Mud Creek 2014 Summary Report

Watershed Features	
Area	57.55 square kilometres 1.36% of the Rideau Valley watershed
Land Use	64% agriculture 19% wooded area 10% urban/rural 5% transportation 2% wetland
Surficial Geology	49% clay 27% diamicton 15% sand 6% gravel 3% organic deposits
Watercourse Type	*Watercourse Type:* 98% natural 2% channelized *Flow Type:* 100% permanent
Invasive Species	There were ten invasive species observed by CSW staff in 2014: purple loosestrife, European frogbit, buckthorn, Manitoba maple, curly leafed pondweed, flowering rush, garlic mustard, Himalayan balsam, wild parsnip, rusty crayfish
Fish Community	34 fish species have been captured in Mud Creek including six game fish species: rock bass, small mouth bass, largemouth bass, yellow perch, walleye, and muskellunge

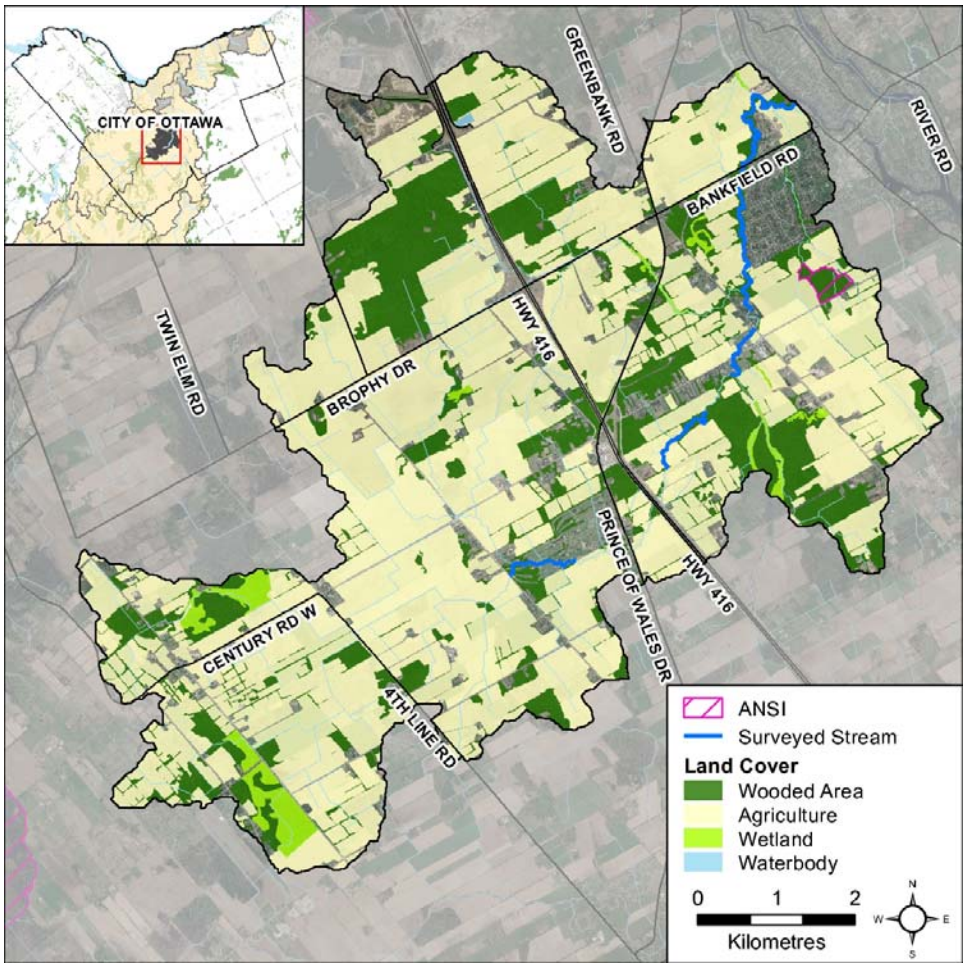

Figure 1 Land cover in the Mud Creek catchment

Vegetation Cover		
Types	**Hectares**	**% of Cover**
Wetlands	116	10
Wooded	959	80
Hedgerow	83	7
Plantation	43	4
TOTAL		**100%**

Woodlot Cover		
Size Category	**Number of Woodlots**	**% of Woodlot Cover**
10-30 ha	16	5
>30 ha	7	2

Wetland Cover
2% of the watershed is wetland
Wetlands make up 10% of the vegetation cover

The Rideau Valley Conservation Authority, in partnership with seven other agencies in Ottawa (City of Ottawa, Heron Park Community Association, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, National Defence HQ - Fish and Game Club, and the National Capital Commission) form the 2014 City Stream Watch collaborative.

Introduction

Mud Creek is approximately 11 kilometres long. The land use in the area is mainly agricultural and it's headwaters consist primarily of agricultural drains. Further downstream, development pressures have occurred at Highway 416 and adjacent to the creek around the village of Manotick. The geology of the area is predominantly marine clays and till, with some gravel deposits, glaciofluvial deposits and wetlands (City of Ottawa, 2011). The Kars esker is an important geological feature that intersects Mud Creek near First Line Road. Comprised of sand and gravel deposits, eskers are very permeable and can be significant for water resources (City of Ottawa, 2011). The aquatic habitat conditions are further influenced by slow moving sediment resulting from the historic removal of forest cover and clearing of land for agriculture (City of Ottawa, 2011).

In 2014, permission was granted to survey 78 sections (7.8 km) of Mud Creek as part of the City Stream Watch monitoring activities. The following is a summary of observations made by staff and volunteers along those 78 sections.

Mud 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. Mud Creek did not quite meet this target by having a buffer of greater than 30 meters along 58 percent of the right bank and 56 percent along the left bank. Figure 2 demonstrates the buffer conditions of the left and right banks separately.

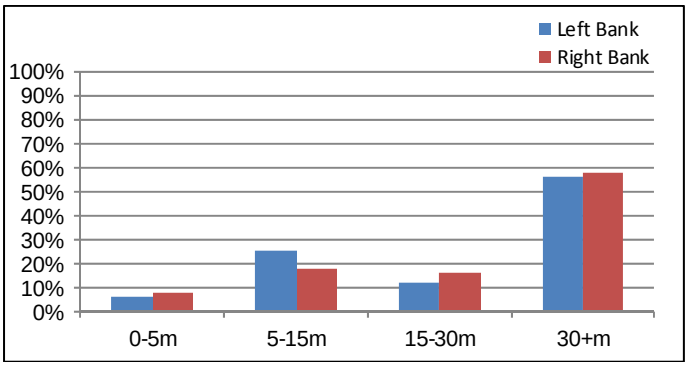

Figure 2 Vegetated buffer width along Mud Creek

Forested buffer along Mud Creek

Adjacent Land Use

The RVCA's Stream Characterization Survey Program identifies ten different land uses beside Mud Creek (Figure 3). Surrounding land use is considered from the beginning to end of each 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 surveyed stream, characterized by forest, scrubland, meadow and wetland. Thirty-one percent of the land use along the surveyed sections of the stream was made up of residential, industrial/commercial , recreational and infrastructure. The remaining 17 percent of the land use surveyed was active agriculture and abandoned agriculture.

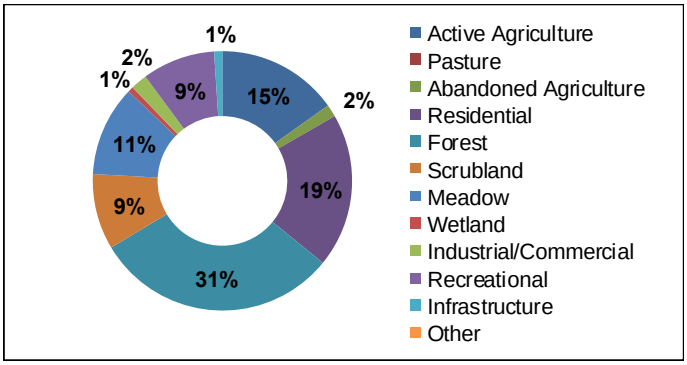

Figure 3 Land use along Mud Creek

Infrastructure along Mud Creek

Mud Creek 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. 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 4 shows that low to moderate levels of bank erosion were observed along many sections of Mud Creek, with a couple of sections of high erosion. Most of the bank erosion observed was concentrated in the stream sections where development has occurred adjacent to the creek. Specifically from the mouth of the creek to close to First Line Road as well as near Third Line Road.

