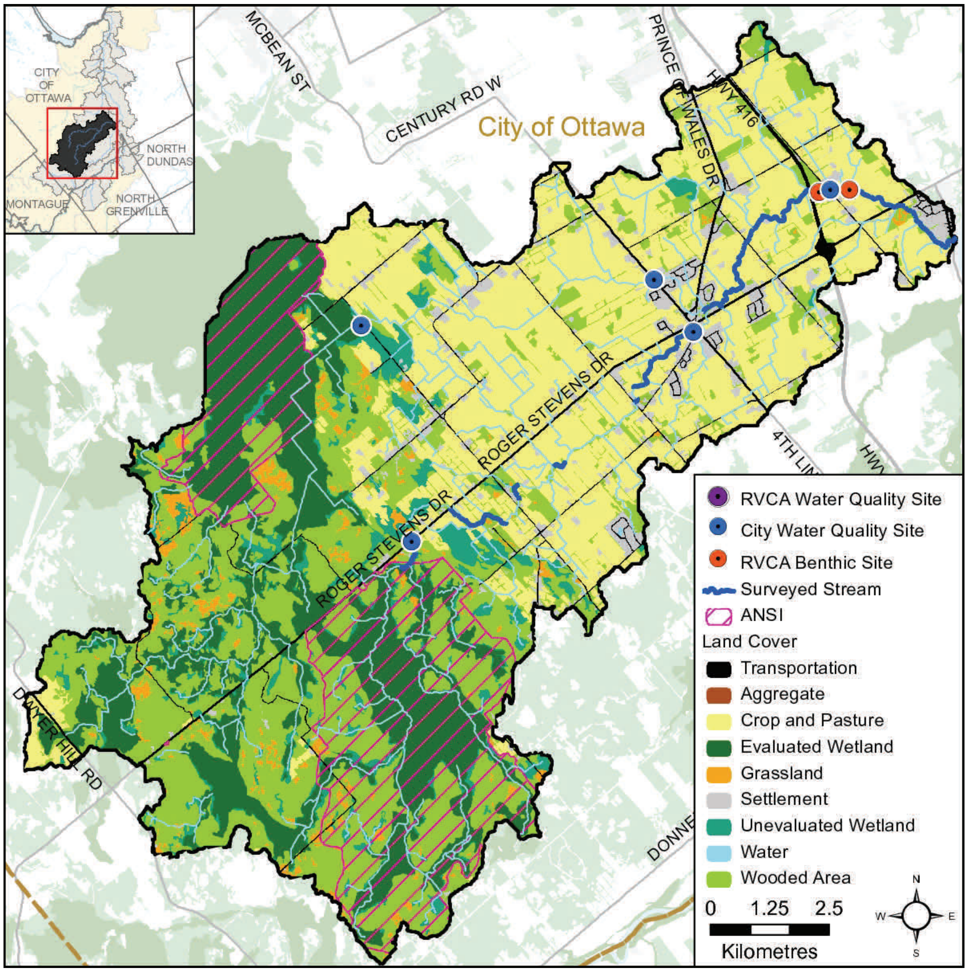
STEVENS CREEK CATCHMENT

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 Stevens 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 Lower Rideau Subwatershed Report, please visit the RVCA website at www.rvca.ca.

Inside

Catchment Facts

- Extensive areas of low-lying cultivated lands and a small number of residential and farm structures between North Gower and Kars are flood prone
- Older portions of the Village of North Gower have been inundated in the past and are within the designated flood plain - newer suburban developments in the North Gower area are above expected 1:100 year flood levels
- No artificial water controls on Steven Creek itself, but water levels on the lower reaches of the Creek (from approximately Third Line Road to the Rideau River are affected by the managed water levels of the Rideau Waterway (as controlled at the dams in Manotick and flow releases from upstream reaches of the Waterway), and by Rideau River flood level (with the dams at Manotick fully opened)
- Drains 166 sq. km of land or 21.6% of the Lower Rideau Subwatershed and 3.9% of the Rideau Valley Watershed
- Dominant land cover is crop and pastureland (36%), followed by woodland (30%), wetland (26%), settlement (5%), transportation (2%) and grassland (1%)
- Riparian buffer (30 m. wide along both sides of Stevens Creek and its tributaries) is comprised of crop and pastureland (41%), wetland (40%), woodland (13%), settlement (3%), transportation (2%) and grassland (1%)
- Contains a warm/cool water recreational and baitfish fishery with 28 fish species
- Contains 49 municipal drains
- Water quality rating along Stevens Creek is good at Roger Stevens Road, poor at Main Street in North Gower and fair at Second Line Road. Over a 12 year reporting period (2000-2005 vs. 2006-2011), the water quality rating has improved at Roger Stevens Road, declined in North Gower (at Main Street) and declined at Second Line Road
- Along the Taylor Drain, the water quality rating is good at Proven Line Road (over a six year period from 2006-2011) and poor at Fourth Line Road, with no change in the water quality rating observed over a 12 year reporting period (2000-2005 vs. 2006-2011)
- Woodland cover has decreased by 5.6 percent (927 ha.) from 2002 to 2008
- One hundred and thirty-three stewardship (landowner tree planting/ clean water/shoreline naturalization) projects have been completed
- Flood plain mapping from Village of North Gower to Rideau River was first completed in 1972 and was updated in 1995 (upstream to Malakoff Road)
- Major studies completed include: North Gower Master Drainage Plan. 1995 (Gore and Storrie for Rideau Twp.); North Gower Community Design Plan. 2006 (City of Ottawa)
- Since 2003, the RVCA has conducted benthic macroinvertebrate sampling downstream of Third Line Road; between 2005 and 2011, fish sampling has been conducted on Stevens Creek and its tributaries by the RVCA, City of Ottawa, City Stream Watch and volunteers; also in 2005 and 2011, volunteers undertook macro stream surveys; in 2011, RVCA staff undertook temperature profiling to gain a better understanding of temperature and habitat variations along 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. Stevens Creek

Surface water quality conditions in Stevens Creek are monitored through the City of Ottawa's Baseline Water Quality Program. See Fig. 1 and Table 2 for their locations.

The water quality rating for Stevens Creek ranges from “Good” to "Poor" (Table 2) 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. For more information on the CCME WQI please see the Lower Rideau Subwatershed Report.

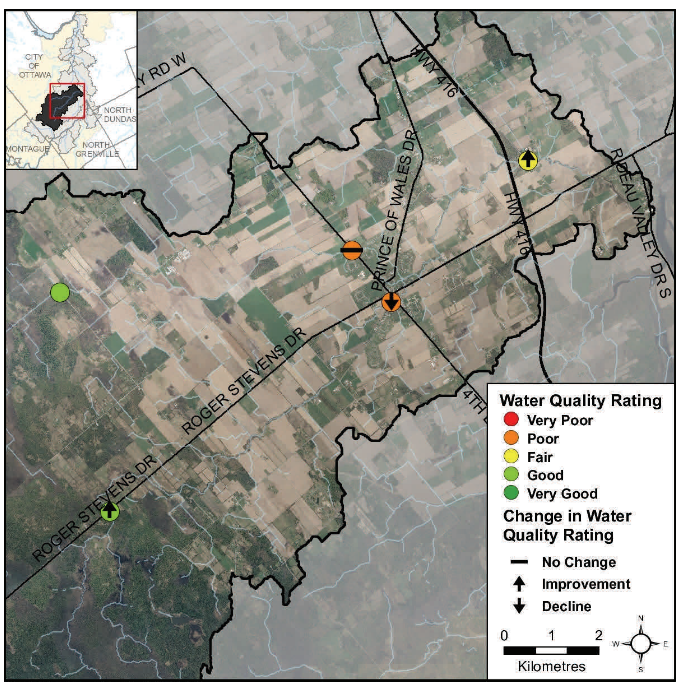


Figure 1. Sampling sites on Stevens Creek and Taylor Drain

Table 1 outlines the WQI scores and their corresponding ratings and Table 2 shows the overall rating for the three monitored sites in Steven's Creek.

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. Water Quality Index Ratings for Steven's Creek from 2000-2005 and 2006-2011

Sampling Site	Nearest Intersection	2000-2005	Rating
CK42-07	Roger Stevens and Malakoff	76	Fair
CK42-04	Church St and 4th Line	65	Fair
CK42-06	2nd Line, south of Phelan Rd	62	Poor
Sampling Site	**Nearest Intersection**	**2006-2011**	**Rating**
CK42-07	Roger Stevens and Malakoff	82	Good
CK42-04	Church St and 4th Line	59	Poor
CK42-06	2nd Line, south of Phelan Rd	64	Fair

Stevens 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. Stevens Creek TP results are shown in Figures 2a and 2b. In addition to the TP guideline, the LRWS set the target for TP concentration of 0.030 mg/l (PWQO) at the 85th percentile for tributaries of the Rideau River, such as Stevens 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. Stevens Creek TKN results are shown in Figures 4a and 4b.

Tables 3 and 4 summarize average nutrient concentrations at monitored sites on Stevens Creek and shows the proportion of samples that meet the guidelines. Highlighted values indicate average value exceeds the guideline.

Table 3. Summary of total phosphorous results for Stevens Creek from 2000-2005 and 2006-2011

Total Phosphorous 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.010	98	52
CK42-04	0.049	38	55
CK42-06	0.076	21	52
Total Phosphorous 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.010	100	52
CK42-04	0.059	36	53
CK42-06	0.094	13	54

Table 4. Summary of total Kjeldahl nitrogen results for Stevens Creek from 2000-2005 and 2006-2011

Total Kjeldahl nitrogen 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.625	33	52
CK42-04	0.863	5	57
CK42-06	0.921	2	52
Total Kjeldahl nitrogen 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.572	38	52
CK42-04	0.771	11	53
CK42-06	0.796	6	54

Stevens Creek Nutrients: Site CK42-07

Site CK42-07 in the upper portion of the creek has relatively low TP with average concentration 0.010 mg/l throughout the period of interest. Ninety-eight percent of sample results (Fig. 2a) met the TP guideline in the 2000 -2005 period; all samples (Fig. 2b) met the guideline in the 2006-2011 period. The target of the LRWS has been achieved at this site as TP concentrations at the 85th percentile are below the guideline in both time periods (Fig. 3a and 3b).

The average concentrations of TKN declined at this site between the two time periods from 0.625 mg/l to 0.572 mg/l. Thirty-eight percent of samples (Fig. 4b) met the TKN guideline in 2006-2011 compared to thirty-three percent (Fig. 4b) from 2000-2005.

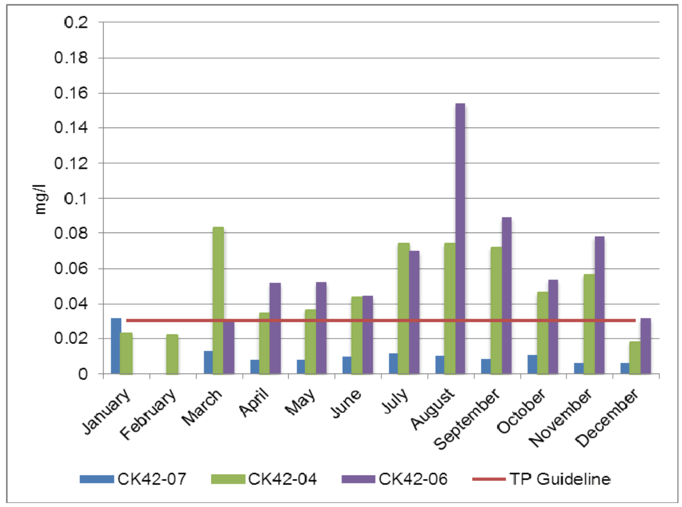


Figure 2.a Total phosphorous concentrations in Stevens Creek from 2000-2005

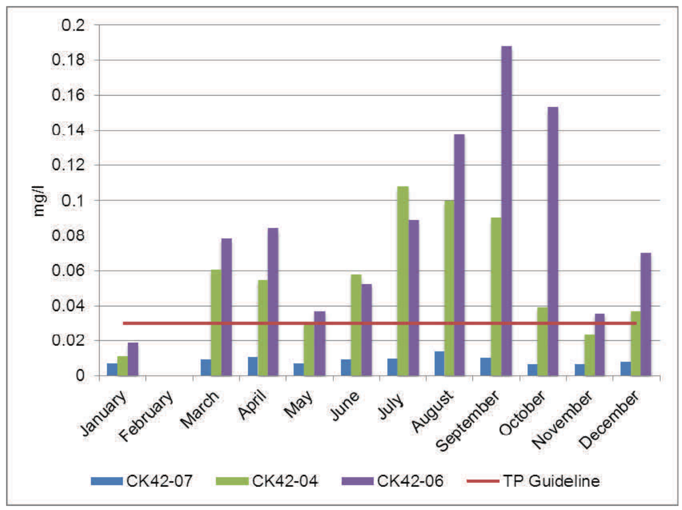


Figure 2b. Total phosphorous concentrations in Stevens Creek from 2006-2011

Stevens Creek Nutrients: Site CK42-04

Site CK42-04 is located further downstream in the village of North Gower. The average TP concentration increased slightly at this site from 0.049 mg/l to 0.059 mg/l. From 2000-2005 (Fig. 2a) and 2006-2011 (Fig. 2b), the number of samples below the guideline was comparable; 38 percent and 36 percent respectively. The LRWS target was exceeded in both time periods with the concentration at the 85th percentile increasing from 0.075 mg/l (Fig. 3a) to 0.093 mg/l (Fig. 3b).

The average concentration of TKN declined at this site between the two time periods from 0.863 mg/l to 0.771 mg/l, though still exceed the guideline. Eleven percent of samples met the TKN guideline in 2006-2011 (Fig. 4a) compared to only five percent in 2000-2005 (Fig. 4b).

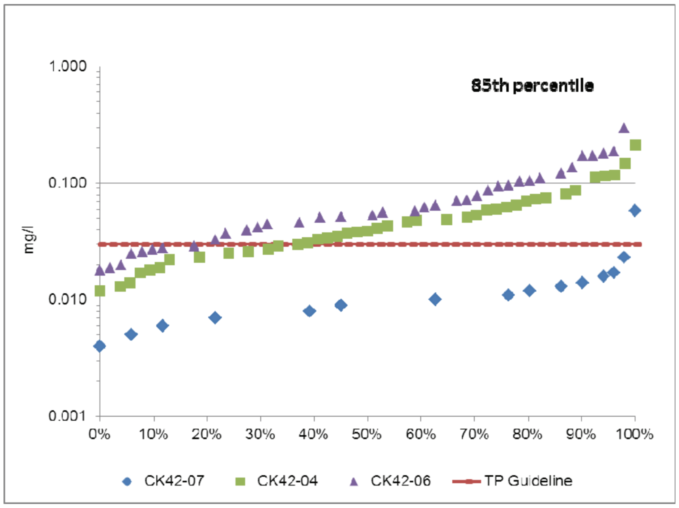


Figure 3a. Percentile plots of total phosphorous in Stevens Creek from 2000-2005

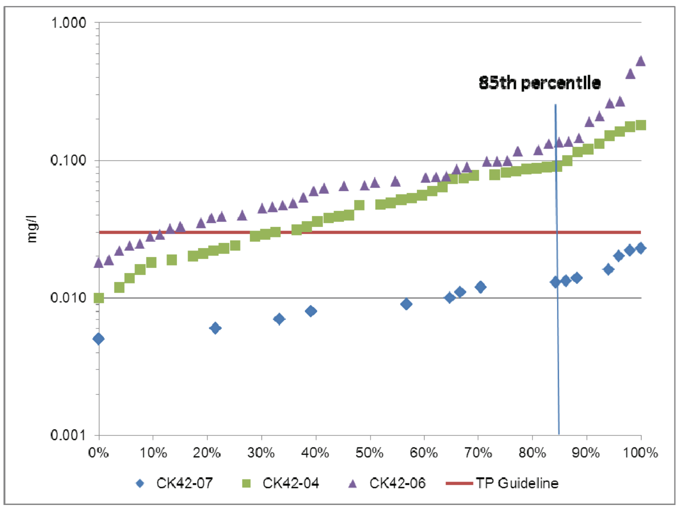


Figure 3b. Percentile plots of total phosphorous in Stevens Creek from 2006-2011

Stevens Creek Nutrients: Site CK42-06

Site CK42-06 has the highest nutrient concentrations of all sites monitored on Stevens Creek; it is also the furthest downstream site where nutrients may accumulate. Average TP concentrations increased from 0.076 mg/l (Fig. 2a, 2000-2005) to 0.094 mg/l (Fig. 2b, 2006-2011). Similarly the proportion of samples below the TP guideline also fell during these same time periods from 21 percent (2000-2005) to 13 percent (2006-2011). This site also did not achieve the LRWS target, between the two time periods (2000-2005 and 2006-2011) the TP concentration at the 85th percentile increased from 0.115 mg/l to 0.135 mg/l (Fig. 3a and Fig. 3b).

