Aquatic Enhancement
& Survey, Inc.

2010 Water Quality Sampling Report
Steuben County Lakes Council
Steuben County, Indiana

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Acknowledgements

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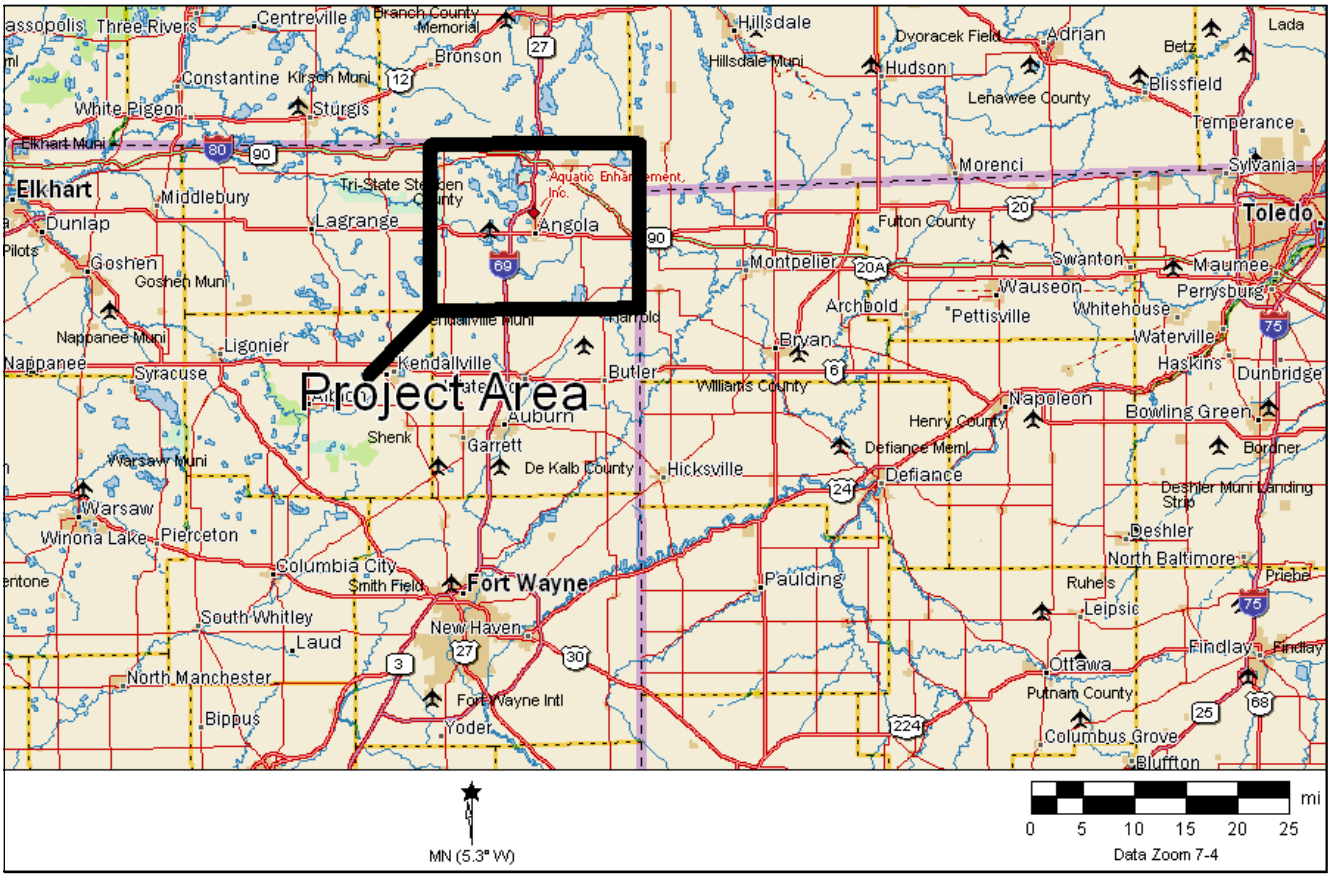

Figure 1 Project location map

1. Project Overview and Purpose:

This project was performed 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 Soil and Water Conservation District (SWCD) (working with the assistance of EPA 319 grant funding administered through the Indiana Department of Environmental Management), and the Steuben County Surveyor's Office. Basic water quality data and stream flow (discharge) measurements were collected from several streams and lakes in Steuben County, Indiana. One sampling site was located in LaGrange County Indiana and one was located in Branch County Michigan (See figure 1 above for general project area location). Sampling was completed in May through August of 2010. Figure 2 (page 6) displays sampling locations and associated surface water features. Measured parameters included total phosphorus, total suspended solids, pH, dissolved oxygen, temperature, specific conductance, E-coli, and a basic measurement of stream flow-rate (discharge) at each sampling site having measurable flow. Total phosphorus and total suspended solids loading figures were calculated for each site at which these measurements were detectible 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 one on page 8 provides a site key showing brief written descriptions of each numbered sampling site. Collected data and calculated loading rates are provided in tables 2-7 on pages 9 through 14.

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 and dissolved oxygen were taken in the field using a YSI 85 dissolved oxygen, temperature, conductivity, and salinity meter. Measurements of pH were taken in the field using an Oakton pH 6 Acorn series meter. Both 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 marked section of rope, tape measure, or laser rangefinder and calculating average stream depth by measuring depth at multiple equidistant points using a tape measure, measuring staff, or sonar unit. Laboratory analysis for all samples was completed by A & L Great Lakes Laboratories, Inc., 3505 Conestoga Dr., Fort Wayne, Indiana 46808. Quality Assurance Procedures and EPA method codes are available upon request.

