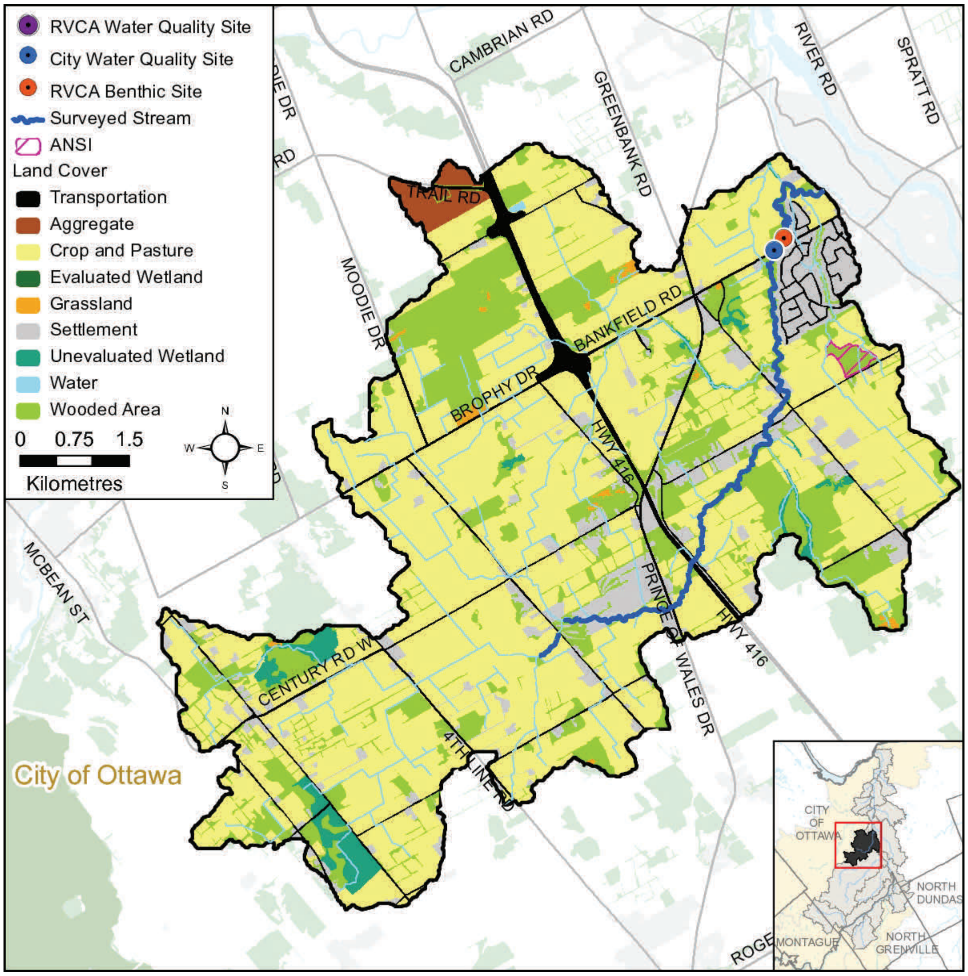
MUD CREEK CATCHMENT

LOWER RIDEAU RIVER SUBWATERSHED REPORT 2012

RIDEAU VALLEY CONSERVATION AUTHORITY



The RVCA produces individual reports for 16 catchments in the Lower Rideau 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 Lower Rideau catchments and the Lower Rideau Subwatershed Report, please visit the RVCA website at www.rvca.ca.

Inside

Catchment Facts

- A mostly rural, agricultural watershed with some suburban development occurring in its most downstream reaches near the Village of Manotick
- The creek and its numerous tributaries are comprised of a combination of channelized and natural meandering features along with a well-defined ravine downstream of Bankfield Road
- Flood plain mapping of the main branch of Mud Creek from First Line Road to the Rideau River has been completed within studies related to urbanization within and adjacent to the Village of Manotick, but has generally not been undertaken upstream of First Line Road. Flooding under 1:100 year conditions will be contained within the watercourse's well-defined valley, in the reach where maping is available
- Erosion and related valley wall instability has been the primary constraint for new development and factored into the establishment of separation distances between new development and the creek/valley system
- RVCA enforces only the "alterations to waterways provisions" of O. Reg. 174/06, as regulation limits mapping of Mud Creek has not been prepared
- Drains 52 sq. km of land or 6.8% of the Lower Rideau Subwatershed and 1.2% of the Rideau Valley Watershed
- Dominant land cover is crop and pastureland (64%), woodland (19%), settlement (10%), transportation (4%) wetland (2%) and aggregate site (1%)
- Riparian buffer (30 m. wide along both sides of Mud Creek and its tributaries) is comprised of crop and pastureland (61%), woodland (21%), transportation (7%), wetland (5%), settlement (5%) and grassland (1%)
- Contains a cold/cool water recreational and baitfish fishery with 20 fish species
- Contains 34 municipal drains
- Water quality rating is poor along Mud Creek and has declined over a 12 year reporting period (2000-2005 vs. 2006-2011)
- Woodland cover has decreased by 1.5 percent (81 ha.) from 2002 to 2008
- Seventy-four stewardship (landowner tree planting/clean water/shoreline naturalization) projects have been completed
- Major studies completed include: Manotick Master Drainage Plan. 1996 (Robinson Consultants for Rideau Township); Jock River Reach 2 and Mud Creek Subwatershed Study: Existing Conditions Report. Vol. 1. Draft. 2005 (Marshall Macklin Monaghan for the City of Ottawa); Village of Manotick Environmental Management Plan: Special Design Area Component. 2005 (Marshall Macklin Monaghan and WESA)
- Between 2003 and 2008, fish sampling has been conducted on Mud Creek and its tributaries by the City Ottawa, City Stream Watch, volunteers and consultants for development related initiatives
- Since 2003, the RVCA has conducted benthic macroinvertebrate sampling downstream of Bankfield Road; in 2003 and 2009, volunteers undertook macro stream surveys along Mud Creek; also in 2008, RVCA staff undertook temperature profiling to gain a better understanding of temperature and habitat variations in the creek

1) Surface Water Quality

Assessment of streams in the Lower Rideau is based on 24 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen, nitrates), 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 Lower Rideau Subwatershed also looks at water quality targets that are presented in the 2005 Lower Rideau Watershed Strategy (LRWS), to see if they are being met. The LRWS identifies improving water quality as a priority concern; specifically reducing the levels of nutrients, bacteria and contaminants in the Lower Rideau.

1) a. Mud Creek

Surface water quality conditions in Mud Creek are monitored through the City of Ottawa's Baseline Water Quality Program. (downstream side of Bankfield Road bridge, see Fig. 1 for the location)

The water quality rating for Mud Creek ranges from "Fair" in the 2000-2005 period to "Poor" in the 2006-2011 period as determined by the CCME Water Quality Index (CCME WQI); analysis of the data has been broken into two periods 2000-2005 and 2006-2011, to examine if conditions have changed in this timeframe. Table 1 outlines the WQI scores and their corresponding ratings

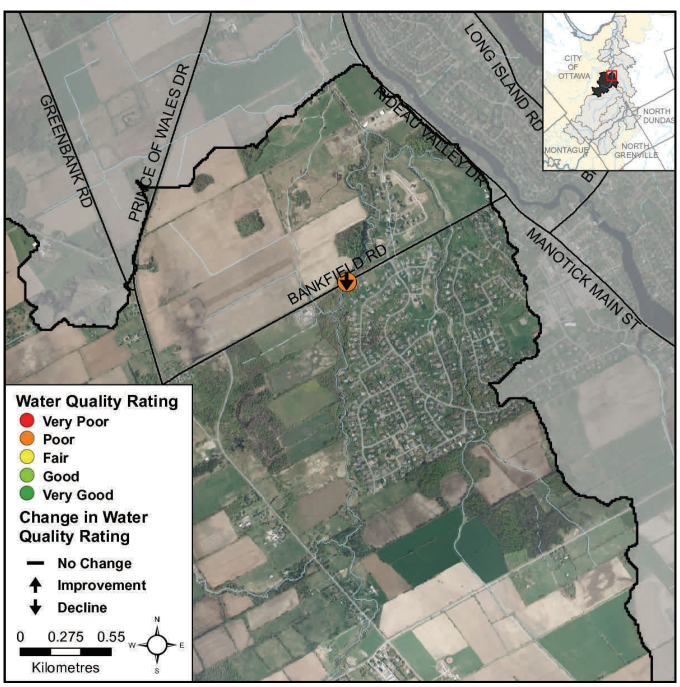


Figure 1. Sample site for Mud Creek

For more information on the CCME WQI please see the Lower Rideau Subwatershed Report.

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

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 Objectives (PWQO) of 0.030mg/l is used as the TP Guideline. Concentrations greater than 0.030 mg/l indicate an excessive amount of TP. Mud Creek TP results are shown in Figures 2a and 2b. In addition to the TP guideline,the Lower Rideau Watershed Strategy also set a target for TP concentration of 0.030 mg/l at the 85th percentile for tributaries of the Rideau River, such as Mud Creek. Percentile plots for this data are shown in Figures 3a and 3b. Any point to the left of the 85th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target.

Total Kjeldahl nitrogen (TKN) is used as a secondary indicator of nutrient loading; RVCA uses a guideline of 0.500 mg/l (TKN Guideline) to assess TKN concentrations. Mud Creek TKN results are shown in Figures 4a and 4b.

Tables 2 and 3 summarize average nutrient concentrations at monitored sites on Mud Creek and shows the proportion of samples that meet guidelines. Highlighted values indicate averages that exceeded guideline

Table 2. Summary of total phosphorous results for Mud Creek

Total Phosphorus 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK41-01	0.052	43	53
Total Phosphorus 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK41-01	0.047	29	52

Table 3. Summary of total Kjeldahl nitrogen results for Mud Creek from 2000-2005 and 2006-2011

Total Kjeldahl Nitrogen 2000-2005			
Site	Average (mg/l)	% Below	No. Samples
CK41-01	0.670	26	53
Total Phosphorus 2006-2011			
Site	Average (mg/l)	% Below	No. Samples
CK41-01	0.683	15	52

Mud Creek Nutrients: Site CK41-01

Total phosphorus (TP) concentrations at site CK41-01 on Mud Creek were frequently elevated and often exceeded the guideline of 0.030 mg/l. The proportion of samples below the guideline decreased over the time periods of interest from forty-three percent (Fig. 2a, 2000-2005) to only twenty nine percent (Fig. 2b. 2006-2011). Though the frequency of exceedances increased there has a slight decline in average TP concentrations 0.052 mg/l (2000-2005) to 0.047 mg/l (2006-2011). Percentile plots of TP data at site CK41-01 in Figures 3a, 2000-2005 and 3b, 2006-2011. These figures show that the target is not achieved at this site though TP concentration at the 85th percentile have declined from 0.067 mg/l to 0.052 mg/l.

