PWF Strategy

A study on Pattingale, Westley's and Ferguson Creeks

Raisin Region Conservation Authority
St. Lawrence River Institute of Environmental Sciences

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A study on Pattingale, Westley's and Ferguson Creeks

A study prepared for the Ontario Ministry of Environment

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EXECUTIVE SUMMARY

Research and monitoring have been conducted on the major tributaries that drain into the St. Lawrence (Cornwall) AOC for several years now to characterize their water quality, determine contaminant sources, and measure improvements from restoration efforts. From this program, three tributaries (Pattingale, Westley's and Ferguson) have been identified to contain significantly higher levels of total phosphorus (TP) than others.

Having recognized these three tributaries as highly polluted ones, the PWF strategy was created to locate sources of contaminants and prioritize restoration efforts.

This report summarizes the results of sampling conducted at sites located near the headwaters, near the middle of the watercourse and near the mouth over the period between July 2010 and June 2012, with nine annual sampling events throughout the fall, summer and spring seasons.

Key results are as follows:

- Annual mean TP concentrations at all sites exceed the delisting criterion of 0.060 mg/L for these sites.
- Pattingale Creek showed the strongest downstream increase in TP with mean concentrations ranging 0.090 - 0.213 mg/L, followed by Ferguson Creek which increased downstream from 0.090 – 0.139 mg/L. A similar trend was observed at Westley's Creek as mean TP values increased downstream from 0.107 to 0.133 mg/L.
- Relationships between TP and suspended solids was weak , however TP strongly predicted total dissolved phosphorus suggesting that TP is mostly in the soluble form in these tributaries.
- Relatively consistent specific conductivity in all three tributaries throughout the year likely reflects shallow groundwater recharge is a significant contribution to the water flow in these watercourses.

The following recommendations are made:

- Further sampling of the three tributaries in order to increase the data set as to fully understand the changes over time and the improvements as restoration activities are carried out.

- Install a permanent monitoring station to collect 24 hour information on the creeks

PWF Strategy

Introduction:

Excessive nutrient loadings, particularly phosphorus, to surface waters within the St. Lawrence River (Cornwall) AOC has been identified as an environmental issue of concern, and has contributed to eutrophication of the St. Lawrence River nearshore environment.

Water quality sampling in the tributary outlets that flow into the north shore of the St. Lawrence River between Cornwall and the Québec/Ontario border have been conducted since 2004 to better understand how effective agricultural landowners are in reducing non point source pollution. (see Figure 1 – Map of Tributaries and Sampling Points)

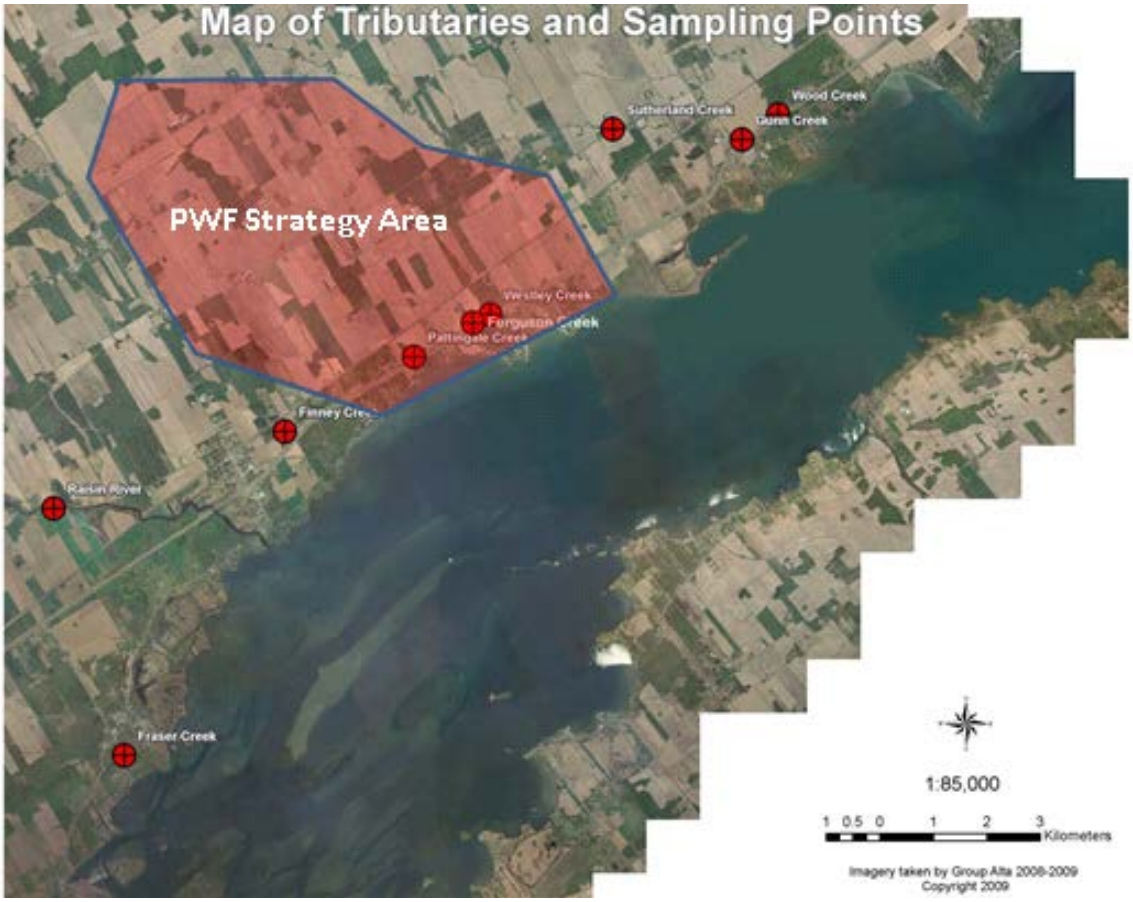


Figure 1 – Map of Tributaries and Sampling Points

Water quality scores generally range from relatively better results in Gray's Creek, Raisin River and Hoople Creek to very poor observations in Pattingale Creek, Westley's Creek and Ferguson Creek. (Table 1: Subwatershed Water Quality Summary)

Table 1: Subwatershed Water Quality Summary

Subwatershed	TP Target (mg/L)	Recent annual TP (2011/2012)	Longer Term TP (since 2004)
Hoople Creek	.045 - .050		.042
Gray's Creek	.055	.058	.068
Fraser Creek	.045 - .050	.055	.072
Raisin River	.045 - .050	.047	.065
Finney Creek	.055	.104	.179
Pattingale Creek	.060	.124	.275
Ferguson Creek	.060	.206	.236
Westley's Creek	.060	.271	.201
Sutherland Creek	.055	.082	.080
Gunn Creek	.060	.103	.110
Wood Creek	.060	.080	.099
Beaudette River	.045 - .050		.099

	Good (< target)
	Fair (<target + .05)
	Poor (>target + .05)

An analysis of the data by AECOM in their 2009 report, "*Evaluation of Remedial Action Plan Tributary Nutrient Delisting Criteria for the St. Lawrence River, Cornwall, Area of Concern*", confirmed that Pattingale, Westley's and Ferguson Creeks are significantly different from the other tributaries with respect to water quality even when land use characteristics are taken into account.

