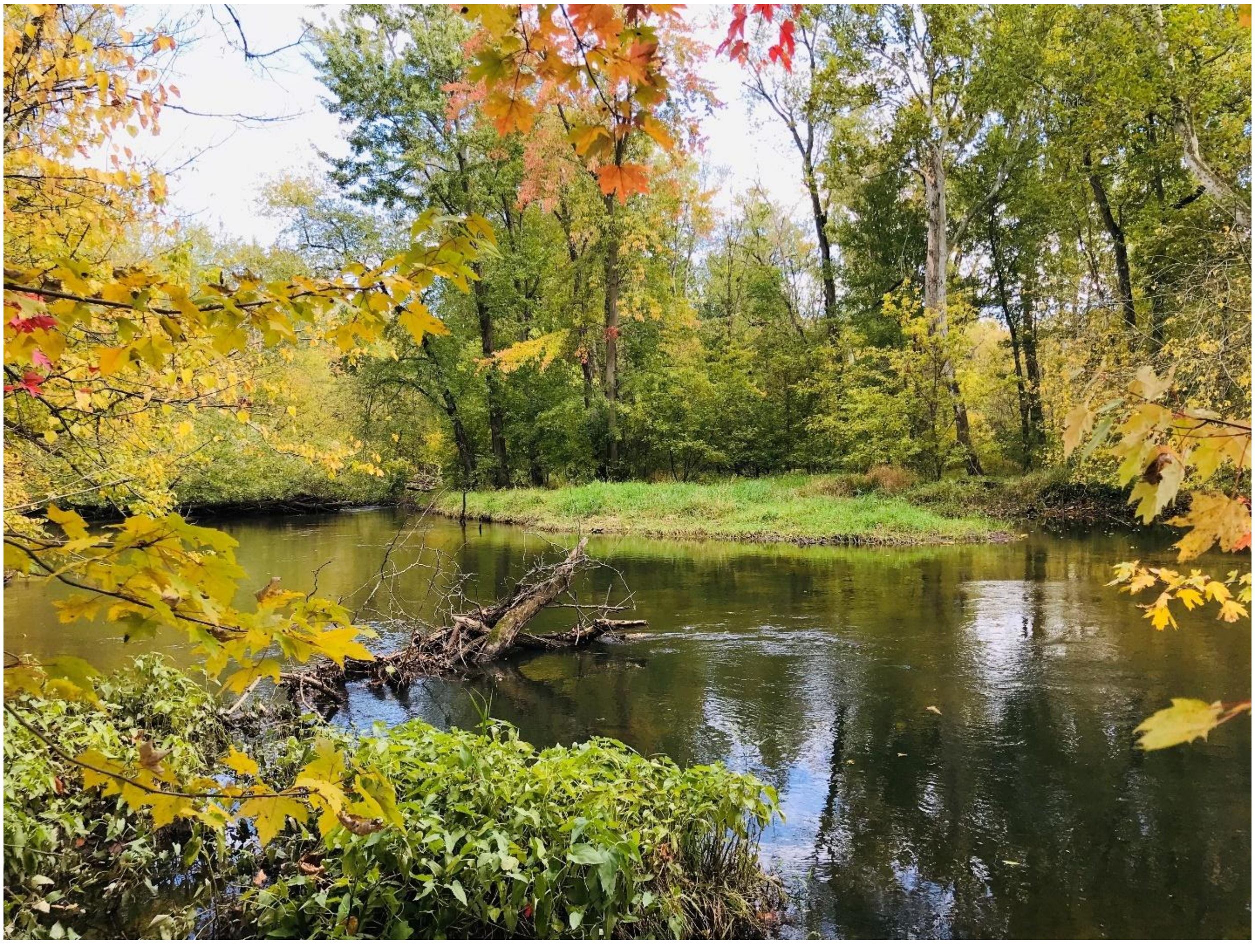
LOWER ELKHART RIVER WATERSHED MANAGEMENT PLAN

ELKHART, KOSCIUSKO AND NOBLE COUNTIES, INDIANA

23 December 2024



A PROJECT OF THE
ELKHART RIVER RESTORATION ASSOCIATION

AND THE CITY OF GOSHEN

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LOWER ELKHART RIVER WATERSHED MANAGEMENT PLAN
ELKHART, NOBLE, AND KOSCIUSKO COUNTIES, INDIANA
EXECUTIVE SUMMARY

The Lower Elkhart River Watershed, covering portions of Elkhart, Noble, and Kosciusko Counties, drains 295 square miles and receives water from the Upper Elkhart River Watershed, which spans 403 square miles. The watershed contains 389 miles of streams, with major tributaries including Turkey Creek, Omar-Neff Ditch, Skinner Ditch, Rock Run Creek, Yellow Creek, and Keiffer Ditch. The Elkhart River flows north and west through Goshen and Elkhart, joining the St. Joseph River in downtown Elkhart. The St. Joseph River then continues west into Michigan before moving north and emptying into Lake Michigan.

The watershed covers approximately 190,000 acres and features diverse land uses, primarily agricultural, with small urban and urbanizing areas found near lakes and in cities like Goshen, Nappanee, and Elkhart, and towns such as Leesburg, Milford, and Syracuse.

Launched in 2021, the Lower Elkhart River Project was initiated through a Section 205j Water Quality Planning Grant to update the 2008 Elkhart River Watershed Management Plan. The Elkhart River Restoration Association (ERRA) recognized several changes in the watershed since the original plan and began this effort to address those changes. A steering committee including representatives from urban areas and counties within the watershed, environmental groups, natural resource professionals, agricultural and commercial sectors, and private citizens was organized to work with the watershed coordinator to develop the watershed management plan.

The Lower Elkhart River Watershed Management Plan is a comprehensive examination of the Lower Elkhart River Watershed and is intended as a guide for the protection and improvement of the water quality of the Elkhart River and its watershed. The plan was developed with the goal of balancing different uses within the watershed and the demands of the natural resource by the community. The scope of the management plan includes the following:

1. Describe and identify the watershed area, review historic studies, current community initiatives, and stakeholder involvement.
2. Assess watershed quality and complete water quality sampling and biological community and habitat quality assessments.
3. Receive community input via Steering Committee meetings, public meetings, and a social indicator survey.
4. Identify watershed problems and causes.
5. Examine pollutant sources and calculate current load estimates and potential load reductions.
6. Determine critical and priority areas.
7. Create goal statements and select appropriate improvement measures to reduce specific loads.
8. Create an outreach plan for future strategies.
9. Outline future tracking and indicators of success.

The management plan included a review of historical studies, mapping exercises, a walking and driving tour of the watershed and subwatershed areas, an assessment of chemical and physical watershed health, water quality, water chemistry, and habitat assessments. These efforts were completed with the goal of determining if stakeholder concerns were supported by watershed data and providing a foundation upon which the watershed management plan could be built. The 2008 Elkhart River Watershed Management Plan identified several sources of *E. coli* contamination, including failing septic systems, erosion and sedimentation, pasture runoff, heavily grazed areas, livestock manure, manure fertilizer, livestock access to streams, wastewater treatment plants, and wildlife. Ninety-four percent of soils in the watershed are severely limited for septic system use. Based on 2019 transect data, approximately 33% of agricultural land in the watershed is conventionally tilled. Additionally, 31% of watershed soils are highly erodible or erodes under wind or water. Livestock on regulated and unregulated farms are estimated to produce over 560,000 tons of manure per year. Reduced channel stability and increased flooding were observed throughout the watershed. Windshield surveys identified 7.5 miles of streambank erosion, 3.3 miles of livestock access to streams, and 2.9 miles of stream buffers that were narrower than ideal. The Indiana Department of Environmental Management has listed several water quality impairments in the Lower Elkhart River Watershed. These include 139.6 miles affected by elevated *E. coli* levels, 7.8 miles with high nutrient levels, 7.8 miles with low dissolved oxygen, 46.9 miles with impaired biotic communities, and 9 miles with PCBs in fish tissues. Additionally, nutrients, impaired biotic communities, and PCBs in fish tissues also affect several lakes in the watershed.

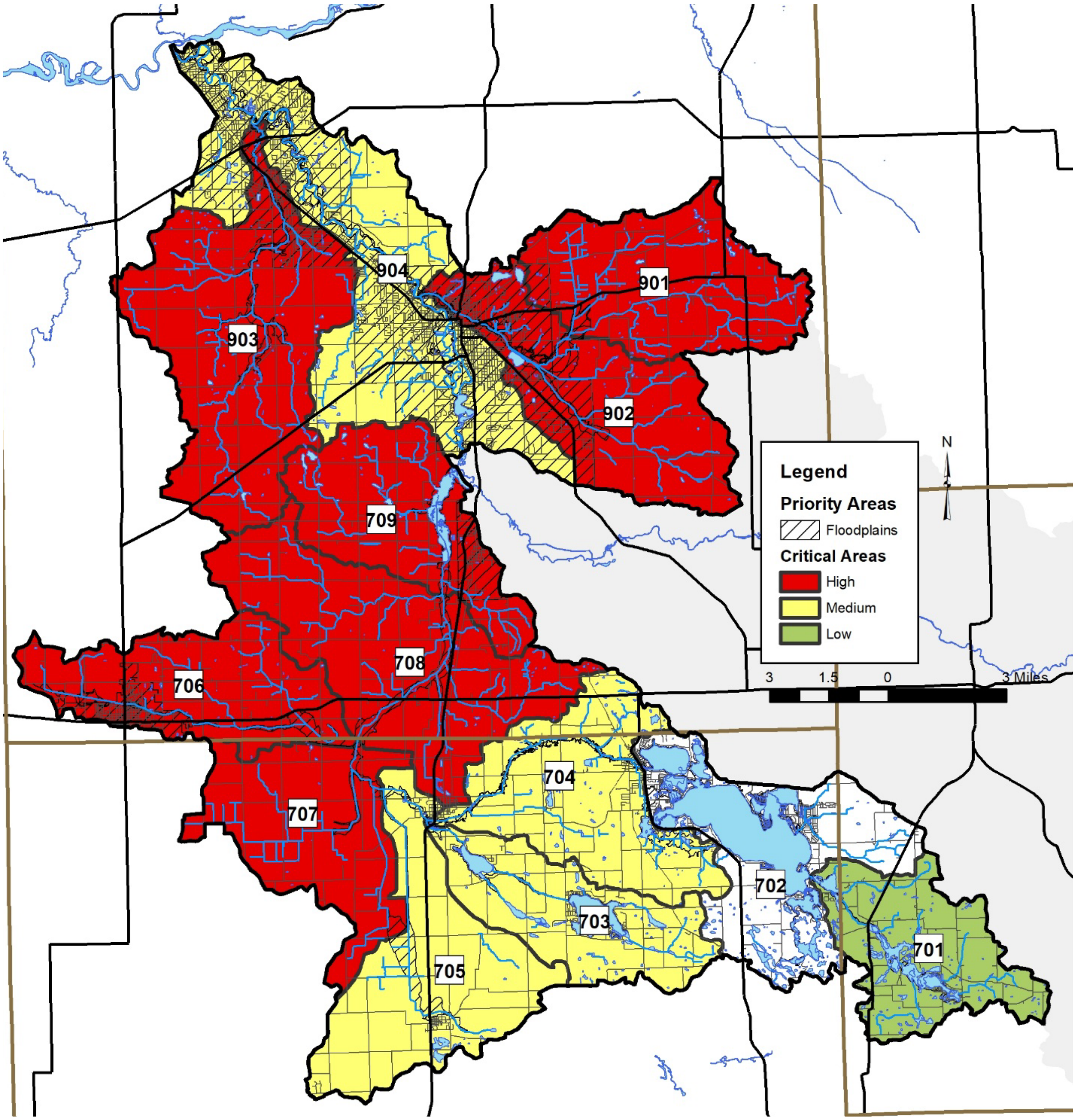
Public participation is crucial for the success of the watershed planning and implementation process. To engage the public, public meetings and listening sessions were held to provide information, gather input, and build support for water quality improvements in the watershed. These meetings were advertised through the project's website, press releases in local newspapers, emails to local landowners and conservation partners, and Soil and Water Conservation District mailings. The first public meeting featured a drop-in and chat format with a presentation on the City of Goshen Flood Resilience Plan. Nearly 100 individuals attended, with around 35 visiting the ERRA table to learn more about the project and provide input on watershed concerns. Public and committee meetings were the primary mechanism for soliciting individual concerns.

Throughout the planning process, project stakeholders, the Steering Committee, and the general public listed concerns for the Lower Elkhart River Watershed including the Elkhart River, its tributaries, and its watershed. All comments were recorded and included as part of the concern documentation and prioritization process.

The Steering Committee reviewed inventory data, assessed resource concerns raised by stakeholders, and identified potential problems and their sources. Based on the available data, the Steering Committee identified areas based on critical priority for focus. To identify subwatersheds by priority, the Steering Committee chose to use all criteria selected by the parameter teams for which data were significantly different (i.e., more than three scores could be assigned across the fourteen subwatersheds). Once all parameters were scored, natural breaks in the data were used to prioritize high, medium, and low-ranking critical areas with those subwatersheds that scored an average of 6 or less rating as high priority critical areas, those scoring 6.1 to 8 rating as medium priority critical areas and those scoring 8.1 to 9 rating as low priority critical areas. Any subwatersheds scoring 9.1 or greater were not ranked as critical. Subwatersheds were prioritized as follows and are shown in the figure below:

- High Priority: Berlin Court Ditch (706), Omar Neff Ditch-Turkey Creek (707), Dausman Ditch-Turkey Creek (708), Swoveland Ditch-Turkey Creek (709), Hoover Ditch-Rock Run Creek (901), Horn Ditch-Rock Run Creek (902), and Headwaters Yellow Creek (903)
- Medium Priority: Wabee Lake-Hammond Ditch (703), Hoopingarner Ditch-Turkey Creek (704), Coppes Ditch-Turkey Creek (705), and Goshen Dam Pond (904)
- Low Priority: Village Creek-Turkey Creek (701)

Lake Wawasee (702) was not prioritized as a critical area meaning it was not identified as an area of highest concern once all data were combined and averaged. Implementation efforts will target high priority critical areas first, followed by medium priority then low priority areas.



Prioritized critical areas in the Lower Elkhart River Watershed.

The Lower Elkhart River Project Steering Committee reviewed historic and current water quality data, local habitat and recreation information, flooding area concerns, and other available data. With this information, five goals were developed which the Steering Committee hopes to achieve through implementation of the Lower Elkhart River watershed management plan. Large reductions are needed across the Lower Elkhart River Watershed to meet watershed management plan goals. In total, a 79%

reduction in nitrogen, 64% reduction in phosphorus, 38% reduction in sediment, and 72% reduction in *E. coli* loading rates are needed to meet water quality goals or state standards. The goals are as follows:

- Reduce nitrate-nitrogen loading from 5,234,958 lb/year to 1,118,743 lb/year (79%) by 2054 and reduce total phosphorus loading from 139,217 pounds per year to 49,718 lb/ year (64%) by 2054.
- Reduce total suspended solids loading from 27,242,542 lb/year to 16,781,148 lb/year (38%) by 2054.
- Reduce *E. coli* loading from 4.23E+15 colonies per year to 1.19E+15 colonies per year (72%) by 2054.
- Increase the current level of outreach to engage a 50% increase of individuals in the watershed within 30 years.

The Lower Elkhart River Watershed Steering Committee reviewed a list of potential Best Management Practices (BMPs) to address resource concerns, land uses, and project goals. From this list, the committee selected the most appropriate BMPs to reduce pollution and improve water quality in the watershed. A combination of practices aimed at controlling and trapping nutrients and sediment, along with conservation systems, will likely be required for lasting, measurable improvements in the watershed. The selected practices focus on agriculture and pasture areas, which were identified as key concerns, and also include urban practices for residential and commercial areas, particularly in small towns and reservoirs. Forestry-based practices were not included in the list. Suggested BMPs to address Lower Elkhart River critical areas include access control, alternate watering system, animal mortality facility, bioreactor, bioretention, composting facility, conservation cover and tillage, cover crop, curb openings/curbless design, diversion structures, drainage water management, field border or filter strip, forage and biomass planting, grade stabilization structure, grassed waterway, habitat corridor identification and improvement, heavy use area protection, infrastructure retrofits, lined waterway or outlet, livestock pipeline, manure management planning, mulching, nutrient and/or pest management plans, prescribed grazing, rain barrel, education: septic system care and maintenance, soil testing, streambank stabilization, subsurface drain (agricultural), threatened and endangered species protection, tree/shrub establishment, two-stage ditch, underground outlet, variable rate application, vegetated swale, waste storage facility, waste utilization, water and sediment control basin, and wetland creation, enhancement, and restoration.

Public engagement is necessary for any of the above goals to be successful. To implement the Lower Elkhart River Watershed Management Plan, a multi-tiered outreach strategy will target agricultural producers to promote conservation practices for controlling nutrients and sediment. The plan will also raise awareness among other landowners and the local community. The goal is to inform and engage the community while encouraging the adoption of conservation practices. Outreach methods will include:

- Mailings: Annual or as-needed mailings to announce the program and encourage conservation.
- Workshops & Field Days: At least two annual events to demonstrate practices.
- Newsletters: Quarterly updates distributed through partners like SWCD, county extension, and FSA.
- Public Information: Posting materials at farm and garden centers and collaborating with regional CCAs.
- Project Website: Monthly updates on events, funding availability, and deadlines.
- Social Media: Monthly posts that are shared across partner platforms.
- Media Outreach: Quarterly radio announcements and news releases to local media.
- Additional Outreach: Billboards, videos, and community event tabling.

The Lower Elkhart River Project, coordinated by ERRA, is responsible for maintaining records for the project including tracking plan successes and failures and any necessary watershed management plan revisions. The plan will be re-evaluated at the end of Year 5 and every 5 years after that.

The first step is planning and following the IDEM 2009 Watershed Management Checklist. The project coordinator worked in concert with and was guided by the Lower Elkhart River Project Steering Committee to develop the WMP using knowledge of the watershed, inputs from stakeholders, new data from water monitoring and windshield surveys, and historical data. This plan includes goals, an action register, and a schedule outlining how and when to achieve the defined goals.

The second step is implementation. The action register and schedule will be implemented to achieve the goals of the Lower Elkhart River Watershed Project objectives and goals. Implementation will include a cost-share program and education events targeting both youth and adults. Practices implemented through the cost-share program will follow the NRCS Field Office Technical Guide (FOTG) Practice Standards or other technical standards as detailed in the cost-share program, once developed. The cost-share program will include but will not be limited to practices such as cover crops, watering facilities, fencing, conservation buffers, grassed waterways, and nutrient and pest management plans. Cost-share funding will be implemented in priority areas. A ranking system will be used to prioritize applications that will have the greatest impact on water quality improvement.

The third step is to evaluate and learn. Evaluations of indicators will occur often to check the progress made toward the project goals. Factors evaluated will include but will not be limited to the number of BMPs installed, calculated/estimated load reductions of installed BMPs, number of individuals reached through outreach, etc. These evaluations will be conducted by the Lower Elkhart River Project Steering Committee. The group will then provide recommendations that will improve project success. Progress against the watershed management plan will be reviewed no less than every two years (i.e., 2027, 2029, etc.).

The last step is to alter the strategy. The project's implementation and management strategy will be adjusted to improve the project's success. If progress is not made proportionate to the time into the project (i.e., at the end of year 3, approximately 30% (3/10) of 10-year goals should be met), the Steering Committee will have the opportunity to alter their strategy to meet the goals of the project. Adjustments will be based on recommendations from the Evaluate and Learn step. Once the adjustments are agreed upon by the Steering Committee, the project will revert to Implementation (Step 2) to continue with the Adaptive Management strategy (steps 2-4) until all goals have been met or all conservation opportunities have been exhausted.

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LOWER ELKHART RIVER WATERSHED MANAGEMENT PLAN
ELKHART, KOSCIUSKO, AND NOBLE COUNTIES, INDIANA

1.0 WATERSHED INTRODUCTION

1.1 Watershed Community Initiative

A watershed is the land area that drains to a common point, such as a location on a river. All of the water that falls on a watershed will move across the landscape collecting in low spots and drainageways until it moves into the waterbody of choice. All activities that take place in a watershed can impact the water quality of the river that drains it. What we do on the land, such as constructing new buildings, fertilizing lawns, or growing crops, affects the water and the ecosystem that depends on it. A healthy watershed is vital for a healthy river, and a healthy river can enhance the community and help maintain a healthy local economy. Watershed planning is especially important in that it will help communities and individuals determine how best to preserve water functions, prevent water quality impairment; and produce long-term economic, environmental, and political health.

The Lower Elkhart River Watershed receives water from the Upper Elkhart River Watershed (Figure 1). In total, the Upper Elkhart River Watershed drains 403 square miles. The watershed includes drainage from the Towns of Wolcottville, Millersburg, Rome City, Albion, and Cromwell and the Cities of Ligonier and Kendallville. The Upper Elkhart River Watershed includes three 10-digit hydrologic unit codes (HUCs): 0405000115 (North Branch Elkhart River), 0405000116 (South Branch Elkhart River) and 0405000118 (Solomon Creek). The Upper Elkhart River Watershed gains water from the North and South Branches of the Elkhart River, which join east of the City of Ligonier to form the mainstem of the Elkhart River. Solomon Creek joins the Elkhart River northeast of New Paris. The Lower Elkhart River Watershed drains an additional 295 square miles and begins south of Goshen near New Paris. The Lower Elkhart River Watershed includes two 10-digit hydrologic unit codes (HUCs): 0405000117 (Turkey Creek) and 0405000119 (Elkhart River) and contains 389 miles of streams. Major tributaries include Turkey Creek, Omar-Neff Ditch, Skinner Ditch, Rock Run Creek, Yellow Creek, and Keiffer Ditch. The Elkhart River continues north and west through the Cities of Goshen and Elkhart to join with the St. Joseph River in downtown Elkhart. The St. Joseph River then flows west and then north into the State of Michigan before emptying into Lake Michigan (Figure 2).

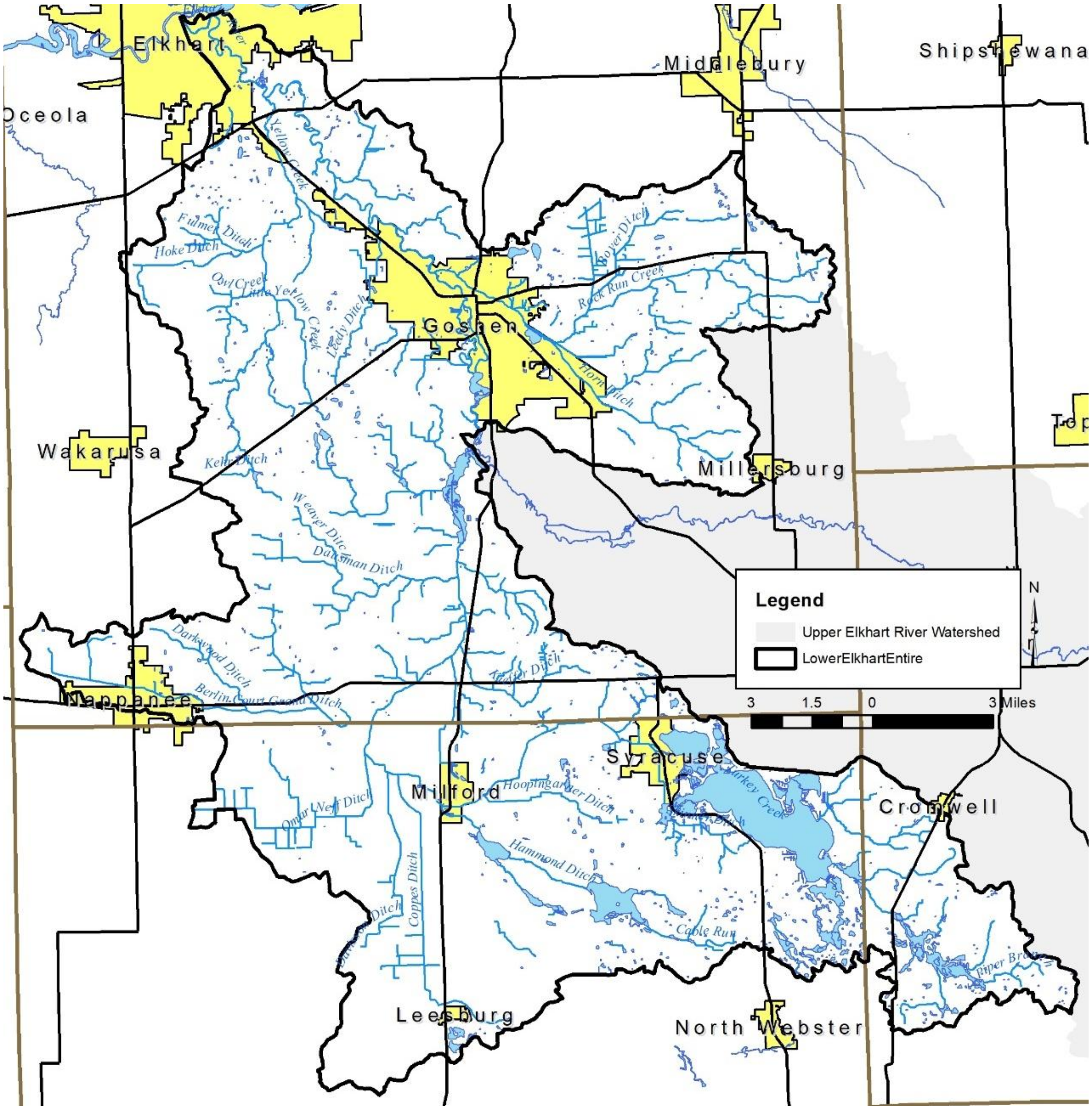


Figure 1. Lower Elkhart River Watershed.

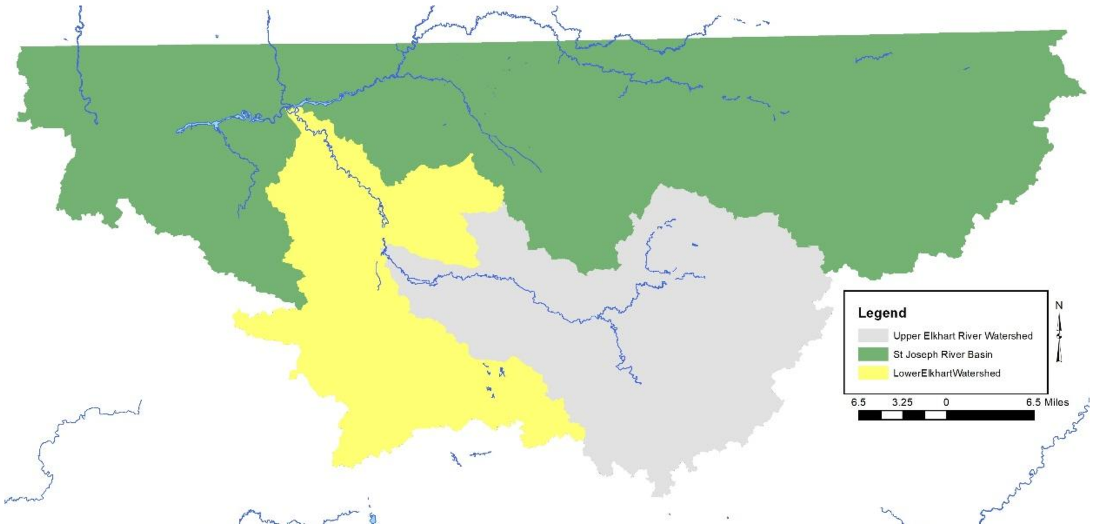


Figure 2. The St. Joseph River Basin highlighting the Lower Elkhart River Watershed.

1.2 Project History

The Lower Elkhart River Project was launched in 2021 as a result of a Section 205j Water Quality Planning Grant awarded to update the 2008 Elkhart River Watershed Management Plan (WMP). The Elkhart River Restoration Association (ERRA) identified several changes in the Elkhart River Watershed since the 2008 plan's completion and initiated this effort to address these changes. Since the 2008 WMP was completed, residents from around the watershed's lakes have been converting houses to larger, more permanent structures. Since 2008, 14% of the watershed has been converted from natural (forest, wetland) and agricultural land uses into urban and urbanizing land uses. Concurrently, the density of agricultural land use has also been impacted with permitted confined feeding operation populations increasing nearly 600% over 2008 animal populations. Further, the Indiana Department of Environmental Management lists water quality impairments on the Lower Elkhart River Watershed, including 139.6 miles of elevated pathogen (*E. coli*), 7.8 miles for nutrient levels, 7.8 miles for low dissolved oxygen levels, 46.9 miles impaired biotic communities, and 9 miles for PCBs in fish tissues. Additionally, nutrients, biotic communities, and PCBs in fish tissues impair several watershed lakes.

The update of the Elkhart River Watershed Management Plan was broken into two sections – the Upper Elkhart River Watershed and the Lower Elkhart River Watershed. This plan will address the Lower Elkhart River Watershed, which includes the Turkey Creek drainage. The Lower Elkhart River Watershed includes a variety of land uses including agricultural, forest, and natural areas, as well as urban and urbanizing land uses. Much of the watershed is dominated by agricultural land use. Urban and urbanizing land is found adjacent to the many watershed lakes and in its cities and towns including the Cities of Goshen, Nappanee, and Elkhart, and the towns of Leesburg, Milford, and Syracuse. Portions of four MS4s (municipal separate storm sewer systems) are located within the Lower Elkhart River Watershed: Elkhart County, City of Elkhart, City of Nappanee, and City of Goshen. Land cover data from 2016 estimates that the watershed is 58% row crop, 9% pasture, 12% forests or wetlands, 3% open water, and 17% urban. The Elkhart River Watershed Management Plan (2008) identified improperly functioning/failing septic systems, erosion and sedimentation, pasture runoff, heavily grazed areas, livestock manure, manure fertilizer, livestock access to streams, wastewater treatment plants, and wildlife as sources *of E. coli*.

Based on these concerns, the Elkhart River Restoration Association approached community groups and individuals throughout the watershed who might be interested in working with them to assess and improve water quality and quantity within the Lower Elkhart River and its tributaries. Identified potential stakeholders included: Elkhart, Kosciusko, and Noble County Soil and Water Conservation District (SWCD) and Natural Resource Conservation Service (NRCS) staff; City of Elkhart, City of Goshen, Indiana Department of Environmental Management (IDEM); Elkhart, Kosciusko, and Noble County surveyors, parks departments, health departments, and Purdue Extension; Goshen College staff; St. Joseph River Basin Commission (SJRBC), and more. This group formed a Steering Committee (Table 1), conducted windshield surveys of the watershed, and held several meetings open to the public in order to generate input in the development of a watershed management plan for the Lower Elkhart River Watershed.

1.3 Stakeholder Involvement

Development of a watershed management plan requires input from interested citizens, local government leaders, and water resource professionals. These individuals are required to not only buy into the project and the process but must also become an integral part of identifying the solution(s) which will result in improved water quality and addressed water quantity concerns. The Lower Elkhart River Project involved stakeholders in the watershed management planning process through a series of public meetings and education and outreach events including windshield surveys, workshops, field days, and youth-focused education events.

1.3.1 Steering Committee

Individuals representing the towns and counties within the watershed, environmental groups, natural resource professionals, agricultural and commercial representatives, and private citizens comprise the steering committee. The steering committee met quarterly to develop the WMP starting in April 2023. Table 1 identifies the steering committee members and their affiliation.

Table 1. Lower Elkhart River Watershed steering committee members and their affiliation.

Individual	Organization(s) Represented
Sara Peel	Arion Consultants
Daragh Deegan	City of Elkhart
Joe Foy	City of Elkhart MS4
Jamison Czarneki	City of Elkhart Parks and Recreation
Tanya Heyde	City of Goshen Parks and Recreation
Jason Kauffman	City of Goshen MS4
Aaron Kingsley	City of Goshen Environmental Resilience
Todd Nunemaker	City of Nappanee Planning/MS4
Donny Aleo	Elkhart County Parks
Jeff Boyle	Elkhart County Parks
Jason Auvil, Natasha Kauffman	Elkhart County Planning
John Heiliger	Elkhart County MS4
Troy Manges	Elkhart County NRCS
Philip Barker	Elkhart County Surveyor
Jim Hess	Elkhart County SWCD
Jeff Zavatsky	Elkhart Environmental Center
Nancy Brown	ERRA

Individual	Organization(s) Represented
Jonathan Schramm	Goshen College
Kristi Todd, Miranda Wentz	IDEM
Margaret Easton	Indiana DNR Volunteer
Chad Shotter	Kosciusko County NRCS
Emily Kresca	Kosciusko County Purdue Extension
Mike Kissinger	Kosciusko County Surveyor
Tashina Lahr-Manifold	Kosciusko County SWCD
Diane Tulloh	Lake Papakeechie
Norm Lorti, Mike Klopfenstein	Noble County Building Inspector
Anita Hess	Noble County Commissioner; SJRBC
Justin Stump	Noble County EMA Director
Mick Newton	Noble County EMA Retired
Teresa Tackett	Noble County Planning Director
Russell Baker	Noble County NRCS
Ann Kline	Noble County Purdue Extension
Randy Sexton	Noble County Surveyor
Stacey McGinnis	Noble County SWCD
Grant Poole	Pokagon Band of Potawatomi
Kate Barrett	SJRBC
Matt Meersman, Kate Barrett	SJRBC
Heather Harwood, Beth Morris	Wawasee Area Conservancy Foundation (WACF)

1.3.2 Public Meetings

Public participation is necessary for the long-term success of any watershed planning and subsequent implementation effort. One component of public participation for this project was public meetings and listening sessions. The purpose of the public meetings was to provide information on the overall planning effort and its progress; solicit stakeholder input, opinions, and participation; create opportunities for the public to recommend programs, policies, and projects to protect and improve water quality; and build support for future phases of the project.

The public meetings/listening sessions were advertised through press releases distributed to local newspapers in the watershed and via the project website and emails sent to local landowners and conservation partners. The meetings/listening sessions were also advertised through word of mouth as staff from the Soil and Water Conservation Districts put together mailings that advertised the events.

The first public meeting occurred on March 16, 2023, and was hosted as a drop-in and chat meeting. A formal presentation highlighting the City of Goshen Flood Resilience Plan occurred with various entities, including the Elkhart River Restoration Association, hosting tables during the event. Nearly 100 individuals attended the meeting with about 35 stopping by the ERRA table to learn more about the project and provide their input on the watershed and associated water quality concerns.

The second meeting occurred on December 17, 2024 and included an update on the status of the project, highlighted project goals, detailed practices selected for implementation and laid out potential next steps for the project.

1.4 Public Input

Throughout the planning process, project stakeholders, the steering committee, and the general public listed concerns for the Lower Elkhart River Watershed including the Elkhart River, its tributaries, and its watershed. Public and committee meetings were the primary mechanism for soliciting individual concerns. All comments were recorded and included as part of the concern documentation and prioritization process. Concerns voiced throughout the process are listed in Table 2. Similar stakeholder concerns were grouped roughly by topic and condensed by the committee. The order of concern listing does not reflect any prioritization by watershed stakeholders.

Table 2. Stakeholder concerns identified during public input sessions, steering committee meetings, and via the watershed inventory process. Note: The order of concern listing does not reflect any prioritization by watershed stakeholders.

Stakeholder Concerns
Falling trees create logjams/dam the river
Recreation - access is needed, recreation should be promoted
Development - too many hard surfaces
Poorly constructed and maintained stormwater management practices
Limited participation by farmers in soil erosion practices
General lack of public awareness about how their activities impact water quality and quantity
Water levels are high - often exceed the 2018 recorded flood level
Floodplain development - used for commercial and residential building sites now and in the future will only cause more flooding
Elevated nutrient levels
Water is brown and cloudy often after rains
We are in the headwaters, our impact to the Elkhart River are not felt locally but we are hopeful in doing our part to address water quality and quantity downstream
Flooding
Slow water movement through the Goshen Dam Pond
Runoff, sedimentation
Goshen dam pond wants to dredge - disagree- maintain natural curves
Protect natural features in the watershed as these help reduce sediment load in the water
Promote quiet recreation - bird watching, canoeing, kayaking
people need to understand the connection up-down stream not just the area nearest them
The river should be used to make money and attract tourists
Logjams
Flooding - our subdivision floods all the time - how can we control it, move water downstream
Livestock access - Rock Run Creek east of Elkhart County fairgrounds, other locations
Wakarusa and other rural Elkhart County sewer system project - how will this impact areas downstream?
Elevated *E. coli* levels

Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety. Removal was completed in December 2023 but this could be a continued issue in the future.
Streambank erosion is a concern on the Elkhart and tributaries
Flooding – Chicago Avenue flooding was noted with the potential impact of Kroger not rebuilding if flooding in the store occurs again
Changes in drainage pattern – Nappanee used to flow west and now flow east into the Elkhart drainage.
Yellow Creek -fecal matter input, highest of Elkhart County drainages – sewer will be constructed this year.
Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above
CR17 will eventually be extended south – this change in pavement may impact impervious surfaces in the Lower Elkhart
Development will continue in rural portions of the watershed – likely subdivisions which will lead to increases in unsewered dense housing. Development in these areas are likely to require more expensive septic options like mound systems
City of Elkhart has stated they will not extend services beyond their boundary, however there are discussions about annexation this year. A map of this should be included in the plan, if/when available
Two TIF districts are located in the lower watershed – Northeastern TIF and one north of Syracuse. Both should be mapped and included in the plan
The Kosciusko County portion of this watershed is pretty sandy – lots of wind erosion, producers often conventional till in the fall in this area
Volume of animal waste produced in the watershed (used in the watershed) is high
Septic limitations due to prevalence of unsuitable soils, lack of maintenance
Excessive sediment load
Problematic siltation issues within the watershed lakes and reservoirs
Stream bank deterioration caused by severe erosion. (refers to general observations of erosion, especially along legal drains)
Interest in making legal drains more natural, install buffer strips between agricultural
Concerns about unregulated drain erosion, working with private landowners
Managing regulated drains to reduce sediment loading (two-stage, buffer strip incentives)
Non-point source pollution (agricultural row crop and animal runoff & septic)
Herbicide distribution within lakes to control nuisance weeds, and the concern for responsible vegetation management as it relates to impacts on wildlife
Nutrient loading due to the use of (lawn, agriculture) fertilizers
Vegetation growth due to eutrophication in lakes and streams
Illicit discharges
Mercury and PCBs in fish tissue
Fear of *E. coli*, perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns.
Fish consumption advisories
No longer feel safe for recreational swimming - duplicate
Concerned over attempts to make the Elkhart River a legal drain: concern over drainage policy in general
Fallen trees impeding navigable passage throughout the waterways.
Create means of access around fallen snags as opposed to removing them in their entirety

PFAS
Litter along roadsides, urban areas and rural dumping
Long term maintenance of post construction stormwater infrastructure
Drainage for agricultural production (both the positive aspect of achieving appropriate drainage for agriculture and the negative aspect of alteration of the hydrologic system were discussed)
Long-term viability of the watershed as an irrigation source (both surface and ground water quantity issues)
Look at irrigation data/well sensitivity, runoff from irrigated areas
Livestock access to surface waters within the watershed
Culvert sizing creating fish passage concerns, restrictions in flows
Loss of habitat with increased development
Rapid increase in impervious surface in the watershed
Urban Development/encroachment on the floodplain
Combined Sewer Overflows (CSO)– *E. coli*, nutrients – long term control – confirm status of Elkhart and Nappanee CSOs
Urban development (whatever anyone wants to do is accepted). Maintain a natural buffer along the water. Need proper planning of developments
Keep Continue sewer development on pace with development - areas that are developed but are not sewered needs to be mapped
Growing Canada goose, mute swan population
Drainage ways that currently have land uses immediately adjacent to their banks would ideally benefit from a vegetated riparian zone buffers (increasing the frequency of filter strips, etc)
Preservation of wetlands upstream, to protect floodplain areas
Blanding's turtles are state endangered and reproduce locally
River otter population increases (need protection) trapping season starts fall 2023
Loss of habitat for ETR species
Invasive species
Fish kills after heavy rains (pollutants in the runoff) – no current evidence of fish kills – leaving but may remove if evidence does not support
State endangered fish and wildlife need habitat protection
Alterations to flood storage and flow conveyance
Impacts of logjams and beaver activities
Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage
Design protected wildlife corridor through the Lower Elkhart Watershed
Levees/canals through Goshen or in other areas are they legal, do they require set back or maintenance activities?
Climate change

2.0 WATERSHED INVENTORY I: WATERSHED DESCRIPTION

2.1 Watershed Location

The Lower Elkhart River includes two 10-digit hydrologic unit codes (HUCs): 0405000117 (Turkey Creek) and 0405000119 (Elkhart River) and covers portions of Elkhart, Noble and Kosciusko Counties (Figure 1). Additionally, the Lower Elkhart River Watershed receives water from the Upper Elkhart River Watershed. In total, the Upper Elkhart River Watershed drains 403 square miles. The Lower Elkhart River Watershed drains an additional 295 square miles and begins south of Goshen near New Paris. Major tributaries include Turkey Creek, Omar-Neff Ditch, Skinner Ditch, Rock Run Creek, Yellow Creek, and Keiffer Ditch. The Elkhart River flows north and west through the Cities of Goshen and Elkhart to join with the St. Joseph River in downtown Elkhart. The St. Joseph River then flows west and then north into the State of Michigan before emptying into Lake Michigan.

2.2 Subwatersheds

In total, thirteen 12-digit Hydrologic Unit Codes are contained within the Lower Elkhart River Watershed (Figure 3, Table 3). Each of these drainages will be discussed in further detail under Watershed Inventory II.

Table 3. 12-digit Hydrologic Unit Code (HUC) watersheds in the Lower Elkhart River Watershed.

Subwatershed Name	Hydrologic Unit Code	Area (acres)	Percent of Watershed
Village Lake-Turkey Creek	040500011701	10,172	5.4
Lake Wawasee	040500011702	14,276	7.5
Wabee Lake-Hammond Ditch	040500011703	10,120	5.3
Hoopingarner Ditch-Turkey Creek	040500011704	13,613	7.2
Coppes Ditch-Turkey Creek	040500011705	14,412	7.6
Berlin Court Ditch	040500011706	11,899	6.3
Omar-Neff Ditch-Turkey Creek	040500011707	11,982	6.3
Dausman Ditch-Turkey Creek	040500011708	19,014	10
Swoveland Ditch-Turkey Creek	040500011709	11,748	6.2
Hoover Ditch-Rock Run Creek	040500011901	13,673	7.2
Horn Ditch-Rock Run Creek	040500011902	14,153	7.5
Headwaters Yellow Creek	040500011903	21,157	11.2
Goshen Dam Pond-Elkhart River	040500011904	23,262	12.3
	Entire Watershed	**189,481**	**100%**

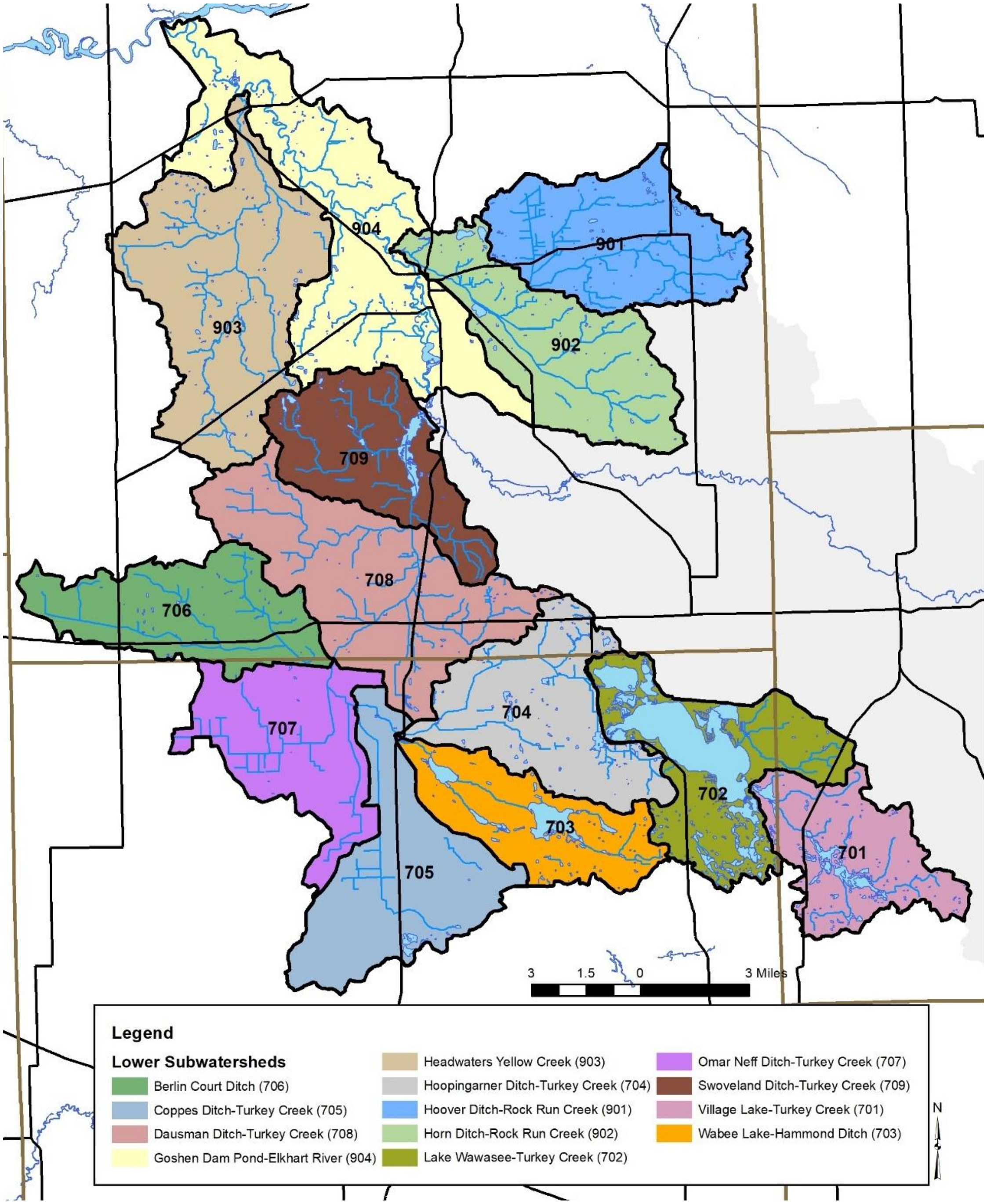


Figure 3. 12-digit Hydrologic Unit Code subwatersheds in the Lower Elkhart River Watershed.

2.3 Climate

In general, Indiana has a temperate climate with warm summers and cool or cold winters. Climate in the Lower Elkhart River Watershed is no different than the rest of the state. There are four seasons throughout the year. The average temperatures measure approximately 71°F in the summer, while low temperatures measure below freezing (25.9°F) in the winter. The growing season typically extends from April through September. On average, 38 inches of precipitation occurs within the watershed per year; approximately 58% of this precipitation falls during the 205-day growing season. According to the City of Goshen Climate Resilience Plan: *The climate in this region is changing, and these changes are causing* *immediate threats to Goshen's citizens, health, economy, and the community's overall vitality. Over the last several years, the region has experienced a 1.4°F increase in average annual temperature, with spring experiencing the greatest amount of warming (a 2.4°F increase). Nighttime temperatures are rising, and the number of cold days (< 32°F) is declining. Annual precipitation is changing too: in the last several decades Goshen has experienced a 10.1% increase in annual precipitation (amounting to 3.9 inches), with the greatest change happening in fall (18% increase, amounting to roughly an extra 1.7 inches). In addition, the frequency and intensity of severe storms are increasing, with the City [of Goshen] experiencing a 9% increase in the number of heavy precipitation events (heaviest 1% of storms) annually with a 16% increase in the total volume of rainfall during these events. These are just some of the changes that have led to serious impacts to the community's infrastructure, economy, social networks, cultural identity, and safety. These impacts are likely to be more extreme as the climate continues to change.*

Rainfall intensity and timing affect watershed response to precipitation. The National Oceanic and Atmospheric Administration's (NOAA's) climate at a glance website (1895-present) indicates rainfall varies from 25 to over 50 inches annually (Figure 4). Christopher B. Burke Engineering, LLC (CBBEL) calculated the 10-year moving average as between 30 and 40 inches/year for the Upper Elkhart River. These estimates likely hold true to the Lower Elkhart River drainage as well. The Purdue Climate Change Research Center (PCCRC) indicates an increase in average annual precipitation of over 4.2 inches/year from 1895 to 2029 (PCCRC, 2019). CBBEL (2020) further notes an increase in heavy rainfall events with one day per year exceeding the 99th percentile in 1900 to more than three days exceeding this level in 2016 (Figure 5). This suggests that more frequent extreme events and larger annual precipitation totals are likely occurring in the entire Elkhart River Basin. This likely results in more water moving through the system which impacts the watershed's lakes, streams and wetlands.

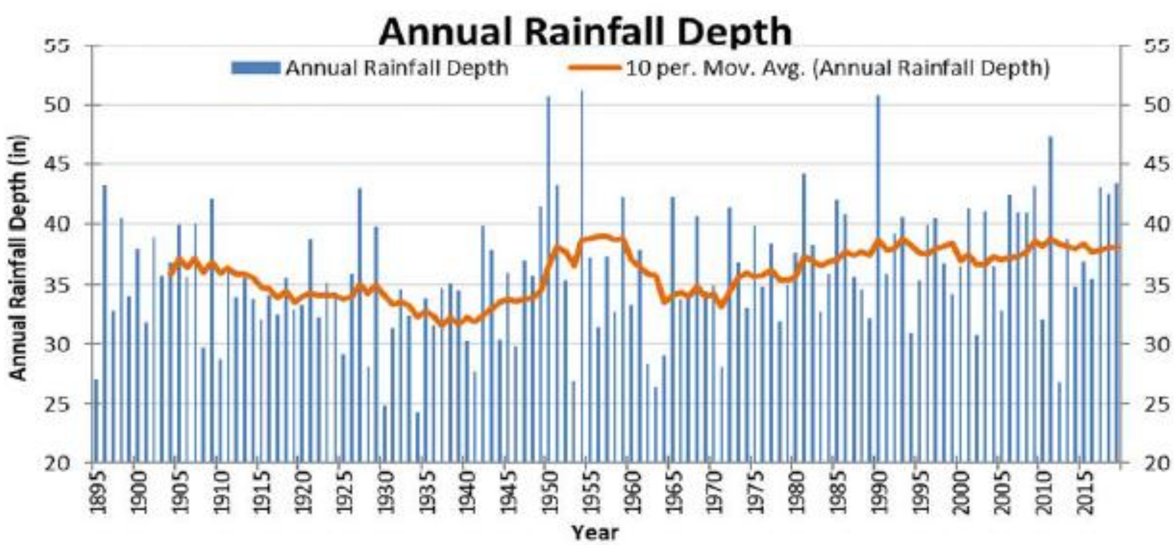


Figure 4. Annual rainfall depth for Noble County (Christopher B. Burke Engineering, Limited (CBBEL, 2020)).

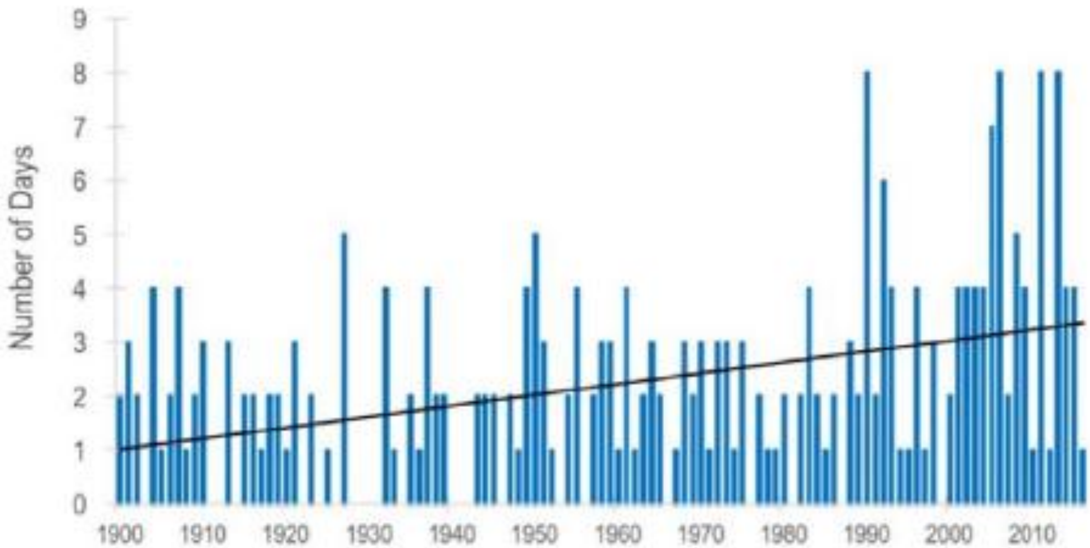


Figure 5. Number of days with extreme precipitation (ie events exceeding 99th percentile for Indiana (PCCRC from CBBEL, 2020).

2.4 Geology and Topography

Bedrock deposits within much of the Lower Elkhart River Watershed are from the Silurian to middle Mississippian age. These deposits consist primarily of layered Paleozoic limestone, dolomite, sandstone, siltstone and shale, which are indicative of ancient inland seas (Clendenon and Beaty, 1987). The bedrock geology of the watershed is comprised of two major types of Devonian Era Shale, either Antrim or Ellsworth, with a small amount of Muscatatuck Group present in the southernmost outcrop of the watershed. Antrim Shale bedrock covers much of the southern portion of the Lower Elkhart River Watershed. The mainstem of the Elkhart River flows through Ellsworth Shale (Figure 6). Most of the Lower Elkhart River Watershed's surface is covered by glacial drift measuring from zero to 200 feet in thickness with deeper drift filling preglacial drainageways. Two distinct glacial stages are represented by the watershed's till and drift deposits. The most recent Wisconsinan drift was deposited by the Ontario-Erie Lobe of the Wisconsinan glacier (Wayne, 1963). Till from the Huron-Erie Lobe is found in the southeastern portion of the watershed, while till from the Saginaw Lobe is widely distributed throughout the watershed. Sand and gravel deposits found along all major and many minor streams originate from the Wisconsinan outwash (Figure 7). Sand and gravel are readily available resources along watershed stream floodplains.

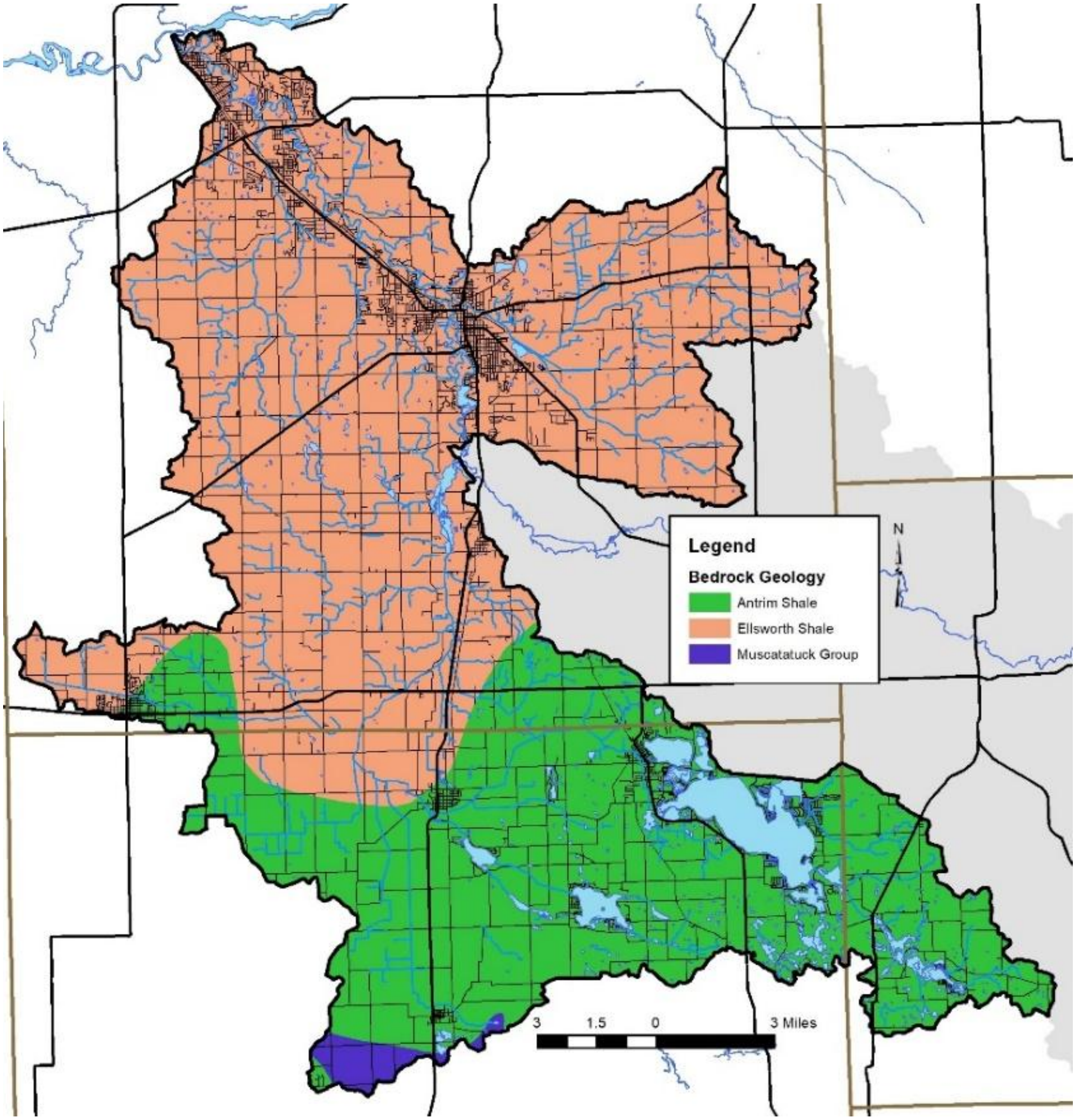


Figure 6. Bedrock in the Lower Elkhart River Watershed.

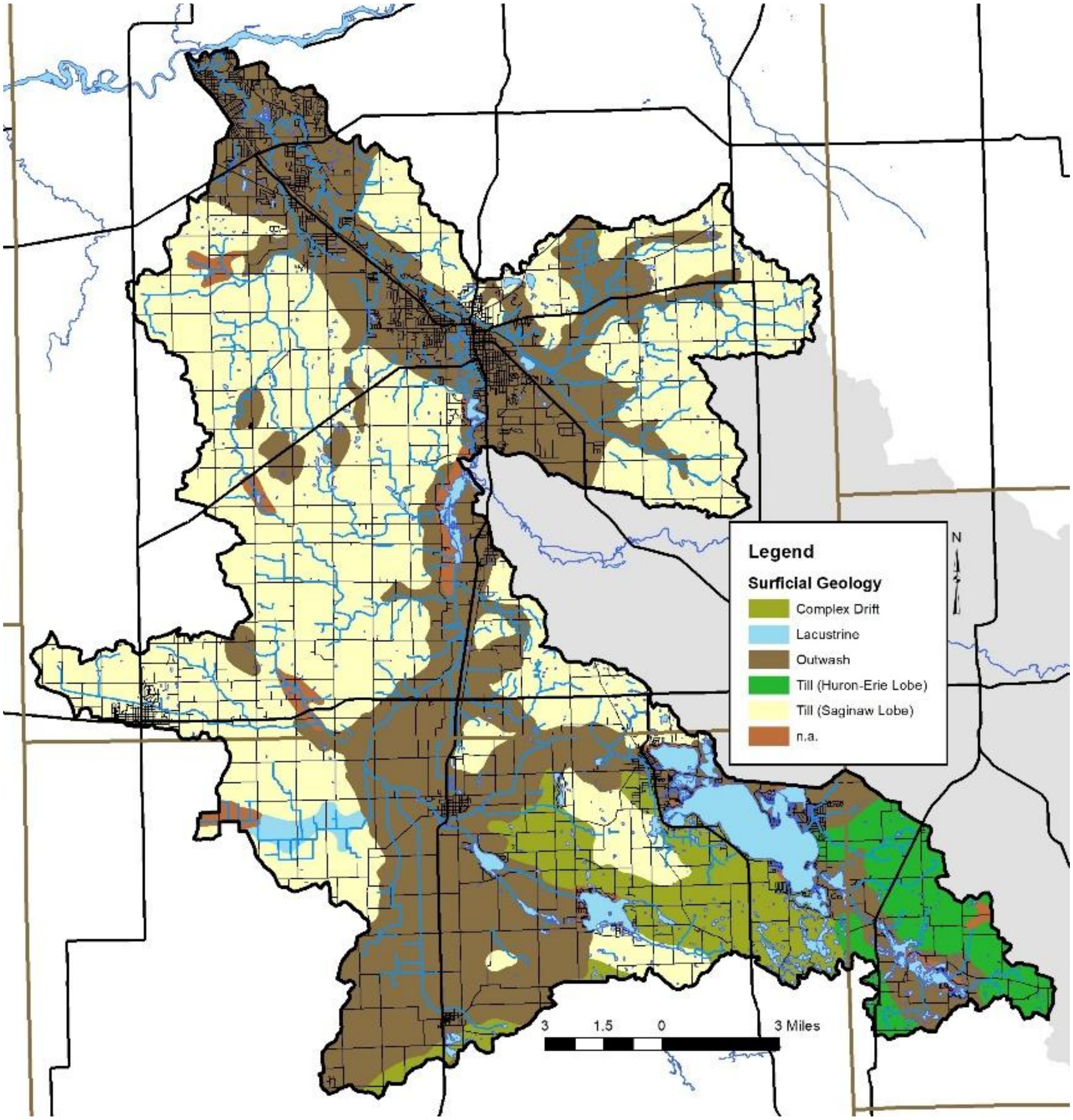


Figure 7. Surficial geology throughout the Lower Elkhart River Watershed.

The topography of the Lower Elkhart River Watershed ranges from flat rolling agricultural fields to undulating hills and valleys (Figure 8). The landscape changes from steeply sloped and rolling terrain in the Rock Run Creek drainage (eastern edge of the watershed) to gently rolling terrain and relatively flat plains along the main stem of the Elkhart River. The lowest elevation (719 feet msl) occurs at the watershed outlet at the St. Joseph River in Elkhart. Steep to rolling terrain is found near Cable Run in the southeastern portion of the watershed, in the Tri-County Fish and Wildlife Area, in an area southwest of Lake Wawasee and Buzzard Hill (elevation 1041 feet) northeast of Milford.

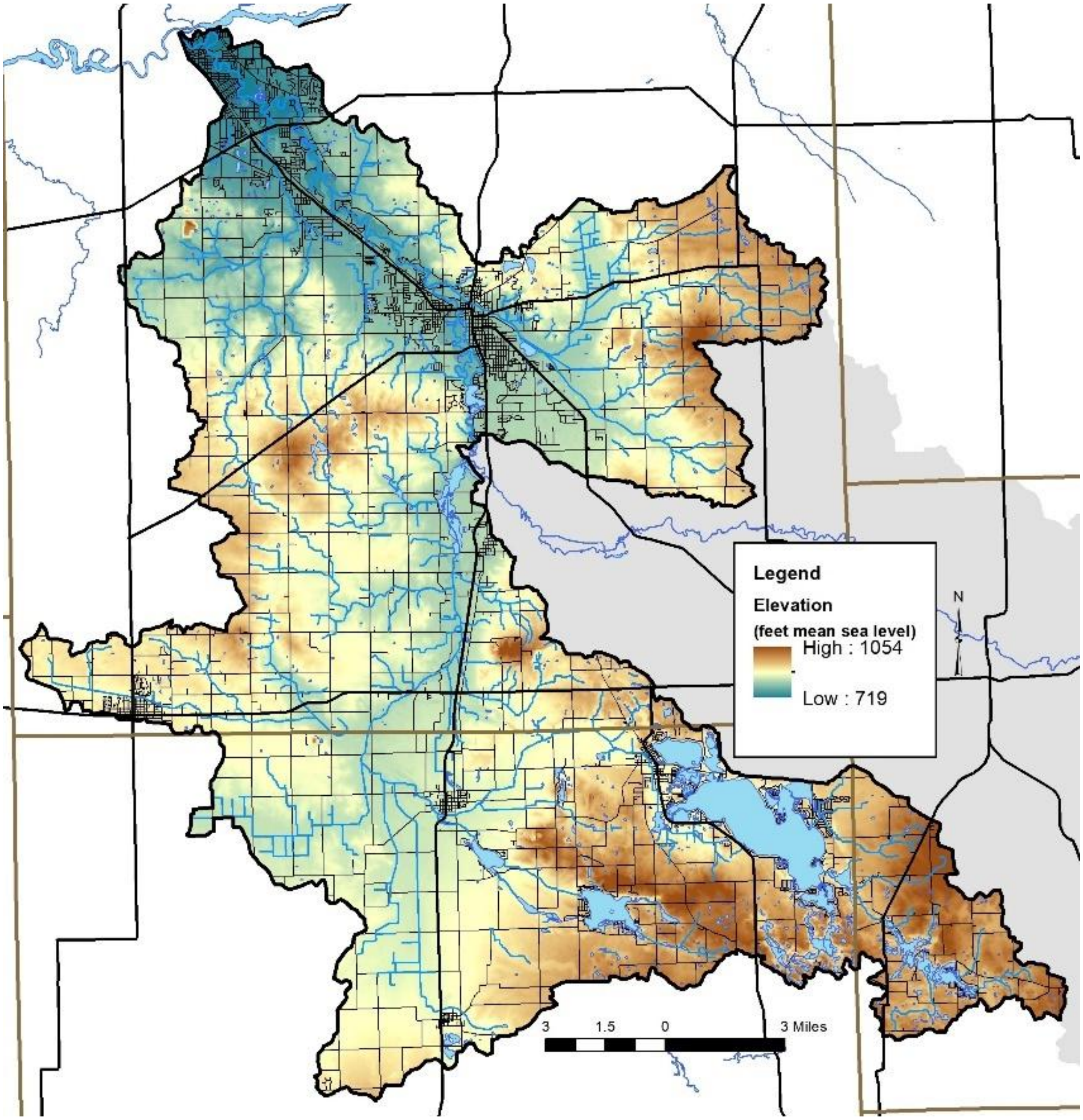


Figure 8. Surface elevation in the Lower Elkhart River Watershed.

2.5 Soil Characteristics

There are hundreds of different soil types located within the Lower Elkhart River Watershed. These soil types are delineated by their unique characteristics. The types are then arranged by relief, soil type, drainage pattern, and position within the landscape into soil associations. These associations provide the overall characteristics across the landscape. Soil associations are not used at the individual field level for decision making. Rather, the individual soil types are used for field-by-field management decisions. Some specific soil characteristics of interest, including septic limitations and soil erodibility, for watershed and water quality management are detailed below.

2.5.1 Hydrologic Soil Group

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Approximately half of the Lower Elkhart River Watershed is covered by well-drained soils from materials weathered from shale, siltstone and limestone. These moderately deep to deep soils are found on moderately sloping to steeply sloped land. Within floodplains, somewhat poorly drained to well-drained soils are located within river deposits on nearly level land. Soils are classified by the NRCS into four hydrologic soil groups based on the soil's runoff potential (Table 4). The majority of the watershed is covered by category D soils (25%) followed by category B soils (24%), category C soils (22%) and category A soils (21%). While the majority of soils are nearly evenly split by all soil types, the location of each hydrologic soil group is important. C and D soils dominate the western portions of the watershed, whereas B soils dominate around Dewart Lake (Figure 9). Category B soil is moderately deep and well drained, while Category C soils are finer and allow for slower infiltration. Category A soils are abundant in the northern section of the watershed and along Turkey Creek. Elkhart County's hydrologic soils are dominated by D soils, likely due to the predominance of glacial drift in this portion of the watershed. While this soil type has the slowest infiltration rates, Elkhart County is also significantly lower in elevation than the rest of the watershed. In these areas, D soils are slow infiltration soils, where flooding can regularly occur. This means that regular flooding is likely in this portion of the watershed.

Table 4. Hydrologic soil group summary.

Hydrologic Soil Group	Description
A	Soils with high infiltration rates. Usually deep, well-drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well-drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

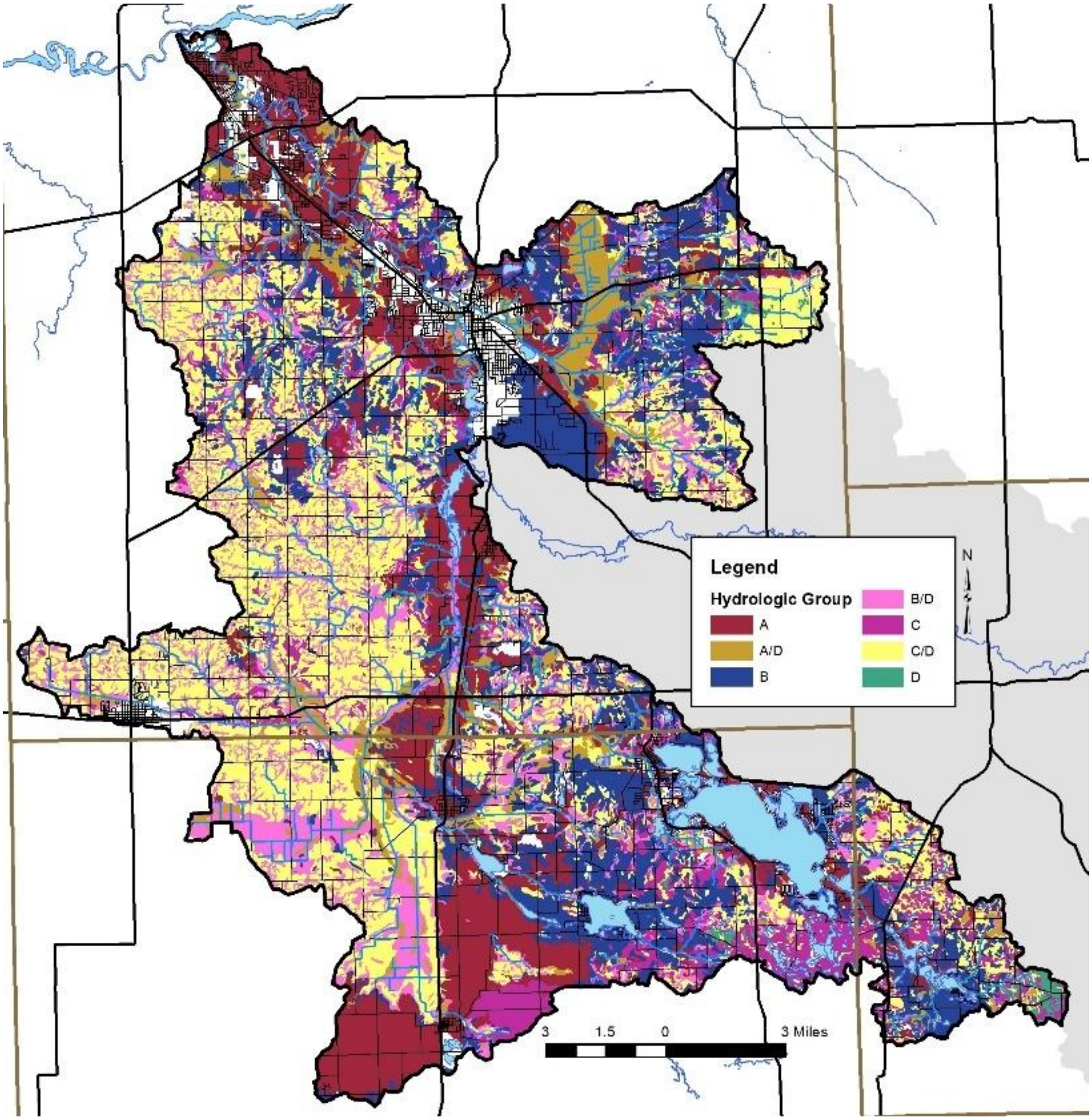


Figure 9. Hydrologic Soil Groups in the Lower Elkhart River Watershed.

2.5.2 Soil Erodibility

Soils that move from the landscape to adjacent waterbodies result in degraded water quality, limited recreational use, and impaired aquatic habitat and health. Soils carry attached nutrients and pesticides, which can result in impaired water quality by increasing plant and algae growth or even killing aquatic life. The ability and/or likelihood for soils to move from the landscape to waterbodies are rated by the Natural Resources Conservation Service (NRCS). The NRCS uses soil texture and slope to classify soils into those that are considered highly erodible, potentially highly erodible, and not highly erodible. The classification is based on an erodibility index which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss T value or tolerance value. The T value is the maximum annual rate of erosion that can occur for a particular soil type without causing a decline in long-term productivity.

Watershed stakeholders are concerned about soil erosion. As detailed above, soils which have high erodibility index values are those that are located on steep slopes and are easily moved by wind, water, or land uses. Figure 10 details locations of highly erodible soils within the Lower Elkhart River Watershed. Highly erodible soils cover 31% of the watershed or 59,509 acres. Highly erodible soils are found throughout the watershed with lesser amounts in the western portion of the watershed in Kosciusko County and along the mainstem of the Elkhart River.

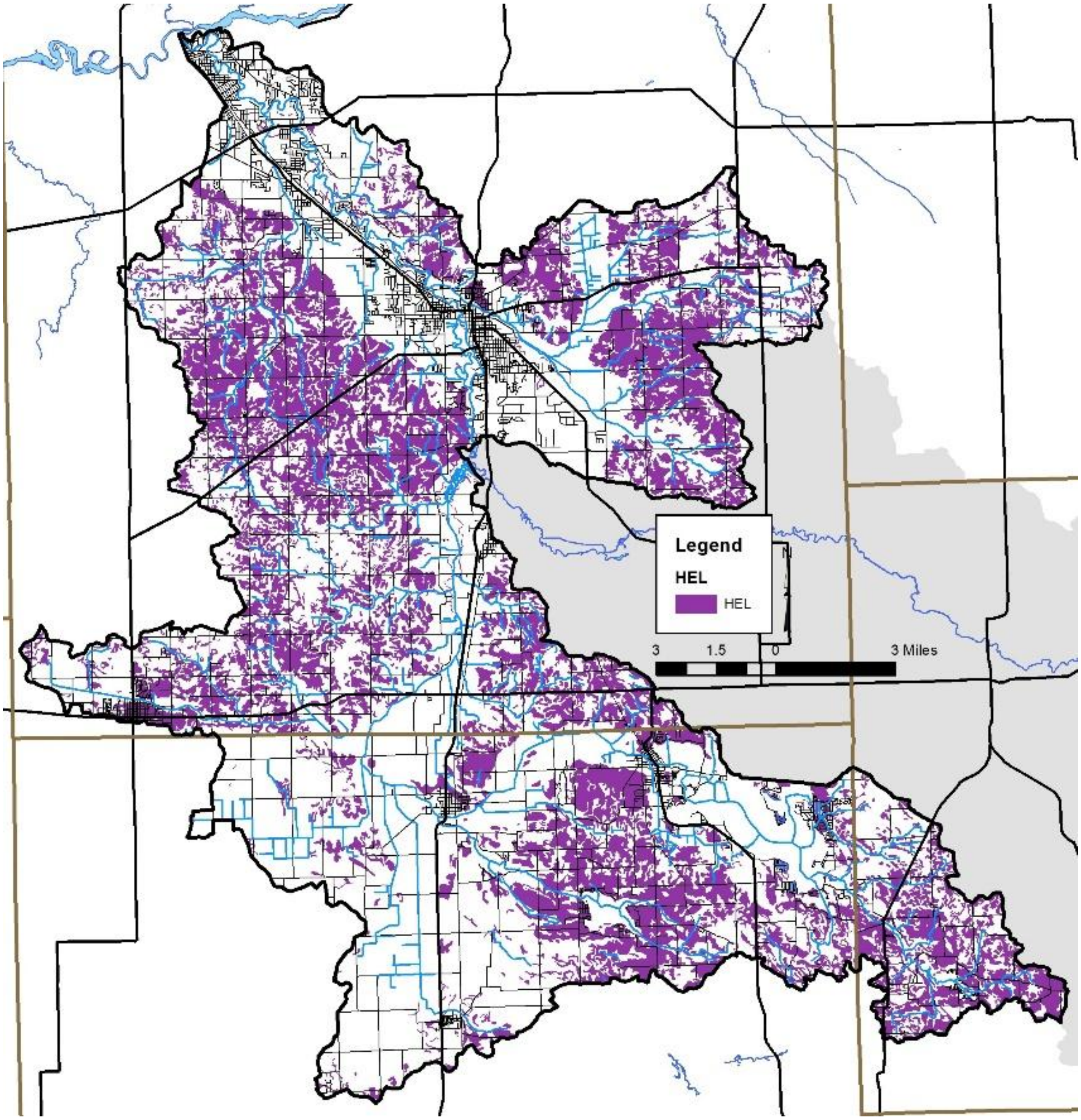


Figure 10. Highly erodible land in the Lower Elkhart River Watershed.

2.5.3 Hydric Soils

Hydric soils are those which remain saturated for a sufficient period of time to generate a series of chemical, biological, and physical processes. The oxidation and reduction of iron in the soil, or "redox", causes color changes characteristic of prolonged fluctuations in the water table. After undergoing these processes, the soil maintains the resultant characteristics even after draining or use modification occurs. Approximately 30,473 acres (16%) of the watershed is covered by hydric soils (Figure 11). While much of Elkhart County has limited hydric soils. They are relatively dense in Kosciusko County portion of the watershed. As these soils are considered to have developed under wetland conditions, they are a good indicator of historic wetland locations and therefore will be revisited in the land use section.

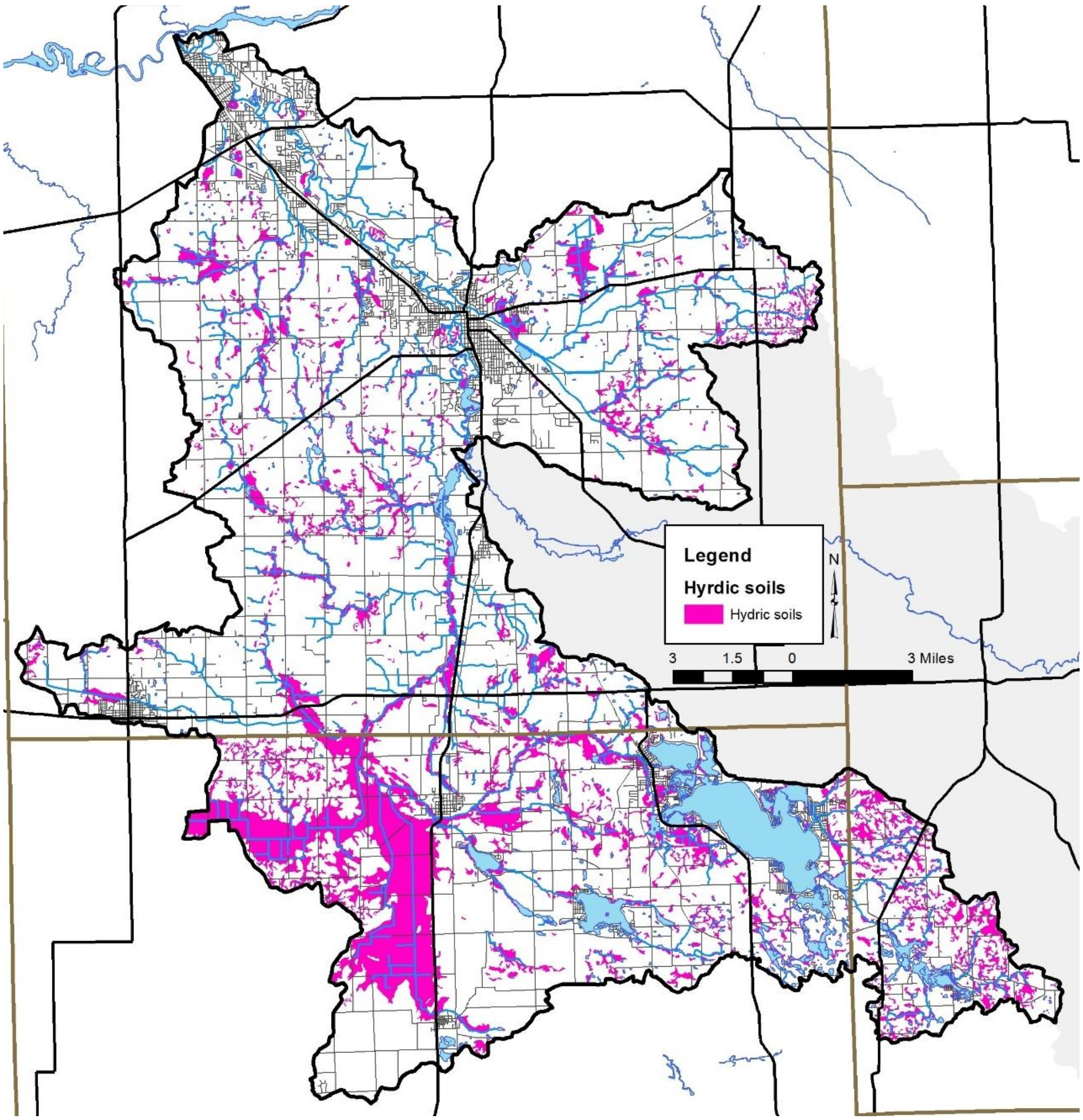


Figure 11. Hydric soils in the Lower Elkhart River Watershed.

2.5.4 Tile-Drained Soils

Soils drained by tile drains cover 72,844 acres or 38% of the Lower Elkhart River Watershed as estimated utilizing methods details in Sugg, 2007. This method of drainage is widely used in row crop agricultural settings within the watershed and has become even more intensively used within the last ten years. This results in altered hydrology, allowing the water to drain from the landscape more quickly to improve conditions for farming, but also potentially exacerbating downstream flooding and incising streams which cuts them off from their natural floodplains. In these areas, materials such as nutrients applied to agricultural soils are directly transported downstream, bypassing natural features such as filter strips that might otherwise filter out or assimilate nutrients. As the demands of production on each acre of land increases more tile is put in, typically in a network or series as extensive as 30 to 50 foot spacing between tiles. Impacts to stream water quality can be reduced by the use of tile control structures and drainage water management. CBBEL (2020) notes that successful agriculture in naturally poorly drained watersheds requires good drainage or the installation of tile drains. This means water more quickly escapes the landscape which in turn means the stream channel receives water more quickly. Coupling the high infiltration rates of soils in the watershed with tile drainage allows more water to infiltrate or soak into the ground rather than runoff as overland flow (CBBEL, 2020). A majority of tile-drained soils are located along the western portion of the watershed in northern Kosciusko County and in much of Elkhart County. Tile-drained soils can also be found in Noble County (Figure 12). Most of these areas are relatively flat where drainage augmentation is required to move water from agricultural fields in order to produce row crops. In these areas, materials applied to agricultural soils are directly transported to downstream waterbodies.

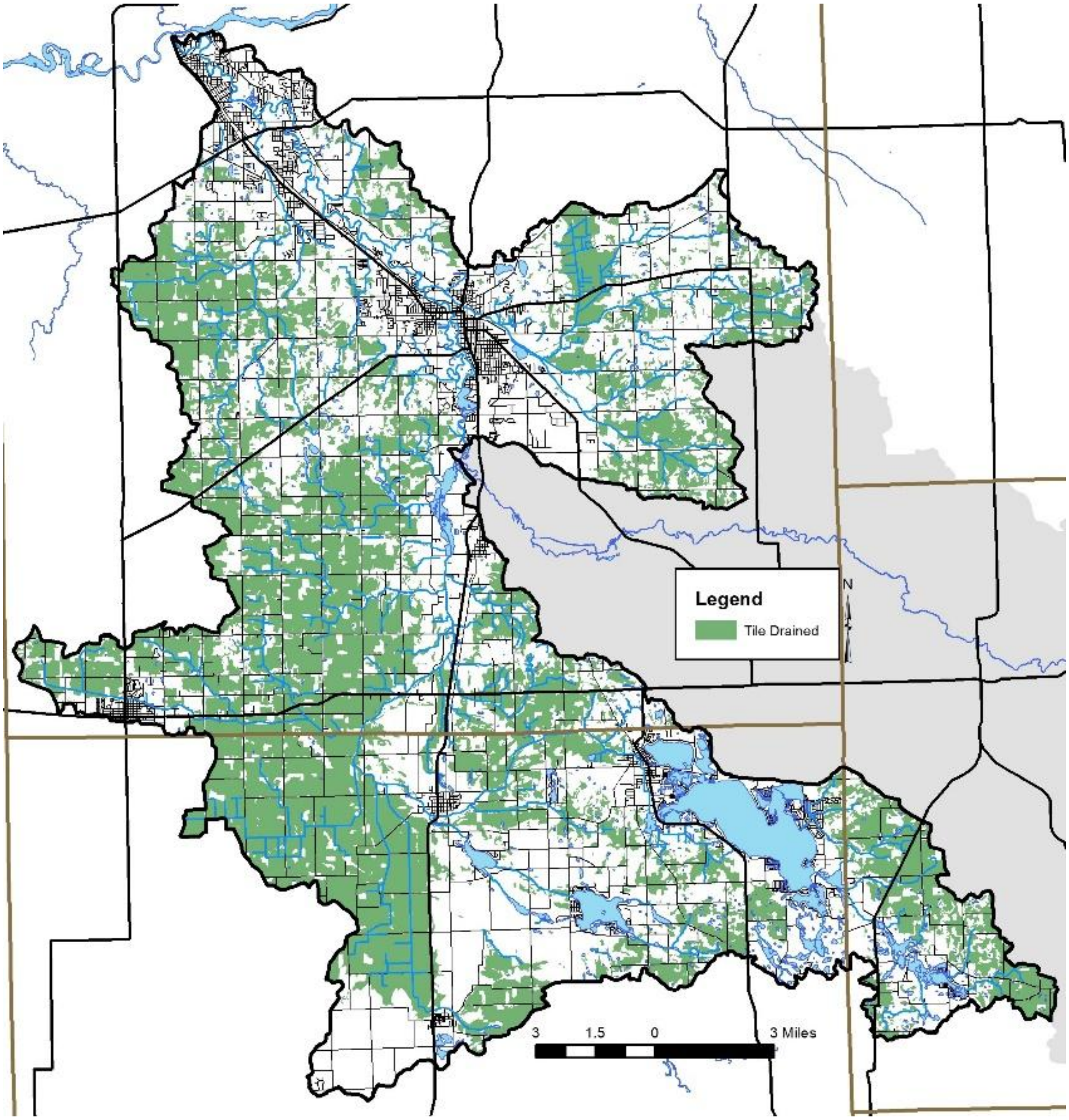


Figure 12. Tile-drained soils in the Lower Elkhart River Watershed.

2.6 <u>Wastewater Treatment</u>

2.6.1 Soil Septic Tank Suitability

Throughout Indiana, households depend upon septic tank absorption fields in order to treat wastewater. Seven soil characteristics, including position in the landscape, soil texture, slope, soil structure, soil consistency, depth to limiting layers and depth to seasonal high water table, are utilized to determine suitability for on-site septic treatment. Septic tanks require soil characteristics that allow for gradual movement of wastewater from the surface into the groundwater. A variety of characteristics limit the ability for soils to adequately treat wastewater. High water tables, shallow soils, compact till, and coarse soils all limit soils abilities in their use as septic tank absorption fields. Specific system modifications are necessary to adequately address soil limitation; however, in some cases, soils are too poor for treatment and therefore prove inadequate for use in septic tank absorption fields.

Until 1990, residential homes located on 10 acres or more and occurring at least 1,000 feet from a neighboring residence were not required to comply with any septic system regulations. In 1990, a new septic code corrected this loophole. Current regulations address these issues and require that individual septic systems be examined for functionality. Additionally, newly constructed systems cannot be placed within the 100-year floodplain and systems installed at existing homes must be placed above the 100-year flood elevation. However, many residences grandfathered into this code throughout the state have not upgraded or installed fully functioning systems (Krenz and Lee, 2005). In these cases, septic effluent discharges into field tiles or open ditches and waterways and will likely continue to do so due to the high cost of repairing or modernizing systems ($4,000 to $15,000; ISDH, 2001). Lee et al. (2005) estimates that 76,650 gallons of untreated wastewater per system is expelled in the state of Indiana annually. The true impact of these systems on the water quality in the watershed cannot be determined without a complete survey of systems.

The NRCS ranks each soil series in terms of its limitations for use as a septic tank absorption field. Each soil series is placed in one of three categories: severely limited, moderately limited, and slightly limited. Some soils are also unranked. Severe or very limited limitations delineate areas whose soil properties present serious restrictions to the successful operation of a septic tank tile disposal field. Using soils with a severe limitation increases the probability of the system's failure and increases the costs of installation and maintenance. Areas designated as having moderate or somewhat limited limitations have soil qualities which present some drawbacks to the successful operation of a septic system; correcting these restrictions will increase the system's installation and maintenance costs. Slight limitations delineate locations whose soil properties present no known complications to the successful operation of a septic tank tile disposal field. Use of soils that are rated moderately or severely limited generally require special design, planning, and/or maintenance to overcome limitations and ensure proper function.

Watershed stakeholders are concerned about the lack of maintenance associated with septic tanks, the use of soils that are not suited for septic treatment and the presence of straight pipe systems within the watershed. These concerns are exacerbated by the fact that severely limited soils cover essentially the entire watershed (Figure 13). Nearly 179,485 acres or 94% of the watershed is covered by soils that are considered very limited for use in septic tank absorption fields. Approximately 11 acres (<1%) are somewhat limited meaning that these soils are generally suitable for septic systems. The remaining 9,885 acres (5%) not rated for septic usage as it is not generally industry standard to install a septic system in these geographic locations.

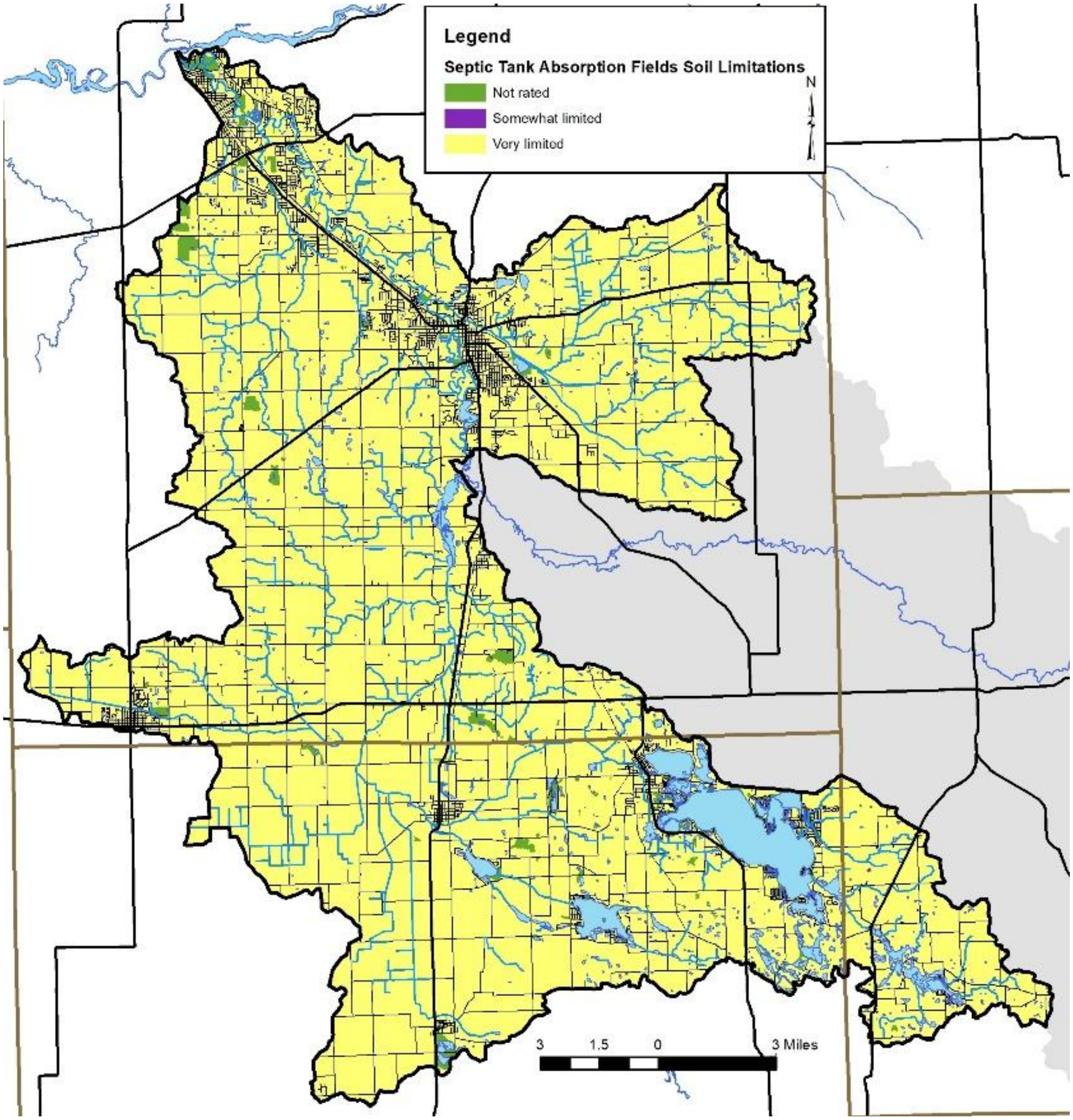


Figure 13. Suitability of soils for septic tank usage in the Lower Elkhart River Watershed.

