Kemptville Creek Subwatershed Report 2013
Mud 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 Mud 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.

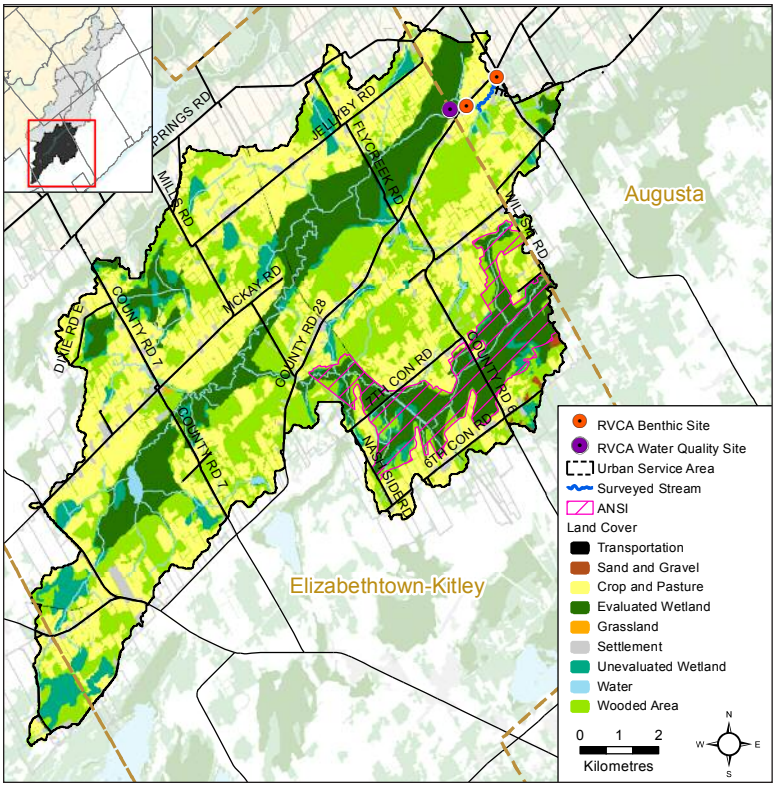
The following pages of this report are a compilation of that work. For other Kemptville Creek catchments and the Kemptville Creek Subwatershed Report, please visit the RVCA website at www.rvca.ca

What's Inside

Catchment Facts

General Geography

- Mud Creek catchment is rural in character with agriculture being the predominant land use



- Ninety-two percent of the catchment lies within the Township of Elizabethtown-Kitley, six percent within Augusta Township and two percent within the Township of Athens

Physical Geography

- Bedrock is overlain by thin glacial till or glacial drift or by organic muck and peat under the reaches of Mud Creek. Across the upper reaches of the catchment, the Smith Falls Limestone Plain consists of layers of quartz sandstone, sandy dolostone and dolostone of the March Formation; across the lower reaches, it consists of thinner layers of shale and sandstone of the Oxford Formation Dolostone.
- The drainage area of 120 square kilometres is about 26 percent of the Kemptville Creek Subwatershed and three percent of the Rideau Valley Watershed
- Dominant land cover is crop and pastureland (38 percent) followed by woodland (29 percent) and wetlands (27 percent). Settlement areas (four percent) and transportation (two percent) occupy the rest of the landscape

Vulnerable Areas

- Flood plain mapping has been available along Mud Creek since 2009 and regulated since then
- Shallow bedrock, especially in areas with very thin soils, is mapped as highly vulnerable to land use activities

Development Trends

- Very limited development activity has taken place in recent years

Conditions at a Glance

- Water quality rating along Mud Creek is "Fair" and has declined at a site upstream of North Augusta, above the County Road 6 crossing, over a 12 year reporting period (2001–2006 vs. 2007–2012)

- Woodland cover proportion has decreased by three percent (364 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 Mud Creek and its tributaries) is made up of wetland (63 percent), crop and pastureland (17 percent), woodland (17 percent), transportation (two percent) and settlement areas (one percent).
- A warm/cool water baitfish and recreational fishery of 13 fish species is present.

Catchment Care

- Eleven stewardship projects (Rural Clean Water/Tree Planting) have been completed (from 1993 to 2012).
- Fish sampling conducted on Mud Creek (RVCA, 2011).
- Annual benthic macroinvertebrate sampling downstream of County Road 6 since 2003 (RVCA).
- RVCA macro stream surveys in 2011, working upstream from North Augusta taking measurements and recording observations on instream habitat, bank stability, other attributes and preparing a temperature profile.
- MOE well records show there are about 560 water wells in the catchment (20 percent of all wells in the Kemptville Creek Subwatershed),
- Permits to Take Water are held by the United Counties of Leeds and Grenville for construction dewatering associated with the Mayhew Bridge works and by Ducks Unlimited for wildlife habitat conservation.
- 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 Mud Creek catchment.

1. Mud 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 Kemptville 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 rating for Kemptville Creek within the Mud Creek catchment is "Fair" (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 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 Kemptville Creek within the Mud Creek catchment.

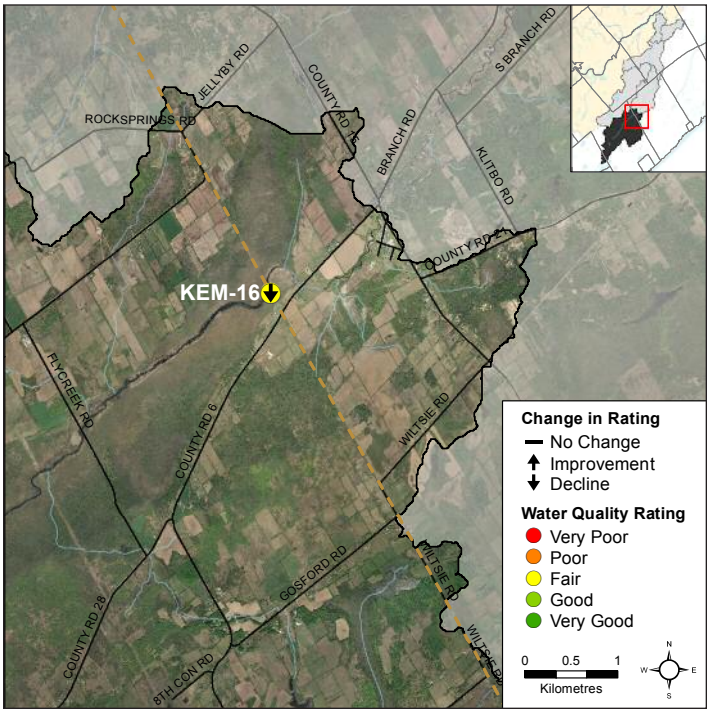


Figure 1 Water quality in Mud Creek. The rating shown on the map is for the 2007–2012 period. Arrows are used to show a change in the rating from the 2001–2006 period

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 Mud Creek from 2001–2006 and 2007–2012

Sampling Site	Nearest intersection	2001-2006	Rating
KEM-16	County Rd. 20 and County Rd. 18	80	Good
Sampling Site	**Nearest intersection**	**2007-2012**	**Rating**
KEM-16	County Rd. 20 and County Rd. 18	53	Fair

Mud 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 loadings. RVCA uses a guideline of 0.500 mg/l assess TKN[1] and the PWQO of 0.020 mg/l to assess NH_3 concentrations in Mud Creek.

Tables 3, 4 and 5 summarize average nutrient concentrations at the monitored site in this catchment and show the proportion of results that meet the guidelines.

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

Total Phosphorus 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.021	83%	30
Total Phosphorus 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.036	69%	39

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

Total Kjeldahl Nitrogen 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.798	20%	30
Total Kjeldahl Nitrogen 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.923	5%	39

Table 5 Summary of ammonia results for Kemptville Creek from 2001–2006 and 2007–2012

Ammonia 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.009	90%	30
Ammonia 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-16	0.011	87%	39

Mud 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

KEM-16

Site KEM-16 is the only site monitored within the Mud Creek catchment. Eighty-three percent of samples were below the guideline in the 2001–2006 period (Figure 2a) and declined to 69 percent of samples in the 2007–2012 period (Figure 2b). Average TP concentration increased from 0.021 mg/l (2000–2005) to 0.036 mg/l (2006-2011) throughout this time period.

