Blair Creek Subwatershed

Cumulative Effects Monitoring – Blair Creek Case Study

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GRAND RIVER CONSERVATION AUTHORITY

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Executive Summary

The Grand River Conservation Authority (GRCA) partnered with the Ontario Ministry of the Environment and Climate Change (MOECC) and the City of Kitchener in a case study of the Blair Creek Monitoring Program. The purpose of the case study was to evaluate the Blair Creek program as an example of a multi-scale pre-, during-, and post- development monitoring program, within a Cumulative Effects Assessment (CEA) framework. The objective of CEA is to identify trends in an ecological system and attempt to relate those trends to environmental stressors, both natural and anthropogenic.

While development-driven monitoring programs are not uncommon, significant challenges exist in the ability of monitoring to characterize natural system variability, establish baseline conditions and thresholds, identify cumulative impacts (due to natural variability, climate change, urban development, changes in land use or stormwater management), and recognize when indicators exceed established thresholds. These limitations hinder the ability to apply an adaptive management approach by delaying recognition of early indicators of impact.

The case study objectives were to:

- Improve the characterization of land-use change and water quality in the Blair Creek watershed;
- Increase the awareness of the importance of cumulative effects monitoring; and
- Enhance the understanding of different scales of monitoring (e.g. site vs receiver), relationships between scales, and how they can be applied.

Blair Creek Subwatershed is located in the central reaches of the Grand River watershed covering the southwest corner of the City of Kitchener and parts of the township of North Dumfries and the City of Cambridge. Blair Creek is a cold water stream which supports a population of brook trout and is one of the few remaining subwatersheds in the City of Kitchener in which the predominant land uses are agriculture and natural areas. Blair Creek has been the subject of three previous studies since the 1990s to assess the potential impact of residential development on ecosystem health within the watershed. Subwatershed monitoring has been ongoing since 2006, to support subwatershed and land use planning. Greenfield residential development began in 2011 and is ongoing.

The goals of this report were to establish an analytical framework for characterization of environmental conditions in Blair Creek, apply the framework to assess pre-development (baseline) and during-development conditions, and compare pre- and during-development conditions to identify potential cumulative effects of development on Blair Creek. This report documents lessons learned in terms of monitoring, analysis, and governance, and establishes a framework for future assessments of conditions in Blair Creek. Recommendations from the Blair Creek Case Study will further adaptive management of the monitoring program, and could inform design and implementation of monitoring programs in other urban or urbanizing subwatersheds.

The Case Study draws on climate data and monitoring data collected from 2006-2016 at 2 stream gauge sites and 7 stream water quality and temperature monitoring sites (Figure E-1). The system-wide monitoring program was designed as a BACI (before, after, control, impact) study, which compares impacted and control sites both before and after a large-scale change to the system, which in the case of Blair Creek, is residential land development. As part of the BACI design, the Blair Creek at Reidel Drive monitoring site was established as a control site (upstream of anticipated development activity on the main branch of Blair Creek) and the Roseville Tributary at Reichert Drive monitoring site was established as a reference site (a tributary catchment with largely natural land cover and no anticipated land use change). The remaining monitoring sites were selected to bracket the residential development blocks. A monitoring site was established at the confluence of Blair Creek with the Grand River in order to assess overall subwatershed cumulative effects and contribution to the Grand River (referred to as the Mouth site) (Figure E-1).

The analytical framework involved characterization of land cover and stormwater management, and a nested and integrated assessment of climate, hydrology (i.e., flow regime including high- and low- flow metrics), surface water quality (wet/dry grab samples for total suspended solids (TSS), total phosphorus (TP), nitrate, and chloride (Cl)), and stream temperature. Baseline pre-development conditions were assessed using indicators and measures identified in the Upper Blair Creek State of the Watershed (SOW) Report (2016) as well as additional metrics. The baseline established for the Case Study drew on a more extensive monitoring dataset than did the SOW (for water quality and stream temperature parameters), but findings were comparable and reflective of a stable cold to coolwater stream with good water quality and a resident brook trout population.