Septic systems that are properly designed and maintained should not serve as a source of contamination to surface waters. However, septic systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are seasonal high water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail via surface breakouts or due to inadequate soil filtration there can be adverse effects to surface waters due to *E. coli*, nitrate, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and businesses and can be significant sources of pathogens and nutrients.

A comprehensive database of septic systems within the Lower Elkhart River Watershed is not available. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural household density. Based on estimates, more than 53,000 individuals live in rural residences within the

Lower Elkhart River Watershed. Those located on Group C and D soils have slow infiltration rates with finer textures and slow water movement and are of higher concern for septic system maintenance issues.

2.6.2 Wastewater Treatment

Several facilities which treat wastewater are permitted to discharge the treated effluent are located within the watershed. These facilities are regulated by National Pollution Discharge Elimination System (NPDES) permits. These include several wastewater treatment plants. NPDES-regulated wastewater treatment plants located within the watershed are shown in Figure 14 and Table 5. Wastewater treatment plant septage sludge is either applied to the land or hauled to a landfill in the Lower Elkhart River Watershed. Table 5 details the NPDES facility name, activity, and permit number for those facilities which discharge into a Lower Elkhart River waterbody. More detailed information for each wastewater facility is discussed below.

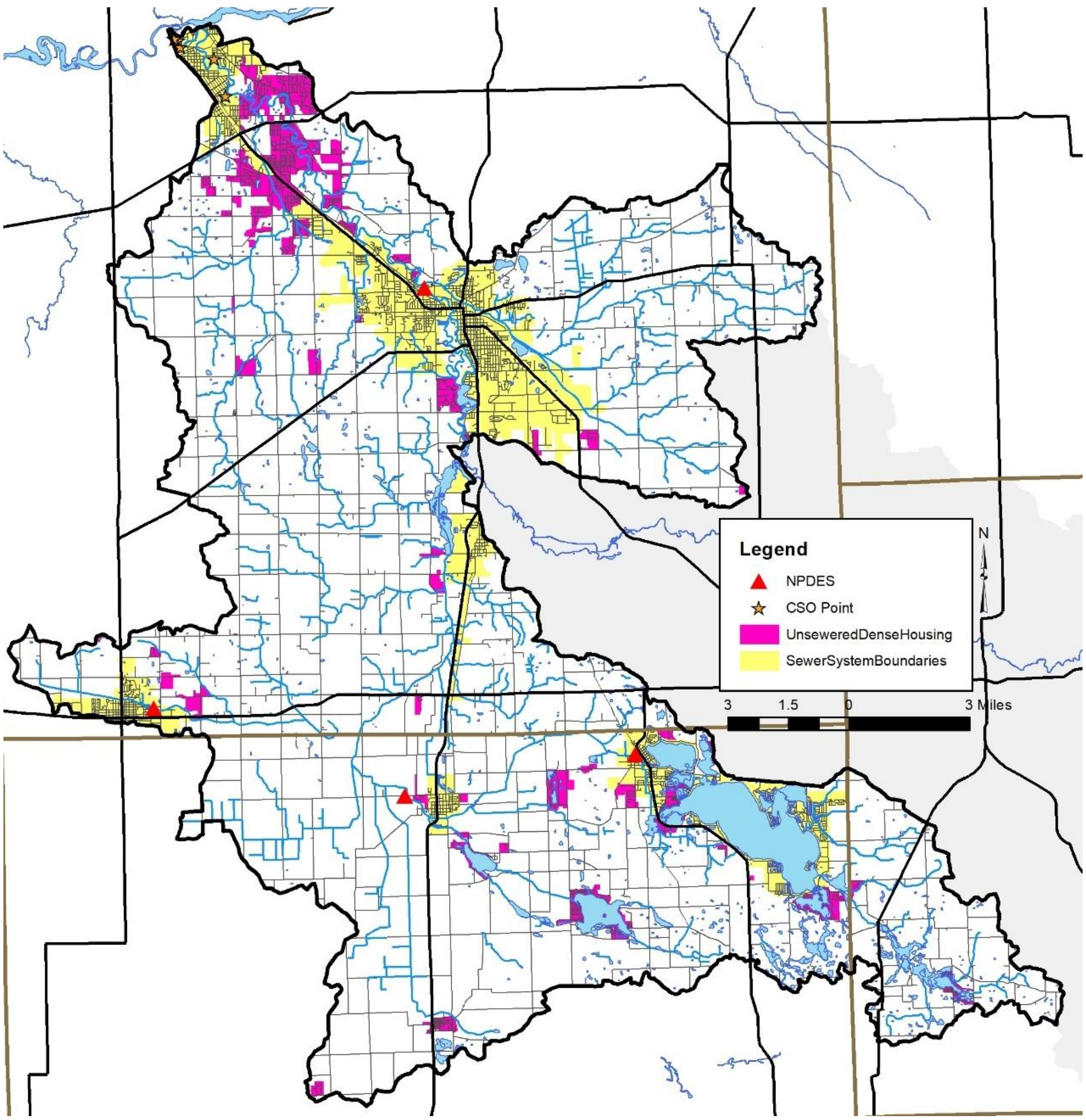


Figure 14. NPDES-regulated wastewater treatment plants, wastewater treatment plant treatment areas, CSO locations and locations of unsewered, dense housing in the Lower Elkhart River Watershed.

Table 5. NPDES-regulated facility information.

NPDES ID	Facility Name	Volume (MGD)
IN0025755	GOSHEN WWTP	5.0
IN0038318	MILFORD WWTP	0.25
IN0021466	NAPPANEE WWTP	1.9
IN0021172	SYRACUSE WWTP	1.05

2.6.3 Municipal Wastewater Treatment

There are four (4) wastewater treatment facilities located within and discharging to waterbodies in the Lower Elkhart River Watershed including Goshen Wastewater Treatment Plant (WWTP), Milford WWTP, Nappanee WWTP and Syracuse WWTP.

The City of Goshen currently operates a Class III, 5.0 MGD (Millions of Gallons per Day) activated sludge facility. The facility consists of a two-bar screen, an influent flow meter, grit removal, six primary clarifiers, four activated sludge tanks, two secondary clarifiers, phosphorus removal chlorination/dechlorination facilities, two final clarifiers and an effluent flow meter. A 5th aeration basin was added in 2022. Sludge is treated with two anaerobic digesters. The final sludge is land-applied. The collection system is comprised of 136 miles of sewers (17 miles separate storm sewers, 57 miles separate sanitary sewers, 62 miles of combined sewers). To store stormwater, the city has a wet-weather detention facility with a storage capacity of 12 MGD. Three combined sewer overflow (CSO) outfalls are prohibited per their NPDES permit and have been diverted to the wet-weather detention facility. This facility has not had a discharge since 2018. There are currently no maintenance or compliance issues with the Goshen WWTP.

The Town of Milford currently operates a Class II, 0.25 MGD extended aeration treatment facility consisting of a lift station, bar screens, two oxidation ditches, phosphorus removal, two secondary clarifiers, chlorination/dechlorination, post aeration, and an effluent flow meter. Sludge handling includes aerobic digestion before it is hauled off-site to a landfill. The collection system is comprised of combined storm and sanitary sewers with no overflow or bypass points. There are currently no maintenance issues or concerns at the Town of Milford's WWTP.

The City of Nappanee currently operates a Class III, 1.9 MGD activated sludge plant consisting of an influent pumping station, mechanical bar screen, aerated grit chamber, two primary clarifiers, six aeration tanks, two final clarifiers, six aerobic digester tanks, two anaerobic digester tanks, a sludge pumping station, belt filter press, sludge drying beds, phosphorus removal, UV disinfection and influent and effluent flow meters. The final sludge is dried and landfilled. The collection system is comprised of combined sanitary and storm sewers. The city also operates a 5.0 MGD wet-weather treatment facility, which has one outfall. This includes a CSO storage basin, screening and pumping, UV disinfection, and a high-rate clarification facility. In 2018, the City of Nappanee implemented a CSO Long Term Control Plan. The NPDES permit lists eleven CSO locations, which are now prohibited per their NPDES permit; however, IDEM shows these points as active CSO locations and they are therefore included in Figure 14. There are currently no maintenance or compliance concerns at the City of Nappanee's WWTP.

The Town of Syracuse operates a Class II 1.05 MGD oxidation ditch facility. The facility includes a mechanically cleaned bar screen, forced vortex-type grit removal chamber, influent flow meter, two oxidation ditches, two secondary clarifiers, post aeration, phosphorus removal, UV disinfection and an effluent flow meter. Sludge handling includes aerobic digestion and dewatering via a belt filter press. The final sludge is land-applied on permitted agricultural land. The collection system is 100% separate sanitary sewers with no overflow or bypass points. In 2020, the facility was sent a non-compliance letter by IDEM regarding copper and chlorine effluent limit violations. An inspection by IDEM in September 2021 rated the collection system, the facility/site, records/reports, pre-treatment and effluent limits compliance as all unsatisfactory. In 2021, monthly average concentrations were exceeded for total recoverable copper, total residual chlorine, total suspended solids, and total phosphorus. It was noted that chemicals were not stored properly, and the UV disinfection system was out of service. As of September 2022, IDEM sent an agreed order listing fines and a timeline for compliance.

Additionally, while they discharge outside of the Lower Elkhart River Watershed, the Turkey Creek, Regional Sewer District, New Paris wastewater treatment plant and City of Elkhart wastewater treatment plant treatment areas are all displayed on Figure 14. It should be noted that the City of Elkhart has six active CSOs which are governed by their long-term control plan. The long-term control plan (2011) will be implemented over several decades. Based on modeling, the plan is expected to:

- Reduce the frequency of overflows to no more than 9 overflow events in a year with typical rainfall.
- Improve system-wide capture of wet-weather sewer flows from a baseline of 82% to 96% in a typical year.
- Reduce average annual overflow volume by 75% compared to baseline conditions.
- Reduce Elkhart's CSO share of the total *E. coli* load to the St. Joseph River from 9.1% to 2.4%.
- Reduce *E. coli* exceedances by more than 50% at locations between Elkhart and Mishawaka.

2.6.4 Unsewered Areas

Approximately 8,043 acres of unsewered dense housing areas were identified within the watershed (Figure 14). Areas that have at least 25 houses within a square mile outside of the sanitary district boundaries were classified as dense, unsewered areas.

2.7 Hydrology

Watershed streams, reservoirs, legal drains, floodplains, wetlands, storm drains, groundwater, subsurface conveyances, and manmade drainage channels all contribute to the watershed's hydrology. Each component moves water into, out of, or through the system. Their contributions will be covered in further detail in subsequent sections.

2.7.1 Watershed Streams

The Lower Elkhart River Watershed contains approximately 488 miles of streams/rivers, canals/ditches, pipelines, and connectors (Figure 15). Of these, approximately 294.5 miles are mapped as canals/ditches, while 144.6 miles are streams and rivers. A majority of the 295 miles mapped as canals/ditches are regulated or legal drains. It should be noted that regulated drains are maintained by the County surveyor's office and all of the regulated drains within the watershed have both a regular maintenance fund and a regular maintenance schedule. Maintenance practices can include dredging with large construction equipment to maintain flow, debris removal, and vegetation management both within the regulated drain and the riparian zone. As these waterbodies are subject to periodic cleaning, it is important to work with the county surveyor to establish priorities for these waterbodies in terms of water quality improvement and erosion control. Each time a ditch is cleaned out or maintained, this action increases the amount of sediment going downstream towards the mainstem of the Elkhart River.

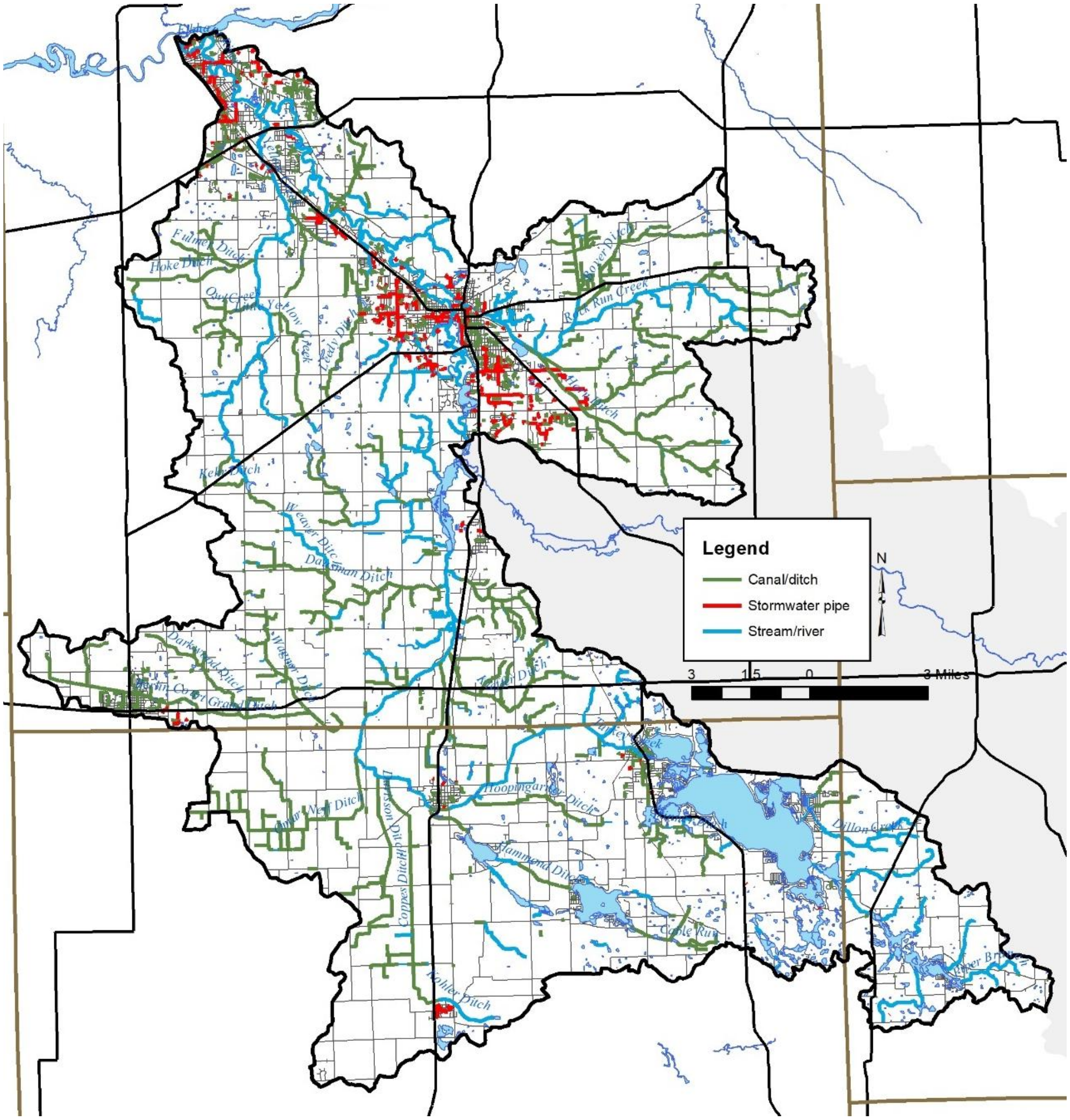


Figure 15. Stream type in the Lower Elkhart River Watershed.

The section of the river considered to be the Lower Elkhart River begins south of Goshen, near its confluence with Turkey Creek. The Elkhart River flows 35.6 miles from this point to the end of this watershed, where it outlets into the St. Joseph River. The major tributaries to Lower Elkhart River include Turkey Creek, Berlin Court Grand Ditch, Yellow Creek, Rock Run Creek, and Dausmann Ditch (Table 6). The Elkhart River is used for recreational kayaking and canoeing as well as fishing, swimming and aesthetic enjoyment. Several tributaries to Lower Elkhart River Creek are also used for canoeing, kayaking, fishing and aesthetic enjoyment.

Table 6. Streams in the Lower Elkhart River Watershed.

Steam Name	Length (mi)	Stream Name	Length (mi)
Berlin Court Grand Ditch	9.0	Kehr Ditch	1.0
Boyer Ditch	5.2	Kieffer Ditch	5.2
Cable Run	2.7	Kohler Ditch	3.2
Coppes Ditch	4.9	Leedy Ditch	5.0
Darkwood Ditch	3.7	Little Yellow Creek	3.8
Dausman Ditch	7.1	New Miller Ditch	1.5
Davisson Ditch	5.4	Omar Neff Ditch	3.5
Dillon Creek	3.1	Owl Creek	1.6
Elkhart River	22.1	Piper Branch	2.1
Fetters Martin Ditch	1.7	Preston Miles Ditch	3.3
Fuller Arm	1.5	Rock Run Creek	12.0
Fulmer Ditch	1.9	Shaffer Ditch	2.0
Hammond Ditch	2.3	Skinner Ditch	3.1
Hoke Ditch	3.1	Turkey Creek	22.0
Hoopingarner Ditch	4.1	Wagner Ditch	2.7
Hoover Ditch	2.8	Weaver Ditch	2.4
Horn Ditch	5.4	Yellow Creek	12.4
Kauffman Ditch	1.0		

In a review of the hydrogeology of the St. Joseph River basin in Indiana (of which the Elkhart River is part), Crompton and others (1986) stated that the St. Joseph River basin has some of the most productive aquifers in the state. The entire basin has unconsolidated glacial deposits underlying it. Much of the basin is underlain by thick (100-300 ft) deposits of sand and gravel. These sands and gravels form an extensive unconfined buried aquifer with very high transmissivity rates that recharge the river (Crompton and others, 1986; Fowler,1992). Crompton and others estimated that 80 percent of the flow in the river is supplied by these aquifers.

Compared to streams in central and southern Indiana, streams in the St. Joseph River basin have higher base flow and lower flood flows. This is a result of: 1) good hydraulic connection between highly permeable outwash aquifers and stream channels and 2) large amount of surface storage from lakes and wetlands. Streams can maintain steady flow even in times of drought because stored water is released (Crompton and others, 1986).

2.7.2 Lakes, Ponds, and Impoundments

Numerous lakes and ponds dot the Lower Elkhart River Watershed landscape. The largest of these include Lake Wawasee, Syracuse Lake, Dewart Lake, Waubee Lake and Goshen Dam Pond, all of which measure 100 or more acres. In total, five dam structures create Flatbelly Lake , Price Lake, Shock Lake, Lake Papakeechie and the Goshen Dam Pond (Figure 16). Many other lakes in the Lower Elkhart River Watershed possess water control structures; however, these are not mapped by the IDNR as part of their dams GIS layer. Lakes throughout the watershed provide local swimming holes, recreational boating options and localized fishing as well as providing water storage and retention to assist with flooding. Table 7 details lakes with public access sites, which are more readily used for fishing, swimming, boating and other recreation. In total, there are 1053 lakes and ponds in the watershed.

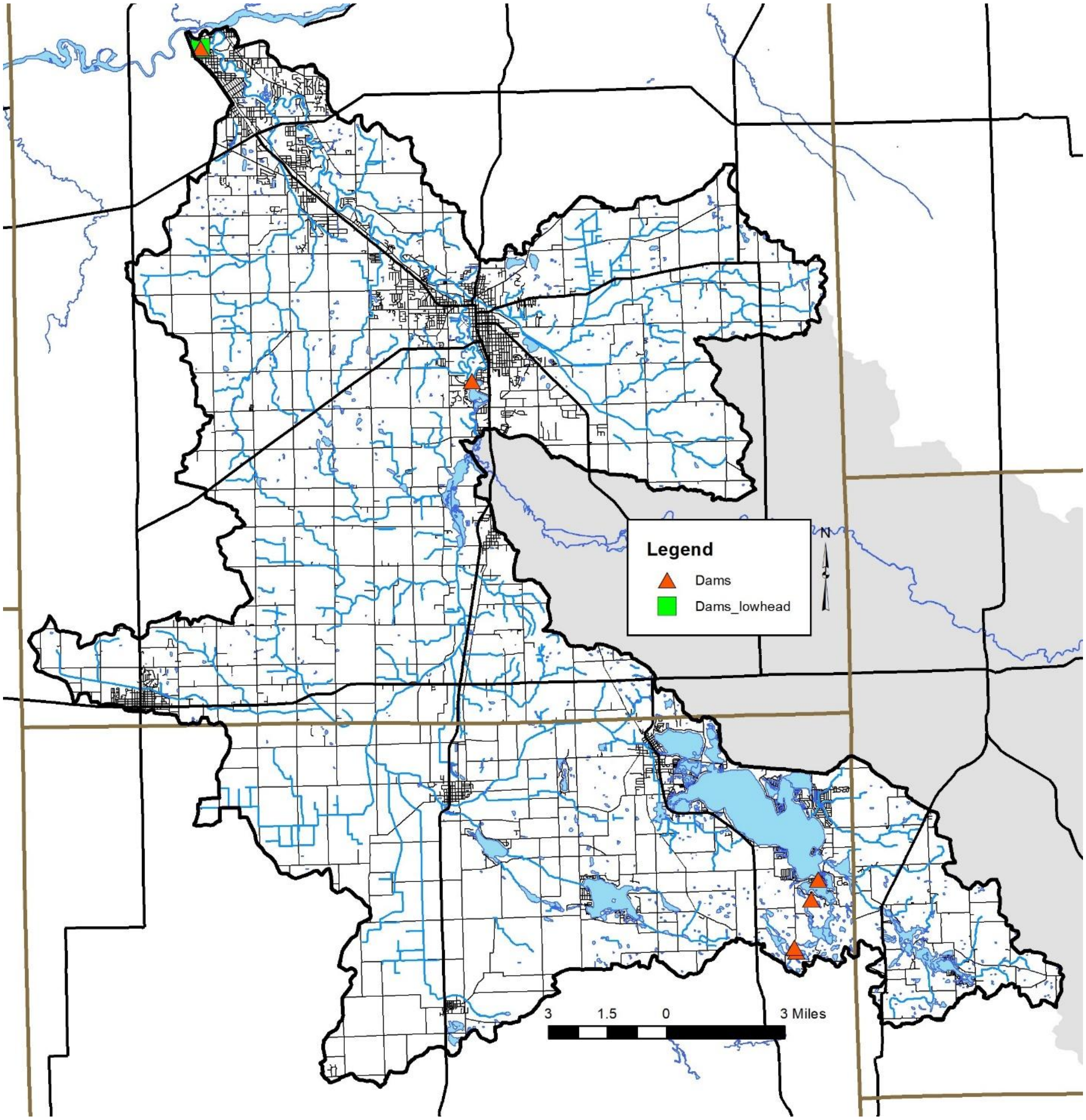


Figure 16. Dams including lowhead dams located in the Lower Elkhart River Watershed.

Table 7. Publicly accessible lakes in the Lower Elkhart River Watershed.

Lake Name	Area (acres)	Lake Name	Area (acres)
Allen	5.3	Moss	7.3
Barrel and a Half	12.3	Norton	50.9
Butts	39.5	Price	8.0
Dewart	557.9	Rider	2.7
Gordy	26.6	Rothenberger	5.3
Goshen Dam Pond	80	Shock	34.4
Hammond	8.0	Spear	40.5
Harper	13.3	Syracuse	413.0
Hindman	9.4	Village	11.5
Knapp	79.1	Wabee (Waubee)	186.7
Wawasee	3464.2	Yellow Creek	15.7
Long	9.4		

2.7.3 Floodplains

Flooding is a common hazard that can affect a local area or an entire river basin. Flooding is a concern to Lower Elkhart River Watershed stakeholders. Increased imperviousness, encroachment on the floodplain, deforestation, stream obstruction, tiling or failure of a flood control structure all are mechanisms by which flooding occurs. Impacts of flooding include property and inventory damage, utility damage and service disruption, bridge or road impasses, streambank erosion and riparian vegetation loss, water quality degradation, and channel or riparian area modification.

Floodplains are lands adjacent to streams, rivers and other waterbodies that provide temporary storage for water. These systems act as nurseries for wildlife, offer green space for humans and wildlife, improve water quality, and buffer the waterbody from adjacent land uses. Local stakeholders are concerned about impacts to floodplains from development, lack of landowner maintenance, and soil erosion and deposition within the floodplain.

Figure 17 details the locations of floodplains within the Lower Elkhart River Watershed. Narrow floodplains lie adjacent to Yellow Creek, Turkey Creek, Berlin Court Ditch, Horn Ditch and the Elkhart River. The widest floodplain lies adjacent to Rock Run Creek before its confluence with Horn Ditch. Approximately 8% (14,851 acres) of the Lower Elkhart River Watershed lies within the 100-year floodplain (Figure 17). This 100-year floodplain is composed of three regions:

- Zone A is the area inundated during a 100-year flood event for which no base flood elevations (BFE) have been established. Nearly 5,031 acres (2.6%) of the Lower Elkhart River Watershed is in Zone A.
- Zone AE is the area inundated during a 100-year flood event for which BFEs have been determined. The chance of flooding in Zone AE is the same as the chance of flooding in Zone A; however, floodplain boundaries in Zone A are approximated, while those in Zone AE are based on detailed hydraulic models which allows Zone AE floodplains to be more accurate. Nearly 9,414 acres (5%) of the Lower Elkhart River Watershed are in Zone AE.
- Zone X includes areas outside the 100-year and 500-year floodplains which have a 1% chance of flooding to a depth of one foot of water. No BFEs are available for these areas and no flood insurance is required. Zone X contains 406 acres (less than 1% of the Lower Elkhart Watershed.

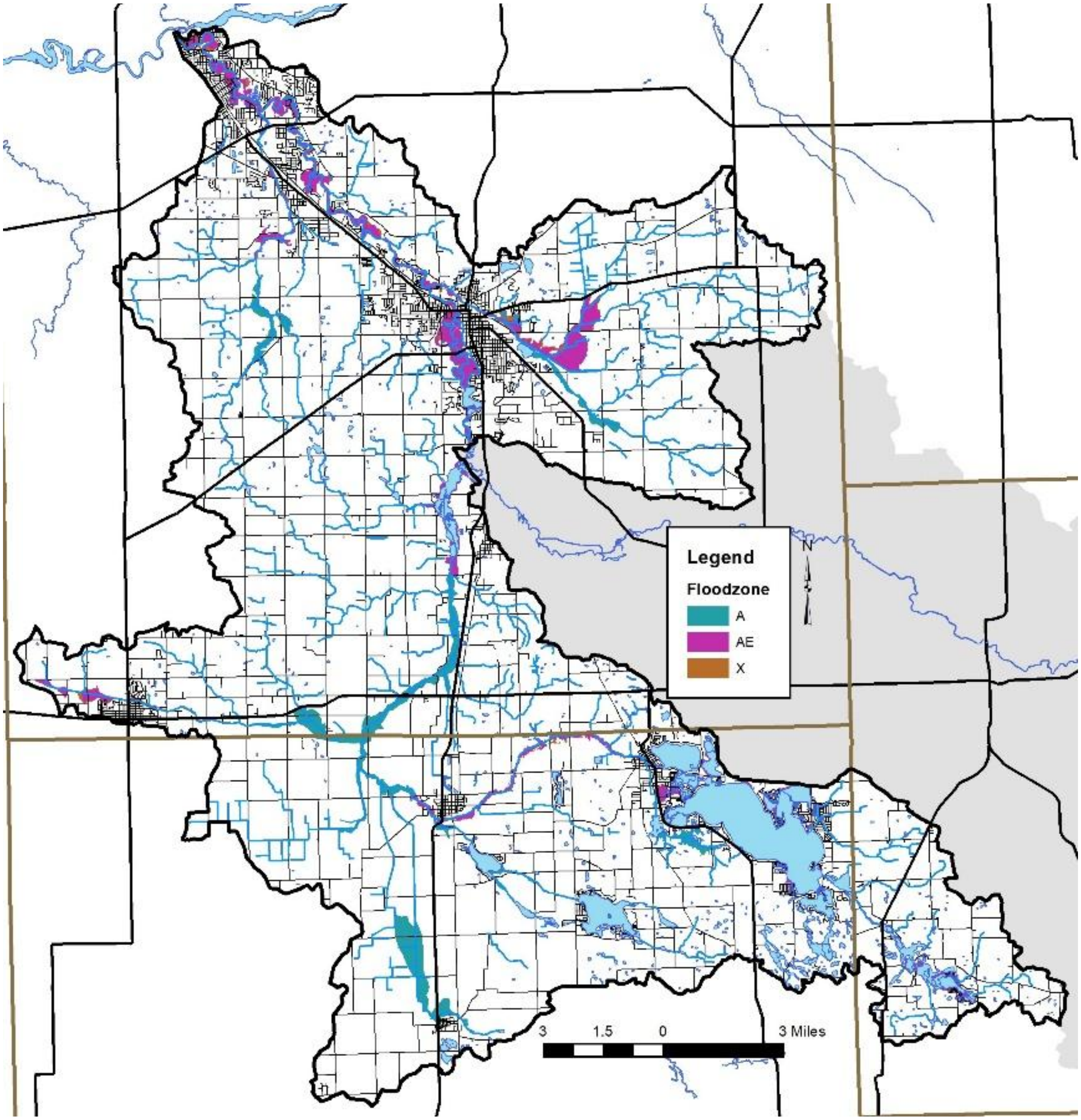


Figure 17. Floodplain locations within the Lower Elkhart River Watershed.

2.7.4 Wetlands

Approximately 25% of Indiana was covered by wetlands prior to European settlement (IDEM, 2007). Overall, 85% of wetlands have been lost resulting in Indiana ranking fourth in the nation in terms of percentage of wetland loss. Wetlands provide numerous valuable functions that are necessary for the health of a watershed and waterbodies. Wetlands play critical roles in protecting water quality, moderating water quantity, and providing habitat. Wetland vegetation adjacent to waterways stabilizes shorelines and streambanks, prevents erosion, and limits sediment transport to waterbodies. Additionally, wetlands have the capacity to increase stormwater detention capacity, increase stormwater attenuation, and moderate low water levels or flow volumes by allowing groundwater to slowly seep back into waterbodies. These benefits help to reduce flooding and erosion. Wetlands also serve as high quality natural areas providing breeding grounds for a variety of wildlife. They are typically diverse ecosystems which can provide recreational opportunities such as fishing, hiking, boating, and bird watching. It should be noted that natural wetlands are regulated through the IDEM and the U.S. Army Corps of Engineers while USDA has jurisdiction over wetlands on agricultural fields. Any modification to wetlands requires permits from these agencies.

Wetlands cover only 14,048 acres, or approximately 7% of the watershed. When hydric soil coverage is used as an estimate of historic wetland coverage, it becomes apparent that more than 9% of wetlands have been modified or lost over time. This represents more than 16,400 acres of wetland loss within the Lower Elkhart River Watershed. As commodity prices continue to go up and down, area land values remain high and as a result, individuals are spending a great deal of money to drain small natural wetlands in their fields in order to be able to farm that additional couple acres of land as it is cheaper to tile it than to buy ground already in production.

Figure 18 shows the current extent of wetlands within the Lower Elkhart River Watershed. Wetlands displayed in Figure 18 results from compilation efforts by the U.S. Fish and Wildlife Service as part of the National Wetland Inventory (NWI). The NWI was not intended to map specific wetland boundaries that would compare exactly with boundaries derived from ground surveys. As such, NWI boundaries are not exact and should be considered to be estimates of wetland coverage. Using this map will help us to identify which portions of the watershed would make ideal candidates for wetland restoration efforts, which would reduce the amount of sediment and nutrients reaching the creek, as well as helping to restore the natural hydrology of the area which could help to reduce flooding impacts locally.

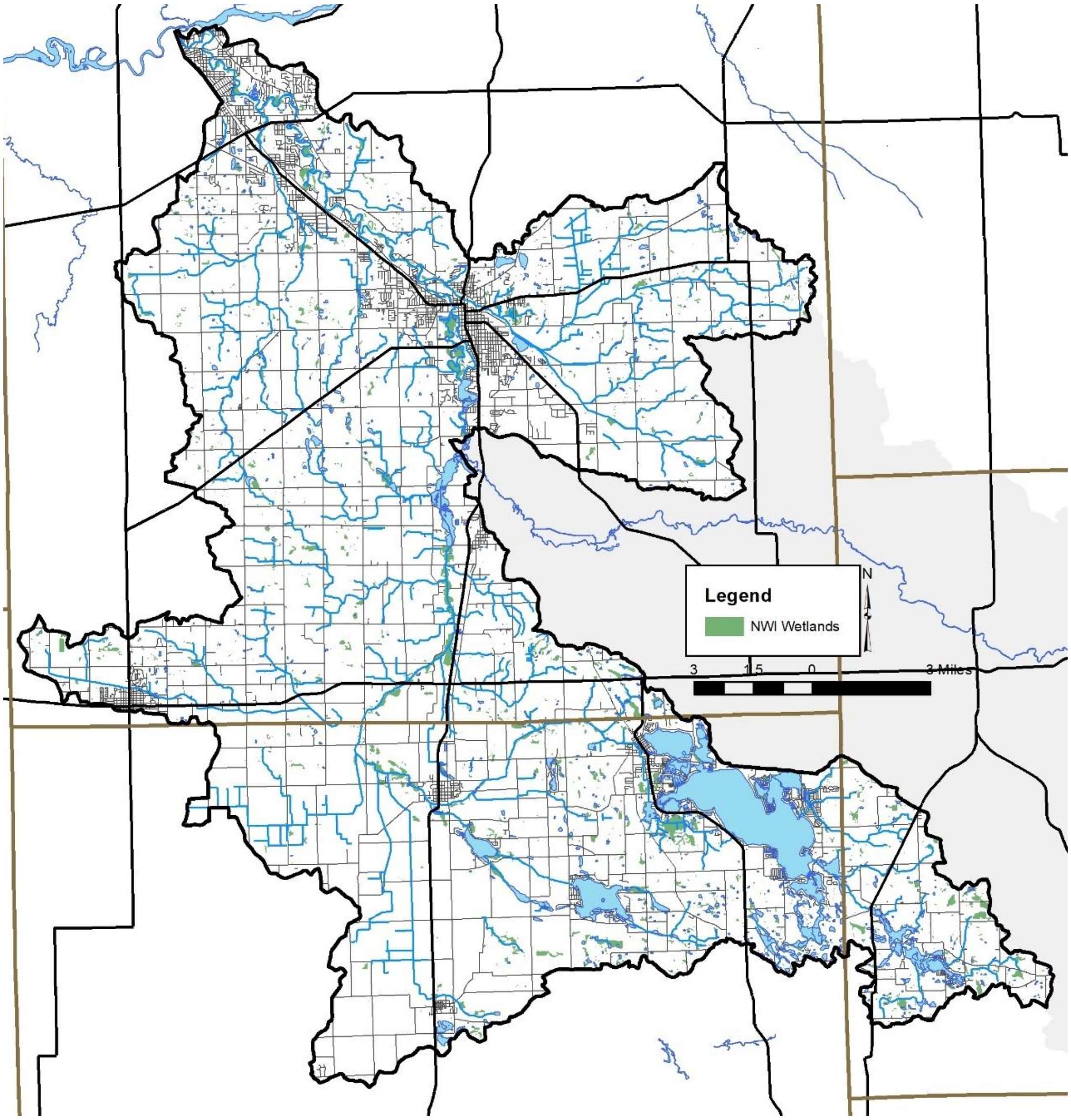


Figure 18. Wetland locations within the Lower Elkhart River Watershed. Source: USFWS, 2017.

2.7.5 Stormwater and Storm Drains

Under natural conditions, the majority of precipitation is allowed to infiltrate the soil and recharge groundwater resources. The volume of infiltration and groundwater recharge diminishes as development increases. To handle the large volume of precipitation falling in urban areas, stormwater systems have been constructed. Storm drain systems are present in most urban areas throughout the watershed. There are four municipal separate storm sewer systems (MS4) in the Lower Elkhart River Watershed: Elkhart County, the City of Elkhart and the City of Goshen, which are part of the Greater Elkhart County Stormwater Partnership, and the City of Nappanee. MS4s are defined as a conveyance or system of conveyances owned by a state, city, town, or other public entity that discharges to waters of the United States and is designed or used for collecting or conveying stormwater. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels and conduits. It does not include CSOs and publicly owned treatment works. Figure 19 details the MS4 boundaries for the Watershed's MS4s.

On December 18, 2021, IDEM issued the MS4 General Permit. This replaced 327 IAC 15-13 (rule 13) that previously established permitting requirements for all designated MS4s in Indiana. In April 2022, the City of Nappanee received a letter from IDEM that the city met the requirements to be regulated under the new general permit. On November 29, 2022, the Board of Public Works and Safety approved an agreement for stormwater consulting to respond to the letter from IDEM.

The Greater Elkhart County Stormwater Partnership is a cooperative effort covering the Town of Bristol, the City of Elkhart, the City of Goshen, and Greater Elkhart County. The Greater Elkhart County Stormwater Partnership has plans which include six minimum control measures and outlines programs to improve the quality of stormwater that runs off of the land and into rivers, lakes, and streams within their boundaries. More than 28,619 acres of the Lower Elkhart River Watershed are located in one of the four designated MS4s (Table 8).

Table 8. MS4 communities in the Lower Elkhart River Watershed.

MS4 Community	Permit ID	Area (Acres)
Elkhart County	INR040137	27,061
City of Elkhart	INR040175	
City of Goshen	INR040176	
City of Nappanee	N/A	1,558

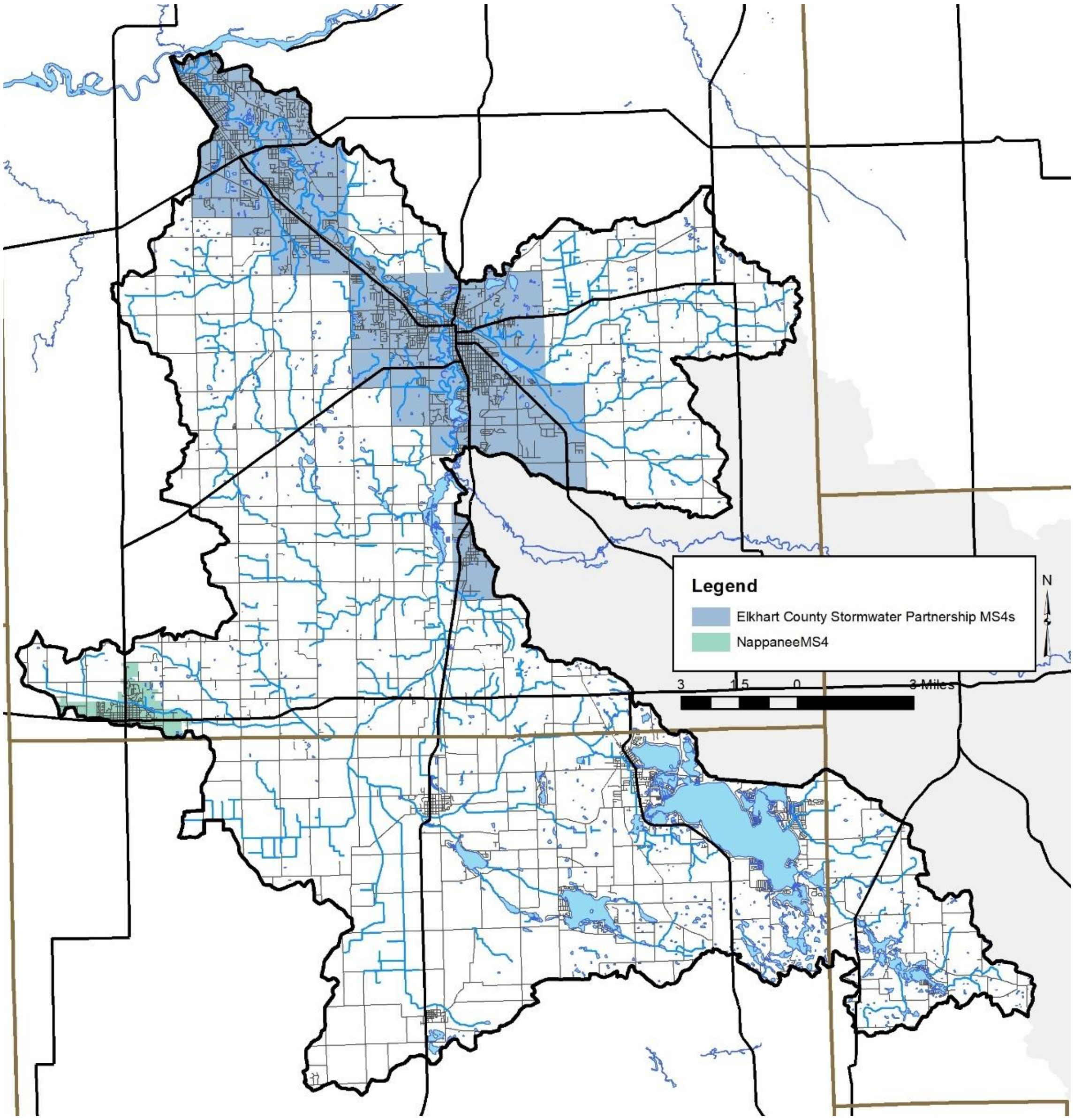


Figure 19. MS4 boundaries for the City of Nappanee and the Elkhart County Stormwater Partnership located within the Lower Elkhart River Watershed.

The growth of towns and cities has occurred along the many waterways that make up the Lower Elkhart River Watershed. However, this growth has sometimes resulted in flooding and drainage issues becoming a problem due to development within floodplains and the interruption of how stormwater flows across the land. To address these issues communities have carried out studies to determine ways to manage stormwater and minimize the impacts of flooding. Those studies which address stormwater drainage in the watershed are detailed as follows:

- Report on Stormwater Problem for Northwest Goshen Suburban Association; Chas. W. Cole & Son, 1966
- West Goshen Watershed Study; Cole Associates, Inc., 1986
- Horn Ditch Modeling for the Construction of a Two-Stage Ditch; Triad Engineering Incorporated, 2005

- Soils Investigation, Horn Ditch, Goshen Indiana; Wightman Petrie Environmental, Inc, 2006
- West Goshen Watershed Drainage Study; American Structurepoint, Inc., 2008
- Report of Findings Goshen Dam Pond, Goshen Indiana; Abonmarche Consultants, Inc., 2020
- West Goshen-Crossing Subdivision Drainage Improvement Project: Drainage Analysis of Stormwater System; Abonmarche Consultants, Inc., 2021
- East College Avenue Industrial Park Watershed Study; Abonmarche Consultants, Inc. 2022
- Keaffaber Property Drainage Study; Abonmarche Consultants, Inc., 2023

2.7.6 Wellfields/Groundwater Sensitivity

Recharge to the bedrock aquifer occurs at bedrock outcrops where precipitation enters the aquifer directly or indirectly via unconsolidated deposits. Table 9 lists wellhead protection areas within and adjacent to the Lower Elkhart River Watershed. Potential pollution from construction, sewage outfalls or overflows, illegal dumping, agriculture, and stormwater runoff must be avoided or controlled due to the recharge of these aquifers from runoff and river water.

Table 9. Wellhead protection areas in and adjacent to the Lower Elkhart River Watershed.

County	PWSID	System Name	Population
Elkhart	522007	Elkhart Mobile Home Park	96
Elkhart	522008	Elkhart Public Works and Utilities	40 880
Elkhart	522009	Goshen Water Utility	32 267
Elkhart	522012	Broadmore Estates	972
Elkhart	522016	Nappanee Water Utility	6 800
Elkhart	522021	Skyview Mobile Home Park	84
Elkhart	522031	Country Meadows Mobile Home Park	55
Kosciusko	5243019	Pinecrest Mobile Home Park	44
Kosciusko	5243025	Syracuse Water Company	2 810
Kosciusko	5243031	Wabee Lake Mobile Home Park	30
Kosciusko	5243032	Turkey Creek Regional Sewer District	593
Kosciusko	524050	Wawasee Mobile Village	25

2.8 Natural History

Geology, climate, geographic location and soils all factor into shaping the native flora and fauna which occurs in a particular area. Categorization of these floral and faunal communities has been completed by a number of ecologists since the earliest efforts by Coulter in 1886. Since this time, Petty and Jackson (1966) identified regional communities; Homoya et al. (1985) classified Indiana into natural regions, while Omernik and Gallant (1988) categorized Indiana into ecoregions.

2.8.1 Natural and Ecoregion Descriptions

According to Homoya et al.'s (1985) classification of natural regions in Indiana, the Lower Elkhart River Watershed lies within the Northern Lakes Section of the Northern Lakes Natural Region. The Northern Lakes section natural region is best identified by the numerous freshwater lakes of glacial origin which were formed by the Wisconsinan age ice sheet. As a result, the area is also covered with a thick and complex deposit of glacial material which, in places, is over 450 feet thick. Glacial topography can be characterized by knobs, kettles, kames, valley trains and outwash plains.

The Lower Elkhart River Watershed also lies in the Southern Michigan/Northern Indiana Drift Plains Ecoregion as defined by Omernik and Gallant (1988). The SMNID plains ecoregion is defined as broad till plains with thick and complex deposits of drift, paleo beach ridges, relict dunes, morainal hills, kames, drumlins, meltwater channel and kettles. This region could be further classified into two sub-regions. The first sub-region is Ecoregion 56a, Lake Country. The Lake Country ecoregion is a hummocky and pitted morainal area characterized by many pothole lakes, ponds, marshes, bogs and clear streams. The well-drained end moraines and kames once supported oak-hickory forests with wetter areas including beech forests or northern swamp forests. The very poorly drained kettles had tamarack swamp, cattail-bulrush marshes or sphagnum bogs. Today, marshes and woodland remain but corn, soybean and livestock farming are dominant. Additionally, recreational and residential developments commonly surround the lakes of Ecoregion 56a. Lake Country covers the southern portion of the watershed. Ecoregion 56b, Elkhart Till Plains, cover the remainder of the watershed. This ecoregion is punctuated by end moraines, kames and lacustrine flats. Kettle hole lakes occur in the Elkhart Till Plains ecoregion, but are much rarer than in the Lake Country ecoregion. Oak-hickory forests and beech maple forests once dominated the Elkhart Till Plains ecoregion; however, corn, soybean and wheat farming is more extensive than woodland in present day. The Elkhart Till Plains ecoregion is fairly diverse as it is also covered with bog, fen, marsh, prairie, sedge meadow, swamp, seep spring, lake and various deciduous forest types. Streams of this sub-region are typically clear, medium to low-gradient, and have sandy gravel beds.

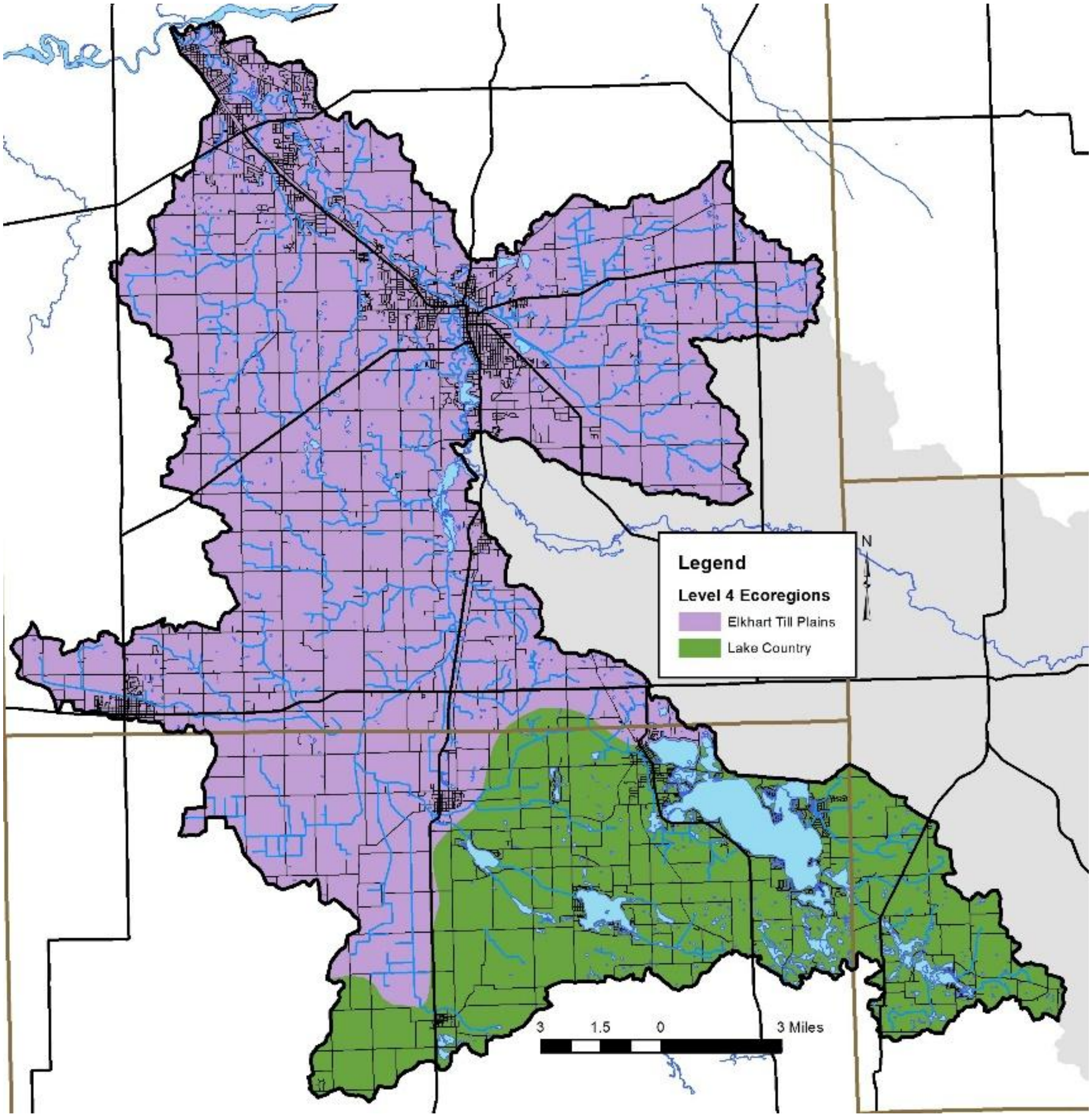


Figure 20. Level 4 eco-regions in the Lower Elkhart River Watershed.

2.8.2 Wildlife Populations and Pets

Individuals are concerned about local wildlife and pet populations, the impact that these have on pathogen levels and the impact that changing land uses could have on these populations. These will be quantified in subsequent sections. With these concerns in mind, wildlife density can be estimated from a variety of sources. The Indiana Department of Natural Resources (IDNR) is tasked with managing wildlife populations throughout the state. In order to complete this task, the IDNR must have an idea of the population density within specific areas, counties, or regions. The most recent survey of wildlife populations for which data are publicly available occurred in 2005. Those densities are shown in Table 10 with deer, squirrels and turkey being the most common wildlife present within the region. It should be noted that these numbers could both underestimate and overestimate populations within the watershed. Densities are recorded based on animal observations per 1000 hours of overall observation.

If observation areas are not equally spread throughout the region, over or underestimates of the populations could occur. Likewise, animals are not likely equally distributed throughout the region; therefore, the regional density may again over or underestimate the true density of the animal in question. Nonetheless, these estimates provide the best guess at wildlife densities. Wildlife waste will be an issue in the more natural, forested or wetland portions of the watershed.

Table 10. Surrogate estimates of wildlife density in the IDNR northeast region, which includes the Lower Elkhart River Watershed.

Animal	2005 Population Observation (per 1,000 hours of observation)
Badger	0.4
Bobcat	0.2
Bobwhite	31.1
Coyote	14.4
Deer	1,038.2
Fox Squirrel	564.5
Gray Fox	0.2
Gray Squirrel	61.8
Grouse	0.7
Domestic Cat	24.8
Muskrat	3.7
Opossum	8.3
Rabbit	29.9
Raccoon	53.5
Red Fox	8.5
Skunk	10.2
Turkey	205.7

Source: Plowman, 2006.

Pet populations can affect pathogen levels similar to the impacts provided by wildlife. While a count of pets located in the Lower Elkhart River Watershed was not completed, dog and cat populations were estimated for the watershed. Statistics reported in the 2022 U.S. Pet Ownership & Demographics Sourcebook were used to find these figures. Specifically, the Sourcebook reports that on average 37.4 percent of households own dogs and 32.9 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* in population centers including Elkhart, Goshen, Nappanee, Syracuse, and Milford. The estimated number of domestic pets in the Lower Elkhart River Watershed is based on the average number of pets per household multiplied by the population of the watershed resulting in a suggested population of 39,571 cats and 34,760 dogs. Pet waste issues are more predominant in the urban areas noted above but are also present at any residential parcel.

2.8.3 Endangered Species

The Indiana Natural Heritage Data Center, part of the Indiana Department of Natural Resources, Division of Nature Preserves, maintains a database documenting the presence of endangered, threatened, or rare species (ETR); high quality natural communities; and natural areas in Indiana. The database originated as a tool to document the presence of special species and significant natural areas and to assist with management of said species and areas where high quality ecosystems are present. The database is populated using individual observations which serve as historical documentation or as sightings occur; no systematic surveys occur to maintain the database.

The state of Indiana uses the following definitions to list species:

- Endangered: Any species whose prospects for survival or recruitment with the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government which occur in Indiana. Plants currently known to occur on five or fewer sites in the state are considered endangered.
- Threatened: Any species likely to become endangered within the foreseeable future. This includes all species classified as threatened by the federal government which occur in Indiana. Plants currently known to occur on six to ten sites in the state are considered threatened.
- Rare: Plants and insects currently known to occur on eleven to twenty sites.

In total, 103 observations of listed species and/or high-quality natural communities occurred within the Lower Elkhart River Watershed (Figure 21; Davis, personal communication). These observations include five invertebrate species, 23 vascular plant species, 26 vertebrate animal species, including two bat species, 11 birds, two turtle and one snake species, as well as seven terrestrial high quality natural communities including Northern Lakes Dry-mesic Upland Forest, Lake, Circumneutral Bog, Marsh, Sedge Meadow and Shrub Swamp. State endangered species include the Upland Sandpiper, American Bittern, Black Tern, Sedge Wren, Least Bittern, Loggerhead shrike, King Rail, Virginia Rail, Cerulean Warbler, Lake Sturgeon, cisco (fish), greater redhorse (fish), boreal stonefly, American salmonfly, Indiana Bat, evening bat, spotted turtle, Blanding's turtle, eastern massasauga, Beck's water-marigold, wild calla, pink lady's slipper, Bicknell's northern cranesbill, Fries' pondweed, Oakes' pondweed and horned bladderwort. While state threatened species include Hickey's clubmoss, green-keeled cotton-grass, herb-Robert, butternut, ground juniper, ostrich fern, whorled water-milfoil, straight-leaf pondweed, American wintergreen, water bulrush, false asphodel and marsh arrow-grass. State species of special concern include: Blanchard's cricket frog, four-toed salamander, common mudpuppy, osprey, longnose dace (fish) and American badger. These species are found in high quality natural areas identified in the Lower Elkhart River Watershed as well as in forests, wetlands and other natural areas throughout the watershed. Appendix A includes the database results for the Lower Elkhart River Watershed, as well as County-wide listings for Elkhart, Noble, and Kosciusko counties.

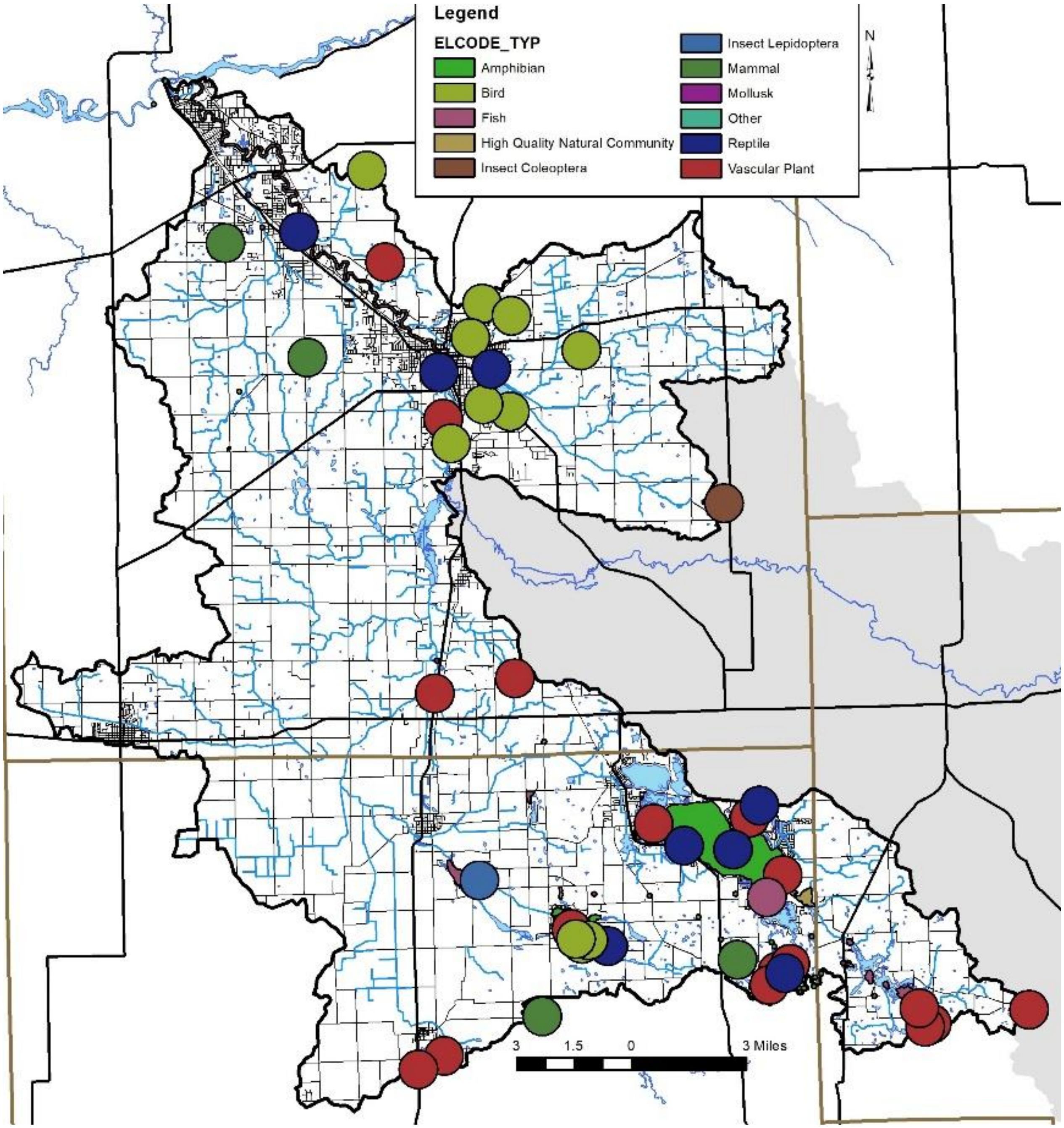


Figure 21. Locations of special species and high quality natural areas observed in the Lower Elkhart River Watershed. Source: Davis, 2023.

2.8.4 Recreational Resources and Significant Natural Areas

A variety of recreational opportunities and natural areas exist within the Lower Elkhart River Watershed. Recreational opportunities include local parks, fish and wildlife areas, nature preserves, fairgrounds, golf courses and school grounds (Table 11, Figure 22). There are several significant natural areas located within the Lower Elkhart River Watershed. The Indiana DNR; Elkhart, Nappanee, and Goshen Park Boards and Goshen College maintain, preserve, and protect these properties. There are many lake public access sites maintained by the Indiana DNR. Additional recreational opportunities exist at Goshen College, various schools, and recreational facilities.

Table 11. Natural areas in the Lower Elkhart River Watershed.

Natural Area	County	Organization	Access
Allen Lake, Rothberger Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
American Park	Elkhart	Elkhart County Park & Rec Dept.	Open
Baker Park	Elkhart	Elkhart County Park & Rec Dept.	Open
Barrell & A Half Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Bass Pond Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Burdick St. Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Crosson Mill Park	Kosciusko	Syracuse Parks & Recreation Dept.	Open
Dam Access Site	Elkhart	Goshen Parks and Recreation Dept.	Open
Derksen Farm and Wetland Area	Elkhart	Nappanee Park Board	Open
Dewart Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Dorothy McFarland Park	Elkhart	Goshen Parks and Recreation Dept.	Open
East Goshen Park, Dykstra Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Elkhart Environmental Center	Elkhart	Elkhart County Park & Rec Dept.	Open
Elkhart River Public Access Site	Elkhart	Indiana DNR Div. of Fish & Wildlife	Open
Gans Park	Elkhart	Elkhart County Park & Rec Dept.	Open
Greider's Woods Nature Preserve	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Goshen Millrace Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Hammond Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Henry Ward Park	Kosciusko	Syracuse Parks and Recreation Dept	Open
Hoy's Beach	Kosciusko	Syracuse Parks and Recreation Dept.	
Indian Village Lake Public Access Site	Noble	Indiana DNR Div. of Fish & Wildlife	Open
Island Park	Elkhart	Elkhart County Park & Rec Dept.	Open
John Derksen (Stauffer) Park	Elkhart	Nappanee Park Board	Open
John O. Abshire Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Knapp Lake Public Access Site	Noble	Indiana DNR Div. of Fish & Wildlife	Open
Linway Lake Park	Elkhart	Goshen Parks and Recreation Dept.	Open
McCormick Creek Golf Course	Elkhart	Nappanee Park Board	Open
Mullett Park	Elkhart	Goshen Parks and Recreation Dept.	
Nappanee (Westside) Community Park	Elkhart	Nappanee Park & Recreation Dept.	Open
North Goshen Park (N.8th St. Park)	Elkhart	Goshen Parks and Recreation Dept.	Open
Oakridge Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Oxbow County Park	Elkhart	Elkhart County Park & Rec Dept.	Open
Price & Long Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Pringle Park	Elkhart	Goshen Parks and Recreation Dept.	Open
Rieth Park	Elkhart	Goshen Parks and Recreation	Open
Rogers Park	Elkhart	Goshen Parks and Recreation	Open
Shanklin Park & Public Access Site	Elkhart	Goshen Parks and Recreation Dept.	Open
Shock Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Shoup-Parson Woods Park	Elkhart	Goshen Parks and Recreation	Open
Spear Lake Public Access & Nature Trail	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Studebaker Park	Elkhart	Goshen Parks and Recreation	Open
Sunnyside Park	Elkhart	Town of New Paris	Open

Natural Area	County	Organization	Access
Syracuse Lake Public Access Site	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Syracuse Lakeside Park	Kosciusko	Syracuse Parks & Recreation Dept.	Open
Tri-County Fish and Wildlife Area	Kosciusko, Noble	Indiana DNR Div. of Fish & Wildlife	Open
Turkey Creek Site	Elkhart	Elkhart County Park & Rec Dept.	Open
Walnut Park (N. 5th St. Park)	Elkhart	Goshen Parks and Recreation Dept.	Open
Wawasee Public Fishing Area	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Open
Wawasee Wetlands Conservation Area	Kosciusko	Indiana DNR Div. of Fish & Wildlife	Restrictions
Waubee Lake Park	Kosciusko	Milford Park Board	Open
West Goshen Park (Baker Park)	Elkhart	Goshen Parks and Recreation Dept.	Open
Yellow Creek Lake Public Access Site	Elkhart	Indiana DNR Div. of Fish & Wildlife	Open

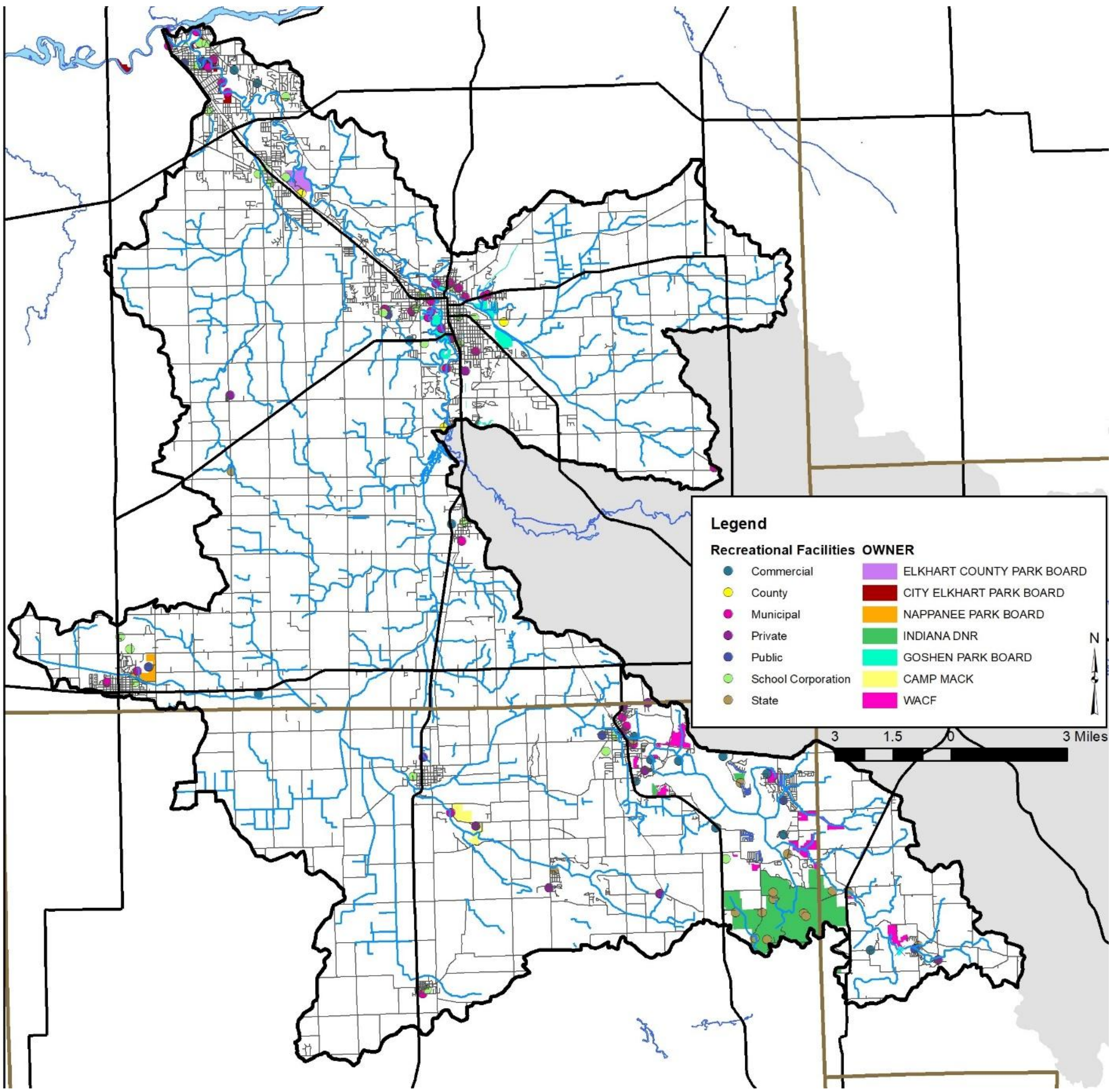


Figure 22. Recreational opportunities and natural areas in the Lower Elkhart River Watershed.

2.9 Land Use

Water quality is greatly influenced by land use both past and present. Different land uses contribute different contaminants to surface waters. As water flows across agricultural lands, it can pick up pesticides, fertilizers, nutrients, sediment, pathogens and manure, to name a few. However, when water flows across parking lots or from roof tops it not only picks up motor oil, grease, transmission fluid, sediment and nutrients, but it reaches a waterbody faster than water flowing over natural or agricultural land. Hard or impervious surfaces present in parking lots or on rooftops create a barrier between surface and groundwater. This barrier limits the infiltration of surface water into the groundwater system resulting in increased rates of transport from the point of impact on the land to the nearest waterbody.

2.9.1 Current Land Use

Today, the majority of the Lower Elkhart River Watershed is covered by agricultural land uses (127,078 acres or 67%; (Table 12, Figure 23) which consists of pastureland/hay (16,699 acres or 9%) and row crop agriculture (110,379 acres or 58%). Nearly 12% of the watershed is mapped in natural land uses including forest, grassland and wetlands. Developed open space and low, medium and high density developed land covers 18% of the watershed, while open water covers the remaining 3% of the watershed.

Table 12. Detailed land use in the Lower Elkhart River Watershed.

Classification	Area (acres)	Percent of Watershed
Cultivated crop	110,379	58%
Pasture/hay	16,699	9%
Developed open space	14,245	8%
Low intensity development	11,488	6%
Deciduous forest	11,212	6%
Woody wetland	9,261	5%
Open water	5,515	3%
Medium intensity development	4,493	2%
High intensity development	2,854	2%
Emergent wetland	1,708	1%
Barren land	442	0%
Mixed forest	435	0%
Grassland	343	0%
Evergreen forest	238	0%
Shrub/scrub	175	0%
Entire Watershed	**189,488**	**100%**

Source: USGS, 2016

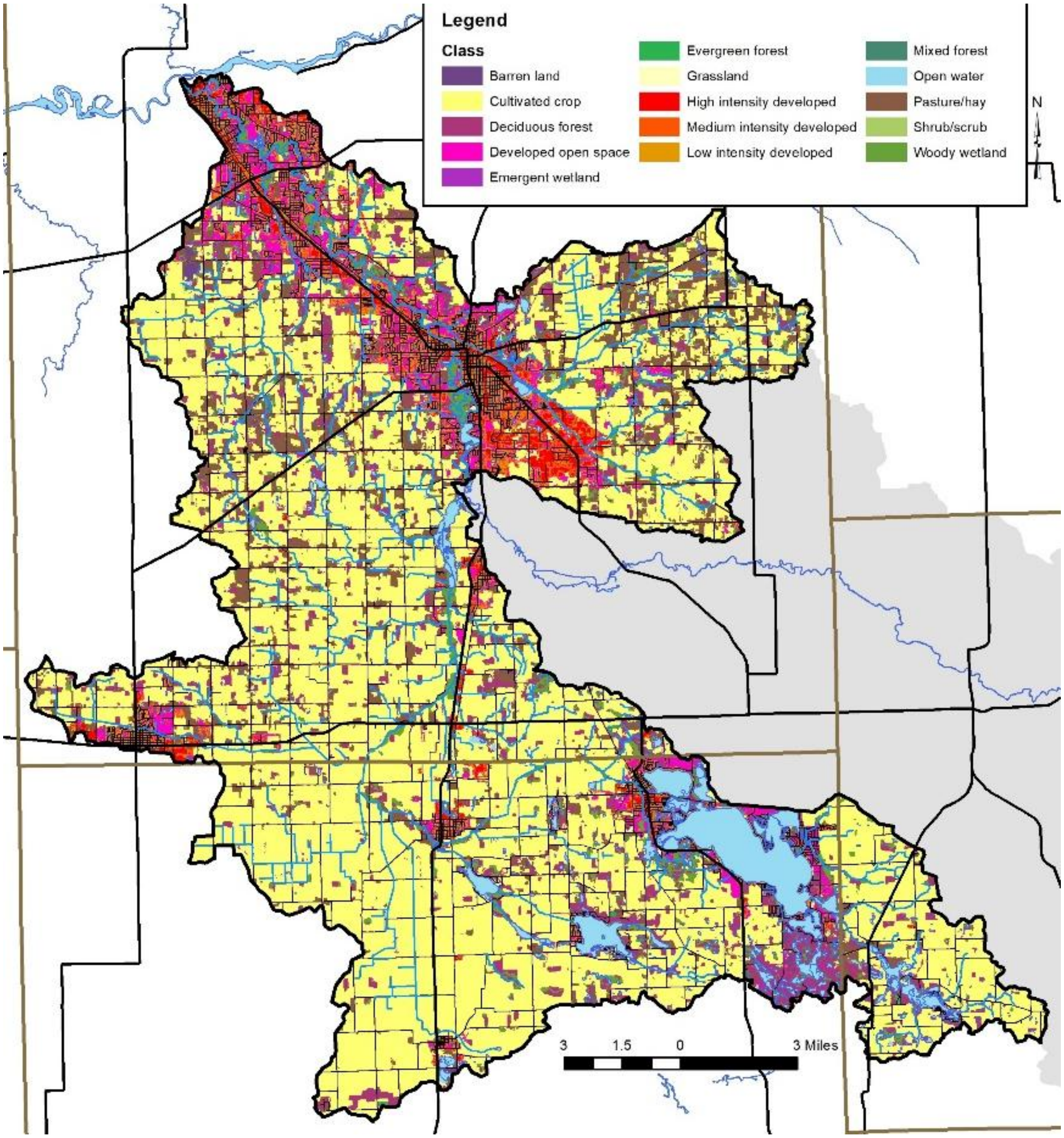


Figure 23. Land use in the Lower Elkhart River Watershed. Source: NLCD, 2016.

2.9.2 Agricultural Land Use

Individuals are concerned about the impact of agricultural practices on water quality. Specifically, the volume of exposed soil entering adjacent waterbodies, the prevalence of tiled fields and thus the transport of chemicals into waterbodies, the use of agricultural chemicals, and the volume of manure applied via small animal farms and through confined animal feeding operations are concerning to local residents. Each of these issues will be discussed in further detail below.

Tillage Transect

Tillage transect information data for Elkhart, Kosciusko, and Noble counties was compiled for 2022 (Table 13; ISDA, 2022 A-D). As reported by the Indiana State Department of Agriculture, members of Indiana's Conservation Partnership (ICP) conduct a field survey of tillage methods. A tillage transect is an on-the-ground survey that identifies the types of tillage systems farmers are using and long-term trends of conservation tillage adoption using GPS technology, plus a statistically reliable model for estimating farm management and related annual trends. Table 13 provides the number of acres and percent of acres on which conservation tillage was utilized for each county by corn and soybeans. These numbers may be an underestimate due to the timing of tillage transects in each county.

Table 13. Conservation tillage data as identified by County tillage transect data for corn and soybeans (ISDA, 2022).

County	Corn (acres)	Corn (%)	Soybeans (acres)	Soybeans (%)
Elkhart	28,143	59%	34,503	69%
Kosciusko	67,670	67%	67,680	80%
Noble	52,983	87%	57,660	93%

Agricultural Chemical Usage

Agricultural pesticides and fertilizers are commonly applied to row crops in Indiana. These chemicals can be carried into adjacent waterbodies through surface runoff and via tile drainage. This is especially an issue if a storm occurs prior to the chemicals being broken down and used by the crops.

Data for chemical usage on an individual County or watershed level are not currently collected. Rather, data is collected for the state as a whole in two forms. First, the National Agricultural Statistics Survey (NASS) collects information on chemical usage, number of applications per year, type of chemical applied, and the application rate. These data were last collected in 2006 (NASS, 2006). Additionally, NASS collects farmland data for the number of acres in agricultural production by type (i.e. corn, soybeans, grains) by County (NASS, 2022). These data indicate that corn (209,600 acres planted in Elkhart, Kosciusko and Noble counties) and soybeans (183,700) acres planted in Elkhart, Kosciusko and Noble counties) are the two primary crops grown in the watershed.

Nitrogen is more typically applied to corn than to soybeans. Soybeans have symbiotic bacteria on their roots that act as nitrogen fixers, which means that they pull the nitrogen that they need from the atmosphere then convert it into a form which they can use. Corn does not fix nitrogen; therefore, nitrogen needs to be applied. Nitrogen is typically applied twice in Indiana – once at or before planting and a second time when corn reaches approximately one foot in height (NASS, 2007). Fall application of nitrogen also occurs and is particularly problematic. Agricultural data indicate that corn receives 98% of the nitrogen applied in the state and 87% of the phosphorus. For these reasons, nutrient calculations were only completed for corn as applications to soybeans are likely negligible. Based on these data, it is estimated that 22,227 tons of nitrogen and 10,995 tons of phosphorus are applied annually within the counties in which the Lower Elkhart River Watershed is located (Table 14).

Table 14. Agricultural nutrient usage for corn in the Lower Elkhart River Watershed counties.

Nutrient	Acres of Corn	% of Area Applied	Applications (#/year)	Rate/Application (lb/acre)	Total Applied/Year (tons)
Nitrogen	209,600	100	2.2	67	22,227
Phosphorus	209,600	93	1.4	56	10,995

Source: NASS, 2007; NASS, 2022

Pesticides are also used on crops grown in Indiana. The Office of the Indiana State Chemist indicates that the two predominant herbicide active ingredients applied are atrazine and glyphosate. Atrazine is most commonly applied as a corn herbicide, while glyphosate is used on both corn and soybean fields as an herbicide. NASS indicates that in 2005, an average of 1.24 pounds of atrazine and 0.6 pounds of glyphosate were applied per acre of corn and 0.73 pounds of glyphosate were applied per acre of soybeans (NASS, 2006). Using these rates, we estimated that approximately 187 tons of atrazine and approximately 173 tons of glyphosate are applied to cropland in the Lower Elkhart River Watershed counties annually (Table 15).

Table 15. Agricultural herbicide usage in the Lower Elkhart River Watershed counties.

Crop	Acres	Application Rate (lb/acre)	Total Applied (lbs)	Total Applied/ Year (tons)
Corn (Atrazine)	209,600	1.24	373,976	187
Corn (Glyphosate)	209,600	0.60	180,956	90
Soybeans (Glyphosate)	183,700	0.73	165,115	83

Source: NASS, 2006; NASS, 2022

Confined Feeding Operations and Hobby Farms

A mixture of small, unregulated and larger, regulated livestock operations (concentrated animal and confined feeding operations) is found within the Lower Elkhart River Watershed. Small farms are those which house less than 300 animals, while larger farms that house large numbers of animals for longer than 45 days per year are regulated by IDEM. These regulations are based on the number and type of animals present. IDEM requires permit applications which document animal housing, manure storage, and disposal and nutrient management plans for farms which maintain 300 or more cows, 600 or more hogs or 30,000 or more fowl. These facilities are considered confined feeding operations (CFO). In Indiana, all regulated animal feeding operations are considered CFOs. The difference between a CFO and a concentrated animal feeding operation (CAFO) relates to the size of the operation. A CFO that meets the size classification as a CAFO is a farm that meets or exceeds an animal threshold number in the U.S. Environmental Protection Agency's definition of a large CAFO, which is 700 mature dairy cows, 1,000 veal calves, 1,000 cattle other than mature dairy cows, 2,500 swine above 55 pounds, 10,000 swine less than 55 pounds, 500 horses, 10,000 sheep or lambs, 55,000 turkeys, 30,000 laying hens or broilers with a liquid manure handling system, 125,000 broilers with a solid manure handling system, 82,000 laying hens with a solid manure handling system, 30,000 ducks with a solid manure handling system or 5,000 ducks with a liquid manure handling system.

There are 10 CAFOs and 28 CFOs located in the watershed (Figure 24). In total, these facilities are permitted to house up to 59,950 pigs, 236 beef cattle, 3,272 dairy cattle, 649,800 chickens, 83,900 ducks and 83 horses. In total, 346 small, unregulated animal farms containing more than 6,570 animals were identified during the windshield survey, which is most likely an underestimate of the actual number. These small "mini farms" contain small numbers of cattle, horses, bison, sheep or goats, which could be sources of nutrients and *E. coli* as these animals exist on small acreage lots with limited ground cover. In total, approximately 803,885 animals per year are housed in CAFOs, CFOs and on unregulated farms in the watershed, generating approximately 560,288 tons of manure per year spread over the watershed. This volume of manure contains approximately 20,287,514 pounds of nitrogen, 16,418,073 pounds of phosphorus and 1.36E+20 col of *E. coli*.

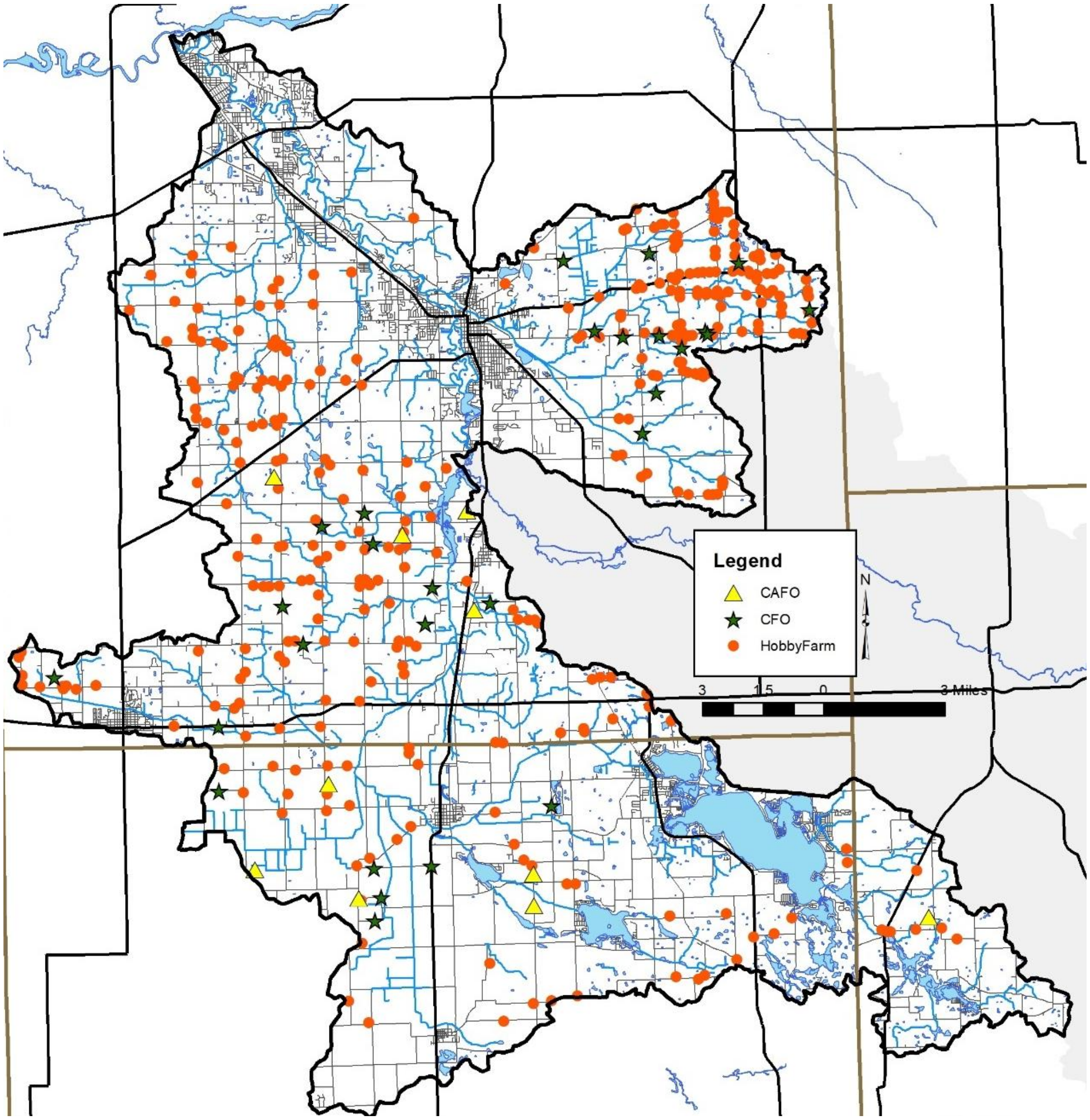


Figure 24. Confined feeding operation and unregulated animal farm locations within the Lower Elkhart River Watershed.

2.9.3 Natural Land Use

Natural land uses including forest, wetlands, and open water cover approximately 15% of the watershed. Approximately 20,844 acres or 11% of the watershed is covered by trees. Forest cover occurs adjacent to waterbodies throughout the watershed.

2.9.4 Urban Land Use

Urban land uses cover approximately 32,213 acres or 18% of the watershed (Table 12). Most developed areas are associated with the Cities of Goshen and Elkhart, as well as the various lake communities in the southeastern portion of the watershed. Although this is only a small portion of the watershed, there are some significant issues related to the developed areas. Especially troublesome are issues related to failing septic systems, impervious surfaces, flooding, and stormwater runoff that allow untreated sewage and stormwater to flow into the watershed during heavy rain events.

Impervious Surfaces

Impervious surfaces are hard surfaces which limit surface water from infiltrating into the land surface to become groundwater thereby creating high overland flow rates. Hard surfaces include concrete, asphalt, compacted soils, rooftops, and buildings or structures. In developed areas, land which was once permeable has been covered by hard, impervious surfaces. This results in rain which once absorbed into the soil running off of rooftops and over pavement to enter the stream with not only higher velocity but also higher quantities of pollutants. There are also four MS4 Communities in the watershed, covering more than 28,619 acres of the Lower Elkhart River Watershed.

Legacy Pollutant Remediation Sites

Remediation sites including industrial waste, leaking underground storage tanks (LUST), open dumps and brownfields are present throughout the Lower Elkhart River Watershed (Figure 25). Most of these sites are located within the developed areas of the watershed. In total, 55 industrial waste sites, 103 leaking underground storage tanks (LUST facilities), 10 voluntary remediation project (VRP) locations, two solid waste sites and 48 brownfields are present within the watershed.

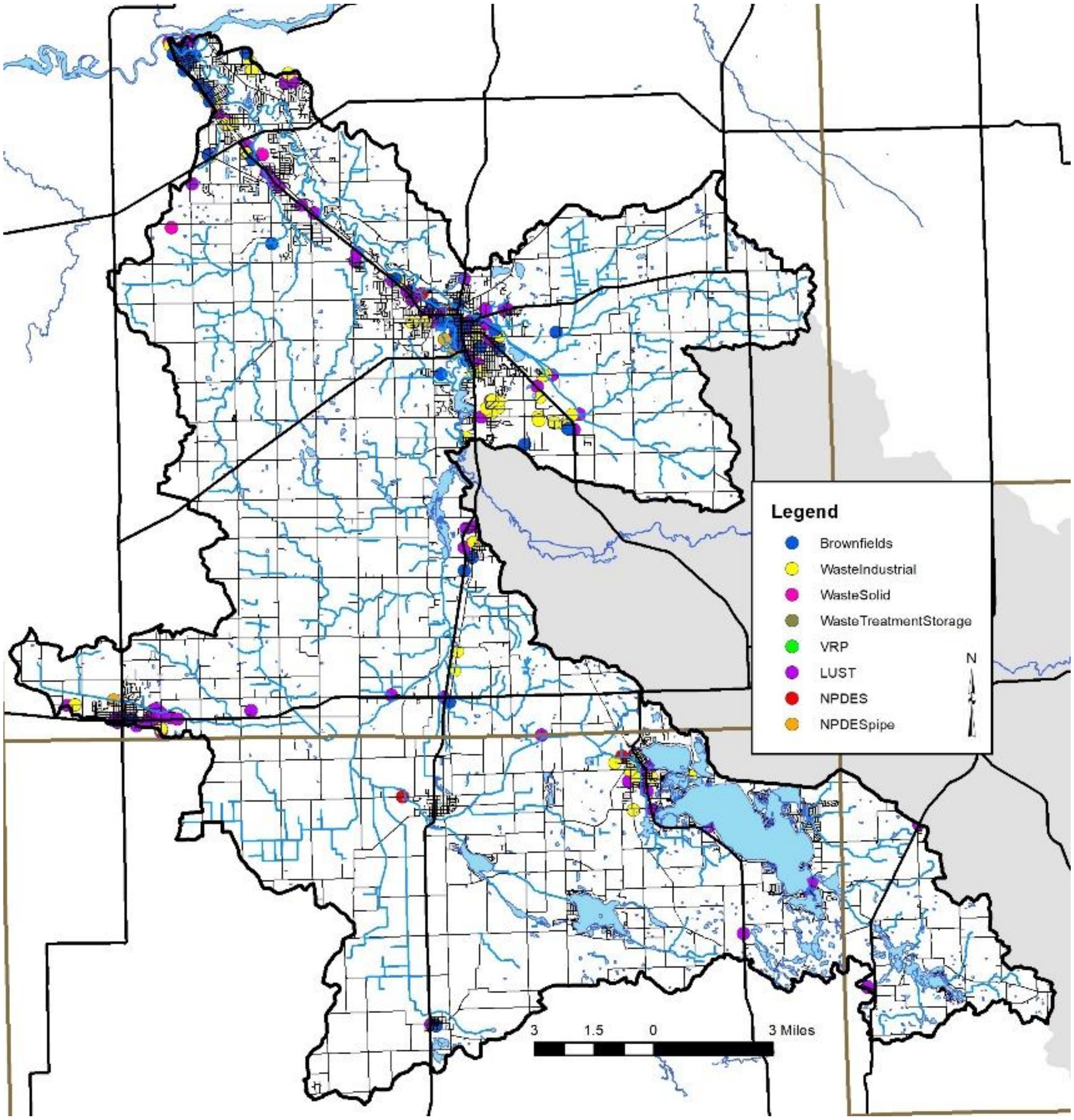


Figure 25. Industrial remediation and waste sites within the Lower Elkhart River Watershed.

2.10 Population Trends

The Lower Elkhart River Watershed is a mix of relatively sparsely populated areas and urban centers in general. The City of Goshen, City of Elkhart, City of Nappanee, Town of Syracuse and Town of Milford house the highest density populations. Table 16 details the population of each county in the Lower Elkhart River Watershed. These data indicate that two of the counties, Elkhart and Kosciusko, are growing; however, Noble County saw a slight decrease in population from 2010 to 2020. The steering committee identified that development can be sources of pollutants including sediment, nutrients and pathogens.

Table 16. Population data for counties in the Lower Elkhart River Watershed.

County	2000	2010	2020	Population Change 2010 to 2020
Elkhart	182,791	197,559	205,184	+7,625
Kosciusko	74,057	77,358	80,240	+2,882
Noble	46,275	47,536	47,640	-104

Tracking population changes within a watershed is challenging as data is published by counties and townships rather than watershed boundaries. Changes in watershed population and the associated land use changes and infrastructure impacts were noted by watershed stakeholders. Estimated populations in the Lower Elkhart River Watershed indicate that 35% of the population is rural residents while 65% of the population reside in urban locations. Table 17 displays estimated populations for the portion of each County located within the watershed (US Census data, 2020).

Table 17. Estimated watershed demographics for the Lower Elkhart River Watershed.

County	2020 Population	Total Estimated Watershed Population	Total Estimated Watershed Urban Population	Total Estimated Watershed Rural Population	Percent of Total Watershed Population
Elkhart	205,184	124,636	95,389	29,247	80.9%
Kosciusko	80,240	26,399	4,799	21,600	17.1%
Noble	47,457	3,005	0	3,005	2.0%
Total	**332,882**	**154,040**	**100,188**	**53,853**	**100%**

2.11 Planning Efforts in the Watershed

Multiple plans have encompassed portions of the Lower Elkhart River Watershed or areas which it drains or outlets into. Planning efforts cover three main areas: 1) Project-focused planning efforts where a specific area or portion of the Lower Elkhart River Basin was assessed and specific water quality improvement projects identified, 2) Flow-based assessments and planning efforts, and 3) Comprehensive plans. Plans are listed in chronological order.

2.11.1 Project-Focused Planning Efforts

Waubee Lake Diagnostic Study (2002)

In July 2002, the INDR Division of Soil Conservation released the Waubee Lake Report. In 2001, the Waubee Lake Association became concerned about nutrient and sediment loading in the lake. The IDNR Division of Soil Conservation assisted in an investigation to determine the sources of nutrients and sediment. From December 2001 to May 2002, sampling was conducted three times on the lake's two main tributaries: Hammond Ditch and Felkner Ditch. Felkner Ditch originates in an animal waste pond, although no water quality problems were found to be associated with the animal waste. It was concluded that that an overabundance of vegetation in the wetlands could release nutrients from decomposing plant materials.

Waubee Lake Sediment Removal Plan (2005)

In September 2005, JFNew released the Waubee Lake Sediment Removal Plan, completed with guidance from the Waubee Lake Association and funded by the IDNR Lake and River Enhancement (LARE) program. The plan was designed to improve the aesthetics and usability of Waubee Lake. Dredging began in the middle of July 2005 and was completed by the end of August 2005. Approximately 3.8 acres of sediment was removed with an average depth of 4.4 feet from near the outlet of Felkner Ditch. It was estimated that the sediment originated from bare ground areas, such as agricultural fields, or from decomposing plant material. Dredge spoils were disposed of in a nearby abandoned gravel pit.

Dewart Lake Diagnostic Study (2005)

In May 2005, JFNew released a diagnostic study for Dewart Lake, funded by the IDNR LARE program. Although Dewart Lake had better water clarity and nutrient values than most Indiana lakes, lake residents had noticed changes in the lake for several years preceding the study. Specifically, changes were noted in the types and distribution of aquatic vegetation and decreased water clarity during weekend heavy boat use. It was determined that Dewart Lake's phosphorus concentration had the potential to increase the lake's productivity. Continued attainment of water quality goals will require both in-lake and watershed management.

- Recommendations (watershed): Ravine stabilization, homeowner best management practices, filter strip implementation, livestock fencing, wetland restoration, use Conservation Reserve Program and conservation tillage, streambank stabilization.
- Recommendation (in-lake): Comprehensive recreational use plan, creation of a rooted plant management section that considers use of ecozones.

