

Phase I SJRBC Water Quality Testing Program Final Report

Phase I of a three phase water testing program began in April 2014 and ended March 2015. The following parameters were collected on a monthly basis for a total of 12 collection cycles: pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), chlorides, conductivity, total dissolved solids (TDS), nitrates-nitrites, total phosphorus, turbidity, total suspended solids, flow (cf/s), and *E.coli*. During the field portion of the project, data for the physical parameters of pH, temperature, DO, conductivity, TDS, turbidity, and flow were collected immediately at each location. Temperature, pH, DO, conductivity, and TDS were measured using HACH sensION meters with detection limits of 0.1°C, 0.1 standard units (pH), 0.1 mg/l (DO), 0.1 µS/CM (conductivity), and 0.1g/l (TDS). Turbidity was collected using a HACH 2100P turbidity meter with a detection limit of 0.1 NTU. Velocity measurements were taken with the 6712 HOBO Monitor with a detection limit of 0.01 fps.

Discharge or flow was calculated using the following formula:

$$\text{Discharge} = \frac{(\sum di) w * v}{(n+1)}$$

where d equals stream depth, i equals individual depths, n equals the number of stream depths measured, w equals the width of the stream, and v equals the velocity of the stream (0.9 times the fastest velocity recorded).

Grab samples were collected at each location for laboratory analysis of BOD, chlorides, nitrates-nitrites, total phosphorus, total suspended solids, and *E.coli*. The samples were collected in 500ml plastic bottles and 250ml BOD glass dark bottles. Grab samples were collected from stream center at an approximate depth of 6 inches when possible. The pole mounted collection bottle was rinsed three times at the collection site before laboratory bottles were filled to minimize cross site contamination and bias.

Laboratory analysis of samples was completed immediately upon return from the field. This procedure produces the most accurate data values for nutrient and chloride parameters. A HACH DR 2500 and DR 2800 Laboratory Spectrophotometer was used to analyze chlorides, nitrates/nitrites, total phosphorus, and total suspended solids. Each procedure requires a strict set of protocols clearly outlined in the instruments handbook. All reagents used in the process were checked before use each month to insure they fall within the shelf life date. In addition, standards and blanks were employed for each parameter to insure accuracy. Standards are using a "known" concentration that is ran through the reagent process to validate the accuracy of the equipment. Blanks use deionized water in the process to apply corrections for the reagent stock being used for each parameter. If after applying blank corrections any parameter data still seemed to be above expected levels, a "spike" test was performed to validate the data curve of the spectrophotometer. If the curve was off a correction procedure for the instrument was employed.

BOD bottles were placed in a dark area for a five day digestion period. The DO was again taken to determine the consumption rate. This rate is recorded by mg/l and by percentage. The percentage value is for quick reference to determine if any particular site is degraded. Essentially, the lower the percentage value the better. Anything over 50% is considered degraded.

E. coli plates using the Coliscan Easygel technique developed by Micrology Laboratory were employed to determine bacterial contamination. The procedure is widely accepted around the world. Prepared plates, using 1 ml samples, were placed into an incubator for 24 hours. Since there is keen interest in this procedure a detailed explanation taken directly from the Micrology Laboratory website is below:

Coliscan Easygel

Coliform bacteria are members of the family Enterobacteriaceae and are defined as gram negative, non-spore-forming rods which ferment the sugar lactose with the evolution of gas and acids. Many coliforms are normally found in soil and water and do not necessarily indicate the presence of fecal contamination, but Escherichia coli (E. coli) is a primary bacterium in the human and animal intestinal tract and its presence in food or water indicates fecal contamination. Therefore, E. coli is the coliform that is used as an indicator for fecal contamination. Other coliform genera include Citrobacter, Enterobacter and Klebsiella. The USEPA acknowledges that E. coli is the best indicator of health risk in fresh water and is currently recommending testing for E. coli instead of fecal coliforms. The term "fecal coliform" indicates coliforms which will grow at a temperature of 44.5 °C. This is not an accurate designation as there are coliforms of non-fecal origin that will grow at 44.5 °C and there are strains of E. coli that will not grow at 44.5 °C.

Traditional tests for coliforms and E. coli or fecal coliforms require the inoculation of media containing lactose, incubation under carefully controlled temperatures, and examination for the presence of gas from lactose fermentation. Additional special media must then be inoculated and incubated at elevated, carefully controlled temperatures to confirm the presence of E. coli or fecal coliforms. All these require

extra equipment and careful regulation of time and temperature. This approach is not only expensive and time consuming, but can be less than precise in indicating the numbers of specific organisms present.

*As a result of the difficulties and lack of precision inherent in the older technology, new approaches have been developed and are being used very successfully. One of the best approaches is based on the fact that in order for coliforms to ferment lactose, they must produce certain enzymes which can be identified and used to verify the presence of the coliforms. General coliforms produce the enzyme galactosidase in lactose fermentation and *E. coli* produces the enzyme glucuronidase in addition to galactosidase.*

*Coliscan takes advantage of these facts to give you a simple, accurate and quantitative way to identify and differentiate coliforms and *E. coli* (true fecal coliform) from other bacteria in water or other types of samples. This patented method incorporates two special chromogenic substrates which are acted upon by the presence of the enzymes galactosidase and glucuronidase to produce pigments of contrasting colors. All that is needed to identify the presence and numbers of coliforms and *E. coli* is to add a test sample to the medium, pour it into a petri dish and incubate it at room temperature or at a higher controlled temperature (35° C is suggested). General coliforms will produce the enzyme galactosidase and the colonies that grow in the medium will be a pink color. *E. coli* will produce both galactosidase and glucuronidase and will therefore grow as dark blue to purple colonies in the medium. It is simple to count the blue/purple colonies (*E. coli*) which indicate the number of *E. coli* per sample. The pink colonies indicate the number of general coliforms per sample. The combined general coliform and *E. coli* number equals the total coliform number. Any non-colored colonies which grow in the medium are not coliforms, but may be members of the family Enterobacteriaceae. Since the Coliscan contains inhibitors, most other bacterial types will not grow. It is best for the Coliscan to be incubated at a temperature higher than room temperature so that the organisms will grow faster. The suggested temperature range is between 30-37° C (85-99° F). The coliform/*E. coli* organisms will grow faster at this temperature range than at room temperature, so that results can be counted at 24-48 hours incubation time instead of about 24 hours later if incubated at room temperature, 22-27° C (72-80° F).*

Micrology Laboratories can provide information on homemade or inexpensive commercial incubators.

*The beauty of the Coliscan method is that it uses proven and accepted technology to allow anyone to do effective coliform/*E. coli* testing. For water testing, you can add up to a 5 mL sample of water to the bottle of medium that makes one petri plate. This will detect as small a number of coliforms or *E. coli* as one living bacterium in five milliliters of water. The method is also easily adapted for large samples with membrane filter use. Beware of copycat methods by other manufacturers who claim similar red and blue colors for coliforms and fecal coliforms, but whose results are unreliable due to inferior technology. They cannot legally copy the patented Coliscan technology.*

Coliscan has a shelf life of 1 year and should be kept frozen until used. You may refrigerate for up to 2 weeks, but freezing is best in order to maintain color intensity throughout the 1 year period.

Analysis Procedure:

Introduction

*The Coliscan Easygel medium is a patented formulation for water testing. It contains a sugar linked to a dye which, when acted on by the enzyme β -galactosidase (produced by coliforms including *E. coli*), turns the colony a pink color. Similarly, there is a second sugar linked to a different dye which produces a blue-green color when acted on by the enzyme β -glucuronidase. Because *E. coli* produces both β -galactosidase and β -glucuronidase, *E. coli* colonies grow with a purple color (pink + blue). The combination of these two dyes makes possible the unique ability to use one test to differentiate and quantify coliforms and *E. coli*. (Because *E. coli* is a member of the coliform group, add the number of purple colonies to the number of pink colonies when counting total coliforms.)*

Instructions

1. *Either collect your water sample in a sterile container and transport the water back to the test site, or take a measured water sample directly from the source and place directly into the bottle of Coliscan Easygel. Water samples kept longer than 1 hour prior to plating, or any Coliscan Easygel bottle that has had sample placed into it for transport longer than 10 minutes, should be kept on ice or in a refrigerator until plated.*
2. *Label the petri dishes with the appropriate sample information. A permanent marker or wax pencil will work.*
3. *Sterilely transfer water from the sample containers into the bottles of Coliscan Easygel (Consult the following table for rough guidelines for inoculum amount). Swirl the bottles to distribute the inoculum and then pour the medium/inoculum mixtures into the correctly labeled petri dishes. Place the lids back on to the petri dishes. Gently swirl the poured dish until the entire dish is covered with liquid (but be careful not to splash over the side or on the lid).*

Inoculation of Coliscan Easygel	
Water Sources	Inoculum Amount
<i><u>Environmental:</u> River, lake, pond, stream, ditch</i>	<i>1.0 to 5.0 mL</i>
<i><u>Drinking water:</u> Well, municipal, bottled</i>	<i>5.0 mL</i>

4. *The dishes may be placed right-side-up directly into a level incubator or warm level spot in the room while still liquid. Solidification will occur in approximately 45 minutes.*
5. *Incubate at 35 C (95 F) for 24 hours, or at room temperature for 48 hours. (see Comments on incubation)*
6. *Inspect the dishes.*
 - a. *Count all the purple colonies on the Coliscan dish (disregard any light blue, blue-green or white colonies), and report the results in terms of E. coli or Fecal Coliform per mL of water.*

Note: To report in terms of E. coli or Fecal Coliform per 100 mL of water, first find the number to multiply by:

 1. *Divide 100 by the number of mL that you used for your sample.*
 2. *Multiply the count in your plate by the result obtained from #1.*

e.g. For a 3 mL sample, $100 / 3 = 33.3$. So 4 E. coli colonies multiplied by 33.3 will be equal to 133.2 E. coli per 100 mL of water.
 - b. *Count all the pink and purple colonies on the Coliscan dish (disregard any light blue, blue-green or white colonies) and report the results in terms of coliforms per mL of water.*
7. *Do one of the following prior to disposal in normal trash:*
 - a. *Place dishes and Coliscan bottles in a pressure cooker and cook at 15 lbs. for 15 minutes. (This is the best method.)*

- b. Place dishes and Coliscan bottles in an oven-proof bag, seal it, and heat in an oven at 300° F for 45 minutes.
- c. Place dishes and Coliscan bottles in a large pan, cover with water and boil for 45 minutes.
- d. Place 5 mL (about 1 teaspoon) of straight bleach onto the surface of the medium of each plate. Allow to sit at least 5 minutes. Place in a water-tight bag and discard in trash.