TKN results revealed a different trend with a drop in average concentrations from 0.921 mg/l (Fig. 4a, 2000-2005) to 0.796 mg/l (Fig. 4b, 2006-2011). Though a reduction in the overall concentration was observed, very few samples were below the TKN guideline itself; two percent of samples in 2000-2005 and six percent of samples in 2006-2011.

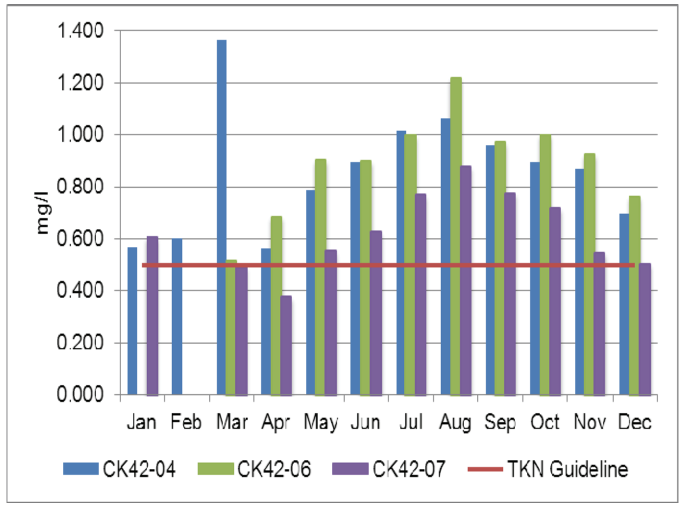


Figure 4a.Total Kjeldahl nitrogen concentrations in Stevens Creek from 2000-2005

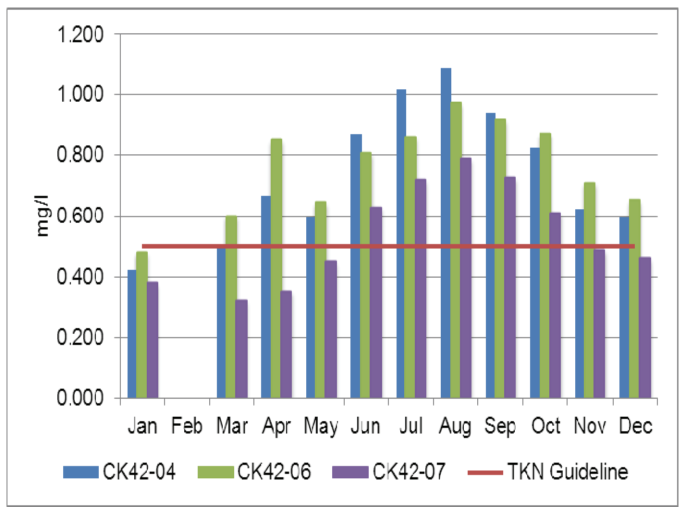


Figure 4b. Total Kjeldahl nitrogen concentrations in Stevens Creek from 2006-2011

Stevens Creek Nutrients Summary

The data shows that nutrient enrichment is a problem in Stevens Creek, the only site that meets water quality objectives (PWQO and LRWS) is site CK42-07 in the upper reaches of the creek. This indicates that downstream nutrient loading is negatively impacting the water quality as Stevens Creek flows towards the Rideau River.

Stevens 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 Objectives 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 (2005) also set a target of E. coli counts at the 200 CFU/100ml for the 80th percentile and no counts that exceed 200 CFU/100ml in tributaries of the watershed.

Table 5 summarizes the geometric mean at monitored sites on Stevens 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 5. Summary of E. coli results for Stevens Creek.

E. coli 2000-2005			
Site	Geometric Mean	% Below Guideline	No. Samples
CK42-07	23	84	50
CK42-04	100	44	55
CK42-06	68	67	51
E. coli 2006-2011			
Site	**Geometric Mean**	**% Below Guideline**	**No. Samples**
CK42-07	62	69	52
CK42-04	158	38	53
CK42-06	85	59	54

The results presented in table 5 show that overall E. coli counts have increased at all monitored sites in Stevens Creek between the 2000-2005 and 2006-2011 period. A comparison between figures 5a and 5b also shows that the frequency of samples with counts greater than 500 CFU/100ml increased at all sites between the two time periods.

Stevens Creek E. coli: Site CK42-07

Site CK42-07 had a large increase in the geometric mean from 23 CFU/100m (Fig. 5a, 2000-2005) to 62 CFU/100ml (Fig. 5b, 2006-2011). Sixty nine percent of samples in 2006-2011 were below the E. coli guideline, this is a decrease from the 2005-2005 period where 84 percent of samples were below the guideline. The count at the 80th percentile increased from 63 CFU/100ml (Fig. 6a) to 434 CFU/100ml (Fig. 6b) exceeding the LRWS target in the 2006-2011 period.

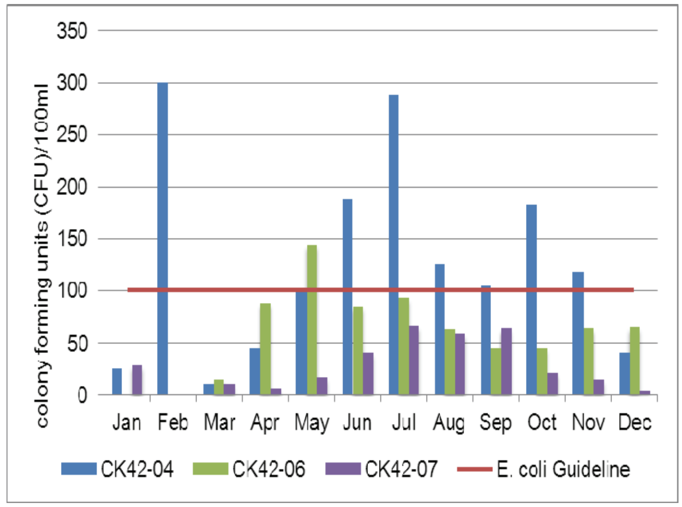


Figure 5a. E. coli counts for Stevens Creek from 2000-2005

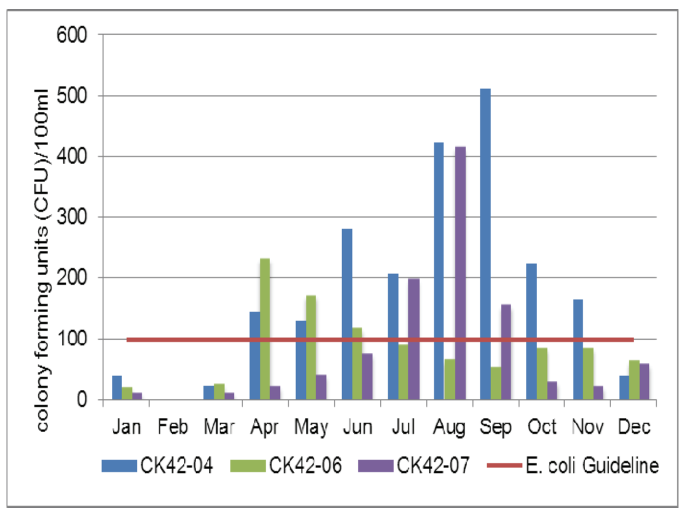


Figure 5b. E. coli counts in Stevens Creek from 2006-2011

Stevens Creek E. coli: Site CK42-04

Site CK42-04 had a geometric mean of 158 CFU/100mL for samples taken from 2006-2011 (Fig. 5b) an increase from 100 CFU/100ml reported between 2000-2005 (Fig. 5a). Similarly the proportion of samples below the guideline also decreased from 44 percent to 38 percent, respectively. The LRWS target was exceeded in both the 2000-2005 and 2006-2011 periods. The count at the 80th percentile increased from 212 CFU/100ml (Fig. 6a) to 518 CFU/100ml (Fig. 6b)

Stevens Creek E. coli: Site CK42-06

At site CK42-06 the geometric mean also showed increasing E. coli counts on Stevens Creek in the monitoring period. The E. coli counts at the geometric mean increased overall, from 68 CFU/100ml (Fig. 5a, 2000-2005) to 85 CFU/100ml (Fig. 5b, 2006-2011). The proportion of samples below the guideline dropped from 67 percent (2000-2005) to 59 percent (2006-2011). E. coli counts at the 80^{th} percentile were below the LRWS target during both periods and no count exceeded 2000 CFU/100ml (Fig. 6a and Fig. 6b).

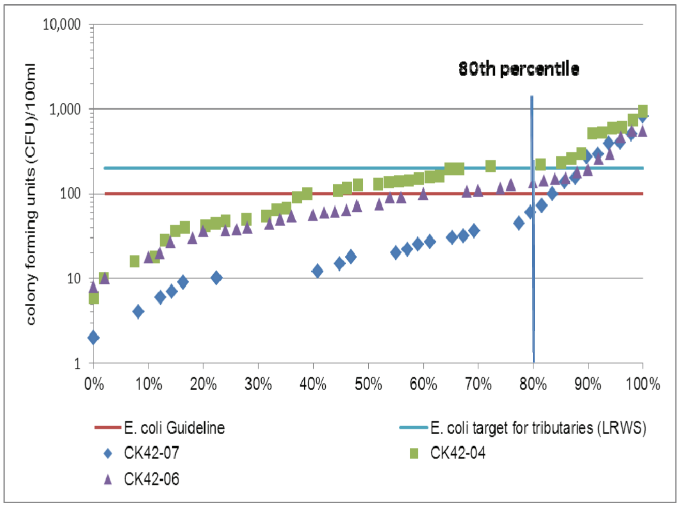


Figure 6a. Percentile plots of E. coli in Stevens Creek for 2000-2005

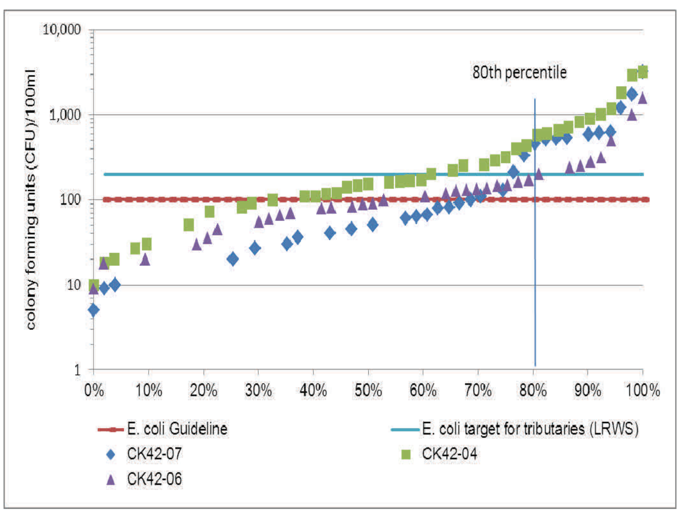


Figure 6b. Percentile plots of E. coli in Stevens Creek from 2006-2011

Stevens Creek E. coli Summary

The results indicate that bacterial contamination continues to be a problem in Stevens Creek; counts have increased at all sites in recent years, with high average counts, frequent exceedances and a greater proportion of results that exceed the E. coli guideline.

Stevens Creek Metals

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

Table 6 summarizes average metal concentrations at monitored sites on Stevens Creek and shows the proportion of samples that meet guidelines. Highlighted values indicate averages that have exceeded the 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 (2005) also set a target for Cu concentration of 0.005mg/l at the 80^{th} percentile. Figure 10 shows percentile plots of the data for the two time periods of interest (Fig. 10a, 2000-2005) (Fig. 10b, 2006-2011). Any point to the left of the 80^{th} percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target

Stevens Creek Metals: Site CK42-07

Site CK42-07 in the upper portion of the creek, had low concentrations of all metals throughout the period of interest, with the majority of samples below the guideline for each metal. The concentration of Cu at the 80^{th} percentile increased from 0.003 mg/l (Fig. 10a) to 0.005 mg/l (Fig. 10b), just meeting the LRWS in the 2006-2011 period.

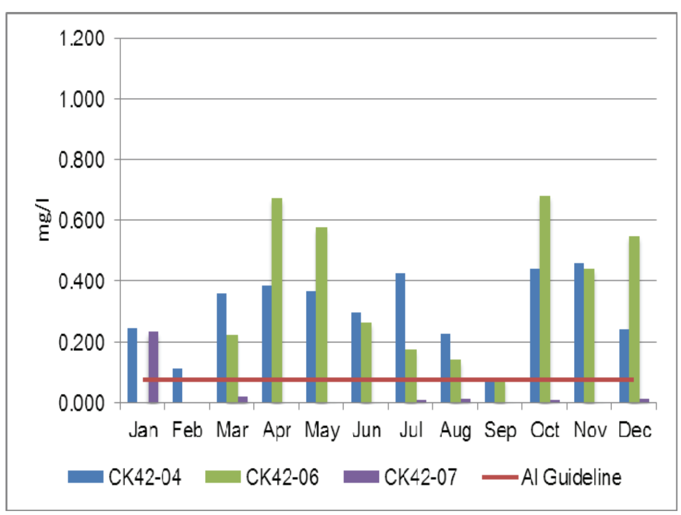


Figure 7a. Aluminum concentrations in Stevens Creek from 2000-2005

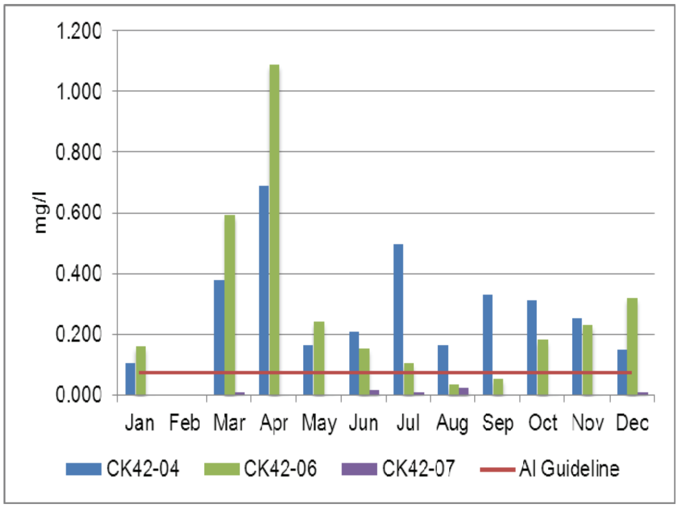


Figure 7b. Aluminum concentrations in Stevens Creek from 2006-2011

Stevens Creek Metals: Site CK42-04

Further downstream the results for site CK42-04 showed very high aluminum results with fewer than 20 percent of samples below the guideline of 0.075 mg/l; average concentrations were 0.326 mg/l (Fig. 7a, 2000-2005) and 0.311 mg/l (Fig. 7b, 2006-2011).