Wawasee Area Watershed Watershed Management Plan (2007)

In April 2007, JFNew released the Wawasee Area Watershed Management Plan (WMP). The watershed is located in southwestern Noble and northeastern Kosciusko Counties and contains 25 lakes and 14 miles of streams. The Wawasee Area Conservancy Foundation (WACF) obtained funding from the IDNR LARE program in an effort to improve water quality. Input from stakeholders expressed numerous concerns. Stressors associated with the top concerns were: 1) high nutrient and sediment loads in the watershed; 2) Lack of knowledge by property owners in the watershed; 3) pathogenic contamination by high *E. coli* levels; 4) Overuse through recreation. Goals developed in the WMP were:

- Reduce nutrient loading reaching Lake Wawasee by 25% over the next 10 years.
- Reduce sediment loading to the waterbodies within the Wawasee Area Watershed by 50% over the next 5 years.
- Reduce the concentration of *E. coli* within Wawasee Area Watershed so that water within the streams and lakes meet the state's standard for *E. coli* within 10 years.
- Within 5 years, 50% of landowners within the Wawasee Area Watershed will attend one educational event, and 25% of landowners implement one water quality improvement project.
- Maintain and improve the recreational setting of the Wawasee Area Watershed by developing and implementing a recreational management plan for Lake Syracuse and Lake Wawasee within five years.

Bayshore Watershed Sediment Control Project Design Report (2007)

The Bayshore watershed project was named after an embayment on the south end of Lake Wawasee. In April 2007, JFNew, in partnership with the WACF and with funding from the IDNR LARE program, released the Bayshore Watershed Sediment Control Project Design Report. The Bayshore Watershed consists of 105 acres of agricultural land which drains into Lake Wawasee through an approximately 3700-foot channel. The purpose of the project was to develop a plan to reduce heavy sediment loads entering Lake Wawasee from the channel. A four-step sediment removal system was proposed:

1) A sediment trap that can be accessed and cleaned of heavier particles.
2) A second settling pond for finer materials.
3) A wetland filter.
4) A finishing pond for the finest sediments.

It was noted that sediment is derived from the upper watershed surface erosion, and ultimately the upper watershed should be converted to grassland or forest.

Turkey Creek Sediment Trap Project Design-Build (2008)
In April 2008, JFNew released the Turkey Creek Sediment Trap Project report. This design-build project was funded by IDNR LARE program and presented to the WACF. The project objective was the reconstruction of a previously existing sediment trap that had filled with sediment from the Turkey Creek watershed. The project location was Turkey Creek as it flows into Gordy Lake in Noble County. The average sediment load from Turkey Creek to Gordy Lake was estimated to be 3-4 tons per year. The trap was designed to be large enough to capture any bed load, sand particles in suspension, and a majority of the silt and organic matter coming down Turkey Creek. Construction was completed in 2008.

Elkhart River WMP (2008)
The Elkhart River Alliance (ERA) was formed as a committee of the Elkhart River Restoration Association, Inc. (ERRA) to address concerns regarding sediment in the Goshen Dam Pond and pollution in the Elkhart River Watershed. With assistance from the Elkhart County SWCD, the ERRA obtained funding from a Section 319 grant for the development and implementation of a watershed management plan for the Elkhart River Watershed. A steering committee was organized to work with the watershed coordinator to develop and implement the WMP and contracted with V3 Companies to guide WMP development.

The Elkhart River WMP is intended as a guide for the protection and enhancement of the environment and quality of the Elkhart River Watershed while balancing the different uses and demands of the community on this natural resource. Watershed plan goals include:

- Sustain the financial and institutional capacity of a stakeholder group. Increase the collaboration of both urban and agricultural stakeholders to eliminate program duplication, reduce costs and identify effective solutions.
- Reduce soil erosion and sedimentation so that surface water functions and aesthetics are improved and protected. By the year 2027, surface waters within the Elkhart River Watershed will comply with the recommended water quality threshold of 80 mg/L total suspended solids.
- Reduce the concentration levels of *E. coli* so the primary and secondary contact waters within the Watershed do not pose an adverse human health impact. By the year 2027, surface waters within the Elkhart River Watershed will comply with the Indiana state *E. coli* water quality standard of 235 cfu/100 ml.
- Reduce the amount of nutrient loading (phosphorus and nitrogen) so that surface water functions and aesthetics are improved and protected. By the year 2027, surface waters within the Elkhart River Watershed will comply with the recommended water quality threshold of 10 mg/L of nitrate/nitrite and 0.3 mg/L of phosphorus.
- Increase preservation, restoration, and appreciation of open space and maintain a proper balance between the many diverse land uses in the Elkhart River Watershed.
- Develop an outreach and education program that keeps stakeholders involved in issues in the Watershed, and coordinate volunteer activities that benefit the health of the Elkhart River Watershed.

ERRA initiated one round of cost share project implementation including implementing 13 rain gardens, 50 rain barrels, completed three stream buffers, seven bioretention projects, eight pervious pavement projects, one green roof, two grassed waterways, one WASCOB and two rotational grazing systems.

Engineering Feasibility Study for Dewart Lake (2012)
In May 2012, Cardno JFNew released an Engineering Feasibility Study for Dewart Lake. The study was funded by IDNR LARE program and identified four feasibility projects involving nine individual sites. When constructed, the projects should save approximately 72 tons of eroded soil from entering Dewart Lake each year. The project focused on the Cable Run subwatershed, with one additional site in a ravine, and another additional site at an eroding hillside.

- Project 1: A ravine containing a minor tributary to the lake was the source of sedimentation and nutrient loading through bank erosion. Recommendation was installation of grade control structures.
- Project 2: Direct drainage to the lake was the source of sedimentation from an eroding slope. Recommendation was installation of a vegetated swale.
- Project 3: Three sites along Cable Run were the source of sedimentation and nutrient loading from bank erosion. Recommendations were installation of rock toes to stabilize eroding slopes, bank regrading, banks to be seeded with a native slope stabilization mix and covered with an erosion control blanket.
- Project 4: Four sites along Cable Run and a small tributary were the source of sedimentation and nutrient loading from bank erosion. Recommendations were installation grade control structures, installation of rock toes to stabilize eroding slopes, bank regrading, banks to be seeded with a native slope stabilization mix and covered with an erosion control blanket.

Goshen Dam Pond Sediment Removal Plan (2014)
In March 2014, Cardno JFNew released the Goshen Dam Pond Sediment Removal Plan. The Elkhart River Restoration Association received a grant from the IDNR LARE program to develop a sediment removal plan. Goshen Dam Pond is an impoundment of the Elkhart River located within the city of Goshen. Accumulated sediment made the water too shallow for residents to access the lake with boats, and also provided habitat for nuisance vegetation such as purple loosestrife. The majority of the sediment is deposited just as the Elkhart River enters the impoundment. The sediment has formed an island at this location, which grows as more sediment settles. Accumulated sediment was measured as deep as 8 feet in some spots. It was proposed that 36.3 acres of the 140-acre lake be dredged.

Turkey Creek Branch Stream Bank Restoration Engineering Design Report (2017)
In June 2017, S&L Environmental Group released the Turkey Creek Branch Stream Bank Restoration Engineering Design Report, funded by the IDNR LARE program. Turkey Creek Branch is in Noble County and is a tributary of Turkey Creek, which flows into Lake Wawasee. Large amounts of sediment were being deposited upstream from Turkey Creek Branch's confluence with Turkey Creek near the Noble-Kosciusko County Line. Areas where sediment was being deposited, such as a small lake, were nearly at capacity, thus allowing sediment and associated nutrients to move farther downstream toward Lake Wawasee. Preliminary field investigations indicated that the most critical bank erosion was occurring from near the county line upstream to State Road 5. The streambanks and channel are eroding from water velocities exceeding permissible soil velocities. Streambanks were being undercut, resulting in fallen trees and logjams. The design focused on using bio-engineered best management practices to reduce stream velocities by 20-50%, thereby reducing bank and channel erosion. In addition, 32% (approximately 5100 lineal feet) of the design reach will also have bank reconstruction and stabilization.

Lake Wawasee Sediment Removal Plan (2019)
In January 2019, Aquatic Weed Control, in partnership with the Wawasee Property Owner's Association, released the Lake Wawasee Sediment Removal Plan. The report was funded by the IDNR LARE program. Fourteen sites where sediment deposits hindered lake activities were selected. These sites were

scattered around the lake and were investigated for water and sediment depths. Sediment depths ranged from 1.9 feet to 6.4 feet. Sediments included decomposing organic matter, sand and gravel. Tributary streams Turkey Creek, Launer Ditch and a small un-named ditch, in addition to a small spillway from Papakeechie Lake were associated with some of the sediment deposits. Four sites were not recommended for dredging because the water depth was greater than 6 feet, and an additional site was not recommended for dredging because aquatic vegetation control needed to be the focus of efforts. A five-foot wide shelf along the shoreline was proposed at all dredging sites as a zone for emergent vegetation growth.

Lake Wawasee National Water Quality Initiative Watershed Management Plan (in development)
In December 2021, WACF in partnership with NRCS, launched an updated watershed management plan. As of this draft, the plan has not yet been completed; however, the following goals have been identified:

- Measure an increase in acres enrolled in BMPs as percentage of total agricultural acres in watershed.
- 40% increase in BMP practices across the watershed. Practices identified for implementation include cover crops, filter strips, grassed waterways, nutrient management, two-stage ditch, drainage water management, conservation tillage, riparian buffers, bioreactors, waste storage and wetland restoration.
- 10% reduction in sediment, nitrogen and phosphorous loading rates.

The plan represents the first phase of the project. The second phase was awarded in December 2022 and includes $1.25 million in conservation funding to implement agricultural BMPs over three years (2023, 2024, 2025).

2.11.2 Resilience-based Assessments and Plans

A series of maps was developed by the U.S. Geological Survey (USGS; Strauch, 2013) to illustrate the potential for flooding of the Elkhart River in an 8.3-mile reach from Goshen Dam downstream to County Road 17. This river reach includes the City of Goshen. One major tributary, Rock Run Creek, flows into the Elkhart River in the City of Goshen. Based on the USGS gauge at Goshen (station number 04100500), estimates were made of the areal extent and depth of flooding corresponding to nine selected water levels at 1-foot intervals. This USGS gauge has data for peak streamflow since 1925 and has data for continuous stage monitoring since 1931. An assumption was made that runoff in the Elkhart River basin would be uniformly distributed in time and space. A hydraulic model was used to compute surface water profiles from bankfull (5 ft.) to greater than the highest recorded water level (13 ft.). Flood stage is 7 feet. Surface water profiles were then combined with Geographic Information Systems (GIS) and Digital Elevation Models (DEM) to delineate flooded areas at each water level. These maps provide residents and emergency management personnel with critical information for flood response and post-flood recovery.

City of Goshen Climate Change Vulnerability Assessment for Stormwater (2022)
In 2022, the City of Goshen completed their climate resilience plan. The plan includes identification of landscape features that affect Goshen's stormwater system and its vulnerability, steps through an assessment of vulnerability, identifies 18 areas and their potential flood impacts, conducts landscape analysis for heat island and flooding impacts and completes a sensitivity analysis. The assessment recommends the following:

- Align vulnerable reduction efforts with Goshen's Flood Resilience Plan.
- Align efforts with other relevant community planning including the City's tree canopy goals and Climate Adaptation Plan.

- Align vulnerable reduction efforts with Elkhart County's multi-hazard mitigation planning and disaster risk reduction efforts.
- Expand collaboration with upstream and downstream peer communities in the region to foster greater regional resilience towards climate change and natural disasters.
- Update stormwater polices, ordinances and strategic planning documents to align with and complement the climate vulnerability assessment.
- Continue to work with Goshen's Floodplain Manager, the Indiana DNR, FEMA and others to ensure the floodplains for relevant waterbodies are up to date and utilized for planning and flood risk education.
- Increase asset management documents and assess the age, health, and capacity of current stormwater conveyance systems to identify vulnerabilities and prioritize system updates.
- Participate in capital planning for storm infrastructure improvement projects and work to ensure adequate funding.
- Convene a working group of city department stakeholders to evaluate the barriers to and opportunities for implementing green infrastructure and low impact development into city projects.
- Cultivate private and public support for more forward-thinking flood resilience planning.
- Engage in public education about expected climate impacts and their consequences for storms, flooding and heat as it relates to the stormwater system.

City of Goshen Flood Resilience Plan (2022)

In July 2022, the City of Goshen completed their Flood Resilience Plan (CBBEL, 2022). The flood resilience plan identifies smart growth strategies to mitigate and improve flood resilience for the City of Goshen in a two-pronged approach including 1) using land use planning policies to direct growth, development and capital improvement to areas that are less vulnerable to flooding and 2) implementing projects to protect the people and critical assets that already exist in vulnerable flood areas. The plan creates six flood resilience areas across the city and identifies strategies for each area including protecting open, undeveloped land and where development is unavoidable requires compensatory flood storage; preparing a flood response plan and stormwater master plan; relocation or buying out structures; floodproofing and brining nonconforming uses into compliance. Figure 26 details the vulnerable system components in Goshen, while Figure 27 details flood resilience areas.

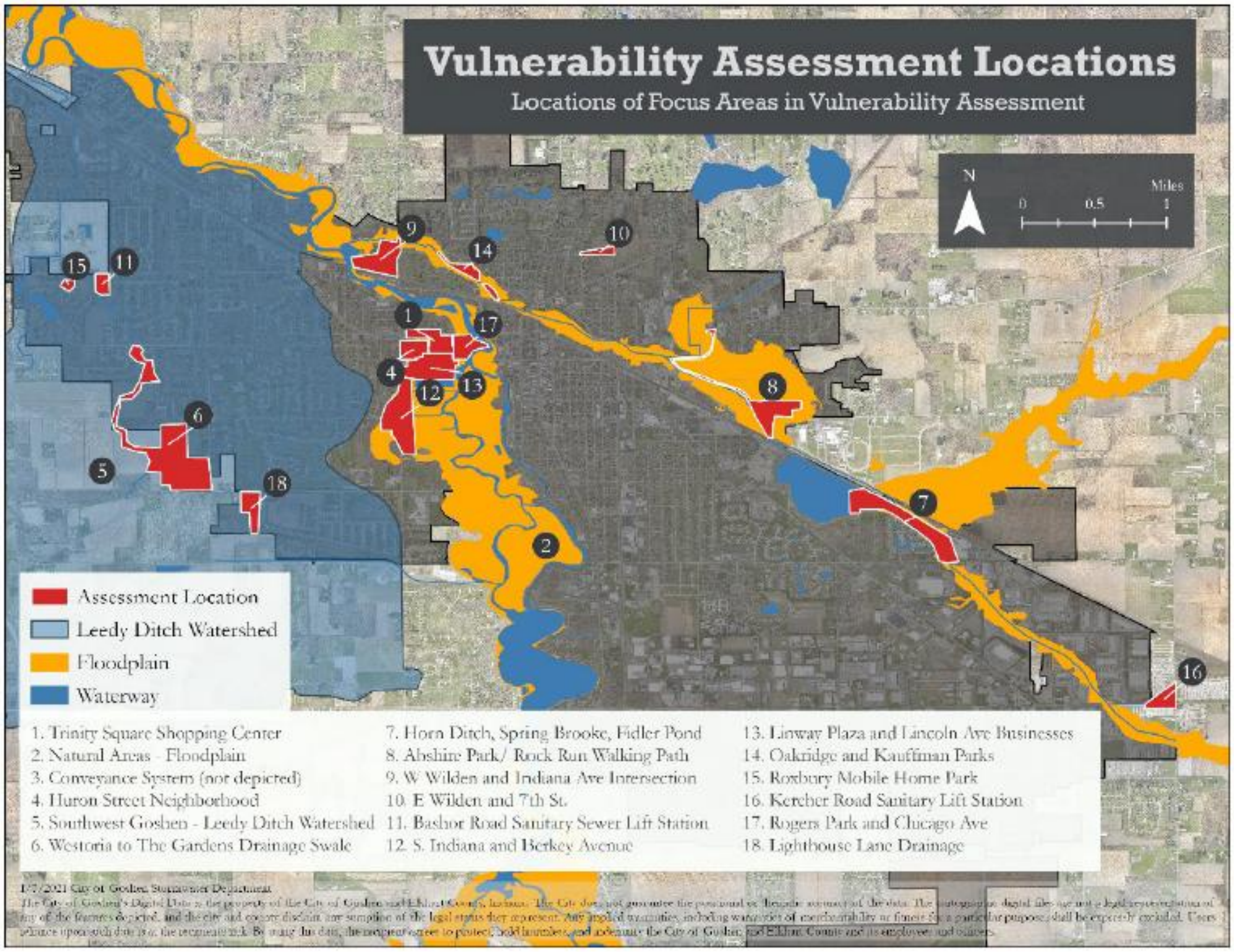


Figure 26. Locations of vulnerable system components in the City of Goshen.

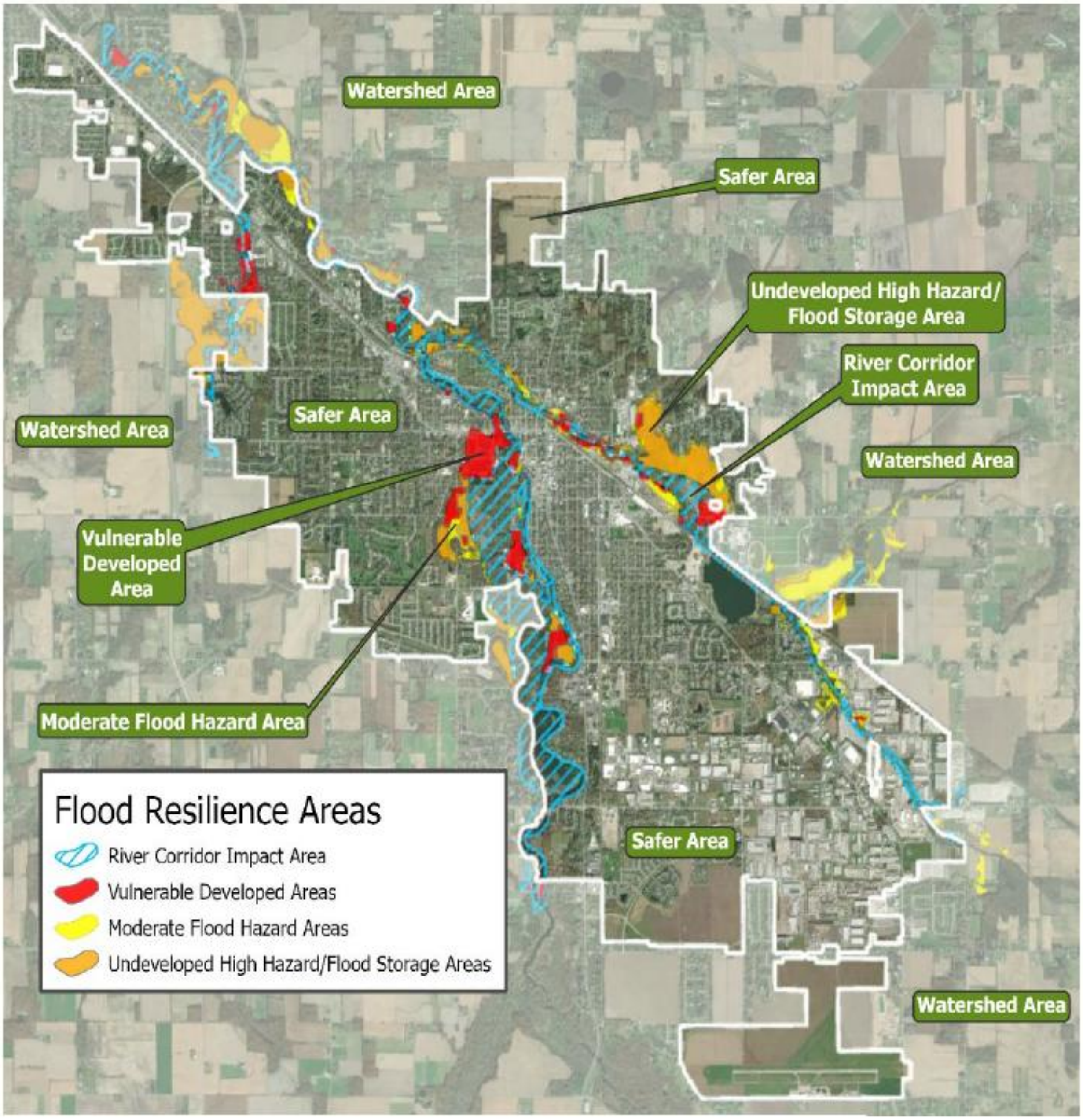


Figure 27. Flood resilience areas in the City of Goshen.

The following strategies were identified as part of the plan:

- Customize and adopt the LTAP Model Stormwater Ordinance and Technical standards including requirement fluvial erosion hazard areas, channel protection volume, compensatory flood storage, low impact development/green infrastructure and climate change.
- Train city stormwater inspection and maintenance staff about green infrastructure practices to improve function, performance and appearance.
- Expand current flood communication efforts and develop a flood risk education and outreach program to improve people's risk awareness and motivate them to take measures to protect themselves and their property.

- Complete the flood resilience checklist at least annually to track progress made and continue to do so until all questions are marked "yes."
- Expand the tree preservation language in the Zoning Ordinance to include replacement of trees lost to development. Consider a tree mitigation ratio of 5:1 based on tree size and require a variety of native species to reduce the risk of mass tree casualties from future pest damage.
- Promote the use of native plants in the Zoning Ordinance by requiring a higher percentage to meet the landscape standards and update the recommended tree list in the City Code to include more native species and cultivars.
- Allow vegetated green infrastructure practices, including parking areas, to count toward landscape requirements in the Zoning Ordinance.
- Amend the Flood Control District regulations to require new critical facilities to be located out of known flood hazard areas only, including the 0.2% AEP. If placement of new critical facilities in flood hazard area is unavoidable, the facility, including access, should be protected to at least one foot above the 0.2% AEP flood elevation.
- Amend the Flood Control District regulations to prohibit and if not possible, discourage new development or redevelopment within the floodway and undeveloped high flood hazard storage areas in the floodway fringe.
- Update flood resilience planning areas based on updated FIRM information.
- Work with the County to study and update the stormwater utility rate collectively, otherwise complete an independent Stormwater Utility Rate Study that includes stormwater program costs and a fair and equitable rate structure; update the stormwater utility fee accordingly within the City of Goshen.
- Add a discussion on flooding, climate change, and flood resilience planning areas to the Comprehensive Plan.
- Cross-reference the Flood Resilience Plan, Redevelopment Capital Plan and Elkhart County MHMP for strategies and mitigation measures related to flooding, growth and development priorities.
- Focus redevelopment efforts (site preparation, remediation and public infrastructure) in locations that are designated as safe growth areas outside the 0.2% AEP floodplain and local flooding areas.
- Continue to acquire available land in the SFHA for flood storage and compatible open space uses; build on the city-owned parkland along the Elkhart River and create a Central Park like amenity for the city and region.
- Consider climate change and flood impacts in capital projects; promote low impact development/green infrastructure to manage stormwater.
- Incorporate the flood resilience planning areas into the proposed Future Growth Plan.
- Cross-reference the Flood Resilience Plan, Comprehensive Plan and Elkhart County MHMP for strategies and mitigation measures related to flooding, growth and development priorities.
- Minimize impacts of flooding by retaining stormwater onsite using low impact development/green infrastructure practices.
- Maintain channels and regulated drains to prevent localized flooding.
- Educate the population of known flood hazard areas.
- Prohibit development of new critical facilities in known flood hazard areas; protect existing critical facilities.
- Relocate, buyout or floodproof (nonresidential) existing structures that are subject to repetitive flooding.

- Maintain a database of accurate and community specific information following each hazard event including extent, magnitude, cost, response and recovery efforts (partner with EMA).
- Establish procedures to alert and evacuate the population in known hazard areas.
- Incorporate hazard information, risk assessment and hazard mitigation practices into plans and policies to better guide future growth and development.
- Reduce flood insurance premiums through participation in the NFIP Community Rating System.
- Support FEMA flood depth mapping (RiskMAP) to better understand the flood risk potential.
- Encourage restoration of the natural stream corridor in new and redevelopment projects.
- Cross-reference the Flood Resilience Plan, Comprehensive Plan and Redevelopment Capital Plan for strategies and mitigation measures related to flooding, growth and development priorities.
- Participate in the MHMP five-year update; multi-departments needed (partner with EMA).

2.11.3 <u>Comprehensive Plans</u>

St. Joseph River TMDL Study (2004)

In February of 2004, IDEM released a Total Maximum Daily Load (TMDL) report for *E. coli* for the St. Joseph River in Elkhart and St. Joseph counties. This TMDL evaluated the data collected on the St. Joseph River and several tributaries, including the Elkhart River, and made recommendations for load reductions to bring the St. Joseph River into compliance with both Indiana and Michigan's WQS.

It was noted in the study that when *E. coli* limits were being surpassed in the St. Joseph River, many of the tributaries, including the Elkhart River were also exceeding the water quality standard for *E. coli*. Therefore, *E. coli* sources were not restricted to the St. Joseph River itself but were being exacerbated by inputs from tributaries. Data indicated several violations in the Elkhart River. The St. Joseph River TMDL indicated that both point and nonpoint sources of pollution were responsible for the *E. coli* contamination in the St. Joseph River. It was also determined that to meet the state standard, the target load had to be set at a concentration value of 125 cfu per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over thirty days. Some specific sources indicated in the TMDL include combined sewer overflows. The communities named in the TMDL that are part of the Elkhart River Watershed are the cities of Elkhart and Goshen. All of these communities are required to reduce the impact of CSOs by developing Long Term Control Plans (LTCPs) for their CSOs. These plans are approved by IDEM through the National Pollutant Discharge Elimination System (NPDES).

St. Joseph River Watershed Management Plan (2005)

In June 2005, the Friends of the St. Joe River (FOTSJR) released a watershed management plan for the St. Joseph River Watershed. In the fall of 2002, the Friends of the St. Joe River was awarded a grant from the Michigan Department of Environmental Quality to develop a Watershed Management Plan for the entire St. Joseph River Watershed. This plan was intended to unite stakeholders in a concerted effort to address water quality issues and natural resource protection across jurisdictional boundaries. Although several Lake Michigan Lakewide Management Plan, LARE, and federally funded Clean Water Act projects had been conducted in subwatersheds in both Michigan and Indiana, and the St. Joseph River was identified by U.S. EPA as the biggest contributor of atrazine to Lake Michigan and a significant contributor of sediments and toxic substances such as mercury and PCBs, comprehensive planning efforts for the entire watershed had not been conducted at the time in which this WMP was written.

The FOTSJR coordinated with other key organizations for watershed plan preparation. The watershed management plan was developed from November 2002 through June 2005 and objectives include:

- Reduce soil erosion and sedimentation so that surface water functions and aesthetics are improved and protected.
- Reduce the amount of nutrient loading that so that surface water functions and aesthetics are improved and protected.
- Increase preservation, restoration, protection, and appreciation of open space (a system of natural areas, natural systems, corridors, farmland, open land, and parklands).
- Educate local planning officials/commissions about water quality issues, smart growth, and the protection of natural resources through coordinated planning, zoning, and ordinances.
- Provide riparian landowners, both private and public, with information regarding shoreline protection.
- Establish Michigan Heritage Water Trails on all navigable rivers in the watershed.
- Eliminate/correct sources of disease-causing organisms that are harmful to public health and that limit the use of rivers, creeks, and lakes.
- Increase the development of certified manure management plans.
- Reduce the levels of pesticides, and other toxins that are harmful to public health and that degrade aquatic habitat.
- Develop and implement residential/commercial stormwater education programs in urban areas to reduce volume and velocity of runoff.
- Increase the number of small and medium size producers who complete chemical storage and handling assessments, particularly in areas with high water tables, porous soils, and those near surface or sensitive water resources.
- Provide and/or enhance hazardous waste collection programs.

Town of Syracuse Comprehensive Plan (2017)

The Town of Syracuse completed a comprehensive plan in 2006. Recommendations identified in the 2006 plan were used as the basis for an update in 2017. Goals were grouped into nine categories. Objectives pertaining to natural resources were included in categories for 1) Land Use and Development and 2) Environment and Sustainability. Specifically:

1. Land Use and Development
    - Require land uses that are sensitive to adjacent environmental features where necessary.
    - Encourage infill development and rehabilitation of existing structures.
    - Use the future land use map as a guideline for new development and policy decisions.
2. Environment and Sustainability
    - Identify and protect environmentally sensitive areas within the Syracuse-Wawasee watershed.
    - Identify and address existing and future threats to the community's natural resources.
    - Protect and expand the vast tree canopy within Syracuse.
    - Encourage the continued participation of the Syracuse Lake Association, Wawasee Property Owners Association, and the Wawasee Area Conservation Foundation in local planning efforts.
    - Acquire and protect additional land for environmental protection as needed.
    - Continue educating and encouraging local residents and organizations to preserve the overall quality of Syracuse's natural resources.
    - Protect and celebrate viewsheds that are special to the community.
    - Encourage alternative stormwater management techniques for new developments within the town.
    - Explore and promote individual and municipal use of alternative energy sources.

City of Goshen Comprehensive Plan (2018)

The City of Goshen Comprehensive Plan was adopted in 2014. It outlines ten-year visions and goals for Goshen. The Comprehensive Plan was updated in 2018 to include the Elkhart and Goshen Bicycle and Pedestrian Master Plan. Goals in the City of Goshen Comprehensive Plan that pertain to natural resources include:

- Protect, preserve, and enhance natural habitats and resources.
- Maintain and increase open spaces and parks.
- Promote environmental education.
- Maintain, promote, and grow Goshen's urban forest system.
- Reduce toxins in the community.
- Improve water and air quality.
- Use best practices to reduce and dispose of solid waste.
- Encourage sustainable living and business practices.
- Encourage development that is sensitive to the natural environment.
- Protect and enhance the quality of ground and surface water.
- Minimize impacts on habitats and public safety through enhanced stormwater management.
- Strengthen regional land-use planning.

Noble County Comprehensive Plan (2019)

In 2019, Noble County and its major cities wrote comprehensive plans to govern their future. The Countywide plans are detailed below.

The first County comprehensive plan was adopted in 1968 and updated in 1986. The next plan was adopted in 2007 and the 2019 comprehensive plan was written with the intent to replace it. The planning process for the 2019 Noble County Comprehensive Plan, Noble Tomorrow, was started in Spring of 2017. A steering committee comprised of Noble County citizens and stakeholders convened to write this plan based on the input of the public through surveys, workshops, and interest group meetings. While this plan also has goals that cover economic values and other areas of Noble County resources, the goals that pertain to natural resources include:

- Protecting lakes and natural resources.
- Preserving agricultural heritage while continuing to use innovative farming practices.
- Implement land use planning and strategic investments to encourage growth.
- Prioritize incremental development in towns rather than large scale development further away from towns.
- Require sanitary sewers in all new large-scale developments.
- Protect prime farmland from development.
- Restrict development in environmentally sensitive areas beyond minimum requirements from the state and federal government to ensure higher quality building.
- Development should be symbiotic with the natural environment.
- Establish a county regional sewer district to decrease pollution potential from septic systems on ill-suited lands.
- Sensitive land like wetlands, floodplain, and older growth forests should be conserved through education of existing programs that provide financial incentives.
- Require all development in hazardous areas to meet strong flood protection standards.
- Require all development to have no adverse impact on neighboring landowners.
- Promote the establishment of conservancy districts to effectively manage flood risks and maintain waterways.

- Prohibit new septic systems in the floodplain without higher regulatory standards for the protection from infiltration.
- Encourage use of innovative stormwater management practices like bio-swales, on-site bio-retention, and filter strips on developments both big and small.
- Strictly limit impervious surfaces that do not mitigate their own ill effects.
- Become a participating community in FEMA's Community Rating System to reduce flood risks and decrease flood insurance costs.
- Keep all parts of the Elkhart River clean and free from excessive obstruction.
- Build a multi-modal trail between Ligonier and West Noble Schools along the creek, between Cromwell and West Noble Schools, between Albion and Chain O' Lakes State Park, and between Albion and West Noble Schools.

Noble County Parks Plan (2019)

The Noble County 2019-2024 Parks Plan was created to provide direction for the parks board to accomplish their goal of providing recreational facilities that meet the needs of Noble County residents. Goals of the park plan include:

- Increase the miles of trails available to residents.
- Develop a trail head for the Fishing Line Trail.
- Install emergency trail markers along trails.
- Improve Americans with Disabilities Act (ADA) accessibility along trails.
- Develop water based recreational opportunities on the Elkhart River.
- Publicize recreation assets.
- Develop a master plan for the next five years.

Elkhart County Parks & Recreation Master Plan (2019)

The 2019-2023 Elkhart County Parks & Recreation Master Plan was prepared by Lehman & Lehman, Inc in April of 2019. Their purpose of writing this master plan was to enable Elkhart County Parks to continue balanced planning for the overall park system; meet local recreation needs within available resources and to help the Parks and Recreation Board, community members and leaders to establish their current state of operations, their future desired state and provide structure to help achieve their goals and to monitor their successes. The Elkhart County Park Department staff and the Park Board have agreed on the following goals for the 5-Year Parks and Recreation Plan:

- Use national recreation standards, combined with a careful needs analysis to create new priorities for parks and recreation in the county.
- Receive approval from IDNR for eligibility for application for Land and Water Conservation Fund grant programs.
- Make Park sites more ADA accessible.
- Protect natural resources through land acquisition and invasive species removal.
- Survey property boundaries.

Nappanee Parks and Recreation Five-Year Master Plan 2019-2023 (2019)

Nappanee Parks and Recreation updated their five-year master plan in 2019. Prepared by the Troyer Group, this plan replaced the 2013-2017 Parks Master Plan. The city updated its Parks Master plan to ensure its parks support the goals and objectives of the city, meet the needs of its residents, and contribute to a high quality of life in the community. The objectives of the updated Master Plan are:

- Inventory and evaluate the physical condition of existing parks, amenities, and programming.

- Acquire input from a diverse group of stakeholders, residents and park users and report the findings in an accurate manner.
- Gather public support and increase parks awareness in the community.
- Discover strengths, weaknesses, opportunities, and threats.
- Set achievable goals and objectives that reflect current issues, challenges, and opportunities as they relate to the current park system.
- Analyze information and public input to determine strategies, priorities, and an action plan for the next five years.
- Provide a guide for the development of park and recreation amenities that reflect the interests and needs of the community.
- Develop master plans for each of the individual parks, showing potential improvements and new amenities.
- Expand opportunities to obtain funding for the park system amenities and programming.
- Serve as a supporting document to secure funding for proposed projects.
- Provide the foundation to make accurate budget decisions.

Kosciusko County Comprehensive Plan (2022)

Kosciusko County adopted a Comprehensive Plan in 1996. In March 2022, Kosciusko County updated their county plan. The project team recruited five primary groups acting as advisors: project steering committee, project leadership group, community committees, outreach committee, and residents of Kosciusko County. The completed plan, titled FORWARD Kosciusko County, outlined goals for physical, social cultural, and economic outcomes. Goals which pertain to natural resources include:

- Encourage the development and expansion of outdoor facilities and amenities.
- Encourage building practices and infrastructure improvements which preserve natural areas and amenities.
- Encourage the preservation and conservation of productive agricultural land.
- Encourage the development, expansion, and maintenance of wastewater systems along lakefronts to protect water quality.
- Support the protection and restoration of local lakes, watersheds, natural drains, rivers and riverbank areas, forested lands, and natural habitats.
- Support the preservation and use of public easements and rights-of-way to access local lakes and waterbodies.
- Support an increase in parkland to ensure equitable access to parks and open spaces based on the needs of county residents.
- Promote the educational opportunities offered by Grace College-Lilly Center for Lakes and Streams, The Watershed Foundation, and the Wawasee Area Conservancy Foundation for residents and visitors interested in exploring the county’s natural features.

Town of Milford Comprehensive Plan (2022)

In 2022, Kosciusko County drafted a new county-wide comprehensive plan as well as new plans for its cities and towns. While the county-wide plan is an all-encompassing document, the individual city plans were written with each town's unique needs in mind. In addition to the county-wide goals listed above, goals and policies that are specific to Milford include:

- Encourage development to utilize site design standards that are complementary to adjacent agricultural uses.
- Expand park and playground facilities within the Town, as well as gathering spaces for community and private events.
- Encourage neighborhood reinvestment by providing resources for building repair, maintenance, and sidewalk improvements.

2.12 Watershed Summary: Parameter Relationships

Several relationships among watershed parameters become apparent when watershed-wide data are examined. These relationships are discussed here in general, while relationships within specific subwatersheds are discussed in more detail in subsequent sections.

2.12.1 Topography, Soils, and Nutrient, and Sediment Loss

Much of the topography and terrain characteristics within the Lower Elkhart River Watershed have a direct correlation to water quality. Approximately 31% of the Lower Elkhart River Watershed is mapped in highly erodible lands. Highly erodible lands are very susceptible to erosion. Nutrients, such as phosphorus, and sediment erode easily when these soils are not covered. Sediments and nutrients that reach Lower Elkhart River waterbodies are likely to degrade water quality. Highly erodible lands that are used for animal production or are located on cropland are more susceptible to soil erosion.

2.12.2 Wetland Loss, Hydromodification, and Flooding

Wetlands cover 14,049 acres, or 7% of the watershed. When hydric soil coverage (30,473 acres) is used as an estimate of historic wetland coverage, it becomes apparent that more than 53% of wetlands have been modified or lost over time. Additionally, it is estimated that more than 150 miles of surface drains have been constructed in the watershed to move water more rapidly from land to adjacent waterbodies. In total, nearly 36% of the watershed is estimated to be covered by tile-drained soils. As commodity prices continue to go up and down, area land values remain high and as a result, individuals are spending a great deal of money to drain small natural wetlands in their fields in order to be able to farm that additional couple acres of land as it is cheaper to tile it than to buy ground already in production. The modification of the Lower Elkhart River Watershed directly impacts its ability to retain and store water. Additionally, these efforts push water from one area to another resulting in flooding in portions of the watershed.

1.5 Topography, Population Centers, and Septic Soil Suitability/Manure Volume

While much of the watershed's population is located within incorporated areas, there are large swaths of unsewered, dense housing as well as individuals housing in unincorporated areas outside cities and towns in the Lower Elkhart River Watershed. Unsewered, dense housing areas are located throughout the watershed with small subdivisions and lake and roadside housing developments occurring throughout the watershed covering nearly 8,050 acres. This is a concern because adequate filtration may not occur, and this water may easily reach water sources and groundwater. With a lack of natural filtration of septic fields to groundwater, degradation of water quality is likely if septic systems are not maintained. Septic maintenance is a concern of Lower Elkhart River Watershed stakeholders. Additionally, the large volume of manure produced on small, unregulated animal farms, confined feeding operations and concentrated animal feeding operations lead to *E. coli* impairments throughout the watershed.

2.12.3 High-quality Habitat and ETR Species

Many high-quality natural communities occur throughout the Lower Elkhart River Watershed. Several of these are preserved for future generations. The high-quality natural areas, including heavily forested riparian areas associated with the mainstem of Elkhart River, provide unique habitats which house several endangered, threatened, or rare (ETR) communities and species. The topography, bedrock and soils in this area support ravines and mature forest habitats that provide rare habitat that is home to many species of wildlife, fish, and plants. The topography here made this area less suitable for farming and so more of the natural community and habitat has been preserved here. Many of the endangered, threatened, and rare species and high-quality natural communities in the watershed are found along this stretch of the stream corridor, making this an important area to focus habitat preservation and restoration efforts.

3.0 WATERSHED INVENTORY II-A: WATER QUALITY AND WATERSHED ASSESSMENT

In order to better understand the watershed, an inventory and assessment of the watershed and existing water quality studies conducted within the watershed is necessary. Examining previous efforts allowed the project participants to determine if sufficient data was available or if additional data needed to be collected in order to characterize water quality problems. Once the water quality data assessment occurred, the watershed was then characterized to determine potential sources of any water quality issues identified by the data review. Subsequently, pollutant sources could then be tied to stakeholder concerns and collected data could be used to estimate pollutant loads from each identified source location. The following sections detail the water quality and watershed assessment efforts on both the broad, watershed-wide scale and in a focused manner looking at each subwatershed within the Lower Elkhart River Watershed.

3.1 Water Quality Targets

Many of the historic water quality assessments occurred using different techniques or goals. Several sites were sampled only one time and for a limited number of parameters. Monitoring committee members were reluctant to draw too many conclusions based on a single sampling event. Nonetheless, the available data are detailed below and compared in general with water quality targets. In order to compare the results of these assessments, the steering committee identified a standard suite of parameters and parameter benchmarks. Table 18 details the selected parameters and the benchmark utilized to evaluate collected water quality data.

Table 18. Water quality benchmarks used to assess water quality from historic and current water quality assessments.

Parameter	Water Quality Benchmark	Source
Dissolved oxygen	<4 mg/L and >12 mg/L	Indiana Administrative Code
pH	>6 or <9	Indiana Administrative Code
Temperature	Monthly standard	Indiana Administrative Code
Conductivity	<1050 mmhos/cm	Indiana Administrative Code
E. coli	<235 colonies/100 mL	Indiana Administrative Code
Nitrate-nitrogen	<1.0mg/L	Dodds et al. (1998)
Ammonia-nitrogen	0.0 – 0.21 mg/L	Indiana Administrative Code
Total Kjeldahl nitrogen	0.57 mg/L	USEPA (2000)
Total phosphorus	<0.08 mg/L	Dodds et al. (1998)
Orthophosphorus	<0.03 mg/L	Dunne and Leopold (1978)
Total suspended solids	<15 mg/L	Waters (1995)
Turbidity	<4.7 NTU	USEPA (2000)
Qualitative Habitat Evaluation Index	>51 points	IDEM (2008)
Index of Biotic Integrity	>36 points	IDEM (2008)
Macroinvertebrate Index of Biotic Integrity	>2.2 points (old) >36 points (new)	IDEM (2008)

3.2 <u>Historic Water Quality Sampling Efforts</u>

A variety of water quality assessment projects have been completed within the Lower Elkhart River Watershed (Figure 28). Statewide assessments and listing including the impaired waterbodies assessments and fish consumption advisories. Additionally, the Wawasee Area Conservancy Foundation (WACF), the Greater Elkhart County Stormwater Partnership, the ERRA, the Indiana Department of Environmental Management (IDEM), the Indiana DNR Lake and River Enhancement Program (LARE), the U.S. Geological Survey (USGS), the U.S. EPA National Aquatic Resource Survey (NARS) and Lake Papakeechie have completed assessments within the watershed. Volunteer based sampling of water quality through the Hoosier Riverwatch program also provides water quality data that can characterize the watershed. A summary of each assessment methodology and general results are discussed below.

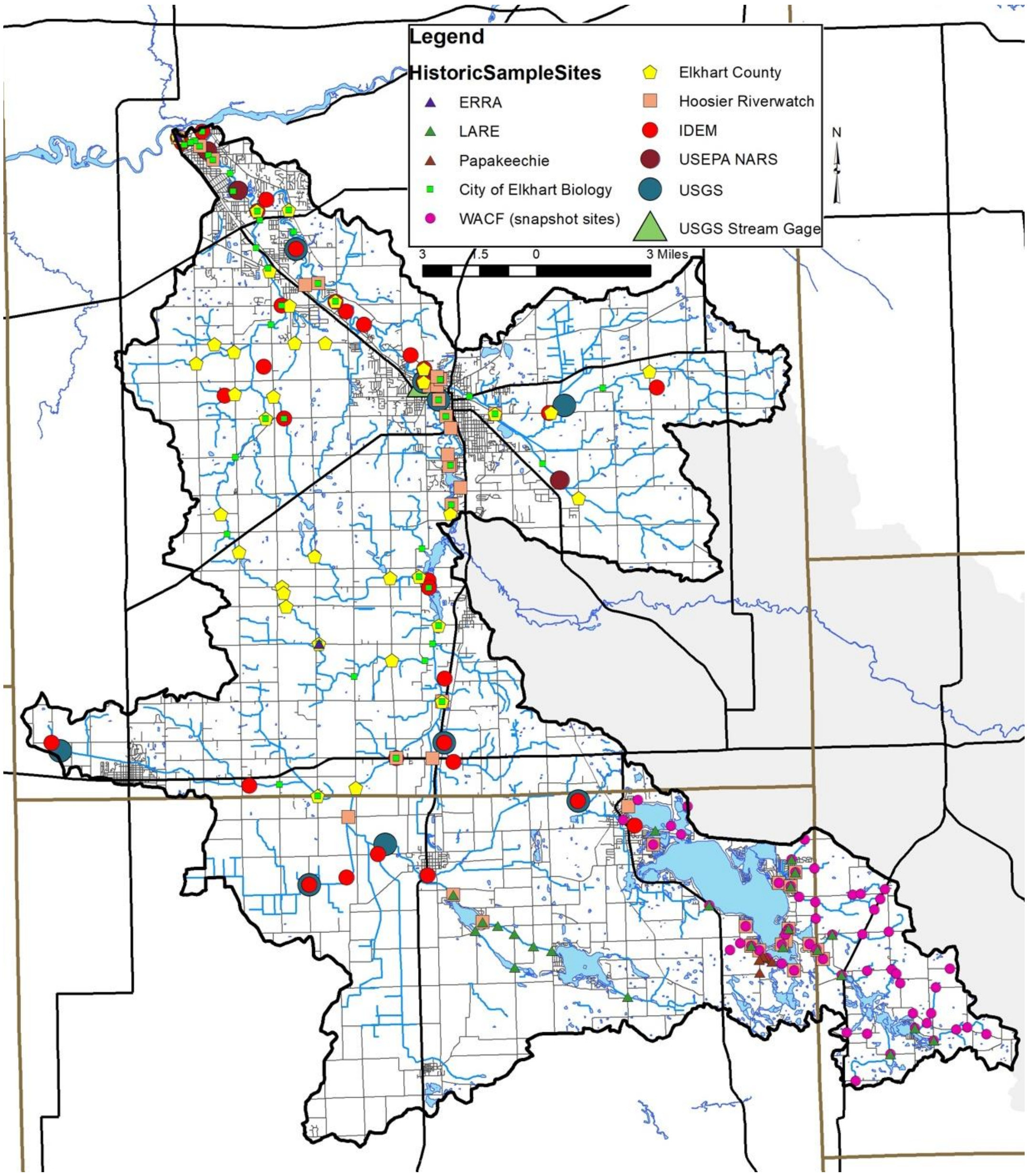


Figure 28. Historic water quality assessment locations.

3.2.1 Impaired Waterbodies (303(d) List)

The impaired waterbodies, or 303(d) list, is prepared biannually by the Indiana Department of Environmental Management. Waterbodies are included on the list if water quality assessments indicate that they do not meet their designated use. A total of 39 stream segments as well as several lakes in the Lower Elkhart River Watershed are included on the list of impaired waterbodies (Figure 29,Table 19). Waterbodies are listed as impaired for E. coli (154.7 miles), nutrients (7.8 miles), dissolved oxygen (7.8 miles) and PCBs in fish tissue (8.9 miles). Impaired lakes include Hammond Lake, Rothenberger Lake and Barrel and a Half Lake for total phospohorus; Lake Wawasee for PCBs in fish tissue and Gordy Lake, Hindman Lake, Knapp Lake, and Village Lake for impaired biotic communities.

Table 19. Impaired waterbodies on the Lower Elkhart River Watershed impaired waterbodies list.

Stream/LakeName	Assessment ID	Impairment(s)
BARREL AND A HALF LAKE	INJ01P1187_00	Total phosphorus
BERLIN COURT DITCH	INJ01H6_03	Nutrients, DO, *E. coli*
BERLIN COURT DITCH (LTD)	INJ01H6_04	Nutrients, DO, *E. coli*
DAUSMAN DITCH	INJ01H8_T1003	*E. coli*
ELKHART RIVER	INJ01J4_04	*E. coli*
ELKHART RIVER	INJ01J4_05	*E. coli*
ELKHART RIVER	INJ01J4_08	*E. coli*
ELKHART RIVER	INJ01J4_03	*E. coli*, fish consumption
ELKHART RIVER	INJ01J4_09	*E. coli*, fish consumption
ELKHART RIVER	INJ01J4_10	*E. coli*, fish consumption
ELKHART RIVER - UNNAMED TRIBUTARY	INJ01J4_T1005	*E. coli*
ELKHART RIVER HYDRAULIC CANAL	INJ01J4_T1006	*E. coli*
GORDY LAKE	INJ01P1196_00	IBC
HAMMOND LAKE	INJ01P1184_00	Total phosphorus
HINDMAN LAKE	INJ01P1195_00	IBC
HOOPINGARNER DITCH	INJ01H4_T1003	*E. coli*
KIEFFER DITCH	INJ01H8_T1005	*E. coli*, IBC
KNAPP LAKE	INJ01P1193_00	IBC
LAKE WAWASEE	INJ01P1023_00	PCBS in fish tissue
OMAR-NEFF DITCH	INJ01H7_T1005	*E. coli*, IBC
OWL CREEK	INJ01J3_T1004	*E. coli*, IBC
ROCK RUN CREEK	INJ01J1_04	*E. coli*
ROCK RUN CREEK	INJ01J1_05	*E. coli*
ROCK RUN CREEK	INJ01J2_06	*E. coli*
ROCK RUN CREEK	INJ01J2_07	*E. coli*
ROTHENBERGER LAKE	INJ01P1186_00	Total phosphorus
ROCK RUN CREEK	INJ01J2_08	*E. coli*
ROCK RUN CREEK - UNNAMED TRIBUTARY	INJ01J1_T1005	*E. coli*
ROCK RUN CREEK - UNNAMED TRIBUTARY	INJ01J1_T1006	*E. coli*
ROCK RUN CREEK - UNNAMED TRIBUTARY	INJ01J2_T1013	*E. coli*
ROCK RUN CREEK - UNNAMED TRIBUTARY	INJ01J2_T1014	*E. coli*
SKINNER DITCH	INJ01H4_T1004	*E. coli*
SKINNER DITCH	INJ01H4_T1005	*E. coli*
TURKEY CREEK	INJ01H4_02	*E. coli*
TURKEY CREEK	INJ01H4_03	*E. coli*
TURKEY CREEK	INJ01H4_04	*E. coli*
TURKEY CREEK	INJ01H5_02	*E. coli*, IBC
TURKEY CREEK	INJ01H5_03	*E. coli*, IBC
TURKEY CREEK	INJ01H7_05	*E. coli*

TURKEY CREEK	INJ01H7_06	*E. coli*
TURKEY CREEK	INJ01H7_07	*E. coli*
TURKEY CREEK	INJ01H8_02	*E. coli*
TURKEY CREEK	INJ01H8_03	*E. coli*
TURKEY CREEK	INJ01H9_02	*E. coli*
TURKEY CREEK	INJ01H9_03	*E. coli*
TURKEY CREEK- UNNAMED TRIBUTARY	INJ01H4_T1006	*E. coli*
VILLAGE LAKE	INJ01P11198_00	IBC

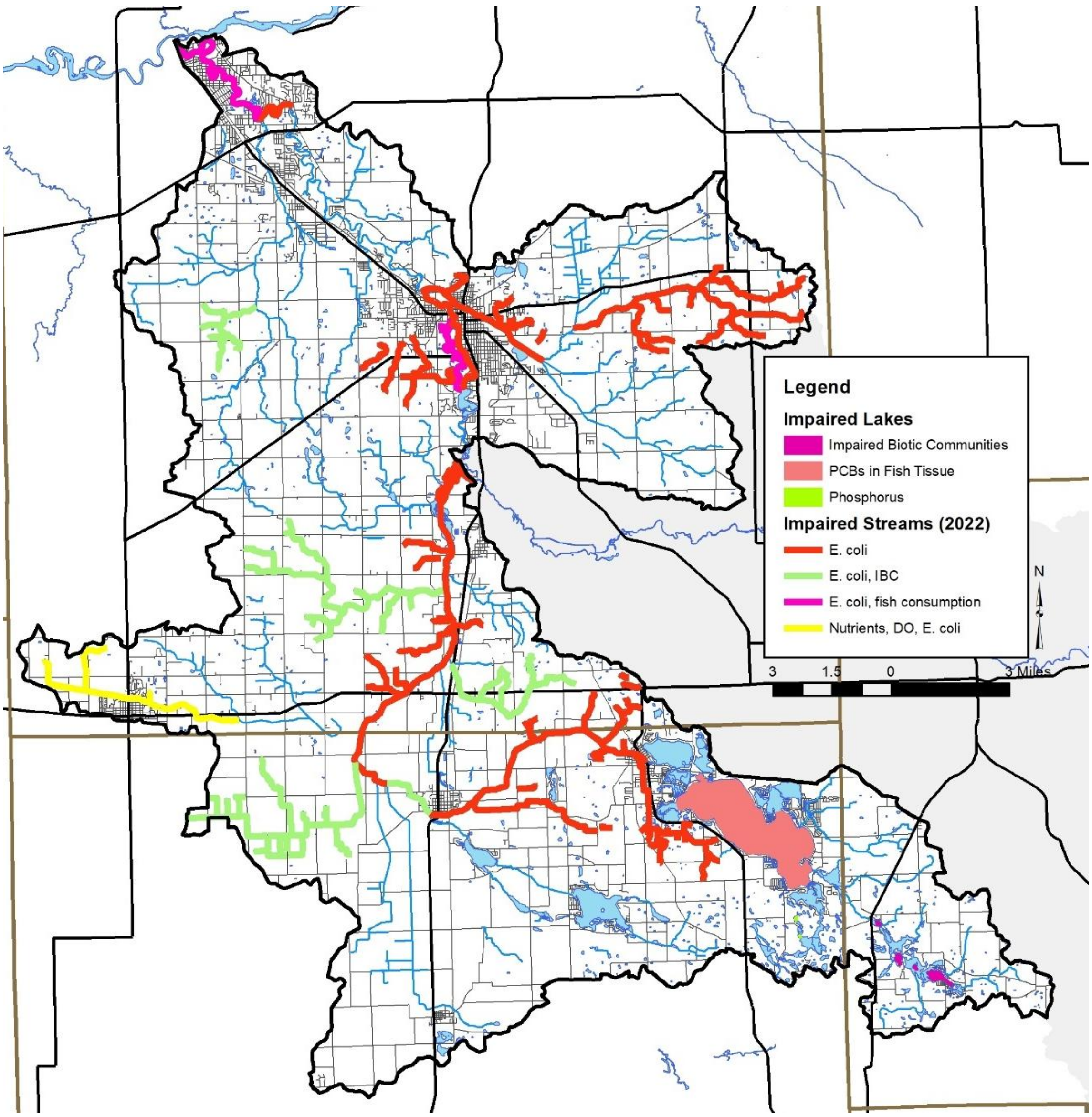


Figure 29. Impaired waterbody locations in the Lower Elkhart River Watershed.

3.2.2 Fish Consumption Advisory (FCA)

Three state agencies collaborate annually to compile the Indiana Fish Consumption Advisory (FCA). The Indiana Department of Natural Resources, Indiana Department of Environmental Management and

Indiana State Department of Health have worked together since 1972 on this effort. Samples are collected through IDEM's rotating basin assessment for bottom feeding, mid-water column feeding and top feeding fish. Fish tissue samples are then analyzed for heavy metals, PCBs, and pesticides. Advisories listings are as follows:

- Level 3 – limit consumption to one meal per month for adults with pregnant or breastfeeding women, women who plan to have children, and children under 15 consuming zero volume of these fish.
- Level 4 – limit consumption to one meal every 2 months for adults with women and children detailed above having zero consumption.
- Level 5 – zero consumption or do not eat.

For the Elkahrt River in Elkhart County, the following conclusions can be drawn:

Sensitive populations should follow the eating guideline which includes not consuming:

- Channel Catfish up to 20 inches in size more than once a month and more than six times a year for 20+ inches.
- Northern Hog Sucker of all sizes more than once a week.
- Redhorse species of all sizes more than once a month.
- Rock Bass of all sizes more than once a week.
- Smallmouth Bass of all sizes more than once a week.
- Walleye of all sizes more than once a week.
- White Sucker up to 16 inches in size more than once a week and more than once a month for 16+ inches.

General populations should not consume:

- Channel Catfish up to 20 inches in size more than once a month and more than six times a year for 20+ inches.
- Redhorse species of all sizes more than once a week.
- Smallmouth Bass of all sizes more than once a week.
- Walleye of all sizes more than once a week.
- White Sucker of all sizes more than once a week.

The general population may have unrestricted consumption of the Northern Hog Sucker species and Rock Bass species.

3.2.3 IDEM Rotational Basin Assessments (1990-2023)

Between the years of 1990 and 2023, IDEM sampled water chemistry at many locations in the Lower Elkhart River Watershed. Based on the water chemistry assessments, the following conclusions can be drawn:

- Ammonia concentrations exceeded state standards in 36% (138 of 380) of samples collected.
- *E. coli* concentrations exceeded the state standard in 34% (98 of 285) samples collected.
- Dissolved oxygen (DO) concentrations exceeded state standards (<4 mg/L or >12 mg/L) in 34% (251 of 743) samples collected.
- pH levels exceeded state standards in 20% (197 of 996) of samples collected.
- Total Kjeldahl nitrogen (TKN) exceeded water quality targets in 86% (520 of 606) samples collected.

- Orthophosphorus (OP) concentrations exceeded target concentrations (0.03 mg/L) in 100% (3 of 3) samples collected.
- Total suspended solids (TSS) concentrations exceeded water quality targets (15 mg/L) in 21% (119 of 567) samples collected.
- Turbidity exceeded water quality in 71% (460 of 645) of samples collected.

3.2.4 USGS (2005, 2007-2010)

The USGS assessed stream water chemistry within the Lower Elkhart River Watershed at seven locations. Based on the assessments, the following conclusions can be drawn:

- pH levels did not exceed water quality standards in any sample (26) collected.
- Turbidity exceeded water quality targets in 91% (10 of 11) of samples collected.

3.2.5 U.S. EPA NARS (2008, 2014, 2018, 2019)

The U.S. EPA NARS sampled water chemistry at one location in the Lower Elkhart River Watershed. Based on the water chemistry assessments, the following conclusions can be drawn:

- Ammonia concentrations did not exceed state standards in any collected samples (4).
- Conductivity did not exceed water quality targets in any samples (3) collected.
- DO concentrations did not exceed state standards (<4 mg/L or >12 mg/L) in any collected samples (3).
- pH levels did not exceed state standards in any collected samples (7).
- TSS concentrations did not exceed water quality targets (15 mg/L) in any collected samples (4).
- Turbidity exceeded water quality targets in 25% (1 of 4) of samples collected.

3.2.6 Indiana DNR, Lake and River Enhancement Program (2001, 2004, 2006)

The Indiana DNR completed a diagnostic study for Waubee Lake in 2001 and JFNew completed a diagnostic study for the Dewart Lake Watershed in 2004 and a watershed management plan for Lake Wawasee in 2007 utilizing Indiana Department of Natural Resources (IDNR) Lake and River Enhancement Program funding. The IDNR and JFNew assessed many sites for varying parameters within the watersheds. Based on data collected, the following conclusions can be drawn:

- Ammonia concentrations exceeded water quality targets in 11% (3 of 28) of samples collected.
- Conductivity did not exceed water quality targets in any samples (28) collected.
- *E. coli* concentrations exceeded the state standard in 83% (25 of 30) samples collected.
- DO concentrations exceeded state standards (12 mg/L) in 13% (4 of 30) samples collected.
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 86% (24 of 28) of samples collected.
- pH levels did not exceed state standards in any samples (35) collected.
- TKN exceeded water quality targets in 60% (18 of 30) samples collected.
- Total phosphorus (TP) concentrations exceeded target concentrations (0.08 mg/L) in 23% (7 of 30) samples collected.
- TSS concentrations exceeded water quality targets (15 mg/L) in 3% (1 of 29) samples collected.
- Turbidity exceeded water quality in 3% (1 of 29) of samples collected.

3.2.7 Hoosier Riverwatch Sampling (1999-2013, 2015-2018, 2021, 2022)

Between 1999 and 2022, volunteers trained through the Hoosier Riverwatch program assessed several sites in the Lower Elkhart River Watershed. Based on data collected, the water chemistry assessments suggest:

- *E. coli* concentrations exceeded the state standard in 58% (75 of 129) samples collected.

- DO concentrations exceeded state standards (<4 mg/L or >12 mg/L) in 8% (13 of 165) samples collected.
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 58% (100 of 172) of samples collected.
- pH levels exceeded state standards in 1% (2 of 171) of samples collected.
- TP concentrations exceeded target concentrations (0.08 mg/L) in 75% (3 of 4) samples collected.
- Turbidity exceeded water quality in 44% (70 of 160) of samples collected.

3.2.8 WACF Snapshot Sites (2021-2023)

The WACF Snapshot Day is a citizen science water quality monitoring event to research stream data in the Lower Elkhart River Watershed. Data are collected from up to 33 sites throughout the Lake Wawasee drainage in one afternoon annually to create a snapshot of water quality. Based on data collected, the water chemistry assessments suggest:

- *E. coli* concentrations exceeded the state standard in 40% (18 of 45) samples collected.
- DO concentrations exceeded state standards (<4 mg/L or >12 mg/L) in 15% (10 of 65) samples collected.
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 50% (23 of 46) of samples collected.
- pH levels exceeded state standards in 19% (16 of 84) of samples collected.
- Orthophosphorus (OP) concentrations exceeded target concentrations (0.03 mg/L) in 42% (27 of 65) samples collected.

3.2.9 Lake Papakeechie (2013, 2015-2023)

Lake Papakeechie samples three stream sites across their watershed. Based on data collected, the water chemistry assessments suggest:

- DO concentrations exceeded state standards (12 mg/L) in 89% (17 of 19) samples collected.
- Ammonia concentrations did not exceed state standards in any collected samples (6).
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 18% (14 of 77) of samples collected.
- pH levels did not exceed state standards in any samples (1) collected.
- TP concentrations exceeded target concentrations (0.08 mg/L) in 46% (70 of 152) samples collected.

3.2.10 Greater Elkhart County Stormwater Partnership (2009-2022)

The Greater Elkhart County Stormwater Partnership includes the Town of Bristol, Elkhart County, the City of Elkhart, City of Goshen and others collect water quality at multiple locations throughout the county from April to October. In total, up to 24 samples are collected from each site annually. The St. Joseph River Basin Commission (Barrett, 2022) cleaned and compiled data and drew the following conclusions for the data collected across the county:

- All the water quality variables exhibited significant annual, seasonal, and regional changes. The high variability in water quality over regions, years, and months reinforce the value of this program in establishing baseline conditions for monitoring sites. However, DO and temperature exhibit a typical seasonal pattern that is characteristic of waterbodies in the region.
- Several variables are correlated with each other and the strength of many of these relationships appears to increase under wet weather conditions. The negative associations between dissolved oxygen and conductivity, dissolved oxygen and total phosphorus and dissolved oxygen and total suspended solids are consistent with known patterns of eutrophication and subsequent reductions in oxygen availability in aquatic systems. The correlation analysis also revealed a strong positive association between total suspended solids and *E. coli*, suggesting that both components increase in similar ways in the watershed.

- Correlations must be interpreted with caution because not all variables were reported completely in each year and across all sites. Thus, the correlations give an overall snapshot of potential relationships among variables, but they do not prove cause-and-effect.
- The proportion of sites exceeding the water quality targets for *E. coli* and phosphorus is trending upwards over time, while the exceedances of the water quality standards for DO, nitrates, and TSS are much lower in comparison. Collectively, Turkey Creek, Yellow Creek, Rock Run Creek and Pine Creek exceed water quality standards much more frequently compared to the other major surface waters.
- Analysis of long-term water quality trends across major water regions revealed striking spatial trends in TSS, nitrates, phosphorus, and *E. coli*. Presenting aggregated water quality trends for major waterways aided in identifying areas of concern and should serve as a basis for detailed analysis of specific sites.
- SJRBC noted that the above trends may be influenced by the site selection process. Since different combinations of sites are sampled each year, differences in water quality over time may be due, in part, to the differences in sites sampled over years.

Based on data collected within the Lower Elkhart River only, the water chemistry assessments suggest:
- Conductivity exceeded water quality targets in 5% (132 of 2,694) of samples collected.
- *E. coli* concentrations exceeded the state standard in 72% (1,993 of 2,779) samples collected.
- DO concentrations exceeded state standards (<4 mg/L or >12 mg/L) in 17% (465 of 2,771) samples collected.
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 82% (2,320 of 2,834) of samples collected.
- pH levels exceeded state standards in 1% (31 of 2,708) of samples collected.
- TP concentrations exceeded target concentrations (0.08 mg/L) in 98% (2,916 of 2,962) samples collected.
- TSS concentrations exceeded water quality targets (15 mg/L) in 31% (650 of 2,064) samples collected.

3.2.11 Elkhart Watershed Management Plan (2007)

The Elkhart River Alliance (ERA) formed as a committee through the Elkhart River Restoration Association, Inc. (ERRA) for the development and implementation of a watershed management plan for the Elkhart River Watershed. Two sites are located in the Lower Elkhart River Watershed. Based on data collected from these efforts, water chemistry assessments suggest:
- Conductivity did not exceed water quality targets in any collected samples (4).
- *E. coli* concentrations did not exceed the state standard in any collected samples (4).
- DO concentrations did not exceed state standards (<4 m/L or >12 mg/L) in any collected samples (4).
- Nitrate-nitrogen exceeded target concentrations (1 mg/L) in 100% (4 of 4) of collected samples.
- pH levels did not exceed state standards in any collected samples (4).
- TP concentrations did not exceed target concentrations (0.08 mg/L) in any collected samples (4).
- TSS concentrations did not exceed water quality targets (15 mg/L) in any collected samples (4).
- Turbidity exceeded water quality targets in 25% (1 of 4) of samples collected.

3.3 Current Water Quality Assessment

3.3.1 Water Quality Sampling Methodologies

As part of the current project, the Lower Elkhart River Watershed Project implemented a one-year water quality monitoring program. The program included monthly water chemistry sample collection and one macroinvertebrate community and habitat assessment. The program is detailed below and in the Quality Assurance Project Plan for the Lower Elkhart River Watershed Management Plan approved on February 7, 2023. Sites sampled through this program are displayed in Figure 30.

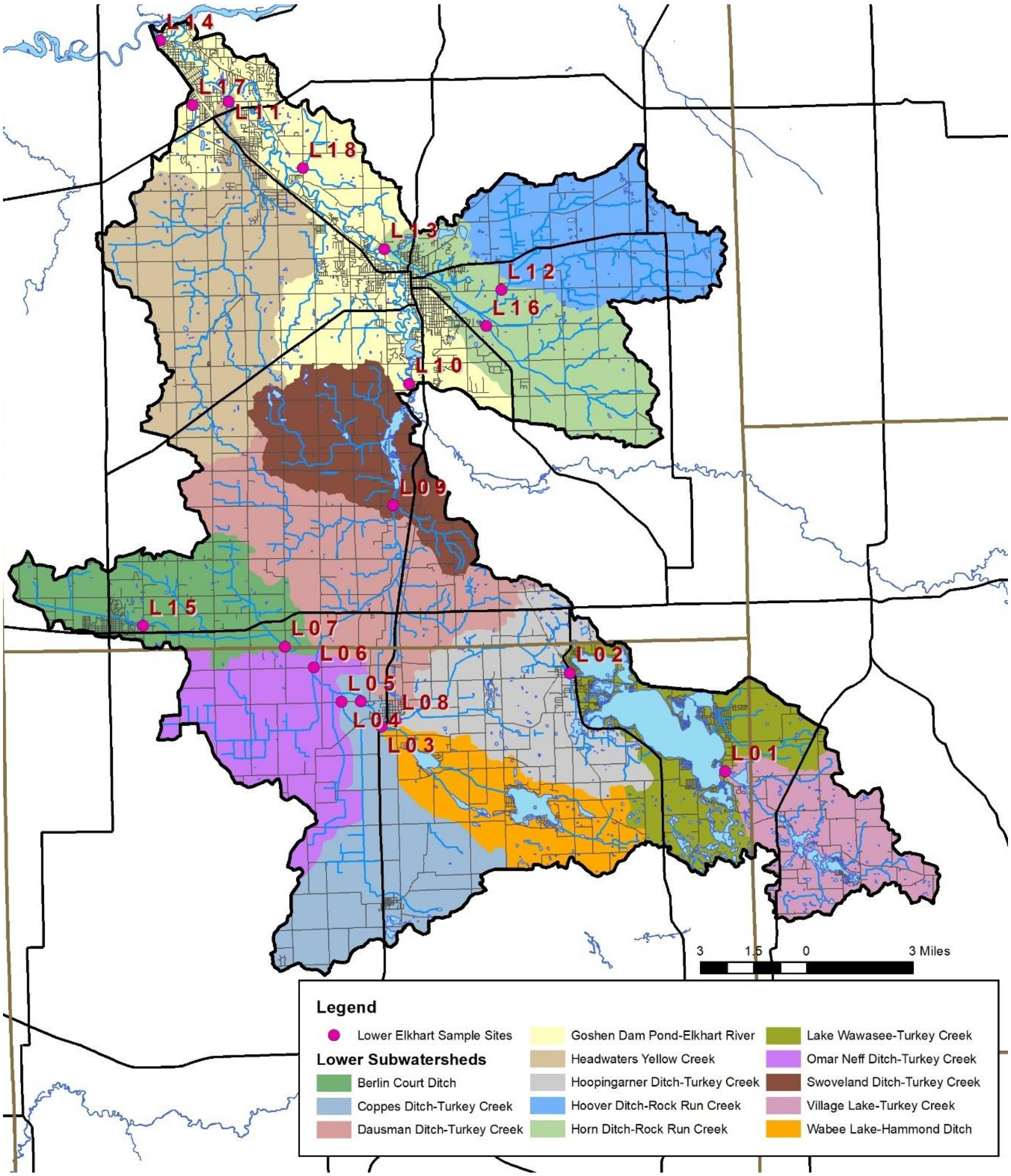


Figure 30. Sites sampled as part of the Lower Elkhart River Watershed Management Plan.

Stream Flow
Stream flow was calculated by scaling stream flow measured at the U.S. Geological Survey (USGS) stream gages to subwatershed drainage area during high flow events and measuring during low flow events. The Elkhart River USGS gage near Goshen (USGS 04100500) was used for tributary stream sites. It should be noted that Sailor Ditch (Site 18) is an intermittent stream which was observed as dry from June through December 2023.

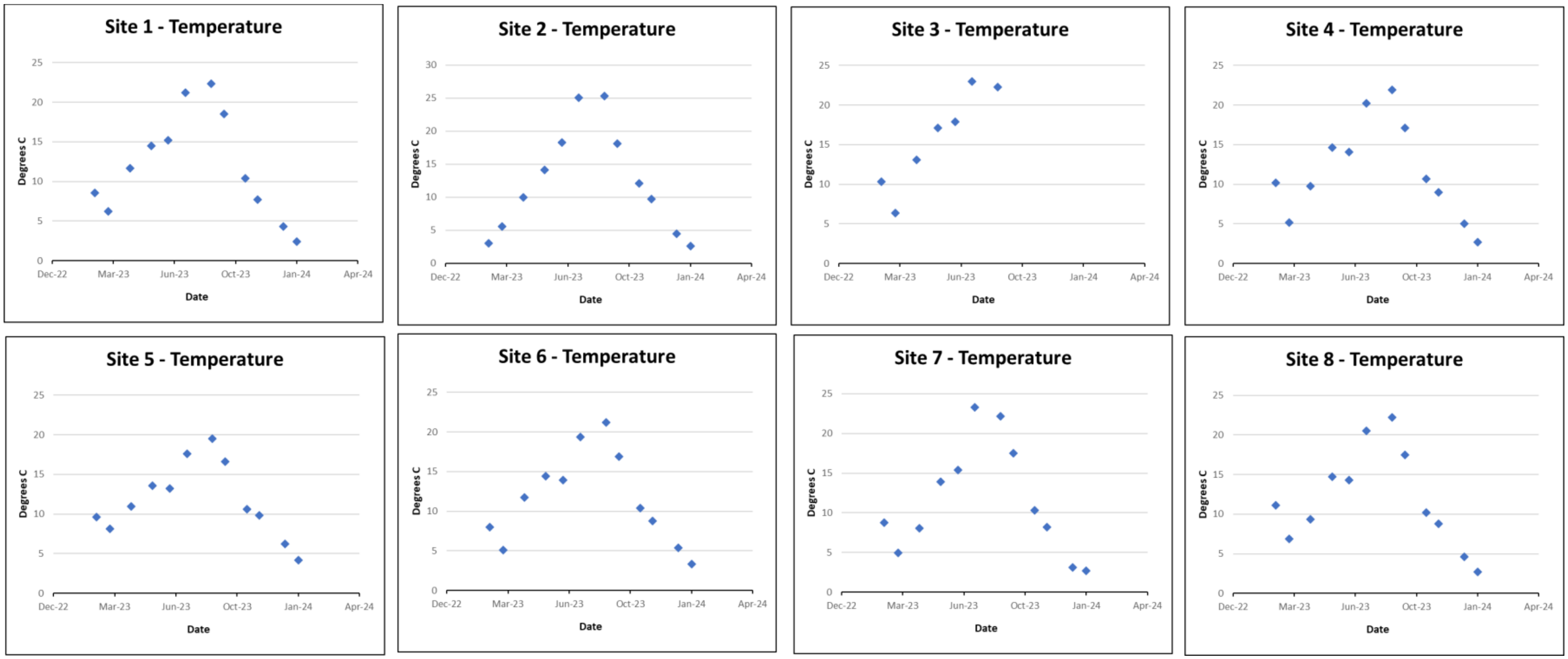
Field and Laboratory Chemistry Parameters
The Lower Elkhart River Watershed Project established 18 chemistry monitoring stations as part of the monitoring program. Dissolved oxygen, temperature, pH, turbidity, conductivity, nitrate-nitrogen, total phosphorus, *E. coli* and total suspended solids were measured monthly at the sampling stations. Sampling occurred from February 2023 through January 2024. Appendix B details the parameters measured.

Biological Community and Habitat
The physical habitat at each of the 18 sample sites was evaluated using the Qualitative Habitat Evaluation Index (QHEI). The Ohio EPA developed the QHEI for streams and rivers in Ohio (Rankin, 1989, 1995) and the IDEM adapted the QHEI for use in Indiana. Macroinvertebrate communities were assessed using the macroinvertebrate Index of Biotic Integrity (mIBI) with all 18 sites assessed in the fall of 2023. As noted above Sailor Ditch is an intermittent stream which was observed as dry from June through December 2023. Biological data were not collected at this site.

3.3.2 Field Chemistry Results
Figure 31 through Figure 35 display results for non-nutrient field chemistry data collected monthly at the 18 sample sites. At each of the stream sites, a multi-parameter probe was deployed during each sampling event. The probe collects data for temperature, dissolved oxygen, specific conductivity, and pH. All field chemistry results are contained in Appendix B.

Temperature

Figure 31 illustrates the monthly temperature measurements in the watershed streams. As shown, temperatures measure approximately the same at each of the stream sites with seasonal changes in temperature creating major differences in temperature throughout the sampling period. Temperatures measured between 0.7 and 25.3 °C in all streams. The highest temperatures generally occurred during July, August and September assessments depending on riparian cover and stream depth present at each location.



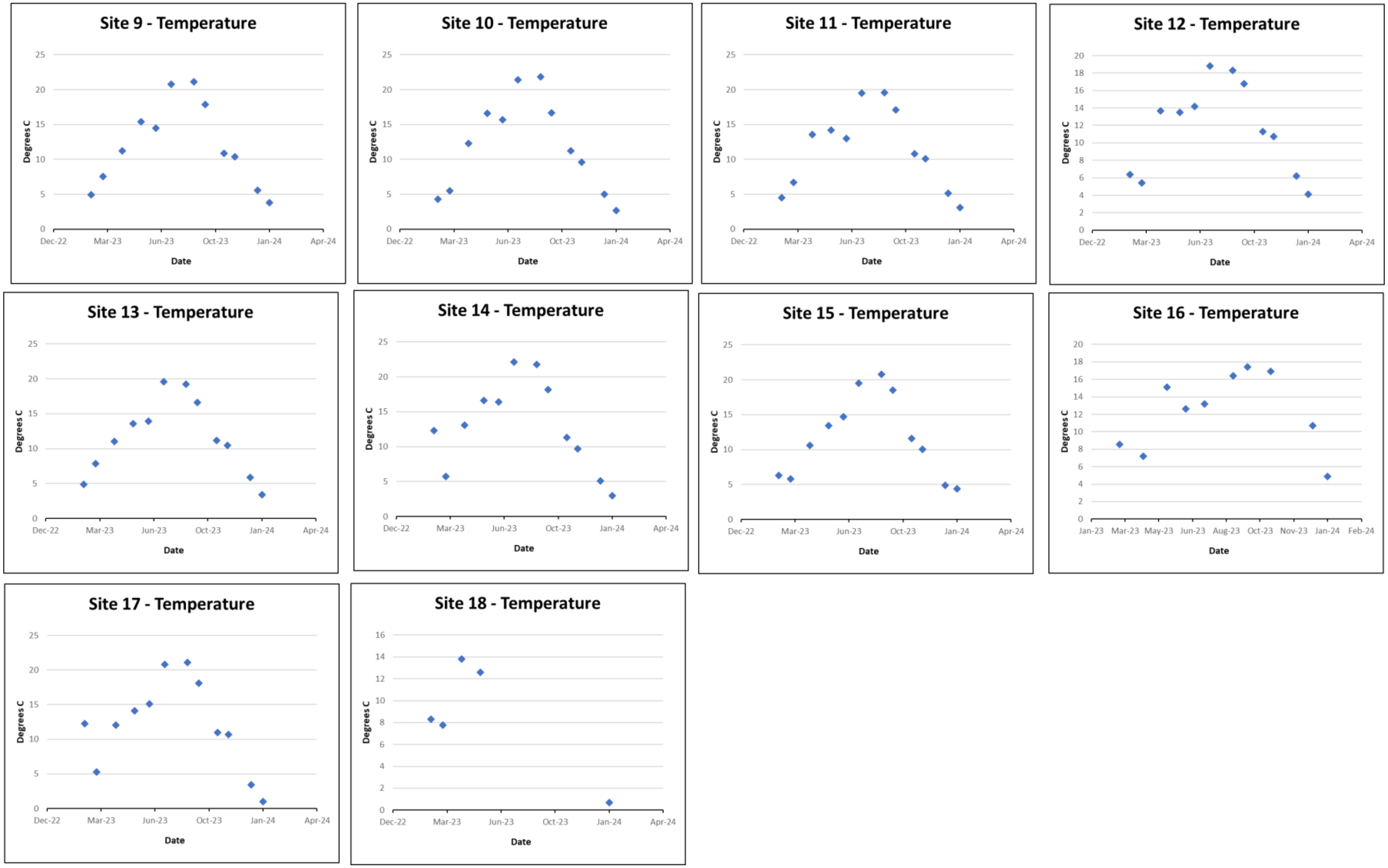
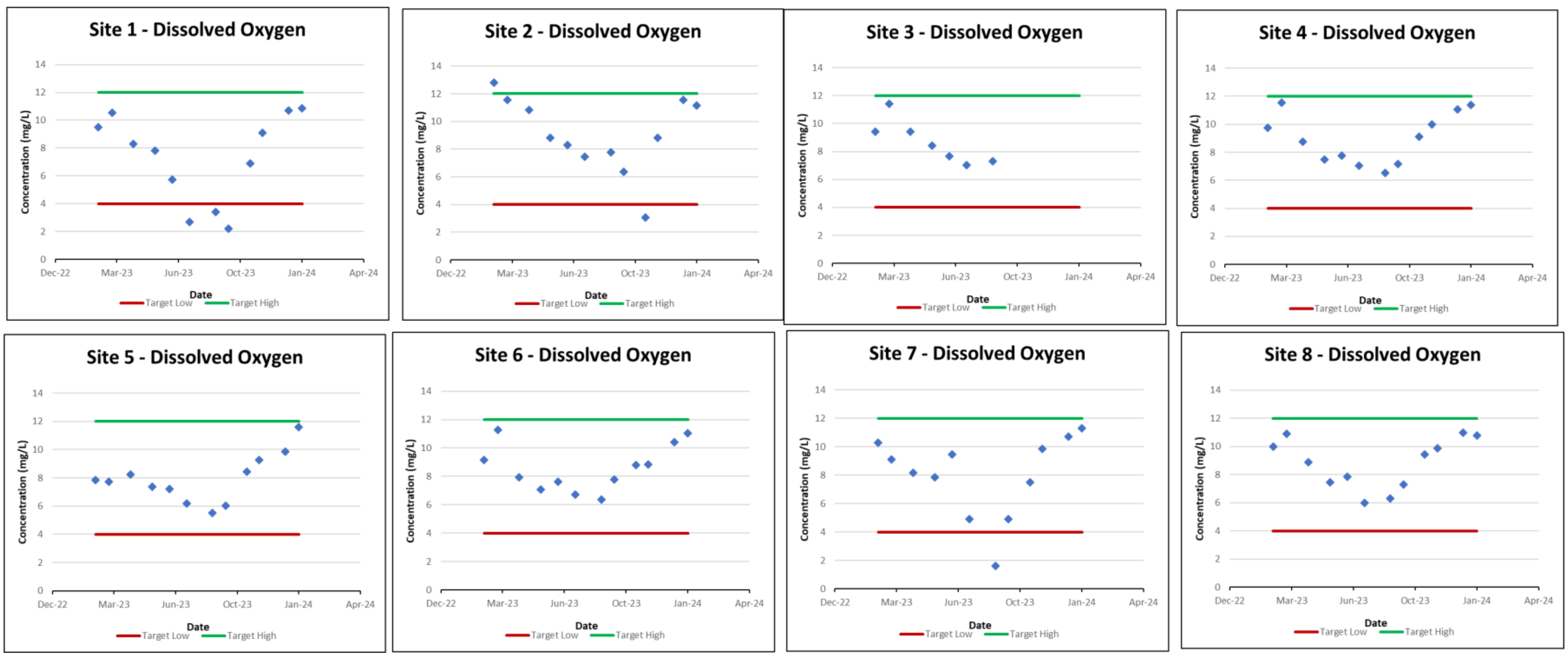


Figure 31. Temperature measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

Dissolved Oxygen

Dissolved oxygen concentrations also display seasonal changes like those observed for temperature. However, as shown in Figure 32, dissolved oxygen concentrations are opposite those measured for temperature. This is as expected as colder water holds more dissolved oxygen than warmer water; therefore, when water temperatures are low, dissolved oxygen concentrations are high and vice versa. As such, the dissolved oxygen graph shows a general pattern where dissolved oxygen concentrations lower in summer. All streams display variation in dissolved oxygen concentration due to individual conditions present within each system. The lowest dissolved oxygen concentration occurred at Site 7 (Berlin Court Grand Ditch) during August 2023 with a concentration of 1.7 mg/L. The highest dissolved oxygen concentration occurred at Site 2 (Turkey Creek at Hickory Street) during February 2023 with a concentration of 12.79 mg/L. In total, 3% of samples (6 of 203) measured below the lower or above the higher dissolved oxygen state standard (4 mg/L and 12 mg/L, respectively).



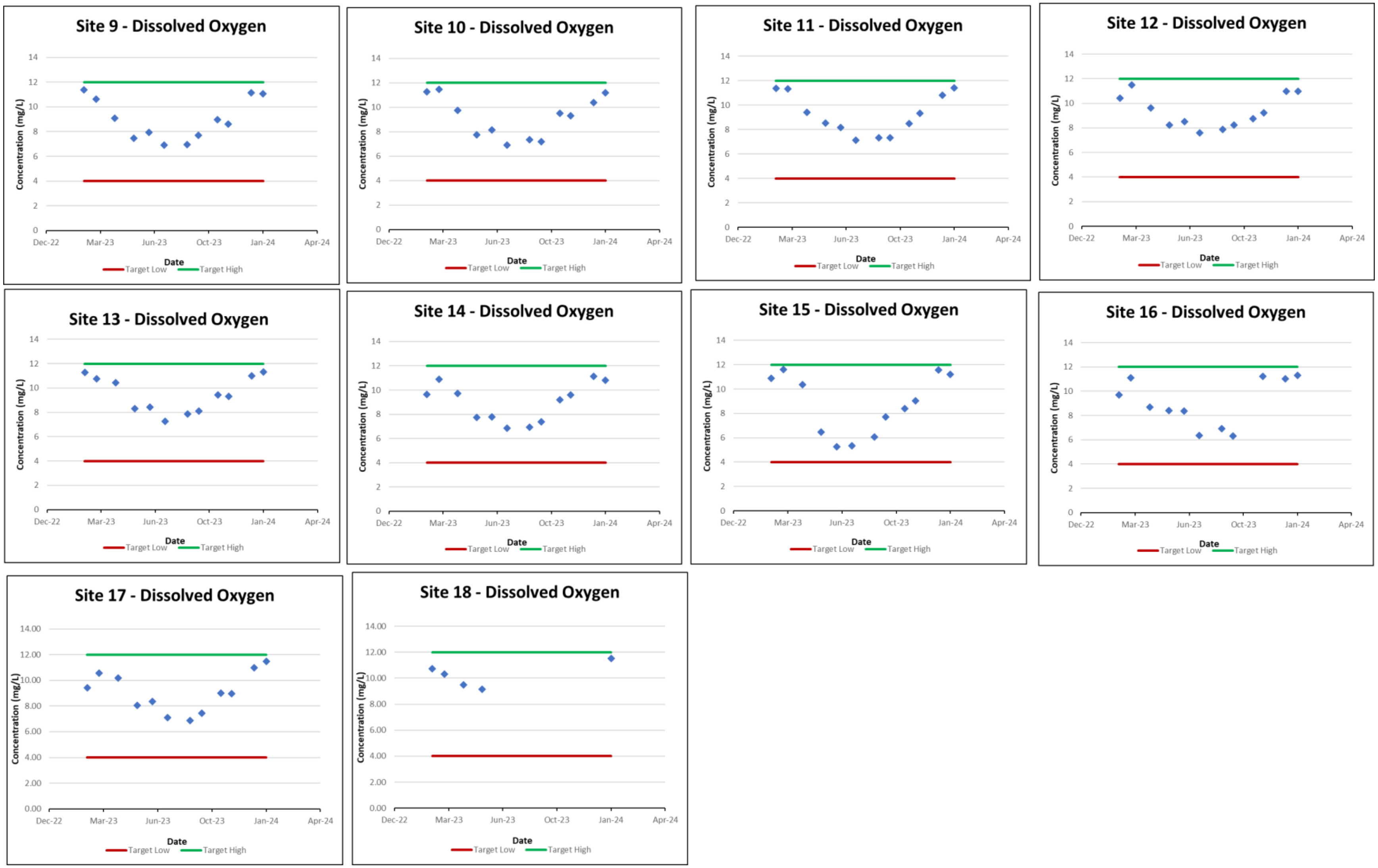


Figure 32. Dissolved oxygen measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

pH

Throughout the sampling period, pH generally remained in an acceptable range in all watershed streams. In total, 2% (4 of 203) samples exceeded the acceptable upper pH range of 9. Exceedances occurred at Site 2 (Turkey Creek at Hickory Street) between February and April 2023 and at Site 3 (Waubee Lake Outlet) during February 2023. In general, pH levels seem highest in cooler months (Figure 33). Elevated pH levels may be due to algal activities.

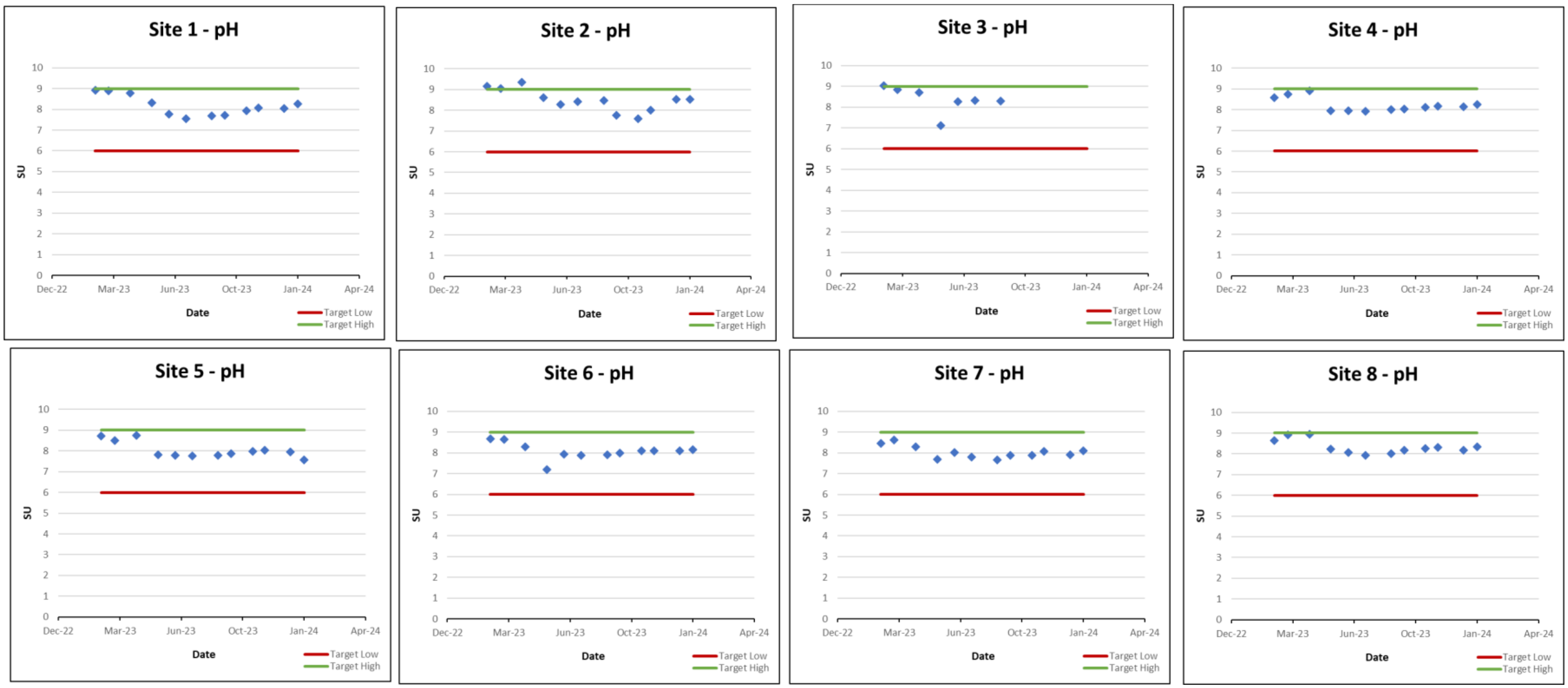
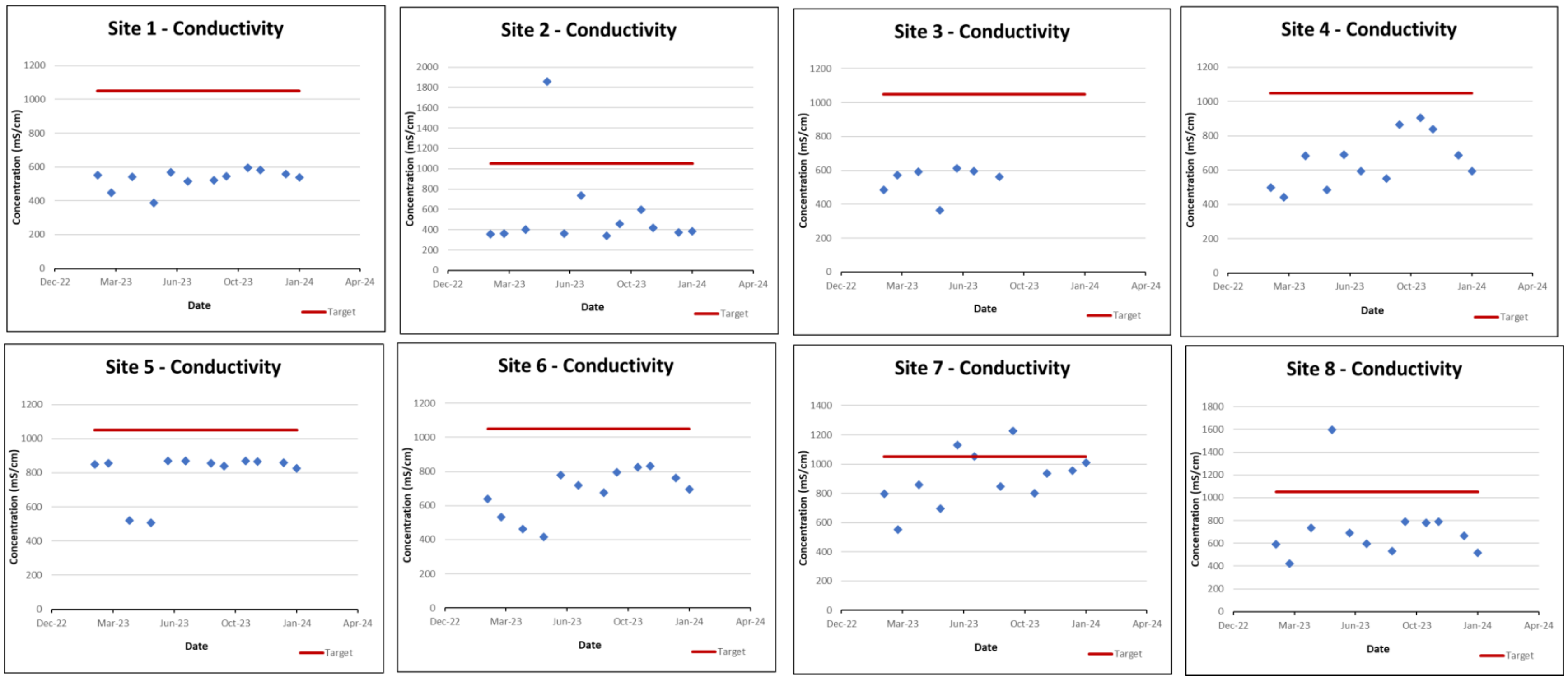


Figure 33. pH measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

Specific Conductivity

Figure 34 displays the conductivity measurements in the watershed streams. In total, nearly 6% (12 of 203) samples measured above state standards (1060 mS/cm). Site 15 (Berlin Court Grand Ditch) exceeded conductivity standards five times, while Site 7 (Berlin Court Ditch at US 6) exceeded three times and Site 2 (Turkey Creek at Hickory Street), Site 8 (Turkey Creek at Old SR 15), Site 11 (Yellow Creek at CR 18) and Site 16 (Horn Ditch at College Ave) exceeded once. Conductivity did not exceed state standards at any other site. The greatest conductivity level occurred at Site 2 with a measurement of 1859 mS/cm.



