Rideau Lakes Subwatershed Report 2014
BLACK CREEK CATCHMENT

RIDEAU VALLEY CONSERVATION AUTHORITY

The RVCA produces individual reports for eight catchments in the Rideau Lakes subwatershed. Using data collected and analysed by the RVCA through its watershed monitoring and land cover classification programs, surface water quality conditions are reported for Black Creek along with a summary of environmental conditions for the surrounding countryside every six years.

This information is used to better understand the effects of human activity on our water resources, allows us to better track environmental change over time and helps focus watershed management actions where they are needed the most.

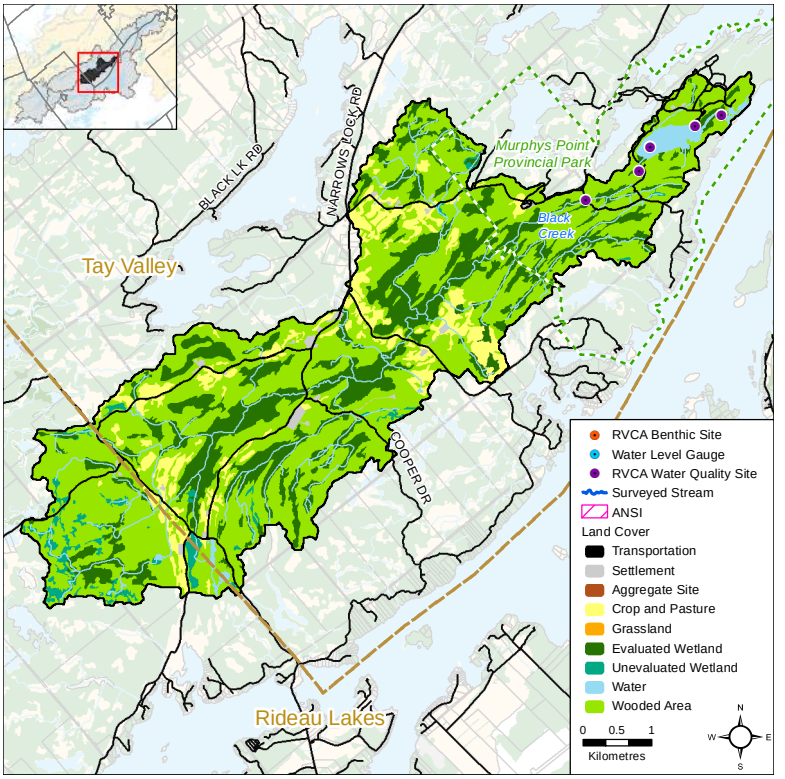
The following pages of this report are a compilation of that work. For other Rideau Lakes catchments and the *Rideau Lakes Subwatershed Report,* please visit the RVCA website at www.rvca.ca.

What's Inside

Catchment Facts

General Geography

- The Rideau Lakes are a very popular seasonal tourist and residential destination because of its diverse natural amenity, cultural history associated with the UNESCO World Heritage Site designated Rideau Canal, close proximity to a number of large cities and towns and ease of access via the Rideau Canal. Residents and vacationers flock to Rideau Lakes in the summer to take advantage of its natural heritage and recreational opportunities such as boating, fishing and swimming. Cottages, houses, campgrounds, B&Bs and marinas stretch extensively along the shoreline that was once largely untouched, putting pressure on the natural resources that support the Rideau Lakes many uses and users



- Parks Canada manages water levels for recreational purposes along the Rideau Canal/Waterway (also designated a National Historic Site and a Canadian Heritage River) that runs through the catchment, ensuring 1.5 metres of draft during the navigation season. In this managed system, water levels on the Rideau Canal are manipulated by operation of numerous dams. In the Rideau Lakes subwatershed, Parks Canada staff operate dams at Wolfe Lake, the Narrows on Upper Rideau and Poonamalie at the outlet of Lower Rideau Lake. The dams on Westport Sand Lake and Westport Pond are operated by the Ministry of Natural Resources and Forests in cooperation with Parks Canada. Water levels are lowered in October throughout the Canal system to the winter operating level that is maintained until early March when snow, ice and precipitation data are used to estimate spring snow melt conditions. At the onset of the spring freshet, water levels are targeted using a rule curve (i.e. a pre-determined estimate of water levels to ensure a "best fit" to prevent as much as possible high and low levels). In late May, levels are at the maximum for the beginning of the navigation season. Levels decline gradually throughout the summer until the winter level is reached once again. The annual range of operational water levels on the lakes is in the order of one metre
- Black Creek catchment is within the Frontenac Arch Biosphere Reserve (Frontenac Axis), an important intra-regional landscape feature which supports a wide variety of species and their movements between Algonquin Park in Central Ontario and Adirondack Park in Upper New York State

Physical Geography

- Black Creek catchment and the majority of the Rideau Lakes subwatershed resides within the Algonquin Highlands, which is an ancient (Precambrian) hilly area made up of thin and variable glacial deposits overlying igneous and metamorphic rock ridges and knolls. Here, these rocks are marble with smaller areas of granitic and syenitic gneisses. The sediment overlying the bedrock is generally thin and composed primarily of mixed glacial sediment often referred to as drift. Organic deposits are also found within the catchment where swamps and marshes are situated
- Eighty-four percent of the catchment lies within Tay Valley Township and 16 percent within the Township of Rideau Lakes
- Black Creek catchment drainage area is 27 square kilometres and occupies about six percent of the Rideau Lakes subwatershed and less than one percent of the Rideau Valley watershed
- Dominant land cover is woodland (60 percent) followed by wetland (27 percent), crop and pastureland (nine percent), settlement areas (two percent), transportation routes (one percent) and water (one percent)

Vulnerable Areas

- The Assessment Report developed under the Ontario *Clean Water Act,* identified the catchment area as a Highly Vulnerable Aquifer

Development/Trends

- Consists largely of scattered rural properties comprised of cottage and residential lots along with some agricultural lands
- Current land-use zoning is predominantly Rural along with a large Open Space block that coincides with Murphys Point Provincial Park

Conditions at a Glance

- Surface water quality rating in Black Creek is “Fair” and “Poor” in Hoggs Bay on Big Rideau Lake within Murphys Point Provincial Park
- Woodland cover proportion has changed/increased by two percent (56 ha) from 2002 to 2008, due to a combination of changes in land cover/land uses and/or applied digital air photo classification methods
- In the Black Creek catchment, the riparian buffer (30 metre wide strip along the shoreline of all lakes and streams) is comprised of wetland (58 percent), woodland (37 percent), crop and pastureland (three percent) and transportation routes (two percent)
- Development in the Black Creek catchment occurs on private wells (of which there are about 35 water well records in the catchment) and septic systems

Catchment Care

- Since 2005, RVCA monitors the Rideau Lakes surface water quality through its Watershed Watch Program. In 2006, the program was altered to gain consistent, year to year data for the set of lakes being monitored. In response to the 2009 *Rideau Lakes Watershed Plan* action to “Develop a more intensive and coordinated water quality monitoring program for the Rideau Lakes,” RVCA monitors surface water quality: In Hoggs Bay (on Big Rideau Lake) four times of the year at one deep point site (four samples annually) and twice a year at three shoreline sites (six samples annually); Along Black Creek one site is monitored monthly from April to November
- RVCA provides septic system re-inspection at the request of the Township of Rideau Lakes (since 2007) and Tay Valley Township (since 2004)
- Six stewardship projects have been completed with assistance from the RVCA’s Tree Planting and Rural Clean Water Programs (see Section 4 of this report for details)
- A watershed model developed by the RVCA in 2009 was used to study the hydrologic function of wetlands in the Rideau Valley watershed, including those found in the Black Creek catchment
- The Townships of Rideau Lakes and Tay Valley have land use planning policies and zoning provisions (on lake capacity, water setbacks, frontage, naturalized shorelines and wetland protection) and use site plan control to implement these policies and provisions. Together with RVCA, they work with landowners on a case by case basis to achieve net environmental gains (particularly with respect to shoreline vegetation protection and rehabilitation) through the use of shoreline best management practices. Collectively, the Townships and the agencies request conditions on planning approvals to ensure that development and redevelopment is appropriate for the property, impacts on neighbours are minimized (particularly on very small lots) and development setbacks for the shoreline are maximized
- Development in and adjacent to Provincially Significant Wetlands and some locally significant wetlands is subject to Ontario Regulation 174-06 (entitled “Development, Interference with Wetlands and Alterations to Shorelines and Watercourses”) that protects the hydrologic function of the wetland and also protects landowners and their property from natural hazards (flooding, fluctuating water table, unstable soils) associated with them

1. Surface Water Quality Conditions

Surface water quality conditions in the Black Creek catchment are monitored by the Rideau Valley Conservation Authority's (RVCA) Watershed Watch Program and Baseline Water Quality Monitoring Program. Watershed Watch monitors watershed lakes to assess nutrient concentrations, water clarity, dissolved oxygen availability and pH. The Baseline Water Quality Program focuses on streams; data is collected for 22 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen and ammonia), *E. coli,* metals (like aluminum and copper) and additional chemical/physical parameters (such as alkalinity, chlorides, pH and total suspended solids). The locations of monitoring sites are shown in Figure 1 and Table 1.

