SECTION 2: IDENTIFY PROBLEMS AND CAUSES OF POLLUTION

Stakeholder Concerns from Initial Public Meeting

To address the concerns of stakeholders in the Sugar Creek Watershed, the Steering Committee began by identifying the major stakeholder groups within the Watershed; individuals who best represented those stakeholder groups; and identified a current Steering Committee member that would be responsible for presenting individuals a personal invitation to attend a meeting on the Sugar Creek Watershed. A list of identified stakeholder groups is included in Appendix A. A representative from each of the stakeholder groups was invited to a meeting on May 14, 2007 to discuss the watershed planning process, to begin gathering information on concerns people had related to Sugar Creek and its watershed, and to solicit volunteers to help with different aspects of the planning and implementation process.

Following the success of this initial meeting, an open public meeting was held on October 11, 2007 to convey this information to all interested stakeholders in the watershed. At this meeting, stakeholders were informed of the watershed planning process, updated on where the Steering Committee was in the process, and given the opportunity to provide suggestions of priority resource concerns in the watershed. Over 40 people attended this meeting. Overall the meeting was successful and individuals volunteered for various portions of the planning and implementation process. Specific concerns were taken verbatim from the stakeholders and later listed in categories by Steering Committee members to aid in understanding the issues. The priority resource concerns that were identified at the public meeting are listed as follows.

Agricultural Issues:

- Drainage – need to maintain proper drainage for farming
- Log Jams – issues related to proper drainage
- Beaver – damming up drainage ways
- Flooding Impacts

Pollution Issues:

- Wildlife Effects on Water Quality
- Streambank Erosion – sediment and associated nutrients
- Trash/Illegal dumping
- Water Clarity
- Health Issues with bacteria – is it safe to swim and fish in Sugar Creek?
- Fish Consumption Advisories
- Cattle in the stream –health issues (*E. coli* etc.)

Development/Urban Issues:

- Land Use Changes – increased urbanization
- Stormwater Management
- Flooding Impacts

Recreational Issues:

- Log Jams – issues related to canoeing
- Beaver – desired for wildlife viewing
- Canoeing and fishing, swimming (is it safe- bacterial problems)
- Identify hunter-friendly farms

Wildlife/Habitat Issues:

- Proper Wildlife Management – balance of diversity
- Sandbars (erosion and hydrologic modification)
- Habitat and Wildlife preservation, conservation
- Cattle in the stream – destruction of habitat

Other Issues and Concerns:

- Streams are more wide and shallow – what is the cause?
- Changes in weather patterns – effect on watershed
- Land Use Changes – Large Farms converted to Mini Farms
- Greenways along the river – desire to create parks and work through private property issues
- Finances – how do we pay for the changes that need to be made?
- Preservation – acquire land along streams from willing sellers

As part of the Sugar Creek Watershed management planning process, the concerns listed above from the public meeting held on October 11, 2007 will be evaluated as more information and data are gathered. The collection and analysis of the information/data will validate or invalidate some of the concerns as well as identify some of the listed concerns as not capable of being addressed under the proposed scope of this watershed management plan.

Windshield Survey Review

A windshield survey is a type of watershed assessment conducted via a motorized vehicle at stream crossings and accessible locations where real time data was collected. During Fall 2007 and Spring 2008, the Steering Committee volunteers, and employees of the Hancock County Soil and Water Conservation District conducted a windshield survey at 33 site locations within the Sugar Creek Watershed (Exhibit 15).

Evidence of problems identified in the Sugar Creek Watershed as a result of the windshield survey data include, but are not limited to:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where field drain tiles discharge into Sugar Creek or its tributaries
- Areas where vegetated buffer is lacking along a waterway within the Watershed

The windshield survey data results (Appendix B) provided concrete evidence that many of the Stakeholders concerns, expressed at the initial public meeting and beyond, exist within the Sugar Creek Watershed and need to be addressed in this watershed management plan. Table 13a demonstrates the number of windshield survey stations observed to have the previously listed problems from both the fall 2007 and spring 2008 surveys.

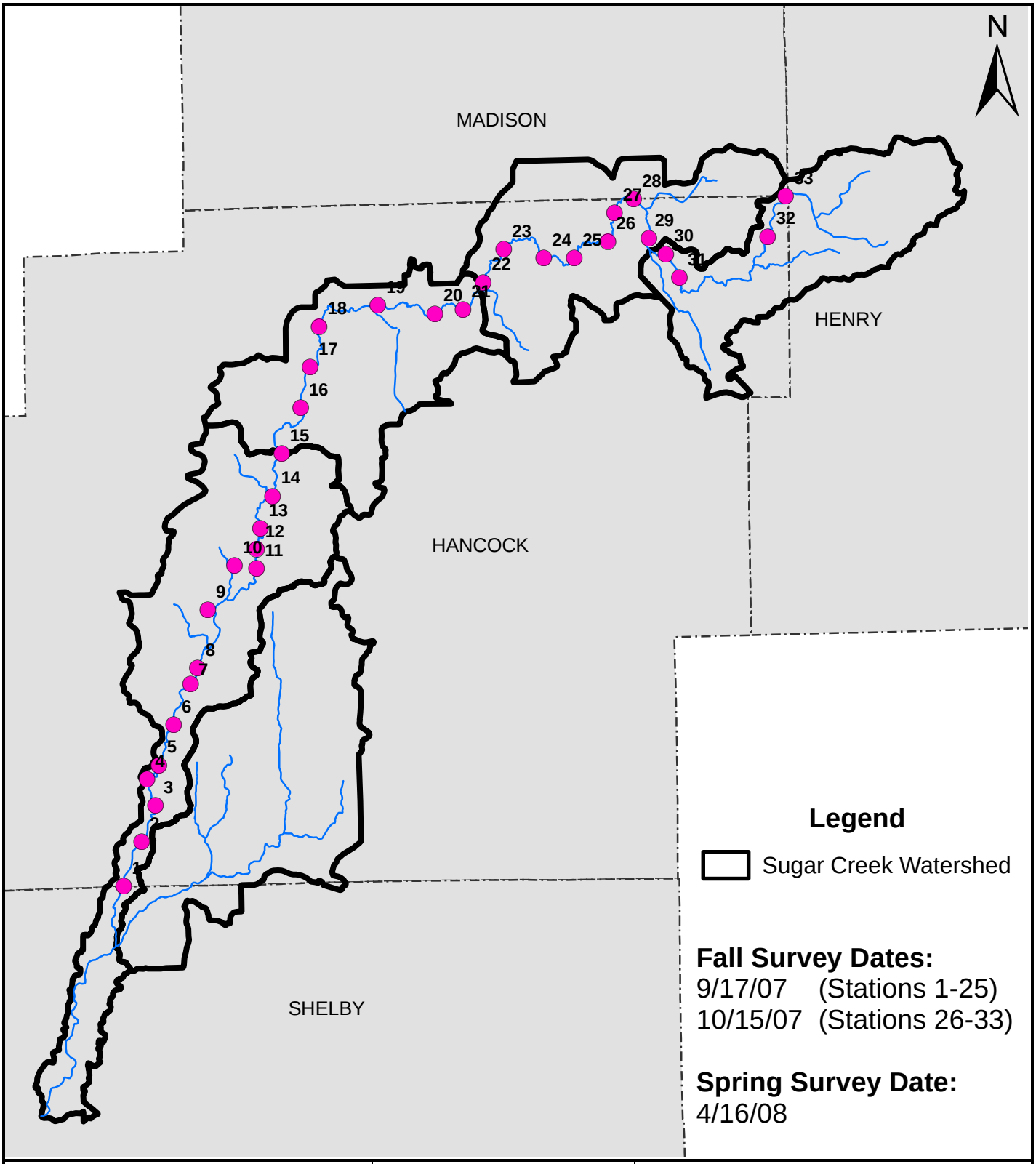
Table 13a. Windshield Survey Summary by Problem for 2007 and 2008

Observed Watershed Problem	Fall 2007 Survey Results		Spring 2008 Survey Results	
	Total Number	Percent	Total Number	Percent
Areas of sedimentation	8	24%	12	36%
Log jams	7	21%	9	27%
Bank protection and stabilization needed	9	27%	11	33%
Excessive streambank erosion	9	27%	11	33%
Flooding	2	6%	6	18%
Livestock have direct stream access	10	30%	17	52%
Stagnant water	4	12%	4	12%
Excessive trash and debris	9	27%	11	33%
Septic system pipes	1	3%	5	15%
Field drain tile discharge	0	0	5	15%
Needs vegetated buffer along stream	0	0	1	3%

Relating subwatersheds to problems and causes from the windshield survey data results, *E. coli* demonstrates the most significant problem within the Pee Dee Ditch subwatershed with up to 75% of the 2007 and 100% of the 2008 stations observing livestock having direct access to the stream. Sedimentation and erosion problems are most significant within the Pee Dee Ditch subwatershed as well, as up to 50% of the stations observed areas of sedimentation, log jams, need for bank protection/stabilization, and excessive streambank erosion. Nutrient problems are linked to animal excrement and the attachment of phosphorus and nitrogen to fine particles within sediment, therefore, the Pee Dee Ditch subwatershed also contributes to the most significant nutrient problem within the Sugar Creek Watershed. The windshield survey summary data listed by problems and the percent of subwatershed observation stations is shown in Table 13b.

Table 13b. Windshield Survey Problems by Subwatershed for 2007 and 2008

Observed Watershed Problem	Percent contributions of stations in 2007 & 2008, respectively			
	Pee Dee Ditch	Marsh/Tree Ditch	Barrett Ditch	Boyd Ditch
Areas of sedimentation	25% / 50%	11% / 22%	33% / 33%	28% / 43%
Log jams	25% / 50%	33% / 33%	0 / 0	21% / 28%
Bank protection and stabilization needed	25% / 50%	33% / 33%	17% / 17%	28% / 36%
Excessive streambank erosion	25% / 50%	33% / 33%	17% / 17%	28% / 36%
Flooding	0 / 0	11% / 33%	0 / 17%	7% / 14%
Livestock have direct stream access	75% / 100%	44% / 56%	33% / 50%	7% / 36%
Stagnant water	25% / 25%	33% / 33%	0 / 0	0 / 0
Excessive trash and debris	25% / 0	33% / 44%	17% / 17%	28% / 43%
Septic system pipes	0 / 0	0 / 11%	0 / 17%	7% / 21%
Field drain tile discharge	0 / 75%	0 / 22%	0 / 0	0 / 0
Needs vegetated buffer along stream	0 / 0	0 / 0	0 / 0	0 / 7%



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Title: **Windshield Survey Locations**		Project: **Sugar Creek Watershed Project**	
Base Layer: N/A	Project No. 07065	Exhibit: 15	Sheet: 1 of: 1
Client: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	Quadrangle: N/A	Date: 9/5/07	Scale: NTS

Summary of Information and Data (Establish Baseline)

On December 12, 2007 and January 10, 2008, the Sugar Creek Watershed's Steering Committee discussed the water quality parameters of concern, and the general locations that the contributions from these pollutants were most prominent. Eight members of the steering committee, one representative of IDEM and two representatives of V3 evaluated the historic Total Maximum Daily Load (TMDL) water quality data sets collected by IDEM within the Sugar Creek Watershed. The exceedances of *E. coli* from the IDEM TMDL studies of 2002 and 2007 were presented. V3 used eight sampling stations to sample water quality, habitat, and macroinvertebrates in 2007 and 2008 (Table 14). All of the data, both historic and current, was depicted on a large Sugar Creek Watershed map for use by the steering committee.

In addition to the data presented by V3 to the steering committee on December 12, 2007 and January 10, 2008, the windshield survey results were also presented by the Hancock County SWCD and analyzed by the group. The windshield survey data was collected by members of the Steering committee and representatives of the Hancock County SWCD.

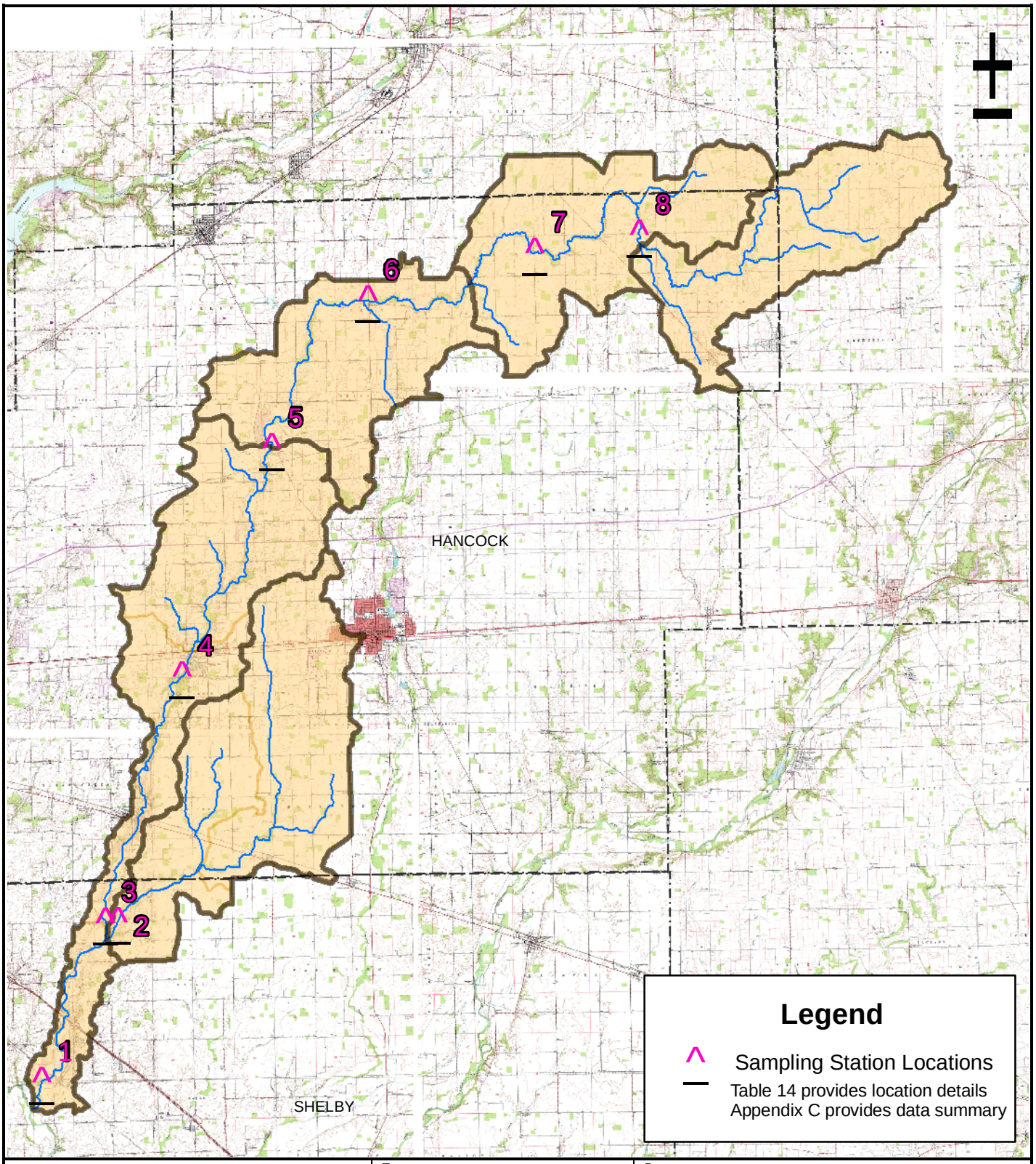
Collection and Analysis of Biological, Habitat, and Water-quality Information

Evaluation Methods

As part of the Sugar Creek WMP process, eight stations in the Sugar Creek Watershed were evaluated for macroinvertebrate communities, habitat, and water chemistry. Water chemistry parameter summary tables are included in Appendix C. These eight sampling locations were chosen for sampling in 2007 and 2008 based on access locations from bridge crossings and spatial locations throughout the watershed that would provide information for the entire Sugar Creek Watershed (Exhibit 16, Table 14). Station photographs are located in Appendix D. Macroinvertebrates were sampled on June 4 and 5, 2007, October 15 and 16, 2007, July 21 and 22, 2008, and October 6, 2008. The habitat evaluation was conducted in June and October 2007, and July and October, 2008. Water Chemistry was sampled for a period of one year which occurred on a monthly basis. Monthly water quality sampling started in June, 2007 and ended in May, 2008.

Table 14. V3 Water Chemistry, Habitat, and Macroinvertebrate Sampling Station Locations for 2007 and 2008

Station #	ID Number	Stream Name	Latitude	Longitude	Location	County
1	SC01	Sugar Creek	39.624967	-85.92965	East of Woodnotes and CR 700 N	Shelby
2	SC02	Little Sugar Creek	39.682733	-85.892867	East of 600 W and CR 1100 N	Shelby
3	SC03	Sugar Creek	39.682717	-85.898717	West of 600 W and CR 1100 N	Shelby
4	SC04	Sugar Creek	39.772133	-85.861117	East of 400 W and 200 S	Hancock
5	SC05	Sugar Creek	39.855000	-85.187000	West of N Fortville Pike and CR 500 N	Hancock
6	SC06	Sugar Creek	39.908083	-85.770883	North of SR 234 and Highway 9	Hancock
7	SC07	Sugar Creek	39.92455	-85.691550	South of CR 1000 N and CR 600 E	Hancock
8	SC08	Sugar Creek	39.930533	-85.642100	West of SR 109 and CR 1000 N	Hancock



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TITLE: **V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 16	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS

Biological Evaluation Explanation

The IBI, or Index of Biotic Integrity, is composed of 12 different metrics that are used to evaluate the quality of the fish community. The IBI takes into consideration species, trophic composition (feeding and reproductive guilds), and the overall health of the fish community. The total IBI score and associated integrity class help compare the quality of one site to another, and provide a way to categorize the quality of a particular section of the river or stream. Table 15 shows the IBI scores developed by Karr et al. (1986). Although this evaluation indicates the overall health of the aquatic system, it does not specify the cause or causes of the impairment.

Table 15 IBI Scores Developed for Indiana

Total IBI Score	Integrity Class	Attributes
57-60	Excellent	Comparable to "least impacted" conditions, exceptional assemblage of species.
48-52	Good	Decreased species richness (intolerant species in particular), sensitive species present.
40-44	Fair	Intolerant and sensitive species absent, skewed trophic structure.
28-34	Poor	Top carnivores and many expected species absent or rare, omnivores and tolerant species dominant.
22-12	Very Poor	Few species and individuals present, tolerant species dominant, diseased fish frequent.
<12	No Fish	No fish captured during sampling.

Source: Karr et al. (1986)

Macroinvertebrate monitoring followed IDEM's macroinvertebrate Index of Biotic Integrity (mIBI) for the single habitat approach (personal communication from Steve Newhouse of IDEM on 11/20/2007). The single habitat approach involves sampling riffle/run areas within the sampling reach. A composite sample should be made from two kick samples (2 m^2). The sample is collected by using a one meter wide kick net with 500 µ opening mesh. A kick net is comprised of hemmed sides for poles and a reinforced bottom seam for anchoring while sampling. One person stands downstream holding the kick net in front of them, while another person disturbs a 1 m^2 area upstream of the net by using the heel or toe of the their boot to dislodge the material in the streambed. Larger substrate should be picked up and rubbed by hand to dislodge the organisms that are attached to the rocks. A one-hundred individual sub-sample should be used in order to analyze the data. The collected organisms are sorted at V3 and identified to the family level using appropriate field guides. In addition, macroinvertebrate vouchers are sent to Purdue University to verify that all taxon identifications are correct. Vouchered specimens and correspondence with Purdue is included

in Appendix E. The collection procedure provides representative macroinvertebrate fauna from riffle/run substrate in the sampling reach.

The mIBI uses ten metrics which evaluate a macroinvertebrate community's species richness, evenness, composition, and density within the stream. These metrics include the family-level HBI (Hilsenhoff Biotic Index), number of taxa, number of individuals, Percent Dominant Taxa, EPT index, EPT count, EPT count to total number of individuals, EPT count to Chironomid count, Chironomid count, and number of individuals per number of squares sorted. (EPT stands for the *Ephemeropteran*, *Plecopteran*, and *Trichopteran* orders). These metrics are shown in Table 16. Each metric is scored from 0 – 8 where 8 is the highest quality. All metrics are added together and averaged to get a station score. A final score of 0 – 2 is a severely impaired stream, 2 – 4 is moderately impaired, 4 – 6 is slightly impaired and 6 – 8 is not impaired for biological quality.

Table 16 Scoring Criteria for mIBI

	Scoring				
	0	**2**	**4**	**6**	**8**
	Severely Impaired	**Moderately Impaired**	**Slightly Impaired**	**Not Impaired**	
HBI	≥ 5.63	5.06 - 5.62	4.55 - 5.05	4.09 - 4.54	≤ 4.08
Number of Taxa	≤ 7	8 -10	11 – 14	15 - 17	≥ 18
Number of Individuals	≤ 79	80 - 129	130 – 212	213 - 349	≥ 350
Percent Dominant Taxa	≥ 61.6	43.9 - 61.5	31.2 - 43.8	22.2 - 31.1	≤ 22.1
EPT Index	≤ 2	3	4 – 5	6 - 7	≥ 8
EPT Count	≤ 19	20 - 42	43 – 91	92 - 194	≥ 195
EPT To Total Number	≤ 0.13	0.14 - 0.29	0.30 - 0.46	0.47 - 0.68	≥ 0.69
EPT to Chironomid	≤ 0.88	0.89 - 2.55	2.56 - 5.70	5.71 - 11.65	≥ 11.66
Chironomid Count	≥ 147	55 - 146	20 – 54	7 - 19	≤ 6
Total Number To Number of Squares Sorted	≤ 29	30 - 71	72 – 171	172 - 409	≥ 410

Biological Evaluation Methodologies

An explanation of key benthic macroinvertebrate evaluations is summarized as follows:

Richness Measures

Total number of distinct taxa is a measure of the diversity within the sample. This value generally increases with increasing water quality, habitat diversity, and habitat suitability.

Total number of EPT taxa summarizes the richness of the benthic macroinvertebrate community within the taxa groups that are generally considered pollution sensitive and will generally increase with increasing water quality. This metric is the total number of distinct taxa within the groups Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly).

Composition Measures
Percent Contribution of Dominant Taxa uses the abundance of the numerically dominant taxa relative to the total number of organisms as an indication of community balance. This value will decrease as water quality, habitat diversity and habitat suitability improve.

The ratio of EPT (mayflies, stoneflies and caddisflies) and Chironomidae (midges) reflects good biotic condition if the sensitive groups (EPT's) demonstrate a substantial representation. If the Chironomidae have a disproportionately large number of individuals in comparison to the sensitive groups then this situation is indicative of environmental stress.

Tolerance/Intolerance Measures
Tolerance/intolerance measures are intended to be representative of relative sensitivity to perturbation. Tolerance is generally non-specific to the type of stressor. However, metrics such as the Hilsenhoff Biotic Index are oriented toward the detection of organic pollution.