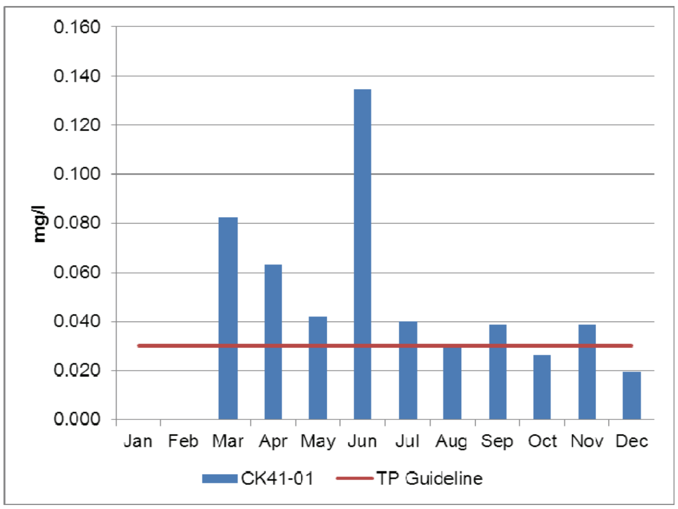


Figure 2a. Total phosphorous concentrations in Mud Creek from 2000-2005

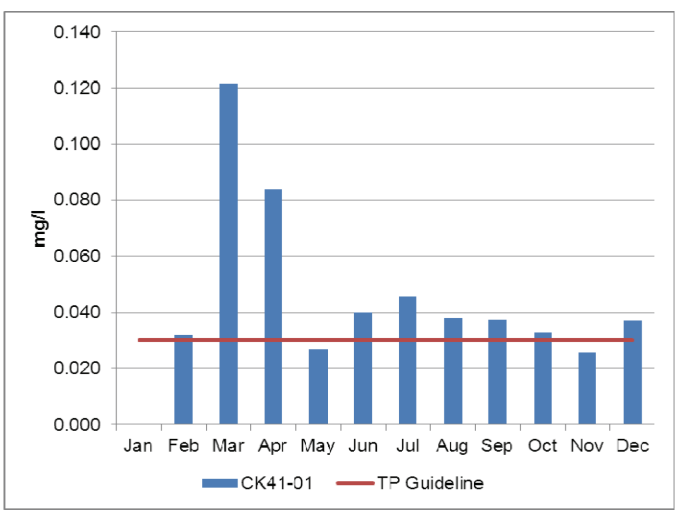


Figure 2b. Total phosphorous concentrations in Mud Creek from 2006-2011

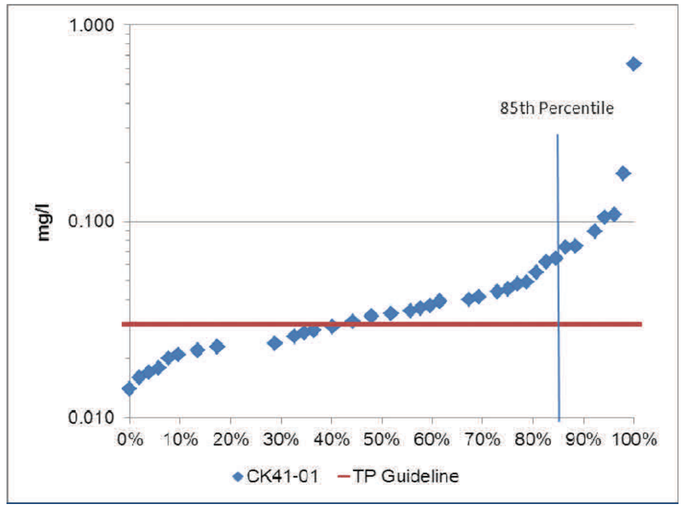


Figure 3a. Percentile plots of total phosphorus in Mud Creek from 2000-2005

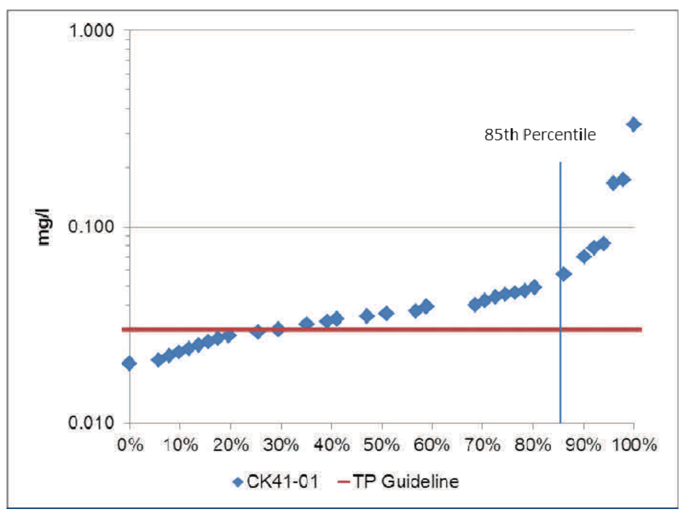


Figure 3b. Percentile plots of total phosphorous in Mud Creek from 2006-2011

TKN is used as a secondary indicator of nutrient enrichment and results remained fairly consistent at the site. Exceedances above the guideline of 0.500 mg/l were common; the proportion of samples below the guideline decreased from twenty-six percent (Fig. 4a, 2000-2005) to fifteen percent (Fig. 4b, 2006-2011). The mean concentration however dropped slightly from 0.670 mg/l to 0.638 mg/l and continued to exceed the guideline.

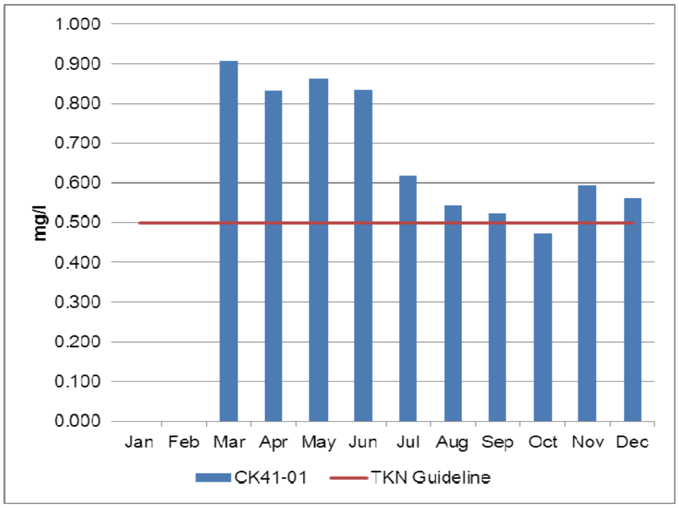


Figure 4a. Total Kjeldahl nitrogen concentrations in Mud Creek from 2000-2005

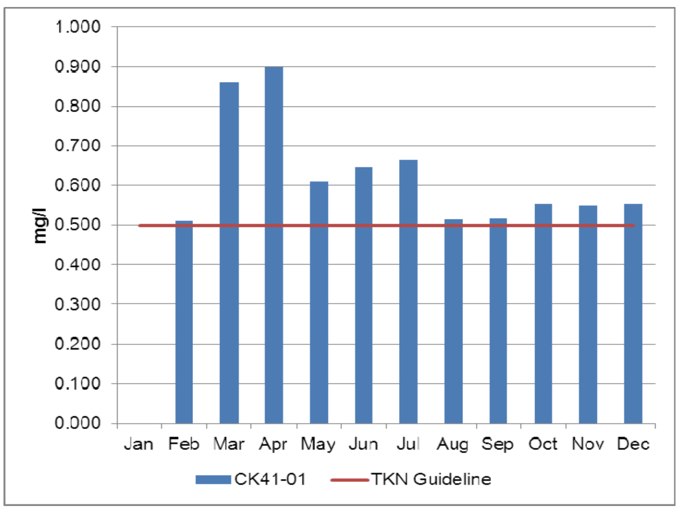


Figure 4b. Total Kjeldahl nitrogen concentrations in Mud Creek from 2006-2011

Mud Creek Nutrients Summary

Overall the data suggests that nutrient loading does occur at this site and effort should be made to reduce any possible sources of nutrient inputs.

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 is used. E. coli counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody. The Lower Rideau Watershed Strategy also set a target for E. coli counts of 200 CFU/100 ml at the 80th percentile for tributaries of the Rideau River, such as Mud Creek.

Table 4 summarizes the geometric mean at the monitored site on Mud Creek and shows the proportion of samples that meet the E. coli guideline of 100 CFU/100ml. Highlighted values indicate averages that have exceeded the guideline.

Figure 5 shows the results of the geometric mean with respect to the guideline for the two periods 2000-2005 (Fig. 5a) and 2006-2011 (Fig 5b). Figures 6a and 6b show percentile plots of the data for the two time periods of interest 2000-2005 (Fig. 6a) and 2006-2011 (Fig. 6b). Any point to the left of the 80th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target

Table 4. Summary of E. coli results for Mud Creek.

E. coli 2000-2005			
Site	Geometric mean	% Below Guideline	No. Samples
CK41-01	89	52	52
E. coli 200-2006			
Site	Geometric mean	% Below Guideline	No. Samples
CK41-01	142	35	52

Mud Creek E. coli: Site CK41-01

E. coli counts above the guideline of 100 colony forming units per 100 mL (CFU/100mL) were common at site CK41-01. In comparing the two time periods the proportion of samples below the guideline decreased from fifty-two percent (Fig. 5a) to thirty-five percent (Fig. 5b), indicating higher counts occur more frequently. The count at the geometric mean increased from 89 CFU/100 ml to 142 CFU/100 ml. Percentile plots of E. coli data at site CK41-01 are shown for both periods. Figures 6a, 2000-2005 and 6b, 2006-2011 show that the LRWS target has exceeded in both time periods, the E. coli count at the 80th percentile increased from 250 CFU/100 ml to 428 CFU/100 ml.