Fe concentrations did exceed the guideline of 0.300 mg/l, however there was a slight decrease between the two time periods. Average Fe concentrations were 0.414 mg/l with 49 percent of samples below the guideline in 2000-2005 (Fig. 8a) and dropped to an average concentration of 0.399 mg/l; with 57 percent of sample below the guideline in 2006-2011 (Fig. 8b).

An increase can also be seen in average Cu concentrations from 0.002 mg/l (Fig. 9a, 2000-2005) to 0.006 mg/l (Fig. 9b, 2006-2011). Though this seems like a slight change it is more significant when noted that the proportion of samples below the Cu guideline fell from 91 percent to 86 percent between the two monitoring periods. The LRWS was exceeded in the 2006-2011 period as concentrations at the 80th percentile increased from 0.004 mg/l (Fig. 10a) to 0.006 mg/l (Fig. 10b).

Stevens Creek Metals: Site CK42-06

Site CK42-06 is the furthest site downstream and had results similar to CK42-04. Al concentrations showed a slight decrease from an average of 0.383 mg/l and 22 percent of samples below the guideline from 2000-2005 (Fig. 7a) to 0.291 mg/l with 31 percent of samples below the guideline from 2006-2011 (Fig. 7b).

Table 6. Summary of metal results for Stevens Creek.

Aluminum (Al)			
2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.017	98	51
CK42-04	0.326	11	55
CK42-06	0.383	22	50
2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.01	98	52
CK42-04	0.311	19	53
CK42-06	0.291	31	54
Copper (Cu)			
2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.002	98	51
CK42-04	0.002	91	55
CK42-06	0.003	90	50
2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.003	81	52
CK42-04	0.006	68	53
CK42-06	0.005	72	54
Iron (Fe)			
2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-07	0.172	82	51
CK42-04	0.414	49	55
CK42-06	0.461	44	50
2006-2011			
Site	Average (mg/l)2	% Below Guideline3	No. Samples4
CK42-07	0.129	94	52
CK42-04	0.399	57	53
CK42-06	0.341	61	54

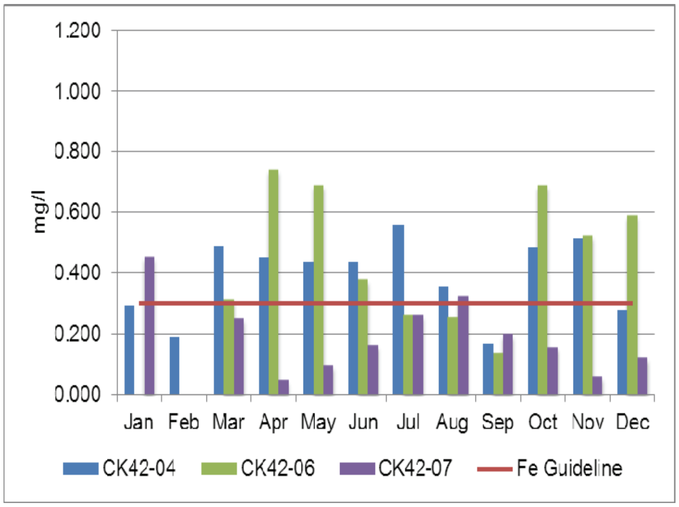


Figure 8a. Iron concentrations in Stevens Creek from 2000-2005

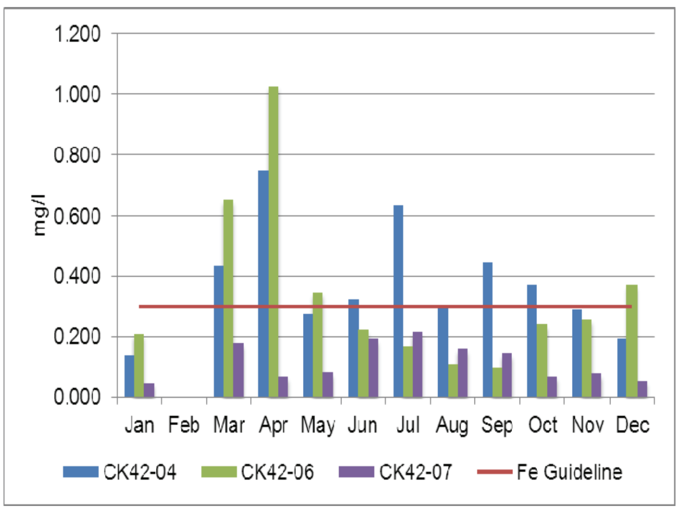


Figure 8b. Iron concentrations in Stevens Creek from 2006-2011

As with the results for Al a slight decrease was also observed in average Fe concentrations from 0.461 mg/l and 44 percent of samples below the guideline (Fig. 8a, 2000-2005) to 0.341 mg/l and 61 percent of samples below the guideline (Fig. 8b, 2006-2011).

Between these same time periods Cu concentration increased slightly from 0.003 mg/l to 0.005 mg/l, and a decrease in the proportion of samples below the guideline of 0.005 mg/l from 90 percent (Fig. 9a) to 72 percent (Fig. 9b). Concentrations at the 80th percentile increased slightly from 0.004 mg/l (Fig. 10a) to 0.005 mg/l (Fig. 10b) to just meet the LRWS target.

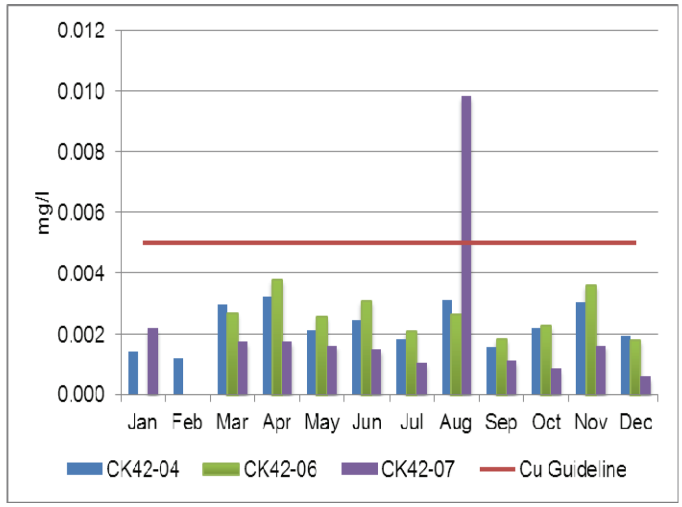


Figure 9a. Copper concentrations in Stevens Creek from 2000-2005

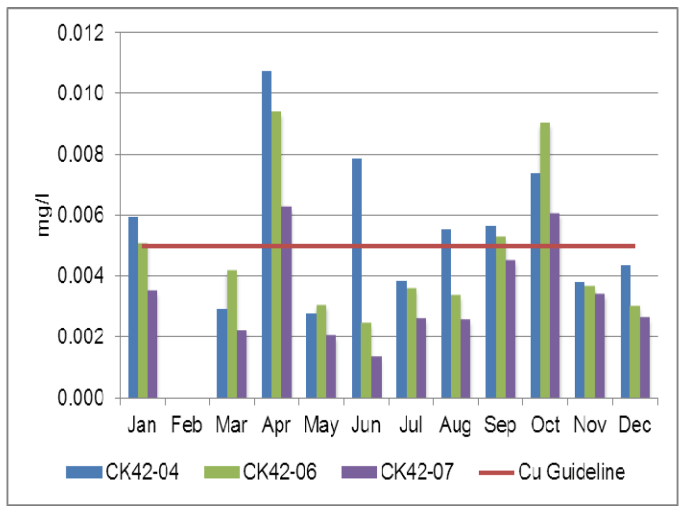


Figure 9b. Copper concentrations in Stevens Creek from 2006-2011

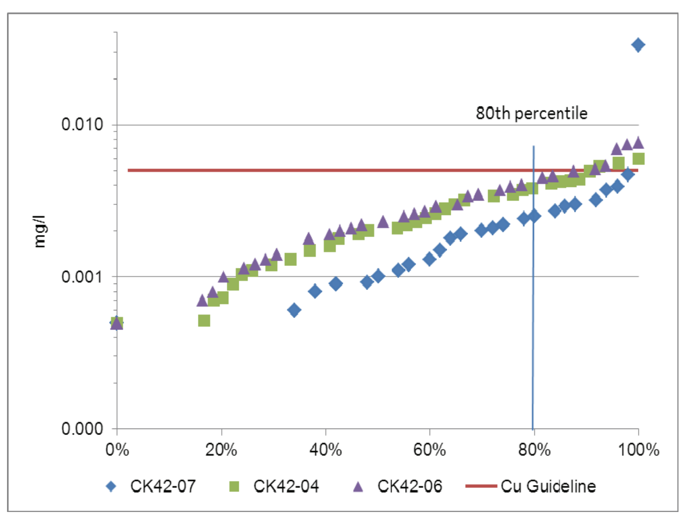


Figure 10a. Percentile plots of Copper in Stevens Creek from 2000-2005

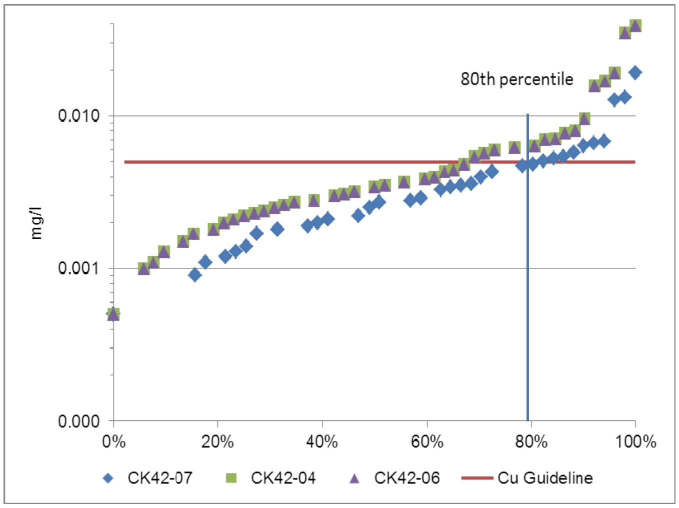


Figure 10b. Percentile plots of Copper in Stevens Creek from 2006-2011

Stevens Creek Metals Summary

Overall a slight decrease was observed in metal concentrations between the two periods of interest with the exception of Cu. However the concentration of all metals tends to exceed the guidelines at sites CK42-04 and CK42-06. This indicates that upstream pollution sources are likely impacting the system and deteriorating water quality; efforts should be made to reduce any inputs to improve overall stream health.

Stevens 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 Stevens Creek in Rideau Municipality, 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 Stevens Creek at Second Line 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 Stevens 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.

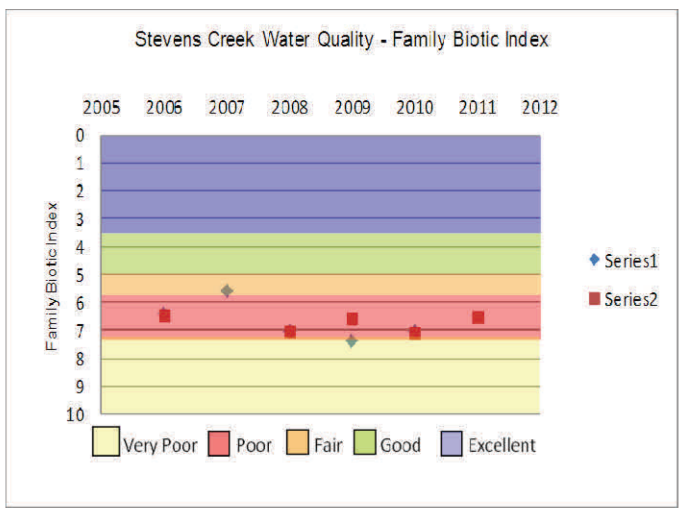


Figure 11. Surface water quality conditions in Stevens Creek based on the Family Biotic Index

Family Richness measures the health of the community through its diversity and increases with increasing habitat diversity suitability and healthy water quality. Family Richness is equivalent to the total number of benthic invertebrate families found within a sample.

Using Family Richness as the indicator, Stevens Creek is reported to have "Fair" to "Good" water quality (Fig.12).

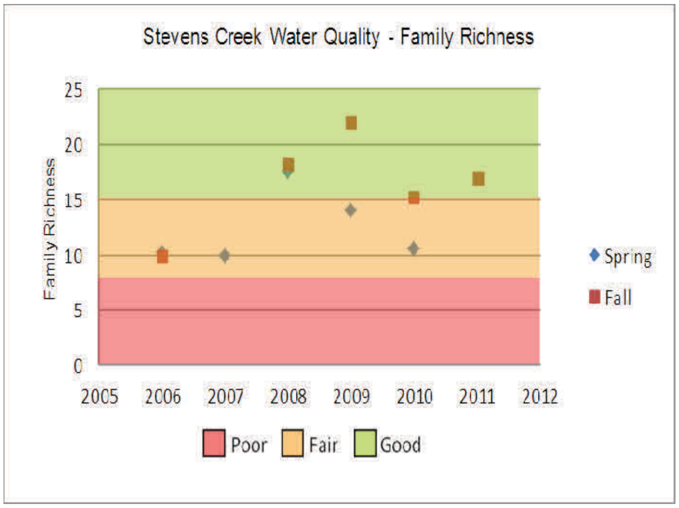


Figure 12. Surface water quality conditions in Stevens Creek based on Family Richness

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, Stevens Creek is reported to have a "Poor" water quality rating (Fig.13) from 2006 to 2011.

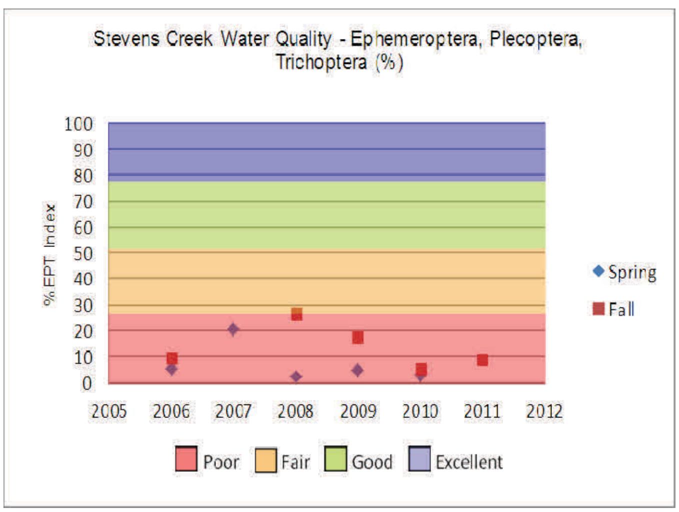


Figure 13. Surface water quality conditions in Stevens Creek using the EPT Index

Overall Stevens Creek has a water quality rating of "Poor" from 2006 to 2011.

1)b. Taylor Drain

Surface water quality conditions in Taylor Drain are monitored through the City of Ottawa's Baseline Water Quality Program. (Ck42-05-03 downstream side of 4th Line Road bridge and CK42-05-07 Proven Line Road) (See Fig. 1, on page 2 for their location)

The water quality rating for Taylor Drain ranges from "Good" to "Poor" (Table1) 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.

Taylor Drain 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. Taylor Drain TP results are shown in Figures 14a and 14b. The LRWS set the target for TP concentration of 0.030 mg/l (PWQO) at the 85th percentile for tributaries of the Rideau River, such as Stevens Creek. Percentile plots for this data are shown in Figures 15a and 15b. 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. Taylor Drain TKN results are shown in Figures 16a and 16b.