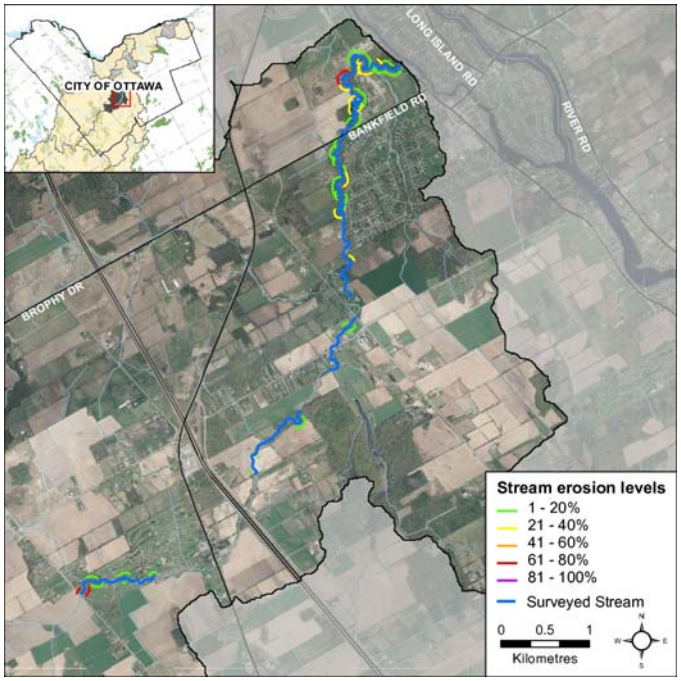

Figure 4 Erosion along Mud Creek

Stream bank erosion along Mud Creek near Third Line Road

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 5 shows that Mud Creek had low to moderate levels of undercut banks along many sections of the creek downstream of Century Road. No bank undercutting was observed in the creek sections upstream of Century Road.

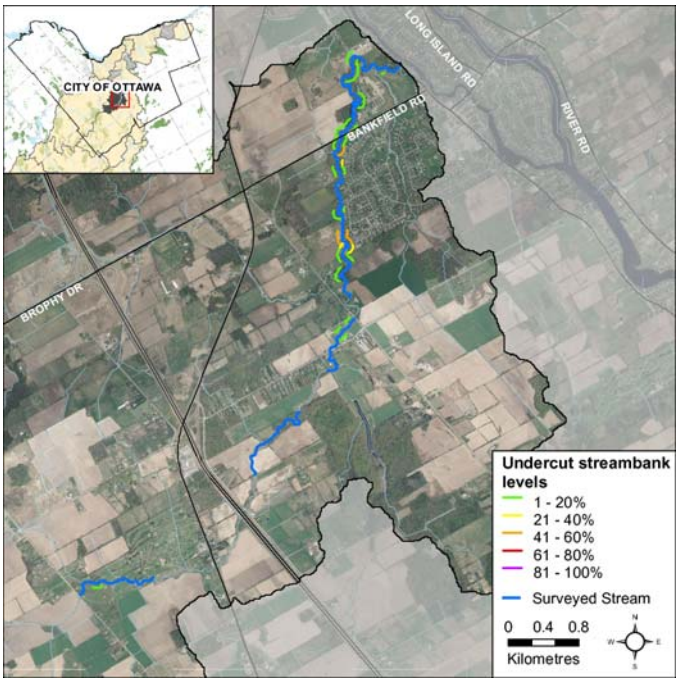

Figure 5 Undercut stream banks along Mud Creek

A section of Mud Creek with no bank undercutting

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 6 shows stream shading along Mud Creek. Moderate levels of shading were seen along most of the creek. Some areas of high levels of shading were observed in forested areas where there was significant tree cover.

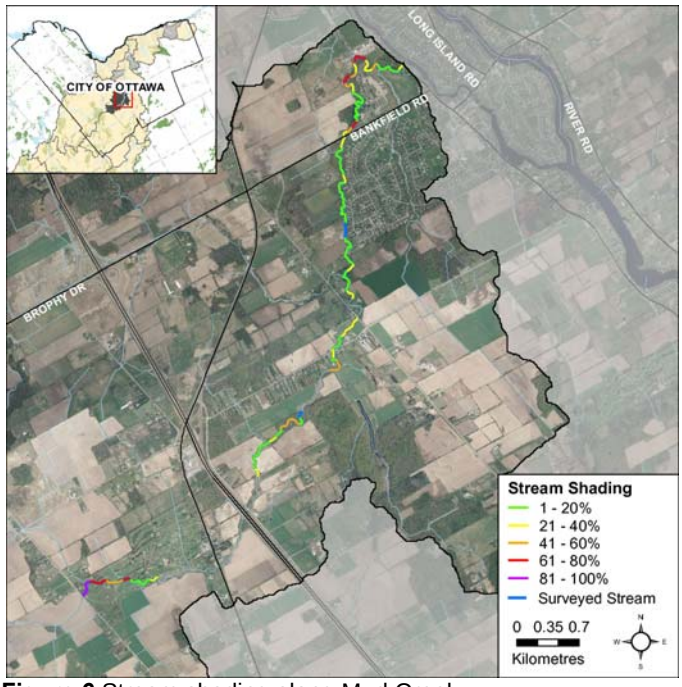

Figure 6 Stream shading along Mud Creek

Stream shade along Mud Creek

Instream Woody Debris

Figure 7 shows that overall, the surveyed sections along Mud Creek had moderate 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.

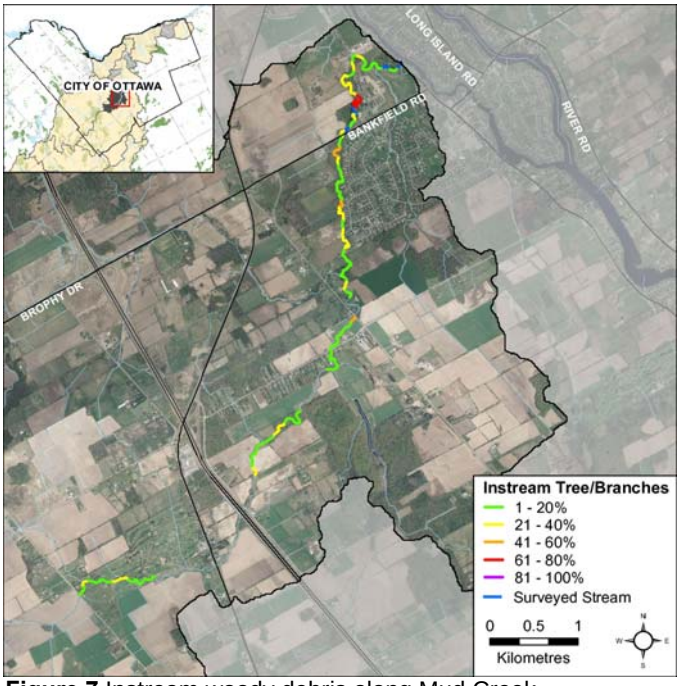

Figure 7 Instream woody debris along Mud Creek

Instream woody debris on Mud Creek

Overhanging Trees and Branches

Figure 8 shows that most of the sections surveyed on Mud Creek had low or moderate levels of overhanging branches and trees. Trees and branches that are less than one meter from the surface of the water are defined as overhanging. At this proximity to the water branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

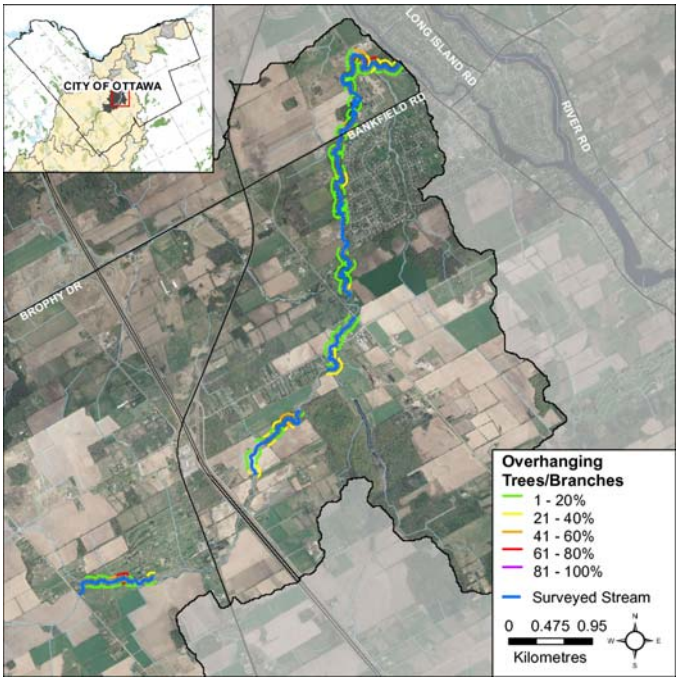

Figure 8 Overhanging trees and branches on Mud Creek

Overhanging trees and branches on Mud Creek

Anthropogenic Alterations

Figure 9 shows that 66 percent of the sections on Mud Creek remain “unaltered” or "natural". Sections considered "altered" account for 19 percent of the stream, while 14 percent of the sections sampled were considered “highly altered”. Very few of the surveyed sections of Mud Creek were channelized so the highly altered sections of the creek refer to areas where the creek runs through a culvert or there is a road crossing with associated instream/shoreline modifications.

