2014

Tributary Monitoring for Cootes Paradise to Support the Hamilton Harbour Remedial Action Plan

Hamilton Conservation Authority

Healthy Streams...Healthy Communities!

Watershed Planning & Engineering

March 31, 2015

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2. Background

In spring of 2014, the Hamilton Conservation Authority (HCA) and the Royal Botanical Gardens (RBG) began discussions for a plan to divide and expand a monitoring protocol aimed at understanding water quality contributions from creeks flowing into Cootes Paradise Marsh and ultimately, Hamilton Harbour. It was determined that the HCA would assume sampling responsibilities for three existing creek sampling sites within the Cootes Paradise study area previously sampled by RBG staff. These sites are known as CP-7, CP-11 and CP-18.1 (See figure 2) and their respective locations are on Spencer Creek, Chedoke Creek and Borers Creek upstream of the locations where they drain into the Cootes Paradise Marsh. The protocol was expanded to include four new sites to help characterize the water quality contributions coming from the Ancaster Creek sub-watershed, which has relatively little water quality and flow data near the lower reaches of the sub-watershed boundaries.

A proposal submitted by the HCA was approved by the Ministry of the Environment and Climate Change (MOECC) to assist in the acquisition of equipment required for this expanded sampling protocol. The proposal outlined the need for more water quality and quantity data for Ancaster Creek, as well as the continuation of water quality monitoring at the three established locations noted above. An addition of four sample locations (AC-1, AC-2, AC-3 & AC-4) along Ancaster Creek and its tributaries for the 2014 sampling season was agreed upon between HCA and RBG staff. Sampling commenced on May 6, 2014 and ended on September 23, 2014 at a bi-weekly sampling frequency.

The proposal also outlined plans to further expand the monitoring program in 2015. HCA and MOECC staff installed equipment in Ancaster Creek (at site AC-1) to continuously monitor water levels during the sampling period as well as remotely collect water samples throughout the duration of select storm events. Using water level information collected from the sampling equipment, HCA staff can make a level-weighted composite sample of the entire storm event to help understand water quality conditions during high flow events. A total of six storm events per sampling season (2 events in each of spring, summer and fall) will be sampled and analyzed. A rating curve will also be established at site AC-1 in 2015, to allow for the determination of flow rates and loading volumes. The sampling period is to commence in April 2015 and end in November 2015, extending the period by 3 months from the previous season for a total of 17 water quality grab sample days and 6 storm event capture days.

It is beneficial to undertake an enhanced surface water monitoring program on lower Ancaster Creek to help identify important contributors and sources of inputs as well as provide information to support where mitigation activities can be best applied to benefit the overall water quality within Cootes Paradise. Currently, there is a nutrient loadings model being developed for Cootes Paradise by the University of Toronto. This model could benefit greatly by utilizing the data from non-defined inputs being collected by this monitoring program and the HCA would welcome the opportunity to share this information to help better the understanding of the inputs into Cootes Paradise. Overall, several years of measurements will be required to establish

trends and determine baseline and wet event conditions. This program covers the 2014 and 2015 sample seasons but will look to continue for the next 3-5 years.

