).

Photo 23. LRT tracks at Silver Lake (north side of crossing).

- **Soil Erosion (Figure 1 - Location 8)**

Within the perimeter of Silver Lake there are several issues identified. These primarily relate to surface runoff, surrounding bare surfaces and discharge likely from roof leaders which are eroding adjacent banks. As a result of exposed soils and surface treatment, sediment is accumulating along the boardwalk surrounding Silver Lake. Not only are these items providing additional sediment load into the Lake, they are also aesthetically unpleasant.

Photo 24. Rill erosion and sediment deposition, Waterloo Park near Silver Lake.

Photo 25. Exposed soil, Waterloo Park.

Photo 26. Exposed soil. Waterloo Park. Silver Lake at right.

Photo 27. Exposed soil, Waterloo Park.

- **Debris in Trash Racks (Figure 1 - Location 9)**

Debris is accumulating on the inside of outlets within the trash racks (see attached photos). It is unknown as to the maintenance schedule of removing debris from the structures, however, the accumulation per the attached photo are reducing the outlet capacity.

Photo 28. Debris in trash rack of stormwater outlet.

- **Silver Lake Outlet (Figure 1 - Location 11)**

The maintenance access road at the outlet structure is experiencing significant erosion and as such, the access is limited to the remaining intact portion. This is a result of the spill over the armoustone scouring the terrafix and dislodging the blocks.

Photo 29. Silver Lake outlet structure.

Photo 30. Terrafix access road at outlet structure.

Google Earth images from 2013 and 2017 are provided in Figures 2 and 3 which clearly show the modifications to the bridge/LRT crossing at the mouth of the Lake as well as the extended area of sediment accumulation.

To further determine the sediment accumulation rates, a Bathymetric survey was completed on July 25, 2017. The cross-sections developed from the 2013 Bathymetric survey will be compared to the July 2017 survey in subsequent analysis to confirm accumulation rates and the existing volume of sediment within the Lake.

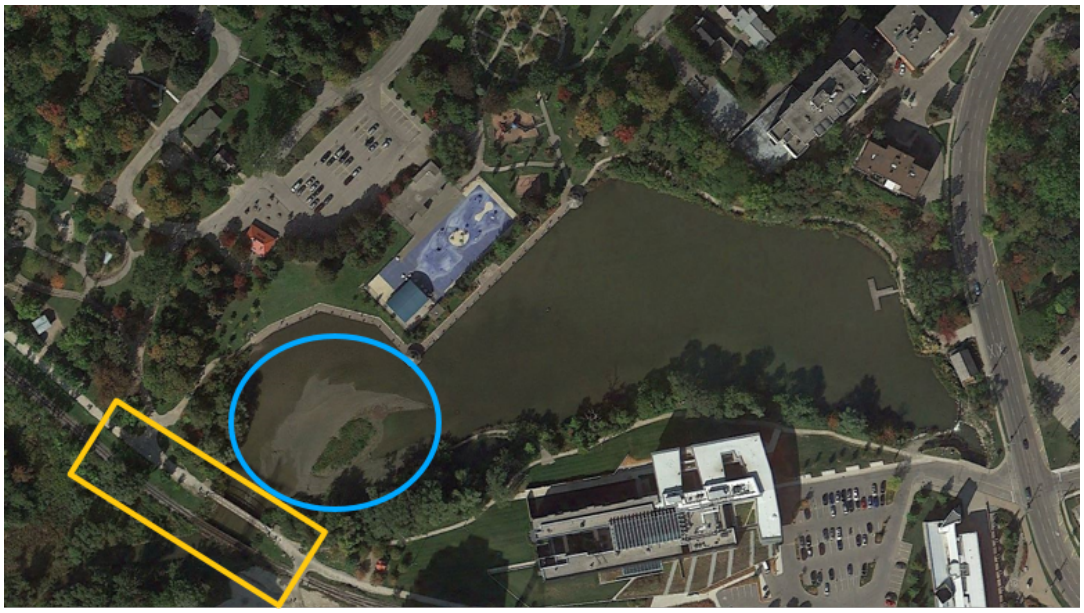


Figure 2: Sediment deposition Silver Lake - 2013 Google Earth Image

Figure 3: Sediment deposition Silver Lake - 2017 Google Earth Image

6.0 Hydraulic Modelling

A significant amount of modeling has historically been completed for Laurel Creek, particularly within the vicinity of Waterloo Park due to the Special Policy Area and particular flood sensitivities within the area. As part of the 2013 Report, a hydraulic analysis was completed which was limited to refining the flood elevations associated with design storms up to and including the 100-year storm. The Regulatory storm was not updated as part of the 2013 Report scope as there had been extensive modelling previously completed which split flows upstream at University and Westmount Road.