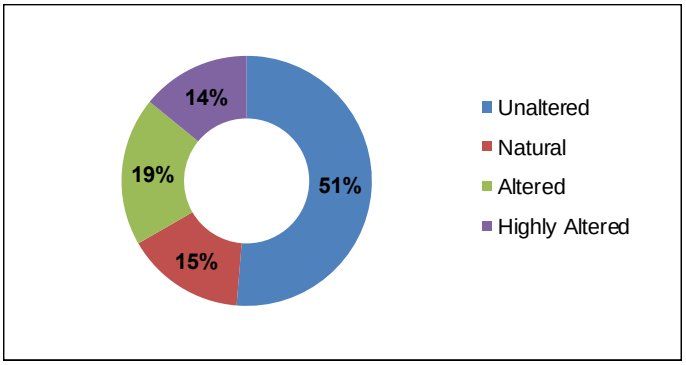

Figure 9 Anthropogenic alterations along Mud Creek

A highly altered section of Mud Creek which runs through a culvert

Mud Creek 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. 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. The complexity of Mud Creek varied considerably with 58 percent of system considered heterogeneous and 42 percent considered homogeneous.

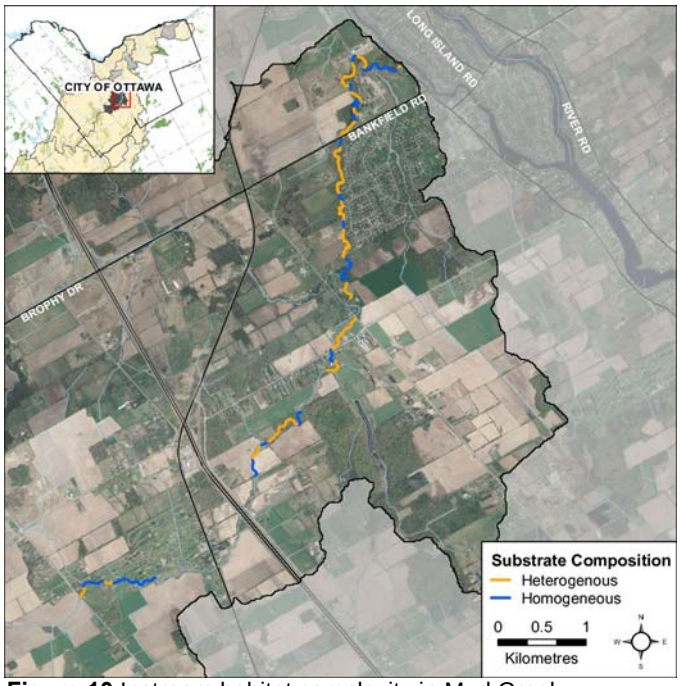

Figure 10 Instream habitat complexity in Mud Creek

Habitat complexity on 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 11 shows that 47 percent of the instream substrate observed on Mud Creek was clay. Thirty six percent of the substrate was recorded as silt and sand and the remaining 18 percent was made up of gravel, cobble and boulder. The dominance of clay substrate with pockets of sand, silt, cobble and boulder throughout the system is also reflected in Figure 12. The presence of the Kars esker is reflected in Figure 12 by the dominance of sand substrate around First Line Road.

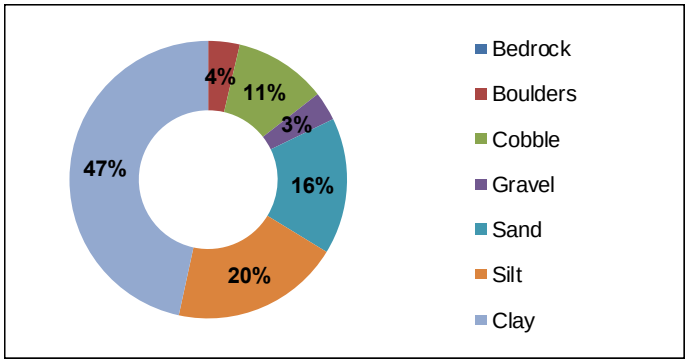

Figure 11 Instream substrate along Mud Creek

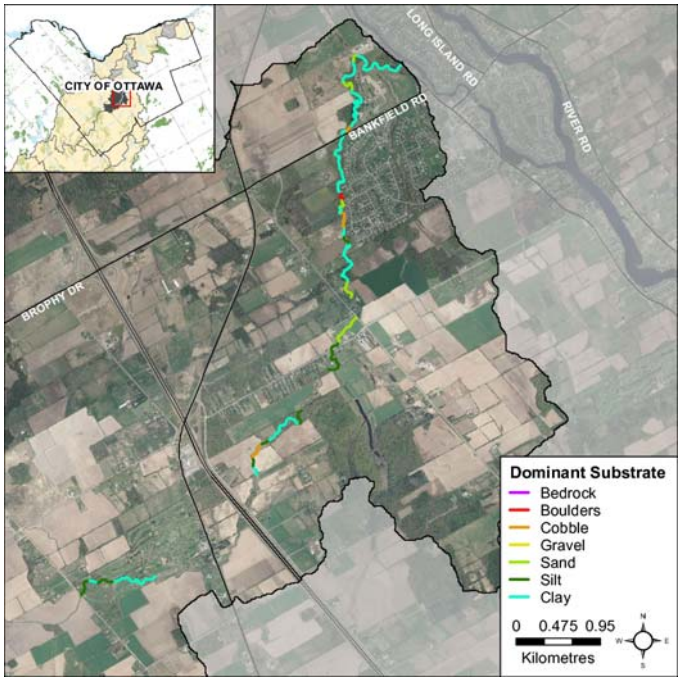

Figure 12 Dominant instream substrate along Mud Creek

Cobble and Boulder Habitat

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 13 shows that although it wasn't often the dominant substrate feature, cobble and boulder substrate was present in most of the surveyed sections of Mud Creek.

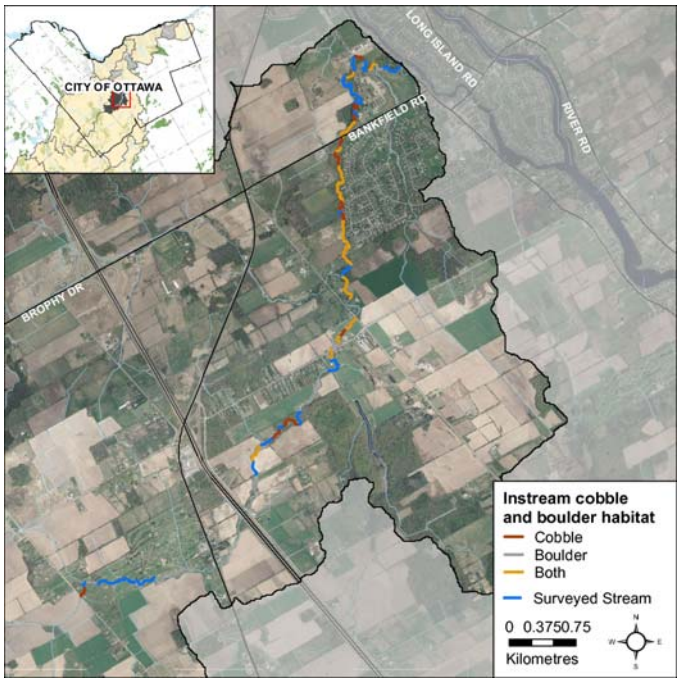

Figure 13 Cobble and boulder habitat in Mud Creek

Cobble and boulder habitat observed 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 areas 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 14 shows that Mud Creek has minimal variability in instream morphology; 85 percent consists of runs, 12 percent consists of pools and four percent consists of riffles. Figure 15 shows where areas of riffle habitat was observed in Mud Creek.