Figure 1: Hamilton Conservation Authority Sub-watersheds

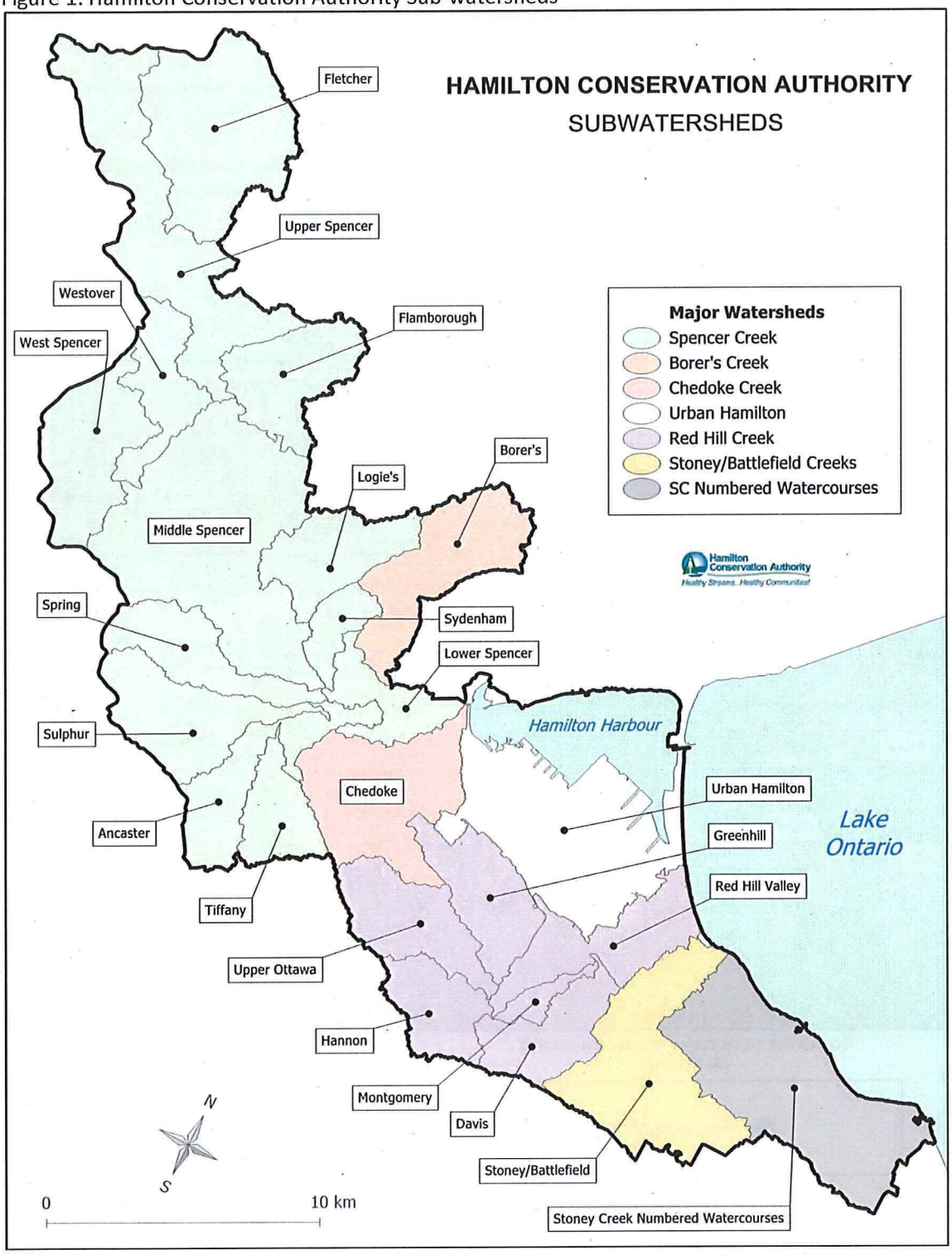


Figure 2: Study Area and Sampling Locations

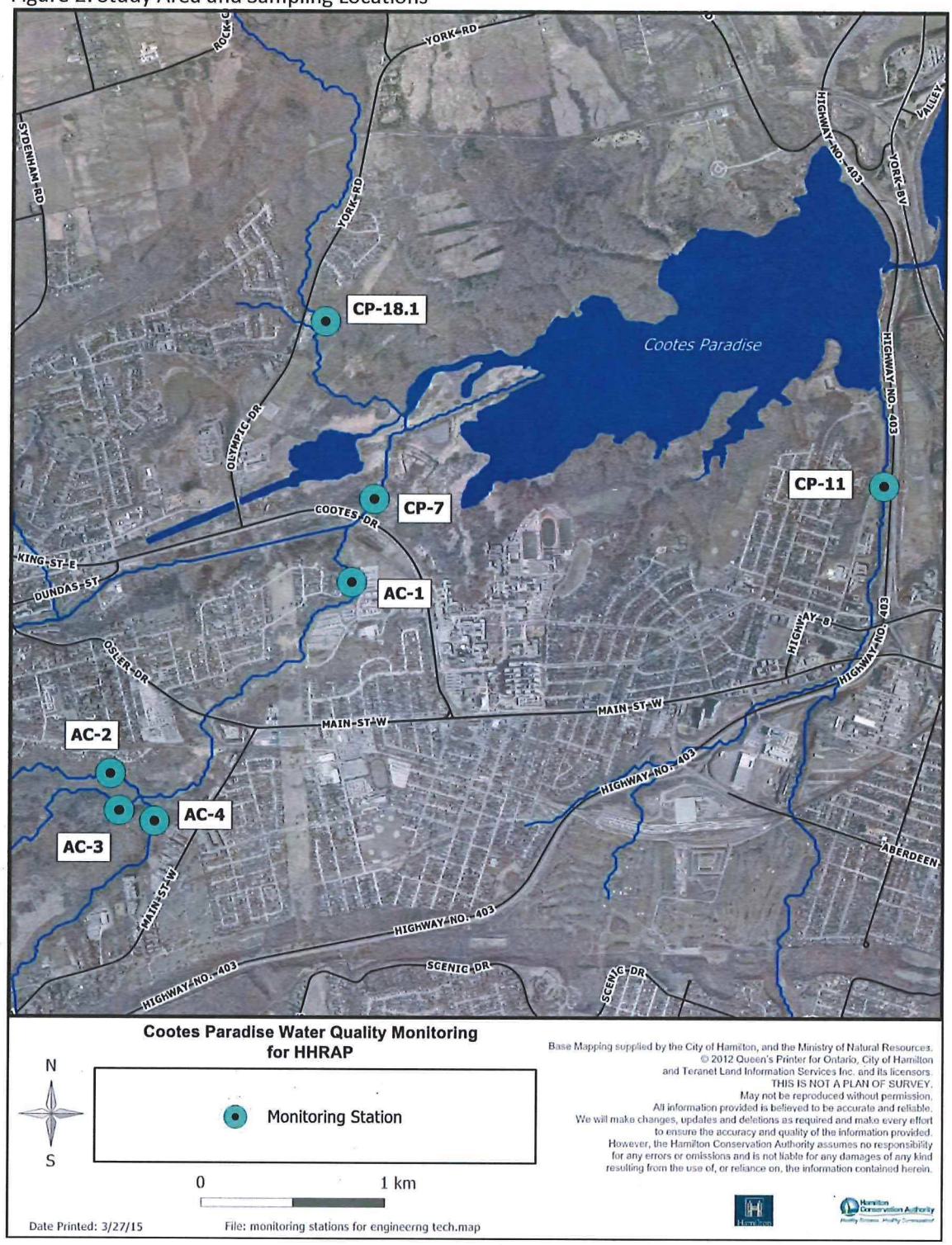


Table 1: Sampling Stations Identified by Location and Sub-watershed

Station	Location	Sub-watershed
CP-7	Downstream of Cootes Drive	Lower Spencer Creek
CP-11	Downstream of King Street	Chedoke Creek
CP-18.1	Downstream of York Road	Borers Creek
AC-1*	Upstream of Spencer Creek	Ancaster Creek
AC-2*	Upstream of confluence with Ancaster Creek	Sulphur Creek
AC-3*	Upstream of confluence with Sulphur Creek	Ancaster Creek
AC-4*	Downstream of Wilson Street	Ancaster Creek

* indicates new sampling location for 2014

3. Water Quality Monitoring

3.1 Methodology

Water quality grab samples were taken during daylight hours with same day drop off for analysis at the City of Hamilton Regional Environmental Lab. Sampling frequency was every other week to coincide with RBG and Conservation Halton staff sampling programs, see table 2 for sampling dates. Measurements of temperature, pH, conductivity, turbidity, and dissolved oxygen were measured on site by HCA staff for each sample site using a YSI 6600. Chlorophyll-a is measured in an ac-credited laboratory once every three years (samples in 2013 were analyzed for Chlorophyll-a, so the