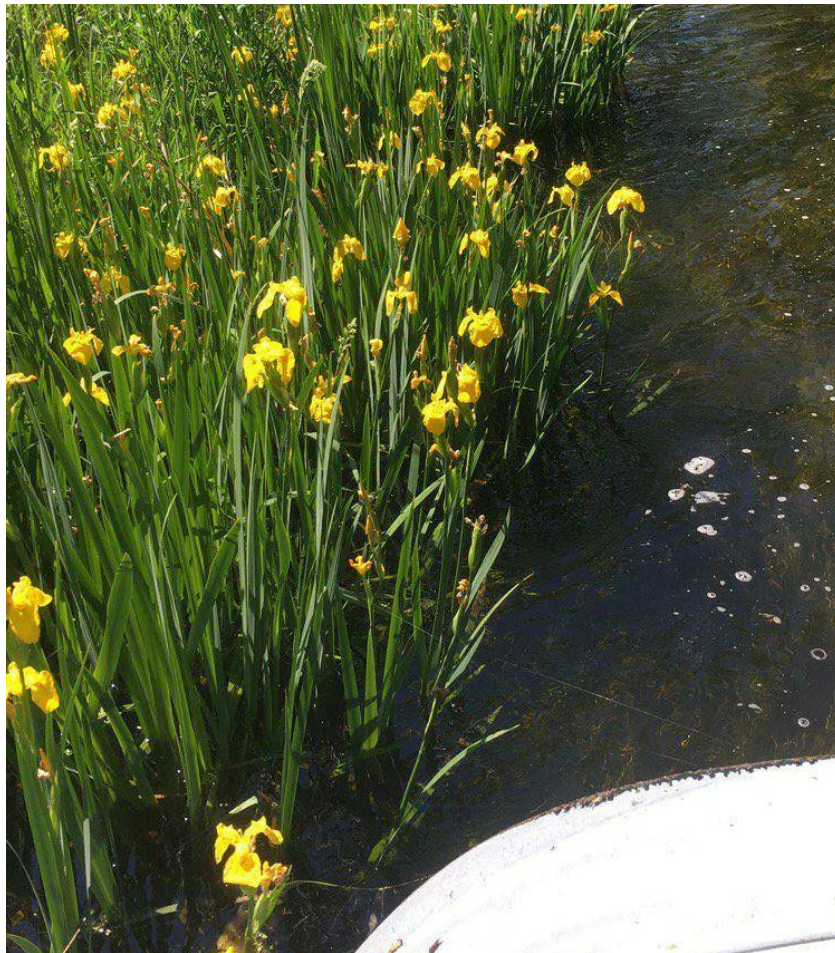




*Aquatic Enhancement
& Survey, Inc.*

**2017 Water Quality Sampling Report
Steuben County Lakes Council
Steuben County, Indiana**

December 1, 2017



Aquatic Enhancement
& Survey, Inc.
P.O. Box 1036
Angola, IN 46703

1-888-867-5253
260-665-8226
www.aquaticenhancement.com

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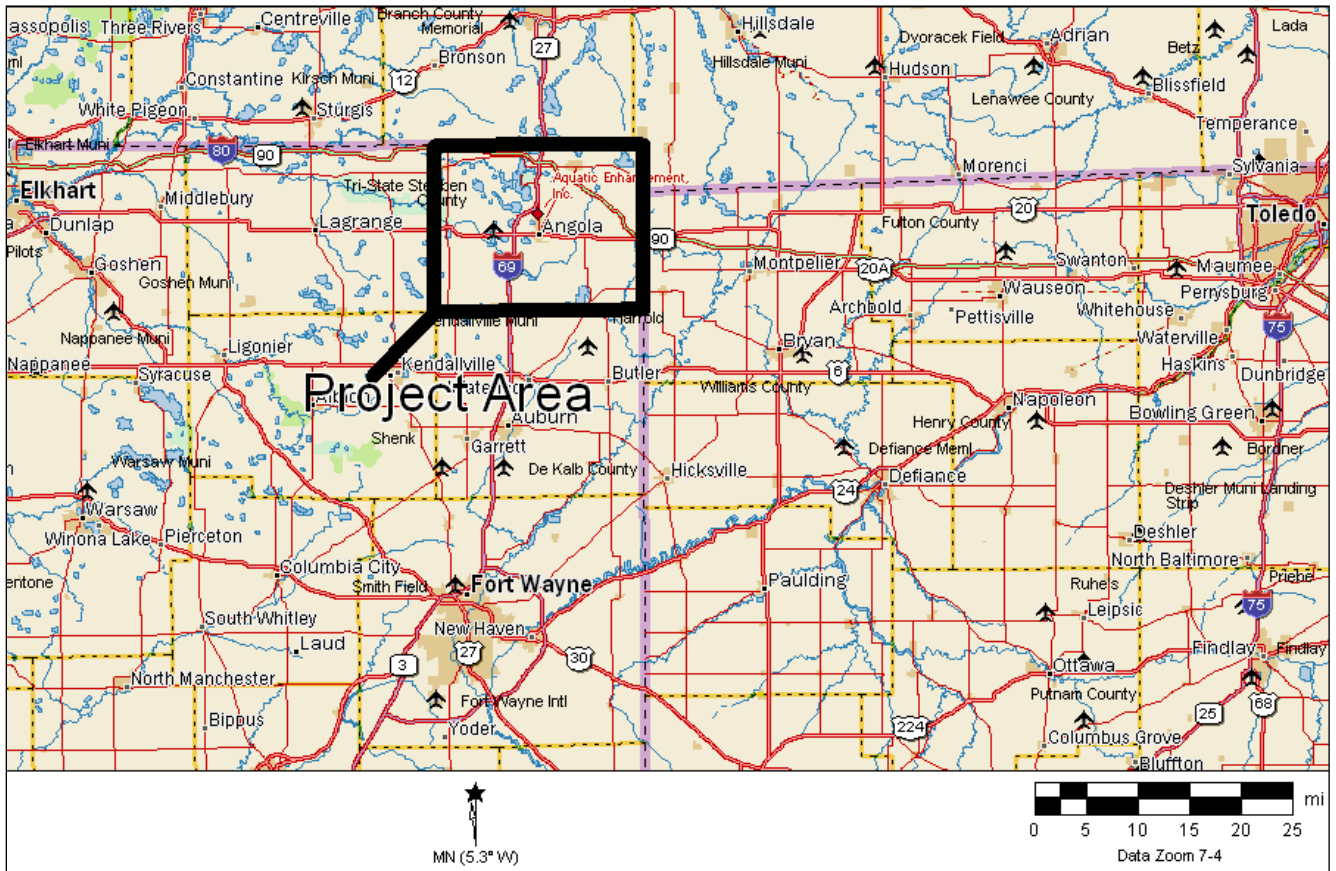