Comments on Incubation

Micrology Laboratories, LLC. in-house studies indicate that **Coliscan** can effectively differentiate general coliforms from **E. coli** when incubated at either room temperatures or at elevated temperatures (such as 90-98 F). However, some further explanation may be helpful.

There is no one standard to define room temperature. Most would consider normal room temperature to vary from 68-74 F, but even within this range the growth of bacteria will be varied. Members of the bacterial family **Enterobacteriaceae** (which includes coliforms and **E. coli***) are generally hardy growers that prefer higher than room temperatures, but which will grow at those temperatures. They tend to grow at a faster rate than most other bacterial types when conditions are favorable. It is therefore logical to try to place inoculated dishes in a "warm" place in a room for incubation if a controlled temperature incubator is not available. It is a very easy task to make an adequate incubator from a box with a 40-60 watt bulb in it to provide heat at an even rate. One can also use a heat tape such as is used to prevent the freezing of pipes in the winter as your heat source.

Our general instructions indicate that incubation times for coliforms (including **E. coli**) are generally 24-48 hours at elevated temperatures (90-98 F) and 48 or more hours at room temperatures. At elevated temperatures, no counts should be made after 48 hours as any coliforms present will be quite evident by that time and if new colonies form after 48 hours they are most likely not coliforms, but some other type of slow growing organism that should not be included in your data. At room temperatures, the best procedure is to watch the plates by checking them at 10-12 hour intervals until you observe some pink or purple colonies starting to form and then allowing another 24-30 hours for the maturation of those colonies. Since the coliforms (including **E. coli**) are generally the fastest growing organisms, these will be the first to grow and be counted. Colonies that may show up at a later time are likely to not be coliforms. As you can see, there are advantages to incubating your dishes at elevated temperatures. First, you can count the results earlier. At 95 F, it is often possible to do accurate counts at 18-20 hours of incubation. There is also less probability of variation from batch to batch when the incubation temperatures are kept at one uniform level. And a higher incubation temperature will tend to inhibit the growth of non-coliforms that may prefer lower temperatures.

***E. coli** is the primary fecal coliform, however, **Klebsiella** is sometimes of fecal origin. Other general coliform genera include **Enterobacter** and **Citrobacter**.

Interpretation of Results

This test method utilizes well established, widely accepted criteria for the recognition of coliforms and **E. coli** and proper application of the method will result in accurate results. Therefore, if you suspect that your water is dangerously contaminated based on the results you get using Coliscan Easygel, you should contact your local health department and ask for their help in performing an official assessment of the water.

Non-fecal coliforms are widely distributed in nature, being found both as naturally occurring soil organisms, and in the intestines of warm-blooded animals and humans. Fecal coliforms are coliforms

found naturally only in the intestines of warm-blooded animals and humans. Fecal coliform contamination is therefore the result of some form of fecal contamination. Sources may be either animal or human.

General Notes on Differentiating Coliforms and E. coli

Generally, water containing E. coli (the fecal contamination indicator organism) should not be used for drinking water unless it is sanitized in some manner. Contact your local health department for guidelines regarding E. coli and coliforms in recreational waters. Inform them if you suspect that contamination may be occurring from a specific source.

Colonies which have the blue-green color are not exhibiting any β -galactosidase activity (which is evidenced by the pink color). Because of this, they are not considered to be either coliforms or E. coli and therefore should be ignored when counting your coliform or E. coli colonies. Similarly, colonies which are white are exhibiting neither color-causing enzyme, and should also be ignored.

Colonies on the surface of the plate are exposed to the medium on only the underside of the colony. This causes these colonies to appear with much less of the indicator color. E. coli colonies may only have a slight purple tinge to them, and it may appear only in the center of the colony with the remainder of the colony being white. Similarly, coliforms on the surface may be light pink or white with a pink center.

The above explanation of using the Easygel technique (although very detailed) should alleviate any questions concerning the procedure.

Figure 1 is an overview map demonstrating the relative locations of all ten sites sampled during Phase I of the project. All of the locations were in Noble County and were selected by the SJRBC. The design was intended to capture data for the headwater regions of the North and South branches of the Elkhart River drainage. It concentrated along ditch systems in areas not already sampled by the Lagrange County Lakes Council (in LaGrange County) to prevent duplication of data sites. Data collected by the lakes council will be interpreted and included in the projects final analysis at a later date.

The sampling regime was conducted during the morning hours once each month for data consistency and bias reduction. The sampling process was generally completed in four hours with the laboratory analysis completed immediately upon return. The *E.coli* plates were read 24 hours after plate preparation and the BOD was completed after a five day incubation period.

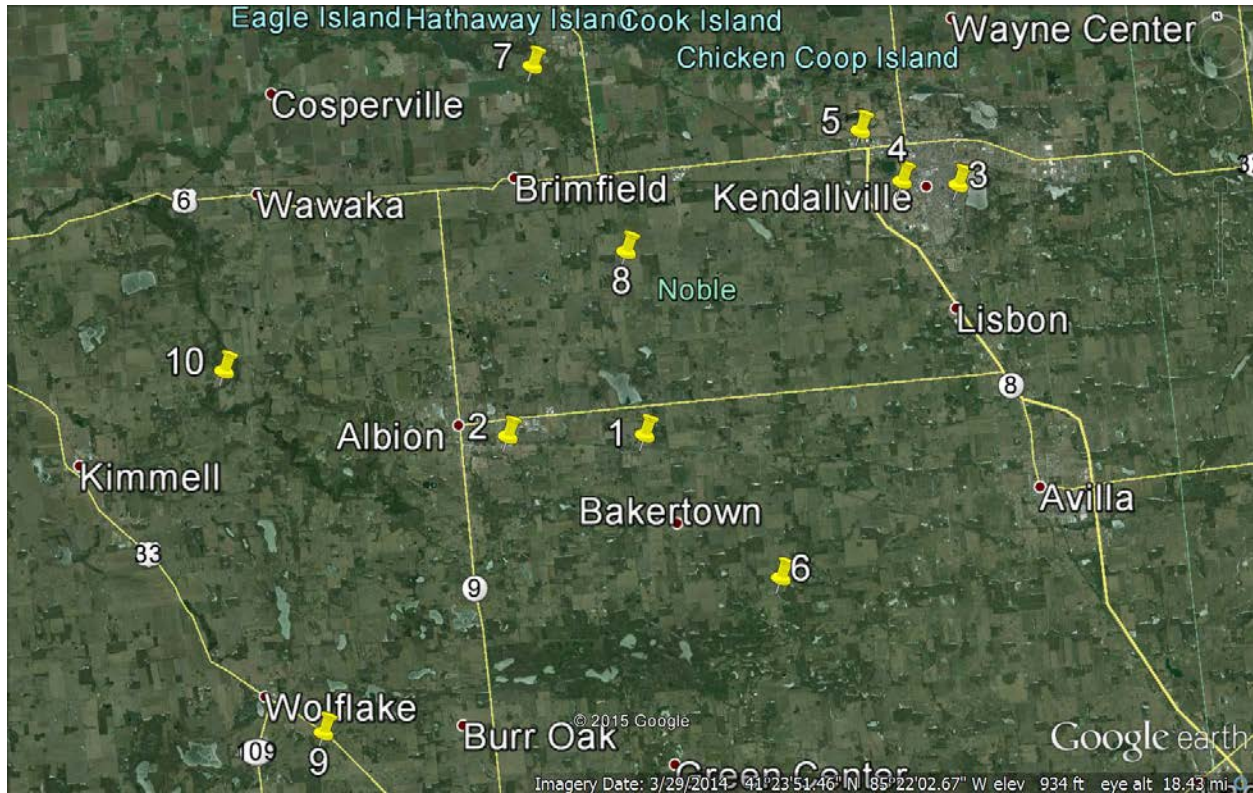


Figure 1: Overview map of Phase I sites.

It is important to discuss target parameters before interpreting individual site data. Table 1 shows the target values of each parameter. In most cases it is the maximum concentration considered acceptable. However, in many cases individual parameters may have several target concentrations depending on the information source. For example, total phosphorus in Ohio is ≤ 0.08 mg/l for the headwater regions of any river or stream system. In Indiana, < 0.3 mg/l is the number generally accepted by IDEM even though this target is not officially set in stone at this time. For the highly channelized and ditched lateral systems feeding into the main channels of any river in northern Indiana, the < 0.3 mg/l is a realistic target. Generally, these lateral systems are providing the major loading of Non-Point Source (NPS) pollutants that are reaching the Great Lakes.

With this target variation in mind, Table 1 signifies numbers accepted by IDEM in Watershed Management plan development based on years of research and recent water quality testing efforts in agrarian regions of northern Indiana. Since the preponderance of influence throughout the Phase I sites is agriculture, the target levels represented are realistic and are used in the data discussion to explain relative water quality at each test site.