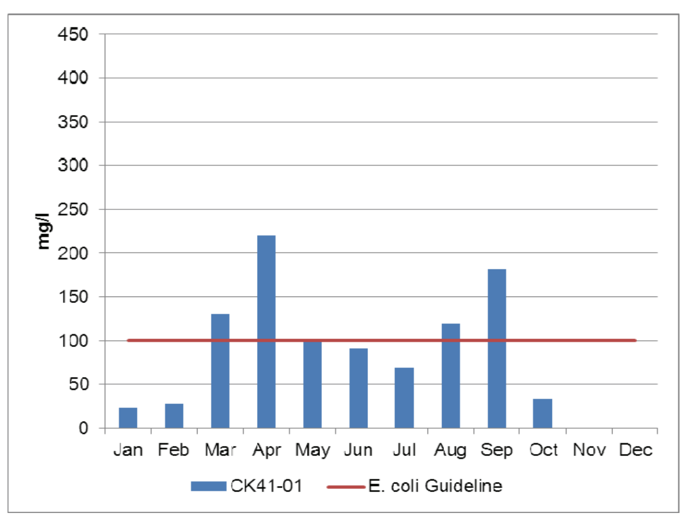


Figure 5a. E. coli counts in Mud Creek from 2000-2005

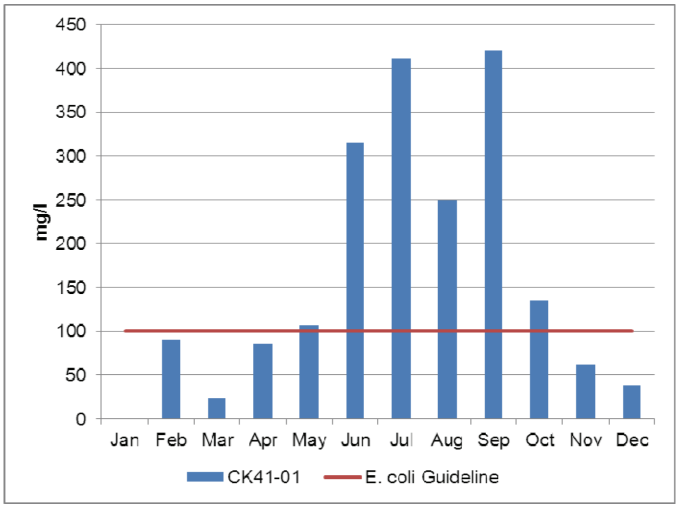


Figure 5b. E. coli counts in Mud Creek from 2006-2011

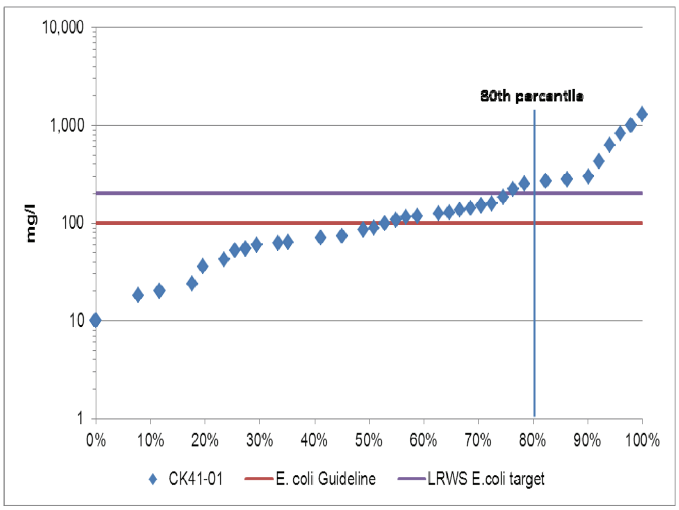


Figure 6a. Percentile plots of E. coli in Mud Creek from 2000-2005

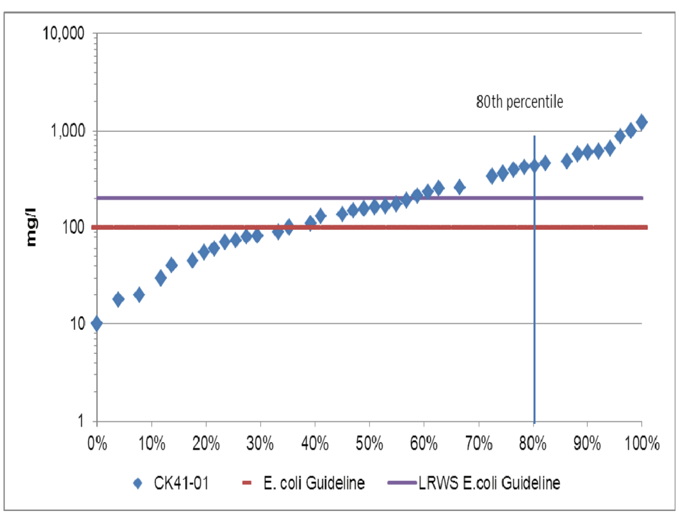


Figure 6b. Percentile plots of E. coli in Mud Creek from 2006-2011

Mud Creek E. coli Summary

These statistics indicated that bacterial counts have increased at this site and efforts should be made to reduce any possible sources of contamination to the creek to protect overall water quality and aquatic life.

Mud Creek Metals

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

Table 5 summarizes average metal concentrations at monitored sites in Mud Creek and shows the proportion of samples that meet guidelines.

Figures 7, 8 and 9, show the results for each site with respect to guidelines for the two periods 2000-2005 (Figures 7a, 8a and 9a) and 2006-2011 (Figures 7b, 8b and 9b). The guidelines for each metal as stated by the PWQO are Al 0.075 mg/l, Cu 0.005 mg/l and Fe 0.300 mg/l. The Lower Rideau Watershed Strategy set a target for Cu concentration of 0.005 mg/l (Cu guideline) at the 80th percentile for tributaries of the Rideau River, such as Mud Creek. Figure 10 shows percentile plots of the data for the two time periods of interest (Fig. 10a, 2000-

Table 5. Summary of metal results for Mud Creek

Aluminum (Al)			
2000-2005			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.221	27	20
2006-2011			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.372	23	18
Iron (Fe)			
2000-2005			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.317	75	20
2006-2011			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.479	77	18
Copper (Cu)			
2000-2005			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.003	83	20
2006-2011			
Site	Average (mg/l)	% below	No. Samples
CK41-01	0.006	62	18

2005) (Fig. 10b, 2006-2011). Any point to the left of the 80th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target

Mud Creek Metals: Site CK41-01

The majority of metals monitored at site CK41-01 were below guidelines however results for aluminum (Al), iron (Fe) and copper (Cu) were all occasionally elevated.

The Al guideline of 0.075 mg/l was generally exceeded in both time periods (7a, 2000-2005 and 7b, 2006-2011), only twenty-seven percent of samples were below the guideline in the 2000-2005 period and this remained fairly consistent at twenty-three percent in the 2006-2011 period. There was an increase in average Al concentration from 0.221mg/l (2000-2005) to 0.372 mg/l (2006-2011).

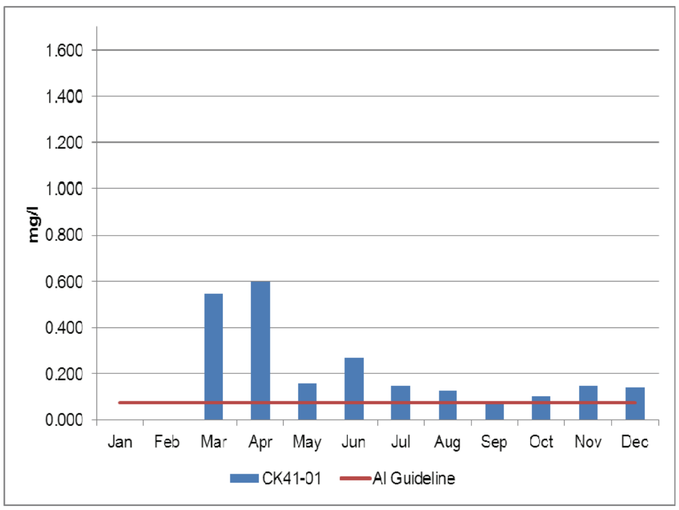


Figure 7a. Aluminum concentrations in Mud Creek from 2000-2005

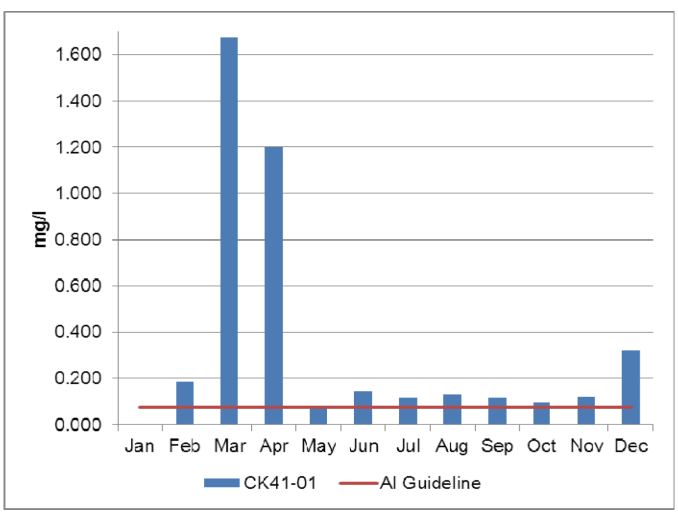


Figure 7b. Aluminum concentrations in Mud Creek from 2006-2011

Figures 8a, 2000-2006 and 8b, 2006-2011 show that the Fe results occasionally exceed the guideline of 0.300 mg/l and there was an overall increase in concentrations over the periods of interest. Seventy-five percent of samples were below the guideline in 2000-2005 and increased to seventy-seven percent in the 2006-2011 period. The average concentration increased from 0.317 mg/l to 0.479 mg/l, exceeding the guideline.

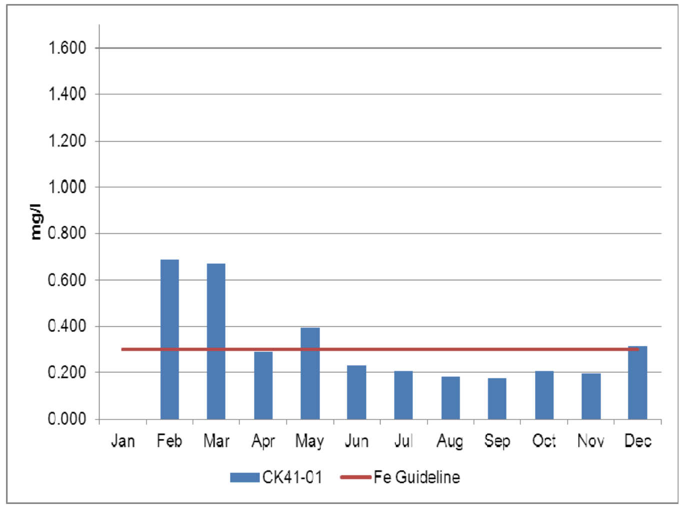


Figure 8a. Iron concentrations in Mud Creek from 2000-2005

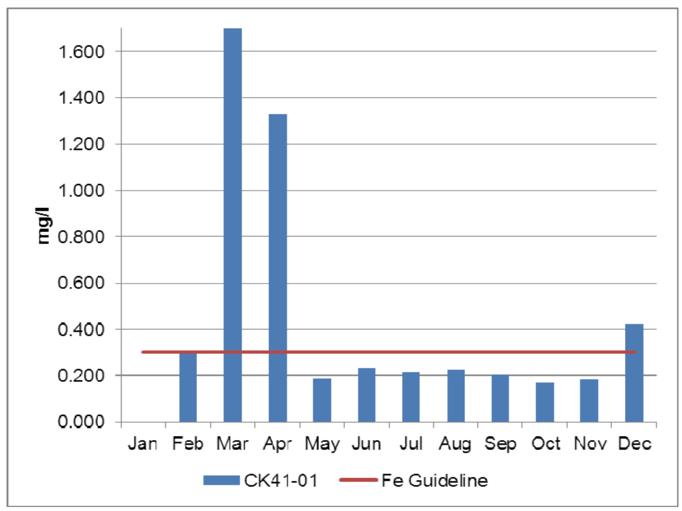


Figure 8b. Iron concentrations in Mud Creek from 2006-2011

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. The proportion of samples below the guideline decreased slightly from eighty-three percent (Fig. 9a, 2000-2005) to sixty-two (Fig. 9b, 2006-2011); the average concentration increased from 0.003 mg/l to 0.006 mg/l to just exceed the guideline. Percentile plots of Cu data are shown for the two time periods 2000-2005 (Fig. 10a) and 2006-2011 (Fig. 10b). The target of a Cu concentration of 0.005 mg/l at the 80th percentile has not been achieved at this site, the concentration at the 80th percentile