The Hilsenhoff Biotic Index (HBI) was developed to detect organic pollution and is based on the family level index developed by William Hilsenhoff in 1988. Pollution tolerance values range from 0 to 10 and increase as water quality decreases. The lower the HBI, the greater the number of pollution intolerant species. A population of benthic macroinvertebrates that poses a lower HBI value is indicative of higher water quality.

V3 Biological Evaluation 2007 Results

V3 identified all macroinvertebrate specimens to family level after collecting all the field data. Appendix E includes a table that shows how many of each family were found at each station. V3 sent 49 voucher specimens of macroinvertebrates to Purdue University, Department of Entomology to be verified by Arwin Provonsha. Representative photographs of the macroinvertebrates arranged by vial and a copy of the letter sent to Purdue are located in Appendix E. V3 used the mIBI to analyze macroinvertebrates. Table 16 shows the ten metrics and scoring ranges for each. Macroinvertebrate data was taken at all stations in spring and fall of 2007. The raw macroinvertebrate data and the mIBI scoring for stations in both sampling events in 2007 are located in Exhibit 17 and Tables 17a - d respectively.

Table 17a Results From Spring Macroinvertebrate Sampling June 4 and 5, 2007

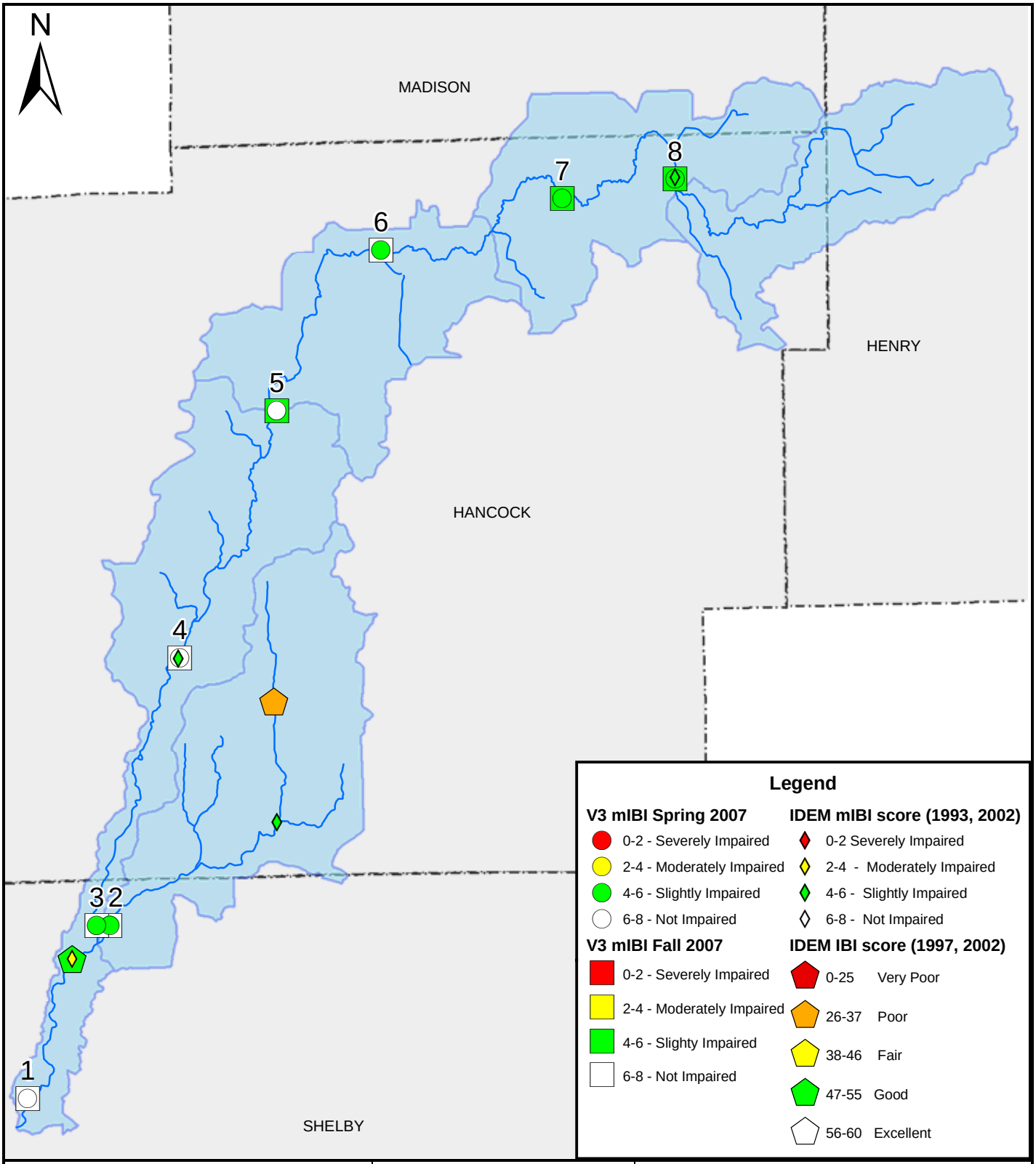
	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	3.85	5.299	4.611	3.888	4.163	5.154	4.522	4.95
Number of Taxa	21	19	18	25	26	24	25	15
Number of Individuals	142	134	137	156	158	139	182	148
Percent Dominant Taxa	27.5	19.4	20.4	19.9	17.1	18.7	13.2	23.6
EPT Index	8	6	7	10	10	6	8	4
EPT Count	100	59	74	82	90	43	71	69
EPT to Total Number	0.704	0.44	0.54	0.526	0.57	0.309	0.39	0.466
EPT to Chironomid	7.692	1.513	3.7	9.111	5.294	1.132	1.69	2.091
Chironomid Count	13	39	20	9	17	38	42	33
Total Number of Individuals/Number of Squares Sorted	72.5	134	34.25	78	79	69.5	60.67	49.33

Table 17b mIBI Scoring for Spring Macroinvertebrate Sampling June 4 and 5, 2007

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	8	2	4	8	6	2	6	4
Number of Taxa	8	8	8	8	8	8	8	6
Number of Individuals	4	4	4	4	4	4	4	4
Percent Dominant Taxa	6	8	8	8	8	8	8	6
EPT Index	8	6	6	8	8	6	8	4
EPT Count	6	4	4	4	4	4	4	4
EPT to Total Number	8	4	6	6	6	4	4	4
EPT to Chironomid	6	2	4	6	6	2	2	2
Chironomid Count	6	4	4	6	6	4	4	4
Total Number of Individuals/Number of Squares Sorted	4	4	2	4	4	2	2	2
Station mIBI Score	6.40	4.60	5.00	6.20	6.00	4.40	5.00	4.00

Table 17c Results From Fall Macroinvertebrate Sampling October 15, 16 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	4.058	4.361	4.012	3.908	4.148	4.044	4.494	5.866
Number of Taxa	17	19	19	23	19	24	17	19
Number of Individuals	169	184	201	160	191	192	174	155
Percent Dominant Taxa	36.1	55.4	34.3	22.5	25.7	33.9	29.9	45.2
EPT Index	7	7	8	7	7	7	7	7
EPT Count	128	139	145	108	134	136	113	100
EPT to Total Number	0.757	0.755	0.721	0.675	0.702	0.708	0.649	0.645
EPT to Chironomid	128/0	27.8	24.167	54	10.308	45.333	4.52	100/0
Chironomid Count	0	5	6	2	13	3	25	0
Total Number of Individuals/Number of Squares Sorted	84.5	92	100.5	80	63.67	86	87	51.67

Table 17d mIBI Scoring for Fall Macroinvertebrate Sampling October 15, 16 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	8	6	8	8	6	8	6	0
Number of Taxa	6	8	8	8	8	8	6	8
Number of Individuals	4	4	4	4	4	4	4	4
Percent Dominant Taxa	4	2	4	6	6	4	6	2
EPT Index	6	6	8	6	6	6	6	6
EPT Count	6	6	6	6	6	6	6	6
EPT to Total Number	8	8	8	6	8	8	6	6
EPT to Chironomid	8	8	8	8	6	8	4	8
Chironomid Count	8	8	8	8	6	8	4	8
Total Number of Individuals/Number of Squares Sorted	4	4	4	4	2	4	4	2
Station mIBI Score	6.20	6.00	6.60	6.40	5.80	6.40	5.20	5.00



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TITLE: **IBI and mIBI Scores (V3 2007 Data and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 17	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS

V3 Biological Evaluation 2007 Results Discussion

Station 1 had a slightly higher spring score (6.4) than fall (6.2). Station 1 was not impaired for either sampling. The Number of Individuals and Total Number of Individuals to Number of Squares Sorted metrics were slightly impaired for both samplings. Percent Dominant Taxa was also slightly impaired during the fall sampling. 36 percent of the fall sampling consisted of web spinning caddisflies, which are desirable to have in the stream.

Station 2 had a higher fall score (6.0) than spring (4.6). The spring sampling was slightly impaired, while the fall sampling was not impaired. The main reason for this is that during the spring sampling 39 chironomids were found compared to 5 in the fall. This reduced the scores of Chironomid Count, EPT to Chironomid, and the HBI metrics. The other factor was that 59 EPTs were found in the spring and 139 were found in the fall. This caused the HBI, EPT Count, EPT to Total Number, and EPT to Chironomid ratio to have lower scores.

Station 3 was slightly impaired in the spring (5.0) and not impaired in the fall (6.6). Station 3 follows the trend of having impairments due to increased chironomids and decreased EPTs during the spring. All stations followed this trend. In some stations (Station 2 for instance) the difference was dramatic from spring to fall while others (Station 4) did not have metric stores influenced much by the difference.

Along with Station 1, Station 4 had the highest average score. Station 4 was not impaired for the spring (6.2) or the fall sampling (6.4). The only metrics that were slightly impaired were Number of Individuals, Total Number of Individuals to Number of Squares Sorted, and EPT Count (spring only).

Station 5 was not impaired during the spring (6.0) and slightly impaired during the fall (5.8). The main difference was that several of the metrics were lower in the fall including Percent Dominant Taxa, EPT Index, EPT to Total Number, and Total Number of Individuals to Number of Squares Sorted. The Dominant Taxa was the web spinning caddisfly. Overall, the differences from spring to fall at station 5 were very small.

Station 6 was slightly impaired during the spring (4.4) and not impaired during the fall (6.4). There were several metrics that decreased significantly from spring to fall. HBI and EPT to Chironomid Count were both moderately impaired in the spring (2.0) and not impaired in the fall (8). A large portion of this is caused by 38 chironomids collected in the spring and 3 in the fall. Also, 43 EPTs were collected in the spring and 136 EPTs were collected in the fall.

Station 7 was slightly impaired for both samplings, but increased slightly from spring (5.0) to fall (5.2). This station was moderately impaired during the spring for EPT to Chironomid and Total Number of Individuals to Number of Squares Sorted.

Station 8 had the lowest mIBI score for both samplings. Both sampling events were slightly impaired with the spring (4.0) being lower than fall (5.0). The HBI (5.87) scored a 0 during the fall and was severely impaired. During the fall the dominant taxa was a type of mayfly in the family Caenidae. They made up 45 percent of the sample and have a HBI rating of 7. This is one of the main reasons for the low fall score. In the spring sampling, there were 33 chironomids found and 69 EPTs found. This caused many of the metrics to have a low score. Overall, the habitat at this station was more silty and conducive to macroinvertebrates with high tolerance values.

V3 Biological Evaluation 2008 Results

V3 sampled macroinvertebrates in the spring and fall of 2008 which concluded Sugar Creek's biological evaluation. V3 used the mIBI to analyze macroinvertebrates (Table 16). Macroinvertebrate data was taken at all stations in spring of 2008. Macroinvertebrate data was taken at stations 1 through 7 in the fall of 2008. Sampling station 8 could not be sampled in the fall of 2008 as water was not flowing. The raw macroinvertebrate data and the mIBI scoring for stations in both sampling events of 2008 are located in Exhibit 18 and Tables 18a - d respectively.

Table 18a Results From Spring Macroinvertebrate Sampling July 21 and August 5, 2008

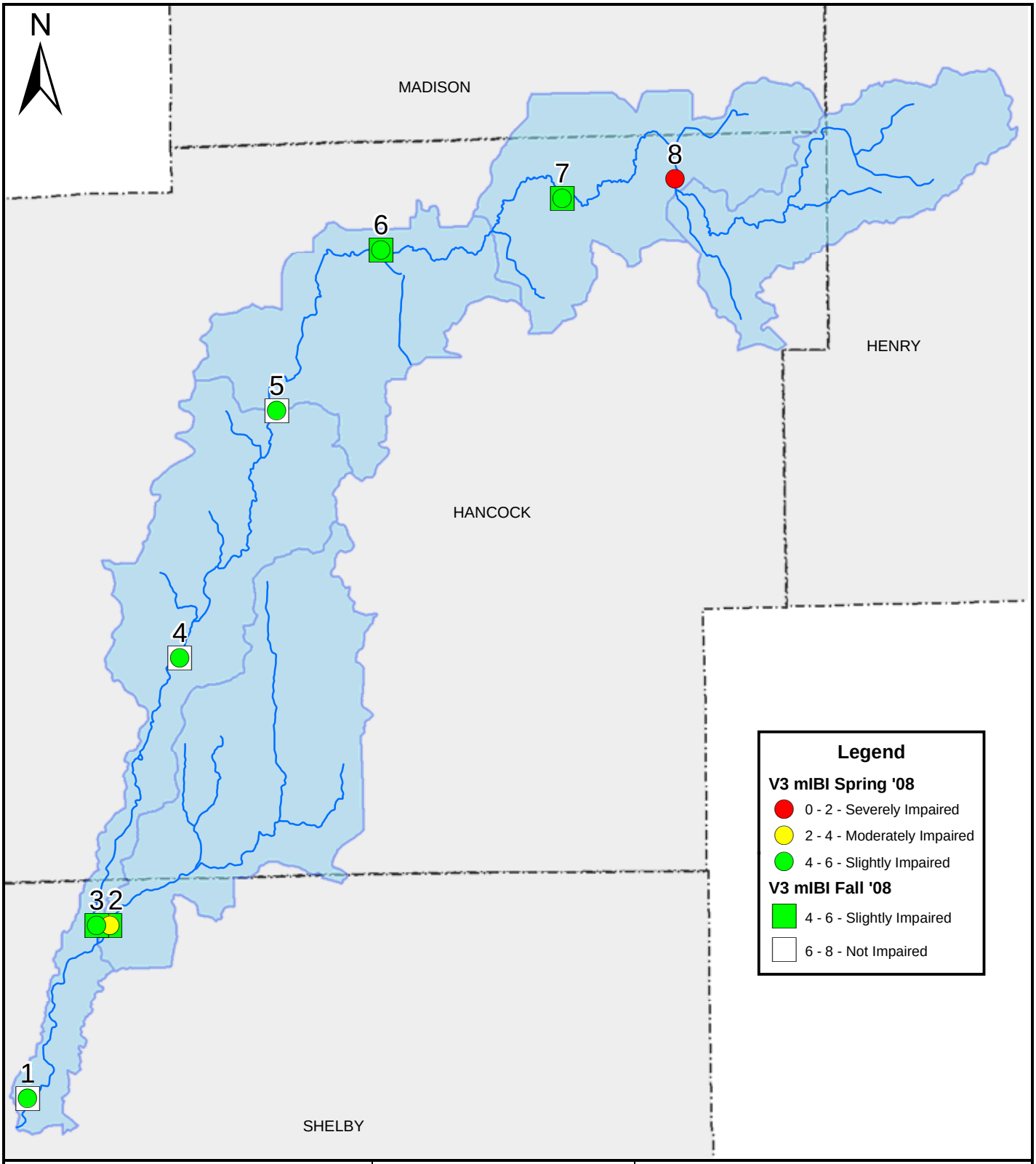
	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	4.224	5.047	4.536	4.326	3.675	4.56	4.394	5.667
Number of Taxa	13	13	12	19	18	15	17	9
Number of Individuals	114	246	197	235	209	187	213	136
Percent Dominant Taxa	60.5	45.5	25.9	32.3	27.8	41.7	18.8	58.8
EPT Index	5	4	5	7	8	6	6	3
EPT Count	88	103	106	128	122	100	125	24
EPT to Total Number	0.772	0.419	0.538	0.545	0.584	0.535	0.587	0.176
EPT to Chironomid	8.8	0.912	2.078	11.636	4.519	4.762	5.952	0.3
Chironomid Count	10	113	51	11	27	21	21	80
Total Number of Individuals/Number of Squares Sorted	16.28	49.2	65.67	117.5	69.67	46.75	71	27.2

Table 18b mIBI Scoring for Spring Macroinvertebrate Sampling July 21 and August 5, 2008

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	6	2	6	6	8	4	6	0
Number of Taxa	4	4	4	8	8	6	6	2
Number of Individuals	2	4	4	6	4	4	6	4
Percent Dominant Taxa	2	6	6	4	6	4	8	2
EPT Index	4	4	4	6	8	6	6	2
EPT Count	4	6	6	6	6	6	6	2
EPT to Total Number	8	6	6	6	6	6	6	2
EPT to Chironomid	6	2	2	6	4	4	6	0
Chironomid Count	6	2	4	6	4	4	4	2
Total Number of Individuals/Number of Squares Sorted	0	2	2	4	2	2	2	0
Station mIBI Score	4.20	3.80	4.40	5.80	5.60	4.60	5.60	1.60

Table 18c Results From Fall Macroinvertebrate Sampling October 6, 7 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	4.236	4.134	4.158	4.135	4.256	4.247	4.378	-
Number of Taxa	19	17	15	17	17	20	18	-
Number of Individuals	205	215	209	258	245	199	260	-
Percent Dominant Taxa	21.5	54.4	23.0	32.6	51.4	25.6	37.3	-
EPT Index	7	5	6	7	8	7	6	-
EPT Count	154	177	131	189	182	102	143	-
EPT to Total Number	0.751	0.823	0.627	0.732	0.743	0.512	0.55	-
EPT to Chironomid	8.105	59	3.97	47.25	14	7.846	3.763	-
Chironomid Count	19	3	33	4	13	13	38	-
Total Number of Individuals/Number of Squares Sorted	51.5	107.5	104.5	129	122.5	49.75	260	-

Table 18d mIBI Scoring for Fall Macroinvertebrate Sampling October 6, 7 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	6	6	6	6	6	6	6	-
Number of Taxa	8	6	6	6	6	8	8	-
Number of Individuals	4	6	4	6	6	4	6	-
Percent Dominant Taxa	8	2	6	4	2	6	4	-
EPT Index	6	4	6	6	8	6	6	-
EPT Count	6	6	6	6	6	6	6	-
EPT to Total Number	8	8	6	8	8	6	6	-
EPT to Chironomid	6	8	4	8	8	6	4	-
Chironomid Count	6	8	4	8	6	6	4	-
Total Number of Individuals/Number of Squares Sorted	2	4	4	4	4	2	6	-
Station mIBI Score	6.00	5.80	5.20	6.20	6.00	5.60	5.60	-



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TITLE: **V3 mIBI Scores 2008**		PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 18	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 1/22/09	SCALE: NTS

V3 Biological Evaluation 2008 Results Discussion

Station 1 had a lower spring score (4.2) than fall (6.0). Station 1 was slightly impaired in the spring in the spring sampling and not impaired in the fall sampling. The Number of Taxa, EPT Index and EPT Count were slightly impaired for the spring sampling. The Number of Individuals was the only metric that was slightly impaired for the fall sampling. Total Number of Individuals to Number of Squares Sorted was severely impaired during the spring sampling and moderately impaired during the fall sampling. 60 percent of the spring sampling consisted of web spinning caddisflies, which are desirable to have in the stream.

Station 2 had a higher fall score (5.8) than spring (3.8). The spring sampling was moderately impaired, while the fall sampling was slightly impaired. The main reason for this is that during the spring sampling 113 chironomids were found compared to 3 in the fall. This reduced the scores of Chironomid Count, EPT to Chironomid, and the HBI metrics.

Station 3 was slightly impaired in the spring (4.4) and the fall (5.2). Along with Station 2, Station 3 had the lowest average score of all stations (4.8). The dominant taxa at Station 3 in the fall were web spinning caddisflies, flat-head mayflies, and chironomids. These dominant species represent filters, scrapers and gatherers which are all important functional feeding groups in a stream system.

Station 4 had the highest average score (6.0). Station 4 was slightly impaired for the spring (5.8) and not impaired for the fall sampling (6.2). Percent Dominant Taxa was the only metric slightly impaired in both sampling efforts. Chironomids accounted for 25 percent of the spring sampling. Web spinning caddisflies and flat-head mayflies were the most frequently occurring species in the fall sampling (33% and 21% respectively).

Station 5 was slightly impaired during the spring (5.6) and not impaired during the fall (6.0). Station 5 had the second highest average score (5.8). The main difference between spring and fall sampling was several of the metrics were slightly lower in the spring including Percent Dominant Taxa, EPT to Chironomid, and Total Number of Chironomids. Individuals to Number of Squares Sorted was moderately impaired in spring and slightly impaired in the fall. The Dominant Taxa was the web spinning caddisfly in both the spring and the fall. Overall, the differences from spring to fall at this station were very small.

Station 6 was slightly impaired in the spring (4.6) and fall (5.6). Total Number of Individuals to Number of Squares Sorted was moderately impaired during the spring and fall sampling (2). Station 6 had a greater Number of Taxa in the fall and a lower Chironomid Count than the spring. EPT count was 100 in the spring and 102 in the fall. EPT to Chironomid was slightly impaired in the spring and not impaired in the fall because of the decrease in chironomid count.

Station 7 was slightly impaired for both samplings. This station was slightly impaired for Chironomid Count during the spring and fall. EPT Count increased from 125 in the spring to 143 in the fall. Percent Dominant Taxa metric was not impaired in the spring and slightly impaired in the fall. Web spinning caddisflies were the most frequently occurring species in both the fall and spring sampling.

Station 8 had the lowest mIBI score of all sampling stations (1.6). Sampling station 8 was not be sampled in the fall as water was not flowing. Station 8 was severely impaired for the spring sampling effort. The HBI (5.67) scored a 0 during the spring and was severely impaired. Chironomids were the dominant taxa and made up 59 percent of the sample. Chironomids have a HBI rating of 4.103. This is the main reasons for the low spring score. Station 8 is siltier and has significant runoff from adjacent fields which results in undesirable habitat for macroinvertebrates with lower tolerance values.

IDEM Biological Evaluation Results

Several previous macroinvertebrate studies have been conducted within the Sugar Creek Watershed. IDEM sampled macroinvertebrates (Exhibit 17; Table 19) in 1993 and in 2002. All three stations sampled in 1993 were slightly impaired and the only station sampled in 2002 was moderately impaired. All stations are considered fully supporting, as the mIBI score is greater than or equal to 2.2 (IDEM 2006). The station at CR 675 W in Shelby County sampled in 2002 scored had the lowest score at 3. Most of the lowest metric scores were a result of about 53 percent (88/164 individuals) of the sample being Chironomids, which affects many of the metric including HBI, Chironomid count, dominant taxa, and EPT to Chironomid ratio.