The PWF strategy includes a water quality sampling program to better understand why this area is subject to so much higher nutrient loadings. The sampling is in concert with other actions being taken to increase the awareness about sources of nutrients amongst the agricultural community and place a higher priority on projects to reduce surface water pollution in these subwatersheds.

Methods

The PWF strategy sampling began in July 2010, with nine annual sampling events: three in the fall, three in the spring and three in the summer. Samples

were taken at three different locations along each watercourse: at upstream, middle and downstream sites (Figure 2 – Pattingale, Westley's and Ferguson Creeks Sampling Stations).

In all nine events, in-field measurements of temperature, specific conductivity, dissolved oxygen and pH were taken, as well as samples to be analyzed for total phosphorus (TP), total dissolved phosphorus, total suspended solids (TSS) and turbidity. In addition, throughout the sampling year, analysis for dissolved reactive phosphorus (DRP), *Escherichia coli*, nitrates/nitrites, chlorophyll a and total nitrogen-kjeldahl (TKN) were done on occasion.

All sites are located at culvert crossings where grab samples were taken with a clean steel bucket while standing upon the culvert end. Most sites maintained a water level of between 0.5-1 m depth throughout the year, though the most upstream sites; most notably Pat 3 and Ferg 3, were dry on some occasions and so were not sampled at these times. Because of the low water levels in these tributaries, great care was taken when sampling with the bucket as to not agitate the sediment and to retrieve surface water only.

Once the sample was obtained, it was brought back to the vehicle where pH, specific conductivity, temperature and dissolved oxygen were measured and recorded using calibrated meters. At this point, the sample was poured into the various containers from the bucket, and stored in a cooler until arrival at the laboratory. In the laboratory, CALA (Canadian Association for Laboratory Accreditation) accredited methods were used to determine TSS, TP and *E.coli* at the St. Lawrence River Institute of Environmental Sciences, Cornwall, ON, and nitrates/nitrites and TKN at SGS laboratories in Lakefield, ON. Also at the St. Lawrence River Institute, in house methods were used to measure TDP, DRP, turbidity and chlorophyll a. Once all nine sampling events were completed, it was possible to relay all the data in order to interpret the results.

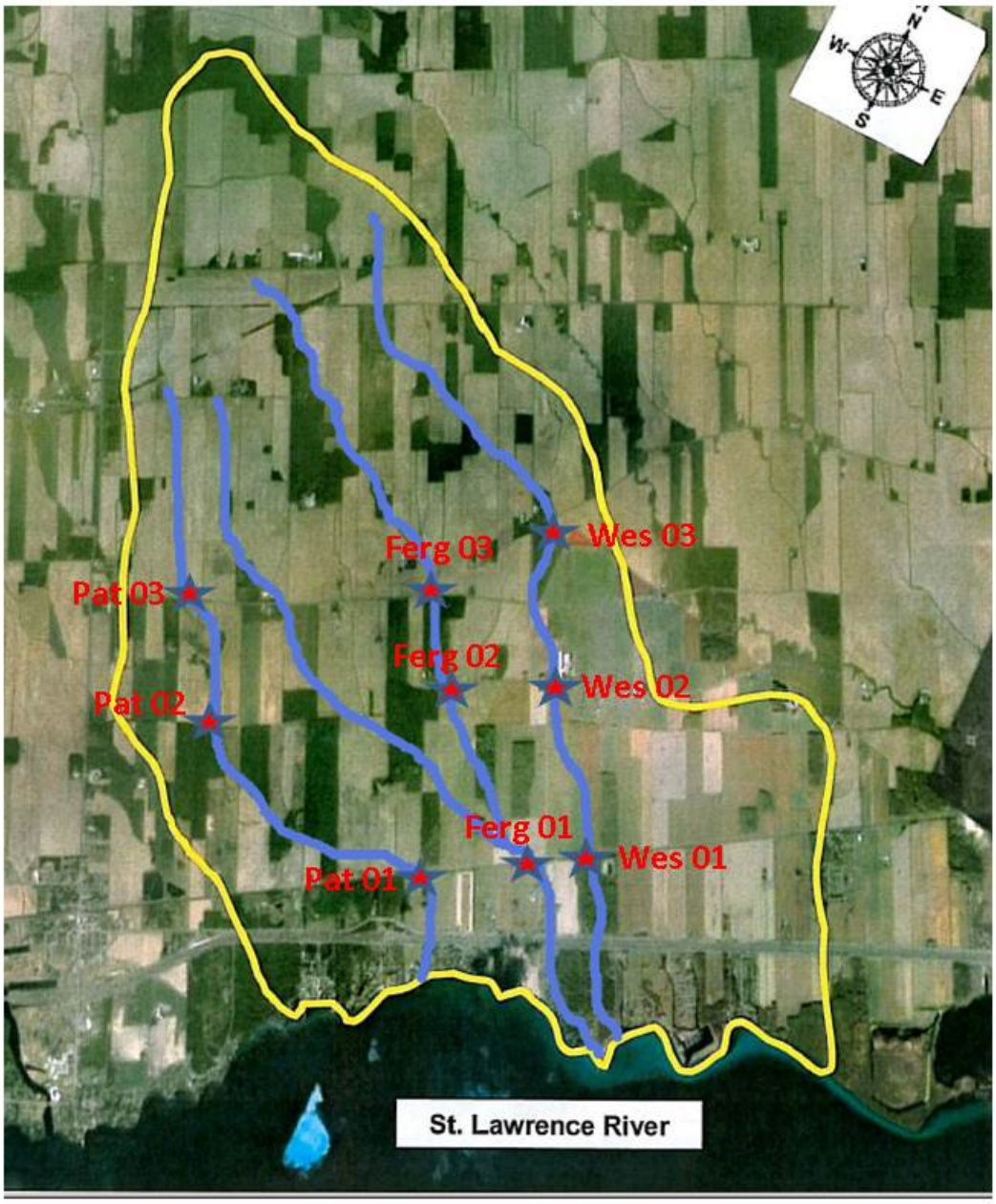


Figure 2 – Pattingale, Westley's, Ferguson Creeks sampling stations

Results and Discussion

Specific Conductivity

Specific conductivity measurements at the three tributaries are shown in Figure 3. A small seasonal trend is observed with fresher waters in the spring and higher conductivity in late summer. Overall results, though, are relatively consistent with specific conductivity values in all three tributaries generally ranging between 500 and 700 µS/cm throughout the year and little variation between upstream and downstream sites. All three tributaries exhibit high values on the November 2, 2011 sampling event. The consistency between sites and over time likely reflects the importance of shallow groundwater recharge to the water flow in these watercourses.