Parameter	Target	Source
Dissolved Oxygen	> 6 mg/L and not > 9 mg/L	327 IAC 2-1-6/US EPA recommendation
Temperature	40-85 degrees F	MI – R.323.1075
<i>Escherichia coli</i>	< 235 CFU/100 ml per single sample and < 125 CFU/100 ml per the geometric mean of 5 equally spaced samples over a 30 day period	327 IAC 2-1.5-8
Turbidity	< 10.4 NTU	US EPA recommendation (2000)
Total Dissolved Solids	< 750 mg/L	MI – R.323.1051 / 327 IAC 2-1-6
Total Suspended Solids	< 25 mg/L	US EPA recommendation
Total Phosphorus	< 0.3 mg/L	IDEM 303d listing criteria
Nitrate	< 1.5 mg/L	US EPA reference level (2000)
Nitrate-Nitrite	< 1.5 mg/L	Dodds et al. (1998)
Biological Oxygen Demand	< 50%	IDEM/Purdue University
pH	> 6 or < 9	327 IAC 2-1-6
Chlorides	<25 mg/l	IDEM

Table 1: Target levels of tested parameters.

Site 1

Site 1 (Figure 2) is on the Rimmell Branch Ditch and is a culvert on CR300E just south of SR 8 (south of Skinner Lake). This location was moved from its original location due to a recent channelization that interfered with ditch flow allowing lake water bias in samples.

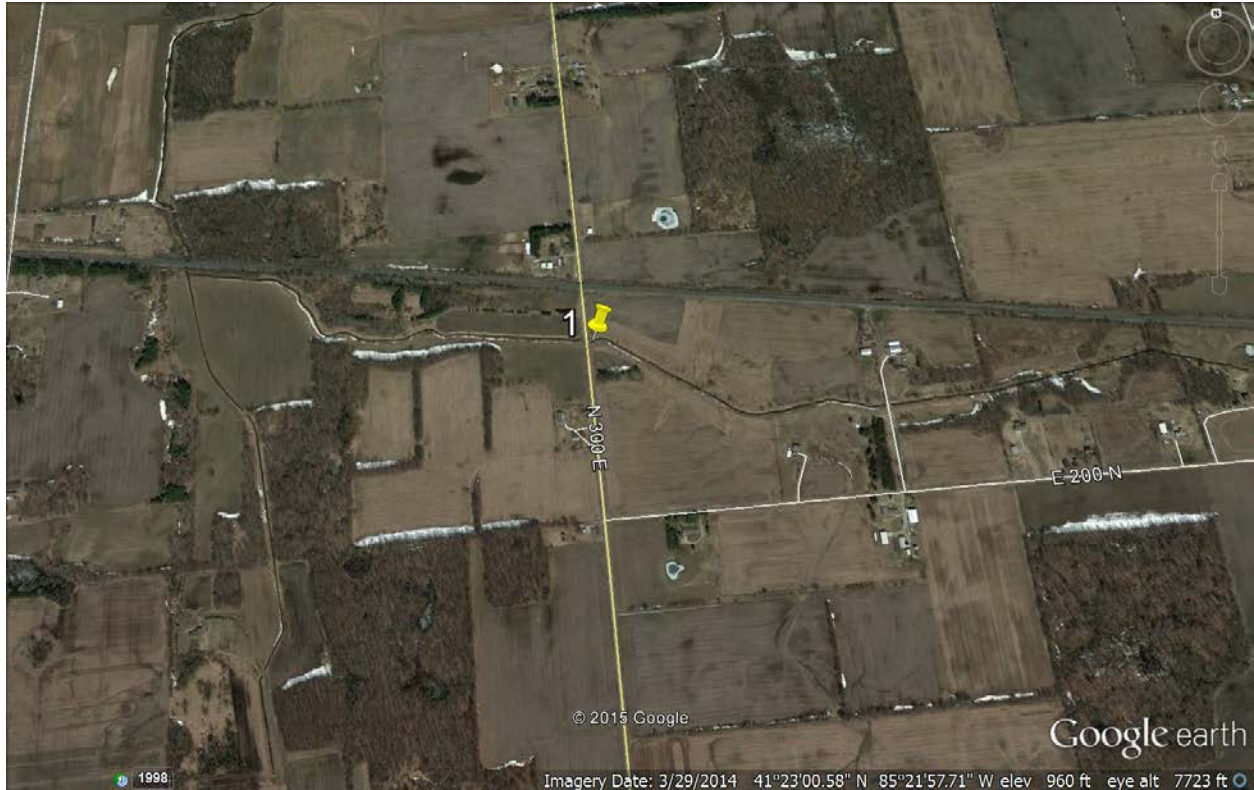


Figure 2: Site 1 location.

Table 2 displays the data for Site 1 and clearly shows this as a problematic site for *E.coli*, nitrates-nitrites, total phosphorus, turbidity and total suspended solids. *E.coli* target limits were exceeded 4 times or 33.33% of total samples taken, Nitrates-nitrites limits were exceeded 8 times or 66.66%, total phosphorus limits were exceeded 8 times or 66.66%, turbidity limits were exceeded 7 times or 58.33%, and total suspended solids limits were exceeded 8 times or 66.66% of total samples taken during phase I.

The contamination appears to be associated with large dairy operations upstream. Several locations allow livestock direct access into the ditch system and have barnyards with little or no buffering to prevent runoff. Skinner Lake receives this contaminated runoff which is certainly unhealthy for the lake. However, the lake does act a buffer to prevent or at least significantly reduce the contamination from moving further downstream.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
1	4/23/2014	Y	WW	7.60	8.9	9.14	0.7	8.6	16.7	564	288	0	4.8	0.35	3	31	1.755
1	5/29/2014	Y	WW	7.30	16.2	7.74	1.5	18.73	14.9	610	311	2400	10.1	0.62	70	99	4.577
1	6/27/2014	Y	WW	7.67	18.3	7.48	0	0	17.9	715	365	600	3.2	0.46	51	58	2.565
1	7/29/2014	N	BF	8.08	16.9	11.48	6.4	56.1	8.2	692	353	200	1.0	0.72	73	92	0.406
1	8/27/2014	Y	BF	8.02	21.2	4.78	1.4	28.87	19.7	711	363	0	0.8	0.42	68	72	0.117
1	9/25/2014	N	BF	8.10	13.3	6.49	0.4	18.03	11.3	745	380	500	2.5	0.59	32	98	0.108
1	10/29/2014	N	BF	8.16	10.1	7.80	1.3	16.15	9.2	721	368	100	1.2	0.09	21	45	0.115
1	11/24/2014	Y	WW	7.64	9.0	8.53	5.4	62.95	27.8	477	243	400	9.7	1.65	63	189	12.167
1	12/30/2014	N	BF	8.13	1.6	11.33	1.2	10.86	12.5	893	491	100	4.1	0.07	4	13	2.971
1	1/28/2015	N	BF	8.01	1.1	11.34	1.3	11.46	14.3	545	300	50	2.1	0.07	2	7	1.954
1	2/27/2015	N	BF	7.87	0.8	11.56	0.5	4.33	9.5	542	298	50	1.2	0.07	1	4	1.105
1	3/25/2015	Y	BF	7.89	5.5	10.07	0.7	6.95	16.3	562	309	200	2.8	0.24	3	5	2.481
Average				7.87	10.2	9.0	1.733333	20.2525	14.85833	648.0833333	339.0833	383.33333	3.625	0.44583333	32.58333	59.4166667	2.52675

Table 2: Site 1 data.

Site 2

Site 2 (Figure 3) is on Croft Ditch and is a bridge on 75E just south of SR 8. This location was moved approximately 1 mile west of the original site in order to capture dairy operation runoff during rain events.

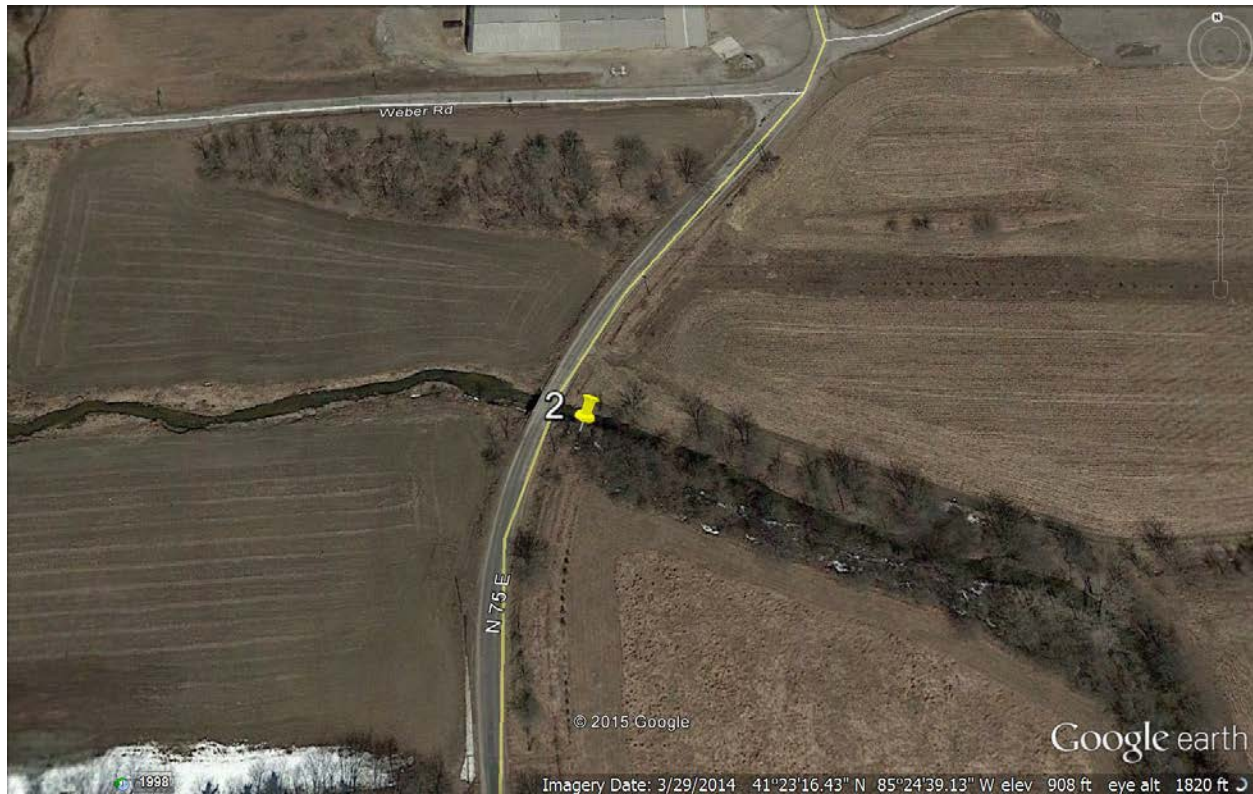


Figure 3: Site 2 location.