Table 19 IDEM Field Data (IDEM 1993, 1997, 2002)

Sample Date	Location	Stream Name	County	mIBI	IBI	QHEI	Water Temp (°C)	D.O. (mg/L)	pH	Sp. Cond. (mhos)	Turbidity (NTU)
8/14/2002	CR 675W	Sugar Creek	Shelby	3	54	78	22.11	6.91	8.15	681	16
7/14/1997	CR 200S	Little Sugar Creek	Hancock	-	34	47	23.42	11.35	8.3	1129	15
7/15/1993	CR 100W	Little Sugar Creek	Hancock	4.4	-	64	21.01	6.6	7.23	491	-
7/20/1993	CR1000N	Sugar Creek	Hancock	4.4	-	67	22.78	6.19	7.71	639	-
7/20/1993	CR 100S	Sugar Creek	Hancock	5.6	-	75	23.35	6.34	7.73	639	-

Sugar Creek Watershed fisheries data was pulled to determine species within the Watershed and changes in species composition and quantity over time. The USGS has been sampling for fish presence since 1993 within the months of July, August and September. IDEM has conducted two fish studies within the Sugar Creek Watershed (1997, 2002). Sampling locations are shown in Exhibit 17 and described in Table 19. A species presence list is located in Table 20 which includes the results of sampling efforts of USGS and IDEM.

The USGS fisheries surveys were conducted on Sugar Creek at CR 400S in New Palestine. Fisheries surveys were not conducted by USGS from 1999 to 2001. The total number of species collected at each USGS survey ranged from 27 species in 1993 to 50 species in 2002. The average number of species collected from all USGS surveys was 35 species. Species collected at all of the USGS surveys include: black redhorse, blacknose darter, bluntnose minnow, central stoneroller, creek chub, golden redhorse, greenside darter, logperch, longear sunfish, mottled sculpin, northern hog sucker, rainbow darter, rock bass, sand shiner, smallmouth bass, striped shiner, and white sucker.

During the 1997 survey, IDEM sampled one station. This was Wilson Ditch and CR 200S in Hancock County. The IBI score for this survey was a 34, with that resulting in a poor rating. Ten species were collected during the 1997 IDEM survey which was the lowest species count of all the years surveys were conducted. Wilson Ditch also had a Qualitative Habitat Evaluation Index (QHEI) score of 47 which indicates poor habitat for fish which is likely related to the low IBI score at this station. In 2002, IDEM sampled Sugar Creek at CR 675 W in Shelby County. Their result on this survey was an IBI score of 54 which is in the "good" category.

Table 20: USGS Data of Fish Presence in the Sugar Creek Watershed (IDEM Data 1997, 2002*)

Species	1993	1994	1995	1997	Wilson Ditch (Hancock County) 1997*	1998	2002	Sugar Creek (Shelby County) 2002*	2003	2004	2005	2007
Bigeye Chub		X	X				X	X	X	X	X	X
Bigeye Shiner				X			X					
Black Redhorse	X	X	X	X		X	X	X	X	X	X	X
Blacknose Dace					X							
Blackside Darter	X	X	X	X		X	X		X	X	X	X
Blackside Topminnow							X					
Bluegill		X	X	X		X	X	X	X	X	X	X
Bluntnose Minnow	X	X	X	X	X	X	X	X	X	X	X	X
Brindled Madtom		X		X			X		X	X	X	
Central Stoneroller	X	X	X	X	X	X	X	X	X	X	X	X
Channel Catfish		X					X					
Chestnut Lamprey								X				
Common Carp		X	X			X		X		X		
Common Sunfish		X										
Creek Chub	X	X	X	X	X	X	X	X	X	X	X	X
Creek Chubster										X		
Dusky Darter	X	X		X			X	X				X
Eastern Shiner						X						
Emerald Shiner			X			X			X		X	X
Fantail Darter						X						
Flathead Catfish		X						X				
Gilt Darter												X
Golden Redhorse	X	X	X	X		X	X	X	X	X	X	X
Grass Pickerel										X		
Green Sunfish		X	X	X	X	X	X	X	X	X	X	X
Greenside Darter	X	X	X	X		X	X	X	X	X	X	X
Hornyhead chub										X		
Johnny Darter		X	X	X	X	X	X	X	X	X	X	
Largemouth Bass						X	X				X	X
Logperch	X	X	X	X		X	X	X	X	X	X	X
Longear Sunfish	X	X	X	X		X	X	X	X	X	X	X
Longnose Gar							X	X				
Mimic Shiner		X					X					
Mottled Sculpin	X	X	X	X	X	X	X	X	X	X	X	X
Northern Hog Sucker	X	X	X	X		X	X	X	X	X	X	X
Northern Starhead Topminnow										X		
Northern Studfish							X	X		X	X	X
Orangespotted Sunfish							X					
Orangethroat Darter		X	X		X		X	X	X	X	X	
Pumpkinseed							X					
Quillback		X										X
Rainbow Darter	X	X	X	X		X	X	X	X	X	X	X
Redear Sunfish							X					X

Table 20 Continued: USGS Data of Fish Presence in the Sugar Creek Watershed (IDEM Data 1997, 2002*)

Species	1993	1994	1995	1997	Wilson Ditch (Hancock County) 1997*	1998	2002	Sugar Creek (Shelby County) 2002*	2003	2004	2005	2007
Redfin Shiner	X	X		X		X	X	X	X	X		
River Carpsucker											X	
River Chub	X	X	X	X			X			X	X	X
River Redhorse		X										
River Shiner							X					
Rock Bass	X	X	X	X		X	X	X	X	X	X	X
Rosyface Shiner	X	X	X				X				X	X
Sand Shiner	X	X	X	X		X	X	X	X	X	X	X
Shorthead Redhorse		X		X			X	X	X	X		
Silver Redhorse	X	X	X	X		X	X	X	X	X		X
Silver Shiner	X	X	X	X		X	X	X		X	X	X
Silverjaw Minnow		X	X	X	X		X	X	X	X	X	X
Slenderhead Darter						X						
Smallmouth Bass	X	X	X	X		X	X		X	X	X	X
Smallmouth Buffalo												X
Spotfin Shiner	X	X		X		X	X	X	X	X	X	X
Spotted Bass	X	X	X	X			X	X	X	X	X	
Spotted Gar							X					
Spotted Sucker	X	X	X			X	X		X			X
Steelcolor Shiner		X	X									
Striped Shiner								X				
Stonecat		X					X		X	X		
Striped Shiner	X	X	X	X		X	X		X	X	X	X
Warmouth							X					
White Crappie	X						X					
White Sucker	X	X	X	X	X	X	X	X	X	X	X	X
Yellow Bullhead		X					X	X		X		
Total Number of Species:	**27**	**44**	**32**	**31**	**10**	**31**	**50**	**34**	**32**	**39**	**33**	**35**

Habitat Evaluation Explanation

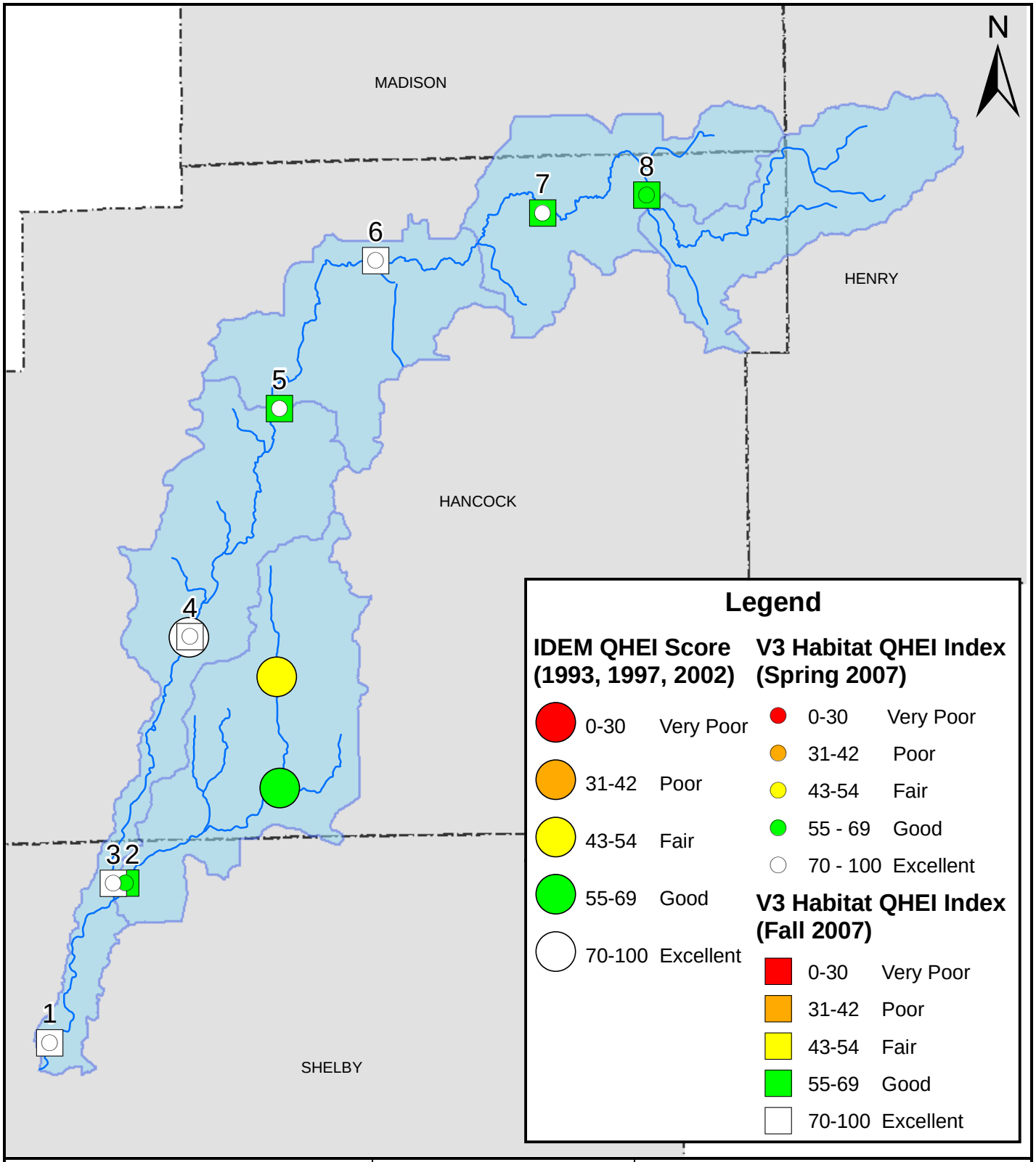
Habitat evaluation followed the IDEM QHEI habitat assessment approach which evaluates physical characteristics of a stream. Habitat incorporates all aspects of physical and chemical constituents along with the biotic interactions. Habitat includes all of the in-stream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The purpose for evaluating the physical habitat features of the selected locations within the Sugar Creek Watershed is to quantify the condition and quality of the in-stream and riparian habitat. The QHEI habitat assessment approach was developed to describe the overall quality of the physical habitat.

The maximum score that can be obtained using the IDEM QHEI is a value of 100. QHEI scores below 51 indicate that the stream is non supporting for aquatic communities (IDEM, 2006). QHEI scores form 51 to 64 are partially supporting to aquatic communities and scores above 64 are fully supporting. QHEI can also be broken down in several different categories that range from Excellent (70-100), Good (55-69), Fair (43-54), Poor (31-42), to Very Poor (<30). The maximum points possible for each of the habitat parameters are as follows: Substrate = 20, In-stream Cover = 20, Channel Morphology = 20, Riparian Zone and Bank Erosion = 10, Pool/Glide Quality = 12, Riffle/Run Quality = 8 and Gradient = 10.

Habitat Evaluation Results

Habitat was surveyed previously by IDEM (Table 19) in 1993, 1997, and 2002. Only Wilson Ditch in 1997 was considered to be non supporting habitat for aquatic life. All other stations had scores greater than 51, indicating sustainable habitat.

The V3 field collected data for habitat during spring 2007 (Exhibit 19; Table 21a) indicated that all stations were fully supportive for aquatic life. During the fall 2007 (Exhibit 19; Table 21b) showed that Stations 2 and 8 were partially supporting and all other stations were fully supporting. Habitat data was taken in July, 2008 and October, 2008 and is located in Exhibit 20; and Tables 22a and 22b. Stations 2, 7, and 8 had QHEI ratings in the good category and all other stations have a QHEI in the Excellent category. Overall, Station 8 had the lowest observed QHEI scores, which also corresponds with the lowest mIBI scores. Combined, Station 6 had the highest QHEI of all of V3's stations.



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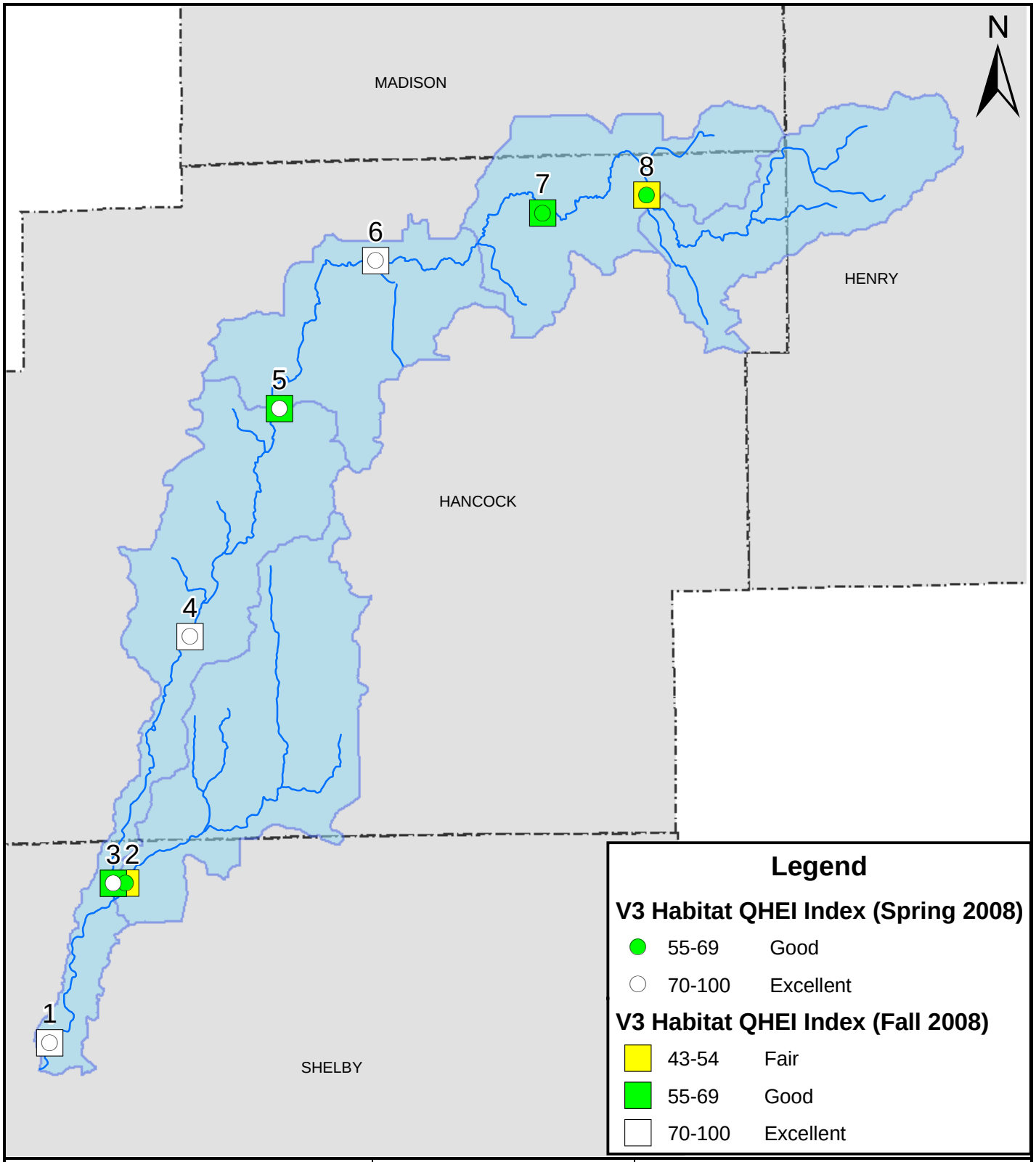
TITLE: **Habitat QHEI Index Map (V3 and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 19	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS

Table 21a V3 Habitat Results for Sugar Creek in May, 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	16	18	18	18	16	18	18	15
Instream Cover	15	13	17	20	20	20	18	16
Channel Morphology	16	13	13	16	16	16	12	10.5
Riparian Zone and Bank Erosion	6	2.5	4.5	4	6.5	8	1.5	6.5
Pool/Glide Quality	12	11	10	12	10	12	12	11
Riffle/Run Quality	4	4	5	6	5	7	6.5	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**79**	**65.5**	**73.5**	**84**	**79.5**	**85**	**72**	**66**

Table 21b V3 Habitat Results for Sugar Creek in October, 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	17	15	15	17	15	18	16	9
Instream Cover	18	15	17	17	15	20	15	15
Channel Morphology	16	12	12	15	16	15	12	10.5
Riparian Zone and Bank Erosion	6	2.5	4.5	4	6.5	8	1.5	5.5
Pool/Glide Quality	12	11	12	12	7	11	11	11
Riffle/Run Quality	4	2	3	3	3	6	4.5	2
Gradient	10	4	6	8	6	4	4	4
Total Score	**83**	**61.5**	**69.5**	**76**	**68.5**	**82**	**64**	**57**
Year Avg. Score	81	63.5	71.5	80	74	83.5	68	61.5



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TITLE: **Habitat QHEI Index Map (V3 and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 20	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS

Table 22a Habitat Results for Sugar Creek in July, 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	11	14	15	18	16	13	15	10
Instream Cover	16	12	15	20	16	19	15	15
Channel Morphology	16	12	12	16	14	16	10	10
Riparian Zone and Bank Erosion	6	2.5	4.5	6.5	6	8	3	6.5
Pool/Glide Quality	12	12	12	12	9	12	11	11
Riffle/Run Quality	5	4	5	6	5	6	6	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**76**	**60.5**	**69.5**	**86.5**	**72**	**78**	**64**	**59.5**

Table 22b Habitat Results for Sugar Creek in October, 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	15	9	16	18	10	17	14	9
Instream Cover	15	14	12	19	15	15	13	10
Channel Morphology	16	12	12	16	14	16	11	10
Riparian Zone and Bank Erosion	6	2.5	4.5	6	6.5	8	3.5	5.5
Pool/Glide Quality	10	8	8	10	9	9	7	10
Riffle/Run Quality	4	4	5	4	4	6	2	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**76**	**53.5**	**63.5**	**81**	**64.5**	**75**	**54.5**	**51.5**
Year Avg. Score	76	57	66.5	83.75	68.25	76.5	59.25	55.5

Analysis of Studies Related to the Sugar Creek Watershed

The IDEM Assessment Branch evaluates all the data they collect to develop the 305(b) report, and the 303(d) list. The 305(b) report is a document that summarizes the quality of surface waters throughout Indiana. Evaluations are based on different stream segments or lakes, and are discussed in the context of watersheds. To complete the evaluation, IDEM considers not only the data they collect, but data collected by other entities as long as that data meets the rigorous quality controls that IDEM uses in the collection and analysis of their own data. Other data that doesn't meet these standards may be used informally to validate data that does meet the quality controls.

Analysis of Information Related to the IDEM 303(d) List

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's water quality standards for designated uses. These streams are to be listed on the State's 303(d) list of impaired waters. For such waters, the State is required to establish total maximum daily loads (TMDLs) to meet the state water quality standards. To determine if a waterbody should be listed on Indiana's 303(d) list, the IDEM Assessment Branch has developed a surface water quality monitoring strategy to assess the quality of Indiana's ambient waters. The goals of this monitoring strategy are as follows (IDEM 303(d) listing methodology):

1. Measure the physical, chemical, bacteriological and biological quality of the aquatic environment in all river basins and identify factors responsible for impairment.
2. Assess the impact of human and other activities on the surface water resource.
3. Identify trends through the analysis of environmental data, and
4. Provide environmental quality assessment to support water quality management programs.

Once data is collected, waterbodies are evaluated by a team of water-quality professionals within IDEM to determine if the waterbodies meet the water-quality standards set by the State, and that all designated uses are met. If a stream fails to meet these requirements, as outlined in the 303(d) listing methodology, the waterbody is considered impaired and must be listed on the 303(d) list, and a TMDL developed to address the problem.

Approximately 85% of Sugar Creek proper is listed on the 303 (d) list. The impairments include *E. coli* contamination and Fish Consumption Advisories for both PCB's and Mercury.

The specific methodologies for these listings are identified in IDEM 303(d) listing methodology and are shown in Table 23. These data are for *E. coli* impairments (Human Health Recreation Use Support [Swimmable]) and Fish Consumption Advisories (Human Health Use Support [Fishable]).

Table 23: IDEM 303(d) Listing Methodology Human Health Recreational Use Support (Swimmable)		
IDEM has two different criteria for recreational use assessments depending on the type of data set being used in making the assessment. For data sets consisting of five equally spaced samples over a 30-day period, we apply two tests, both of which are based on U.S. EPA's *Ambient Water Quality Criteria for Bacteria - 1986* (EPA440/5-84-002), which provides the foundation for Indiana's water quality standards for recreational use. For data sets consisting of ten (10) or more grab samples where no five (5) of which are equally spaced over a 30-day period, the 10% rule is applied. Specific criteria are as follows.		
	Fully Supporting	**Not Supporting**
Bacteria (*E. coli*): at least five (5) equally spaced samples over thirty (30) days. (CFU = colony forming units)	Geometric mean ≤125 CFU/100ml and no more than one sample >576 CFU/100ml.	Geometric mean exceeds 125 CFU/100mL.
Bacteria (*E. coli*): grab samples (CFU = colony forming units)	No more than 10% of measurements >576 CFU/100ml and no more than one (1) sample >2400 CFU/100ml.	More than 10% of samples >576 CFU/100ml or more than one (1) sample >2,400 CFU/100ml.
Human Health Use Support – Fish Consumption (Fishable)		
The Indiana Fish Consumption Advisory (FCA) provides site-specific advice as well as general advice for any waterbody not specifically addressed in the FCA. FCAs are presented as advisory groups based safe eating guidelines for the amount and type of fish caught. Site-specific advisories are based on site-specific fish tissue data and indicate the advisory group associated with a given species within a given size range and identify the contaminant of concern (PCBs and/or mercury) for each. The general advice provided in the FCA states that all waters for which no site-specific advisory is provided should be assumed to be a Group 2 advisory. In addition, the Indiana FCA includes a statewide advisory for carp consumption for rivers and streams. Neither the general advice nor the statewide advisory for Carp is used to make fish consumption assessments. Only site-specific fish consumption advisories were considered in determining use support status.		
	Fully Supporting	**Not Supporting**
Fish tissue (PCBs and mercury)	Waterbody has only a Group 1 "Unlimited Consumption" advisory.	Waterbody has one or more Groups 2, 3, or 4 "Limited Consumption" or Group 5 "Do Not Eat" advisories for any species.
Aquatic Life Use Support – Lakes and Reservoirs		
Indiana Department of Natural Resources surveys of the status of sport fish communities in lakes and information on trout stocking.	**Fully Supporting**	**Not Supporting**
	Supports cold water fishery, including native cisco and stocked trout, or both.	Native cisco population is gone or lake unable to support stocked trout and lake attributes, or both, appear to contribute to warm water fishery condition.