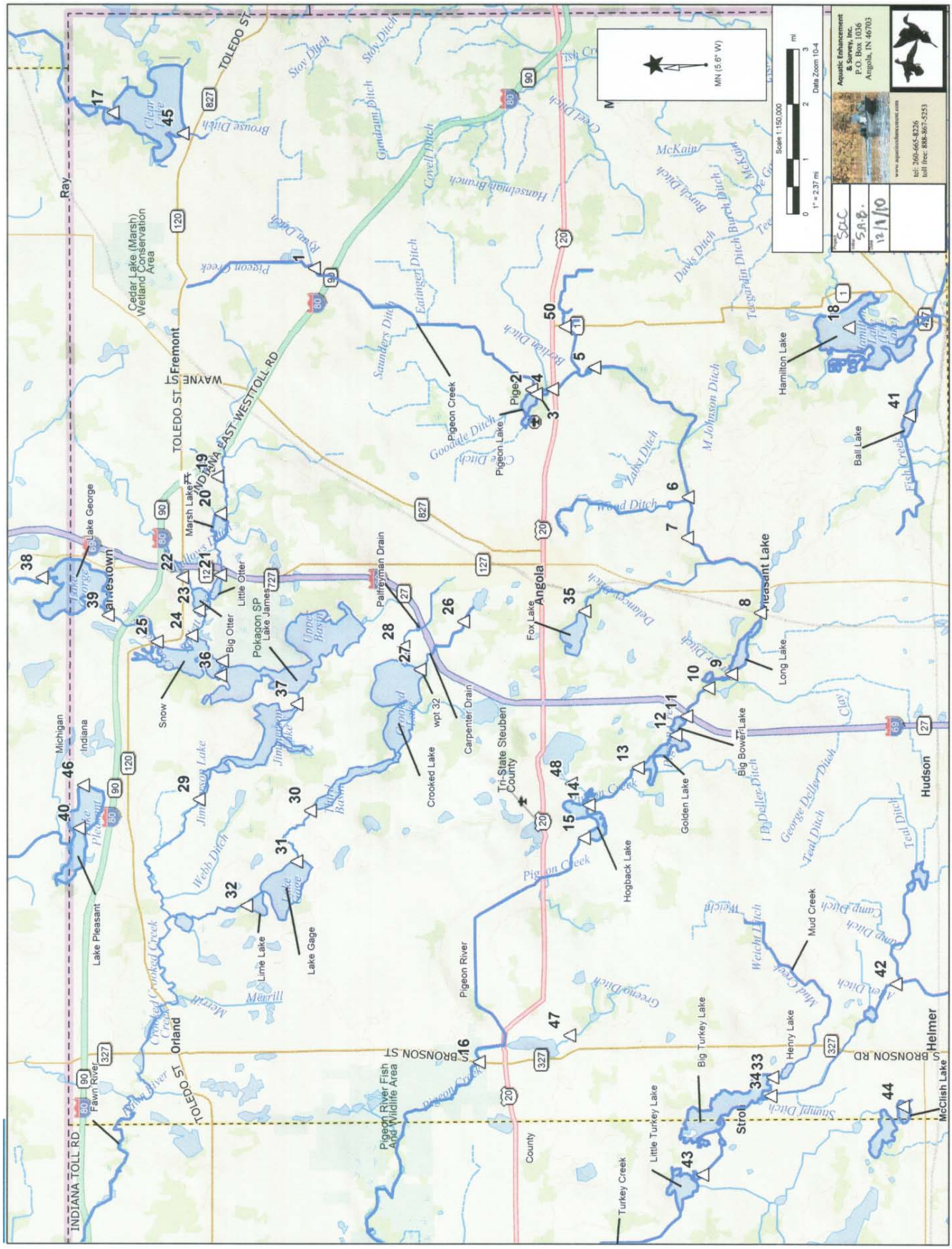

Figure 2 Sampling site map.

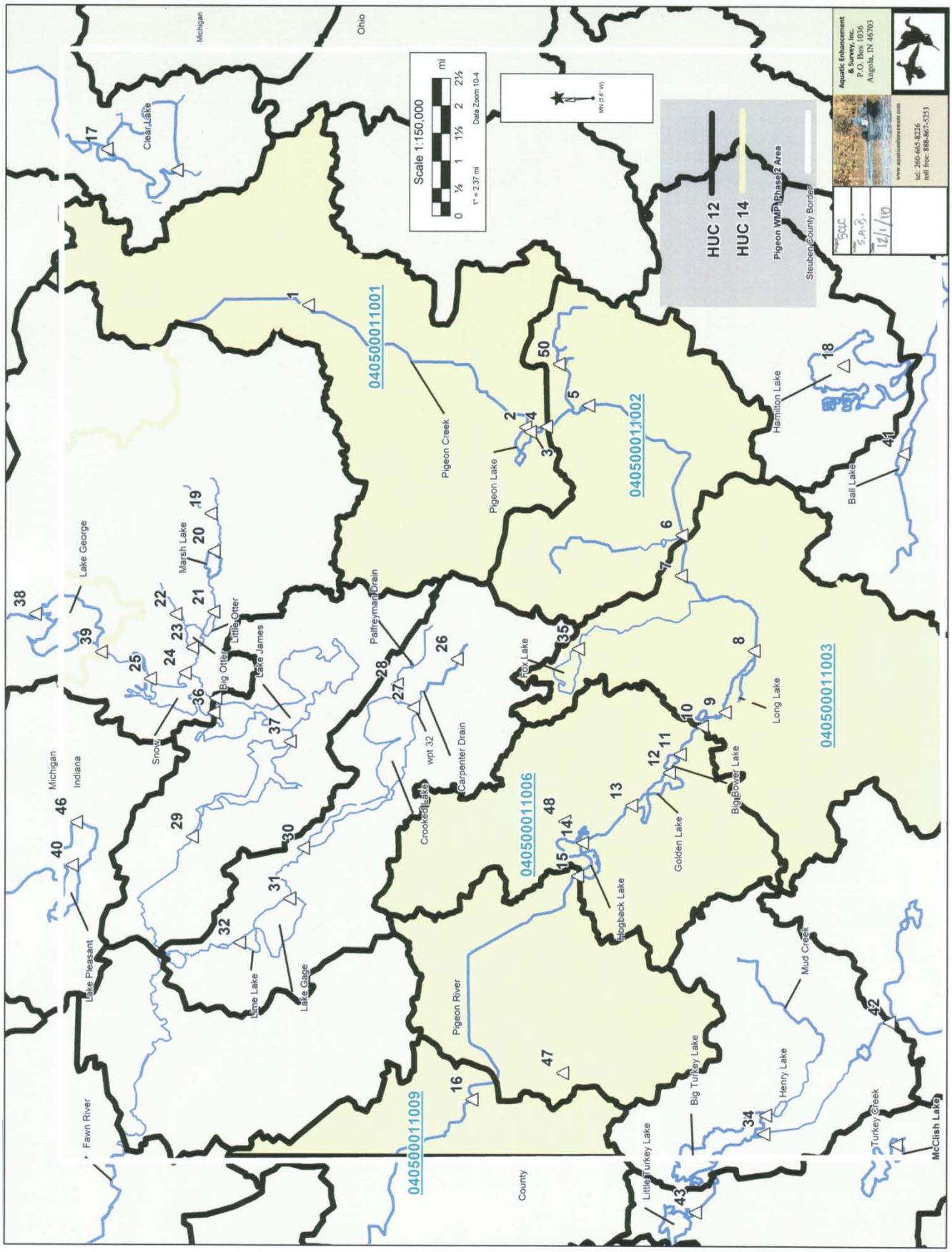

Figure 3. Sampling site map showing HUC 14 subwatershed units.