Figure 1 Project location map

1. Project Overview and Purpose:

This project was completed by Aquatic Enhancement & Survey, Inc. under contract with the Steuben County Lakes Council (SCLC) and Angola/Trine MS4. Also partnered with the SCLC in support of this work was the Steuben County Surveyor's Office, and the Clear Lake Township Land Conservancy. Basic water quality data and stream flow (discharge) measurements were collected from a total of 60 sites on several streams and lakes in Steuben County, Indiana, LaGrange County, Indiana, and Branch County Michigan. The sampling reported in this work was completed in May, July, and August of 2017. Figure 2 (page 6) displays sampling locations and associated surface water features. For most sites, measured parameters included total phosphorus, total suspended solids, pH, dissolved oxygen, temperature, specific conductance, and E-coli. A basic measurement of stream flow-rate (discharge) at each sampling site was taken when conditions permitted.

Total phosphorus and total suspended solids loading figures were calculated for certain sites at which these measurements were detectable and at which a flow measurement was taken. The purpose of the sampling was to gain a basic understanding of the fate and source of contaminants in these systems with a goal of directing future sampling or directing remediation of watershed point and non-point pollution sources. Table 1 provides a site key showing brief written descriptions of each numbered sampling site. Collected data and calculated loading rates are provided in tables 1-6.

2. Methods:

All samples collected were grab samples. Samples were placed on ice immediately after collection. All samples held overnight were refrigerated. Measurements for temperature, dissolved oxygen, and specific conductance were taken in the field using a meter. Measurements of pH were taken in the field using a meter or measured in the laboratory. Meters were calibrated at the beginning of each sampling day. Where possible, stream flows were calculated using measurements of the stream cross-sectional area and stream velocity. Stream flow cross-sectional area was calculated by measuring stream width using a tape measure and calculating average stream depth by measuring depth at multiple equidistant points using a measuring staff or tape measure. Quality Assurance Procedures and EPA method codes for laboratory analysis are available upon request.

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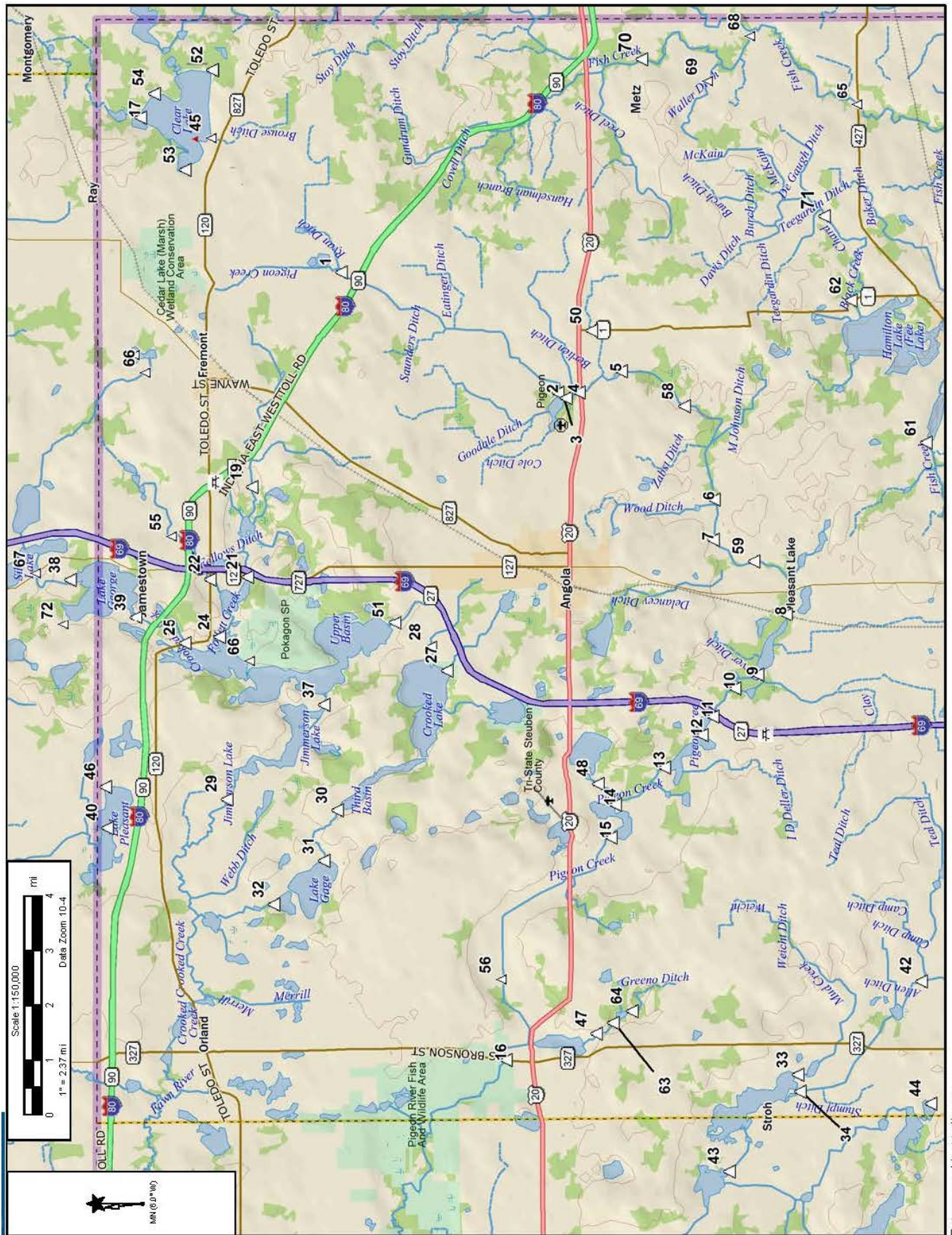