next year would be 2016). Sampling events were classified as wet or dry by viewing and confirming rain data recorded at Environment Canada precipitation monitoring station at Hamilton Airport Climate ID 6153193, if 4mm of rain occurred in the previous 24 hours it was considered a wet event. Wet and dry events are classified in Table 2. A visual inspection of storm water outfalls in the area was also completed if storm water conditions were suspected.

Table 2: Rainfall Events for Corresponding Sampling Dates

Sampling Date	Previous 24 Hour Rainfall (mm)	Classification
5/6/2014	0.0	Dry
5/20/2014	0.2	Dry
6/4/2014	0.0	Dry
6/16/2014	0.0	Dry
7/2/2014	0.0	Dry
7/14/2014	0.0	Dry
7/28/2014 & 7/29/2014	67.5	Wet
8/11/2014	0.0	Dry
8/25/2014	0.0	Dry
9/8/2014	0.0	Dry
9/23/2014	0.0	Dry

3.2 Water Quality Targets / Objectives

Samples were analyzed for the parameters listed in Table 3. Each station was sampled 11 times throughout the 2014 sampling season. Objectives to ensure that water quality is satisfactory for aquatic life were based on Provincial Water Quality Objectives (MOE 1999), federal guidelines outlined by the Canadian Council of Ministers of the Environment (2001) and Cootes – Grindstone Water Quality Targets (RAP office 2012). The target objective is to apply to 9 out of the 11 samples taken in 2014.