Table 2: Summary of data for Specific Conductivity at each sampling site since 2010

Pattingale Creek

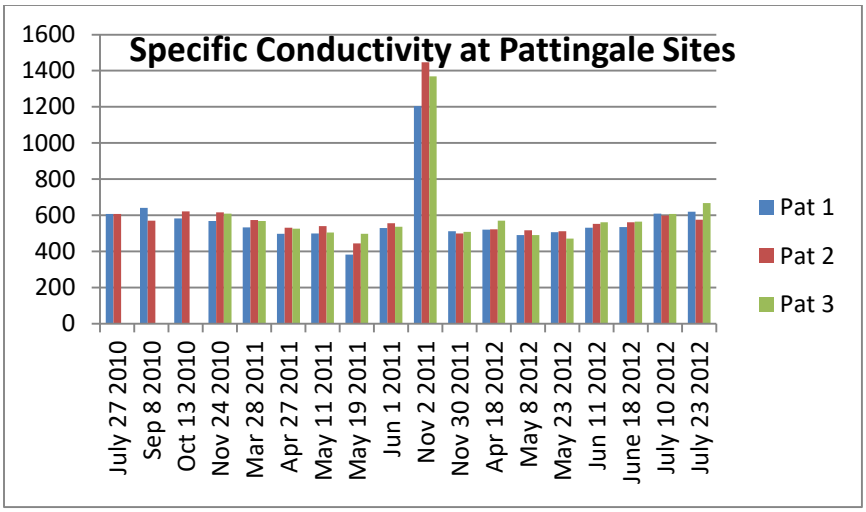
Site	Mean	Median	Minimum	Maximum
1	576	532	383	1205
2	603	559	445	1447
3	603	562	471	1369

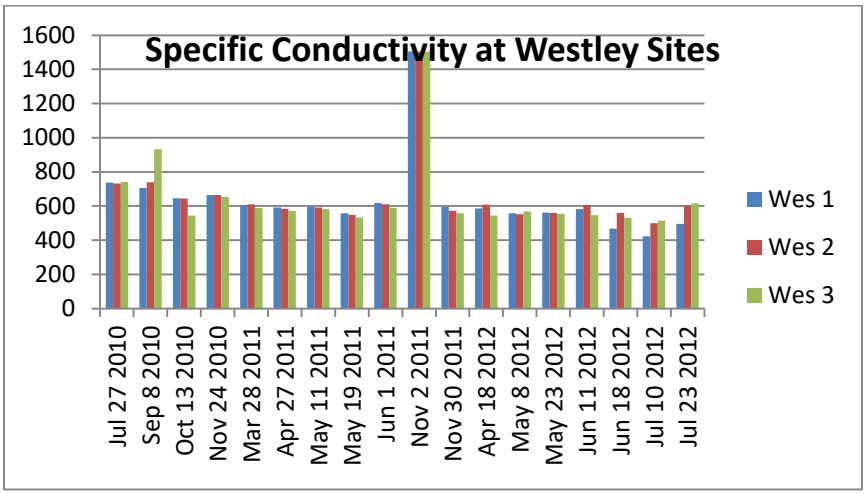
Westley's Creek

Site	Mean	Median	Minimum	Maximum
1	639	594	423	1505
2	655	604	500	1504
3	648	569	514	1503

Ferguson Creek

Site	Mean	Median	Minimum	Maximum
1	613	561	459	1491
2	644	562	410	1496
3	597	537	400	1423





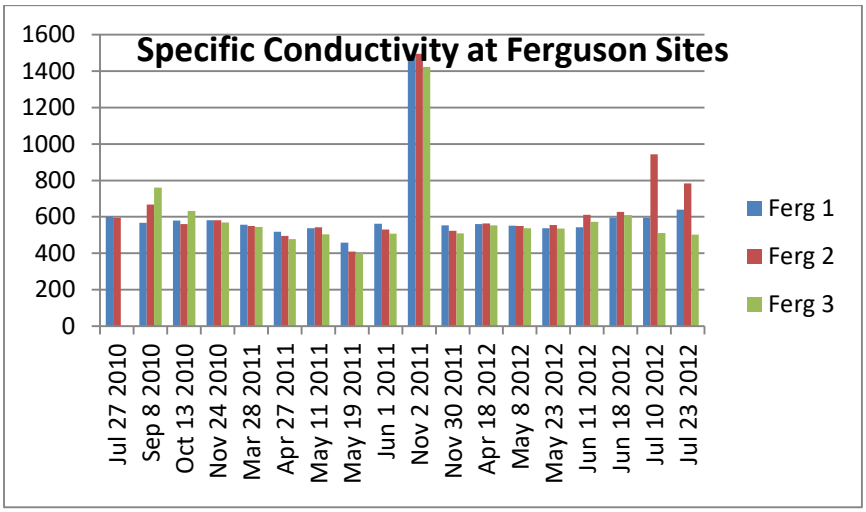


Figure 3 – Specific conductivity values at sites

Total Phosphorus

Annual mean TP concentrations at all sites exceed the delisting criterion of 0.060 mg/L for these sites (Table 3). Pattingale Creek showed the strongest downstream increase in TP with annual mean concentrations ranging 0.090 - 0.213 mg/L, followed by Ferguson Creek which increased downstream from 0.090 – 0.139 mg/L. Westley's Creek followed the same increasing downstream trend from 0.107 – 0.133 mg/L. Median TP values exhibit a similar downstream trend.

Table 3: Summary of data for TP at each sampling site since 2010

Pattingale Creek

Site	Mean	Median	Minimum	Maximum
1	0.213	0.068	0.022	1.410
2	0.170	0.058	0.029	1.199
3	0.090	0.043	0.017	0.522