Sampling Site	Location Description
1.	Pigeon, East Ray Clark Road at culvert, below juncture with the Ryan Ditch
2.	Pigeon Creek, Pigeon Lake Inlet
3.	Pigeon Creek, Pigeon Lake Outlet
3.D	Pigeon Creek, Pigeon Lake Outlet (duplicate)
4.	Pigeon, U.S. 20 Bridge, Below juncture with Berlien Ditch
5.	Pigeon Creek, Metz Road
6.	Pigeon Creek, Bill Deller Road
7.	Pigeon Creek, Meridian Road
8.	Pigeon Creek, Long Lake Inlet
9.	Pigeon Creek, Long Lake Outlet
9. D	Pigeon Creek, Long Lake Outlet (duplicate)
B	Blank
10.	Pigeon Creek, Mud Lake Outlet just west of Long Lake, Johnson Ditch from Ashley
11.	Pigeon Creek, Big Bower Lake Inlet
12.	Pigeon Creek, Big Bower Lake Outlet/Golden Lake Inlet
13.	Pigeon Creek, Golden Lake Outlet
14.	Pigeon Creek, Hogback Lake Inlet
15.	Pigeon Creek, Hogback Lake Outlet
16.	Pigeon Creek at 327
17.	Clear Lake Outlet
18.	Hamilton Lake
19.	Crane Marsh Outlet, (tributary to Marsh Lake)
20.	Deller Ditch (Tributary to Marsh Lake)
21.	Follet Creek, Little Otter Lake Inlet
22.	Walter's Lakes Drain (tributary to Big Otter Lake)
23.	Follet Creek, Big Otter Lake Outlet
24.	Follet Creek, Snow Lake Inlet
25.	Crooked Creek at 120 (Tributary to Snow Lake)
26.	Carpenter Ditch (outlet from Center Lake)
27.	Carpenter Ditch (Tributary to Crooked Lake)
28.	Palfreyman Ditch (Tributary to Crooked Lake)
29.	Crooked Creek (Jimmerson outlet at Nevada Mills)
30.	Concorde Creek (Outlet from Crooked Lake)
31.	Concorde Creek (Inlet to Lake Gage)
32.	Concorde Creek (Outlet from Lime Lake)
33.	Dewitt Ditch (Tributary to Big Turkey Lake)
34.	Turkey Creek (Tributary to Big Turkey Lake)
35.	Fox Lake Outlet
36.	Crooked Creek (Snow Lake outlet, Inlet to James)
37.	Crooked Creek (James Outlet, Jimmerson Inlet at 4 corners)
38.	Lake George NE tributary (from Silver Lake)
39.	Crooked Creek (Lake George Outlet)
40.	Lake Pleasant
41.	Ball Lake
42.	Turkey Ck at 700S east of 800W, below Little Turkey and Deetz Ditch juncture
43.	Big Turkey Outlet at 350S on curve north of Stroh or west of Turkey Lake Tavern
44.	Trib. To McClish Lake (east end)
45.	Trib. To Clear Lake (Cyrus Brouse Ditch)
46.	Trib. To Lake Pleasant (East End)
47.	Trib. To West Otter (Between Arrowhead and Otter)
48.	Trib. Between Silver and Hogback
49.	Trib. To Snow Lake (Pokagon State Park)
50.	William Jack Ditch

Table 1 Description of numbered sampling sites.

Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1	5/26/10	142	.16	29	5.11	7.22	19.0	455	*	2359.67	2788.68	15.39
2	5/26/10	296	.16	44	6.5	7.4	19.8	481	*	3978.23	7133.32	25.94
3	5/26/10	98	.16	24	6.44	7.23	21.1	418.5	*	flooding	flooding	flooding
3D	5/26/10	110	QA sampling	26	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
4.	5/26/10	68	.17	24	6.9	7.32	21.8	431.1	*	6765.47	6616.95	46.87
5.	5/26/10	120	.16	21	6.36	7.23	21.7	444	*	6937.57	5937.12	45.24
6.	5/26/10	110	.22	16	4.10	7.32	21.9	399.4	*	16600.50	10824.06	148.83
7.	5/26/10	108	.18	15	4.64	7.37	22.7	462.6	*	18029.40	11021.01	132.25
8.	5/26/10	100	.16	16	5.8	7.49	22.4	469.9	*	flooding	flooding	flooding
9.	5/27/10	206	.12	8	5.3	7.4	21.7	455.2	*	flooding	flooding	flooding
9. D	5/27/10	QA sampling	.17	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		flooding	flooding	flooding
B	5/26/10	0	<.01	6						flooding	flooding	flooding
10.	5/27/10	128	.14	10	4.87	7.35	21.5	475.8	*	flooding	flooding	flooding
11.	5/27/10	174	.16	14	4.85	7.34	21.7	468.7	*	flooding	flooding	flooding
12.	5/27/10	122	.16	11	5.24	7.47	22.6	464.4	*	flooding	flooding	flooding
13.	5/27/10	84	.13	8	6.22	7.47	22	473.9	*	flooding	flooding	flooding
14.	5/27/10	128	.19	9	5.41	7.37	21.7	476.7	*	flooding	flooding	flooding
15.	5/27/10	96	.14	4	7.43	7.74	22.3	506	*	flooding	flooding	flooding
16.	5/27/10	88	.14	14	6.90	7.77	22.3	521	*	flooding	flooding	flooding
17.	5/20/10	<1	.02	4	8.94	8.27	15.7	358.8		849.88	138.54	0.69
18.	5/24/10	278	.06	18	9.33	8.33	20.4	336.6	*	no flow measurement	no flow measurement	no flow measurement
19.	5/20/10	16.1	.47	13	7.34	7.64	15.9	1298		119.76	63.45	2.29
20.	5/20/10	47.1	.05	13	8.33	7.91	17.1	710		998.15	528.80	2.03
21.	5/20/10	16	.02	6	9.35	8.05	17.0	645		1354.57	331.21	1.10
22.	5/21/10	>24196	.07	6	4.94	7.48	16.8	658	*	273.65	66.91	0.78
23.	5//20/10	<1	.01	1	9.51	8.24	17.5	660		no flow measurement	no flow measurement	no flow measurement
24.	5//20/10	9.1	.03	8	10.14	8.35	18.1	592		no flow measurement	no flow measurement	no flow measurement
25.	5/21/10	96	.01	3	6.87	8.04	18	405.1	*	1621.97	198.30	0.66

