Kemptville Creek Subwatershed Report 2013
Barnes Creek Catchment

RIDEAU VALLEY CONSERVATION AUTHORITY

The RVCA produces individual reports for six catchments in the Kemptville Creek 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 Barnes Creek along with a summary of environmental conditions for the surrounding countryside every six years.

This information is used to help 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.

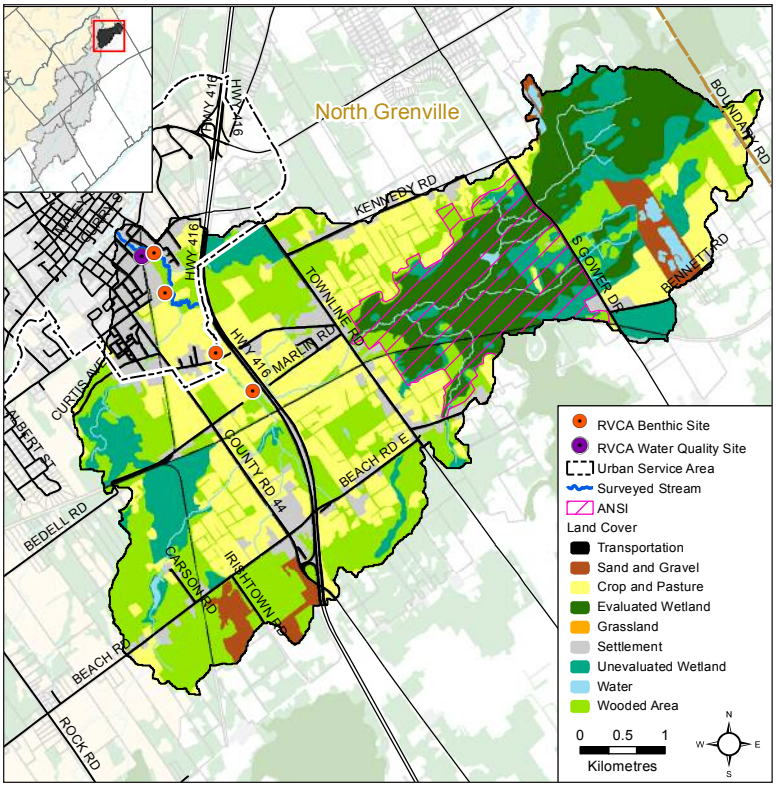
The following pages of this report are a compilation of that work. For other Kemptville Creek catchments and the Kemptville Creek Subwatershed Report, please visit the RVCA website at www.rvca.ca.

What's Inside

Catchment Facts

General Geography

- Town of Kemptville in the Municipality of North Grenville is the only urban area in the Kemptville Creek Subwatershed. The Town is the service centre for the large, rural, agricultural area that surrounds it. The east section of the Town of Kemptville urban area is situated within the lower reach of the Barnes Creek catchment. The remainder of the urban area is in one of the adjacent Town of Kemptville, Arcand Drain and Rideau River-Kars drainage areas
- Ninety-nine percent of the catchment lies within the Municipality of North Grenville and one percent within the Township of North Dundas.



Physical Geography

- Most of the Barnes Creek catchment is a glacial till plain over which lies small sections of ancient beach. Elsewhere, sand plains blanket the north central part of the catchment; while sand and organic deposits (peat associated with the South Gower Wetland) blanket the northeast part of the catchment. Large aggregate extraction operations are located in the northeast and southern parts of the catchment. A regionally important esker associated with numerous small beach features lies across the northern boundary of the catchment. Dolostone, with thinner layers of shale and sandstone, lies near the surface in the southern part of the catchment and elsewhere it underlies the sand and till plains. Several geological faults cut across the catchment
- The drainage area of 27 square kilometres occupies six percent of the Kemptville Creek Subwatershed and less than one percent of the Rideau Valley Watershed
- Dominant land cover is wetland (29 percent), woodland (28 percent) and crop and pastureland (26 percent). Settlement areas (eight percent), transportation (five percent), aggregates (three percent) and water (one percent) occupy the rest of the landscape

Vulnerable Areas

- Flood plain mapping has been available along Barnes Creek from the South Gower Wetland downstream to Kemptville Creek since 2009 and regulated since then
- Sand plains, beach features and esker are mapped as significant groundwater recharge areas. The lower half of the catchment

(southwest) is within the combined wellhead protection zone for the Town of Kemptville municipal wells

Development Trends

- Development is mostly residential with some mixed commercial and service oriented uses within the Urban Service Area boundary. Land use in the remainder of the catchment is predominantly agricultural with scattered rural residential development. The Highway 416 corridor bisects the western section of the catchment

Conditions at a Glance

- Water quality along Barnes Creek is "Poor," with no change in the water quality rating observed at a site on Van Buren Street over a 12 year reporting period (2001-2006 vs. 2007-2012)
- Woodland cover proportion has changed/decreased by seven and a half percent (207 hectares) from 2002 to 2008, due to a combination of changes in land cover and land use
- The riparian buffer (30 metres wide along both sides of Barnes Creek and its tributaries) is made up of wetland (52 percent), woodland (17 percent), crop and pastureland (16 percent), sand and gravel (seven percent), settlement areas (four percent), transportation (three percent) and water (one percent)
- A warm/cool water baitfish and recreational fishery of 22 fish species is present

Catchment Care

- Fifteen stewardship projects (Rural Clean Water/Ontario Drinking Water/Tree Planting) have been completed (from 2002 to 2011)
- Fish sampling conducted on Barnes Creek (RVCA, 2011)
- From 2003, annual benthic macroinvertebrate sampling occurs upstream of Van Buren Street (RVCA). In 2005, three new sites were added at Concession, College and Bedell Roads to the Ontario Benthos Biomonitoring Network following recommendations from the Kemptville Creek Subwatershed Study (1999)
- In 2011, RVCA conducted a macro stream survey, working upstream from the mouth of Barnes Creek — where it empties into Kemptville Creek — to its headwaters, taking measurements and recording observations on instream habitat, bank stability, other attributes and preparing a temperature profile
- MOE well records indicate there are about 300 water wells in this catchment (11 percent of all wells in the Kemptville Creek Subwatershed)
- Permits to Take Water are held by the Municipality of North Grenville for three municipal water supply wells; Ducks Unlimited for a wetland habitat initiative and aggregate extraction operations for dewatering purposes
- Well casings of the three drinking water production wells in the Town of Kemptville (one of which is located in the Barnes Creek catchment) have been extended, resulting in a municipal drinking water source that is less vulnerable to contamination
- Watershed model developed by the RVCA in 2009 was used to study the hydrological function of wetlands in the Rideau Valley Watershed, including those found in the Barnes Creek catchment
- 2005 North Grenville Water and Wastewater Servicing Master Plan prepared by Stantec Consulting and Golder Associates for the Municipality of North Grenville

1. Barnes Creek Surface Water Quality Conditions

Assessment of streams in the Kemptville Creek watershed is based on 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). Each parameter is evaluated against established guidelines to determine water quality conditions. Those parameters that frequently exceed guidelines are presented below.

The assessment of water quality throughout the Kemptville Creek Subwatershed also looks at water quality targets that are presented in the 2007 Kemptville Creek Watershed Plan Update (KCWP). The KCWP identifies nutrient and bacteria loading to be of concern as well as maintaining and/or improving water quality aesthetics throughout the Kemptville Creek watershed..

Surface water quality conditions in Barnes Creek are monitored through the RVCA's Baseline Water Quality Monitoring Program. See Figure 1 and Table 2 for the monitored site's location.

The water quality in Barnes is rated as "Poor" (Table 2) as determined by the CCME Water Quality index (CCME WQI); analysis of the data has been broken into two periods 2001–2006 and 2007–2012, to examine if conditions have changed in this timeframe. Water quality scores at this site are largely influenced by nutrient concentrations. For more information on the CCME WQI please see the Kemptville Creek Subwatershed Report.

Table 1 outlines the WQI scores and their corresponding ratings and Table 2 shows the overall rating for the monitored site on Barnes Creek.

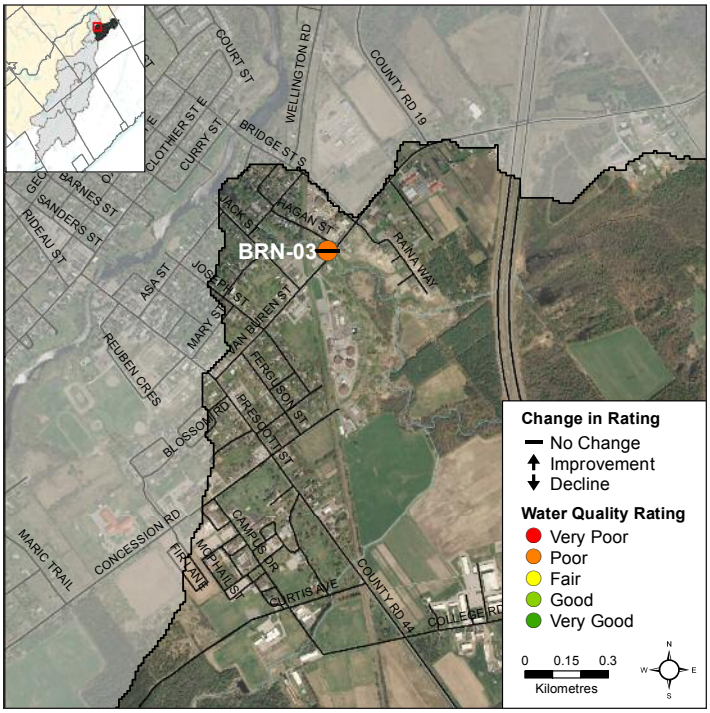


Figure 1 Water quality in Barnes Creek. The rating shown on the map is for the 2007–2012 period. Arrows are used to show a change in the rating from the 2001–2006 period

Table 1 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

Table 2 WQI Ratings for Barnes Creek from 2001–2006 and 2007–2012

Sampling Site	Nearest interesction	2001-2006	Rating
BRN-03	Van Buren St. and Hurd St.	57	Poor
Sampling Site	**Nearest interesction**	**2007-2012**	**Rating**
BRN-03	Van Buren St. and Hurd St.	53	Poor

Barnes Creek 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) of 0.030 mg/l is used as the TP Guideline. 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 loading. RVCA uses a guideline of 0.500 mg/l to assess TKN[1] and the PWQO of 0.020 mg/l to assess NH_3 concentrations in Barnes Creek.

Tables 3, 4 and 5 summarize average nutrient concentrations at the monitoring site on the creek and show the proportion of samples that meet the guidelines.

Table 3 Summary of total phosphorus results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate average concentrations exceed the guideline.