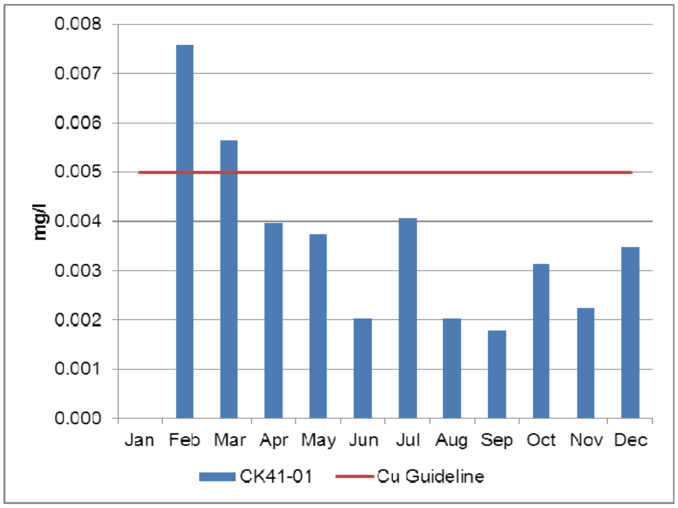


Figure 9a. Copper concentrations in Mud Creek from 2000-2005

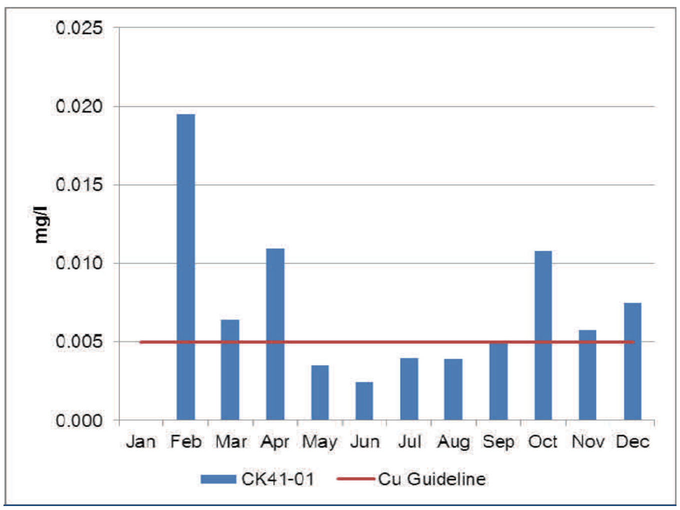


Figure 9b. Copper concentrations in Mud Creek from 2006-2011

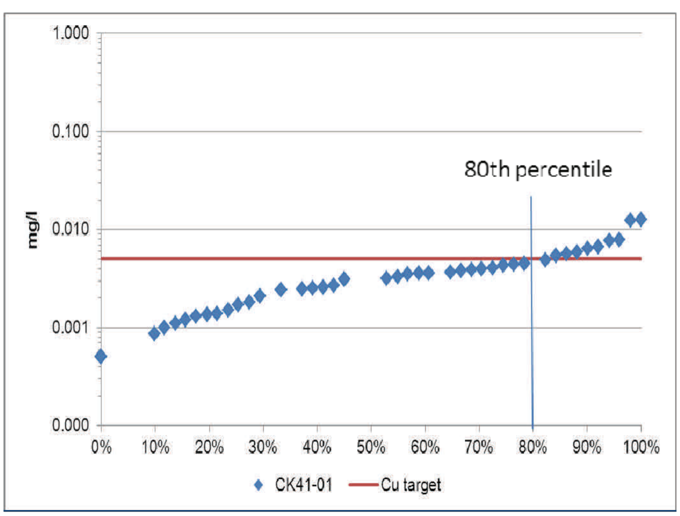


Figure 10a. Percentile plots of Copper in Mud Creek from 2000-2005

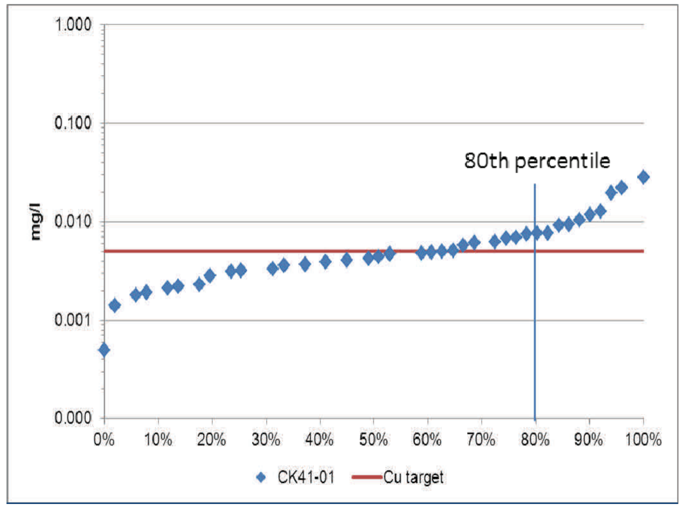


Figure 10b. Percentile plots of copper in Mud Creek from 2006-2011

increased from 0.005 mg/l (2000-2005, Fig. 10a) to 0.008 mg/l (2006-2011, Fig. 10b).

Mud Creek Metals Summary

Overall the data shows that metal pollution is a problem in the creek and efforts should be made to reduce concentrations wherever possible.

Mud Creek 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.

Benthic sampling site replicate one on Mud Creek at Bankfield in the City of Ottawa, this image was captured in the spring of 2008.

As part of the Ontario Benthic Biomonitoring Network (OBBN), the RVCA has been collecting benthic invertebrates at one location on Mud Creek at Bankfield Road since 2003. Monitoring data is analyzed and the results are presented using the Family Biotic Index, Family Richness and percent Ephemeroptera, Plecoptera and Trichoptera.

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 2006 to 2011 (Fig.11) and scores an overall “Poor” surface water quality rating using a grading scheme developed by Conservation Authorities in Ontario for benthic invertebrates.

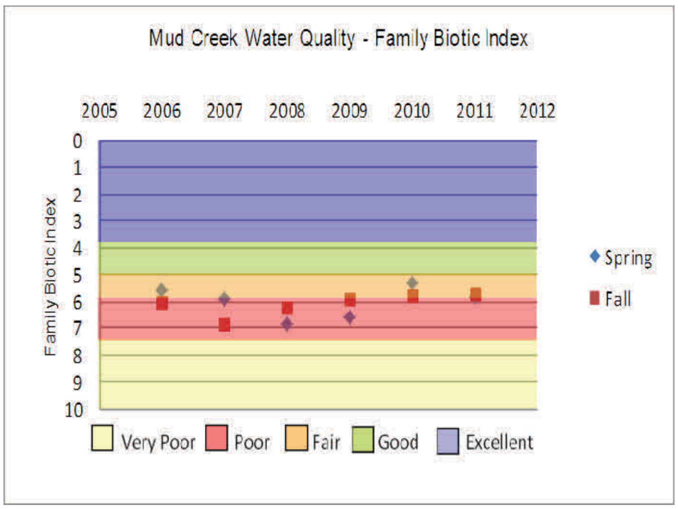


Figure 11. Surface water quality conditions in Mud Creek based on the Family Biotic Index

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.

Using Family Richness as the indicator, Mud Creek is reported to have “Fair” water quality (Fig.12).

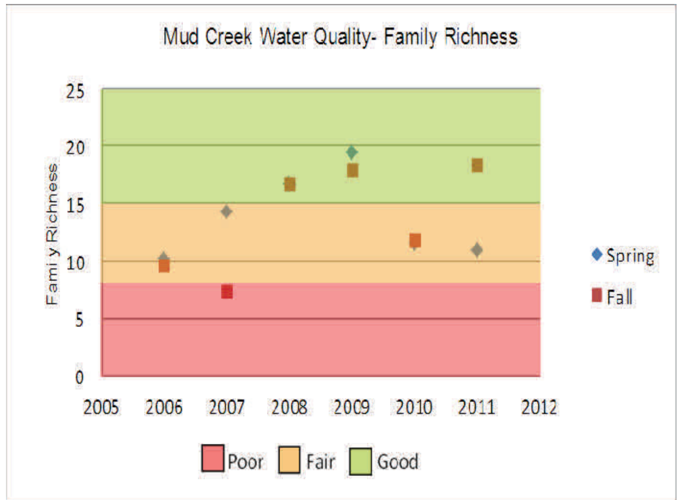


Figure 12. Surface water quality conditions in Mud Creek based on Family Richness

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.

With the EPT indicator, Mud Creek is reported to have water quality ranging from “Poor” to “Fair” (Fig.13) from 2006 to 2011.

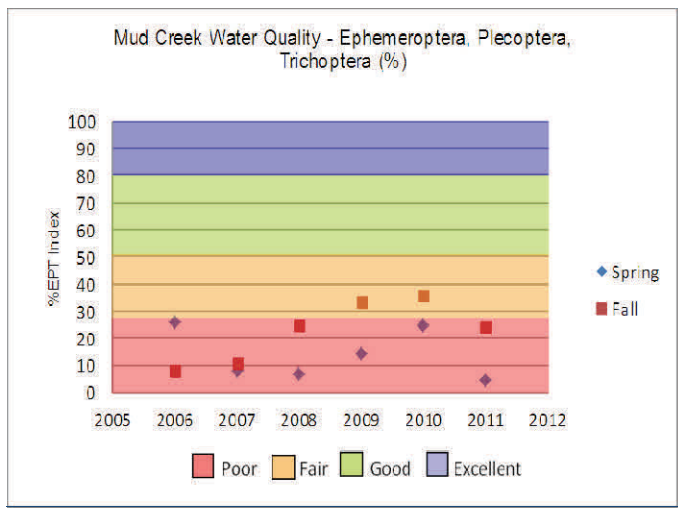


Figure 13. Surface water quality conditions in Mud Creek using the EPT Index

Overall Mud Creek has a water quality rating of “Poor” from 2006 to 2011.

2) a. Overbank Zone

Riparian Buffer along Mud Creek and Tributaries

Figure 14 shows the extent of the naturally vegetated riparian zone in the catchment, 30 metres on either side of all waterbodies and watercourses. Results from the RVCA's Land Cover Classification Program show that 27 percent of streams, creeks and lakes are buffered with woodland, wetland and grassland; the remaining 73 percent of the riparian buffer is occupied by settlement, crop and pastureland, transportation and grassland.

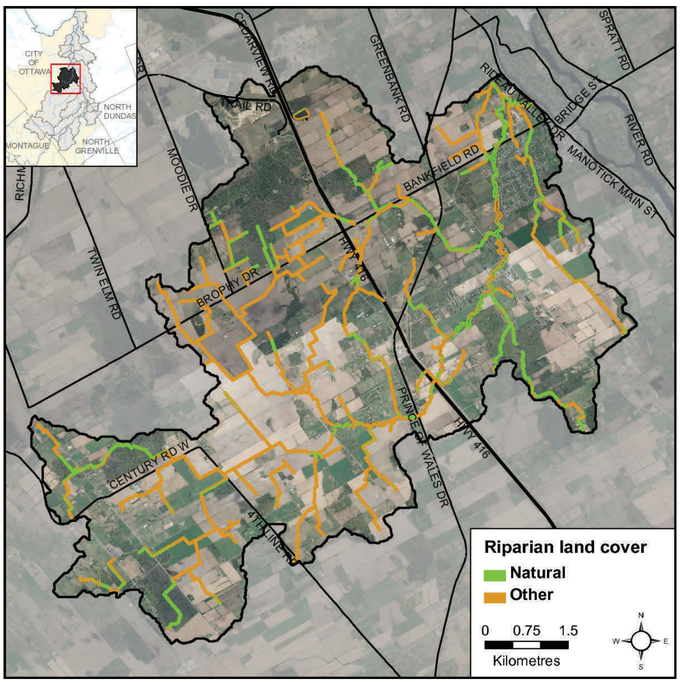


Figure 14. Catchment land cover in the riparian zone

Data from the RVCA's Macrostream Survey Program (Stream Characterization) is used in this section of the report and is generated from an assessment of 94 (100 metre long) sections along Mud Creek in 2008.