TKN results show that the bulk of results exceeded the guideline of 0.500 mg/l (Figures 3a and 3b), 20 percent of samples were below the guideline in the 2001-2006 period and declined to five percent in the 2007–2012 period. The average concentration increased from 0.798 mg/l to 0.923 mg/l. NH_3 results were generally below the guideline (Figures 4a and 4b). The proportion of samples below the guideline declined slightly from 90 percent (2001–2006) to 87 percent (2007–2012). An increase was also observed in the average concentration which increased from 0.009 mg/l (2001–2006) to 0.011 mg/l (2007-2012).

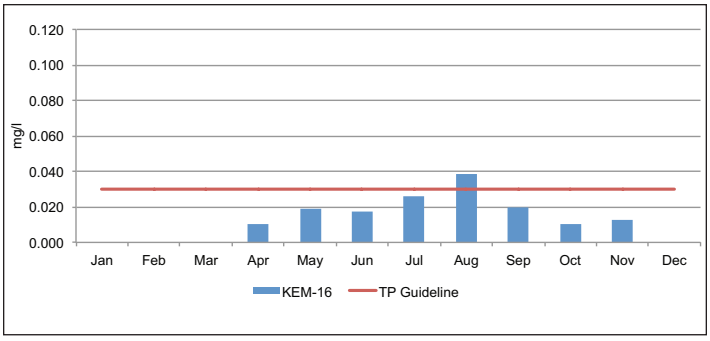


Figure 2a Total phosphorus concentrations in Mud Creek from 2001–2006

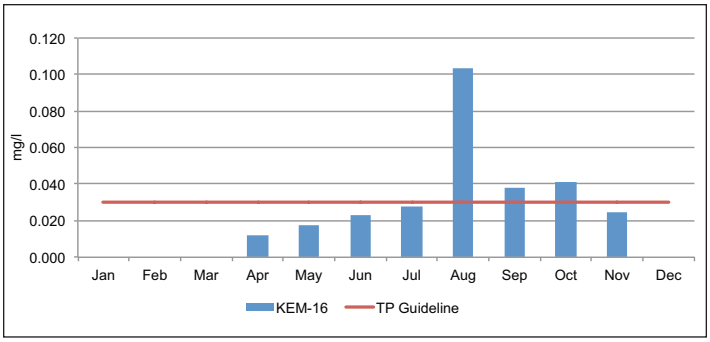


Figure 2b Total phosphorus concentrations in Mud Creek from 2007–2012

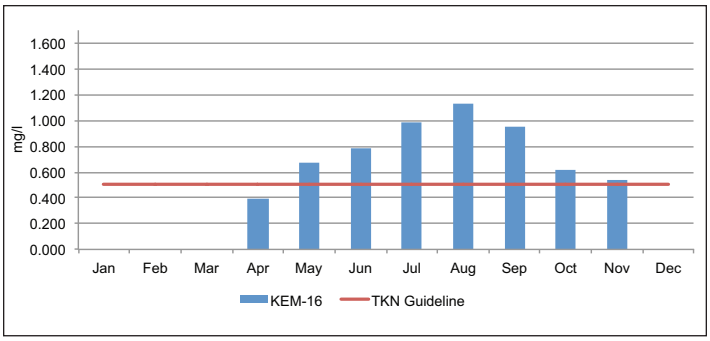


Figure 3a Total Kjeldahl nitrogen concentrations in Mud Creek from 2001–2006

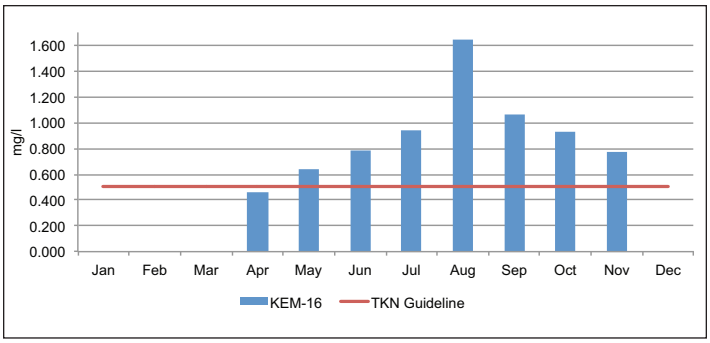


Figure 3b Total Kjeldahl nitrogen concentrations in Mud Creek from 2007–2012

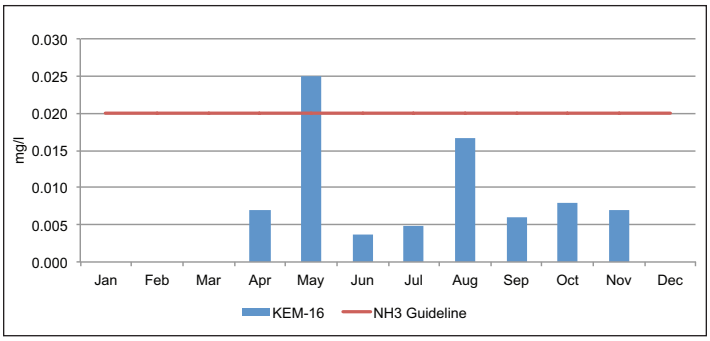


Figure 4a Ammonia concentrations in Mud Creek from 2001–2006

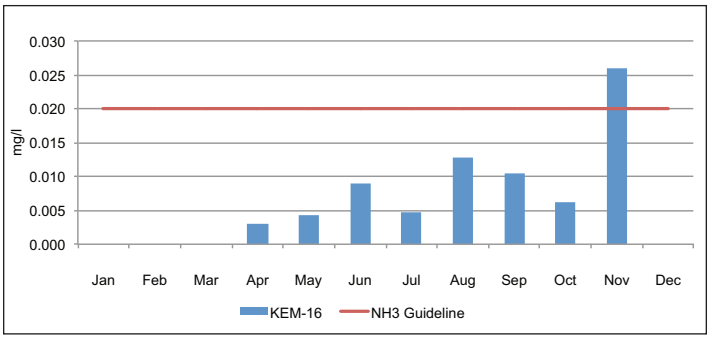


Figure 4b Ammonia concentrations in Mud Creek from 2007–2012

Mud Creek Nutrients Summary

The data shows that nutrient enrichment continues to be a concern in this catchment. Water quality guidelines for TP and NH_3 are generally met. However, TKN concentrations are elevated with frequent exceedances across all sites and may be influenced by the organic matter held by the large wetland areas within the catchment, resulting in naturally high concentrations of organic nitrogen.

Mud 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 millilitres (CFU/100 ml) is used. *E. coli* counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody. The KCWP also set a target of *E. coli* counts of 100 CFU/100 ml at the 70th percentile.

Table 6 summarizes the geometric mean[2] at monitored sites on Mud 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 and 2007–2012. Figure 6 shows percentile plots of the data for the two time periods of interest. Any point to the left of the 70th percentile line (vertical) and above the guideline (horizontal line) has failed to reach the KCWP target.

KEM-16

E. coli counts at site KEM-16 show increase in regard to bacterial counts. Counts at the 70th percentile increased from 84 CFU/100 ml (Figure 6a) to 150 CFU/100 ml (Figure 6b). The proportion of samples below the guideline decreased from 72 percent to 54 percent (Figures 5a and 5b), and the count at the geometric mean increased from 53 CFU/100 ml to 76 CFU/100 ml.

E.coli Summary

The results indicate that bacterial contamination continues to be a concern at this site. The target set by the KCWP has not been achieved, the proportion of samples below guideline decreased and there was an increase in the count at the geometric mean.