Tables 7 and 8 summarize average nutrient concentrations at monitored sites on Taylor Drain and shows the proportion of samples that meet guidelines. Highlighted values indicates that that average exceeds the guideline.

Table 7. Summary of total phosphorous results for Taylor Drain from 2000-2005 and 2006-2011

Total Phosphorus 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-05-03	0.091	21	52
CK42-05-07			
Total Phosphorus 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK42-05-03	0.230	4	54
CK42-05-07	0.015	85	13

Taylor Drain Nutrients: Site CK42-05-03

The majority of samples at site CK42-05-03 were above the TP guideline of 0.030mg/l for both time periods (Fig. 14a, 2000-2005 and 14b, 2006-2011), only twenty-one percent of samples were below the guideline in the 2000-2005 period, this declined to only four percent of samples in the 2006-2011 period. There was also an increase in average TP concentration from 0.091 mg/l (2000-2005) to 0.230 mg/l (2006-2011).The LRWS target

Table 8. Summary of total Kjeldahl nitrogen results for Taylor Drain from 2000-2005 and 2006-2011

Total Kjeldahl Nitrogen 2000-2005			
Site	Average (mg/l)	% Below	No. Samples
CK42-05-03	1.221	0	52
CK42-05-07			
Total Kjeldahl Nitrogen 2006-2011			
Site	Average (mg/l)	% Below	No. Samples
CK42-05-03	1.242	4	54
CK42-05-07	0.742	23	13

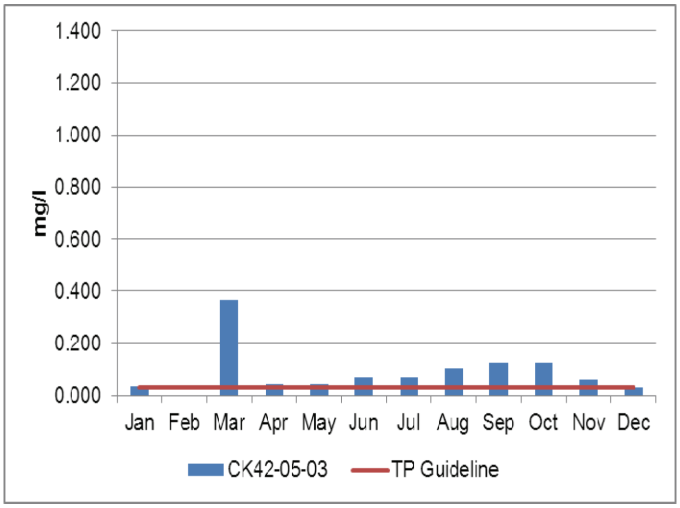


Figure 14a. Total phosphorous concentrations in Taylor Drain from 2000-2005

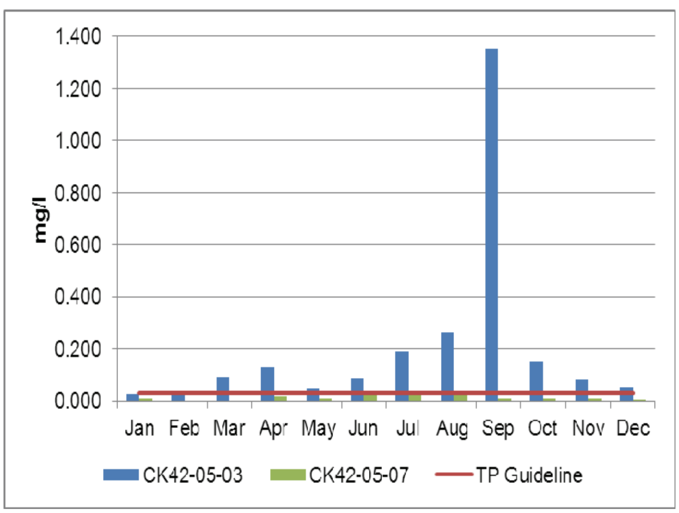


Figure 14b. Total phosphorous concentrations in Taylor Drain from 2006-2011

has not been achieved at site CK42-05-03, the concentration at the 85th percentile increased from 0.212 mg/l (2000-2005, Fig. 15a) to 0.260 mg/l (2006-2011, Fig. 15b).

TKN is used as a secondary indicatory of nutrient enrichment. Figures 16a, 2000-2005 and 16b, 2006-2011 show that the majority of results exceeded the TKN guideline of 0.500 mg/l, there were no samples below the guideline in 2000-2005 period and only four percent of samples were below the guideline in the 2006-2011 period. The average concentration was fairly consistent and decreased slightly from 1.221mg/l to 1.242 mg/l, far exceeding the guideline.

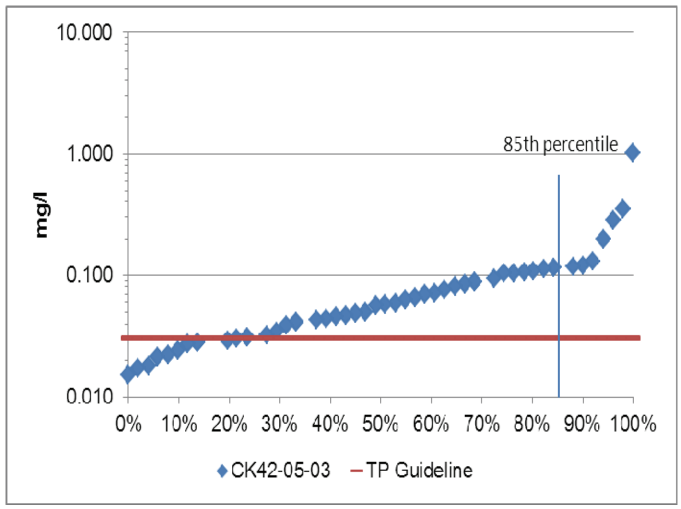


Figure 15a. Percentile plots of total phosphorous in Taylor Drain from 2000-2005

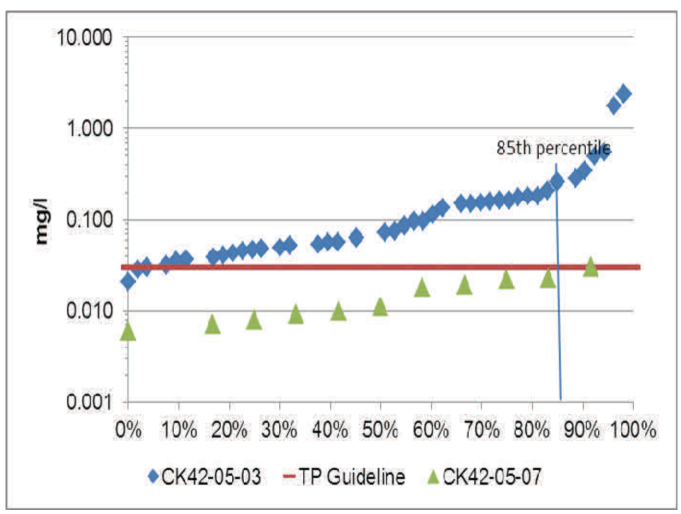


Figure 15b. Percentile plots of total phosphorous in Taylor Drain from 2006-2011

Taylor Drain Nutrients: Site CK42-05-07

The majority of samples at site CK42-05-07 were below the TP guideline of 0.030mg/l for the 2006-2011 time period (Fig. 14b), please note the data was not available for the 2000-2005 period. Average TP concentration was below the guideline at 0.015 mg/l. Percentile plots of TP data show that the target set by the LRWS has been achieved at site CK42-05-07 as the concentration at the 85th percentile is equal to 0.024 mg/l (2006-2011, Fig. 15b).

TKN results show that the majority of results exceeded the TKN guideline of 0.500 mg/l (Fig. 16b), with only twenty-three percent of samples below the guideline and an average concentration of 0.742 mg/l.

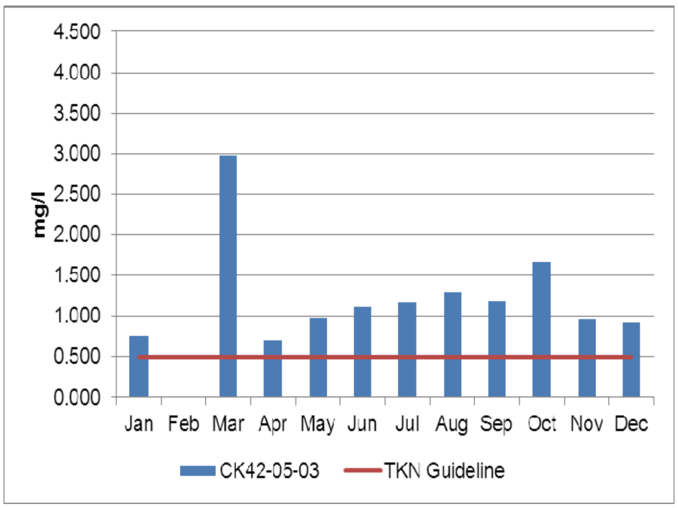


Figure 16a. Total Kjeldahl nitrogen concentrations in Taylor Drain from 2000-2005

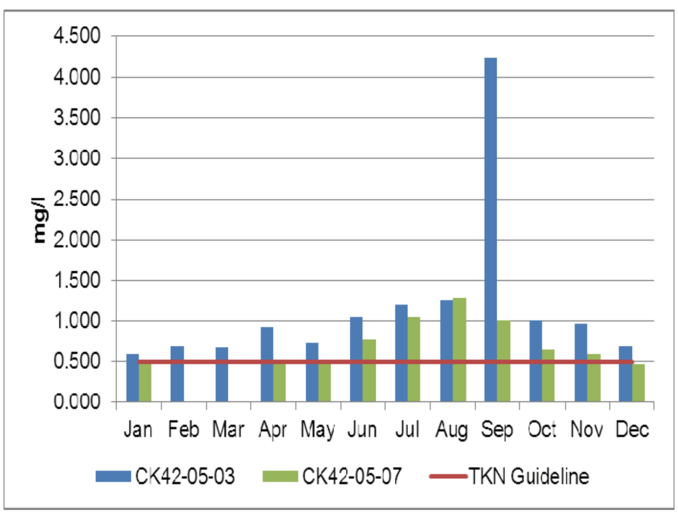


Figure 16b. Total Kjeldahl nitrogen concentrations in Taylor Drain from 2006-2011

Taylor Drain Nutrients Summary

Overall the data suggests that nutrient loading is a significant problem at site CK42-05-03; efforts should be made to reduce nutrient inputs to the creek.

Overall the data suggests that TP is relatively low at site CK42-05-07, though TKN loading may be a problem. Efforts should be made to reduce nutrient inputs to the creek wherever possible.

Taylor Drain 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 Objectives 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 (2005) also set a target of E. coli counts at the 200 CFU/100ml for the 80th percentile and no counts that exceed 200 CFU/100ml in tributaries of the watershed

Table 9 summarizes the geometric mean at monitored sites in Taylor Drain 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.

Figures 17a and 17b show the results of the geometric mean with respect to the guideline for the two periods 2000-2005 (Fig. 17a) and 2006-2011 (Fig. 17b). Figures 18a and 18b show percentile plots of the data for the two time periods of interest 2000-2005 (Fig. 18a) and 2006-2011 (Fig. 18b). 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 9. Summary of E. coli results in Taylor Drain.

E. coli 2000-2005			
Site	Geometric mean (CFU/100ml)	% Below Guideline	No. Samples
CK42-05-03	99	47	49
CK42-05-07			
E. coli 2006-2011			
Site	Geometric mean (CFU/100ml)	% Below Guideline	No. Samples
CK42-05-03	148	44	54
CK42-05-07	62	62	13

Taylor Drain E. coli: Site CK42-05-03

In comparing the two time periods at site CK42-05-03 the proportion of samples below the guideline remained fairly consistent decreasing from forty-seven percent (Fig. 17a, 2000-2005) to forty-four percent (Fig. 17b, 2006-2011). The count at the geometric mean increased from 99 CFU/100 ml to 148 CFU/100 ml. Percentile plots of E. coli data at site CK42-05-03 are shown for both periods. Figures 18a, 2000-2005 and 18b, 2006-2011 show that the LRWS target was exceeded in both time periods; the E. coli count at the 80th percentile increased from 492 CFU/100 ml to 644 CFU/100 ml.

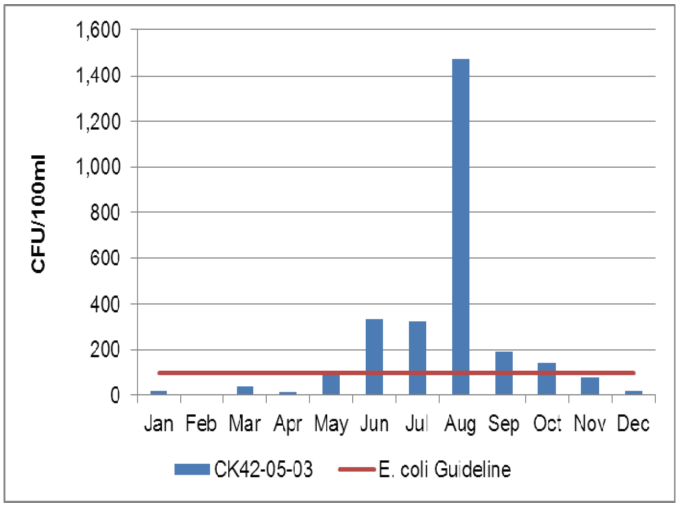


Figure 17a. E. coli counts in Taylor Drain from 2000-2005

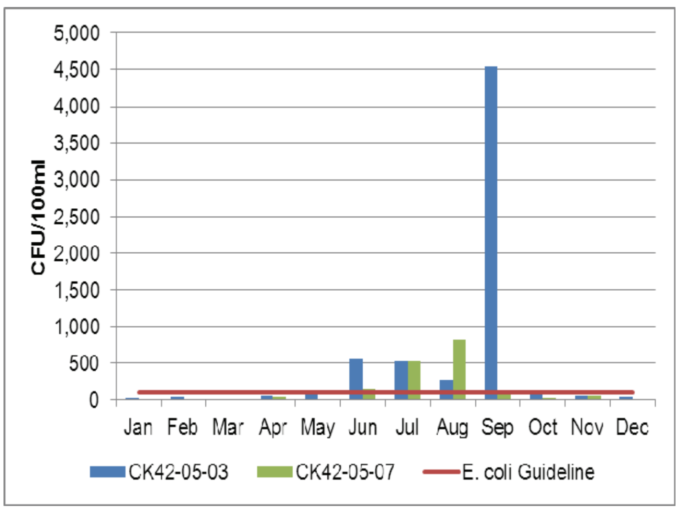


Figure 17b. E. coli counts in Taylor Drain from 2006-2011

Taylor Drain E. coli: Site CK42-05-07

A second water quality monitoring site, CK42-05-07 is located downstream of CK42-05-03. The proportion of samples below the guideline at CK42-05-07 was sixty-two percent (Fig. 17b) and the count at the geometric mean was 62 CFU/100ml. Figure 18b shows that the LRWS target for E. coli was not achieved at site CK42-05-07 as the E. coli count at the 80th percentile was 396 CFU/100ml.

Taylor Drain E. coli: Summary

These statistics indicated that bacterial counts have increased at site CK42-05-03 and efforts should be made to reduce any possible sources of contamination to the creek to protect overall water quality and aquatic life.