Figure 2 Sampling site map

Samp. Site	SCLC funded	At or near HUC 12 Outlet (10)	At or near HUC14 Outlet Site (13)	Steuben Surveyor Funding (6)	MS4 Funding (4 sites)	Clear Lake funding (2)	Location Description
1.	yes		yes				Pigeon, East Ray Clark Road at culvert, below juncture with the Ryan Ditch.
2.	yes						Pigeon Creek, Pigeon Lake Inlet.
3.	yes						Pigeon Creek, Pigeon Lake Outlet.
4.	yes	yes	yes				Pigeon, U.S. 20 Bridge, Below juncture with Berlien Ditch.
5.	yes						Pigeon Creek, Metz Road.
6.		yes	yes		yes		Pigeon Creek, Bill Deller Road.
7.					yes		Pigeon Creek, Meridian Road.
8.	yes						Pigeon Creek, Long Lake Inlet.
9.	yes						Pigeon Creek, Long Lake Outlet.
10.	yes	yes	yes				Pigeon Creek, Mud Lake Outlet just west of Long Lake, Johnson Ditch from Ashley.
11.	yes						Pigeon Creek, Big Bower Lake Inlet.
12.	yes						Pigeon Creek, Big Bower Lake Outlet/Golden Lake Inlet.
13.	yes						Pigeon Creek, Golden Lake Outlet.
14.	yes						Pigeon Creek, Hogback Lake Inlet.
15.	yes	yes	yes				Pigeon Creek, Hogback Lake Outlet.
16.	yes	yes*	yes*				Pigeon Creek at 327.
17.	yes		yes				Clear Lake Outlet.
19.	yes						Crane Marsh Outlet, (tributary to Marsh Lake).
21.	yes						Follet Creek, Little Otter Lake Inlet.
22.	yes						Walter's Lakes Drain (tributary to Big Otter Lake).
24.	yes						Follet Creek, Snow Lake Inlet.
25.	yes						Crooked Creek at 120 (Tributary to Snow Lake).
27.	yes						Carpenter Ditch (Tributary to Crooked Lake).
28.	yes						Palfreyman Ditch (Tributary to Crooked Lake).
29.	yes	yes*	yes*				Crooked Creek (Jimmerson outlet at Nevada Mills).
30.	yes						Concorde Creek (Outlet from Crooked Lake).
31.	yes						Concorde Creek (Inlet to Lake Gage).
32.	yes	yes*	yes*				Concorde Creek (Outlet from Lime Lake).
33.	yes						Dewitt Ditch (Tributary to Big Turkey Lake).
34.	yes						Turkey Creek (Tributary to Big Turkey Lake).
37.	yes						Crooked Creek (James Outlet, Jimmerson Inlet at 4 corners).
38.	yes						Lake George NE tributary (from Silver Lake).
39.	yes		yes				Crooked Creek (Lake George Outlet).
40.	yes						Lake Pleasant.
42.	yes	yes	yes				Turkey Ck at 700S east of 800W, below Little Turkey and Deetz Ditch juncture.
43.	yes	yes*	yes*				Big Turkey Outlet at 350S on curve north of Stroh or west of Turkey Lake Tavern.
44.	yes						Trib. To McClish Lake (east end).
45.	yes						Trib. To Clear Lake (Cyrus Brouse Ditch).
46.	yes						Trib. To Lake Pleasant (East End).
47.	yes						Trib. To West Otter (Between Arrowhead and Otter).
48.	yes						Trib. Between Silver and Hogback.
50.	yes						William Jack Ditch (at State Rd. 1).
51.	yes						Croxton Ditch (at West 275 North).
52.				yes			Clear Lake Trib. (Harry Teeters Ditch).
53.						yes	Clear Lake Trib. (Peter Smith Ditch).
54.						yes	Clear Lake Trib. (Alvin Patterson Ditch).
58.					yes		Pigeon Creek at Hanselman.
59.					yes		Pigeon Creek at 400 South.
61.				yes			Tributary to Ball Lake.
62.				yes			Black Creek, Tributary to Hamilton Lake.
63.	yes						Tributary just downstream of Arrowhead Lake.
64.				yes			Tributary to Arrowhead Lake at south end of Arrowhead Lake
65.	yes						Fish Creek at 427
66.							Pokagon Effluent Outlet
67.							Silver Lake Outlet at S. Angola Rd.
68.							Fish Creek at E 400 S
69.							Fish Creek at S 850 E (5/19/17 upstream of S 850 E)
70.							Fish Creek at E Metz Rd.
71.							Black Creek at S 600 E
72.							Tributary to Lake George at 150 W (Flint Rd. in MI) N. of launch