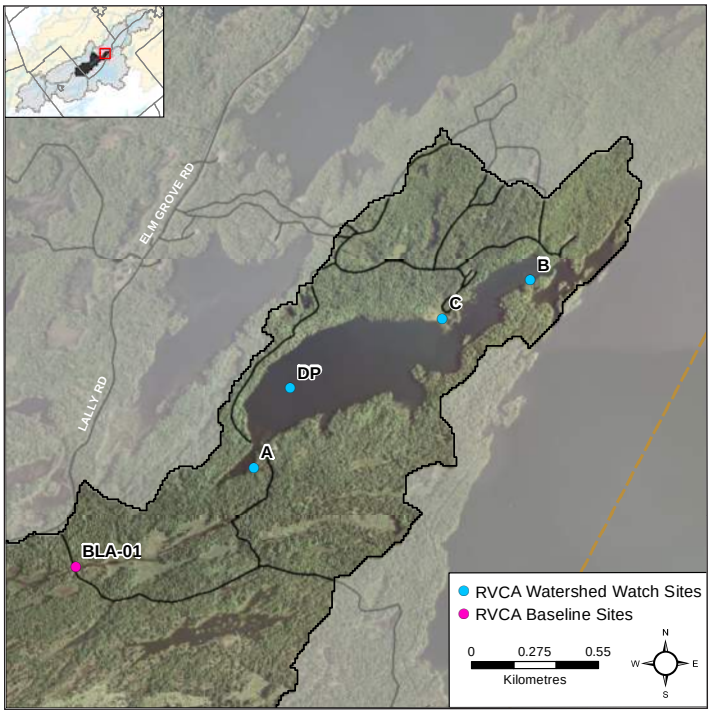


Figure 1 Water quality monitoring sites on Black Creek and Hoggs Bay

The water quality ratings for the Black Creek catchment range from "Fair" to "Poor" (Table 1) as determined by the CCME Water Quality Index. Each parameter is evaluated against established guidelines to determine water quality conditions. Those parameters that frequently exceed guidelines are presented below. There is limited data available for Hoggs Bay (RVL-36) prior to 2005 thus only the 2008 to 2013 data is considered in this report. Analysis of the data has been broken into two periods–2002 to 2007 and 2008 to 2013–for the stream monitoring site located on Black Creek (BLA-01) to examine if conditions have changed between these periods. Table 1 shows the overall rating for the monitored surface water quality sites within the Black Creek catchment and Table 2 outlines the Water Quality Index (WQI) scores and their corresponding ratings.

Table 1 Water Quality Index Ratings for the Black Creek catchment

Sampling Site	Location	2002-2007	Rating
BLA-01	Black Creek at Black Ance Point	65	Fair
RVL-36	Hoggs Bay	NA	NA
Sampling Site	**Location**	**2008-2013**	**Rating**
BLA-01	Black Creek at Black Ance Point	70	Fair
RVL-36	Hoggs Bay	53	Poor

Table 2 WQI Ratings and corresponding index scores (RVCA terminology, original WQI category names in brackets)

Rating	Index Score
Very good (Excellent)	95-100
Good	80-94
Fair	65-79
Poor (Marginal)	45-64
Very poor (Poor)	0-44

1) a. Black Creek Water Quality

There is one stream site on Black Creek monitored in the Black Creek catchment (BLA-01, Figure 1). Analysis of the data has been broken into two periods, 2002-2007 and 2008-2013, to examine if conditions have changed within this timeframe. Water quality at this site is reported as "Fair" (Table 1); the score at this site is largely influenced by high nutrient concentrations, metals and high bacterial counts. For more information on the CCME WQI, please see the *Rideau Lakes Subwatershed Report.*

Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and may contribute to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) is used as the TP Guideline and states that in streams concentrations greater than 0.030 mg/l indicate an excessive amount of TP.

Total Kjeldahl nitrogen (TKN) and ammonia (NH_3) are used as secondary indicators of nutrient loadings. RVCA uses a guideline of 0.500 mg/l to assess TKN[1] and the PWQO of 0.020 mg/l to assess ammonia concentrations at the monitored site.

Tables 3, 4 and 5 summarize average nutrient concentrations at BLA-01 and show the proportion of results that meet the guidelines.

[1] No Ontario guideline for TKN is presently available; however, waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) Water Quality Sourcebook, A Guide to Water Quality Parameters, Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

Table 3 Summary of total phosphorus results for Black Creek, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Total Phosphorus 2002-2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.031	53%	38
Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.059	44%	39

Table 4 Summary of total Kjeldahl nitrogen results for Black Creek, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Total Kjeldahl Nitrogen 2002-2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.704	18%	38
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.842	13%	39

Table 5 Summary of ammonia results for Black Creek, 2002-2007 and 2008-2013

Ammonia 2002-2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.018	74%	38
Ammonia 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BLA-01	0.018	69%	39

Elevated TP results were a regular occurrence at site BLA-01; 53 percent of samples were below the guideline in the 2002-2007 period (Figure 2); this declined to 44 percent of samples in the 2008-2013 period (Figure 3). The average TP concentration also increased from 0.031 mg/l (2002-2007) to 0.059 mg/l (2008-2013).

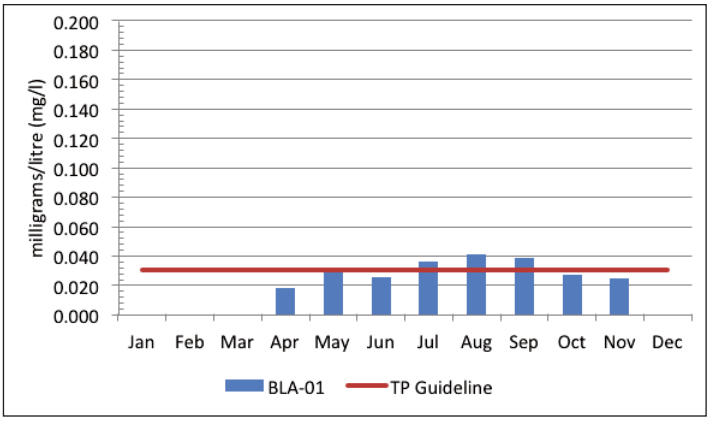


Figure 2 Total phosphorus concentrations in Black Creek, 2002-2007

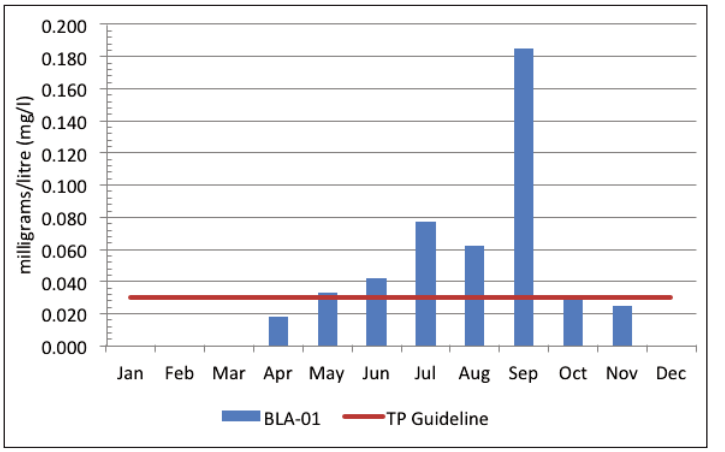


Figure 3 Total phosphorus concentrations in Black Creek, 2008-2013

TKN results show that the bulk of results exceeded the guideline (Figures 4 and 5); there were few samples (18 percent) below the guideline in the 2002-2007 period and this declined marginally to only 13 percent in the 2008-2013 period. The average concentration was generally elevated and increased from 0.704 mg/l to 0.842 mg/l (Table 4).