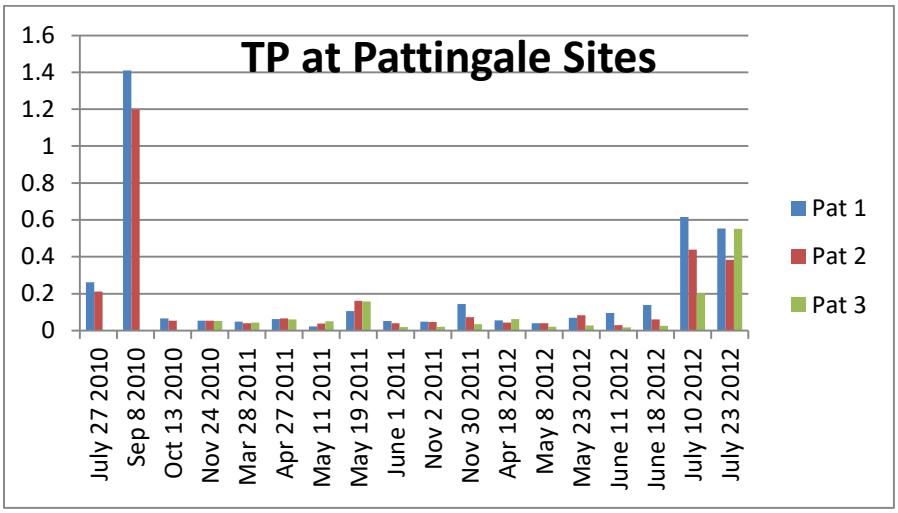
Westley's Creek

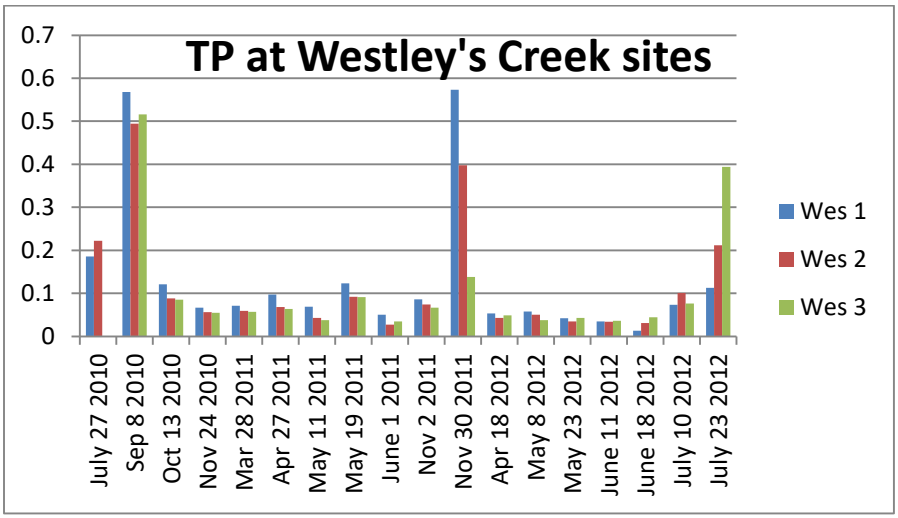
Site	Mean	Median	Minimum	Maximum
1	0.133	0.072	0.013	0.573
2	0.118	0.064	0.027	0.494
3	0.107	0.057	0.035	0.516

Ferguson Creek

Site	Mean	Median	Minimum	Maximum
1	0.139	0.070	0.030	0.698
2	0.112	0.065	0.034	0.462
3	0.090	0.045	0.023	0.489

In terms of relative variations of TP between sites, little trends are discernable within each sampling event (Figure 4). All of the three creeks display an outlying peak level of total phosphorus on the 8th of September 2010. This peak may be explained by rain events prior to this date. Because of the dry conditions over the last couple of years, flows were observed to be very low in all the tributaries to the St. Lawrence including the Pattingale, Westley's and Ferguson Creeks and particularly during the very dry summer of 2012. This may be contributing to the very high TP levels found in the three tributaries during this past summer. The little rain received was not enough to flush the systems out to the St. Lawrence but enough to allow the accumulation of nutrients within the tributaries. Details of nearshore studies are contained in a separate report and confirm the lower nutrient contributions of the tributaries to the nearshore areas during these very dry conditions of this past summer.





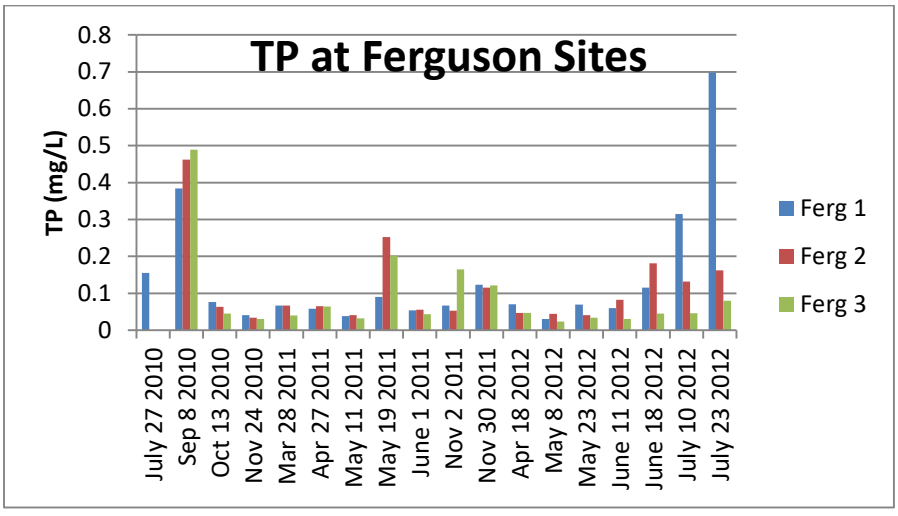


Figure 4 – TP values at the tributary sites

Total Suspended Solids

TSS values varied greatly between sampling events with high concentrations found in Sept 2010 and May 19, 2011 dates following significant rain events (Table 4, Figure 5). In terms of potential sources of TP, log TSS weakly predicted log TP in all three tributaries (Figure 6) with an r^2 value ranging from 0.304 in Westley's Creek to 0.3742 in Pattingale Creek. TP strongly predicted total dissolved phosphorus with r^2 values ranging from 0.732 in Ferguson Creek to 0.8846 in Pattingale Creek (Figure 7) suggesting that TP is mostly in the soluble form in these tributaries – not bound to algae or mineral particles.

Table 4: Summary of data for Total Suspended Solids at each sampling site since 2010

Pattingale Creek

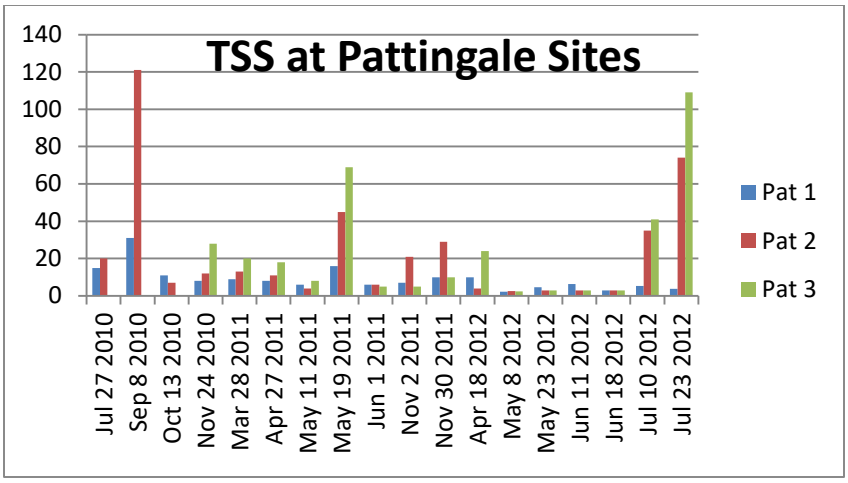
Site	Mean	Median	Minimum	Maximum
1	9	8	2	31
2	23	12	3	121
3	23	10	2	109