Riparian Buffer 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 15 demonstrates the buffer conditions of the left and right banks separately. Mud Creek had a buffer of greater than 30 metres along 45 percent of the left bank and 54 percent of the right bank.

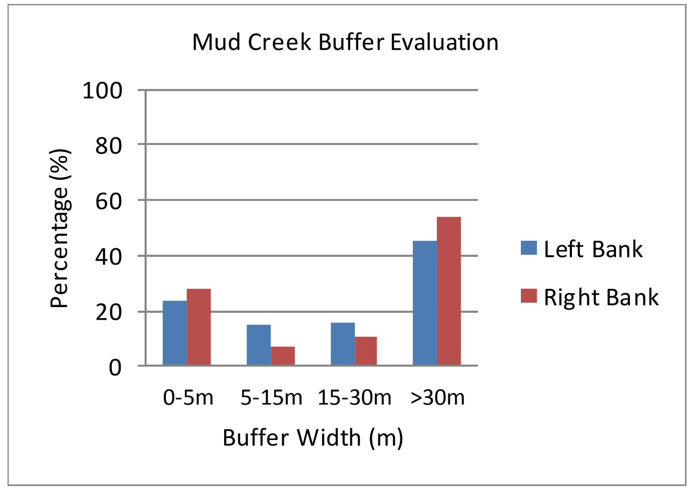


Figure 15. Vegetated buffer width along Mud Creek

Land Use beside Mud Creek

The RVCA's Macrostream Survey Program identified 11 different land uses beside Mud Creek (Figure 16). 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 52 percent of the stream, characterized by wetland, forest, scrubland and meadow. The remaining land use consisted of residential, pasture, active agriculture, abandoned agriculture, commercial/ industrial, infrastructure, and recreational.

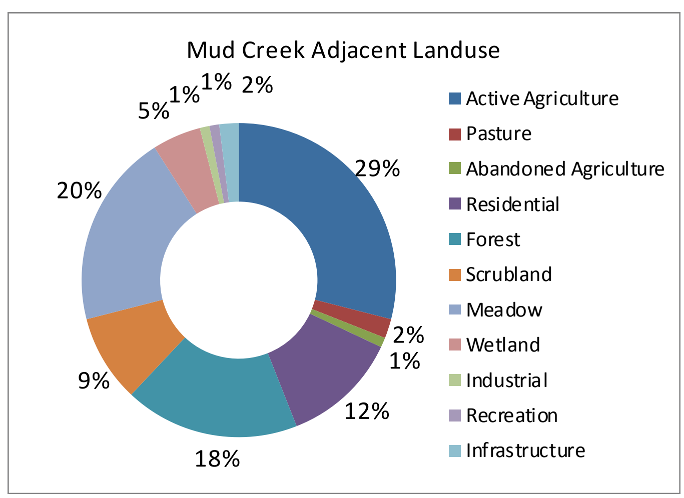


Figure 16. Land use alongside Mud Creek

2) b. Shoreline Zone

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. Bank stability indicates how much soil has eroded from the bank into the stream. 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 17 shows the bank stability of the left and right bank along Mud Creek.

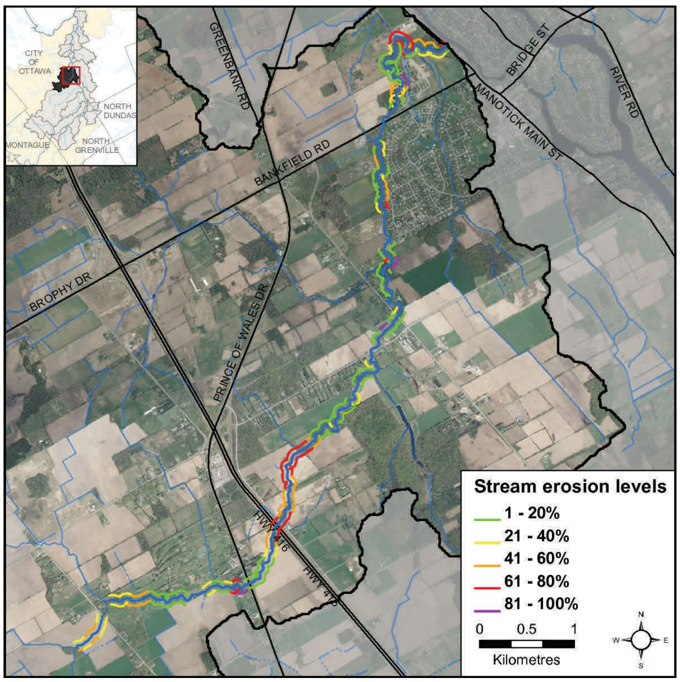


Figure 17. Erosion along Mud Creek

Streambank Undercutting

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 18 shows that Mud Creek had several locations with identified undercut banks.

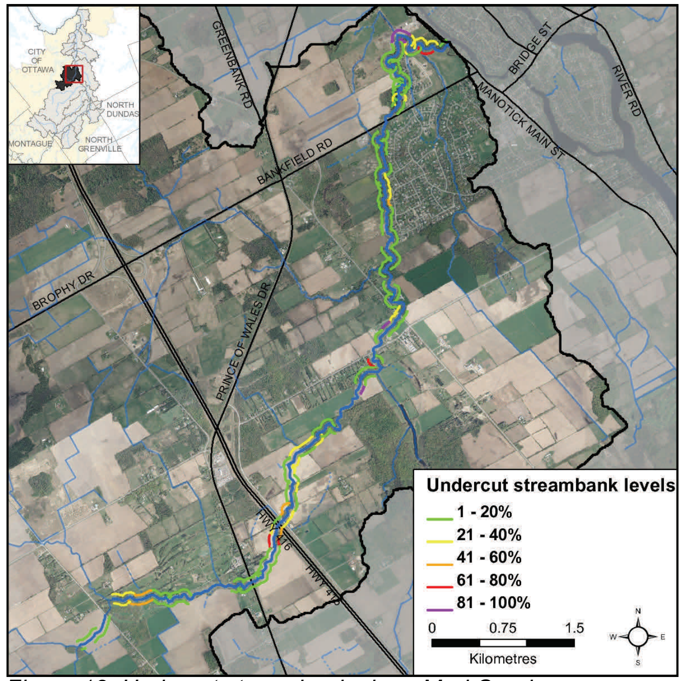


Figure 18. Undercut streambank along Mud Creek

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 19 shows the stream shading locations along Mud Creek.

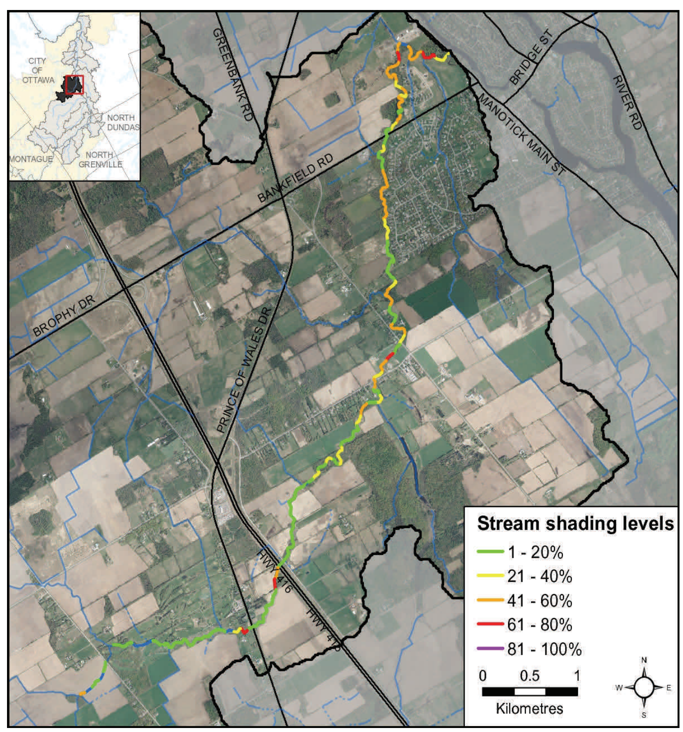


Figure 19. Stream shading along Mud Creek

Human Alterations

Figure 20 shows that 57 percent of Mud Creek remains "unaltered." Sections considered "natural" with some human changes account for 26 percent of sections, with the remaining 17 percent of sections sampled being considered "altered" (e.g., with road crossings and little or no buffer). No areas were recorded as being "highly altered" along Mud Creek.

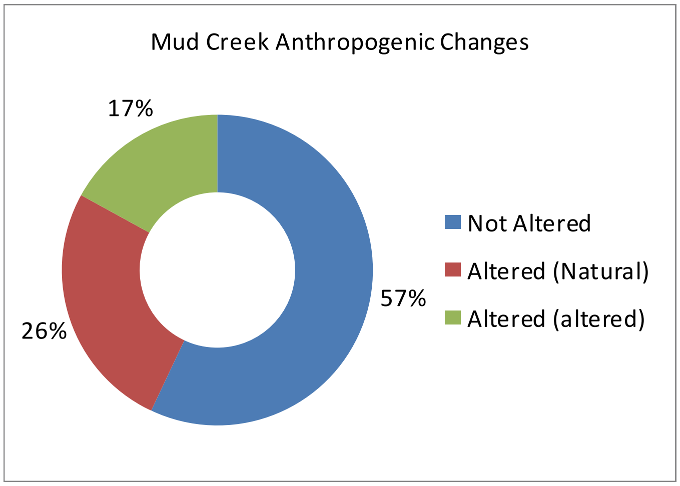


Figure 20. Alterations to Mud Creek

Overhanging Trees and Branches

Figure 21 shows that the majority of Mud Creek has varying levels of overhanging trees and branches. Overhanging trees and branches provide a food source, nutrients and shade which helps to moderate instream water temperatures.