Table 1 Descriptions of numbered sampling sites

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading	(ppm)	Loading					
					(kg/day)		(kg/day)					
1	5/25/17	4.611.0	nd	0.290	nd	21.0	nd	nd	7.14	15.4	460.5	*
2	5/25/17	2909.0	nd	0.352	nd	6.3	nd	nd	7.32	16.0	416.9	*
3	5/25/17	1421.0	nd	0.188	nd	14.0	nd	nd	7.52	15.8	485.9	*
4	5/26/17	1291.0	nd	0.189	nd	17.0	nd	nd	7.51	15.2	460.7	*
5	5/26/17	1553.0	nd	0.181	nd	17.0	nd	nd	7.45	15.2	470.8	*
6	5/26/17	754.0	nd	0.170	nd	12.0	nd	nd	7.51	15.4	461.1	*
7	5/26/17	771.0	nd	0.169	nd	12.0	nd	nd	7.53	15.5	474.0	*
8	5/26/17	697.0	nd	0.172	nd	18.0	nd	nd	7.63	16.0	481.7	*
9	5/26/17	565.0	nd	0.122	nd	7.0	nd	nd	7.70	17.2	557.0	*
10	5/26/17	1539.0	nd	0.196	nd	24.0	nd	nd	7.50	16.2	526.0	*
11	5/26/17	717.0	nd	0.143	nd	14.0	nd	nd	7.67	16.3	551.0	*
12	5/26/17	884.0	nd	0.141	nd	16.0	nd	nd	7.71	16.6	559.0	*
13	5/26/17	203.0	nd	0.062	nd	4.6	nd	nd	7.93	17.3	603.0	*
14	5/26/17	684.0	nd	0.065	nd	4.4	nd	nd	7.87	17.7	601.0	*
15	5/26/17	84.0	nd	0.058	nd	4.0	nd	nd	8.01	18.6	589.0	*
16	5/26/17	83.0	nd	0.055	nd	6.2	nd	nd	7.99	18.6	565.0	*
17	5/31/17	<10.0	685.77	<0.022	nd	1.5	nd	nd	8.44	19.2	336.4	*
19	5/5/17	708.0	1829.25	0.078	5.82	9.4	701.22	nd	7.88	10.3	571.0	*
21	5/30/17	41.0	3658.1	0.025	3.73	1.8	268.52	nd	7.78	19.6	542.0	*
22	5/30/17	82.0	519.75	0.067	1.42	1.9	40.27	nd	7.71	19.5	517.0	*
24	5/30/17	>10.0	nd	<0.022	nd	<1.0	nd	nd	8.06	20.2	574.0	*
25	5/30/17	31.0	1864.43	<0.022	nd	1.5	nd	nd	8.00	21.5	423.1	*
27	5/5/17	384.0	451.75	0.046	0.85	6.7	123.43	nd	7.89	9.9	435.6	*
28	5/5/17	279.0	676.71	0.086	2.37	15.0	413.95	nd	7.76	10.7	467.0	*
29	5/30/17	41.0	14812.95	<0.022	nd	3.3	nd	nd	8.10	21.3	530.0	*
30	5/5/17	52.0	674.69	<0.022	nd	2.9	nd	nd	8.04	13.0	468.4	*

Table 2 May data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading	(ppm)	Loading					
					(kg/day)		(kg/day)					
31	5/5/17	83.0	663.54	<0.022	nd	3.1	nd	nd	8.17	12.4	457.5	*
32	5/5/17	<10.0	928.71	<0.022	nd	4.3	nd	nd	8.30	13.2	443.3	*
33	5/30/17	144.0	nd	0.069	nd	1.8	nd	nd	7.61	18.7	509.0	*
34	5/30/17	20.0	nd	0.166	nd	5.0	nd	nd	7.49	19.8	530.0	*
37	5/30/17	<10.0	nd	<0.022	nd	4.2	nd	nd	8.40	20.7	517.0	*
38	5/30/17	41.0	933.68	<0.022	nd	1.2	nd	nd	7.60	20.8	411.2	*
39	5/30/17	10.0	1718.82	<0.022	nd	1.3	nd	nd	8.50	20.0	400.7	*
40	5/22/17	15.3	lake site	<0.022	lake site	<1.0	lake site	nd	8.32	17.9	424.1	*
42	5/30/17	97.0	nd	0.206	nd	5.0	nd	nd	7.58	19.1	549.0	*
43	5/30/17	<10.0	nd	0.026	nd	4.3	nd	nd	8.20	21.2	574.0	*
44	5/30/17	52.0	133.04	0.030	0.16	2.5	13.56	nd	7.46	16.3	718.0	*
45	5/31/17	216.0	nd	0.084	nd	6.9	nd	nd	7.65	14.5	580.0	*
46	5/22/17	214.2	59.6	0.024	0.06	4.8	11.67	nd	7.32	19.1	614.0	*
47	5/31/17	31.0	981.25	0.069	2.76	3.1	124.05	nd	7.77	18.7	438.6	*
48	5/31/17	31.0	732.89	<0.022	nd	1.4	nd	nd	7.95	20.7	431.1	*
50	5/5/17	345.0	599.74	0.143	3.50	8.1	198.11	nd	7.29	9.9	403.9	*
51	5/5/17	148.0	226.94	<0.022	nd	2.0	nd	nd	7.85	12.1	619.0	*
52	5/31/17	146.0	122.76	0.168	0.84	4.0	20.03	nd	7.68	14.9	554.0	*
53	5/31/17	10.0	21.92	0.133	0.12	2.6	2.32	nd	7.15	16.6	408.0	*
54	5/31/17	nd	no flow	nd	nd	nd	nd	nd	nd	nd	nd	*
58	5/26/17	1664.0	nd	0.191	nd	19.0	nd	nd	7.51	15.3	469.5	*
59	5/26/17	733.0	nd	0.166	nd	21.0	nd	nd	7.58	15.9	474.1	*
61	5/30/17	272.0	989.66	0.179	7.22	11.0	443.95	nd	7.80	16.6	429.6	*
62	5/5/17	2613.0	9576.22	0.329	128.48	27.0	10544.20	nd	7.63	9.8	272.3	*
62	6/23/17	6016.7	nd	0.151	nd	nd	nd	nd	nd	nd	nd	
63	5/31/17	63.0	nd	0.079	nd	2.7	nd	nd	7.71	18.8	445.8	*
64	5/31/17	63.0	640.1	0.069	1.80	7.1	185.34	nd	7.76	17.9	473.4	*
65	5/5/17	5794.0	nd	0.350	nd	42.0	nd	nd	7.76	9.7	318.5	*
65	6/23/17	8664.5	nd	0.250	nd	nd	nd	nd	nd	nd	nd	
66	5/31/17	<10.0	1.18	0.191	0.01	<1.0	nd	nd	7.87	17.1	3128.0	*
67	5/30/17	120.0	1049.02	<0.022	nd	2.9	nd	nd	8.20	22.1	399.0	*
68	5/19/17	177.3	2628.02	0.510	54.66	4.9	525.15	nd	7.99	17.3	574.0	
69	5/19/17	186.7	1252.01	0.063	3.22	3.3	168.49	nd	7.98	17.8	586.0	
70	6/23/17	1454.7	nd	0.073	nd	nd	nd	nd	nd	nd	nd	
71	6/23/17	6498.3	nd	0.300	nd	nd	nd	nd	nd	nd	nd	