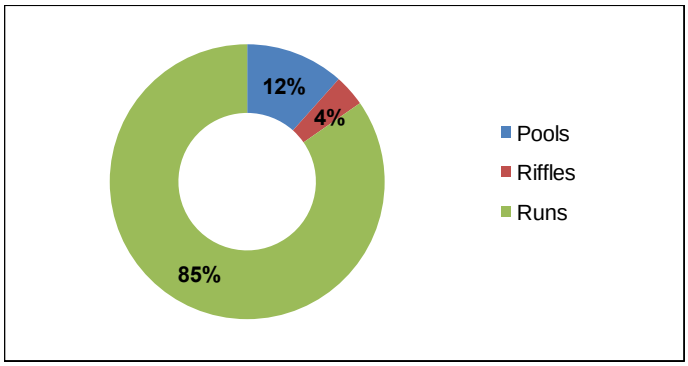

Figure 14 Instream morphology along Mud Creek

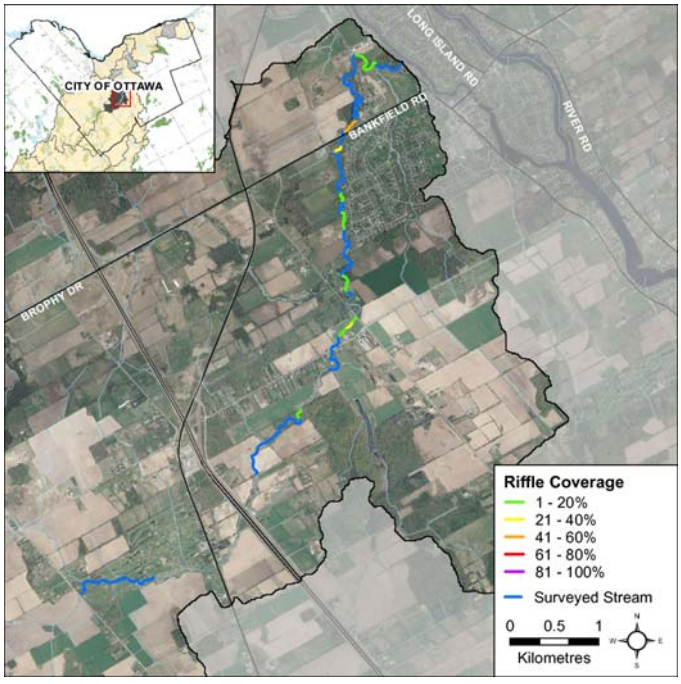

Figure 15 riffle coverage in Mud Creek

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 has high diversity of instream vegetation. Figure 16 depicts the highly varied plant community structure for Mud Creek. The overall dominant vegetation type, recorded at 33 percent, is narrowed-leaved emergent plants. The dominance of narrow-leaved emergent plants is also reflected in Figure 17; where narrow-leaved emergent plants, algae and submerged plants were observed as the dominant plant types along some sections of the creek.

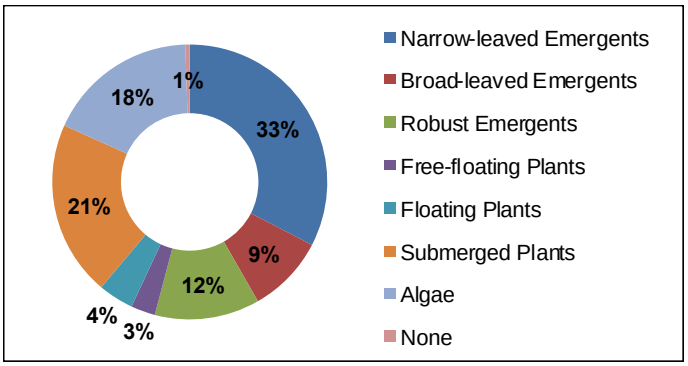

Figure 16 Vegetation types along Mud Creek

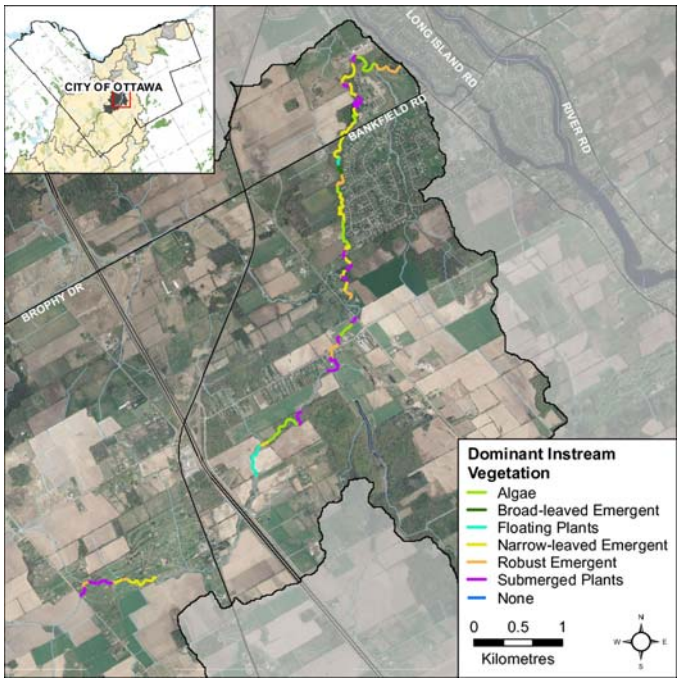

Figure 17 Dominant instream vegetation types in Mud Creek

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 18 demonstrates that overall Mud Creek had normal levels of instream vegetation. The levels of instream vegetation in Mud Creek were fairly well distributed between normal levels accounting for 32 percent, common levels accounting for 30 percent and low levels accounting for 29 percent.

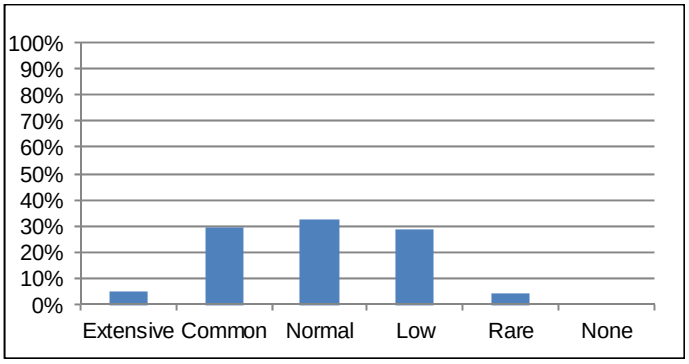

Figure 18 Instream vegetation abundance along Mud Creek

Instream vegetation observed on Mud Creek

Mud Creek Stream Health

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. Invasive species were observed along seventy four percent of the sections surveyed along Mud Creek (Figure 19). Figure 20 shows the variety of invasive species observed along Mud Creek. The invasive species that were observed most often were purple loosestrife (*Lythrum salicaria)* which was observed in 50 percent of the sections with invasive species, Manitoba maple (*Acer negundo*) which was observed in 36 percent of the sections with invasive species, and flowering rush (*Botomus umbellatus*) which was observed in 35 percent of the sections with invasive species.

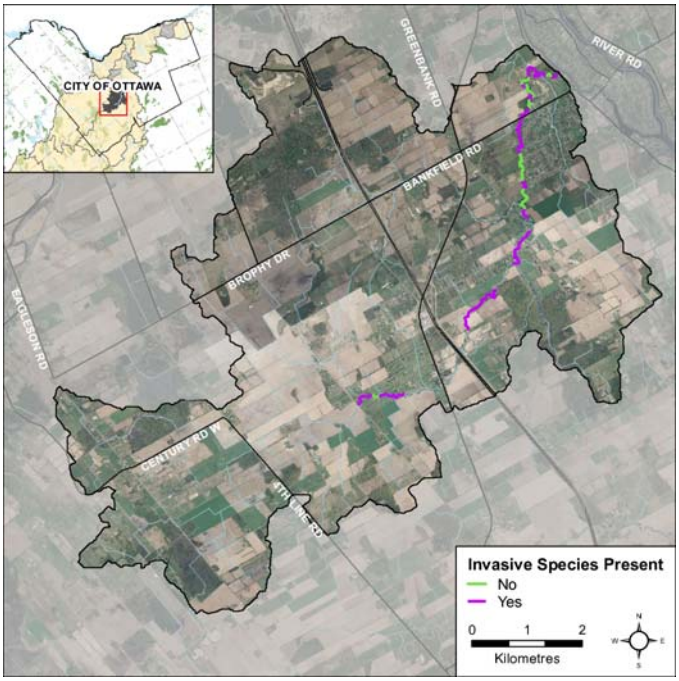

Figure 19 Presence of invasive species along Mud Creek

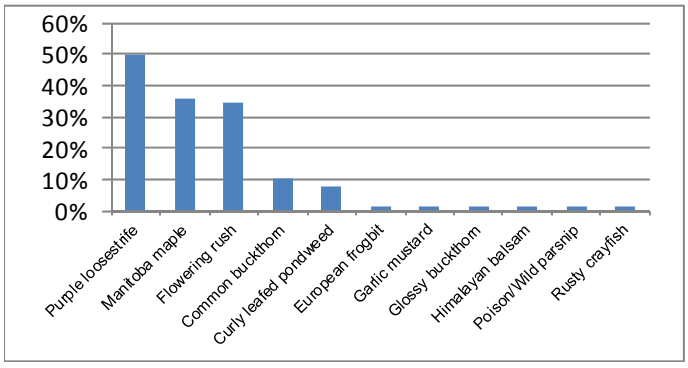

Figure 20 Invasive species observed along Mud Creek

Pollution

Figure 21 demonstrates the incidence of pollution/ garbage in Mud Creek. Fifty-seven percent of the sections surveyed on Mud Creek did not have any observable garbage. Twenty-eight percent had garbage on the stream bottom, twenty-one percent had floating garbage, and one percent had an unclassified type of garbage. Most of the sections where garbage was observed were near road crossings or where development has occurred close to the creek.