Table 3: Water Quality Parameters and their Desired Target/Objective

Parameter	Units	Target/Objective	Reference
Unionized Ammonia	mg/L	0.02 mg/L	HHRAP
Nitrate as N	mg/L	3 mg/L	HHRAP
Nitrite as N	mg/L	0.06 mg/L	CWQG
o-Phosphate as P	mg/L	n/a	
Total Phosphorous	mg/L	0.03 mg/L	PWQO
Total Suspended Solids	mg/L	25 mg/L	HHRAP
Volatile Suspended Solids	mg/L	n/a	
Escherichia coli	CFU/100mL	1000 CFU/100mL	PWQO

Although the sampling locations span several watersheds, indices from Conservation Ontario's guide to developing Watershed Report Cards was applied to some analysis to provide tools in data analysis and context in examining the water quality data from site to site. Table 3 outlines our desired targets for water quality for each of the parameters analyzed.

Total Phosphorus

Table 4: Conservation Ontario Total Phosphorus Range System

A	<0.03
B	0.03 - 0.10
C	0.11 - 0.17
D	0.18 - 0.24
F	>0.24

Using Conservation Ontario's guide to developing Watershed Report Cards, Table 4 can be used to define a letter grade for the average concentration of Total Phosphorus (TP) for each location. Using the PWQO of 0.03mg/L, we can categorize each location according to their average TP concentrations throughout the sampling season.

Unionized Ammonia

Ammonia is the preferred nitrogen containing nutrient for plant growth, yet it can also cause algal blooms and stress to fish in high concentrations. In water, ammonia occurs in two forms; ionized and unionized ammonia. This difference is important to know because NH3, un-ionized ammonia, is the form more toxic to fish. Both water temperature and pH affect which form of ammonia is predominant at any given time in an aquatic system.

Ortho-Phosphate

There is no current target set for ortho-Phosphate for the HHRAP or PWQO's.

Nitrate

Nitrates are an essential nutrient for regulating plant life but can cause degraded water quality in excess concentrations. The target concentration for nitrates in this study is based on the Canadian Water Quality Guideline (CWQG) of 3.0mg/L. Typically nitrate concentrations tend to be low during base-flow conditions; however runoff from fertilizer, waste water treatment plants and storm sewer outfalls can bring the concentration of nitrates up to and beyond the target for water quality.

Nitrite

For this study, we've adopted the CWQG target of 0.06mg/L as N.

Total Suspended Solids

Targeted concentrations of Total Suspended Solids (TSS) vary depending on the system being monitored. TSS thresholds are established by understanding the underlying background levels of a site which may or may not have clear flow during base-flow conditions. Storm events move sediment downstream and therefore TSS values are expected to be much higher during these events. Since background levels of TSS is unavailable for the majority of the sites sampled, the Hamilton Harbour Remedial Action Plan interim target of 25 mg/L was used as the target for TSS (RAP office 2012). This target is derived from the Canadian Water Quality Guideline (CWQG) for total suspended sediment.

Escherichia coli

E.coli is well known to have harmful effects on human health when found in the environment at certain concentrations. There are strict guidelines for E.*coli* targets for drinking and recreational purposes. Since there is little to no background data for the majority of the sites, we will be comparing the geometric mean concentrations from each site to Health Canadas recommended target for secondary contact of 1000CFU/100mL

4. Results and Discussion

4.1 Total Phosphorus

As seen in Table 6, a large majority of the samples taken exceeded the PWQO of 0.03mg/L. Total phosphorus exceedances were common throughout the sample season at all locations, with only 19 of the 77 samples taken at or below the PWQO. The highest individual sample and highest average TP concentrations were from Chedoke Creek (CP-11). Concentrations are well above the PWQO in each sample taken at this location, especially during wet events as seen in Table 5. These poor results have given site CP-11 a letter grade of F according to Conservation Ontario's guide for developing Watershed Report Cards. All other locations received a letter grade B. Table 5 shows that during the one wet event sampled, total phosphorus concentrations were notably higher at all sample locations. Results indicate that most of the total phosphorus loadings are likely received during storm events.

The Ancaster Creek locations (AC-1 → AC-4) all exceeded the PWQO for the seasonal average TP. Ancaster Creek TP values for dry events are relatively low compared to the wet event on July 28, 2014. AC-3 TP concentration is generally higher than at other sites. This may be a result of land usages in the upper Ancaster Creek subwatershed compared to Sulphur Creek subwatershed (AC-2) and the lower reaches of Ancaster Creek (AC-4). Land uses in the upper reaches of Ancaster Creek, such as agriculture and a golf course, could be the reason for higher TP levels in AC-3 (it should be noted that site AC-4 was sampled on July 29, 2014 due to an unpassable channel).