Table 6 Summary of *E. coli* results for Mud Creek 2001–2006 and 2007–2012

***E. coli* 2001–2006**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-16	53	72%	29
***E. coli* 2007–2012**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-16	76	54%	39

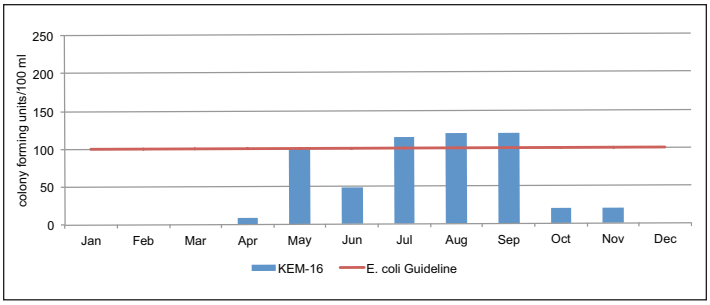


Figure 5a *E. coli* counts in Mud Creek from 2001–2006

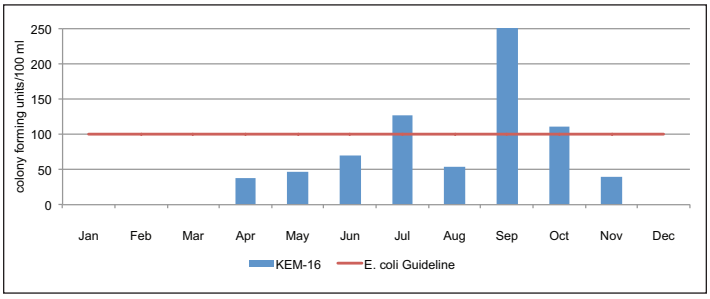


Figure 5b *E. coli* counts in Mud Creek from 2007–2012

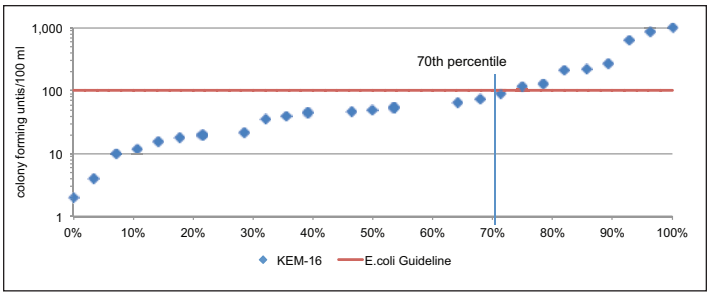


Figure 6a Percentile plots of *E. coli* in Mud Creek for 2001–2006

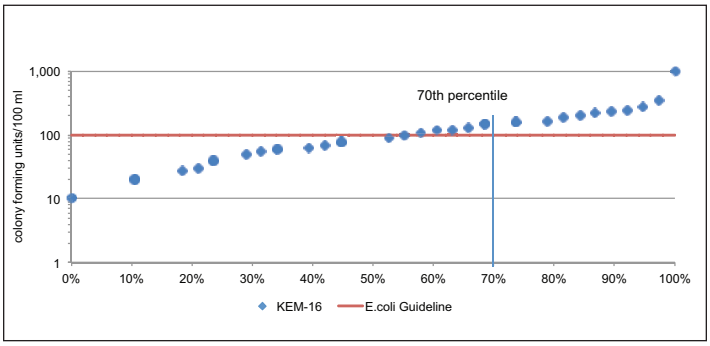


Figure 6b Percentile plots of *E. coli* in Mud Creek for 2007–2012

[2] 2A 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. Mud Creek Riparian Conditions

MUD CREEK OVERBANK ZONE

Riparian Buffer Width Evaluation

Figure 10 shows the extent of the naturally vegetated riparian zone in the catchment, 30 metres on either side of all water bodies and watercourses. Results from the RVCA's Land Cover Classification Program show that 79 percent of rivers, streams and creeks are buffered with woodland, and wetland; the remaining 21 percent of the riparian buffer is occupied by settlement, transportation and crop and pastureland.

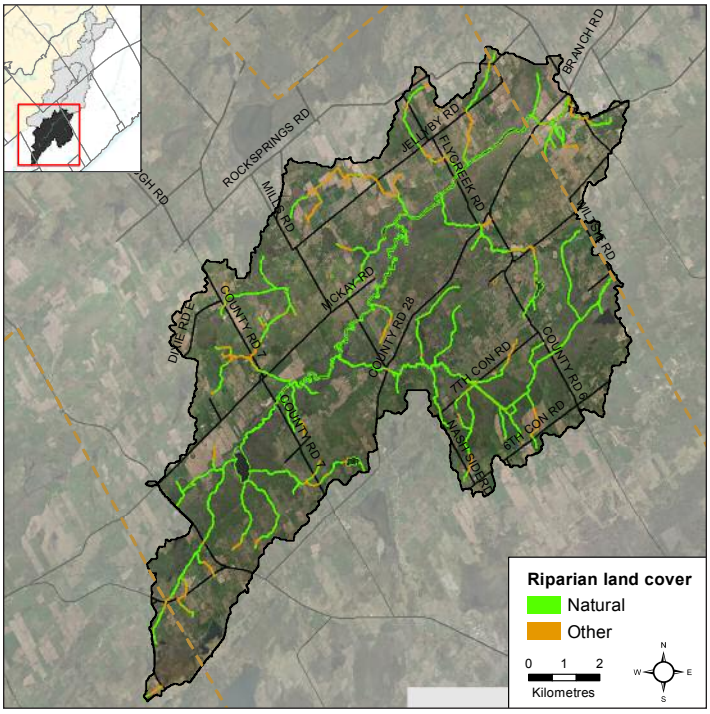


Figure 10 Natural and other riparian land cover along Mud Creek

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 11 demonstrates the buffer conditions of the left and right banks separately. Mud Creek had a buffer of greater than 30 metres along 100 percent of the right and left bank.

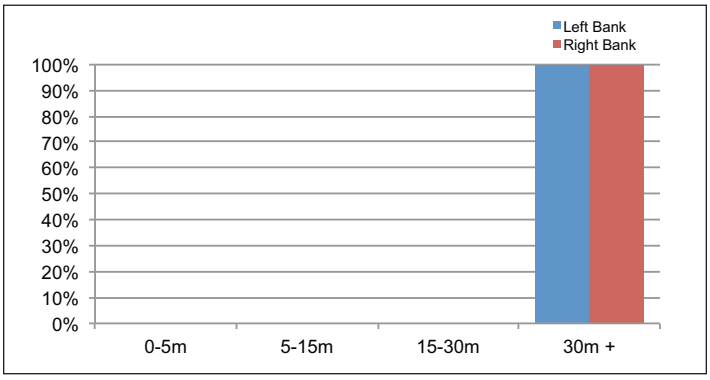


Figure 11 Riparian Buffer Evaluation along Mud Creek

Adjacent Land Use

The RVCA's Macro Stream Survey Program identifies eight different land uses beside Mud Creek (Figure 12). Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m 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 17 percent of the stream, characterized by forest, scrubland and wetland. The remaining land use consisted of agriculture, residential, pasture, infrastructure, and industrial/commercial.

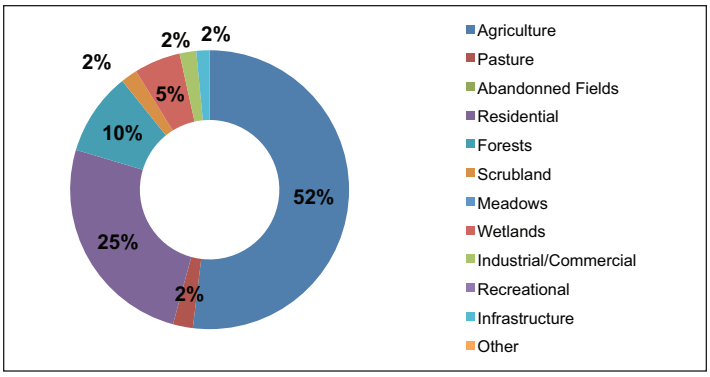


Figure 12 Land Use along Mud Creek

10 percent of Mud Creek is forested

MUD 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 that there was high levels of bank erosion observed on the left and right bank along Mud 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 Mud Creek had moderate to high levels of undercut banks.