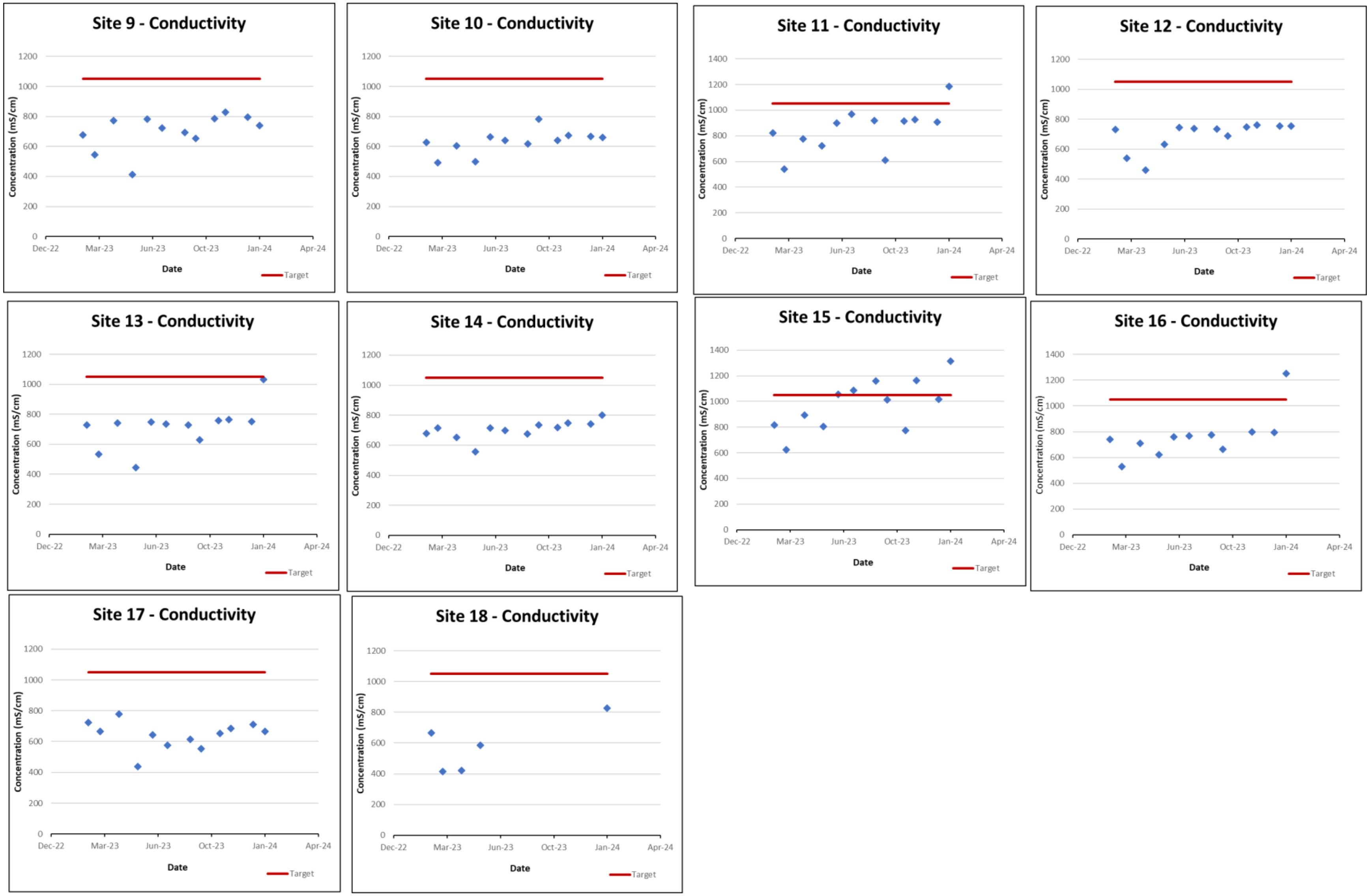
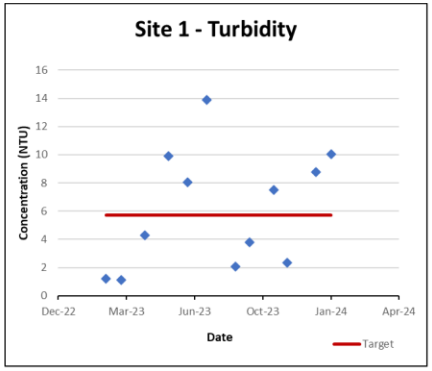
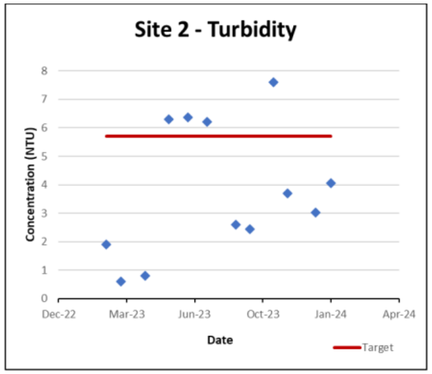


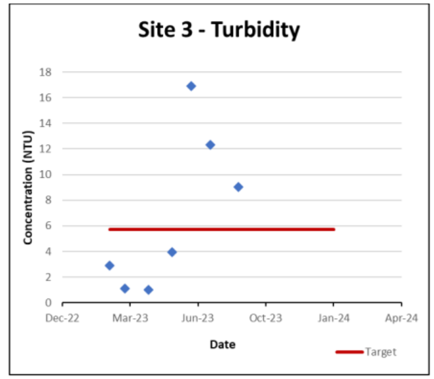
Figure 34. Conductivity measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

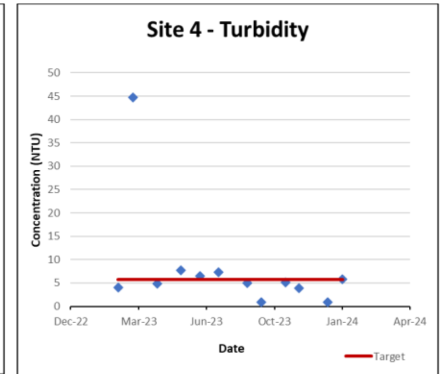
Turbidity

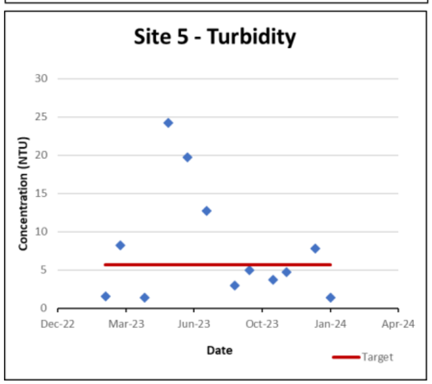
Turbidity varied greatly among the 18 sites with all sites exceeding target levels (5.7 NTU) at least three times. In total, 97 of 203 samples exceeded turbidity targets with nearly 48% of samples exceeding targets during the sampling period. The highest turbidity levels occurred at Site 16 (Horn Ditch at College Ave) and Site 15 (Berlin Court Ditch at CR 17) in January 2024. Site 16 (Horn Ditch at College Ave), Site 18 (Sailor Ditch at Old CR 17), Site 13 (Rock Run Creek at Indiana Ave), Site 12 (Rock Run Creek at CR 34) and Site 7 (Berlin Court Ditch at US 6) exceeded target concentrations in more than 50% of samples collected. Only Site 2 (Turkey Creek at Hickory Street), Site 8 (Turkey Creek at SR 15) and Site 9 (Turkey Creek at CR 146) had an average turbidity level less than target levels of 5.7 NTU. All other sites possessed an average turbidity levels which measured above target levels.

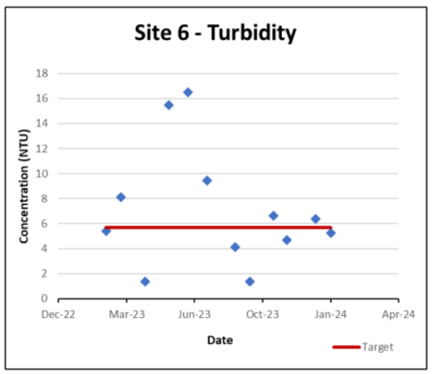


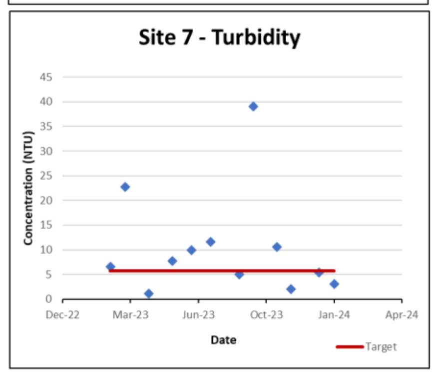


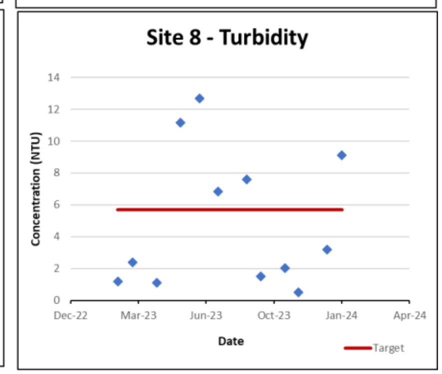












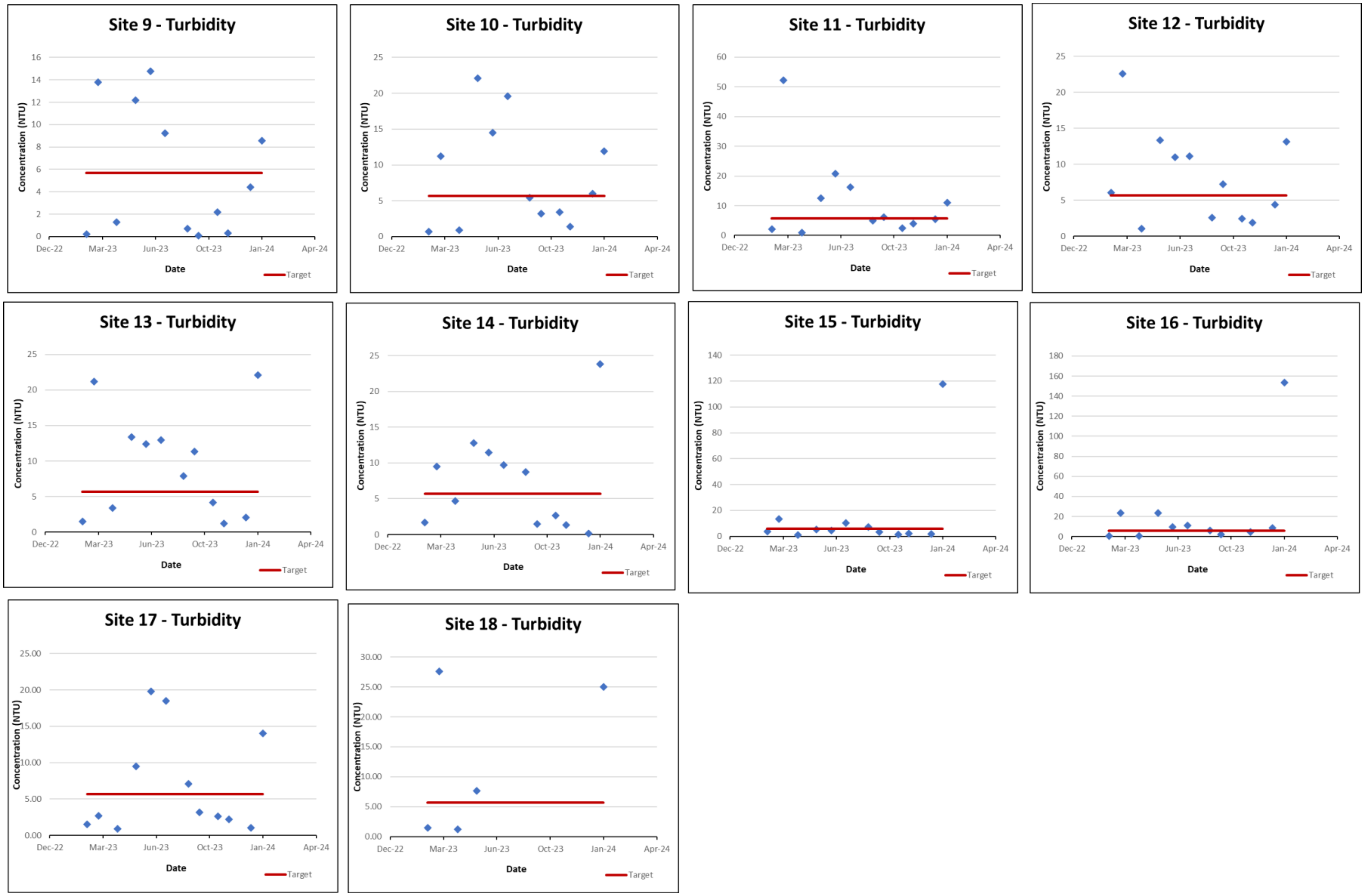


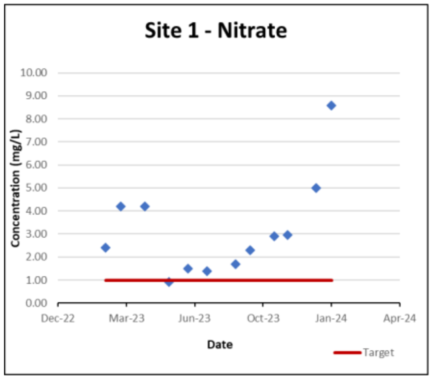
Figure 35. Turbidity measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

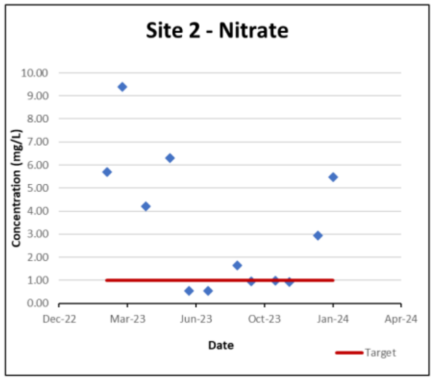
3.3.3 Water Chemistry Results

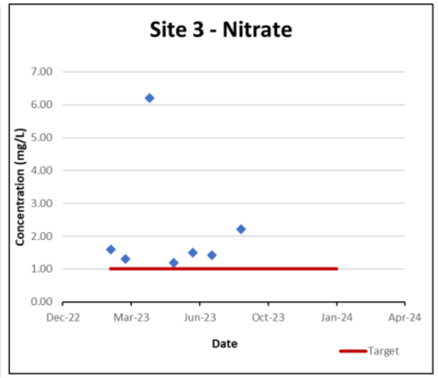
Figure 36 to Figure 39 displays results for nitrate-nitrogen, total phosphorus, total suspended solids, and *E. coli* collected monthly from 18 locations in the Lower Elkhart River Watershed. Data are displayed in comparison to target concentration and on load duration curves during the sample period. Appendix B details individual measurements collected throughout the sampling period.

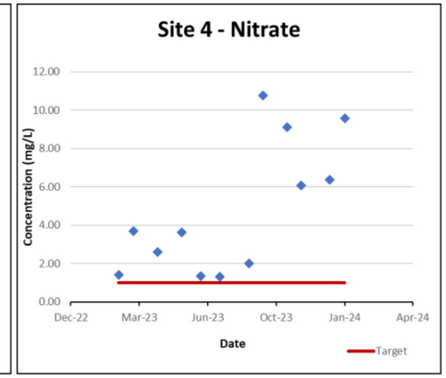
Nitrate-Nitrogen

Figure 36 displays nitrate-nitrogen concentrations compared to target levels (1 mg/L). As shown below, nitrate-nitrogen concentrations exceeded targets levels in a majority (92% or 186 of 203) of samples collected. Exceedances occurred every month with concentrations generally lowest during spring and summer and increasing through the fall and winter. Site 3 (Waubee Lake Outlet), Site 4 (Turkey Creek at CR 1250 N) , Site 5 (Coppes Ditch), Site 7 (Berlin Court Grand Ditch at US 6), Site 8 (Turkey Creek at Old SR 15), Site 12 (Rock Run Creek at CR 34), Site 13 (Rock Run Creek at Indiana Ave), Site 14 (Elkhart River at Elkhart Street) and Site 15 (Berlin Court Grand Ditch at CR 7) exceeded concentration targets in all 100% of samples collected during the sampling period. Site 1 (Turkey Creek at Turkey Creek Road), Site 6 (Turkey Creek at CR 1250 N), Site 9 (Turkey Creek at CR 146) and Site 16 (Horn Ditch) exceeded target concentrations in eleven of the 12 sampling events. Every site had an average nitrate-nitrogen concentration level greater than the target of 1 mg/L. Site 15 possessed the greatest nitrate-nitrogen concentration measuring 53.29 mg/L in January 2024 and possessed an average concentration of 22.61 mg/L.


Site 1 - Nitrate
Concentration (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 2 - Nitrate
Concentration (mg/L)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 3 - Nitrate
Concentration (mg/L)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 4 - Nitrate
Concentration (mg/L)
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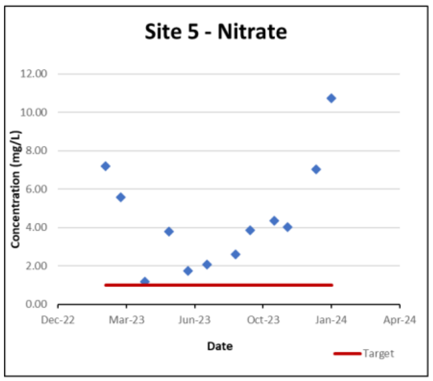
10.00
8.00
6.00
4.00
2.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 5 - Nitrate
Concentration (mg/L)
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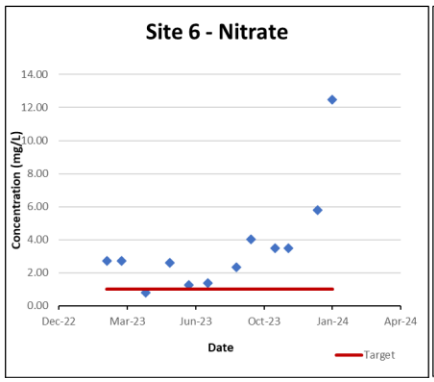
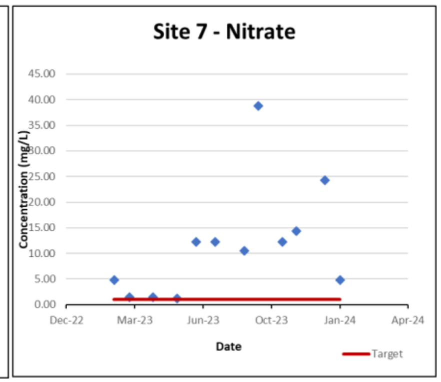
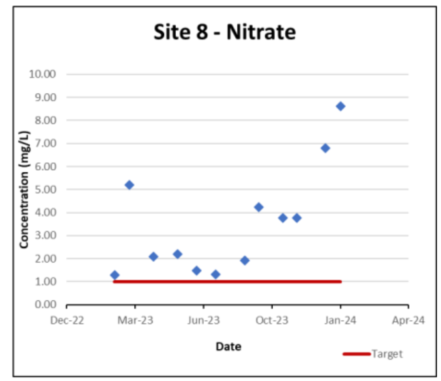
10.00
8.00
6.00
4.00
2.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 6 - Nitrate
Concentration (mg/L)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 7 - Nitrate
Concentration (mg/L)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target


Site 8 - Nitrate
Concentration (mg/L)
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9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Dec-22
Mar-23
Jun-23
Oct-23
Jan-24
Apr-24
Date
Target

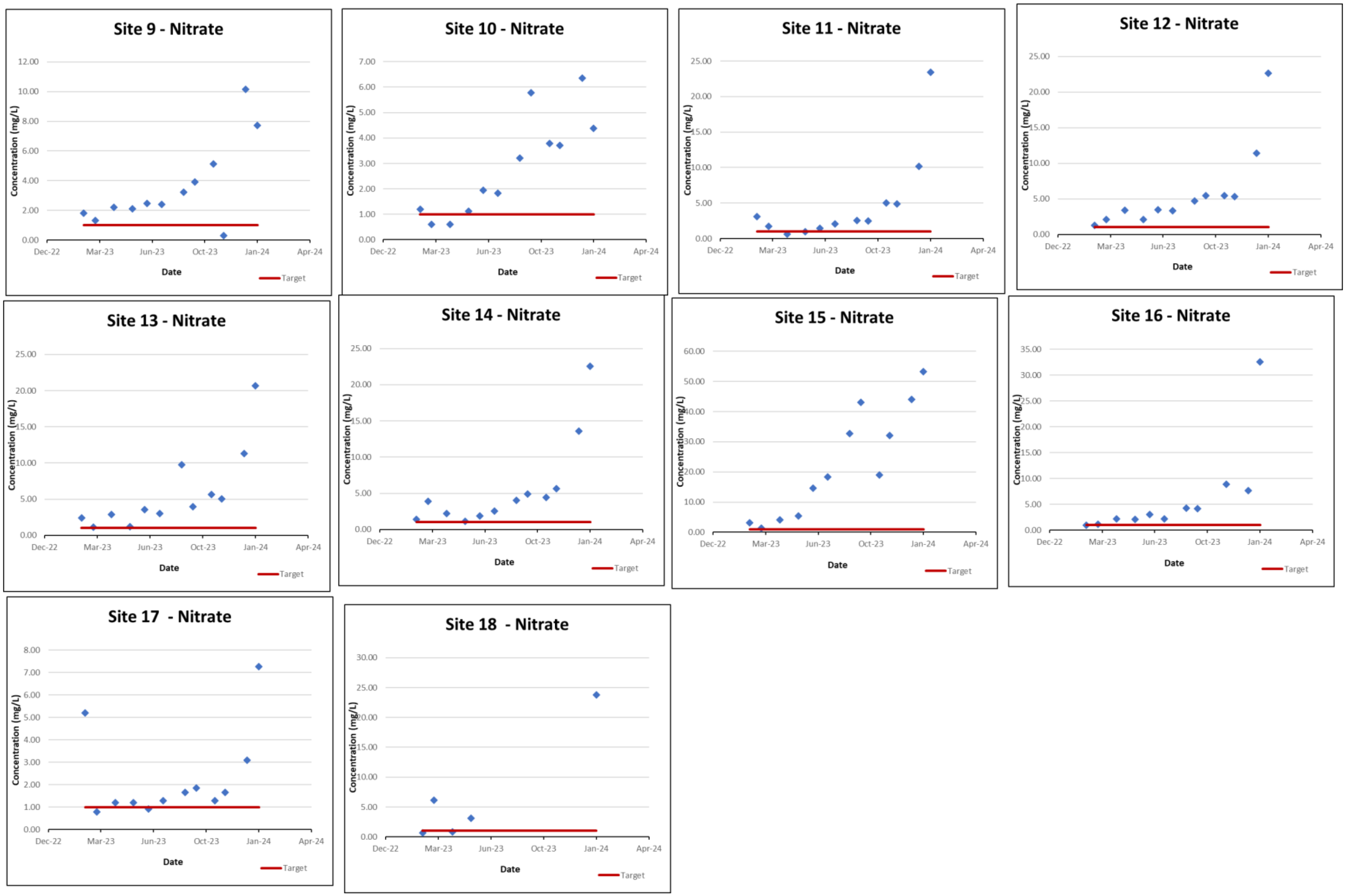
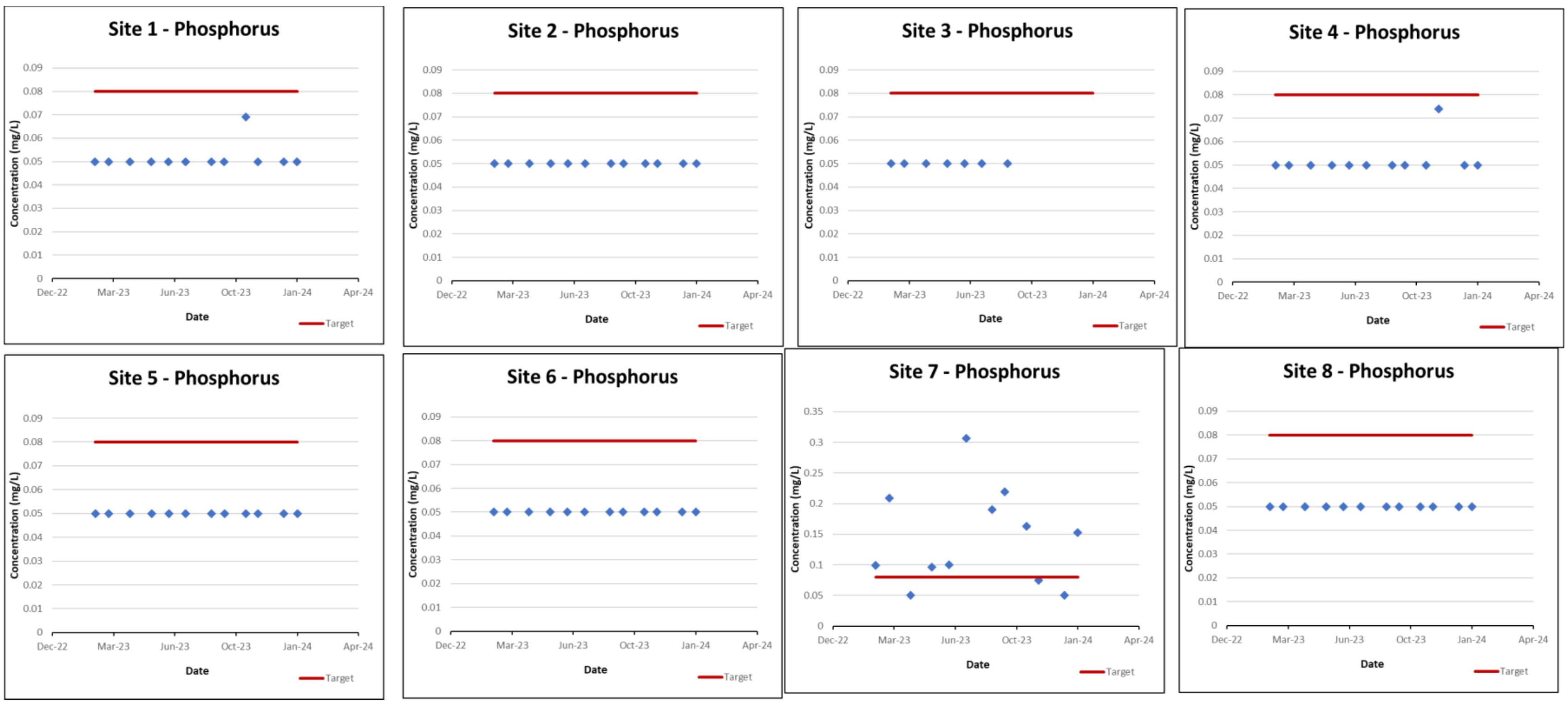


Figure 36. Nitrate-nitrogen measurements in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

Total Phosphorus

Total phosphorus concentrations exceed target concentrations in roughly 16% of samples collected (34 of 215; Figure 37). Site 7 (Berlin Court Grand Ditch at US 6), Site 11 (Yellow Creek), Site 14 (Elkhart River at Elkhart Street), Site 15 (Berlin Court Ditch at CR 7) and Site 16 (Horn Ditch) possess average total phosphorus concentrations in excess of the level at which biological impairments occur (0.08 mg/L). Site 7 and Site 15 TP concentrations measured above water quality targets in more than 50% of samples collected with Site 15 possessing the highest average total phosphorus concentration. Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 3 (Waubee Lake Outlet), Site 4 (Turkey Creek), Site 5 (Coppes Ditch), Site 6 (Turkey Creek), Site 8 (Turkey Creek at Old SR 15) and Site 17 (Howard Ditch) consistently measured below total phosphorus target levels.



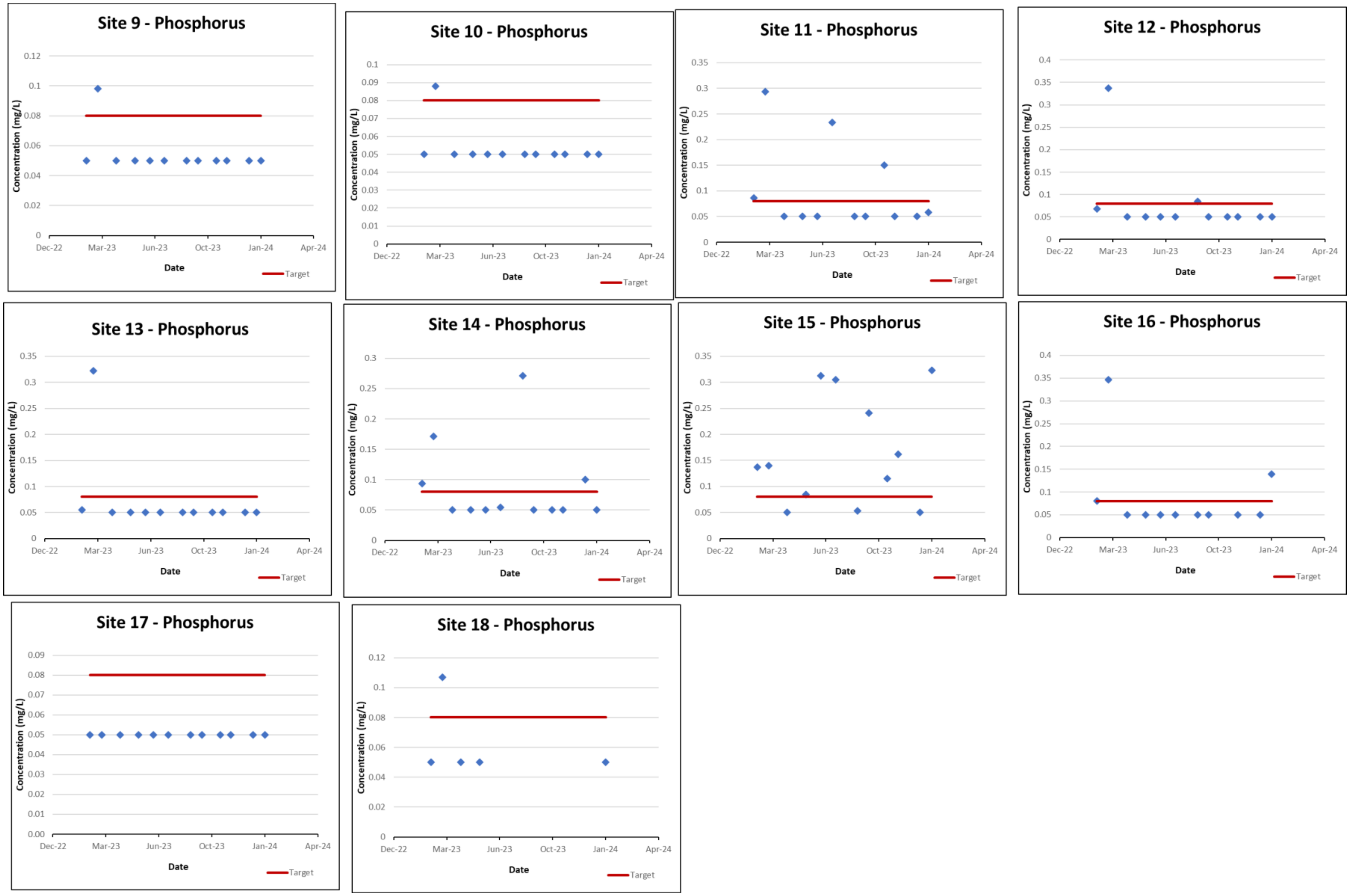
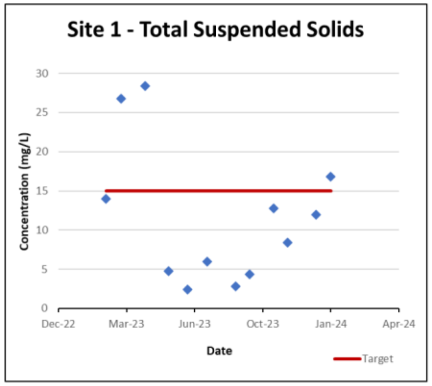
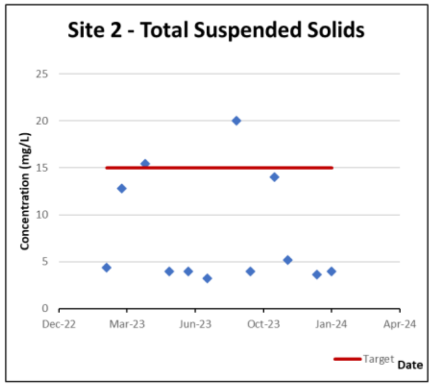


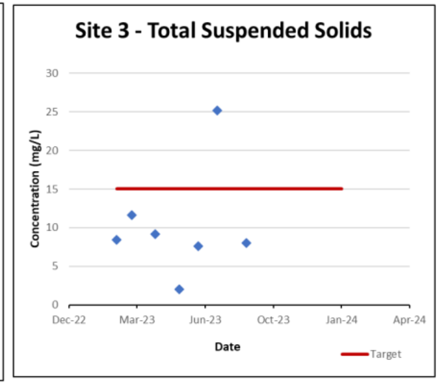
Figure 37. Total phosphorus concentrations measured in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

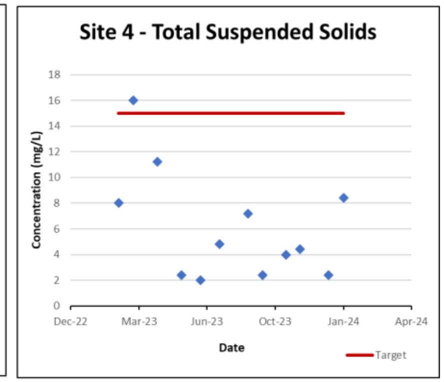
Total Suspended Solids

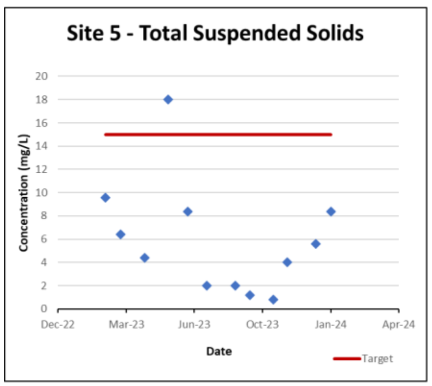
Total suspended solids (TSS) levels measured above target levels (15 mg/L) in 33 of 215 (15%) samples collected. Only Site 8 (Turkey Creek at Old SR 15) had TSS levels that consistently measured below target levels. This resulted in the lowest average TSS concentration of all sites. All other sites exceeded TSS target levels at least once. Site 15 (Berlin Court Ditch at CR 7) possessed the highest TSS measurement with 114.4 mg/L during the January 2024 sampling event. Site 15, Site 16 (Horn Ditch) and Site 18 (Sailor Ditch) exceeded TSS water quality targets in a majority of samples collected and possessed an average TSS level that measures above the target level of 15 mg/L.

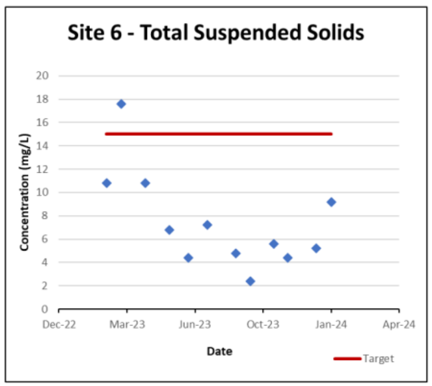


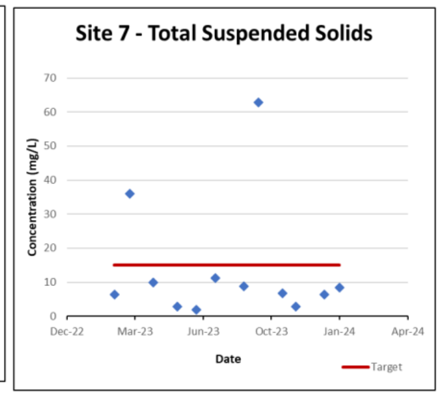


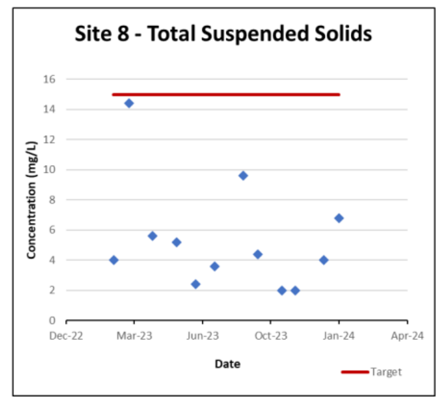












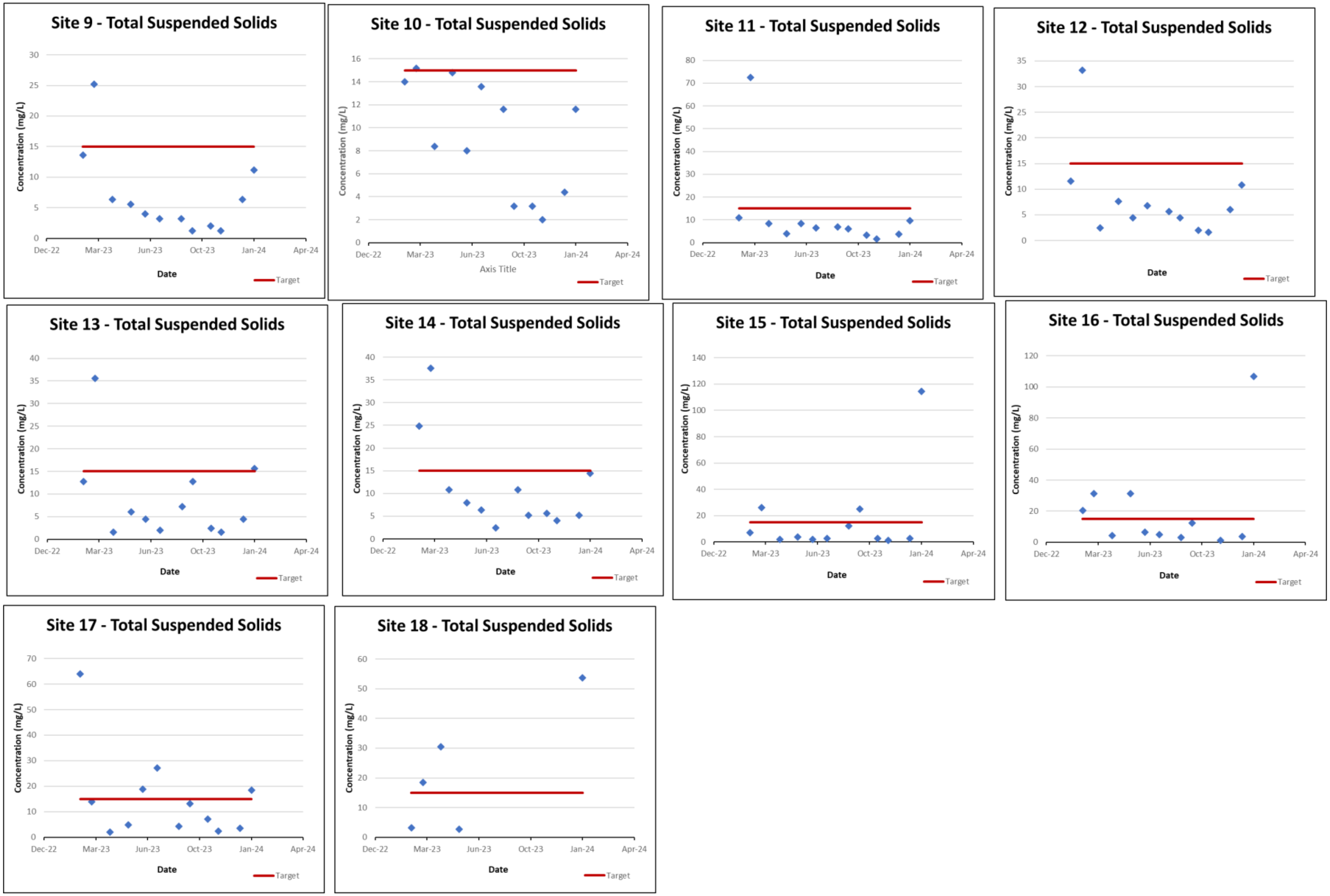
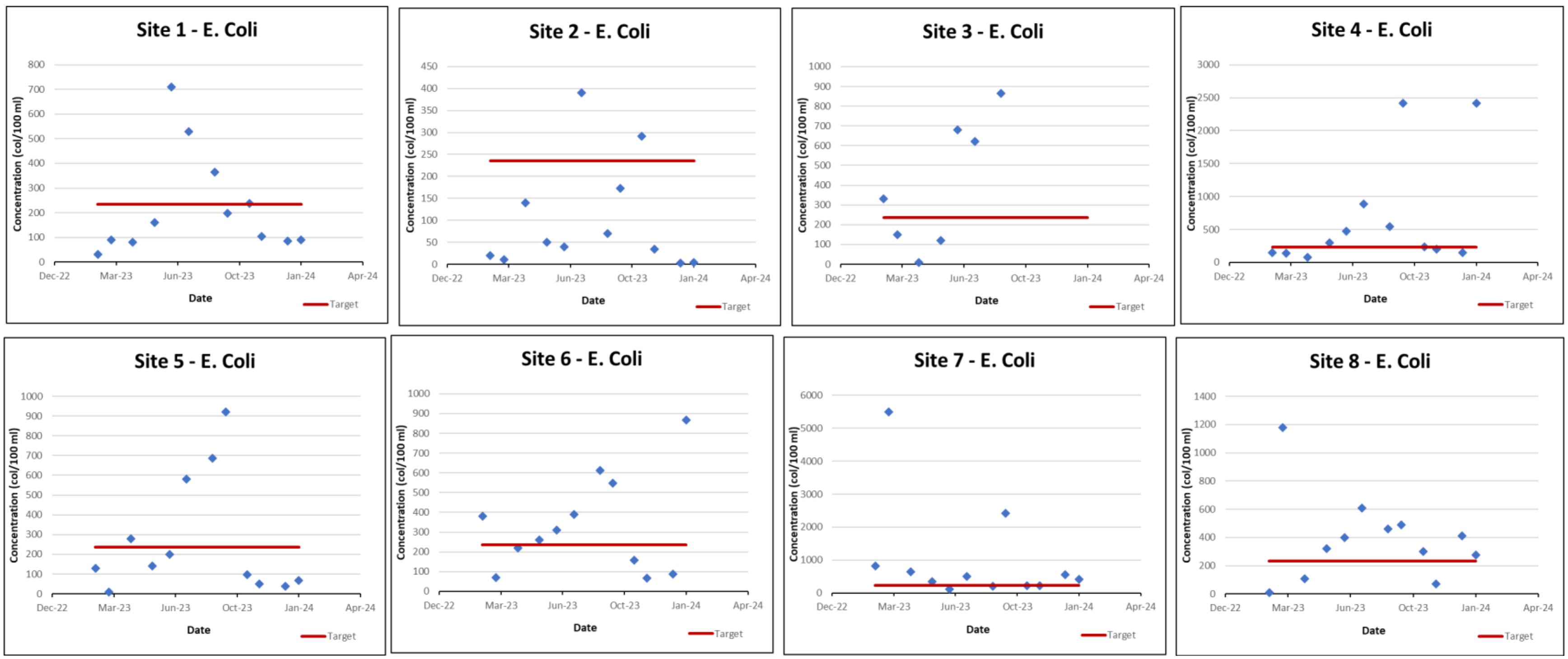


Figure 38. Total suspended solids concentrations measured in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

E. coli

E. coli concentrations observed at Lower Elkhart River Watershed sample sites are shown in Figure 39. *E. coli* concentrations exceed state standards (235 col/100 mL) in 51% (109 of 215) of collected samples. Exceedances occurred at all sites at least once. Site 18 (Sailor Ditch) possessed the highest concentration measured during the May 2023 sampling event with a level of 9610 col/100 mL. Site 3 (Waubee Lake Outlet), Site 4 (Turkey Creek at CR 1250 N), Site 6 (Turkey Creek at CR 1250 N), Site 7 (Berlin Court Grand Ditch at US 6), Site 8 (Turkey Creek at Old SR 15), Site 9 (Turkey Creek at CR 146), Site 11 (Yellow Creek), Site 12 (Rock Run Creek at CR 34), Site 13 (Rock Run Creek at Indiana Ave), Site 15 (Berlin Court Ditch at CR 7), Site 16 (Horn Ditch) and Site 18 (Sailor Ditch at CR 17) exceeded state standards in more than 50% of samples collected. Only Site 1 (Turkey Creek at Turkey Creek Road) and Site 2 (Turkey Creek Hickory Street) possessed an average *E. coli* concentration which measured below the state standard.



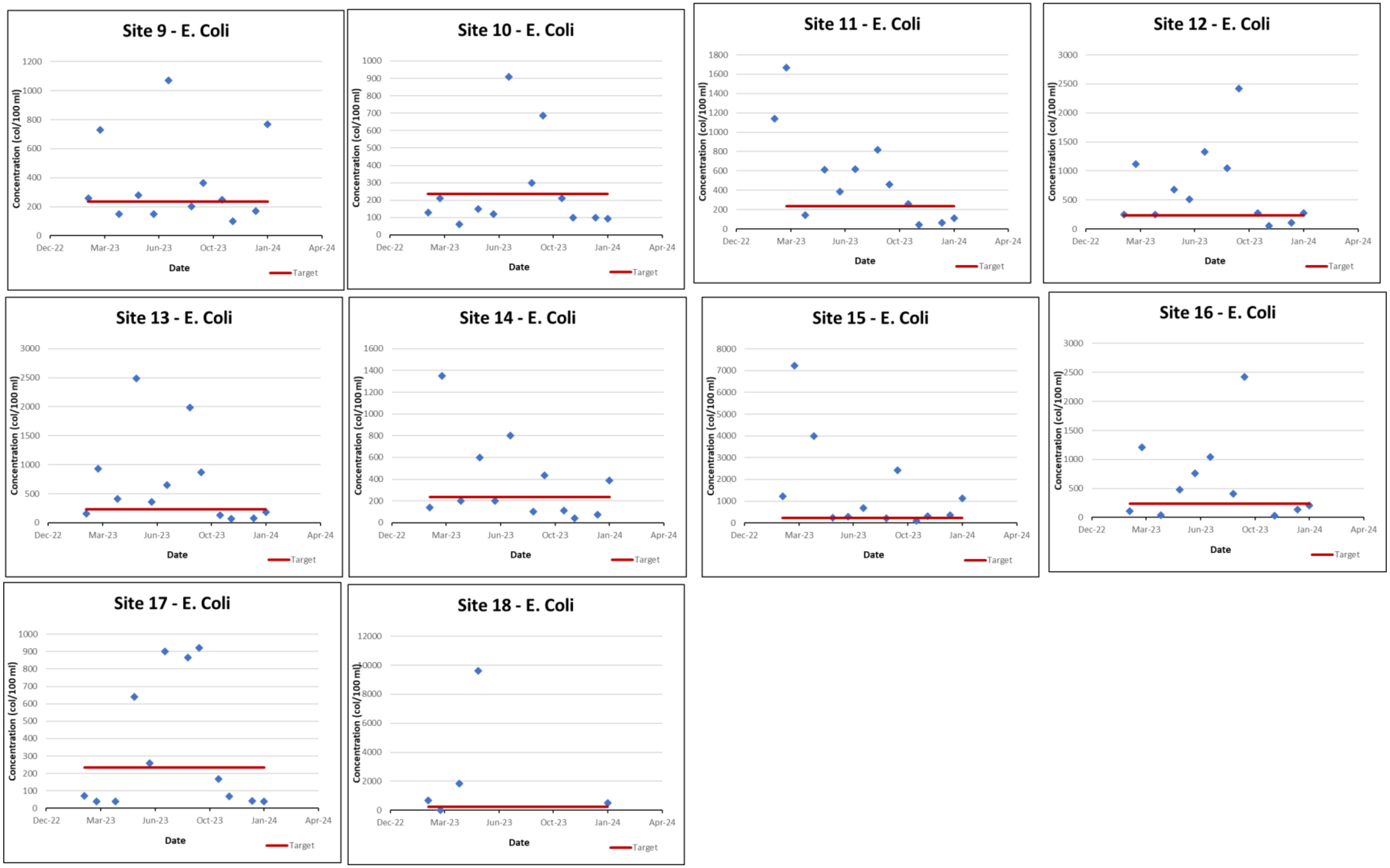


Figure 39. *E. coli* concentrations measured in Lower Elkhart River Watershed sample sites from February 2023-January 2024. Note differences in scale along the concentration (y) axis.

3.3.4 Load Duration Curves

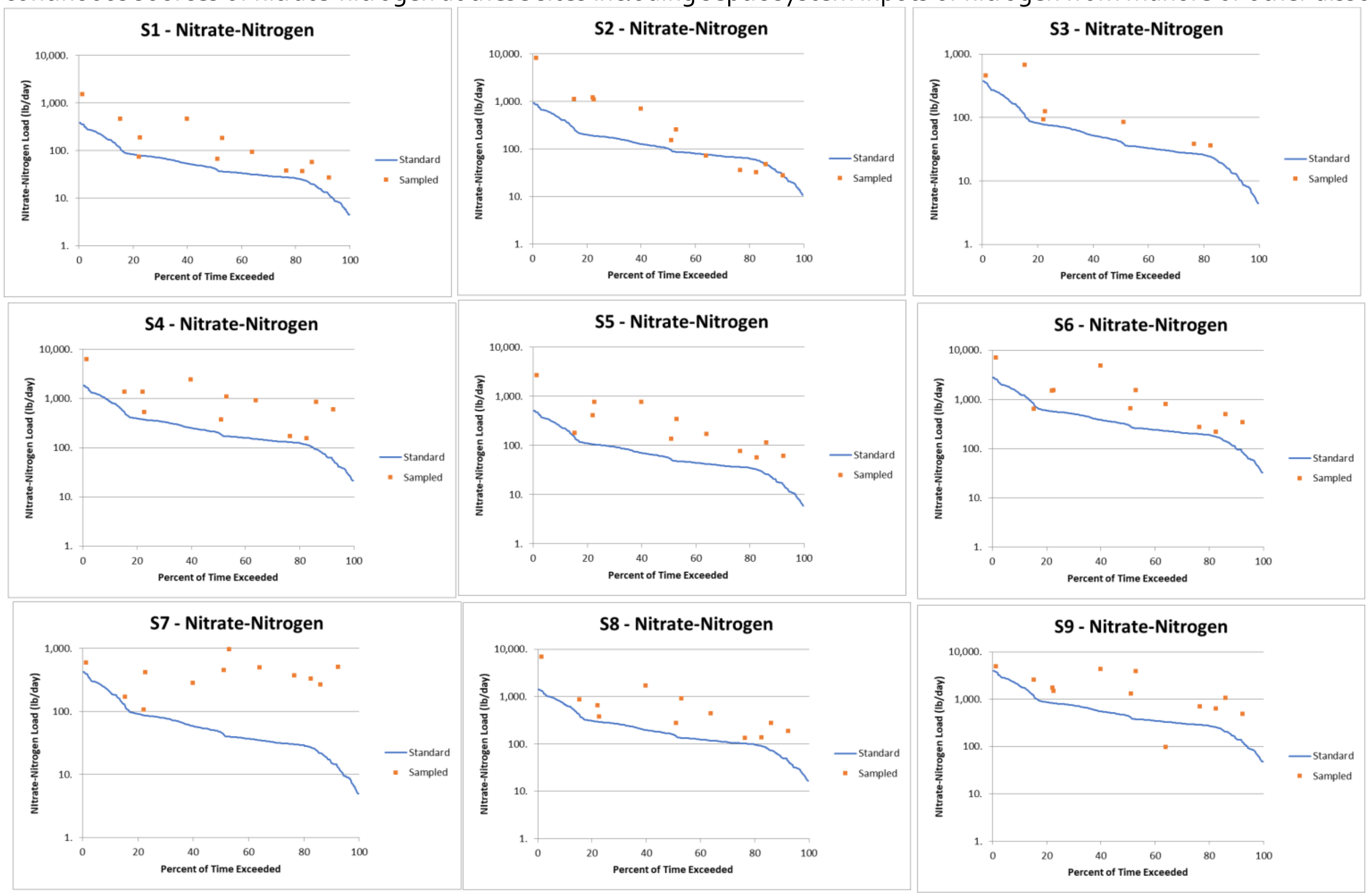
Load duration curves allow for comparison of instream loading with stream flow so that conditions of concern can be identified. The load duration curves present the flow characteristics for 18 sample sites during the time of study from February 2023 to January 2024. Data used for the curves were calculated by scaling flow measured at Elkhart River at Goshen, Indiana. Stream flow measured at the U.S. Geological Survey gauge was scaled to watershed size for each of the 18 monitoring stations as follow:

observed flow (cfs)) x (conversion factor) x (target concentration or state criteria) = total load /day

The individual load duration curves, also known as the allowable load curves, are displayed below (Figure 40 to Figure 43). In the graphs, the total daily load of each contaminant sample result (points) is plotted against the "percent time exceeded" for the day of sampling (curve). The time exceeded refers to instream flow conditions. Those points above the curve exceed the state criterion or target concentration. Values on a load duration curve can be grouped by hydrologic condition to help identify possible sources and conditions that result in the material being present in the system under those flow conditions. Most often, the flow ranges fall in High (0 to 10), Moist (10-40), Mid-Range (40-60), Dry (60-90), and Low (90-100). Exceedances falling in the moist range (10-40) are typically associated with surface runoff or stormwater loads, while exceedances associated with the dry zone are most often associated with dry conditions. These exceedances are suggested to result from point sources that are the most likely source.

Nitrate-nitrogen Load Duration Curves

Nitrate-nitrogen loads generally measure higher than target loads at most sites under all flow conditions (Figure 40), indicating a steady stream of nitrate-nitrogen is available during low and high flow conditions. Nitrate-nitrogen loads measured below target levels mostly during moist or dry conditions. Site 3 (Waubee Lake Outlet), Site 4 (Turkey Creek at CR 1250 N), Site 5 (Coppes Ditch), Site 7 (Berlin Court Grand Ditch at US 6), Site 8 (Turkey Creek at Old State Road 15), Site 12 (Rock Run Creek at CR 34), Site 13 (Rock Run Ceek at CR 21), Site 14 (Elkhart River at Elkhart Street) and Site 15 (Berlin Court Ditch at CR 7) measured above target levels 100% of the time. This indicates there are sources of nitrate-nitrogen to these streams during both high flow, high runoff conditions and during low flow, low runoff conditions. This could mean that there are continuous sources of nitrate-nitrogen at these sites including septic system inputs or nitrogen from manure or other dissolved sources.



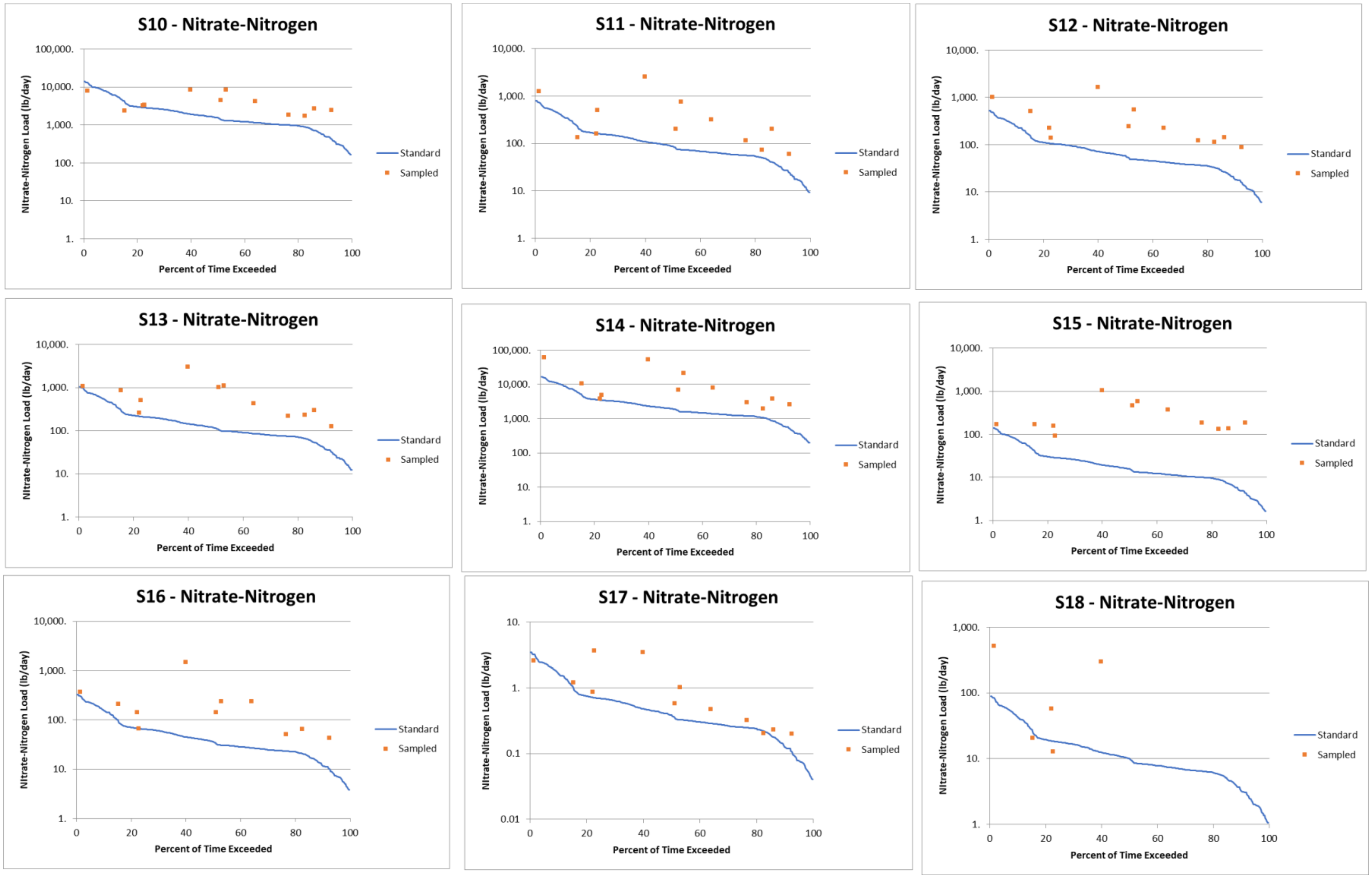
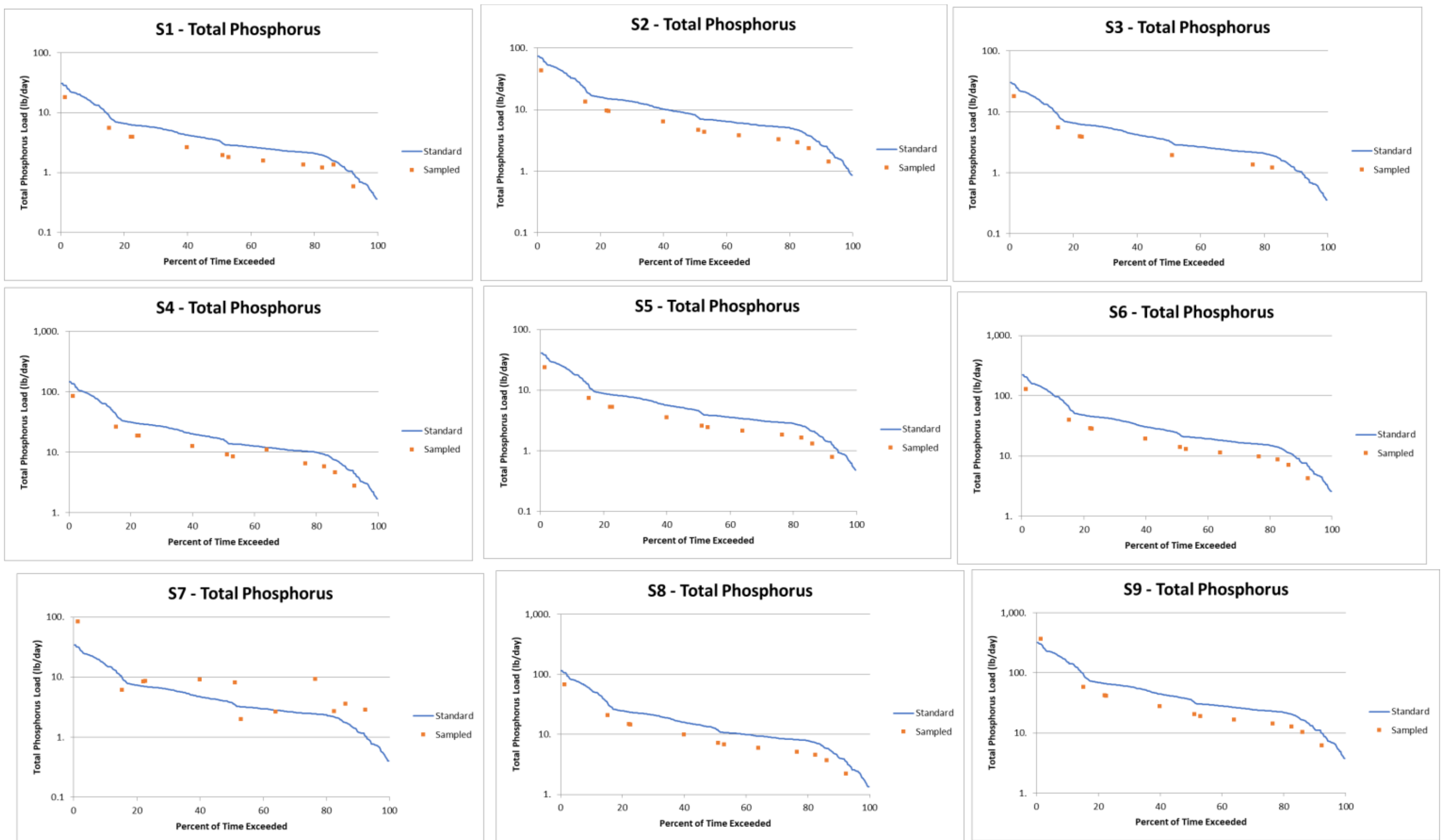


Figure 40. Nitrate-nitrogen load duration curves for Lower Elkhart River Watershed sample sites from February 2023-January 2024.

Total Phosphorus Load Duration Curves

Total phosphorus (TP) levels generally measured below target loads under moist to low flow conditions (Figure 41). TP load levels generally measured near or above target load levels under high and dry conditions, suggesting a steady stream of TP is present in much of the Lower Elkhart River Watershed under high and low flow conditions. Site 7 (Berlin Court Grand Ditch) and Site 15 (Berlin Court Ditch) had several exceedances under most flow conditions.



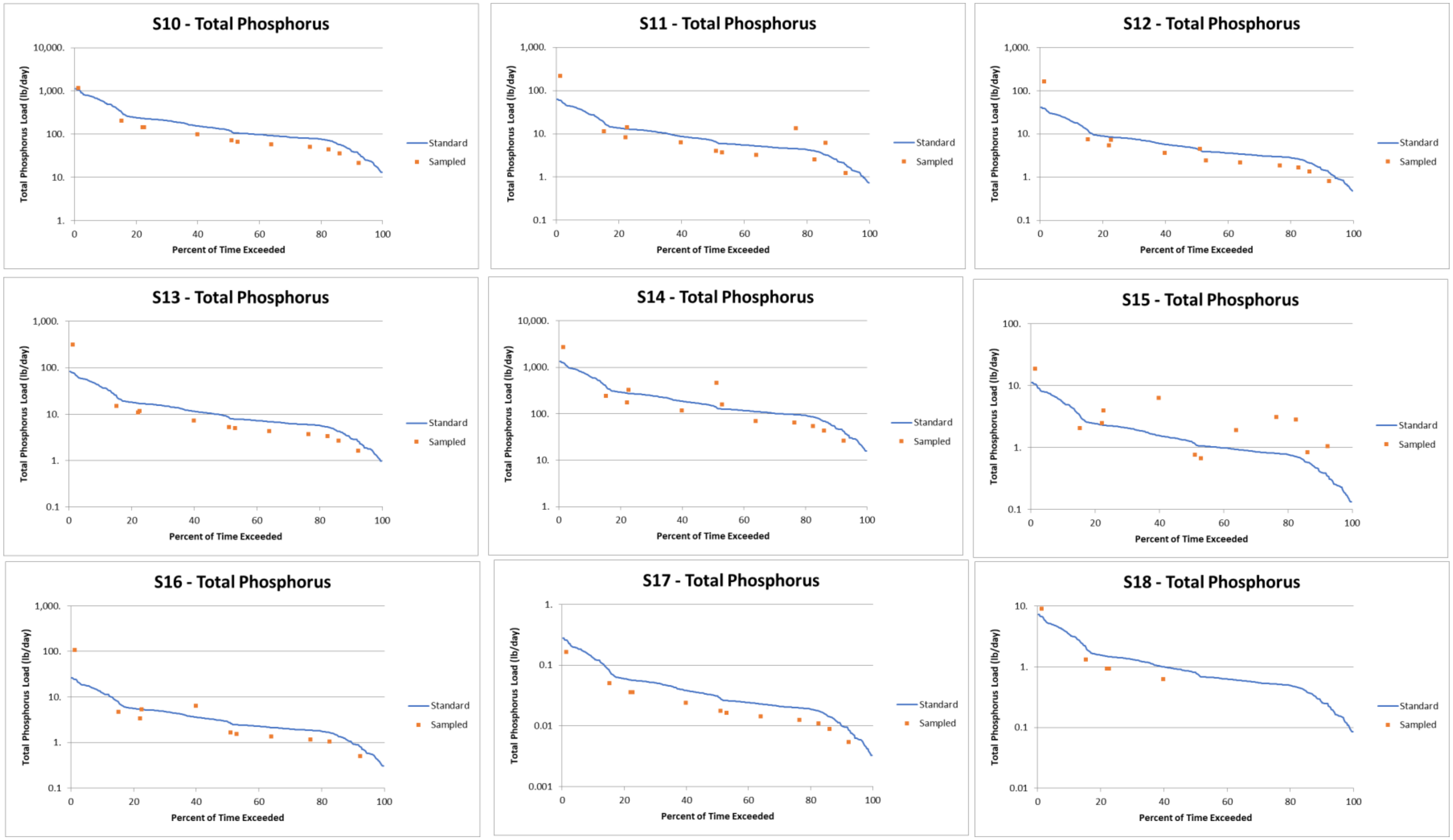
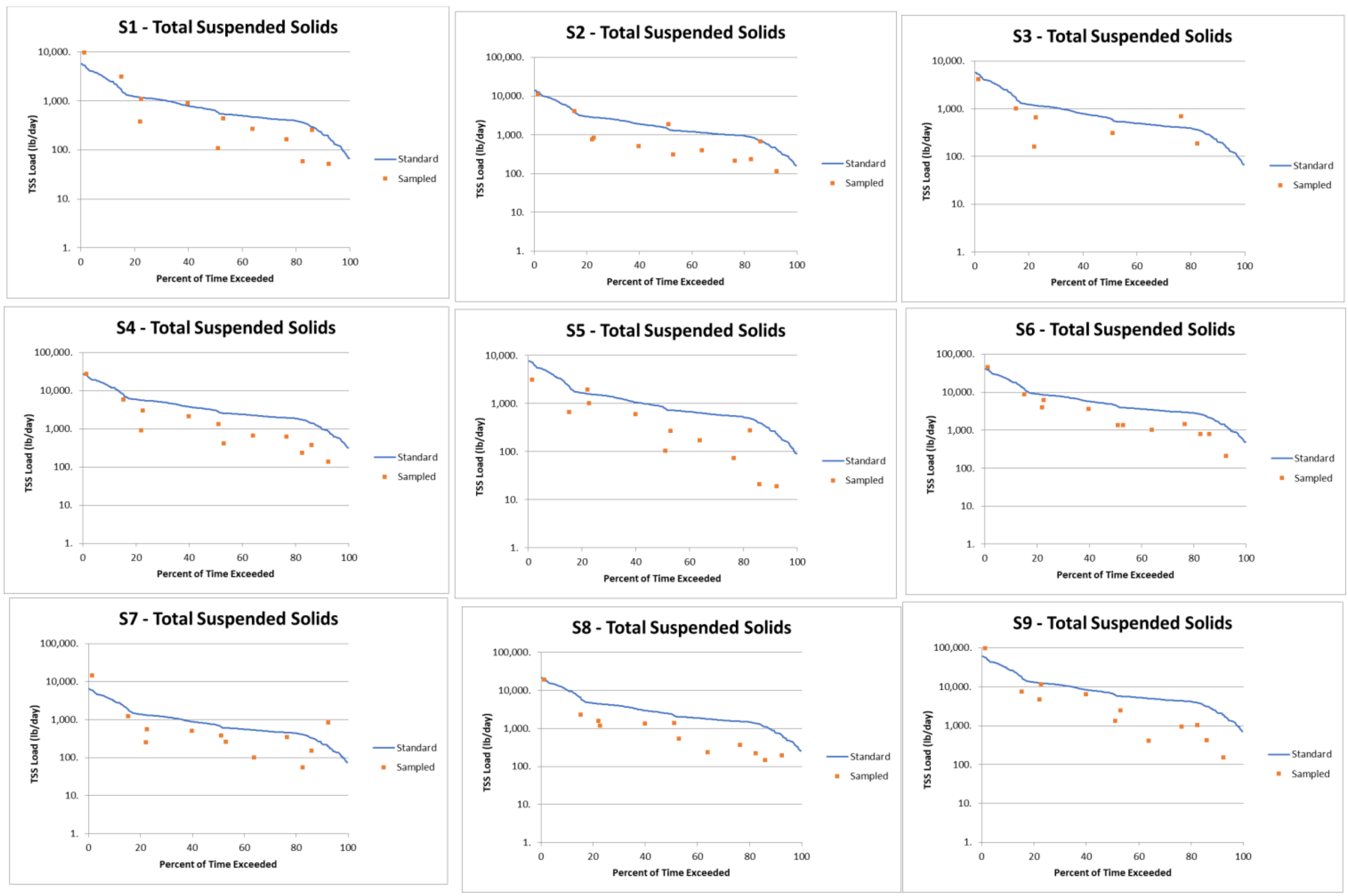


Figure 41. Total phosphorus load duration curves for Lower Elkhart River Watershed sample sites from February 2023-January 2024.

Total Suspended Solids Load Duration Curves

Similar to total phosphorus load levels, total suspended solids (TSS) levels generally measured below target loads under moist to low flow conditions (Figure 42). TSS levels measured near or above target load levels under high conditions at all sites except Site 5 (Coppes Ditch). Additionally, Site 2 (Turkey Creek at Hickory Street), Site 3 (Waubee Lake Outlet), Site 7 (Berlin Court Grand Ditch), Site 10 (Elkhart River at CR 40), Site 15 (Berlin Court Ditch) and Site 17 (Howard Ditch) had TSS load exceedance levels during dry flow conditions. Possible sources of total suspended solids include livestock access or streambank and bed erosion, both of which can provide a continuous source of total suspended solids.



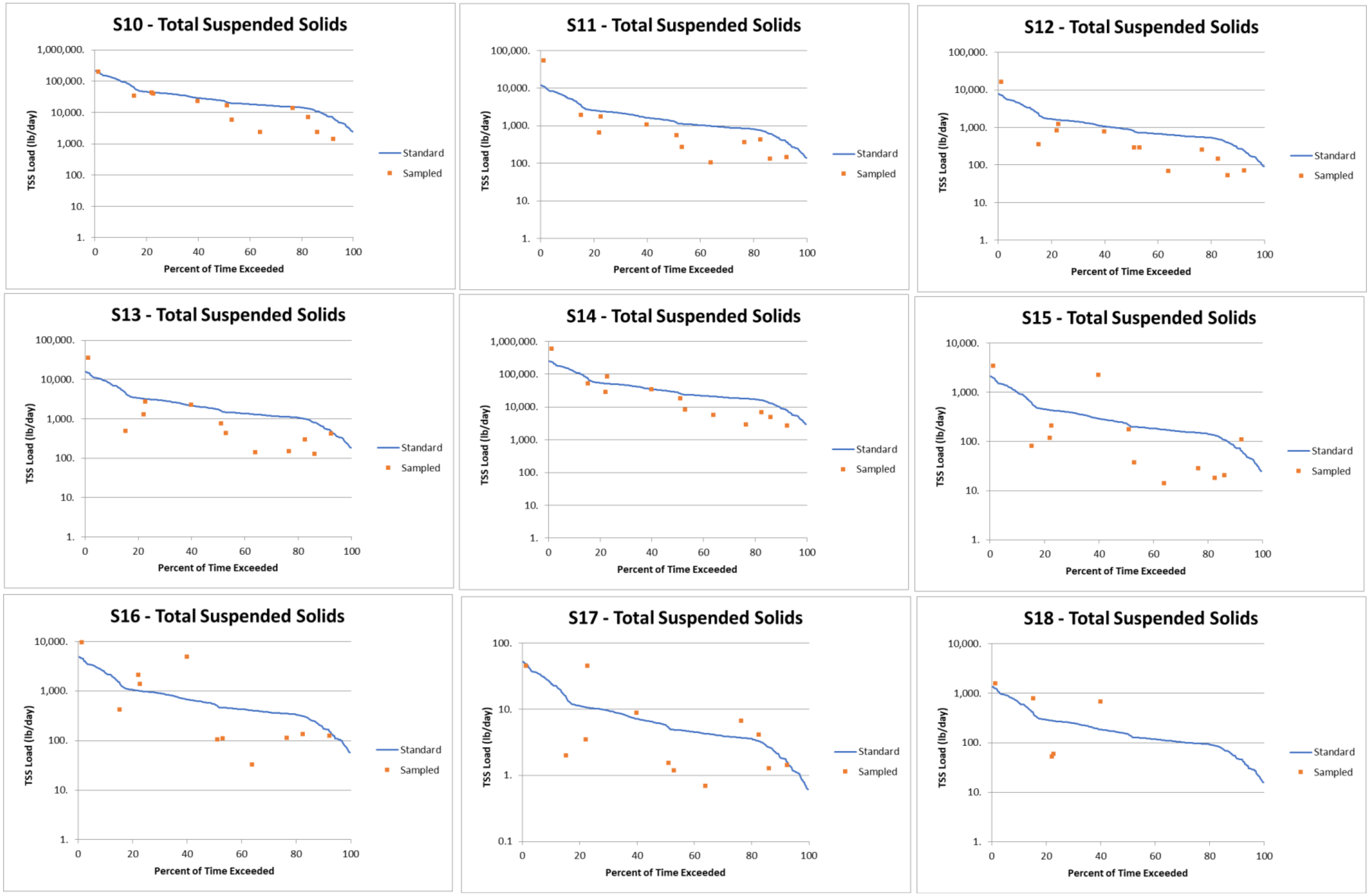
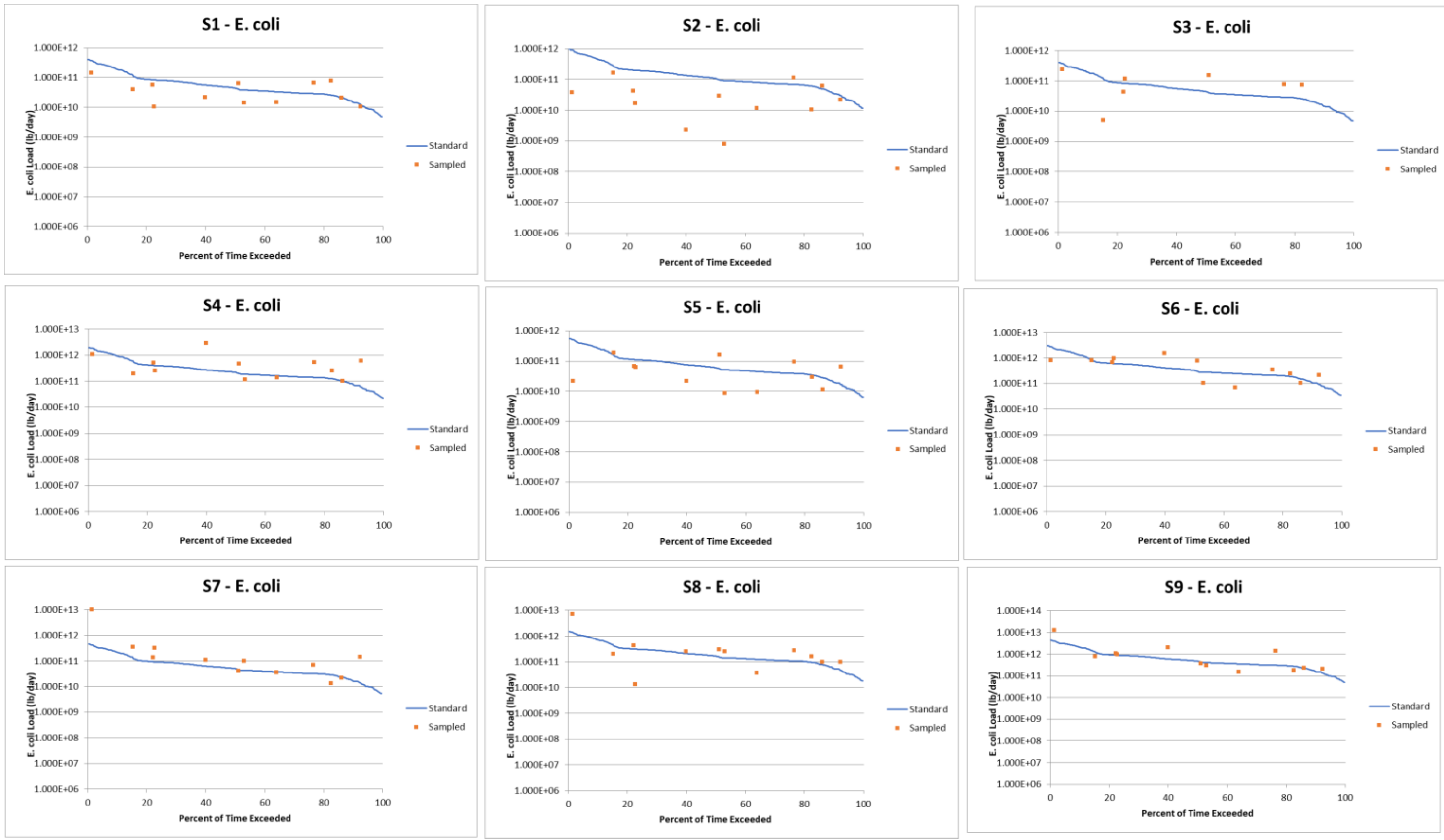


Figure 42. Total suspended solids load duration curves for Lower Elkhart River Watershed sample sites from February 2023-January 2024.

E. coli Load Duration Curves

E. coli load duration curves indicate that *E. coli* levels exceed targets during most flow conditions (Figure 43). Multiple exceedances occurred at all sites between high and low flow conditions. These data suggest a relatively continuous source of *E. coli* within these streams during all flow conditions.



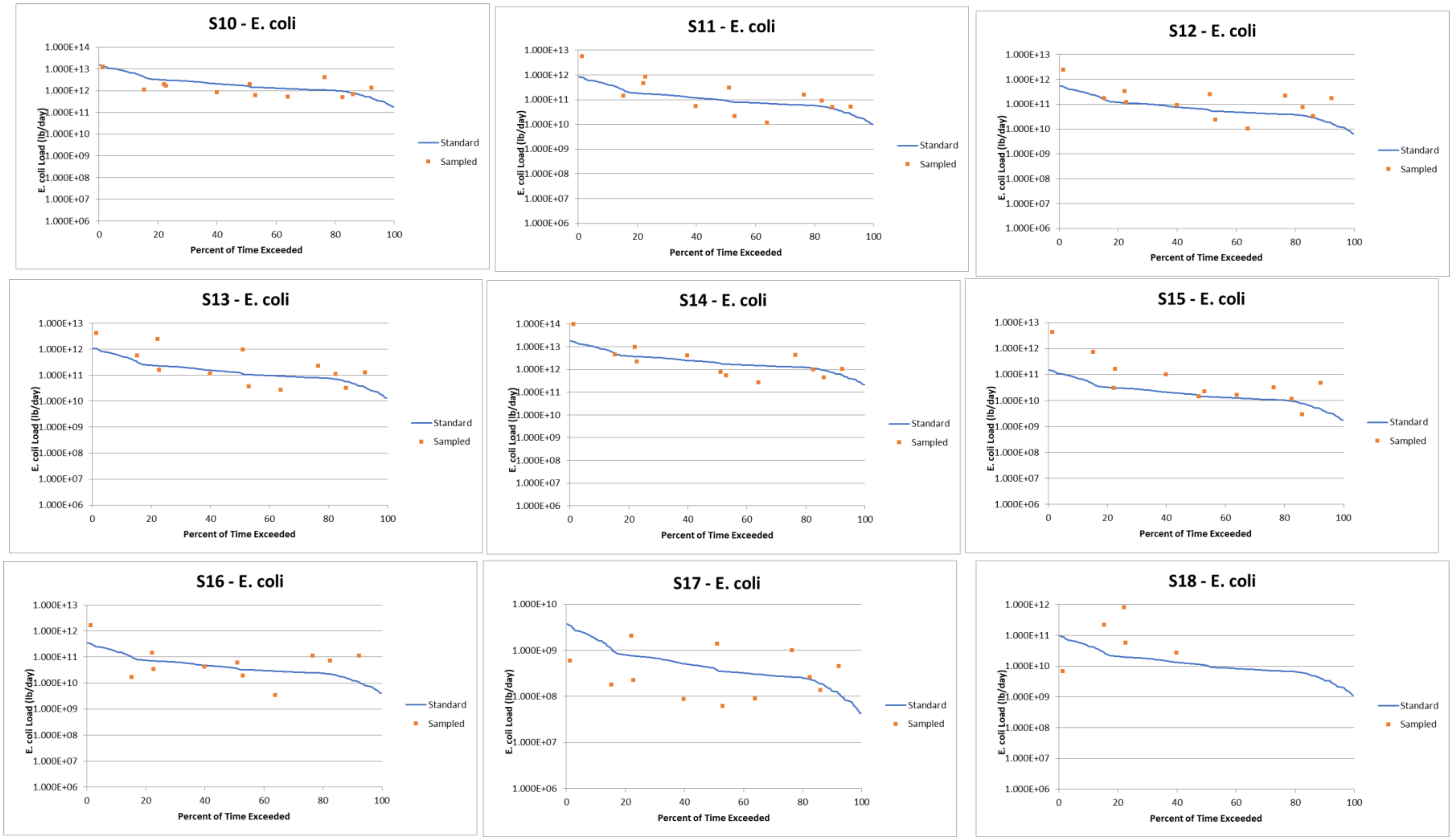


Figure 43. *E. coli* solids load duration curves for Lower Elkhart River Watershed sample sites from February 2023-January 2024.

3.3.5 Macroinvertebrate Community Assessment

Site 8 (Turkey Creek at Old State Road 15, Site 14 (Elkhart River at Elkhart Street) and Site 17 (Howard Ditch) supported the most diverse communities with 26, 23 and 23 taxa observed, respectively (Table 20). Figure 44). Site 8 (Turkey Creek at State Road 15) possessed the greatest mIBI score with a score of 47. Site 14 (Elkhart River at Elkhart Street) contained the highest number of sensitive EPT taxa observed with 12 individuals collected. Site 7 (Berlin Court Grand Ditch at US 6) and Site 10 (Elkhart River at Country Road 40) supported the least diverse communities with eight taxa observed at both sites. It is important to note that Site 7 (Berlin Court Grand Ditch) possessed the greatest percentage (80%) of individuals from the Chironomid family - one that typically represents low quality streams - or mobile species, such as isopods, amphipods, beetles, damselflies and dragonflies. Additionally, this site possessed the highest percent tolerant species (97%) while having no intolerant species or EPT taxa observed. Site 10 (Elkhart River at County Road 40) also represented the lowest mIBI score with a score of 24. In general, there was a low percentage of intolerant species at all sites in the Lower Elkhart River Watershed. Site 14 (Elkhart River at Elkhart Street) and Site 6 (Turkey Creek at County Road 1250 N) possessed the greatest percentage of intolerant taxa with 13% and 12% observed species classified as intolerant, respectively. The remaining 15 sites contained five percent or less intolerant species identified, with seven sites having no observed intolerant species. As noted above, Sailor Ditch (Site 18) is an intermittent stream which was observed as dry from June through December 2023. Biological data were not collected at this site. Macroinvertebrate data are detailed in Appendix B.

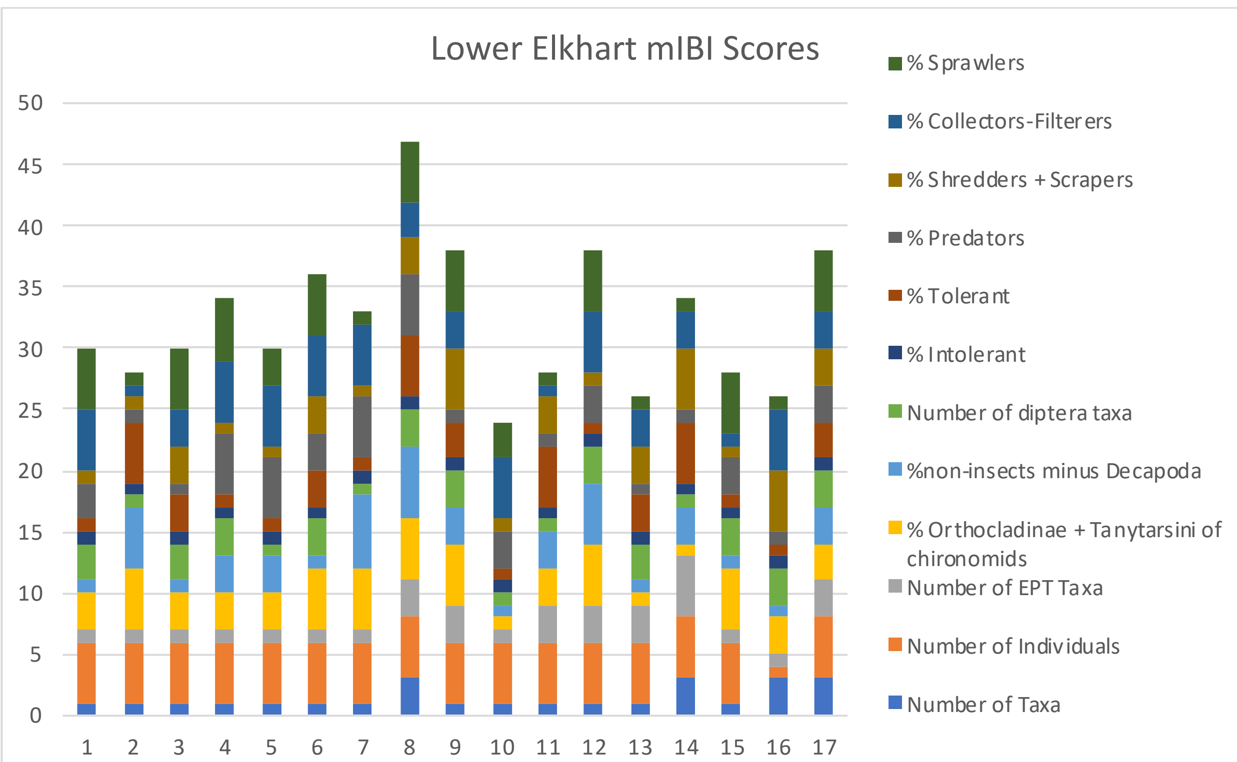


Figure 44. Cumulative metrics used to calculate mIBI scores for Lower Elkhart River Watershed streams in 2023.

As shown in Figure 45, Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 3 (Waubee Lake Outlet), Site 4 (Turkey Creek at 1250 CR North), Site 5 (Coppes Ditch at CR 1250 N), Site 7 (Berlin Court Grand Ditch), Site 10 (Elkhart River at CR 40), Site 11 (Yellow Creek), Site 13 (Rock Run Creek at Indiana Ave/CR 21), Site 14 (Elkhart River at Elkhart Street), Site 15 (Berlin Court Ditch) and Site 16 (Horn Ditch) possessed mIBI scores which rated as impaired. Site 6 (Turkey Creek at CR 1250 North), Site 8 (Turkey Creek at Old State Road 15), Site 9 (Turkey Creek at CR 146), Site 12 (Rock Run Creek at CR 34) and Site 17 (Howard Ditch) possessed mIBI scores which rated as not impaired. mIBI scores suggest Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 3 (Wabee Lake Outlet), Site 4 (Turkey Creek at CR 1250 North), Site 5 (Coppes Ditch), Site 7 (Berlin Court Grand Ditch), Site 10 (Elkhart River at CR 40), Site 11 (Yellow Creek), Site 13 (Rock Run Creek at Indiana Ave/CR 21), Site 14 (Elkhart River at Elkhart Street), Site 15 (Berlin Court Ditch) and Site 16 (Horn Ditch) and Site 17 (Howard Ditch) rated as poor. Site 6 (Turkey Creek at CR 1250 North), Site 9 (Turkey Creek at CR 146), Site 12 (Rock Run Creek at CR 34), Site 15 (Berlin Court Ditch) and Site 17 (Howard Ditch) rated as fair. Site 8 (Turkey Creek at Old SR 15) rated as good.

Table 20. Metric classification scores and mIBI score for the Lower Elkhart River Watershed sample sites as sampled in 2023.

Metrics Scoring	**L01**	**L02**	**L03**	**L04**	**L05**	**L06**	**L07**	**L08**	**L09**	**L10**	**L11**	**L12**	**L13**	**L14**	**L15**	**L16**	**L17**
Total Taxa Score	1	1	1	1	1	1	1	3	1	1	1	1	1	3	1	3	3
Total # Individuals Score	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1	5
#EPT Taxa Score	1	1	1	1	1	1	1	3	3	1	3	3	3	5	1	1	3
% Orthoclads &Tanytarsids Score	3	5	3	3	3	5	5	5	5	1	3	5	1	1	5	3	3
% Non-Insects Score	1	5	1	3	3	1	6	6	3	1	3	5	1	3	1	1	3
# Dipteran Taxa Score	3	1	3	3	1	3	1	3	3	1	1	3	3	1	3	3	3
% Intolerant Score	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
% Tolerant Score	1	5	3	1	1	3	1	5	3	1	5	1	3	5	1	1	3
%Predators Score	3	1	1	5	5	3	5	5	1	3	1	3	1	1	3	1	3
%Shredders & Scrapers Score	1	1	3	1	1	3	1	3	5	1	3	1	3	5	1	5	3
% Collector-Filterers Score	5	1	3	5	5	5	5	3	3	5	1	5	3	3	1	5	3
% Sprawlers Score	5	1	5	5	3	5	1	5	5	3	1	5	1	1	5	1	5
mIBI Score	**30**	**28**	**30**	**34**	**30**	**36**	**33**	**47**	**38**	**24**	**28**	**38**	**26**	**34**	**28**	**26**	**38**
Rating	P	P	P	P	P	F	P	G	F	P	P	F	P	P	P	P	F
P=Poor, F=Fair, G=Good																	

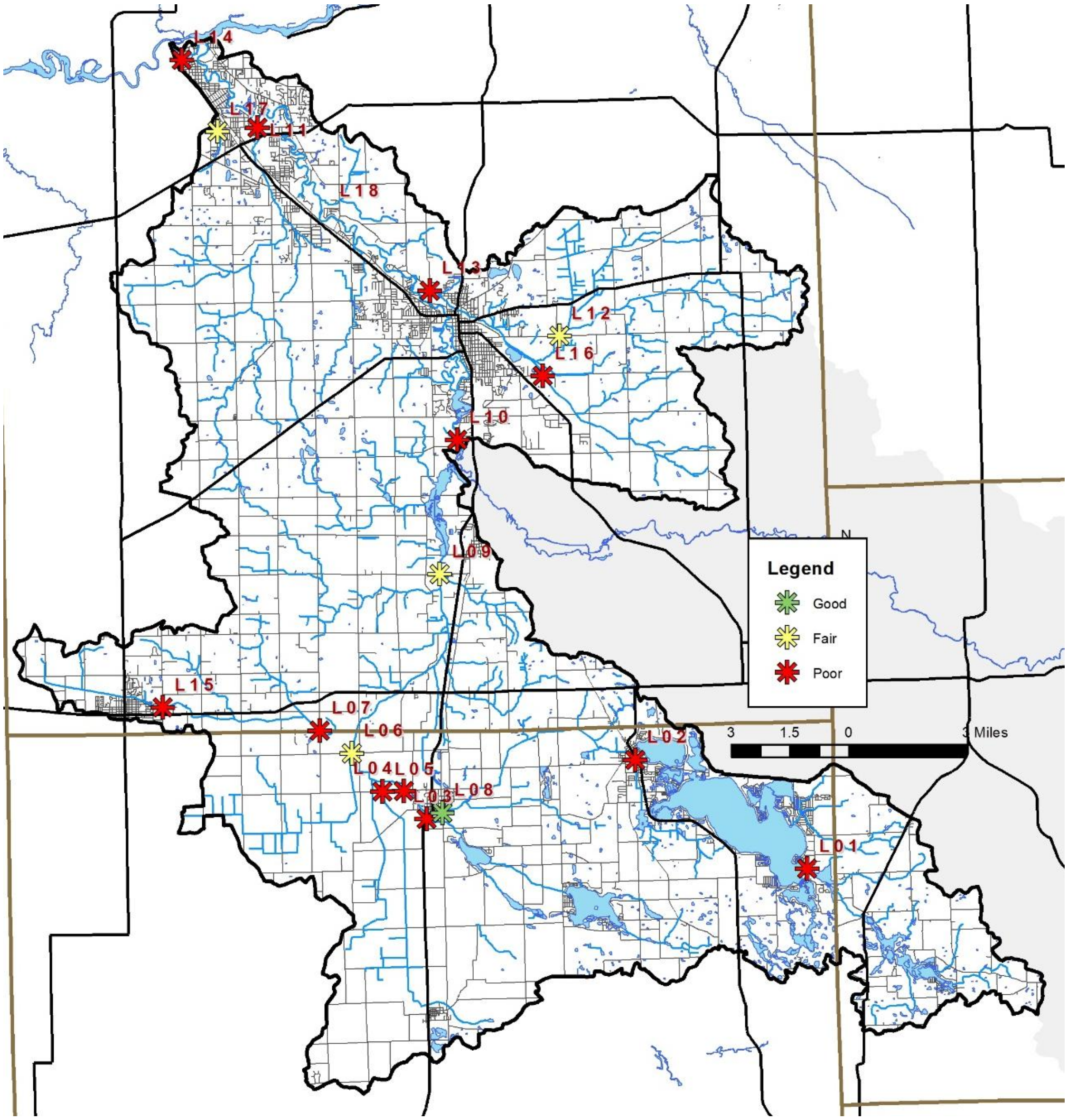


Figure 45. mIBI ratings for Lower Elkhart River Watershed stream sites.