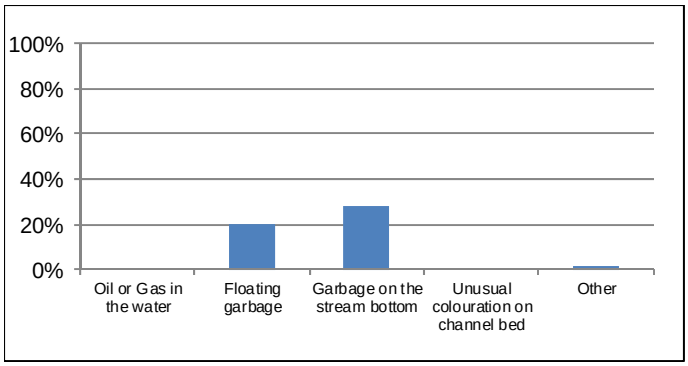

Figure 21 Pollution observed along Mud Creek

Wildlife

The diversity of fish and wildlife populations can be an indicator of water quality and overall stream health. Table 1 is a summary of all wildlife observed during stream surveys.

Wildlife	Observed
Birds	mallard, great blue heron, red-winged black bird, song sparrow, blue jay, red tail hawk, downy woodpecker, grey catbird, chickadee, red-eyed vireo, cardinal, pileated woodpecker, goldfinch, flicker, grackle, cedar waxwing, warbling vireo, crow, robin, kingfisher, mourning dove, turkey vulture, starling, roan chipping sparrow, barn swallow,
Mammals	deer, raccoon, chipmunk, red squirrel, muskrat
Reptiles Amphibians	green frog, tadpoles, wood frog, snapping turtle, american toad, bullfrog, leopard frog
Aquatic Insects	snail, mussel, clam, crayfish, giant water bug
Other	jewelwing, cabbage white, dragonfly, familiar bluet, deer fly, cicada, pollinators caddisfly, scalebug, slug, cricket, spider

Table 1 Wildlife observed along Mud Creek

Mud Creek Water Chemistry

Water Chemistry Measurement

During the stream characterization survey, a YSI probe is used to collect water chemistry information. Dissolved oxygen, conductivity and pH are measured at the start and end of each section.

A volunteer measuring water chemistry using a YSI

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen dissolved in water. The Canadian Environmental Quality Guidelines of the Canadian Council of Ministers of the Environment (CCME) suggest that for the protection of aquatic life the lowest acceptable dissolved oxygen concentration should be 6 mg/L for warmwater biota (red line in Figure 22) and 9.5 mg/L for coldwater biota (blue line in Figure 22) (CCME, 1999). Figure 22 shows that all the surveyed stretches of the creek achieved the standard for warmwater biota. The stretch of creek from Century Rd to Second Line Rd had lower average dissolved oxygen compared to other stretches but it still meets the standard of 6 mg/L.

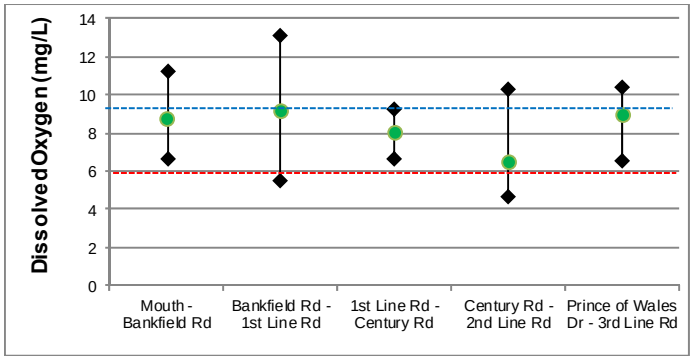

Figure 22 Dissolved oxygen ranges in Mud Creek

Conductivity

Conductivity in streams is primarily influenced by the geology of the surrounding environment, but can vary drastically as a function of surface water runoff. Currently there are no CCME guideline standards for stream conductivity, however readings which are outside the normal range observed within the system are often an indication of unmitigated discharge and/or stormwater input. The average conductivity observed within Mud Creek was 746 µs/cm. Figure 23 shows that the average conductivity in each of the stretches of creek analyzed does not vary significantly from the overall average. The highest conductivity reading on Mud Creek was 957 µs/cm which was recorded in the stretch of creek between Prince of Wales Drive and Third Line Road. The lowest recorded conductivity was 513 µs/cm which was recorded in the stretch of creek downstream of Bankfield Road.

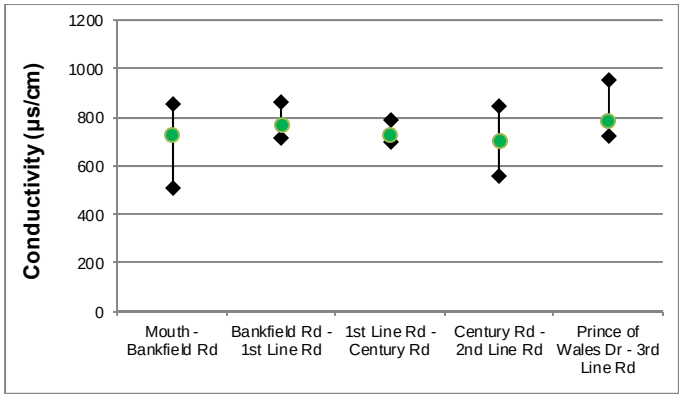

Figure 23 Conductivity ranges in Mud Creek

pH

Based on the PWQO for pH, a range of 6.5 to 8.5 should be maintained for the protection of aquatic life. pH values for Mud Creek ranged between 7.3 and 8.7, thereby meeting the provincial standard.

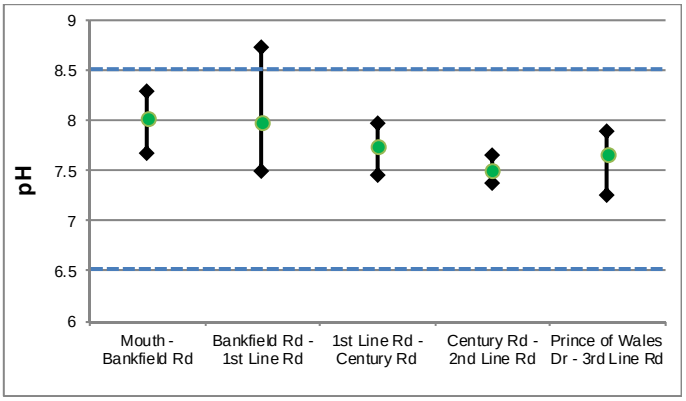

Figure 24 pH ranges in Mud Creek

Mud Creek Thermal Classification

Thermal Classification

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Four temperature loggers were deployed in late April to monitor water temperature in Mud Creek. Water temperature is used along with the maximum air temperature (using a revised Stoneman and Jones method) to classify sampling reaches into one of five categories that correspond to the thermal preferences of local fish communities (figure 27). Figure 25 shows the locations where temperature loggers were installed on Mud Creek Analysis of the data collected indicates that the thermal classification of Mud Creek ranges between coolwater and cool-warm water (Figure 27).

Groundwater

Groundwater discharge areas can influence stream temperature, contribute nutrients, and provide important stream habitat for fish and other biota. During stream surveys, indicators of groundwater discharge are noted when observed. Indicators include: spring/seeps, watercress, iron staining, significant temperature change, and rainbow mineral film. Figure 26 shows areas where one or more groundwater indicators were observed during stream surveys.