Mud Creek has moderate to high levels of undercut stream banks

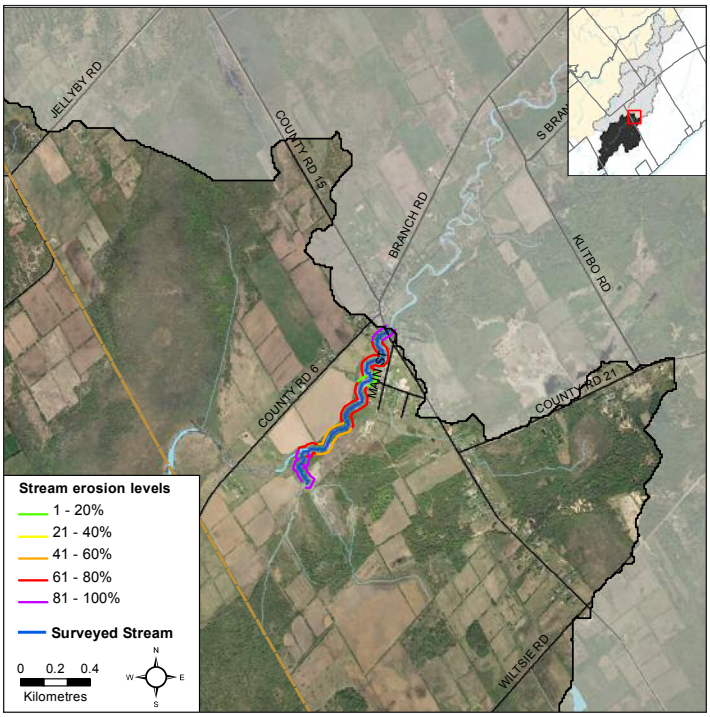


Figure 13 Erosion along Mud Creek.

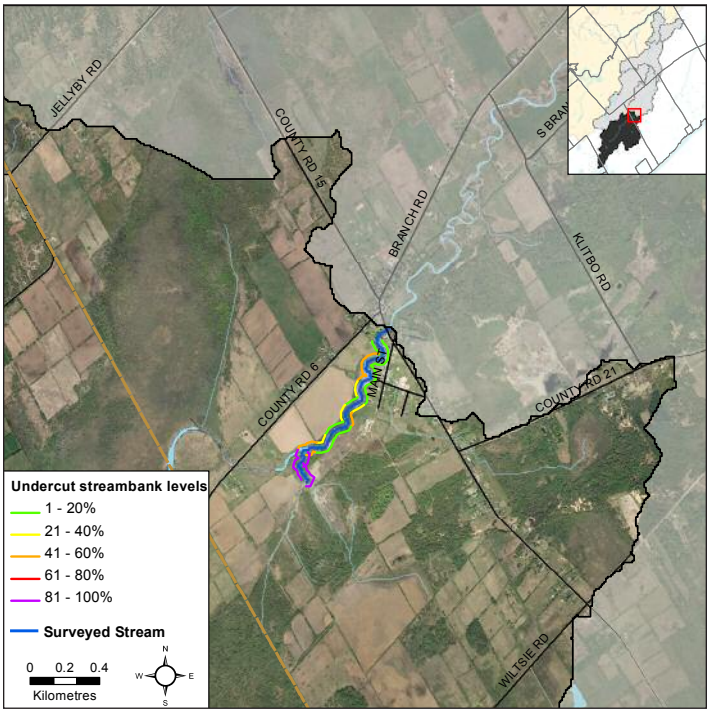


Figure 14 Undercut stream banks along Mud Creek.

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 the stream shading locations along Mud Creek.

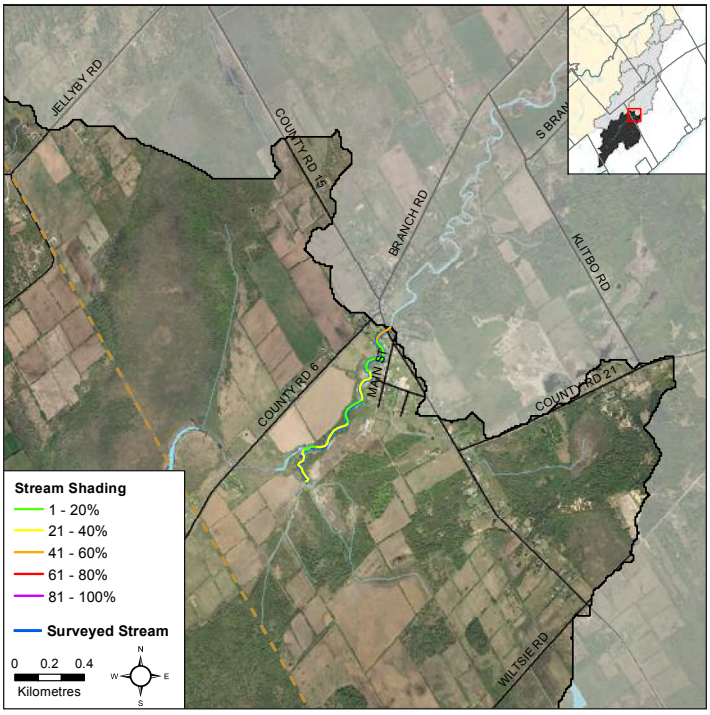


Figure 15 Stream shading along Mud Creek

Instream Woody Debris

Figure 16 shows that Mud Creek had no 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.

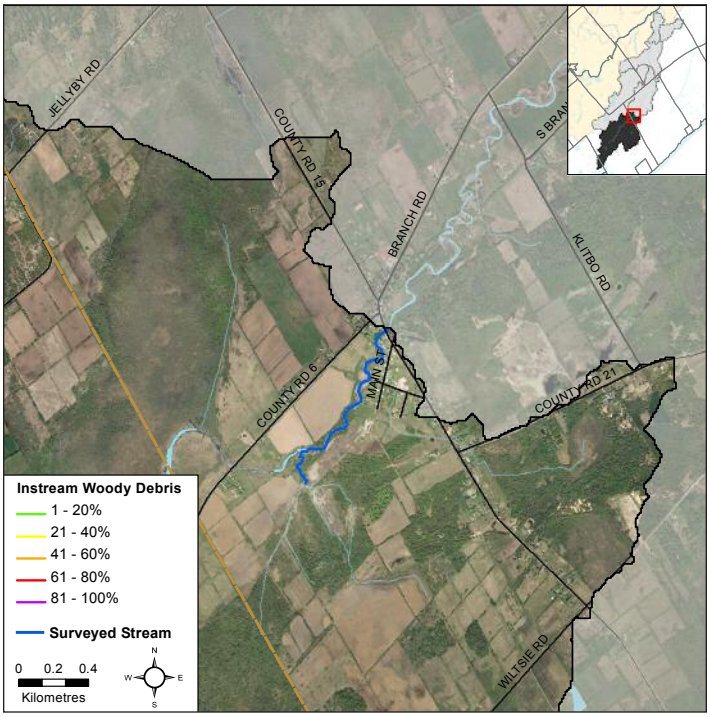
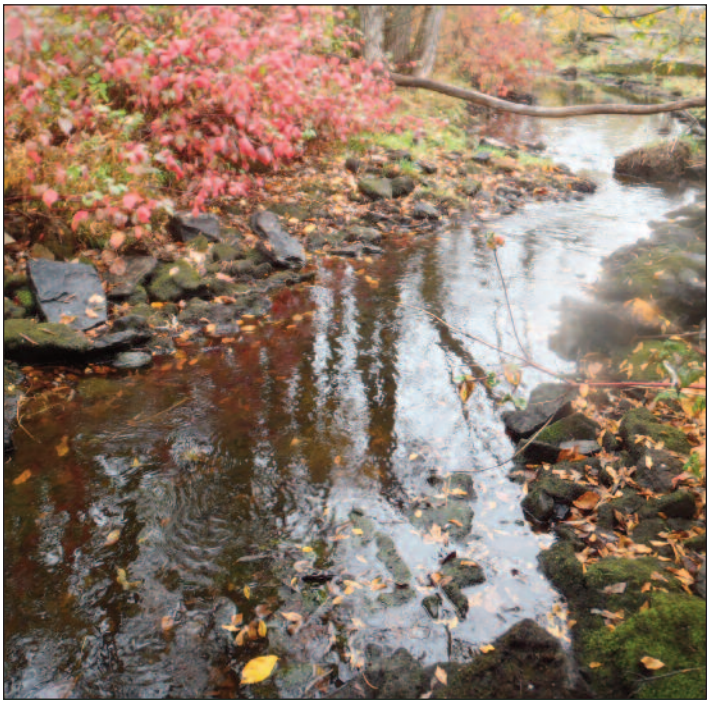