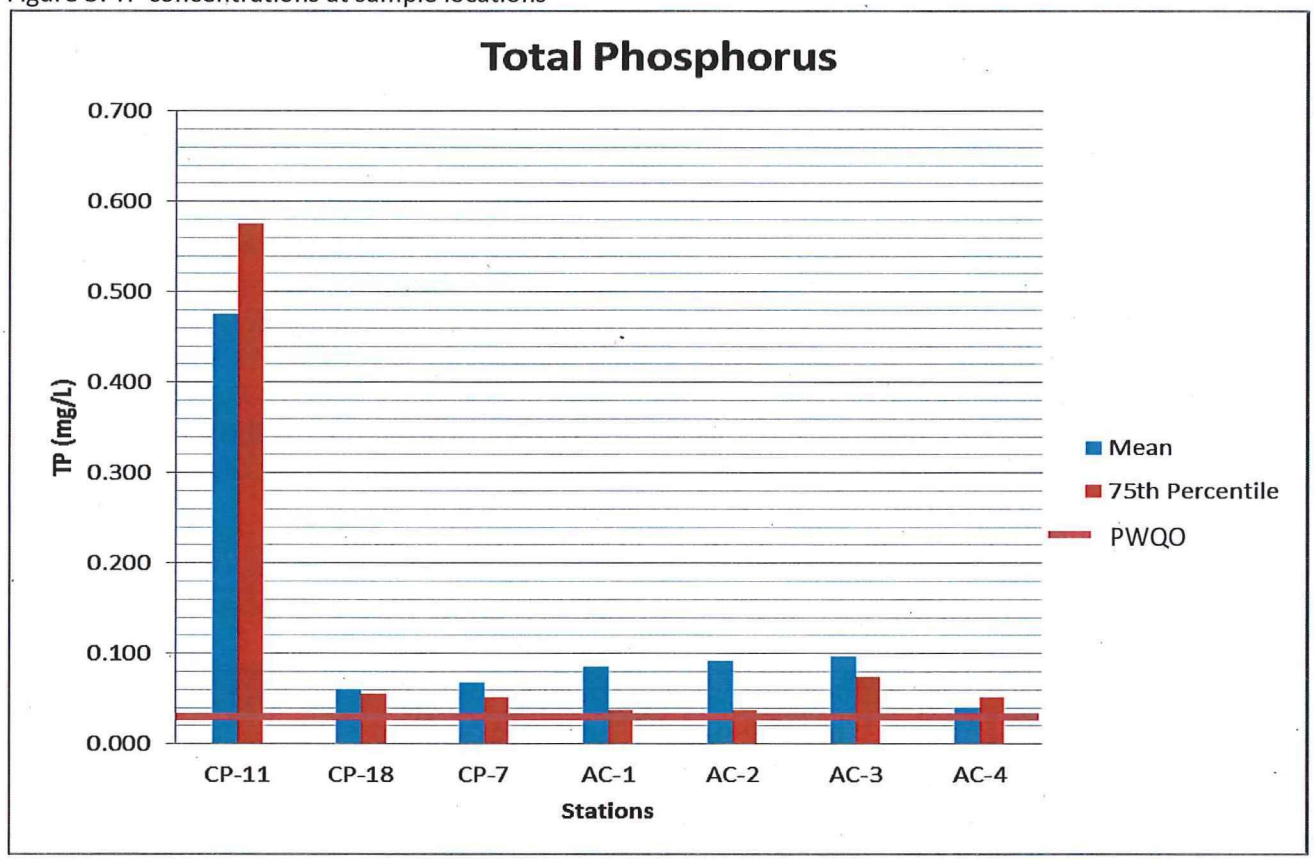
Table 5: Total Phosphorus values in mg/L

Date	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	0.306	0.023	0.027	0.032	0.038	0.033	0.031
5/20/2014	D	0.156	0.024	0.056	0.035	0.03	0.038	0.063
6/4/2014	D	0.508	0.057	0.038	0.041	0.028	0.084	0.033
6/16/2014	D	0.66	0.053	0.034	0.025	0.038	0.049	0.022
7/2/2014	D	0.306	0.076	0.047	0.045	0.033	0.078	0.033
7/14/2014	D	0.296	0.042	0.04	0.035	0.031	0.071	0.032
7/28/2014	W	0.956	0.222	0.321	0.65	0.689	0.627	0.074
8/11/2014	D	0.642	0.045	0.045	0.015	0.027	0.014	0.07
8/25/2014	D	0.502	0.038	0.041	0.017	0.015	0.013	0.027
9/8/2014	D	0.397	0.036	0.066	0.027	0.074	0.04	0.041
9/23/2014	D	0.496	0.044	0.034	0.017	0.014	0.018	0.022
Mean		0.475	0.060	0.068	0.085	0.092	0.097	0.041

Conservation Ontario's Total Phosphorus Grading System

A	<0.03
B	0.03 - 0.10
C	0.11 - 0.17
D	0.18 - 0.24
F	>0.24

Figure 3: TP concentrations at sample locations



4.2 Ortho-Phosphate

As shownin Table 6, ortho-Phosphate concentrations were below detection limits in 76 of 77 sample events. This water quality parameter does not appear to be of concern at this time.