Summary of the 2008 Published IDEM TMDL for Escherichia coli (E. coli)

Section 303(d) of the Federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards. A TMDL provides a basis for determining the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of their water resources.

This TMDL applies to the 69.5 miles of the Sugar Creek Watershed where recreational uses are impaired by elevated levels of *E. coli* during the recreational season (April 1 to October 31). The target level for *E. coli* during the recreational season is 125 colony forming units (CFU) per one hundred milliliters as a geometric mean based on no less than five samples equally spaced over a thirty day period. Failing septic tanks and wildlife are known sources of *E. coli* impairments in waterbodies. Deer, geese, ducks, raccoons, and other animals all create potential sources of *E. coli* through contaminated runoff from animal habitats. IDEM conducted an intensive study of the five NPDES Permitted Discharge sites within the Sugar Creek Watershed (Exhibit 21). None of the facilities have past or open enforcement cases for violations and therefore these facilities are not considered to be major sources of *E. coli* to Sugar Creek. The linkage between the *E. coli* concentrations in the Sugar Creek Watershed and the potential sources provides the basis for the development of the TMDL. Land use within the Sugar Creek Watershed is predominately agricultural and requires drain tiles due to soil type. Field tiles are not sources of *E. coli* but they can carry *E. coli* from land applied manure and runoff from the fields and pastures. IDEM's 2002 study consisted of 15 sampling sites. IDEM's 2007 study consisted of 59 sampling sites, of which 39 were within the Sugar Creek Watershed (Exhibit 22). *E.coli* exceedance results from water quality testing from 2002 and 2007 are found in Table 24. Site Numbers that are in a corresponding row indicate sites that were used in both the 2002 and 2007 TMDL studies. The locations of sites remained the same within the watershed but were renumbered to accommodate the increase in sampling sites that occurred in 2007.

Table 24 TMDL *E.coli* Exceedance Results

2002 Site Number	2002 Geometric Mean (MPN/100mL)	2007 Site Number	2007 Geometric Mean (MPN/100mL)
		6	235.03
		9	892.81
4	n/a (30.88)	13	358.89
		17	399.53
		19	280.65
		22	276.81
		23	504.37
7	448.55	24	262.56
		25	562.67
8	263.66	28	252.41
9	309.27	32	n/a (151.07)
		43*	301.54
		47*	677.10
11	3846.25	48*	n/a (dry)
		49*	338.92
12	443.24	56*	n/a (40.8)
13	347.95	57*	n/a (dry)

*Included in 2007 TMDL study but extends outside this study's watershed boundary.

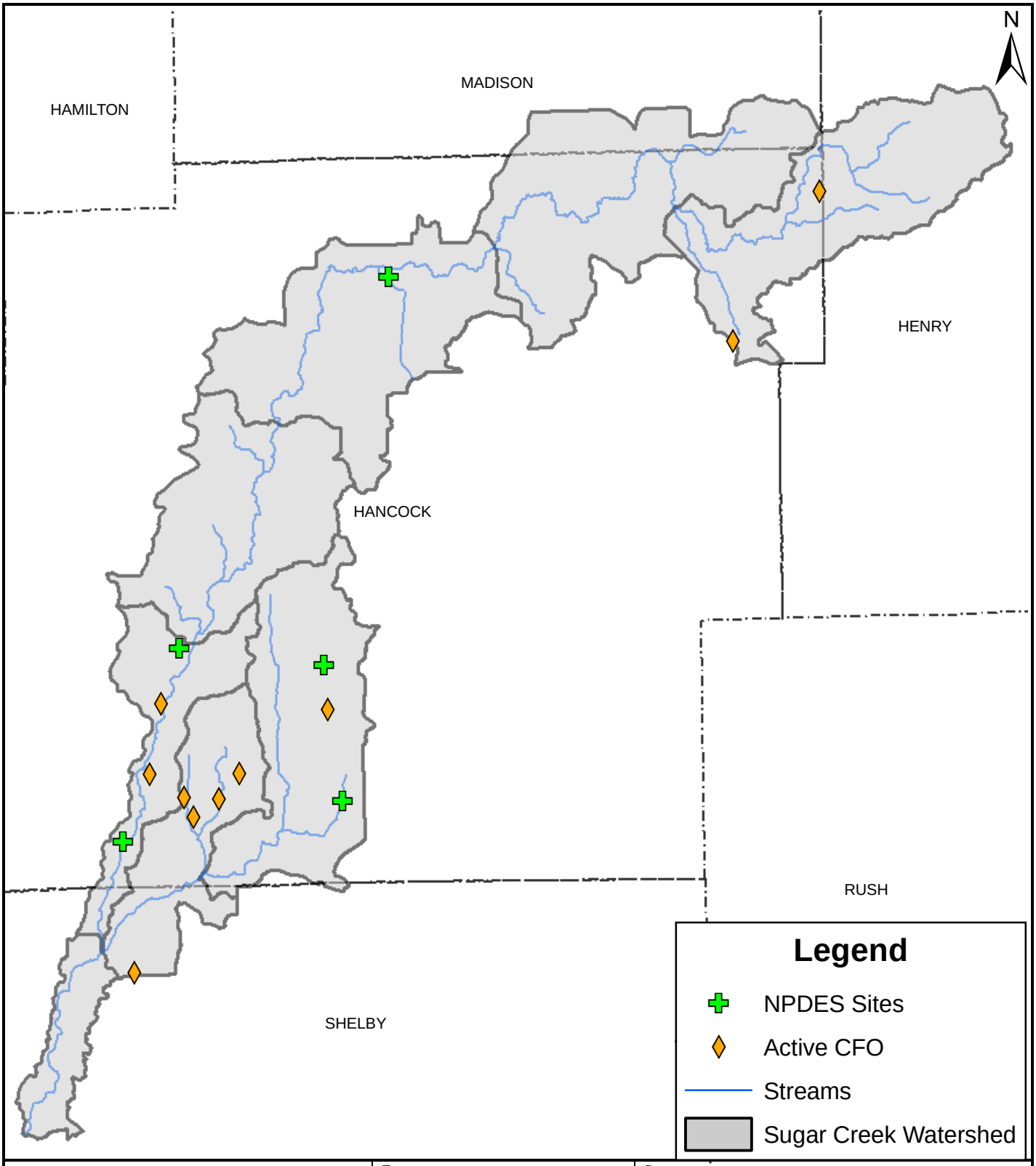
The *E. coli* exceedance results for both 2002 and 2007 IDEM TMDL studies demonstrate that the Boyd Ditch subwatershed possessed the most exceedances with 39% of the samples (9 of 23) being higher than the state standard. The second most exceedances of the state standard was the Marsh & Trees Ditch subwatershed with 33% of the samples (3 of 9) being higher than the state *E. coli* standard. The remaining two Sugar Creek subwatersheds had a 20% (2 of 10) sampling station exceedance in the Barrett Ditch subwatershed, and a 12% (1 of 8) sampling station exceedance in the Pee Dee Ditch subwatershed for *E. coli* levels.

In order for the Sugar Creek Watershed to achieve water quality standards the wasteload and load allocations for the Sugar Creek Watershed have been set to the *E. coli* water quality standard of 125 CFU per 100 mL as a geometric mean. Achieving the wasteload and load allocations for the Sugar Creek Watershed depends on:

1.) *E. coli* limits being added to dischargers who monitor for total residual chlorine.
2.) Confined feeding operations are not violating their permits.
3.) Non-point sources of *E. coli* being controlled by implementing best management practices in the Watershed.
4.) The issuance of the MS4 permits for Hancock, Johnson and Madison Counties as well as New Palestine and Edinburgh.
5.) Education and outreach for septic system care.

Analysis of Information Related to the 2007 IDEM TMDL Study

An *E. coli* TMDL has been developed by IDEM and is available for review at www.in.gov/idem/4685.htm. Sites were evaluated along Sugar Creek for *E. coli*, 10 of which are located within the Sugar Creek Sampling Area (Exhibit 22). Load duration curves were developed for four of these sites to help determine possible sources of the contamination. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources based on the time of the sampling events (TMDL for E. coli for Sugar Creek Watershed, 2007). Potential sources outlined by IDEM include: 1) Wildlife, such as deer, geese, ducks, raccoons, turkeys, and other animals, 2) Failing septic systems, 3) National Pollutant Discharge Eliminations System (NPDES) permitted dischargers including, Act III Estates, Arrowhead Mobile Home Park, Eden Elementary School, Creekside Mobile Home Park, New Palestine Municipal STP, Sugar Creek Utility Company, Franklin Plant IAWC, Shelby Petroleum, Inc., and Sonoco Flexible Packaging, and 4) Confined Feeding Operations (CFOs).



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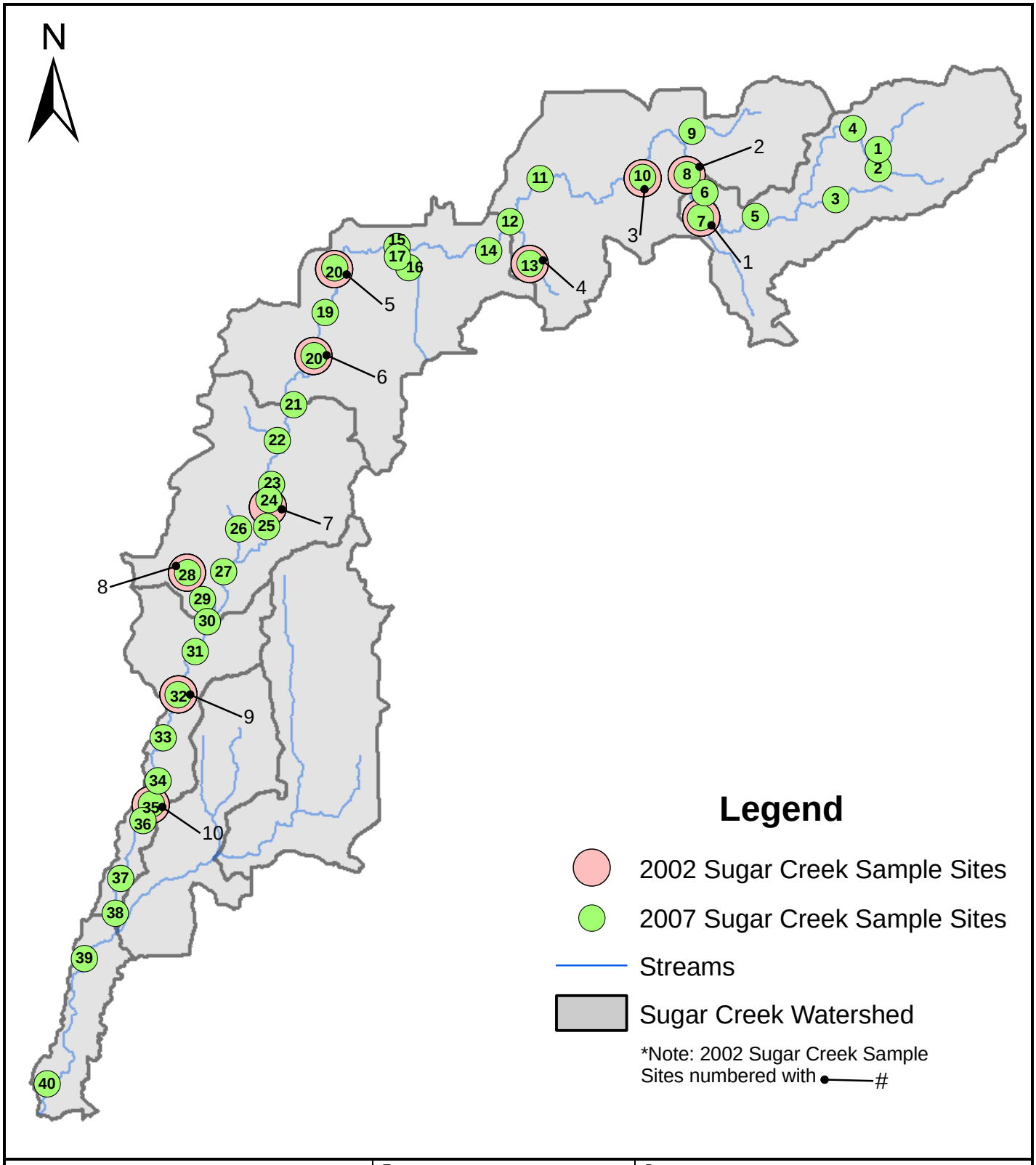
TITLE: **Active CFO and NPDES Sites**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 21	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 09/05/07	SCALE: NTS



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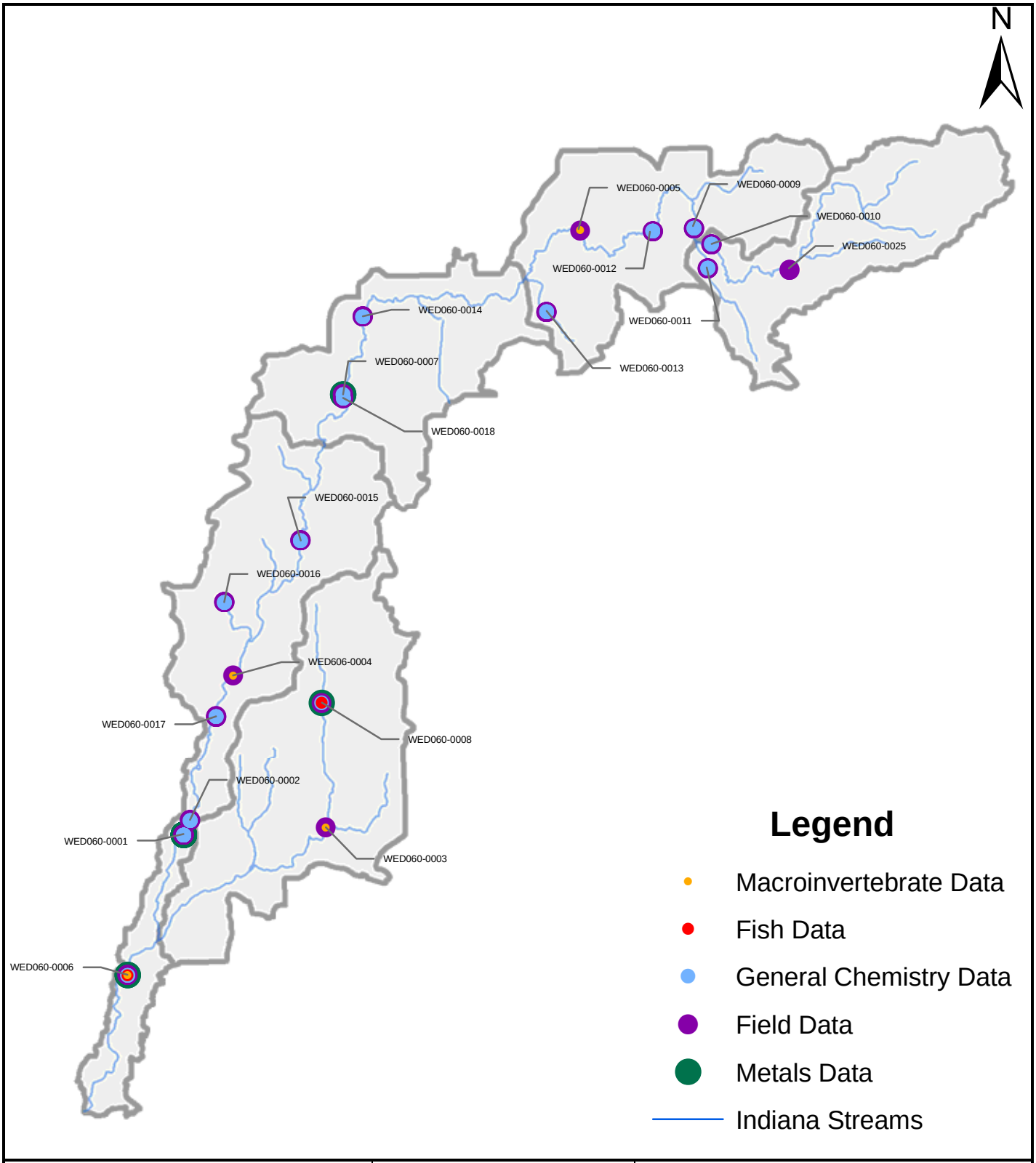
TITLE: **2002 & 2007 TMDL Sampling Location Map**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 22	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 09/05/07	SCALE: NTS

Summary of 1993 to 2007 IDEM Data

Available data from the Indiana Department of Environmental Management for the Sugar Creek Watershed between 1993 and 2007 was obtained and evaluated to determine where water-quality problems were noted in the Watershed. Data included field data, general chemistry data, metals data, macroinvertebrate data, fish community data and habitat quality data. IDEM identified each site location by assigning a code which included WED followed by a numeric sequence. Site locations were spread throughout the Watershed and are shown in Exhibit 23. Sugar Creek Watershed stream impairments are shown in Exhibit 24-26. Exhibits 24-26 are presented in the 14-digit HUC subwatershed boundary because that was the boundary used when the study was conducted.



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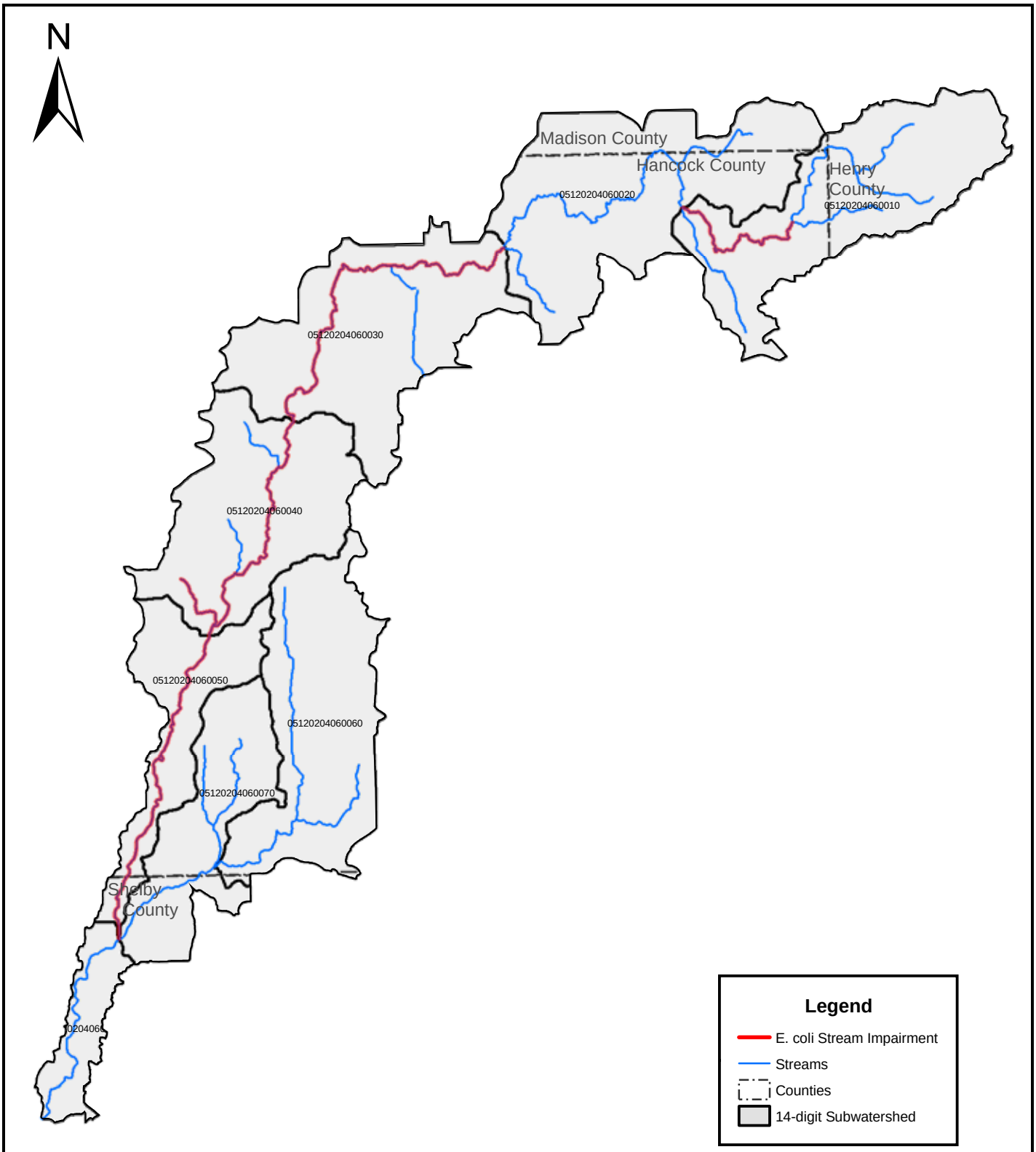
TITLE: **IDEM Data**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 23	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS



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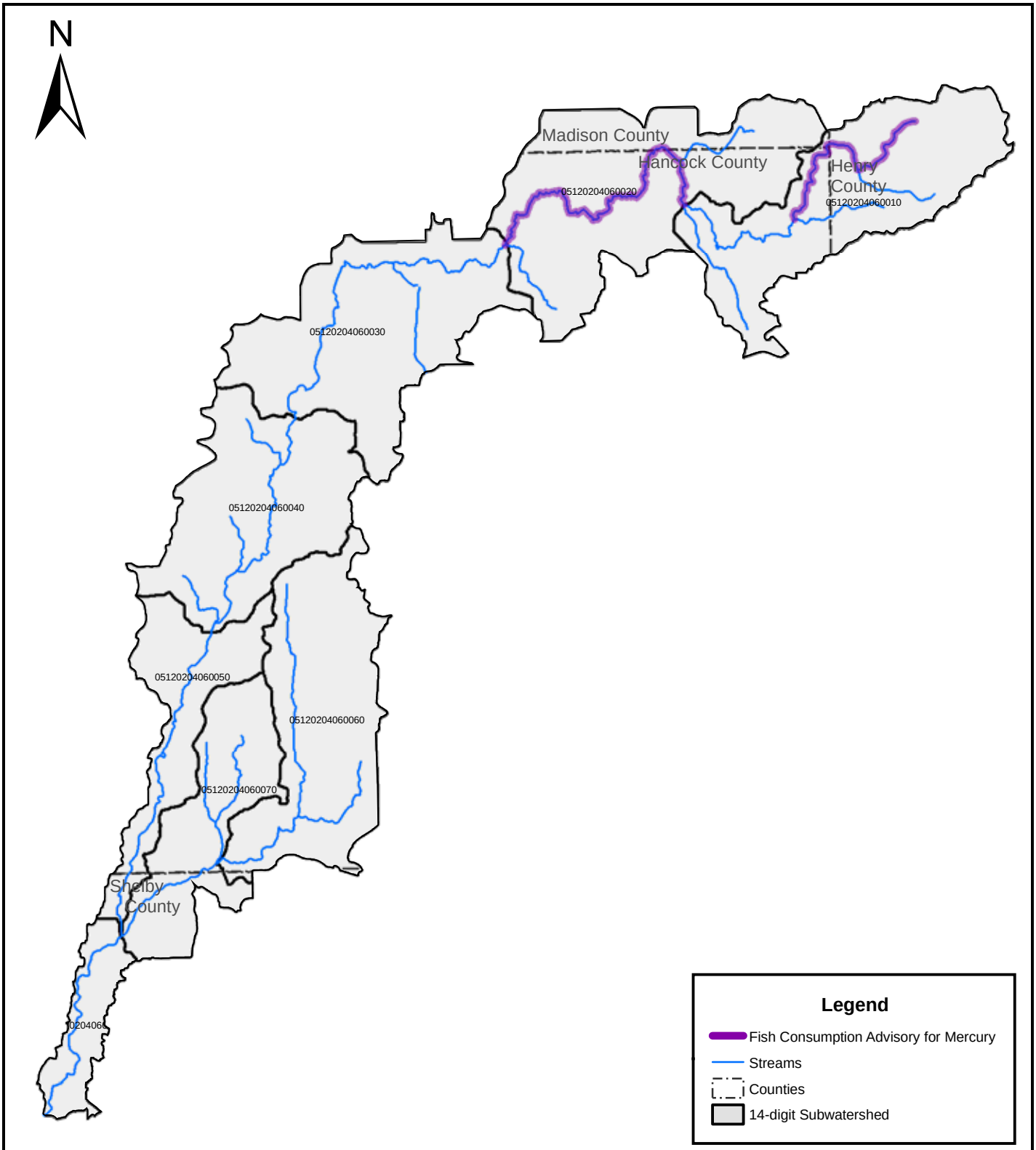
TITLE: **2006 303(d) E. coli Stream Impairments**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: Indiana Department of Environmental Management	PROJECT NO. 07065	EXHIBIT: 24	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 5/1/08	SCALE: NTS



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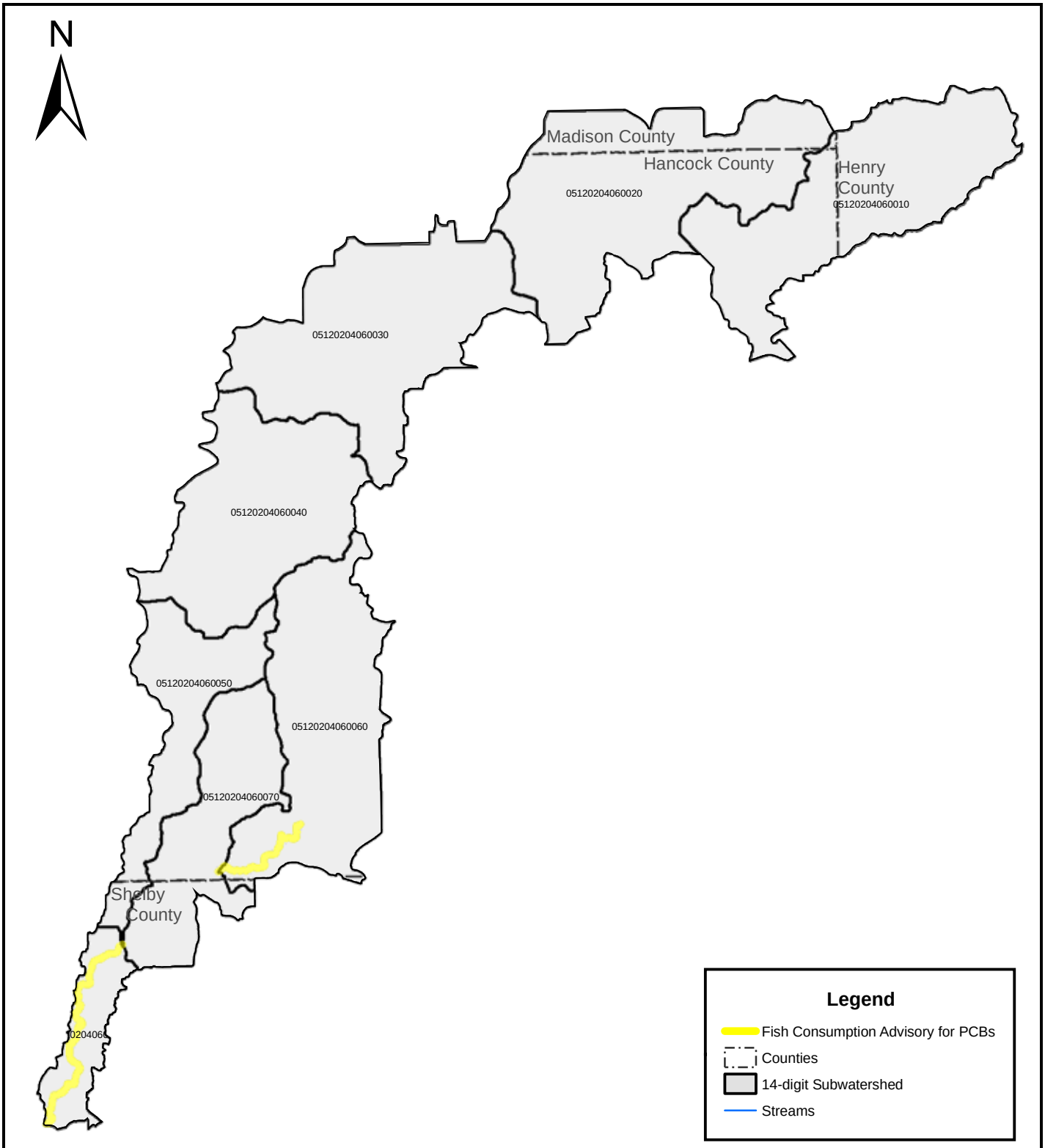
TITLE: **Fish Consumption Advisory for Mercury 2006 303(d) Stream Impairments**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: Indiana Department of Environmental Management	PROJECT NO. 07065	EXHIBIT: 25	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS



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TITLE: **Fish Consumption Advisory for PCBs 2006 303(d) Stream Impairments**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: Indiana Department of Environmental Management	PROJECT NO. 07065	EXHIBIT: 26	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 5/1/08	SCALE: NTS

Nutrients of concern within the Sugar Creek Watershed include both nitrogen and phosphorus, although phosphorus is the limiting nutrient in most of Indiana's aquatic systems, and is therefore the nutrient of most concern. Only one station had phosphorus levels exceeding 0.3 mg/L. This occurred at station WED060-0008 on Wilson Ditch with a value of 1.4 mg/L (Exhibit 23). It is interesting to note that this site also had a poor fish community, and the QHEI also indicated that the habitat was poor and unable to support a healthy aquatic community. Further analysis would need to be completed to evaluate whether habitat or pollution was causing this impairment of the fish community. Presently, no streams within the Sugar Creek Watershed are listed as impaired for nutrients. However the lack of impairment may be attributed to the lack of a numeric standard for nutrient exceedances. At this time, Indiana addresses nutrient exceedances based on more general narrative criteria that is dependant on the basis of best professional judgment. This makes the determination of impairment more difficult as there is a need for continuity between assessments. In addition, the impact of nutrients on water bodies and aquatic life has not been fully evaluated in Indiana. To address nutrient exceedances within Indiana IDEM is presently working on this issue, and hopes to have developed specific nutrient criteria for waterbodies in Indiana in the near future.

One way to indirectly assess the impact of nutrients is to look at dissolved oxygen levels in the stream. As algae and plants photosynthesize, they produce oxygen. If excessive plant and algal growth is present due to high inputs of nutrients, photosynthesis will increase causing high dissolved oxygen levels. High levels of dissolved oxygen are generally not a problem, but as night falls and plants and algae cease photosynthesis, their respiration results in a net loss of oxygen to the system. This can cause significant drops in DO levels that are harmful to many aquatic species. Sustained values below 5 mg/L and any drop in oxygen below 4 mg/L can be lethal to many aquatic organisms. Evaluation of data throughout the years has indicated that streams where DO levels above 12 mg/L most likely suffer from these large swings in DO levels.

Although no sites were found with DO levels below 4 mg/L, three sites did have values below 5 mg/L. These include WED060-0013, WED060-0014 and WED060-0015. One of these sites, WED060-0013 is on a smaller tributary stream. Small tributaries are often more susceptible to fluctuations in DO values due to lack of flow through the system, however, the other two sites are on Sugar Creek itself and may indicate a more basin-wide problem. In addition, two stations were found to have DO levels above 12 mg/L indicating a possible night-time drop in DO values. These included WED060-0011 on Pee Dee Ditch and WED060-0001 on Sugar Creek near New Palestine. IDEM data indicated problems at both WED060-0002 and WED060-0001. These sites are relatively near each other and between them had DO values over 12 mg/L, high turbidity values, and high specific conductance values ranging from 1,399 – 2,316. This can often be a sign of untreated or poorly treated wastewater.

Water Quality Evaluation Explanation

Water quality analysis was measured in the field using an YSI Model 63 Handheld pH, Conductivity, Salinity and Temperature System, YSI Model 55 Dissolved Oxygen Meter, LaMotte 2020 Turbidimeter, and MARSH-McBIRNEY FLO-MATE Model 2000 Portable Flowmeter. V3 performed the water quality measurements for the following parameters: temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow, and turbidity. V3 also collected water samples for water chemistry analysis at ESG Laboratories in Indianapolis, Indiana, for the following parameters: Biochemical Oxygen Demand (BOD), Total Phosphorus, and *Escherichia coli (E. coli)*.

An explanation of key water quality parameters is summarized as follows:

Turbidity. The water's transparency can be affected by two primary factors: algae and suspended particulate matter. An increase in the density of the phytoplankton or suspended particles signifies an increase in the water's turbidity.

Bacteria, Fecal Coliform and E coli. Escherichia coli, known as *E. coli*, is a member of the fecal coliform group of bacteria. When this organism is detected within water samples, it is an indication of fecal contamination. *E. coli* is an indigenous fecal flora of warm-blooded animals. Contributions of detectable *E. coli* colonies may appear within water samples due to the input from human or animal waste. Common sources of animal waste are agricultural feedlots (pigs, cattle, etc.), pet waste, or bird waste (such as Canada geese or seagulls). Rain storm events or snow melts frequently wash waste and the associated *E. coli* into surface water systems. The single sample state standard in Indiana for *E. coli* is 235 CFU/100 mL. The measure of CFU per 100 mL means the count of colony forming units (CFU) that exist in 100 milliliters of water.

Phosphorus. Phosphorus is a major cellular component of organisms. Phosphorus can be found in dissolved and sediment-bound forms. However, phosphorus is often locked up in living biota, primarily algae. In the Watershed, phosphorus is found in fertilizers and in human and animal wastes. The availability of phosphorus determines the growth and production of algae and makes it the limiting nutrient in the system. In this study, water samples were analyzed for dissolved and total phosphorus. Dissolved phosphorus is important because it is readily usable by algae. Total phosphorus values are important because concentrations greater than 0.03 mg/L (30ug/L) can cause algal blooms. The suggested exceedance level for Total Phosphorus within the Watershed is 0.3 mg/L. Those levels of Total Phosphorus greater than 0.3 mg/L exceed the suggested water quality target limit for Total Phosphorus in the state of Indiana.

Nitrogen. Nitrogen is another major cellular component of organisms. Nitrogen can enter water bodies from the air and as inorganic nitrogen and ammonia for use by bacteria, algae and larger plants. The four common forms of nitrogen are:

- Nitrite (NO_2^- or simply NO_2) – is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate. Nitrite is a negative charged ionized form of nitrogen (anion).
- Nitrate (NO_3^- or simply NO_3) – Nitrate generally occurs in trace quantities in surface water but may attain high levels in some groundwater. In excessive amounts, it contributes to the illness known as methemoglobinemia in infants. The current EPA standard of 10 parts per million (ppm) for drinking water is specifically designated to protect infants from this disorder. Nitrate is a negative charged ionized form of nitrogen (anion).

- Ammonia (NH_3) and Ammonium (NH_4^+ or simply NH_4) – Ammonia has a polar charge and can be toxic to fish, Ammonium is a positive charged ionized form (cation) and is considered nontoxic. Ammonia is present naturally in surface waters. Bacteria produce ammonia as they decompose dead plant and animal matter. The concentration of ammonia is generally low in groundwater because it adheres to soil particles and clays and does not leach readily from soils.
- Organic nitrogen (TKN) – is defined functionally as organically bound nitrogen in the trinegative oxidation state. Organic nitrogen includes nitrogen found in plants and animal materials, which includes such natural materials as proteins and peptides, nucleic acids and urea. In the analytical procedures, Total Kjeldahl Nitrogen (*TKN*) determines both organic nitrogen and ammonia. Raw sewage will typically contain more than 20 mg/L.

The suggested exceedance level for Total Nitrate and Nitrite within the Watershed is 10 mg/L. Those levels of Total Nitrate and Nitrite greater than 10 mg/L exceed the suggested water quality target limit for Total Nitrate and Nitrite in the state of Indiana.

Dissolved Oxygen. Dissolved oxygen is the gaseous form of oxygen and is essential for respiration of aquatic organisms (i.e. fish and plants). Dissolved oxygen enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Oxygen saturation in water would equal 100% if equilibrium were reached. Values greater than 100% saturation indicate photosynthetic activity within the water. Large amounts of dissolved oxygen in the water indicate excessive algae growth. Dissolved oxygen is consumed by respiration of aquatic organisms and during bacterial decomposition of plant and animal matter. The suggested exceedance levels for Dissolved Oxygen within the Watershed are values less than 5 mg/L and levels greater than 12 mg/L. Those levels of Dissolved Oxygen less than 5 mg/L and greater than 12 mg/L exceed the suggested water quality target limit for Dissolved Oxygen in the state of Indiana.

Biochemical Oxygen Demand (BOD). BOD provides a means of determining the relative oxygen requirements of wastewaters, effluents and polluted waters. The test measures the molecular oxygen utilization during a five day incubation test period for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron.

Temperature. The ecological effects of light and temperature on the photosynthesis and growth of algae are inseparable because of the interrelationships in metabolism and light saturation. One commonly observed change in the rate of respiration of planktonic algae is an increase of the rate with increasing temperature. Additionally, the ability of water to hold oxygen decreases as temperatures increase. When water is oxygen saturated, warmer water has the ability to possess lower amounts of oxygen when compared to colder water that is likewise oxygen saturated.

Conductivity. The conductance of water is the reciprocal of its resistance to electrical flow. The resistance of a water solution to electrical current or electron flow is reduced with increasing content of ionized salt. Distilled water has a conductivity of zero. The purer the water is, the lower its conductivity.

Specific Conductance. Specific Conductance is the conductance at 25°C. This reading is important because conductivity readings are directly linked to temperature and can change up to 3% for a change of one degree Celsius.

Arsenic. Arsenic enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices. Arsenic has been classified by the EPA as a human carcinogen (cancer causing agent). Long term exposure to arsenic has been linked to cancer, cardiovascular disease, immunological disorders, diabetes and other medical issues. Arsenic in water has no smell, taste or coloration even at high concentrations therefore water quality testing is required to determine its presence. The suggested exceedance level for Arsenic within the Watershed is 0.5 ug/L. Those levels of Arsenic greater than 0.5 ug/L exceed the suggested water quality target limit for Arsenic in the state of Indiana.

pH (Acidic and Alkaline). The pH of a water body reflects the hydrogen ion activity in the water body. pH is defined as the –log $[H^+]$. A low pH signifies an acidic medium (lethal effects of most acids begin to appear at pH = 4.5) while a high pH signifies an alkaline medium (lethal effects of most alkalis begin to appear at pH = 9.5). Neutral pH is 7. The actual pH of a water sample indicates the buffering capacity of that water body.

Salinity. Salinity is a measure of the total salts that are dissolved in water, in parts per thousand (ppt). Salinity will be variable from location and time of year. Plants are adversely affected by high salinity, which can cause stunted growth, leaf burn and defoliation. The ocean's salinity is approximately 35 ppt. The following list denotes various concentration levels of salinity in natural environments, however, urban influences of salt distribution during wintertime provides a non-natural situation:

- Fresh water, 0 ppt, no tidal influence
- Tidal Fresh, 0 – 1 ppt, tidal influence
- Oligohaline, 2 – 5 ppt, slightly brackish
- Mesohaline, 8 – 15 ppt, brackish
- Polyhaline, >18 ppt, salt water

The most commonly used road salt is sodium chloride (NaCl). NaCl dissociates in aquatic systems into chloride ions (Cl-) and sodium cations (Na+). This also results in a higher conductivity reading. Elevated sodium and chloride levels create osmotic imbalances in plants, which inhibit water absorption and reduce root growth. Various species of fish, amphibians and aquatic macroinvertebrates are adversely impacted by increased levels of sodium and chloride.

Water Quality Evaluation Methodologies

Water quality data was collected in the field using a Conductivity/Salinity/Temperature Meter, YSI 63 pH, YSI Model 55 Dissolved Oxygen Meter, and LaMotte 2020 Turbidimeter. V3 performed water quality measurements for the following parameters: temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow and turbidity. V3 utilized ESG laboratories to analyze total phosphorus, *E. coli* concentrations, and biological oxygen demand (BOD). Phosphate and Nitrate concentrations were measured using the HACH field instruments.

Water Quality Evaluation Results

Historical and current water quality data collected from within the Watershed has been reviewed from various sources which include IDEM sampling, TMDL sampling, National Pollutant Discharge Eliminations System (NPDES) sampling, and volunteer monitoring. In an effort to summarize the problems within the Watershed and evaluate their results, water

quality standards were used as benchmarks. If water quality results were either below lower limit thresholds or results were greater than higher limit thresholds, an increment of exceedance was tallied. Condensing the water quality results was the method in which the eight 14-digit HUC subwatersheds were compared and prioritized.

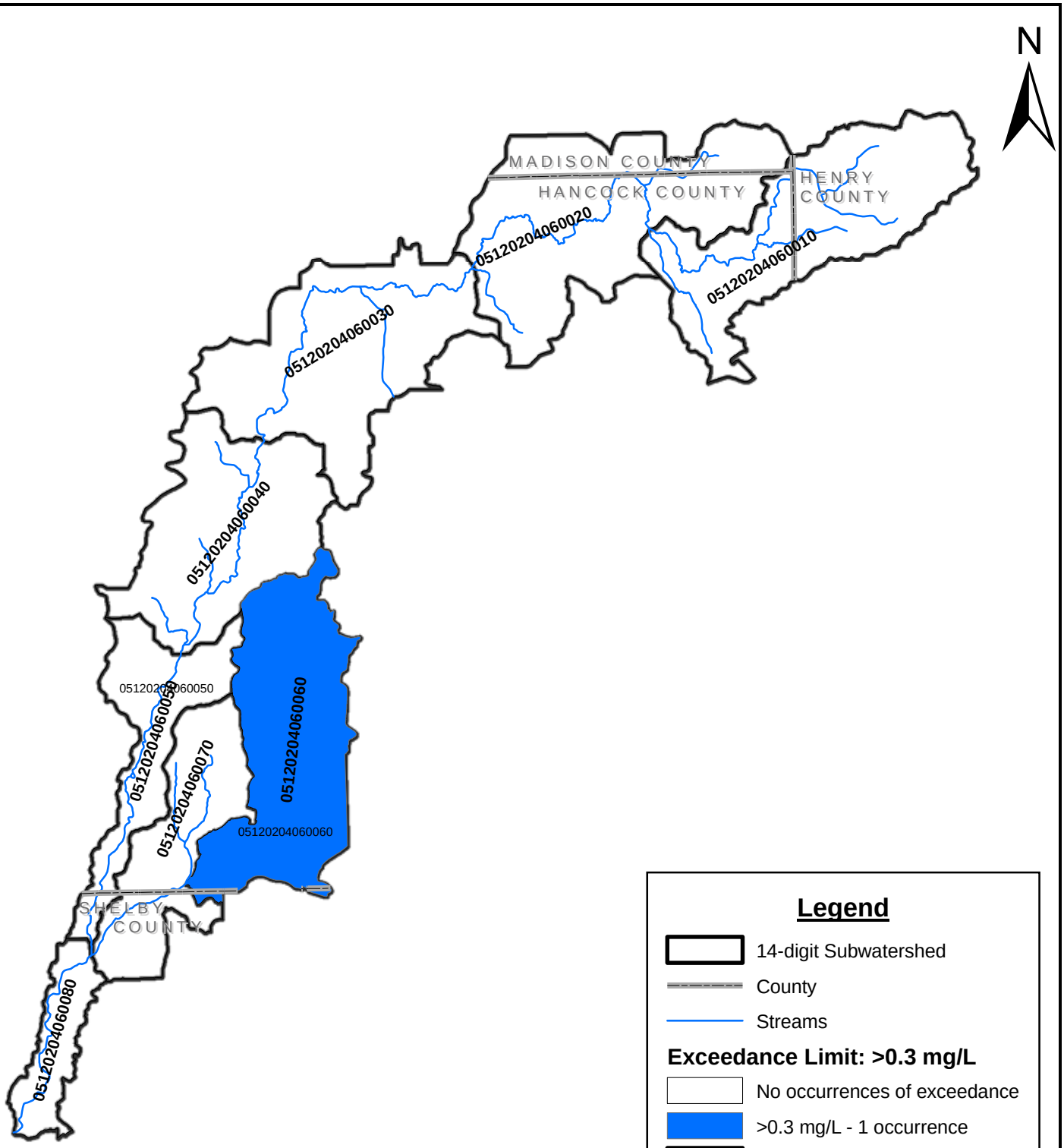
The water quality parameters which have standard limits associated with them were screened to determine which priorities for subwatersheds demonstrated impairments or degradations. V3 water quality results were not included in these exhibits to distinguish between historical and current trends in impairment. The water quality parameters evaluated from the historical data set and their suggested limits include:

- Total Phosphorus (Exhibit 27), values which exceed 0.3 mg/L
- Total Nitrate and Nitrite (Exhibit 28), values which exceed 10 mg/L
- DO (Exhibit 29), values less than 5 mg/L & greater than 12 mg/L
- *E. coli* (Exhibit 30), values greater than 235 CFU/100 mL
- Arsenic (Exhibit 31), values greater than 0.5 μg/L

Exhibits 27-31 are presented in the 14-digit HUC subwatershed boundary because that was the boundary used when the study was conducted. Sugar Creek historical water quality results demonstrated impairment or degradation throughout the watershed. Infractions on suggested limits/standards for nitrate/nitrite and arsenic were present at one of the eight 14-digit HUC subwatersheds (05120204060050). One infraction was noted for phosphorus exceedance at the 05120204060060 HUC subwatershed. Four of the eight subwatersheds demonstrated an impairment or degradation with respect to DO levels and *E. coli* concentrations. Subwatersheds which had DO levels in exceedance include 05120204060010, 05120204060020, 05120204060030 and 05120204060050. Subwatersheds which had *E. coli* concentration exceedances include 05120204060010, 05120204060030, 05120204060040, and 05120204060050.