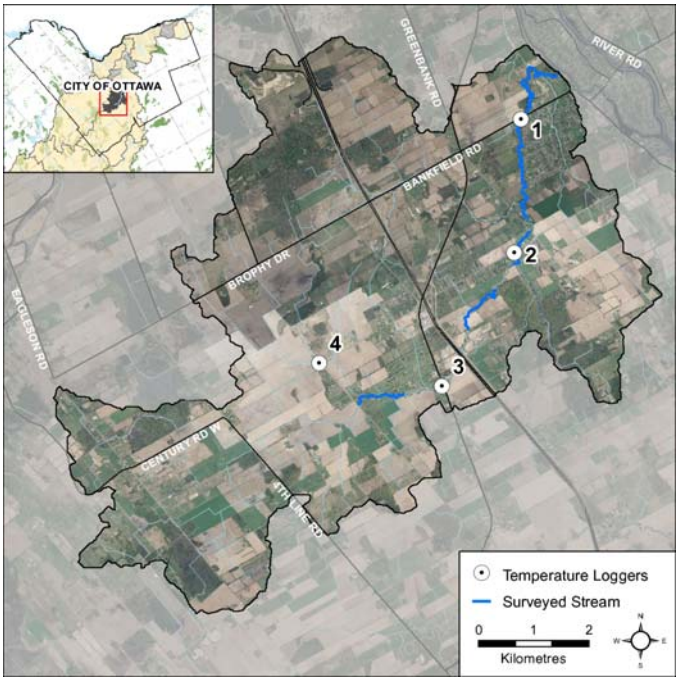

Figure 25 Temperature loggers along Mud Creek

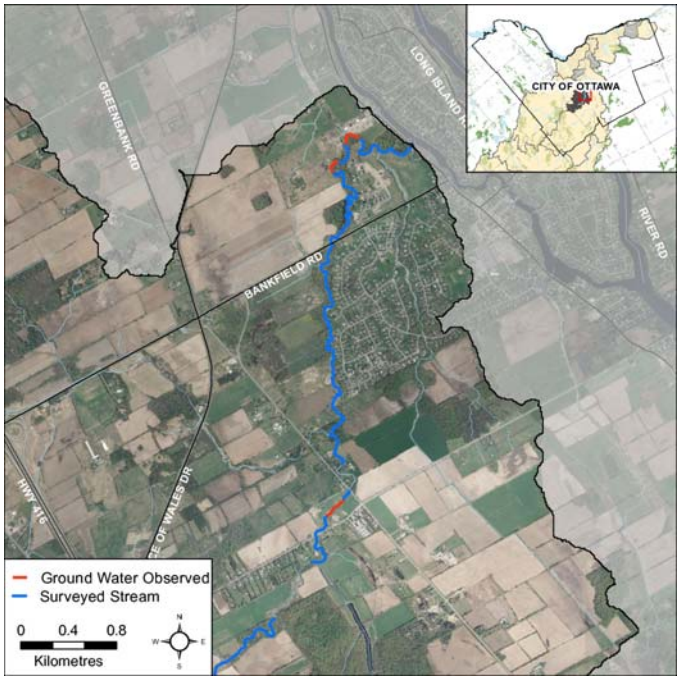

Figure 26 Groundwater indicators observed on Mud Creek

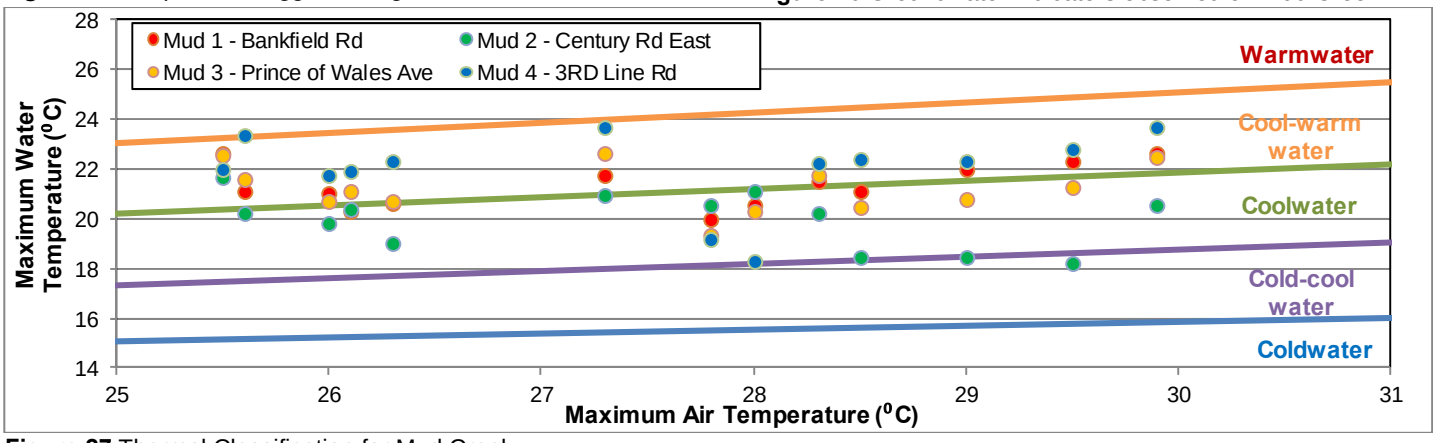

Figure 27 Thermal Classification for Mud Creek

Mud Creek Fish Community

Fish Community

Fish community sampling results for all the fish sampling sessions completed by RVCA from 2003 to 2014 along Mud Creek are shown in Figure 28. The provincial fish codes shown on the following map are listed (in Table 2) beside the common name of those fish species identified in Mud Creek. The thermal classification of Mud Creek ranges between coolwater and cool-warm water. Thirty-four fish species have been observed.

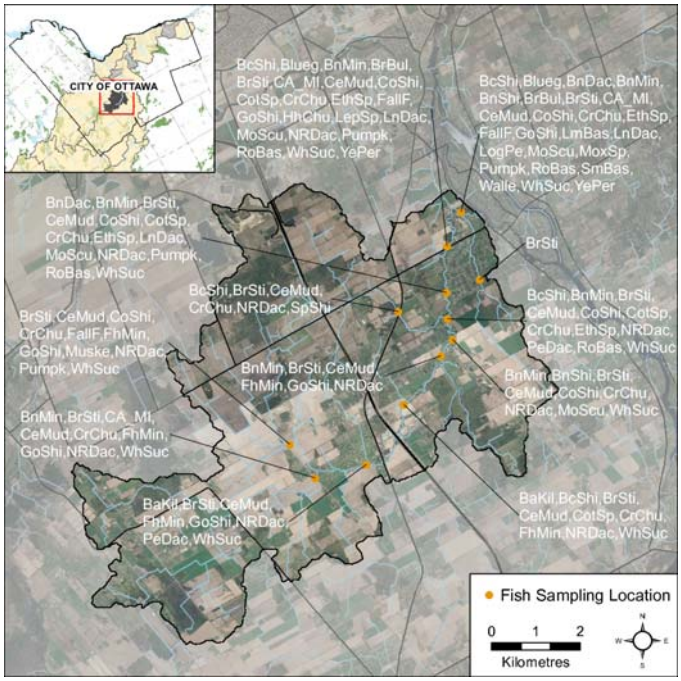

Figure 28 Mud Creek fish community

Species observed in Mud Creek (with fish code)			
banded killifish.....	BaKil	hornyhead chub.....	HdChu
blackchin shiner.....	BcShi	lepomis sp.....	LepSp
bluegill.....	Blueg	largemouth bass.....	LmBas
blacknose dace.....	BnDac	longnose dace.....	LnDac
bluntnose minnow.....	BnMin	logperch.....	LogPe
blacknose shiner.....	BnShi	mottled sculpin.....	MoScu
brown bullhead.....	BrBul	*Moxostoma sp*	MoxSp
brook stickleback.....	BrSti	muskellunge.....	Muske
carps and minnows...	CA_MI	northern redbelly dace	NRDac
central mudminnow...	CeMud	pearl dace.....	PeDac
common shiner.....	CoShi	pumpkinseed.....	Pumpk
Cottus sp	CotSp	rock bass.....	RoBas
creek chub.....	CrChu	smallmouth bass.....	SmBas
Etheostoma sp.....	EthSp	spottail shiner.....	SpShi
fallfish.....	Fallf	walleye.....	Walle
fathead minnow.....	FhMin	white sucker.....	WhSuc
golden shiner.....	GoShi	yellow perch.....	YePer

Table 2 Fish species observed in Mud Creek

Staff pulling a seine net on Mud Creek near First Line Road

Horny head chub and brown bullhead caught on Mud Creek

Walleye caught near the mouth of Mud Creek

Migratory Obstructions

It is important to know locations of migratory obstructions because these can prevent fish from accessing important spawning and rearing habitat. Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. Figure 29 shows that on Mud Creek, one permanent debris dam was observed downstream of First Line Road and one seasonal weir was observed between First Line Road and Century Road East.

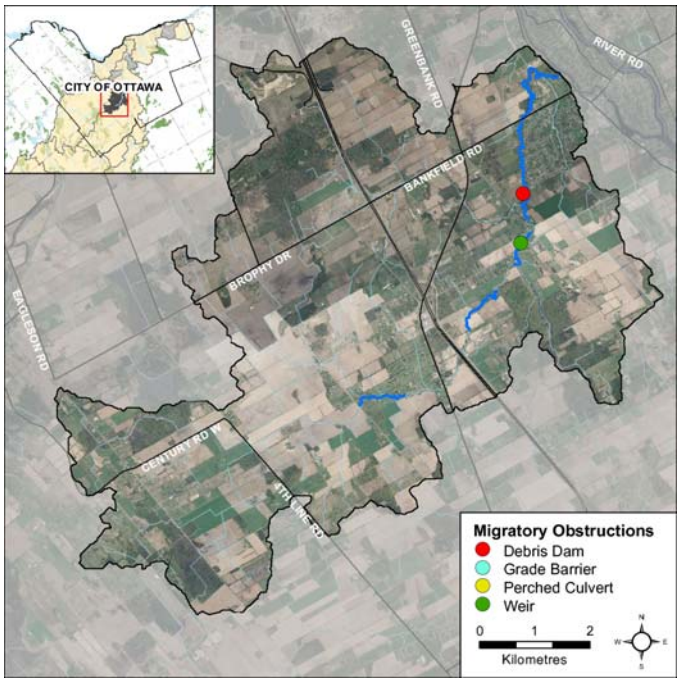

Figure 29 Mud Creek migratory obstructions

Beaver Dams

Beaver dams can also act as obstructions to fish migration. Figure 30 shows that one abandoned beaver dam was observed on Mud Creek downstream of Third Line Road. The head, or difference between the water level up and down stream, of the abandoned beaver dam was 11cm.