Table 3 displays the data for Site 2 and shows, as in Site 1, a likely livestock contamination problem for *E.coli*, nitrates-nitrites, total phosphorus, turbidity and total suspended solids. *E.coli* exceeded the target maximum loading 5 times or 45.45% of the samples taken, nitrates-

nitrites 7 times or 63.63%, total phosphorus 5 times or 45.45%, turbidity 4 times or 36.36%, and total suspended solids 3 times or 27.27% of the samples taken for analysis.

A dairy operation 1 mile upstream has a severely sloped barnyard that allows direct runoff into the stream. As expected, runoff caught during or immediately after a significant rain event captured the high NPS pollutant problem.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
2	4/23/2014	Y	WW	7.74	10.6	9.53	2.3	24.13	18.2	592	302	100	5.3	0.29	2	18	18.365
2	5/29/2014	Y	WW	7.89	21.2	7.98	3.1	38.85	11.0	553	282	8100	4.6	0.39	33	43	39.62
2	6/27/2014	Y	WW	7.92	22.2	7.31	2.0	27.91	6.5	538	274	4300	1.9	0.32	36	44	15.017
2	7/29/2014	N	BF	8.03	15.3	7.65	1.3	17.39	3.6	763	389	850	0.9	0.59	2	11	0.932
2	8/27/2014	Y	BF	7.83	19.4	6.03	0	0	16.5	768	392	0	1.2	0.30	15	12	0.792
2	9/25/2014	N	Road Closed														
2	10/29/2014	N	BF	8.06	9.9	8.08	1.8	22.64	8.3	711	363	200	2.2	0.11	5	4	2.422
2	11/24/2014	Y	WW	7.81	8.6	9.41	4.2	44.53	15.2	589	300	250	9.9	0.66	37	59	33.383
2	12/30/2014	N	BF	7.83	1.8	11.85	2.5	21.27	5.2	595	327	50	3.5	0.12	2	7	5.302
2	1/28/2015	N	BF	7.77	1.3	12.09	0.8	6.62	16.6	583	321	0	1.5	0.09	1	3	3.232
2	2/27/2015	N	BF	7.79	0.9	12.21	0.3	2.46	3.2	585	322	50	1.1	0.09	1	2	2.172
2	3/25/2015	Y	BF	7.81	6.2	10.29	1.2	11.66	18.7	582	320	350	3.1	0.22	1	2	3.019
Average				7.861818	10.67273	9.311818	1.772727	19.76909	11.18182	623.5454545	326.5455	1295.4545	3.2	0.28909091	12.27273	18.6363636	11.296

Table 3: Site 2 data.

Site 3

Site 3 (Figure 4) is located in Kendallville, next to East Noble High School and is a culvert on Bixler Lake Ditch approximately a quarter mile downstream of the lake outlet. Both sides of the site are sloped and maintained as grassways which will act as a buffer for runoff during rain events. The soils are muck and the ditch system is maintained to keep the soil well drained.

Table 4 shows Site 3 data and demonstrates some high levels of nitrates-nitrites, total phosphorus, turbidity, and total suspended solids. *E.coli* was found high on only 1 sample or 11.11% of samples taken. Nitrates-nitrates exceeded the target maximum threshold 5 times or 55.55%, total phosphorus 2 times or 22.22%, turbidity 2 times or 22.22%, and total suspended solids 2 times or 22.22% of total samples taken during the sampling cycle. An interesting note is that this ditch system maintains a rather large population of Carp year round. Except for the single high *E.coli* sample, mechanical disturbance of sediments is the likely cause of the higher readings during the sampling cycle. In every case where high numbers were recorded, Carp were observed disturbing the ditch sediments. The single high *E.coli* reading was likely caused by over 100 geese observed at the outlet to Bixler Lake.

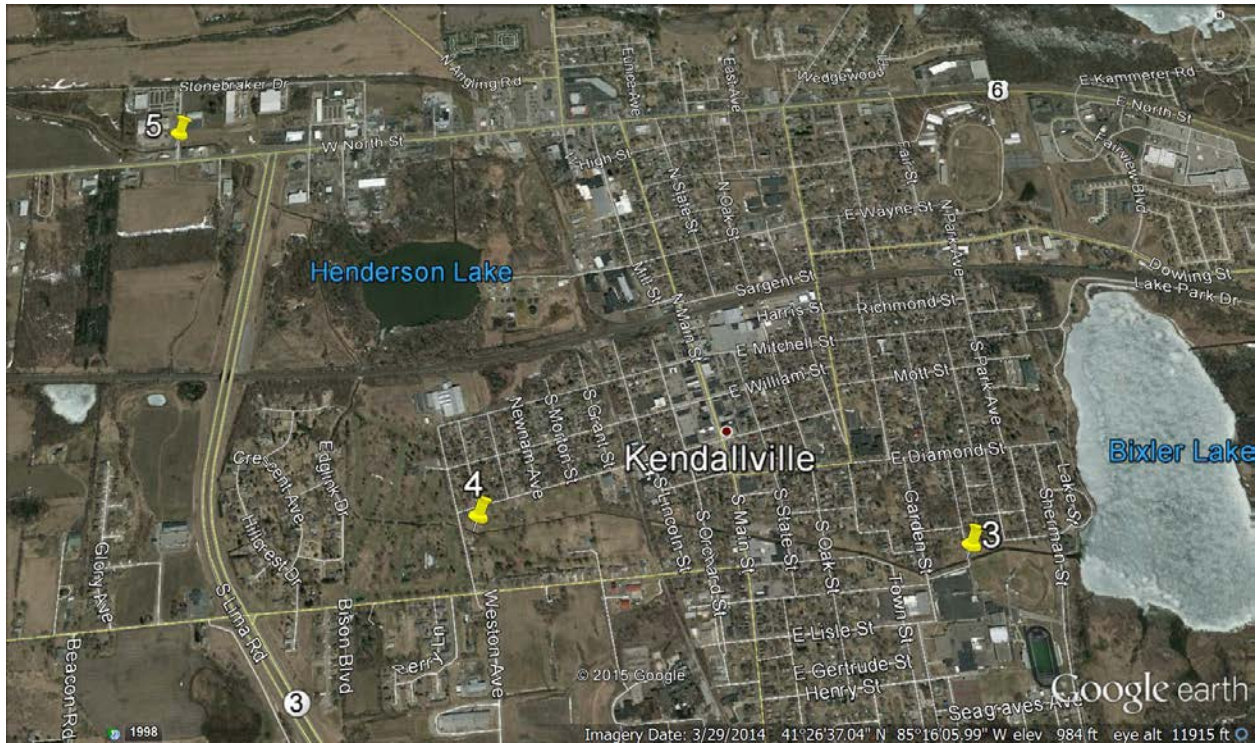


Figure 4: Sites 3, 4, and 5 locations.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	Escherichia coli	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
3	4/23/2014	Y	WW	8.04	10.9	10.19	2.4	24.04	23.8	567	289	0	1.9	0.27	2	10	10.800
3	5/29/2014	Y	WW	7.86	18.7	7.66	0.8	10.31	25.9	650	391	100	5.6	0.12	6	12	1.697
3	6/27/2014	Y	WW	7.76	23.3	5.78	0.8	13.67	25.0	630	321	200	0.9	0.27	23	27	0.802
3	7/29/2014	N	BF	7.83	16.7	3.94	2.7	69.04	12.5	651	332	400	0.1	0.48	13	15	0.864
3	8/27/2014	Y	No Flow														
3	9/25/2014	N	No Flow														
3	10/29/2014	N	No Flow														
3	11/24/2014	Y	WW	7.49	9.8	8.22	7.2	88.08	9.0	480	245	200	5.8	0.77	23	37	3.078
3	12/30/2014	N	BF	7.45	1.1	9.47	1.3	13.72	3.9	473	260	0	1.8	0.17	3	9	1.005
3	1/28/2015	N	BF	7.51	1.2	10.52	1.0	9.51	19.1	579	318	0	1.1	0.11	2	4	0.074
3	2/27/2015	N	BF	7.63	1.1	10.78	0.6	5.57	2.7	567	312	0	0.8	0.06	1	2	0.032
3	3/25/2015	Y	BF	7.71	6.1	9.58	0.9	9.39	23.2	571	314	100	1.5	0.22	3	4	0.396
Average				7.697778	9.877778	8.46	1.966667	27.03667	16.1	574.2222222	309.1111	111.11111	2.166667	0.27444444	8.444444	13.3333333	2.083

Table 4: Site 3 data.

Site 4

Site 4 (Figure 4) is located in Kendallville just upstream of the Elks Golf Course and is a culvert located on Bixler Lake Ditch. A city park surrounds the site and acts as a buffer from runoff contaminants generated by the city.