Table 2 Summary table of May sampling results, sites 1-25.

Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
26.	5/21/10	206.4	.19	46	6.59	7.93	18	415.6	*	249.62	467.94	1.93
27.	5/21/10	240	.44	56	5.66	7.55	17.2	457.4		355.85	812.09	6.38
28.	5/21/10	69.1	.04	9	6.9	7.79	17.7	631		158.63	58.18	0.26
29.	5/21/10	35.9	.02	7	7.62	8.15	18.4	494.2	*	6218.52	1773.92	5.07
30.	5/21/10	151.5	.07	26	6.46	7.84	18.6	422.2	*	683.18	723.86	1.95
31.	5/21/10	224.7	.04	14	7	7.88	18.3	305	*	1077.48	614.73	1.76
32.	5/21/10	142.1	.01	16	6.98	7.97	18.1	430.8	*	1029.81	671.47	0.42
33.	5/24/10	194	.05	20	9.44	7.92	22.6	578	*	flooding	flooding	flooding
34.	5/24/10	228	.09	14	5.77	7.47	20.8	568	*	flooding	flooding	flooding
35.	5/24/10	12	.09	14	8.57	8.42	23.7	488.6	*	1769.85	1009.75	6.49
36.	5/20/10	3.1	.02	12	10	8.45	18	554		no flow measurement	no flow measurement	no flow measurement
37.	5/21/10	95.9	.01	7	8.15	8.35	17.1	513	*	4360.87	1244.00	1.78
38.	5/21/10	270	.02	10	5.85	7.36	18.4	399.1	*	893.07	363.94	0.73
39.	5/21/10	14.5	<.01	9	8.52	8.33	17.5	392.3	*	3029.40	1111.09	N.D.
40.	5/24/10	16	<.01	9	8.59	8.30	21.6	413.7	*	Lake site	Lake site	Lake site
41.	5/24/10	296	.12	19	8.23	7.93	20.5	390.7	*	Lake site	Lake site	Lake site
42.	5/24/10	242	.11	20	6.07	7.41	22	587	*	flooding	flooding	flooding
43.	5/24/10	44	.02	8	8.45	8.21	22.2	592	*	flooding	flooding	flooding
44.	5/24/10	64	.08	15	5.82	7.22	19.7	657	*	157.31	96.16	0.51
45.	5/20/10	21	.06	186	8.9	7.54	12.2	588		195.41	1481.18	0.48
46.	5/24/10	184	.02	10	6	7.23	16.9	555	*	65.25	26.59	0.05
47.	5/24/10	116	.05	10	7.26	7.8	22.1	440.1	*	923.47	376.33	1.88
48.	5/24/10	14	.02	9	8.10	8.25	25.1	457.9	*	678.05	248.69	0.55
49.	5/27/10	16	.85	6	9.32	7.78	20.3	288.7		1.48	0.36	0.05

Table 3 Summary table of May sampling results, sites 26-49.

Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1	7/28/10	560	.02	3	9.32	7.95	22.9	758		116.78	14.28	0.10
2	7/28/10	254	.02	1	9.17	7.94	23.5	763		114.01	4.65	0.09
3	7/28/10	28	.02	4	9.39	8.28	28.1	611		547.25	89.21	0.45
4.	7/29/10	66	.06	12	6.13	8.07	24.3	637		1286.61	629.18	3.15
4.D	7/29/10	QA sampling	.05	QA sampling	9.59	8.31	28.1	615		QA sampling	QA sampling	QA sampling
5.	7/29/10	32	.07	10	5.57	7.84	24.1	655		597.59	243.53	1.70
5.D	7/29/10	QA sampling	QA sampling	6	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
6.	7/29/10	206	.09	25	5.57	7.86	21.7	665		907.26	924.32	3.33
6.D	7/29/10	242	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
6.B	7/29/10	QA sampling	<.01	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
7.	7/29/10	396	.11	26	5.44	7.84	20.8	911		1978.88	2096.73	8.87
7.B	7/29/10	QA sampling	QA sampling	4	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
8.	7/29/10	212	.10	19	6.10	7.86	22.4	880		1852.49	1434.36	7.55
8.B	7/29/10	0	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
9.	7/29/10	10	.04	15	9.86	8.13	26.5	715		2298.81	1405.22	3.75
10.	7/29/10	36	.05	13	7.24	7.81	26.1	840		3297.99	1747.20	6.72
11.	7/29/10	104	.06	11	6.43	7.85	26	752		2727.59	1222.70	6.67
12.	7/30/10	26	.04	13	8.22	8.04	26.3	751		2508.24	1328.81	4.09
13.	7/30/10	52	.03	15	10.16	8.12	27.1	683		2584.12	1579.62	3.16
14.	7/30/10	82	.04	20	7.64	7.93	25.5	684		2849.12	2322.15	4.64
15.	7/30/10	54	.04	9	8.52	8.10	26.8	610		2992.48	1097.55	4.88
16.	7/30/10	264	.04	10	6.25	7.71	20.6	643		3657.39	1490.46	5.96
17.	7/16/10	6	<.01	3	6.77	8.22	27.8	332.8		no flow measurement	no flow measurement	no flow measurement
18.	7/26/10	0	.02	4	7.78	8.06	27.7	354.8		Lake site	Lake site	Lake site
19.	7/27/10	28	.5	12	6.19	7.60	26.3	1421		53.27	26.05	1.09
20.	7/26/10	196	.08	2	7.55	7.91	22	844		239.97	19.56	0.78
21.	7/26/10	6	.01	2	9.35	8.29	29.1	609		440.30	35.89	0.18
22.	7/21/10	600	.08	9	5.29	7.46	23.7	755		68.58	25.15	0.22
23.	7/21/10	4	.02	5	7.31	7.91	27.1	691		no flow measurement	no flow measurement	no flow measurement
24.	7/26/10	88	.02	1	6.26	8.03	27.4	618		no flow measurement	no flow measurement	no flow measurement
25.	7/27/10	40	.02	<1	5.75	7.70	26.6	416.1		85.65	BDL	0.07