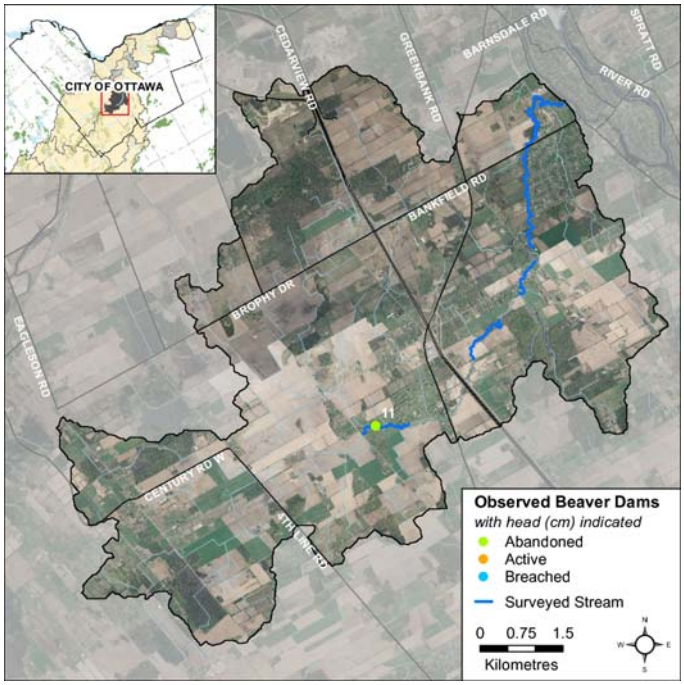

Figure 30 Beaver dams observed on Mud Creek

A seasonal weir observed along Mud Creek

An abandoned beaver dam observed on Mud Creek

Headwater Drainage Feature Sampling

The Headwater Drainage Feature sampling protocol is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features (HDF). An HDF is a depression in the land that conveys surface flow. These features may provide direct, both permanent and seasonal, habitat for fish by the presence of refuge pools, seasonal flow, or groundwater discharge. They may also provide indirect habitat through the contribution of exported food (detritus/invertebrates) (Wipfli and Gregovich 2002).
As a result of their importance and a lack of existing information for headwater drainage features, the City Stream Watch program incorporated monitoring of these systems at 36 sites in the Mud Creek catchment in 2014 (Figure 31).

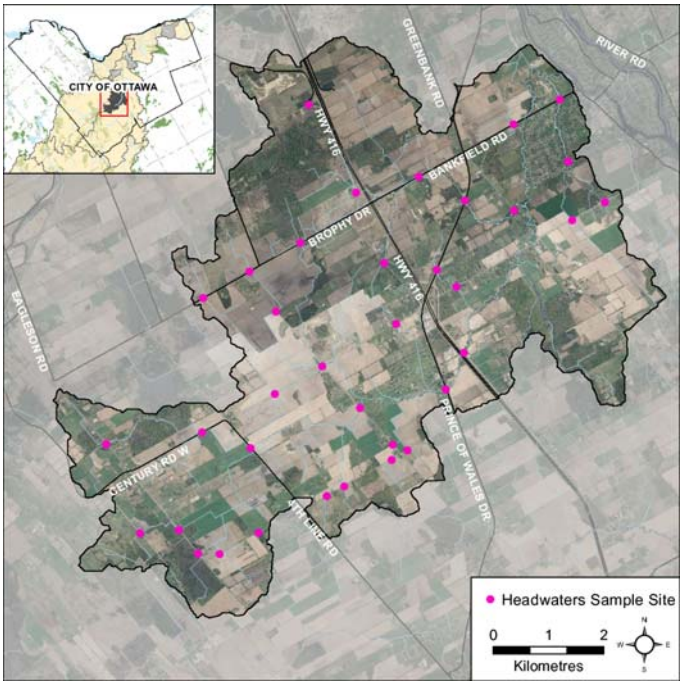

Figure 31 HDF sampling sites on Mud Creek

Headwaters site at Century Road East during spring sampling in April

The same site at Century Road East in August

Below: measuring bankfull width at a headwaters site on Fourth Line

Stream Comparison Between 2008 and 2014

The following tables provide a comparison of observations on Mud Creek between the 2008 and 2014 survey years. Mud Creek was also surveyed in 2003, but the surveying protocol has changed significantly since that time so data from 2003 cannot be compared to data from 2008 and 2014. In addition, the sections surveyed in 2014 were different from the sections surveyed in 2008 so the comparison is only done for those sections that were surveyed in both years. A comparison of the results of fish community sampling is done for all three survey years.

Anthropogenic Changes

Table 3 shows that between 2008 and 2014 anthropogenic alterations along Mud Creek have increased. This change can be attributed to residential development which has taken place between Bankfield Road and First Line Road as well as changes in the stream survey protocol and the classification of channelization. In 2010 anthropogenic alterations were further defined in the protocol, which has caused some land uses to shift categories.

Anthropogenic Alterations	2008 (%)	2014 (%)
No anthropogenic alterations	63	51
"Natural" conditions with minor human alterations	28	15
"Altered" with considerable human impact but significant natural portions	8	19
"Highly altered" by humans with few natural portions	0	14

Table 3 Comparison of anthropogenic alterations along Mud Creek between 2008 and 2014

A pedestrian bridge near Revell Drive that was not present in 2008

Bank Stability Changes

According to observations bank stability has improved overall since 2008. In 2008, 72 percent of the left bank and 74 percent of the right bank were considered stable. In 2014, 94 percent of the left bank and 93 percent of the right bank were stable. Mud Creek is a very stable system overall with most of the erosion occurring in areas between Rideau Valley Drive and First Line Road.

Bank Stability	2008 (%) Left Bank	2008 (%) Right Bank	2014 (%) Left Bank	2014 (%) Right Bank
Stable	72	74	94	93
Unstable	28	26	6	7

Table 4 Comparison of bank stability along Mud Creek between 2008 and 2014

Changes in Instream Vegetation

Figure 32 shows that there has been a decrease in instream vegetation in Mud Creek since 2008. The amount of extensive levels of vegetation totaled 17 percent in 2008, and that number has decreased to 5 percent in 2014. In addition, the number of areas classified as having common levels of vegetation has decreased from 54 percent in 2008 to 30 percent in 2014. The decrease in instream vegetation may be in part attributed to increased sedimentation in the system but vegetation growth is also dependent on climatic variables as well as the stage of the growing season when observations took place.

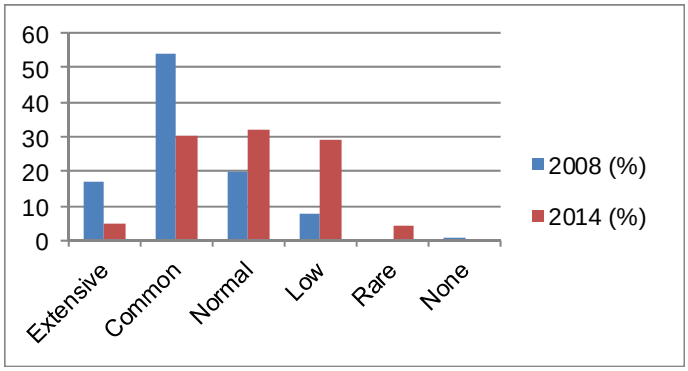

Figure 32 Comparison of instream vegetation levels between 2008 and 2014

Changes in Pollution and Garbage

Overall the amount of pollution and garbage in Mud Creek has decreased since 2008. Table 5 shows that the number of sections surveyed that were free from garbage has increased from 47 to 56 percent since 2008.

Pollution/Garbage	2008 (%)	2014 (%)
None	47	56
Floating garbage	35	21
Garbage on stream bottom	13	28
Oil or gas trails	5	0
Discoloration of channel bed	2	0

Table 5 Comparison of pollution/garbage levels between 2008 and 2014

Mud Creek upstream of Revell Drive

Mud Creek upstream of Century Road

Fish Community

Fish sampling was conducted on Mud Creek by the City Stream Watch program in 2003, 2008 and 2014. In total, 26 species of fish have been captured through City Stream Watch fish sampling efforts.
In 2003, eight species were caught in one fish sampling session using a seine net. In 2008 fish sampling effort was significantly increased resulting in seventeen species were caught by seining at seven sites and electrofishing at two sites. In 2014, 24 species were caught using a variety of methods (electrofishing, seining, fyke nets) at seven sites.
Two species caught in 2008 were not found in 2014, which are blackchin shiner, and largemouth bass. This does not mean the species have disappeared from Mud Creek but could be influenced by location, weather conditions or time of sampling.