Figure 16 Instream woody debris along Mud Creek

Stream shading on Mud Creek



Mud Creek has limited instream woody debris

Overhanging Trees and Branches

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

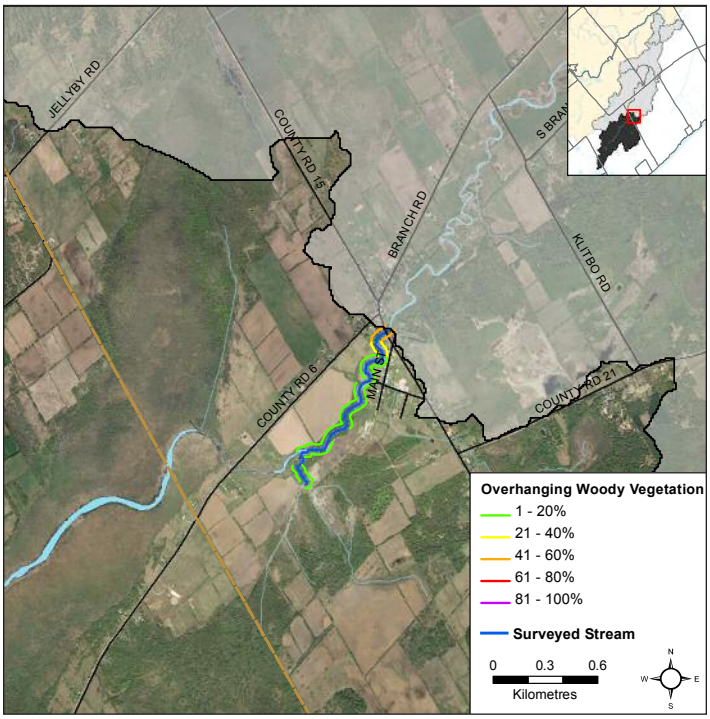


Figure 17 Overhanging trees and branches along Mud Creek

Mud Creek has low to moderate levels of overhanging branches

Anthropogenic Alterations

Figure 18 shows 77 percent of Mud Creek remains “not altered.” Sections considered “natural” with some human changes account for 8 percent of sections. "Altered" sections accounted for 15 percent of the stream, with no sections sampled being considered “highly altered.” Areas classified as altered included existing road crossings and shoreline modifications.

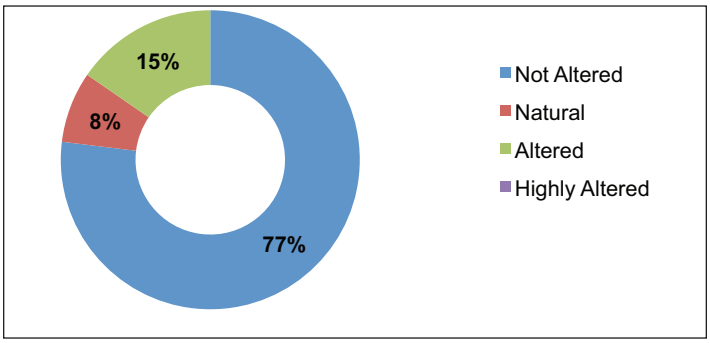


Figure 18 Anthropogenic alterations along Mud Creek

Man-made alterations along Mud Creek

MUD 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 this location on Mud Creek at County Road 6 since 2003. Monitoring data is analyzed and the results are presented using the Family Biotic Index, Family Richness and percent Ephemeroptera, Plecoptera and Trichoptera.

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 Mud Creek show that it has "Poor" water quality conditions 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 the samples are dominated by species that are moderately tolerant and tolerant to poor water quality conditions. Using Family Richness as the indicator, Mud 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 Mud Creek is reported to have "Poor" water quality (Figure 21) from 2007 to 2012.

Conclusion

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

Benthic invertebrate sampling

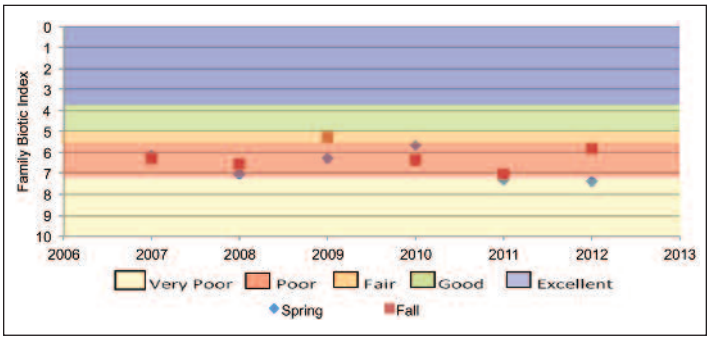


Figure 19 Hilsenhoff Family Biotic Index on Mud Creek

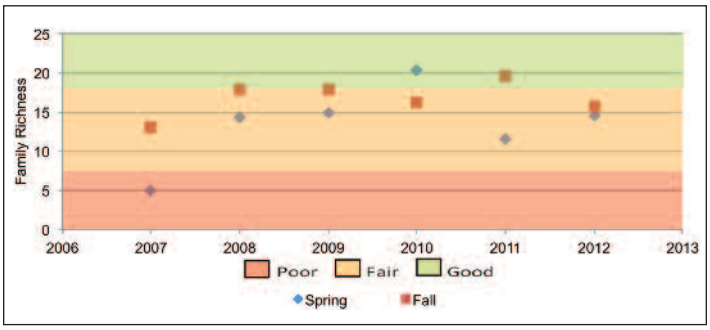


Figure 20 Family Richness in Mud Creek

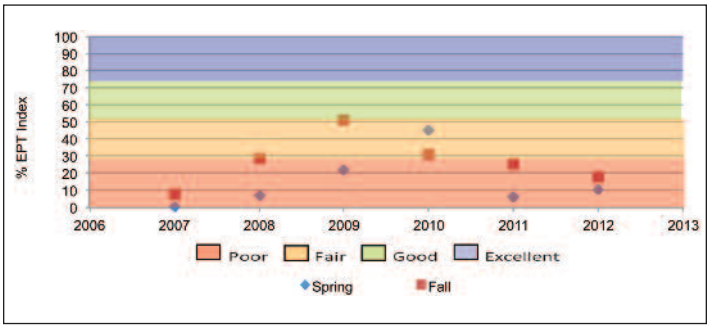


Figure 21 EPT in Mud Creek

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. One hundred percent of Mud Creek was considered heterogeneous, as shown in Figure 22.