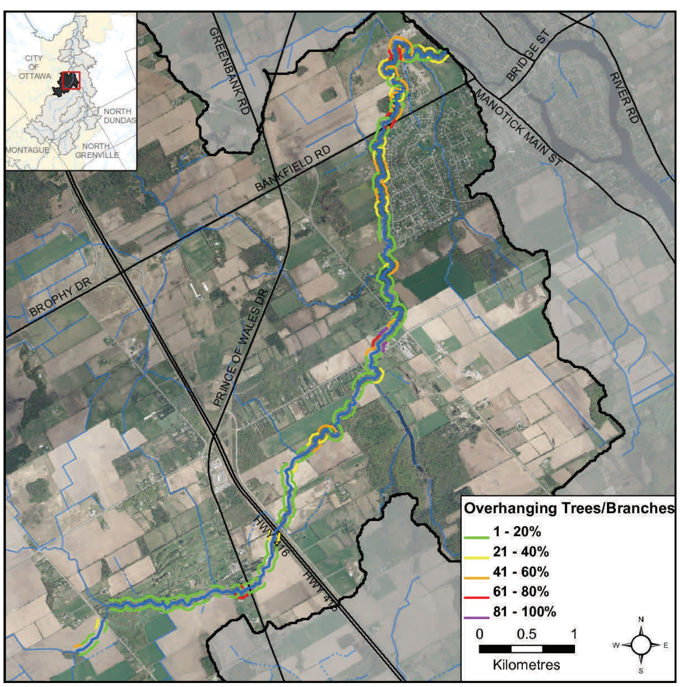


Figure 21. Overhanging trees and branches

Instream Woody Debris

Figure 22 shows that the majority of Mud Creek has varying levels of instream woody debris in the form of trees and branches. Instream woody debris is important for fish and benthic habitat, by providing refuge and

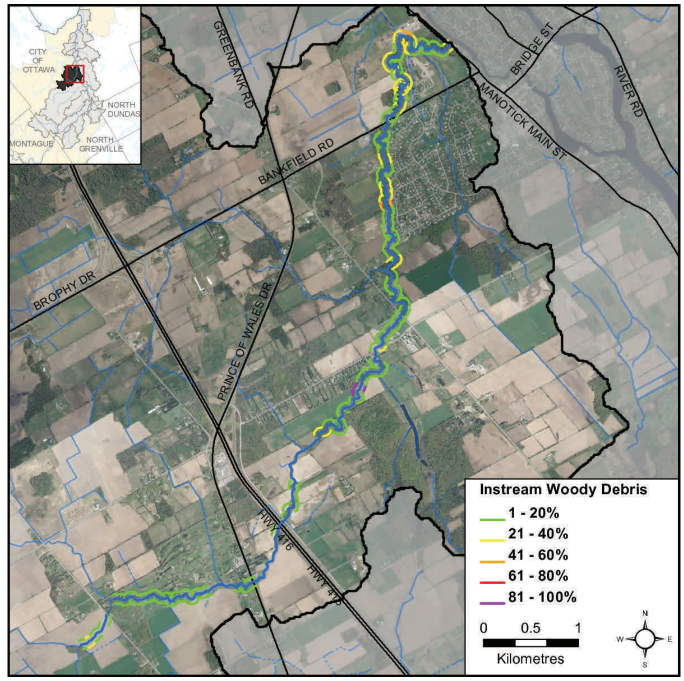


Figure 22. Instream woody debris

2) c. Instream Aquatic Habitat

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Seventy-six percent of Mud Creek was considered heterogeneous, as shown in Figure 23.

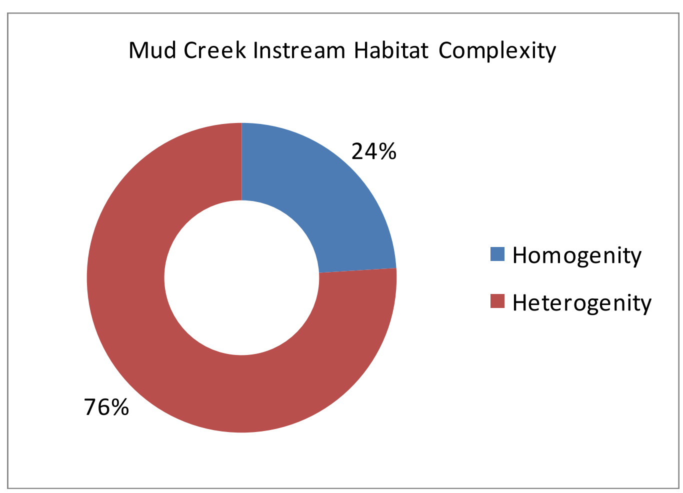


Figure 23. Instream habitat complexity in Mud Creek.

Instream Substrate

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 24 shows the diversity of substrate for Mud Creek.

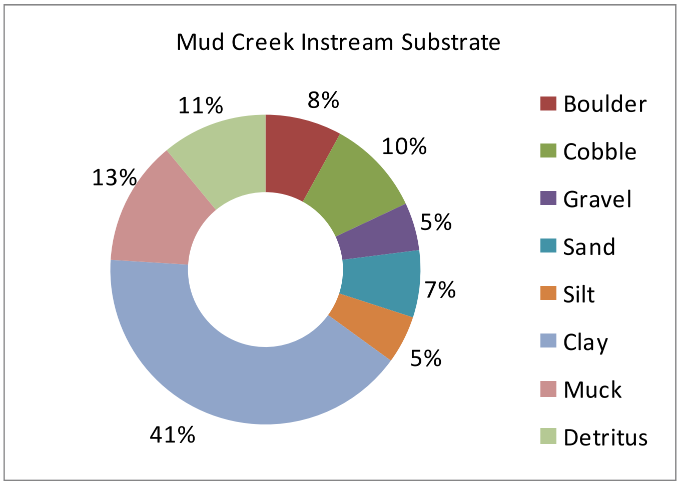


Figure 24. Instream substrate in Mud Creek

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 25 shows where cobble and boulder substrate was found in Mud Creek.

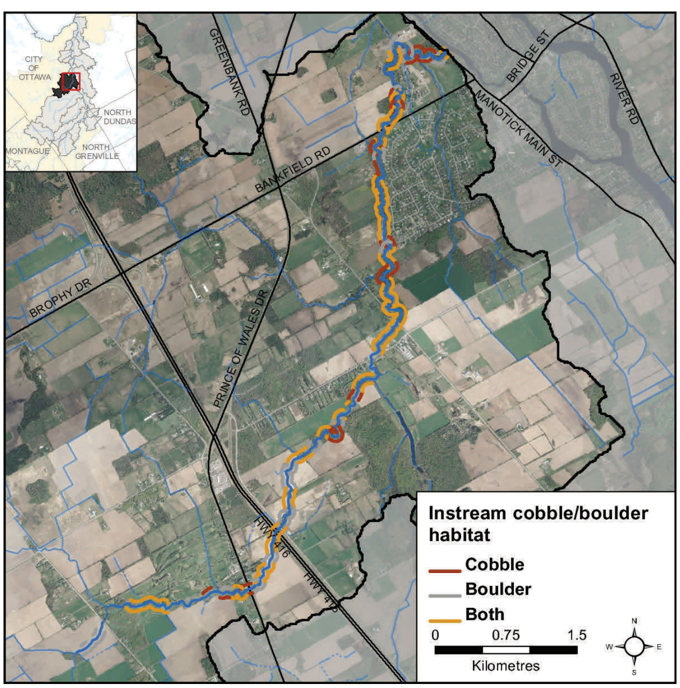


Figure 25. Instream cobble and boulder habitat along Mud Creek

Instream Morphology

Pools and riffles are important features for fish habitat. 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 26 shows that Mud Creek was fairly uniform; 90 percent consisted of runs, eight percent pools and two percent riffles.

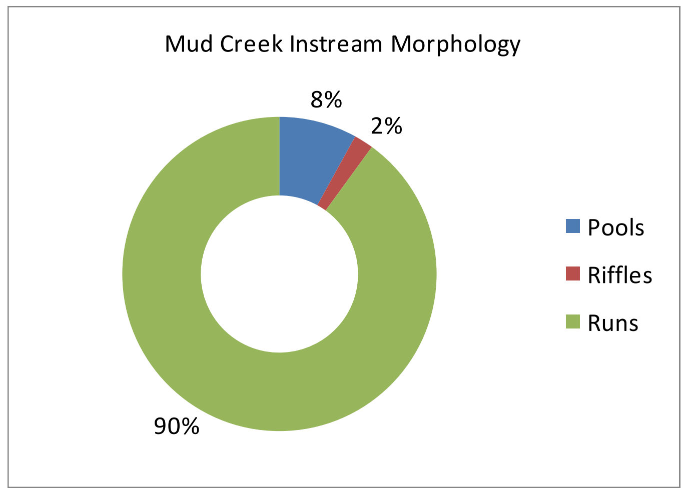


Figure 26. Instream morphology in Mud Creek

Types of Instream Vegetation

Mud Creek had fairly diverse types of instream vegetation (Figure 27). The dominant vegetation type recorded at twenty-nine percent consisted of algae. Submerged vegetation was recorded at 22 percent. Robust emergents were recorded at 16 percent. Narrow emergents were recorded at 15 percent. Free floating vegetation made up 13 percent of the vegetation types recorded in the stream. Broad emergent vegetation made up the remaining five percent of the vegetation community.

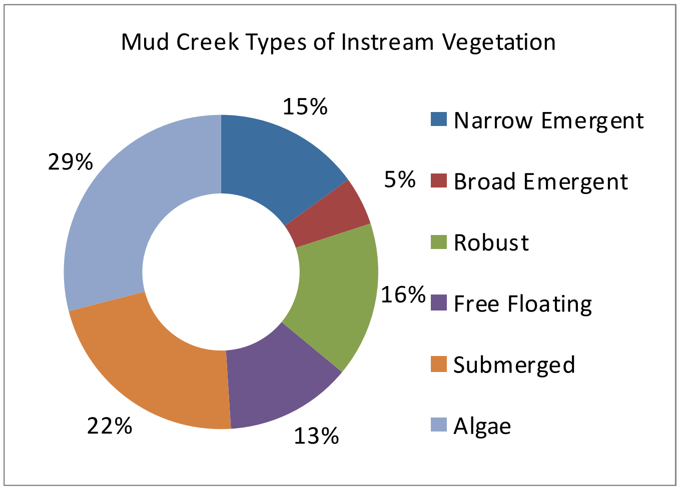


Figure 27. Instream vegetation types in Mud Creek.

Amount of Instream Vegetation

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 28 demonstrates that Mud Creek had healthy instream vegetation levels for most of its length.