Species	Code	2003	2008	2014
blackchin shiner.....	BcShi		X	
bluegill.....	Blueg			X
blacknose dace.....	BnDac		X	X
bluntnose minnow.....	BnMin	X	X	X
blacknose shiner.....	BnShi	X	X	X
brown bullhead.....	BrBul			X
brook stickleback.....	BrSti		X	X
carps and minnows....	CA_MI		X	X
central mudminnow.....	CeMud		X	X
common shiner.....	CoShi	X		X
creek chub.....	CrChu	X	X	X
Etheostoma sp.....	EthSp	X	X	X
fallfish.....	Fallf			X
fathead minnow.....	FhMin			X
golden shiner.....	GoShi		X	X
hornyhead chub.....	HdChu			X
largemouth bass.....	LmBas		X	
longnose dace.....	LnDac		X	X
mottled sculpin.....	MoScu	X	X	X
Moxostoma sp	MoxSp			X
northern redbelly dace	NRDac			X
pumpkinseed.....	Pumpk		X	X
rock bass.....	RoBas	X	X	X
walleye.....	Walle			X
white sucker.....	WhSuc	X	X	X
yellow perch.....	YePer		X	X
Total		**8**	**17**	**24**

Table 6 Comparison of fish species caught in 2003, 2008 and 2014

Monitoring and Restoration

Monitoring and Restoration Projects on Mud Creek

Table 7 below highlights the monitoring and restoration work that has been done on Mud Creek to date by the Rideau Valley Conservation Authority.

Accomplishment	Year	Description
City Stream Watch Monitoring	2003	37 stream surveys were completed on Mud Creek
	2008	95 stream surveys were completed on Mud Creek
	2014	78 stream surveys were completed on Mud Creek
City Stream Watch Fish Sampling	2003	One site was sampled on Mud Creek
	2008	Seven sites were sampled on Mud Creek
	2014	Eight sites were sampled on Mud Creek
City Stream Watch Termal Classification	2008	Three temperature loggers were deployed
	2014	Four temperature loggers were deployed
City Stream Watch Headwater Drainage Feature Sampling	2014	36 headwater drainage feature sites were sampled in the Mud Creek catchment
City Stream Watch Invasive Species Removal	2014	City Stream Watch volunteers removed Himalayan Balsam from Mud Creek
Shoreline Naturalization Program Planting	2010 -2014	Shoreline Naturalization Program staff and volunteers have completed 13 projects planting over 3000 shrubs and trees along Mud Creek

Table 7 Monitoring and Restoration on Mud Creek

Mud Creek Himalayan Balsam Removal

A patch of Himalayan Balsam was observed during stream surveys this year on Mud Creek. City Stream Watch staff returned to the site with one volunteer for three hours to remove the plants. Ten paper yard waste bags were filled with Himalayan Balsam plants and 50m of shoreline was successfully cleared of the invasive species before it spread any further along the stream banks.

Volunteer and staff removing Himalayan Balsam along Mud Creek

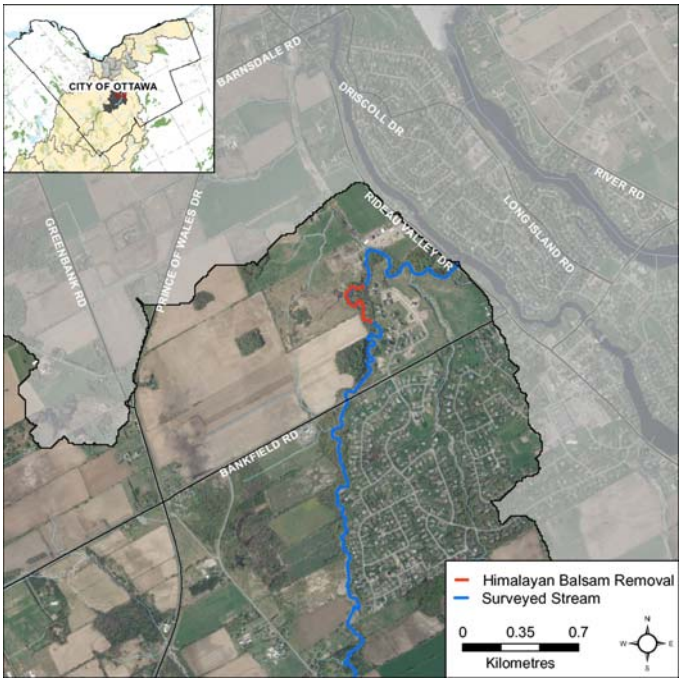

Figure 33 Himalayan Balsam Removal on Mud Creek

Potential Riparian Restoration Opportunities

Figure 34 depicts the locations where City Stream Watch staff and volunteers made note of areas where the riparian zone could be restored or enhanced using one or more of the following techniques: riparian planting, erosion control, invasive species control and wildlife habitat creation.
The majority of the opportunities listed were riparian planting and erosion control in targeted developed areas along the creek.

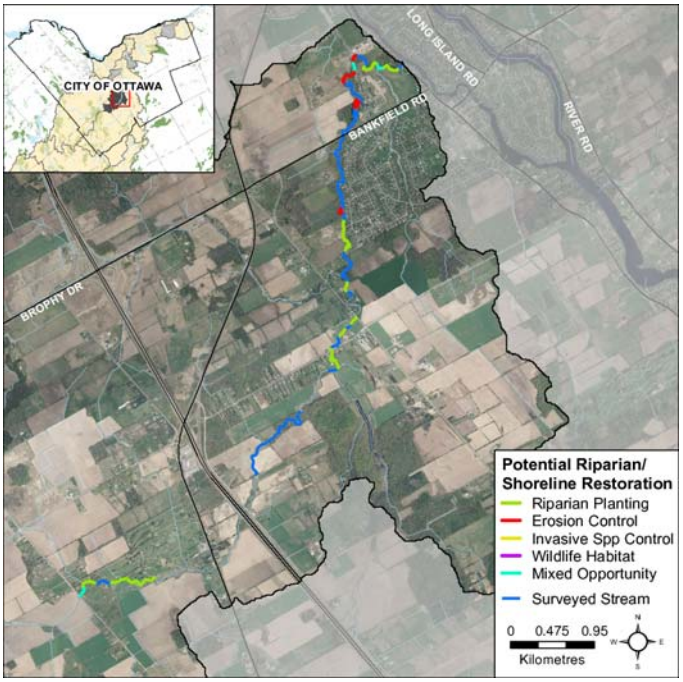

Figure 34 Potential riparian/shoreline restoration opportunities

An area along Mud Creek with riparian planting opportunity on the left bank

Potential Instream Restoration Opportunities

Figure 35 depicts the locations where City Stream Watch staff and volunteers made note of areas where there were one or more of the following instream restoration opportunities: fish habitat enhancement, garbage cleanup and channel modification.
There were two opportunities for fish habitat enhancement; one upstream of First Line Road and one downstream of First Line Road. There was also a small garbage cleanup opportunity downstream of First Line Road.

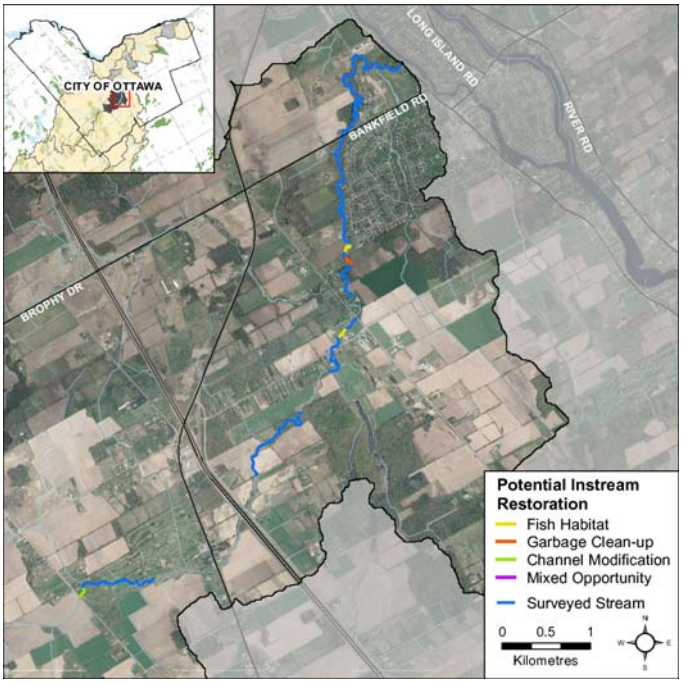

Figure 35 Potential instream restoration opportunities

An area along Mud Creek where fish habitat would be enhanced by removing a seasonal migratory obstruction



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For more information on the overall 2014 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2014 Summary Report.