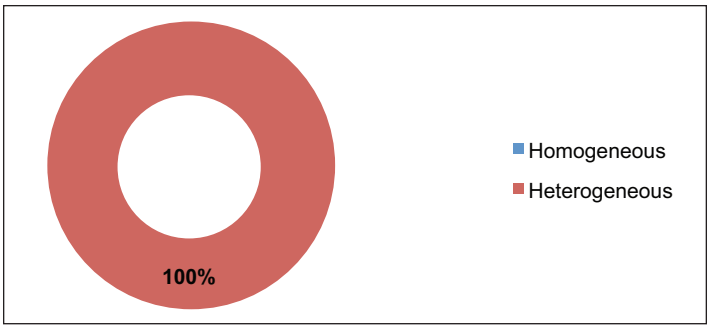


Figure 22 Habitat complexity along Mud Creek

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 Mud 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).

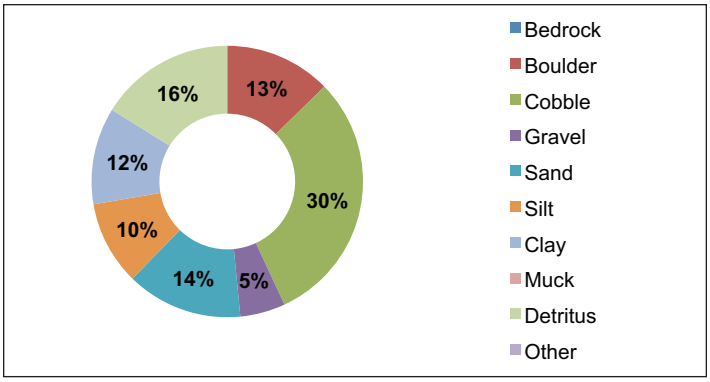


Figure 23 Instream substrate along Mud Creek

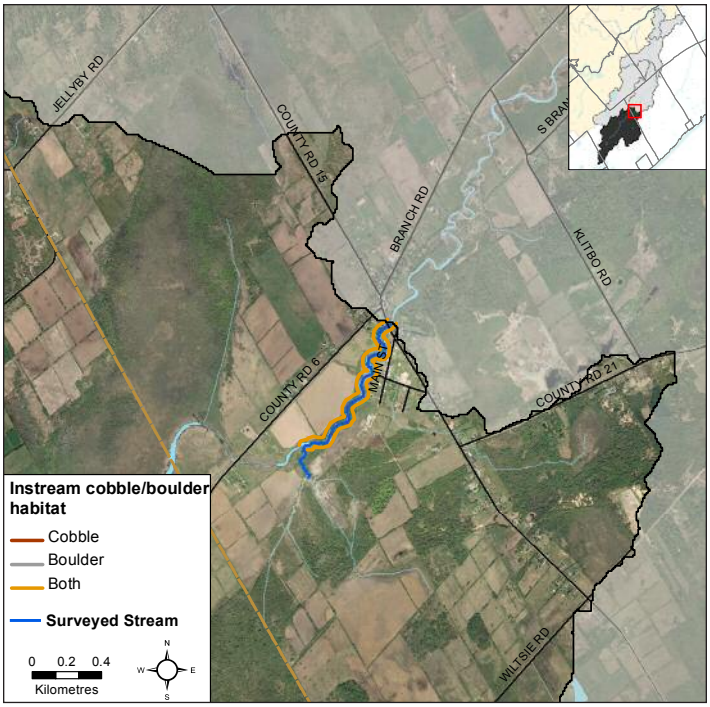


Figure 24 Instream substrate along Mud Creek.

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 Mud Creek is highly variable; 61 percent consists of runs, 13 percent pools and 26 percent riffles.

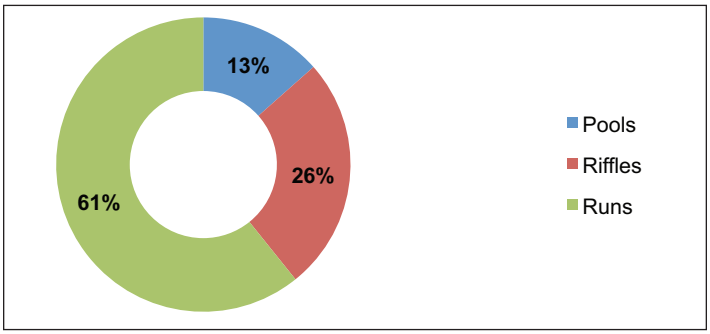


Figure 25 Instream morphology along Mud Creek

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. Mud Creek had limited diversity of instream vegetation. The dominant vegetation type recorded at sixty percent consisted of algae. Figure 26 depicts the plant community structure for Mud Creek.

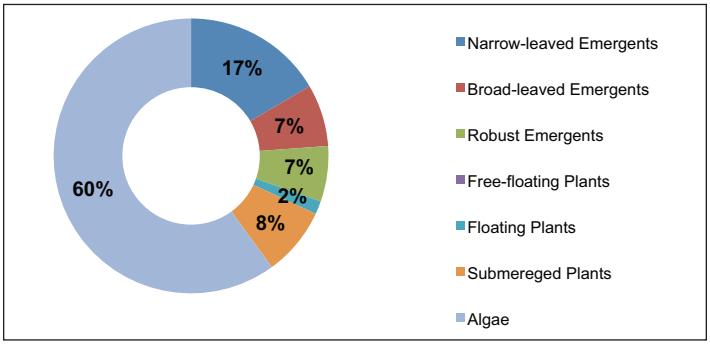


Figure 26 Vegetation type along Mud Creek

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 26 demonstrates that Mud Creek has low levels of instream vegetation for most of its length.

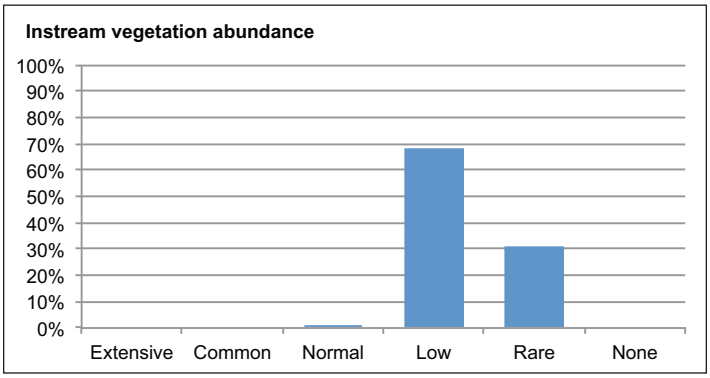


Figure 27 Instream vegetation abundance along Mud Creek

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. Eighty-five percent of the sections surveyed along Mud Creek had invasive species (Figure 28). The invasive species observed in Mud Creek were European frogbit and purple loosestrife.

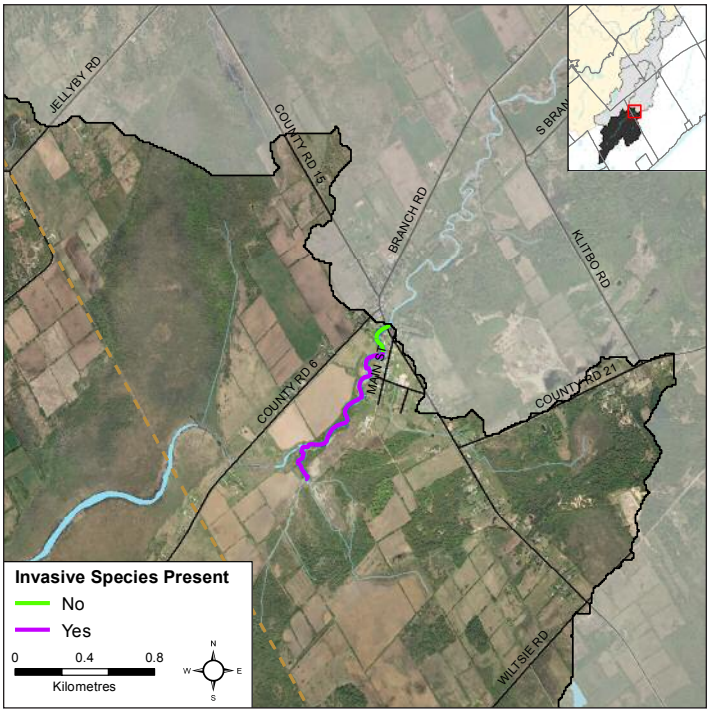


Figure 28 Invasive species along Mud Creek

European frogbit is an invasive found on Mud Creek

Fish Sampling

Fish sampling sites located along Mud Creek are shown in Figure 29. The provincial fish codes shown on the preceding map are listed (in Table 10) beside the common name of those fish species identified in Mud Creek. Mud Creek is classified as a warm/cool water recreational and baitfish fishery with 13 species observed.