V3 performed monthly water quality sampling at eight stations for a period of one year, and was complete as of May 2008. Monthly sampling was performed as part of the preparation of this WMP. The water quality result summary tables are shown in Appendix C. Water quality parameters evaluated from the V3 data set include:

- Total Phosphorus (Exhibit 32), values which exceed 0.3 mg/L
- Total Nitrate and Nitrite (Exhibit 33), values which exceed 10 mg/L
- DO (Exhibit 34), values less than 5 mg/L & greater than 12 mg/L
- *E. coli* (Exhibit 35), values greater than 235 CFU/100 mL
- pH (Exhibit 36), values greater than 8.7



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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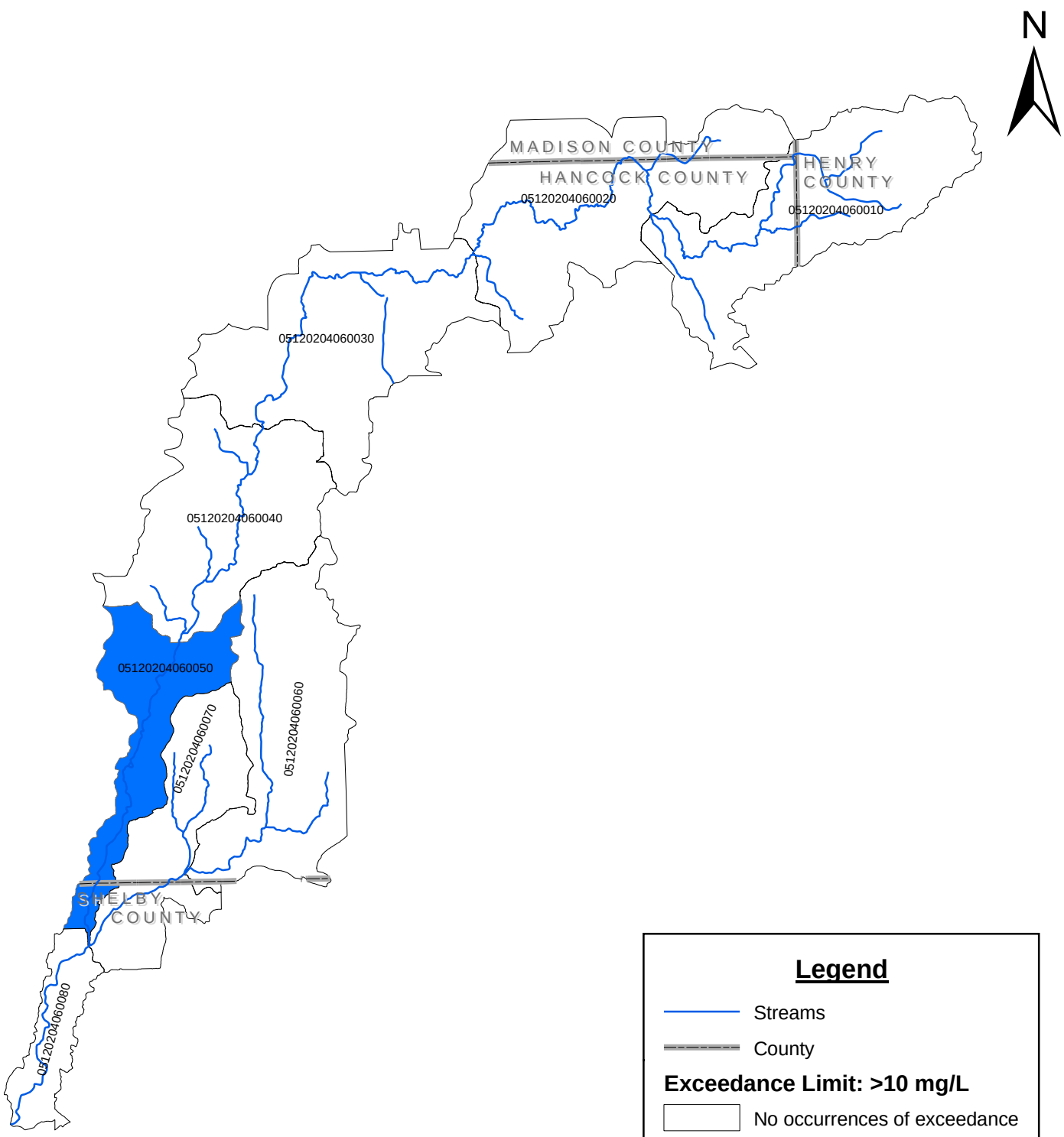
TITLE: Phosphorus Exceedance	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 27	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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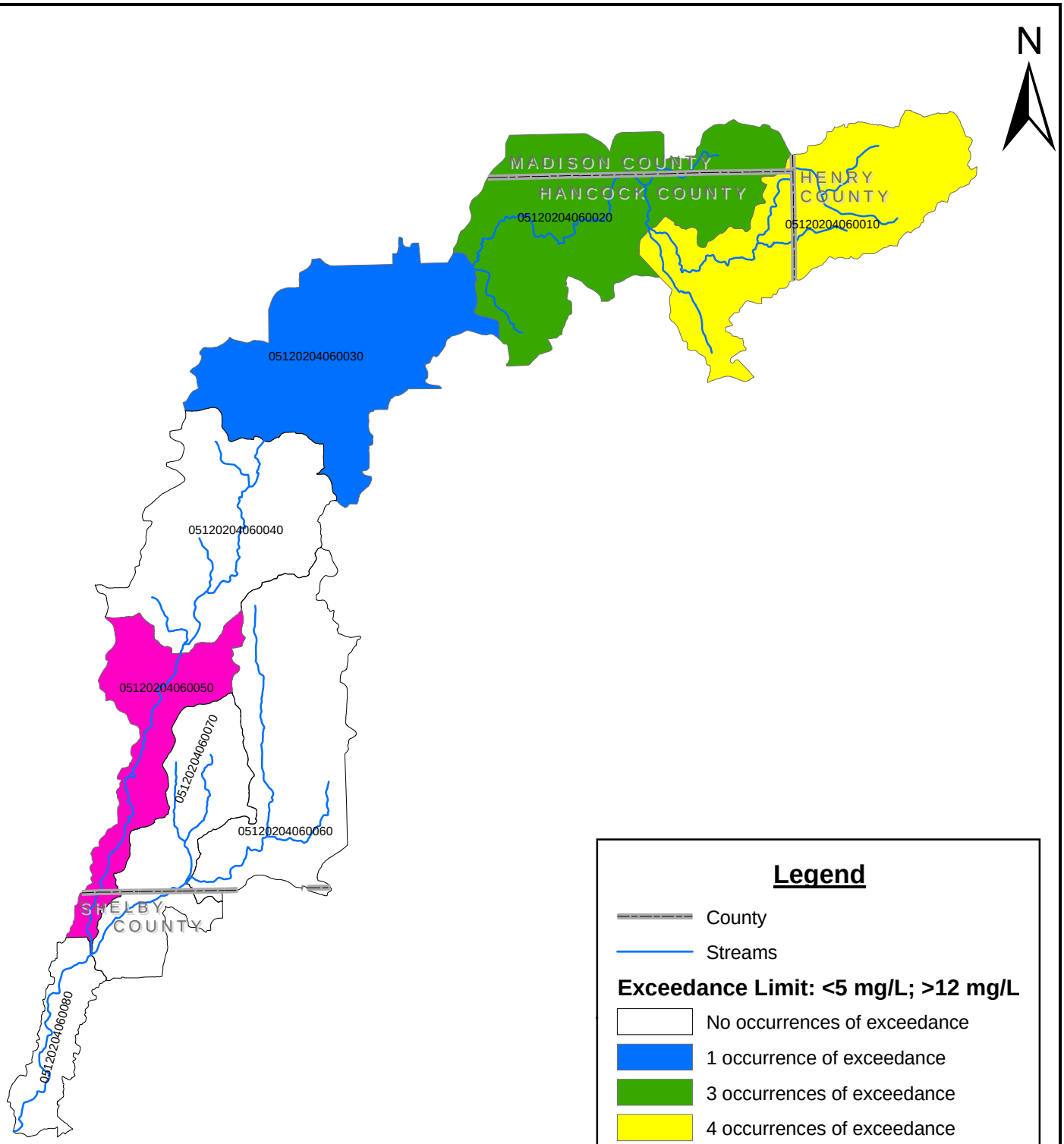
TITLE: **Nitrate and Nitrite Exceedance**		PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 28	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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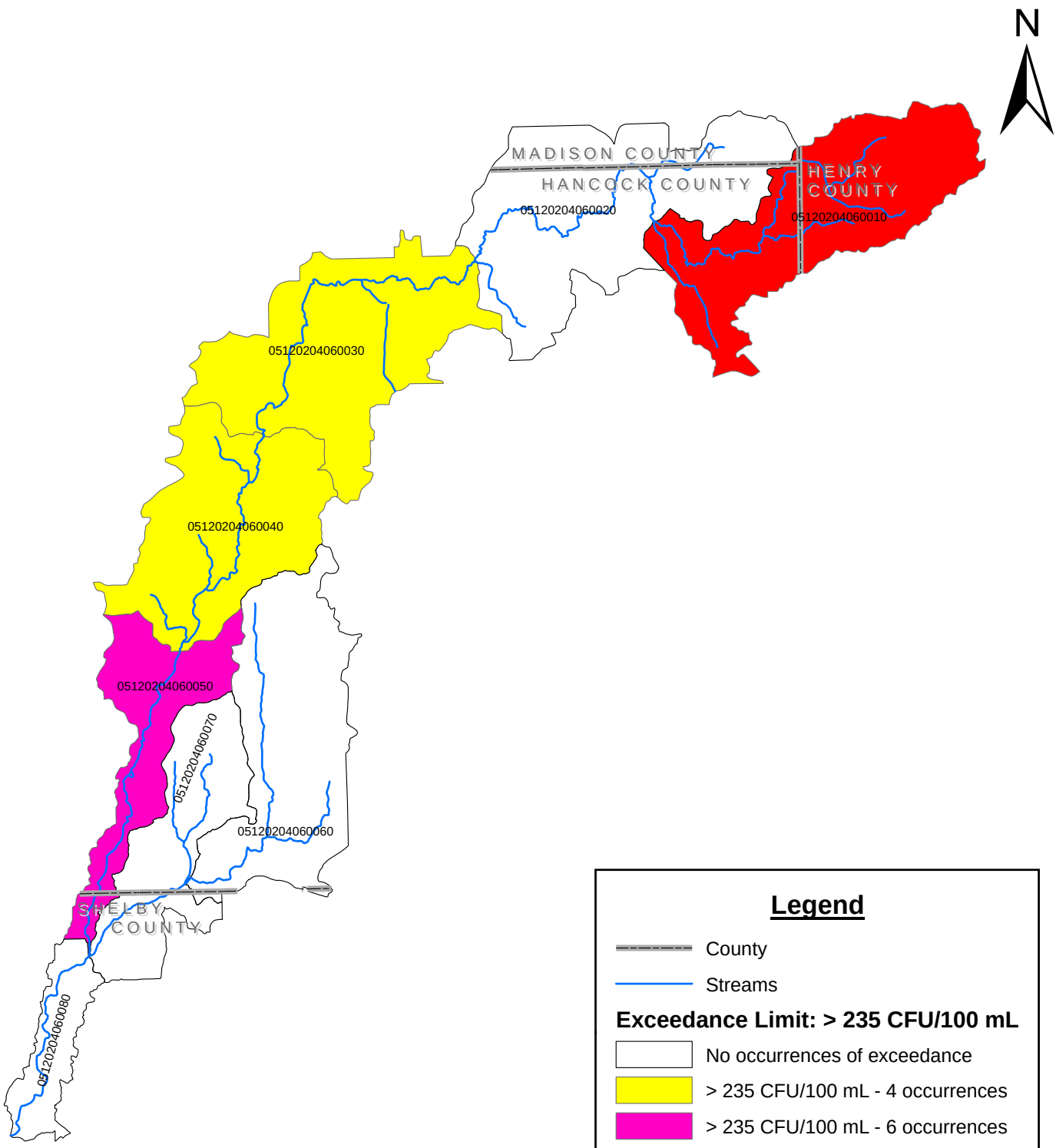
TITLE: **Dissolved Oxygen Exceedance**		PROJECT: **Sugar Creek Watershed Project**	
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 29	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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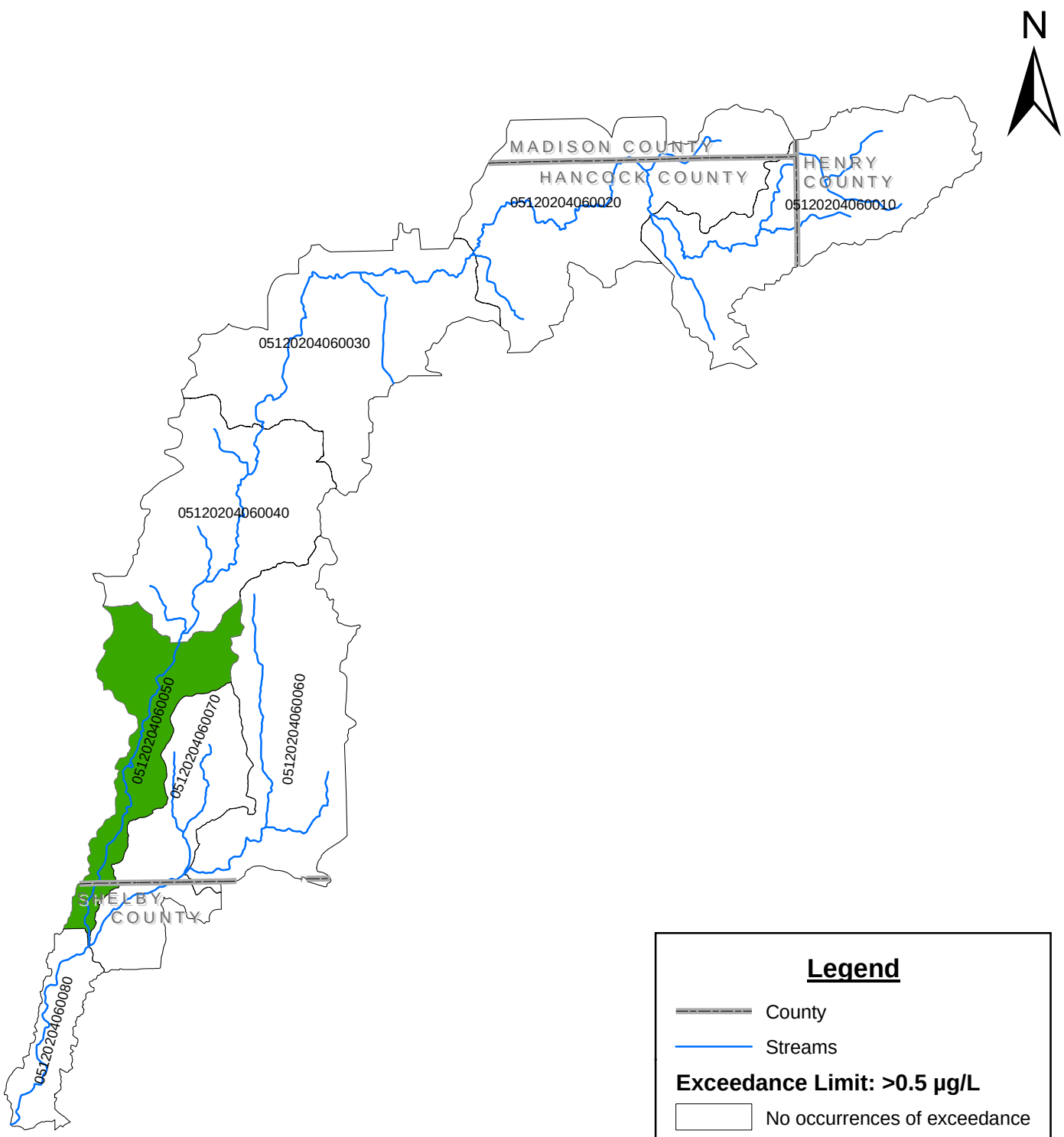
TITLE: E. coli Exceedance		PROJECT: Sugar Creek Watershed Project	
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 30	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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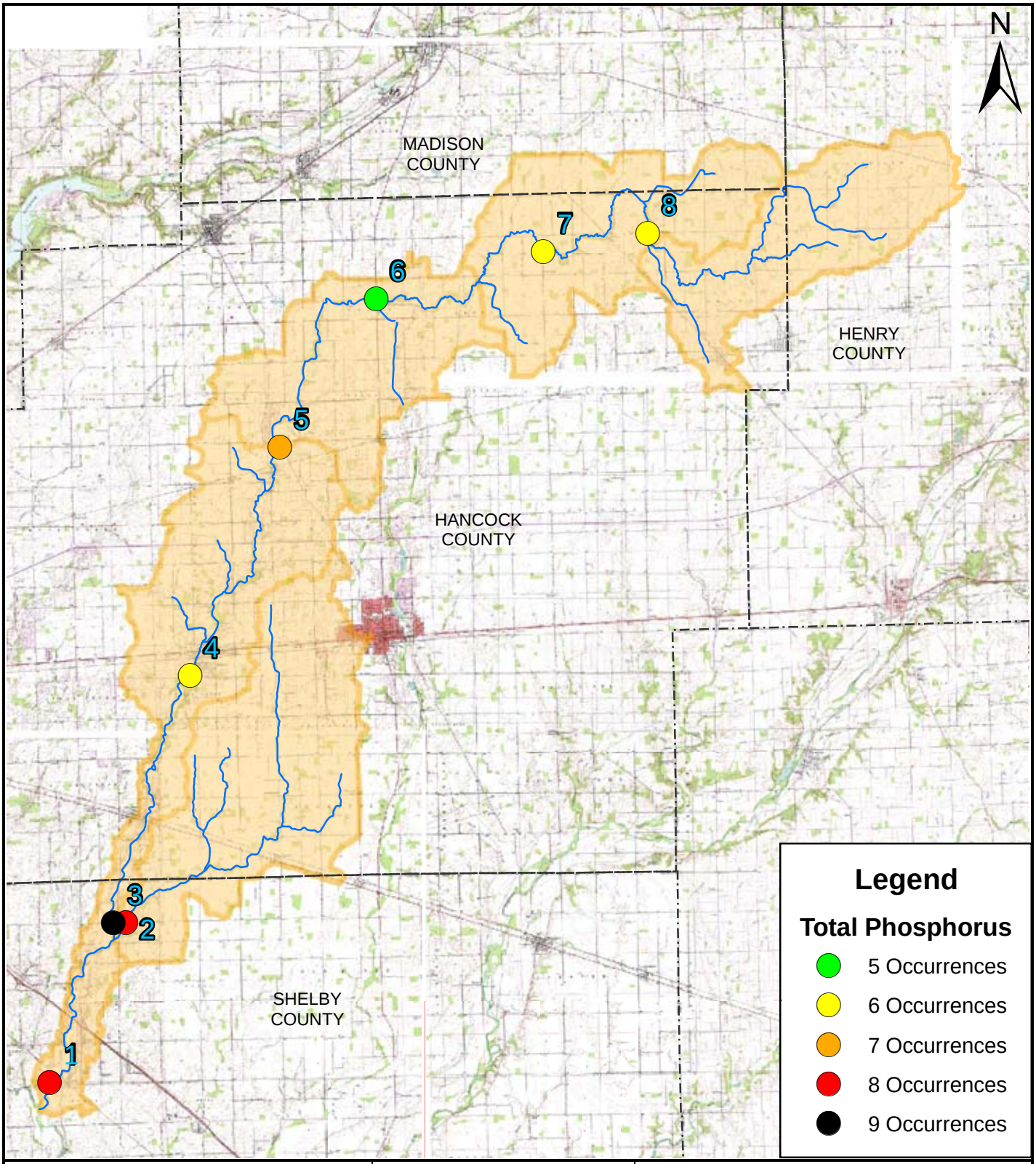
TITLE: **Arsenic Exceedance**		PROJECT: **Sugar Creek Watershed Project**	
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 31	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



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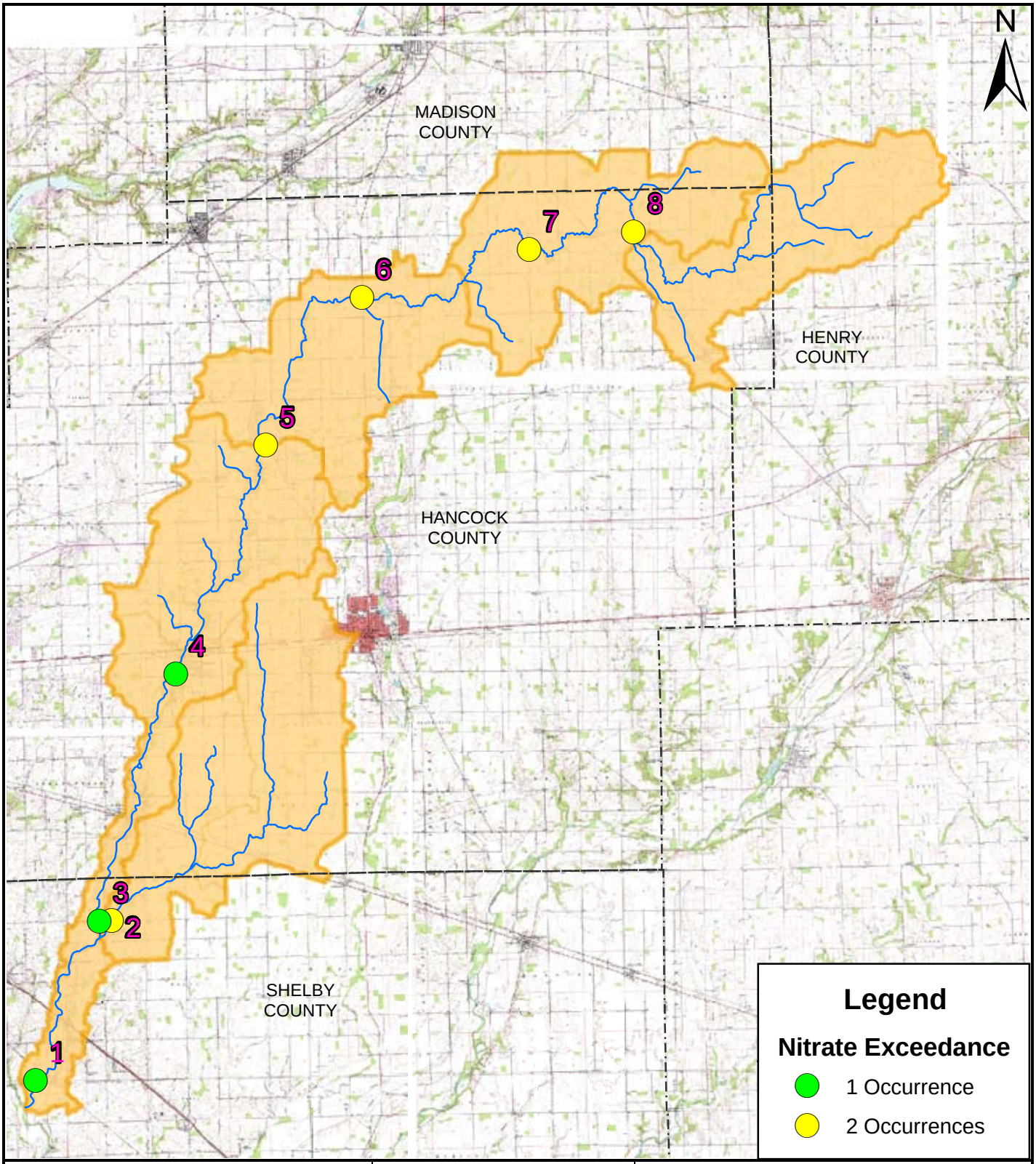
TITLE: **Total Phosphorus Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 32	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/29/08	SCALE: NTS