3.3.6 Habitat Quality Assessment

Stream water quality and available habitat influence the quality of a biological community in a stream, and it is necessary to assess both factors when reviewing biological data. Table 21 presents the results of QHEI assessments at each of 17 stream sites sampled in the Lower Elkhart River Watershed during September 2023. Figure 47 details metric and total scores for all sites. More than half (76%) of sites sampled rated as poor or very poor. Berlin Court Grand Ditch (Site 7) and Howard Ditch (Site 17) had the lowest scores, rated as very poor and possessed poor substrate, poor instream cover, moderate erosion, limited riparian quality and lacked pool/riffle complexes. Yellow Creek (Site 11) and Elkhart River at Elkhart Street (Site 14) possessed the highest habitat scores, rating as good. Instream cover, pool/riffle development and channel morphology contributed to higher QHEI scores at these sites. As noted above, Sailor Ditch (Site 18) is an intermittent stream which was observed as dry from June through December 2023. Biological data were not collected at this site. Habitat data are detailed in Appendix B.

Table 21. Qualitative Habitat Evaluation Index (QHEI) scores measured in the Lower Elkhart River Watershed.

Site	Substrate	Cover	Channel	Riparian	Pool Quality	Riffle/Run Quality	Gradient	Total Score	Rating
1	0	8	7	6	9	0	2	32.0	Poor
2	14	5	10	5.5	3	0	2	39.5	Poor
3	6	5	9	6	1	0	2	29.0	Very Poor
4	9	7	6	4.5	4	0	3	33.5	Poor
5	0	9	8	2	10	0	3	32.0	Poor
6	10	10	6	2	7	0	3	38.0	Poor
7	3	3	6	2	4	0	2	20.0	Very Poor
8	9	6	9	4	3	0	3	34.0	Poor
9	5	11	11	6.5	6	0	3	42.5	Poor
10	10	9	12	6.25	8	0	2	47.3	Fair
11	9	15	14	5.5	9	2.5	3	58.0	Good
12	9	6	8	3	4	0	3	33.0	Poor
13	14	8	10	7.5	4	2	3	48.5	Fair
14	14	9	14	1.5	10	5.5	2	56.0	Good
15	9	8	8.5	3	5	0	3	36.5	Poor
16	9	6	4	2	5	0	3	29.0	Very Poor
17	5	7	4	3.5	3	0	3	25.5	Very Poor
18	Habitat not assessed; dry.								

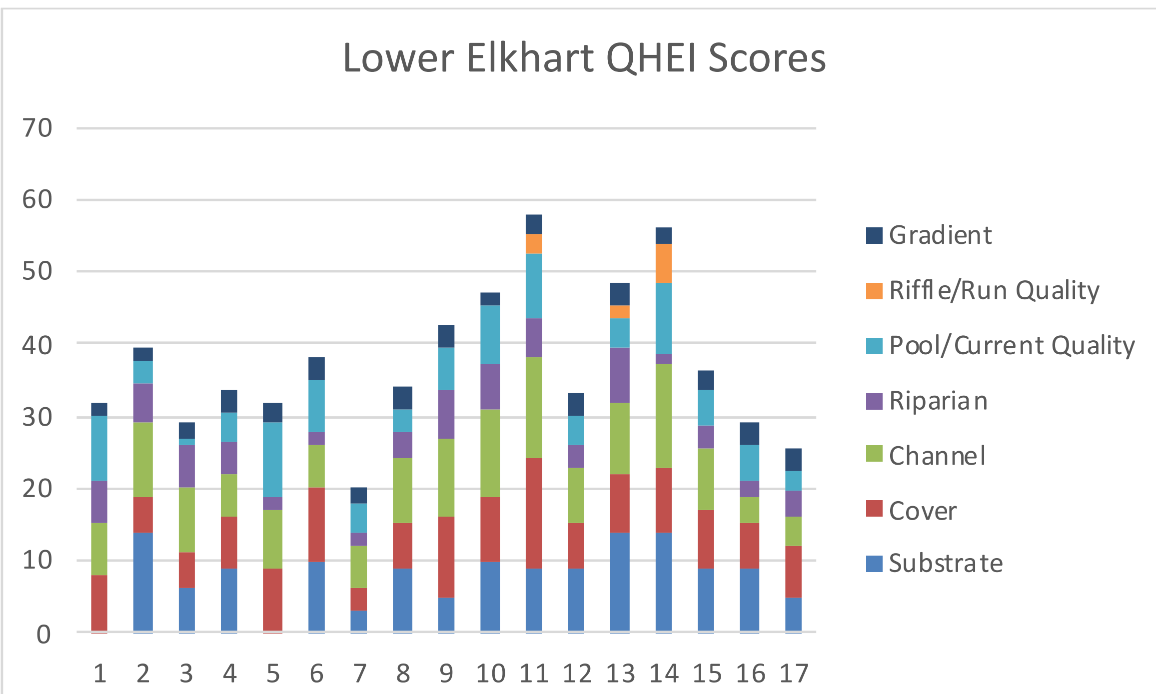


Figure 46. Cumulative metrics used to calculate QHEI scores for Lower Elkhart River Watershed streams in 2023.

As shown in Figure 47, Site 3 (Waubee Lake Outlet), Site 7 (Berlin Court Grand Ditch), Site 16 (Horn Ditch) and Site 17 (Howard Ditch) rated as very poor. Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 4 (Turkey Creek at CR 1250 North), Site 5 (Coppes Ditch), Site 6 (Turkey Creek at CR 1250 North), Site 8 (Turkey Creek at Old SR 15), Site 9 (Turkey Creek at CR 146), Site 12 (Rock Run Creek at CR 34) and Site 15 (Berlin Court Ditch) rated as poor. Site 10 (Elkhart River at CR 40) and Site 13 (Rock Run Creek at Indiana Ave/CR 21) rated as fair. Site 11 (Yellow Creek) and Site 14 (Elkhart River at Elkhart Street) rated as good.

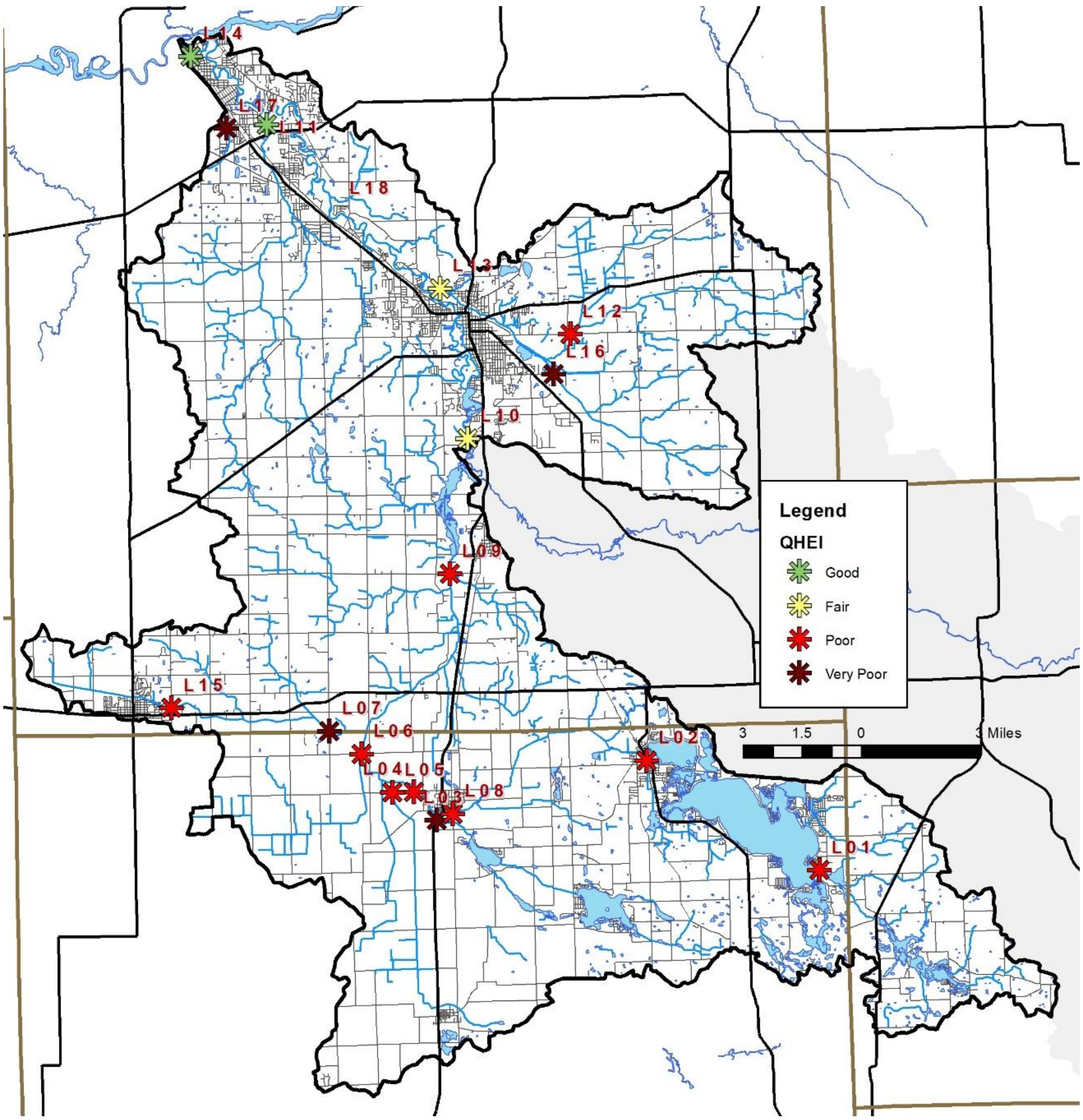


Figure 47. QHEI ratings for Lower Elkhart River Watershed stream sites.

3.4 Watershed Inventory Assessment

3.4.1 Watershed Inventory Methodologies

Windshield surveys were completed throughout the Lower Elkhart River Watershed in the spring of 2023. Surveys were conducted by driving all accessible roads throughout the watershed. Large maps with aerial photographs, road and stream names, and public property labels were provided to assess in surveying. Observations were recorded on the provided maps and data sheets, field conditions were documented using photographs, and additional notes were provided to the Project Coordinator for review. The windshield surveys were also used to confirm GIS map layer data throughout the watershed. Items targeted during the surveys included, but were not limited to the following:

- Aerial land use category
- Field or gully erosion
- Pasture locations and condition
- Livestock access and impact to streams
- Buffer condition and width
- Bank erosion or head-cutting
- Logjams located within the stream
- Dumping areas or areas where trash or debris accumulate
- Small, unregulated farms
- Environmental site confirmation (NPDES, CFO, open dump, Superfund, etc.)

3.4.2 Watershed Inventory Results

All accessible road-stream crossings were inventoried. Issues identified within the watershed fall under 3 categories: erosion, narrow buffer, and livestock access. Figure 48 details locations throughout the Lower Elkhart River Watershed where problems are identified. A total of 7.5 miles of streams were eroded among 33 different locations, 2.9 miles possessed narrow buffers at eight different locations, and livestock had access to 3.3 miles of streams at three different locations.

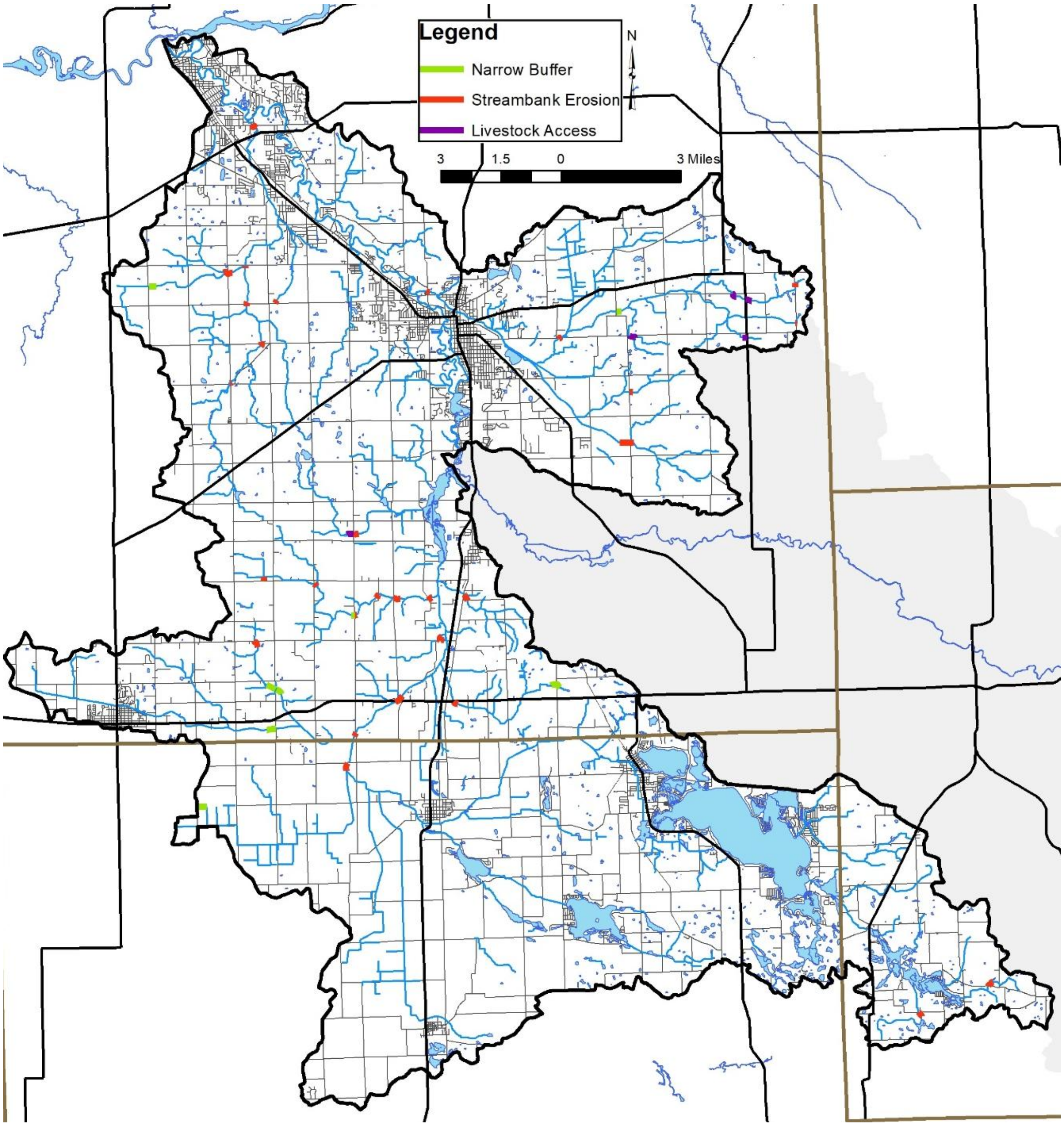


Figure 48. Stream-related watershed concerns identified during watershed inventory efforts.

4.0 <u>WATERSHED INVENTORY II-B: SUBWATERSHED DISCUSSIONS</u>

To gather more specific, localized data, the Lower Elkhart River Watershed was divided into thirteen (13) subwatersheds with each subwatershed reflecting one 12-digit Hydrologic Unit Code (HUC; Figure 49). These subwatersheds reflect specific tributary drainages and similar land uses and hydrology. Land uses, point and non-point watershed concern areas, and historic water quality sampling locations and results are discussed in detail below for each subwatershed.

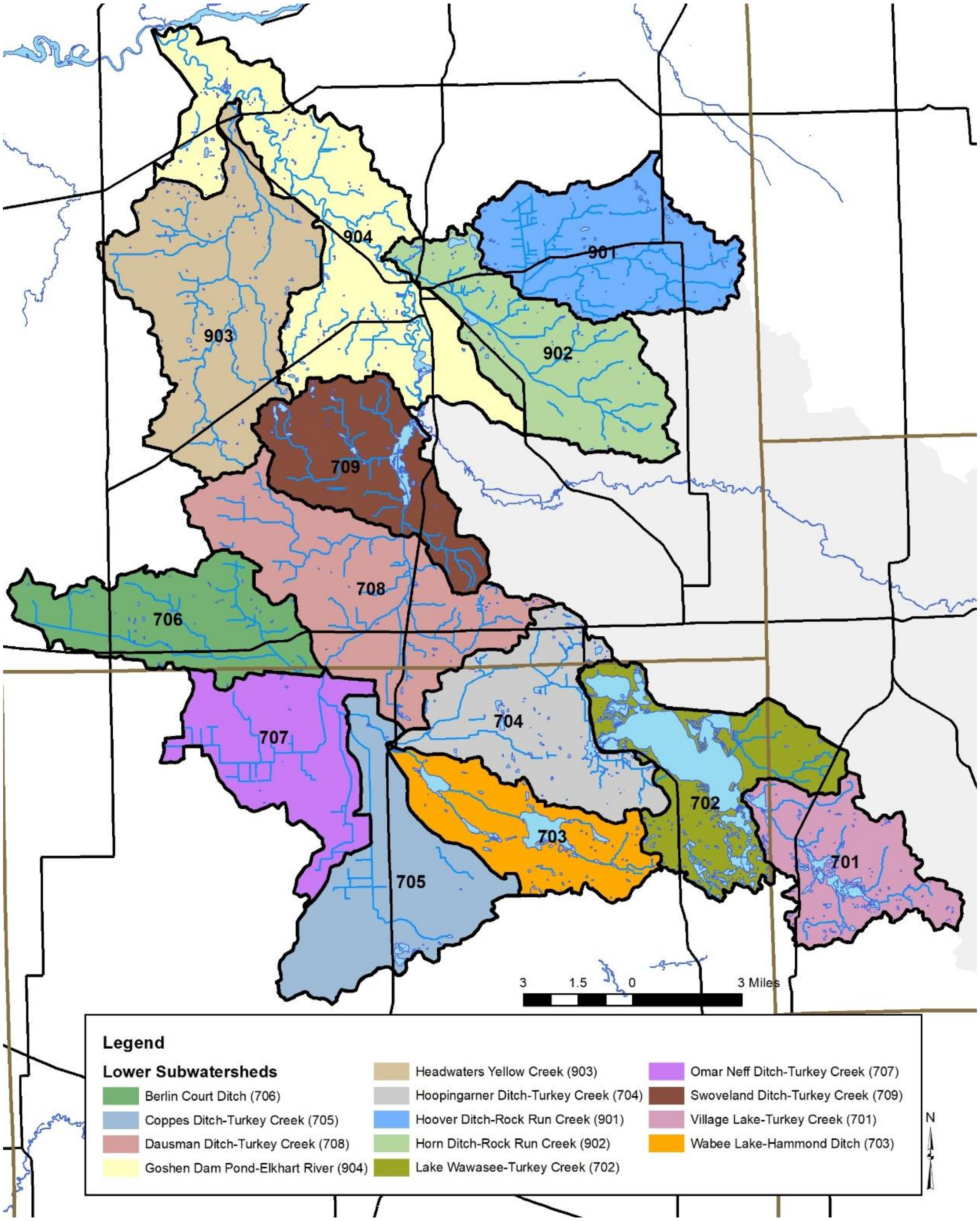


Figure 49. 12-digit Hydrologic Unit Codes subwatersheds in the Lower Elkhart River Watershed.

4.1 <u>Village Lake-Turkey Creek Subwatershed</u>

The Village Lake-Turkey Creek subwatershed forms the southeastern tip of the Lower Elkhart River Watershed and lies within Kosciusko and Noble counties (Figure 49). It encompasses one 12-digit HUC watershed: 040500011701. This subwatershed drains 10,172 acres and accounts for 5% of the total watershed area. There are 17.6 miles of stream in the Village Lake-Turkey Creek subwatershed. IDEM has classified four lakes as impaired in the Village Lake-Turkey Creek including Gordy Lake, Hindman Lake, Knapp Lake and Village Lake, all of which are impaired for biotic communities (Figure 50).

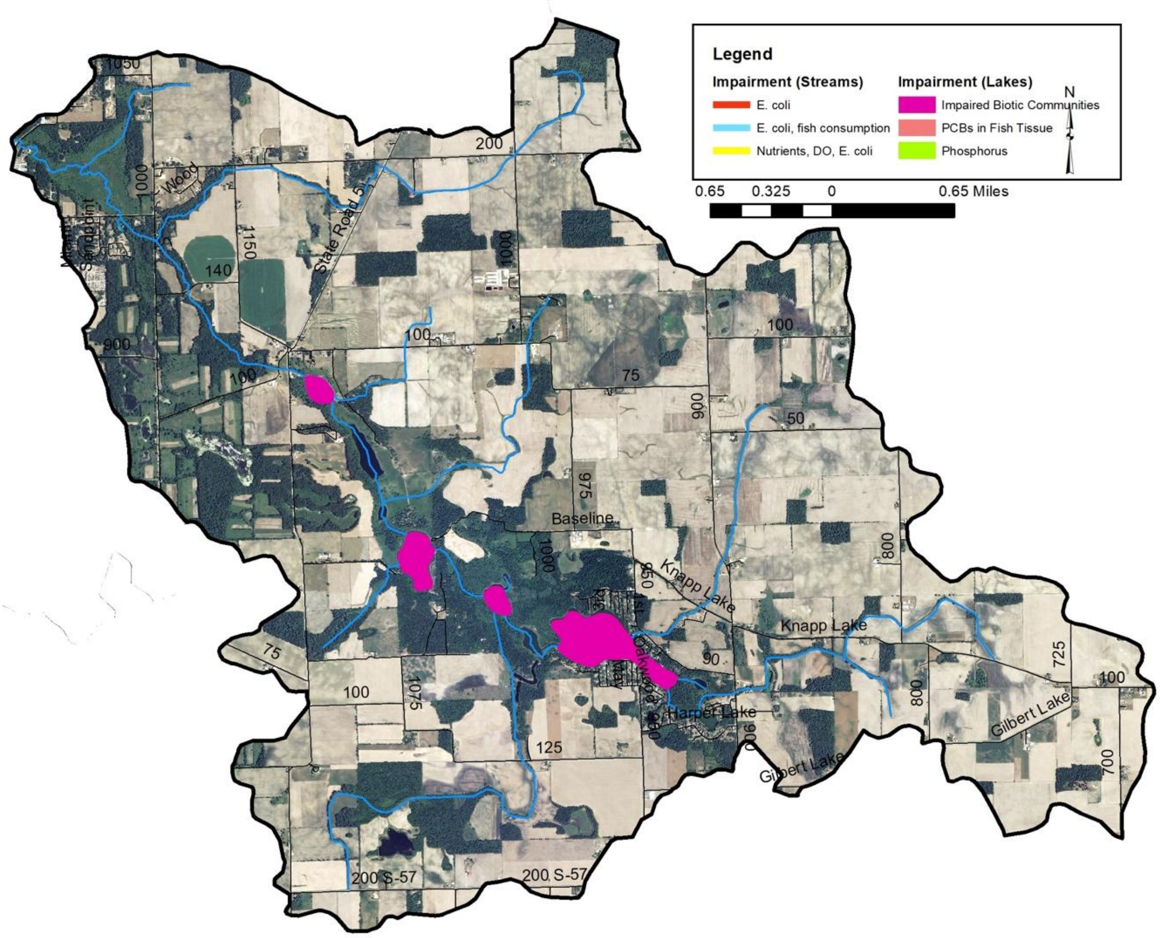


Figure 50. Impairments in the Village Lake-Turkey Creek subwatershed.

4.1.1 Soils

Hydric Soils cover 25.5%, or 2,598.1 acres, of the subwatershed. Highly erodible soils cover more than half (52.4%, or 5,334.5) of the subwatershed. In total, 9,843.3 acres (96.8%) of the subwatershed are identified as very limited for septic use. Maintenance and inspection of septic systems in this area are important to ensure proper function and capacity.

4.1.2 Land Use

Agricultural land is the majority land use in the Village Lake-Turkey Creek subwatershed, with 71.3% (7,252.6 acres) of land used for agriculture. Forested land use accounts for 10.7% (1,089.9 acres) of the subwatershed. Urban land use accounts for 11.2% (1,136.6 acres) of the subwatershed. Wetlands, open water, and grassland represents 10.7%, or 1,089.9 acres, of the subwatershed.

4.1.3 Point Source Water Quality Issues

There are very few potential point sources of water pollution in the subwatershed (Figure 51). One leaking underground storage tank is in the Village Lake-Turkey Creek subwatershed.

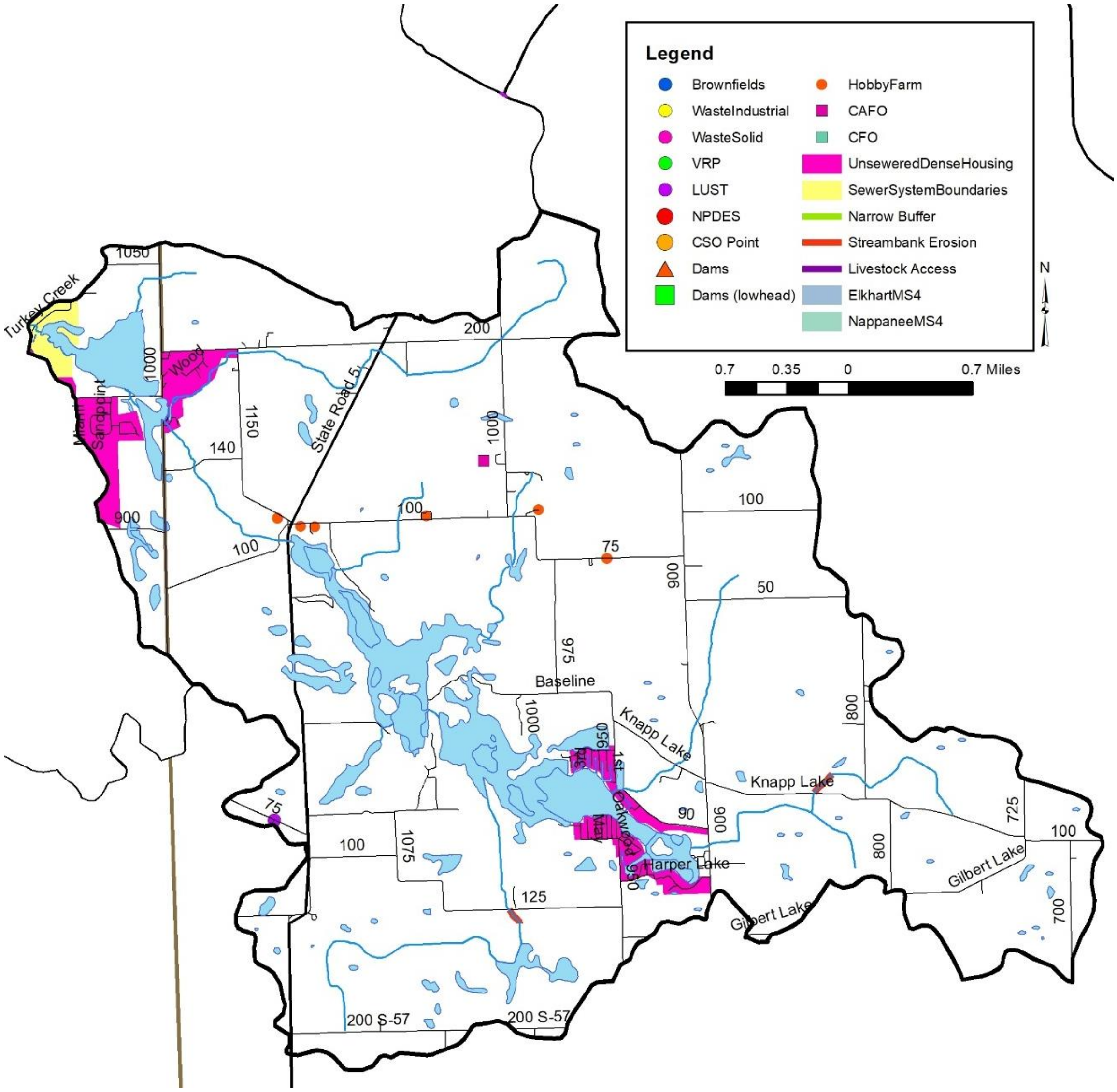


Figure 51. Potential point and non-point sources of pollution in Village Lake-Turkey Creek subwatershed.

4.1.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Village Lake-Turkey Creek subwatershed. Additionally, a number of small animal operations and one confined feeding operation are also present (Figure 54). In total, 8 unregulated animal operations housing more than 67 cows, horses, and sheep were identified during the windshield survey. There is one active CAFO housing approximately 83,900 ducks in the subwatershed. Based on windshield survey observations, livestock do not appear to have access to the subwatershed streams. In total, manure from animal operations total over 4,987 tons per year, which contains almost 2,350,229 pounds of nitrogen, 1,963,745 pounds of phosphorus and 2.90E+14 colonies of *E. coli*. Streambank erosion is a concern in the subwatershed. Approximately 0.5 miles (2.8%) of streambank erosion were identified within the subwatershed.

4.1.5 Water Quality Assessment

Waterbodies within the Village Lake-Turkey Creek subwatershed have been sampled historically at 17 locations. One site (L01) in the subwatershed is being sampled as part of the current project. Historic assessments include collection of water chemistry by WACF (12 snapshot sites), Hoosier Riverwatch (1 site), and LARE (7 sites). No stream gages are in the Village Lake-Turkey Creek subwatershed.

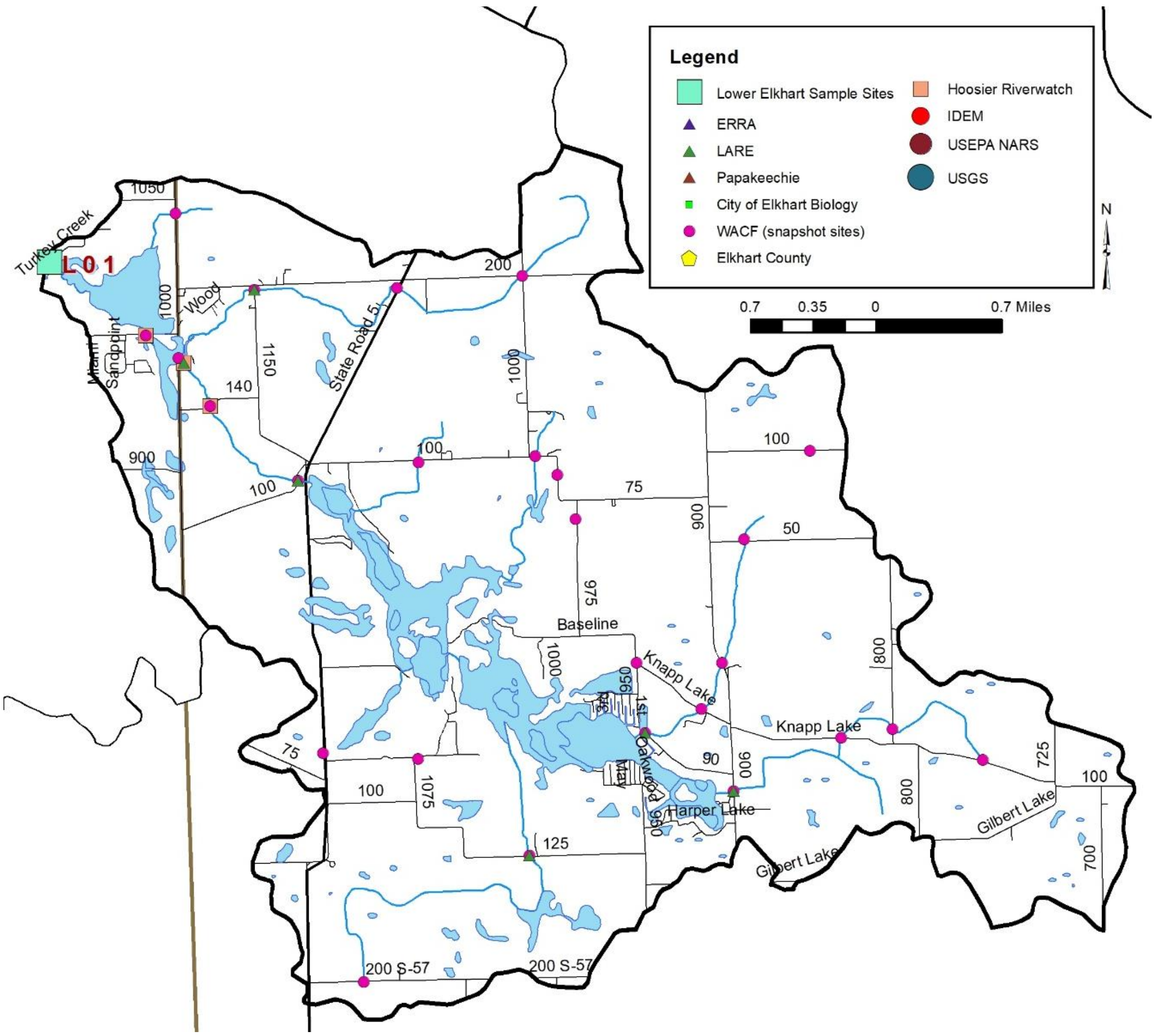


Figure 52. Locations of historic and current water quality data collection in the Village Lake-Turkey Creek subwatershed.

Table 22 details historic water chemistry data collected in the Village Lake-Turkey Creek subwatershed. As shown in the table, ammonia, conductivity, and TSS levels did not exceed in any samples collected. DO concentrations exceed water quality targets in 3% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 74% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 90% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 71% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 21% of samples, while orthophosphorus concentrations exceed water quality targets (0.03 mg/L) in 25% of samples collected. pH levels exceed water quality targets in 11% of samples collected. TSS levels did not exceed water quality targets (15 mg/L) in any samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 7% of samples.

Table 22. Village Lake-Turkey Creek historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.0	0.12	0	14	0%
Conductivity	493.0	809.0	0	14	0%
DO	3.0	12.0	1	34	3%
E. coli	0.0	51,000.0	154	208	74%
Nitrate	0.5	10.0	27	30	90%
OP	0.0	2.0	5	20	25%
pH	0.0	9.0	4	38	11%
TKN	0.279	1.128	10	14	71%
TP	0.02	0.14	3	14	21%
TSS	0.3	7.3	0	13	0%
Turbidity	0.5	23.0	1	15	7%

Table 23 details water quality data collected in the Village Lake-Turkey Creek Subwatershed (Site 1) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 33% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 25% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Dissolved oxygen concentrations measured both above and below water quality standards in 25% of samples collected. pH, total phosphorus and conductivity did not exceed targets in any sample collected.

Table 23. Village Lake-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mg/L)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
1	Median	11.04	8.07	8.06	544.15	5.90	2.65	0.05	10.20	132.50
	Max	22.30	10.88	8.92	594.00	13.87	8.58	0.07	28.40	710.00
	Min	2.40	2.21	7.54	386.00	1.10	0.92	0.05	2.40	30.00
	#Samples	12	12	12	12	12	11	12	12	12
	#Exceed		3	0	0	6	12	0	3	4
	% Exceed		25%	0%	0%	50%	92%	0%	25%	33%

Biological monitoring was conducted as part of the current project. Habitat rated as 32 scoring below the state target (51). The macroinvertebrate assessment (30) scored below the target (36) rating as poor.

4.2 <u>Lake Wawasee-Turkey Creek Subwatershed</u>

The Lake Wawasee-Turkey Creek subwatershed forms some of the eastern boundary of the Lower Elkhart River Watershed and encompassing Lake Wawasee, Syracuse Lake and other lakes as well as part of the Tri County Fish and Wildlife Area. The subwatershed stretches over Kosciusko and Noble counties (Figure 49). It encompasses one 12-digit HUC watershed: 040500011702. This subwatershed drains

14,276 acres and accounts for 8% of the total watershed area. There are 11.3 miles of stream. IDEM has identified four lakes in the subwatershed as impaired, including Lake Wawasee for PCBs in fish tissue and Hammond Lake, Rothenberger Lake and Barrel and a Half Lake for phosphorus (Figure 53).

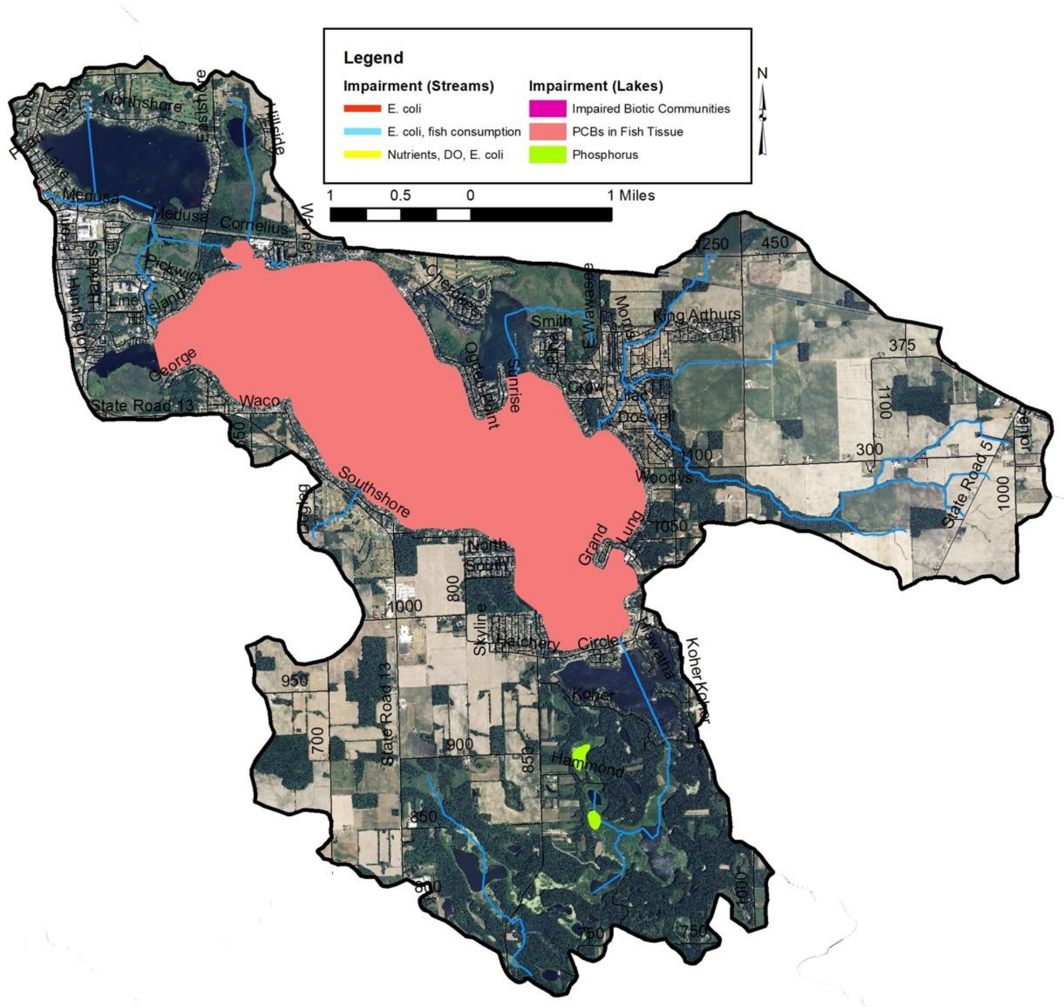


Figure 53. Impairments in the Lake Wawasee-Turkey Creek subwatershed.

4.2.1 Soils

Hydric soils cover 2,692.4 acres (18.9%) of the subwatershed. Highly erodible soils cover 3,211.3 (22.5%) of the subwatershed. In total, 8,893.7 acres (62.3%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.2.2 Land Use

Wetland, open water, and grassland cover is the largest land cover use in this subwatershed, covering almost 39% (5,548.0 acres) of land. Agricultural land use is lowest of any Lower Elkhart River subwatershed, with 30.2% (4,309.1 acres) of the Lake Wawasee-Turkey Creek subwatershed used for agriculture. Urban land use accounts for 17.4% (2,484.8 acres) of the subwatershed including areas around Lake Wawasee. Forested land use covers 13.5% (1,934.3 acres).

4.2.3 Point Source Water Quality Issues

There are multiple potential point sources of water pollution in the Lake Wawasee-Turkey Creek subwatershed (Figure 54). There are 11 leaking underground storage tank sites and two industrial waste sites located in the subwatershed. Additionally, 22 underground storage tank sites not identified as leaking are in the subwatershed. One NPDES-permitted facility is in the subwatershed in Syracuse.

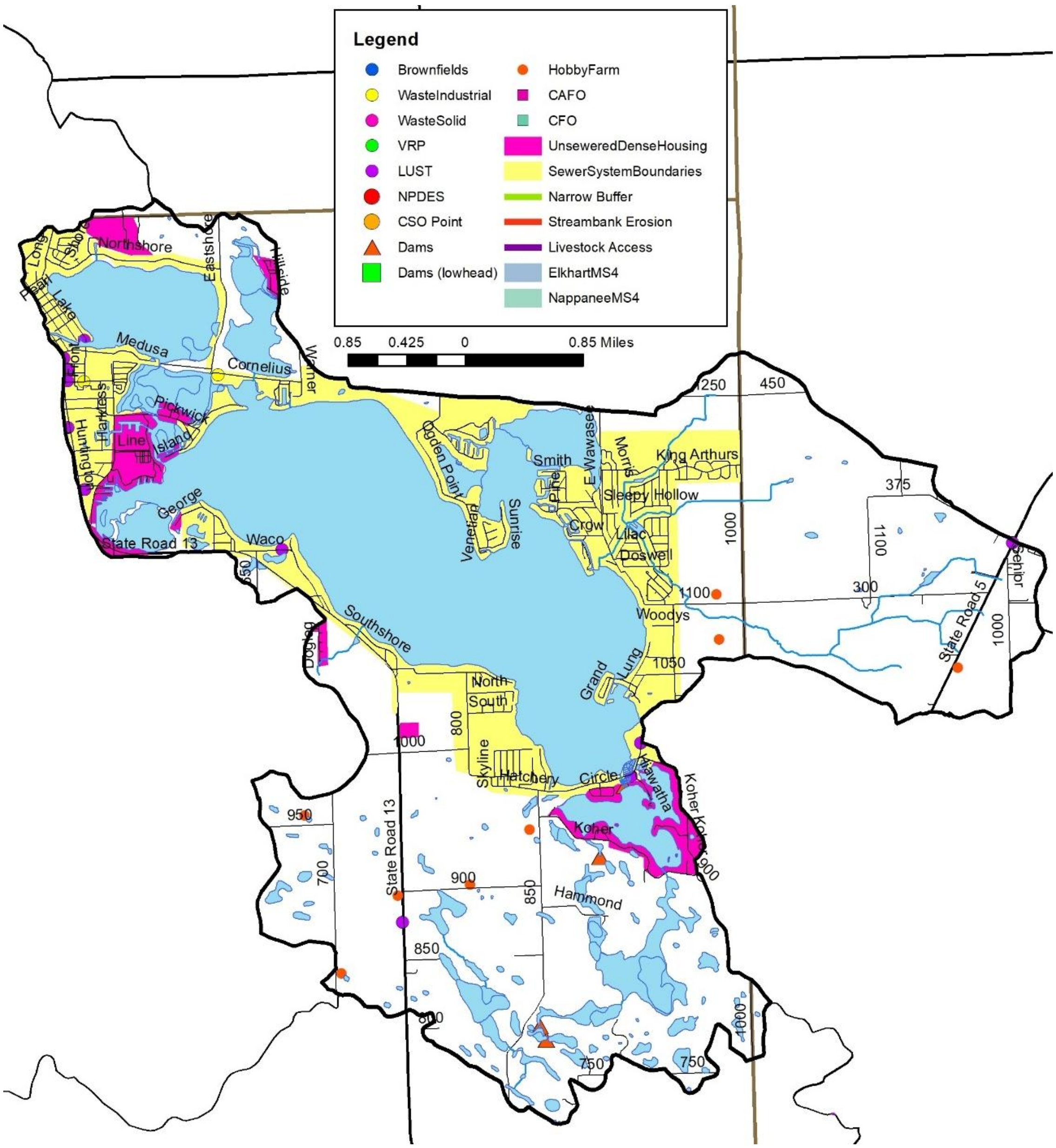


Figure 54. Potential point and non-point sources of pollution in the Lake Wawasee-Turkey Creek subwatershed.

4.2.4 Non-Point Source Water Quality Issues

While agricultural land use is not the predominant land use in the Lake Wawasee-Turkey Creek subwatershed, a number of small animal operations are still present. In total, eight unregulated animal operations housing more than 53 cows and horses were identified during the windshield survey. No active

CFOs are located within the Lake Wawasee-Turkey Creek subwatershed. In total, manure from small animal operations total over 1,136 tons per year, which contains almost 568 pounds of nitrogen, 282 pounds of phosphorus and 2.96E+13 colonies of *E. coli*. Livestock do not appear to have access to the subwatershed streams based on windshield survey observations. Streambank erosion is not a concern in the subwatershed.

4.2.5 Water Quality Assessment

Waterbodies within the Lake Wawasee-Turkey Creek subwatershed have been sampled historically at 70 locations. One site in the subwatershed (L02) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (2 sites), WACF (17 snapshot sites), Hoosier Riverwatch (17 sites), LARE (7 sites), and Lake Papakeechie (27 sites).

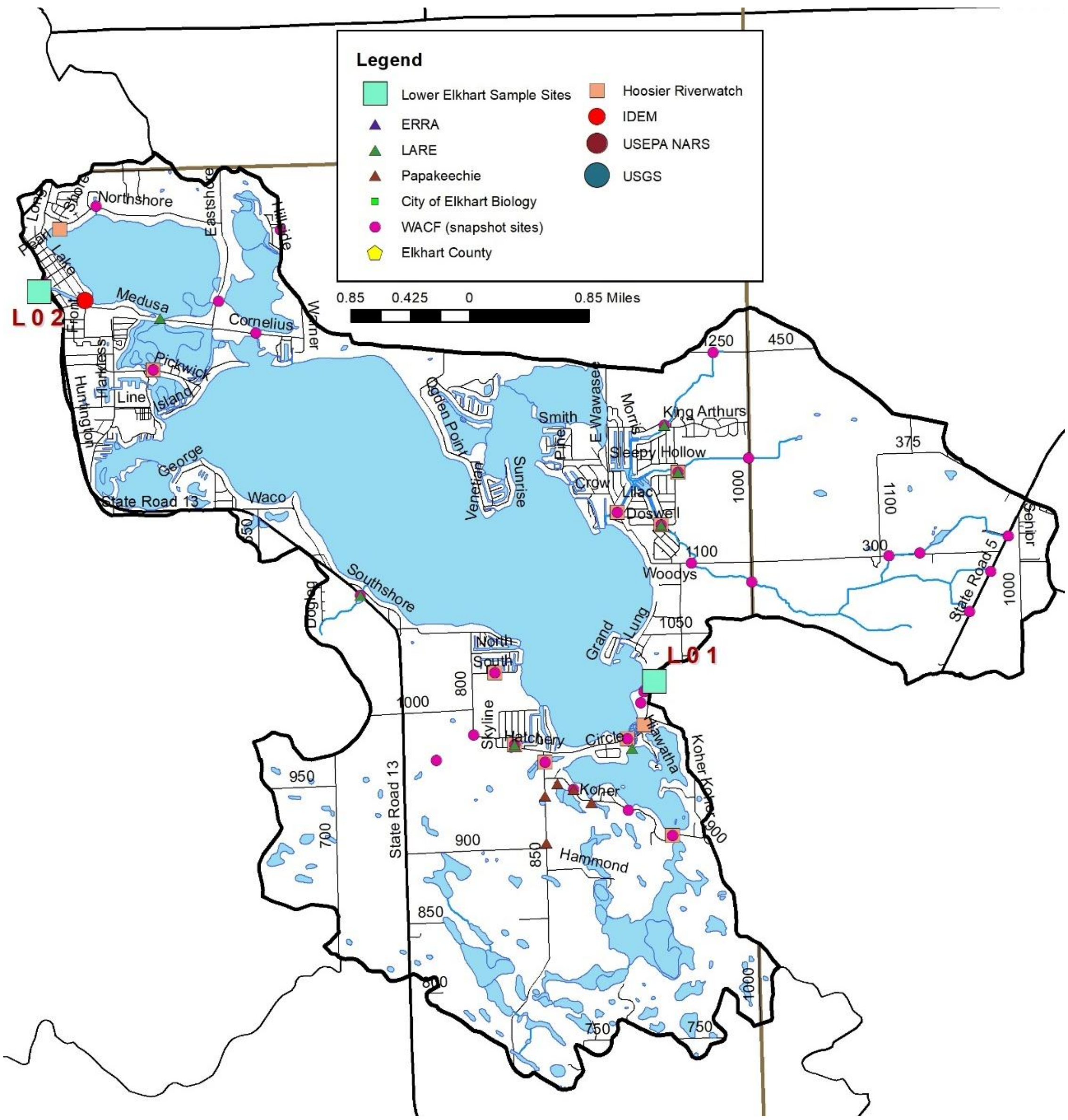


Figure 55. Locations of historic and current water quality data collection in the Lake Wawasee-Turkey Creek subwatershed.

Table 24 details historic water chemistry data collected in the Lake Wawasee-Turkey Creek subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 25% of samples collected. Conductivity concentrations did not exceed water quality targets (1050 mg/L) in any samples collected. DO concentrations exceed water quality targets in 27% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 38% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 29% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 50% of samples. pH levels exceed water quality targets in 10% of samples collected. Orthophosphorus concentrations exceed water quality targets (0.03 mg/L) in 62% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 1% of samples. TSS levels exceed water quality targets (15 mg/L) in 7% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 4% of samples.

Table 24. Lake Wawasee-Turkey Creek historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.2	5.17	5	20	25%
Conductivity	255	675.0	0	14	0%
DO	0.0	305.0	32	118	27%
E. coli	0.0	12,400.0	29	76	38%
Nitrate	0.0	20.0	45	157	29%
OP	0.0	4.5	49	79	62%
pH	0.0	9.5	12	116	10%
TKN	0.23	0.843	7	14	50%
TP	0.0	5.0	2	169	1%
TSS	0.5	46.7	1	14	7%
Turbidity	0.0	8.9	1	24	4%

Table 25 details water quality data collected in the Lake Wawasee-Turkey Creek Subwatershed (Site 2) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 17% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 58% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 33% of samples. Dissolved oxygen concentrations measured both above and below water quality standards in 17% of samples collected. pH levels exceed the upper range (9) in 25% of samples. Conductivity levels exceed sample standards (1050 mg/L) in 8% of samples collected. Total phosphorus did not exceed targets in any sample collected.

Table 25. Lake Wawasee-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
2	Median	11.04	8.83	8.50	394.70	3.37	2.30	0.05	4.20	45.00
	Max	25.30	12.79	9.34	1859.00	7.61	9.40	0.05	20.00	390.00
	Min	2.60	3.05	7.60	340.20	0.60	0.54	0.05	3.20	2.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		2	3	1	4	7	0	2	2
	% Exceed		17%	25%	8%	33%	58%	0%	17%	17%

Biological monitoring was conducted by LARE at 14 sites, three times for macroinvertebrate community assessments and 14 times for habitat assessment and once for macroinvertebrate and habitat assessment as part of the current project (Table 26). Habitat scores ranged from 37 to 71.5, with 66% of sites scoring below the state target (51). Macroinvertebrate assessments consistently rated above the target level using the kick method but below target using the multi habitat method.

Table 26. Lake Wawasee-Turkey Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	37	71.5	10	15	66%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	2.7	5.1	0	3	0%
Macroinvertebrates (mIBI, Multi Habitat)	28	28	1	1	100%

4.3 <u>Wabee Lake-Hammond Ditch Subwatershed</u>

The Wabee Lake-Hammond Ditch subwatershed sits at the center of the southern border of the Lower Elkhart River Watershed and lies entirely in Kosciusko County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011703. This subwatershed drains 10,120 acres and accounts for 5% of the total watershed area. There are 13.0 miles of stream, none of which IDEM has classified as impaired (Figure 56).

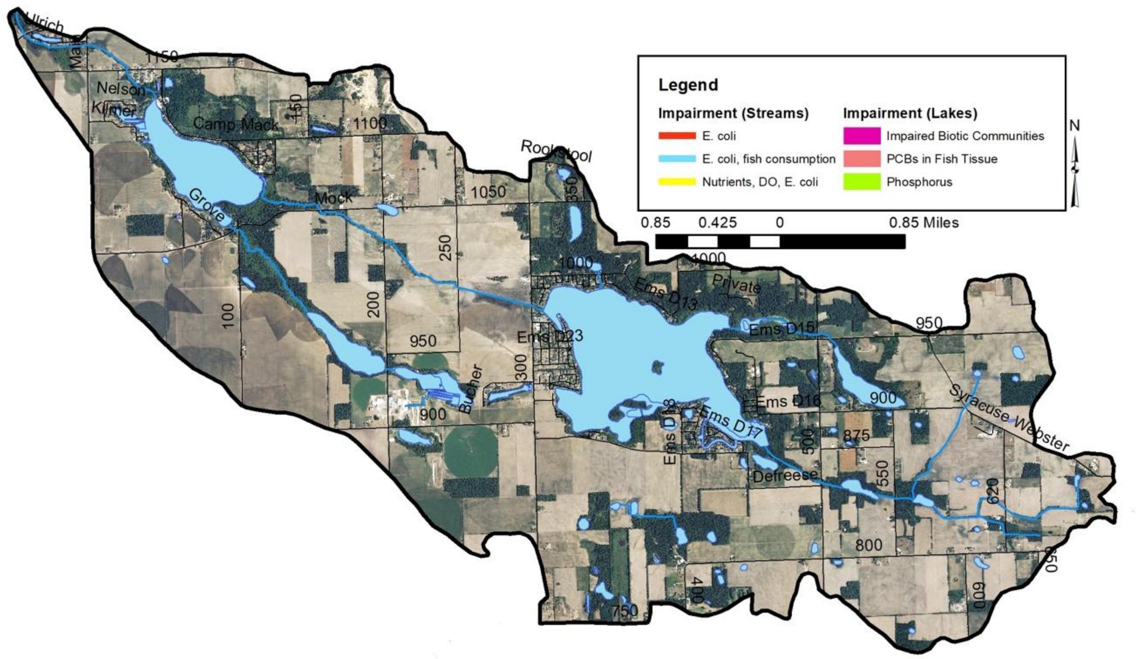


Figure 56. Wabee Lake-Hammond Ditch subwatershed.

4.3.1 Soils

Hydric soils cover 1,100.8 acres (10.9%) of the subwatershed. Highly erodible soils cover 47% of the subwatershed (4,752.1 acres). In total, 8,984.8 acres (88.8%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.3.2 Land Use

Agricultural land use is the majority land use in the Wabee Lake-Hammond Ditch subwatershed with 66.7% (6,755.0 acres) in agricultural land usage. Forested land use covers 10.7% of land in the subwatershed, or 1,086.3 acres. Urban land is the smallest in this subwatershed, covering 7.6% (773.0 acres) of the land. Wetlands, open water, and grassland cover 1,506.3 acres, or 14.9%, of the subwatershed.

4.3.3 Point Source Water Quality Issues

There are few potential point sources of water pollution in the subwatershed (Figure 57). There are two underground storage tank sites not identified as leaking in the Wabee Lake-Hammond Ditch subwatershed.

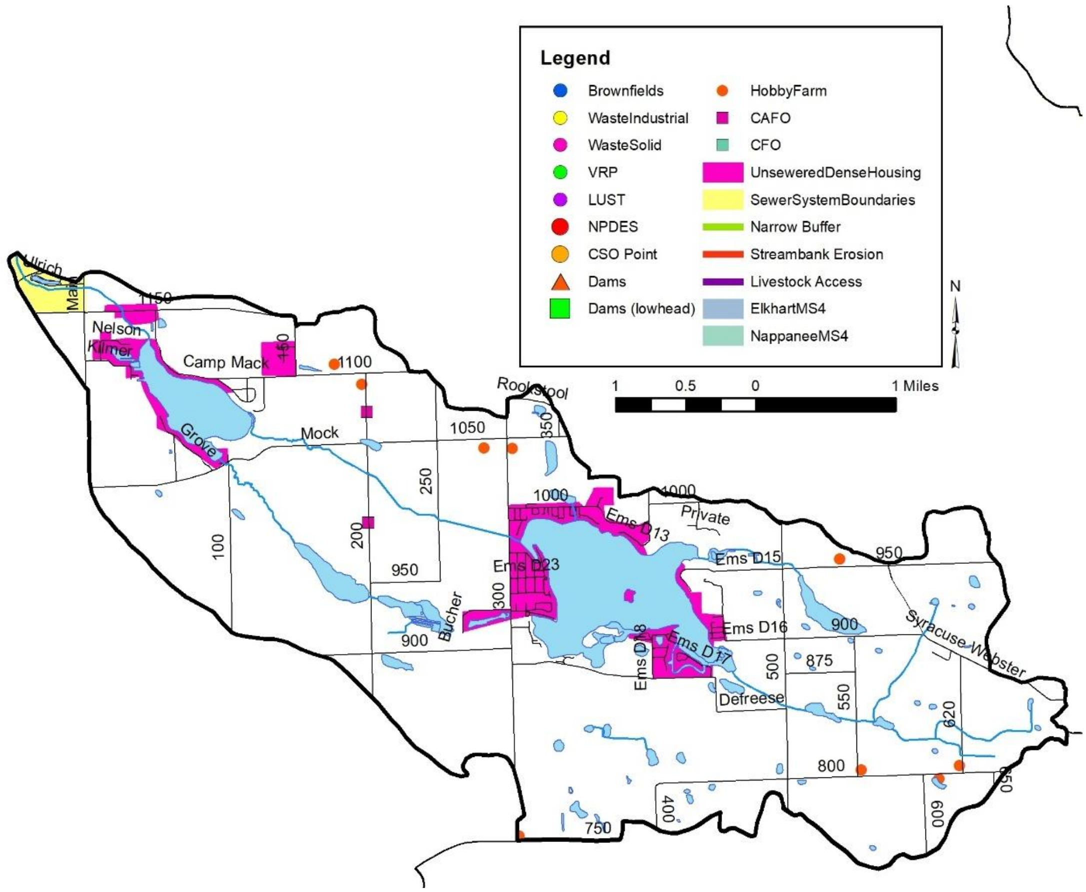


Figure 57. Potential point and non-point sources of pollution in Wabee Lake-Hammond Ditch subwatershed.

4.3.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Wabee Lake-Hammond Ditch subwatershed. Additionally, a number of small animal operations and pastures are also present (Figure 57). In total, eight unregulated animal operations housing more than 52 cows, horses, goats, sheep and donkeys were identified during the windshield survey. Two active concentrated animal feeding operations housing up to 7,670 pigs are located within the Wabee Lake-Hammond Ditch subwatershed. In total, manure from animal operations total over 32,206 tons per year, which contains almost 95,077 pounds of nitrogen, almost 71,688 pounds of phosphorus and 1.76E+16 colonies of *E. coli*. Livestock do not appear to have access to the subwatershed streams based on windshield survey observations. Streambank erosion and narrow buffer was not identified during the windshield survey, therefore may not be a concern in the subwatershed.

4.3.5 Water Quality Assessment

Waterbodies within the Wabee Lake-Hammond Ditch subwatershed have been sampled historically at 11 locations (Figure 58). One site in the subwatershed (L03) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (1 site), LARE (8 sites), and Hoosier Riverwatch (2 sites). No stream gages are in the Wabee Lake-Hammond Ditch subwatershed.

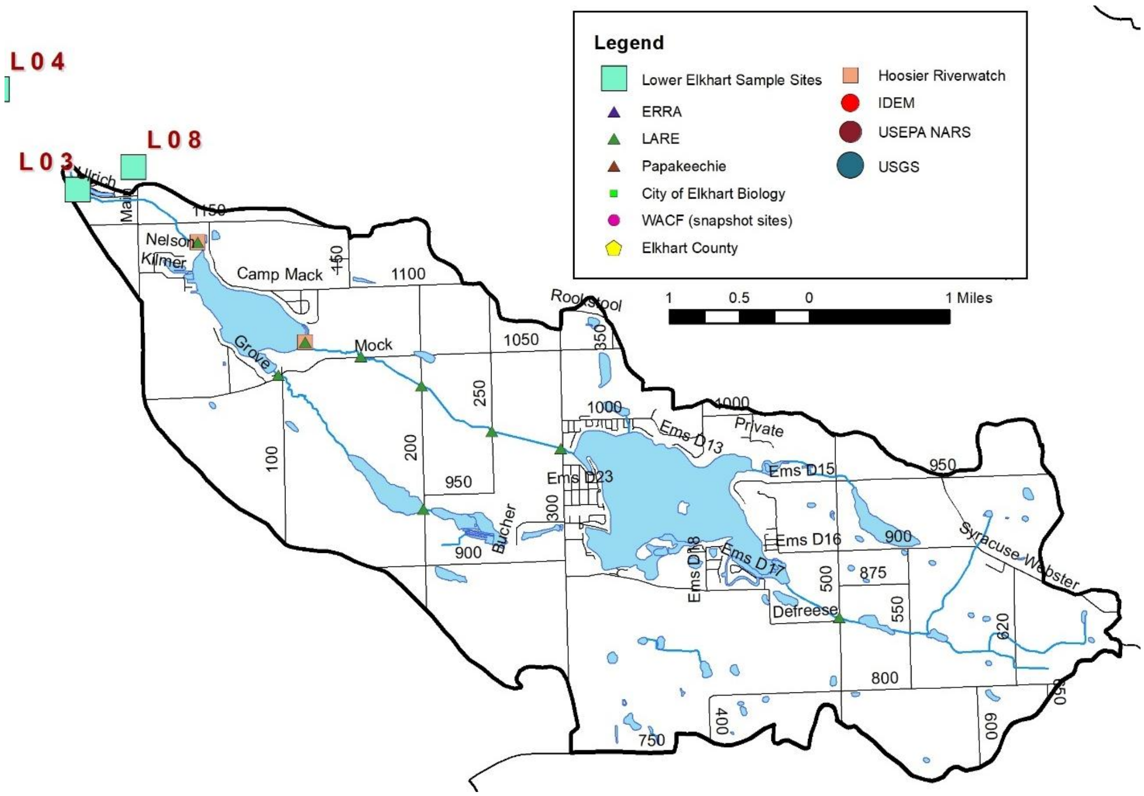


Figure 58. Locations of historic and current water quality data collection in the Wabee Lake-Hammond Ditch subwatershed.

Table 27 details historic water chemistry data collected in the Wabee Lake-Hammond Ditch subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 50% of samples collected. DO concentrations exceed water quality targets in 8% of samples collected. *E. coli* concentrations do not exceed state grab sample standards (235 col/100 ml) in any samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 50% of samples. pH levels exceed water quality targets in 6% of samples collected. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 50% of samples. TSS levels exceed water quality targets (15 mg/L) in 50% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Conductivity was not sampled in Wabee Lake-Hammond Ditch subwatershed.

Table 27. Wabee Lake-Hammond Ditch historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.2	0.75	1	2	50%
DO	6.0	88.0	1	13	8%
E. coli	0.0	60.0	0	8	0%
Nitrate	2.2	29.33	9	9	100%
pH	5.7	9.0	1	18	6%
TKN	0.227	1.943	1	2	50%
TP	0.057	0.347	1	2	50%
TSS	2.25	16.9	1	2	50%
Turbidity	0.2	60.0	6	12	50%

Table 28 details water quality data collected in the Wabee Lake-Hammond Ditch Subwatershed (Site 3) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 57% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 14% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 43% of samples. pH levels exceed the upper range (9) in 14% of samples. Dissolved oxygen, total phosphorus and conductivity did not exceed targets in any sample collected.

Table 28. Wabee Lake-Hammond Ditch Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
3	Median	17.10	8.43	8.32	572.00	3.97	1.51	0.05	8.40	330.00
	Max	23.00	11.42	9.04	613.00	16.89	6.20	0.05	25.20	866.00
	Min	6.38	7.01	7.11	363.00	1.00	1.20	0.05	2.00	10.00
	#Samples	7	7	7	7	7	7	7	7	7
	#Exceed		0	1	0	3	7	0	1	4
	% Exceed		0%	14%	0%	43%	100%	0%	14%	57%

Biological monitoring was conducted by LARE at one site with one site assessed for macroinvertebrates and at one site as part of the current project (Table 29). Habitat assessment occurred once and resulted in a score of 40, not reaching the state target of 51. Fish community assessments rated good and meets the state's aquatic life use designation. Macroinvertebrate assessments using the kick sampling method measured above the state target of 2.2 but rated below the state target of 36 using the multihabitat method.

Table 29. Wabee Lake-Hammond Lake subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	29	40	2	2	100%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	5.3	5.3	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	30	30	1	1	100%

4.4 Hoopingarner Ditch-Turkey Creek Subwatershed

The Hoopingarner Ditch-Turkey subwatershed is in the middle to eastern edge of the Lower Elkhart Watershed and lies within Elkhart and Kosciusko Counties (Figure 49). It encompasses one 12-digit HUC watershed: 040500011704. This subwatershed drains 13,613 acres and accounts for 7% of the total watershed area. There are 28 miles of stream. IDEM has classified almost all (27.6 miles) length of stream in the Hoopingarner Ditch-Turkey Creek subwatershed as impaired for *E. coli* (Figure 59).

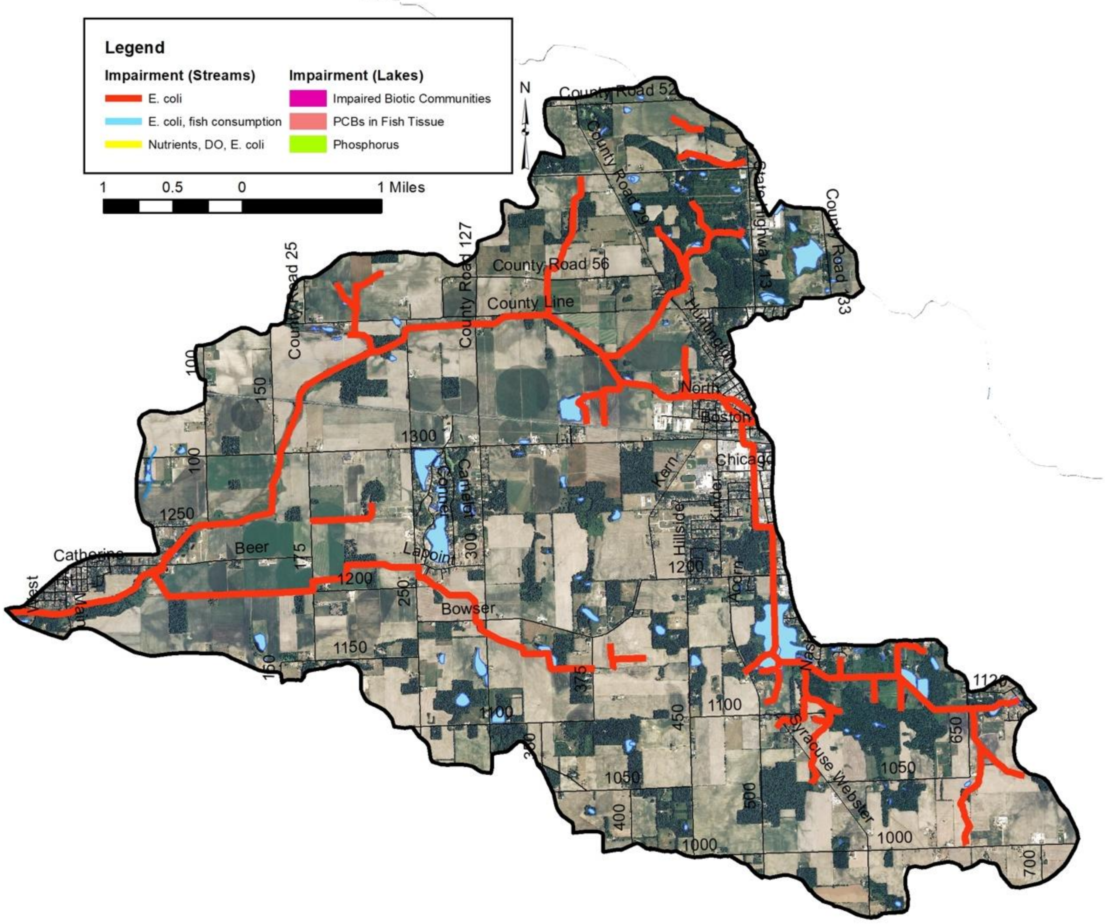


Figure 59. Impairments in the Hoopingarner Ditch-Turkey Creek subwatershed.

4.4.1 Soils

Hydric soils cover 3,029.3 acres (22%) of the subwatershed. Highly erodible soils cover 5,698.2 acres (42%) of the subwatershed. In total, 13,269.9 acres (97%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.4.2 Land Use

Agricultural land uses are the major land use of the Hoopingarner Ditch-Turkey Creek subwatershed, with 71% of land (9,670 acres) used for agriculture. Nearly 12% (1,615.5 acres) of the subwatershed is in urban land use including the Town of Syracuse. Forest land use accounts for 8% (1,086.4 acres) of the subwatershed. Wetlands, open water, and grassland cover the remaining approximately 9% (1,241.4 acres) of the subwatershed.

4.4.3 Point Source Water Quality Issues

There are few potential point sources of water pollution in the Hoopingarner Ditch-Turkey Creek subwatershed (Figure 60). One NPDES-permitted location is located in the Hoopingarner Ditch-Turkey Creek subwatershed, the City of Syracuse wastewater treatment plant. Six leaking underground storage tanks and six industrial waste sites are located in the subwatershed. Twelve underground storage tanks that are not identified as leaking are also located in this subwatershed.

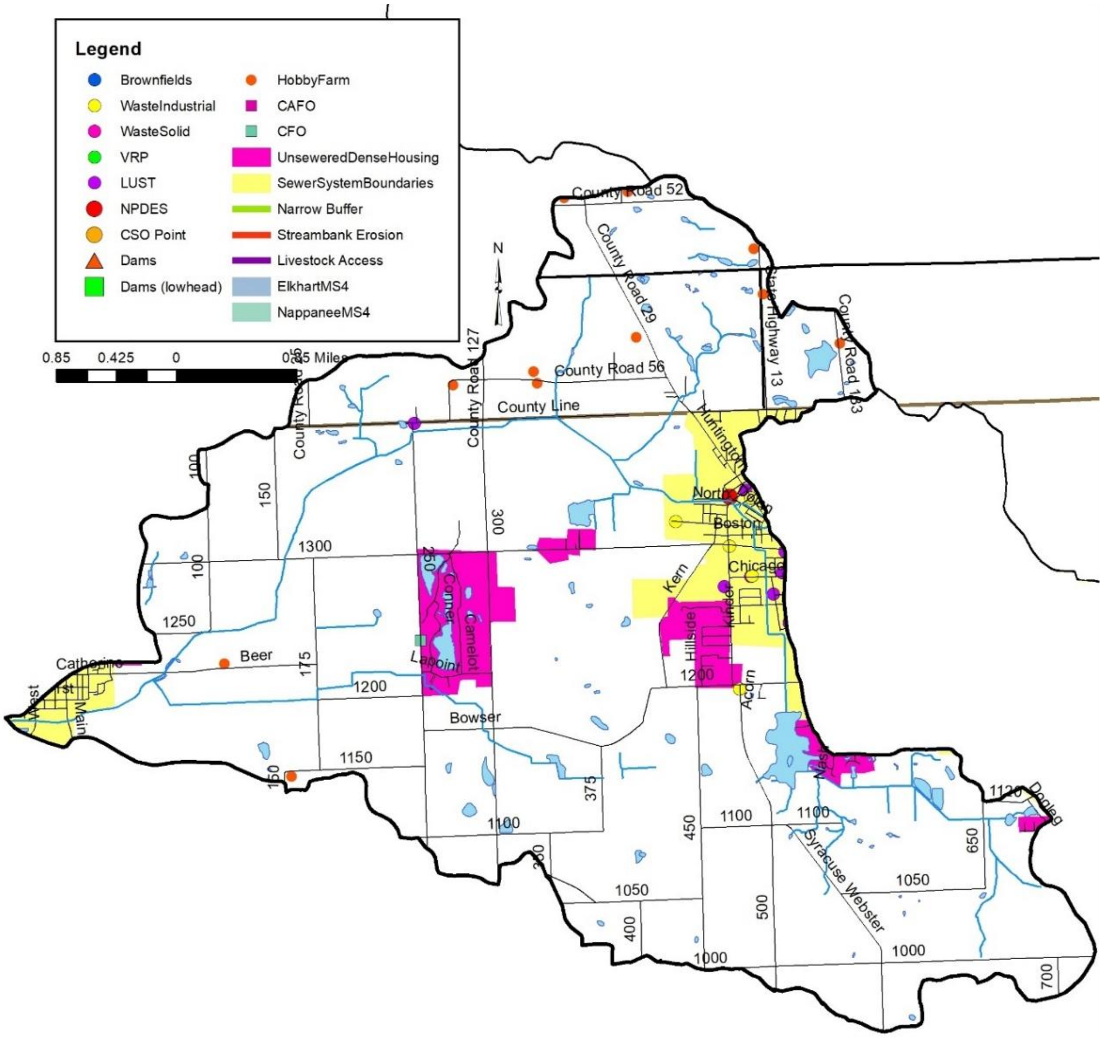


Figure 60. Potential point and non-point sources of pollution and suggested solutions in the Hoopingarner Ditch-Turkey Creek subwatershed.

4.4.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land uses in the Hoopingarner Ditch-Turkey Creek subwatershed. Eleven unregulated animal operations housing more than 149 cows, horses and sheep were identified during the windshield survey. Livestock do not appear to have access to streams in the subwatershed. There is one active CFO housing 1,700 pigs located in the Hoopingarner Ditch-Turkey Creek subwatershed. In total, manure from all small animal operations total over 9,521 tons per year, which contains almost 22,818 pounds of nitrogen, 16,731 pounds of phosphorus and 4.20E+15 colonies of *E. coli*. Streambank erosion and lack of buffers are not a concern in the subwatershed.

4.4.5 Water Quality Assessment

Waterbodies within the Hoopingarner Ditch-Turkey Creek subwatershed have been sampled historically at four locations. One site in the subwatershed (L08) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (3 sites) and USGS (1 site). No stream gages are in the Hoopingarner Ditch-Turkey Creek subwatershed.

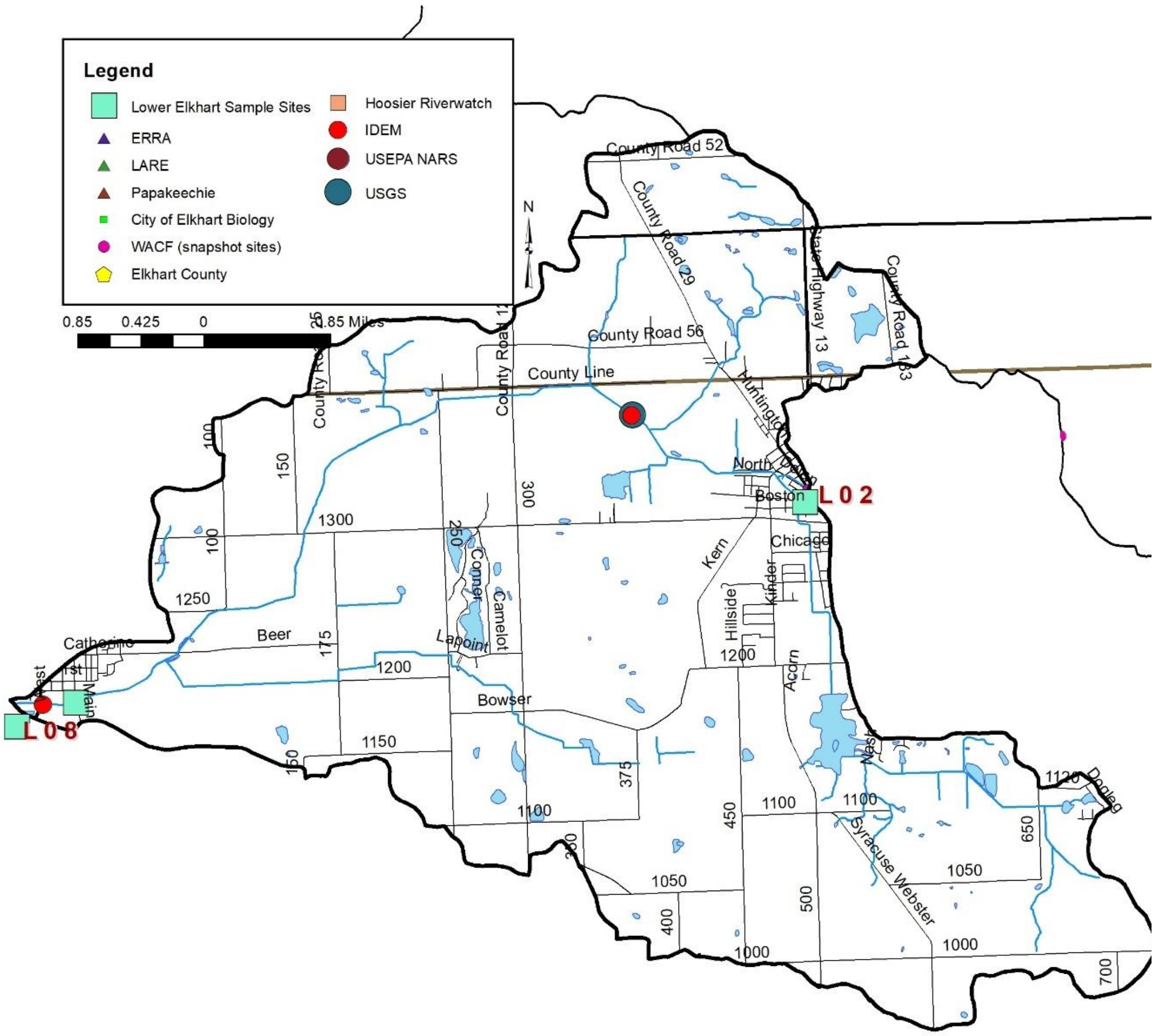


Figure 61. Locations of historic and current water quality data collection in the Hoopingarner Ditch-Turkey Creek subwatershed.

Table 30 details historic water chemistry data collected in the Hoopingarner Ditch-Turkey Creek subwatershed. As shown in the table, ammonia, DO, pH, and turbidity results do not exceed water quality targets in any samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in more than half (60%) of samples collected. Conductivity, nitrate-nitrogen, OP, TKN, TP, and TSS were not sampled in Hoopingarner Ditch-Turkey Creek subwatershed.

Table 30. Hoopingarner Ditch-Turkey Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.1	0	1	0%
DO	7.3	10.0	0	13	0%
E. coli	88.0	816.0	6	10	60%
pH	7.8	8.2	0	16	0%
Turbidity	0.0	3.89	0	13	0%

Table 31 details water quality data collected in the Hoopingarner Ditch-Turkey Creek Subwatershed (Site 8) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 75% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total suspended solids concentrations did not exceed water quality targets while turbidity levels exceeded water quality targets (5.7 NTU) in 42% of samples. Conductivity levels exceed water quality targets (1050 mg/L) in 8% of samples collected. Dissolved oxygen, pH and total phosphorus did not exceed targets in any sample collected.

Table 31. Hoopingarner Ditch-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (ms/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
8	Median	10.66	9.15	8.25	677.00	2.80	2.98	0.05	4.20	360.00
	Max	22.20	10.98	8.94	1599.00	12.68	8.61	0.05	14.40	1180.00
	Min	2.70	5.99	7.93	422.20	0.50	1.30	0.05	2.00	10.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	1	5	12	0	0	9
	% Exceed		0%	0%	8%	42%	100%	0%	0%	75%

IDEM assessed the biological data at two sites, with one site assessing fish community and one site assessing macroinvertebrate community (Table 32). Additionally, one site was assessment for macroinvertebrate community and habitat as part of the current project. Habitat was assessed at both IDEM sites and one site as part of the current project, with scores ranging from 34 to 60, measuring below state target of 51 in 33% of samples. Macroinvertebrate assessments using the multihabitat assessment measured above target, indicating it meets the state's aquatic life use designation. The fish community assessment scored above the target level.

Table 32. Hoopingarner Ditch-Turkey Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	34	60	1	3	33%
Fish (IBI)	42	42	0	1	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	40	47	0	2	0%

4.5 Coppes Ditch-Turkey Creek Subwatershed

The Coppes Ditch-Turkey Creek subwatershed forms the southwestern boundary of the Lower Elkhart River Watershed and sits entirely in Kosciusko County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011705. This subwatershed drains 14,412 acres and accounts for 8% of the total watershed. There are 15.2 miles of stream. IDEM has classified 1.6 miles of stream length in this subwatershed as impaired for *E. coli* and impaired biotic communities.

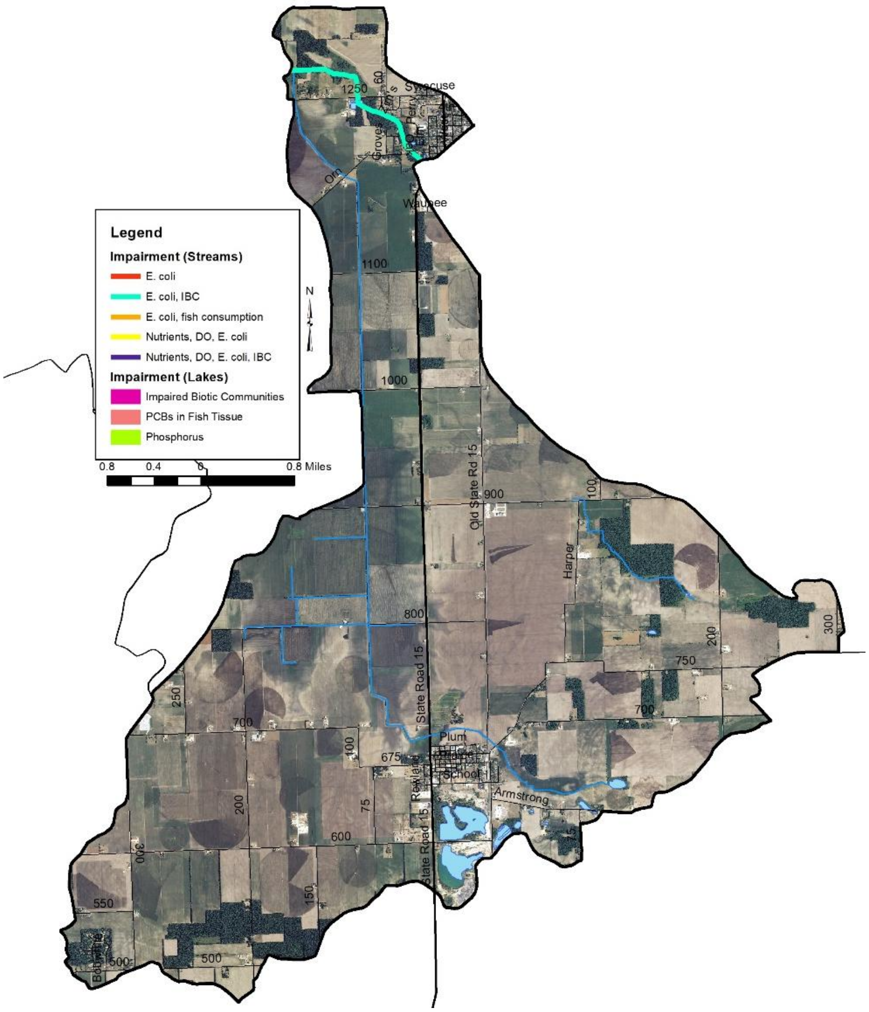


Figure 62. Impairments in the Coppes Ditch-Turkey Creek Subwatershed.

4.5.1 Soils

Hydric soils cover 3,879.0 acres, or 26.9%, of the Coppes Ditch-Turkey Creek subwatershed. Highly erodible soils cover only 967.0 acres (6.7%) of the subwatershed. In total, 14,155.9 acres or 98.2% of the subwatershed is identified as very limited for septic use.

4.5.2 Land Use

Agricultural land use dominates the Coppes Ditch-Turkey Creek subwatershed at 85.4% (12,309.3 acres). Urban land use, including the portions of the Town of Milford and of the City of Nappanee, accounts for 7.2% (1,034.2 acres) of the subwatershed land use. Forest land makes up 4.8% (688.7 acres) of the subwatershed. Wetlands, open water, and grassland are the smallest land use in the Coppes Ditch-Turkey Creek subwatershed with 380.5 acres, or 2.6%, of the subwatershed.

4.5.3 Point Source Water Quality Issues

There are 12 potential sources of water pollution in the Coppes Ditch-Turkey Creek subwatershed: one leaking underground storage tanks and 11 underground storage tanks (Figure 63). One NPDES-permitted location is within the subwatershed (Milford wastewater treatment plant). One brownfield is also located within this subwatershed. No superfund sites, corrective action sites or voluntary remediation sites are located within the Coppes Ditch-Turkey Creek subwatershed.

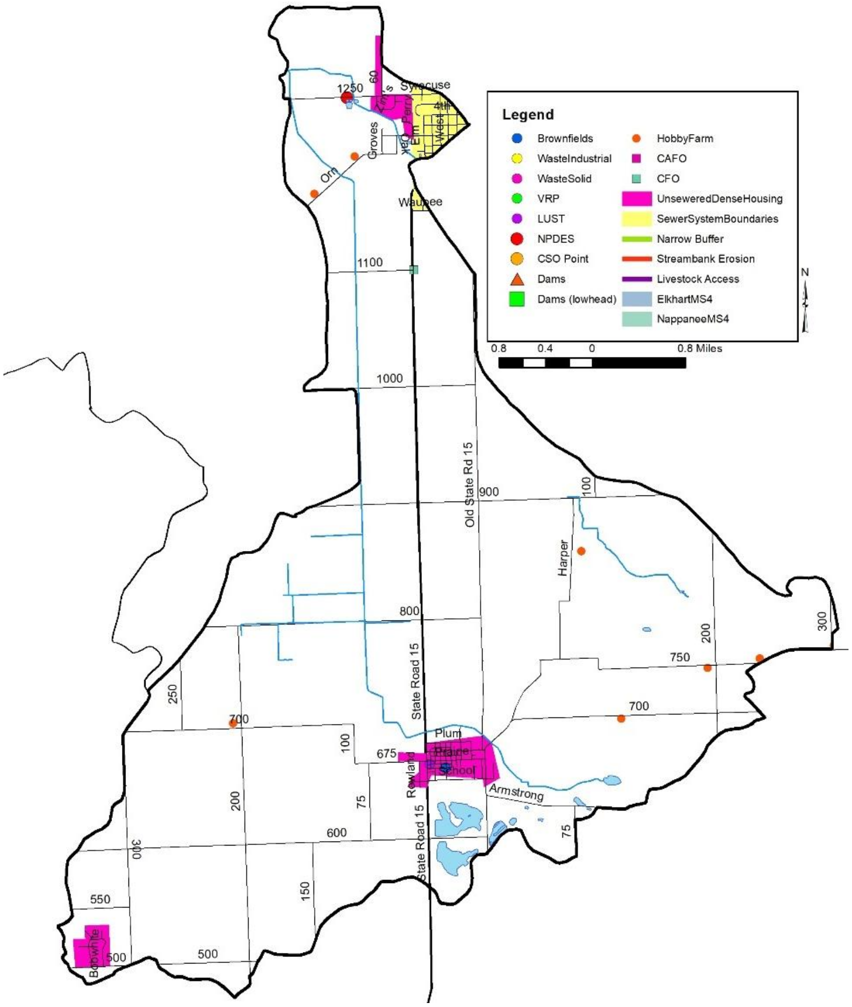


Figure 63. Potential point and non-point sources of pollution in the Coppes Ditch-Turkey Creek subwatershed.

4.5.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Coppes Ditch-Turkey Creek subwatershed. Additionally, a number of animal operations are present. In total, seven unregulated animal operations housing more than 55 cows, horses and goats were identified during the windshield survey. Based on windshield survey observations, livestock do not appear to have access to subwatershed streams. There are two CAFOs/CFOs housing 9,600 pigs in the Coppes Ditch-Turkey Creek subwatershed. These small unregulated and confined feeding animal operations produce more than 40,519 tons of manure annually which contains more than 118,674 pounds nitrogen, 89,579 pounds of phosphorus and more than 2.18E+16 colonies of *E. coli*. Streambank erosion and lack of buffers are not a concern in the subwatershed based on observations during the windshield survey.

4.5.5 Water Quality Assessment

Waterbodies within the Coppes Ditch-Turkey Creek subwatershed have been sampled historically at four sites (Figure 64). Two sites in the subwatershed (L04 and L05) are being sampled as part of the current project. Historic assessments include collection of water chemistry and biological data and water chemistry by IDEM (3 sites) and USGS (1 site). No stream gages are in the Coppes Ditch-Turkey Creek subwatershed.

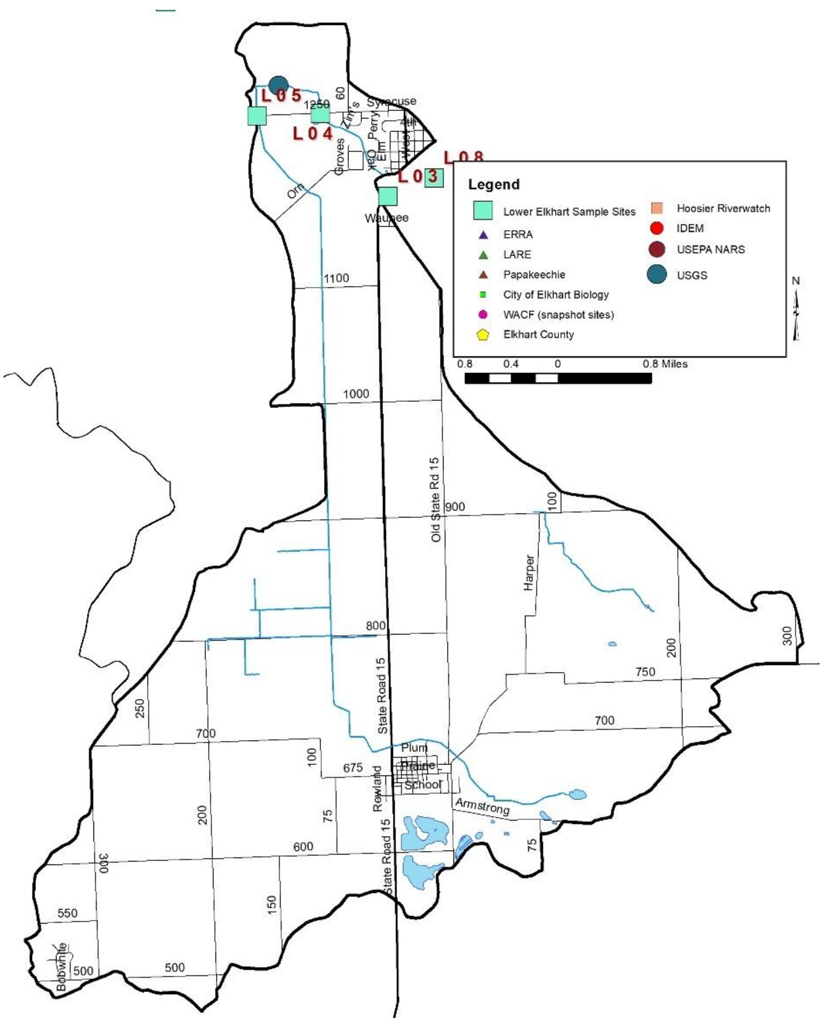


Figure 64. Locations of historic and current water quality data collection in the Coppes Ditch-Turkey Creek subwatershed.