Comparison of Pre- and During- Development Conditions

A weight-of-evidence approach was adopted by assessing each of the three ecosystem components (i.e., water quantity, water quality and stream temperature) using a multitude of analytical techniques and statistical methods (Table E-1). The weight-of-evidence assessment concluded that overall, no substantive during-development impacts have been documented to date on hydrologic, surface water quality, or thermal regime parameters in Blair Creek. However, some potential early indicators of change have been identified that may point to localized impacts of construction activity, and represent key metrics to revisit in future assessments of condition.

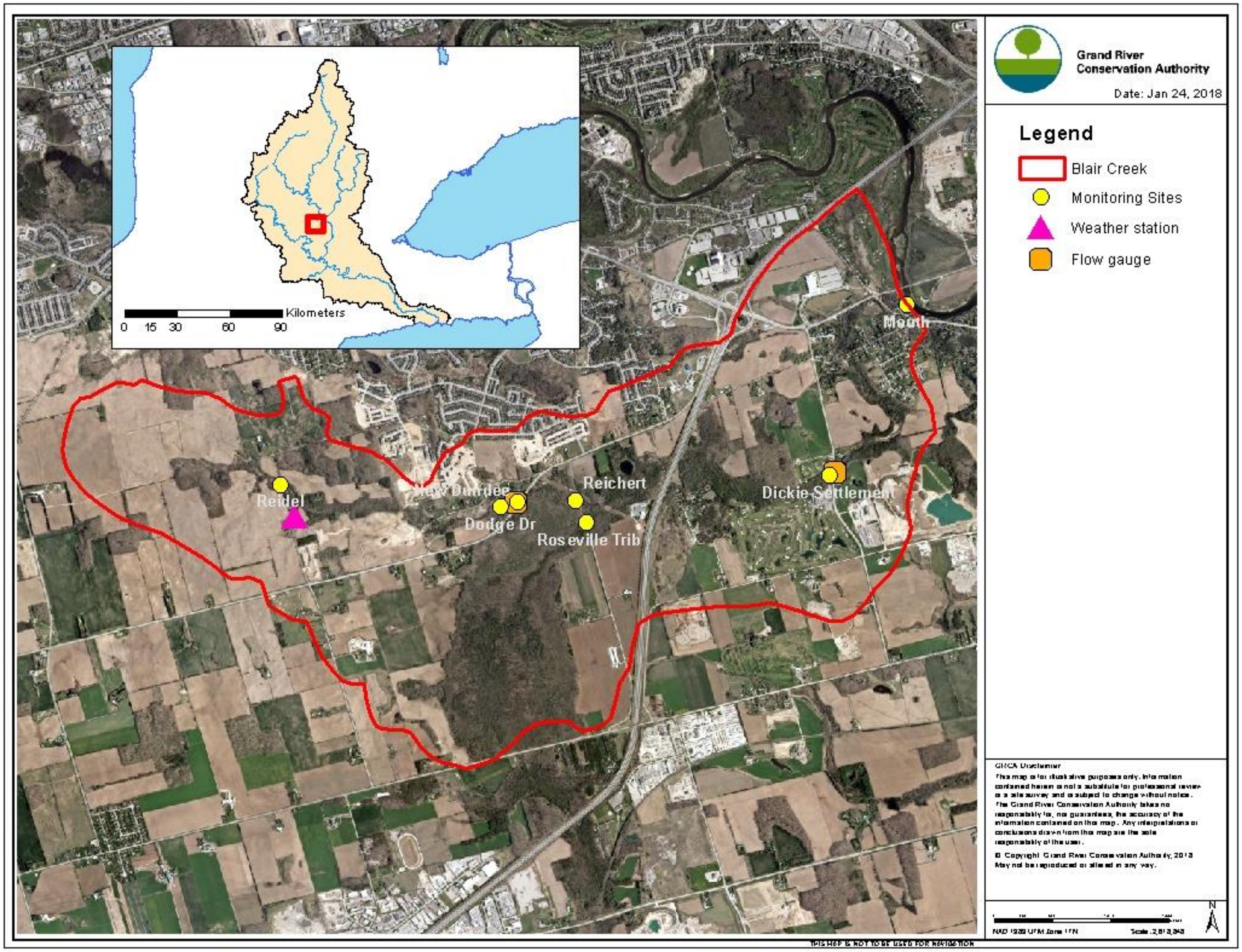

Figure E-1: Monitoring locations within Blair Creek Subwatershed. Monitoring sites are labeled using the grouped monitoring site names.