Table 3 May data for sites 31 through 71. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading	(ppm)	Loading					
					(kg/day)		(kg/day)					
1	7/20/17	420.0	492.95	0.048	0.96	4.4	88.45	5.88	7.52	22.0	nd	
2	7/20/17	933.0	638.96	0.038	0.99	5.0	130.29	8.23	7.92	21.3	nd	
3	7/20/17	10.0	1056.44	0.026	1.12	2.8	120.63	9.64	8.56	25.5	nd	
4	7/20/17	241.0	914.69	0.056	2.09	13.0	484.92	7.49	8.12	25.7	nd	
5	7/20/17	110.0	875.89	0.049	1.75	5.4	192.89	7.93	8.12	25.0	nd	
6	7/20/17	684.0	882.93	0.038	1.37	4.0	144.03	8.52	8.23	24.4	nd	
7	7/20/17	794.0	1717.3	0.070	4.90	8.4	588.28	7.84	8.11	24.4	nd	
8	7/20/17	471.0	384.64	0.043	0.67	6.8	106.66	8.77	8.13	24.7	nd	
9	7/20/17	31.0	1634.51	0.070	4.67	7.2	479.93	15.46	8.54	26.4	nd	
10	7/20/17	816.0	nd	0.028	nd	8.6	nd	10.7	8.11	26.2	nd	
11	7/21/17	134.0	nd	0.041	nd	11.0	nd	10.48	8.07	25.5	nd	
12	7/21/17	41.0	2362.64	0.032	3.08	3.6	346.86	11.58	8.25	26.8	nd	
13	7/21/17	10.0	nd	0.010	nd	2.7	nd	11.75	8.54	26.6	nd	
14	7/21/17	74.0	2744.16	0.023	2.57	5.1	570.74	7.89	8.31	25.9	nd	
15	7/21/17	10.0	3030.54	0.048	5.93	5.7	704.45	11.45	8.41	26.9	nd	
16	7/21/17	132.0	4217.07	0.019	3.27	<2.0	nd	8.51	8.01	23.8	nd	
17	7/7/17	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
19	7/6/17	861.0	348.58	0.035	0.50	10.0	142.15	nd	8.08	20.7	828.0	
21	7/6/17	37.0	1269.96	0.011	0.57	<2.0	nd	nd	7.96	24.8	694.0	
22	7/6/17	31.5	62.25	0.064	0.16	2.0	5.08	nd	7.48	21.7	690.0	
24	7/6/17	31.5	nd	0.019	nd	<2.0	nd	nd	8.22	26.8	613.0	
25	7/6/17	31.5	528.17	0.012	0.26	<2.0	nd	nd	7.68	26.1	408.3	
27	7/5/17	97.0	4.3	0.060	0.01	7.2	1.26	nd	7.76	25.0	741.0	
28	7/5/17	908.0	19.61	0.079	0.06	16.0	12.80	nd	8.19	23.6	620.0	
29	7/6/17	20.5	2764.87	0.010	1.13	<2.0	nd	nd	8.15	27.9	529.0	
30	7/6/17	123.0	237.2	0.018	0.17	3.3	31.92	nd	7.71	28.2	432.0	