Table 4. Summary table of July sampling results, sites 1-25.

Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
26.	7/16/10	3140	.05	35	5.68	7.38	21.8	476.9	0.02	7.43	10.60	0.02
27.	7/15/10	1180	.05	6	8.98	8.03	22	613	0.03	15.75	3.85	0.03
28.	7/15/10	540	.04	1	6.75	7.71	24.8	736	0.05	31.12	1.27	0.05
29.	7/27/10	50	.01	2	6.12	7.72	28.5	495	1.13	2784.24	226.93	1.13
30.	7/15/10	960	.02	16	6.41	7.7	28.1	451	0.28	346.09	225.66	0.28
31.	7/15/10	960	.03	16	7.82	7.97	27.4	458.1	0.61	495.40	323.02	0.61
32.	7/15/10	228	<.01	3	7.30	8.10	28.5	434.3	BDL	65.49	8.01	BDL
33.	7/28/10	26	.06	2	7.24	7.94	26	612	no flow measurement	no flow measurement	no flow measurement	no flow measurement
34.	7/28/10	178	.07	<1	5.27	7.53	23.4	602	BDL	801.52	2.29	BDL
35.	7/15/10	500	<.01	4	8.57	8.39	30.6	469	BDL	43.06	7.02	BDL
36.	7/26/10	14	.01	5	8.11	8.2	28.3	516	no flow measurement	no flow measurement	no flow measurement	no flow measurement
37.	7/26/10	42	<.01	2	8.55	8.23	28.2	501	BDL	3825.04	311.76	BDL
38.	7/21/10	84	.02	3	4.14	7.33	28.7	427.9	0.16	197.91	24.20	0.16
39.	7/21/10	14	.08	3	6.73	7.86	27.8	399.6	0.67	206.69	25.27	0.67
40.	7/27/10	14	.01	5	7.69	8.39	28.6	420.2	Lake site	Lake site	Lake site	Lake site
41.	7/26/10	2	.02	<1	8.6	8.31	27.9	432.6	Lake site	Lake site	Lake site	Lake site
42.	7/28/10	1720	.10	9	5.11	7.54	21.3	625	1.41	345.76	126.81	1.41
43.	7/28/10	102	.02	6	5.92	7.91	27.1	510	0.46	559.90	136.90	0.46
44.	7/28/10	780	.02	<1	735	7.42	17.7	735	0.01	12.35	BDL	0.01
45.	7/16/10	1360	.03	3	7.08	7.51	17.6	847	0.03	28.56	3.49	0.03
46.	7/27/10	284	<.01	<1	7.95	7.57	21.2	607	BDL	42.34	BDL	BDL
47.	7/27/10	2280	.12	1	5.34	7.77	26.4	535	0.15	31.63	1.29	0.15
48.	7/27/10	314	.01	2	6.96	8.23	29.8	413.6	0.05	114.81	9.36	0.05
49.	7/28/10	74	3.6	3	6.95	7.78	23.7	2317	0.40	2.74	0.33	0.40
50.	7/28/10	860	.10	5	6.25	7.75	23.5	774	0.02	5.04	1.03	0.02

Table 5. Summary table of July sampling results, sites 26-50, 2010.

Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading estimate Kg/day	Phos. Loading estimate Kg/day
1	8/24/10	420	0.03	3	8.72	7.92	19.5	771		337.90	41.31	0.41
2	8/24/10	720	0.03	6	7.63	7.84	18.3	759		270.99	66.26	0.33
3	8/24/10	38	0.06	3	9.84	8.26	23.5	581		626.98	76.65	1.53
4	8/24/10	158	0.06	3	6.98	7.98	24.4	611		1140.86	139.48	2.79
5	8/24/10	74	0.1	10	4.31	7.63	23.3	614		542.64	221.14	2.21
6	8/24/10	820	0.06	5	6.57	7.97	22.5	633		689.43	140.48	1.69
7	8/24/10	880	0.1	15	7	7.97	22.4	862		1850.97	1131.46	7.54
8	8/24/10	600	0.07	7	7.16	7.97	21.6	847		948.87	270.68	2.71
9	8/24/10	8	0.04	8	11	8.50	25.7	677		1849.65	603.02	3.02
10	8/24/10	300	0.04	6	7.13	8.06	23.8	728		1792.11	438.19	2.92
10.D	8/25/10	QA sampling	.04	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
10.B	8/25/10	QA sampling	<.01	QA sampling	QA sampling	QA sampling	QA sampling	QA sampling		QA sampling	QA sampling	QA sampling
11	8/25/10	150	0.05	7	7.45	8.03	23.5	702		2020.12	576.27	4.12
12	8/25/10	22	0.06	11	6.45	7.99	24.5	712		1417.43	635.39	3.47
12.D	8/25/10	QA sampling	QA sampling	10	6.5	8.02	24.4	712		QA sampling	QA sampling	QA sampling
12.B	8/25/10	QA sampling	QA sampling	3	10.42	6.42	10.9	10.8		QA sampling	QA sampling	QA sampling
13	8/25/10	18	0.04	14	7.06	8.16	25.9	669		1620.56	924.57	2.64
14	8/25/10	96	0.04	5	6.5	8.06	24.3	670		1273.46	259.48	2.08
15	8/25/10	10	0.04	8	7.84	8.17	25.8	606		2550.94	831.65	4.16
16	8/25/10	176	0.03	2	6.62	7.89	21.2	638		3192.55	260.21	3.90
17	8/17/10	18	0.01	7	6.93	8.18	24.6	325.1		no flow measurement	no flow measurement	no flow measurement
18	8/17/10	1	0.02	4	6.54	8.24	22.4	356.9		Lake site	Lake site	Lake site
19	8/18/10	60	0.4	30	6.56	8.3	23.5	1328		67.28	82.25	1.10
20	8/19/10	364	0.06	15	7.15	7.78	20.2	821		227.10	138.82	0.56
21	8/19/10	112	0.02	3	4.71	7.70	23.2	679		524.45	64.12	0.43
22	8/18/10	580	0.08	10	3.75	7.58	18.3	728		77.63	31.64	0.25
23	8/19/10	2	0.01	9	7.68	8.26	26.3	617		no flow measurement	no flow measurement	no flow measurement
24	8/19/10	30	0.01	8	5.03	7.92	25.5	619		no flow measurement	no flow measurement	no flow measurement
25	8/18/10	56	0.02	9	4.37	7.70	23.6	410.1		480.26	176.14	0.39