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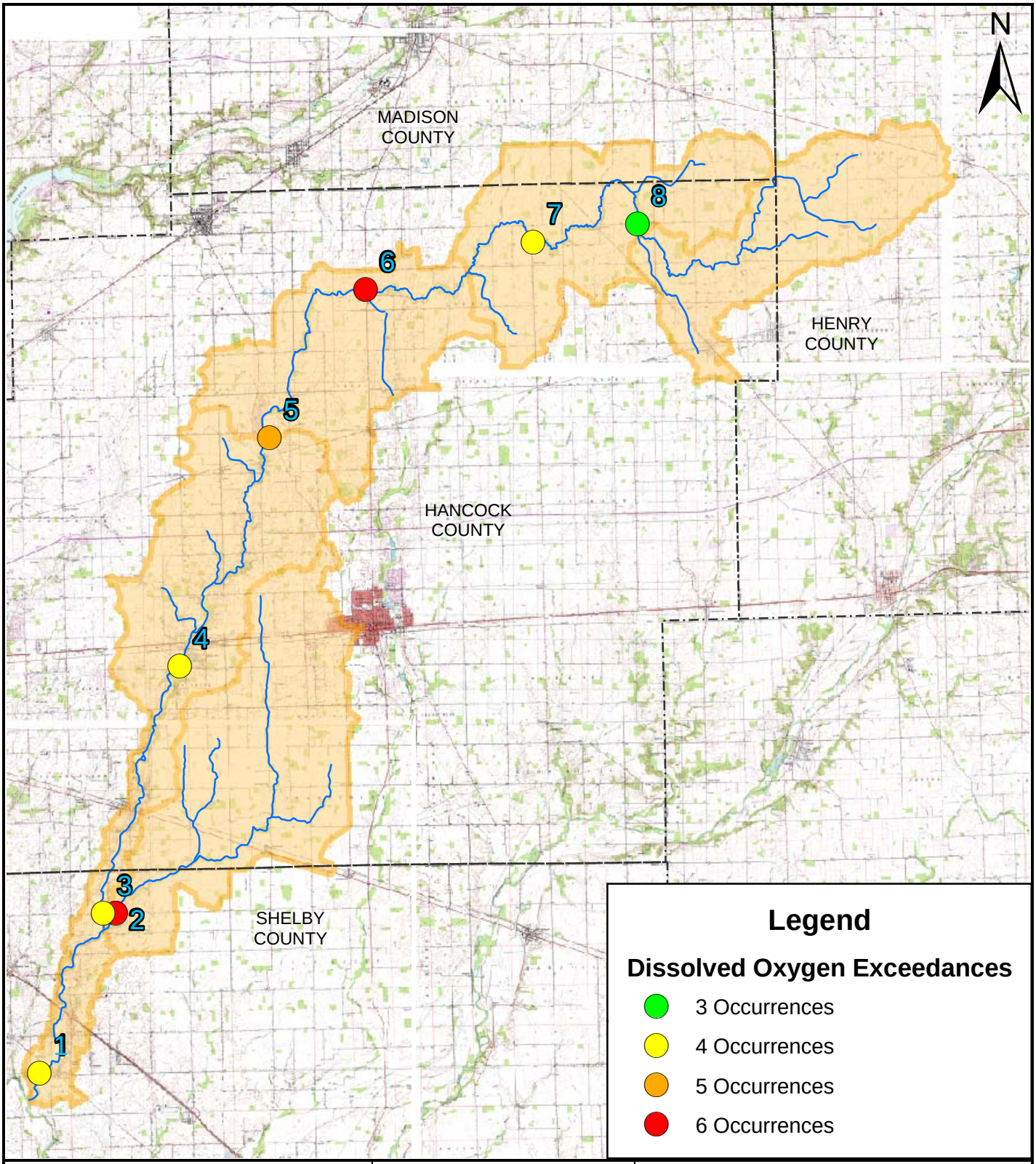
TITLE: **Nitrate Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 33	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS



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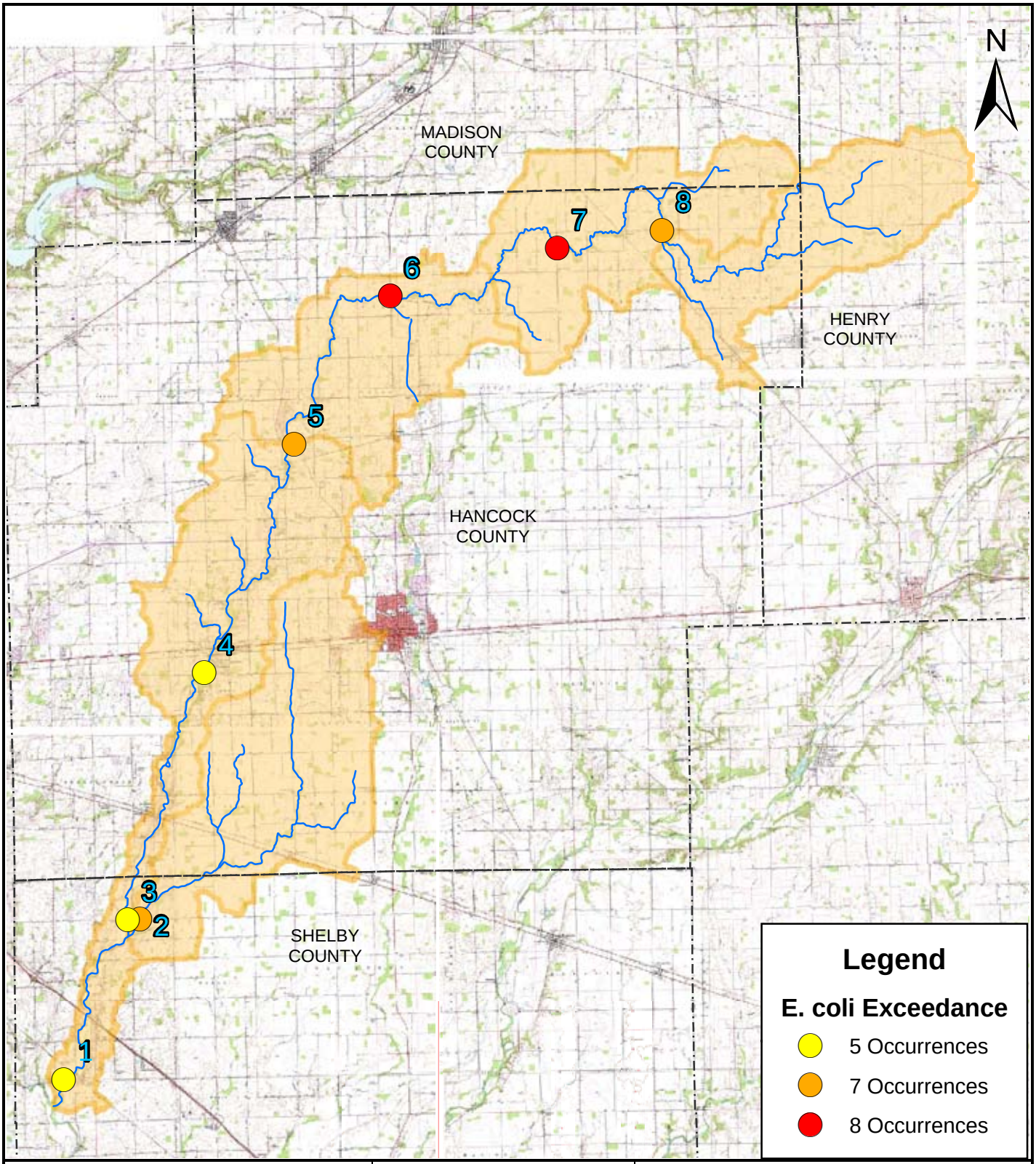
TITLE: **Dissolved Oxygen Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 34	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/28/08	SCALE: NTS



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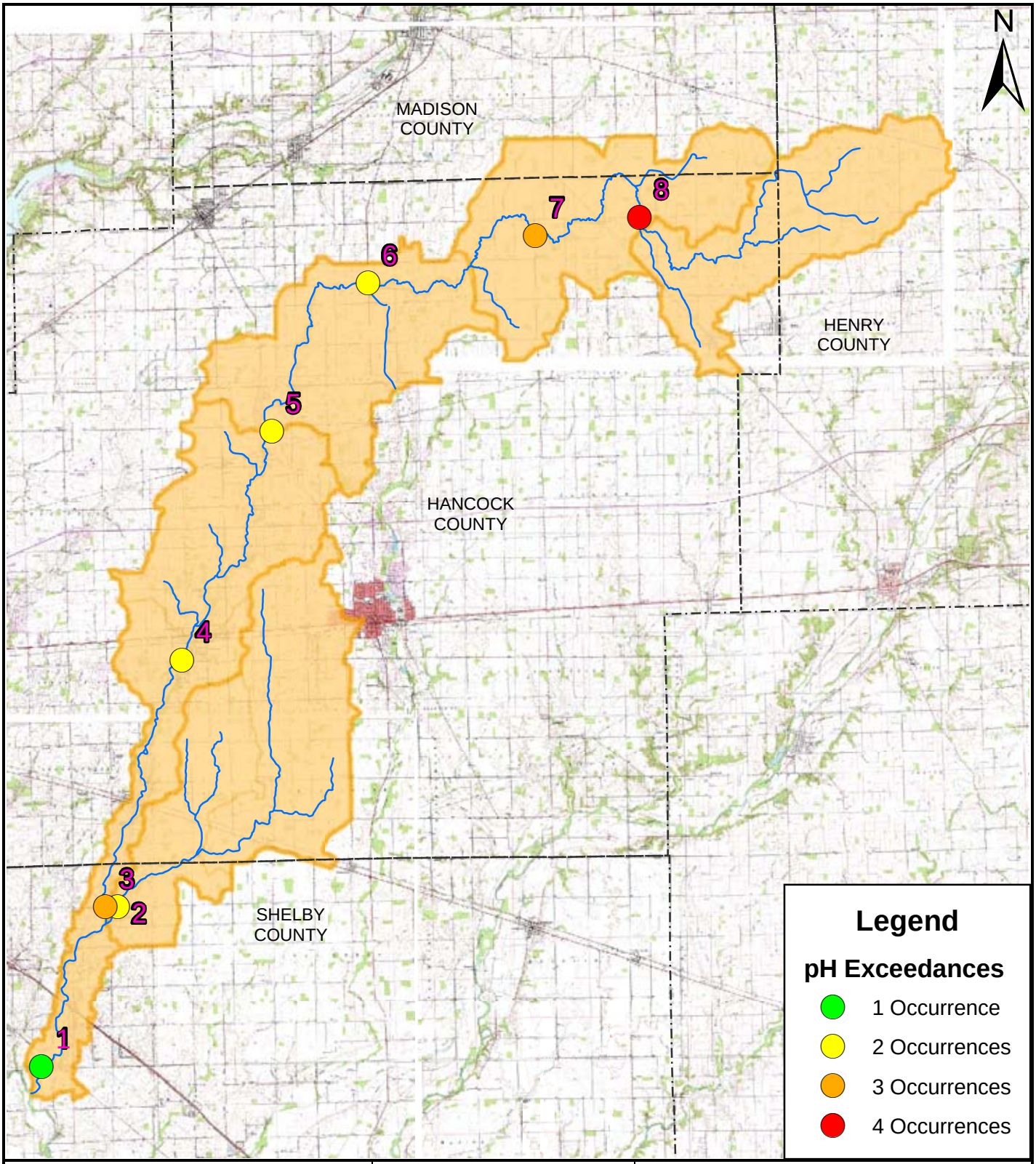
TITLE: **E.coli Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 35	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/29/08	SCALE: NTS



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TITLE: **pH Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 36	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/29/08	SCALE: NTS

Sediment is another parameter of concern within the Sugar Creek Watershed, not only due to the impacts of the sediment itself, but of the contaminants that often bind with, or otherwise reside in the sediment. Evidence from the windshield survey supports severe erosion from land surface and stream banks throughout the watershed that contribute to the excessive load of sediment within Sugar Creek. Suspended sediments is a component of the amount of particulate matter in the water column and contributes to increases in the turbidity values, making it more difficult and often times impossible for fish and aquatic macroinvertebrates to live. The sediment itself can smother aquatic habitat and therefore negatively affect the aquatic flora and fauna. Sediment can also transport nutrients, especially phosphorus that tends to adhere to sediment particles causing excess algal growth leading to the large swings in DO as discussed above. *E. coli* has also been found to live, and under certain conditions, grow within sediments.

Metals data did not show any values of concern, and pesticide data was not collected by IDEM in the Watershed. In addition, most areas studied had good habitat and healthy aquatic communities, so enhancement and preservation of the resource rather than restoration may be the strategy needed in many portions of the Watershed. One area that should be further evaluated is on Sugar Creek near New Palestine.

E. coli has been found to be a persistent and ubiquitous problem. In evaluating IDEM's data, many sites in the Watershed violated Indiana's standards for *E. coli* as was verified by the Sugar Creek TMDL study conducted by IDEM in 2007. In response, many streams within the basin are listed on IDEM's 303(d) list of impaired waterbodies (Exhibit 30 and Exhibit 35; Table 25). Because this is such a widespread issue, it must be addressed in many parts of the Watershed.

Table 25 2006 303(d) Stream Impairments within Sugar River Watershed									
Segment ID	**Segment Name**	**County**	**Miles** (Length of NHD reach)	**Segment Size** (Length of ADB assessment unit in miles)	**HUC14**	**Impairment Total** (Total # of impairments for ADB assessment unit segment)	**FCA HG** (Waterbody impaired-has Fish Consumption Advisory for mercury)	**FCA PCBS** (Waterbody impaired-has a Fish Consumption Advisory for PCBs)	***E. coli*** (Waterbody is impaired for *E. coli*)
INW0461_T1028	Sugar Creek (Upstream of Grain Ditch)	Hancock	3.54	4.39	05120204060010	1.00	Yes	No	No
INW0461_T1028	Sugar Creek (Upstream of Grain Ditch)	Hancock	2.08	4.39	05120204060010	1.00	Yes	No	No
INW0461_T1028	**Total**			**8.78**					
INW0461_T1029	Sugar Creek (Downstream of Grain Ditch)	Hancock	4.39	5.62	05120204060010	1.00	No	No	Yes
INW0462_T1029	Sugar Creek	Hancock	7.74	8.97	05120204060020	1.00	Yes	No	No
INW0462_T1029	Sugar Creek	Hancock	1.23	8.97	05120204060020	1.00	Yes	No	No
INW0462_T1029	**Total**			**23.56**					
INW0463_T1030	Sugar Creek	Hancock	6.40	10.03	05120204060030	2.00	Yes	No	Yes
INW0463_T1030	Sugar Creek	Hancock	3.63	10.03	05120204060030	2.00	Yes	No	Yes
INW0463_T1030	**Total**			**20.06**					
INW0464_T1003	Kirkhoff Ditch	Hancock	1.80	1.58	05120204060040	1.00	No	No	Yes
INW0464_T1003	**Total**			**1.58**					
INW0464_T1031	Sugar Creek	Hancock	0.25	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	1.68	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	3.62	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.31	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.46	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.61	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	**Total**			**41.58**					
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	3.48	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	5.01	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	0.11	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	0.22	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	**Total**			**35.36**					
INW0466_T1026	Little Sugar Creek	Hancock	3.00	3.00	05120204060060	2.00	Yes	Yes	No
INW0466_T1026	**Total**			**3.00**					
INW0468_T1033	Sugar Creek-Sugar Creek (Town)	Shelby	5.92	5.92	05120204060080	2.00	Yes	Yes	No
INW0468_T1033	**Total**			**5.92**					
Grand Total				**139.84**					

Analysis of Information Related to the USGS NAWQA Studies and Water-Quality Analysis of Leary-Weber Ditch

Between 1991 and 2001 the US Geological Survey (USGS) completed the National Water-Quality Assessment (NAWQA) study to help support local, regional, and national information needs related to water-quality management and policy. The goal was to create a baseline understanding of water-quality conditions throughout the nation to aid decisions and policy recommendations affecting this vital resource. USGS plans on continuing studies from 2001 – 2012, to address five national priority topics to establish links between sources of contaminants and the fate and transport of these contaminants. Priorities include:

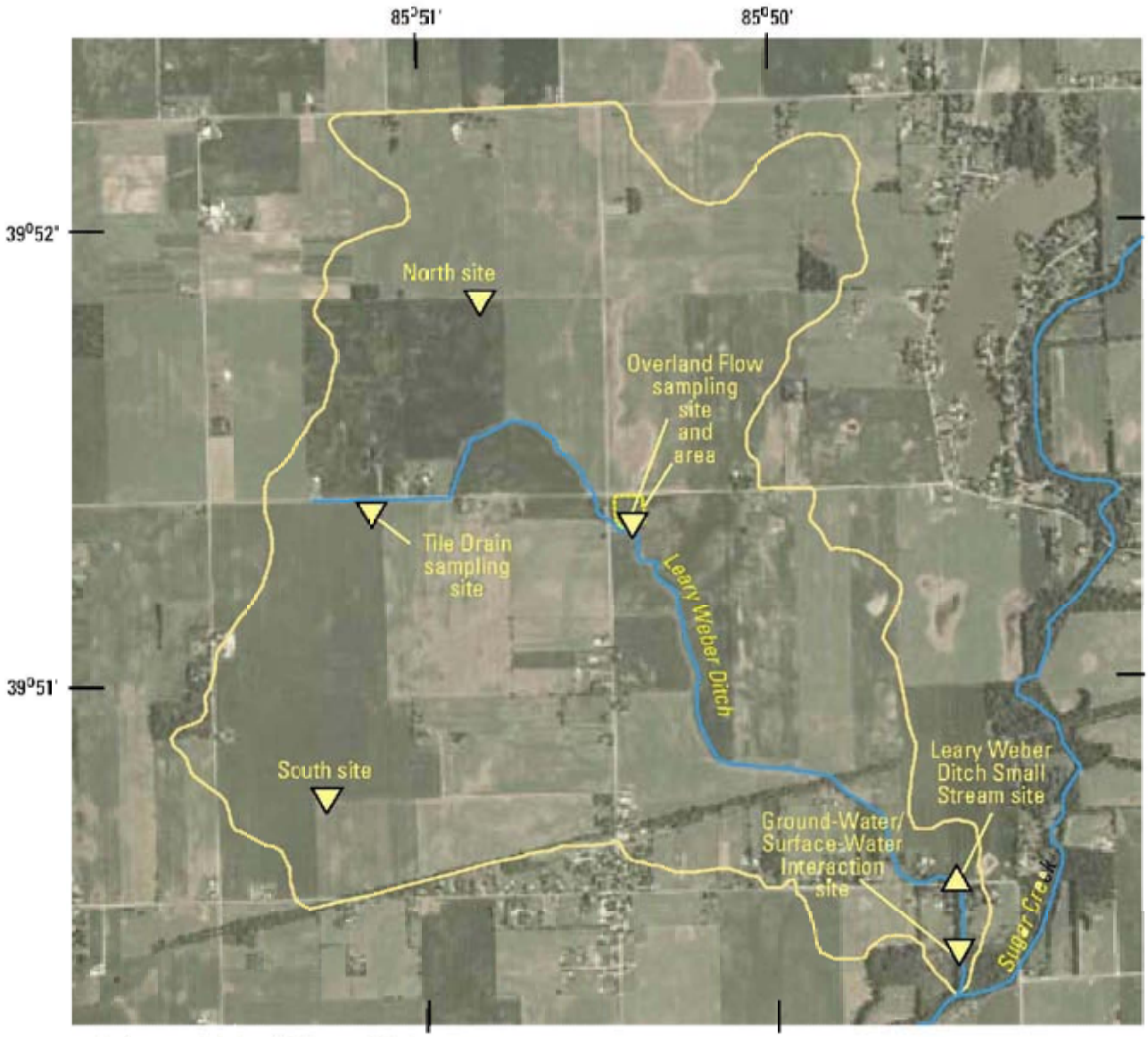
1 Fate of agricultural chemicals
2 Effects of urbanization on stream ecosystems
3 Bioaccumulation of mercury in stream ecosystems
4 Effects of nutrient enrichment on aquatic ecosystems
5 Transport of contaminants to public-supply wells

As part of this mission the USGS conducted a study on the source, transport, and fate of agricultural chemicals in Leary Weber Ditch which is located in the Sugar Creek Watershed in Hancock County. Hydrologic and chemical analysis indicated that the lowest concentrations of pesticides and nutrients were found in rain water, soil water, and ground water, whereas the highest concentrations were found in tile drain water, overland flow, and in samples of Leary Weber Ditch itself. Contamination to the stream from overland flow was only a problem during high-intensity rain events (0.75 inches of rain/hour or greater). These events were rare, so the majority of the impact, both during rain events and between rain events is due to tile flow. Specifically looking at nutrients, nitrate is transported to the greatest amount through tile drains, and orthophosphate has its highest concentration in overland flow. This study will provide insight to possible sources of contaminants with the Sugar Creek Watershed.

Summary of the National Water-Quality Assessment Program's Environmental Setting of the Sugar Creek and Leary Weber Ditch Basins, Indiana, 2002-04 Report

In the Sugar Creek and Leary Weber Ditch Basins, the study was designed to develop an understanding of the sources, pathways, and transformational processes that water and selected chemicals undergo during movement from a local field to a large river. Comparing findings in a nested small basin like Leary Weber Ditch basin to those in a larger basin like Sugar Creek Basin, effects of agricultural chemicals and hydrologic transport at larger geographic scales can be better understood.