During the 2013 Report, a topographic survey was completed which included collection of creek cross section data which were used to update the HEC-RAS model through the Park. The update of the sections during the 2013 MTE Report revealed that the majority of the hydraulic sections within Laurel Creek upstream of Silver Lake were deeper than what was reflected in the previous hydraulic model. In addition, minor updates were made to the bridge crossings and the removal of the gabion dam was completed within the model to reflect the 2013 conditions.

Subsequent to the 2013 model update, design and construction of the LRT commenced which included the introduction of a new triple culvert to facilitate the LRT crossing of Laurel Creek immediately upstream of the pedestrian bridge at the mouth of Silver Lake. During the design of the structure, AECOM prepared a Hydraulic Design Report – Structure 4 – Laurel Creek Culvert dated August, 2014. In order to facilitate the new dual track, a triple barrel culvert was required to replace the previous wood trestle bridge which carried a single railway track. The hydraulic design requirements of this structure were based on the Regional Storm in that the design was to result in no increase in water levels and flood storage for the Regional Storm over the existing condition. In addition, culverts were to be designed for the 100-year flood with a minimum of 1.0 freeboard. The HEC-RAS model (LAUREL2CREEKMS – model from the MTE 2013 Report) was updated as part of the design with the following cross-section modifications to establish a 2014 existing conditions prior to construction of the triple barrel culvert:

- Update of the pedestrian bridge (Section 322 to 325) to reflect the modified location and constructed condition; and
- Update of the existing Rail Bridge sections (Section 326 to 328) including updated survey information and rail crossing information.

Subsequently, in order to confirm the detailed design characteristics and impact with the proposed double track LRT crossing, the 2014 existing conditions model was updated with the triple box culvert. This required updating of sections 325.5 to 328.75 and renaming the model to LaurelLRTPR. The overall Regional Water Level increase was 0.05m with 0.97m of freeboard available based on a minimum top of rail elevation of 326.44.

This model is the most current model and generally reflects the current conditions of Laurel Creek and Silver Lake with respect to infrastructure additions and deletions. A new survey of each creek section was not completed as the survey sections are relatively recent and it is not anticipated that any major changes to the sections upstream of the triple barrel have occurred with the exception of the main pedestrian bridge crossing which was replaced as part of the 2013 MTE recommendations.

7.0 Local Drainage and Contributing Area

A review of the local and surrounding drainage characteristics identified similarities to the 2013 MTE Report with some notable differences:

- The single track rail line has been replaced with a double track rail line and has been completely fenced on either side prohibiting movement across the track;
- The parking lot on the west side of the tracks has been removed and replaced with a trail per Figure 4 (2013) below and Figure 5 (2017) on the following page; and
- The discharge from Lions Lagoon was previously directed untreated to Silver Lake. Following completion of the 2013 MTE Report, the discharge is now directed to the sanitary system, thus eliminating the discharge to the Lake.

Figure 4: 2013 Google Image with West Parking Lot and Single Rail Track

Figure 5: 2017 Google Image with Parking Eliminated and Double LRT Track

Other than the above noted elements, the overall characteristics of the contributing drainage area remain largely unchanged from the 2013 MTE Report. There appears to be a greater source of sediment immediately north of the Lake adjacent to the boardwalk in part due to what is likely roof leader discharge eroding the back as well as lack of vegetation along the bank. The reduced vegetation may be the result of the bank restoration not stabilizing following construction of the Lions Lagoon sanitary connection in this area. There is visible sediment accumulation on the boardwalk due to the sediment washing from the adjacent slopes.

As indicated in the 2013 MTE Report, the majority of the contributing drainage area is located around University Avenue and contains several large parking lots associated with the University of Waterloo. It is anticipated that quality and quantity controls are not present within these parking lots, and that they likely contribute a significant amount of sediment to the system. These parking lots and other upstream characteristics are similar from the current condition to those noted in the 2013 MTE Report.

In addition, the local drainage characteristics within the Park itself also remain similar in that there are capacity constraints that remain as identified in the 2013 MTE Report as the site infrastructure and grading has not been modified since 2013. The trash racks have accumulated garbage and debris which should be removed.