Table 6: ortho-Phosphate in mg/L

Date	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
5/20/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
6/4/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
6/16/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
7/2/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
7/14/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
7/28/2014	W	0.28	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8/11/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8/25/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
9/8/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
9/23/2014	D	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

4.3 Nitrate/Nitrite/Ammonia

The nitrate target of 3.0mg/L as N is based on the Canadian Water Quality Guideline (CWQG). As shown in Table 7, nitrate concentrations were consistently above the target objective at CP-11 and AC-3 throughout the sampling period. All other sites had a mean value below that of the target objective. The wet event on July 28, 2014 did not seem to have a large effect on nitrate concentrations on any of the sample locations. Site CP-11 had the highest average concentration value while site CP-7 had the lowest. Ancaster Creek locations were relatively consistent throughout the sampling season.

Table 7: Nitrate as N values in mg/L

Date	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	8.73	1.24	1.51	2.08	1.37	2.26	0.97
5/20/2014	D	8.20	1.55	1.86	2.30	1.59	2.75	1.46
6/4/2014	D	0.35	1.73	1.95	2.48	1.42	3.54	1.86
6/16/2014	D	1.42	3.54	2.84	3.15	2.17	4.56	2.35
7/2/2014	D	3.63	1.24	2.48	3.15	2.30	3.94	2.26
7/14/2014	D	2.88	1.42	2.35	3.32	2.53	4.25	1.95
7/28/2014	W	5.98	1.55	2.35	2.08	1.64	2.22	3.99
8/11/2014	D	4.70	0.53	0.89	2.53	2.17	3.54	0.71
8/25/2014	D	5.54	1.20	1.55	2.70	2.30	3.41	1.02
9/8/2014	D	4.43	1.33	1.42	2.84	1.99	3.85	2.44
9/23/2014	D	3.94	0.80	1.33	2.70	2.22	3.90	1.90
Mean		4.53	1.47	1.86	2.67	1.97	3.48	1.90

Nitrite concentrations can be seen in Table 8. The overwhelming majority of samples tested below detection limits (BDL), with only 13 of 77 registering a value above BDL. Site CP-11 was the only site to have some consistency in recording Nitrite concentrations. Using the target of 0.06 mg/L from CWQG we can see that site CP-11 regularly exceeds the target objective. Wet events did not seem to play a major role in altering Nitrite concentrations at any site.

Table 8: Nitrite as N values in mg/L

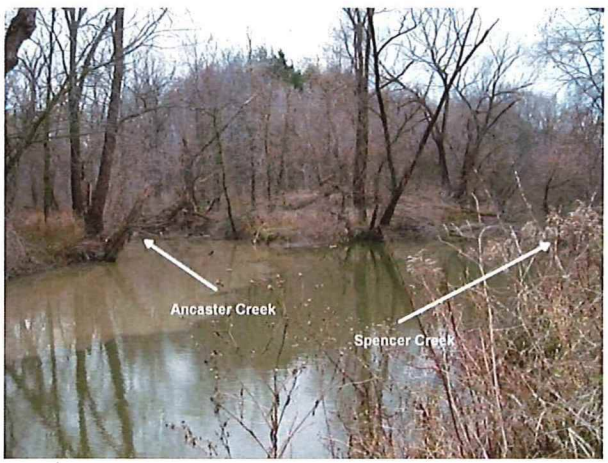
	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
5/20/2014	D	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6/4/2014	D	0.2	<0.05	<0.05	<0.05	<0.05	0.07	0.12
6/16/2014	D	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
7/2/2014	D	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
7/14/2014	D	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7/28/2014	W	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
8/11/2014	D	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
8/25/2014	D	0.1	<0.05	<0.05	0.09	<0.05	<0.05	<0.05
9/8/2014	D	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/23/2014	D	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mean		0.117						

Total ammonia concentrations are listed in Table 9. Site CP-11 was regularly above the target objective of 0.02mg/l, with a mean value above the target at 0.043mg/l. all other sites did not experience any exceedances of the target objective at any time during the sampling period.