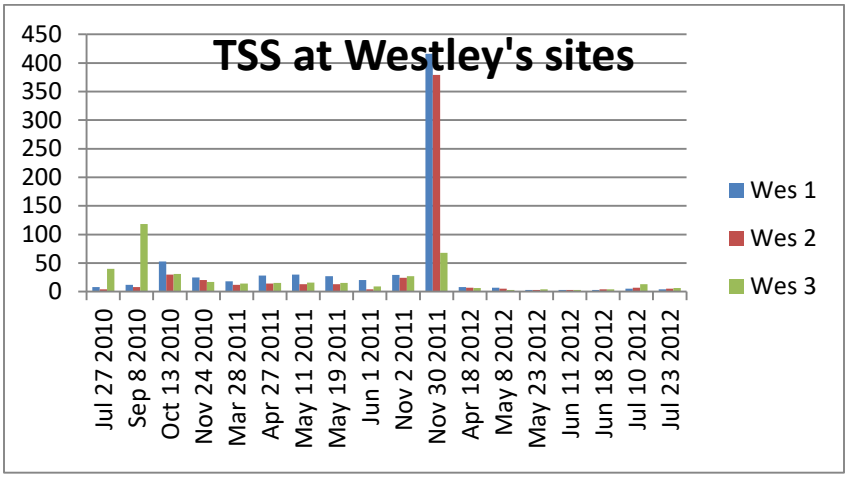
Westley's Creek

Site	Mean	Median	Minimum	Maximum
1	39	15	3	416
2	31	8	3	379
3	23	15	3	118

Ferguson Creek

Site	Mean	Median	Minimum	Maximum
1	8	7	2	21
2	39	23	3	253
3	20	8	2	125





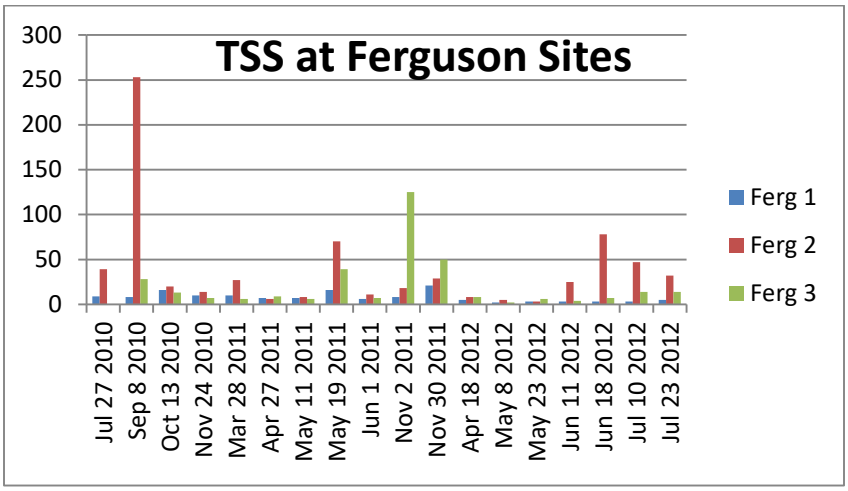
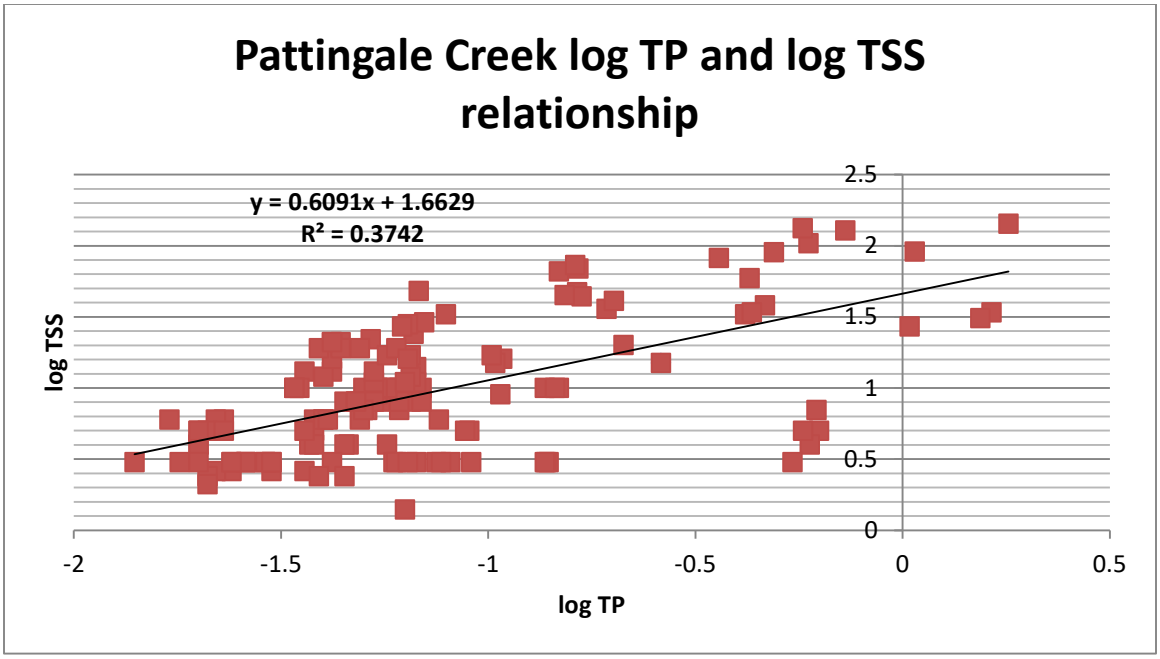
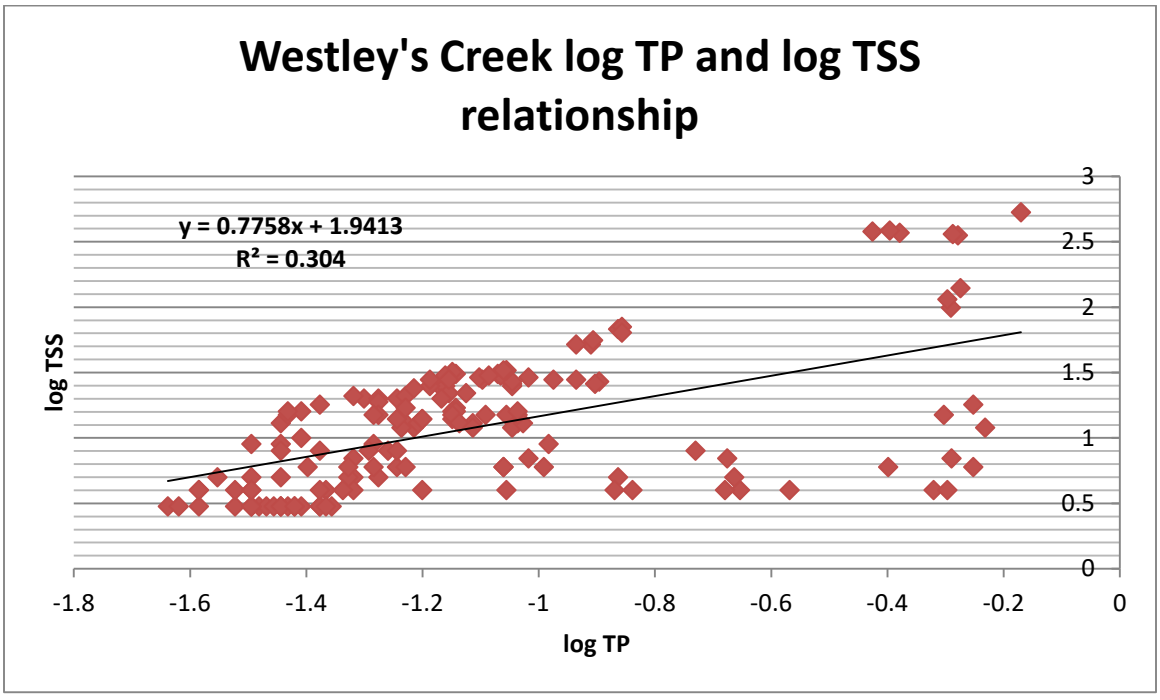