Total Phosphorus 2001-2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.174	3%	30
Total Phosphorus 2007-2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.204	18%	39

Table 4 Summary of total Kjeldahl nitrogen results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate average concentrations exceed the guideline

Total Kjeldahl Nitrogen 2001-2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	1.092	3%	30
Total Kjeldahl Nitrogen 2007-2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.861	3%	39

Table 5 Summary of ammonia results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate average concentrations exceed the guideline

Ammonia 2001-2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.175	3%	30
Ammonia 2007-2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.069	26%	39

Barnes Creek

[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

BRN-03

The majority of samples at site BRN-03 exceeded the TP guideline of 0.030 mg/l for both time periods; only three percent of samples were below the guideline in the 2001–2006 period (Figure 2a) this improved to 18 percent of samples in the 2007–2012 period (Figure 2b). Average TP concentrations increased from 0.174 mg/l (2001–2006) to 0.204 mg/l (2007–2012). Though results are elevated they show a slight improvement from the data in the KCWP which noted TP concentrations were very high with no samples below the guideline.

TKN results show that the bulk of results exceeded the guideline of 0.500 mg/l (Figures 3a and 3b); only three percent of samples were below the guideline in both periods of interest. The average concentration decreased from 1.092 mg/l (2001–2006) to 0.861 mg/l (2007–2012). The KCWP noted that the majority of results exceed the TKN guideline and the recent data reflects that this continues to be the case. NH_3 results were also elevated (Figures 4a and 4b); however the proportion of samples below the guideline did improve from three percent to 26 percent and the average concentration declined from 0.175 mg/l (2001–2006) to 0.069 mg/l (2007–2012).

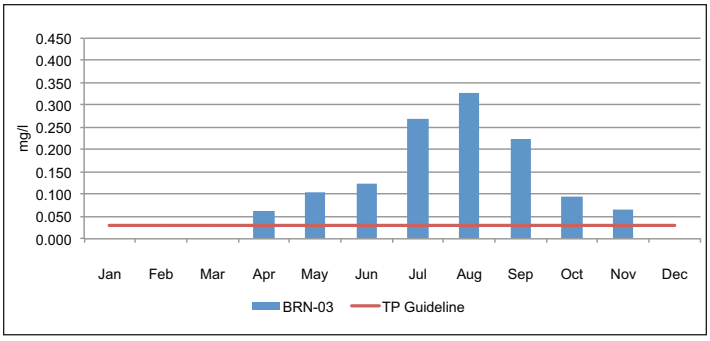


Figure 2a Total phosphorus concentrations in Barnes Creek from 2001–2006

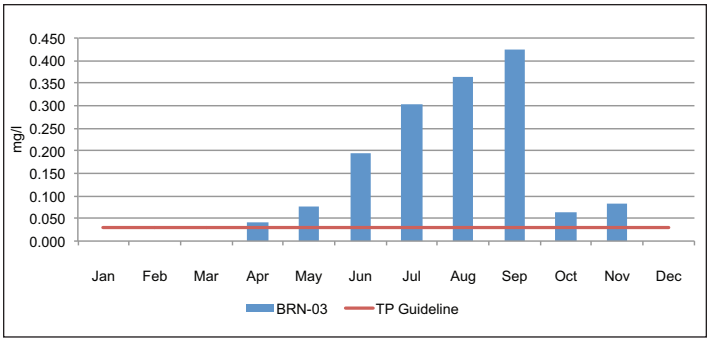


Figure 2b Total phosphorus concentrations in Barnes Creek from 2007–2012

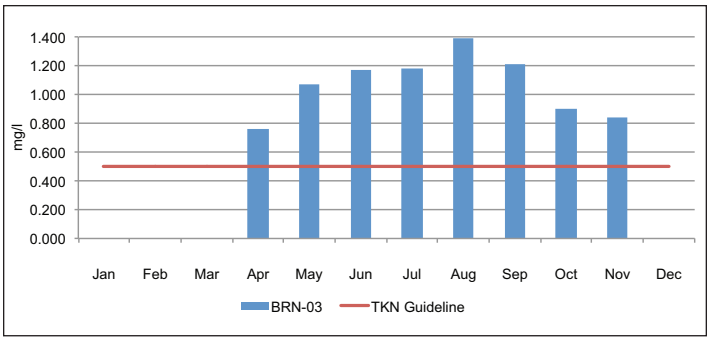


Figure 3a Total Kjeldahl nitrogen concentrations in Barnes Creek from 2001–2006

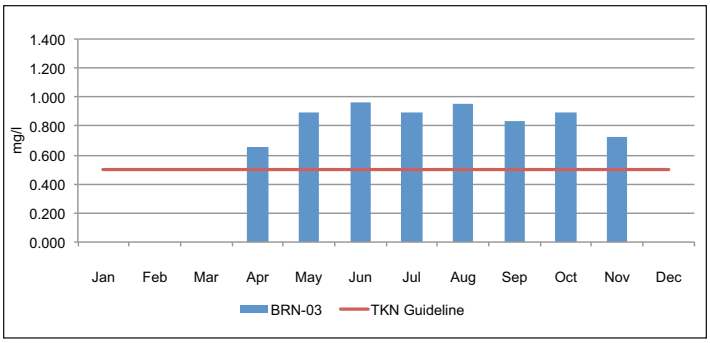


Figure 3b Total Kjeldahl nitrogen concentrations in Barnes Creek from 2007–2012

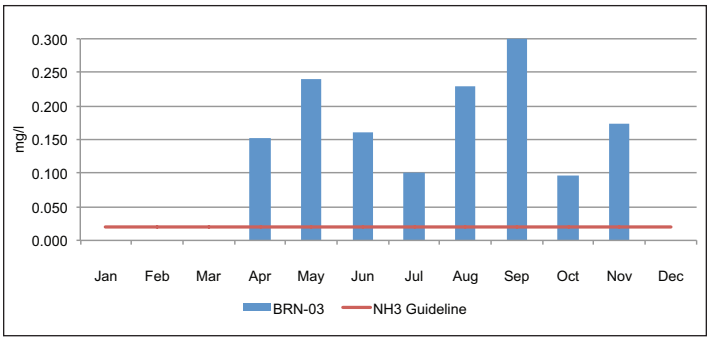


Figure 4a Ammonia concentrations in Barnes Creek from 2001–2006

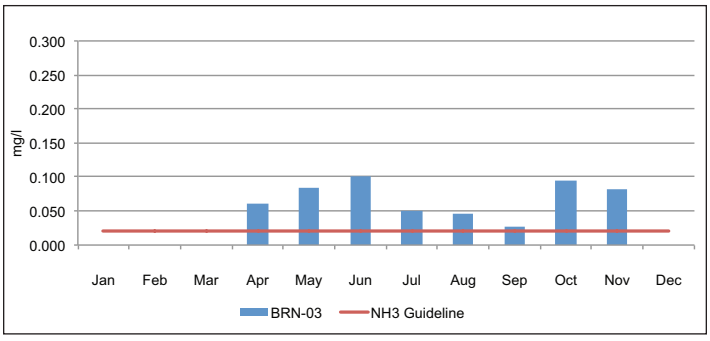


Figure 4b Ammonia concentrations in Barnes Creek from 2007–2012

Barnes Creek Nutrients Summary

The data shows that nutrient enrichment is a concern on Barnes Creek. Water quality guidelines for TP, TKN and NH_3 are generally exceeded. This indicates that Barnes Creek may be contributing negatively to nutrient concentrations as it flows downstream and into Kemptville Creek.

Barnes Creek *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. The KCWP also set a target for *E. coli* counts of 100 CFU/100 ml at the 70th percentile.

Table 6 summarizes the geometric mean[2] for the monitored site on Barnes Creek and shows the proportion of samples that meet the *E. coli* guideline of 100 CFU/100 ml.

Figure 5 shows the results of the geometric mean with respect to the guideline for the two periods, 2001-2006 (Figure 5a) and 2007-2012 (Figure 5b). Figures 6a and 6b show percentile plots of the data for the two time periods . Any point to the left of the 70th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the KCWP target.

BRN-03

E. coli counts at site BRN-03 indicate little improvement with regard to bacterial contamination. Counts at the 70th percentile increased from 376 CFU/100 ml (Figure 6a) to 384 CFU/100 ml (Figure 6b) far exceeding the KCWP target. The proportion of samples below the guideline increased marginally from 31 percent (Figure 5a) to 33 percent (Figure 5b) and the count at the geometric mean declined from 195 CFU/100 ml (2001-2006) to 133 CFU/100 ml (2007-2012). The KCWP noted that though exceedances were common there was evidence of a decline in counts at this site; however the data presented above shows that conditions have remained fairly comparable.

E.coli Summary

The results indicate that bacterial contamination continues to be a concern in Barnes Creek. The target set by the KCWP has not been achieved and the proportion of samples below the guideline increased slightly, finally though there was a decline in the geometric mean of counts between the two time periods this value remains above the guideline.

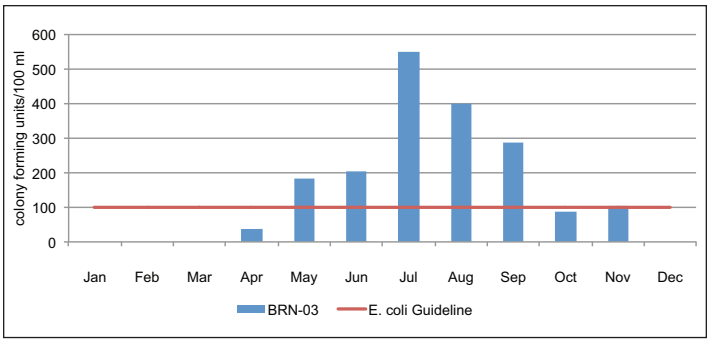


Figure 5a *E. coli* counts in Barnes Creek from 2001–2006

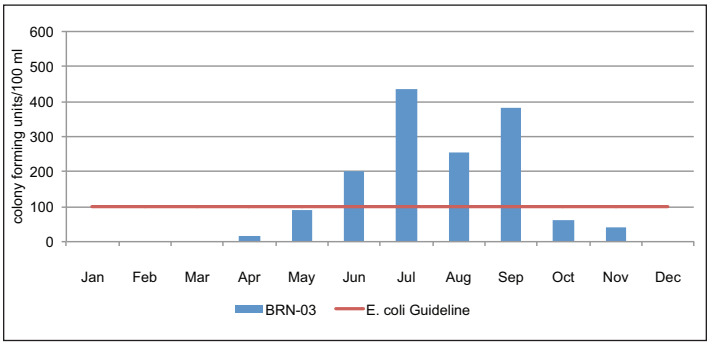


Figure 5b *E. coli* counts in Barnes Creek from 2007–2012

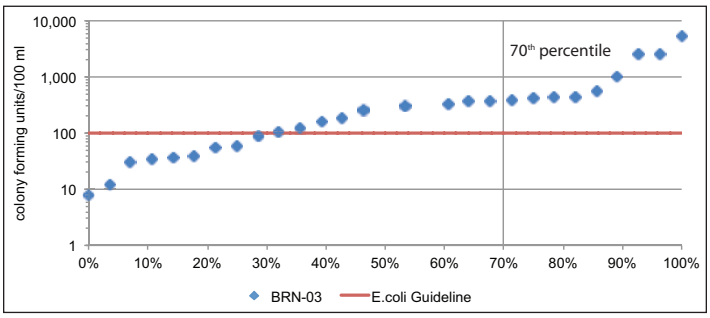


Figure 6a Percentile plots of *E. coli* in Barnes Creek for 2001–2006

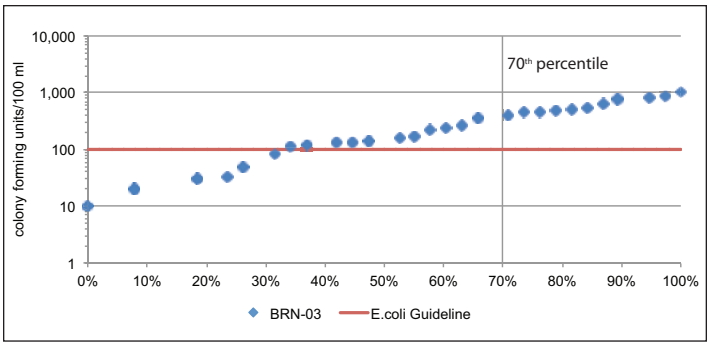


Figure 6b Percentile plots of *E. coli* in Barnes Creek for 2007–2012

Table 6 Summary of *E. coli* results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate the geometric means exceeds the guideline.