Table 9: Unionized Ammonia values in mg/L

	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	0.064	0.004	0.002	BDL	BDL	0.001	BDL
5/20/2014	D	0.005	BDL	0.000	BDL	BDL	BDL	BDL
6/4/2014	D	0.038	BDL	0.002	0.001	BDL	0.001	0.000
6/16/2014	D	0.037	0.001	0.001	0.001	0.001	0.001	0.001
7/2/2014	D	0.033	0.000	0.002	0.001	0.001	0.001	0.001
7/14/2014	D	0.004	BDL	0.001	0.001	0.000	0.000	0.001
7/28/2014	W	0.04	0.001	0.002	0.001	0.001	0.001	0.001
8/11/2014	D	0.084	0.001	0.001	0.001	BDL	BDL	BDL
8/25/2014	D	0.057	0.001	0.002	0.001	BDL	BDL	0.001
9/8/2014	D	0.041	BDL	0.002	0.001	BDL	BDL	0.001
9/23/2014	D	0.067	BDL	0.001	BDL	BDL	BDL	0.001
Mean		0.043	0.001	0.002	0.001	0.001	0.001	0.001

4.4 Total Suspended Solids



As Table 10 shows, the majority of sample locations were lower than the interim target of 25 mg/L. Of the 77 samples taken, 62 were below the RAP objective. The Ancaster Creek locations had some of the highest recorded vales for TSS. However, the lowest values were observed in AC-4, upstream of the confluence with Ancaster Creek main channel. Although AC-4 is within the Ancaster Creek subwatershed, the catchment area is quite small in comparison to AC-3 and AC-4 as the channel forms about 2 kilometers upstream of the sample location and consists of mostly forested and some urban residential land uses. The small catchment area consisting of mostly undeveloped floodplain/forest area is the likely reason for lower TSS values seen at AC-4. The highest values recorded were after the wet event, specifically at sites AC-1, AC-2 and AC-3. The origins of the creeks represented by AC-1, AC-2 and AC-3 are within agricultural areas about 8 kilometers upstream. AC-2 watershed (Sulphur Creek) is in mostly protected floodplain area or conservation areas and thus has little to no impact from typical

urban influences. Site AC-1 and AC-3 (Ancaster Creek) go form agriculture in the upper watershed, through a golf course and then into urban residential areas before entering the forested/floodplain area below the escarpment. Site CP-7 and CP-11 saw a gradual increase in TSS concentrations over the season compared to the Ancaster Creek sites up until the wet event and then began to decrease nearing the end of the summer season.

Table 10: Total Suspended Solids in mg/L

Date	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	9.2	1.8	6.1	16.2	18.6	20.6	13.5
5/20/2014	D	9.5	3.4	12.3	22.6	20.8	38.3	12.1
6/4/2014	D	19	4.2	17.5	23.8	17.9	49.5	4
6/16/2014	D	21.5	5.4	12.9	12.5	12.3	24	6
7/2/2014	D	29	12	23.1	21.8	25.9	70.4	6
7/14/2014	D	25.9	8.1	22.5	19	22.3	51.5	6.4
7/28/2014	W	89.6	109	250	335	645	353	16.6
8/11/2014	D	52.4	8.1	13.4	2.5	7.5	4.7	17.5
8/25/2014	D	55.5	3.8	9.6	1.6	5.4	3.4	1.8
9/8/2014	D	7	4.2	20.4	4.4	7.8	8	2.4
9/23/2014	D	12.4	4	9	2.7	3.6	2.7	2
Mean		30.09	14.91	36.07	42.01	71.55	56.92	8.03

4.6 Escherichia coli (E. coli)

As with most other parameters, E.*coli* levels increased in concentration during the wet event at all locations. In some cases such as CP-11, the levels are high – indicating possible sewage contamination. All locations can be considered to be in urban locations or under urban stormwater conditions. Although sites AC-2 → AC-4 are within a forested floodplain area, they still experienced a high E.*coli* concentration throughout the sample season and especially during the wet event. The high exceedances at site CP-11 may be a result of combined sewers and cross connections upstream, as the seasonal geometric mean for this location was calculated to be 61,077 CFU/100mL which is much higher than other locations. Site AC-1 had the second highest concentrations of E.*coli* recorded. This site captures the combination of contaminants from AC-2, AC-3 and AC-4, plus a stretch of about 1.5 km of forested floodplain area in which it can gather more bacteria from wildlife and urban runoff.