Table 5 shows the data and demonstrates nitrates-nitrites as the most prevalent NPS contaminant by exceeding the target threshold 5 times or 41.66% of samples taken, followed by turbidity and total suspended solids each exceeding the target 2 times or 16.66%, and total phosphorus 1 time at 8.33% of total samples. Again, Carp were observed disturbing streambed

soils during sampling. Some of the high nitrates-nitrites can be explained with grass fertilizers at the Park. Fertilizer applications were directly observed.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
4	4/23/2014	Y	WW	8.20	10.6	9.40	3.8	40.85	21.3	466	238	100	2.1	0.29	17	28	5.481
4	5/29/2014	Y	WW	8.18	18.5	7.18	1.7	24.32	25.5	622	317	0	2.6	0.24	7	14	3.84
4	6/27/2014	Y	WW	7.96	22.6	7.34	0	0	17.6	680	340	150	1.1	0.17	5	6	1.620
4	7/29/2014	N	BF	7.93	16.1	8.87	1.5	16.8	8.6	855	436	0	0.1	0.21	2	1	0.292
4	8/27/2014	Y	BF	7.71	22.0	7.53	0	0	3.2	723	368	0	1.0	0.20	3	5	0.011
4	9/25/2014	N	BF	7.60	14.8	8.62	0	0	3.2	1074	548	0	0.8	0.11	0	4	0.091
4	10/29/2014	N	BF	7.75	9.9	9.12	2.5	27.52	2.4	987	503	150	1.5	0.10	2	3	0.326
4	11/24/2014	Y	WW	7.51	9.6	8.28	6.4	77.05	17.8	512	261	100	9.7	0.55	24	40	4.714
4	12/30/2014	N	BF	7.37	1.5	10.36	1.3	13.47	7.1	678	373	0	1.4	0.14	1	3	1.023
4	1/28/2015	N	BF	7.60	1.3	11.13	0.7	6.29	16.7	425	234	0	1.1	0.09	1	3	0.073
4	2/27/2015	N	BF	7.60	1.1	11.37	0.2	1.76	5.3	425	234	0	0.8	0.08	1	2	0.059
4	3/25/2015	Y	BF	7.94	5.9	10.13	1.4	13.82	20.4	487	268	100	1.7	0.25	2	4	0.641
			Average	7.78	11.15833	9.110833	1.625	18.49	12.425	661.1666667	343.3333	50	1.991667	0.2025	5.416667	9.41666667	1.51425

Table 5: Site 4 data.

Site 5

Site 5 (Figure 4) is located on the northwest side of Kendallville and is a culvert on Henderson Lake Ditch. This location is significant since it is downstream of the wastewater treatment plant for the city. Henderson Lake buffers the plant discharge and flows through the ditch system approximately 1 mile before reaching the sampling site.

Table 6 shows Site 5 data and demonstrates nitrates-nitrites as the highest NPS pollutant exceeding the target threshold 7 times or 58.33% of total samples taken, followed total phosphorus with 5 times or 41.66%, turbidity 2 times or 16.66%, and total suspended solids and *E.coli* 1 time each or 8.33% of total samples collected. Carp disturbance can explain on two of the sampling events with high numbers. The high *E.coli* was likely from several hundred geese observed at Henderson Lake outlet (only observed once during that particular sample collection). It is suspect some of the high nutrient readings could be associated with the discharge from the treatment facility, although this is speculation from a limited number of samples taken a significant distance downstream.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
5	4/23/2014	Y	WW	7.94	11.1	9.81	2.2	22.43	20.7	815	416	0	2.0	0.33	0	9	2.869
5	5/29/2014	Y	WW	7.91	19.7	6.74	2.4	35.31	26.5	831	424	500	6.2	0.26	9	13	4.536
5	6/27/2014	Y	WW	6.79	23.2	7.95	1.8	22.39	25.0	981	500	200	0.2	0.37	11	19	1.607
5	7/29/2014	N	BF	7.96	18.1	9.45	7.3	77.46	11.9	1157	590	0	1.1	0.43	6	16	1.559
5	8/27/2014	Y	BF	7.73	23.5	6.82	4.2	61.73	23.0	1356	692	0	2.1	0.34	13	8	0.557
5	9/25/2014	N	BF	7.70	16.7	7.68	0	0	11.6	1290	658	50	3.7	0.28	15	16	0.347
5	10/29/2014	N	BF	7.6	10.5	7.29	1.1	14.81	8.5	1078	550	100	2.3	0.21	2	2	0.549
5	11/24/2014	Y	WW	7.40	8.4	9.12	5.6	61.51	20.6	858	438	100	4.3	0.49	45	61	8.235
5	12/30/2014	N	BF	7.87	1.7	10.83	1.1	10.16	9.7	482	265	0	1.1	0.15	1	3	2.719
5	1/28/2015	N	BF	7.83	1.1	11.56	1.1	9.52	16.3	715	393	0	0.8	0.08	1	3	1.779
5	2/27/2015	N	BF	7.77	1.1	11.82	0.5	4.23	7.1	707	389	0	0.6	0.04	1	2	1.247
5	3/25/2015	Y	BF	7.88	5.9	10.05	1.7	16.92	20.1	759	417	100	1.5	0.27	3	5	2.563
			Average	7.70	11.75	9.093333	2.416667	28.03917	16.75	919.0833333	477.6667	87.5	2.2	0.27083333	8.916667	13.0833333	2.380583

Table 6: Site 5 data.

Site 6

Site 6 (Figure 5) is a culvert on Thumma Ditch located on 500E slightly over a quarter mile south of Baseline Road. Chain O' Lakes State Park is just west of the site. This ditch system flows into the state park's lake system.



Figure 5: Site 6 location.

Table 7 shows Site 6 data with nitrates-nitrites exceeding the target threshold 6 times or 50% of the total samples taken, followed by total phosphorus exceeding 3 times or 25%, and turbidity, total suspended solids, and *E.coli* each exceeding the target threshold 2 times or 16.66% of the total samples collected. All of these high values are likely from dairy operations upstream that have steep sloping barnyards and pastures next to the ditch that are totally denuded of vegetation from overgrazing. The lake system in Chain O' Lakes State Park is likely preventing the majority of these contaminants from flowing further downstream.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
6	4/23/2014	Y	WW	7.96	9.9	9.78	1.0	10.22	14.6	570	291	0	2.4	0.26	7	7	1.928
6	5/29/2014	Y	WW	8.04	18.6	7.79	0.9	11.81	12.7	583	297	300	5.8	0.29	11	15	1.706
6	6/27/2014	Y	WW	7.90	20.4	7.72	0	0	13.9	510	260	450	3.6	0.66	28	28	4.165
6	7/29/2014	N	BF	8.16	15.6	8.05	1.2	14.91	6.7	660	337	0	1.3	0.20	5	4	0.395
6	8/27/2014	Y	BF	8.13	20.7	6.25	0	0	8.5	658	336	0	0.7	0.51	4	4	0.024
6	9/25/2014	N	BF	8.17	13.7	8.91	0	0	4.7	660	337	0	1.5	0.08	2	6	0.037
6	10/29/2014	N	BF	8.14	9.5	9.56	1.9	19.87	3.2	645	329	100	1.4	0.08	2	3	0.277
6	11/24/2014	Y	WW	7.69	9.8	8.52	4.2	48.94	16.3	340	173	0	1.8	0.91	57	79	25.175
6	12/30/2014	N	BF	7.78	1.4	11.34	1.4	12.35	6.4	434	239	0	1.2	0.15	2	5	5.378
6	1/28/2015	N	BF	7.92	1.2	11.39	0.5	4.39	11.8	589	324	0	0.8	0.11	1	3	3.348
6	2/27/2015	N	BF	7.93	1.0	11.59	0.1	0.09	4.6	593	326	0	0.5	0.06	1	2	2.458
6	3/25/2015	Y	BF	7.97	6.1	10.21	1.4	13.71	14.2	554	304	200	1.8	0.26	1	3	4.254
Average				7.9825	10.65833	9.259167	1.1	11.3575	9.8	566.3333333	296.0833	87.5	1.9	0.2975	10.08333	13.25	4.095417

Table 7: Site 6 data.

Site 7

Site 7 (Figure 6) is a culvert on Clock Creek located on 175E just north of 850N. This stretch is heavily buffered by trees and swamp.

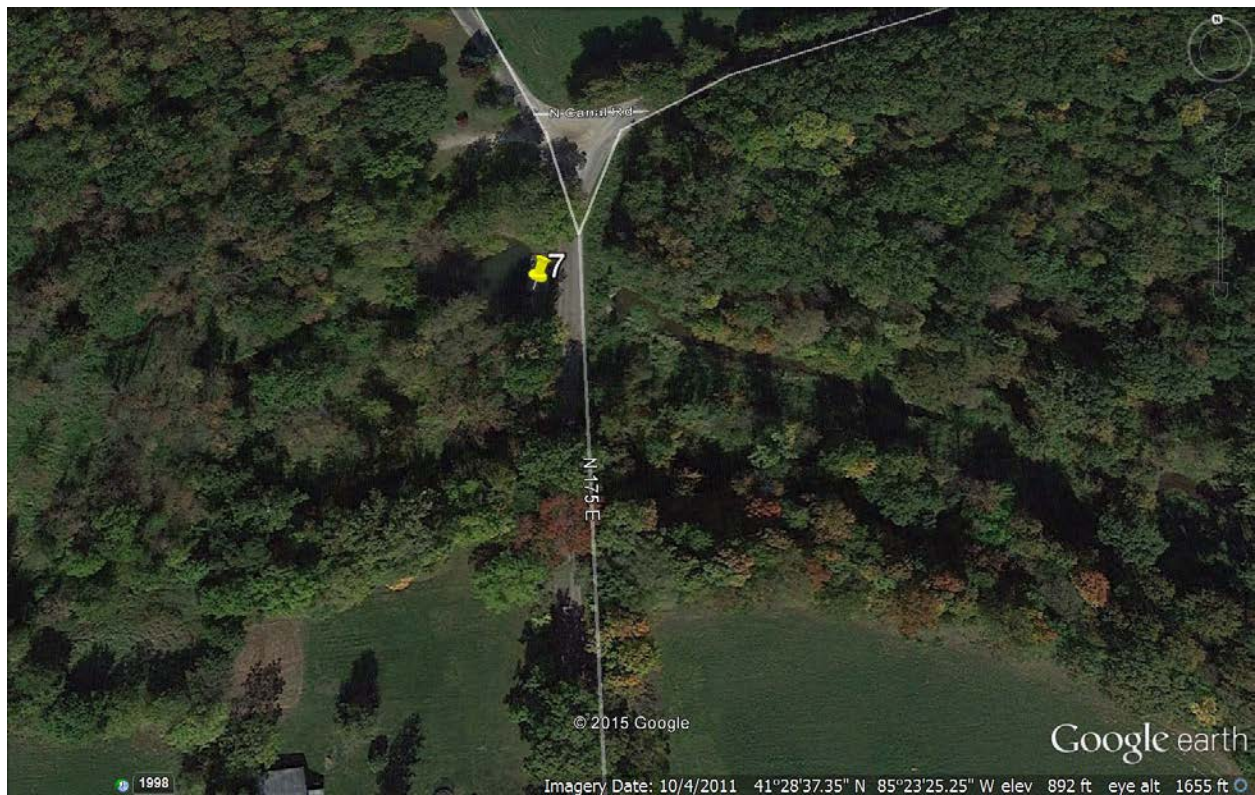


Figure 6: Site 7 location.