Table 6. Summary table of August sampling results, sites 1-25.

Sample Site	Sampling Date	E-coli (CFU or colonies/100 ml)	Total Phos. (ppm)	Total Suspended Solids (ppm)	D.O.	pH	Temp (C)	Specific Conductance	Post rain event *	CFM discharge estimate	T.S.S. Loading Kg/day	Phos. Loading Kg/day
26	8/18/10	540	0.08	28	6.01	8	22.8	411.3		65.94	75.24	0.21
27	8/20/10	720	0.08	18	7.36	8.04	20.8	458.7		52.36	38.41	0.17
28	8/20/10	640	0.04	11	6.03	7.86	21.5	699		57.73	25.88	0.09
29	8/19/10	34	0.01	4	6.37	7.94	26.4	493		2257.60	368.01	0.92
30	8/20/10	900	0.02	11	4.54	7.67	24.5	458.9		142.61	63.93	0.12
31	8/20/10	380	0.03	13	8.78	7.96	22.4	479		201.90	106.96	0.25
32	8/19/10	10	<.01	4	6.60	8.14	26.8	422.5		no flow measurement	no flow measurement	no flow measurement
33	8/23/10	42	0.04	12	8.03	7.99	22.7	509		no flow measurement	no flow measurement	no flow measurement
34	8/23/10	360	0.09	<1	4.66	7.54	20.4	619		329.03	BDL	1.21
35	No flow	No flow	No flow	No flow	No flow	No flow	No flow	No flow		No flow	No flow	No flow
36	8/19/10	6	<.01	4	6.80	8.21	26.6	520		no flow measurement	no flow measurement	no flow measurement
37	8/19/10	52	<.01	6	7.55	8.32	26.3	496		1400.47	342.43	BDL
38	8/18/10	222	0.02	4	3.38	7.5	22	364.2		195.36	31.85	0.16
39	8/18/10	14	0.01	3	6.77	8.02	24.2	373.2		443.04	54.16	0.18
40	8/17/10	6	0.01	4	6.29	8.12	26.8	424.5		Lake site	Lake site	Lake site
41	8/17/10	8	0.02	6	8.72	8.47	27.2	411.3		Lake site	Lake site	Lake site
42	8/23/10	1120	0.09	6	6.93	7.72	19.2	359		262.43	64.17	0.96
43	8/23/10	62	0.02	<1	6.32	7.87	24.7	473		372.17	BDL	0.30
44	8/20/10	520	0.01	13	6.29	7.54	18.2	726		26.70	14.15	0.01
45	8/17/10	1360	0.03	12	6.84		16.9	873		33.24	16.26	0.04
46	8/17/10	260	<.01	3	8.62	7.70	18.4	606		25.84	3.16	BDL
47	8/20/10	8300	0.17	10	6.17	7.95	21.9	521		11.91	4.85	0.08
48	8/20/10	124	0.01	10	5.96	8.08	26	408.1		119.89	48.86	0.05
49	8/23/10	48	0.9	<1	7.76	7.76	21.7	2223		3.06	BDL	0.11
50	8/17/10	1400	0.11	7	7.45	7.85	21.5	777		4.91	1.40	0.02

Table 7. Summary table of August sampling results, sites 26-50. Data shaded exceeds water quality standards selected from those provided by IDEM. (see corresponding shaded standards on table 8 page 15)

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 coldwater fishery streams	Indiana Administrative Code (IAC)
	Min: 7.0 mg/L in spawning areas of coldwater fishery streams	Indiana Administrative Code (IAC)
E. coli	Max: 235 CFU/ 100mL in a single sample,	Indiana Administrative Code (IAC)
	Max: Geometric Mean 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

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

Stream and lake sampling was performed at 49 sites between May 20 and May 27. Sampling results are listed in tables 2 and 3 (pages 9 and 10). Samples collected in May represented mostly high-flow conditions following significant rainfall. Flow measurements could not be taken at most Pigeon Creek sites due to dangerously fast flow rates and high water levels. Table 8, page 15 contains a variety of stream water quality targets provided by the Indiana Department of Environmental Management (IDEM) for comparison with the 2010 season data. Also provided for comparison is table 9 page 17 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 2010 SCLC data are also within the St. Joseph River watershed and therefore represent somewhat similar soil types, topography, and land uses. This allows a judgment to be made as to whether the 2010 SCLC samples were "below average", "average" or "above average" in terms of Indiana stream water quality.