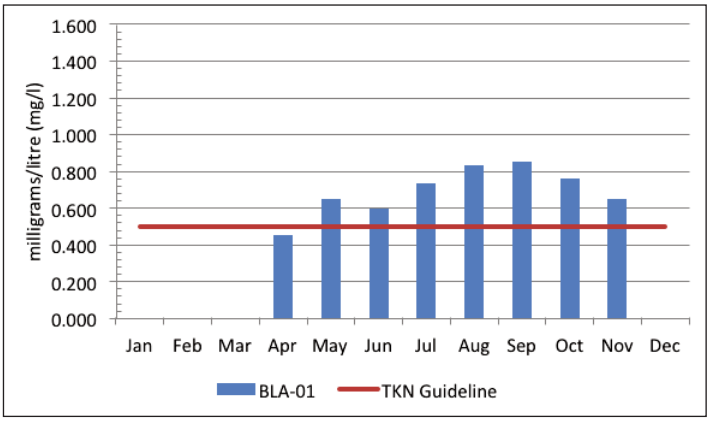


Figure 4 Total Kjeldahl nitrogen concentrations in Black Creek, 2002-2007

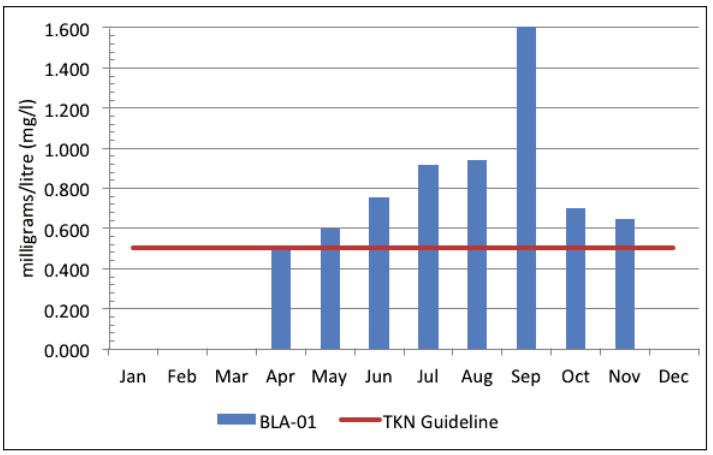


Figure 5 Total Kjeldahl nitrogen concentrations in Black Creek, 2008-2013

NH_3 data reported fewer instances of exceedances and results at this site were generally below the guideline of 0.020 mg/l (Figures 6 and 7); the proportion of samples below the guideline improved slightly from 61 percent to 65 percent. The average concentration showed no change between time periods remaining at 0.018 mg/l (Table 5).

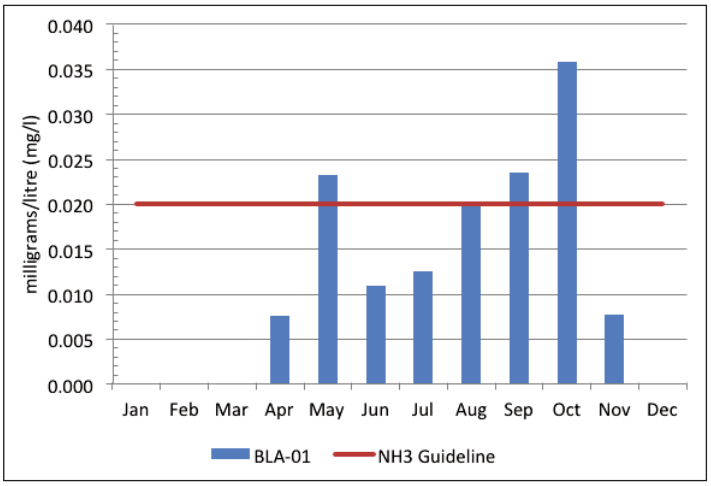


Figure 6 Ammonia concentrations in Black Creek, 2002-2007

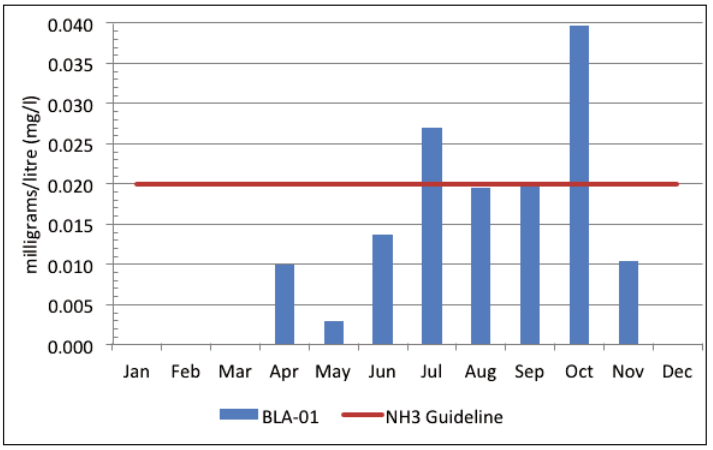


Figure 7 Ammonia concentrations in Black Creek, 2008-2013

Summary

The data shows that nutrient enrichment is a feature of Black Creek. This creek was previously identified as having high TKN concentrations (RVCA, 2008, *Rideau Lakes Watershed Plan–Draft*, unpublished) and elevated concentrations across all nutrient parameters continue to be observed. Elevated nutrients may result in nutrient loading to Hoggs Bay. High nutrient concentrations can help stimulate the growth of algae blooms and other aquatic vegetation in a waterbody and deplete oxygen levels as the vegetation dies off. Given the extensive expanse of natural area through which the creek flows it is likely that elevated concentrations are a result of the large wetlands associated with the creeks. Wetlands have nutrient rich organic soils; during periods of high flows this can cause a flush of nutrients to the creek and thus higher nutrient concentrations. Though it seems feasible that natural sources contribute to high background concentrations, it is important to reduce human impacts wherever possible. Strategies to reduce nutrient inputs may include diversion of runoff to the creek and enhanced shoreline buffers.

E. coli

E. coli is used as an indicator of bacterial pollution from human or animal waste; in elevated concentrations it can pose a risk to human health. The PWQO of 100 colony forming units/100 milliliters (CFU/100 ml) is used to assess *E. coli.* Counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody.

Table 6 summarizes the geometric mean for the monitored site on Black Creek and shows the proportion of samples that meet the *E. coli* guideline of 100 CFU/100 ml. The geometric mean[2] with respect to the guideline for the two periods (2002-2007 and 2008-2013) is shown in Figures 8 and 9 respectively.

Table 6 Summary of *E. coli* results for Black Creek, 2002-2007 and 2008-2013

***E. coli* 2002-2007**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
BLA-01	42	76%	38
***E. coli* 2008-2013**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
BLA-01	27	90%	39

[2] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as E. coli counts

E. coli results at site BLA-01 indicate bacterial counts are generally below the *E. coli* guideline. The proportion of samples below the guideline improved from 76 percent (Figure 8) to 90 percent (Figure 9). Reduced counts are also observed at the geometric mean which declined from 42 CFU/100ml to 27 CFU/100ml (Table 6).

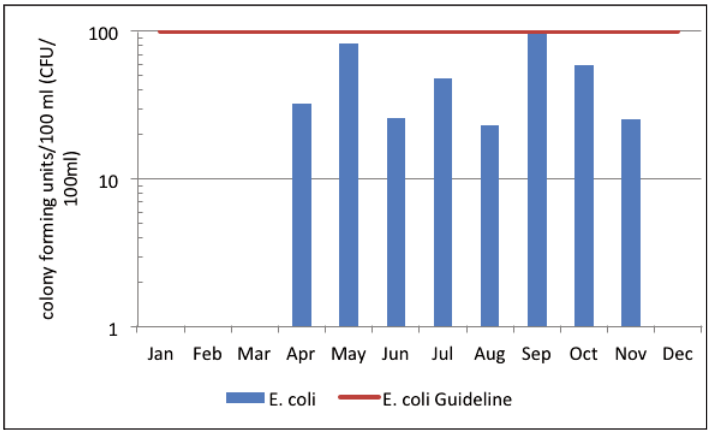


Figure 8 Geometric mean of *E. coli* counts in Black Creek, 2002-2007

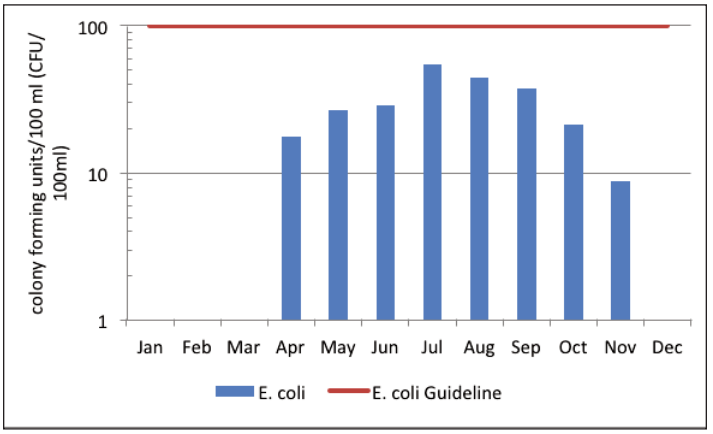


Figure 9 Geometric mean of *E. coli* counts in Black Creek, 2008-2013

Summary

The results indicate that bacterial contamination is not a significant concern in Black Creek. The majority of sampled counts do not exceed the PWQO (*E. coli* guideline) and the count at the geometric mean is below the PWQO.

Metals

Of the metals routinely monitored in Black Creek, iron (Fe) was the only metal that frequently reported concentrations above the PWQO. In elevated concentrations metals can have toxic effects on sensitive aquatic species. Table 7 summarizes Fe concentrations at the monitored site and show the proportion of samples that meet the guideline. Figures 10 and 11 show Fe concentrations with respect to guidelines for the two periods of interest, 2002–2007 and 2008–2013. The PWQO guideline for Fe is 0.300 mg/l.