Table 33 details historic water quality sampled collected in the Coppes Ditch-Turkey Creek subwatershed. As shown in the table, ammonia concentrations did not exceed water quality targets in any samples collected. DO concentrations exceeded water quality targets in 11% of samples collected. *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 100% of samples collected. pH levels did not exceed water quality targets in any samples collected. Total Kjeldahl nitrogen (TKN) concentrations exceed water quality targets (0.57 mg/L) in 0% of samples. TSS did not exceed water quality targets in any collected sample, while turbidity levels exceed water quality targets (5.7NTU) in 33% of collected samples. Conductivity, nitrate-nitrogen, OP, and TP were not sampled in Coppes Ditch-Turkey Creek subwatershed.

Table 33. Coppes Ditch-Turkey Creek historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.1	0	3	0%
DO	5.38	13.0	1	9	11%
E. coli	325.5	2419.0	5	5	100%
pH	7.5	8.2	0	12	0%
TKN	0.5	0.5	0	3	0%
TSS	10.0	11.0	0	3	0%
Turbidity	0.0	14.4	3	9	33%

Table 34 details water quality data collected in the Coppes Ditch-Turkey Creek Subwatershed (Site 4 and Site 5) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 58% of samples collected from Site 4 and 33% of samples collected from Site 5. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples from Site 4 and Site 5. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples from both sites, while turbidity levels exceed water quality targets (5.7 NTU) in 42% of samples from both sites. Dissolved oxygen, pH, total phosphorus and conductivity did not exceed targets in any sample collected.

Table 34. Coppes Ditch-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
4	Median	10.43	8.94	8.13	639.20	5.05	3.66	0.05	4.60	268.00
	Max	21.90	11.53	8.91	905.00	44.70	10.77	0.07	16.00	2420.00
	Min	2.70	6.51	7.93	441.60	0.85	1.31	0.05	2.00	80.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	5	12	0	1	7
	% Exceed		0%	0%	0%	42%	100%	0%	8%	58%
5	Median	10.80	7.78	7.91	856.10	4.83	3.96	0.05	5.00	135.00
	Max	19.50	11.58	8.74	870.00	24.20	10.75	0.05	18.00	921.00
	Min	4.20	5.52	7.57	508.00	1.36	1.20	0.05	0.80	10.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	5	12	0	1	4
	% Exceed		0%	0%	0%	42%	100%	0%	8%	33%

Biological monitoring was conducted by IDEM at two sites, with a fish community assessment occurring once at one site and macroinvertebrate assessments and habitat assessment occurring simultaneously at one site (Table 35). Additionally, two sites were assessed for macroinvertebrate community and habitat as part of the current project. Habitat scores ranged from 32 to 52, measuring below the state target (51) in 33% of samples. The fish community assessment scored above the target level. Macroinvertebrate multihabitat samples did not meet their aquatic life use designation in any samples.

Table 35. Coppes Ditch-Turkey Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	32	52	1	3	33%
Fish (IBI)	40	40	0	1	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	26	34	0	4	0%

4.6 Berlin Court Ditch Subwatershed

The Berlin Court Ditch subwatershed is in the western center of the Lower Elkhart River Watershed and forms the western edge of the watershed (Figure 49). The Berlin Court Ditch subwatershed lies primarily within Elkhart County, with its southern border falling in Kosciusko County (Figure 65). It encompasses one 12-digit HUC watershed: 040500011706. This subwatershed drains 11,899 acres and accounts for 6% of the total watershed area. There are 22.5 miles of stream. IDEM has classified 7.8 miles of stream as impaired for *E. coli*, nutrients, impaired biotic communities and DO.

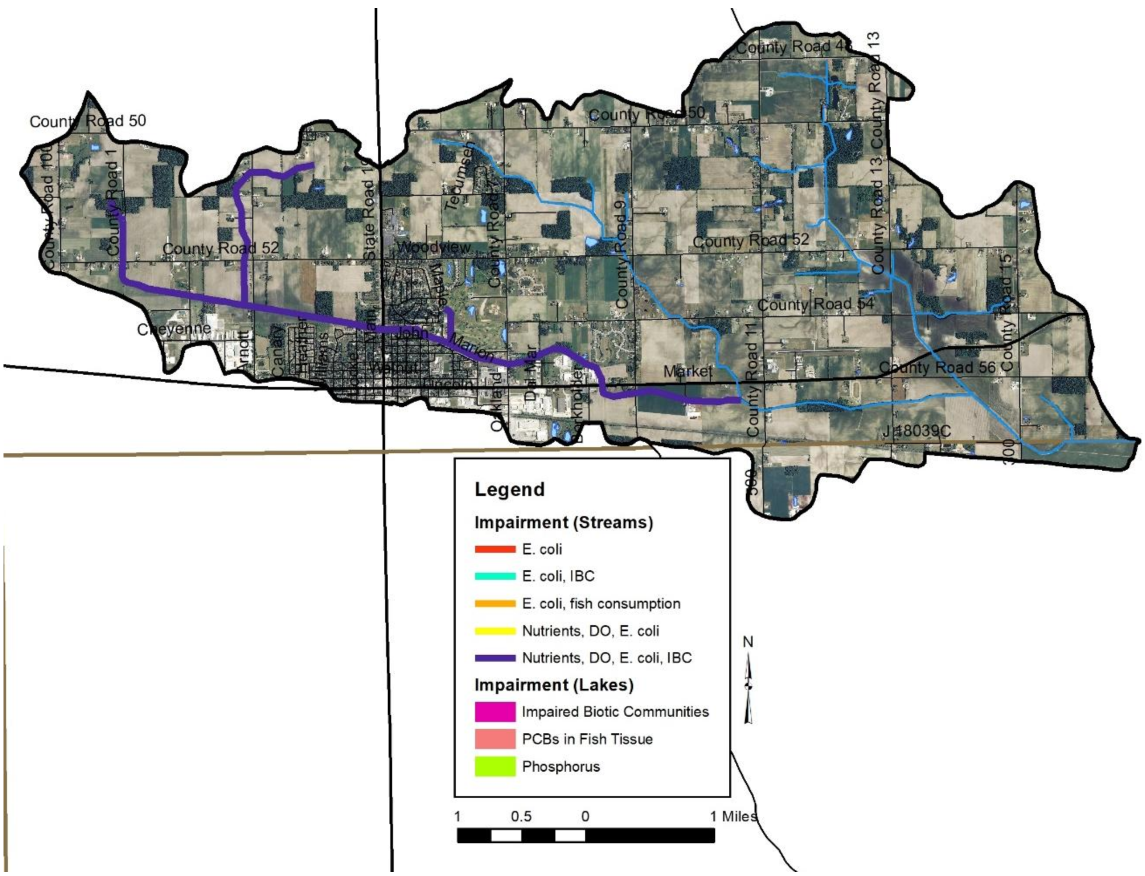


Figure 65. Impairments in the Berlin Court Ditch Subwatershed.

4.6.1 Soils

Hydric soils cover 1,191.8 acres or 10% of the subwatershed; wetlands currently cover 1.4% (168.1 acres) of the subwatershed. Highly erodible soils are prevalent throughout the subwatershed covering 4,147.4

acres or 34.9% of the subwatershed. Nearly all of the subwatershed (99% or 11,797.9 acres) has soils which are very limited for septic use.

4.6.2 Land Use

Agricultural land use covers nearly three quarters of the Berlin Court Ditch subwatershed at 74% (8,824.3 acres) with row crops and pastureland accounting for the majority of agricultural land uses. Urban land use including portions of Nappanee is the next largest use of the subwatershed, but only accounts for 19% (2,285 acres) of land use. Forest land covers 5.2% (621.4 acres) of the subwatershed. Wetlands, open water, and grassland cover just 168.1 acres, or 1.4%, of the subwatershed.

4.6.3 Point Source Water Quality Issues

There are multiple potential point sources of water pollution in the subwatershed (Figure 66). There are 32 underground storage tanks listed in this watershed, 18 of which are listed as leaking. One NPDES-permitted location is located in the Berlin Court Ditch subwatershed, the City of Nappanee wastewater treatment plant, as is the designated Nappanee MS4, which covers 1,558 acres. There are no superfund sites, corrective action sites or voluntary remediation sites located within the Berlin Court Ditch subwatershed.

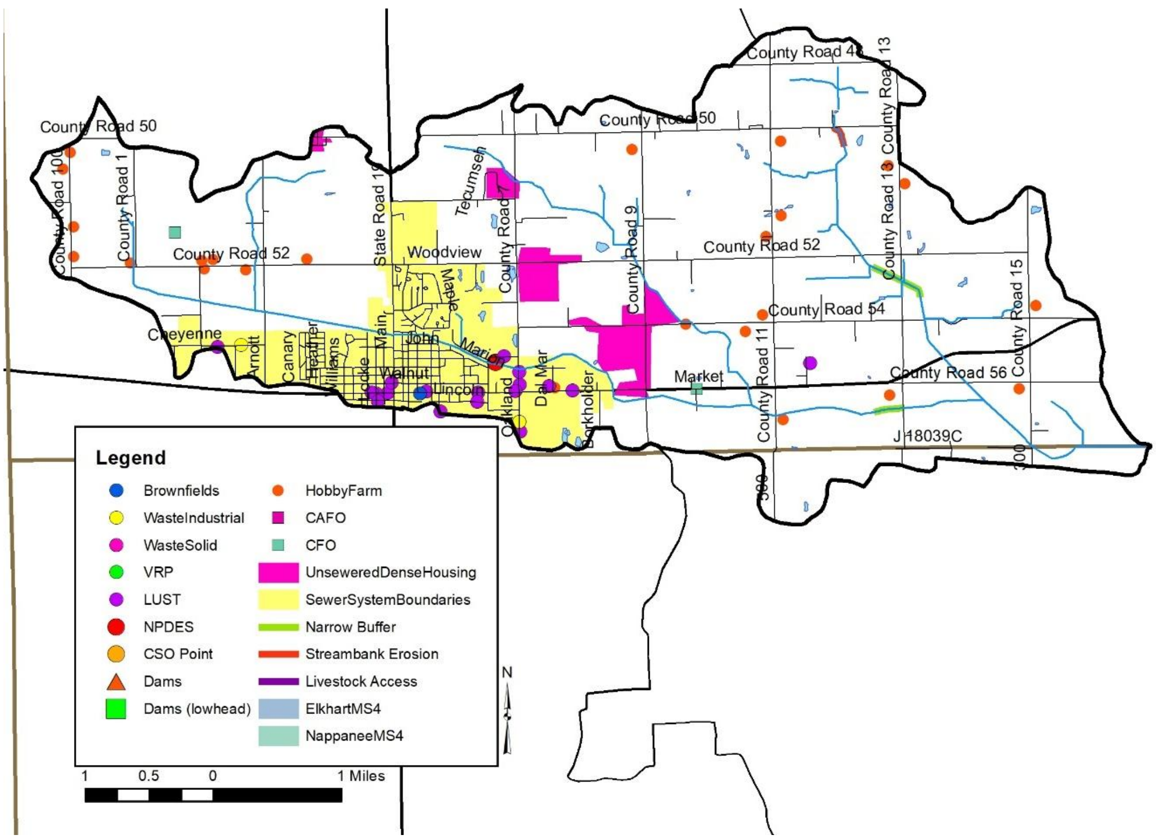


Figure 66. Potential point and non-point sources of pollution in the Berlin Court Ditch Subwatershed.

4.6.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Berlin Court Ditch subwatershed. As a result, various small animal operations and pastures are also present. Twenty-four unregulated animal operations housing more than 208 cows, horses, goat and donkeys were identified during the windshield survey. Livestock do not have access to Berlin Court Ditch subwatershed streams based on observations during the windshield survey. Two active CFOs are located in the subwatershed housing 83,000 chickens and 800 dairy cattle. In total, manure from these animal operations total over 35,111 tons per year, which contains almost 21,935,710 pounds of nitrogen, 1,773,193 pounds of phosphorus and 1.74E+19 col of *E. coli*. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 1.3 miles (6%) of insufficient stream buffers and 0.4 miles (1.7%) of streambank erosion were identified within the subwatershed.

4.6.5 Water Quality Assessment

Waterbodies within the Berlin Court Ditch subwatershed have been sampled historically at four locations (Figure 67). Two sites in the subwatershed (L07, L15) are being sampled as part of the current project. Collection of water chemistry and biological data has been conducted by IDEM (3 sites), USGS (1 site), Greater Elkhart County Stormwater Partnership (2 sites), and City of Elkhart (2 sites). No stream gages are in the Berlin Court Ditch subwatershed.

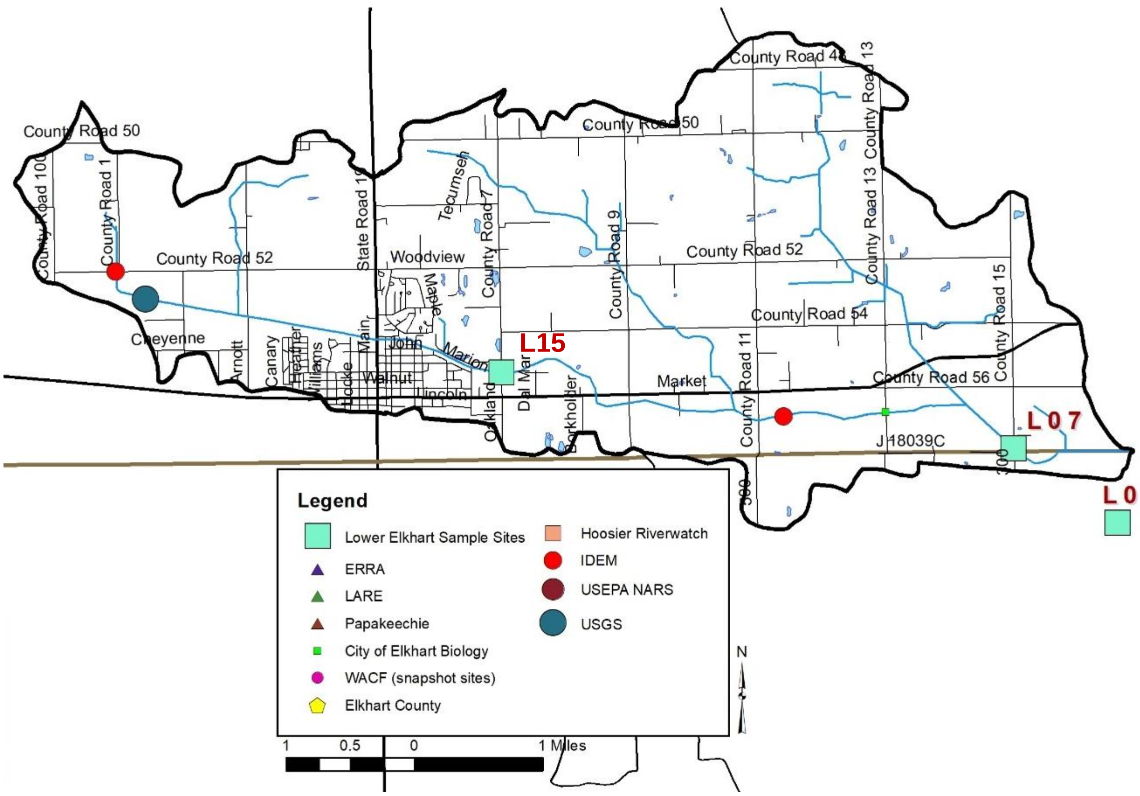


Figure 67. Locations of historic and current water quality data collection in the Berlin Court Ditch Subwatershed.

Table 36 details historic water quality sampled collected in the Berlin Court Ditch subwatershed. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 69% of samples collected. Total Kjeldahl nitrogen (TKN) concentrations exceed water quality targets (0.57 mg/L) in 100% of samples. Turbidity levels exceed water quality targets (5.7 NTU) in 33% of samples. Additionally, dissolved oxygen concentrations exceeded the lower state standard (4 mg/L) in 29% of samples collected. Ammonia exceeded water quality targets in 50% of samples. pH exceeded the upper pH state standard in 5% of samples. Total Suspended Solids (TSS) exceeded water quality targets (15 mg/L) in

23% of collected samples. Nitrate-nitrogen exceeded water quality targets (1 mg/L) in 99% of collected samples.

Table 36. Berlin Court Ditch Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.3	1	2	50%
Conductivity	124	1344	6	79	8%
DO	1.0	11.0	25	86	29%
E. coli	46.0	128,980	52	75	69%
Nitrate	0.04	17.9	75	76	99%
pH	6.1	13.4	4	82	5%
TKN	1.3	1.3	1	1	100%
TP	0.2	5.5	76	76	100%
TSS	0.9	2536.0	16	71	23%
Turbidity	0	39.5	2	6	33%

Table 37 details water quality data collected in the Berlin Court Ditch Subwatershed (Site 7 and Site 15) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 67% and 75% of samples collected from Site 7 and Site 15, respectively. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples from both sites. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples from Site 7 and 25% of samples from Site 15. Turbidity levels exceed water quality targets (5.7 NTU) in 58% of samples from Site 7 and 33% of samples collected from Site 15. Dissolved oxygen concentrations measured below water quality standards in 8% of samples collected from Site 7 and did not exceed in any samples from Site 15. Conductivity levels exceed water quality targets (1050 mg/L) in 25% and 42% of samples collected from Site 7 and Site 15, respectively. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 75% of samples collected from both sites. pH did not exceed targets in any sample collected from either site.

Table 37. Berlin Court Ditch Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
7	Median	9.53	8.63	7.97	898.60	7.15	11.39	0.13	7.60	455.50
	Max	23.30	11.28	8.62	1228.00	39.10	38.75	0.31	62.80	5490.00
	Min	2.70	1.61	7.67	552.20	1.20	1.22	0.05	2.00	110.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		1	0	3	7	12	9	2	8
	% Exceed		8%	0%	25%	58%	100%	75%	17%	67%
15	Median	11.09	8.70	8.06	1015.00	4.18	18.68	0.14	3.40	522.50
	Max	20.80	11.62	8.65	1313.00	117.80	53.29	0.32	114.40	7220.00
	Min	4.40	5.28	7.78	623.60	1.00	1.30	0.05	1.20	88.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	5	4	12	9	3	9
	% Exceed		0%	0%	42%	33%	100%	75%	25%	75%

IDEM conducted biological assessments at two sites (Table 38). Additionally, two sites were assessed for macroinvertebrate community and habitat as part of the current project. Habitat assessment and macroinvertebrate assessment were conducted simultaneously at one site by IDEM and at two sites as part of the current project. Habitat scores ranged from 20 to 47 with 75% of sites scoring below the state target (51). Macroinvertebrate assessments using the kick sampling method resulted in all sites meeting their aquatic life use designation while all sites not meeting their aquatic life use designation using the multihabitat method.

Table 38. Berlin Court Ditch Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	20	47	3	4	75%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	2.4	2.4	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	28	33	2	2	100%

4.7 Omar-Neff Ditch-Turkey Creek Subwatershed

The Omar-Neff Ditch-Turkey Creek subwatershed forms a southwestern edge of the Lower Elkhart River Watershed and lies within Kosciusko County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011707. This subwatershed drains 11,982 acres and accounts for 6% of the total watershed area. There are 25.1 miles of stream. IDEM has classified 18.5 miles of stream length in the Omar-Neff Ditch-Turkey Creek subwatershed as impaired for *E. coli* and 16.5 miles of stream length as impaired for biotic communities (Figure 68).

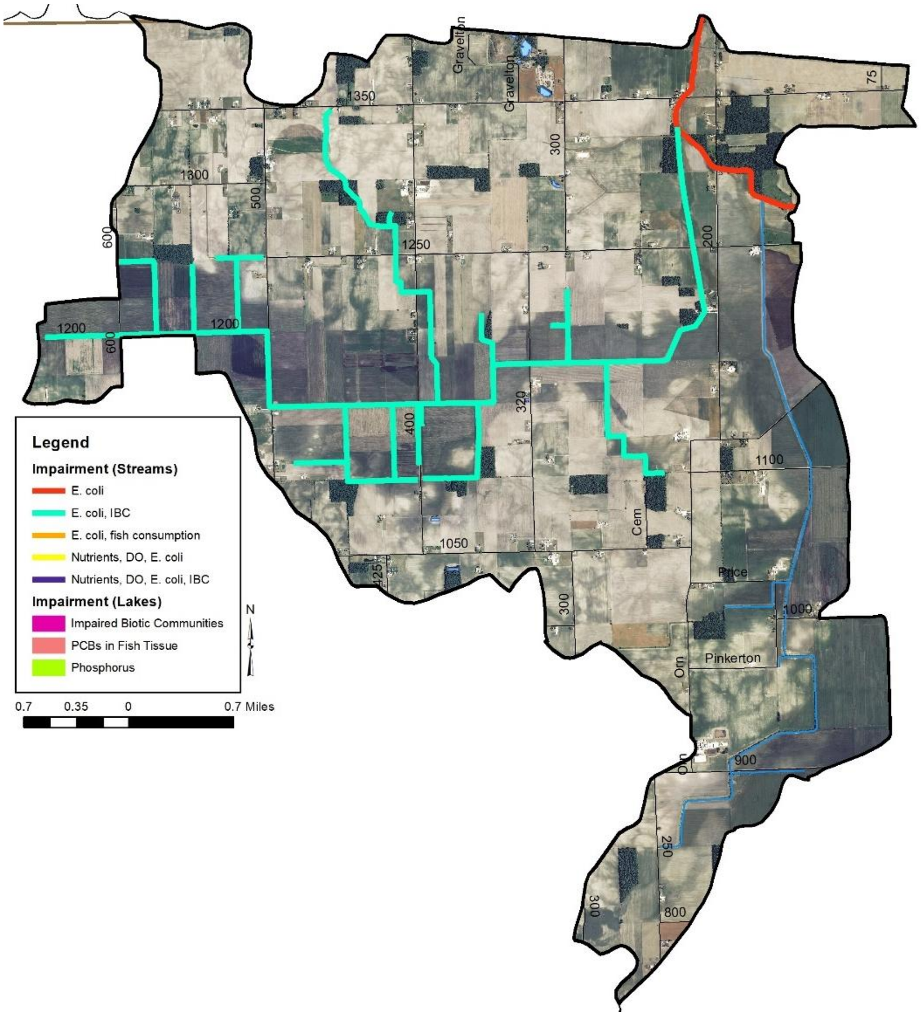


Figure 68. Impairments in the Omar-Neff Ditch-Turkey Creek Subwatershed.

4.7.1 Soils

Hydric soils cover over half (52%, or 6,276.4) of the subwatershed. Highly erodible soils cover just 7.5%, or 902.7 acres, of the subwatershed. In total, 11,932.3 acres (99.6%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.7.2 Land Use

Agricultural land use is the prevalent land use in the Omar Neff Ditch-Turkey Creek subwatershed, with 91.8% (11,002.5 acres) of land used for agriculture. Forest land use covers 2.4% of land in the subwatershed, or 286.3 acres. Wetlands, open water, and grass land cover only 1.6% (192.0 acres) of land in the subwatershed. Urban land covers the remaining 4.2% (501.8 acres) of land in the subwatershed.

4.7.3 Point Source Water Quality Issues

There are no potential point sources of water pollution in the Omar Neff Ditch-Turkey Creek subwatershed.

4.7.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Omar Neff Ditch-Turkey Creek subwatershed. Sixteen unregulated animal operations housing more than 592 cows and horses were identified during the windshield survey. Livestock do not appear to have access to streams in the subwatershed based on windshield surveys. There are eight active CAFOs/CFOs housing 10 beef cattle, 5 horses, 1,585 dairy cattle and 22,683 pigs in the subwatershed. In total, manure from all animal operations total over 140,577 tons per year, which contains almost 301,272 pounds of nitrogen, 221,730 pounds of phosphorus and 5.27E+16 colonies of *E. coli*. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 0.2 miles (1%) of insufficient stream buffers and 0.4 miles (1.6%) of streambank erosion were identified within the subwatershed.

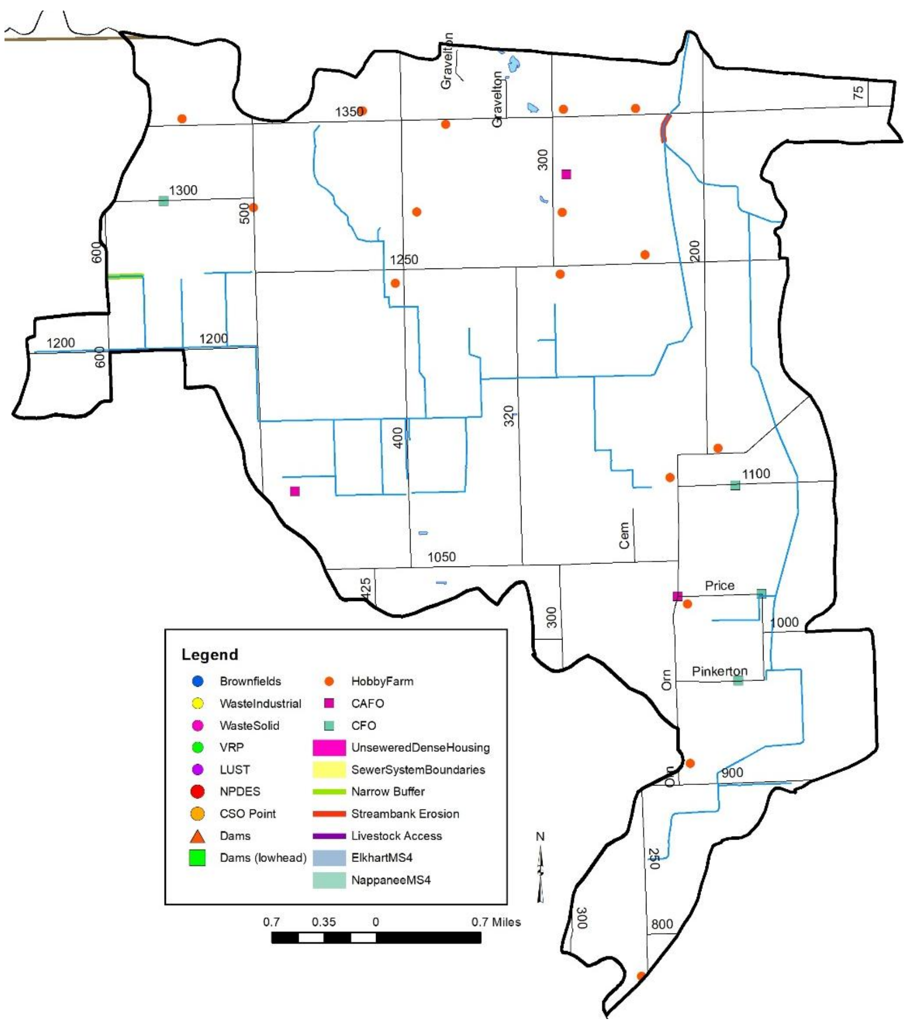


Figure 69. Potential non-point sources of pollution in the Omar Neff Ditch-Turkey Creek Subwatershed.

4.7.5 Water Quality Assessment

Waterbodies within the Omar Neff Ditch-Turkey Creek subwatershed have been sampled historically at three locations (Figure 70). One site in the subwatershed (L06) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (2 sites), USGS (1 site) and HRW (1 site).

Table **39** details historic water chemistry data collected in the Omar Neff Ditch-Turkey Creek subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 40% of samples collected. DO concentrations exceed water quality targets in 50% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 73% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 63% of samples. TSS levels exceed water quality targets (15 mg/L) in 38% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. OP was not sampled in the Omar Neff Ditch-Turkey Creek subwatershed.

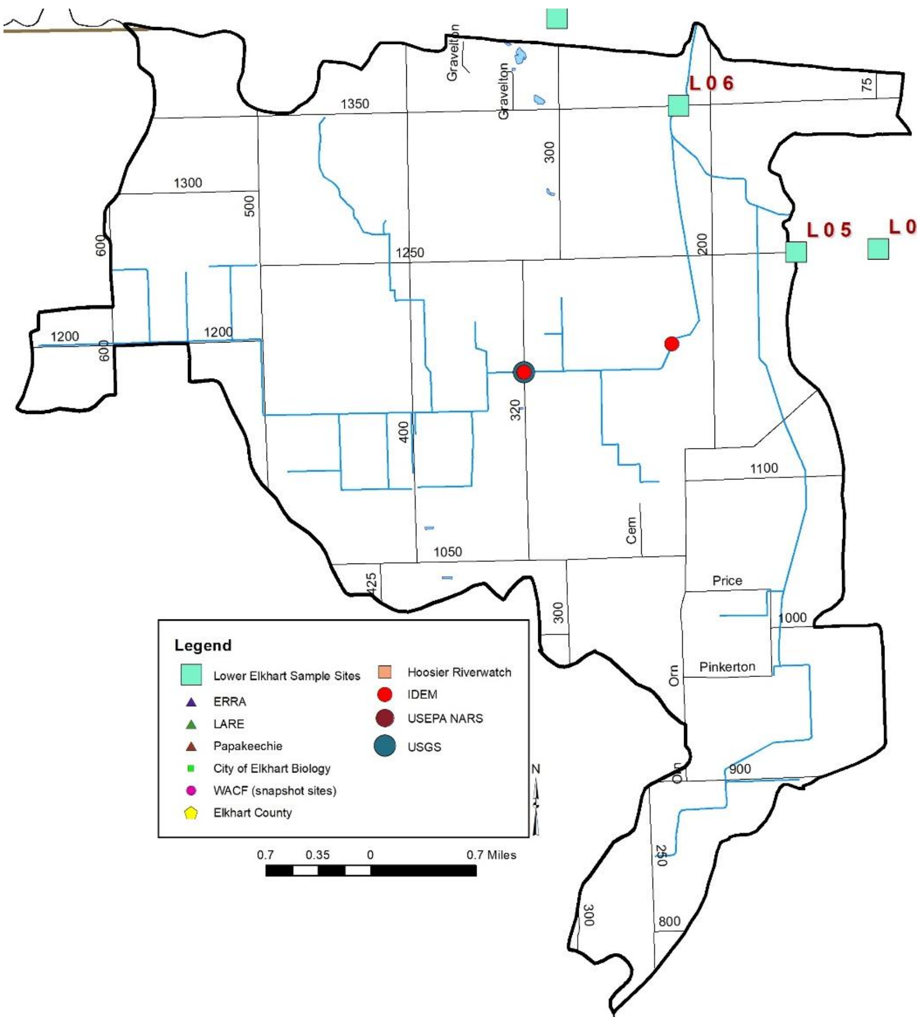


Figure 70. Locations of historic and current water quality data collection in the Omar Neff Ditch-Turkey Creek Subwatershed.

Table 39. Omar Neff Ditch-Turkey Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.27	2	5	40%
DO	0.33	12.0	9	18	50%
E. coli	90.7	816	8	11	73%
Nitrate	4.5	13.0	5	5	100%
pH	7.0	8.2	0	21	0%
TKN	0.5	2.5	5	8	63%
TSS	6.0	94.0	3	8	38%
Turbidity	0.0	141.0	9	18	50%

Table 40 details water quality data collected in the Omar Neff Ditch-Turkey Creek Subwatershed (Site 6) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 58% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Dissolved oxygen, pH, total phosphorus and conductivity did not exceed targets in any sample collected.

Table 40. Omar Neff Ditch-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
6	Median	11.06	8.36	8.10	706.50	5.90	2.70	0.05	6.20	285.00
	Max	21.20	11.29	8.67	833.00	16.51	12.48	0.05	17.60	866.00
	Min	3.30	6.37	7.19	415.00	1.36	0.80	0.05	2.40	68.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	6	11	0	1	7
	% Exceed		0%	0%	0%	50%	92%	0%	8%	58%

Biological monitoring was conducted by the City of Elkhart at four sites with three sites assessed for fish and four sites assessed for habitat and by IDEM at one site for macroinvertebrates (Table 41). Additionally, one site was assessment for macroinvertebrate community and habitat as part of the current project. Habitat assessment occurred a total of six times and resulted in scores ranging from 31 to 63. In total, 33% of sites did not reach the state target of 51 for habitat assessment. Fish community assessments scores ranged from 12 to 42, with 33% of sites not reaching the target of 36. The macroinvertebrate assessment covering multiple habitats did not measure to the state target of 36 during 67% of assessments.

Table 41. Omar Neff Ditch-Turkey Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	31	63	2	6	33%
Fish (IBI)	12	42	1	3	33%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	24	38	2	3	67%

4.8 Dausman Ditch-Turkey Creek Subwatershed

The Dausman Ditch-Turkey Creek subwatershed lies in the middle of the Turkey Creek drainage forming as small portion of the western border of the Lower Elkhart River Watershed. The Dausman Ditch-Turkey Creek subwatershed lies within Kosciusko and Elkhart Counties (Figure 49). This subwatershed drains 19,014 acres and accounts for 8% of the total watershed. It encompasses one 12-digit HUC watershed: 040500011708. There are 44.2 miles of stream. IDEM has identified 35.3 miles of stream length as impaired for *E. coli* and 23.5 miles as impaired for biotic communities (Figure 71).

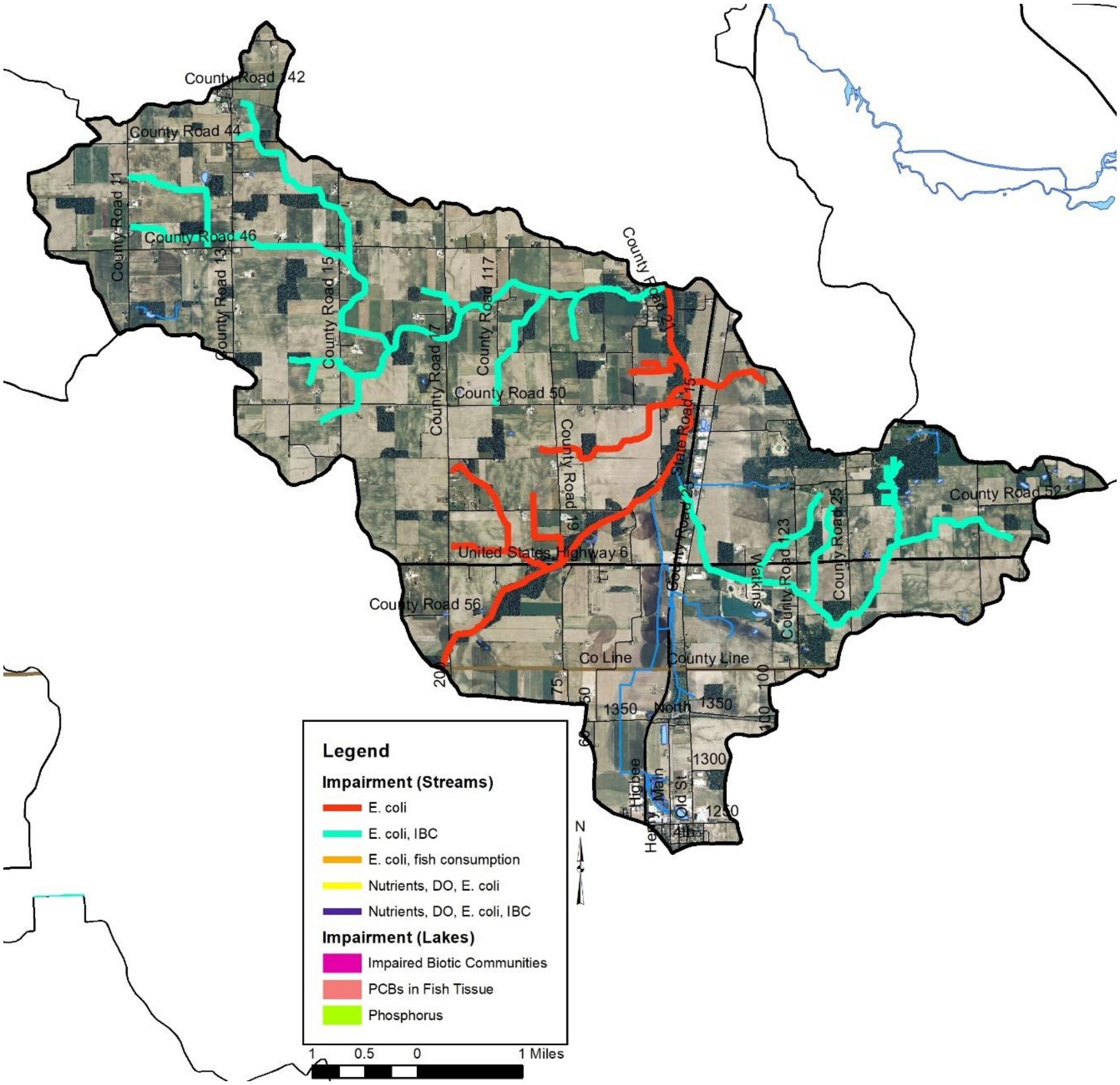


Figure 71. Impairments in Dausman Ditch-Turkey Creek Subwatershed.

4.8.1 Soils

Hydric soils cover 2,074.4 acres (10.9%) of the subwatershed. Highly erodible soils cover 31.5% of the subwatershed (5,983.8 acres). A majority of the entire subwatershed, 18,783.0 acres (98.8%) are identified as very limited for septic use.

4.8.2 Land Use

Agricultural land use is the prevalent land use in the Dausman Ditch-Turkey Creek subwatershed with 82.4% (15,663.7 acres) in agricultural land uses. Approximately 8% (1,534.6 acres) of the subwatershed is in urban land use including portions of the Town of Milford and much of the State Road 15 corridor south of US. Highway 6. Forested land use covers 5%, or 952.9 acres, of the subwatershed. Wetland, open water, and grass land use accounts for 4.5% (863.4 acres) of the subwatershed.

4.8.3 <u>Point Source Water Quality Issues</u>

There are ten potential sources of water pollution in the Dausman Ditch-Turkey Creek subwatershed (Figure 72). Three leaking underground storage tanks, one brownfield and two industrial waste sites are located within the subwatershed. Four underground storage tanks not classified as leaking are also in the subwatershed. The Elkhart County MS4 covers a small portion of this subwatershed (5.6 acres).

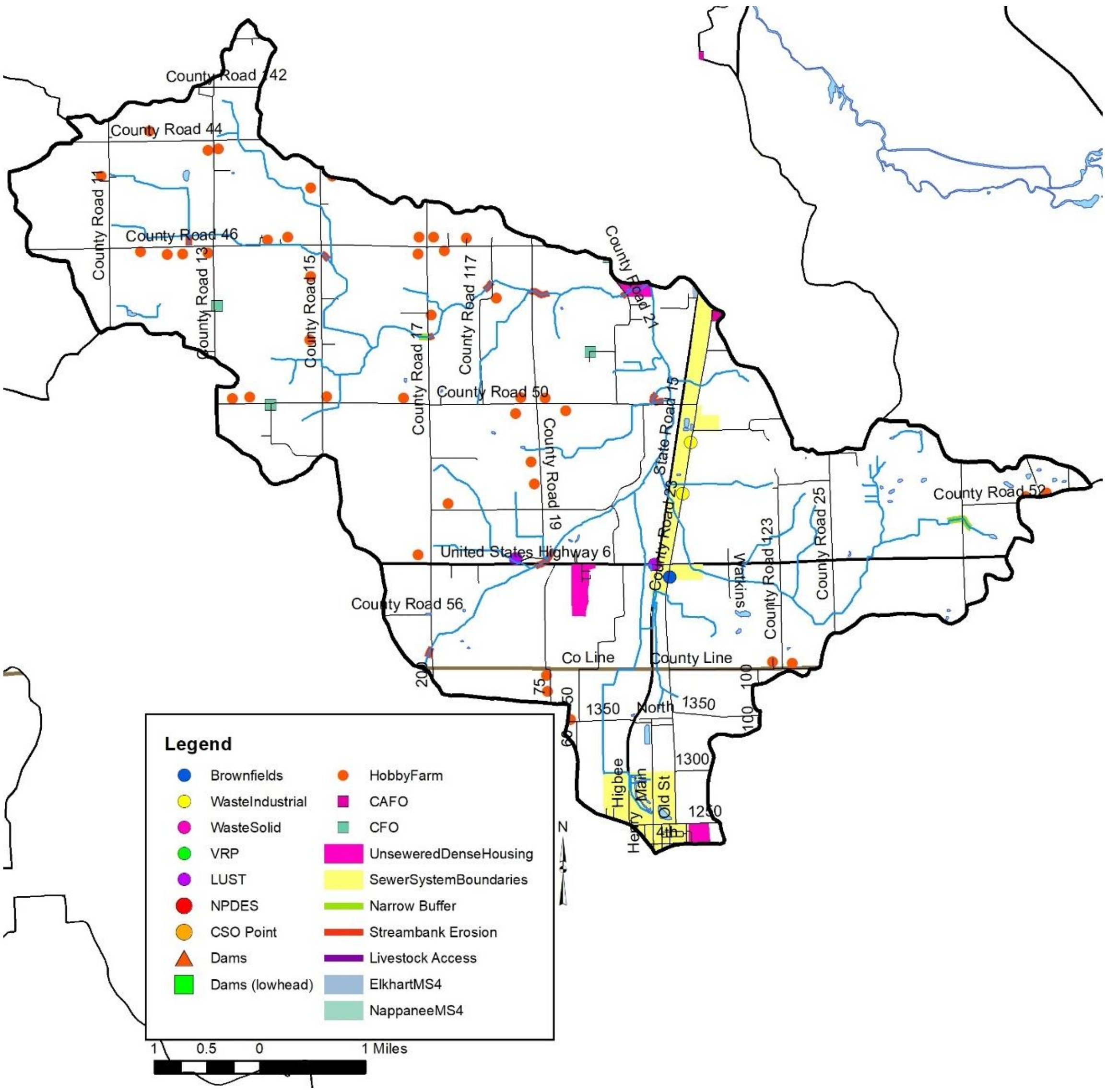


Figure 72. Potential point and non-point sources of pollution in the Dausman Ditch-Turkey Creek Subwatershed.

4.8.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Dausman Ditch-Turkey Creek subwatershed. Additionally, nearly 40 unregulated animal operations housing more than 1,242 cows, horses and sheep were identified during the windshield survey. Based on windshield survey observations, livestock do not have access to subwatershed streams. There are four active CFOs/CAFOs in the Dausman Ditch-Turkey Creek subwatershed housing 8,790 pigs and 100 dairy cattle. In total, manure from these animal operations total over 64,799 tons per year, which contains almost 122,418 pounds of nitrogen, 88,773 pounds of phosphorus and 2.09E+16 colonies of *E. coli*. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 0.7 miles (1.5%) of insufficient stream buffers and 2.6 miles (6%) of streambank erosion were identified within the subwatershed.

4.8.5 Water Quality Assessment

Waterbodies within Dausman Ditch-Turkey Creek subwatershed have been sampled at 18 locations. One site (L09) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (7 sites), Greater Elkhart County Stormwater Partnership (6 sites), City of Elkhart (2 sites), Hoosier Riverwatch (4 sites), Goshen (6 sites), and USGS (1 site). No stream gages are in the Dausman Ditch-Turkey Creek subwatershed.

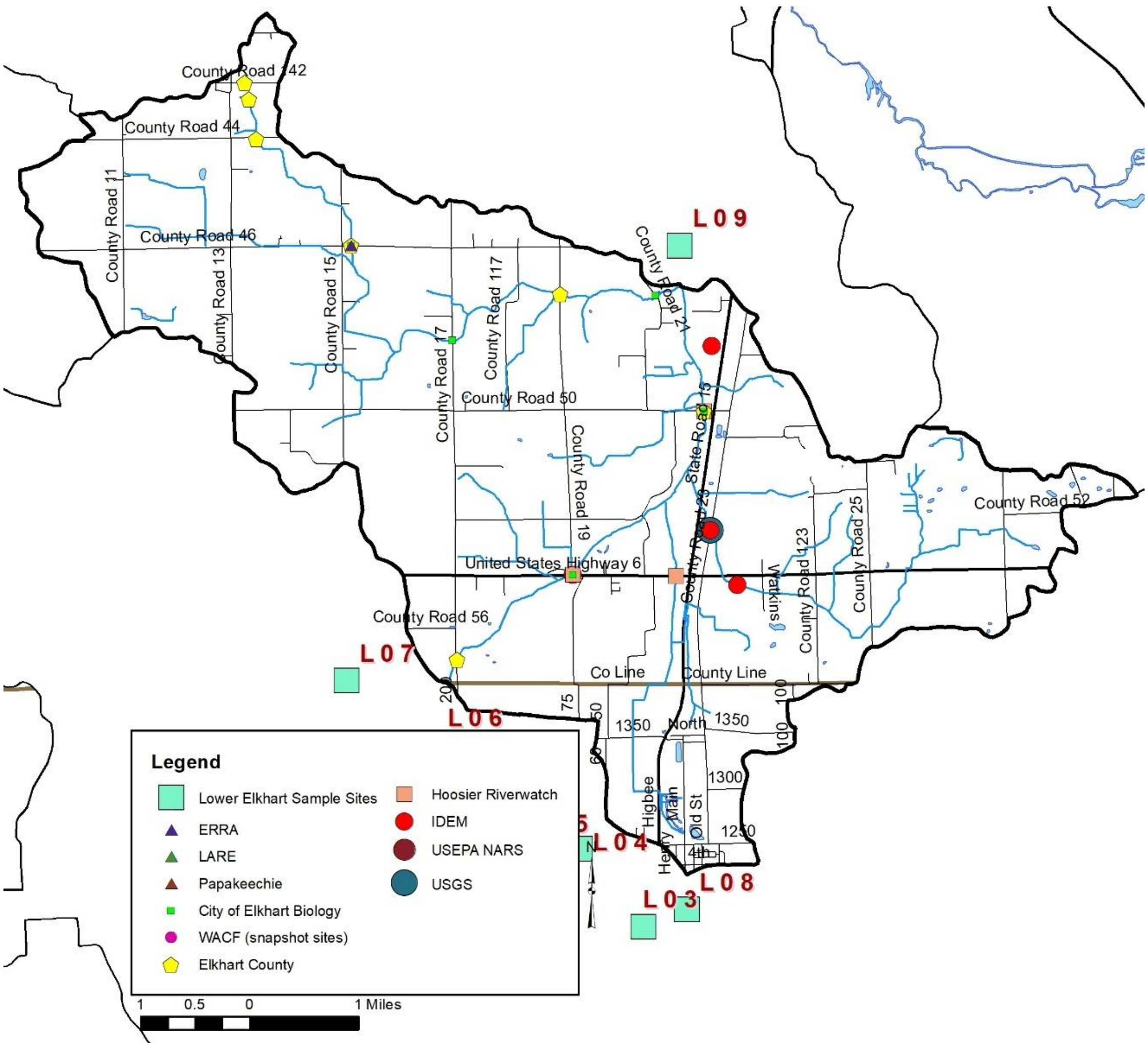


Figure 73. Locations of historic and current water quality data in Dausman Ditch-Turkey Creek Subwatershed.

Table 42 details historic water chemistry data. Ammonia concentrations did not exceed water quality targets in any samples collected. Conductivity concentrations exceed water quality targets (1050 mg/L) in 16% of samples collected. DO concentrations exceed water quality targets in 24% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 83% of samples collected.

Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 83% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 67% of samples. pH exceeded target samples in 3% of samples collected. Orthophosphorus concentrations exceed water quality targets (0.03 mg/L) in 80% of samples collected. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 99% of samples. TSS levels exceed water quality targets (15 mg/L) in 39% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 57% of samples.

Table 42. Dausman Ditch-Turkey Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.10	0.10	0	3	0%
Conductivity	9	3102	83	520	16%
DO	0.01	14.0	133	544	24%
E. coli	4.0	3,465,800.0	422	510	83%
Nitrate	0.0	26.3	431	521	83%
OP	0.0	1.5	4	5	80%
pH	5.3	12.5	16	533	3%
TKN	0.5	0.86	2	3	67%
TP	0.027	14.4	527	535	99%
TSS	1.0	10,690.0	172	439	39%
Turbidity	0.0	425.0	12	21	57%

Table 43 details water quality data collected in the Dausman Ditch-Turkey Creek Subwatershed (Site 9) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 58% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 42% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% of samples collected. Dissolved oxygen, pH and conductivity did not exceed targets in any sample collected.

Table 43. Dausman Ditch-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
9	Median	11.06	8.79	8.12	732.00	3.31	2.43	0.05	4.80	254.50
	Max	21.10	11.38	8.81	827.00	14.77	10.17	0.10	25.20	1070.00
	Min	3.80	6.92	7.96	413.00	0.10	0.29	0.05	1.20	101.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	5	11	1	1	7
	% Exceed		0%	0%	0%	42%	92%	8%	8%	58%

Biological monitoring was conducted by the City of Elkhart and IDEM at 12 sites in total (Table 44). Fish community assessments occurred at four sites and macroinvertebrate assessments occurred at three sites in total. Additionally, one site was assessment for macroinvertebrate community and habitat as part of the current project. Habitat scores ranged from 38 to 72, with 13% of sites scoring below the state target (51). Fish community assessments scored below the target level in 25% (1 of 4) of sites assessed.

Macroinvertebrate assessments using the kick sampling method and macroinvertebrate multihabitat samples did not meet their aquatic life use designation, with 67% of assessments not reaching target values.

Table 44. Dausman Ditch-Turkey Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	38	72	2	15	13%
Fish (IBI)	14	46	1	4	25%
Macroinvertebrates (mIBI, Kick)	1.6	1.6	1	1	100%
Macroinvertebrates (mIBI, Multi Habitat)	24	38	2	3	67%

4.9 Swoveland Ditch-Turkey Creek Subwatershed

The Swoveland Ditch-Turkey Creek subwatershed forms a central portion of the Lower Elkhart River Watershed and lies between Elkhart and Kosciusko counties (Figure 49). It encompasses one 12-digit HUC watershed: 040500011709. This subwatershed drains 11,748 acres and accounts for 6% of the total watershed area. There are 35.2 miles of stream. IDEM has classified 10.9 miles of stream as impaired for *E. coli* (Figure 74).

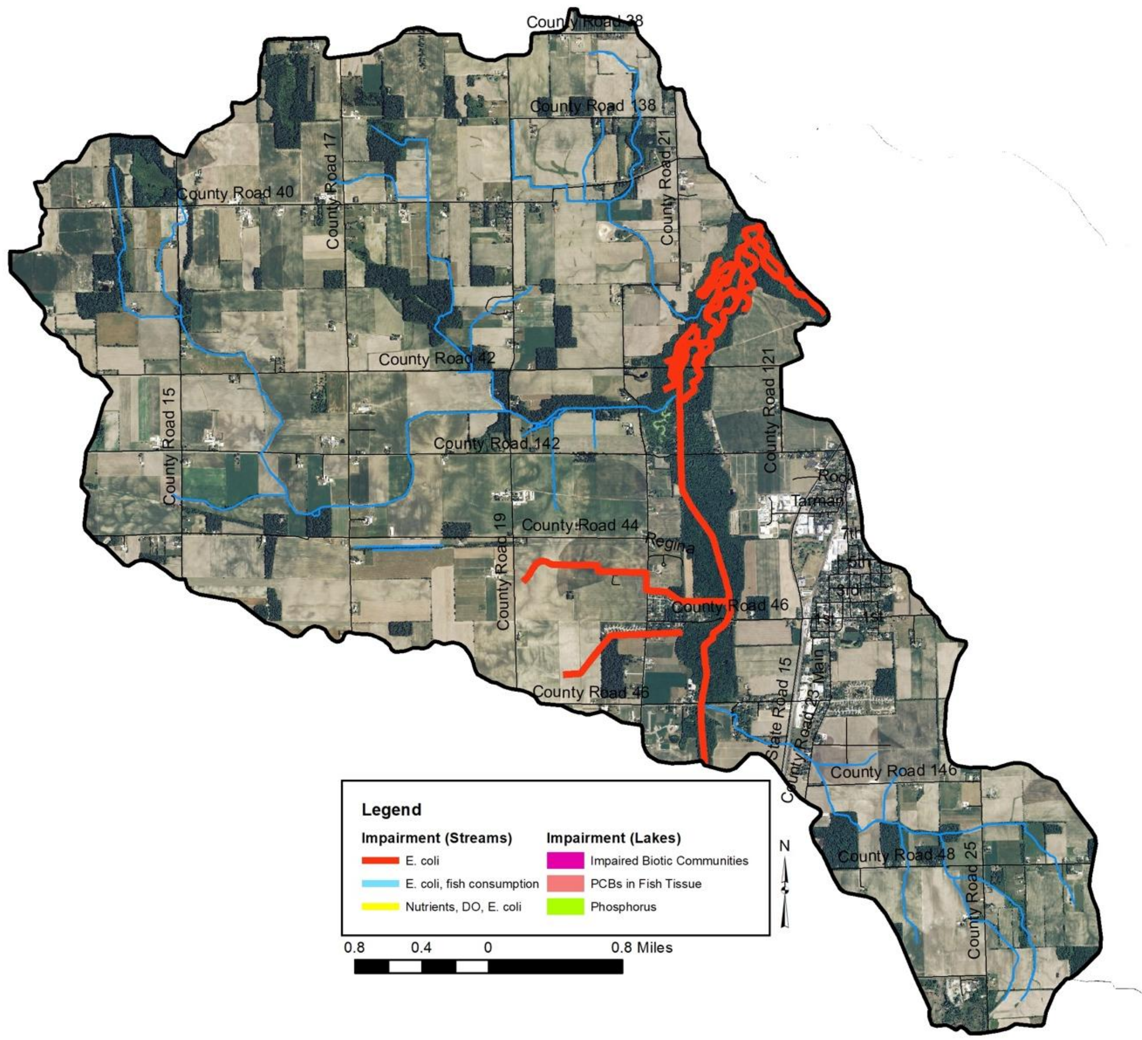


Figure 74. Impairments in the Swoveland Ditch-Turkey Creek Subwatershed.

4.9.1 Soils

Hydric soils cover 1,686.9 acres (14%) of the subwatershed. Highly erodible soils cover 41% of the subwatershed, or 4,813.6 acres. In total, almost all of the subwatershed (99%, or 11,600.0 acres) is identified as very limited for septic use. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity.

4.9.2 Land Use

Agricultural land use is the majority land use in the Swoveland Ditch-Turkey Creek subwatershed covering 76.9% (9,032.5 acres) of land in the subwatershed. Urban land use covers 9.3% (1,087.8 acres) of the subwatershed. Forest land use makes up 4.9% or 576.2 acres of this subwatershed. Wetlands, open water, and grassland cover 1,052.0 acres, or 9%, of the subwatershed.

4.9.3 Point Source Water Quality Issues

There are multiple potential sources of water quality issues in the Swoveland Ditch-Turkey Creek subwatershed. There are four leaking underground storage tanks, two brownfields, and one industrial waste site in the subwatershed. Additionally, ten underground storage tanks identified as not leaking are in the subwatershed. The Elkhart County MS4 is also located within this subwatershed covering 1,248 acres.

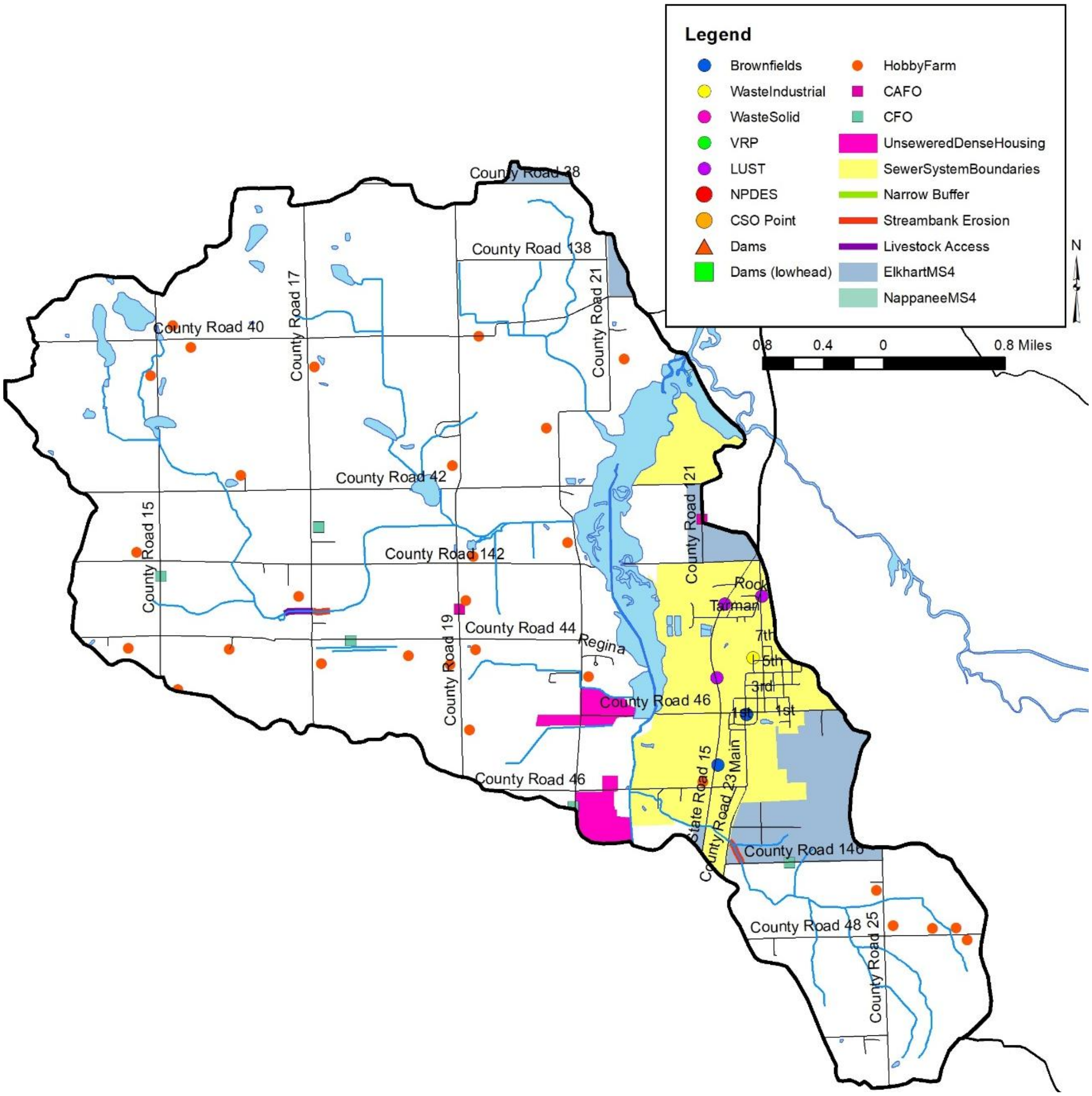


Figure 75. Potential point and non-point sources of pollution in the Swoveland Ditch-Turkey Creek subwatershed.

4.9.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Swoveland Ditch-Turkey Creek subwatershed. Additionally, a number of small animal operations and confined feeding operations are also present. Nearly 30 unregulated animal operations housing more than 541 cows, horses, goats, and pigs were identified during the windshield survey. Seven active CFOs/CAFOs housing 6 beef cattle, 27,000 chickens, 10,632 pigs, and 400 veal calves are located within the Swoveland Ditch-Turkey Creek subwatershed. Manure from animal operations total over 98,925 tons per year, which contains almost 7,242,561 pounds of nitrogen, 5,856,572 pounds of phosphorus and 5.65E+19 colonies of *E. coli*. Livestock appear to have access to 0.4 miles (1.1%) the subwatershed streams based on windshield survey observations. Streambank erosion is a concern in the subwatershed. Approximately 0.6 miles (1.7%) of streambank erosion were identified within the subwatershed.

4.9.5 Water Quality Assessment

Waterbodies within the Swoveland Ditch-Turkey Creek subwatershed have been sampled historically at eight locations (Figure 76). One site (L10) in the subwatershed is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (2 sites), Elkhart WMP (1 site), Greater Elkhart County Stormwater Partnership (4 sites), and City of Elkhart (4 site). No stream gages are in the Swoveland Ditch-Turkey Creek subwatershed.

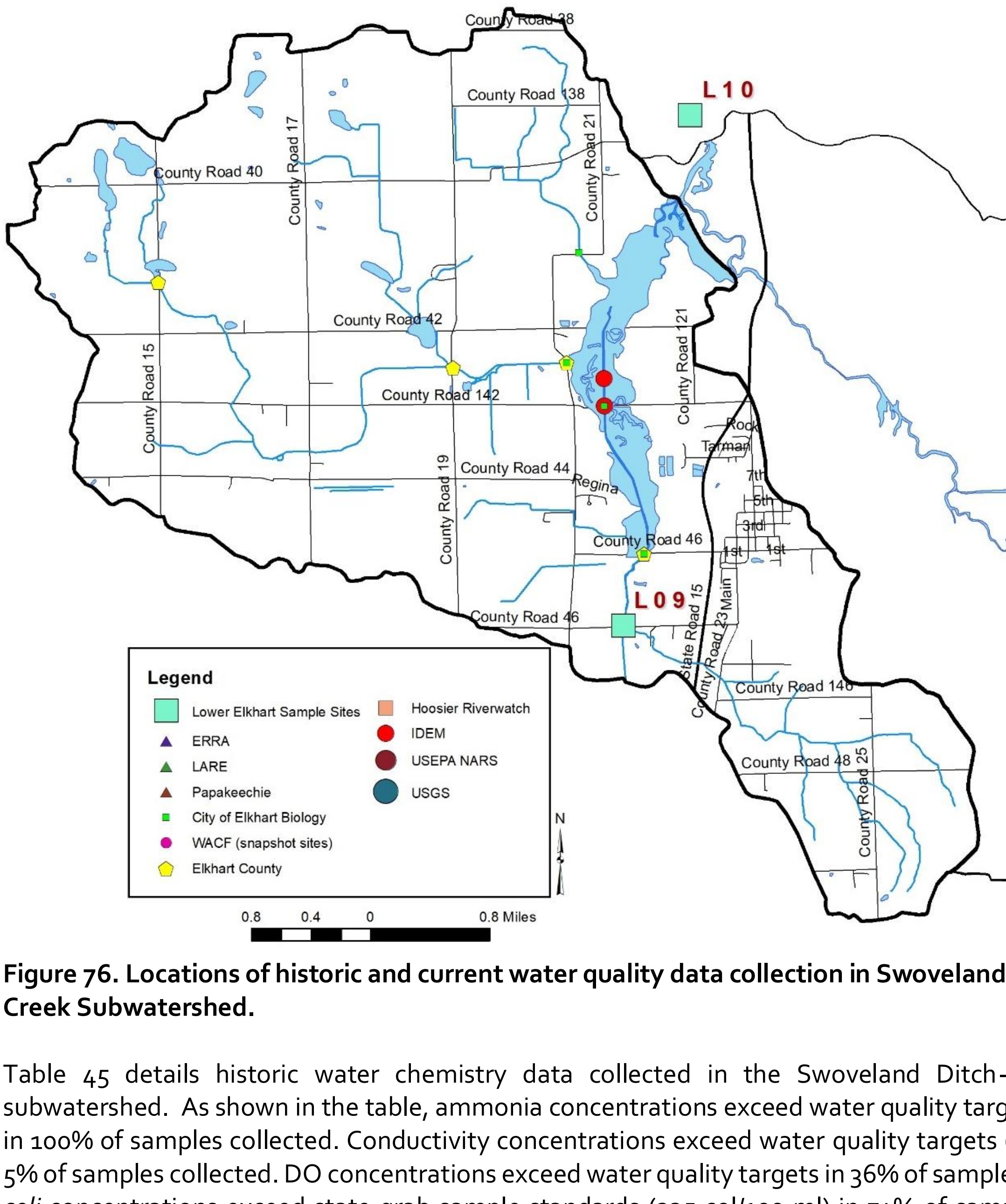


Figure 76. Locations of historic and current water quality data collection in Swoveland Ditch-Turkey Creek Subwatershed.

Table 45 details historic water chemistry data collected in the Swoveland Ditch-Turkey Creek subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 100% of samples collected. Conductivity concentrations exceed water quality targets (1050 mg/L) in 5% of samples collected. DO concentrations exceed water quality targets in 36% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 74% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 83% of samples, while total

Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 80% of samples. pH levels exceed water quality targets in 1% of samples collected. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 34% of samples. TSS levels exceed water quality targets (15 mg/L) in 26% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 42% of samples. OP was not sampled in Swoveland Ditch-Turkey Creek subwatershed.

Table 45. Swoveland Ditch-Turkey Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.29	0.29	1	1	100%
Conductivity	6	2,090.0	11	212	5%
DO	0.40	17.0	80	223	36%
E. coli	8.0	120,980	154	208	74%
Nitrate	0.07	24.4	177	214	83%
pH	4.9	9.2	2	219	1%
TKN	0.39	2.9	4	5	80%
TP	0.046	9.31	76	222	34%
TSS	0.73	460.0	49	191	26%
Turbidity	0.0	135.0	5	12	42%

Table 46 details water quality data collected in the Swoveland Ditch-Turkey Creek Subwatershed (Site 10) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 100% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 83% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% of samples collected. Dissolved oxygen, pH and conductivity did not exceed targets in any sample collected.

Table 46. Swoveland Ditch-Turkey Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mg/L)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
10	Median	11.76	9.39	8.27	640.50	5.72	2.58	0.05	10.00	140.00
	Max	21.80	11.46	8.91	782.00	221.00	6.36	0.09	15.20	910.00
	Min	2.70	6.89	8.03	492.30	0.70	0.60	0.05	2.00	60.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	6	10	1	1	12
	% Exceed		0%	0%	0%	50%	83%	8%	8%	100%

Biological monitoring was conducted by the City of Elkhart at one site. Additionally, one site was assessment for macroinvertebrate community and habitat as part of the current project. Habitat assessment occurred twice and resulted in 50% of assessments not reaching the state target of 51 (Table 47). Macroinvertebrate assessments indicate the Elkhart River at CR 40 does not meet its aquatic life use designation.

Table 47. Swoveland Ditch-Turkey Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	34	47.5	1	2	50%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	24	24	1	1	100%

4.10 Hoover Ditch-Rock Run Creek Subwatershed

The Hoover Ditch-Rock Run Creek subwatershed forms the northeastern corner of the Lower Elkhart River Watershed and lies entirely in Elkhart County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011901. It drains 13,673 acres and accounts for 7% of the total watershed area. There are 35.8 miles of stream. IDEM has classified 18.5 miles of stream as impaired for *E. coli* (Figure 77).

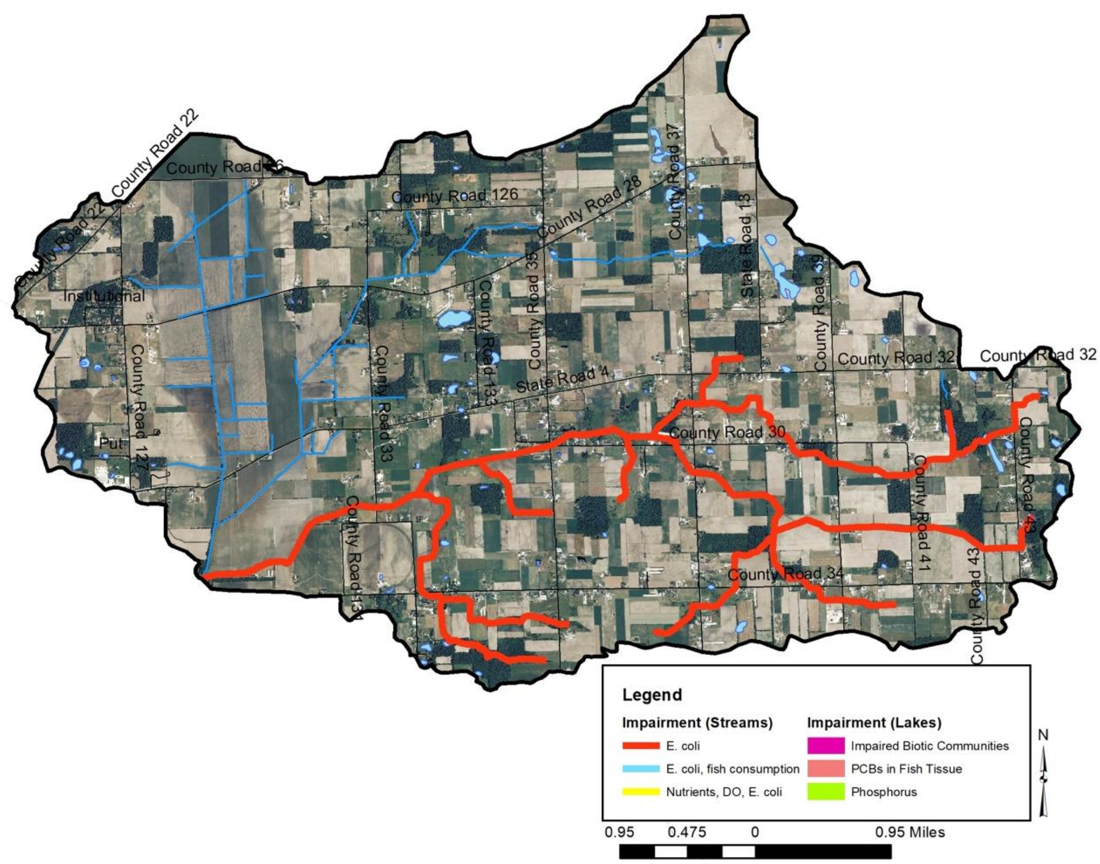


Figure 77. Impairments in the Hoover Ditch-Rock Run Creek Subwatershed.

4.10.1 Soils

Hydric soils cover 1,506.8 acres (11%) of the subwatershed. Highly erodible soils cover 5,262.5 acres (38.5%) of the subwatershed. In total, almost all of the subwatershed (99.9%, or 13,657.4 acres) is identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.10.2 Land Use

Agricultural land use covers a majority of the Hoover Ditch-Rock Run Creek subwatershed with 82.8% (11,327.3 acres) in agricultural land usage. Urban land use accounts for 7% (963.9 acres) of the subwatershed. Additionally, forest land use covers 5% (689.0 acres) and wetlands, open water, and grassland cover 5.1% (693.5 acres) of the subwatershed.

4.10.3 Point Source Water Quality Issues

There are very few potential point sources of water pollution in the Hoover Ditch-Rock Run Creek subwatershed (Figure 78. Potential point and non-point sources of pollution in the Hoover Ditch-Rock Run Creek Subwatershed.). There is one underground storage tank not identified as leaking in the subwatershed. Approximately 400 acres of City of Goshen MS4 are located in the subwatershed.

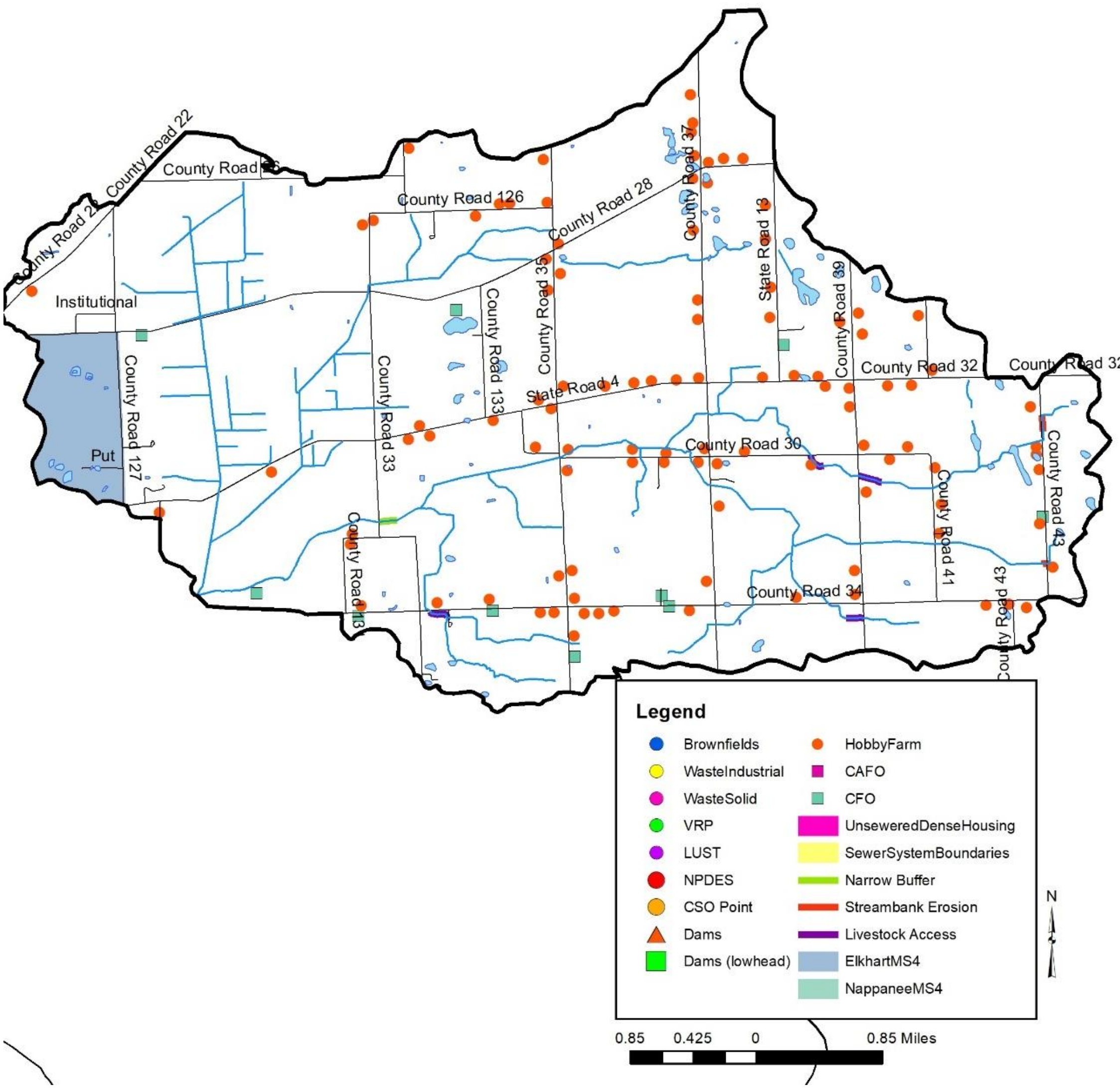


Figure 78. Potential point and non-point sources of pollution in the Hoover Ditch-Rock Run Creek Subwatershed.

4.10.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Hoover Ditch-Rock Run Creek subwatershed. During the windshield survey, more than 100 unregulated animal operations housing more than 331 cows, horses, goats and sheep were identified. Livestock have access to 1.1 miles (3.1%) of subwatershed streams. There are ten active CFOs within the Hoover Ditch Rock Run Creek subwatershed housing 220 beef cattle, 248,800 chickens, 177 dairy cattle, 73 horses, and 6,812 pigs. In total, manure from all animal operations total over 87,673 tons per year, which contains almost 6,641,034 pounds of nitrogen, 5,370,062 pounds of phosphorus and 5.21E+19 colonies of *E. coli*. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 0.2 miles (0.7%) of insufficient stream buffers and 0.3 miles (0.9%) of streambank erosion were identified within the subwatershed.

4.10.5 Water Quality Assessment

Waterbodies within the Hoover Ditch-Rock Run Creek subwatershed have been sampled historically at six locations. One site (L12) in the subwatershed is being sampled as part of the current project Historic assessments include collection of water chemistry and biology data by IDEM (4 sites), USGS (1 site), and Greater Elkhart County Stormwater Partnership (1 site). No stream gages are in the Hoover Ditch-Rock Run Creek subwatershed.

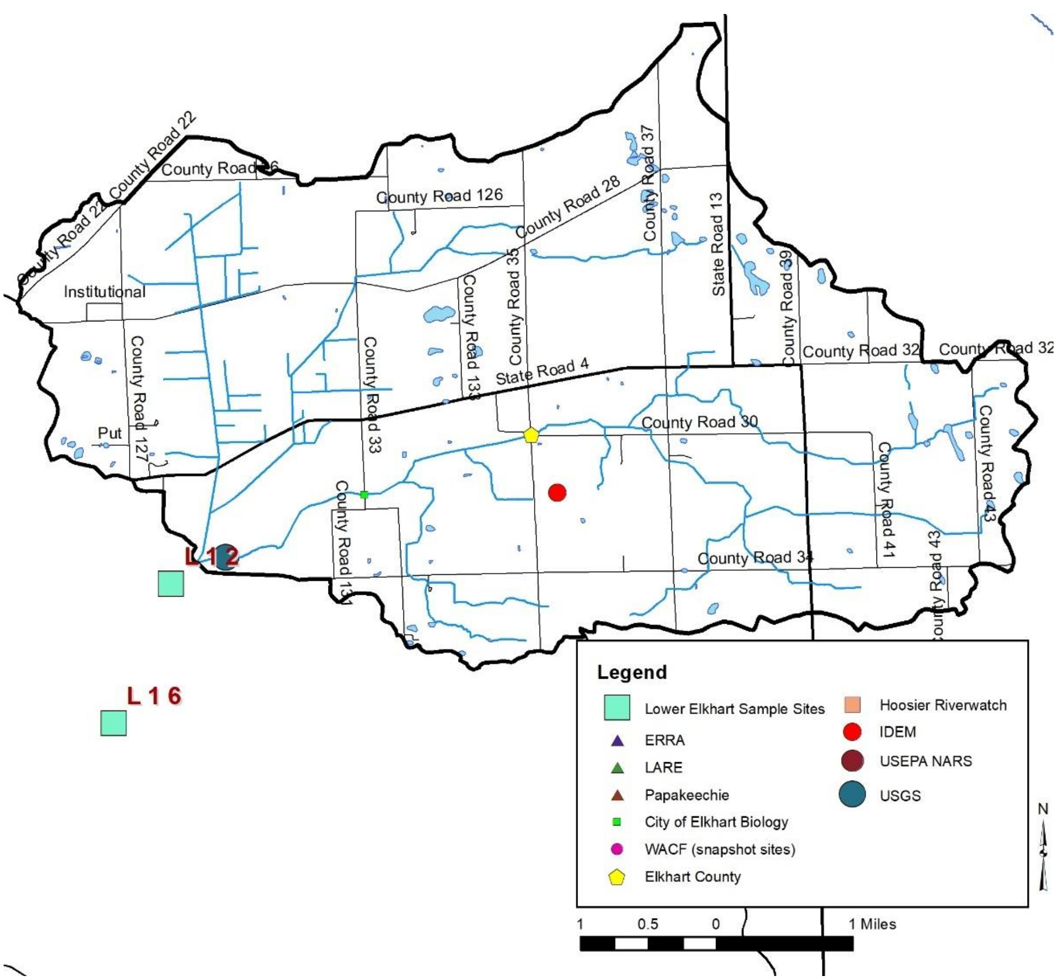


Figure 79. Locations of historic and current water quality data collection in the Hoover Ditch-Rock Run Creek Subwatershed.

Table 48 details historic water chemistry data collected in the Hoover Ditch-Rock Run Creek subwatershed. As shown in the table, ammonia and pH concentrations did not exceed water quality targets in any samples collected. DO concentrations exceed water quality targets in 18% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 100% of samples collected. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 50% of samples. TSS levels exceed water quality targets (15 mg/L) in 50% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 9% of samples. Conductivity, nitrate-nitrogen, OP, and TP were not sampled in Hoover Ditch-Rock Run Creek subwatershed.

Table 48. Hoover Ditch-Rock Run Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.1	0	3	0%
DO	5.75	17.0	2	11	18%
E. coli	1,119.9	2,481.0	6	6	100%
pH	7.7	8.3	0	14	0%
TKN	0.5	1.7	2	4	50%
TSS	10.0	20.0	2	4	50%
Turbidity	0.0	9.5	1	11	9%

Table 49 details water quality data collected in the Hoover Ditch-Rock Run Creek Subwatershed (Site 12) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 83% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 58% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% of samples collected. Dissolved oxygen, pH and conductivity did not exceed targets in any sample collected.

Table 49. Hoover Ditch-Rock Run Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
12	Median	12.40	8.97	8.16	736.50	6.68	4.08	0.05	5.80	393.00
	Max	18.80	11.49	8.90	760.00	22.60	22.61	0.34	33.20	2420.00
	Min	4.10	7.59	8.04	459.60	1.10	1.30	0.05	1.60	52.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	7	12	2	1	10
	% Exceed		0%	0%	0%	58%	100%	17%	8%	83%

Biological monitoring was conducted by IDEM at three sites, with fish community assessments occurring at one site and macroinvertebrate assessments occurring at two sites in total (Table 50). Additionally, one site was assessed for macroinvertebrate community and habitat as part of the current project. Habitat scores assessed at three sites ranged from 33 to 69 with 20% of assessments scoring below the state target (51). The fish community assessment scored above the target level. Macroinvertebrate assessments using the kick sampling method resulted in all sites meeting their aquatic life use designation, while 50% macroinvertebrate multihabitat samples did not meet their aquatic life use designation (Table 28).

Table 50. Hoover Ditch-Rock Run Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	33	69	1	5	20%
Fish (IBI)	42	42	0	1	0%
Macroinvertebrates (mIBI, Kick)	2.4	5	0	3	0%
Macroinvertebrates (mIBI, Multi Habitat)	28	38	1	2	50%

4.11 Horn Ditch-Rock Run Creek Subwatershed

The Horn Ditch-Rock Run Creek subwatershed forms a northeastern corner of the Lower Elkhart River Watershed and sits in Elkhart County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011902. This subwatershed drains 14,153 acres and accounts for 7% of the total watershed area. There are 31.8 miles of stream. IDEM has identified 8.4 miles of stream length in the Horn Ditch-Rock Run Creek subwatershed as impaired for *E. coli* (Figure 80).

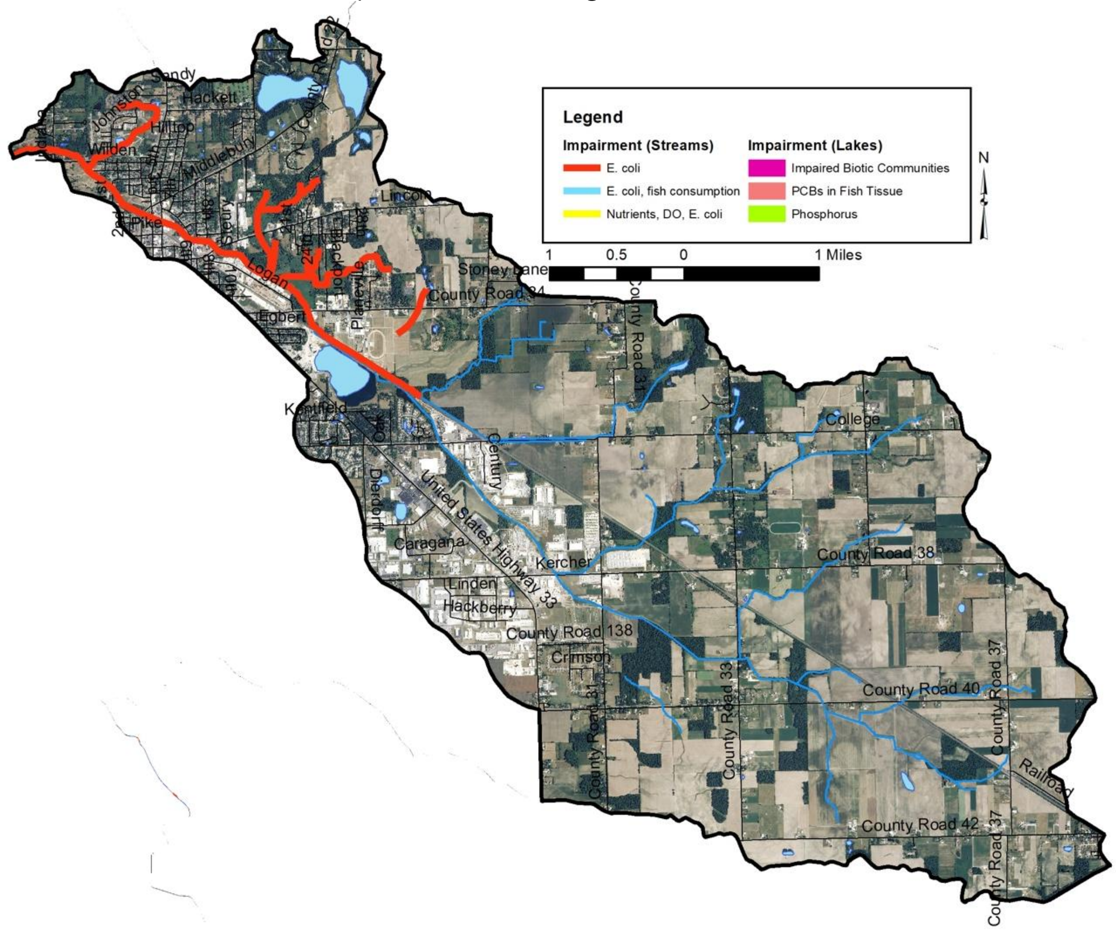


Figure 80. Impairments in the Horn Ditch-Rock Run Creek subwatershed.

4.11.1 Soils

Hydric soils cover 1,160.1 acres (8.2%) of the subwatershed. Highly erodible soils cover 37.3% (5,275.3 acres) of the subwatershed. In total, 13,879.2 acres (98.1%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.11.2 Land Use

Agricultural land use covers over half of the Horn Ditch-Rock Run Creek subwatershed with 57% (8,074.2 acres) in agricultural land use. An additional 31.8% (4,506.1 acres) of the subwatershed is in urban land use including portions of the City of Goshen. Wetlands, open water, and grassland cover 950.5 acres, or 6.7%, of the subwatershed. Forested land use accounts for 4.4% of the subwatershed as well (622.8 acres).

4.11.3 Point Source Water Quality Issues

There are many potential point sources of water pollution in the Horn Ditch-Rock Run Creek subwatershed (Figure 81). There are 12 leaking underground storage tank sites, five brownfields, six industrial sites and ten solid waste sites in the subwatershed.There are 49 underground storage tanks not identified as leaking in the subwatershed. In total, slightly more than 5,600 acres of City of Goshen MS4 are located in the subwatershed.

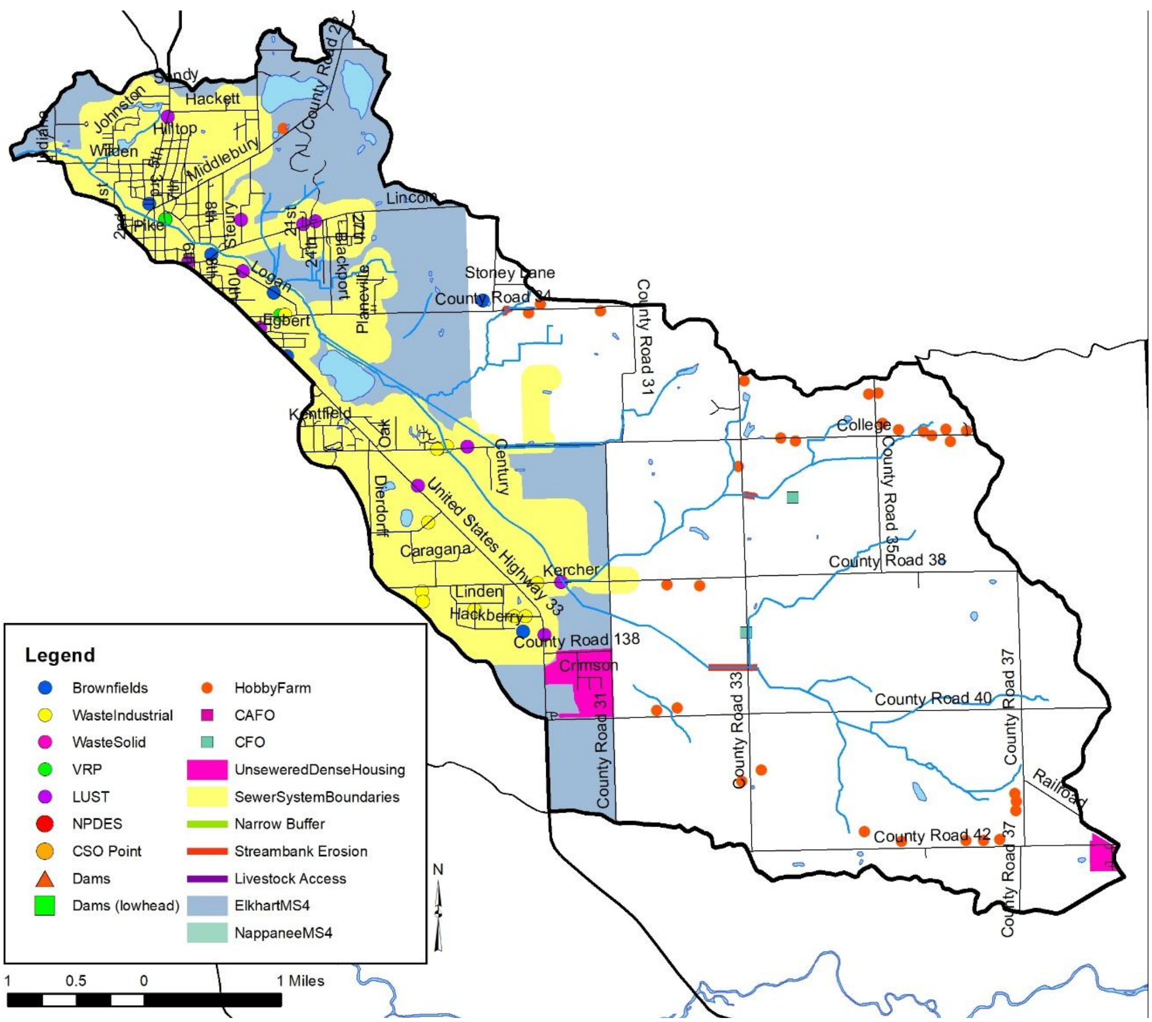


Figure 81. Potential point and non-point sources of pollution in the Horn Ditch-Rock Run Creek Subwatershed.

4.11.4 Non-Point Source Water Quality Issues

Agricultural and urban land uses are the predominant land uses in the Horn Ditch-Rock Run Creek subwatershed. Additionally, a number of small animal operations and CFOs are also present. In total, 31 unregulated animal operation housing more than 331 cows, horses, goats and sheep were identified during the windshield survey. Two active CFOs housing 48,000 chickens and 1,200 pigs are located in the Horn Ditch-Run Creek subwatershed. In total, manure from all animal operations total over 19,583 tons per year, which contains almost 1,280,751 pounds of nitrogen, almost 1,035,350 pounds of phosphorus and 1.00E+19 colonies of *E. coli*. Livestock appear to have no access to the subwatershed streams based on windshield survey observations. Streambank erosion is a concern in the subwatershed. Approximately 1.2 miles (3.8%) of streambank erosion were identified within the subwatershed.

4.11.5 Water Quality Assessment

Waterbodies within the Horn Ditch-Rock Run Creek subwatershed have been sampled historically at ten locations. Two sites in the subwatershed (L13, L16) are being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by Hoosier Riverwatch (4 sites), Goshen (3 sites), Greater Elkhart County Stormwater Partnership (4 sites), and City of Elkhart (5 sites). No stream gages are in the Horn Ditch-Rock Run Creek.