Table E-1: Summary of the analytical approaches for each of the major indicators.

Climate	Hydrology	Water Quality	Stream Temperature
Annual precipitation and average mean temperatures	Peakiness factors and flood frequency analysis	Non- parametric, flow stratified comparisons	Thermal regime comparisons
Seasonal patterns	Indicators of Hydrologic Alteration (IHA)	Range of concentration comparisons (percentiles)	Exceedances occurring during brook trout spawning months
Climate trends	Range of Variability Analysis (RVA)	BACI comparisons with 2-factor ANOVA	
		Seasonal Mann-Kendall	
		Load estimates using $FLUX_{32}$	

Results from the hydrologic analyses are preliminary. The early stage of the during-development phase impairs the ability to conclude whether observed changes are the result of construction activities or climate variability. Both flow gauge stations showed indications of an altered flow regime when comparing pre- and during- development time periods using multiple analytical methods. The results suggest that during-development Blair Creek at New Dundee Road had increasing frequencies of high and low flows (i.e., high and low “pulse” counts, a flashier hydrograph) and increasing maximum flows at a number of temporal scales (1- to 90-day). Blair Creek at Dickie Settlement Road also had an increasing frequency of low flows (i.e., low “pulse” counts), and declining minimum flows at a number of temporal scales (1- to 90-day).

Most of the results from water quality analyses suggested no significant increase in water quality parameter concentrations between pre- and during- development time periods. However, Blair Creek at Reichert Drive had no difference in TSS concentration between dry weather samples and wet weather samples in the pre- development time period, while during-development, the wet weather samples had significantly higher TSS concentrations compared to the dry weather samples. Additionally, a key finding was an increase in during-development high ranges of TSS concentrations (i.e., 75th, 90th, and 95th percentiles) at the monitoring sites located within the developing area (Blair Creek upstream of Dodge Drive Tributary, Blair Creek at New Dundee Road, and Blair Creek at Reichert Drive). These increases were not observed at the control site (Blair Creek at Reidel Drive), the reference site (Roseville Tributary at Reichert Drive), or at either of the downstream sites (Blair Creek at Dickie Settlement Road and Blair Creek at the Mouth) (Figure E-2). These results suggest a localized increase in the high range of TSS concentrations. While the changes in mean and median TSS concentrations were not statistically significant, the potential ecological significance of increases in the high range of TSS concentrations for the brook trout population is unknown.

A key limitation of the analysis is lack of monitoring data for the winter season, a time of year when erosion and sediment control (ESC) failures have been documented on subdivision construction sites, resulting in sediment discharges to Blair Creek. While the monitoring program is not able to offer insight to potential effects during that season, Rapid Assessment and Action Protocols offer some documentation of these events and their effects on Blair Creek.