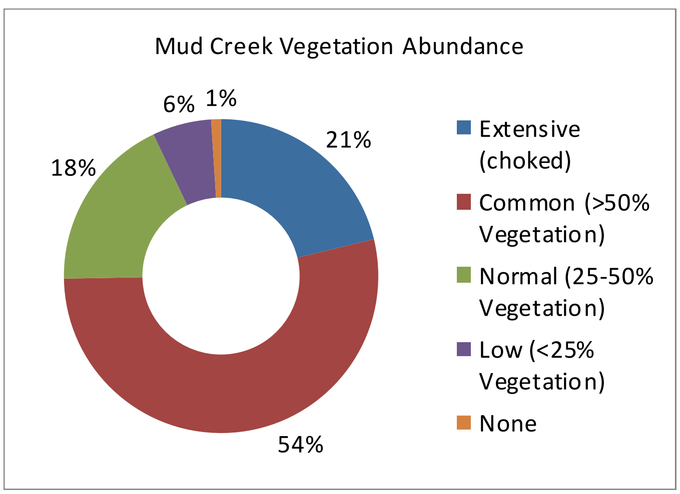


Figure 28. Vegetation abundance in Mud Creek

Riparian Restoration

Figure 29 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

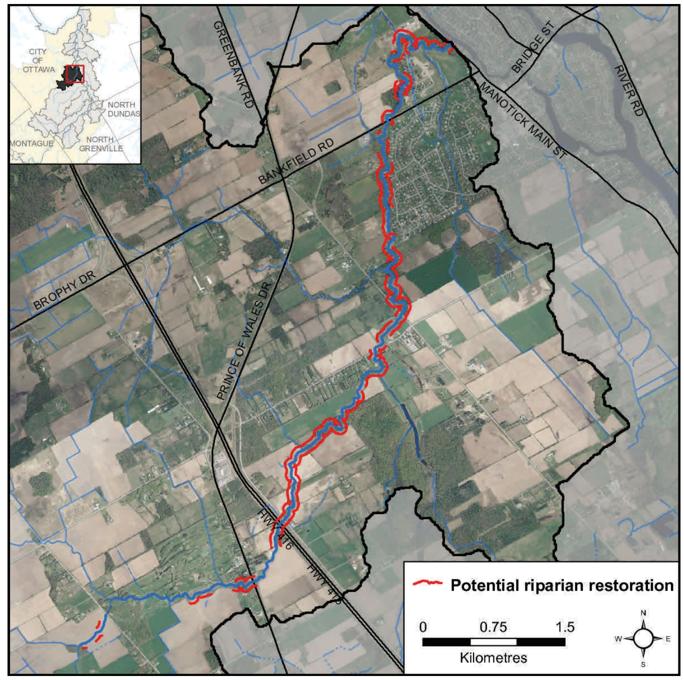


Figure 29. Riparian restoration opportunities

Instream Restoration

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

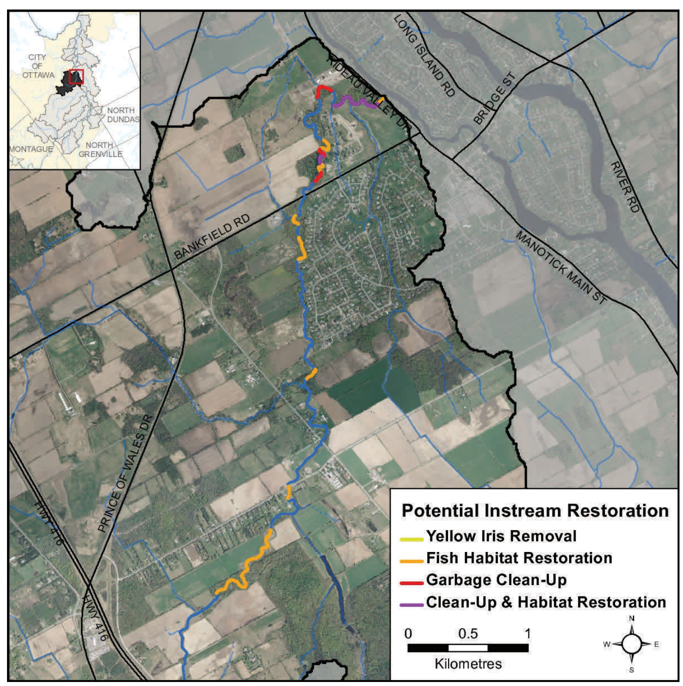


Figure 30. Instream restoration opportunities

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. Fifty percent of the sections surveyed along Mud Creek had invasive species (Figure 31). The species observed in Mud Creek were purple loosestrife, European frogbit, oxeye daisy, rusty crayfish, flowering rush.

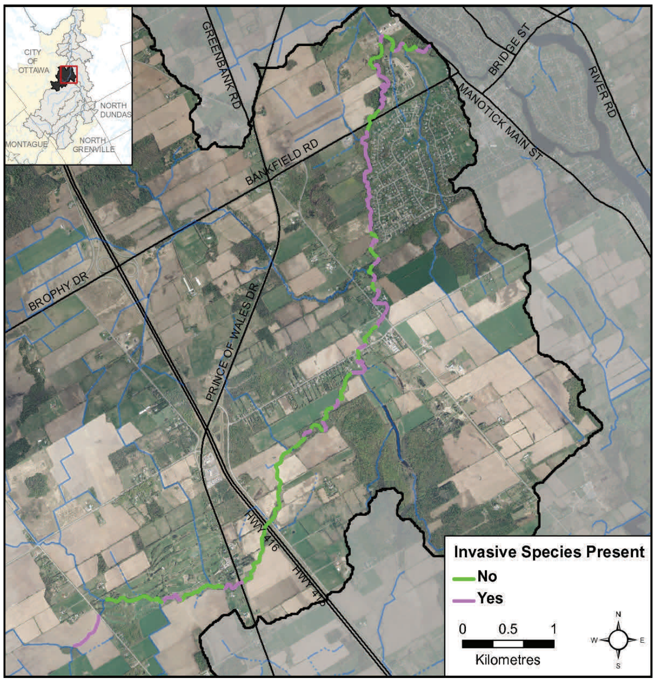


Figure 31. Invasive species along Mud Creek

Thermal Classification

Temperature is an important parameter in streams as it influences many aspects of physical, chemical and biological health. Three temperature dataloggers were deployed in Mud Creek from April to late September 2008 (Figure 32) to give a representative sample of how water temperature fluctuates. 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 warmwater, coolwater or cold water. Analysis of the data collected indicates that Mud Creek is a coolwater system.

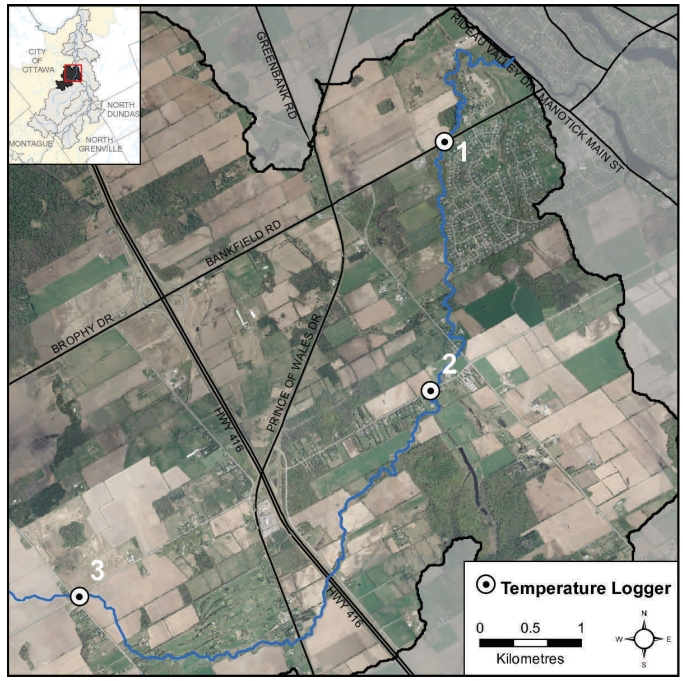


Figure 32. Temperature dataloggers along Mud Creek

Fish Sampling

Fish sampling sites located along Mud Creek are shown in Figure 33. The provincial fish codes shown on the map below are listed (in Table 6) beside the common name of those fish species identified in Mud Creek (Data source: RVCA and City of Ottawa).

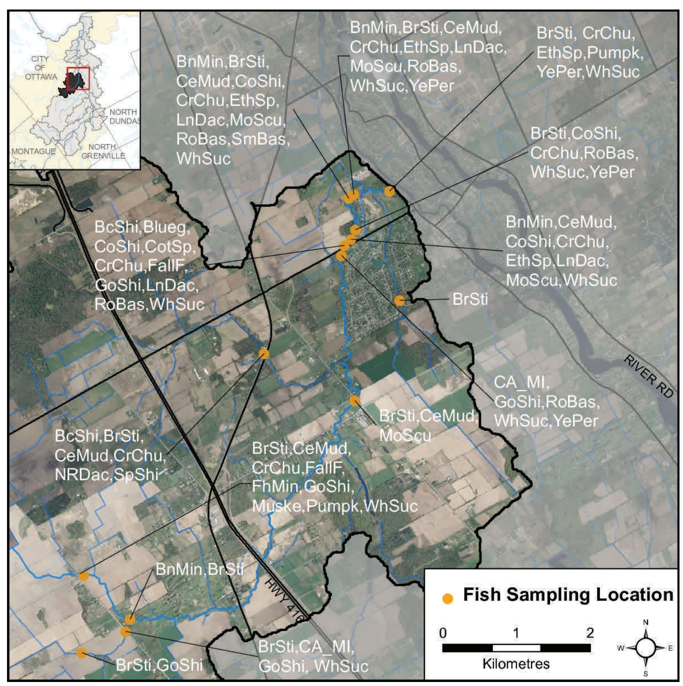


Figure 33. Fish species observed along Mud Creek

Table 6. Fish species observed in Mud Creek

BcShi **blackchin shiner**	Blueg **bluegill**	BnMin **bluntnose minnow**	BrSti **brook stickleback**	CeMin **central mudminnow**
CoShi **common shiner**	CrChu **creek chub**	EthSp **etheostoma spp.**	Fallf **fallfish**	FhMin **fathead minnow**
GoShi **golden shiner**	LnDac **longnose dace**	MoScu **mottled sculpin**	Muske **muskellunge**	NRDac **northern redbelly dace**
Pumpk **pumpkinseed**	RoBass **rock bass**	SpShi **spottail shiner**	WhSuc **white sucker**	YePer **yelllow perch**
CA_MI **carps and minnows**	SmBas **smallmouth bass**	Cotsp **cottus species**		

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 34). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There were four beaver dams and one grade barrier within the Mud Creek catchment at the time the survey.

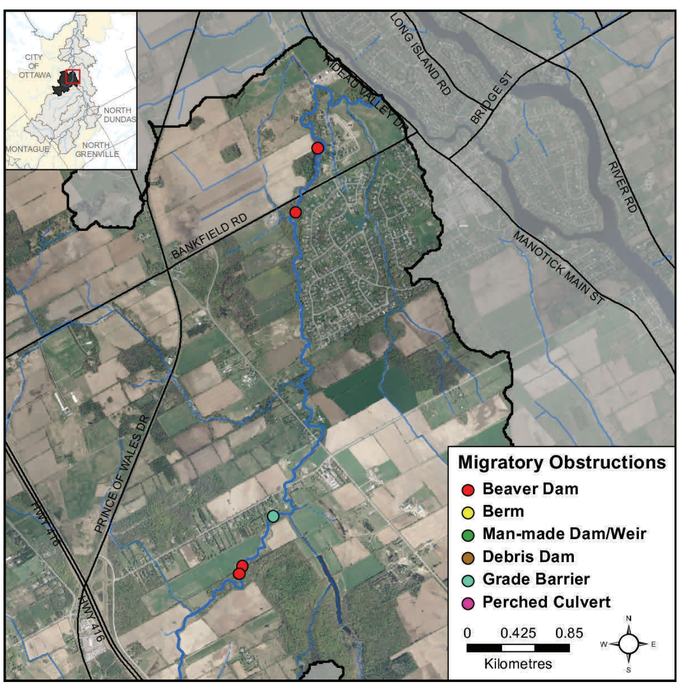


Figure 34. Migratory obstructions in Mud Creek

Water Chemistry

During the macrostream 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 warmwater 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
- 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.

2008 data for these three parameters is summarized in Table 7.