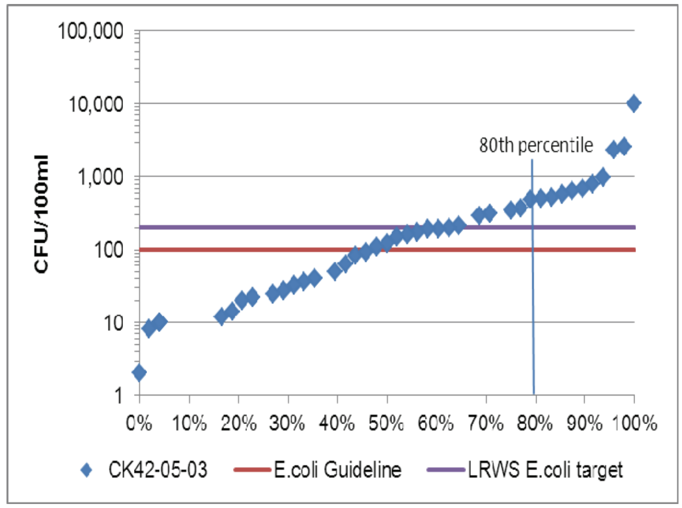


Figure 18a. Percentile plots of E. coli in Taylor Drain from 2000-2005

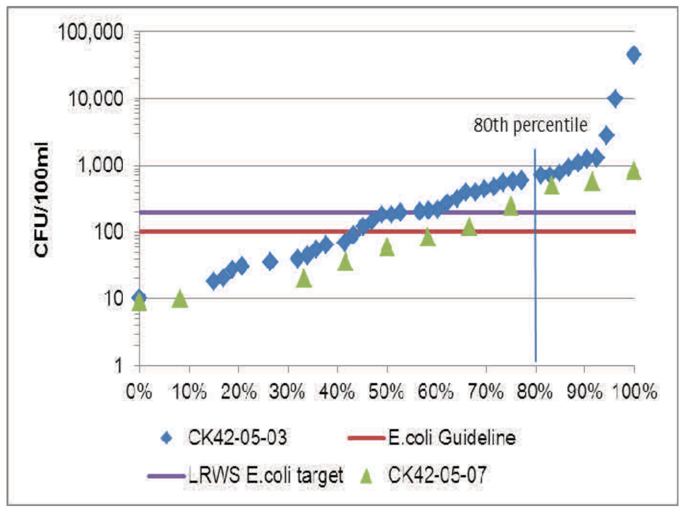


Figure 18b. Percentile plots of E. coli in Taylor Drain from 2006-2011

These statistics indicated that bacterial counts are occasionally elevated at site CK42-05-07, therefore efforts should be continued to reduce any additional sources of contamination to the creek to protect overall water quality and aquatic life.

Taylor Drain: Metals

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

Table 10 summarizes average metal concentrations at monitored sites on Taylor Drain and shows the proportion of samples that meet guidelines. Highlighted values indicate averages that have exceeded the guidelines.

Figures 19, 20 and 21, show the results for each site with respect to guidelines for the two periods 2000-2005 (Figures 19a, 20a and 21a) and 2006-2012 (Figures 19b, 20b and 21b). 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 (2005) also set a target for Cu concentration of 0.005 mg/l at the 80th percentile. Figure 22 shows percentile plots of the data for the two time periods of interest (Fig. 22a, 2000-2005) (Fig. 22b, 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.

Table 10. Summary of metal concentrations in Taylor Drain.

Site	Average (mg/l)	% Below	No. Samples
Aluminum 2000-2005			
CK42-05-03	0.509	8	51
CK42-05-07			
Aluminum 2006-2011			
CK42-05-03	0.580	7	54
CK42-05-07	0.030	92	13
Iron 2000-2005			
CK42-05-03	0.633	33	51
CK42-05-07			
Iron 2006-2011			
CK42-05-03	0.728	33	54
CK42-05-07	0.530	46	13
Copper 2000-2005			
CK42-05-03	0.004	73	51
CK42-05-07			
Copper 2006-2011			
CK42-05-03	0.006	57	54
CK42-05-07	0.005	62	13

Taylor Drain Metals: Site CK42-05-03

The majority of metals monitored at site CK42-05-03 were below guidelines however results for aluminum (Al), iron (Fe) and copper (Cu) were occasionally elevated.

The Al guideline of 0.075 mg/l was generally exceeded in both time periods (Fig. 19a, 2000-2005 and Fig. 19b, 2006-2011), only eight percent of samples were below the guideline in the 2000-2005 period this remained fairly consistent at seven percent in the 2006-2011 period. There was a slight increase in average Al concentration from 0.509 mg/l (2000-2005) to 0.580 mg/l (2006-2011).

Figures 20a, 2000-2005 and 20b, 2006-2011 show that the Fe results often exceed the guideline of 0.300 mg/l; only thirty three percent of samples were below the guideline in both the 2000-2005 and 2006-2011 time periods. The average concentration increased from 0.633 mg/l to 0.728 mg/l, exceeding the guideline.

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. The proportion of samples below the guideline decreased from seventy-three percent (Fig. 21a, 2000-2005) to fifty-seven percent (Fig. 21b, 2006-2011), the average

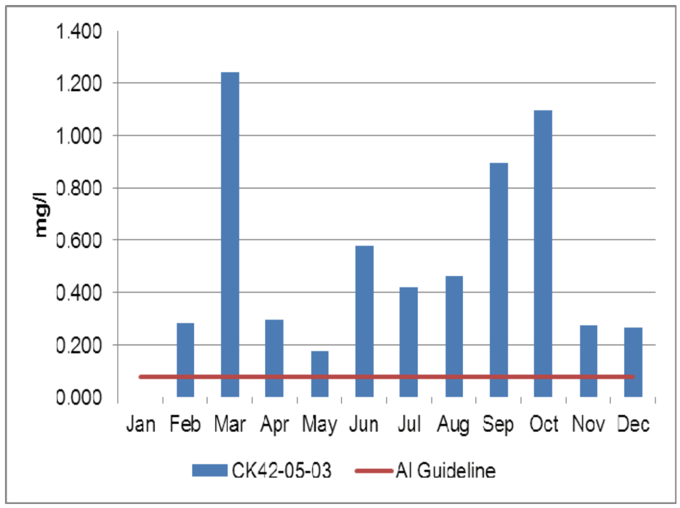


Figure 19a. Aluminum concentrations in Taylor Drain from 2000-2005

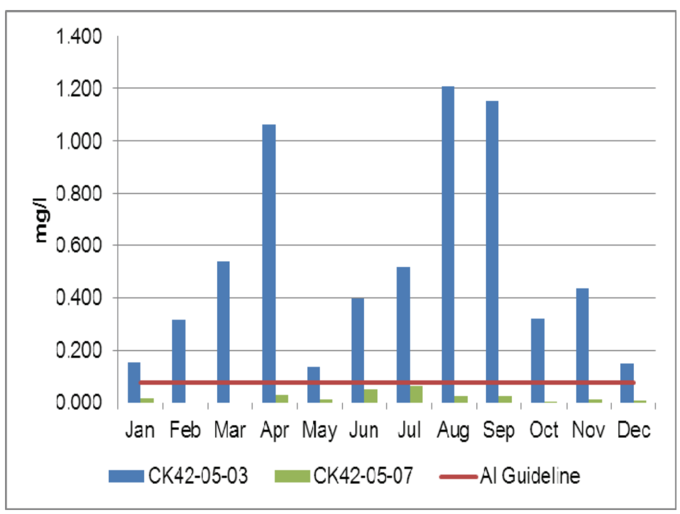


Figure 19b. Aluminum concentrations in Taylor Drain from 2006-2011

concentration increased from 0.004 mg/l to 0.006 mg/l. The LRWS target for site CK42-05-03 was not achieved in the 2006-2011 period. The concentration at the 80th percentile increased from 0.004 mg/l (2000-2005, Fig. 22a) to 0.006 mg/l (2006-2011, Fig. 22b).

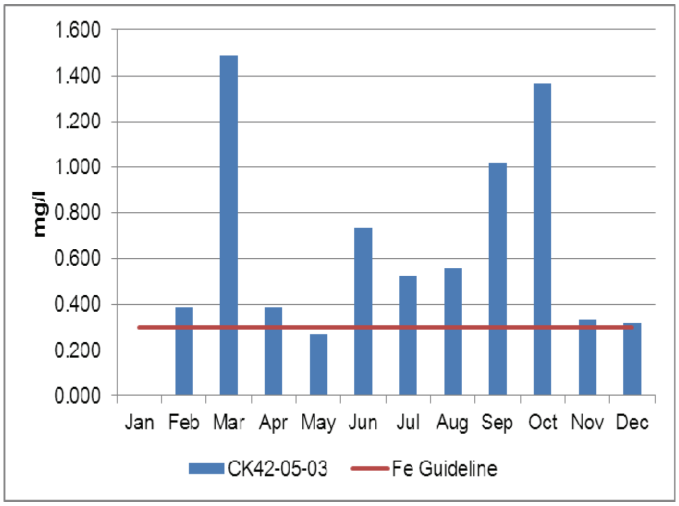


Figure 20a. Iron concentrations in Taylor Drain from 2000-2005

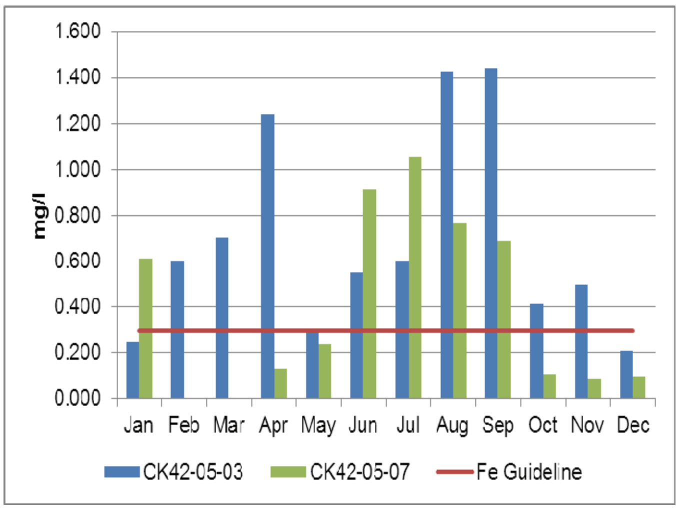


Figure 20b. Iron concentrations in Taylor Drain from 2006-2011

Taylor Drain: Site CK42-05-07

Results for Al were generally below the guideline at CK42-05-07, ninety-two percent of samples were below the guideline in the 2006-2011 period (Fig. 19b) and the average Al concentration was only 0.030 mg/l.

Figure 20b shows that the Fe results often exceed the guideline of 0.300 mg/l, forty-six percent of samples were below the guideline and the average concentration was 0.530 mg/l.

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. Sixty two percent (Fig. 21b) of samples were below the guideline and the average concentration was equal to the guideline at 0.005 mg/l. The LRWS target was achieved at site CK42-05-07 as the concentration at the 80th percentile equaled 0.005 mg/l (Fig. 22b).

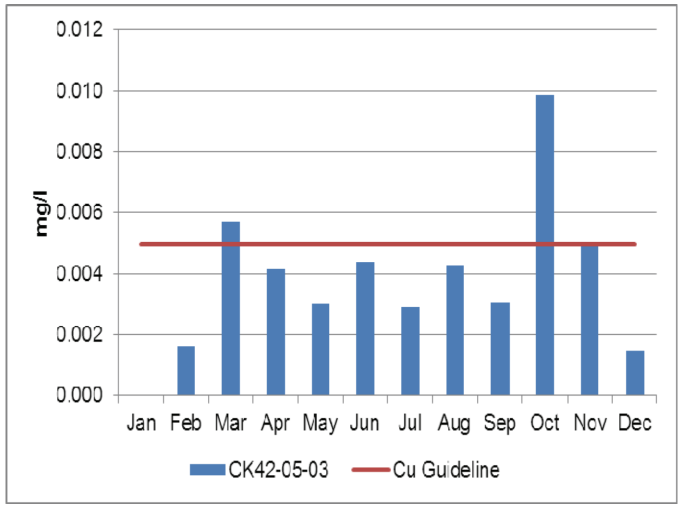


Figure 21a. Copper concentrations in Taylor Drain from 2000-2005

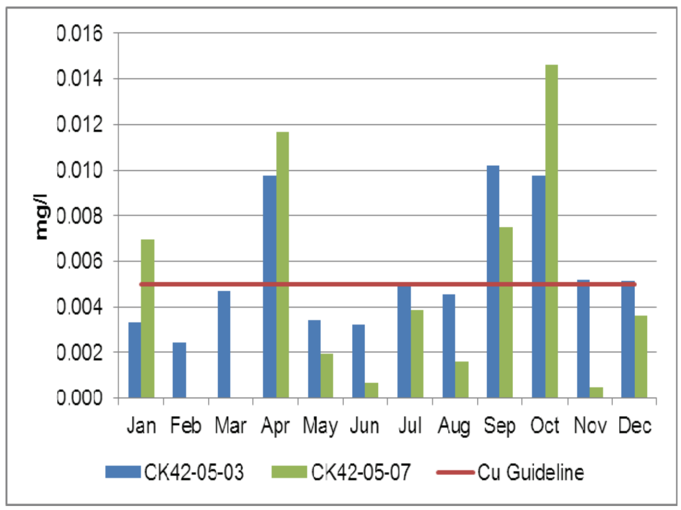


Figure 21b. Copper concentrations in Taylor Drain from 2006-2011

Taylor Drain Metals Summary

Overall the data shows that metal pollution at site CK42-05-03 is a problem in the creek and efforts should be made to reduce concentrations wherever possible.

Overall the data indicates that metal pollution in site CK42-05-07 occasionally occurs at this site and efforts should be made to reduce sources where possible.

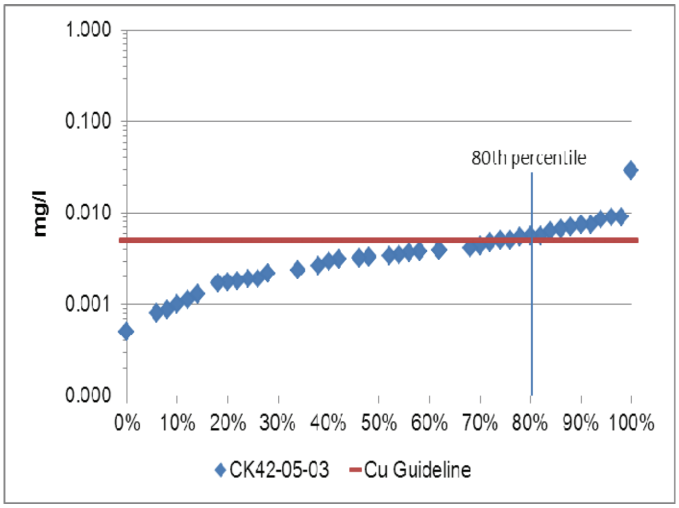


Figure 22a. Percentile plots of copper in Taylor Drain from 2000 -2005

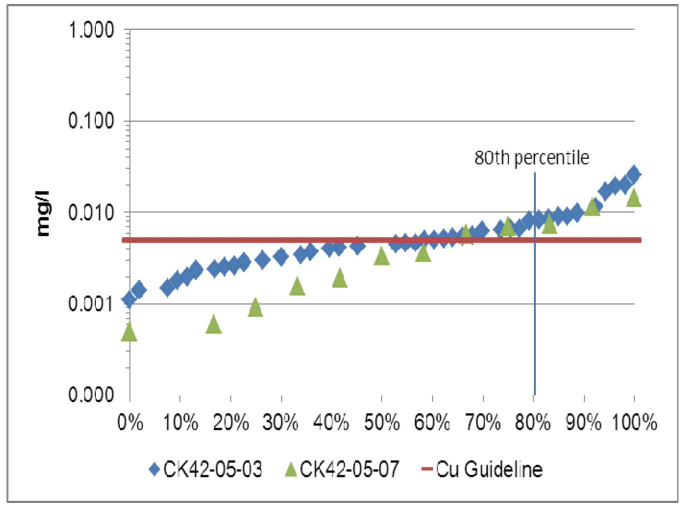


Figure 22b. Percentile plots of copper in Taylor Drain from 2006-2011

Collecting water quality using an YSI

Image of a Mink frog

Collecting flow data in Steven's Creek

Image of a native aquatic plant the Pickerel Weed

2) a. Overbank Zone

Riparian Buffer along Stevens Creek and Tributaries

Figure 23 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 54 percent of streams and creeks are buffered with woodland, wetland and grassland; the remaining 46 percent of the riparian buffer is occupied by settlement, crop and pastureland and transportation

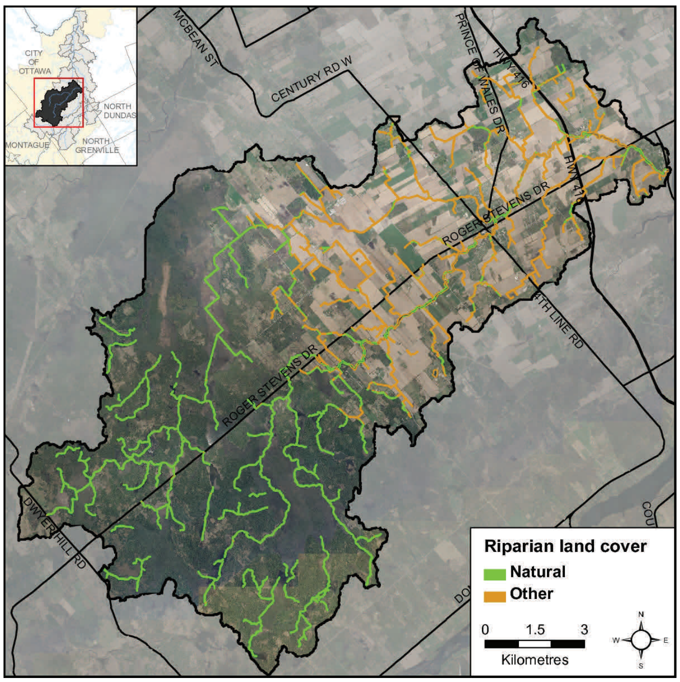


Figure 23. Catchment land cover in the riparian zone

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 140 (100 metres long) sections along Stevens Creek in 2011.