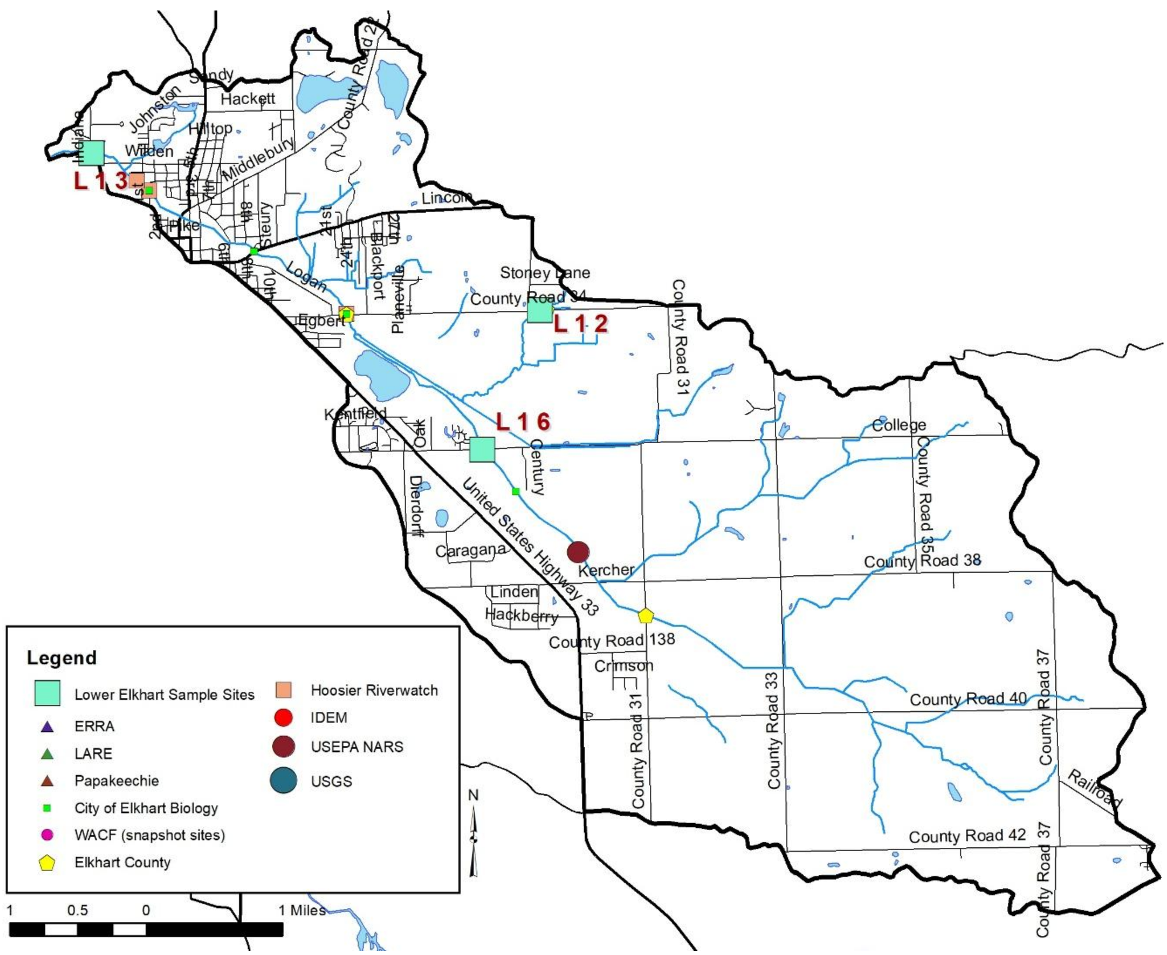


Figure 82. Locations of historic and current water quality data collection in the Horn Ditch-Rock Run Creek Subwatershed.

Table 51 details historic water chemistry data collected in the Horn Ditch-Rock Run Creek subwatershed. As shown in the table, conductivity concentrations did not exceed water quality targets in any samples collected. DO concentrations exceed water quality targets in 1% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 90% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 86% of samples. Orthophosphorus concentrations exceed water quality targets (0.03 mg/L) in 78% of samples collected. pH levels did not exceed water quality targets in any samples collected. Total phosphorus concentrations exceeded water quality targets (0.08 mg/L) in 97% of samples collected. TSS levels exceed water quality targets (15 mg/L) in 16% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 30% of samples. Ammonia and TKN were not sampled in the Horn Ditch-Rock Run Creek subwatershed.

Table 51. Horn Ditch-Rock Run Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	105	1033	0	450	0%
DO	4.01	23	3	460	1%
E. coli	0.0	241,960	427	476	90%
Nitrate	0.0	22.2	416	484	86%
OP	0.0	1.0	7	9	78%
pH	6.5	9.2	1	455	0%
TP	0.0	11.4	468	484	97%
TSS	0.0	312.0	50	312	16%
Turbidity	5.0	19.3	9	30	30%

Table 52 details water quality data collected in the Horn Ditch-Rock Run Creek Subwatershed (Site 13 and Site 16) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 58% of samples collected from Site 13 and 55% of samples from Site 16. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples from Site 13 and 91% from Site 16. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples from Site 13 and 36% of samples from Site 16. Turbidity levels exceed water quality targets (5.7 NTU) in 58% of samples collected from Site 13 and 64% of samples collected from Site 16. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% of samples collected from Site 13 and 18% of samples from Site 16. Conductivity levels exceed water quality targets (1050 mg/L) in 9% of samples collected from Site 16 while they did not exceed in samples collected from Site 13. Dissolved oxygen and pH did not exceed targets in any sample collected from either site.

Table 52. Horn Ditch-Rock Run Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
13	Median	11.13	9.36	8.26	738.65	9.63	3.75	0.05	5.20	385.00
	Max	19.60	11.33	8.95	1033.00	22.10	20.67	0.32	35.60	2490.00
	Min	3.40	7.28	8.05	445.00	1.19	1.10	0.05	1.60	70.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	0	7	12	1	2	7
	% Exceed		0%	0%	0%	58%	100%	8%	17%	58%
16	Median	12.60	8.69	8.29	760.00	8.31	3.11	0.05	6.40	411.00
	Max	17.40	11.29	8.92	1250.00	153.60	32.56	0.35	106.80	2420.00
	Min	2.70	6.32	7.76	530.20	0.60	1.00	0.05	1.20	28.00
	#Samples	11	11	11	11	11	11	11	11	11
	#Exceed		0	0	1	7	10	2	4	6
	% Exceed		0%	0%	9%	64%	91%	18%	36%	55%

Biological monitoring was conducted by the City of Elkhart at seven sites with four sites assessed for fish (Table 53). Additionally, two sites were assessment for macroinvertebrate community and habitat as part of the current project. Habitat assessments conducted at each site resulted in scores ranging from 29 to 64, with 13% of sites not reaching state target of 51 for habitat assessment. Fish community assessments scores ranged from 35 to 42, with 25% of sites not reaching the target of 36. Macroinvertebrate multihabitat assessments indicate that none of the assessments meet their aquatic life use designation.

Table 53. Horn Ditch-Rock Run Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	29	64	1	8	13%
Fish (IBI)	35	42	1	4	25%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	26	26	0	2	0%

4.12 <u>Headwaters Yellow Creek Subwatershed</u>

The Headwaters Yellow Creek subwatershed forms the western edge of the northern portion of the Lower Elkhart River Watershed and lies fully within Elkhart County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011903. This subwatershed drains 21,157 acres and accounts for 12% of the total watershed area. There are 46.9 miles of stream. IDEM has classified 5.05 miles of stream length in the Headwaters Yellow Creek subwatershed as impaired for *E. coli* and impaired biotic communities (Figure 83).

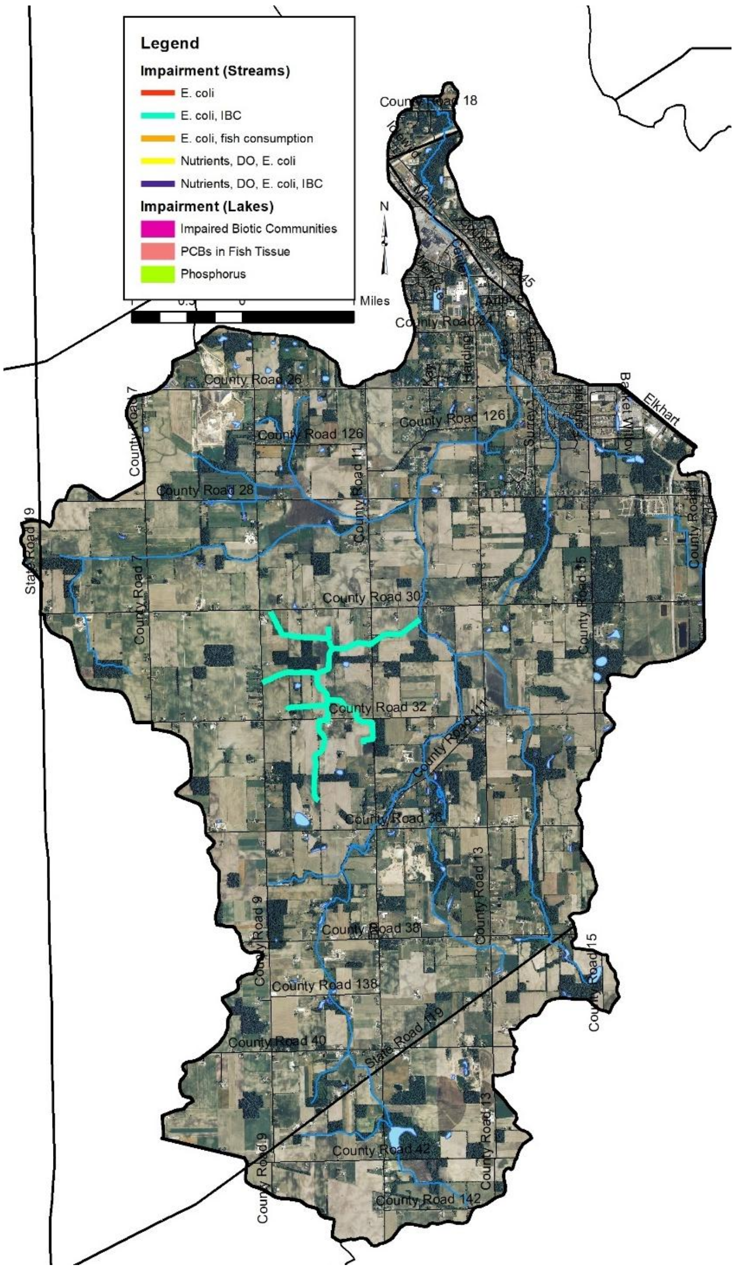


Figure 83. Impairments in the Headwaters Yellow Creek Subwatershed.

4.12.1 Soils

Hydric soils cover 2,155.0 acres (10.2%) of the subwatershed. Highly erodible soils cover 42.2% (8,936.8 acres) of the subwatershed. In total, 20,649.4 miles (97.6%) of the subwatershed are identified as very limited for septic use. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

4.12.2 Land Use

Agricultural land use makes up the majority of the Headwaters Yellow Creek subwatershed with 71.7% (15,173.4 acres) in agricultural land uses, including row crop and pastureland. Urban land use accounts for 16% (3,391.1 acres) including portions of the Cities of Elkhart and Goshen and the urban corridor along

US Highway 33. Forested land use accounts for 7.4% (1,566.5 acres). Wetlands, open water, and grassland cover nearly 5% (1,026.7 acres) of the subwatershed.

4.12.3 Point Source Water Quality Issues

There are many potential point sources of water pollution in the subwatershed (Figure 84). Five leaking underground storage tanks, two brownfields, one industrial waste site and two solid waste sites are located within the Headwaters Yellow Creek subwatershed. Sixteen underground storage tank sites that are not leaking are also in the subwatershed. The Greater Elkhart County Stormwater Partnership MS4s are in the subwatershed and covers 2,630 acres.

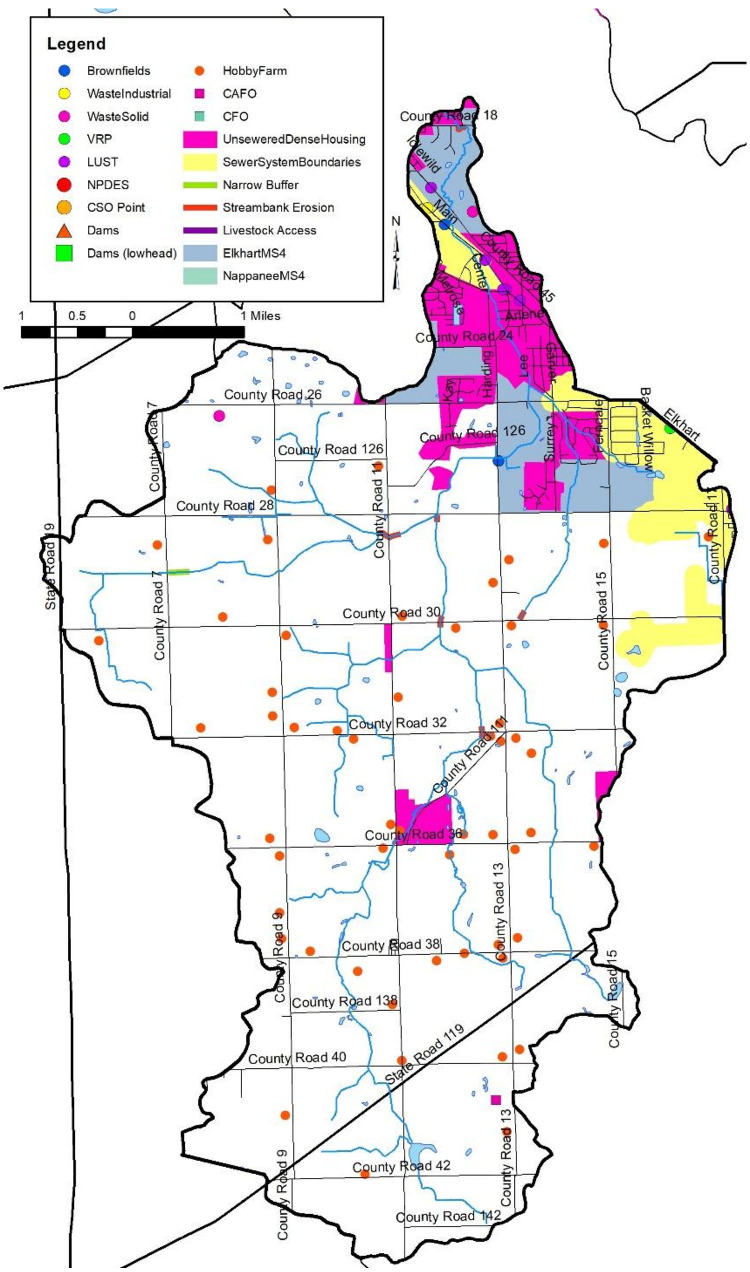


Figure 84. Potential point and non-point sources of pollution and suggested solutions in the Headwaters Yellow Creek Subwatershed.

4.12.4 Non-Point Source Water Quality Issues
Agricultural land use is the predominant land use in the Headwaters Yellow Creek subwatershed. During the windshield survey, approximately 55 unregulated animal operations housing more than 2,596 cows, horses, goats, sheep and donkeys were identified. Livestock have access to 1.8 miles (4.1%) of subwatershed streams. There is one active CAFO located in the Headwaters Yellow Creek subwatershed housing 1,795 dairy cattle. In total, manure from all animal operations total over 96,990 tons per year, which contains almost 46,677 pounds of nitrogen, 22,899 pounds of phosphorus and 2.95E+15 colonies of *E. coli*. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 0.4 miles (0.9%) of insufficient stream buffers and 1.5 miles (3.6%) of streambank erosion were identified within the subwatershed.

4.12.5 Water Quality Assessment
Waterbodies within the Headwaters Yellow Creek subwatershed have been sampled historically at 17 locations. One site in the subwatershed (L11) is being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (8 sites), Greater Elkhart County Stormwater Partnership (13 sites), Goshen (9 sites), and City of Elkhart (10 sites). No stream gages are in the Headwaters Yellow Creek subwatershed.

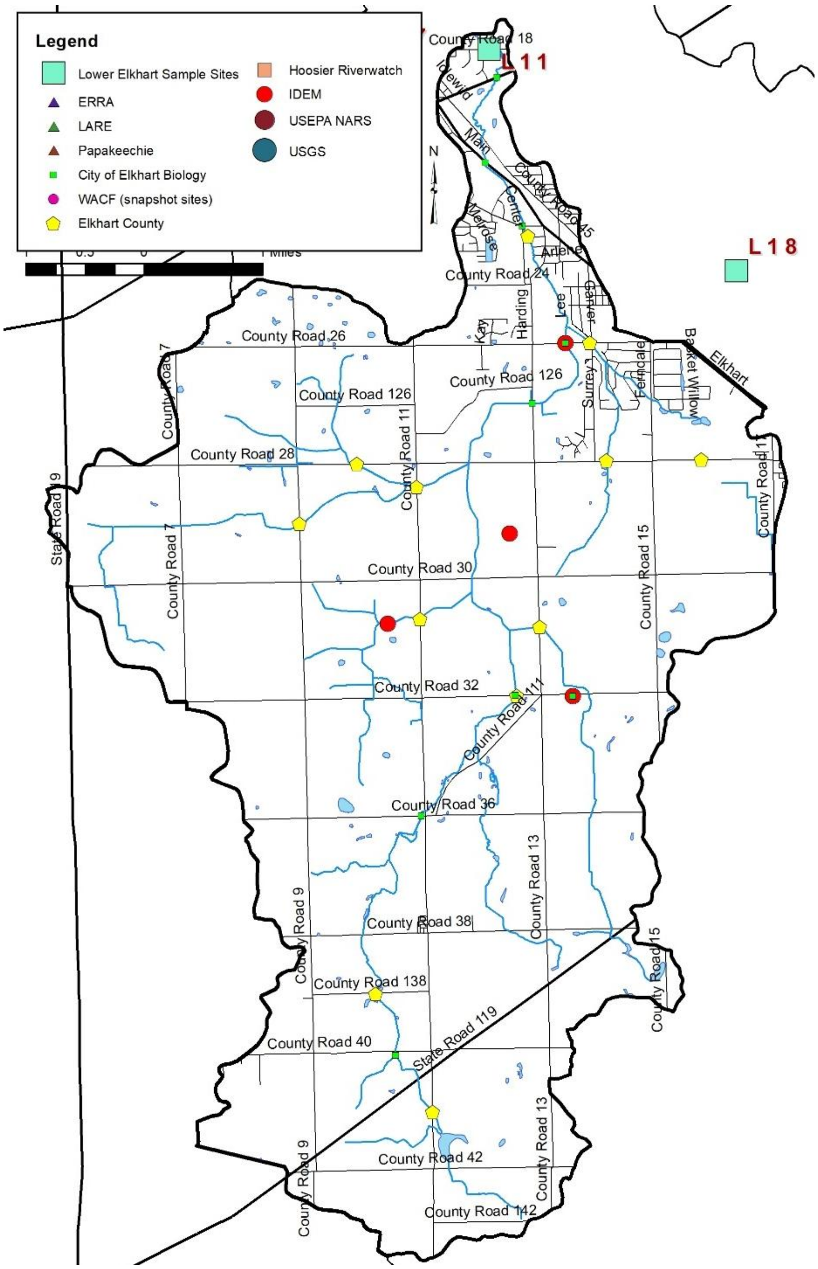


Figure 85. Locations of historic and current water quality data collection in the Headwaters Yellow Creek subwatershed.

Table 54 details historic water chemistry data collected in the Headwaters Yellow Creek subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 25% of samples collected. Conductivity concentrations exceed water quality targets (1050 mg/L) in 4% of samples collected. DO concentrations exceed water quality targets in 26% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 89% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 82% of samples, while total Kjeldahl nitrogen concentrations similarly exceed water quality targets (0.57 mg/L) in 80% of samples. pH levels exceeded state standards in 1% of samples collected. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 99% of samples collected. TSS levels exceed water quality targets (15 mg/L) in 46% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 65% of samples. OP was not sampled in Headwaters Yellow Creek subwatershed.

Table 54. Headwaters Yellow Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.1	0.4	1	4	25%
Conductivity	103	2123	31	791	4%
DO	0.05	19	215	815	26%
E. coli	0.0	241,960	755	850	89%
Nitrate	0.01	22.2	690	844	82%
pH	5.7	12.3	12	806	1%
TKN	0.48	6.1	4	5	80%
TP	0.047	14.4	879	884	99%
TSS	0.0	2,092.0	338	739	46%
Turbidity	1.6	746.0	13	20	65%

Table 55 details water quality data collected in the Headwaters Yellow Creek Subwatershed (Site 11) sampled during the current project. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 67% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 83% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 8% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Conductivity levels exceed water quality targets (1050 mg/L) in 8% of samples collected. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 33% of samples collected. Dissolved oxygen and pH did not exceed targets in any sample collected.

Table 55. Headwaters Yellow Creek Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
11	Median	11.90	8.94	8.09	903.50	5.81	2.50	0.05	6.60	424.50
	Max	19.60	11.40	8.99	1183.00	52.30	23.44	0.29	72.40	1670.00
	Min	3.10	7.14	7.87	541.20	0.90	0.60	0.05	1.60	40.00
	#Samples	12	12	12	12	12	12	12	12	12
	#Exceed		0	0	1	6	10	4	1	8
	% Exceed		0%	0%	8%	50%	83%	33%	8%	67%

Biological monitoring was conducted by IDEM at 37 sites, with fish community assessments occurring 39 times and macroinvertebrate assessments occurring 3 times in total (Table 56). Additionally, one site was assessed for macroinvertebrate community and habitat as part of the current project. Habitat scores ranged from 24 to 80, with 21% of sites scoring below the state target (51). The fish community assessment scored below the target level of 36 in almost half (49%) of assessments. Macroinvertebrate assessments using the kick sampling method resulted in all sites meeting their aquatic life use designation, while 100% macroinvertebrate multihabitat samples did not meet their aquatic life use designation.

Table 56. Headwaters Yellow Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	24	80	7	34	21%
Fish (IBI)	14	45	19	39	49%
Macroinvertebrates (mIBI, Kick)	3.4	5	0	2	0%
Macroinvertebrates (mIBI, Multi Habitat)	24	28	2	2	100%

4.13 Goshen Dam Pond-Elkhart River Subwatershed

The Goshen Dam Pond-Elkhart River subwatershed forms the northern tip of the Lower Elkhart River Watershed and extends along the mainstem of the Elkhart River between two other subwatersheds. The Goshen Dam Pond-Elkhart River subwatershed lies entirely in Elkhart County (Figure 49). It encompasses one 12-digit HUC watershed: 040500011904. This subwatershed drains 23,262 acres and accounts for 12% of the total watershed area. There are 46.9 miles of stream in the Goshen Dam Pond-Elkhart River subwatershed. IDEM has classified 21.35 miles of stream as impaired for *E. coli* and fish consumption for PCBs (Figure 86).

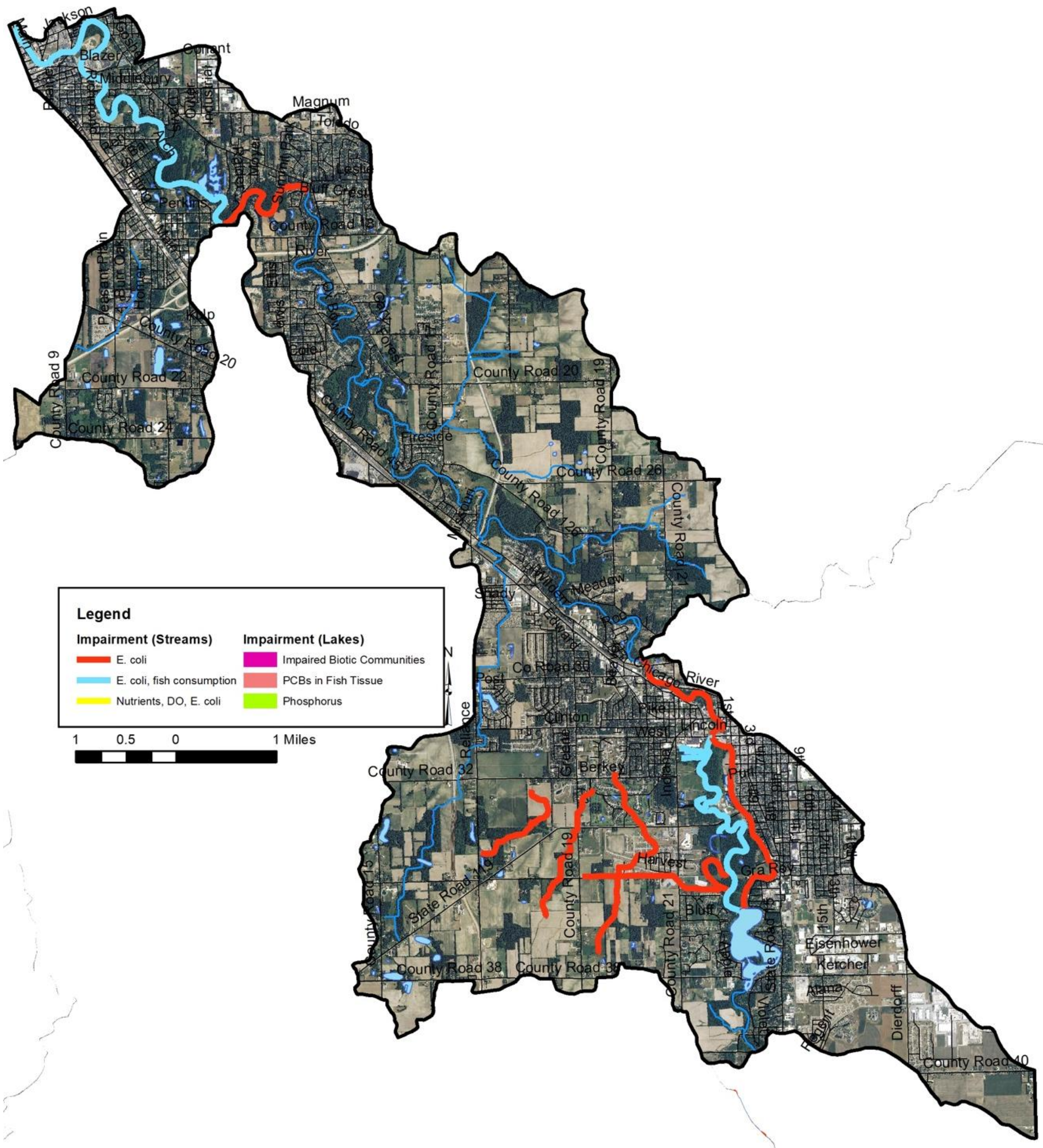


Figure 86. Impairments in the Goshen Dam Pond-Elkhart River Subwatershed.

4.13.1 Soils

Hydric soils cover 1,122.3 acres, or 4.8%, of the subwatershed. Highly erodible soils cover 18.2% of the subwatershed, or 4,224.1 acres. In total, 22,038.6 acres, or 94.7%, of the subwatershed is identified as very limited for septic use. Maintenance and inspections of septic systems in the Goshen Dam Pond-Elkhart River subwatershed is important to ensure proper function and capacity.

4.13.2 Land Use

Urban land use is the predominant land cover in the subwatershed, with more than half (52.5%, or 12,208.5 acres) of the land identified as urban land. This includes portions of the Cities of Goshen and Elkhart and large areas of unincorporated Elkhart County. Agricultural land use in the Goshen Dam Pond-

Elkhart River subwatershed is smaller compared to surrounding subwatersheds, with 33% (7,685.1 acres) of land in the subwatershed used for agricultural purposes. Forested land use only accounts for 4.8% (1,125.7 acres). Wetlands, open water, and grassland cover 2,243.2 acres, or 9.6%, of the subwatershed.

4.13.3 Point Source Water Quality Issues

There are many potential sources of water quality issues in the Goshen Dam Pond-Elkhart River subwatershed (Figure 87). In total, 42 leaking underground storage tanks, 37 brownfields, 33 industrial waste sites and six combined sewer overflow locations (CSO) are located in the subwatershed. One NPDES permitted facility (Goshen wastewater treatment plant) is located in the subwatershed, as are the Elkhart County and City of Goshen MS4s which covers 17,088 acres. Eight voluntary remediation programs are located in the Goshen Dam-Pond Elkhart River subwatershed.

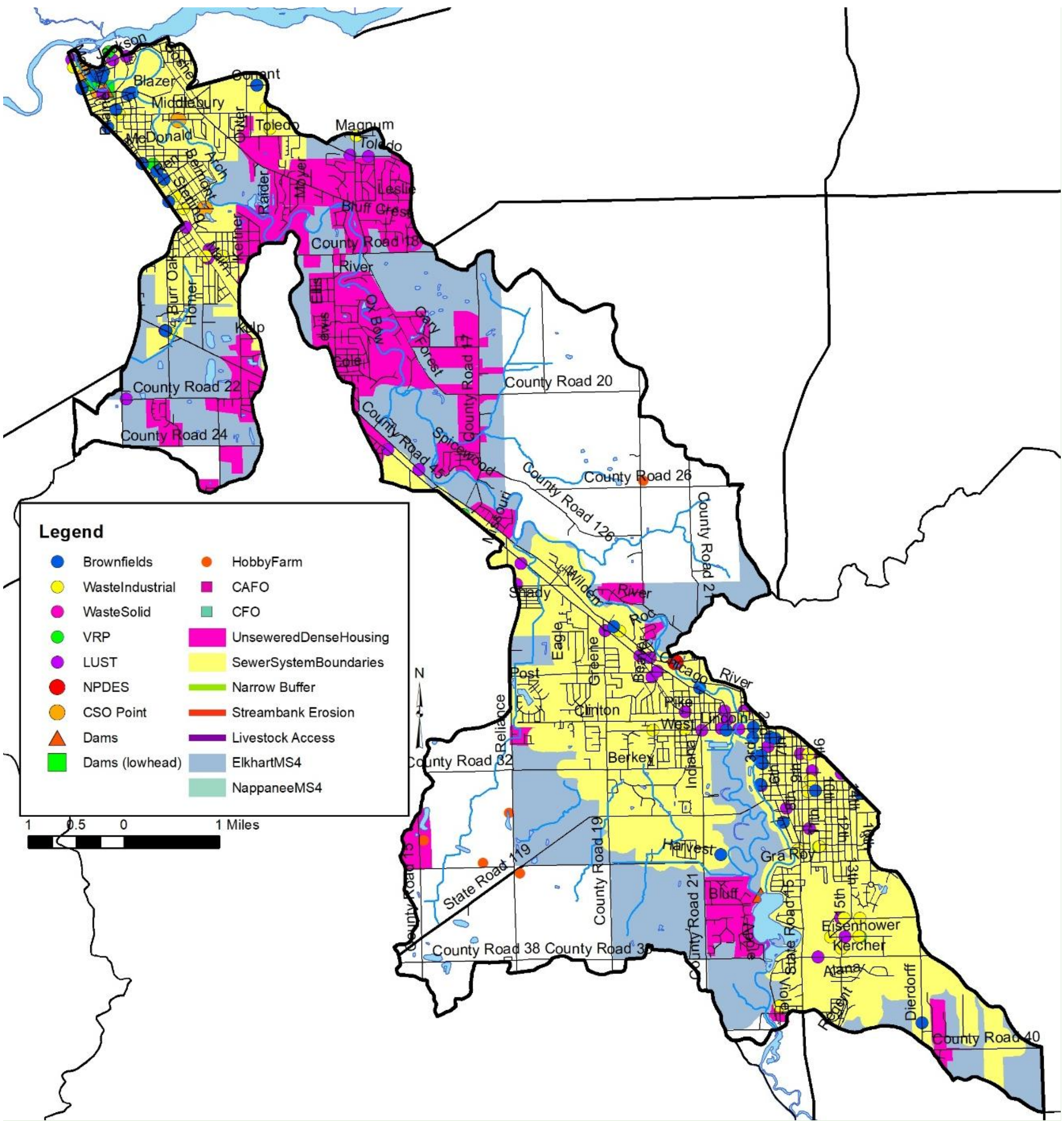


Figure 87. Potential point and non-point sources of pollution in the Goshen Dam-Elkhart River Subwatershed.

4.13.4 Non-Point Source Water Quality Issues

While agricultural land uses are not the predominant land uses in the Goshen Dam-Elkhart River subwatershed, a number of small animal operations are still present. Surveyors observed five unregulated animal operations housing more than 11 cows and horses during the windshield survey. There are no active CFOs in the subwatershed. Based on windshield survey observations, livestock do not have access to subwatershed streams. Animals produce more than 231 tons of manure annually which contains more than 121 pounds of nitrogen, 61 pounds of phosphorus and more than 5.51E+12 colonies of *E. coli*. Streambank erosion and lack of buffers are not a concern in the subwatershed.

4.13.5 Water Quality Assessment

Waterbodies within the Goshen Dam-Elkhart River subwatershed have been sampled historically at 44 locations (Figure 59). Three sites in the subwatershed (L14, L17, L18) are being sampled as part of the current project. Historic assessments include collection of water chemistry and biology data by IDEM (16 sites), City of Elkhart (16 sites), Greater Elkhart County Stormwater Partnership (5 sites), Hoosier Riverwatch (16 sites), NARS (4 sites), Goshen (5 sites), and USGS (2 sites). One stream gage is located in the Goshen Dam-Elkhart River subwatershed.

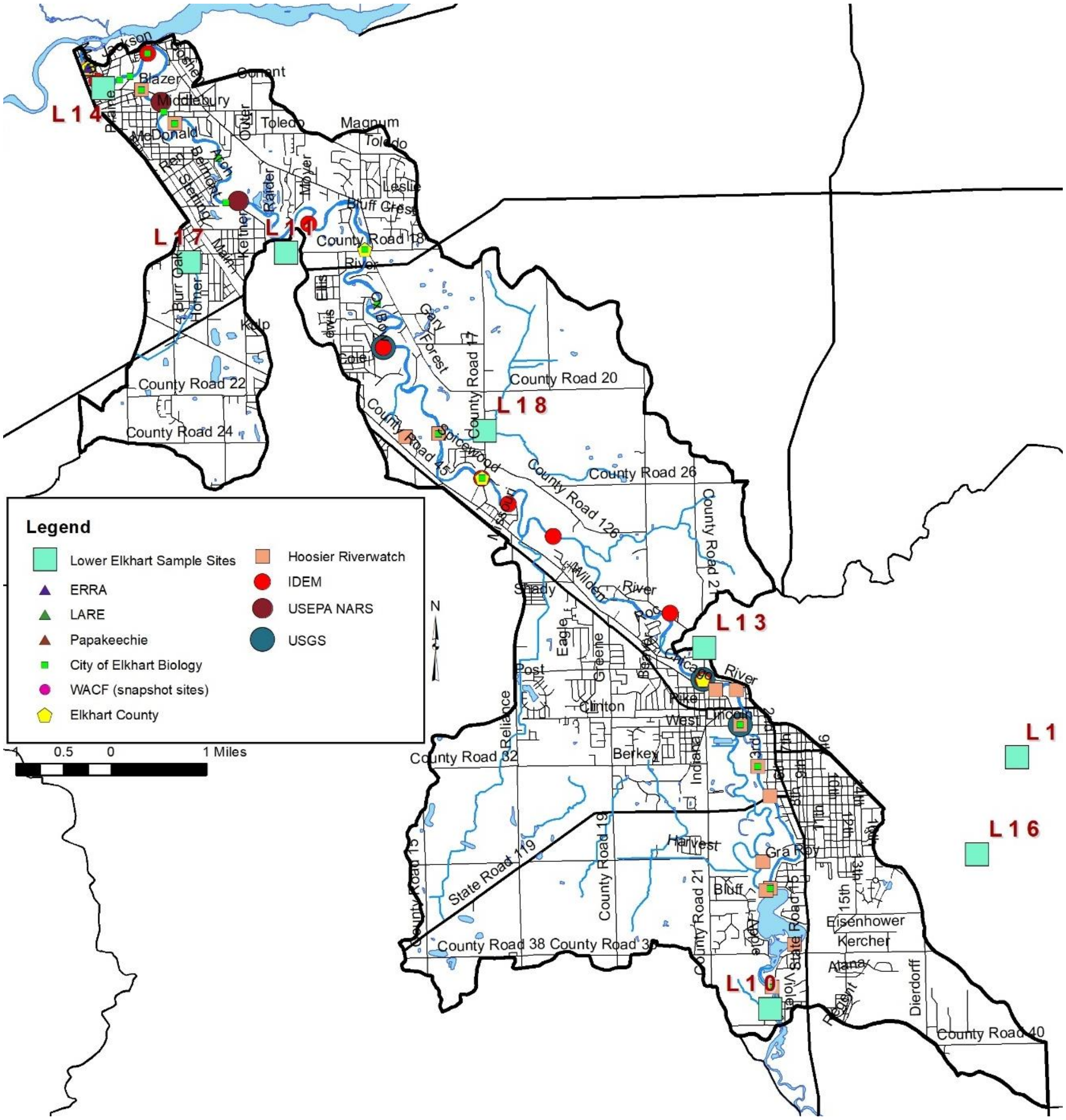


Figure 88. Locations of historic and current water quality data collection in the Goshen Dam-Elkhart River Subwatershed.

Table 57 details historic water chemistry data collected in the Goshen Dam-Elkhart River subwatershed. As shown in the table, ammonia concentrations exceed water quality targets (0.2 mg/L) in 2% of samples collected. Conductivity concentrations exceed water quality targets (1050 mg/L) in 0.2% of samples collected. DO concentrations exceed water quality targets in 12% of samples collected. *E. coli* concentrations exceed state grab sample standards (235 col/100 ml) in 36% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 74% of samples, while total Kjeldahl nitrogen concentrations similarly exceed water quality targets (0.57 mg/L) in 77% of samples. Orthophosphorus concentrations exceed water quality targets (0.03 mg/L) in 63% of samples collected. pH levels did not exceed water quality targets. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 98% of samples. TSS levels exceed water quality targets (15 mg/L) in 15% of samples collected. Turbidity levels exceed water quality targets (5.7 NTU) in 73% of samples.

Table 57. Goshen Dam-Elkhart River Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Ammonia	0.2	0.5	8	362	2%
Conductivity	2	1,331	1	649	0.2%
DO	1.42	16	168	1,457	12%
E. coli	0.0	154,800	363	1,007	36%
Nitrate	0.0	22.0	614	827	74%
OP	0.0	0.6	25	40	63%
pH	5.6	9.3	6	1,698	0%
TKN	0.2	2.6	446	577	77%
TP	0.001	18.8	748	766	98%
TSS	0.4	249.0	135	872	15%
Turbidity	0.0	171.0	462	632	73%

Table 58 details water quality data collected in the Goshen Dam Pond-Elkhart River Creek Subwatershed (Site 14, Site 17, and Site 18) sampled during the current project. Site 10 represents the drainage from the Upper Elkhart River Watershed. As shown in the table, *E. coli* samples exceed state grab sample standards (235 col/100 ml) in 42% of samples collected at Site 14 and Site 17 and 80% of samples collected from Site 18. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples from Sites 14 but only 60% from Site 18 and 83% of samples from Site 17. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples from Site 14, 33% of samples from Site 17 and 60% of samples from Site 18. Turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples from Site 14, 42% of samples from Site 17 and 60% of samples from Site 18. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 33% of samples collected from Site 14 and 20% of samples from Site 18 while no samples from Site 17 exceeded. Dissolved oxygen, pH and conductivity did not exceed targets in any sample collected from any of the three sites.

Table 58. Goshen Dam Pond-Elkhart River Subwatershed water quality data summary, 2023-2024.

Site		Temp (deg C)	DO (mg/L)	pH	Cond (mS/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
14	Median	12.68	9.39	8.27	714.50	6.71	3.97	0.05	7.20	200.00
14	Max	22.10	11.13	8.88	802.00	23.80	22.57	0.27	37.60	1350.00
14	Min	3.01	6.86	8.09	556.00	0.12	1.11	0.05	2.40	41.00
14	#Samples	12	12	12	12	12	12	12	12	12
14	#Exceed		0	0	0	6	12	4	2	5
14	% Exceed		0%	0%	0%	50%	100%	33%	17%	42%
17	Median	12.14	8.98	8.19	658.60	2.94	1.48	0.05	10.20	118.50
17	Max	21.10	11.47	8.66	779.30	19.78	7.26	0.05	64.00	921.00
17	Min	1.00	6.89	7.22	438.00	0.90	0.80	0.05	2.00	40.00
17	#Samples	12	12	12	12	12	12	12	12	12
17	#Exceed		0	0	0	5	10	0	4	5
17	% Exceed		0%	0%	0%	42%	83%	0%	33%	42%
18	Median	8.32	10.32	8.61	585.00	7.66	3.11	0.05	18.40	680.00
18	Max	13.82	11.51	8.86	825.00	27.60	23.81	0.11	53.60	9610.00
18	Min	0.70	9.13	8.22	413.90	1.20	0.70	0.05	2.80	18.00
18	#Samples	5	5	5	5	5	5	5	5	5
18	#Exceed		0	0	0	3	3	1	3	4
18	% Exceed		0%	0%	0%	60%	60%	20%	60%	80%

The City of Elkhart conducted biological data assessments 117 times at 37 sites (Table 59). Additionally, three sites were assessed for macroinvertebrate community and habitat as part of the current project. Habitat was assessed 96 times while fish communities were assessed 104 times. Habitat scores ranged between 25.5 and 94, with all but one assessment measuring above the state target of 51. The fish community assessment consistently measured above target for all sites assessed. The macroinvertebrate community assessment indicates that the community measured above targets in all sites assessed.

Table 59. Goshen Dam-Pond Elkhart River Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	25.5	94	1	98	<0.5%
Fish (IBI)	41	56	0	104	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	34	38	0	2	0%

5.0 WATERSHED INVENTORY III: WATERSHED INVENTORY SUMMARY

Several important factors and relationships become apparent when the Lower Elkhart River Watershed is observed both as a whole and in part. Many of these were discussed in the individual subwatershed discussions above. An overall summary of water quality impairments and a review of stakeholder concerns and any data which support these concerns are included below.

5.1 Water Quality Summary

Several water quality impairments were identified during the watershed inventory process, based on historic data collected from the Wawasee Area Conservancy Foundation (WACF), Greater Elkhart County Stormwater Partnership, ERRA, the Indiana Department of Environmental Management (IDEM), Indiana DNR Lake and River Enhancement Program (LARE), U.S. Geological Survey (USGS), U.S. EPA National Aquatic Resource Survey (NARS) and Lake Papakeechie and Hoosier Riverwatch volunteers as well as current water quality assessments conducted during the current project. These impairments include elevated nutrient, sediment and *E. coli* concentrations. Based on historic data, Table 60 highlights those locations within the Lower Elkhart River Watershed where concentrations of these parameters measured higher than the target concentrations or those locations where impaired waterbodies were identified by IDEM. Table 60 summarizes where historic samples were outside the target values and are grouped by subwatershed. Figure 89 shows the locations of historical sites that exceeded target values. Sample sites are mapped only if 50% or more of samples collected at those sites were outside the target values.

Historic nitrate-nitrogen concentrations sampled in all subwatersheds except those where no samples were collected, including Coppes Ditch-Turkey Creek, Hoopingarner Ditch-Turkey Creek and Hoover Ditch-Rock Run, and the Lake Wawasee-Turkey Creek subwatershed exceeded targets in more than 50% of samples collected. Ammonia concentrations were elevated in the Berlin Court Ditch, Swoveland Ditch-Turkey Creek and Wabee Lake-Hammond Ditch subwatersheds. Total phosphorus concentrations in the Berlin Court Ditch, Dausman Ditch-Turkey Creek, Goshen Dam Pond-Elkhart River, Headwaters Yellow Creek, Horn Ditch-Rock Run Creek, and Wabee Lake-Hammond Ditch subwatersheds exceeded water quality targets in at leaset 50% of samples collected. Total Kjeldahl nitrogen concentrations measured in the Berlin Court Ditch, Dausman Ditch-Turkey Run, Goshen Dam Pond-Elkhart River, Headwaters Yellow Creek, Hoover Ditch-Rock Run, Lake Wawasee-Turkey Creek, Omar Neff Ditch-Turkey Creek, Swoveland Ditch-Turkey Creek, Village Lake-Turkey Creek and Wabee Lake-Hammond Ditch subwatersheds exceeded water quality targets in 50% of historic samples. Dissolved oxygen exceedances occurred historically across much of the watershed with Omar Neff Ditch-Turkey Creek exceeding in 50% of collected samples, while Swoveland Ditch-Turkey Creek (36%) and Berlin Court Ditch (29%) exceeded in a relatively high volume of collected samples. A relatively limited number of conductivity and pH exceedances occurred in the Lower Elkhart River historically with 11% of pH samples collected in the

Village Lake-Turkey Creek subwatershed and 16% and 8% of conductivity samples exceeding targets in the Dausman Ditch-Turkey Creek and Berlin Court Ditch subwatersheds. TSS concentrations exceeded water quality targets in 50% of collected samples in the Hoover Ditch-Rock Run Creek and Wabee Lake-Hammond Ditch subwatersheds and were elevated in nearly every subwatershed where samples were collected. Turbidity levels exceeded water quality targets in 50% or more of collected samples in Dausman Ditch-Turkey Creek, Goshen Dam Pond-Elkhart River, Headwaters Yellow Creek, Omar Neff Ditch-Turkey Creek and Wabee Lake-Hammond Ditch historically. *E. coli* concentrations were elevated across the watershed with 50% or more of samples collected exceeding state standards in all subwatersheds except Goshen Dam Pond-Elkhart River, Lake Wawasee-Turkey Creek and Wabee Lake-Hammond Ditch.

Table 60. Percent of samples historically collected in Lower Elkhart River Subwatersheds which measured outside target values.

Subwatershed	DO	pH	Cond	Turb	Nitrate	Amm	TKN	TP	TSS	E.coli
Berlin Court Ditch	29%	5%	8%	33%	99%	50%	100%	100%	23%	69%
Coppes Ditch-Turkey Creek	11%	0%	--	33%	--	0%	0%	--	0%	100%
Dausman Ditch-Turkey Creek	24%	3%	16%	57%	83%	0%	67%	99%	39%	83%
Goshen Dam Pond-Elkhart River	12%	0%	0%	73%	74%	2%	77%	98%	15%	36%
Headwaters Yellow Creek	26%	1%	4%	65%	82%	25%	80%	99%	46%	89%
Hoopingarner Ditch-Turkey Creek	0%	0%	--	0%	--	0%	--	--	--	60%
Hoover Ditch-Rock Run Creek	18%	0%	--	9%	--	--	50%	--	50%	100%
Horn Ditch-Rock Run Creek	1%	0%	0%	30%	86%	--	--	97%	16%	90%
Lake Wawasee-Turkey Creek	27%	10%	0%	4%	29%	25%	50%	1%	7%	38%
Omar-Neff Ditch-Turkey Creek	50%	0%	--	50%	100%	40%	63%	--	38%	73%
Swoveland Ditch-Turkey Creek	36%	1%	5%	42%	83%	100%	80%	34%	26%	74%
Village Lake-Turkey Creek	3%	11%	0%	7%	90%	0%	71%	21%	0%	74%
Wabee Lake-Hammond Ditch	8%	6%	--	50%	100%	50%	50%	50%	50%	0%

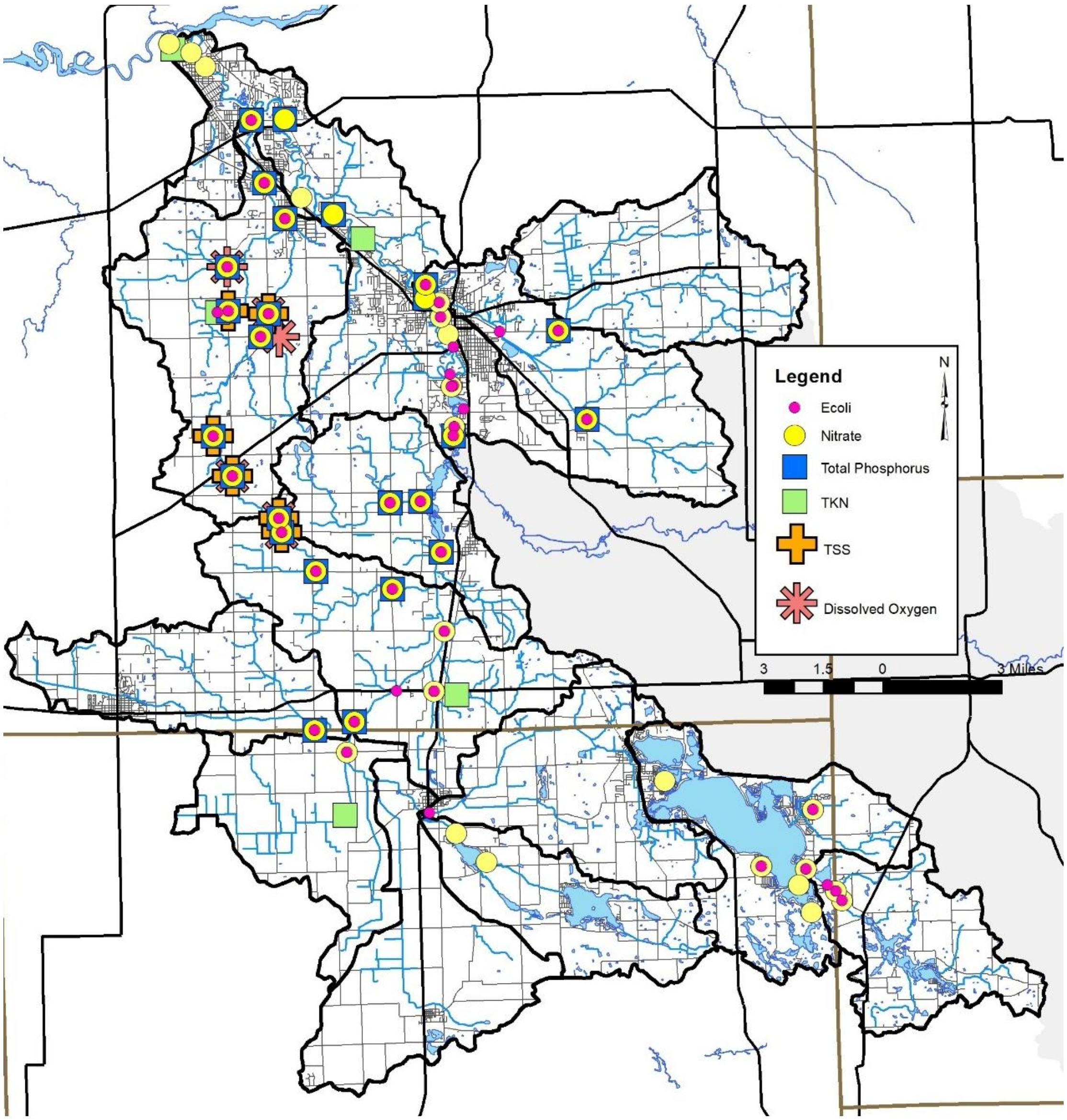


Figure 89. Lower Elkhart River Watershed historical sampling sites that exceed target values.

Table 61 summarizes current samples which measured outside the target values during the current assessment. Figure 90 provides a map of current sampling sites that exceed target values. Elevated nitrate-nitrogen concentrations were observed in all subwatershed with Berlin Court Ditch, Coppes Ditch-Turkey Creek, Headwaters Yellow Creek, Hoopingarner Ditch-Turkey Ceek, Hoover Ditch-Rock Run Creek, Swoveland Ditch-Turkey Creek and Wabee Lake-Hammond Ditch subwatersheds exceeding in 100% of collected samples. In total, 92% of collected samples throughout the watershed exceeded nitrate-nitrogen target concentrations. Elevated total phosphorus concentrations were observed at all sample sites with concentrations exceeding total phosphorus targets in 16% of collected samples. Berlin Court Ditch and Wabee Lake-Hammond Ditch samples exceeded target total phosphorus concentrations in 50% or more of collected samples. Elevated total suspended solids concentrations were observed at all sites with 15% of all samples exceeding targets. However, no site exceeded target TSS concentrations in more than half of collected samples. Rather, TSS concentrations generally measured low then increased to concentrations higher than targets during storm flow events, which were few and far between during the sampling period. *E. coli* concentrations that exceeded the state grab sample standard were measured at all sites. Exceedances were most common at Berlin Court Ditch, Dausman Ditch-Turkey Creek, Headwaters Yellow Creek, Hoopingarner Ditch-Turkey Creek, Hoover Ditch-Rock Run Creek, Horn Ditch-Rock Run Creek, Omar Neff Ditch-Turkey Creek, Swoveland Ditch-Turkey Creek and Wabee Lake-Hammond Ditch where exceedances occurred in more than 50% of collected samples. In total, 51% of samples exceeded state standards.

Berlin Court Ditch, Lake Wawasee-Turkey Creek and Village Lake-Turkey Creek exceeded dissolved oxygen state standards; however, none of the sites exceeded dissolved oxygen standards in a majority of collected samples. Specific conductivity exceeded targets in Berlin Court Ditch-Headwaters Yellow Creek, Hoopingarner Ditch-Turkey Creek, Horn Ditch-Rock Run Creek and Lake Wawasee-Turkey Creek subwatershed. pH concentration exceeded water quality targets in the Lake Wawasee-Turkey Creek and Wabee Lake-Hammond Ditch subwatersheds.

Table 61. Percent of samples collected by subwatershed in the Lower Elkhart River Watershed during the 2023-2024 sample collection which measured outside target values.

Subwatershed	DO	pH	Turb	Cond	TP	Nitrate	TSS	*E. coli*
Berlin Court Ditch	4%	0%	46%	33%	75%	100%	21%	71%
Coppes Ditch-Turkey Creek	0%	0%	42%	0%	0%	100%	8%	46%
Dausman Ditch-Turkey Creek	0%	0%	42%	0%	8%	58%	8%	58%
Goshen Dam Pond-Elkhart River	0%	0%	48%	0%	17%	86%	31%	48%
Headwaters Yellow Creek	0%	0%	50%	8%	33%	100%	8%	67%
Hoopingarner Ditch-Turkey Creek	0%	0%	42%	8%	0%	100%	0%	75%
Hoover Ditch-Rock Run Creek	0%	0%	58%	0%	17%	100%	8%	83%
Horn Ditch-Rock Run Creek	0%	0%	61%	4%	13%	96%	26%	57%
Lake Wawasee-Turkey Creek	17%	25%	33%	8%	0%	92%	17%	17%
Omar Neff Ditch-Turkey Creek	0%	0%	50%	0%	0%	83%	8%	58%
Swoveland Ditch-Turkey Creek	0%	14%	43%	0%	0%	100%	14%	57%
Village Lake-Turkey Creek	25%	0%	50%	0%	0%	92%	25%	33%
Wabee Lake-Hammond Ditch	8%	0%	58%	25%	75%	100%	17%	67%

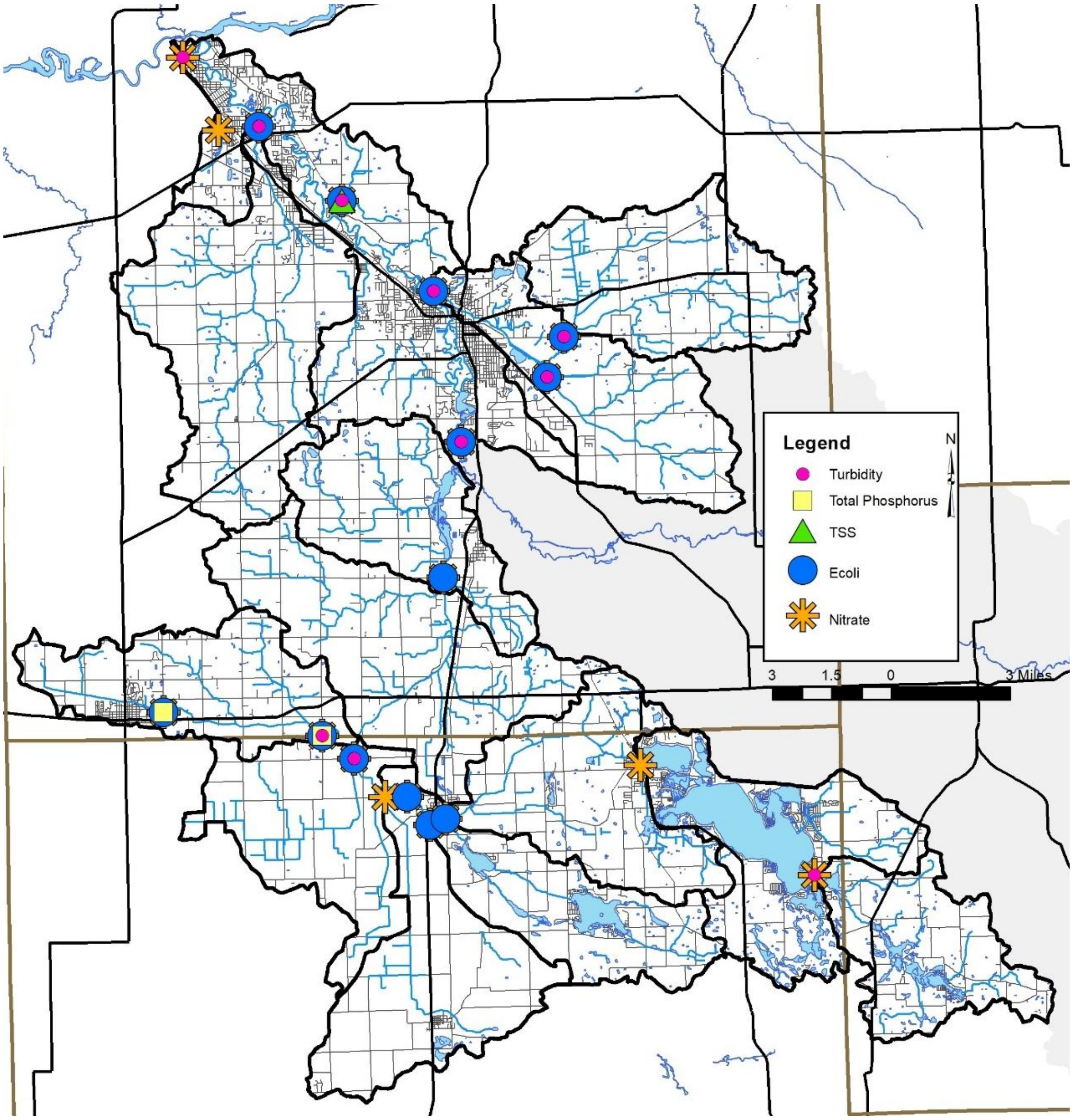


Figure 90. Lower Elkhart River Watershed sampling sites that exceed target values during the current sampling period.

Biological assessments of the macroinvertebrate community and an associated habitat assessment occurred once during the project. There is no pattern between habitat, macroinvertebrate community and fish community ratings (Table 62). mIBI scores suggest Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 3 (Wabee Lake Outlet), Site 4 (Turkey Creek at CR 1250 North), Site 5 (Coppes Ditch), Site 7 (Berlin Court Grand Ditch), Site 10 (Elkhart River at CR 40), Site 11 (Yellow Creek), Site 13 (Rock Run Creek at Indiana Ave/CR 21), Site 14 (Elkhart River at Elkhart Street), Site 15 (Berlin Court Ditch) and Site 16 (Horn Ditch) and Site 17 (Howard Ditch) rated as poor. Site 6 (Turkey Creek at CR 1250 North), Site 9 (Turkey Creek at CR 146), Site 12 (Rock Run Creek at CR 34), Site 15 (Berlin Court Ditch) and Site 17 (Howard Ditch) rated as fair. Site 8 (Turkey Creek at Old SR 15) rated as good. QHEI scores indicate that habitat at Site 3 (Wabee Lake Outlet), Site 7 (Berlin Court Grand Ditch), Site 16 (Horn Ditch) and Site 17 (Howard Ditch) rated as very poor. Site 1 (Turkey Creek at Turkey Creek Road), Site 2 (Turkey Creek at Hickory Street), Site 4 (Turkey Creek at CR 1250 North), Site 5 (Coppes Ditch), Site 6 (Turkey Creek at CR 1250 North), Site 8 (Turkey Creek at Old SR 15), Site 9 (Turkey Creek at CR 146), Site 12 (Rock Run Creek at CR 34) and Site 15 (Berlin Court Ditch) rated as poor. Site 10 (Elkhart River at CR 40) and Site 13 (Rock Run Creek at Indiana Ave/CR 21) rated as fair. Site 11 (Yellow Creek) and Site 14 (Elkhart River at Elkhart Street) rated as good.

Table 62. Biological and habitat assessment summary for Lower Elkhart River Watershed streams. Green shading indicates the highest rated stream reaches, while red indicates the poorest rated reaches.

Site	Subwatershed	mIBI	QHEI
1	Village Lake-Turkey Creek	Poor	Poor
2	Lake Wawasee-Turkey Creek	Poor	Poor
3	Wabee Lake-Hammond Ditch	Poor	Very Poor
4	Coppes Ditch-Turkey Creek	Poor	Poor
5	Coppes Ditch-Turkey Creek	Poor	Poor
6	Omar Neff Ditch-Turkey Creek	Fair	Poor
7	Berlin Court Ditch	Poor	Very Poor
8	Hoopingarner Ditch-Turkey Creek	Good	Poor
9	Dausman Ditch-Turkey Creek	Fair	Poor
10	Swoveland Ditch-Turkey Creek	Poor	Fair
11	Headwaters Yellow Creek	Poor	Good
12	Hoover Ditch-Rock Run Creek	Fair	Poor
13	Horn Ditch-Rock Run Creek	Poor	Fair
14	Goshen Dam Pond-Elkhart River	Poor	Good
15	Berlin Court Ditch	Poor	Poor
16	Horn Ditch-Rock Run Creek	Poor	Very Poor
17	Goshen Dam Pond-Elkhart River	Fair	Very Poor

Agricultural Conservation Planning Framework (ACPF) Summary

The Agricultural Conservation Planning Framework (ACPF) was developed by the USDA's Agricultural Research Service in partnership with the USDA Natural Resources Conservation Service. ACPF supports agricultural watershed management by using high-resolution elevation data and an ArcGIS toolbox to identify site-specific opportunities for installing conservation practices across watersheds. This non-prescriptive approach provides a menu of conservation options to facilitate conservation discussions. The framework is used in conjunction with local knowledge of water and soil resource concerns, landscape features, and producer conservation preferences. Together, these provide a better understanding of the options available to develop and implement a watershed management plan.

Sediment delivered from watershed erosion can cause substantial damage and degradation to waterways and water quality. Controlling sediment loading requires knowledge about soil erosion and sedimentation. Drainage area, basin slope, climate, land use and land cover affect the sediment delivery process. Problems caused by soil erosion and sediments include losses of soil productivity, water quality degradation, and less capacity to prevent natural disasters such as floods. Sediments may carry pollutants into water systems and cause significant water quality problems. Sediment yields are also associated with waterway damage. Sediment deposition in streams reduces channel capacity and results in flooding damage. The water storage capacity of a reservoir can be depleted by accumulated sediment deposition. Sediment yield is a critical factor in identifying non-point source pollution as well as in the design or construction projects such as dams and reservoirs. However, sediment yield is usually not available as a direct measurement but estimated by using a sediment delivery ratio (SDR). Figure 91 details the sediment delivery ratio for each agricultural field in the Lower Elkhart River Watershed. Sediment delivery ratio utilizes both the distance from the stream and the field's steepness to calculate the rating. Coarser texture sediment and sediment from sheet and rill erosion have more chances to be deposited or to be trapped, compared to fine sediment and sediment from channel erosion. Therefore, the delivery ratio of sediment with coarser texture or from sheet and rill erosion are relatively lower than the fine sediment or sediment from channel erosion. A small watershed with a higher channel density has a higher sediment delivery ratio compared to a large watershed with a low channel density. Conversely, a watershed with steep slopes has a higher sediment delivery ratio than a watershed with flat and wide valleys.

Similarly, runoff risk calculates the direct runoff contribution to stream channels in the watershed. Runoff risk prioritizes fields where multiple erosion control practices are most needed. Fields that are closer in proximity to a stream and are steeper in slope have a higher runoff risk. Those that are further away, or flatter, have a lower runoff risk. Because sediment and phosphorus are not lost evenly from all parts of a fields but rather are lost from a few critical source areas these are the most limiting areas of significant extent or are generally those areas of the field that have the steepest slope. Figure 92 details the runoff risk for farm fields in the Lower Elkhart River Watershed. Runoff risk is categorized into low, moderate, high and very high. It should be noted that even fields rated as low will benefit from runoff control-based conservation practices; however, fields which rank moderate, high or very high will likely benefit more.

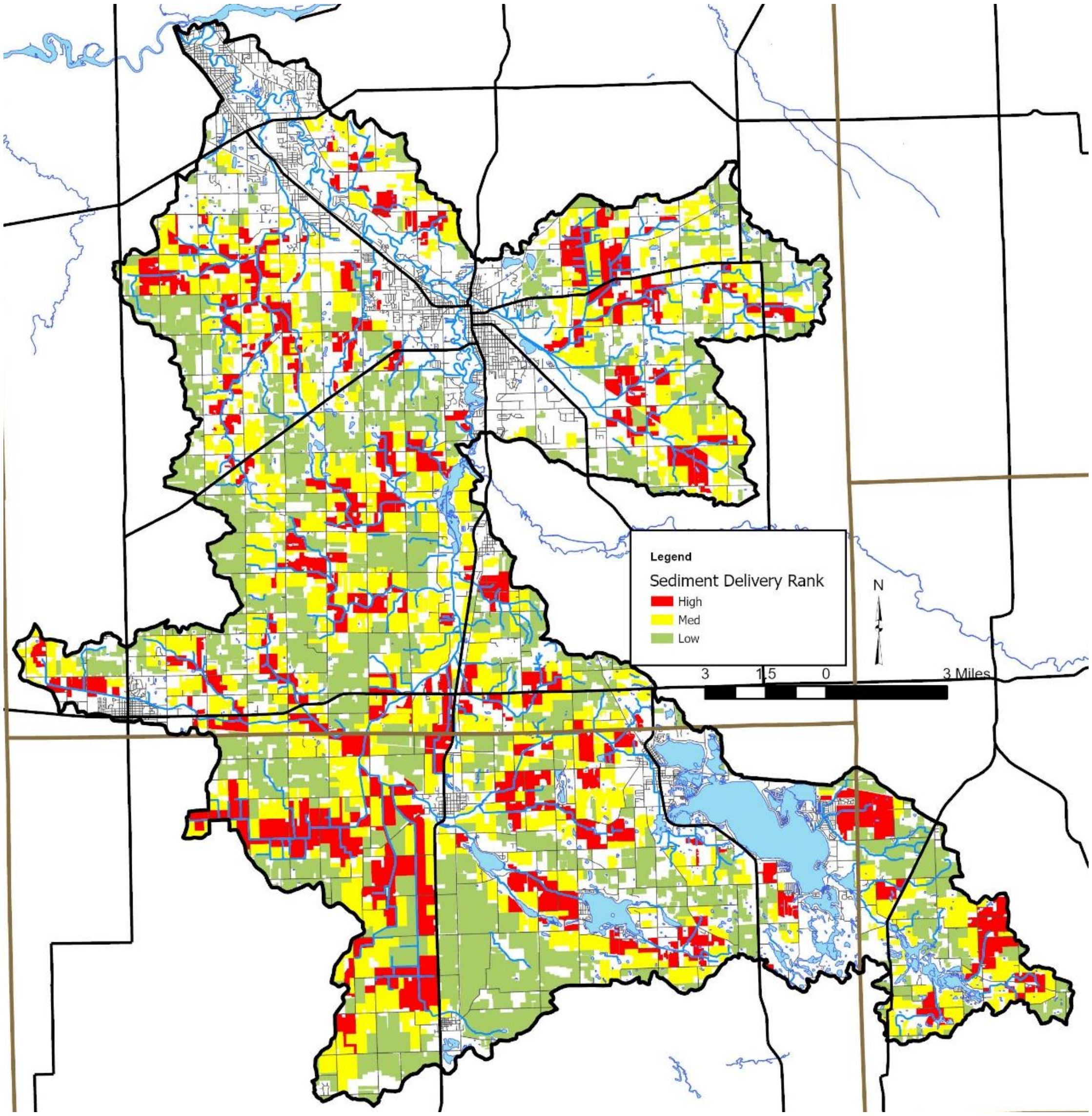


Figure 91. Sediment delivery ratio developed using ACPF for the Lower Elkhart River Watershed.

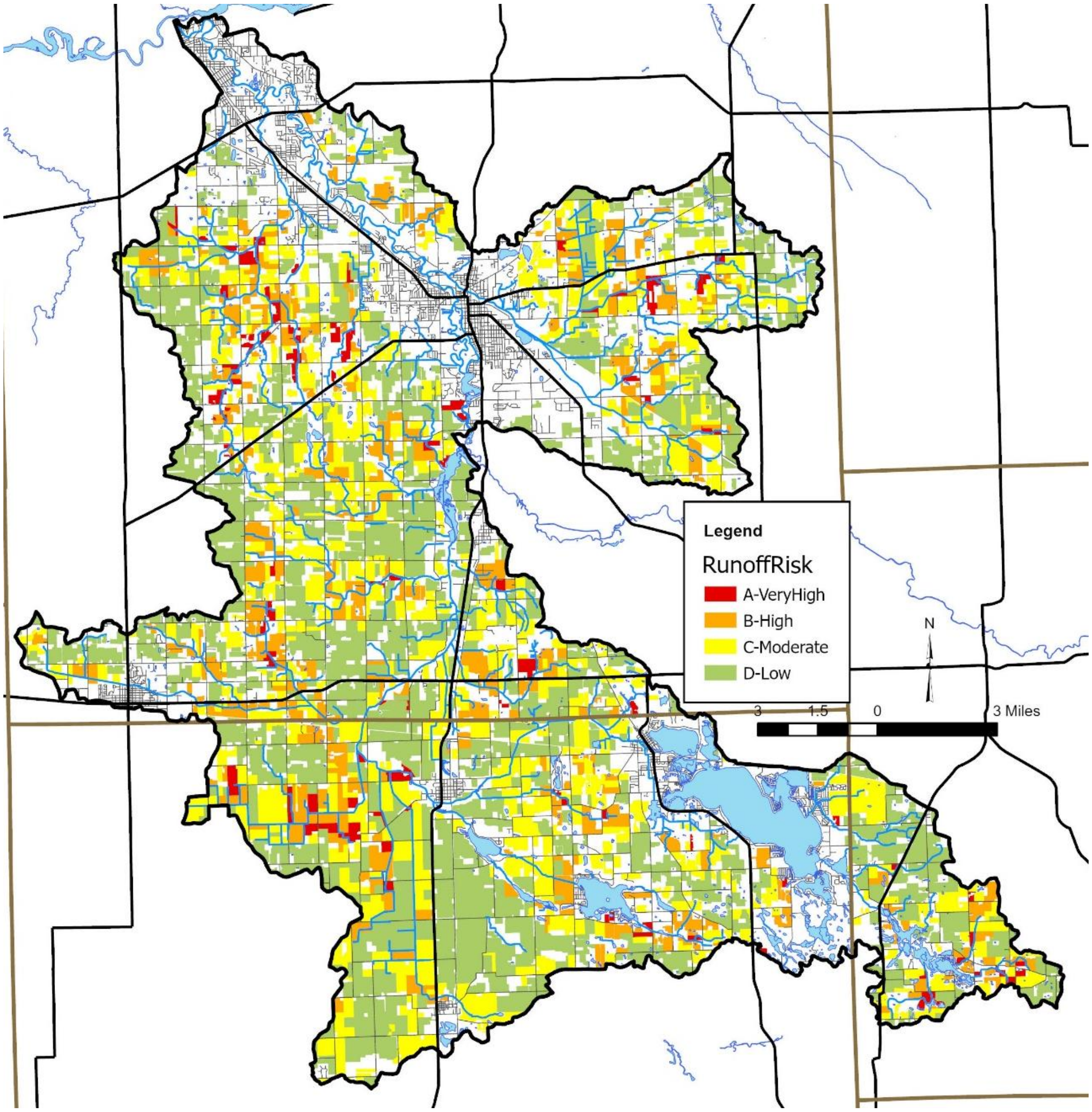


Figure 92. Runoff risk ratio developed using ACPF for the Lower Elkhart River Watershed.

5.2 Stakeholder Concern Analysis

All identified concerns generated both from stakeholder input and through water quality and watershed inventory efforts are detailed in Table 63. This list represents a work in progress and additional concerns may be added as the steering and monitoring committees work through data analysis. The steering committee rated each concern as to whether it is supported by watershed-based data, what evidence does or does not support the concern, whether the concern is quantifiable, whether it is in the scope of the watershed management plan, and if it is something on which the committee wants to focus. Nearly all concerns were quantifiable, and many were rated as being within the scope and items on which the committee wants to focus.

Following a review of the stakeholder concerns, the steering committee determined the following concerns identified by the public to be outside of this project's approach:

- Changes in drainage pattern – Nappanee used to flow west and now flow east into the Elkhart drainage.

- Slow water movement through the Goshen Dam Pond
- Goshen Dam Pond wants to dredge - disagree- maintain natural curves
- Levees/canals through Goshen or in other areas are they legal? Required set back and maintenance activities impacts
- City of Elkhart has stated they will not extend services beyond their boundary, however there are discussions about annexation this year.
- Two TIF districts are located in the lower watershed – Northeastern TIF and one north of Syracuse. Public funds should be used for public purposes.
- Fish kills after heavy rains (pollutants in the runoff).
- River otter population increases (need protection) trapping season starts fall 2023

All of the above concerns except the slow water movement and fish kill concern are supported by available data; however, the steering committee determine that they have little ability to impact any of these concerns. Specifically, there is very little likelihood of changing the drainage pattern around Nappanee now or in the future, impacting slow water flow through Goshen Dam Pond, determining whether dredging or maintaining the Goshen Dam Pond should occur, modifying the Goshen Levee system or its use, the City of Elkhart extending services beyond their boundaries or impacting the TIF districts in the watershed. With the exception of the preference of dredging or maintain natural conditions in Goshen Dam Pond, these concerns are factually based and were deemed that they should not be the focus of future watershed planning efforts.

Table 63. Analysis of stakeholder concerns identified in the Lower Elkhart River Watershed.

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Elevated nutrient levels	Yes	15% of TSS, 16% of TP, 92% of nitrate and 51% of *E. coli* samples collected during the WMP monitoring exceed water quality targets. 69% of *E. coli*, 29% of TSS samples, 95% of TP, 79% of nitrate samples collected historically exceed targets. 7.8 miles of stream are impaired for nutrients,154.7 mi are impaired for *E. coli*, 7.8 mi are impaired for DO. 79% reduction in nitrate, 36% reduction in TP, 38% reduction in TSs and 72% reduction in E. coli is necessary to meet targets.	Yes	No	Yes
Water is brown and cloudy often after rains; Excessive sediment load; Runoff, sedimentation	Yes		Yes	No	Yes
	Yes		Yes	No	Yes
	Yes		Yes	No	Yes
Elevated *E. coli* levels	Yes		Yes	No	Yes
No longer feel safe for recreation or full body contact					
Fear of *E. coli*, perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns.	No	Anecdotal.	No	Yes	Education
Yellow Creek -fecal matter input, highest of Elkhart County drainages – sewer will be constructed this year.	Yes	Elkhart County data summary report (SJRBC) notes that Yellow Creek (among others) consistently has higher *E. coli* (and other parameters)	Yes	No	Yes
Septic limitations due to prevalence of unsuitable soils, lack of maintenance	yes	94% of watershed soils are limited for use in septic adsorption fields.	Yes	Yes	Education
Combined Sewer Overflows – *E. coli*, nutrients – long term control – confirm status of Elkhart, Goshen, and Nappanee CSOs	Yes	CSOs are located in the City of Elkhart and historically occurred in the Cities of Goshen and Nappanee, both of which divert stormwater to a wet weather detention facility.	Yes	No	Yes
Limited participation by farmers in soil erosion practices	Yes	ICP data indicates that agricultural BMP adoption is occurring within the watershed.	Yes	No	Yes
The Kosciusko County portion of this watershed is pretty sandy – lots of wind erosion, producers often conventional till in the fall in this area	Yes	Highly erodible soils cover 31% of the watershed. Highly erodible soils are found throughout the watershed with lesser amounts in the western portion of the watershed in Kosciusko County and along the mainstem of the Elkhart River.	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
CR17 will eventually be extended south – this change in pavement may impact impervious surfaces in the Lower Elkhart	Not at this time	Data are not currently available but will be included in the five-year plan, once updated.	Yes	No	Yes
Development will continue in rural portions of the watershed – likely subdivisions which will lead to increases in unsewered dense housing. Development in these areas are likely to require more expensive septic options like mound systems	Yes	8% of the watershed is mapped as floodplain. 58% of floodplain is mapped in forest, wetland or open water; 13% is developed and 25% is used for agricultural row crop or pastureland. County has maps where development is located, but not where houses are located and area is not sewered. MS4 requires 25-50 ft natural buffer along rivers and streams.	Yes	Yes	Education
Keep/Continue sewer development on pace with development - areas that are developed but are not sewered needs to be mapped	Yes		Yes	Yes	Education
Urban development: Maintain a natural buffer along the water. Need proper planning of developments/policies should include urban development.	Yes		Yes	Yes	Education
Development - too many hard surfaces	Yes		Yes	Yes	Education
Alterations to flood storage and flow conveyance	Yes		Yes	Yes	Education
Rapid increase in impervious surface in the watershed	Yes		Yes	Yes	Education
Floodplain development - used for commercial and residential building sites now and in the future will only cause more flooding	Yes		Yes	Yes	Education
Urban development /encroachment on the floodplain	Yes		Yes	Yes	Education
Loss of habitat with increased development	Yes		Yes	Yes	Education

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Flooding	Yes	CBBEL noted a 4.2 inch/year increase in precipitation in the NBER 1895-2019 and notes an increase in heavy rain events from 1 day/yr to 3 days/year exceeding the 99th percentile OR more frequent extreme events and larger annual precipitation totals. Soils drained by tile drains cover approximately 38% of the watershed. Nearly 300 miles of regulated drains are located in the watershed. 8% of the watershed is mapped as floodplain.	Yes	Yes	Education
Flooding - our subdivision floods all the time - how can we control it, move water downstream	Yes		Yes	Yes	Education
Flooding – Chicago Avenue flooding was noted with the potential impact of Kroger not rebuilding if flooding in the store occurs again	Yes		Yes	Yes	Education
Water levels are high - often exceed the 2018 recorded flood level	Yes		Yes	Yes	Education
Drainage for agricultural production (both the positive aspect of achieving appropriate drainage for agriculture and the negative aspect of alteration of the hydrologic system)	Yes		Yes	No	Yes
Drainage ways that currently have land uses immediately adjacent to their banks would ideally benefit from a vegetated riparian zone buffers (increasing the frequency of filter strips, etc)	Yes		Yes	No	Yes
Wakarusa and other rural Elkhart County sewer system project - how will this impact areas downstream?	Yes		Yes	No	Yes
Changes in drainage pattern – Nappanee used to flow west and now flow east into the Elkhart drainage.	Yes	Historic maps detail Nappanee historically drained to Baugo Creek.	Yes	Yes	No
Slow water movement through the Goshen Dam Pond	Maybe	Anecdotal evidence suggests this is both true and false.	Maybe	Yes	No
Goshen Dam Pond wants to dredge - disagree- maintain natural curves	Yes	Local residents are interested in dredging and a sediment removal plan was developed in 2014.	Yes	Yes	No

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage	Yes	The only lowhead dam in the watershed is located at the Goshen Dam Pond. Committee agrees that dam removal improves fish passage	Yes	No	Yes
Culvert sizing creating fish passage concerns, restrictions in flows	Yes	When dams are removed it does increase fish passage. Great lakes culvert inventory. Anecdotal.	Yes	No	Yes
Volume of animal waste produced in the watershed (used in the watershed) is high	Yes	67% of the watershed is covered by row crop or pastureland. 94% of the watershed is covered by soils which rate as very limited for septic use. Anecdotal information suggests that straight pipes and facility maintenance is an issue in the watershed. Livestock have access to approximately 3.3 miles of watershed streams. Additional access is likely present but was not observed during the windshield survey. 797,241 animals are permitted on CFOs in the watershed producing more than 560,289 tons of manure annually.	Yes	No	Yes
Livestock access to surface waters within the watershed	Yes		Yes	No	Yes
Non-point source pollution (agricultural row crop and animal runoff & septic)	Yes		Yes	No	Yes
Livestock access - Rock Run Creek east of Elkhart County fairgrounds, other locations	Yes		Yes	No	Yes
Poorly constructed and maintained stormwater management practices	Yes	Data have not been collected but anecdotal information suggests that some practices are poorly constructed and/or poorly maintained. All BMPs need long term maintenance. Foraker project	Yes	No	Yes
Long term maintenance of post construction stormwater infrastructure.	Yes		Yes	No	Yes
Streambank erosion is a concern on the Elkhart and tributaries; Stream bank deterioration caused by severe erosion. (refers to general observations of erosion, especially along legal drains)	Yes	7.5 miles of streambank erosion were observed during the windshield survey. Note Elkhart River not mapped.	Yes	No	Yes
	Yes				
River otter population increases (need protection)	Yes	River otter populations have increased and trapping was allowed starting Fall 2023.	No	Yes	No

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Problematic siltation issues within the watershed lakes and reservoirs	Yes	The Goshen Dam Pond and Lake Wawasee have sediment removal plans. Other watershed lakes have not yet developed plans but that does not mean that siltation is not occurring.	Yes	No	Yes
Interest in making legal drains more natural, install buffer strips between agricultural fields	Yes	2.9 miles of streams with narrow buffer and 7.5 miles of streambank erosion were observed during the windshield survey.	Yes	No	Yes
Concerns about unregulated drain erosion, working with private landowners	Yes		Yes	No	Yes
Managing regulated drains to reduce sediment loading (two-stage, buffer strip incentives)	Yes		Yes	No	Yes
Vegetation growth due to eutrophication in lakes and streams	Yes	Lake Wawasee and Dewart Lakes have an aquatic plant management plan. Other watershed lakes likely also manage aquatic plants.	Yes	No	Yes
Herbicide distribution within lakes to control nuisance weeds, and the concern for responsible vegetation management as it relates to impacts on wildlife	Yes		Yes	No	Yes
Nutrient loading due to the use of (lawn, agriculture) fertilizers	Yes	NASS estimates (2005) indicate that approximately 22,000 tons of atrazine and 11,000 tons of glyphosate are applied to cropland in the Lower Elkhart Watershed counties annually.	Yes	No	Education
Long-term viability of the watershed as an irrigation source (both surface and ground water quantity issues)	Yes	Data from the IN Chamber indicates that 56.8 MGD of water is used for irrigation in Upper Elkhart River Counties.	Yes	No	Yes
Well sensitivity, runoff from irrigated areas	Yes		Yes	No	Yes
Impacts of logjams and beaver activities	Yes	Logjams were identified during the windshield inventory. Anecdotal	Yes	No	Yes
Logjams					

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
		information documents the presence of logjams. Anecdotal information documents the impacts of beavers in the watershed. No data have been collected on their impacts.			
Falling trees create logjams/dam the river		Logjams (continued from above)			
Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety.					
Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above					
Create means of access around fallen snags as opposed to removing them in their entirety					
Fallen trees impeding navigable passage throughout the waterways.					
Recreation - access is needed, recreation should be promoted	Yes	7 river and lake public access sites are located within the watershed.	Yes	No	Yes
Loss of habitat for ETR species	Yes	Nearly 30 state endangered species have been observed in the Lower Elkhart River watershed. State endangered fish and wildlife need habitat protection	Yes	No	Yes
Blanding's turtles are state endangered and reproduce locally					
State endangered fish and wildlife need habitat protection					
Protect natural features in the watershed as these areas help reduce sediment load in the water	Yes	Indiana DNR; Cities of Goshen, Elkhart, Syracuse, Nappanee, New Paris and Milford; Elkhart County maintain, preserve and protect natural areas in the watershed. Wetlands cover 7% of the watershed. It is estimated that 9% of wetlands have been modified or lost over time. More than 294 miles	Yes	No	Yes
Preservation of wetlands upstream, to protect floodplain areas					

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
		of surface drains have been constructed in the watershed.			
The rivers should be used to make money and attract tourists and recreational enthusiasts	Yes	Anecdotal information documents there is interest in drift boat fishing, livery and other tourist options.	Yes	No	Yes
Design protected wildlife corridor through the Lower Elkhart Watershed Promote quiet/passive recreation - bird watching, canoeing, kayaking	Yes	IDNR notes that seven terrestrial high quality natural communities including Northern Lakes Dry-mesic Upland Forest, Lake, Circumneutral Bog, Marsh, Sedge Meadow and Shrub Swamp	Yes	No	Yes
Invasive species Growing Canada goose population Growing mute swan population	Yes	Anecdotal information documents the presence of invasive species. However, lists have not been generated and population density data are not available.	Yes	No	Yes, Education
Litter along roadsides, urban areas and rural dumping	Yes	Long term dumping locations were mapped as part of the inventory; trash is present along watershed streams. Anecdotal evidence based on communication with stakeholders.	Yes	No	Yes, Education
Illicit discharges	Yes	The Cities of Goshen and Elkhart and Elkhart County MS4s maintain illicit discharge lists for locations within their jurisdiction.	Yes	No	Yes
Fish consumption advisories Mercury and PCBs in fish tissue	Yes	Consumption advisories for sensitive populations are in place in Elkhart County. 8.9 miles of watershed streams and Lake Wawasee are listed as impaired for fish consumption.	Yes	Yes	Education
PFAS	NO	PFAS is present across the state, volumes and impacts have not been measured in the Lower Elkhart River Watershed.	Yes	Yes	Education
Fish kills after heavy rains (pollutants in the runoff	No	There is no evidence of fish kills being present currently.	No	Yes	No
Levees/canals through Goshen or in other areas are they legal. Required set back and maintenance activities impacts	Yes	The entire length of the mill race is a levee and requires a setback and maintenance.	Yes	Yes	No

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Concerned over attempts to make the Elkhart River a legal drain: concern over drainage policy in general	Yes	Efforts to regulate portions of the Elkhart River as a legal drain occurred in 2009. More recent data or efforts could not be identified. IDNR, restoration complete report (clearing, snagging) 1992	Yes	No	Yes, awareness of issue
We are in the headwaters, our impact to the Elkhart River are not felt locally but we are hopeful in doing our part to address water quality and quantity downstream	Yes	Anecdotal information suggests that messaging cohesion and sense of place education is needed across the watershed.	Yes	No	Education
People need to understand the connection up-down stream not just the area nearest them					
General lack of public awareness about how their activities impact water quality and quantity					
City of Elkhart has stated they will not extend services beyond their boundary, however there are discussions about annexation this year.	Yes	Annexation of rural areas may not change utilities which are available in annexed areas.	Yes	Yes	No
Two TIF districts are located in the lower watershed – Northeastern TIF and one north of Syracuse. Public funds should be used for public purposes.	Yes		Yes	Yes	No
Climate change	Yes	The City of Goshen Climate Ready Action Plan highlights impacts of climate change on the local watershed.	Yes	No	Yes

6.0 PROBLEM AND CAUSE IDENTIFICATION

After evaluation of stakeholder concerns and completion of the watershed inventory, watershed problems can be summarized as shown in Table 64. Problems represent the condition that exists due to a particular concern or group of concerns, then details potential causes of problems identified.

Table 64. Problems and causes identified for the Lower Elkhart River watershed based on stakeholder and inventory concerns.

Concern(s)	
• Concerns about unregulated drain erosion, working with private landowners • Create means of access around fallen snags as opposed to removing them in their entirety • Drainage ways that currently have land uses immediately adjacent to their banks would ideally benefit from a vegetated riparian zone buffers (increasing the frequency of filter strips, etc) • Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage • Excessive sediment load • Fallen trees impeding navigable passage throughout the waterways. • Falling trees create logjams/dam the river • Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above • Impacts of logjams and beaver activities • Interest in making legal drains more natural, install buffer strips between agricultural • Limited participation by farmers in soil erosion practices • Livestock access to surface waters within the watershed • Long term maintenance of post construction stormwater infrastructure • Managing regulated drains to reduce sediment loading (two-stage, buffer strip incentives) • No longer feel safe for recreational swimming • Non-point source pollution (agricultural row crop and animal runoff & septic) • Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety. Removal was completed in December 2023 however this could be a continued issue in the future. • Poorly constructed and maintained stormwater management practices • Problematic siltation issues within the watershed lakes and reservoirs • Protect natural features in the watershed as these help reduce sediment load in the water • Runoff, sedimentation • Stream bank deterioration caused by severe erosion. (refers to general observations of erosion, especially along legal drains) • Streambank erosion is a concern on the Elkhart and tributaries	**Problem:** Sediment & Erosion: area streams are cloudy/turbid **Cause(s)**: Suspended Sediment concentration levels exceed the target set by this project

<table>
<tr><td>• The Kosciusko County portion of this watershed is pretty sandy – lots of wind erosion, producers often conventional till in the fall in this area
• Water is brown and cloudy often after rains
• Climate change</td><td></td></tr>
<tr><td rowspan="2">• Create means of access around fallen snags as opposed to removing them in their entirety
• Drainage ways that currently have land uses immediately adjacent to their banks would ideally benefit from a vegetated riparian zone buffers (increasing the frequency of filter strips, etc)
• Elevated nutrient levels
• Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage
• Excessive sediment load
• Fallen trees impeding navigable passage throughout the waterways.
• Falling trees create logjams/dam the river
• Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above
• Herbicide distribution within lakes to control nuisance weeds, and the concern for responsible vegetation management as it relates to impacts on wildlife
• Illicit discharges
• Impacts of logjams and beaver activities
• Limited participation by farmers in soil erosion practices
• Livestock access to surface waters within the watershed
• Non-point source pollution (agricultural row crop and animal runoff & septic)
• Nutrient loading due to the use of (lawn, agriculture) fertilizers
• Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety. Removal was completed in December 2023 however this could be a continued issue in the future.
• Poorly constructed and maintained stormwater management practices
• Vegetation growth due to eutrophication in lakes and streams
• We are in the headwaters, our impact to the Elkhart River are not felt locally but we are hopeful in doing our part to address water quality and quantity downstream
• Climate change</td><td>Problem: Nutrients: Area streams have nutrient levels exceeding the target set by this project</td></tr>
<tr><td>Cause(s): Nutrient levels exceed the target set by this project

Targeted nutrient reduction education does not exist</td></tr>
</table>

• Combined Sewer Overflows – *E. coli*, nutrients – long term control – confirm status of Elkhart and Nappanee CSOs • Development will continue in rural portions of the watershed – likely subdivisions which will lead to increases in unsewered dense housing. Development in these areas are likely to require more expensive septic options like mound systems	**Problem**: *E. coli*: Area streams are impaired for recreational contact by IDEM's 303(d) list
• Septic limitations due to prevalence of unsuitable soils • Lack of septic maintenance • Elevated *E. coli* levels • Litter along roadsides, urban areas and rural dumping • Livestock access - Rock Run Creek east of Elkhart County fairgrounds, other locations • No longer feel safe for recreational swimming • Volume of animal waste produced in the watershed (used in the watershed) is high • Yellow Creek -fecal matter input, highest of Elkhart County drainages – sewer will be constructed this year. • Climate change	**Cause(s)**: E.coli levels exceed the water quality standard
• Create means of access around fallen snags as opposed to removing them in their entirety • Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage • Fallen trees impeding navigable passage throughout the waterways. • Falling trees create logjams/dam the river • Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above • Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above • Impacts of logjams and beaver activities • Livestock access to surface waters within the watershed • No longer feel safe for recreational swimming • Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety. Removal was completed in December 2023 however this could be a continued issue in the future. • Promote quiet recreation - bird watching, canoeing, kayaking • Recreation - access is needed, recreation should be promoted • The river should be used to make money and attract tourists	**Problem:** Recreation **Cause(s)**: -Unsafe water for swimming and boating -Concern for long term negative impacts to recreation

• Alterations to flood storage and flow conveyance • CR17 will eventually be extended south – this change in pavement may impact impervious surfaces in the Lower Elkhart • Development - too many hard surfaces • Drainage for agricultural production (both the positive aspect of achieving appropriate drainage for agriculture and the negative aspect of alteration of the hydrologic system were discussed) • Flooding • Flooding – Chicago Avenue flooding was noted with the potential impact of Kroger not rebuilding if flooding in the store occurs again • Flooding - our subdivision floods all the time - how can we control it, move water downstream • Floodplain development - used for commercial and residential building sites now and in the future will only cause more flooding • Logjams • Long-term viability of the watershed as an irrigation source (both surface and ground water quantity issues) • Look at irrigation data/well sensitivity, runoff from irrigated areas • Managing regulated drains to reduce sediment loading (two-stage, buffer strip incentives) • Preservation of wetlands upstream, to protect floodplain areas • Rapid increase in impervious surface in the watershed • Water levels are high - often exceed the 2018 recorded flood level • Development will continue in rural portions of the watershed – likely subdivisions which will lead to increases in unsewered dense housing. Development in these areas are likely to require more expensive septic options like mound systems • Keep/Continue sewer development on pace with development - areas that are developed but are not sewered needs to be mapped • Loss of habitat with increased development • Septic limitations due to prevalence of unsuitable soils, lack of maintenance • Urban development (whatever anyone wants to do is accepted). Maintain a natural buffer along the water. Need proper planning of developments • Urban Development/encroachment on the floodplain • Wakarusa and other rural Elkhart County sewer system project - how will this impact areas downstream?	**Problem:** Drainage patterns impact water quantity **Cause(s)**: Humans altered the natural drainage pattern. Balance should be restored. -Land use changes are impacting the ability to store, retain and infiltrate water. -Local regulations are key to minimizing impacts from development in the watershed.

• Blanding's turtles are state endangered and reproduce locally • Culvert sizing creating fish passage concerns, restrictions in flows • Design protected wildlife corridor through the Lower Elkhart Watershed • Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage • Growing Canada goose, mute swan population • Impacts of logjams and beaver activities • Invasive species • Loss of habitat for ETR species • State endangered fish and wildlife need habitat protection	**Problem:** Wildlife Impacts **Cause(s)**: Habitat modification both historic and present day altered the watershed use and impacted biological communities
• Alterations to flood storage and flow conveyance • Concerned over attempts to make the Elkhart River a legal drain: concern over drainage policy in general • Concerns about unregulated drain erosion, working with private landowners • Create means of access around fallen snags as opposed to removing them in their entirety • Development - too many hard surfaces • Development will continue in rural portions of the watershed – likely subdivisions which will lead to increases in unsewered dense housing. Development in these areas are likely to require more expensive septic options like mound systems • Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage • Fallen trees impeding navigable passage throughout the waterways. • Falling trees create logjams/dam the river • Fear of *E. coli*, perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns. • Fish consumption advisories • Flooding • Flooding – Chicago Avenue flooding was noted with the potential impact of Kroger not rebuilding if flooding in the store occurs again • Floodplain development - used for commercial and residential building sites now and in the future will only cause more flooding • General lack of public awareness about how their activities impact water quality and quantity • Goshen Parks used to provide canoe rental but this has been suspended due to the logjam noted above • Impacts of logjams and beaver activities • Keep/Continue sewer development on pace with development - areas that are developed but are not sewered needs to be mapped	**Problem**: Education and cohesion are lacking **Cause(s)**: Local regulations are key to minimizing impacts from development in the watershed. Lack of focused education programming focused on agricultural/rural area and agricultural area highlighting their common ground and differences.