***E. coli* 2001–2006**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
BRN-03	195	31%	29
***E. coli* 2007–2012**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
BRN-03	133	33%	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.

Barnes Creek Metals

Of the metals routinely monitored in Barnes Creek, aluminum (Al), copper (Cu) and iron (Fe) were metals that frequently reported concentrations above their respective PWQOs. In elevated concentrations these metals can have toxic effects on sensitive aquatic species.

Tables 7, 8 and 9 summarize metal concentrations at the monitored site and show the proportion of samples that meet guidelines.

Figures 7, 8 and 9 show metal concentrations with respect to guidelines for the two periods of interest, 2001–2006 and 2007–2012. The guidelines as stated by the PWQOs are Al 0.075 mg/l, Cu 0.005 mg/l and Fe 0.300 mg/l.

BRN-03

Results from the monitoring site shows that Al concentrations were often elevated; 37 percent of samples were below the guideline in the 2001–2006 period (Figure 7a) this improved to 47 percent of samples in the 2007–2012 period (Figure 7b). The average Al concentration also exceeded the guideline and increased from 0.153 mg/l (2001–2006) to 0.264 mg/l (2007–2012).

Copper concentrations provided evidence of an increasing trend. In the 2001-2006 period 85 percent of samples were below the guideline (Figure 8a) and declined to 58 percent of samples in the 2007–2012 period (Figure 8b). This contributed to an increase in the average concentration from 0.003 mg/l (2001–2006) to 0.005 mg/l (2007–2012).

Fe concentrations also exceeded guidelines. The proportion of samples below the guideline improved from 44 percent to 58 percent (Figures 9a and 9b), however the average concentration exceeded the guideline and increased from 0.443 mg/l (2001–2006) to 0.577 (2007–2012).

Barnes Creek Metal Summary

Overall a general increase in metal concentrations was observed between the two periods of interest, though for some metals (Al and Fe) the proportion of results below the guideline did improve. The data indicates that surrounding land uses are likely impacting the system and deteriorating water quality; efforts should be made to reduce any inputs (such as runoff from roadways, metal alloys, fungicides and pesticides) to improve overall stream health.

Barnes Creek

Table 7 Summary of aluminum results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate the average concentration exceeds the guideline

Aluminum 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.153	37%	27
Aluminum 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.264	47%	30

Table 8 Summary of copper results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate the average concentration exceeds the guideline

Copper 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.003	85%	27
Copper2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.005	58%	31

Table 9 Summary of iron results for Barnes Creek from 2001–2006 and 2007–2012, highlighted values indicate the average concentration exceeds the guideline

Iron 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.443	44%	27
Copper2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
BRN-03	0.577	58%	31

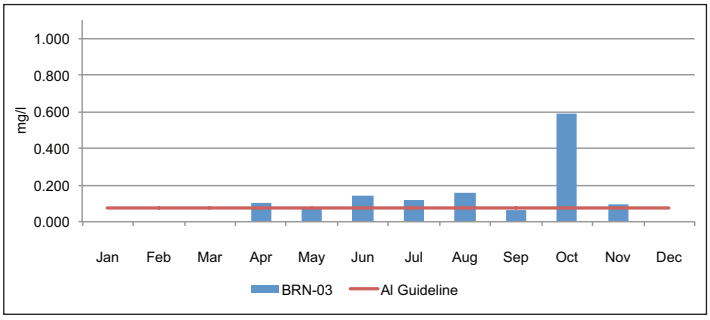


Figure 7a Aluminum concentrations in Barnes Creek from 2001–2006

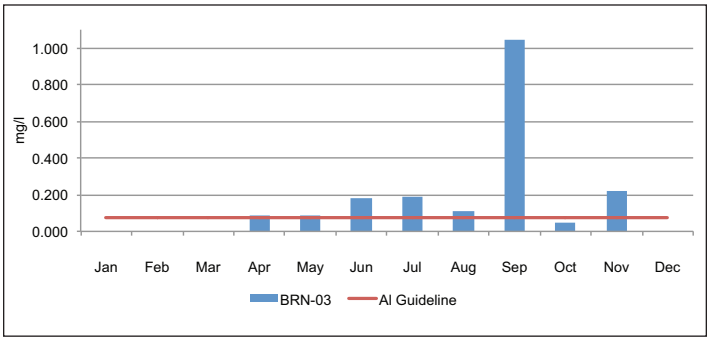


Figure 7b Aluminum concentrations in Barnes Creek from 2007–2012

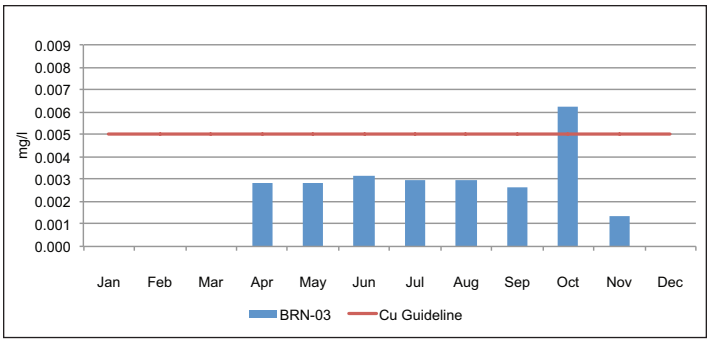


Figure 8a Copper concentrations in Barnes Creek from 2001–2006

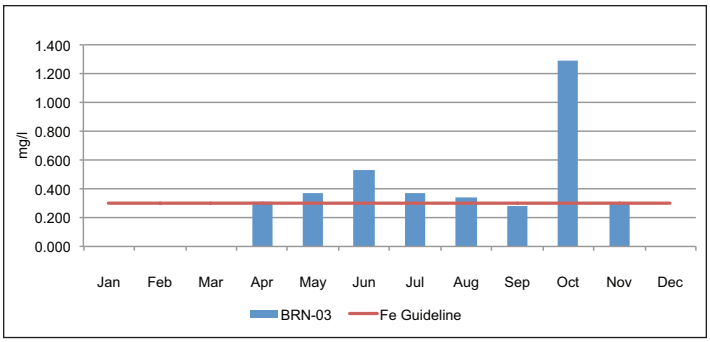


Figure 9a Iron concentrations in Barnes Creek from 2001–2006

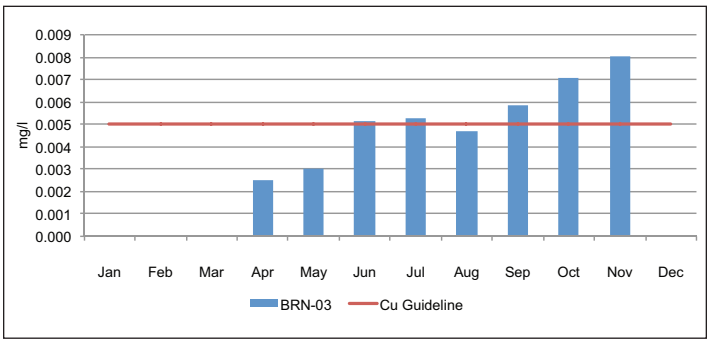


Figure 8b Copper concentrations in Barnes Creek from 2007–2012

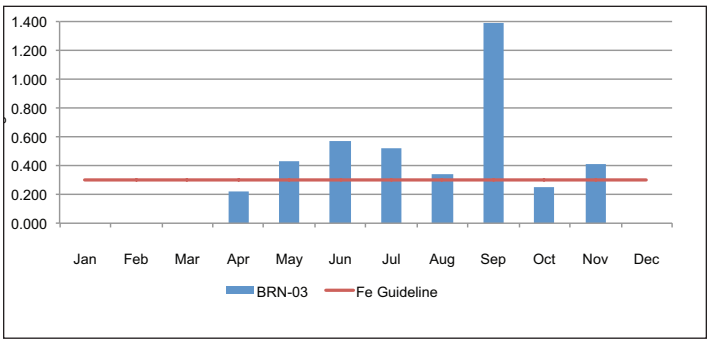


Figure 9b Iron concentrations in Barnes Creek from 2007–2012

Monitoring activities on Barnes Creek

2. Barnes Creek Riparian Conditions

BARNES CREEK OVERBANK ZONE

Riparian Buffer Width 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 meter wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Figure 11 demonstrates the buffer conditions of the left and right banks separately. Barnes Creek had a buffer of greater than 30 meters along 98 percent of the right bank and 96 percent along the left bank (Figure 10).

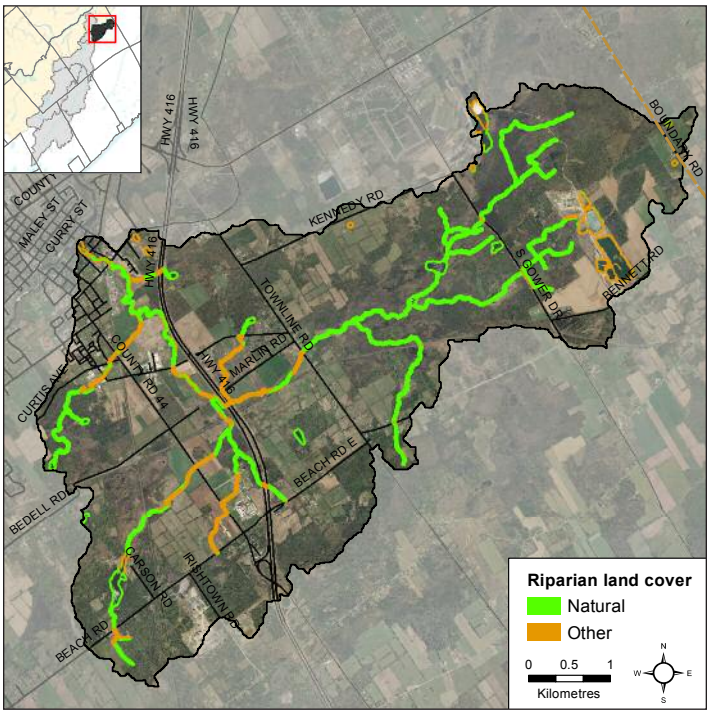


Figure 10 Natural and other riparian land cover along Barnes Creek

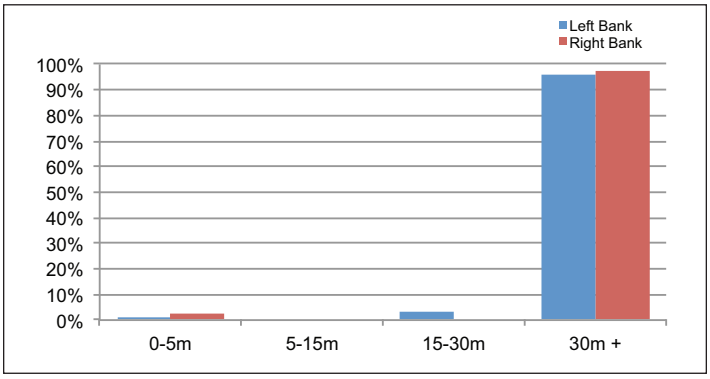


Figure 11 Riparian Buffer Evaluation along Barnes Creek

Adjacent Land Use

The RVCA's Macro stream Survey Program identifies seven different land uses beside Barnes Creek (Figure 12). Surrounding land use is considered from the beginning to end of the survey section (100 metres) and up to 100 metres on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 63 percent of the stream, characterized by forest, scrubland and meadow. The remaining land use consisted of residential, agriculture, infrastructure, and industrial/commercial.