Table 11: *E.coli* in CFU/100mL

Date	Event Type	CP-11	CP-18	CP-7	AC-1	AC-2	AC-3	AC-4
5/6/2014	D	53000	<10	30	20	<10	<10	10
5/20/2014	D	2600	30	100	210	50	250	180
6/4/2014	D	420000	390	900	1390	440	680	670
6/16/2014	D	120000	100	470	520	130	310	280
7/2/2014	D	1900	1900	420	570	430	300	810
7/14/2014	D	60000	120	420	460	440	360	490
7/28/2014	W	1120000	8700	8400	9700	6000	12600	1200
8/11/2014	D	260000	500	300	700	600	170	100
8/25/2014	D	2900	190	270	360	240	120	170
9/8/2014	D	120000	210	270	490	300	210	390
9/23/2014	D	550000	120	250	980	150	510	790
Geometric Mean		61077	298	352	530	340	416	280

5. Discussion Summary

The water quality data collected over the 2014 sampling season provides valuable insight into which creeks and tributaries are contributing poor water quality to the Cootes Paradise Marsh. The water quality issues identified in 2014 will need to be verified by samples obtained from additional monitoring seasons. Once trends have been further established and input sources have been identified, water quality issues can be more definitively stated and remedial activities designed and implemented.

Of all the parameters measured for this monitoring, ortho-phosphate and Nitrite were found to be of the least concern at most locations and therefore will only be mentioned briefly. Nitrite and ortho-Phosphate analysis consistently tested below detection limits throughout the sample season. However, nitrite at CP-11 received an average of 0.117 mg/L which is higher than the CWQG of 0.06 mg/L, and is consistent with the abnormally high nutrient concentrations associated with this site. Site CP-11 seems to be heavily impacted by nutrients whether its under wet or dry conditions.

Discuss nitrate and unionized ammonia

Total suspended solids during base flow conditions were of relatively good quality and regularly resulted in concentrations below the target of 25 mg/L at all locations. The one storm event captured suggests that the largest loads likely happen during wet events. Sites AC-1 → AC-3 appear to be more susceptible to sediment loading during wet events, as their concentrations during the July 28, 2014 event were relatively quite high. There appears to be a significant amount of erosion taking place within the floodplain near the sample locations. Heavily eroded

banks, fallen trees and loose soils are a common sight within the floodplain (visual evidence to follow on further reports). Stream and bank restoration efforts through these stretches may assist is decreasing the amount of sediments being eroded from the stream bank during storm events.

Total phosphorus concentrations regularly exceeded the PWQO of 0.03 mg/L at all locations. Site CP-11 was once again associated with a very high nutrient concentration. All sites recorded elevated levels of TP during the wet event as total phosphorus is known to adsorb to sediments. Erosion and runoff reducing mitigations could be applied to help reduce nutrient rich sediments from entering the watercourse.

Site CP-11 was severely impacted by E.*coli*, especially after the wet event. The abnormally high results indicate possible sewage contamination from an upstream combined sewer outfall, cross connections or aging infrastructure. Ancaster Creek sampling locations also tested high for E.*coli*, which may be indicative of the land uses across the sub-watershed. Ancaster Creek headwaters begin in agricultural fields south of Garner Rd. and Hwy 6 in Ancaster and move through residential areas and a golf course before flowing into a forested floodplain. Surface waters can pick-up bacteria from organic fertilizer and pet waste associated with these types of land uses during wet events. More information and monitoring is required to identify any possible point-source contributors of E.*coli* in Ancaster Creek.

Due to the limited data set for this monitoring program, it is difficult to draw any final conclusions about the state of water quality for the sampling locations. It can, however, point us in the right direction for future monitoring opportunities as well as allow us to begin to establish water quality trends in areas where there was no data previously. By continuing this program, we can begin to develop strategies that will identify, target and remediate potential water quality issues affecting the Cootes Paradise Marsh and Hamilton Harbour. Data from this program can also be used amongst monitoring partners to supplement future studies in the area, such as the nutrient loading model currently being developed by the University of Toronto.

6. Future Planned Monitoring Activities As Part of the Cootes Paradise Tributary Water Quality Monitoring Program

In order to estimate loadings coming from Ancaster Creek into Spencer Creek and the Harbour, HCA and MOECC staff set-up a temporary flow monitoring and remote sample collection station on Ancaster Creek just upstream of the confluence with Spencer Creek at site AC-1 (see Figure 4) to sample six storm events per sample season starting in April 2015 (2 events in each of spring, summer and fall). Continuous flow monitoring will be conducted from April to October using a pressure transducer (730 Bubbler Flow Module) attached to an ISCO automated remote sampler. This will provide accurate flow data by establishing a level-to-flow relationship using a Marsh McBirney flow meter to develop a rating curve at site AC-1. Rating curve points will be taken once a month throughout the study period while paying close attention to capture both high and low flow conditions. With 24 sample bottles in the ISCO carousel, we will be able to capture a 24 hour time period of the storm and its effect on the creek (this sample timeframe

may change depending on expected storm durations). Using the water level data collected by the 730 Bubbler Flow Module, a level weighted composite sample can be made from the 24 bottles and submitted for analysis.

Figure 4: AC-1 equipment installation

7. References

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