Table 7 Summary of iron results for Black Creek in the Black Creek catchment, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Iron 2002-2007			
Site	**Average**	**% that meet guideline**	**No. Samples**
BLA-01	0.163	87%	30
Iron 2008-20013			
Site	**Average**	**% that meet guideline**	**No. Samples**
BLA-01	0.855	71%	14

Results from BLA-01 shows that Fe concentrations are occasionally elevated; 87 percent of samples were below the guideline in the 2002-2007 period (Figure 10); this declined to 71 percent of samples in the 2008-2013 period (Figure 11). Average Fe concentrations also increased to exceed the guideline in the second period from 0.163 mg/l (2002-2007) to 0.855 mg/l (2008-2013).

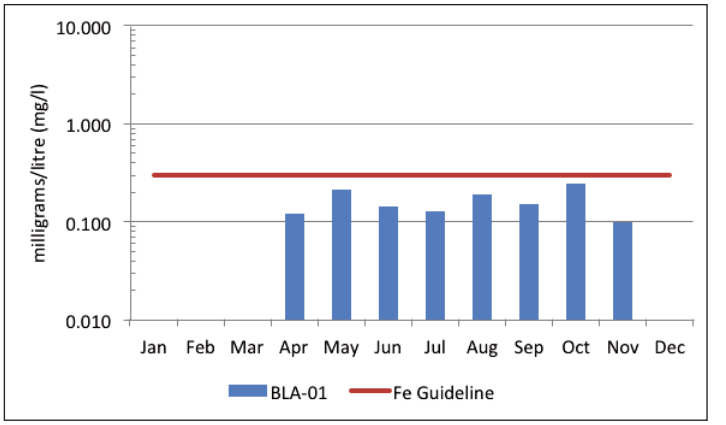


Figure 10 Average iron concentrations in Black Creek, 2002-2007

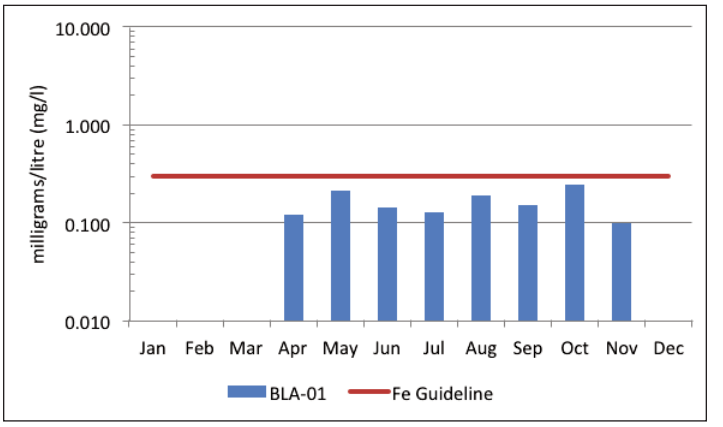


Figure 11 Average iron concentrations in Black Creek, 2008-2013

Summary

Overall, a general increase in Fe concentrations was observed between the two periods of interest. One possible explanation for this is that surrounding land uses are likely impacting the system and deteriorating water quality through increased runoff and erosion; efforts should be made to identify pollution sources and reduce any inputs (such as runoff, metal alloys, fungicides and pesticides) to improve overall stream health and potential downstream impacts to Hoggs Bay.

1) b. Hoggs Bay Water Quality

Surface water quality conditions in Hoggs Bay have been monitored by RVCA's Watershed Watch Program since 2005. Data from one deep point site has been used to calculate the WQI rating for Hoggs Bay, which was determined to be "Poor" (Table 1). Elevated nutrient concentrations, periods of reduced oxygen availability, clear water and occasionally elevated pH levels contributed to the rating. The following discussion explains how each of the monitored water quality parameters contributes to the Bay's water quality.

This report also considers data from three additional shoreline sites that are regularly monitored around the lake. These sites have not been included in the calculation of the CCME WQI rating as they are not monitored with the same frequency as deep point sites. However, they do provide important information on water quality conditions in the near shore areas. For locations of shoreline sites please see Figure 1.

Previous reports have noted that moderate nutrient concentrations are a feature of the Rideau Lakes. The data presented in the *2009 Rideau Lakes Watershed Plan* indicates that this continues to be the case and that a proactive program of best management practices around the lake's drainage area is critical to ensure the improvement and protection of the lake environment.

Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and contributes to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) is used as the TP Guideline and states that in lakes, concentrations greater than 0.020 mg/l indicate an excessive amount of TP within the water column.

Total Kjeldahl nitrogen (TKN) is used as a secondary indicator of nutrient loading. RVCA uses a guideline of 0.500 mg/l to assess TKN[3] within surface waters.

At the Deep Point

One deep point site is monitored within Hoggs Bay. Average nutrient concentrations in the Bay are summarized in Table 8 as well as the proportion of results that meet the guideline.

Table 8 Summary of nutrient results in Hoggs Bay, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-36	0.016	61%	23
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-36	0.448	65%	23

TP and TKN sampling results are presented in Figures 12 and 13. Sixty-one percent of samples analyzed for TP were less than the TP guideline and the average concentration was 0.016 mg/l (Table 8). TKN concentration show a similar result; 69 percent of results were below the TKN guideline and the average concentration was 0.448 mg/l (Table 8). Average year to year concentrations have varied for both TP and TKN (Figure 14 and 15). Generally, average TP concentrations are below the guideline; 2011 was an exception to this and the average concentrations just exceeded the guideline at 0.021 mg/l (Figure 14). Average TKN results do not exceed the guideline with the exception of 2009 with a concentration of 0.548 mg/l (Figure 15).

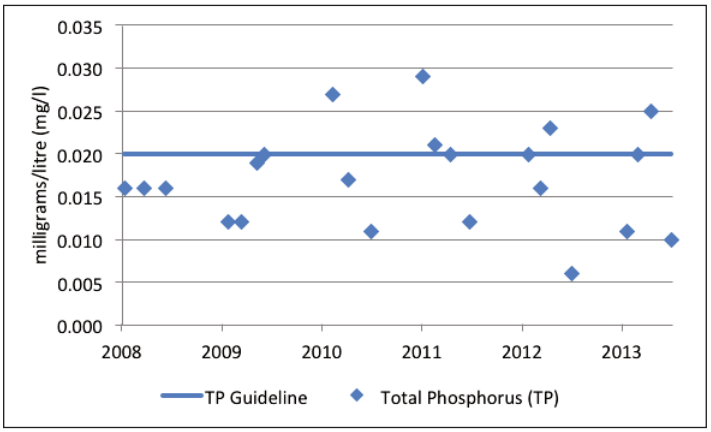


Figure 12 Total phosphorus sampling results at the deep point in Hoggs Bay, 2008-2013

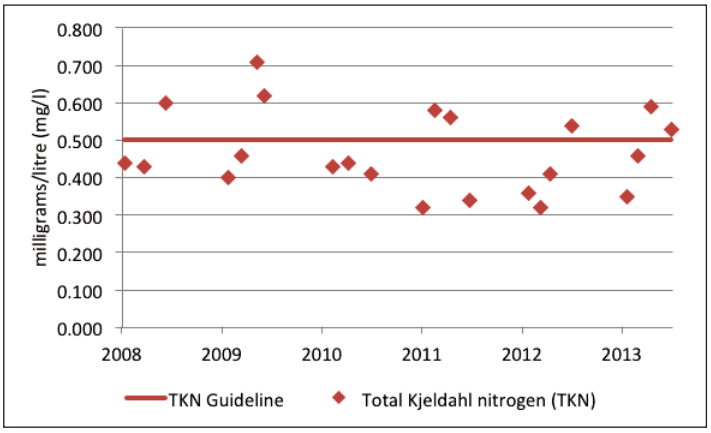


Figure 13 Total Kjeldahl nitrogen sampling results at the deep point in Hoggs Bay, 2008-2013

[3] No Ontario guideline for TKN is presently available; however, waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) *Water Quality Sourcebook, A Guide to Water Quality Parameters,* Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