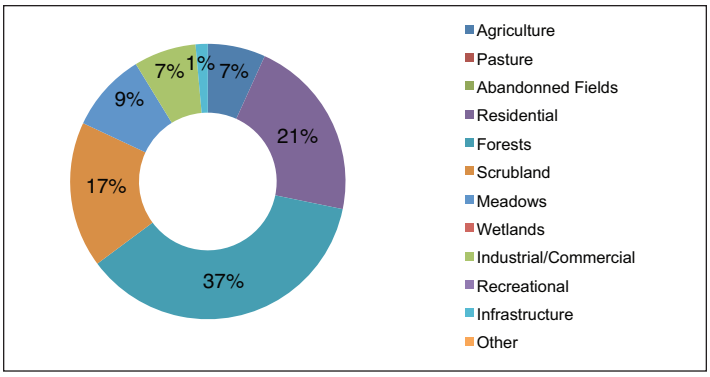


Figure 12 Land Use along Barnes Creek

37 percent of Barnes Creek is forested

BARNES CREEK SHORELINE ZONE

Instream Erosion

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have a detrimental effect on important fish and wildlife habitat. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the potential to impact instream migration. Figure 13 shows high to moderate erosion levels in the lower to middle reaches on the left and right bank along Barnes Creek.

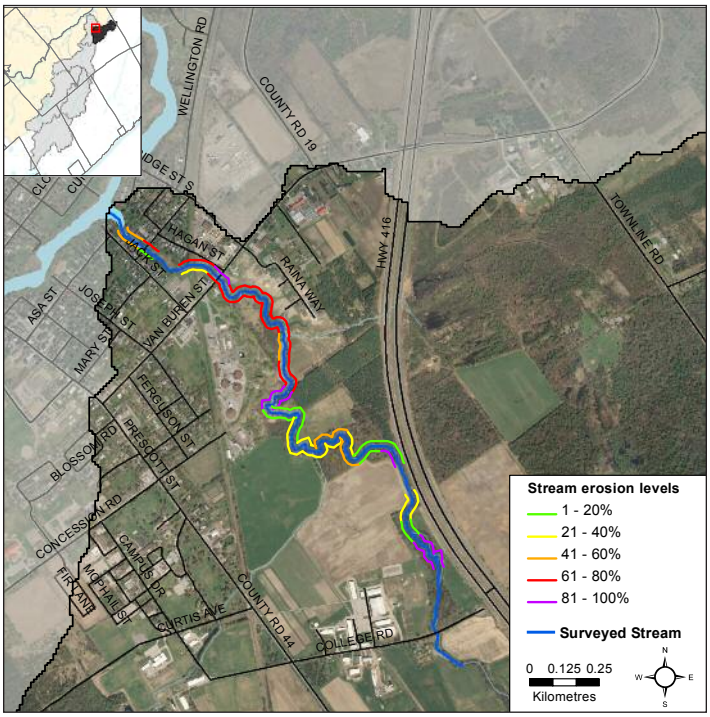


Figure 13 Erosion along Barnes Creek.

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 14 shows that Barnes Creek had moderate to high levels of undercut banks.

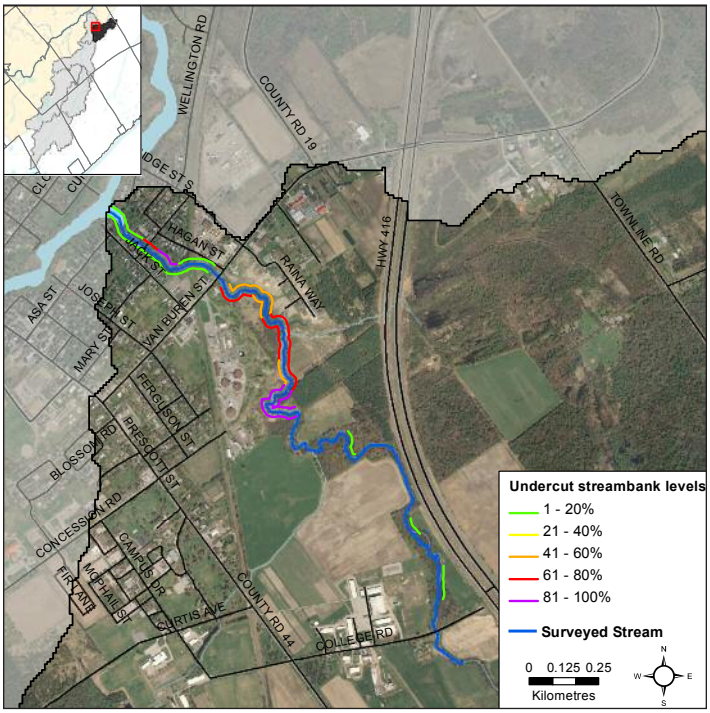


Figure 14 Undercut stream banks along Barnes Creek.

Erosion on Barnes Creek

Undercut stream bank along Barnes Creek

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 15 shows moderate to high levels of stream shading along Barnes Creek.

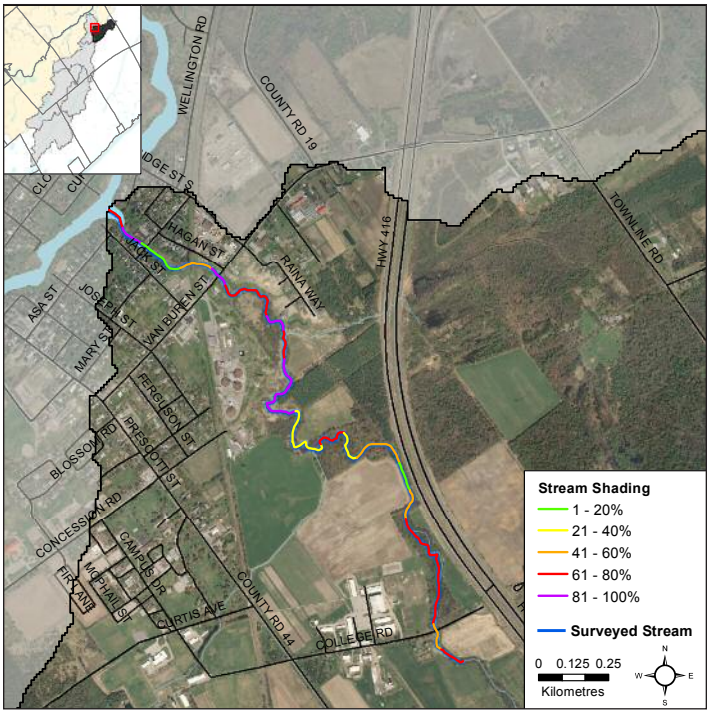


Figure 15 Stream shading along Barnes Creek

Instream Woody Debris

Figure 16 shows that the majority of Barnes Creek had varying levels of instream woody debris in the form of branches and trees. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas.

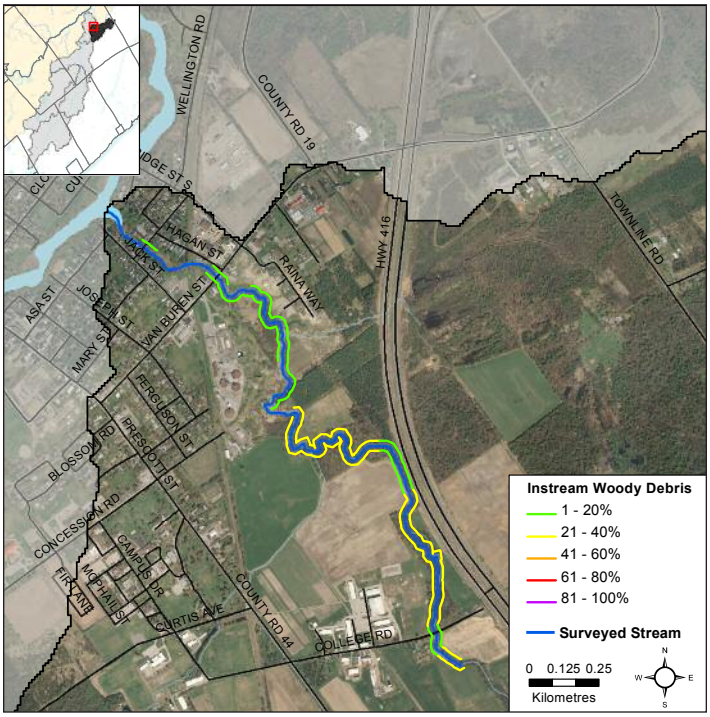


Figure 16 Instream woody debris along Barnes Creek

Stream shading on Barnes Creek

Instream woody debris on Barnes Creek

Overhanging Trees and Branches

Figure 17 shows that the majority of Barnes Creek had varying levels of overhanging branches and trees. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

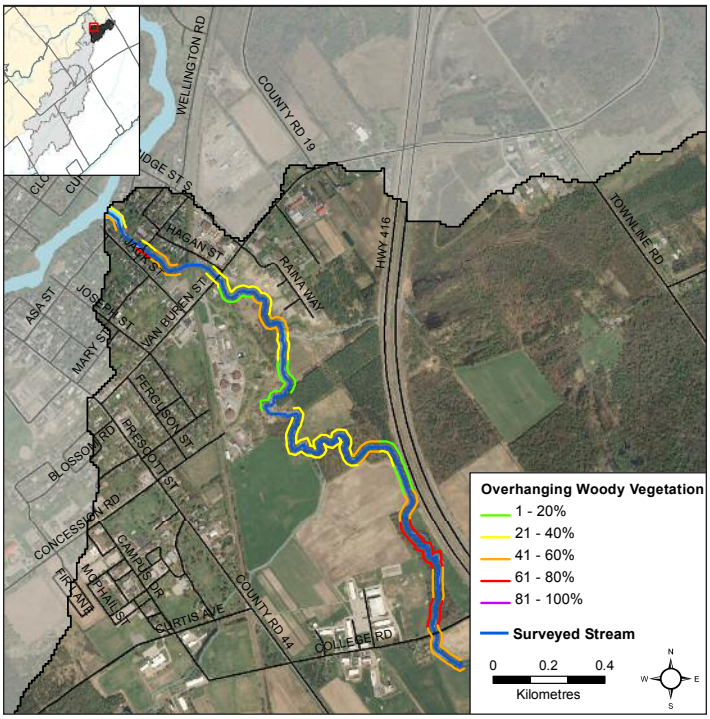


Figure 17 Overhanging trees and branches along Barnes Creek

Overhanging trees and branches

Anthropogenic Alterations

Figure 18 shows 79 percent of Barnes Creek remains “unaltered.” Sections considered “natural” with some human changes account for 7 percent of sections. "Altered" sections accounted for 14 percent of the stream, with no sections sampled being considered “highly altered”. Areas classified as altered included existing road crossings, shoreline/instream modifications and areas with little or no buffer.