Table 4 July data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading (kg/day)	(ppm)	Loading (kg/day)					
31	7/6/17	304.5	234.68	0.027	0.26	6.6	63.16	nd	7.99	26.7	459.2	
32	7/6/17	5.0	272.04	<0.007	nd	2.6	28.84	nd	8.35	28.8	456.9	
33	7/5/17	52.0	384.06	0.018	0.28	4.0	62.65	nd	8.12	26.7	645.0	
34	7/5/17	272.0	2614.24	0.048	5.12	<2.0	nd	nd	7.96	26.1	657.0	
37	7/6/17	5.0	nd	0.011	nd	3.7	nd	nd	8.28	26.3	552.0	
38	7/6/17	348.5	319.84	0.027	0.35	<2.0	nd	nd	7.44	24.2	391.5	
39	7/6/17	15.5	705.22	0.011	0.32	<2.0	nd	nd	8.76	25.8	344.8	
40	7/21/17	<10.0	lake site	0.014	lake site	3.7	lake site	9.55	8.64	27.8	nd	
42	7/5/17	364.0	986.82	0.083	3.34	2.8	112.68	nd	7.86	24.5	678.0	
43	7/5/17	63.0	2828.92	0.018	2.08	2.6	299.95	nd	8.29	28.0	558.0	
44	7/5/17	620.0	44.34	0.036	0.07	11.0	19.89	nd	7.48	19.0	775.0	
45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
46	7/21/17	243.0	28.92	0.023	0.03	9.0	10.61	5.62	7.47	19.5	nd	
47	7/7/17	584.5	59.65	0.075	0.18	2.8	6.81	nd	7.86	23.6	518.0	
48	7/7/17	175.0	61.59	0.023	0.06	<2.0	nd	nd	7.67	24.3	448.0	
50	7/7/17	2897.0	34.00	0.148	0.21	8.6	11.92	nd	7.68	20.1	753.0	
51	7/5/17	355.0	87.99	<0.007	nd	<2.0	nd	nd	8.08	23.3	813.0	
52	7/7/17	2305.5	25.39	0.257	0.27	15.0	15.53	nd	7.69	21.3	647.0	
53	7/7/17	5.0	5.18	0.008	0.00	<2.0	nd	nd	7.22	14.4	672.0	
54	7/7/17	374.0	nd	0.133	nd	2.2	nd	nd	7.18	22.2	413.1	
58	7/20/17	455.0	875.00	0.029	1.03	7.2	256.92	7.55	8.1	23.6	nd	
59	7/21/17	1210.0	2183.63	0.065	5.79	13.0	1157.65	7.60	8.01	22.9	nd	
61	7/7/17	861.5	171.75	0.101	0.71	7.2	50.43	nd	8.01	20.4	645.0	
62	7/7/17	891.0	105.96	0.095	0.41	4.7	20.31	nd	8.08	21.0	647.0	
63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
64	7/7/17	719.5	82.66	0.094	0.32	5.4	18.20	nd	7.87	20.5	612.0	
65	7/7/17	12976.4	940.94	0.154	5.91	25.0	959.31	nd	8.08	22.2	649.0	
66	7/6/17	<5.0	4.17	0.218	0.04	<2.0	nd	nd	7.46	21.8	3373.0	
67	7/6/17	106.5	294.66	0.012	0.14	<2.0	nd	nd	7.70	25.3	386.0	
68	7/7/17	4902.0	9.65	0.142	0.06	20.0	7.87	nd	8.04	21.7	670.0	
69	7/7/17	7765.5	954.99	0.11	4.32	9.6	373.87	nd	8.08	22.3	658.0	
70	7/28/17	832.7	nd	0.059	nd	nd	nd	nd	nd	nd	nd	
71	7/21/17	3075.9	nd	0.433	nd	nd	nd	nd	nd	nd	nd	

Table 5 July data for sites 31 through 72. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading (kg/day)	(ppm)	Loading (kg/day)					
1	8/23/17	236.5	279.61	<0.007	nd	3.3	37.63	7.80	7.77	17.2	817.0	
2	8/23/17	556.0	263.19	0.021	0.23	2.1	22.54	9.09	8.03	18.7	808.0	
3	8/23/17	15.0	939.56	0.017	0.65	8.3	318.02	10.65	8.40	23.0	622.0	
4	8/23/17	128.0	773.62	0.042	1.33	9.1	287.09	5.82	7.86	22.6	671.0	
5	8/23/17	109.0	473.15	0.029	0.56	3.7	71.39	8.42	8.05	23.1	703.0	
6	8/23/17	792.5	598.43	0.038	0.93	6.4	156.19	8.11	8.12	21.3	702.0	
7	8/23/17	861.5	1491.92	0.110	6.69	17.0	1034.31	8.81	8.13	21.0	888.0	
8	8/24/17	168.0	573.75	0.053	1.24	4.1	95.93	8.39	7.98	17.6	854.0	
9	8/24/17	15.5	924.57	0.070	2.64	10.0	377.05	9.35	8.12	21.9	727.0	
10	8/24/17	10.0	nd	0.046	nd	6.0	nd	7.82	8.01	21.6	776.0	
11	8/24/17	55.0	nd	0.046	nd	3.3	nd	5.60	7.87	21.4	662.0	
12	8/24/17	<5.0	1755.70	0.060	4.30	6.2	443.91	8.70	8.12	22.6	733.0	
13	8/24/17	5.0	nd	0.044	nd	8.1	nd	7.70	8.25	23.6	682.0	
14	8/24/17	48.5	2268.32	0.055	5.09	4.0	370.02	6.75	8.12	21.6	657.0	
15	8/24/17	10.0	1590.40	0.040	2.59	7.4	479.95	7.21	8.14	23.0	647.0	
16	8/25/17	106.5	2947.40	0.029	3.49	1.8	216.36	9.31	8.09	19.4	640.0	
17	8/25/17	<5.0	nd	0.010	nd	1.5	nd	6.73	8.00	21.3	348.0	
19	8/29/17	202.0	202.34	0.028	0.23	7.2	59.41	8.61	8.11	17.2	865.0	
21	8/25/17	15.5	1141.65	0.014	0.65	1.1	51.21	9.21	8.07	21.6	714.0	
22	8/29/17	90.5	39.91	0.038	0.06	1.1	1.79	3.61	7.47	17.0	691.0	
24	8/25/17	5.0	nd	0.013	nd	2.6	nd	11.20	8.49	23.2	636.0	
25	8/25/17	179.5	266.41	0.029	0.32	1.1	11.95	6.03	7.62	22.7	478.0	
27	8/29/17	312.0	18.02	0.042	0.03	1.6	1.18	6.86	7.82	18.9	865.0	
28	8/29/17	633.0	6.20	0.052	0.01	2.4	0.61	8.63	8.16	17.3	693.0	
29	8/29/17	5.0	857.14	0.015	0.52	1.9	66.41	7.76	7.89	21.2	535.0	
30	8/30/17	158.0	nd	0.040	nd	18.6	nd	6.07	7.59	23.3	494.0	