Figure 5 – TSS Values at Tributary Sites


Pattingale Creek log TP and log TSS relationship
y = 0.6091x + 1.6629
R² = 0.3742
log TSS
log TP
2.5
2
1.5
1
0.5
0
-2
-1.5
-1
-0.5
0
0.5


Westley's Creek log TP and log TSS relationship
y = 0.7758x + 1.9413
R² = 0.304
log TSS
log TP
3
2.5
2
1.5
1
0.5
0
-1.8
-1.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4
-0.2
0

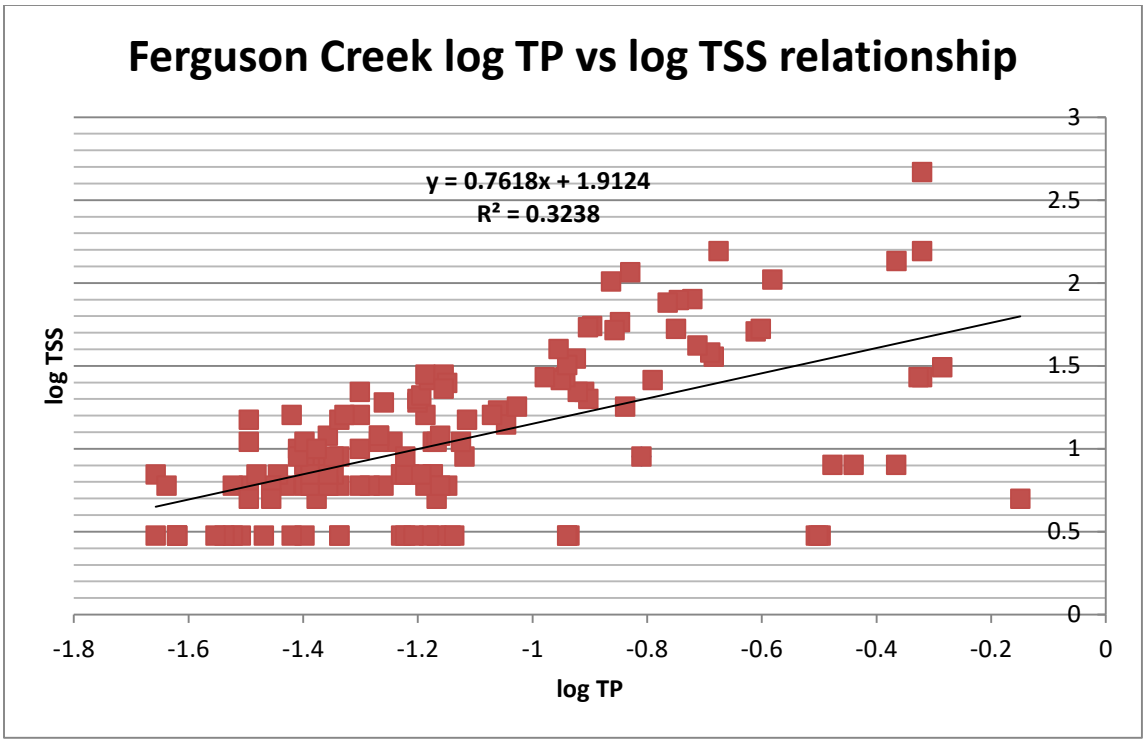
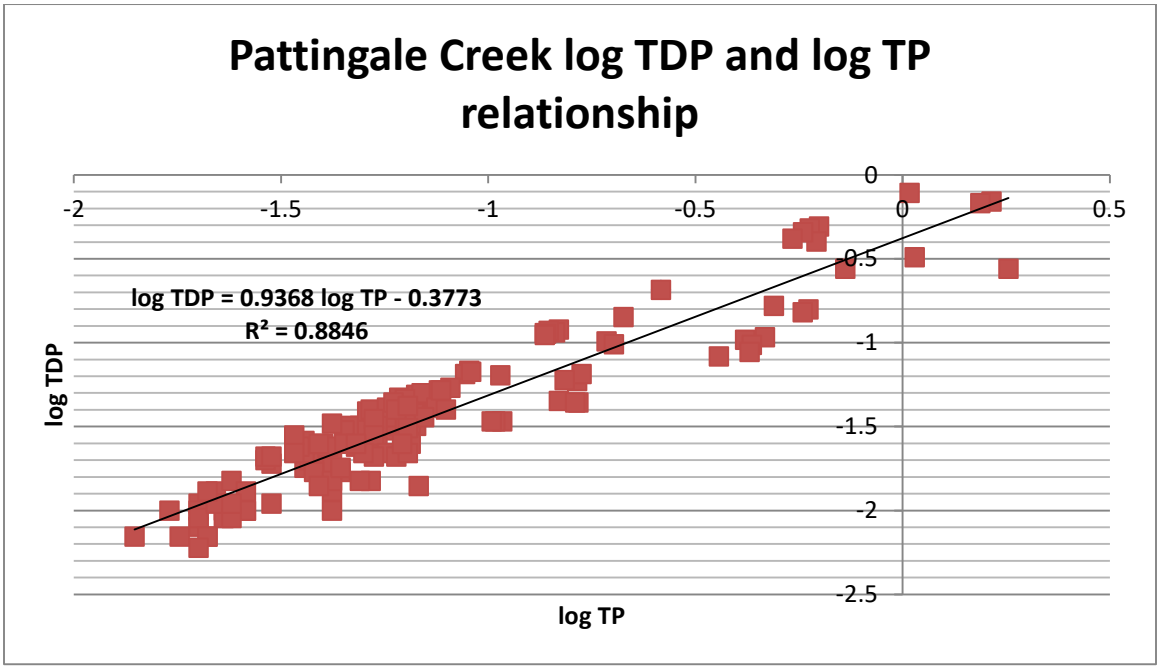
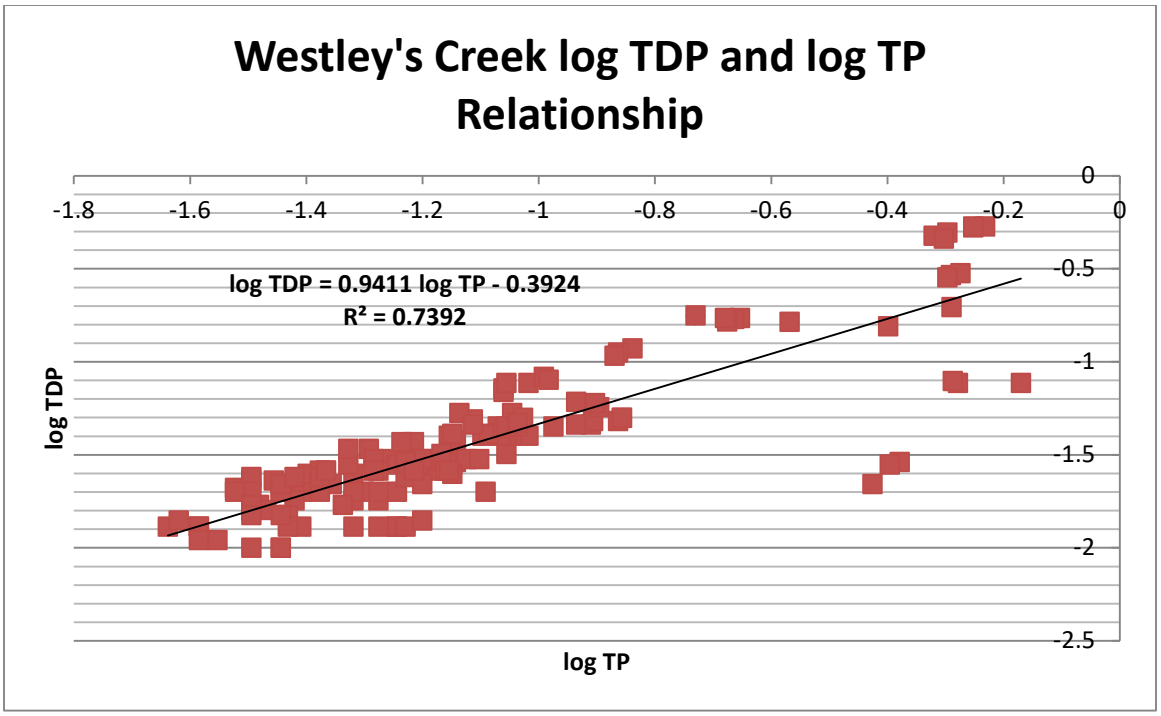