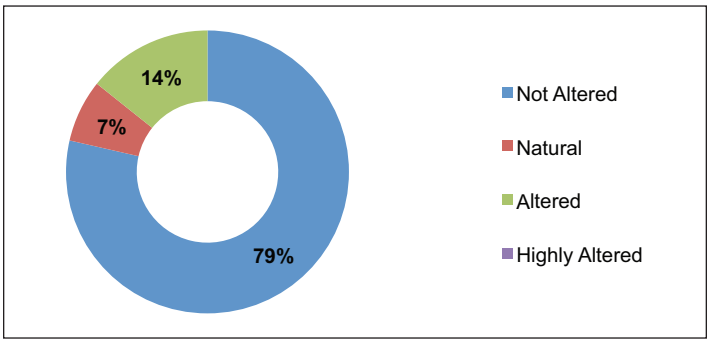


Figure 18 Anthropogenic alterations along Barnes Creek

Man-made alterations along Barnes Creek

BARNES CREEK INSTREAM AQUATIC HABITAT

Benthic Invertebrates

Freshwater benthic invertebrates are animals without backbones that live on the stream bottom and include crustaceans such as crayfish, molluscs and immature forms of aquatic insects. Benthos represent an extremely diverse group of aquatic animals and exhibit wide ranges of responses to stressors such as organic pollutants, sediments and toxicants, which allows scientists to use them as bioindicators. As part of the Ontario Benthic Biomonitoring Network (OBBN), the RVCA has been collecting benthic invertebrates at the Van Buren Street site on Barnes Creek since 2003. In response to a recommendation made in the 2007 Kemptville Creek Watershed Plan additional benthic invertebrate monitoring sites were added to understand how water quality and aquatic habitat conditions change along Barnes Creek. Monitoring data is analyzed for each sample site and the results are presented using the Family Biotic Index, Family Richness and percent *Ephemeroptera, Plecoptera* and *Trichoptera*. BS1 is located at Van Buren Street, BS2 is located at Concession Road, BS3 is located at College Road and BS4 is located at Bedell Road.

Hilsenhoff Family Biotic Index

The Hilsenhoff Family Biotic Index (FBI) is an indicator of organic and nutrient pollution and provides an estimate of water quality conditions for each site using established pollution tolerance values for benthic invertebrates. FBI results for Barnes Creek are separated by sample location with "Poor" water quality conditions being observed at all sample locations for the period from 2007 to 2012 (Figure 19) using a grading scheme developed by Conservation Authorities in Ontario for benthic invertebrates.

Family Richness

Family Richness measures the health of the community through its diversity and increases with increasing habitat diversity suitability and healthy water quality conditions. Family Richness is equivalent to the total number of benthic invertebrate families found within a sample. Although the family richness appears to be high most of the Barnes Creek sample locations are dominated by species that are moderately tolerant and tolerant to poor water quality conditions. Using Family Richness as the indicator, Barnes Creek is reported to have "Poor" water quality (Figure 20).

EPT

Ephemeroptera (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies) are species considered to be very sensitive to poor water quality conditions. High abundance of these organisms is generally an indication of good water quality conditions at a sample location. The community structure is dominated by species that are tolerant to poor water quality conditions. As a result, the EPT indicates that Barnes Creek is reported to have "Poor" water quality (Figure 21) from 2007 to 2012.

Conclusion

Overall Barnes Creek has a water quality rating of "Poor" from 2007 to 2012.

Benthic invertebrate sampling

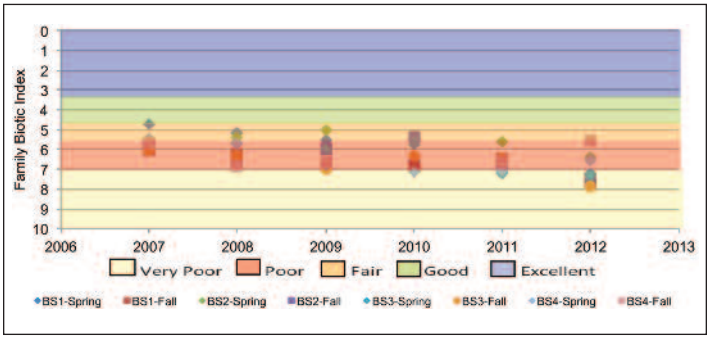


Figure 19 Hilsenhoff Family Biotic Index on Barnes Creek

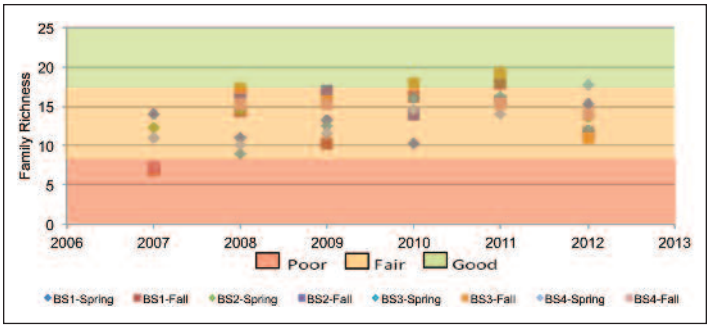


Figure 20 Family Richness in Barnes Creek

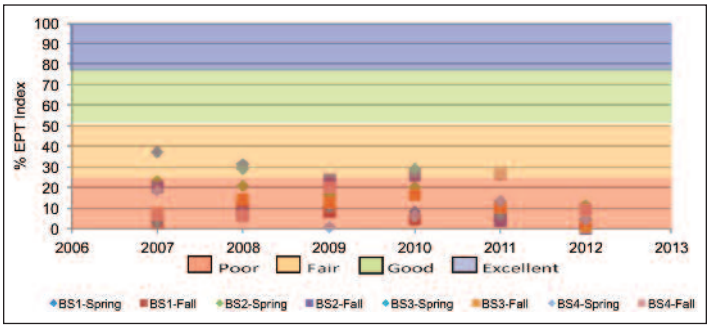


Figure 21 EPT in Barnes Creek

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. Examples of habitat complexity include variable habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Seventy-five percent of Barnes Creek was considered heterogeneous, as shown in Figure 22.

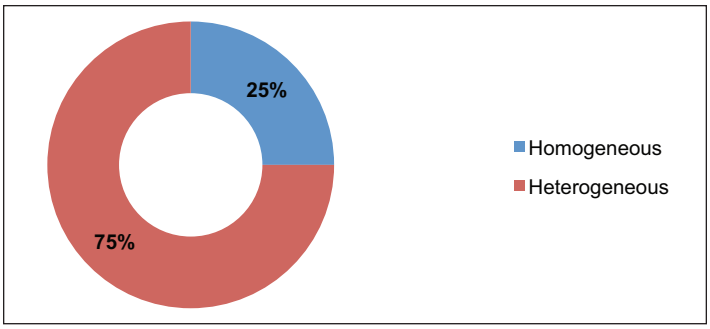


Figure 22 Habitat complexity along Barnes Creek

Instream Substrate

Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current. Cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 24 shows where cobble and boulder substrate is found in Barnes Creek. Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and for example will only reproduce on certain types of substrate (Figure 23).

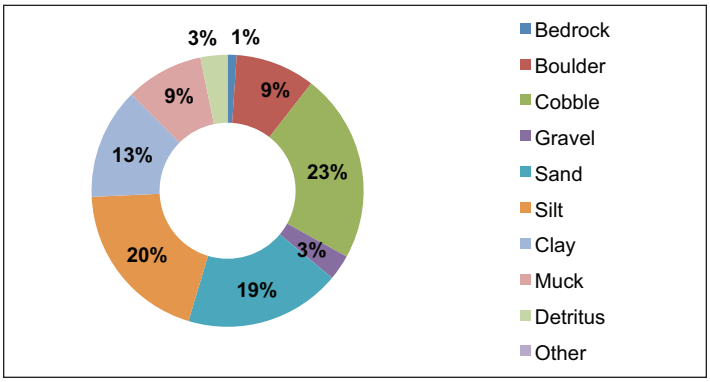


Figure 23 Instream substrate along Barnes Creek

Instream substrate in Barnes Creek

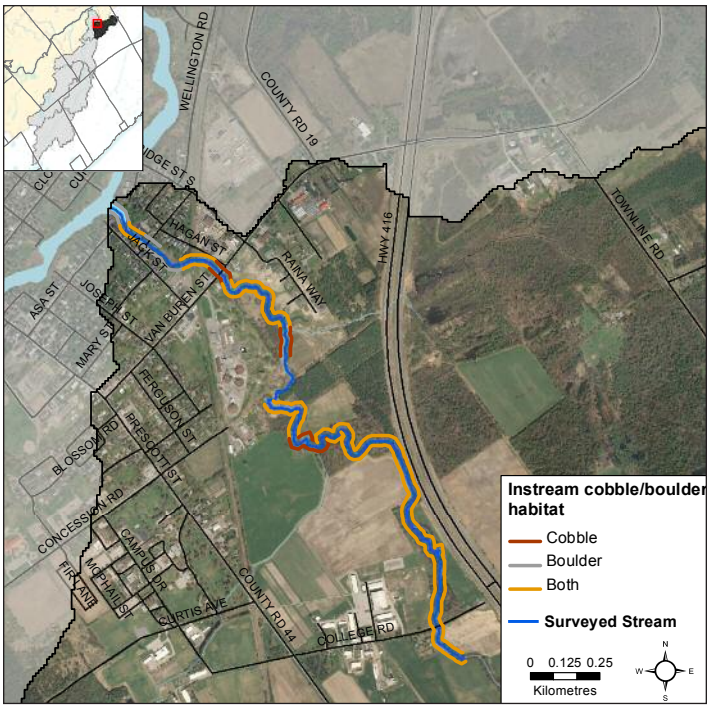


Figure 24 Instream substrate along Barnes Creek.

Instream Morphology

Pools and riffles are important habitat features for fish. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Pools also provide important over wintering areas for fish. Runs are usually moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 25 shows that Barnes Creek is somewhat variable; 77 percent consists of runs, three percent pools and 20 percent riffles.