Riparian Buffer along Stevens 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 metres wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Figure 24 demonstrates the buffer conditions of the left and right banks separately. Stevens Creek had a buffer of greater than 30 metres along 36 percent of the left bank and 37 percent of the right bank.

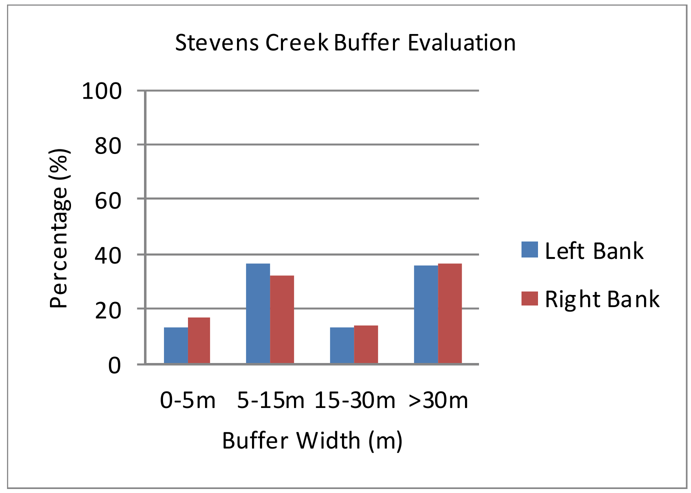


Figure 24. Vegetated buffer width along Stevens Creek

Land Use beside Stevens Creek

The RVCA's Macrostream Survey Program identified 11 different land uses beside Stevens Creek (Figure 25). Surrounding land use is considered from the beginning to the 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 43 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.

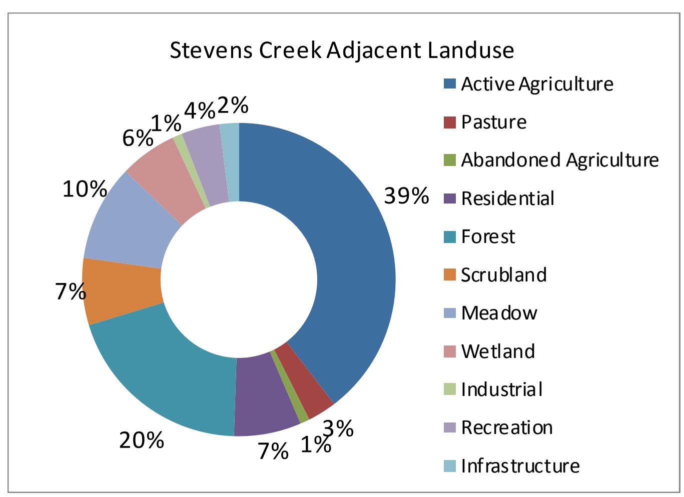


Figure 25. Land use alongside Stevens Creek

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 26 shows the bank stability of the left and right bank along Stevens Creek.

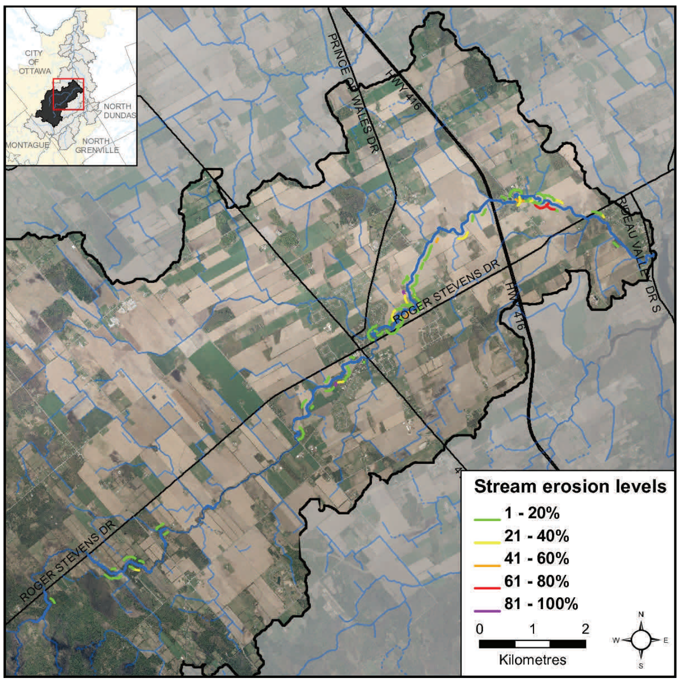


Figure 26. Erosion along Stevens Creek

Streambank Undercutting

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 27 shows that Stevens Creek had minimal locations with identified undercut banks.

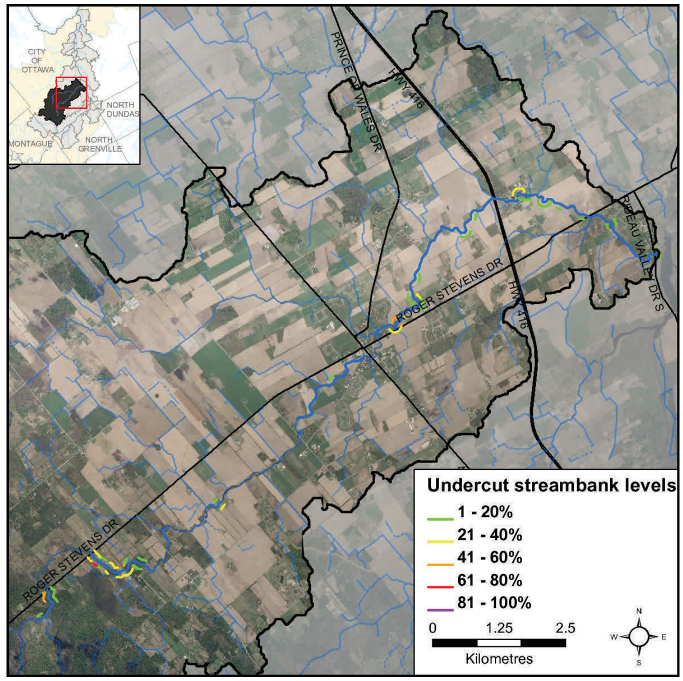


Figure 27. Undercut streambank along Stevens Creek

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 28 shows the stream shading locations along Stevens Creek.

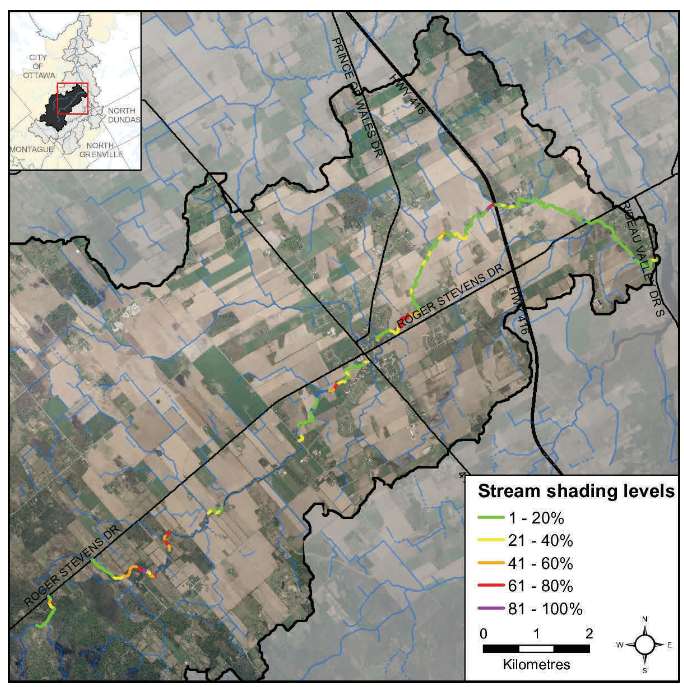


Figure 28. Stream shading along Stevens Creek

Human Alterations

Figure 29 shows that 18 percent of Stevens Creek remains “unaltered.” Sections considered “natural” with some human changes account for 21 percent of sections. "Altered" sections accounted for 35 percent of the stream, with the remaining 26 percent of sections sampled being considered “highly altered” (e.g., include road crossings, shoreline/ instream modifications and little or no buffer).

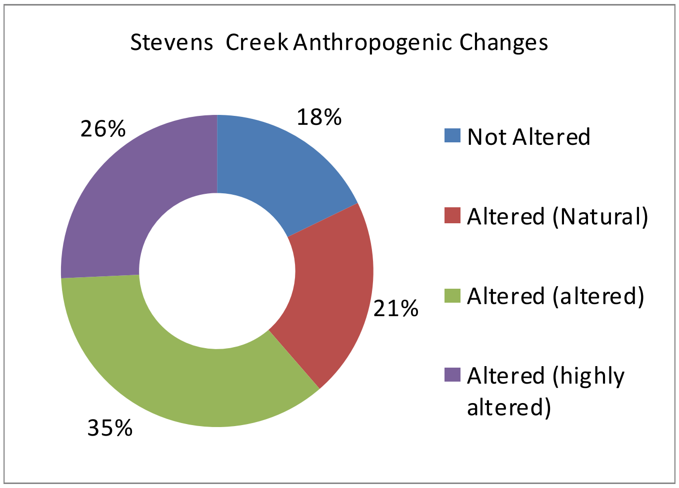


Figure 29. Alterations to Stevens Creek

Overhanging Trees and Branches

Figure 30 shows that the majority of Stevens Creek had 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.

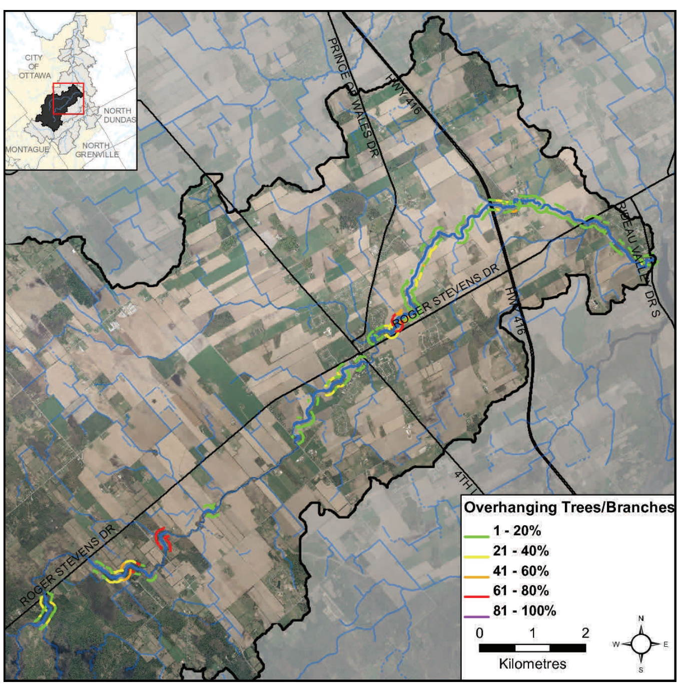


Figure 30. Overhanging trees and branches

Instream Woody Debris

Figure 31 shows that the majority of Stevens Creek had low 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 feeding areas.

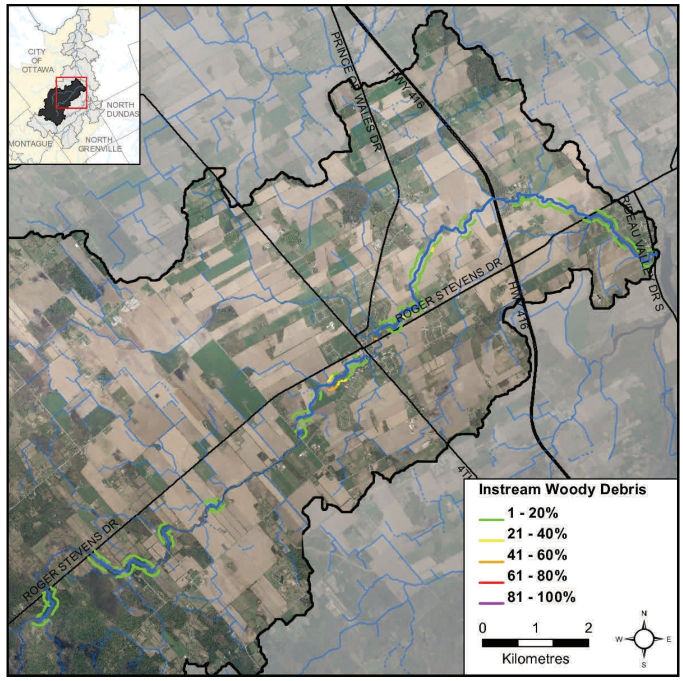


Figure 31. Instream woody debris

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. Fifty-three percent of Stevens Creek was considered heterogeneous as seen in Figure 32.

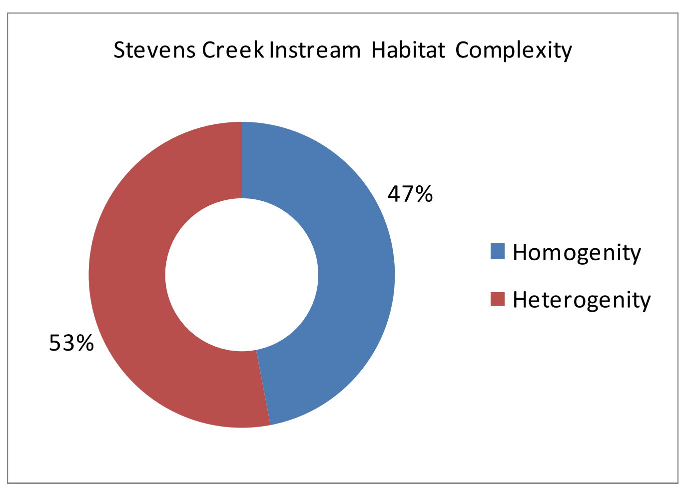


Figure 32. Instream habitat complexity in Stevens Creek.