Table 8 shows Site 7 data with nitrates-nitrites exceeding the target threshold 9 times or 75% of the total samples taken, followed by total phosphorus exceeding 4 times or 33.33%, and turbidity, total suspended solids, and *E.coli* exceeding 2 times or 16.66% of the total samples collected. Turbidity and total suspended solids numbers can be explained by an observed large population of White Sucker and Carp. The nutrient and *E.coli* numbers can be explained by the

large livestock operations along the ditch and heavy manure spreading during the spring months.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
7	4/23/2014	Y	WW	7.56	10.5	9.19	1.02	11.10	13.3	582	297	0	3.2	0.68	0	4	4.095
7	5/29/2014	Y	WW	7.56	19.0	6.20	2.1	33.39	26.3	432	220	8400	5.4	0.86	45	46	32.076
7	6/27/2014	Y	WW	8.09	19.5	7.41	0	0	8.8	645	329	350	7.2	0.26	11	15	2.835
7	7/29/2014	N	BF	7.78	16.6	12.25	6.3	51.18	5.8	641	326	200	1.2	0.41	2	3	0.068
7	8/27/2014	Y	BF	7.95	19.6	6.28	0	0	6.3	635	324	200	2.0	0.28	11	8	0.216
7	9/25/2014	N	BF	8.26	13.8	12.61	0	0	2.8	660	337	50	1.6	0.21	0	8	2.814
7	10/29/2014	N	BF	8.02	9.7	7.98	1.6	19.55	2.1	651	332	50	1.4	0.18	1	2	3.683
7	11/24/2014	Y	WW	8.14	9.1	7.70	4.1	53.64	8.1	475	242	100	3.9	0.65	22	34	17.242
7	12/30/2014	N	BF	8.40	2.2	11.32	1.2	10.69	3.3	716	394	0	3.5	0.08	3	9	1.112
7	1/28/2015	N	BF	8.37	1.5	10.87	0.9	8.28	9.2	561	309	0	1.5	0.08	2	5	0.879
7	2/27/2015	N	BF	8.13	1.1	10.99	0.5	4.55	2.3	575	316	0	1.1	0.05	1	3	0.559
7	3/25/2015	Y	BF	8.49	6.2	9.54	1.1	11.53	12.7	583	321	100	2.2	0.28	3	5	3.888
Average				8.0625	10.73333	9.361667	1.568333	16.99	8.416667	596.3333333	312.25	787.5	2.85	0.335	8.416667	11.8333333	5.788917

Table 8: Site 7 data.

Site 8

Site 8 (Figure 7) is a culvert on Boughey/Dry Run Ditch located on 300E just north of 500N. It is surrounded by grain fields and has a heavy agricultural influence further upstream.

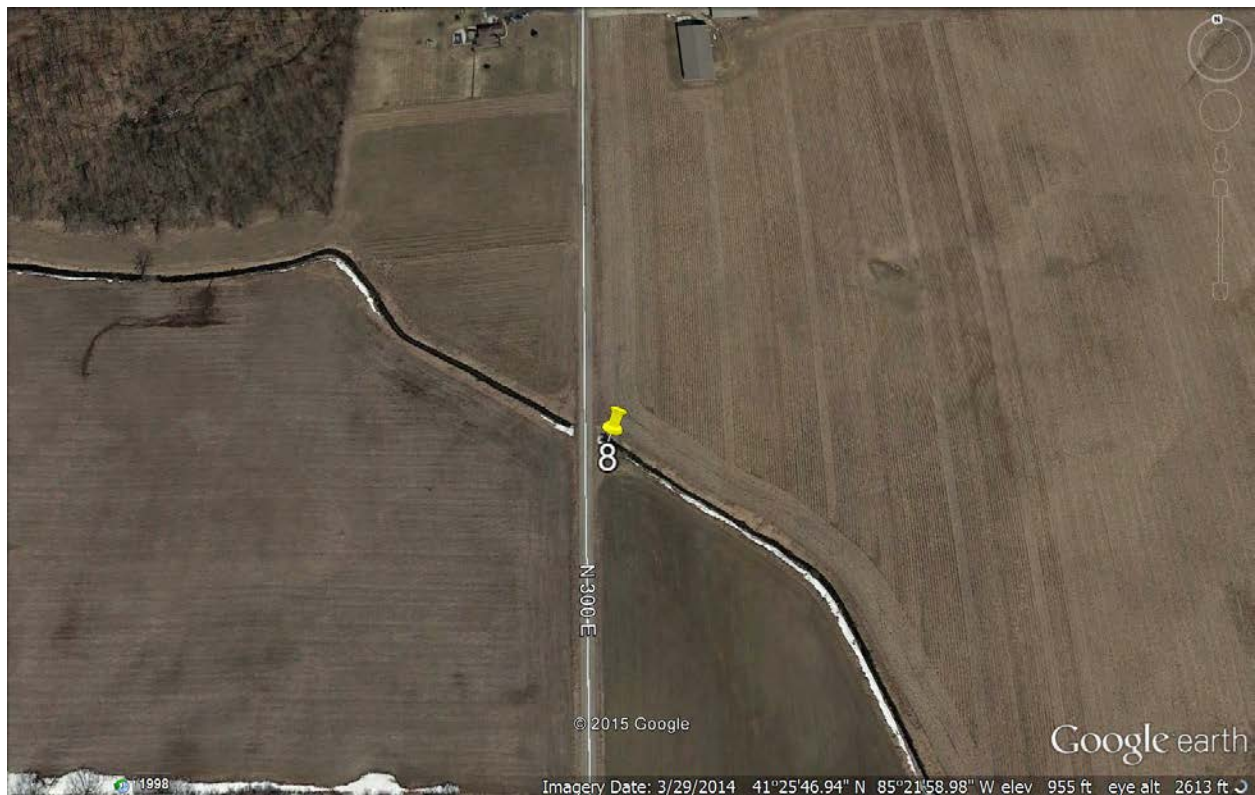


Figure 7: Site 8 location.

Table 9 shows Site 8 data with nitrates-nitrites BOD exceeding the target threshold 8 times or 80% of total samples taken, followed by *E.coli* exceeding 4 times or 40%, total phosphorus 3 times or 30%, and turbidity and total suspended solids exceeding the target threshold 2 times or 20% of

the total samples collected. Again, these numbers can explained by livestock operations and spring manure spreading on fields adjacent to the ditch.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	Escherichia coli	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
8	4/23/2014	Y	WW	7.97	8.9	7.17	0.9	13.25	12.1	659	336	0	3.0	0.16	3	6	0.496
8	5/29/2014	Y	WW	7.32	17.1	4.94	2.4	49.39	26.5	448	228	3900	5.3	0.83	65	62	5.427
8	6/27/2014	Y	WW	7.73	17.9	5.98	0	0	14.0	731	373	400	0.5	0.25	4	7	0.576
8	7/29/2014	N	BF	7.77	14.7	3.74	1.3	35.29	3.1	719	367	0	1.7	0.75	4	5	0.189
8	8/27/2014	Y	BF	7.79	15.3	6.03	1.3	35.29	4.5	755	385	0	1.1	0.29	5	5	0.128
8	9/25/2014	N	Dry														
8	10/29/2014	N	Dry														
8	11/24/2014	Y	WW	8.00	9.7	7.94	4.2	53.15	13.3	620	316	100	16.6	0.67	22	32	5.653
8	12/30/2014	N	BF	8.10	1.4	10.51	0.5	5.14	5.8	869	478	0	4.3	0.06	2	4	3.182
8	1/28/2015	N	BF	7.94	0.9	10.76	0.3	2.79	9.5	637	350	0	2.3	0.05	1	3	1.837
8	2/27/2015	N	BF	7.87	0.8	11.17	0.9	8.06	3.9	645	355	0	1.7	0.05	1	3	1.131
8	3/25/2015	Y	BF	8.11	5.7	9.41	0.9	9.56	12.3	672	370	250	2.5	0.11	2	3	2.673
			Average	7.86	9.24	7.765	1.27	21.192	10.5	675.5	355.8	465	3.9	0.322	10.9	13	2.1292

Table 9: Site 8 data.

Site 9

Site 9 (Figure 8) is a bridge on Carrol Creek located on S300 W57 just south of SR 33. This site was moved 1 miles east of the original location due to safety concerns from heavy vehicle traffic.