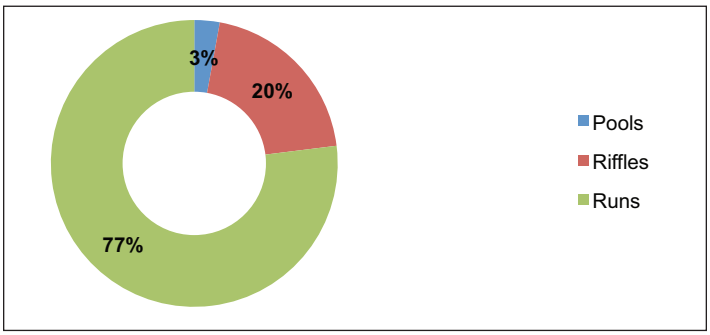


Figure 25 Instream morphology along Barnes Creek

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. Barnes Creek had limited diversity of instream vegetation. The dominant vegetation type recorded at sixty-seven percent consisted of algae. Figure 26 depicts the plant community structure for Barnes Creek.

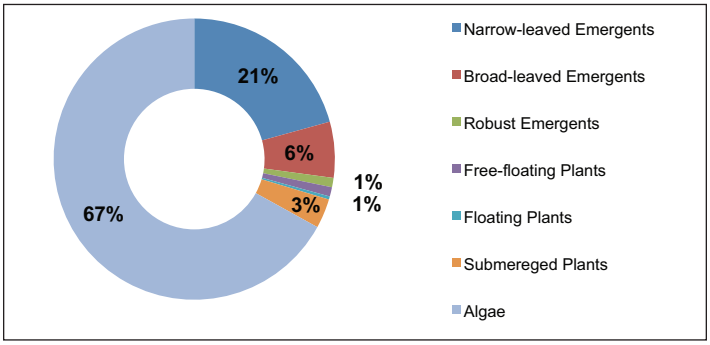


Figure 26 Vegetation type along Barnes Creek

Instream Vegetation Abundance

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Too much vegetation can also be detrimental. Figure 27 demonstrates that Barnes Creek has low levels of instream vegetation for most of its length.

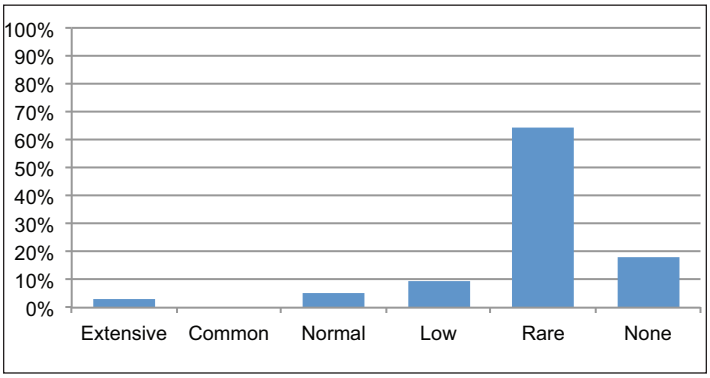


Figure 27 Instream vegetation abundance along Barnes Creek

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. Twenty-nine percent of the sections surveyed along Barnes Creek had invasive species (Figure 28). The invasive species observed in Barnes Creek were common buckthorn, curly leaf pondweed and dog strangling vine.

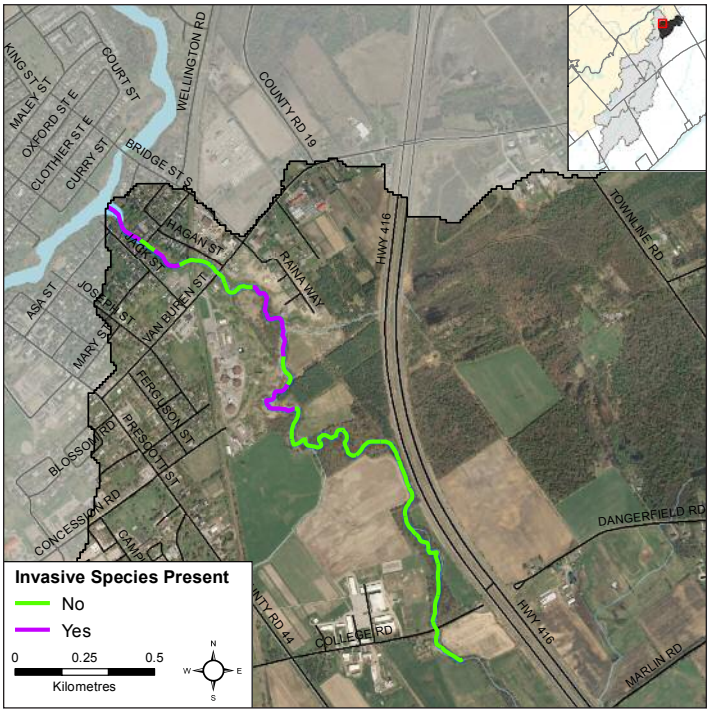


Figure 28 Invasive species along Barnes Creek

Common buckthorn is an invasive species found on Barnes Creek

Thermal Regime

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Water temperature is used along with the maximum air temperature (using the Stoneman and Jones method) to classify a watercourse as either warm water, cool water or cold water. Analysis of the data collected indicates that Barnes Creek is classified as a warm water system in the middle and upper reaches and as a cool water system in the lower reach (Figure 30). Figure 29 shows the location of temperature loggers at three sampling locations on Barnes Creek.

Figure 30 shows termperature logger data for three sampling locations on Barnes Creek.

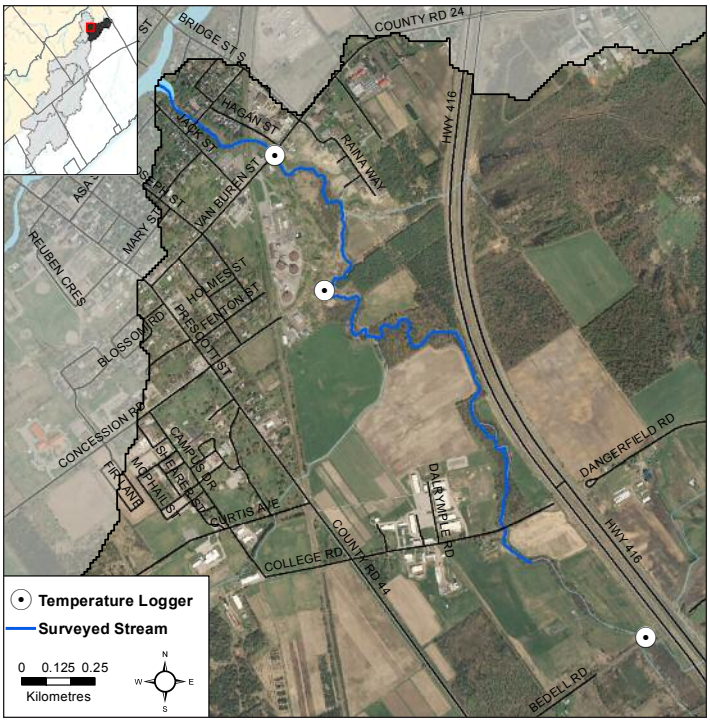
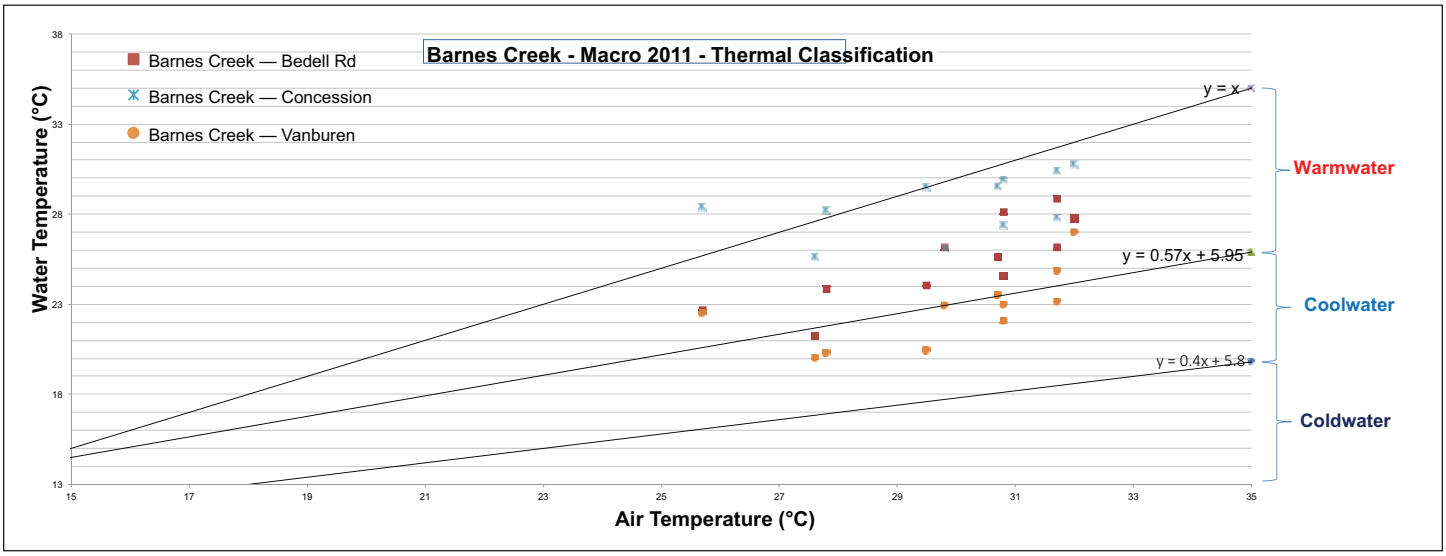


Figure 29 Temperature loggers in Barnes Creek



SITE ID	SOURCE_ID	Y_WATER	X_AIR	CLASSIFICATION	PROGRAM	YEAR
Barnes Creek — Bedell Rd	BARN-1	25.68	30.3	WARMWATER	MACRO	2011
Barnes Creek — Concession	BARN-2	28.76	30.3	WARMWATER	MACRO	2011
Barnes Creek — Vanburen	BARN-3	23.12	30.3	COOLWATER	MACRO	2011

Figure 30 Temperature logger data for three sites on Barnes Creek
Each point on the graph represents a temperature that meets the following criteria:

- Sampling dates between July 1st and September 7
- Sampling date is preceded by two consecutive days above 24.5 °C, with no rain
- Water temperatures are collected at 4 p.m.
- Air temperature is recorded as the max temperature for that day

Migratory Obstructions

It is important to know the locations of migratory obstructions because they can prevent fish from accessing important spawning and rearing habitat (Figure 31). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There were four migration barriers within the Barnes Creek catchment at the time of the survey.