8.0 Previous Recommendations and Current Conditions

As part of the 2013 MTE Report, Remedial Options for both Silver Lake and Laurel Creek were identified as follows in Table 1 below:

Table 1: Silver Lake and Laurel Creek Remedial Options Summary (MTE, 2013)

Option	Silver Lake	Laurel Creek
1.0	Do Nothing	Remove Weir Remnants
2.0	Dredge Silver Lake to Original Depth	Replace Pedestrian Bridges
3.0	Dredge Lake and Provide New Forebay	Remove Gabion Walls and Replace with Naturally Meandering Channel
4.0	Natural Channel (Eliminate Lake)	Remove Historic Dam Structure
5.0	Natural Channel with offline Wetland Pockets (Vernal Pools)	Remove Large Woody Debris
6.0	Offline Pond/Bypass	Enlarge Local Floodplain, Improve Bank Treatments & Riparian Cover
7.0		Implement a Natural Channel Design Through the Entire Site

Some of the above options for Silver Lake will be constrained by the construction of the LRT and more specifically the triple culvert rail crossing. This condition did not exist in the 2013 MTE Report. The main pedestrian crossing per Laurel Creek Recommendation #2.0 (see Table 1) has been replaced with a larger pedestrian bridge and associated bank restoration in the vicinity of the replacement. These repairs appear to be in excellent condition and functioning appropriately.

General Recommendations were also identified and are summarized in Table 2 below with their status.

Table 2: General Recommendations (MTE, 2013)

Recommendation	Status
Implement Canada Geese Deterrents	Not Completed
Trumpeter Swans	N/A
Aeration and Beneficial Bacteria	Not Completed
Restrict Fishing in Silver Lake	Not Completed
Storm Sewer Upgrades	Not Completed
Pedestrian Crossing Upgrades and Future Creek Crossings	Main crossing upgraded
Enhancement of Riparian Cover	Not Completed
Potential for Groundwater Feeds	N/A
Removal of South Inlet Trail	Not completed
Eliminate Splash Pad Discharge	Yes – connected to sanitary

The above recommendations will be incorporated into the overall options to be developed as part of the EA Update Report and then further into the detailed design to follow.

In relation to overall observations, disturbances to watercourses in Waterloo Park have been reported previously. Many of these disturbances were observed again during a field inspection in 2017. These disturbances, and recommendations for their restoration, are summarized in Table 3.

Table 3. Summary of disturbed creek sites and restoration recommendations for watercourses in Waterloo Park.

Site	Previous Observation[a]		Stantec Observation (2017)	
	Creek Disturbance	Recommendation	Creek Disturbance	Recommendation
1[b]	No disturbance reported	N/A	Eroded outfall along Clair Creek	Spot repairs to bank and infrastructure
2	No disturbance reported	N/A	Debris accumulation	Remove and continue monitoring
2[a]	No disturbance reported	N/A	Debris accumulation	Remove and continue monitoring
3	Historic dam and gabion walls	Remove dam and gabions, reshape banks	Historic dam and gabion walls	Remove dam and gabions, reshape banks
4	No disturbance reported	N/A	Mid-channel bar	Monitor
5	Weir remnant	Remove weir remnant, transition banks	Weir remnant	Remove weir remnant, transition banks
6	Sedimentation in Silver Lake	Various	Sedimentation in Silver Lake	Previous recommendations are considered appropriate options
7	No disturbance reported	N/A	LRT track and culvert constructed	N/A
8	No disturbance reported	N/A	Soil erosion	Stabilize with vegetation
9	No disturbance reported	N/A	Debris in trash racks	Remove and continue monitoring
10	No disturbance reported	N/A	Rill erosion	Stabilize with vegetation
11	No disturbance reported	N/A	Outlet structure in poor condition	Repair structure so it may continue fulfilling its present function
Other	Undersized pedestrian bridge	Lengthen bridge	Bridge was lengthened and is no longer an issue	None required
Other	Large woody debris	Monitor/remove	Only local accumulations of large woody debris observed	Continue monitoring
Other	Bank erosion/incision throughout creek upstream of Silver Lake	Spot repairs to strengthen bank and to reduce force of flows on bank	Bank erosion/incision observed. Tree roots provide moderate protection	Spot repairs to strengthen bank and to reduce force of flows on bank

[a] Baseline Inventory Summary Report – Final (MTE, 2013)
[b] Site 1 is in Clair Creek. All other sites are in Laurel Creek.

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References:

- Baseline Inventory Summary Report for Silver Lake / Laurel Creek Rehabilitation Assessment, prepared by MTE Consultants Inc., dated June 13, 2013
- Structure 4 – Laurel Creek Culvert Hydraulic Design Report, prepared by AECOM, dated August 18, 2014