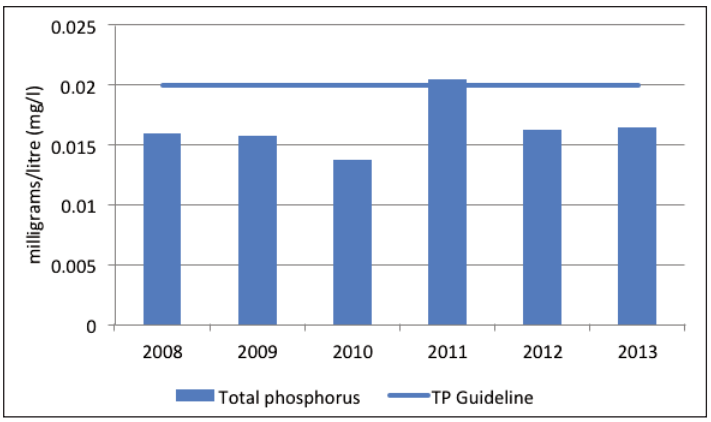


Figure 14 Average total phosphorus at the deep point in Hoggs Bay, 2008-2013

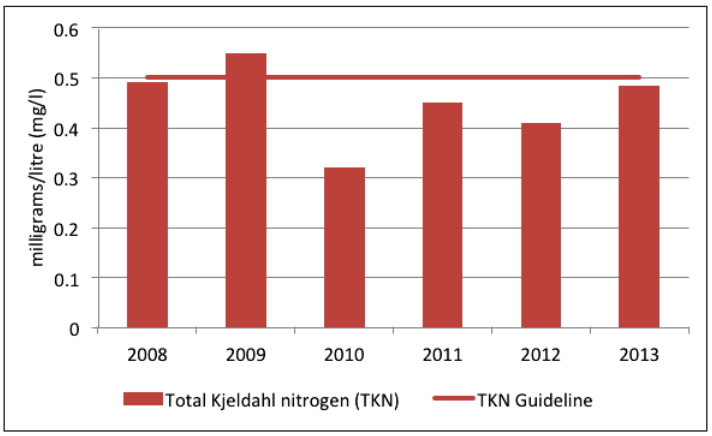


Figure 15 Average total Kjeldahl nitrogen concentrations at the deep point in Hoggs Bay, 2008-2013

Around the Lake

The average nutrient concentrations at monitored sites around the lake vary from year to year (Figures 16 and 17). Total phosphorous concentrations at site A were generally above the TP guideline; exceedances were also observed at site C in 2010 and 2012. All results at site B were below the guideline with the exception of a slight elevation in 2010. Site A is located where Black Creek flows into the southwest corner of Hoggs Bay. The elevated nutrients in the creek may be responsible for higher concentrations at this site. Site C is located within Murphys Point Provincial Park on Hoggs Bay. Elevated results may be attributed to runoff from the surrounding parklands and/or from sediment being stirred up along the bottom of the waterbody by recreational users.

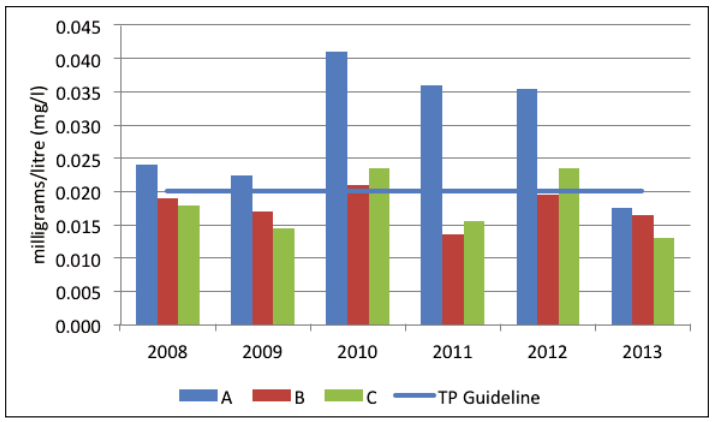


Figure 16 Average total phosphorus concentration at shoreline monitoring sites on Hoggs Bay, 2008-2013

TKN concentrations exceeded the guideline at all sites in more than one year. These results provide further evidence that high background nutrients are a feature of this waterbody, influenced by organic rich soils in near shore areas such as at sites A and B.

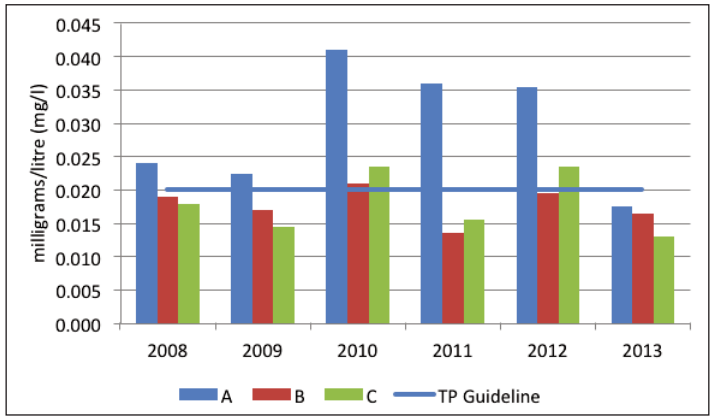


Figure 17 Average total Kjeldahl nitrogen concentration at shoreline monitoring sites on Hoggs Bay, 2008-2013

Summary

Within Hoggs Bay, nutrient concentrations generally meet the guidelines, with the exception of TKN at some shoreline sites. TP concentrations at the deep point are comparable to the 0.01-0.02 mg/l range that was noted as a feature of the Rideau Lakes (Centre for Sustainable Watersheds, 2003. *Rideau Lake State of the Lake Report* 2002) as is TKN which was noted as typically less than 0.500 mg/l.

Areas where high nutrient concentrations persist may exhibit excessive aquatic plant growth, algae blooms and depleted oxygen concentrations. Hoggs Bay is surrounded by Murphys Point Provincial Park with its natural shoreline, and some very limited development and recreational areas that are not likely having significant impacts on nutrient concentrations. Increased education on the role park users can play in protecting water quality is important to safeguard and improve water quality in Hoggs Bay.

Aging of the waterbody can be slowed with the help of all catchment residents by reducing nutrient inputs through practices such as proper maintenance of septic systems, keeping shorelines natural and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 9 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of 2 metres, indicating good water quality; the average Secchi depth is 4.1 metres. Figure 18 shows that no individual reading has been below the guideline and measured depths range from 2.5 metres to 7.5 metres. It should also be noted that Secchi depths in many waterbodies have been influenced by the colonization of zebra mussels resulting in clearer waters than may have been seen prior to the introduction of this species.

Table 9 Summary of Secchi depths recorded at the deep point in Hoggs Bay, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-36	4.1	100%	22

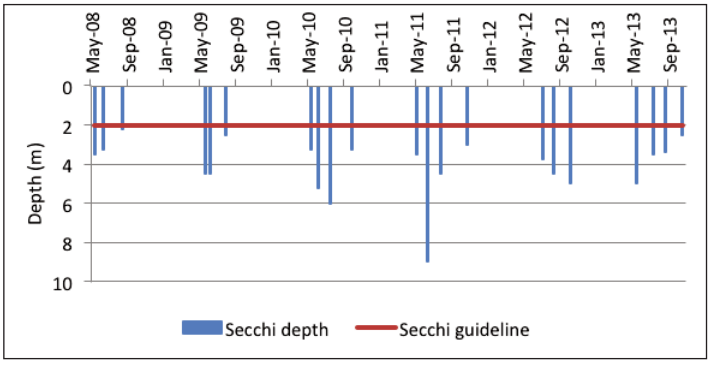


Figure 18 Recorded Secchi depths at the deep point in Hoggs Bay, 2008-2013

Summary

This data indicates that waters are clear and adequate sunlight is able to penetrate the water column to support aquatic life and provide sufficient visibility for safe recreational use (i.e. boating, swimming).

Fish Habitat

Two other factors, dissolved oxygen/temperature and pH were also assessed to provide an overall sense of the health of Hoggs Bay from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 19 show the depths where suitable conditions exist for warm water fish species (temperature less than 25°C and dissolved oxygen greater than 4 mg/l) at the monitored deep point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen temperatures exist over an average depth of 14 metres at site RVL-36DP (Figure 19).

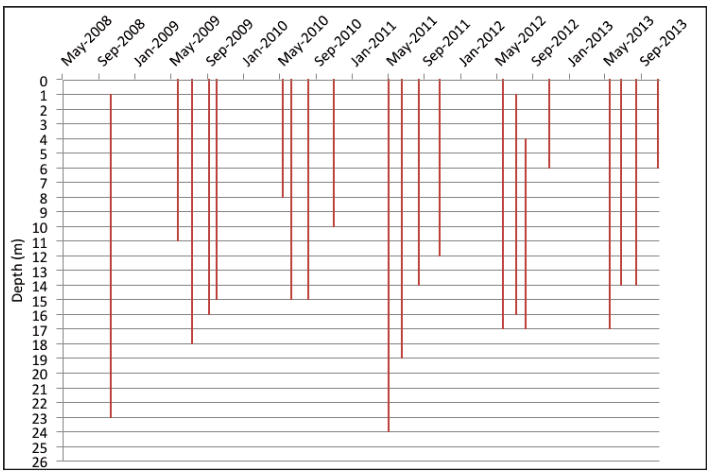


Figure 19 Depths suitable for warm water fish in Hoggs Bay, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 20 shows pH concentrations in Hoggs Bay and Figure 21 summarizes average concentrations by year.