Figure 6 – Relationship between log TP and log TSS





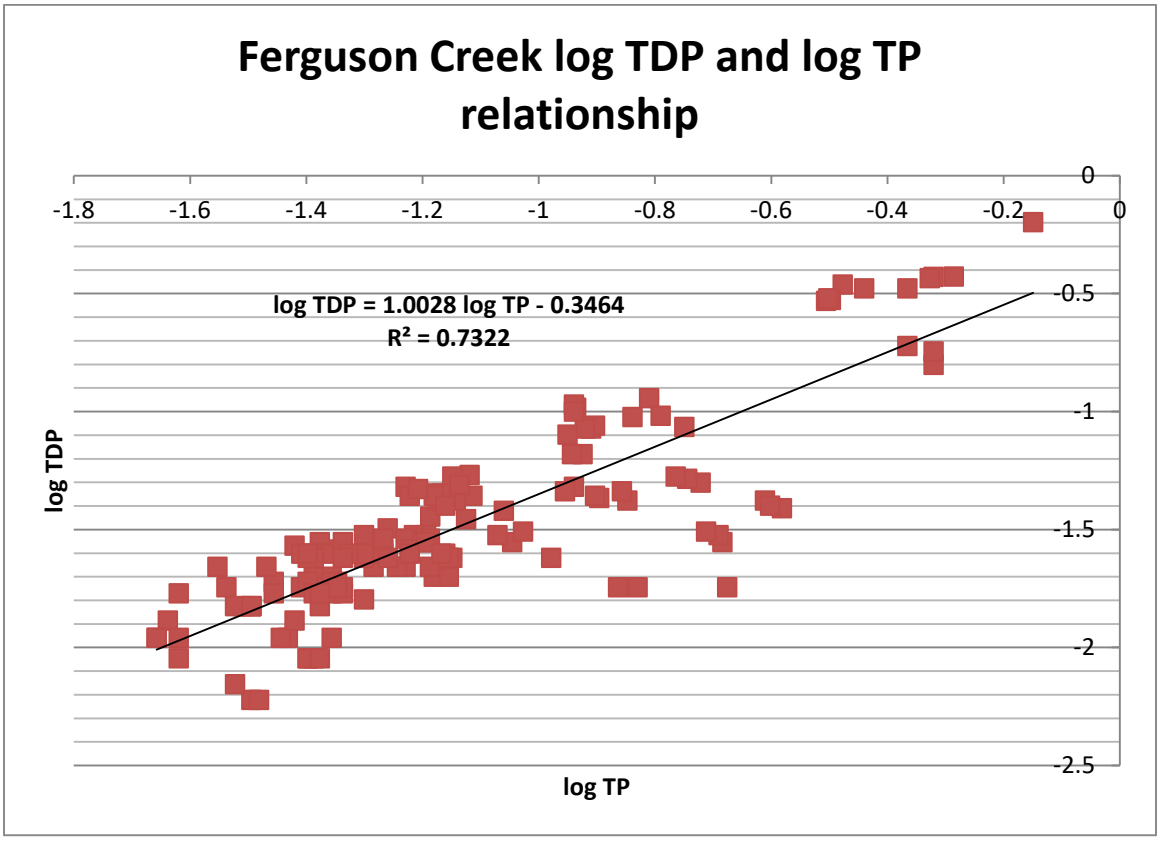


Figure 7 – Relationship between log TP and log TDP

Escherichia coli

E.coli counts in these three watercourses fluctuate at elevated levels, averaging close to 350cfu/100mL with events greatly exceeding 1000 cfu/100 ml. This would suggest the presence of strong sources to the watercourse (Table 5). Pattingale and Westley's Creeks exhibit an increase in average E. coli concentrations as one moves downstream. However, the reverse is encountered in Ferguson Creek where E. coli values decreased downstream. However, the very high results from the July 10, 2012 sampling date at Station Ferg 3 are having a large influence results. (Figure 8)

Table 5: Summary of data for E. Coli at each sampling site since 2010

Pattingale Creek

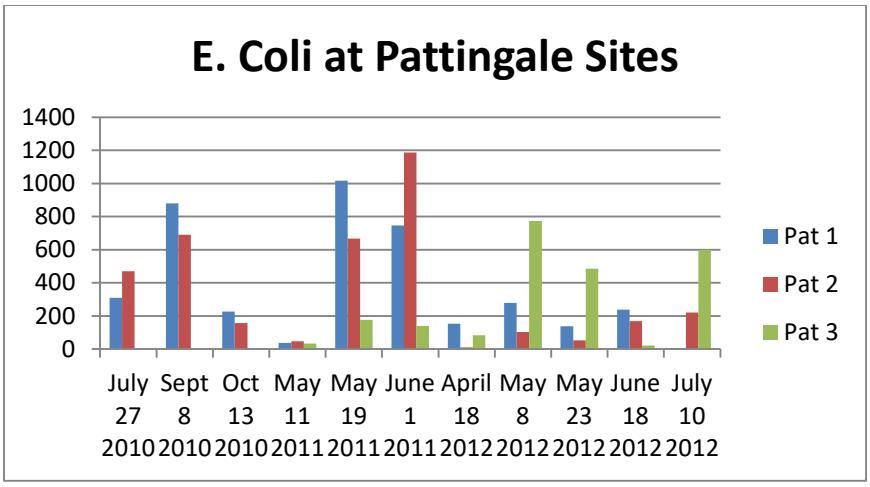
Site	Mean	Median	Minimum	Maximum
1	367	239	6	1017
2	343	169	10	1187
3	289	159	21	773