Table 6 August data for sites 1 through 30. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Site	Date	E-coli	CFM	Total Phos.	Total Phos.	TSS	TSS	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *
		(CFU or colonies/100 ml)		(ppm)	Loading	(ppm)	Loading					
					(kg/day)		(kg/day)					
31	8/30/17	152.5	21.28	<0.007	nd	1.6	1.39	9.56	8.29	19.0	646.0	
32	8/30/17	10.0	21.75	0.011	0.01	1.4	1.24	7.80	8.28	24.1	453.0	
33	8/30/17	25.5	nd	0.043	nd	10.2	nd	8.20	7.87	20.6	617.0	
34	8/30/17	366.5	808.59	0.089	2.93	1.8	59.35	6.17	7.82	19.3	601.0	
37	8/29/17	<5.0	nd	0.007	nd	2.0	nd	8.23	8.30	21.4	548.0	
38	8/25/17	235.5	108.65	0.020	0.09	<1.0	nd	5.37	7.38	19.4	391.0	
39	8/25/17	5.0	130.07	0.018	0.10	<1.0	nd	8.51	8.22	21.8	369.0	
40	8/30/17	<5.0	lake site	0.017	nd	3.4	nd	8.13	8.51	22.5	456.0	
42	8/30/17	623.0	311.18	0.069	0.88	5.2	65.99	8.22	7.93	18.5	686.0	
43	8/30/17	31.5	648.21	0.025	0.66	4.3	113.67	9.09	8.34	23.0	485.0	
44	8/30/17	202.0	14.59	0.023	0.01	2.9	1.73	6.75	7.57	17.6	779.0	
45	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
46	8/30/17	26.0	13.71	0.025	0.01	5.9	3.30	5.39	7.54	15.1	692.0	
47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
48	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
50	8/23/17	239.5	8.05	0.118	0.04	4.0	1.31	7.05	7.80	18.2	751.0	
51	8/29/17	161.5	53.23	0.007	0.02	1.9	4.12	9.44	8.09	16.1	872.0	
52	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
53	8/25/17	49.0	4.04	0.010	0.00	1.0	0.16	6.57	7.34	13.7	668.0	
54	8/25/17	314.5	nd	0.044	nd	<1.0	nd	3.69	7.21	15.3	435.0	
58	8/23/17	523.0	666.44	0.039	1.06	5.0	135.89	8.00	8.10	22.0	709.0	
59	8/23/17	454.0	854.40	0.083	2.89	9.4	327.53	8.34	8.05	20.5	876.0	
61	8/28/17	572.3	60.86	0.064	0.16	3.4	8.44	8.65	8.11	16.1	7.0	
62	8/28/17	589.0	10.01	0.063	0.03	3.0	1.22	7.45	7.91	16.1	825.0	
63	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	
64	8/28/17	5231.2	30.43	0.101	0.13	6.4	7.94	8.76	8.22	17.6	587.0	
65	8/28/17	707.0	341.48	0.081	1.13	5.8	80.77	8.07	8.27	17.6	706.0	
66	8/30/17	<5.0	0.48	0.137	0.00	<1.0	nd	8.74	7.75	19.6	4454.0	
67	8/25/17	115.5	140.69	0.016	0.09	<1.0	nd	6.57	7.64	19.0	364.0	
68	8/28/17	1244.5	nd	0.062	nd	7.0	nd	8.03	8.20	17.3	728.0	
69	8/28/17	637.0	329.59	0.076	1.02	6.9	92.74	7.93	8.22	17.4	706.0	
70	8/28/17	832.0	470.65	0.066	1.27	6.1	117.08	7.40	7.86	16.2	762.0	
71	8/28/17	442.0	nd	0.160	nd	9.2	nd	5.40	7.93	17.3	725.0	
72	8/28/17	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	

Table 7 August data for sites 31 through 72. The notation “nd” denotes that no data was collected or calculated due to a result below lab detection limits or the constraints of field conditions. Data shaded exceeds certain water quality standards selected from those provided by IDEM (see corresponding shaded standards in table 8). An asterisk (*) in the post rain event column indicated sample collection occurred within 48 hours of .5 inches of rainfall or more.

Parameter	Target	Reference/other information
Temperature	Dependent on time of year and whether stream is designated as a cold water fishery	Indiana Administrative Code (IAC)
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (IAC)
	Min: 6.0 mg/L in cold water fishery streams	Indiana Administrative Code (IAC)
	Min: 7.0 mg/L in spawning areas of cold water fishery streams	Indiana Administrative Code (IAC)
E. coli	Max: 235 CFU/ 100mL in a single sample,	Indiana Administrative Code (IAC)
	Max: <u>Geometric Mean</u> of 125 CFU/ 100mL from 5 equally spaced samples over a 30-day period	
Total Phosphorus	Max: 0.076 mg/L	U.S. EPA recommendation
	0.07 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodd et al. 1998)
	Max: 0.08 mg/L	Ohio EPA recommendation to protect aquatic biotic integrity in WWH
	Max: 0.3 mg/L	IDEM draft TMDL target
Total Suspended Solids (TSS)	Max: 80.0 mg/L	Wawasee Area Conservancy Foundation recommendation to protect aquatic life in lake systems
	Max: 30.0 mg/L	IDEM draft TMDL target
	Range: 25.0-80.0 mg/L	Concentrations within this range reduce fish concentrations (Waters, 1995)
	Max: 40.0 mg/L	New Jersey criteria for warm water streams
	Max: 46.0 mg/L	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
Turbidity	Max: 10.4 NTU	U.S. EPA recommendation

Table 8 Indiana Department of Environmental Quality Table of Water Quality Targets. Standards shaded on results tables correspond to standards shaded in this table.