Table 10 Fish species identified in Mud Creek

Species observed in Kemptvlle Creek (with fish code)			
bluegill	Blueg	longnose dace	LnDac
central mudminnow	CeMud	mottled sculpin	MoScu
common shiner	CoShi	northern redbelly dace	NRDac
etheostoma sp.	EthSp	pumpinkseed	Pumpk
fallfish	FallF	rock bass	RoBas
fathead minnow	FhMin	slimy sculpin	SlScu
golden shiner	GoShi	white sucker	WhSuc

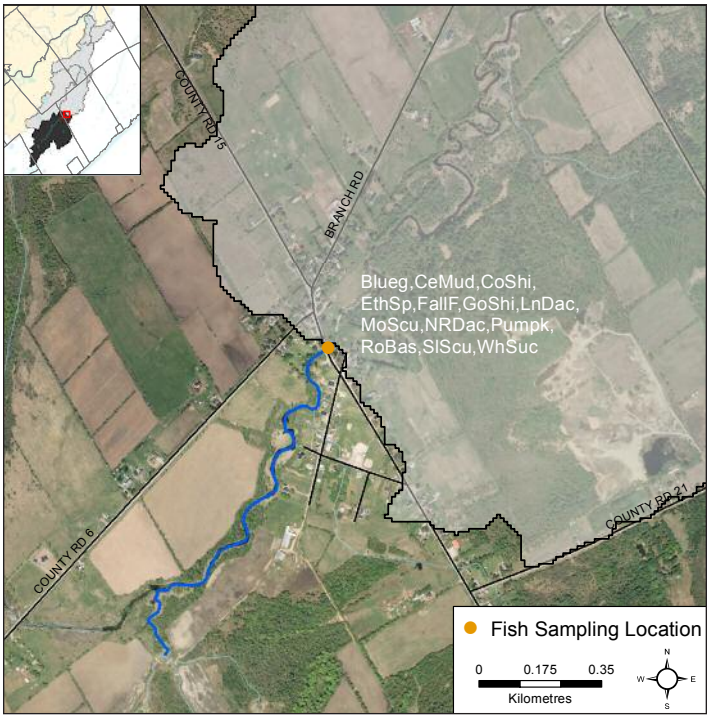


Figure 29 Fish sampling along Mud Creek

Riparian Restoration

Figure 30 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

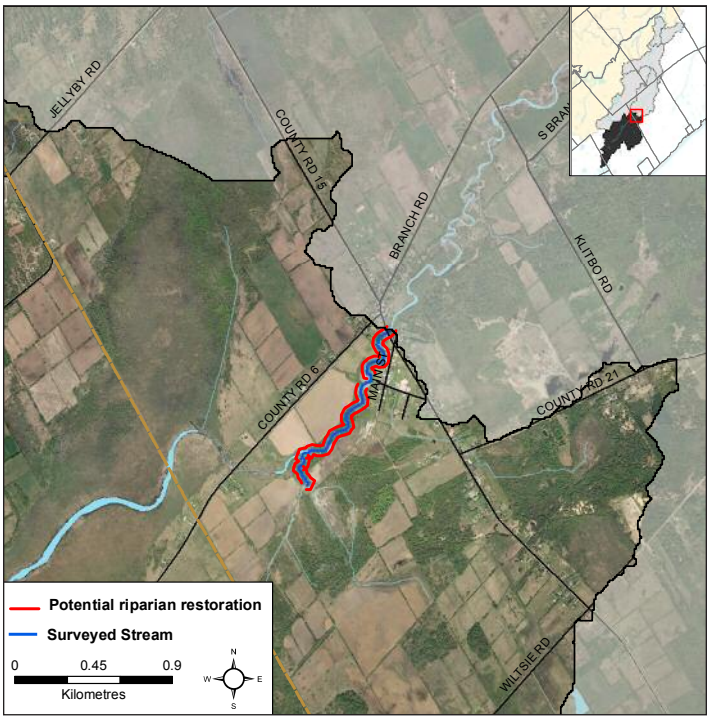


Figure 30 Riparian restoration along Mud Creek

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 1 (most acidic) to 14 (most alkaline/basic), with 7 occupying a neutral point. 2011 data for these four parameters is summarized in Table 11.

Table 11 Water chemistry in Mud 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	835	8.2

3. Land Cover

Crop and pastureland 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)
Crop & Pasture	4,593	38
Woodland*	3,461	29
Wetland**	3,250	27
Settlement	489	4
Transportation	220	2

Woodland Cover

The Mud Creek catchment contains 3461 hectares of upland forest and 577 hectares of lowland forest (treed swamps) (Figure 31) that occupies 34 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.

One hundred and ten (41 percent) of the 266 woodland patches in the catchment are very small, being less than one hectare in size. Another 121 (46 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 35 (13 percent of) woodland patches range between 22 and 317 hectares. Twenty-four 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, 11 (four percent) of the 266 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. Six 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 266 woodlands contain 47 forest interior patches (Figure 31) that occupy seven percent (816 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 (32) have less than 10 hectares of interior forest, 15 of which have small areas of interior forest habitat less than one hectare in size. Another seven patches contain between 10 and 30 hectares of interior forest. Conversely, eight patches have greater than 30 hectares of interior forest, with two patches exceeding 100 hectares (at 118 and 123 hectares).

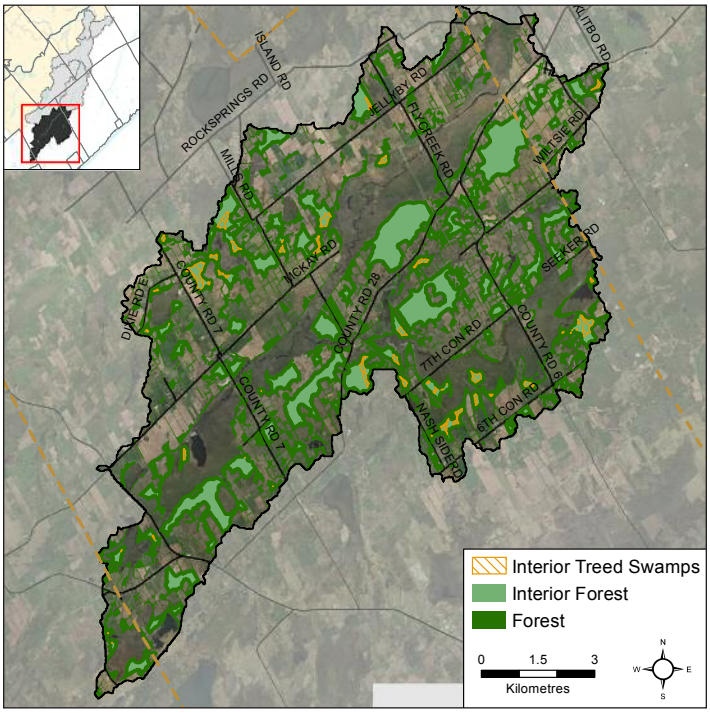
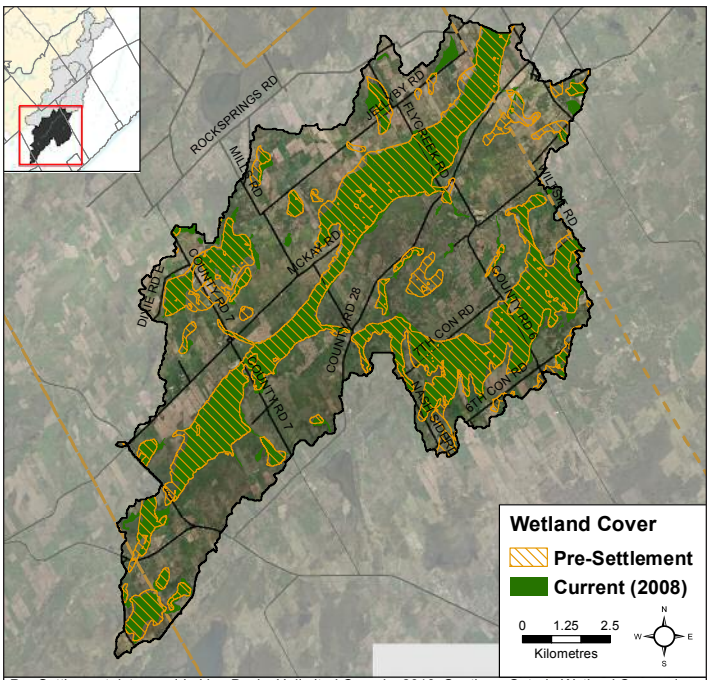