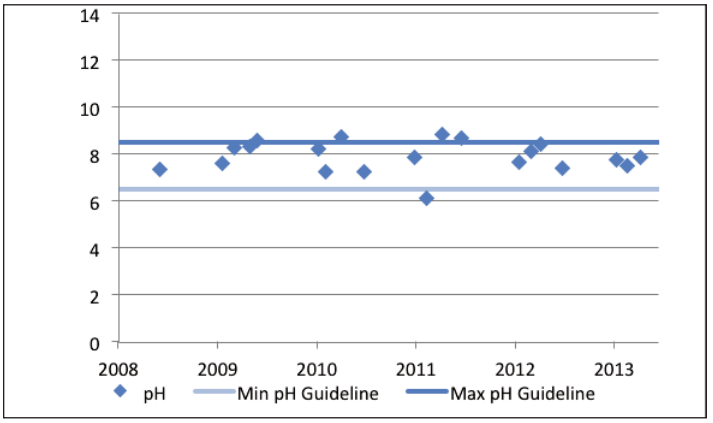


Figure 20 pH concentrations at the deep point in Hoggs Bay, 2008-2013

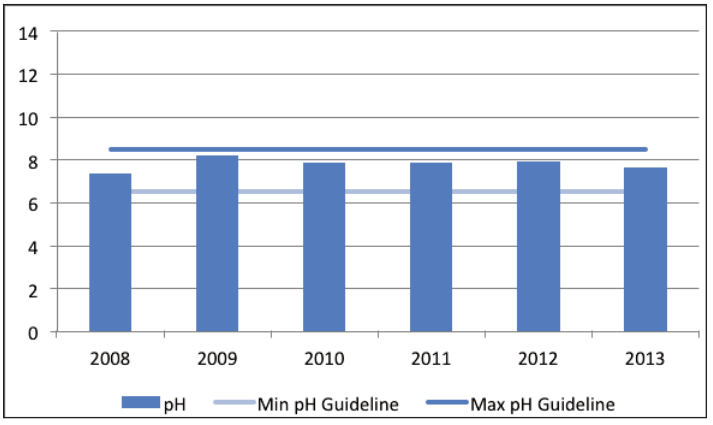


Figure 21 Average pH concentrations at the deep point in Hoggs Bay, 2008-2013

Seventy-six percent of samples (Table 10) were within guidelines established by the PWQO which state that pH should be between 6.5 and 8.5 to protect aquatic life and prevent irritation for anyone using the waters for recreational purposes.

Table 10 Summary of pH results at the deep point in Hoggs Bay, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guidelines**	**No. Samples**
RVL-36	7.9	76%	21

In some areas of the Rideau Lakes subwatershed, surface waters tend to be more alkaline (higher pH), which can generally be attributed to geology rather than anthropogenic activities; biological activities such as photosynthesis may also affect pH.

Summary

Overall, the water chemistry data at the deep point describes good habitat conditions for warm water fish species such as pickerel, bass and pike. There is some evidence that the warming of the water column and oxygen depletion in the late summer/fall limits the amount of habitat available and can cause stress to some aquatic communities. pH conditions are typically within the range recommended for the protection of aquatic life, indicating a healthy environment for aquatic species.

E. coli

E. coli is sampled at monitored shoreline sites twice each sampling season. *E. coli* data was not used in the calculation of the WQI rating for the lake due to differences in sampling frequency and site locations. All samples were below the *E. coli* guideline of 100 colony forming units (CFU) per 100 ml set by the PWQO. Across the lake the count at the geometric mean[4] was only 7 CFU/100ml (Table 11). Figure 22 shows that samples across all sites were well below the guideline.

Table 11 Summary of *E. coli* results for Hogg Bay, 2008-2013

E. coli 2008-2013			
Site	**Geometric mean (CFU/100ml)**	**Within Guidelines**	**No. Samples**
RVL-36	7	100%	33

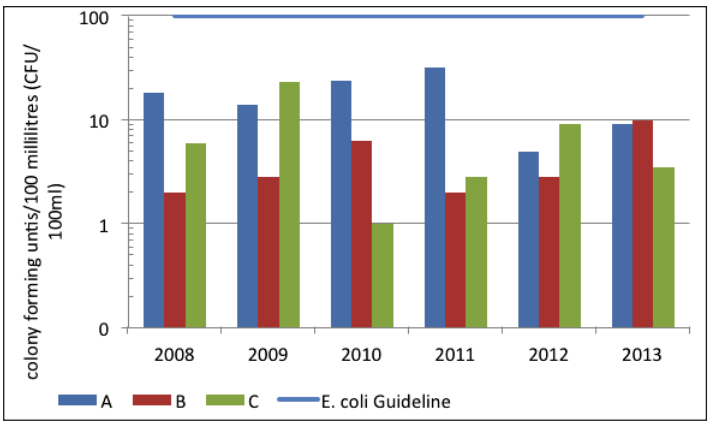


Figure 22 Geometric mean of shoreline sites monitored on Hoggs Bay, 2008-2013

Summary

The results presented above provide evidence that bacterial contamination is not a concern in Hoggs Bay and the water should be safe for recreational activities such as swimming and boating.

[4] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as E. coli counts

2. Riparian Conditions

Shoreline Buffer Land Cover Evaluation

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: *How Much Habitat is Enough?*) is to maintain a minimum 30 metre wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams.

Figure 23 shows the extent of the naturally vegetated riparian zone in the catchment, 30 meters along the shoreline of waterbodies and watercourses. This analysis from the RVCA's Land Cover Classification Program (derived from 2008 DRAPE imagery) shows that the riparian buffer (30 metre wide strip along the shoreline of all lakes and streams) is comprised of wetland (58 percent), woodland (37 percent), crop and pastureland (three percent) and transportation routes (two percent).

Around Hoggs Bay (on Big Rideau Lake), the shoreline buffer is made up of woodland (93 percent), settlement areas (three percent), wetland (two percent) and roads (two percent).

Along Black Creek and its tributaries in the catchment, the riparian buffer is comprised of wetland (57 percent), woodland (37 percent), crop and pastureland (four percent) and transportation routes (two percent).

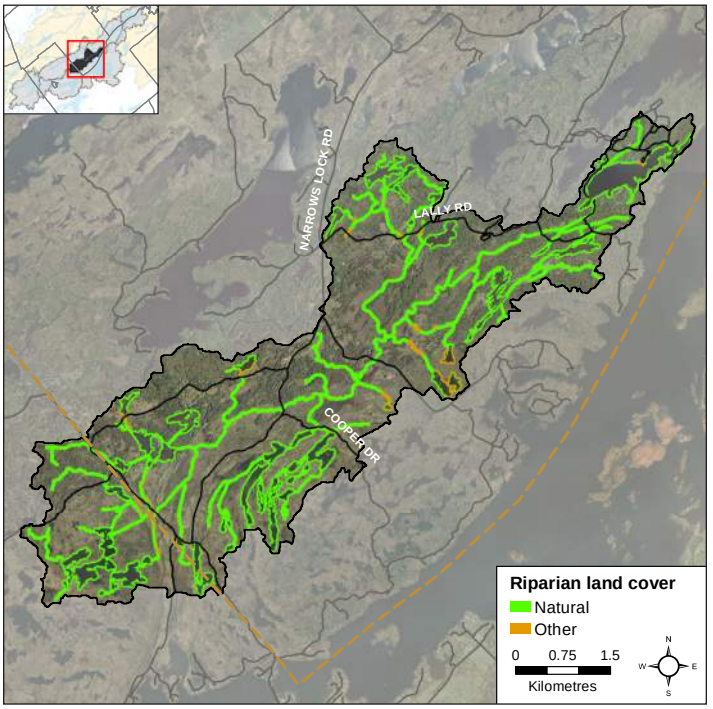


Figure 23 Natural and other riparian land cover in the Black Creek catchment

Headwaters Drainage Features Assessment

The RVCA Stream Characterization program assessed Headwater Drainage Features for the Rideau Lakes subwatershed in 2013. This protocol measures zero, first and second order headwater drainage features (HDF). It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features (HDF). RVCA is working with TRCA and the MNR to implement the protocol with the goal of providing standard datasets to support science development and monitoring on both the interim guideline for headwater drainage features and existing mitigation strategies. An HDF is a depression in the land that conveys surface flow. Additionally, this module provides a means of characterizing the connectivity, form and unique features associated with each HDF (OSAP Protocol, 2013). An initiative is underway to evaluate how these data can help understand the cumulative contributions of individual headwater drainage features on the downstream watershed state (see Stanfield et al., 2013). In 2013 the program sampled 9 sites in the Black Creek catchment area. Figure 24 shows the headwater drainage features sampling locations in the catchment.