The Leary Weber Ditch Basin is a small, intermittent stream that is located 20 miles east of Indianapolis in Hancock County. The ditch is characterized by a clay and muck bottom in its upstream segment, with a more cohesive sand and gravel bottom toward its mouth. The Leary Weber Ditch Basin is primarily an agricultural area and most chemical inputs are the result of crop production. In the Leary Weber Ditch 87% of the total basin is used for row crops. Modifications to natural hydrology of Leary Weber Ditch include subsurface drainage (tile drains) which have been installed to improve the soils for farming and improve yields. Drains greatly increase the rate of water exiting the field and subsequently speed the transport of chemicals and nutrients contained in the soils. At Leary Weber Ditch, there is little to no streamflow when tile drains run dry and at baseflow there is little to no ground-water input. Samples were collected from each environmental compartment within Leary Weber Ditch-precipitation, tile drains, overland flow, unsaturated zone, surface water, ground water, and the ground-water/surface-water interface (Exhibit 37).



Base From U.S. Department of Agriculture, 2003 National Agricu tural Imagery Program, County Tiles for Indiana, Hancock, County. Universal Transverse Mercator projection, Zone 16, North American Datum, 1983

EXPLANATION

Leary Weber Ditch Basin

U.S. Geological Survey streamflow-gaging station

U.S. Geological Survey water-quality station

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TITLE: **Leary Weber Ditch Sampling Locations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 37	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 7/1/08	SCALE: NTS

Summary of Occurrence and Transport of Agricultural Chemicals in Leary Weber Ditch Basin, Hancock County, Indiana, 2003- 2004

An understanding of water movement and chemical properties is necessary for understanding how agricultural chemicals (nutrients and pesticides) move from the field surfaces to streams and ground water. Leary Weber Ditch Basin is one of seven first order basins selected from across the United States as part of the Agricultural Chemicals: Source, Transport, and Fate study. Agricultural chemicals were detected in Leary Weber Ditch and in every hydrologic unit code during 2003 - 2004. Pesticides were detected more frequently in samples collected from overland flow and the ditch rather than ground water samples. The highest concentrations of pesticides and nutrients were detected in samples of tile-drained water, overland flow, and water from Leary Weber Ditch. Overland flow is an important agricultural-chemical transport pathway during high intensity rainfall; however may be sporadic throughout the year.

A conservative mixing analysis, using potassium as a tracer, was used to determine relative contributions of overland flow and tile drain discharge to Leary Weber Ditch during seven storm events in 2003 and 2004. Results of the mixing analysis suggests that overland flow may be a significant contributor of water to Leary Weber Ditch during periods of high intensity rainfall and when soil conditions favor surface runoff. During most storms and between storms tile drains are the most important contributor for the movement of agricultural chemicals to Leary Weber Ditch. Based on the hydrologic contributions of overland flow water and tile drain water to Leary Weber Ditch, tile drains are the primary agricultural chemical transport mechanism.

Analysis of Information Related to USGS Water Quality in White River Basin

From 1992 to 1996 the USGS gathered water quality data within the White River Basin as part of the NAWQA program. There was one sampling station (number 15) located along Sugar Creek in this study (Exhibit 38). This study disclosed several water quality issues directly related to Sugar Creek. From 1992 to 1995, 28 percent of atrazine samples exceeded the USEPA Maximum Contaminant Level (MCL) of 3 µg/L. One probable cause is that during 1993, atrazine had been applied to 90 percent of the corn crop in central and southern Indiana. Pesticides from this evaluation were found more frequently in the surface water of streams than in the ground water. This study also found that the Sugar Creek Watershed had a lower concentration of pesticides than levels found in other watersheds. The lower concentration is attributed to the poorly drained soils characteristic of the Sugar Creek Watershed. Well drained soils have less time for pesticides to break down and are transported to the stream faster. Table 26 shows several parameters of water quality sampling that were collected during the study and how the parameter's results rank compared nationally to other watersheds in the NAWQA program. In the display of this table, it is best to have a lower ranking, meaning the stream is less impaired.

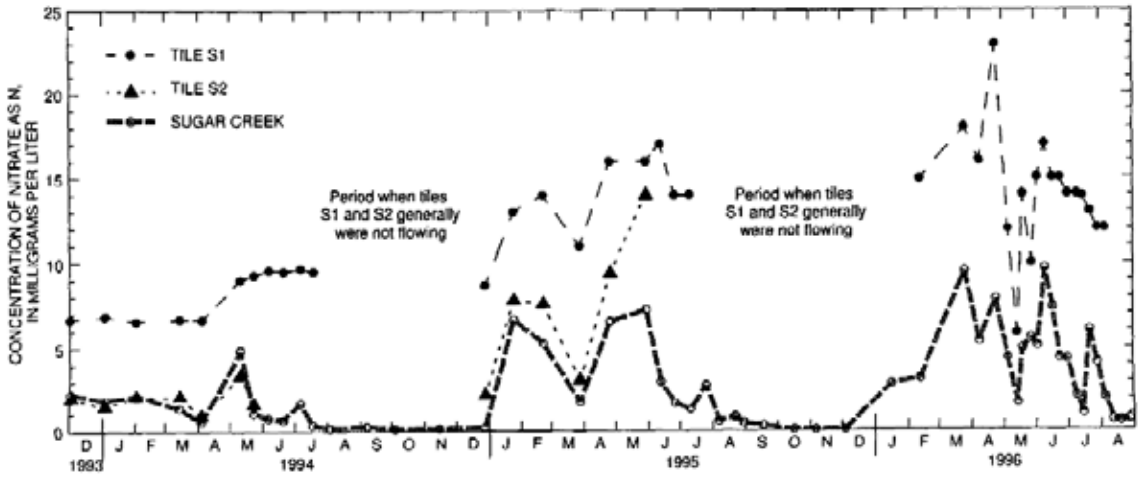
Table 26: Comparison of Sugar Creek to National Water-Quality Assessment (NAWQA) findings (USGS 1998)

Sample Type	Source	Percentile
Nutrients	surface water	50 to 75
Pesticides	surface water	50 to 75
PCBs and Organic Chlorines	streambed sediment	50 to 75
Semivolatile Organic Compounds (SVOCs)	streambed sediment	50 to 75
Fish Communities Degradation	stream	0 to 25
Stream Habitat Degradation	stream	0 to 25

Analysis of Information Related to the USGS Transport of Agrichemicals to Ground and Surface Water in a small Central Indiana Watershed

This study was conducted by Fenelon and Moore in 1998. From 1992 to 1996, nitrate and 82 pesticides and pesticide metabolites were monitored at two drain tiles, eleven wells, and several surface water sampling locations along Sugar Creek. This study concluded that nitrogen and atrazine levels within drain tiles correlate to stream levels of nitrogen and atrazine. When the drain tiles are not carrying flow with nitrate or pesticides, the stream level concentrations of nitrogen and atrazine drop to trace levels. This demonstrates that drain tiles are an important, and often overlooked, pathway for these and other constituents that are applied to agricultural fields. Figure 1 shows the correlation of Nitrate in two tiles and Sugar Creek from December 1993 to August 1996. This study also demonstrated that aquifers which are confined by more than 6m of clay-loam (the primary source of potable drinking water supply in the study area) are protected by the clay-loam layer and are not likely to be contaminated by pesticides or nitrogen. In contrast, the unconfined alluvial aquifers are subjected to contamination from nitrogen and pesticides.

Figure 1. Relation of nitrate concentrations in tile drains and Sugar Creek to time (USGS Fenelon and Moore 1998).



Analysis of Information Related to Indiana State Fish Consumption Advisory

Each year the Indiana State Department of Health in conjunction with the Indiana Department of Natural Resources and IDEM published a fish consumption advisory for Indiana. Advisories are based on actual fish tissue data collected from Indiana's rivers, lakes, and reservoirs. Guidelines are then published so that the public can make informed decisions based on what type of fish they would like to eat, and the amount of fish that is safe to consume within a given time period.

Advisories are based on specific contaminants that can bio-accumulate in fish tissue, polychlorinated biphenyls (PCBs), pesticides, and heavy metals such as mercury. Stream reaches with fish consumption advisories related to Mercury are demonstrated in Exhibit 25 and include two stream reaches located in the northern portion of the Watershed. Stream reaches with fish consumption advisories related to PCB's are demonstrated in Exhibit 26 and also include two stream reaches located in the southern portion of the Watershed. Criteria for these advisories were developed by the Great Lakes Sport Fish Advisory Task Force. Advisories fall in one of the five categories listed in Table 27. Advisories are different for specific high risks groups such as pregnant women, women who are breastfeeding and children under the age of 15. Fish consumption advisories for the Sugar Creek Watershed include the species listed in Table 28.

Table 27: Advisory Groups of the Indiana Fish Consumption Advisory	
Group Number	**Definition**
Group 1	Unrestricted Consumption **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 2	Limit to one meal per week (52 meals per year) for adult males and females. **One meal per month for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 3	Limit to one meal per month (12 meals per year) for adult males and females. **Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 do not eat.**
Group 4	Limit to one meal every 2 months (6 meals per year) for adult males and females. **Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 do not eat.**
Group 5	**No consumption (DO NOT EAT).**

Data from 2008 Indiana Fish Consumption Advisory

Table 28: Fish Consumption Advisory by Species				
Species	**Size Class (inches)**	**Contaminant**	**Advisory****	**Waterbody Name and County**
Creek Chub	All	PCBs	Group 3	Little Sugar Creek/East Fork White River (Hancock County)
Black Redhorse	9-16		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	Up to 24	Mercury	Group 2	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	24+	Mercury	Group 3	Sugar Creek (Hancock/Johnson/Shelby Counties)
Longear Sunfish	Up to 5		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Northern Hogsucker	Up to 11		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	15 - 20	PCBs	Group 3	All rivers and streams
Common Carp	20 - 25	PCBs	Group 4	All rivers and streams
Common Carp	25+	PCBs	Group 5	All rivers and streams

*Data from 2008 Indiana Fish Consumption Advisory

**Any fish not specifically listed in the table should be considered a Group 2 advisory.

The supporting baseline data supports the stakeholder concerns that were gathered from the initial public meeting held on October 11, 2007. The public voiced their concerns with respect to priority resource issues within the watershed including the categories of Agricultural, Pollution, Development/Urban, Recreational, Wildlife/Habitat, and Other Issues and Concerns. The same concerns voiced by the public, were again demonstrated by the observation results of our Windshield Survey performed by the Steering Committee volunteers. Our analysis of the available biological, habitat and water quality data from IDEM, USGS, the National Water-Quality Assessment Program and the Indiana Department of Health, as well as the biological, habitat and water quality data from V3's evaluation effort during this project, similarly supports the same concerns with the validation that these are existing issues within our watershed. We identified *E. coli*, nutrients, sedimentation and flooding throughout various publications and studies from Pages 42 through 105. The beginning portion of Section 2 provided the details of Identifying Problems and Causes of Pollution. The following Pages 106 through 116 streamline this information in a summary narrative for the reader of this Watershed Management Plan to easily understand the relevance of problems throughout the Sugar Creek Watershed. The Sugar Creek Steering Committee discussed the problems and causes of watershed degradation. This discussion included overviews of maps with data summary tables which were presented for interpretation and discussion by the committee. All of this information, through several monthly steering committee meetings, provided the condensed summary here in.

Identify Problems in the Watershed Based on the Information Gathered

On January 10, 2008, the steering committee utilized the windshield survey data that was collected within the Watershed in combination with the current and historical water quality data presented by V3 to assess the potential critical areas of concern within the Sugar Creek Watershed. The steering committee identified the seven most critical water quality components of degradation to the Sugar Creek Watershed as *E. coli*, nutrients, erosion and sedimentation, excessive flow rates and volumes during storm events, lack of open space, lack of stakeholder knowledge regarding impacts, and lack of stakeholder awareness of planning process.

The members of the steering committee suggested that the following contribute to each of the most critical components. *E. coli* problems in the Watershed are caused by the following: livestock, septic systems, Confined Feeding Operations (CFO's), Confined Animal Feeding Operations (CAFO's), wildlife waste, wastewater treatment plants, and package plants. Nutrient problems in the Watershed are caused by the following: agricultural practices and failing septic systems. Sediment problems in the Watershed are caused by the following: streambank erosion, construction sites, home sites, and agricultural practices. The following list of issues is from a public meeting held July 17, 2007 and includes edits and revisions from subsequent steering committee meetings.

Agricultural Issues:

- Drainage – need to maintain proper drainage for farming
- Log Jams – issues related to proper drainage
- Beaver – damming up drainage ways
- Flooding Impacts

Pollution Issues:

- Wildlife Effects on Water Quality
- Streambank Erosion – sediment and associated nutrients
- Trash/Illegal dumping
- Water Clarity
- Health Issues with bacteria – is it safe to swim and fish in Sugar Creek?
- Fish Consumption Advisories (Mercury)
- Cattle in the stream –health issues (*E. coli* etc.)
- Chemical concerns
- Failing Septics

Development/Urban Issues:

- Land Use Changes – increased urbanization
- Stormwater Management
- Flooding Impacts

Recreational Issues:

- Log Jams – issues related to canoeing
- Beaver – desired for wildlife viewing
- Canoeing and fishing, swimming (is it safe- bacterial problems)
- Identify hunter-friendly farms

Wildlife/Habitat Issues:

- Proper Wildlife Management – balance of diversity
- Sandbars (erosion and hydrologic modification)
- Habitat and Wildlife preservation, conservation
- Cattle in the stream – destruction of habitat

Other Issues and Concerns:

- Streams are more wide and shallow – what is the cause?
- Changes in weather patterns – effect on watershed
- Land Use Changes – Large Farms converted to Mini Farms
- Greenways along the river – desire to create parks and work through private property issues
- Finances – how do we pay for the changes that need to be made?
- Preservation – acquire land along streams from willing sellers

The concerns listed above from the public meeting held on October 11, 2007 were evaluated with information and data gathered during the management planning process (Table 29). The collection and analysis of the information/data validate some of the concerns and invalidated some of the concerns. Some of the listed concerns were not capable of being addressed under the proposed scope of this watershed management plan. Problem statements that are included in Table 29 are discussed in detail in the subsequent section.

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
AGRICULTURAL ISSUES:				
DRAINAGE	3, 4	Broken tile, lack of storage, storm water runoff as evidenced by the windshield survey.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Added storage; decrease volume of runoff
LOG JAMS	3, 4	Bank erosion; lack of maintenance as substantiated by the windshield survey and habitat quality data.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Removal of log jams, stream bank stabilization
BEAVER	3, 4	Conflict with human activity and nature as it was identified by attendees at the Sugar Creek Public Meeting.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education and remedy
FLOODING IMPACTS	3, 4, 5	Lack of storage upstream, lack of conveyance downstream based on flood observations from water quality sampling as well as concerns voiced by attendees at the Sugar Creek Public Meeting.	Loss of crops, loss of soil, visual assessment, communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Added storage, field buffers, education
POLLUTION ISSUES:				
WILDLIFE EFFECTS	1, 2, 5	Animal waste as evidenced by water quality data.	*E. coli* values that exceed state standard of 235 CFU. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
POLLUTION ISSUES CONTINUED:				
STREAMBANK EROSION	3, 4	Bank erosion; lack of maintenance as supported by habitat quality data and windshield survey.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization, slow stream velocity
TRASH/ILLEGAL DUMPING	6	Conflict with human activity as identified by stakeholders at the Sugar Creek Public Meeting and watershed clean up efforts.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	More cleanup days, education
WATER CLARITY	2, 3	Suspended sediments from eroding stream banks as supported by water quality data.	Visual assessment, monitoring results. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization and buffers and created wetlands
HEALTH ISSUES	1, 2, 5	Animal waste and human waste as evidenced by the Indiana State Department of Health.	*E. coli* values that exceed state standard of 235 CFU. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands, fishable, swimmable conditions and education
FISH CONSUMPTION	1, 5	PCB, Mercury contamination as evidenced by the Indiana State Department of Health.	Fish Consumption Advisory. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education
CATTLE IN THE STREAM	1, 2, 3	Animal waste as supported by windshield survey and observations during water quality sampling.	*E. coli* values that exceed state standard of 235 CFU, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Exclusionary fencing, increase buffers and wetlands, and education

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
DEVELOPMENT/URBAN ISSUES:				
LAND USE CHANGES	5, 6	Increased urbanization, poor construction practices as identified by stakeholders at the Sugar Creek Public Meeting.	Aerial photography, visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, sustainable development, windfarms, farmland protection
STORMWATER MANAGEMENT	5, 6	Increased urbanization, poor construction practices, untreated storm water runoff as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, wetlands, storm drain markers, increase infiltration, outreach on homeowner practices
FLOODING IMPACTS	3, 4, 5	Increased urbanization, poor construction practices as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders, insurance claims. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, created wetlands, increased storage

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
RECREATIONAL ISSUES:				
LOG JAMS RELATED TO CANOEING	3, 4	Bank erosion; lack of maintenance supported by habitat quality data and windshield survey.	Visual assessment; communication with landowners and boaters. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Removal of log jams, stream bank stabilization
BEAVER	3, 4	Reduced beaver population as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Habitat preservation and protection and increased trails and open spaces
CANOEING; FISHING; SWIMMING	1, 2, 5	Animal waste and human waste as supported by water quality sampling.	*E. coli* values that exceed state standard of 235 CFU, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands, fishable, swimmable conditions and education
*IDENTIFY HUNTER FRIENDLY FARMS	NA	Lack of awareness of available farms for hunting as identified by stakeholders at the Sugar Creek Public Meeting.	Communication with stakeholder.	Create a brochure

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
WILDLIFE/HABITAT ISSUES:				
*PROPER WILDLIFE MGMT.	NA	Lacking balance of diversity as evidenced by stakeholder concerns voiced at the Sugar Creek Public Meeting.	Communication with stakeholder.	Healthy biodiversity checked by inventories
SANDBARS	3, 4, 5	Erosion and hydrologic modification supported by habitat quality data and windshield survey.	Visual assessment; communication with stakeholders, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization, bedload at equilibrium
HABITAT AND WILDLIFE PRESERVATION AND CONSERVATION	5, 6	Lack of awareness and stewardship as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders	Increased awareness of preservation and conservation programs
CATTLE IN THE STREAM	1, 2, 3	Destruction of habitat from free access to the stream as identified in the windshield survey and observations during water quality sampling.	Visual assessment; communication with stakeholders, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Exclusionary fencing, alternative watering systems, education

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
OTHER ISSUES AND CONCERNS:				
STREAMS ARE MORE WIDE AND SHALLOW	3, 4, 5	Lack of streambank stabilization supported by windshield survey and observations during water quality sampling.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Streambank stabilization, increase buffers
*CHANGES IN WEATHER PATTERNS	NA	Natural fluctuations of the weather as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders	N/A (Consistency with Farmers Almanac)
LAND USE CHANGES	5, 6	Large farms converted to mini farms as evidenced by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Farm land preservation
GREENWAYS ALONG THE RIVER	3, 5	Lack of open space as supported by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Create parks and trail systems
FINANCES	6, 7	Lack of funding source awareness as identified by stakeholders at the Sugar Creek Public Meeting.	Communication with stakeholders	Research Grant and Funding opportunities
PRESERVATION	6, 7	Lack of awareness and stewardship as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders.	Increased awareness of preservation, conservation, and land trusts programs

** Problem or concern that is out of scope for this study.*

Developing Problem Statements

Problem statement development occurred through the planning process in an effort to link watershed stakeholders' concerns with existing and historical water quality data, the 5 identified critical areas, and the 7 major concern categories developed by the Steering Committee. Details regarding stressors, pollutant sources, areas where sources have been observed, and the stakeholders' concerns are listed for each problem statement.

Problem Statement 1

E. coli/pathogen levels in the Sugar Creek Watershed regularly exceed the state standard of 235 CFU/100ml, based on current and historical water quality data results, and often exceed safety standards for allowing Sugar Creek to be fishable and swimmable.

Stressor: *E. coli* bacteria

Source: animal waste, human waste, failing septic systems, point sources, package plants, maintaining proper drainage from farmlands, flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to Sugar Creek and its tributaries, land use changes, stormwater management, lack of proper wildlife management

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, Heartland Resort, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision

Problem Statement 2

Excessive nutrient levels, documented in historic and recent water quality sampling, are negatively affecting the Sugar Creek Watershed.

Stressor: Nutrients, including Nitrate (NO_3), Nitrite (NO_2) and Phosphorus.

Source: Flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to the stream, failing septic systems, land use changes, stormwater management

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, and Heartland Resort

Problem Statement 3

Excessive soil erosion and sedimentation associated with agricultural lands, urban lands, and development sites is degrading the Sugar Creek Watershed and limiting the aesthetics, recreational access, wildlife habitat, and drainage of Sugar Creek.

Stressor: Silt and sediment, nutrients that bind to sediment, pathogens that bind to sediment

Source: Flooding impacts, proper drainage from agricultural lands, streambank erosion, cattle access to the stream, land use changes, stormwater management, log jams, beaver, wildlife effects on water quality by contributing to nutrients through their waste, lack of proper wildlife management, presence of existing sandbars

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision

Problem Statement 4

Excessive flow rates and volumes of water during large precipitation events are causing crop damage and loss within the Sugar Creek Watershed.

Stressor: damaging flood levels

Source: Lack of proper drainage in the Watershed, log jams, beaver creating log jams, flooding impacts, streambank erosion, cattle access to the stream, land use changes, stormwater management, presence of existing sandbars

Areas Where Sources Have Been Observed: Urban areas surrounding Eden, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, Arrowhead Mobile Park, and the Sugar Creek Watershed along Sugar Creek between 200 S to 600 S

Problem Statement 5

There is a lack of open space/greenways along Sugar Creek and its tributaries. Pollutants are allowed to enter Sugar Creek and its tributaries without any filtration process.

Stressor: unfiltered stormwater run-off

Source: lack of filter strips and Best Management Practices, lack of native vegetation, lack of greenway corridor along Sugar Creek, Preservation areas that are not maintained

Areas Where Sources Have Been Observed: Areas void of open space and greenway along the Sugar Creek corridor

Problem Statement 6

Stakeholders in the Sugar Creek Watershed are not knowledgeable about their daily impact on the Sugar Creek Watershed and its water quality.

Stressor: Lack of education and outreach with regard to the Watershed health and condition

Source: Lack of sponsored workshops within the Watershed, lack of interest from the Stakeholders, lack of media coverage about the detrimental effects of humans and their daily activities on the Watershed

Target Audience: Stakeholders, local groups

Problem Statement 7

Stakeholders in the Sugar Creek Watershed are not aware of the watershed planning process or the existence of the watershed group.

Stressor: Lack of education and interest with regard to the Watershed health and condition

Source: Lack of time and commitment

Target Audience: Neighborhood groups, stakeholders, schools, local newspapers, local radio, local television