Figure 31 Catchment woodland cover and forest interior

Wetland Cover

Figure 32 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 32 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 33 shows the location of all Rural Clean Water Projects in the Mud Creek drainage area. From 2007 to 2012, landowners completed two projects: one septic system repair/replacement and one education initiative. RVCA contributed $3,000 in grant dollars towards the total project cost of $12,075.

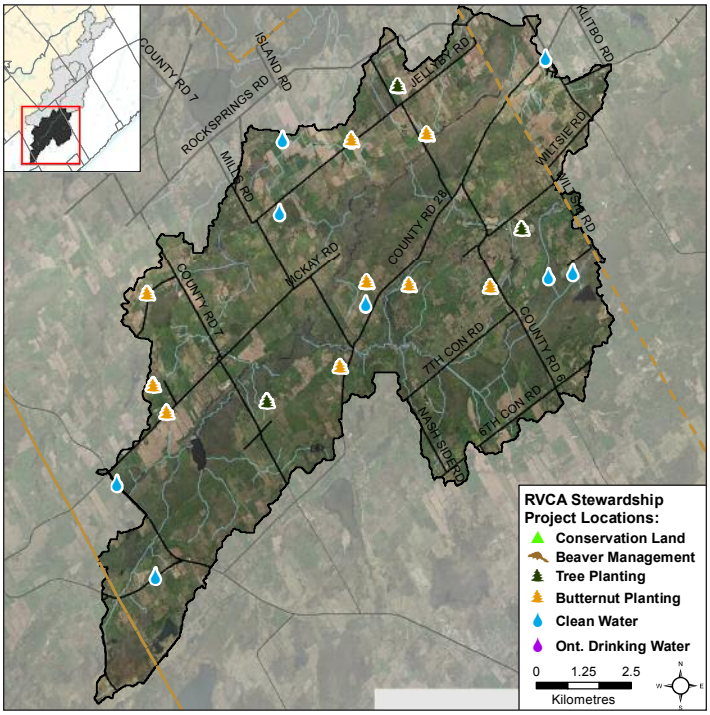


Figure 33 RVCA stewardship program project locations

Prior to 2007, the RVCA completed six projects in the area consisting of one septic system repair/ replacement, one well upgrade, one well decommissioning, one livestock water fencing restriction, one manure storage facility and one surface/wastewater disposal/treatment system. In total, RVCA contributed $20,813 in grant dollars to projects valued at $55,065.

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 33. From 2007 to 2012, 60,450 trees were planted on two sites through the RVCA Tree Planting Program. Project value is $107,687 with $59,581 of that amount coming from other fundraising sources.

Before that, landowners helped plant 26,700 trees, valued at $58,428, on one project site, using the RVCA Tree Planting Program; fundraising dollars accounted for $32,581 of that amount.

Valley, Stream, Wetland and Hazard Land Regulation

Thirty-seven square kilometres or 31 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 34), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

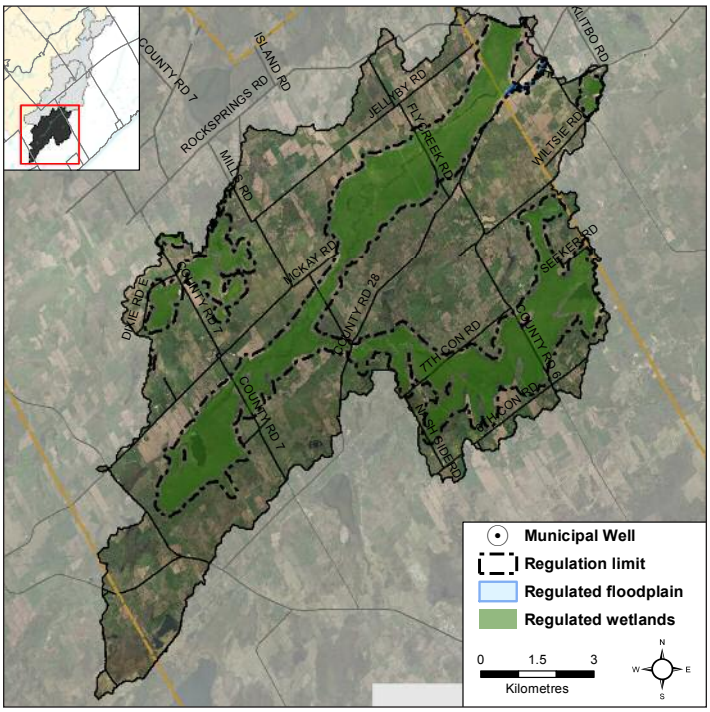


Figure 34 RVCA regulation limits

RVCA's Tree Planting Program at work

5. Issues

- Surface water quality along Mud Creek is "Fair" as determined by surface water chemistry data and has declined at a site upstream of North Augusta, above the County Road 6 crossing, over a 12 year reporting period. Benthic invertebrate data indicates "Poor" aquatic water quality conditions at the same location. Exceedances of *E. coli,* total Kjeldahl nitrogen and total phosphorus above surface water quality guidelines are largely responsible for this change
- There are flood susceptible areas adjacent to Kemptville Creek as identified by the RVCA's Kemptville Creek Floodplain Mapping Study (2009). Although private property extends into the flood risk area, most development is located outside the floodplain due to past (and ongoing) efforts to minimize landowner exposure to natural hazards by regulating development in the floodplain. Regulations administered by the RVCA have been in place around wetlands since 2006 and along the creek since 2009
- The catchment contains 881 hectares of unevaluated wetland (occupying seven percent of its total area) that provides many important social, hydrological, biological and ecological functions/services. Although not under imminent threat from development activity, they do remain vulnerable to drainage and land clearing activities in the absence of any regulatory and planning controls that would otherwise protect them

6. Opportunities for Action

- Investigate cause of "Fair" surface water quality rating along Kemptville Creek. Reported decline (from "Good" to "Fair") in the rating may be attributed to sources such as upstream water quality, land use conversion, wetland cover change and wildlife activity within the catchment. Further study is necessary to better understand the contributing factors
- 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 floodplain along Mud Creek and the Provincially Significant Wetlands found in the catchment (i.e., the Charleville Creek Wetland Complex, Greenbush Wetland Complex and Mud Lake and Creek Wetland)
- Target riparian restoration at areas shown in Figure 30 (to address minimal shoreline buffers and identified erosion sites)
- Consider establishing RVCA regulations limits in areas of unevaluated wetlands subject to site alteration
- Work with landowners to implement agricultural best management practices and pursue improvements to the riparian corridor along Mud Creek and tributaries (by increasing buffers through reforestation/riparian plantings and invasive species removal)
- 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