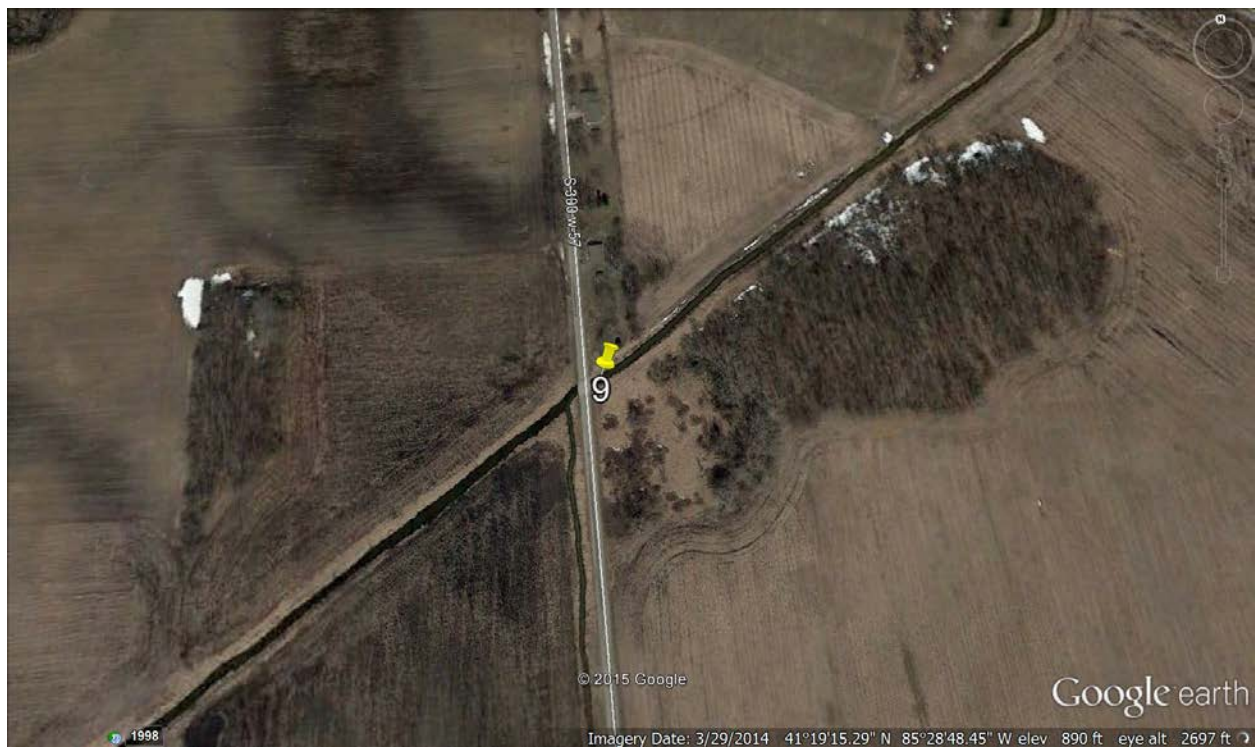


Figure 8: Site 9 location.

Table 10 shows Site 9 data with nitrates-nitrites exceeding the target threshold 11 times or 91.66% of the total samples taken, followed by total phosphorus exceeding 3 times or 25%,

turbidity 2 times or 16.66%, and total suspended solids exceeding 1 time or 8.33% of total samples collected. Turbidity and total suspended solids high numbers occurred during rain events along with most of the nutrient loading. Fields along this ditch had little or no buffering which was likely a major contributor of NPS pollutants found in the samples. Livestock operations were not found to be a major contributor.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	Escherichia coli	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cfs
9	4/23/2014	Y	WW	7.95	10.1	8.91	1.2	13.13	12.2	677	345	0	4.1	0.14	0	8	6.851
9	5/29/2014	Y	WW	7.83	19.5	6.20	2.8	45.16	10.0	648	330	200	4.9	0.31	10	17	4.455
9	6/27/2014	Y	WW	7.71	21.1	5.89	0	0	5.9	664	339	100	0.1	0.24	9	11	5.054
9	7/29/2014	N	BF	7.77	15.4	9.52	4.1	42.86	6.4	716	365	200	1.5	0.29	6	5	3.402
9	8/27/2014	Y	BF	7.71	19.7	6.02	0	0	21.4	755	385	0	2.0	0.30	16	10	2.426
9	9/25/2014	N	BF	7.92	12.6	8.21	0	0	12.2	747	381	0	1.5	0.17	4	10	2.032
9	10/29/2014	N	BF	8.00	9.5	8.47	1.0	12.28	9.7	762	389	50	2.1	0.14	2	5	2.268
9	11/24/2014	Y	WW	7.49	9.5	7.43	6.2	83.45	23.2	525	268	0	13.4	1.13	56	73	80.899
9	12/30/2014	N	BF	8.08	2.1	10.97	1.4	12.79	8.7	740	407	0	3.1	0.07	3	7	6.728
9	1/28/2015	N	BF	7.99	1.5	11.07	1.1	9.94	8.3	657	361	0	2.1	0.06	1	4	4.921
9	2/27/2015	N	BF	7.98	1.1	11.35	0.9	7.93	5.7	623	343	0	1.7	0.06	1	2	3.904
9	3/25/2015	Y	BF	7.79	6.1	9.87	0.8	8.11	12.1	675	371	100	3.3	0.11	2	3	4.357
Average				7.851667	10.68333	8.659167	1.625	19.6375	11.31667	682.4166667	357	54.166667	3.316667	0.25166667	9.166667	12.9166667	10.60808

Table 10: Site 9 data.

Site 10

Site 10 (Figure 9) is a bridge on Black Ditch on West Albion Road approximately one half mile west 350N. This stretch has heavy riparian buffer along with marsh and swamp.

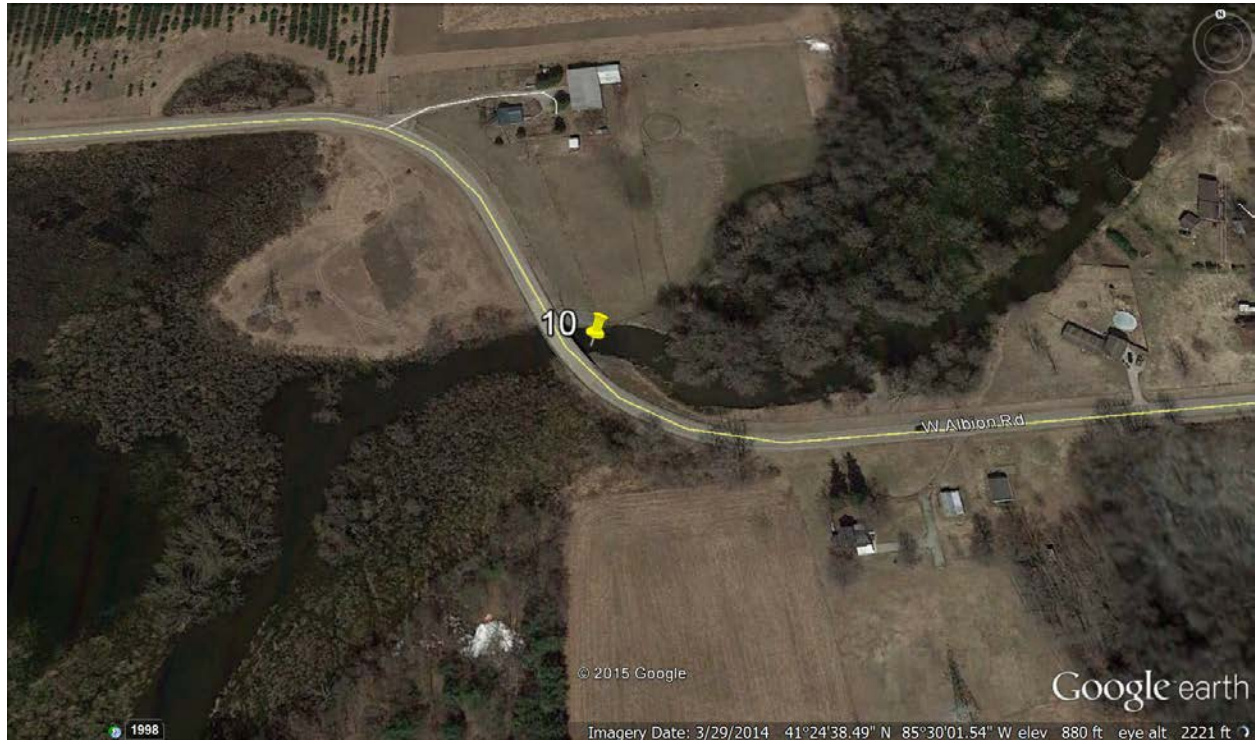


Figure 9: Site 10 location.

Table 11 shows Site 10 data with nitrates-nitrites exceeding the target threshold 5 times or 41.66% of the total samples taken, followed by total phosphorus exceeding 4 times or 33.33%, and total suspended solids and *E.coli* each exceeding the threshold 1 time or 8.33% of the total samples collected. The higher numbers are likely from lateral ditch input that have livestock influence. Black Ditch site may have some input from septic systems directly upstream.

Site Number	Date	Did it rain within 48 hrs. of sampling? (Y/N)	Baseflow or Wet Weather Flow (BF or WW)	pH	Temp °C	Dissolved oxygen mg/l	BOD mg/l	BOD %	Chlorides mg/l	Conductivity µS/CM	Total Dissolved Solids mg/l	<i>Escherichia coli</i>	Nitrate-Nitrite mg/l	Total Phosphorus mg/l	Turbidity ntu	Total Suspended Solids-mg/l	Flow cf/s
10	4/23/2014	Y	WW	7.88	12.2	7.89	2.2	28.26	12.1	554	283	0	1.5	0.32	10	34	70.389
10	5/29/2014	Y	WW	7.81	23.4	5.67	2.9	51.50	12.2	544	277	300	2.9	0.19	3	6	29.059
10	6/27/2014	Y	WW	7.72	24.2	4.07	2.0	47.91	17.0	576	294	100	0.1	0.76	3	4	13.986
10	7/29/2014	N	BF	7.74	19.0	3.72	1.6	42.47	6.4	565	288	50	1.3	0.48	3	2	25.378
10	8/27/2014	Y	BF	7.84	22.3	3.29	0.4	12.77	7.0	587	299	0	1.0	0.49	1	2	19.391
10	9/25/2014	N	BF	8.01	16.4	5.49	0	0	4.6	597	304	0	2.4	0.24	0	3	26.640
10	10/29/2014	N	BF	8.07	11.8	7.22	1.0	13.99	3.3	609	311	0	1.3	0.21	0	1	32.130
10	11/24/2014	Y	WW	7.89	7.5	8.26	2.9	35.47	13.6	615	314	100	5.2	0.26	8	18	116.748
10	12/30/2014	N	BF	8.25	0.15	11.68	2.3	20.03	3.1	633	348	0	2.3	0.14	2	6	98.500
10	1/28/2015	N	BF	8.27	1.1	12.19	1.5	12.31	7.2	521	287	0	1.3	0.09	1	2	81.471
10	2/27/2015	N	BF	8.21	1.1	12.44	0.7	5.63	2.8	555	305	50	1.1	0.04	2	3	75.273
10	3/25/2015	Y	BF	8.12	6.6	10.46	1.2	11.47	12.5	586	322	100	1.1	0.21	2	3	78.149
Average				7.984167	12.14583	7.698333	1.558333	23.48417	8.483333	578.5	302.6667	58.333333	1.791667	0.28583333	2.916667	7	55.59283

Table 11: Site 10 data.