3. Results: May Sampling

May sampling occurred at all 56 sites. Four additional sampling sites were added and sampled in June. May and June sampling results are listed in tables 2 and 3. Samples collected represented rainfall-runoff conditions at all 56 sites sampled in May. The four sites sampled in June represented baseline conditions. Table 8 contains a variety of stream water quality targets provided by the Indiana Department of Environmental Management (IDEM) for comparison with the 2017 season data. Also provided for comparison is table 9 containing averages of stream data from the IDEM probabilistic data set. The data used to calculate these averages was collected from Indiana Streams within the St. Joseph River watershed from year 2000 to 2005. Most of the collection sites included in the 2017 data are also within the St. Joseph River watershed and therefore represent somewhat similar soil types, topography, and land uses. This allows some amount of judgment to be made as to whether the 2017 samples were “below average”, “average” or “above average” in terms of Northern Indiana stream water quality. In May/June several sites did not conform to the standards listed in table 8. Sixteen sites exceeded the E-coli standard of 235 and 14 sites exceeded the total phosphorus standard of .076.

Parameter	IDEM Mean Stream Data St. Joseph Wtrshd 2000-2005
pH	n/d
D.O. (ppm)	7.14
Temp. (deg C)	19.91
Specific conductance umho/cm	764.19
Total Suspended Solids (ppm)	36
Total Phosphorus (ppm)	0.382
E-coli (CFU/100ml)/(MPN)	1895.58

Table 9 Average of IDEM-collected probabilistic Indiana stream data for the St Joseph River Watershed 2000-2005

4. Results: July Sampling

July sampling occurred at 57 sites. One site was not sampled due to a “low flow”, or “no flow” condition and two sites were not sampled due to a lack of legal access to the sampling sites. July sampling results are listed in tables 4 and 5. Samples collected represented baseline flow conditions. E-coli standards were exceeded at 9 of the 57 sites sampled. Total phosphorus standards were exceeded at a single site.

5. Results: August Sampling

August sampling occurred at 54 sites. Six sites were dry at the time of sampling. Sampling results are listed in tables 6 and 7. Samples collected represented baseline flow conditions. E-coli standards were exceeded at 6 of the 54 sites sampled. Total phosphorus standards were exceeded at a single site.

6. Conclusions

A number of notable observations were made during the 2017 season sampling. E-coli measurements above the 235 CFU standard remained relatively common on Pigeon Creek with 30 of 54 sampling events (56%) returning results above 235.

Out of 33 sampling events on the upper Pigeon (sites 1-11 above Big Bower Lake) 22 exceeded the E-coli standard (67%). In 2016 only 33 samplings (30%) were above 235. In 2015 there were 16 (48%) above 235. In 2014 the figure was 34% and in 2013 it was 41%. Undoubtedly the higher results in 2017 were due in part to the May sampling being performed after significant rainfall. The highest E-coli count recorded on the upper Pigeon reach was 2909 recorded in a sample from site 2, the inlet to Pigeon Lake. This was higher than the highest count of 862 from site 7 in 2016. For further comparison, in 2015 a count of 4950 was recorded from site 11 (Big Bower Lake inlet). In 2014 the highest E-coli was 1435 from site 7 (Meridian Road) and in 2013 the highest was a measurement of 9300 colonies at site 1 (Ray Clark Rd.).

With regard to total phosphorus on the upper Pigeon, 14 samplings (42%) exceeded a standard of .076 ppm. In 2016 only 1 sampling (3%) exceeded the standard. In 2015 a total of 3 samplings (9%) exceeded the standard. The higher phosphorus levels are to be expected with the high flow rates in May of 2017, while the 2016 and 2015 sampling represented baseline flow conditions. In 2014 sampling, which included rain events, 13 of 44 upper Pigeon samplings (30%) exceeded the standard. This was similar to the 2013 season when 27 of 88 sites (31%) exceeded that standard.

In 2017 sites 1, 2, 6, 7, 58, and 59 on the Pigeon Creek exceeded the E-coli standard on all three samplings. In 2016 no sites exceeded the standard all three times. In 2015 three sites had exceeded the standard on all three samplings.

The tributary to Ball Lake was well above the standard for E-coli during all three samplings as it was in 2016, although levels were not near the count of 19,862.9 recorded in August of 2015. Supplemental sampling efforts by the Ball Lake residents to track potential pollution sources in that watershed are ongoing.

Fish Creek and Black Creek also had notably high E-coli counts repeatedly in 2017. A count of 12,976.4 was noted for a sample collected from Fish Creek at highway 427 on July 7. A sample collected from Black Creek at highway 1, just upstream of Hamilton Lake on June 23 had a count of 6016.7. Both these waterbodies have received additional sampling in response to the high counts and further investigation of watershed activities and potential sources of runoff in these watersheds has been initiated.

The SCLC has built an extensive body of local water quality data through this sampling program over several years. There are many ways to examine the statistical content of the data and glean information to assist in meeting the needs of local lake residents, government agencies, and land users. The SCLC is encouraged to continue to convey the water quality information through its website, meetings, and other outlets, fostering cooperative community water-quality improvement efforts and encouraging new input and ideas to direct future sampling.