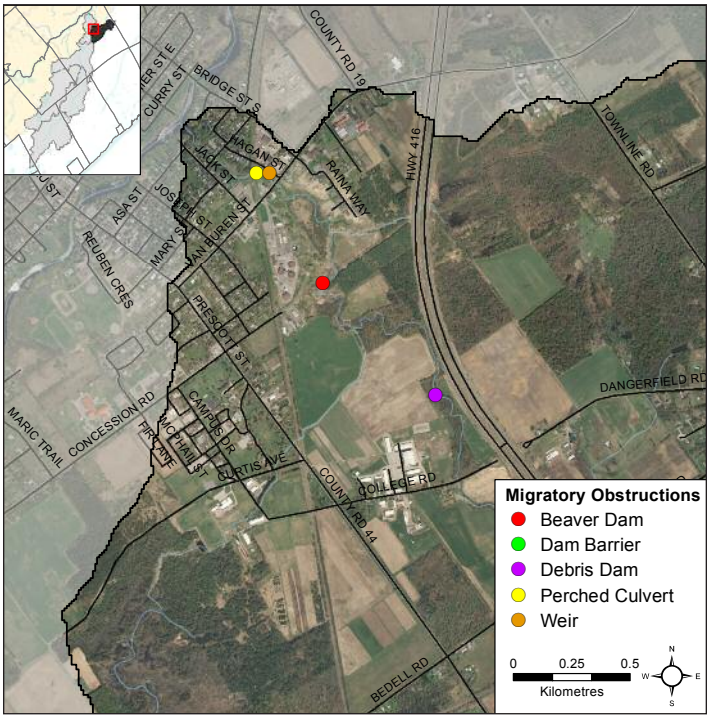


Figure 31 Migratory obstructions along Barnes Creek

Beaver dam — a migratory obstruction on Barnes Creek

Fish Sampling

Fish sampling sites located along Barnes Creek are shown in Figure 32. The provincial fish codes shown on the following map are listed (in Table 10) beside the common name of those fish species identified in Barnes Creek. Barnes Creek is classified as a warm/cool water recreational and baitfish fishery with 22 species observed.

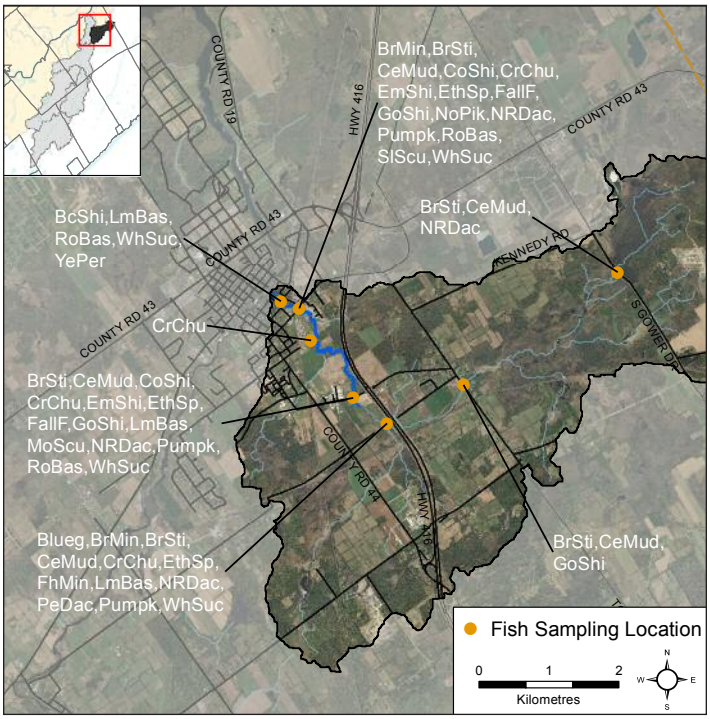


Figure 32 Fish sampling along Barnes Creek

Table 10 Fish species identified in Barnes Creek

Species observed in Kemptville Creek (with fish code)			
blackchin shiner	BcShi	largemouth bass	LmBas
bluegill	Blueg	mottled sculpin	MoScu
brassy minnow	BrMin	northern pike	NoPik
brook stickleback	BrSti	northern redbelly dace	NRDac
central mudminnow	CeMud	pearl dace	PeDac
common shiner	CoShi	pumpkinseed	Pumpk
creek chub	CrChu	rock bass	RoBas
emerald shiner	EmShi	slimy sculpin	SlScu
etheostoma sp.	EthSp	white sucker	WhSuc
fallfish	FallF	yellow perch	YePer
fathead minnow	FhMin		

Small weir on Barnes Creek

Riparian Restoration

Figure 33 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

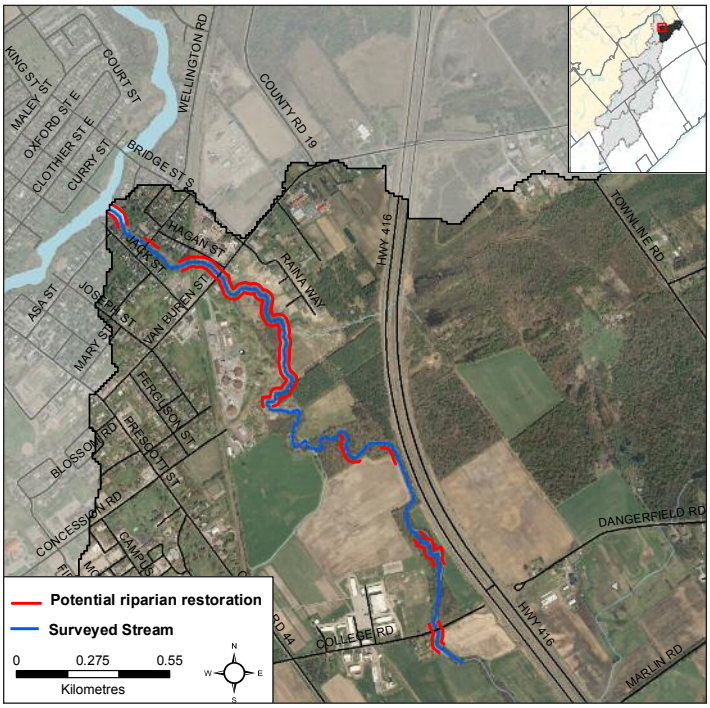


Figure 33 Riparian restoration along Barnes Creek

Opportunities for riparian restoration on Barnes Creek

Water Chemistry

During the macro stream survey, a YSI probe is used to collect water chemistry, as follows:

- Dissolved Oxygen is a measure of the amount of oxygen dissolved in water. The lowest acceptable concentration of dissolved oxygen is 6.0 mg/L for early stages of warm water fish and 9.5 mg/L for cold water fish (CCME, 1999). A saturation value (concentration of oxygen in water) of 90 percent or above is considered healthy. Saturation levels above one hundred percent are not uncommon in sections of stream where there are high amounts of algae and other aquatic plants.
- Conductivity is the ability of a substance to transfer electricity. This measure is influenced by the presence of dissolved salts and other ions in the stream.
- pH is a measure of relative acidity or alkalinity, ranging from one (most acidic) to 14 (most alkaline/basic), with seven occupying a neutral point.

2011 data for these four parameters is summarized in Table 11.

Table 11 Water chemistry in Barnes Creek

Month	Range	DO (mg/L)	DO(%)	Conductivity (µs/cm)	pH
June 2011	Low	4.42	46.6	349	8.12
	High	12.16	128.2	718	8.8
July 2011	Low	7.48	81.0	502	8.2
	High	10.72	116.1	8.35	8.2

Monitoring on Barnes Creek

3. Land Cover

Wetland, woodland and crop and pastureland are the dominant land cover types 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)
Wetland	806	29
Woodland	766	28
Crop & Pasture	713	26
Settlement	231	8
Transportation	129	5
Sand & Gravel	88	3
Water	15	1

Woodland Cover

The Barnes Creek catchment contains 766 hectares of upland forest and 127 hectares of lowland forest (treed swamps) (Figure 34) that occupies 32 percent of the drainage area (versus the 36 percent of woodland cover in the Kemptville Creek 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.

Fifteen (20 percent) of the 74 woodland patches in the catchment are very small, being less than one hectare in size. Another 47 (64 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 12 (16 percent of) woodland 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.

No patch tops 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 74 woodlands contain 21 forest interior patches (Figure 34) that occupy five percent (136 hectares) of the catchment land area (versus the eight percent of interior forest in the Kemptville Creek 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 (13) have less than 10 hectares of interior forest, eight of which have small areas of interior forest habitat less than one hectare in size. The remaining eight patches have between 12 and 21 hectares of interior forest.

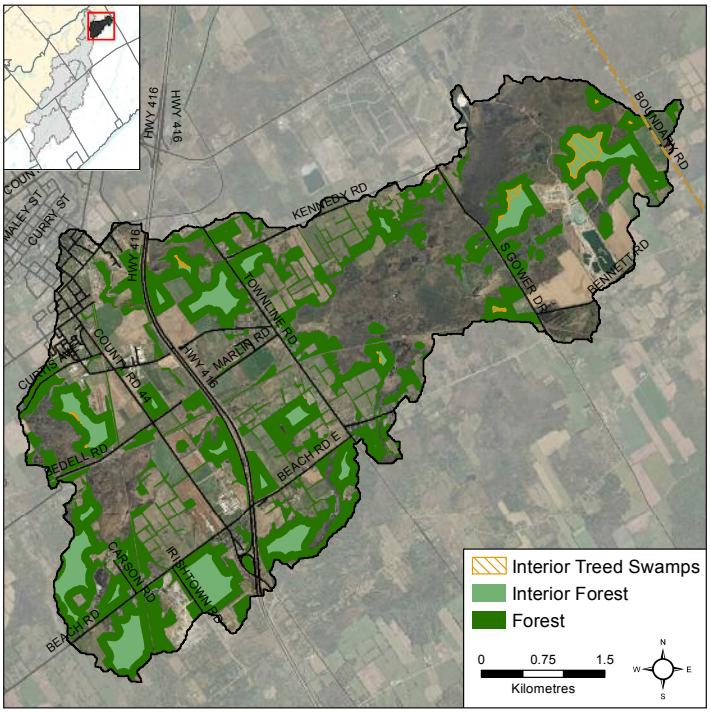
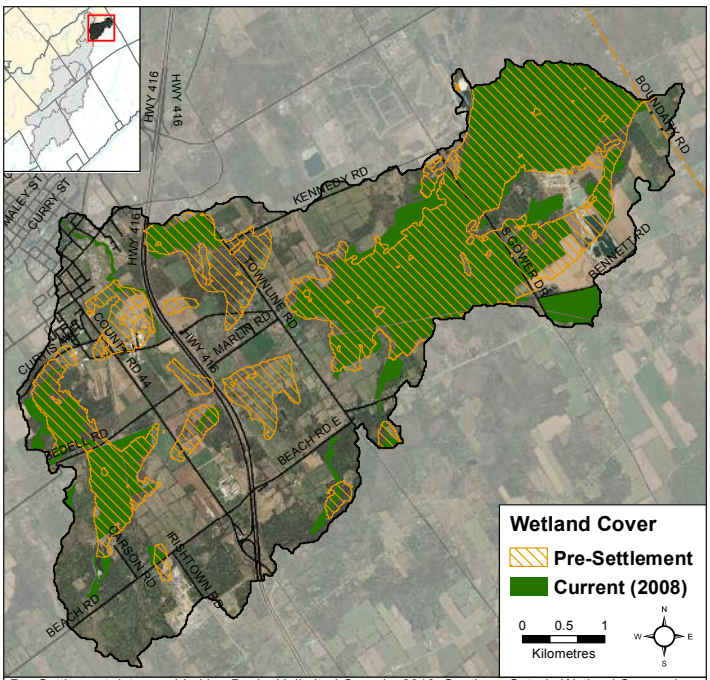


Figure 34 Catchment woodland cover and forest interior

Wetland Cover

Figure 35 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 35 Catchment wetland cover

4. Stewardship and Protection

The RVCA and its partners are working to protect and enhance environmental conditions in the Kemptville Creek Subwatershed.