Table 7. 2008 Water chemistry collected along Mud Creek

Month	Range	DO (mg/L)	DO (%)	Conductivity (µs/cm)	pH
May-08	low	-	-	-	-
	high	-	-	-	-
Jun-08	low	3.9	44	601	7.74
	high	14.84	130	743	8.39
Jul-08	low	-	-	-	-
	high	-	-	-	-
Aug-08	low	8.9	90	666	7.4
	high	12.13	122	733	8.23

Electrofishing is a method of fish sampling for small streams

3) ***Land Cover***

Crop and pastureland is the dominant land cover type in the catchment as shown in Table 8 and displayed in the land cover map on the front cover of the report.

Table 8. Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Crop & Pasture	**3650**	**63**
Woodland	**1085**	**19**
Settlement	**553**	**10**
Transportation	**255**	**5**
Wetland	**116**	**2**
Aggregate Site	**64**	**1**

Woodland Cover

The Mud Creek catchment contains 1085 hectares of woodland (Fig.35) that occupies 19 percent of the drainage area. This figure is less 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.

Eighty-five (44%) of the 194 woodland patches in the catchment are very small, being less than one hectare in size. Another 97 (50%) 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 (6%) of woodland patches range between 21 and 213 hectares. Ten 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, two (1%) of the 194 woodland patches in the drainage area exceeds the 100 plus hectare size needed to support most forest dependent, area sensitive birds and is large enough to support approximately 60 percent of edge-intolerant species. One of these patches 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 194 woodlands contain 33 forest interior patches (Fig.35) that occupy 3 percent (192 ha.) of the catchment land area. 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.

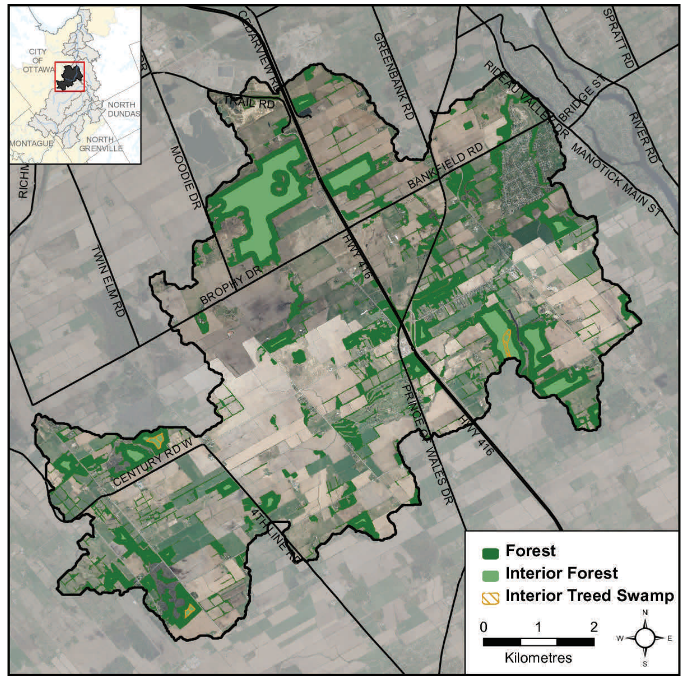
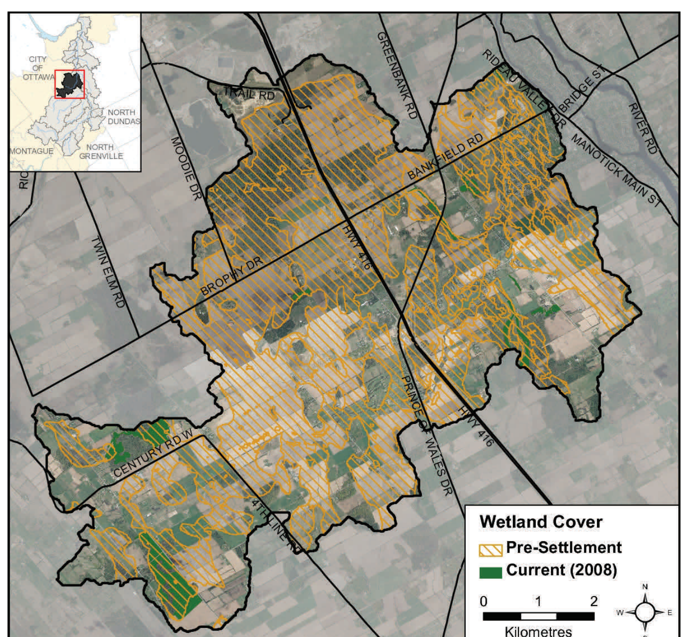


Figure 35. Catchment woodland cover and forest interior

Most patches (29) have less than 10 hectares of interior forest, 22 of which have small areas of interior forest habitat less than one hectare in size. Conversely, four patches have greater than 10 hectares of interior forest, the largest of which contains more than 100 hectares of interior forest (at 106 ha.).



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 36. Pre-settlement and present day wetland cover

4) Stewardship and Protection

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

Rural Clean Water Projects

Figure 37 shows the location of all Rural Clean Water Projects in the Mud Creek drainage area. From 2006 to 2011, landowners completed 30 projects including 9 septic system repair/replacements,12 well upgrades, 2 well decommissions, 1 well replacement, 3 fencing, 2 buffers/windbreaks and 1 precision farming. In total, RVCA contributed $33,671 in grant dollars to projects valued at $211,711.

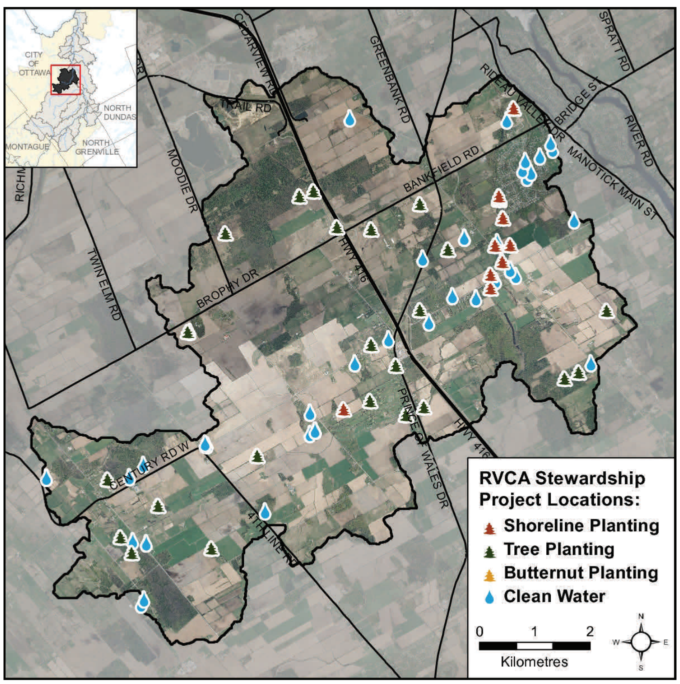


Figure 37. RVCA stewardship program project locations

Prior to 2006, the RVCA completed 20 projects in the area consisting of 2 septic repairs/replacements, 8 well upgrades, 2 well decommissions, 2 well replacements, 3 cropping practices, 2 surface wastewater disposal 1 chemical/fuel storage and handling, 1 manure storage treatment and 1 precision farming. In total RVCA contributed $27,800 in grant dollars to projects valued at project $96,954.

Tree Planting Projects

The location of all tree planting and shoreline projects is also shown in Figure 37. From 2006 to 2011, 17,200 trees, valued at $36,401, were planted on 5 sites through the RVCA Tree Planting Program..

Before that, from 1984 to 2006, landowners helped plant 77,200 trees, valued at $82,607, on 18 project sites, using the RVCA Tree Planting Program, on 39 hectares of private land; fundraising dollars account for $63,257 of that amount.

Shoreline Naturalization Projects

Throughout 2011, 11 shoreline naturalization projects were completed in partnership with private landowners and community volunteers on mud creek. These projects saw just over 2000 tree and shrub seedlings planted along 1.1 km of shoreline, with a combined project value of $14,730. Project funding was provided in part through Environment Canada's EcoAction Community Grants Program during the Rideau Valley Conservation Foundation's *Making Shorelines Natural* Project.

Valley, Stream, Wetland and Hazard Land Regulation

Less than one percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Fig.38), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards. Plotting of the regulation limit on the 105.3 km (or 100 percent) of streams requires identification of flood and erosion hazards and valley systems.

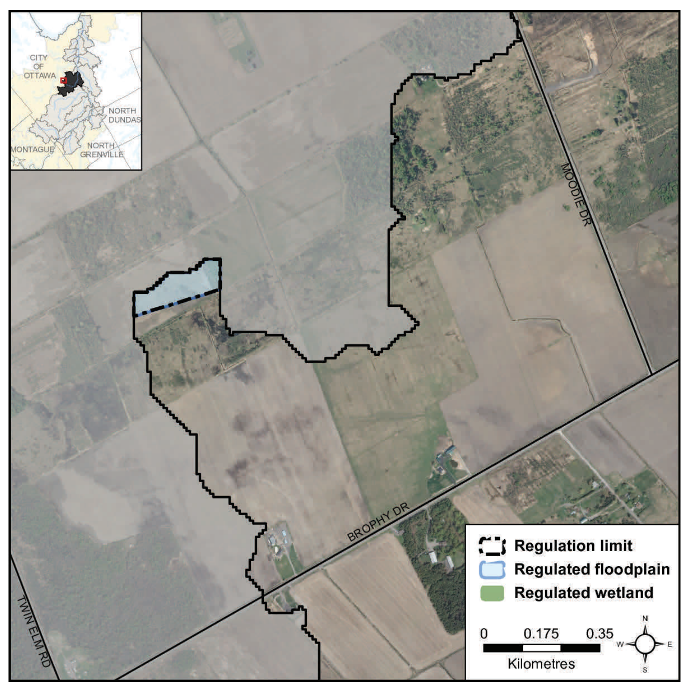


Figure 38. RVCA regulation limits

Within the regulation limit, "development" and "site alteration" require RVCA permission, as do any proposed works to alter a watercourse, which are subject to the "alteration to waterways" provision of Ontario Regulation 174/06.

5) Issues

- Loss and channelization of headwater tributaries due to rural drainage practices
- Removal of natural riparian vegetation
- Altered hydrology causing in-stream erosion and impacts to aquatic habitats
- Reduced biodiversity
- Loss of wetland and forest habitats
- Increasing presence of invasive species
- Barriers to fish movement
- Nutrient, E.coli and metal exceedances observed in water samples taken

6) Opportunities for Action

- Educate landowners about appropriate best management practices for lawn maintenance and yard waste disposal practices
- Work with landowners and other interest groups 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, invasive species removal and creek clean-up)
- In accordance with the direction provided in the Village of Manotick Environmental Management Plan, runoff quality control is required for new development and redevelopment, including the use of infiltrative BMP's where soil conditions are suitable
- Require geotechnical investigation for new development or redevelopment on adjacent table lands to ensure adequate slope stability
- Remove barriers to fish movement and improve in-stream structure
- Improve access to the Mud Creek corridor for public use and recreation
- Target riparian and instream restoration at sites identified in this report (as shown in Figures 29, 30 and 34) and explore other restoration and enhancement opportunities along the Mud Creek riparian corridor