In May measurements of pH ranged from 7.22 at Pigeon Creek East Ray Clark Road and the tributary to McClish Lake to 8.45 at the channel between Snow Lake and Lake James (Crooked Creek). All were considered to be normal. No pH data is available from the IDEM probabilistic dataset for comparison. Dissolved oxygen levels ranged from 4.10 parts per million (ppm) in Pigeon Creek at Bill Deller Road to 10.14 at the inlet to Snow Lake (Follet Creek). Levels at all sites were adequate to sustain fish and other gill-breathing aquatic organisms and were above relevant target minimums listed with IDEM. Measured temperatures ranged from 12.2 C at Cyrus Browse Ditch, (tributary to Clear Lake) to 25.1 measured at the tributary between Silver Lake and Hogback Lake. All measured temperatures were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 305 umho/cm at Concorde Creek just upstream of Lake Gage, and 1219 umho/cm at the outlet of Crane Marsh. All except the measurement from the Crane Marsh outlet were below the mean of the IDEM probabilistic data set. No targets for specific conductance were listed in the IDEM table. No sites returned a TSS measurement below a lab detection limit of one ppm. Four sites showed TSS measurements which exceeded the IDEM probabilistic average of 36 ppm. Samples collected from Carpenter Ditch just downstream of Center Lake and also just upstream of Crooked Lake showed measurements (46 ppm and 56 ppm respectively) in excess of the listed IDEM draft TMDL max. target of 30 ppm. Also exceeding this standard was the May sample collected from Cyrus Browse ditch (tributary to Clear Lake)(186 ppm). The highest Total phosphorus measurement occurred in the sample collected from the Pokagon effluent flowing to Snow Lake (.85ppm). Only three sites returned total phosphorus levels below a lab detection limit of .01 ppm. A total of three sites were above the IDEM probabilistic mean of .382 ppm and a total of 25 sites were above the EPA recommended standard of .076 ppm. This was not surprising considering a severe rain event occurred prior to the May 25 and 26 sampling. E-coli bacteria measurements ranged from less than one colonies per 100 milliliters (col/100 ml) at the Clear Lake and Snow Lake outlets, to over 24,196 occurring at Walter's Lake Drain (tributary to Big Otter Lake). All measurements but the Walter's Lakes Drain sample were below the IDEM probabilistic mean of 1895.58 cfu/100 ml. A total of 6 samples exceeded a target maximum of 235 CFU/100 ml listed in the IDEM standards. May E-coli, total phosphorus, and total suspended solids data exceeding IDEM standard maximums are shaded in tables 2 and 3 on pages 9 and 10 respectively. Where possible a rough estimate of stream flow (discharge) was calculated and total suspended solids and total phosphorus loading figures were calculated using the May data. Of the sites where flow rates could be taken, the highest estimated discharge occurred on Pigeon Creek at Meridian Road. The discharge was estimated to be 18,029.40 cubic feet per minute (CFU). The highest

estimated total suspended solids loading also occurred at Pigeon Creek at Meridian Road (11,021.01 Kilograms per day). The highest estimated total phosphorus loading occurred at Pigeon Creek at Bill Deller Road (148.83 kg/day).

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
Tss Loading Kg/day	n/d
Total Phos. Loading Kg/day	n/d

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 50 sites between July 15 and July 30. Sampling results are listed in tables 4 and 5 (pages 11 and 12). July samples were collected under baseline (non-rain event) flow conditions.

July pH measurements ranged from 7.33 at the northeast tributary to Lake George, to 8.39 measured at both the Fox Lake outlet and in Lake Pleasant. All were considered to be normal. Dissolved oxygen levels ranged from 4.14 ppm at the northeast tributary to Lake George to 10.16 ppm in Pigeon Creek at the Golden Lake Outlet. Levels at all sites were adequate to sustain fish and other gill-breathing aquatic organisms. All were above a target minimum of 4 ppm listed in the Indiana Administrative Code (IAC). Measured temperatures ranged from 17.6 C at Cyrus Browse ditch (tributary to Clear Lake) to 30.6 at the Fox Lake outlet. All measured temperatures were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 332.8 umho/cm at the Clear Lake outlet to 2317 umho/cm at the outlet of the Pokagon Watewater Facility (tributary to Snow Lake). The unusually high specific conductance at this location and also at the outlet of Crane Marsh may be related to the use of iron or other substances for phosphorus removal in the wastewater effluent flowing to these systems. Eight sites showed a higher specific conductance than the 764.19 umho/cm mean of the IDEM probabilistic data set. No targets for specific conductance were provided by IDEM. The highest total suspended solids measurement (35 ppm) occurred in a sample collected from Carpenter Ditch just downstream from Center Lake. A total of 5 sites returned a TSS measurement below a lab detection limit of one ppm. Measurements from all sites were below the IDEM probabilistic average of 36 ppm. Only the Carpenter ditch site exceeded the listed IDEM draft TMDL target of 30 ppm. The highest total phosphorus measurement again

occurred in a sample collected from the tributary to Snow Lake downstream of the Pokagon Wastewater plant (3.6 ppm). Six sites returned a total phosphorus level below a lab detection limit of .01 ppm. All phosphorus measurements except for Pokagon were well below the IDEM probabilistic mean of .382 ppm and only Pokagon and the Crane Marsh outlet were above the draft IDEM TMDL target of .3 ppm. A total of 10 sites exceeded the Environmental Protection Agency (EPA) maximum target of .076 ppm in July. E-coli bacteria measurements ranged from zero at Hamilton Lake to 3140 col/100 ml measured in a sample from Carpenter Ditch just downstream of Center Lake. Two sample measurements were above the IDEM probabilistic mean of 1895.58 cfu/100 ml. A total of 19 samples exceeded a target maximum of 235 CFU/100 ml listed in the Indiana Administrative Code. July E-coli data exceeding this maximum is shaded in grey in tables four and five (pages 11 and 12). The highest estimated discharge occurred on Pigeon Creek at Highway 327 (3657.39 CFM). The highest estimated total suspended solids loading occurred at Pigeon Creek just upstream of Hogback Lake (2322.15 Kilograms per day). The highest estimated total phosphorus loading occurred at Pigeon Creek at Meridian Road (8.87 kg/day).

5. Results: August Sampling

August sampling occurred at 50 sites between August 17 and August 25. Sampling results are listed in table 6 and 7 (pages 13 and 14). Samples were collected during baseline flow conditions.