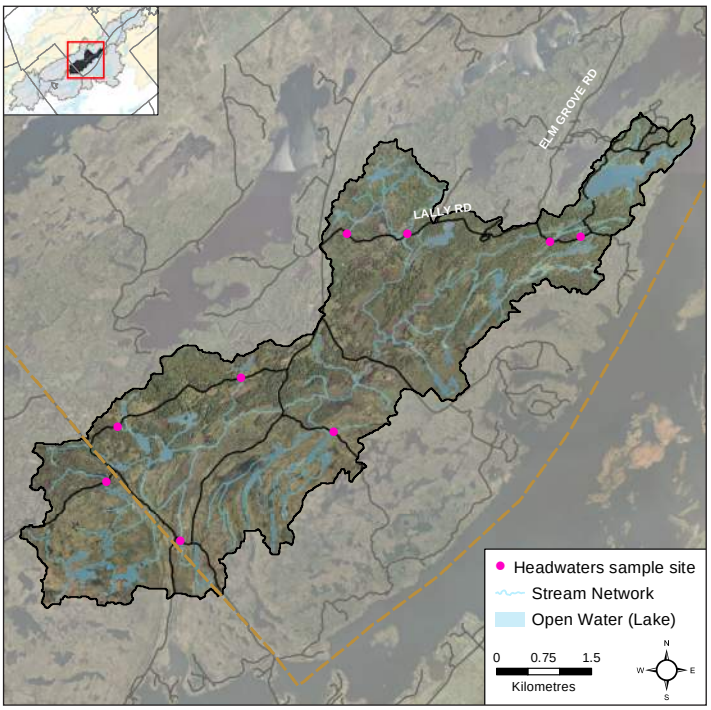


Figure 24 Headwater drainage features sampling sites in the Black Creek catchment

Two headwater drainage features sampled in the Black Creek catchment

Fisheries

The Black Creek catchment is classified as a warm/cool water recreational and baitfish fishery with 14 species observed. The following is a list of species in the watershed (Source: RVCA). Fish sampling sites are shown in Figure 25.

smallmouth bass
finescale dace
brown bullhead
central mudminnow
common shiner
fallfish
rock bass
brook stickleback
northern redbelly dace
pumpkinseed
bluntnose minnow
golden shiner
blacknose shiner
fathead minnow

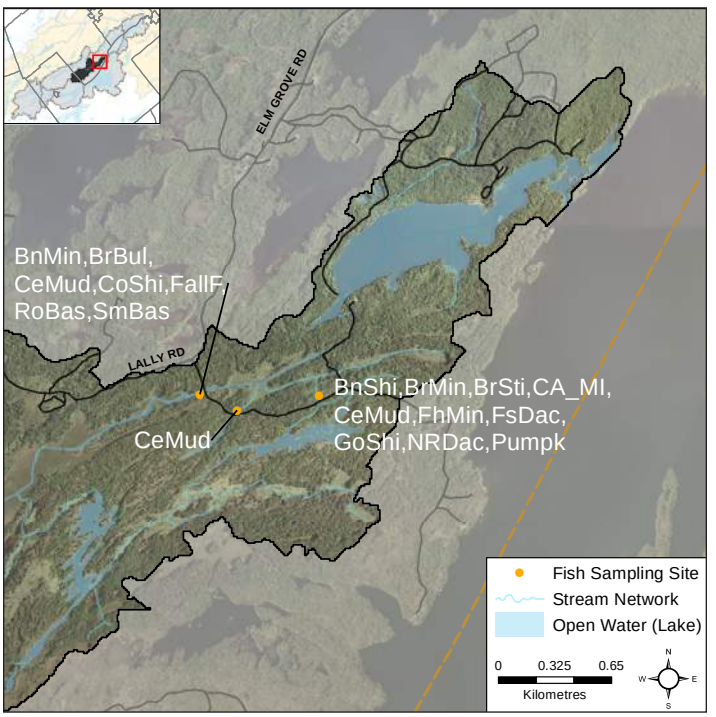


Figure 25 Fish sampling on Black Creek

3. Land Cover

Woodland is the dominant land cover type in the catchment as shown in Table 12 and displayed in the map on the front cover of the report.

Table 12 Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Woodland*	1,624	59
Wetland**	727	27
Crop & Pasture	240	9
Transportation	68	2
Water	42	2
Settlement	24	1

* Does not include treed swamps ** Includes treed swamps

Woodland Cover

The Black Creek catchment contains 1624 hectares of upland forest and 50 hectares of lowland forest (treed swamps) (Fig.26) that occupies 61 percent of the drainage area (versus the 44 percent of woodland cover in the Rideau Lakes subwatershed). This figure is greater than the 30 percent of woodland area required to sustain forest birds, according to Environment Canada's Guideline: *How Much Habitat is Enough?* When forest cover declines below 30 percent, forest birds tend to disappear as breeders across the landscape.

Thirty-one (53 percent) of the 58 woodland patches in the catchment are very small, being less than one hectare in size. Another 14 (24 percent) of the wooded patches ranging from one to less than 20 hectares in size tend to be dominated by edge-tolerant bird species. The remaining 13 (23 percent of) woodland patches range between 27 and 223 hectares. Five of these patches contain woodland between 20 and 100 hectares and may support a few area-sensitive species and some edge intolerant species, but will be dominated by edge tolerant species.

Conversely, eight (14 percent) of the 58 woodland patches in the drainage area exceed the 100 plus hectare size needed to support most forest dependent, area sensitive birds and are large enough to support approximately 60 percent of edge-intolerant species. Two of these patches top 200 hectares, which according to the Environment Canada Guideline will support 80 percent of edge-intolerant forest bird species (including most area sensitive species) that prefer interior forest habitat conditions.

Forest Interior

The same 58 woodlands contain 77 forest interior patches (Fig.26) that occupy seven percent (194 ha.) of the catchment land area (versus the five percent of interior forest in the Rideau Lakes subwatershed). This is below the ten percent figure referred to in the Environment Canada Guideline that is considered to be the minimum threshold for supporting edge intolerant bird species and other forest dwelling species in the landscape.

Most patches (72) have less than 10 hectares of interior forest, 45 of which have small areas of interior forest habitat less than one hectare in size. Another four patches contain between 10 and 30 hectares of interior forest. Conversely, one patch has greater than 30 hectares of interior forest (at 38 ha.).

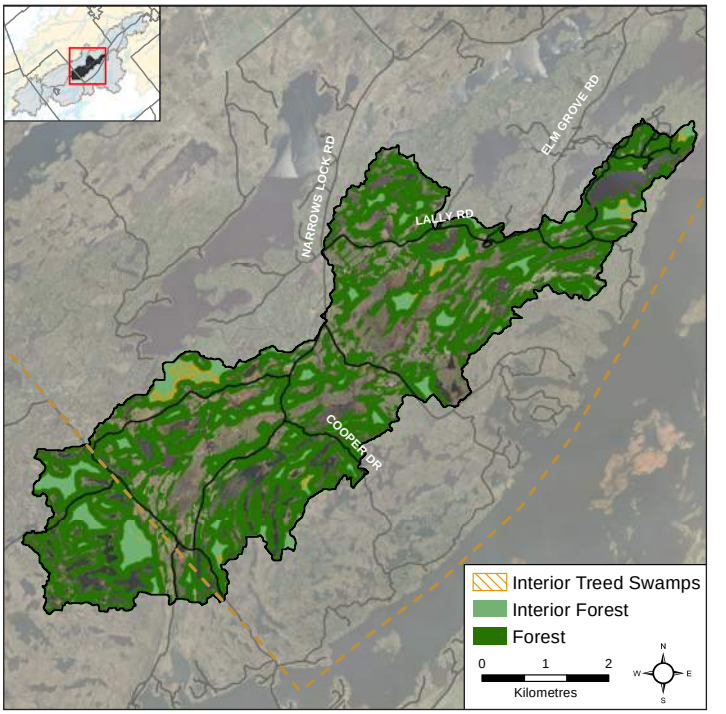
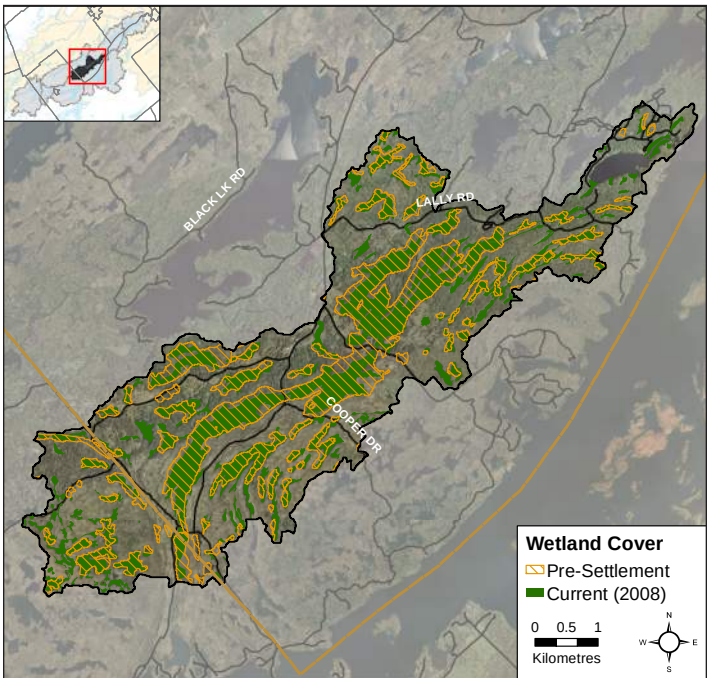


Figure 26 Catchment woodland cover and forest interioror

Wetland Cover

Figure 27 shows pre-settlement versus current (2008) wetland cover in the catchment.