Summary

Overall, this is a brief summary of data collected during Phase I. A much more detailed statistical analysis will be presented after collection of Phase II data. This report is intended to demonstrate there is a contamination problem in the headwater regions of the Elkhart river system. It is apparent that the lake systems are playing a major role in containing a significant amount of the NPS problem, but it is certainly to their degradation.

Phase II has begun with two sampling cycles completed to date. The data to date demonstrates the middle portion of the Elkhart River drainage to be much cleaner than the heavily livestock influenced headwaters. The major agricultural component at Phase II sites is large grain field operations with buffered field along lateral ditch systems. Figure 10 shows the location of Phase II test sites and Figure 11 shows sites imposed over HUC 10 Subwatersheds. Below are Phase II site locations descriptions:

SJRBCWQ Site 011— North Branch Elkhart River (Bridge at 300W south of 900N, Noble Co.)

SJRBCWQ Site 012— Huston Ditch (Bridge at 300W south of 800N, Noble Co.)

SJRBCWQ Site 013— North Branch Elkhart River (Bridge at 450W south of 850N, Noble Co.)

SJRBCWQ Site 014— South Branch Elkhart River (Bridge at US6 west of 450W, Noble Co.)

SJRBCWQ Site 015— South Branch Elkhart River (Bridge at 600N west of 350W, Noble Co.)

SJRBCWQ Site 016— Sparta Lake Ditch (Culvert at 650N east of SR33, Noble Co.)

SJRBCWQ Site 017— Solomon Creek (Bridge at Cromwell Road east of 775W, Noble Co.)

SJRBCWQ Site 018— Solomon Creek (Bridge at 1050W north of 550N, Noble Co.)

SJRBCWQ Site 119— Elkhart Creek (Bridge at 100W north of 950N, Noble Co.)

SJRBCWQ Site 020— Solomon Creek (Bridge at CR50 east of CR35, Elkhart Co.)

SJRBCWQ Site 021— Dry Run (Bridge at CR33 south of SR33, Elkhart Co.)

SJRBCWQ Site 022— Whetten Ditch (Culvert at CR127 south of CR46, Elkhart Co.)

SJRBCWQ Site 023— Kieffer Ditch (Culvert at CR23 north of SR6, Elkhart Co.)

SJRBCWQ Site 024— Omar Neff Ditch (Bridge at 1250N east of 300W, Kosciusko Co.)

SJRBCWQ Site 025— UNT025 (Culvert at 1250N east of site 24, Kosciusko Co.)

SJRBCWQ Site 026— Coppes Ditch (Culvert at 1250N east of site 25, Kosciusko Co.)

SJRBCWQ Site 027— Turkey Creek (Bridge at 1250N east of site 26, Kosciusko Co.)

SJRBCWQ Site 028— Coppes Ditch (Culvert at 900N west of SR15, Kosciusko Co.)

SJRBCWQ Site 029— Unnamed Tributary 029 (Culvert at Old SR15 south edge of Milford, Kosciusko Co.)

SJRBCWQ Site 030— Turkey Creek (Bridge at 250E south of 1400N, Kosciusko Co.)

Please feel free to contact me at any time concerning information in this report or the sampling process currently under way.

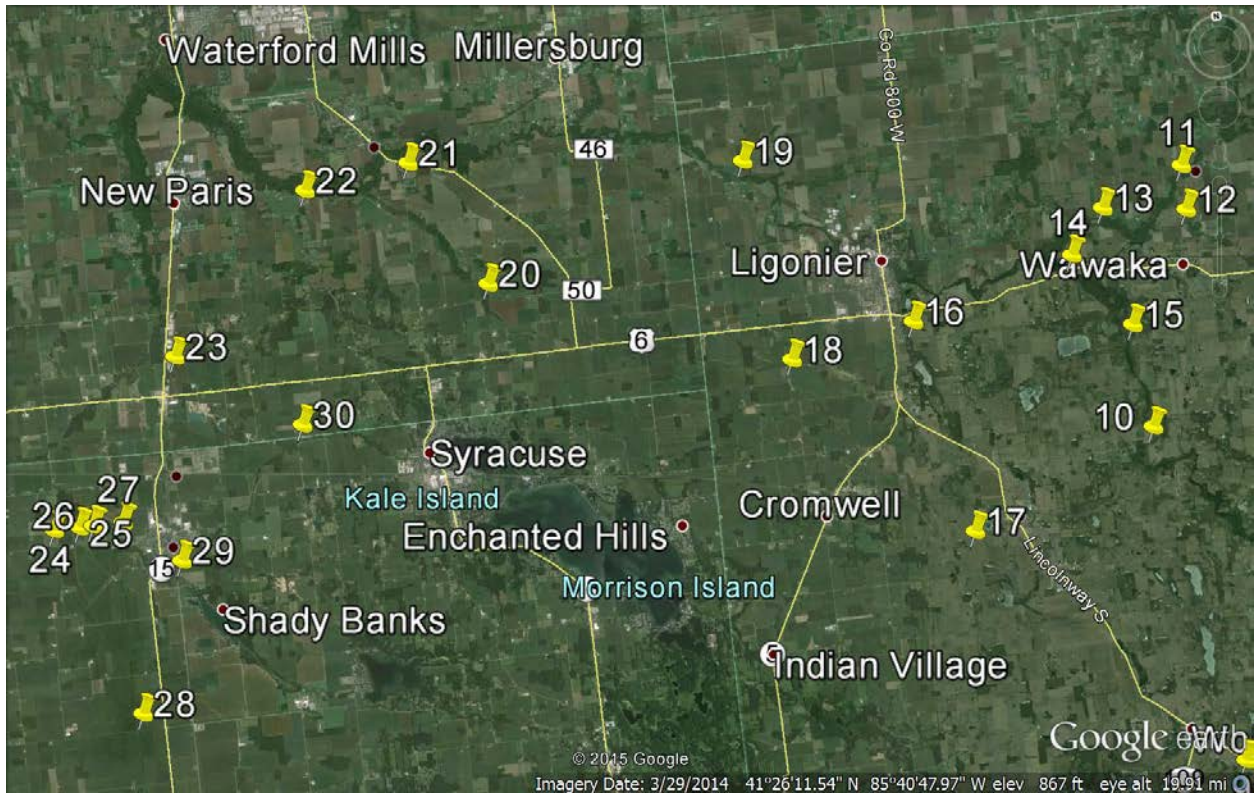


Figure 10: Phase II test site locations numbered 11-30.

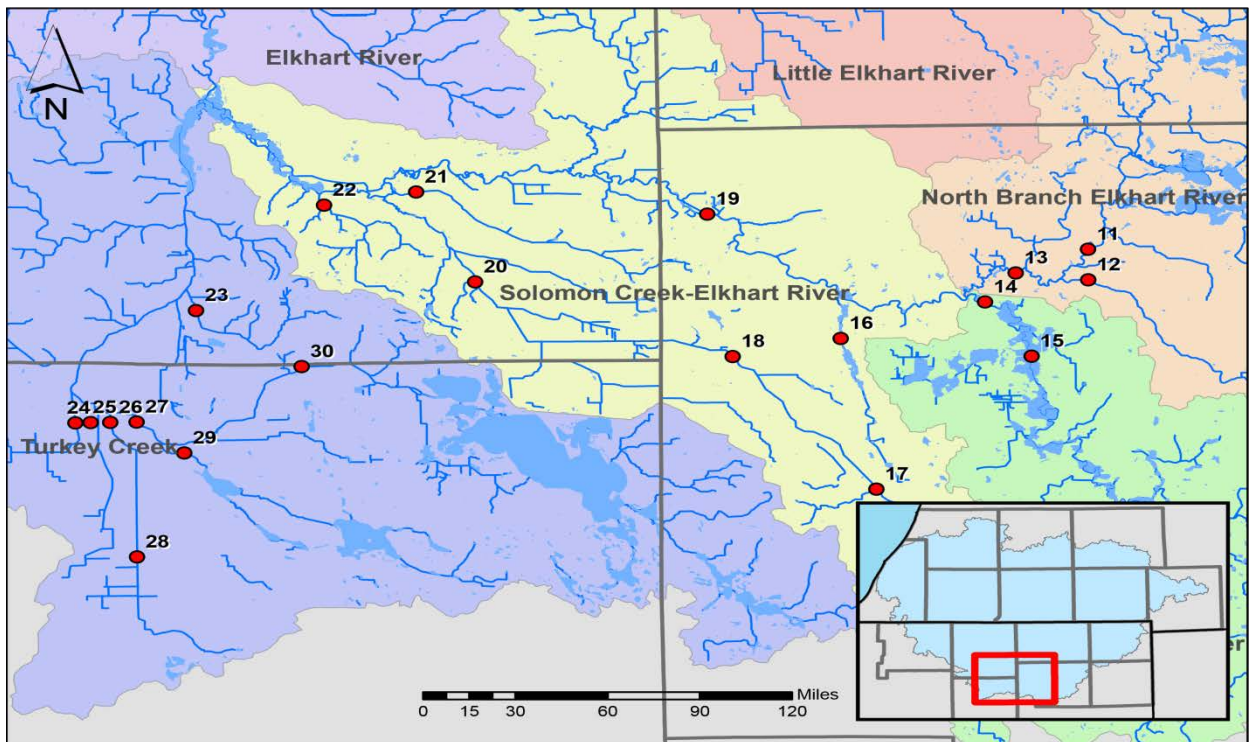


Figure 11: Phase II test sites imposed over HUC Subwatersheds.