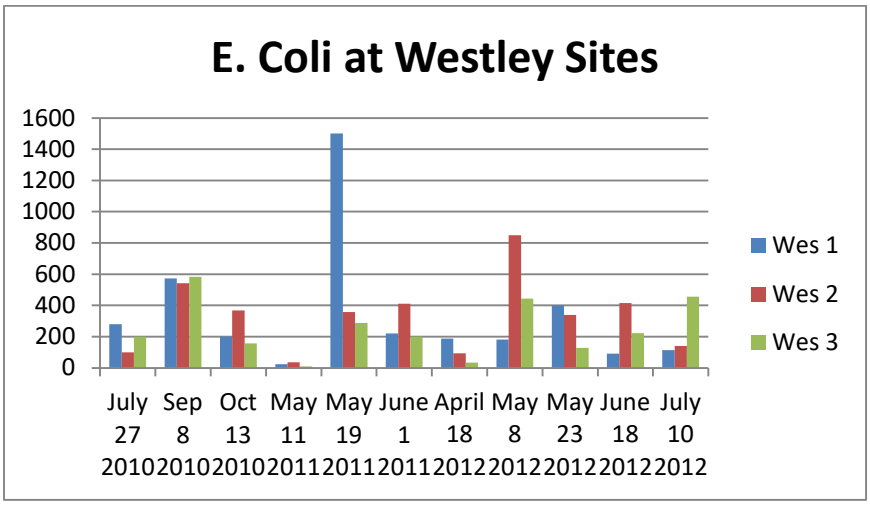
Westley's Creek

Site	Mean	Median	Minimum	Maximum
1	343	200	23	1500
2	332	357	37	850
3	247	200	10	583

Ferguson Creek

Site	Mean	Median	Minimum	Maximum
1	178	133	3	527
2	531	320	57	1813
3	1367	392	53	10200





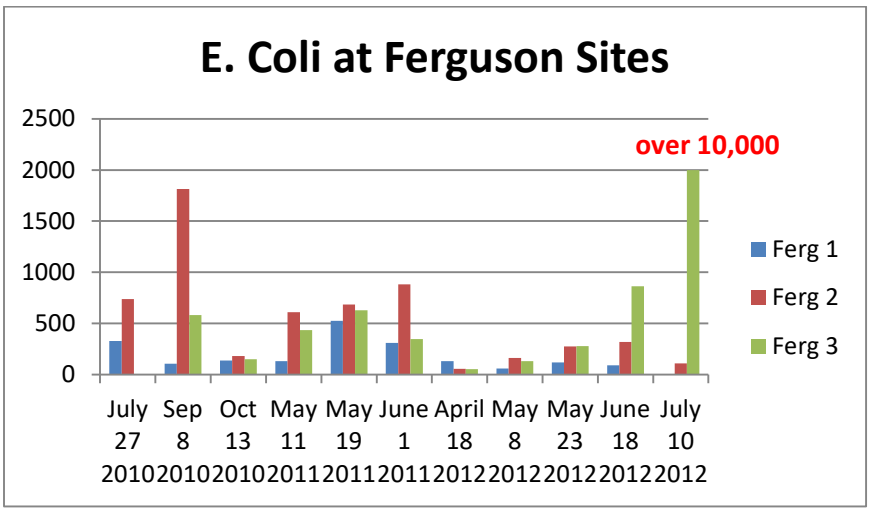


Figure 8 – E. coli data at the tributary sampling sites

Sources of *E. coli* may vary from site to site depending on the surrounding environment, although in this case, because these tributaries are found in agricultural land, it is most likely traced to the spreading of manure onto fields. Other sources include faulty septic systems, improperly maintained manure storage facilities, domesticated animals and wildlife. Overall a very weak relationship is found between log TSS and E. coli (r^2=0.17, Figure 9).

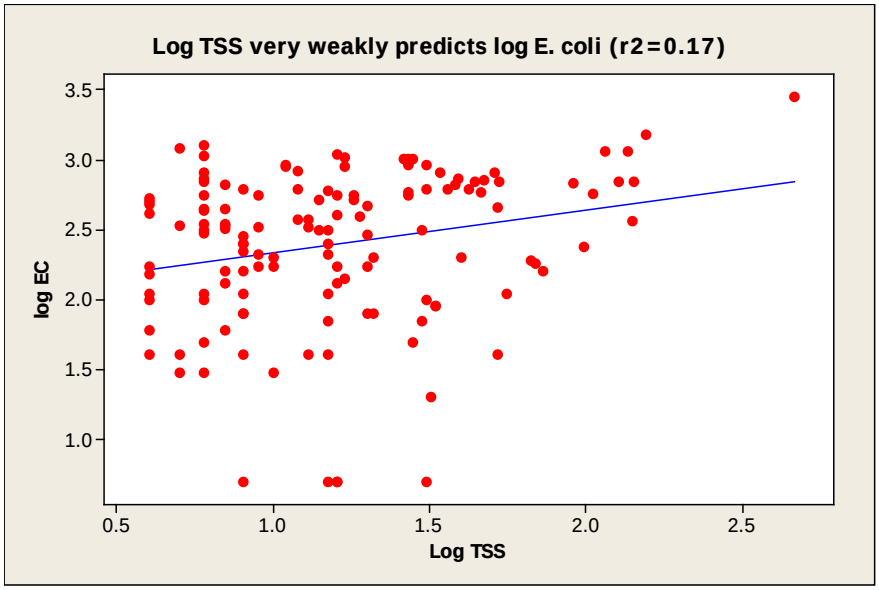


Figure 9 – Relationship between E. coli and TSS

Immediately east of the Ferg 2 site is a chicken farm which on many occasions exists an open manure pile on the land nearby. Chicken farming activities as well as current manure storage arrangement could be a direct point source for *E.coli* to enter the tributary. Westley's and Pattingale creeks show high cfu/100mL counts yet at this point a pattern is ambiguous and further sampling would be needed to determine if there are any point sources adding to the *E. coli* levels in these creeks.

Conclusion and Recommendations

Westley's, Pattingale and Ferguson Creeks are located primarily in agricultural land where corn and soybeans are most commonly grown. Because of this, results obtained throughout the year may reflect annual farm activities such as spreading manure and other fertilizers or plowing and working the fields. These activities also coincide with weather patterns, most notably rainfall, which could carry nutrients and *E. coli* into the creeks.

The most significant results observed are as follows:

- Annual mean TP concentrations at all sites exceed the delisting criterion of 0.060 mg/L for these sites.
- Pattingale Creek showed the strongest downstream increase in TP with mean concentrations ranging 0.090 - 0.213 mg/L, followed by Ferguson Creek which increased downstream from 0.090 – 0.139 mg/L. A similar trend was observed at Westley's Creek as mean TP values increased downstream from 0.107 to 0.133.
- Relationships between TP and suspended solids was weak, however TP strongly predicted total dissolved phosphorus suggesting that TP is mostly in the soluble form in these tributaries.
- Relatively consistent specific conductivity in all three tributaries throughout the year likely reflects shallow groundwater recharge is a significant contribution to the water flow in these watercourses.

The following recommendations are made:

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