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 33 shows the substrate diversity for Stevens Creek

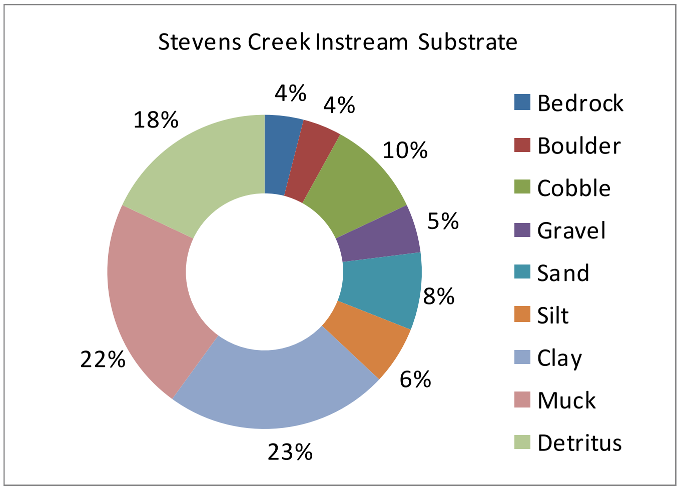


Figure 33. Instream substrate in Stevens Creek

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 34 shows where cobble and boulder substrate was found in Stevens Creek.

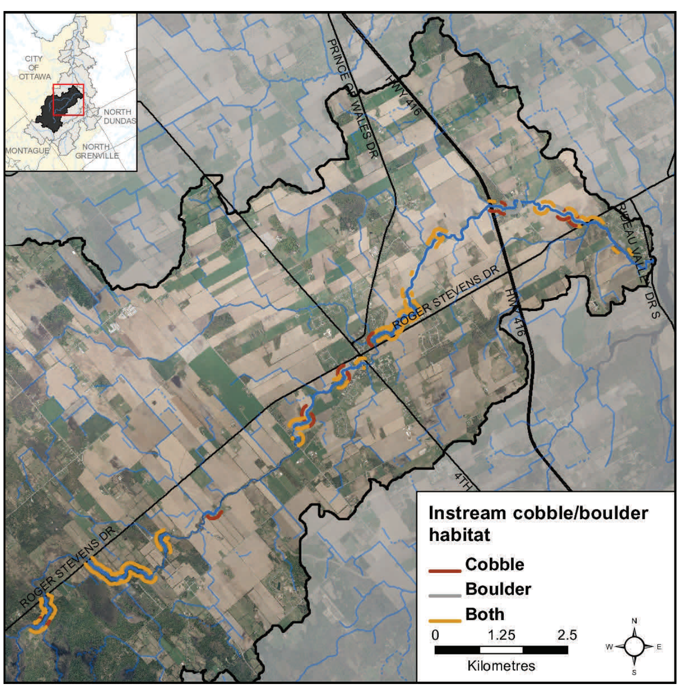


Figure 34. Instream cobble and boulder habitat along Stevens Creek

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 35 shows that Stevens Creek was fairly uniform; 90 percent consisted of runs, eight percent pools and two percent riffles.

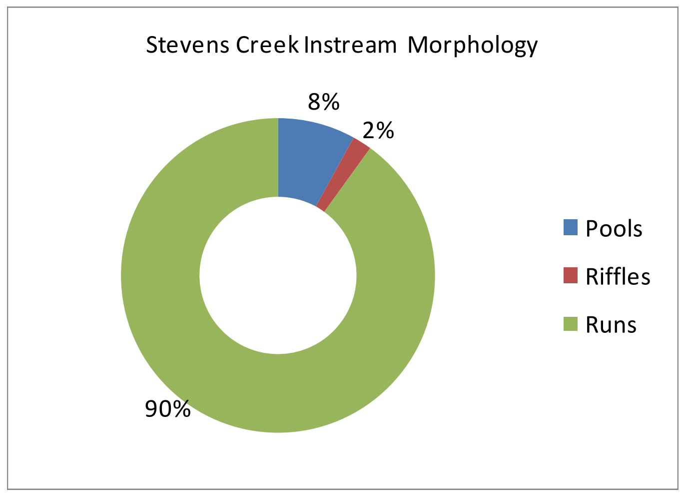


Figure 35. Instream Morphology in Stevens Creek

Types of Instream Vegetation

Stevens Creek had fairly diverse types of instream vegetation(Figure 36). The dominant vegetation type recorded at thirty percent consisted of algae. Narrow emergents were recorded at 21 percent of the vegetation types. Submerged vegetation was recorded at 18 percent. Robust emergents and floating vegetation were both recorded at nine percent of the vegetation types recorded in the stream. Broad emergent vegetation made up seven percent of the vegetation community. Free floating vegetation made up the remaining six percent.

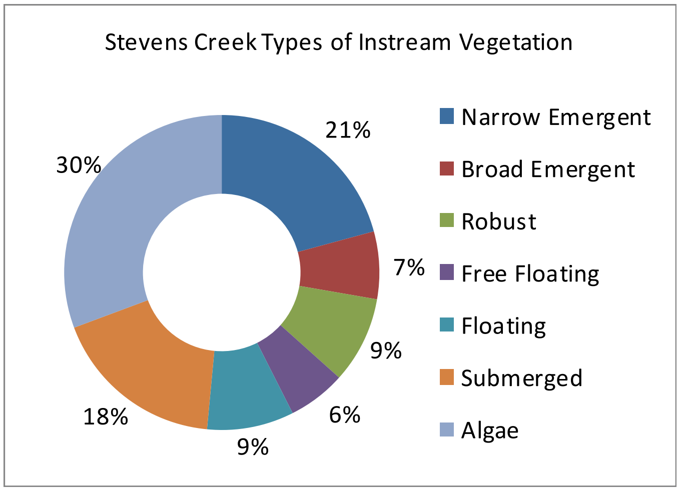


Figure 36. Instream vegetation types in Stevens Creek.

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 37 demonstrates that Stevens Creek had a variety of instream vegetation levels for most of its length.

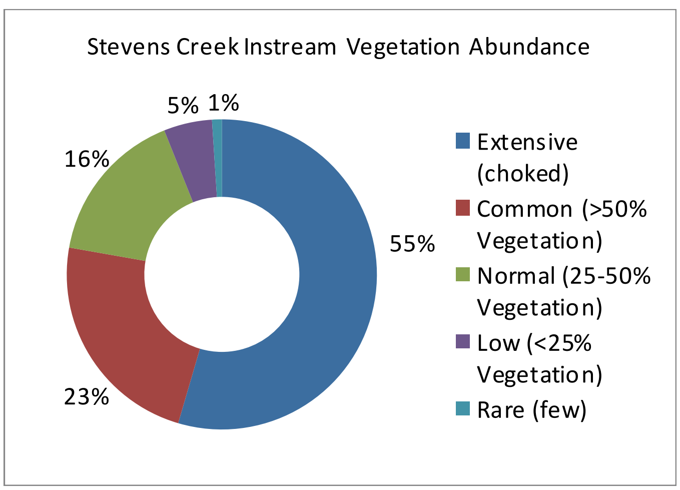


Figure 37. Vegetation abundance in Stevens Creek

Riparian Restoration

Figure 38 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

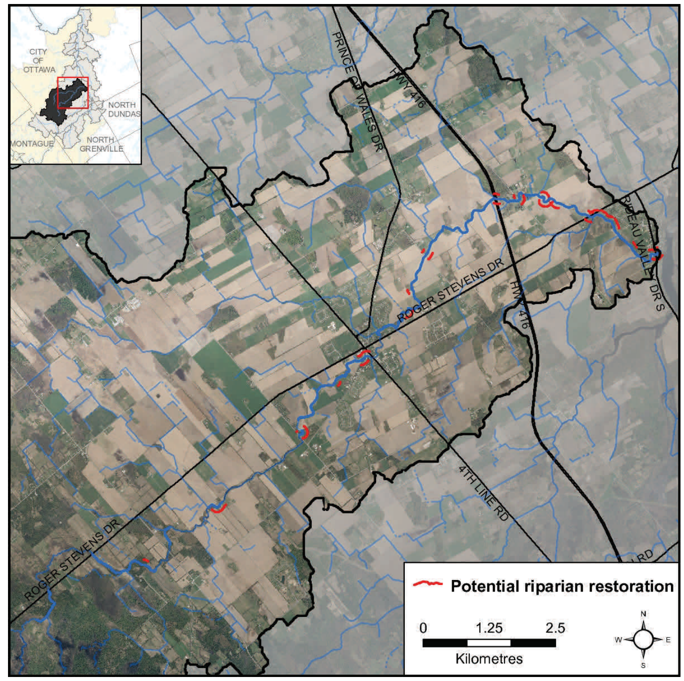


Figure 38. Riparian restoration opportunities

Instream Restoration

Figure 39 depicts the locations where various instream restoration activities can be implemented as a result of observations made during the stream survey assessments.

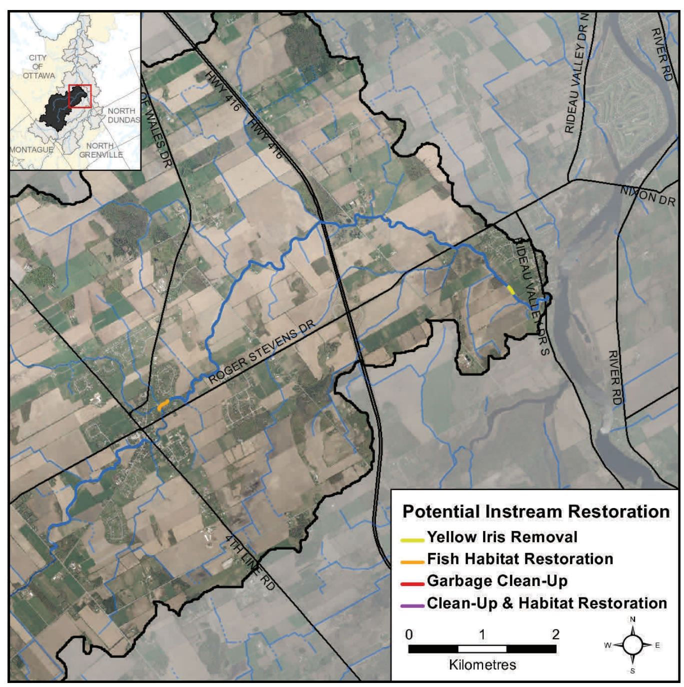


Figure 39. Instream restoration opportunities

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. Ninety-five percent of the sections surveyed along Stevens Creek had invasive species (Figure 40). The species observed in Stevens Creek were purple loosestrife, flowering rush, European frogbit, curly-leaved pondweed, banded mystery snail, Manitoba maple, yellow iris and Eurasian milfoil.

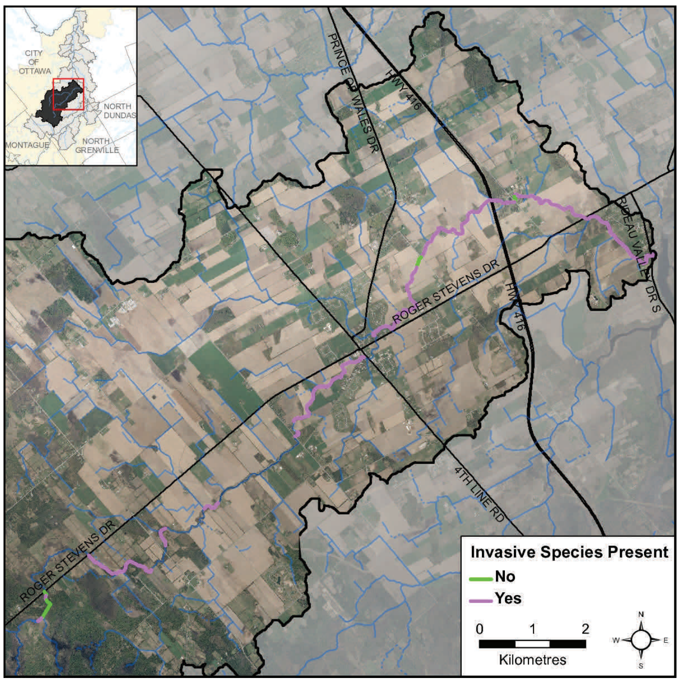


Figure 40. Invasive species along Stevens Creek

Thermal Classification

Temperature is an important parameter in streams as it influences many aspects of physical, chemical and biological health. Five temperature dataloggers were deployed in Steven Creek from April to late September 2011 (Figure 41) 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 Stevens Creek is a warmwater system.

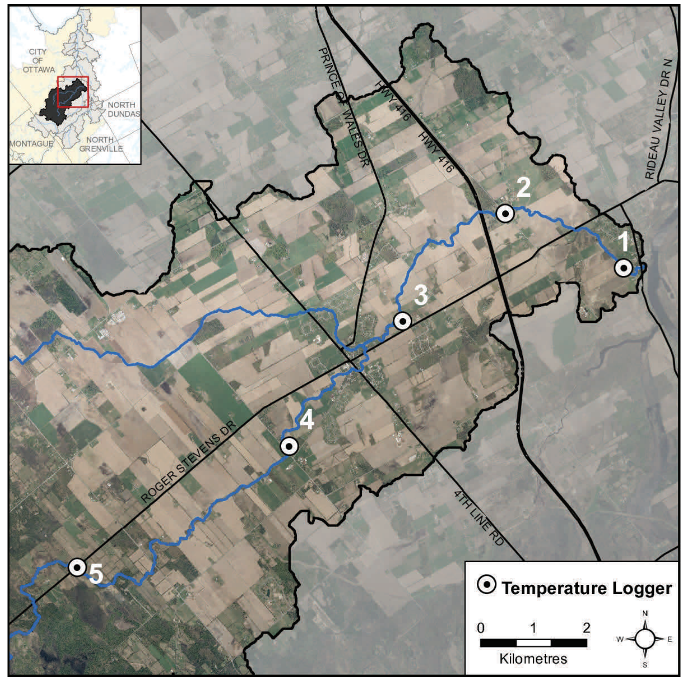


Figure 41. Temperature dataloggers along Stevens Creek

Fish Sampling

Fish sampling sites located along Stevens Creek are shown in Figure 42 and 43. The provincial fish codes shown on the preceding map are listed (in Table 11) beside the common name of those fish species identified in Stevens Creek (Data source: RVCA and City of Ottawa).