Pre-Settlement data provided by: Ducks Unlimited Canada, 2010. Southern Ontario Wetland Conversion Analysis, http://www.ducks.ca/aboutduc/news/archives/prov2010/pdf/duc_ontariowca.pdf, (March 2010)

Figure 27 Catchment wetland cover

4. Stewardship and Protection

The RVCA and its partners are working to protect and enhance environmental conditions in the Rideau Lakes subwatershed.

Rural Clean Water Projects

Figure 28 shows the location of Rural Clean Water Projects in the Black Creek drainage area. Before 2008, landowners completed two projects: one well replacement and one well decommissioning. RVCA contributed $2,594 in grant dollars towards the total project cost of $7,980. No projects were carried out in the catchment from 2008 to 2013.

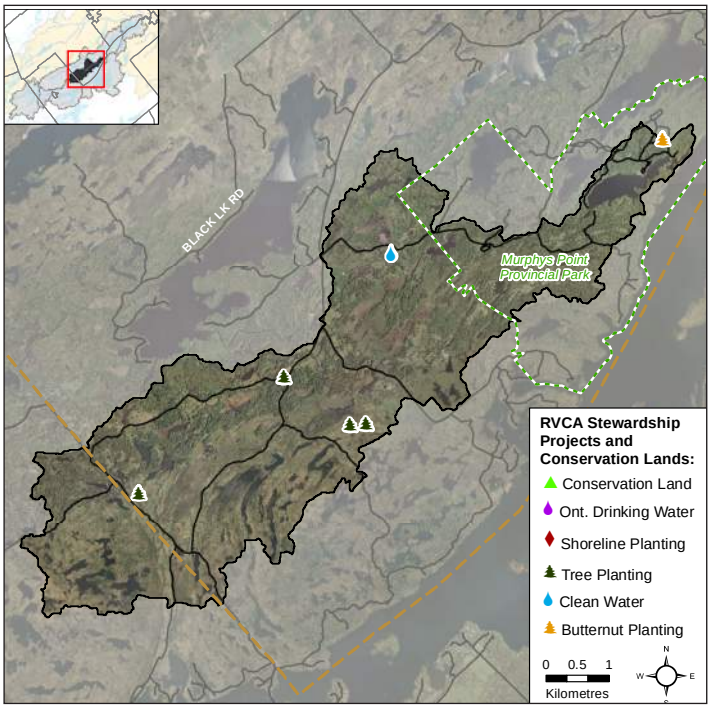


Figure 28 RVCA stewardship program project locations

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 28. From 2008 to 2013, 4,000 trees were planted at one site through the RVCA Tree Planting Program. Project value is $3,354 with $2,461 of that amount coming from other fundraising sources.

Prior to 2008, landowners helped plant 17,100 trees at three project sites valued at $5,370 with assistance forthcoming from the RVCA Tree Planting Program; fundraising dollars accounted for $3,194 of that amount.

Valley, Stream, Wetland and Hazard Land Regulation

Two square kilometres or seven percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 29), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

Natural features within the regulation limit include 0.5 sq. km. of wetlands (representing seven percent of all wetlands in the catchment) and 7.0 kilometers of streams (representing 10 percent of all streams in the catchment). Some of these regulated watercourses (4.4 km or six percent of all streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 2.6 km (or 37 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 65 km (or 90 percent) of streams requires identification of flood and erosion hazards and valley systems.

Within the regulation limit, “development” and “site alteration” require RVCA permission. The “alteration to waterways” provision of Ontario Regulation 174/06 applies to all watercourses.

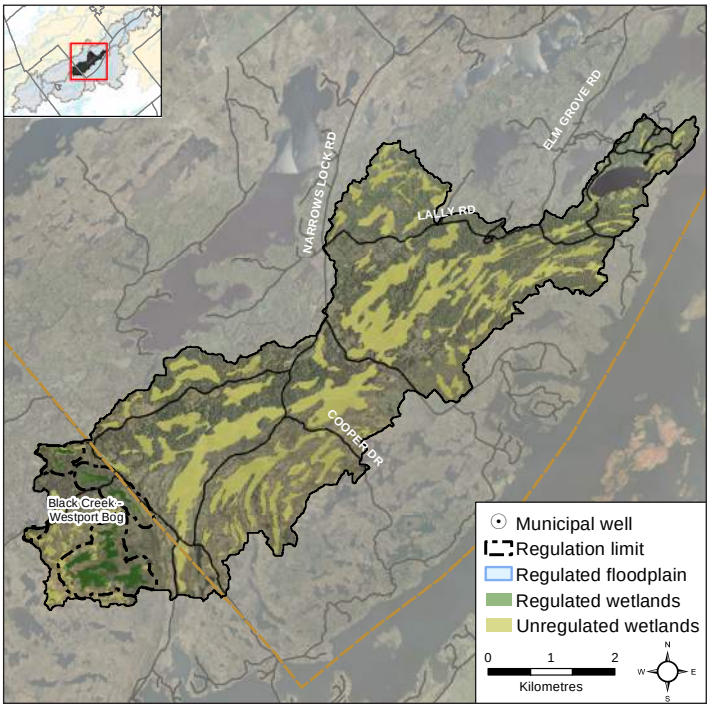


Figure 29 RVCA regulation limits

Vulnerable Drinking Water Areas

The catchment area is considered to have a Highly Vulnerable Aquifer. This means that the nature of the overburden (thin soils, fractured bedrock) does not provide a high level of protection for the underlying groundwater making the aquifer more vulnerable to contaminants released on the surface. The *Mississippi-Rideau Source Protection Plan* includes policies that focus on the protection of groundwater region-wide due to the fact that most of the region, which encompasses the Mississippi and Rideau watersheds, is considered Highly Vulnerable Aquifer.

5. Issues

Water Quality

- Recent findings for the RVCA's surface water quality monitoring program indicate that Hoggs Bay has a "Poor" surface water quality rating (for the 2008-2013 period) and is generally characterized by moderate nutrient concentrations. Given the limited development around this Bay on Big Rideau Lake, this result can largely be attributed to natural conditions such as nutrient rich organic sediment within Hoggs Bay and associated wetlands

Development

- Monitoring implementation of conditions of planning and regulatory approvals is challenging due to a lack of resources

Shorelines

- Emerald ash borer poses a significant threat to the ecology of the area, given the prominence of ash trees along shorelines and in riparian and wetland natural areas. Many tree stands are predominantly ash and with their anticipated loss, it is unclear what will replace them and the overall effect of their collective demise on the physical and natural functions/values they provide for erosion, water quality and fish and wildlife habitat protection

6. Opportunities

Water Quality

- Consider the use of shoreline and stormwater best management practices to reduce and improve the quality of surface water runoff reaching Hoggs Bay in the few areas where the natural landscape has been altered
- Continue to promote the protection of the Rideau Lakes water resources through implementation of municipal and agency land use and development policies and practices
- Review RVCA monitoring of surface water quality in Hoggs Bay on Big Rideau Lake, along with other Rideau Lakes before the next round of the Watershed Watch monitoring cycle begins in 2016 to determine if there is a need to "develop a more intensive and coordinated water quality monitoring program for all Rideau Lakes" (an identified action in the *2009 Rideau Lakes Watershed Plan)*

Development

- Collectively work with approval authorities (Tay Valley Township, Township of Rideau Lakes, Conservation Authority, the Health Unit, and Mississippi-Rideau Septic System Office) to consistently implement current land use planning and development policies for water quality and shoreline protection adjacent to lakes and streams (e.g., a minimum 30 metre development setback from water)
- Explore ways and means to more effectively enforce and implement conditions of land-use planning and development approval to achieve net environmental gains (particularly with respect to rehabilitating or protecting naturally vegetated shorelines and water quality)
- Municipal and agency planners together with development proponents are to use the 2014 *Site Evaluation Guidelines*[5] to inform decision-making about the application of development setbacks on lots with shallow soils/bedrock, steep slopes and sparse vegetation cover along with the use of the appropriate, development related, best management practices
- Utilize RVCA subwatershed and catchment reports to help develop/revise official plan policies to protect surface water resources and the natural environment (including woodlands, wetlands and shoreline cover)

Shorelines

- RVCA and its partners (including the municipalities of Rideau Lakes and Tay Valley) are to continue educating landowners about waterfront property best management practices with respect to shoreline use and development, septic system installation/maintenance and shoreline vegetation retention and enhancement
- Protect the riparian buffer along the shoreline of Black Creek and its tributaries during the development approvals process through adherence to and enforcement of municipal land-use policies and zoning standards
- RVCA and partners are to continue promoting the RVCA's Shoreline Naturalization Program and other similar initiatives to enhance vegetation cover along Black Creek

[5] Hutchinson Environmental Sciences Ltd. 2014. *Assessment of Municipal Site Evaluation Guidelines in Eastern Ontario's Lake Country.* Prepared for: Mississippi Valley Conservation Authority, Rideau Valley Conservation Authority and Cataraqui Region Conservation Authority