Rural Clean Water Projects

Figure 36 shows the location of all Rural Clean Water Projects in the Barnes Creek drainage area. From 2007 to 2012, landowners completed five projects: two septic system repairs/replacements, two well upgrades and one well decommissioning. RVCA contributed $5,878 in grant dollars towards the total project cost of $18,008.

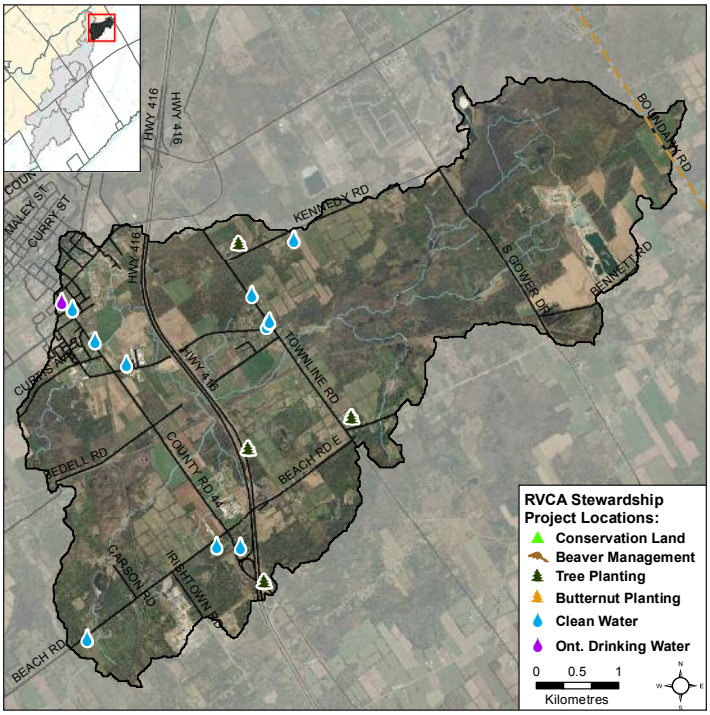


Figure 36 RVCA stewardship program project locations

Prior to 2007, the RVCA completed four projects in the area consisting of two septic system repairs/ replacements, one well decommissioning and one education initiative. In total, RVCA contributed $4,277 in grant dollars to projects valued at $28,842.

Ontario Drinking Water Stewardship Projects

Figure 36 shows the location of all Ontario Drinking Water Stewardship Program (ODWSP) projects in the Barnes Creek drainage area. This Ministry of the Environment funded program has supported two projects between 2007 and 2012. Total project value is $24,013 with landowners receiving $7,840 to support one septic system repair/replacement and one well decommissioning.

In addition to this, the RVCA aided the Municipality of North Grenville in securing $155,100 through the ODWSP Special Projects Category in 2010. The funding has been used to extend the well casings of the three drinking water production wells in Kemptville into the deep Nepean aquifer, resulting in a municipal drinking water source that is less vulnerable to contamination, a substantial reduction in the future cost of implementing Source Protection Plans, as well as greatly reducing the number of properties in Kemptville that are located in an area where certain land use activities can be considered significant drinking water threats.

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 36. From 2007 to 2012, 9,000 trees were planted on three sites through the RVCA Tree Planting Program. Project value is $16,161 with $8,926 of that amount coming from other fundraising sources.

Before that, landowners helped plant 2,000 trees, valued at $4,600, on one project site, using the RVCA Tree Planting Program; fundraising dollars accounted for $3,200 of that amount.

Valley, Stream, Wetland and Hazard Land Regulation

Eight square kilometres or 28 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 37), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

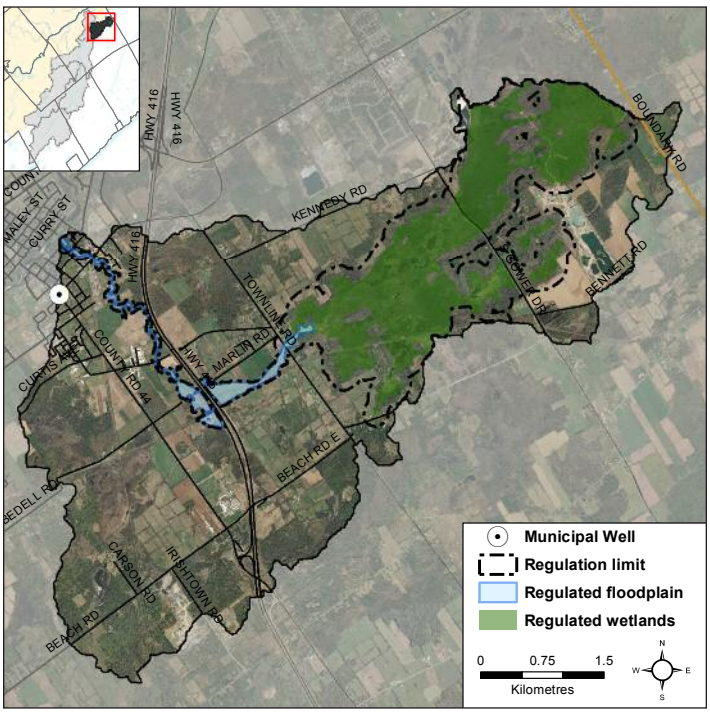


Figure 37 RVCA regulation limits

Natural features within the regulation limit include 4.3 square kilometres. of wetlands (representing 53 percent of all wetlands in the catchment) and 21.2 kilometers of streams (representing 65 percent of all streams in the catchment). Some of these regulated watercourses (11.7 kilometres or 36 percent of all streams) flow through regulated wetlands. Regulation limit mapping has been plotted along 9.5 kilometres (or 45 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the

remaining 11.4 kilometres (or 35 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.

Also within the catchment drainage area is the Wellhead Protection Area for Kemptville's municipal water supply, as shown in Figure 36. Please refer to the Mississippi-Rideau Source Protection Plan at www.mrsourcewater.ca to see what policies have been developed to protect the Town's water supply along with a list of regulated activities in this area.

5. Issues

- Water quality along Barnes Creek is "Poor" as determined by benthic invertebrate and surface water chemistry data. No change has been observed in the surface water quality rating at a site on Van Buren Street over a 12 year reporting period. Exceedances of ammonia, total Kjeldahl nitrogen, total phosphorus, E.coli, aluminum, copper and iron above water quality guidelines are largely responsible for this rating. This result does not meet the 2007 Kemptville Creek Watershed Plan Update objective to reduce bacteria and nutrient loadings along Barnes Creek. A possible explanation for this poor result includes agricultural activity and associated loss of riparian cover along Barnes Creek and its tributaries. Another source could be the lack of on-site stormwater quality and quantity controls that are typically not found in the older parts of the Town of Kemptville, where untreated stormwater is discharged to Barnes Creek
- There are flood susceptible areas and unstable slopes adjacent to Barnes Creek. The floodplain on the lower reach of the creek was first identified through an engineering study in 1972 and regulations have been in place along the lower reach since 1976. The floodplain between Concession Road and the creek's confluence with Kemptville Creek is confined within the valley lands and the predominant constraint is slope stability. In the middle reach from College Street downstream to Concession Road, the predominant constraint is the 1:100 year floodplain with a few areas (meanders) influenced by the staple slope allowance. The predominant constraint on the creek between the South Gower Wetland and College Street is the floodplain. Although private property extends into the floodplain and slope hazard areas, most development is located outside the hazard land due to past (and ongoing) efforts to minimize landowner exposure to natural hazards by regulating development in these areas
- The catchment contains 380 hectares of unevaluated wetlands (occupying 14 percent of its total area), much of which is located in and around the South Gower Provincially Significant Wetland. Development is starting to encroach into these areas, in the absence of any regulatory controls that would otherwise protect them
- Livestock access to Barnes Creek has been observed
- A weir and a perched concrete box culvert are located downstream of Van Buren Street along Barnes Creek and are considered low flow fish migration barriers

6. Opportunities for Action

- Investigate cause (source) of reported "Poor" surface water quality rating along Barnes Creek and consider implementing measures to reduce bacteria and nutrient loadings (an identified action in Table 6 of the 2007 Kemptville Creek Watershed Plan Update)
- Consider initiating a stormwater outfall/outlet monitoring program in the Town of Kemptville to assess any impact from stormwater on the surface water quality in Barnes Creek and Kemptville Creek (an identified action in Table 6 of the 2007 Kemptville Creek Watershed Plan Update)
- Continue exploring on-site opportunities for implementing stormwater best management practices for all redevelopment and infill development within the Town of Kemptville (an identified action in Table 6 of the 2007 Kemptville Creek Watershed Plan Update)
- Municipality of North Grenville Official Plan provides the policy direction to undertake a stormwater master plan for the urban serviced area that would provide guidance to developers and approval authorities with respect to optimal solutions for stormwater management for new development, and opportunities for retrofit of stormwater management infrastructure in the urban serviced area for which there are currently no water quality and quantity controls
- Continue to use official plan policy, zoning and regulatory controls under Section 28 of the Conservation Authorities Act to restrict development in and adjacent to the Barnes Creek hazard lands (floodplain and unstable slopes) and the South Gower Provincially Significant Wetland
- Establish RVCA regulations limits in areas of unevaluated wetlands that may be subject to specific threats (i.e., extensive tree clearing/cutting, drainage works and fill activity). Consider revising the boundary of the South Gower Provincially Significant Wetland to include areas of unevaluated wetland located in and around it. Continue to use official plan policy and zoning to control development in these areas
- Develop natural heritage system targets (for woodlands, wetlands and riparian cover) in and outside of the Town of Kemptville urban boundary to conserve/protect natural habitat values and minimize habitat fragmentation (an identified action in Table 6 of the 2007 Kemptville Creek Watershed Plan Update)
- Riparian cover adjacent to the creek and its tributaries is highly variable. Target riparian restoration to address minimal shoreline buffers, identified erosion sites, livestock access and degraded shorelines in urban and rural sections of the catchment (see Figure 33)
- Investigate the purpose of the weir and consider its removal to restore natural stream processes along Barnes Creek
- As part of the normal life cycle process for the replacement of municipal infrastructure, implement mitigation measures to lower the invert at the perched culvert located downstream of Van Buren Street along Barnes Creek, to allow for low flow seasonal fish migration
- Protect shorelines, floodplains, locally/regionally/provincially significant natural heritage features such as wetlands, woodlands, valleylands, wildlife habitat, areas of natural and scientific interest, aquatic habitat and municipal drinking water intake/wellhead protection zones/areas through conservation agreements/easements or land acquisition programs