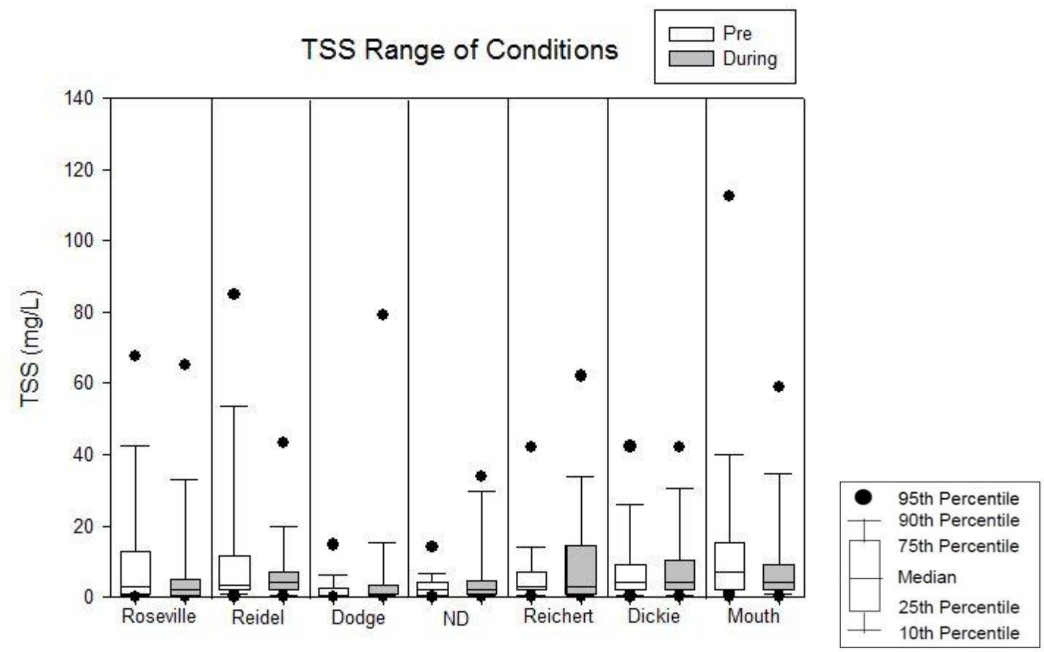

Figure E-2: Boxplots of TSS concentrations with dry and wet weather data combined and grouped by time period (pre- and during-development). The top and bottom of boxes are the 25th and 75th percentiles, the line is the median, the whiskers represent the 10th and 90th percentiles, and the dots represent the 5th and 95th percentiles.

Pre- and during-development stream thermal regimes were assessed and compared for each of the monitoring sites. There were no significant changes in the thermal regimes (interpreted as the distribution of data points falling within cold, cool and warmwater thermal categories) at 6 of the 8 sites. Blair Creek at Reichert Drive had a warmer thermal regime (moving towards coolwater from coldwater) in the during- development period, although it was noted that most of the coolwater data points occurred in a single hot, dry year. Blair Creek at Dickie Settlement Road had a cooler thermal regime in the during- development period. The thermal regime at this site straddles the coldwater/ coolwater boundary, highlighting the sensitivity of the thermal regime (and potentially the brook trout population) to change.

Spatial patterns in the results of multiple parameters (i.e., water quality, water quantity and stream temperature) suggest discharge from the Roseville Swamp Provincially Significant Wetland via the Roseville Tributary, is mitigating effects of upstream construction activities on the downstream reaches of Blair Creek. This highlights the importance of natural wetland features and the ecosystem services provided by such features.

Conclusions and Recommendations

The goals of the Blair Creek monitoring program are to monitor pre-, during- and post-development conditions, establish targets and thresholds, and identify whether thresholds have been exceeded. This Case Study has established an analytical framework for comparisons of pre- and during-/post- development conditions. Key elements of this analysis should be revisited at State of the Watershed reporting milestones (approximately every 5 years). Moving forward, a weight-of-evidence approach to assessing conditions will continue to be necessary, as the monitoring program evolves to include new metrics (e.g., introduction of sampling for Event Mean Concentrations in 2016). This report explored development of predictive relationships among land cover metrics and water quality parameters. This preliminary work should be pursued to create a context for expected future water quality conditions in Blair Creek.

The case study highlights several key lessons learned with regards to developing a monitoring network that is able to detect changes in environmental indicators. The location of the monitoring sites can influence whether or not the impact of stressors can be detected by water quality indicators and it is important for monitoring sites to bracket the potential stressors. Developer- led monitoring in Blair Creek plays a complimentary role in addressing site- scale potential impacts and stormwater management (SWM) facility performance. A receiver- based monitoring program with a limited number of monitoring sites should locate sites immediately downstream of the furthest downstream stressor in order to detect potential indicator changes. Statistical power of analyses can be increased by increasing the sampling frequency and maintaining consistent monitoring program sites, parameters, and sampling protocols.