In August pH measurements ranged from 7.5 at the northeast tributary to Lake George to 8.5 measured at Pigeon Creek at the Long Lake outlet. All were considered to be within normal ranges for northeast Indiana surface waters. Dissolved oxygen levels ranged from 3.38 at the northeast tributary to Lake George to 9.84 in Pigeon Creek at the Pigeon Lake Outlet. Oxygen levels at most sites were adequate to sustain fish and other gill-breathing aquatic life. A reading of 3.38 ppm however, at the northeast tributary to Lake George and a measurement of 3.75 ppm at Walters Lakes Drain both lagged below levels normally required to sustain many organisms. These were the only measurements below a target minimum of 4 ppm listed in the Indiana Administrative Code (IAC). Measured temperatures ranged from 18.2 C at the tributary to McClish Lake to 26.8 measured at both the Lime Lake outlet and Lake Pleasant surface waters. All measured temperatures were considered to be normal for the prevailing climatic conditions. Specific conductance ranged from 325.1 umho/cm at the Clear Lake outlet to 2223 umho/cm in the effluent of the Pokagon Wastewater Facility. Eight sites showed a higher specific conductance than the 764.19 umho/cm mean of the IDEM probabilistic data set. No targets for specific conductance were listed in the IDEM table. The highest total suspended solids (TSS) measurement occurred in a sample collected from Crane Marsh outlet (30 ppm). Three sites returned a TSS measurement below a lab detection limit of one ppm. None of the August samples was above the IDEM probabilistic TSS average of 36 ppm. None of the samples exceeded the listed IDEM draft TMDL target of 30 ppm. The highest Total phosphorus measurement occurred in the sample collected from the Pokagon Wastewater outlet (.9 ppm). Four sites returned a total phosphorus level below a lab detection limit of .01 ppm. Only the samples collected from the Crane Marsh outlet (.4 ppm) and Pokagon Wastewater outlet (.9 ppm) were above the IDEM probabilistic mean of .382 ppm. These were also above the draft IDEM TMDL target of .3 ppm. At total of 8 samples exceeded the Environmental Protection Agency (EPA) maximum target of .076 ppm. E-coli bacteria measurements ranged from 1 col/100 ml at Hamilton Lake to 8300 col/100 ml measured in a sample collected in the tributary running between Arrowhead Lake and West Otter Lake. That was the only August sample to exceed the IDEM probabilistic mean of 1895.58 cfu/100 ml. A total of 20 samples exceeded a

target maximum of 235 CFU/100 ml listed in the Indiana Administrative Code. August E-coli data exceeding this maximum is shaded in grey in tables 6 and 7 on pages thirteen and fourteen. The highest estimated discharge occurred on Pigeon Creek at State Road 327 (3192.55 CFM). The highest estimated total suspended solids loading occurred at Pigeon Creek at Meridian Road (1131.46 Kilograms per day). The highest estimated total phosphorus loading also occurred at Pigeon Creek at Meridian Road (7.54 kg/day).

7. Conclusions

A number of water quality concerns were noted during the 2010 season sampling. The August samples collected from Walter's Lake Drain and the northeast tributary to Lake George showed oxygen levels below the 4 ppm target listed in the IAC. This has been a fairly consistent issue at both these locations and is probably due to decomposition taking place in the marshy areas just upstream of the sampling site. Additionally, significant amounts of emergent or floating vegetation growing in these marshes may have the effect of shading out submersed vegetation that releases oxygen into the water. While these oxygen levels have implications for organisms living in the streams, the low oxygen condition of these streams probably does not persist very far from the confluence of these streams with the lake before diffusion and mixing with oxygenated lake water eliminates it.

The May rain event produced very high flows in Pigeon Creek and boosted phosphorus levels and loading far above those noted in past sampling. The runoff from this event did not appear to increase E-coli levels in Pigeon Creek, it appears to have reduced them significantly over those typically measured in past seasons. The only Pigeon Creek site with an E-coli measurement above the 235 IDEM target in the May sampling was the Pigeon Lake Inlet at 296 cfu/100 ml. In the July and August sampling the E-coli levels measured on the Pigeon Creek at sites upstream of Long Lake were somewhat lower than in past seasons also. Samplings which showed unusually high E-coli counts in 2010 included Walters Lakes Drain. A sample collected on May 21 returned a count above an upper experimental limit of 24,196. Wildlife sources in the marsh upstream of the sampling site may be responsible for this. If significantly elevated E-coli levels are noted at this sampling site in 2011 the collection of a sample upstream of the marsh could help verify this. Whereas this stream also runs through a golf course pond upstream of the sampling site, geese could be a source. Another unusually high E-coli count (8300) was noted in a sample collected from the tributary stream between Arrowhead Lake and West Otter Lake on August 20. Lake residents and Steuben County Soil and Water Conservation District (SWCD) personnel have been in communication to discuss possible sources of bacteria in this watershed. Carpenter and Palfreyman Ditches (tributaries to Crooked Lake) persisted in showing elevated E-coli counts as in the past. The Angola/Trine MS4 coordinator is following up to investigate any possible sources of preventable contamination in these watersheds.

Repeated high e-coli counts in streams can be the result of wildlife sources such as geese and raccoons or may be caused by waste from humans or livestock. Because elevated E-coli levels can indicate a potential source of human disease, persistent problems with E-coli should be further investigated, especially if they occur in the vicinity of waters used for swimming. An examination of stream corridors, watershed land-use, and wastewater disposal practices combined with additional sampling may be able to better identify potential sources of the bacteria in these problem areas. Lake associations may be able to investigate these problem areas further with the goal of eventually eliminating certain bacterial sources. In some cases funding and technical assistance may be available through the Steuben County Lakes Council,

Steuben County Soil and Water Conservation District, USDA Natural Resources Conservation Service, or USEPA.

Total Phosphorus levels measured in the outflow from Crane Marsh (tributary to Marsh Lake) and in the effluent downstream of the Pokagon Wastewater Treatment Facility (tributary to Snow Lake) were the highest of all sampling sites on all three rounds of sampling and exceeded the U.S. EPA recommended max. stream water quality target of .076 ppm on all three samplings. Since both these flows originate in treatment facilities it's reasonable to expect them to contain significant phosphorus concentrations. The staff at these facilities should be able to provide data to verify that operations have been remaining in compliance with current facility NPDES permit requirements.

Significant erosion was again noted along Pigeon Creek upstream of Hogback Lake during sampling. Hogback Lake's past data also suggests it is highly productive and relatively nutrient rich. Additionally the delta area at Hogback Lake is extremely shallow and has probably received considerable deposition of eroded materials over the years. Options for helping stabilize the stream bank along this reach of Pigeon Creek should be investigated with the ultimate goal of providing future benefits to Hogback Lake by reducing nutrient and sediment loads and improving water quality.