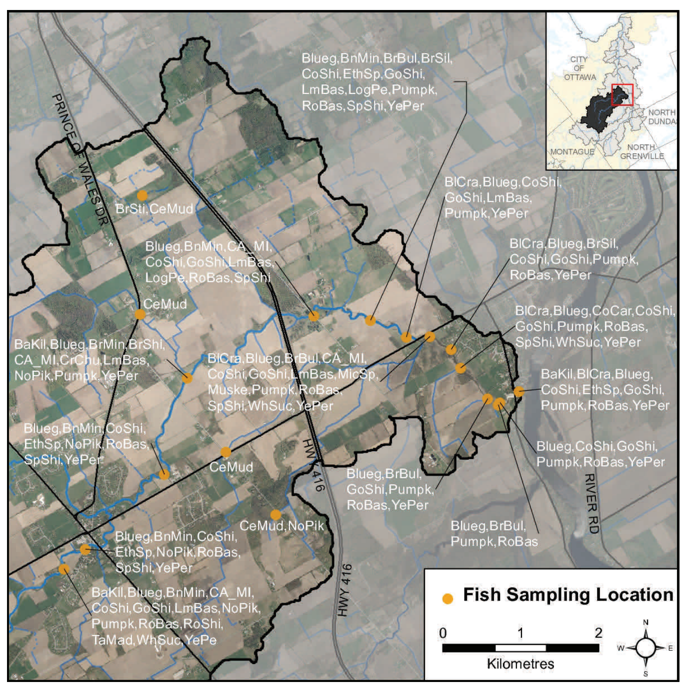


Figure 42. Fish species observed along Stevens Creek

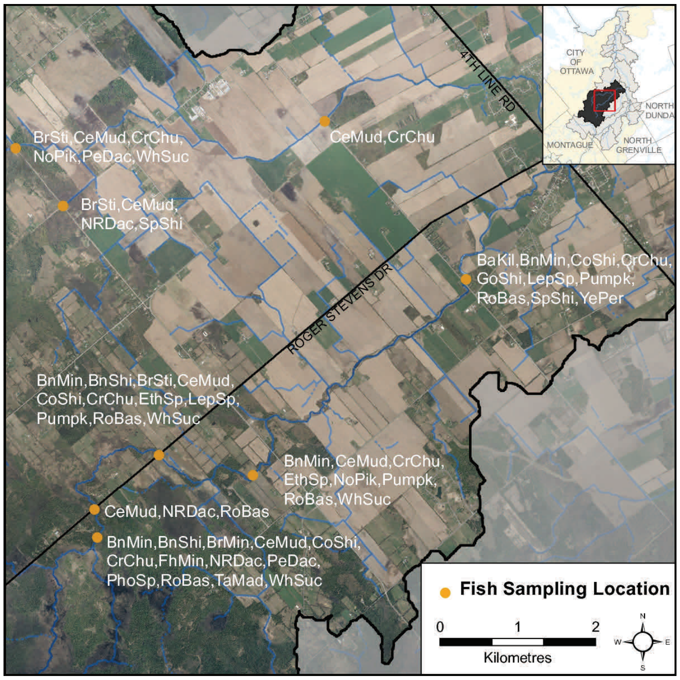


Figure 43. Fish species observed along Stevens Creek

Table 11. Fish species observed in Stevens Creek

BaKil **banded killifish**	BlCra **black crap-pie**	Blueg **bluegill**	BnMin **bluntnose minnow**	BrMin **brassy minnow**
BrSil **brook silverside**	BrSti **brook stickleback**	BrBul **brown bullhead**	CeMud **central mudmin-now**	CoCar **common carp**
CoShi **common shiner**	CrChu **creek chub**	FhMin **fathead minnow**	GoShi **golden shiner**	EthSp. **etheostoma spp.**
LmBas **largemouth bass**	Logpe **logperch**	Muske **muskel-lunge**	NoPik **northern pike**	NRDac **northern redbelly dace**
PeDac **pearl dace**	Pumpk **pumpkin-seed**	RoBas **rock bass**	SpShi **spottail shiner**	TaMad **tadpole madtom**
WhSuc **white sucker**	YePer **yellow perch**	BrShi **bridle shiner**	MicSp. **micropter-us spp.**	CA_MI **carps and minnows**
RoShi **roseface shiner**	BnShi **blacknose shiner**	PhoSp **phoximus species**	LepSp **lepomis species**	

Migratory Obstructions

It is important to know locations of migratory obstructions because these can prevent fish from accessing important spawning and rearing habitat (Figure 44). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There was one migratory obstruction within the Stevens Creek catchment at the time of the survey.

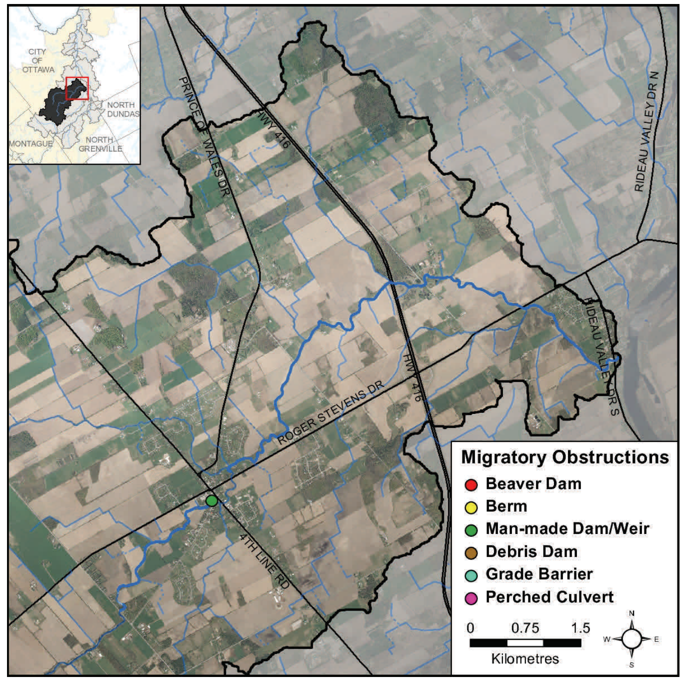


Figure 44. Migratory obstructions in Stevens Creek

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.

2011 data for these three parameters is summarized in Table 12

Table 12. 2011 Water chemistry collected along Stevens Creek

Month	Range	DO (mg/L)	DO (%)	Conductivity (µs/cm)	pH
May-11	low	5.45	63	203	7.56
	high	8.17	87	601	7.76
Jun-11	low	3.35	38	506	7.4
	high	12.5	145	659	8.58
Jul-11	low	3.38	36	322	7.22
	high	9.15	108	765	8.32
Aug-11	low	3	31	163	7.25
	high	10.32	110	515	8.5

3) ***Land Cover***

Crop and pastureland is the dominant land cover type in the catchment as shown in Table 13 and displayed on the front cover of the report.

Table 13. Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Crop & Pasture	5775	35
Woodland	4984	30
Wetland	4238	26
Settlement	800	5
Transportation	350	2
Grassland	365	2

Woodland Cover

The Stevens Creek catchment contains 4984 hectares of woodland (Fig.45) that occupies 30 percent of the drainage area. This figure meets 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 forty-three (41%) of the 349 woodland patches in the catchment are very small, being less than one hectare in size. Another 180 (52%) 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 26 (seven percent of) woodland patches range between 20 and 937 hectares. Sixteen 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, ten (3%) of the 349 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. Seven 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 349 woodlands contain 167 forest interior patches (Fig.45) that occupy nine percent (1554 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.

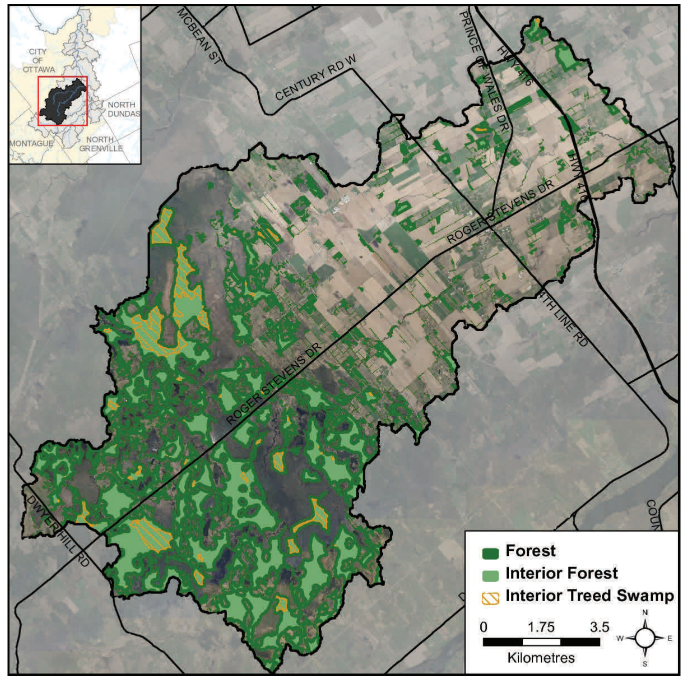


Figure 45. Catchment woodland cover and forest interior

Most patches (134) have less than 10 hectares of interior forest, 86 of which have small areas of interior forest habitat less than one hectare in size. Another 19 patches contain between 10 and 30 hectares of interior forest. Conversely, 14 patches have greater than 30 hectares of interior forest, with four patches exceeding 100 hectares (at 117, 121, 152 and 162 ha.).

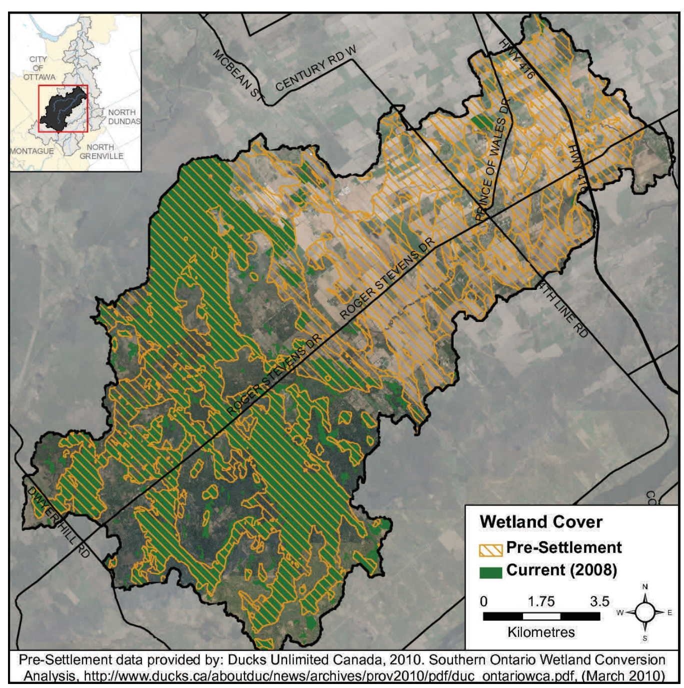


Figure 46. Pre-settlement and present day wetland cover

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 47 shows the location of all Rural Clean Water Projects in the Stevens Creek drainage area. From 2006 to 2011, landowners completed 68 projects including 14 septic system repair/replacement, 27 well upgrades, 7 well decommissionings, 1 well replacement, 3 surface washwater disposals, 3 chemical/fuel storage and handling, 3 manure storages, 5 precision farming, 2 buffers/windbreaks,1 nutrient management plan and 2 cropping practices. In total, RVCA contributed $120,651 grant dollars to projects valued at $1,692,350.

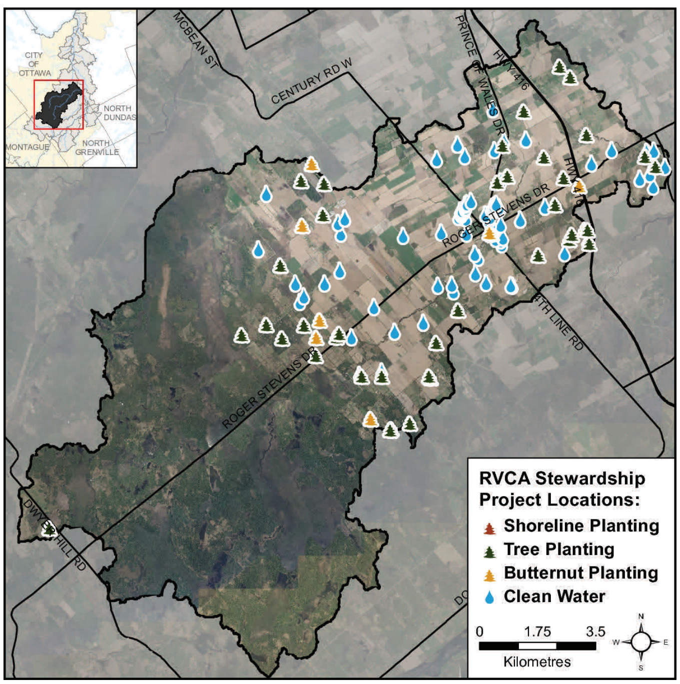


Figure 47. RVCA stewardship program project locations

Prior to 2006, the RVCA completed 28 projects in the area consisting of 6 septic repairs/replacements, 10 well upgrades, 1 well decommissioning, 2 surface & wastewater disposal, 6 fencing, 1 erosion control, 1 cropping practices and 1 manure storage. In total, RVCA contributed $55,755 in grant dollars to projects valued at $297,396.

Tree Planting Projects

The location of all tree planting and shoreline projects is also shown in Figure 47. From 2006 to 2011, 30,880 trees, valued at $62,502, were planted on 11 sites through the RVCA Tree Planting Program.

Before that, from 1984 to 2006, landowners helped plant 182,370 trees, valued at $290,096, on 26 project sites, using the RVCA Tree Planting Program, on 91 hectares of private land; fundraising dollars account for $137,136 of that amount.

City Stream Watch Program

Through City Stream Watch and its volunteers. 150 trees and shrubs were planted in 2006 and 2007.

Valley, Stream, Wetland and Hazard Land Regulation

Sixty-four square kilometres or 39 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Fig.48), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

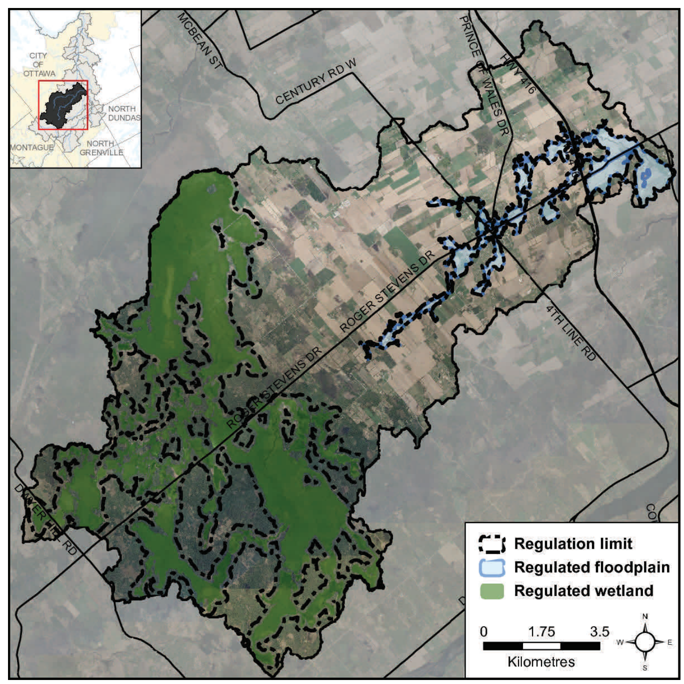


Figure 48. RVCA regulation limits

Natural features within the regulation limit include 34 sq. km. of wetland (representing 80 percent of all wetlands in the catchment) and 135.4 kilometres of streams (representing 54 percent of all streams in the catchment). Many of these regulated watercourses (83.5 km or 34 percent of streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 51.9 km (or 21 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 113.3 (or 46 percent) of streams requires identification of flood and erosion hazards and valley systems. 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 along the creek
- Altered hydrology causing in-stream erosion and impacts to aquatic habitats
- Reduced biodiversity
- Loss of wetland and forest habitats in the middle and lower reaches of Stevens Creek and Taylor Drain
- Increasing presence of invasive species
- Barriers to fish movement
- Some 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 waste disposal practices
- Work with landowners to implement agricultural best management practices and pursue improvements to the riparian corridor along Stevens Creek and tributaries (by increasing buffers through reforestation/riparian plantings and invasive species removal)
- Remove barriers to fish movement and improve in-stream structure
- Improve access to the corridor for public use and recreation
- Target riparian and instream restoration at sites identified in this report (as shown in Figures 38 and 44) and explore other restoration and enhancement opportunities along the Stevens Creek riparian corridor