• Litter along roadsides, urban areas and rural dumping • Livestock access to surface waters within the watershed • Long term maintenance of post construction stormwater infrastructure • Loss of habitat with increased development • Mercury and PCBs in fish tissue • No longer feel safe for recreational swimming • Nutrient loading due to the use of (lawn, agriculture) fertilizers • Oxbow logjam is a major concern, DNR states it is impassable and poses a threat to human safety. Removal was completed in December 2023 however this could be a continued issue in the future. • People need to understand the connection up-down stream not just the area nearest them • PFAS • Protect natural features in the watershed as these help reduce sediment load in the water • Rapid increase in impervious surface in the watershed • Septic limitations due to prevalence of unsuitable soils, lack of maintenance • Urban development (whatever anyone wants to do is accepted). Maintain a natural buffer along the water. Need proper planning of developments • Urban Development/encroachment on the floodplain • Water levels are high - often exceed the 2018 recorded flood level	

7.0 SOURCE IDENTIFICATION AND LOAD CALCULATION

Source Identification: Key Pollutants of Concern

Nonpoint pollution sources are varied, yet common throughout almost any watershed. Several earlier sections of this document identify potential sources of pollutants of concern in the Lower Elkhart River Watershed. These and other potential sources of these causes are discussed in further detail in subsequent sections. A summary of potential sources identified in the Lower Elkhart River Watershed for each of our concerns is listed below:

Sediment:

- Conventional tillage cropping practices
- Streambank and bed erosion
- Poor riparian buffers
- Poor forest management
- Gully or ephemeral erosion
- Cropped floodplains
- Livestock access to streams
- Altered hydrology (ditching and draining, altered stream courses)
- Urban land use and development impacts (diffuse, disorganized, lack of proper stabilization technique use)

- Invasive species impacts to land cover/soil stability
- Stormwater from municipal sources (MS4s)

Nutrients (Nitrogen and Phosphorus):

- Conventional tillage cropping practices
- Wastewater treatment discharges
- Agricultural fertilizer
- Poor riparian buffers
- Poor forest management
- Streambank and bed erosion
- Animal waste (livestock in streams, poor manure management, domestic and wildlife runoff)
- Confined feeding operations
- Human waste (failing septic systems, sanitary sewer overflows, inadequately treated wastewater)
- Development impacts (diffuse, disorganized, lack of proper stabilization technique use)
- Invasive species impacts to land cover/soil stability
- Stormwater from municipal sources (MS4s)

E. coli:

- Human waste (failing septic systems, sanitary sewer overflows, inadequately treated wastewater)
- Animal waste (livestock in streams, poor manure management, domestic and wildlife runoff)

Potential Sources of Pollution

The steering committee used GIS data, water quality data, watershed inventory observations and anecdotal information as available to evaluate the potential sources of nonpoint pollution in the Lower Elkhart River Watershed. Appendix C contains tables detailing each potential source within each subwatershed. Table 65 through Table 71 summarizes the magnitude of potential sources of pollution for each problem identified in the Lower Elkhart River Watershed. Several sources listed above are not included below as specific data for each concern is not available: conventional tillage by subwatershed; gully or ephemeral erosion (none identified during the watershed inventory but likely present); poor forest management (not assessed); animal waste (domestic and wildlife runoff numbers not identified on the subwatershed level); cropped floodplains (they occur but density and distribution was not mapped); development impacts; invasive species (a list was developed but the volume was not assessed).

Table 65. Potential sources causing sediment problems.

Problems:	Sediment & Erosion: area streams are cloudy/turbid.
Potential Causes:	Suspended sediments and/or turbidity exceed target values set by this project.
Potential Sources:	• 7.5 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization Dausman Ditch-Turkey Creek, Horn Ditch-Rock Run Creek and Headwaters Yellow Creek subwatersheds. • Livestock access (3.3 miles of streams) was observed in the Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Swoveland Ditch-Turkey Creek subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 2.9 miles of stream lack adequate buffers with observations occurring in Berlin Court Ditch, Dausman Ditch-Turkey Creek, Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Omar Neff Ditch-Turkey Creek subwatersheds. • 7-31% of soybean fields and 13-41% of corn fields are under conservation tillage. • Nearly 6,650 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Dausman Ditch-Turkey Creek, Headwaters Yellow Creek and Berlin Court Ditch subwatersheds. These operations can be sources due to livestock defecating in or near streams, soil compaction, streambank erosion, and improper manure storage and spreading. • 59,501 acres of highly erodible land occur within the watershed. The highest density of HES occurs in Village Lake-Turkey Creek, Wabee Lake-Hammond Ditch, Headwaters Yellow Creek, Hoopingarner Ditch-Turkey Creek and Hoover Ditch-Rock Run Creek subwatersheds. • 3 of the 4 of the MS4 of the Greater Elkhart County Stormwater Partnership and City of Nappanee MS4 lie partially within the Lower Elkhart River Watershed.

Table 66. Potential sources causing nutrient problems.

Problems:	Nutrient concentrations threaten the health of Lower Elkhart River and its tributaries.
Potential Causes:	Nutrient concentrations exceed target values set by this project.
Potential Sources:	• 7.5 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization Dausman Ditch-Turkey Creek, Horn Ditch-Rock Run Creek and Headwaters Yellow Creek subwatersheds. • Livestock access (3.3 miles of streams) was observed in the Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Swoveland Ditch-Turkey Creek subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 2.9 miles of stream lack adequate buffers with observations occurring in Berlin Court Ditch, Dausman Ditch-Turkey Creek, Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Omar Neff Ditch-Turkey Creek subwatersheds. • 7-31% of soybean fields and 13-41% of corn fields are under conservation tillage. • Nearly 6,650 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Dausman Ditch-Turkey Creek, Headwaters Yellow Creek and Berlin Court Ditch subwatersheds. These operations can be sources due to livestock defecating in or near streams, soil compaction, streambank erosion, and improper manure storage and spreading. • More than 797,000 animals are permitted on confined feeding operations in the watershed. Animals are most dense in the Berlin Court Ditch, Hoover Ditch-Rock Run Creek and Swoveland Ditch-Turkey Creek subwatersheds. • Animals in the watershed produce more than 560,300 tons of manure annually which produces 16,418,000 lbs of phosphorus, 20,287,500 tons of nitrogen and 1.36E+206 colonies of *E. coli* annually. • 59,501 acres of highly erodible land occur within the watershed. The highest density of HES occurs in Village Lake-Turkey Creek, Wabee Lake-Hammond Ditch, Headwaters Yellow Creek, Hoopingarner Ditch-Turkey Creek and Hoover Ditch-Rock Run Creek subwatersheds. • 3 of the 4 of the MS4 of the Greater Elkhart County Stormwater Partnership and City of Nappanee MS4 lie partially within the Lower Elkhart River Watershed.

Table 67. Potential sources causing *E. coli* problems.

Problems:	Area streams are listed by IDEM as impaired for recreational contact.
Potential Causes:	*E. coli* concentrations exceed target values and the state standard.
Potential Sources:	• 7.5 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization Dausman Ditch-Turkey Creek, Horn Ditch-Rock Run Creek and Headwaters Yellow Creek subwatersheds. • Livestock access (3.3 miles of streams) was observed in the Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Swoveland Ditch-Turkey Creek subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 2.9 miles of stream lack adequate buffers with observations occurring in Berlin Court Ditch, Dausman Ditch-Turkey Creek, Headwaters Yellow Creek, Hoover Ditch-Rock Run Creek and Omar Neff Ditch-Turkey Creek subwatersheds. • Nearly 6,650 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Dausman Ditch-Turkey Creek, Headwaters Yellow Creek and Berlin Court Ditch subwatersheds. These operations can be sources due to livestock defecating in or near streams, soil compaction, streambank erosion, and improper manure storage and spreading. • More than 797,000 animals are permitted on confined feeding operations in the watershed. Animals are most dense in the Berlin Court Ditch, Hoover Ditch-Rock Run Creek and Swoveland Ditch-Turkey Creek subwatersheds. • Animals in the watershed produce more than 560,300 tons of manure annually which produces 16,418,000 lbs of phosphorus, 20,287,500 tons of nitrogen and 1.36E+206 colonies of *E. coli* annually. • Soils which are severely limited for septic use cover 66,855 aces or 94% of the Lower Elkhart River Watershed. Failing septic systems could contribute *E. coli* to the system within the rural portion of the watershed.

Table 68. Potential sources causing recreation and access problems.

Problems:	Need to promote and maintain recreation on lakes and rivers; preserve natural areas and access to parks.
Potential Causes:	Unsafe water for swimming and boating. Concern for long term negative impacts to recreation.
Potential Sources:	N/A

Table 69. Potential sources causing flooding problems.

Problems:	Reduced water storage, retention and infiltration.
Potential Causes:	Land use changes are impacting the ability to store, retain and infiltrate water. Local regulations are key to minimizing impacts from development in the watershed. Deregulation, including proposed state regulations that would take away local control, poses a threat to the watershed. Lack of cohesive regulations and governance across the watershed makes funding and implementation of a watershed plan challenging. There is no uniform drainage ordinance for the watershed. There is no single government body that oversees the watershed.
Potential Sources:	Riparian habitat alterations; disconnection and development of the floodplain; ditching, draining and tiling; stormwater runoff.

Table 70. Potential sources causing instream and terrestrial habitat problems.

Problems:	Habitat in the Lower Elkhart River Watershed is impacted by terrestrial and riparian alterations.
Potential Causes:	Habitat modification both historic and present day altered the watershed use and impacted biological communities
Potential Sources:	N/A

Table 71. Potential sources causing education and cohesion problems.

Problems:	Focused cohesive education and outreach activities and promotion of activities are needed to build public awareness and cohesion.
Potential Causes:	Interest and benefits are lacking.
Potential Sources:	N/A

7.1 Load Estimates

Nonpoint source pollution is generated from diffuse sources found on public and private lands. The USEPA notes that sources of nonpoint source pollution include stormwater runoff, construction activities, solid waste disposal, atmospheric deposition, streambank erosion, and more. Inventory data in Table 65 to Table 71 identify potential sources of nonpoint pollution within the watershed. These tables – generated using GIS, water quality data, windshield surveys, local knowledge, and other sources of data – are useful for generally identifying water quality problems. Two methods could be used to understand the loading of nutrients, sediment, and pathogens in waterbodies in the Lower Elkhart River Watershed: 1) measured results from the monitoring regime completed as part of the current watershed planning project and 2) modeled results. Each method can estimate both the current load and the reduction in load needed to reach target concentrations. These methods each present advantages and disadvantages for understanding the loading in this watershed in particular. The steering committee considered the monitoring data to draft long term goals and critical areas.

As discussed in Section 3.4 eighteen monitoring sites were sampled monthly from February 2023 to January 2024 There is clear value in using these measurements from the Lower Elkhart River Watershed to estimate loads and load reductions. However, there are some limitations in the measured dataset. Sampling methods did not allow for continuous flow measurements at each site, so data from the Elkhart River at Goshen USGS gage was used to approximate flow. As discussed in Section 3.1, the steering committee selected water quality benchmarks that will significantly improve water quality in Lower

Elkhart River (Table 18). Target loads needed to meet these benchmarks were calculated for each subwatershed for each parameter. Sample site data from the subwatershed's pour point sampling sites (outlets of each 12-digit hydrology unit code) were used to calculate annual loading rates and load reductions. Subsequent tables include data from Sites 1-14 only as they represent outlets for a 12-digit HUC. The load reduction needed was then calculated for the outlet of each subwatershed, which corresponds to each sample site, in lb/year or col/year and as a percent of the current load (Table 34 to Table 37). It should be noted that sample sites and subwatershed names shown represent the loading rate to that point inclusive of drainage upstream of the subwatershed. Using current targets, several subwatersheds do not required a reduction. These are noted as NRN (no reduction needed).

Table 72. Estimated nitrogen load reduction by subwatershed needed to meet water quality target concentrations in the Lower Elkhart River Watershed.

Subwatershed Name	Site(s)	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	% Reduction
Village Lake-Turkey Creek	1	99,151.8	25,413.8	73,738	74%
Lake Wawasee-Turkey Creek	2	410,929.6	61,174.0	349,756	85%
Wabee Lake-Hammond Ditch	3	61,622.6	25,245.8	36,377	59%
Coppes Ditch-Turkey Creek	4+5	664,970.6	155,219.6	509,751	77%
Omar Neff Ditch-Turkey Creek	6	572,294.6	184,106.3	388,188	68%
Berlin Court Ditch	7	145,535.3	28,294.5	117,241	81%
Hoopingarner Ditch-Turkey Creek	8	404,357.9	94,897.0	309,461	77%
Dausman Ditch-Turkey Creek	9	643,085.7	268,268.0	374,818	58%
Swoveland Ditch-Turkey Creek	10	1,444,815.6	930,527.2	514,288	36%
Headwaters Yellow Creek	11	170,332.2	52,548.1	117,784	69%
Hoover Ditch-Rock Run Creek	12	140,878.4	34,415.9	106,463	76%
Horn Ditch-Rock Run Creek	13	245,348.1	69,303.9	176,044	72%
Goshen Dam Pond-Elkhart River	14	5,234,957.8	1,118,743.2	4,116,215	79%

Table 73. Estimated phosphorus load reduction by subwatershed needed to meet water quality target concentrations in the Lower Elkhart River Watershed.

Subwatershed Name	Site(s)	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	% Reduction
Village Lake-Turkey Creek	1	1,359.2	2,033.1	-674	NRN
Lake Wawasee-Turkey Creek	2	3,253.8	4,893.9	-1,640	NRN
Wabee Lake-Hammond Ditch	3	1,409.3	2,019.7	-610	NRN
Coppes Ditch-Turkey Creek	4+5	8,407.3	12,417.6	-4,010	NRN
Omar Neff Ditch-Turkey Creek	6	9,792.5	14,728.5	-4,936	NRN
Berlin Court Ditch	7	4,718.1	2,263.6	2,454	52%
Hoopingarner Ditch-Turkey Creek	8	5,047.5	7,591.8	-2,544	NRN
Dausman Ditch-Turkey Creek	9	20,602.2	21,461.4	-859	NRN
Swoveland Ditch-Turkey Creek	10	66,885.4	74,442.2	-7,557	NRN

Headwaters Yellow Creek	11	9,764.3	4,203.8	5,560	57%
Hoover Ditch-Rock Run Creek	12	6,768.7	2,753.3	4,015	59%
Horn Ditch-Rock Run Creek	13	12,980.9	5,544.3	7,437	57%
Goshen Dam Pond-Elkhart River	14	139,216.9	89,499.5	49,717	36%

Table 74. Estimated total suspended solids load reduction by subwatershed needed to meet water quality target concentrations in the Lower Elkhart River Watershed.

Subwatershed Name	Site(s)	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	% Reduction
Village Lake-Turkey Creek	1	537,505.2	381,207.5	156,298	29%
Lake Wawasee-Turkey Creek	2	673,764.0	917,610.6	-243,847	NRN
Wabee Lake-Hammond Ditch	3	281,532.3	378,686.9	-97,155	NRN
Coppes Ditch-Turkey Creek	4+5	1,653,910.4	2,328,294.5	-674,384	NRN
Omar Neff Ditch-Turkey Creek	6	2,423,275.2	2,761,593.9	-338,319	NRN
Berlin Court Ditch	7	639,473.8	424,417.4	215,056	34%
Hoopingarner Ditch-Turkey Creek	8	933,805.3	1,423,454.8	-489,649	NRN
Dausman Ditch-Turkey Creek	9	4,284,016.5	4,024,019.7	259,997	6%
Swoveland Ditch-Turkey Creek	10	12,163,880.6	13,957,908.1	-1,794,027	NRN
Headwaters Yellow Creek	11	2,074,972.6	788,220.9	1,286,752	62%
Hoover Ditch-Rock Run Creek	12	675,472.3	516,238.5	159,234	24%
Horn Ditch-Rock Run Creek	13	1,440,507.4	1,039,558.6	400,949	28%
Goshen Dam Pond-Elkhart River	14	27,242,541.7	16,781,148.2	10,461,394	38%

Table 75. Estimated *E. coli* load reduction by subwatershed needed to meet water quality target concentrations in the Lower Elkhart River Watershed.

Subwatershed Name	Site(s)	Current Loading Rate (col/year)	Target Loading Rate (col/year)	Load Reduction (col/year)	% Reduction
Village Lake-Turkey Creek	1	1.68E+13	2.71E+13	-1.03E+13	NRN
Lake Wawasee-Turkey Creek	2	1.72E+13	6.53E+13	-4.81E+13	NRN
Wabee Lake-Hammond Ditch	3	4.22E+13	2.69E+13	1.52E+13	36%
Coppes Ditch-Turkey Creek	4+5	2.21E+14	1.66E+14	5.53E+13	25%
Omar Neff Ditch-Turkey Creek	6	1.84E+14	1.96E+14	-1.22E+13	NRN
Berlin Court Ditch	7	3.86E+14	3.02E+13	3.56E+14	92%
Hoopingarner Ditch-Turkey Creek	8	3.10E+14	1.01E+14	2.09E+14	67%
Dausman Ditch-Turkey Creek	9	6.57E+14	2.86E+14	3.71E+14	56%
Swoveland Ditch-Turkey Creek	10	9.07E+14	9.93E+14	-8.51E+13	NRN
Headwaters Yellow Creek	11	2.52E+14	5.61E+13	1.96E+14	78%
Hoover Ditch-Rock Run Creek	12	1.30E+14	3.67E+13	9.36E+13	72%
Horn Ditch-Rock Run Creek	13	2.77E+14	7.39E+13	2.03E+14	73%
Goshen Dam Pond-Elkhart River	14	4.23E+15	1.19E+15	3.03E+15	72%

8.0 <u>CRITICAL AND PRIORITY AREA DETERMINATION</u>

Critical areas are defined as the areas where sources of water quality problems occur in the highest densities and where restoration measures can improve water quality. These areas indicate locations where best management practices should be targeted to address nonpoint sources of pollution. Priority areas are those areas of the watershed where high quality habitat is found, and the aquatic biological community is classified as good or excellent. Best management practices to protect the higher quality conditions should be targeted to these areas.

Using the list of potential sources developed for each parameter of concern as a base, the steering committee developed a mechanism for determining critical areas for each parameter. GIS-based mapping data from desktop and windshield survey efforts, loading calculations, and current and historic water quality data were used as a basis for decision-making. Data for each subwatershed are detailed in Appendix C. The steering committee divided into teams to review subwatershed data and develop a criteria list for each parameter. For each parameter, each subwatershed was evaluated to determine whether it met each criterion developed by each steering committee team. Teams presented their suggested criteria for each parameter to the entire steering committee and the steering committee reviewed, modified, if needed, and finalized criteria for each parameter. Each parameter team reviewed available data and selected a suite of data they considered most useful for their parameter. Once selected, data for each criterion were normalized by subwatershed acreage or stream miles, then ranked based on each subwatersheds available data. Lower numbers were used for subwatershed with higher subwatershed coverage, volume of material or percent exceedance and higher number were used for lower coverage, volume or exceedance. A score was not assigned to the subwatershed if data were not available for that criterion.

8.1 Critical Areas for Nitrate-Nitrogen and Total Phosphorus

Nitrate-nitrogen and total Kjeldahl nitrogen were the nitrogen forms used to determine our critical areas. Total phosphorus was the form of phosphorus used to determine phosphorus critical areas. Nitrate-nitrogen and total phosphorus are readily available in the watershed, entering surface water via human and animal waste, fertilizer use, and tile drains on agricultural lands. Phosphorus enters the watershed through streambank and bed erosion, unfiltered runoff, agricultural land use in floodplains, stormwater runoff, and livestock access. Based on the data reviewed by the steering committee (Table 76), the following datasets were priorities for nutrients critical areas:

- Nitrogen exceedance – historic and current
- Phosphorus exceedance – historic and current
- Livestock access in miles/acre
- Agricultural (row crop+pasture) land use acreage
- Urban land use acreage
- Impaired waterbodies – nutrients
- Septic system rating – very limited acreage
- Manure volume produced/acre

Upon review, livestock access, impaired waterbodies for nutrients and nitrate current ratings were removed as three were very few different scores which resulted in ranking all subwatershed 0 to 3 which was deemed not helpful in overall rankings.

Table 76. Nutrient critical area criterion ranking based on source evaluation and average rating.

HUC	Septic VL	Manure estimate	Ag - Row +Pasture	Urban Land Use	Nitrate Historic	TP historic	TP current
701	10	11	8	12	4	7	8
702	13	12	13	4	10	8	8
703	12	6	10	9	1	5	8
704	9	10	9	6	--	--	8
705	6	8	2	10	--	--	8
706	3	7	6	3	3	--	1
707	2	1	1	13	1	--	8
708	5	5	4	8	6	1	6
709	4	2	5	7	6	6	6
901	1	3	3	11	--	--	3
902	7	9	11	2	5	4	5
903	8	4	7	5	8	1	2
904	11	13	12	1	9	3	3

8.2 Critical Areas for Sediment

Total suspended solids concentrations were used to determine sediment-based critical areas (Table 77). Total suspended solids enter streams in the watershed through streambank and bed erosion, unfiltered runoff, agricultural land use in floodplains, stormwater runoff, and livestock access. Based on the data reviewed by the steering committee (Table 77), the following datasets were priorities for sediment critical areas:

- Highly erodible land acreage
- Narrow buffer coverage
- Streambank erosion
- Livestock access
- Agricultural land (row crop+pasture)
- Urban land use/stormwater
- TSS exceedance – historic and current

Upon review, livestock access and narrow buffer ratings were removed as three were very few different scores which resulted in ranking all subwatershed 0 to 3 which was deemed not helpful in overall rankings.

Table 77. Sediment critical area criterion ranking based on source evaluation and average rating.

HUC	HEL	Streambank erosion	Ag - Row +Pasture	Urban	TSS historic	TSS current
701	13	4	8	12	11	3
702	3	--	13	4	10	5
703	8	--	10	9	1	6
704	7	--	9	6	--	13
705	1	--	2	10	11	7
706	2	6	6	3	7	4
707	11	7	1	13	5	7
708	5	1	4	8	4	7
709	9	5	5	7	6	7
901	6	8	3	11	1	7
902	4	2	11	2	8	2
903	10	3	7	5	3	7
904	12	--	12	1	9	1

8.3 Critical Areas for *E. coli*

E. coli concentrations were used to determine *E. coli*-based critical areas (Table 78). *E. coli* enters streams in the watershed through human and animal waste, livestock access, and infrastructure issues. Additional areas of concern, such as areas with manure management issues or failing septic systems, may also be included. While those areas have not been quantified, dense unsewered areas were included as a method for identifying these areas. Based on the data reviewed by the steering committee (Table 78), the following datasets were priorities for sediment critical areas:

- *E. coli* exceedance – historic and current
- *E. coli* impaired waterbodies – percent of subwatershed waterbodies
- Septic soils – rejected as there is little variation in the data
- Manure volumes and presence/absence of CFO/CAFOs considered as options with manure estimated deemed the most useful overall for estimating total impacts.

Table 78. *E. coli* critical area criterion ranking based on source evaluation and average rating.

HUC	Impaired *E. coli*	Septic VL	Manure estimate	*E. coli* historic	*E. coli* current
701	11	10	11	8	12
702	11	13	12	12	13
703	11	12	6	12	8
704	1	9	10	10	3
705	10	6	8	1	11
706	6	3	7	9	4
707	3	2	1	7	6
708	2	5	5	5	6
709	7	4	2	6	1
901	4	1	3	1	2
902	8	7	9	3	8
903	9	8	4	4	5
904	5	11	13	11	10

8.4 Critical Area Determination

Initially, the steering committee was in favor of prioritizing critical areas for each parameter. However, upon review of these maps and the subsequent high (critical for all parameters), medium (critical for two parameters) and low (critical for one parameter) ratings and maps, the committee rejected this critical area determination option. The committee expressed concern that this method might be overcounting some criterion and undervaluing other options. With this in mind, the steering committee chose to use all criteria selected by the parameter teams for which data were significantly different (ie. more than three scores could be assigned across the fourteen subwatersheds). Once all parameters were scored, natural breaks in the data were used to prioritize high, medium and low-ranking critical areas with those subwatersheds which scored an average of 6 or less rating as high priority critical areas, those scoring 6.1 to 8 rating as medium priority critical areas and those scoring 8.1 to 9 rating as low priority critical areas. Any subwatersheds scoring 9.1 or greater was not ranked as critical (Table 79). The subwatersheds identified as critical areas for each parameter are summarized in Figure 93.

Table 79. Critical area criterion ranking based on source evaluation and average rating.

HUC	HEL	Stream Erosion	Ag - Row +Pasture	Urban	TSS Hist	TSS Current	Septic VL	Manure Est	N Hist	TP Hist	TP Current	Imp *E. coli*	*E. coli* Hist	*E. coli* Current	Rating
701	13	4	8	12	11	3	10	11	4	7	8	11	8	12	8.71
702	3	--	13	4	10	5	13	12	10	8	8	11	12	13	9.38
703	8	--	10	9	1	6	12	6	1	5	8	11	12	8	7.46
704	7	--	9	6		13	9	10	--	--	8	1	10	3	7.60
705	1	--	2	10	11	7	6	8	--	--	8	10	1	11	6.82
706	2	6	6	3	7	4	3	7	3	--	1	6	9	4	4.69
707	11	7	1	13	5	7	2	1	1	--	8	3	7	6	5.54
708	5	1	4	8	4	7	5	5	6	1	6	2	5	6	4.64
709	9	5	5	7	6	7	4	2	6	6	6	7	6	1	5.50
901	6	8	3	11	1	7	1	3	--	--	3	4	1	2	4.17
902	4	2	11	2	8	2	7	9	5	4	5	8	3	8	5.57
903	10	3	7	5	3	7	8	4	8	1	2	9	4	5	5.43
904	12	--	12	1	9	1	11	13	9	3	3	5	11	10	7.69

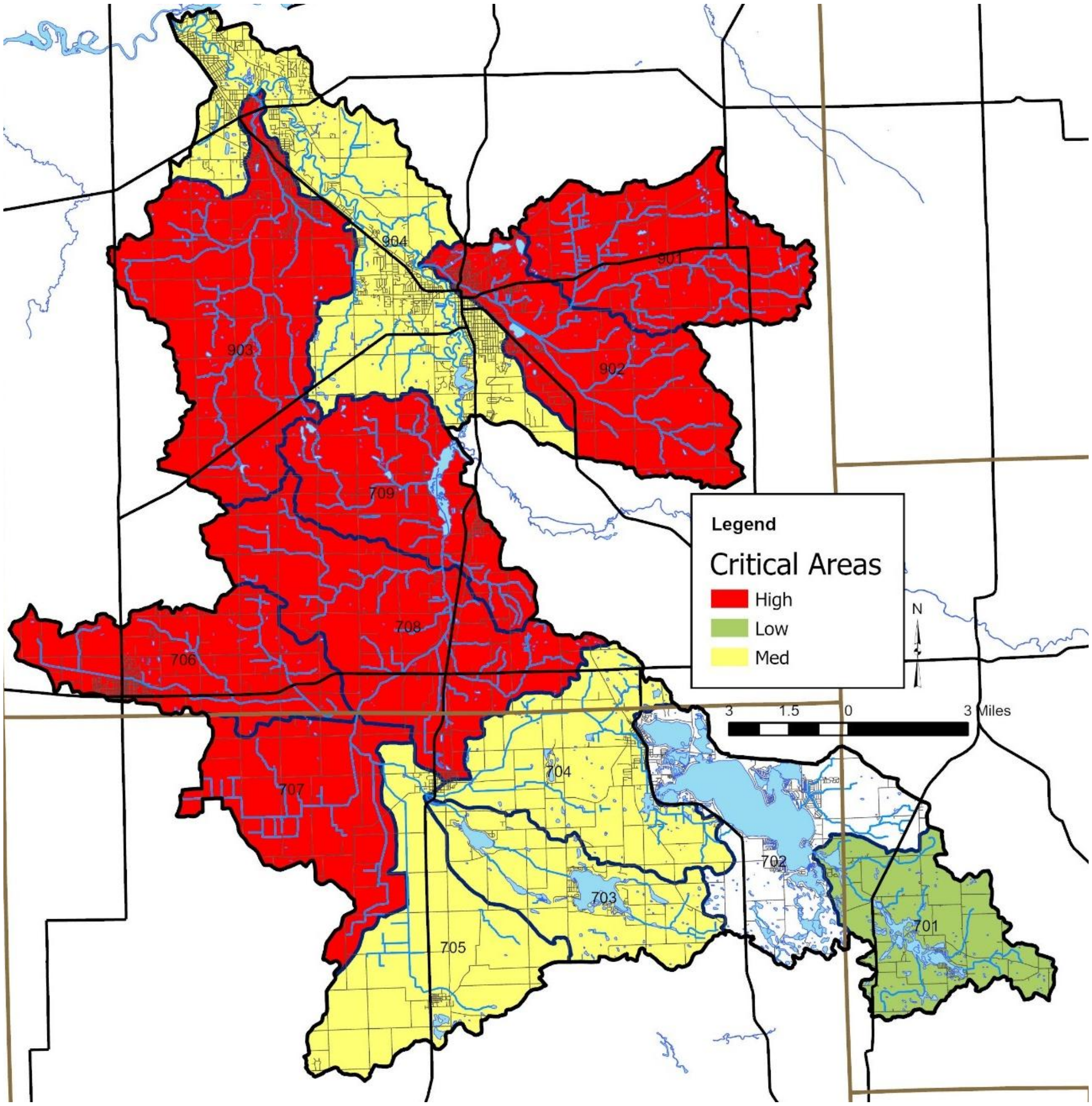


Figure 93. Critical areas in the Lower Elkhart River Watershed.

Subwatersheds were prioritized as follows:

- High priority: Berlin Court Ditch (706), Omar Neff Ditch-Turkey Creek (707), Dausman Ditch-Turkey Creek (708), Swoveland Ditch-Turkey Creek (709), Hoover Ditch-Rock Run Creek (901), Horn Ditch-Rock Run Creek (902), Headwaters Yellow Creek (903)
- Medium priority: Wabee Lake-Hammond Ditch (703), Hoopingarner Ditch-Turkey Creek (704), Coppes Ditch-Turkey Creek (705) and Goshen Dam Pond (904)
- Low priority: Village Creek-Turkey Creek (701)

One subwatershed, Lake Wawasee (702) was not prioritized as a critical area meaning it was not identified as the areas of highest concern once all data were combined and averaged. Implementation efforts will target high priority critical areas first, followed by medium priority then low priority areas. It is anticipated that implementation efforts will be targeted in medium and low priority subwatersheds as part of EPA-funded implementation efforts only after implementation efforts are exhausted in higher priority areas. Implementation via other funding sources, via landowner interest in NRCS-based federal funding programs will occur as landowners are interested. The Lower Elkhart River stakeholder group will continue volunteer monitoring efforts to continue to assess the quality of these subwatersheds and identify any changes in water quality as they occur.

In order to address habitat and flooding concerns, the steering committee created a priority area overlay. This area consists of a combination of floodplain areas and the MS4 communities (Elkhart County urban areas and the City of Nappanee). Options for including high quality natural areas or publicly owned property were also reviewed but rejected as these areas are covered by the two areas identified above. Critical areas with the priority overlay are shown in Figure 94.

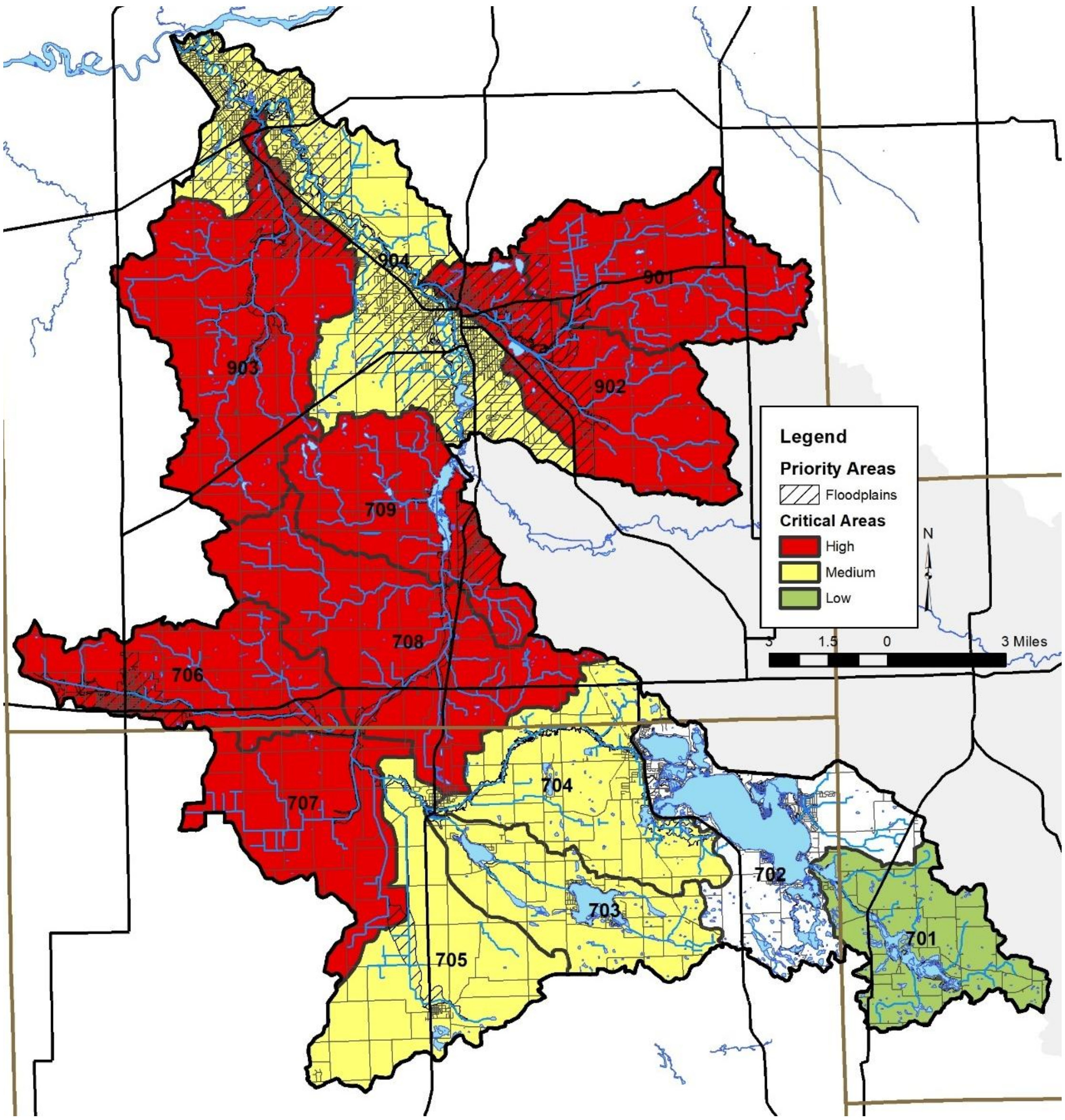


Figure 94. Priority and critical areas in the Lower Elkhart River Watershed.

8.5 Critical Acre Determination

To be eligible for Great Lakes Restoration Initiative (GLRI) Funding, the Lower Elkhart River Watershed steering committee considered critical acres for for targeting all agricultural acreage within the watershed. These critical acres identify fields where practices should be implemented rather than limiting implementation efforts to specific 12-digit HUC subwatersheds. Table 80 details critical acres by subwatershed based on the criteria selected for nutrient, sediment and *E. coli* critical areas. The steering committee will target hot spots or problem areas identified within each subwatershed including but not limit to 1) ensuring that all highly erodible soils are protected or covered; 2) targeting livestock restriction, streambank erosion and buffer strip installation in areas where erosion, livestock access and/or narrow buffers were identified; and 3) working with producers to reduce the impacts from manure production within the Lower Elkhart River Watershed (Figure 95). Lower Elkhart River Watershed stakeholders identified the need for soils with septic limitation to be targeted for septic treatment; however, this is not an GLRI targeted practice and is therefore not included in Table 80. Note that manure application acres have not been mapped as these application areas are only identified as potential areas for manure application for each permitted confined feeding operation.

Table 80. Critical acres by subwatershed in the Lower Elkhart River Watershed.

HUC	Ag Land (acres)	HEL (acres)	Manure estimate (tons)	Livestock Access (miles)	Streambank Erosion (miles)	Narrow Buffer (miles)
040500011701	7,252.6	5,334.5	4,987		0.5	
040500011702	4,309.1	3,211.3	1,136			
040500011703	6,755.0	4,752.1	32,206			
040500011704	9670.0	5,698.2	9,521			
040500011705	12,309.3	967.0	40,519			
040500011706	8,824.3	4,147.4	35,111		0.4	1.3
040500011707	11,002.5	902.7	140576.6		0.4	0.2
040500011708	15,663.7	5,983.8	64,799		2.6	0.7
040500011709	9,032.5	4813.6	98,925	0.4	0.582	
040500011901	11,327.3	5,262.5	87,673	1.1	0.3	0.2
040500011902	8,074.2	5,275.3	19,583		1.2	
040500011903	15,173.4	8,936.8	96,990	1.8	1.5	0.4
040500011904	7,685.1	4,224.1	231			

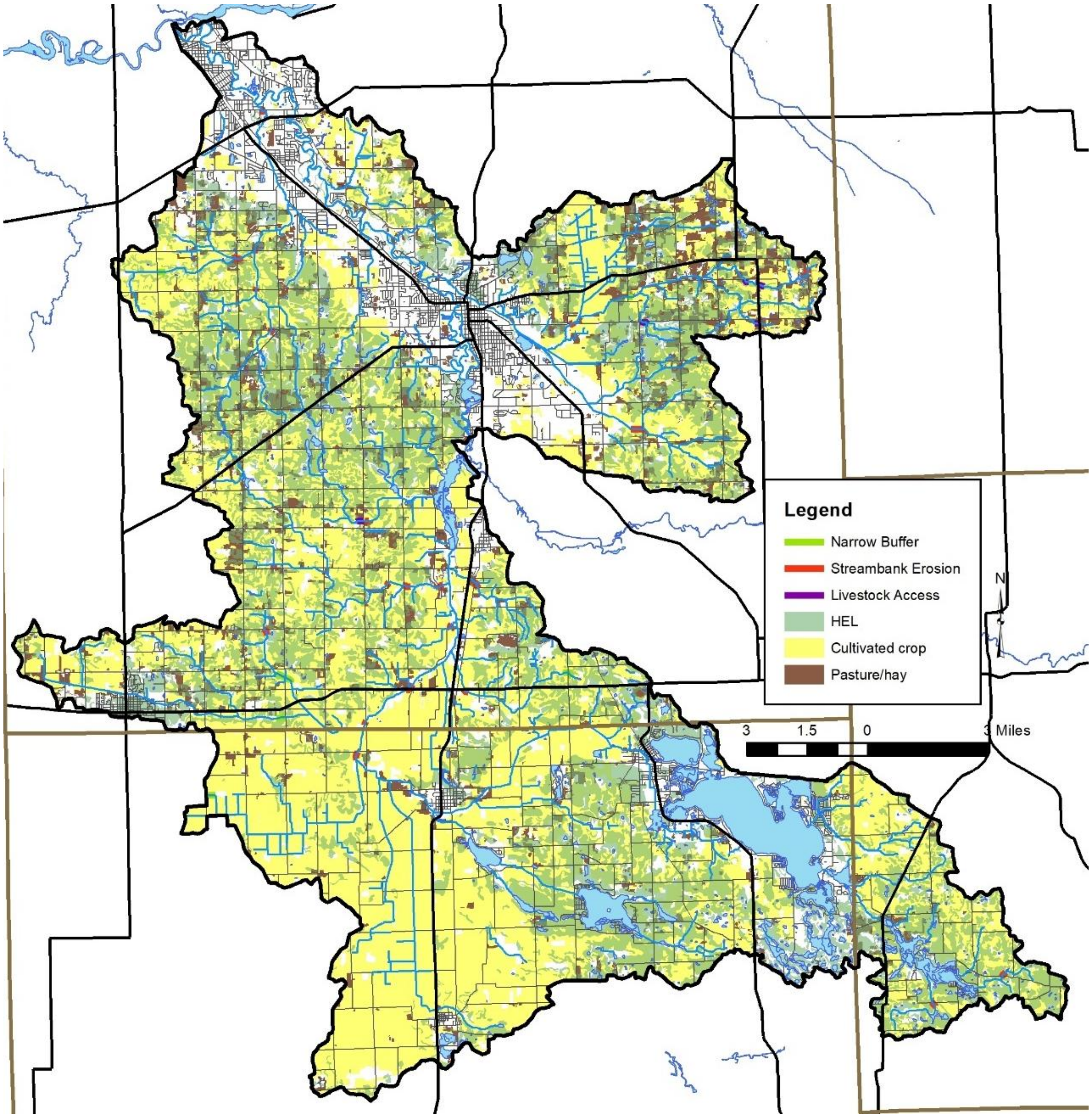


Figure 95. Critical acres in the Lower Elkhart River Watershed.

8.6 Current Level of Treatment

Based on data from the Indiana Conservation Partnership, more than 11,410 acres of best management practices including but not limited to cover crops, conservation cover, critical area planting, forage and biomass planting, prescribed grazing, residue tillage, water facilities, wetland enhancement and heavy use protection area construction and more have been implemented over the last 5 years in the Lower Elkhart River Watershed. Table 81 details practices by acre.

Table 81. Practices installed from 2019-2023 in the Lower Elkhart River Watershed based on Indiana Conservation Partner data in acres.

Practice	701	702	703	704	705	706	707	708	709	901	902	93	904	Grand Total
Conservation Cover	14.4	4.6					2.0				1.2	5.8	1.4	29.4
Cover Crop	2098	3135	397	84.6		257	470	139	450	834	1338			9200.1
Critical Area Planting	1.8													1.8
Early Successional Habitat Development-Mgt	9.0	1.5		2.3			1.0			2.4	6.4	1.3		23.9
Fence			0.0				1258			14751				16009.1
Field Border	1.1	1.5									0.2			2.8
Firebreak											510.0		1157	1667.0
Forage and Biomass Planting					11.8					27.4	3.0		8.5	50.7
Grassed Waterway	7.3	15.0		0.8			3.3							26.4
Heavy Use Area Protection							1050				1250	2900		5200.0
Lined Waterway or Outlet	115.0			30.0										145.0
Prescribed Grazing			75.6				80.1			35.8			25.2	216.7
Residue and Tillage Management, No Till		132.3	396.6	84.6			73.3	147.8	324.4	310.0	263.1			1732.1
Streambank and Shoreline Protection	1110													1110.0
Streambank and Shoreline Stabilization	0.4													0.4
Trails and Walkways							400.0							400.0
Tree/Shrub Establishment			3.7		6.0								6.7	16.4
Upland Wildlife Habitat Management			43.8		14.2			22.0				8.0	3.5	91.5
Waste Storage Facility	1.0													1.0
Watering Facility			0.1								1.0	1.0		2.1
Wetland Enhancement							13.0							13.0
Wildlife Habitat Planting		0.3				0.8				0.4	0.6	1.7		3.8

9.0 GOAL SETTING

Based on watershed inventory efforts; stakeholder input for concerns, problems, and sources; and watershed loading information, the following goals and strategies were developed.

9.1 Goal Statements

The steering committee wrote goals for each parameter or area of concern based on a goal of meeting the target concentrations identified by the committee The current loading rate was calculated using water chemistry data collected monthly at each of the sixteen sample sites and flow data from the Elkhart River at Goshen USGS stream gage). In an effort to scale goals to manageable levels, short term (5 year), medium term (15 year), and long term (30 year) goals were generated. The calculation process is described below:

1. Current and target loading rates were determined for the Lower Elkhart River sample sites. Loading rates and target reductions for the entire watershed were calculated using data generated for the most downstream Elkhart River mainstem site (Site 14)
2. Additionally, drainage basin outlet loading rates were calculated for each of the other 12-digit HUC watershed outlets. This allows for calculation of loading rates within each 12-digit HUC.
3. The steering committee selected low and medium reduction targets target for nutrients, sediment and *E. coli* levels based on what could be achieved in target timeframes: 5 years for short term goals and 15 years for medium term goals.
4. Long term goals will result in water quality nutrient, sediment and *E. coli* targets being met throughout the watershed in 30 years.

Reduce Nutrient Loading

Based on collected water quality data for the Lower Elkhart River Watershed, the committee set the following long-term goals: Reduce nitrate-nitrogen loading from 5,234,958 lb/year to 1,118,743 lb/year (79%) by 2054 and reduce total phosphorus loading from 139,217 pounds per year to 49,718 lb/ year (64%) by 2054.

Short term goal: Reduce total phosphorus inputs from 139,217 pounds per year to 131,262 pounds per year (6% reduction) and nitrate-nitrogen 5,234,958 pounds per year to 4,576,364 pounds per year (13% reduction) in Lower Elkhart River in 5 years (2029).

Medium term goal: Reduce total phosphorus inputs from 131,262 pounds per year to 106,403 pounds per year (19% reduction) and nitrate-nitrogen from 4,576,364 pounds per year to 2,518,256 pounds per year (45% reduction) in Lower Elkhart River in 15 years (2039).

Long term goal: Reduce total phosphorus inputs from 106,403 pounds per year to 89,499 pounds per year (16% reduction) and nitrate-nitrogen from 2,518,256 pounds per year to 1,118,743 pounds per year (56% reduction) in Lower Elkhart River in 30 years (2054).

Table 82. Nitrate-nitrogen short, medium, and long-term goal calculations for prioritized critical areas in Lower Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (5 years)	5,234,957.8	658,594.3	4,576,363.5	13%
Medium Term (15 years)	4,576,363.5	2,058,107.3	2,518,256.2	45%
Long Term (30 years)	2,518,256.2	1,399,513.0	1,118,743.2	56%

Table 83. Total phosphorus short, medium, and long-term goal calculations for prioritized critical areas in Lower Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (5 years)	139,216.9	7,954.8	131,262.1	6%
Medium Term (15 years)	131,262.1	24,858.7	106,403.4	19%
Long Term (30 years)	106,403.4	16,903.9	89,499.5	16%

Reduce Sediment Loading
Based on collected water quality data for the Lower Elkhart River Watershed, the committee set the following long-term goal: reduce total suspended solids loading from 27,242,542 lb/year to 16,781,148 lb/year (38%) by 2054.

Short term goal: Reduce total suspended solids inputs from 27,242,542 pounds per year to 25,568,719 pounds per year (6% reduction) in Lower Elkhart River in 5 years (2029).

Medium term goal: Reduce total suspended solids inputs from 25,568,719 pounds per year to 20,338,022 pounds per year (20% reduction) in Lower Elkhart River in 15 years (2039).

Long term goal: Reduce total suspended solids inputs from 20,338,022 pounds per year to 16,781,482 pounds per year (17% reduction) in Lower Elkhart River in 30 years (2054).

Table 84. Total suspended solids short, medium, and long-term goal calculations for prioritized critical areas in Lower Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (5 years)	27,242,541.7	1,673,823.0	25,568,718.8	6%
Medium Term (15 years)	25,568,718.8	5,230,696.8	20,338,022.0	20%
Long Term (30 years)	20,338,022.0	3,556,873.8	16,781.482.2	17%

Reduce *E. coli* Loading
Based on collected water quality data for the Lower Elkhart River Watershed, the committee set the following long-term goal: reduce *E. coli* loading from 4.23E+15 colonies per year to 1.19E+15 colonies per year (72%) by 2054.

Short term goal: Reduce *E. coli* inputs from 4.23E+15 colonies per year to 3.74E+15 colonies per year (12% reduction) in Lower Elkhart River in 5 years (2029).

Medium term goal: Reduce *E. coli* inputs from 3.74E+15 pounds per year to 2.22E+15 colonies per year (41% reduction) in Lower Elkhart River 15 years (2039).

Long term goal: Reduce *E. coli* inputs from 2.22E+15 pounds per year to 1.19E+15 colonies per year (46% reduction) in Lower Elkhart River in 30 years (2054).

Table 85. *E. coli* short, medium, and long-term goal calculations for prioritized critical areas in Lower Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (5 years)	4.23E+15	4.9E+14	3.74E+15	12%
Medium Term (15 years)	3.74E+15	1.5E+15	2.22E+15	41%
Long Term (30 years)	2.22E+15	1.0E+15	1.19E+15	46%

Flooding
Long term: Reduce flooding impacts by increasing storage and infiltration across the watershed within 30 years.

Baseline in 2024: Wetland acreage (NWI): 14,049 acres; floodplain coverage: 14,852 acres; and coverage of poorly drained and very poorly drained soils: 44,803 acres.

Habitat Alteration/Habitat Loss
Long term: Maintain the current level of natural areas, improve instream habitat and increase floodplain natural area acreage over 30 years.

Short term: High profile locations will be targeted to provide examples for individuals to use on private lands.

Baseline in 2024: Forest, wetland, open water: 28,887 acres; Instream habitat see QHEI scores; Floodplain natural area: 5,694 acres (40% of floodplain)

Recreational Access
Long term: Increase recreational access through increased river access points, ability to paddle from the North Branch-South Branch confluence (Upper Elkhart River Watershed) to the watershed outlet to the Lower Elkhart River and improve habitat connectivity/natural land preservation across the watershed within 30 years.

Increase Public Awareness and Education
Long term: Increase the current level of outreach to engage a 50% increase of individuals in the watershed within 30 years.

Baseline: DTN data indicate 660 agricultural households (spring 2024 purchase). Households: 56,000 estimated

10.0 IMPROVEMENT MEASURE SELECTION

A wide variety of practices are available for on-the-ground implementation to reduce sediment, nutrient, and *E. coli* loading within the Lower Elkhart River Watershed. A list of potential best management practices was reviewed by the project steering committee. From this list, the practices which were deemed most appropriate to remediate the sources of pollution in the watershed and most likely to successfully meet loading reduction targets were identified. It should be noted that no practice list is exhaustive and that additional techniques may be both possible and necessary to reach water quality goals.

10.1 Best Management Practices Descriptions

A list of potential BMPs were reviewed by the Lower Elkhart River Watershed steering committee. Committee members reviewed potential practices taking into account the identified resource concerns, watershed land uses, and Lower Elkhart River Watershed Project goals. From the potential practice list, the most appropriate BMPs to remediate sources of pollution and address resource concerns in the Lower Elkhart River Watershed was developed. This practice list is not exhaustive and new and emerging technologies and techniques should be considered as possible and necessary options to meet water quality targets within the Lower Elkhart River Watershed. A combination of practices detailed below aimed at avoiding, controlling and trapping nutrients and sediment and the implementation of a conservation system could be necessary to make lasting, measurable changes in Lower Elkhart River water quality. Selected practices are appropriate for all critical areas since they predominantly contain agriculture land use and pasture, and crop resource concerns were identified in all subwatersheds. Several urban practices were also identified. These should be targeted at residential and commercial areas throughout the watershed including various small towns and reservoirs present throughout the watershed. It should be noted that specific forestry-based practices are not included in this list. Selected practices with descriptions are listed below.

Potential best management practices include the following:

- Access Control
- Alternate Watering System
- Animal Mortality Facility
- Bioreactor
- Bioretention – Rain Garden, Bioswale
- Composting Facility
- Conservation Tillage: Residue and Tillage Management, No till/Strip till/Direct Seed
- Consider soil characteristics to minimize runoff
- Cover Crop
- Curb Openings/Curbless Design
- Dam Removal
- Diversion structures
- Drainage Water Management
- Fencing
- Field Border or Filter Strip
- Flow Splitter
- Forage and Biomass Planting
- Grade Stabilization Structure
- Grassed Waterway
- Green Roof
- Greenways and Trails
- Habitat Corridor Identification and Improvement
- Heavy Use Area Protection
- Infrastructure Retrofits
- Lined Waterway or Outlet
- Livestock Pipeline
- Livestock Restriction/Prescribed Grazing
- Manure Management Planning
- Mulching
- Nutrient and/or Pest Management
- Pervious Pavement
- Phosphorus Free Fertilizer Usage
- Pollinator Planting
- Prescribed Grazing
- Rain Barrels
- Regular Soil Tests
- Septic System Care and Maintenance
- Streambank Stabilization
- Subsurface Drain (Agricultural)
- Subsurface Infiltration (urban)
- Threatened and Endangered Species Protection
- Treatment Vault
- Tree Box Filter
- Tree/Shrub Establishment
- Two-Stage Ditch
- University fertilization recommendations
- Variable rate application
- Vegetated Swale
- Waste Storage Facility
- Waste Utilization
- Water and Sediment Control Basin
- Wetland Creation, Wetland Enhancement, Wetland Restoration

Access Control
Access control involves the temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area. Access control is used to achieve and maintain desired resource conditions by monitoring and managing the intensity of use by animals, people, vehicles, and/or equipment in coordination with the application schedule of practices, measures and activities specified in the conservation plan.

Alternate Watering Systems/Fencing
Fencing livestock out of stream systems allows for the restoration of the stream channel. Alternative watering systems provide an alternate location for livestock to seek water rather than using a surface water source. This removes the negative impacts of livestock access to streams including direct deposit of manure and bank erosion and destabilization, while improving the health of livestock by providing a clean water source and better footing while drinking. This results in less *E. coli*, phosphorus, nitrogen, and sediment entering a surface waterbody. Alternative watering systems may include pump systems or gravity systems connected to a well or running pipe from a pond or spring.

Animal Mortality Facility
An on-farm facility for the treatment or disposal of animal carcasses due to routine mortality. This standard applies to animal carcass storage, treatment, or disposal for routine mortality in livestock and poultry operations to protect air and water quality including drinking water source protection. Routine mortality is that which occurs at the normally anticipated rate.

Bioreactors
Bioreactors use bacteria to digest organic materials including manure, remnant plant material, and woody debris. Bioreactors typically generate energy, water, and fertilizer. Bioreactors use a series of tanks and treatment processes to separate cellulose-based materials from oils and gases. Materials are then broken down into carbon dioxide or methane gas and ethanol.

Bioretention
Bioretention practices use biofiltration or bioinfiltration to filter runoff by storing it in shallow depressions. Bioretention uses plant uptake and soil permeability mechanisms in a variety of manners typically in combination. Potential practices include sand beds, pea gravel overflow structures, organic mulch layers, plant materials, gravel underdrains, and an overflow system to promote infiltration. Bioinfiltration can also be used to treat runoff from parking lots, roads, driveways and other areas in the urban environment. Bioretention should not be used in highly urbanized areas rather, it should be used in areas where on-site storage space is available.

Composting Facility
A composting facility is a structure to facilitate the controlled anaerobic decomposition of manure or other organic material by microorganisms into a biologically stable organic material that is suitable for use as a soil amendment. It can reduce the pollution potential and improve the handling characteristics of organic waste solids and produce a soil amendment that adds organic matter and beneficial organisms, provides slow-release plant-available nutrients, and improves soil conditions (FOTG Code 317, NRCS, 2011).

Conservation Tillage (No-till)
Conservation tillage refers to several different tillage methods or systems that leave at least 30% of the soil covered with crop residue after planting (Holdren et al., 2001). Tillage methods encompassed by

conservation tillage include no-till, mulch-till, ridge-till, and strip till. The purpose of conservation tillage is to reduce sheet and rill erosion, maintain or improve soil organic matter content, conserve soil moisture, increase available moisture, reduce plant damage, and provide habitat and cover for wildlife. The remaining crop residue helps reduce soil erosion and runoff volume.

Several researchers have demonstrated the benefits of conservation tillage in reducing pollutant loading to streams and lakes. A comprehensive comparison of tillage systems showed that no-till results in 70% less herbicide runoff, 93% less erosion, and 69% less water runoff volume when compared to conventional tillage (Conservation Technology Information Center, 2000). Reductions in pesticide loading have also been reported (Olem and Flock, 1990).

Cover Crops/Critical Area Seeding/Conservation Cover

Cover crops include legumes, such as clover, hairy vetch, field peas, alfalfa, and soybean, and non-legumes, such as rye, oats, wheat, radishes, turnips, and buckwheat which are planted prior to or following crop harvest. Cover crops typically grow for one season to one year and are typically grown in non-cropping seasons. Cover crops are used to improve soil quality and future crop harvest by improving soil tilth, reducing wind and water erosion, increasing available nitrogen, suppressing weed cover, and encouraging beneficial insect growth. Cover crops, conservation cover and critical area seeding reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field. The vegetation recovers plant-available nutrients in the soil and recycles them through the plant biomass for succeeding crops.

Curb Openings/Curbless Design

An essential element of green infrastructure project design is ensuring the stormwater enters the system and is captured. In urban environments where curbs are prevalent, stormwater flow accumulates as it moves along the curbed edges of roadways. Adding curb cuts allows this concentrated flow to spill into green infrastructure practices. To capture stormwater runoff from curbed roads, curb cuts are added at intervals along a raised curb, resulting in areas of concentrated flow. This practice is commonly used in urban bioretention cells, stormwater curb extensions, stormwater planters and urban tree trenches. Three key criteria should be considered when designing curb cuts: placement, grading and size/angle of opening.

In contrast, stormwater drains off curbless roadways under sheet flow conditions to the lowest area. In areas without curbs and gutters, practices are designed to capture runoff via sheet flow across pavement and other surfaces. Establishing sheet f low conditions allows for an even distribution of runoff into the feature (Figures 4-10 and 4-11). Moreover, in conditions of low-velocity sheet flow, pretreatment such as a pea gravel apron installed between the impervious area and the practice can help capture suspended sediment. Green infrastructure practices that capture sheet flow from curbless streets and parking lots often include a band of concrete edging that lies flush with the stormwater feature and the street/parking lot surface. Because of concrete's fine-grain composition, it is easier to use concrete than asphalt to achieve the necessary flat slope that will direct sheet flow into the stormwater feature. Sidewalks can be designed with slight in slopes or out slopes to direct sheet flow into green infrastructure practices, but the sidewalks must also comply with local codes and ordinances and meet the slope requirements outlined in the Americans with Disabilities Act.

Dam Removal

Dam removal requires decommissioning and deconstructing dams, recontouring of river channels and possible eradication of invasive species and reintroduction of desirable ones, resulting in a restoration of natural flow, sediment and carbon regimes.

Diversion Structures

A diversion structure is a channel generally constructed across the slope with a supporting ridge on the lower side. This practice may be applied to support various purposes including breaking up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered too flat or irregular for terracing. Diverting water away from farmsteads, agricultural waste systems, and other improvements. Collecting or directing water for storage, water- spreading or water-harvesting systems. Protecting terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above. Intercept surface and shallow subsurface flow. Reducing runoff damages from upland runoff. Reducing erosion and runoff on urban or developing areas and at construction or mining sites. Diverting water away from active gullies or critically eroding areas. Supplementing water management on conservation cropping or strip cropping systems. Diversion structures can be applied to all land uses where surface runoff water control and/or management are needed and where soils and topography are such that the diversion can be constructed, and a suitable outlet is available or can be provided.

Drainage Water Management/Subirrigation

Subsurface tile drainage is an essential water management practice on highly productive fields. As a result of tile drainage, nitrate carried in drainage water enters adjacent surface waterbodies. Drainage water management is necessary to reduce nitrate loads entering adjacent surface waterbodies from tile drainage networks. Drainage water management uses water control structures within lateral drains to vary the depth of tile outlets. Typically, the outlet is raised after harvest to limit outflow from the tile and reduce nitrate transport to adjacent waterbodies; lowered in the spring and fall to allow tile water to flow freely from the field to adjacent waterbodies; and raised in the summer to help store water making it available for crops (Frankenberger et al., 2006). Drainage water management can be used in concert with a suite of other conservation practices including subirrigation, cover crops and conservation tillage to promote a systems approach and be better stewards of water quantity.

Fencing/Alternate Watering Systems

Fencing livestock out of stream systems allows for the restoration of the stream channel. Alternative watering systems provide an alternate location for livestock to seek water rather than using a surface water source. This removes the negative impacts of livestock access to streams including direct deposit of manure and bank erosion and destabilization, while improving the health of livestock by providing a clean water source and better footing while drinking. This results in less *E. coli*, phosphorus, nitrogen, and sediment entering a surface waterbody. Alternative watering systems may include pump systems or gravity systems connected to a well, or running pipe from a pond or spring.

Field Border/Buffer Strip/Filter Strip

Installing natural buffers or filters along major and minor drainages in the watershed helps reduce the nutrient and sediment loads reaching surface waterbodies. Buffers provide many benefits including restoring hydrologic connectivity, reducing nutrient and sediment transport, improving recreational opportunities and aesthetics, and providing wildlife habitat. Sediment, phosphorus, nitrogen, and *E. coli* are at least partly removed from water passing through a naturally vegetated buffer. The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width.

Many researchers have verified the effectiveness of filter strips in removing sediment from runoff with reductions ranging from 56-97% (Arora et al., 1996; Mickelson and Baker, 1993; Schmitt et al., 1999; Lee et al, 2000; Lee et al., 2003). Most of the reduction in sediment load occurs within the first 15 feet of installed buffer. Smaller additional amounts of sediment are retained and infiltration is increased by increasing the width of the strip (Dillaha et al., 1989). Filter strips have been found to reduce sediment-bound nutrients like total phosphorus but to a lesser extent than they reduce sediment load itself. Phosphorus predominately associates with finer particles like silt and clay that remain suspended longer and are more likely to reach the strip's outfall (Hayes et al., 1984). Filter strips are least effective at reducing dissolved nutrients like those of nitrate and phosphorus, and atrazine and alachlor, although reductions of dissolved phosphorus, atrazine, and alachlor of up to 50% have been documented (Conservation Technology Information Center, 2000). Simpkins et al. (2003) demonstrated 20-93% nitrate-nitrogen removal in multispecies riparian buffers. Short groundwater flow paths, long residence times, and contact with fine-textured sediments favorably increased nitrate-nitrogen removal rates. Additionally, up to 60% of pathogens contained in runoff may be effectively removed. Computer modeling also indicates that over the long run (30 years), filter strips significantly reduce amounts of pollutants entering waterways.

Filter strips should be designed as permanent plantings to treat runoff and should not be considered part of the annual rotation of adjacent cropland. Filter strips should receive only sheet flow and should be installed on stable banks. A mixture of grasses, forbs, and herbaceous plants should be used. In more permanent plantings, shrubs and trees should be intermingled to form a stable riparian community.

Flow Splitter

A flow splitter is an engineered structure used to divide flow into two or more parts and divert these parts to different places. The design of a flow splitter uses specifically designed structures, pipes, orifices, and weirs set at specific elevations to control the direction of flow. An illustration of a simple type of flow splitter is provided in the accompanying figure. Typically, when managing storm water flows, a flow splitter is used to direct initial storm water flows to an off-line BMP. The splitter is placed at an elevation coordinated with the elevation of the treatment BMP, so that the elevation of water in the BMP governs the elevation in the flow splitter. As shown in the example illustration, storm water flows to the BMP until it reaches a pre-determined elevation. Once storm water reaches that elevation, a weir (or other hydraulic feature) directs additional flow to an alternative outlet. This simple type of flow splitter works on hydraulic principles and requires no mechanical components or instrumentation.

Forage and Biomass Planting

Forage and biomass plantings establish adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay or biomass production. Plantings occur to improve or maintain livestock nutrition and/or health; provide or increase forage supply during periods of low forage production; reduce soil erosion; improve soil and water quality; produce feedstock for biofuel or energy production.

Grade Stabilization
A grade stabilization structure is used to stabilize and control soil erosion in natural and artificial channels. It can prevent the formation or advance of gullies, enhance environmental quality, and reduce pollution hazards. Special attention is given to maintaining or improving habitat for fish and wildlife.

Grassed Waterway
Grassed waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate channel dimensions and proper vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels. The amount of precipitation that runs off the soil surface rather than infiltrating down into the soil profile is increased by tillage and other farming activities that increase soil compaction and decrease soil organic matter and macro-pore content. For these reasons, the establishment or refurbishing of a grassed waterway should, when possible, be coupled with other practices that aim to increase the rate of water infiltration into the soil. This BMP can reduce sediment concentrations of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality due to its nutrient removal through plant uptake and absorption by soil. The waterways can also provide wildlife corridors and allows more land to be natural areas.

Green Roof
A green roof system is an extension of the existing roof which involves, at a minimum, high quality waterproofing, root repellent system, drainage system, filter cloth, a lightweight growing medium, and plants.

Green roof systems may be modular, with drainage layers, filter cloth, growing media, and plants already prepared in movable, often interlocking grids, or loose laid/built-up whereby each component of the system may be installed separately. Green roof development involves the creation of "contained" green space on top of a human-made structure. This green space could be below, at, or above grade, but in all cases, it exists separate from the ground.

Green roofs can provide a wide range of public and private benefits and have been successfully installed in countries around the world. Green roofs provide a variety of environmental benefits to aesthetic improvements, waste diversion, moderation of the heat island effect, improved air quality, and stormwater benefits. Some of the water benefits include; water is stored by the substrate and then taken up by the plants from where it is returned to the atmosphere through transpiration and evaporation, in summer, green roofs can retain 70-90% of the precipitation that falls on them, in winter, green roofs can retain between 25-40% of the precipitation that falls on them, green roofs not only retain rainwater, but also moderate the temperature of the water and act as natural filters for any of the water that happens to run off, and green roofs reduce the amount of stormwater runoff and also delay the time at which runoff occurs, resulting in decreased stress on sewer systems at peak flow periods.

Greenways and Trails
Greenways can provide a large number of functions and benefits to nature and the public. For plants and animals, greenways provide habitat, a buffer from development, and a corridor for migration. Greenways located along streams include riparian buffers that protect water quality by filtering sediments and

nutrients from surface runoff and stabilizing streambanks. By buffering the stream from adjacent developed land use, riparian greenways offset some of the impacts associated with increased impervious surface in a watershed. Maintaining a good riparian buffer can mitigate the negative impacts of approximately 5% additional impervious surface in the watershed.

Habitat Corridor Identification and Improvement

Protection of habitat corridors requires a multi-phase program including identification of appropriate habitat corridors, development of a corridor management plan, and creation of an improvement plan. Most long-term corridor protection will require land transfer into protected status. There are several options for land transfer ranging from donation to fee simple land purchase. Donations can be solicited and encouraged through incentive programs. Outright purchase of property offers a secondary option and is frequently the least complicated and most permanent protection technique but is also the costliest. A conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Several techniques can be used for protecting natural areas and open space in both public and private ownership. The first step in the process is to identify and prioritize properties for protection. The highest priority natural areas should be permanently protected by the ownership or under the management of public agencies or private organizations dedicated to land conservation. Other open spaces can be protected using conservation design development techniques and are more likely to be managed by homeowner associations.

Heavy Use Area Protection (HUAP)

HUAP is used to stabilize a ground surface that is frequently used by people, animals, or vehicles and to protect water quality.

Infrastructure Retrofits

Typical stormwater infrastructure includes pipe and storm drains, or hard infrastructure, to convey water away from hard surfaces and into the stormwater system. Retrofitting these structures to implement low impact development techniques, use green practices, and introduce plants and filters to reduce sediment and nutrient concentrations contained in stormwater.

Livestock Restriction/Prescribed (Rotational) Grazing/Livestock Pipeline/Lined Waterway or Outlet

Livestock that have unrestricted access to a stream or wetland have the potential to degrade the waterbody's water quality and biotic integrity. Livestock can deliver nutrients and pathogens directly to a waterbody through defecation. Livestock also degrade stream ecosystems indirectly. Trampling and removal of vegetation through grazing of riparian zones can weaken banks and increase the potential for bank erosion. Trampling can also compact soils in a wetland or riparian zone decreasing the area's ability to infiltrate water runoff. Removal of vegetation in a wetland or riparian zone also limits the area's ability to filter pollutants in runoff. The degradation of a waterbody's water quality and habitat typically results in the impairment of the biota living in the waterbody.

Restoring areas impacted by livestock grazing often involves several steps. First, the livestock in these areas should be restricted from the wetland or stream to which they currently have access. If necessary, an alternate source of water should be created for the livestock. Second, the wetland or riparian zone where the livestock have grazed should be restored. This may include stabilizing or reconstructing the banks using bioengineering techniques. Minimally, it involves installing filter strips along banks or wetland edge and replanting any denuded areas. Finally, if possible, drainage from the land where the livestock are pastured should be directed to flow through a constructed wetland to reduce pollutant loading, particularly nitrate-nitrogen loading, to the adjacent waterbody. Complete restoration of aquatic areas impacted by livestock will help reduce pollutant loading, particularly nitrate-nitrogen, sediment, and pathogens.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc) installed to exclude livestock from streams and areas not intended for grazing. This will reduce erosion, sediment, and nutrient loading, and improve the quality of surface water. Landowners can additionally section off the pastureland and move the animals from one paddock to the next, ensuring adequate vegetation growth for nutrient removal. Using this system of rotational grazing no one piece of land gets overgrazed and ensures a high-quality food for the livestock and adequate ground cover for nutrient and sediment retention. Education and outreach programs focusing on rotational grazing and exclusionary fencing are important in the success of this BMP.

Manure Management Planning

Animal Waste Management (AWM) is a planning/design tool for animal feeding operations that can be used to estimate the production of manure, bedding, and process water and determines the size of storage/treatment facilities. The procedures and calculations used in AWM are based on the USDA-NRCS Agricultural Waste Management Field Handbook.

Mulching

Mulching is the application of plant residues to the land surface. This can help conserve soil moisture, moderate soil temperature, provide erosion control, facilitate the establishment of vegetative cover, improve soil quality, and reduce airborne particulates. This practice can be used alone or in combination with other practices (FOTG Code 484, NRCS, 2011).

Nutrient/Pest Management Planning including Variable Rate Application and Waste Storage Facility

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater and can be in commercial/non-manure fertilizer or manure-based fertilizers. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil. A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater.

Pervious Pavement

Pervious pavement comes in many forms including porous pavement and modular block pavement. Both types of pervious pavement can be installed on most any travel surface with a slope of 5% or less. Pervious pavement has the approximate strength characteristics of traditional pavement with the ability to percolate water into the groundwater system. The pavement reduces sediment and nutrient transmission into the groundwater as water moves through the pores in the pavement. When installed, porous pavement includes a stone layer, filter fabric, and a filter layer covered by porous pavement. Correctly mixed porous pavement eliminates fine aggregates found in typical pavements. Porous asphalt is a type of porous pavement which includes a mix of Portland cement, coarse aggregates, and water that results in the formation of interconnected voids.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area.

Phosphorus Free Fertilizer Usage
Phosphorus-free fertilizers are those fertilizers that supply nitrogen and minor nutrients without the addition of phosphorus. Phosphorus increases algae and plant growth which can cause negative impacts on water quality within aquatic systems. The Clear Choices, Clean Water program estimates that a one acre lawn fertilized with traditional fertilizer supplies 7.8 pounds of phosphorus to local waterbodies annually. Established lawns take their nutrients from the soil in which they grow and need little additional nutrients to continue plant growth. Fertilizers are manufactured in a variety of forms including that without phosphorus. Phosphorus-free fertilizer should be considered for use in areas where grass is already established.

Pollinator Planting
Pollinator plantings focus on selecting plants and providing recommendations on plants which will enhance pollinator populations throughout the growing season. These wildflowers, trees, shrubs, and grasses are an integral part of the conservation practices that landowners and farmers utilize to improve water quality, reduce water quantity issues and augment their natural resources.

Prescribed Grazing
This practice where grazing and/or browsing animals is managed on a prescribed schedule. Removal of herbage by the grazing animals is in accordance with production limitations, plant sensitivities and management goals. Frequency of defoliations and season of grazing is based on the rate of growth and physiological condition of the plants. Duration and intensity of grazing is based on desired plant health and expected productivity of the forage species to meet management objectives. In all cases enough vegetation is left to prevent accelerated soil erosion. Application of this practice will manipulate the intensity, frequency, duration, and season of grazing to: Improve water infiltration, maintain or improve riparian and upland area vegetation, protect stream banks from erosion, manage for deposition of fecal material way from water bodies and promote ecological and economically stable plant communities which meet landowner objectives. (FOTG Code 528, NRCS, 2010)

Rain Barrel
A rain barrel is a container that collects and stores rainwater from your rooftop (via your home's disconnected downspouts) for later use on your lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems. Although rain barrels don't specifically reduce nutrient or sediment loading to waterbodies, their presence can reduce the first flush of water reaching storm drains. This impact is great especially in portions of the watershed where combined sewers are still in operation.

Septic System Care and Maintenance

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment outside of incorporated areas including most of the small towns and unincorporated areas in the Lower Elkhart River Watershed. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-$15,000 per unit based on industry standards.

Property owners are responsible for their septic systems under the regulation of the County Health Department. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources. Additionally, septic systems can contribute significant amounts of nitrogen and phosphorus to the watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up or will not drain, the system is failing. Funding for this practice is limited. Our efforts will include developing an education plan for homeowners in the watershed and hosting a series of septic system care and maintenance workshops.

Soil testing - Consider soil characteristics to minimize runoff

Soil testing can be used to determine nutrient levels in the soil, determine pH levels and thus, lime needs; provides a decision-making tool to determine what nutrients to apply, how much, and when. Regular soil testing and the application of fertilizers at or below university fertilizer recommendations provides the potential for higher yielding, high quality crops with more targeted fertilizer use.

Streambank Stabilization

Streambank stabilization or stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. The most feasible restoration options return many of the stream's natural functions (flood storage, nutrient removal, etc.) without restoring the stream completely to its original condition. However, even a partial restoration of this type is extremely expensive, takes quite a bit of land to accomplish, and is likely unrealistic as a large-scale strategy in this watershed. Our efforts will focus primarily on two-stage ditch construction, which is a cheaper way to incorporate a small floodplain into the ditch itself in the form of benches on either side of the main channel that allow for increased capacity in the ditch resulting in slower moving water along the banks resulting in reduced bank slumping and failure. Restoration and stabilization options are limited by available floodplain, modifications to natural flows, and development structure locations. Reestablishment of riparian buffers, restoration of stream channels, stabilization of eroding stream banks, installation of riffle-pool complexes, and general maintenance can all improve stream function while reducing sediment and nutrient transport into and within the system.

Subsurface Drain

A subsurface drain is a conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water. Subsurface drains are used to improve the environment for crops, reduce erosion, improve water quality, regulate water tables, collect groundwater for beneficial uses, or to remove salts and other contaminants from the soil profile.

Subsurface drainage is used in areas having a high-water table where the benefits of lowering the water level are worth the expense. The practice also applies to areas that will benefit from controlling ground

water and/or surface runoff. The soil must meet certain suitability requirements and an adequate outlet must be available to assure the drain will function properly.
The operation and maintenance of a subsurface drainage system includes periodic inspection and prompt repair of system components (e.g. structures for water control, underground outlets, vents, drain outlets, trash and rodent guards). In cold climates, winterization protection from freezing conditions will be necessary.

T&E Species Protection (Habitat Improvement)
Threatened and endangered species are those plant and animal species whose survival is in peril. Federally and state listed species identified within Lower Elkhart River Watershed are highlighted in the Watershed Inventory. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana.

Protecting threatened and endangered species requires consideration of their habitat including food, water, and nesting and roosting living space for animals and preferred substrate for plants and mussels. Corridors for species movement are also necessary for long-term protection of these species. Protection of habitat can include providing clean water and available food but likely requires protection of the physical living space and associated corridor. Conservation management plans should be developed for each species, if they are not already in place. Such plans should consider habitat needs including purchase or protection of adjacent properties to current habitat locations, hydrologic needs, pollution reduction, outside impacts, and other techniques necessary to protect threatened and endangered species**.**

Treatment Vault
Treatment vaults are a subsurface flow-through structure that physically separates sediment, trash, leaf litter, debris and other particulate pollutants from stormwater via various separation or settling techniques. This includes mechanical separation devices such as hydrodynamic separators, flow separation vaults, and gross solid retention devices. No volume reduction occurs due to impervious base. These may be a confined space but not always. Accumulation of material at the base of BMP can be observed and measured via manhole access.

Tree Box Filters
Tree box filters are a proprietary biotreatment device that is designed to mimic natural systems such as bioretention areas by incorporating plants, soil, and microbes. Tree box filters are installed at curb level and consist of an open bottom concrete barrel filled with a porous soil media, an underdrain in crushed gravel, and a tree. Tree box filters are highly adaptable solutions that can be used in all types of development and in all types of soils but are especially applicable to ultra-urban areas.

Tree/Shrub Establishment/Reforestation and site prep including Invasive Control/Timber Stand Improvement
Reforestation is the establishment of forests, usually accomplished through the planting of tree seedlings. It is important to match the species being planted to the site chosen for reforestation. Control of competing vegetation and invasive plants is often necessary to ensure establishment and survival of planted trees. This is usually done through mowing and/or herbicide application. Reforestation can provide many benefits to the landscape. Increasing the amount of forest through tree planting provides

more habitat for forest dependent species, improves water quality by reducing erosion, decreases nutrient loading and lowers floodwater velocity.

Two-Stage Ditch

Two-stage ditches are drainage ditches that have been modified by adding benches that serve as floodplains within the overall channel. This form is more consistent with fluvial form and process, and therefore leads to greater channel stability. The benches can also function as wetlands during certain times of the year, reducing ditch nutrient loads. This results in a more sustainable ditch that restores some of the beneficial natural processes within the ditch environment while providing the drainage capacity necessary for production.

University fertilization recommendations/Soil testing

Soil Testing can be used to determine Determines nutrient levels in the soil, determine pH levels and thus, lime needs; provides a decision-making tool to determine what nutrients to apply, how much, and when. Regular soil testing and the application of fertilizers at or below university fertilizer recommendations provides the potential for higher yielding, high quality crops with more targeted fertilizer use.

Variable Rate Application/Technologies

Precision agriculture is defined as a management system that uses information, technology, and site-specific data to manage variability within fields for optimum profitability, sustainability, and environmental protection. This method also includes guidance systems for agricultural equipment. The purposes of using precision agriculture are: To improve water quality by targeting pesticide or soil amendment applications to meet field-specific cropland yield capabilities; reduce the potential off-site impacts of fertilizer and pesticide applications; improve water quality by reducing pesticide and fertilizer inputs through avoidance of overlapping and end row/turn row applications; reduce surface runoff and through precisely controlled cropping equipment, resulting in less fuel being used; reduce compaction by limiting traffic to specified travel lane; and increase opportunity to operate equipment after dark.

Vegetated Swale

Vegetated swales are used in agricultural areas and are often considered landscape features. Swales are graded to be linear with a shallow, open channel of a trapezoidal or parabolic shape. Vegetation which is water tolerant is planted within the channel which promotes the slowing of water flow through the system. Swales reduce sediment and nutrients as water moves through the swale and water infiltrates into the groundwater.

Waste Utilization

Large volumes of manure are generated by small, unregulated animal operations located throughout the Lower Elkhart River watershed. Many entities have manure management plans in place and are currently using these plans to manage the volume of manure produced on their facility. Manure management planning includes consideration of the volume and type of manure produced annually, crop rotations by field, the volume of manure and nutrients needed for each crop, field slope, soil type, and manure collection, transportation, storage, and distribution methods. Manure management planning uses similar techniques to nutrient management planning with regards to nutrient budgets. Specific technical practices that can be included in manure management planning can include waste storage facilities and waste utilization.

Animal waste is a major source of pollution to waterbodies. To protect the health of aquatic ecosystems and meet water quality standards, manure must be safely managed. Good management of manure keeps livestock healthy, returns nutrients to the soil, improves pastures and gardens, and protects the environment, specifically water quality. Poor manure management may lead to sick livestock, unsanitary and unhealthy conditions for humans and other organisms, and increased insect and parasite populations. Proper management of animal waste can be done by implementing BMPs, through safe storage, by application as a fertilizer, and through composting. Proper manure management can effectively reduce *E. coli* concentrations, nutrient levels and sedimentation. Manure management can also be addressed in education and outreach to encourage farmers to participate in this BMP.

Water and Sediment Control Basin

A water and sediment control basin is an earthen embankment constructed across the slope of a minor watercourse to form a sediment trap and water detention basin with a stable outlet. This practice can reduce watercourse and gully erosion, trap sediment, and reduce downstream runoff. It is particularly applicable where watercourse or gully erosion is a problem and where sheet and rill erosion is controlled by other conservation practices. It can help in areas where sediment in runoff is severe, though it needs to be placed where adequate outlets can be provided (FOTG Code 638, NRCS, 2011).

Wetland Construction, Enhancement or Restoration

Visual observation and historical records indicate at least a portion of the Lower Elkhart River Watershed has been altered to increase its drainage capacity. Riser tiles in low spots on the landscape and tile outlets along the waterways in the watershed confirm the fact that the landscape has been hydrologically altered. This hydrological alteration and subsequent loss of wetlands has implications for the watershed's water quality. Wetlands serve a vital role in storing water and recharging the groundwater. When wetlands are drained with tiles, the stormwater reaching these wetlands is directed immediately to nearby ditches and streams. This increases the peak flow velocities and volumes in the ditch. The increase in flow velocities and volumes can in turn lead to increased stream bed and bank erosion, ultimately increasing sediment delivery to downstream water bodies. Wetlands also serve as nutrient sinks at times. The loss of wetlands can increase pollutant loads reaching nearby streams and downstream waterbodies.

Restoring wetlands in the watershed could return many of the functions that were lost when these wetlands were drained. Through this process, a historic wetland site is restored to its historic status. These restored systems store nutrients, sediment, and *E. coli* while also increasing water storage and reducing flooding. Wetlands also provide additional habitat, stormwater mitigation, and recreational opportunities.

10.2 Best Management Practice Selection and Load Reduction Calculations

Table 86 details selected agricultural best management practices and reflect those parameters which NRCS eFOTG, if appropriate, indicate can be utilized to impact each parameter. The critical area and the selected best management practices are based on subwatershed characteristics and available water quality data. Table 87 outlines suggested BMPs, estimated load reduction for nutrients and sediment (if available). Table 88 highlights the target volume (area, length) of each practice by implementation phase, while Table 89 details estimated costs for implementing each practice based on the target volume. The steering committee identified BMPs that would be of interest to local producers, while the project coordinator calculated the volume of BMPs necessary to meet project goals.

Table 86. Suggested Best Management Practices to address Lower Elkhart River critical areas. Note BMPs were selected by the steering committee.

Practice	Nutrients	Sediment	Pathogens
Access Control	X	X	X
Alternate Watering System	X	X	X
Animal Mortality Facility	X	X	X
Bioreactor	X		
Bioretention – Rain Garden, Bioswale	X	X	X
Composting Facility	X		X
Conservation Cover	X	X	X
Conservation Tillage	X	X	X
Cover Crop	X	X	X
Curb Openings/Curbless Design	X	X	
Diversion structures	X	X	
Drainage Water Management	X	X	
Field Border or Filter Strip	X	X	X
Forage and Biomass Planting	X	X	X
Grade Stabilization Structure	X	X	
Grassed Waterway	X	X	X
Habitat Corridor Identification and Improvement			X
Heavy Use Area Protection	X	X	X
Infrastructure Retrofits	X	X	X
Lined Waterway or Outlet	X	X	X
Livestock Pipeline	X	X	X
Manure Management Planning	X		X
Mulching	X	X	X
Nutrient and/or Pest Management Plans	X		
Prescribed Grazing	X	X	X
Rain Barrel	X	X	
Education: Septic System Care and Maintenance	X		X
Soil testing	X	X	X
Streambank Stabilization	X	X	
Subsurface Drain (Agricultural)	X	X	X
Threatened and Endangered Species Protection	X	X	
Tree/Shrub Establishment	X	X	
Two-Stage Ditch	X	X	X
Underground outlet	X	X	
Variable Rate Application	X		
Vegetated Swale	X	X	
Waste Storage Facility	X		X
Waste Utilization	X		X
Water and Sediment Control Basin	X	X	
Wetland Creation, Enhancement, Restoration	X	X	X

The Region V model was used to estimate the approximate load reductions for BMPs unless otherwise noted. BMPs with dashes (-) do not have load reductions available using the Region V Model or other identifiable source. The target volumes of BMPs proposed to be installed are 30-year goals. The steering committee estimates steady implementation and are shown in Table 87 for each phase of implemented. The steering committee anticipates that 1/30th of each 30-year goal will be implemented annually. Additionally, it should be noted that these BMP targets are not required to be implemented as the quantities suggested. These targets are simply guidelines for achieving goals. Load reductions solely using this model meet the project targets for nitrogen, phosphorus and sediment goals for short, medium, and long-term goals. If the volume of practices specific in Table 87 is met, then the target loading rates detailed in Table 72 through Table 75 will be achieved. The Region V model does not provide estimated reductions for all suggested BMPs; these load reductions cannot be included in the calculations. The steering committee acknowledges that they have set the bar high by establishing ambitious water quality targets that may be difficult to obtain. The group is committed to improve water quality the best that they can, even in the event that the original load reduction goals are not met.

Table 87. Suggested Best Management Practices, target volumes to meet 30-year goals, their estimated load reduction and estimated cost.

Suggested BMPs:	30 year BMP Targets	Unit	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (t/year)	Total Estimated Cost
Conservation Cover (327)	10,000	acre	6	3	2	$750,000
Cover Crop (340)	90,000	acre	5	2	2	$3,600,000
Drainage Water Management (554)	1,000	units	10.4	-	-	$50,000
Filter Strip (393)	25,000	acre	24	12	10	$3,750,000
Grassed Waterway (412)	10,000	acre	232.9	116.4	101.3	$50,000,000
Grade Stabilization Structure (410)	601	count	69.9	34.9	30.4	$1,502,500
Heavy Use Area Protection (561)	500	Acre	0.14463	0.0712	0.0941	$1,500
Livestock Restriction (Alt Watering System, Access Control)	45,000	feetl; units	2.8	0.83	7.52	$45,000,000
Nutrient/Pest Management (590)^	90,000	Acres	4.16	6.24	-	$360,000
Prescribed Grazing (582)	36,000	Acres	6	3	2	$540,000
Pollinator Planting (CP42)	3,000	Acres	6	3	2	$225,000
Residue and Tillage Management (329)	120,000	Acres	8	4	3	$1,800,000
Two-Stage Ditch (582)	350	Feet	0	0.83	7.52	$350,000
Wetland Creation/Enhancement/Restoration (658,657,659)	3,000	Acre	8.2	2.9	69.77	$3,000,000
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)*	100	units	24	12	10	$100,000

^Assumes all nutrient management is non-manure based. Increase to 6.24 lb/ac/yr for N and 8.77 lb/ac/yr P for manure-based nutrient management.
*Assumes average bioretention reduction – estimates could be higher or lower depending on the BMP selected and practice installed.

Table 88. Suggested Best Management Practices, target volumes, and their estimated load reduction per practice to meet high priority, medium priority and low priority goals.

Suggested BMPs:	High priority BMP Targets	Medium priority BMP Targets	Low priority BMP Targets	Unit	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (t/year)
Conservation Cover (327)	3,333	3,333	3,333	acre	60,000	30,000	20,000
Cover Crop (340)	30,000	30,000	30,000	acre	450,000	180,000	270,000
Drainage Water Management (554)	333	333	333	units	10,400	0	0
Filter Strip (393)	8,333	8,333	8,333	acre	600,000	300,000	250,000
Grassed Waterway (412)	3,333	3,333	3,333	acre	2,329,000	1,164,000	1,013,000
Grade Stabilization Structure (410)	200	200	200	count	42,010	20,975	18,270
Heavy Use Area Protection (561)	167	167	167	acre	72	36	47
Livestock Restriction (Alt Watering System, Access Control)	15,000	15,000	15,000	feet; units	126,000	37,350	338,400
Nutrient/Pest Management (590)^	30,000	30,000	30,000	acres	374,400	561,600	
Prescribed Grazing (582)	12,000	12,000	12,000	acres	216,000	108,000	72,000
Pollinator Planting (CP42)	1,000	1,000	1,000	acres	18,000	9,000	6,000
Residue and Tillage Management (329)	40,000	40,000	40,000	acres	960,000	480,000	360,000
Two-Stage Ditch (582)	117	117	117	feet	0	291	2,632
Wetland Creation/Enhancement/ Restoration (658,657,659)	1,000	1,000	1,000	acre	24,600	8,700	209,310
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)*	33	33	33	units	20,000	30,000	60,000
Total Reduction					**5,210,411**	**2,899,916**	**2,559,613**

^Assumes all nutrient management is non-manure based. Increase to 6.24 lb/ac/yr for N and 8.77 lb/ac/yr P for manure-based nutrient management.
*Assumes average bioretention reduction – estimates could be higher or lower depending on the BMP selected and practice installed.

Table 89. Estimated cost for selected Best Management Practices to meet high priority, medium priority and low priority goals.

Suggested BMPs:	**Estimated Cost per Unit**	**Short-term Estimated Cost**	**Medium-term Estimated Cost**	**Long-term Estimated Cost**
Conservation Cover (327)	$75-$300	$250,000	$250,000	$250,000
Cover Crop (340)	$25-$40	$1,200,000	$1,200,000	$1,200,000
Drainage Water Management (554)	$50	$16,667	$16,667	$16,667
Filter Strip (393)	$75-$300	$1,250,000	$1,250,000	$1,250,000
Grassed Waterway (412)	$5,000	$16,666,667	$16,666,667	$16,666,667
Grade Stabilization Structure (410)	$2,500	$500,833	$500,833	$500,833
Heavy Use Area Protection (561)	$1.25 gravel/ $3.00 concrete	$500	$500	$500
Livestock Restriction (Alt Watering System, Access Control)	$1,000	$15,000,000	$15,000,000	$15,000,000
Nutrient/Pest Management (590)^	$4	$120,000	$120,000	$120,000
Prescribed Grazing (582)	$15.00	$180,000	$180,000	$180,000
Pollinator Planting (CP42)	$75	$75,000	$75,000	$75,000
Residue and Tillage Management (329)	$15	$600,000	$600,000	$600,000
Two-Stage Ditch (582)	$1,000	$116,667	$116,667	$116,667
Wetland Creation/Enhancement/Restoration (658,657,659)	$1,000	$1,000,000	$1,000,000	$1,000,000
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)*	$75-$300	$250,000	$250,000	$250,000
Total Cost		**$36,976,333**	**$36,976,333**	**$36,976,333**

10.3 Action Register

All activities to be completed as part of the Lower Elkhart River Watershed management plan are identified in Table 90. The goals set by the steering committee are listed below. Each objective in the action register corresponds to one or more goals and reflects the estimated amount of each BMP that will be needed in order to achieve the target load reductions. Nutrient and sediment removal efficiencies were not available for all BMPs, so the estimated number of BMPs needed was calculated based only on those BMPs that had load reduction estimates. For those BMPs that did not have associated load reduction estimates, the objective was developed with an amount of each BMP that the steering committee determined to be reasonably achievable. Therefore, if all the BMPs listed in all objectives are implemented, the total load reductions achieved will far exceed the load reductions needed to meet the water quality benchmarks.

Table 90. Action Register.

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Nutrients, Sediment, *E. coli*	Coordinate on-the-ground cost-share program starting in 2025.	Producers, landowners, lake associations and residents, agrobusiness	Develop and continue to implement previously developed a cost-share program (2025).	$25,000 annually staffing	PP: SWCDs, lake associations, parks departments, cities and counties, SJRBC, Purdue Extension TA: SWCDs, NRCS, engineering firms, SJRBC
			Expand Elkhart SWCD's SWAMP program watershed wide.		
			Implement cost-share program (2025-2054).		
			Previous studies identified more than 100 potential implementation opportunities. Review these opportunities and determine if they still need to be implemented or if these areas of concern have been addressed in another way.		
			Work with WACF, County SWCDs, lake associations and other entities across the watershed to implement their conservation planning goals and projects.		
			Identify and apply for potential funding sources to augment cost-share programs including GLRI, GLC, RCPP, LARE, CWA and others. Once received, implement cost-share program per program guidance.		

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Nutrients, Sediment, *E. coli*	Promote and fund conservation practices which emphasize soil health, livestock and manure management, natural resources restoration and management and target urban BMP implementation.	Producers, landowners, lake associations and residents, agribusinesses, commercial and industrial entities	Meet BMP 30-year implementation targets (Table 87).	$3.7 million annually for 30 years for BMP implementation	PP: SWCDs, lake associations, parks departments, cities and counties, SJRBC, Purdue Extension, banks and credit unions TA: SWCDs, NRCS, engineering firms, SJRBC
			Increase adoption of conservation plans and nutrient (including manure management) plans.		
			Consider options to naturalize detention basins and other post construction BMPs and maintain previously implemented BMPs across the watershed.		
			Implement a program that rewards good stewardship and BMP implementation and maintenance (Elkhart SWCD stewardship scorecard).		
			Utilize ACPF analysis completed as part of Lower Elkhart WMP development to target BMP implementation.		
			Complete SWAT modeling and utilize the results to target BMP analysis.		
			Work current and any future MS4 communities to ensure that urban BMPs are implemented on new construction and retrofits are included as possible on lands already developed.		
			Achieve short-term load (5 years), medium term (10 years) and long term (15 years) reductions (Table 87).		
Flooding, Habitat; Nutrients, Sediment, *E. coli*	Protect and restore floodplains and stream buffers	Landowners, cities, towns, elected officials, parks departments	Develop and implement a floodplain maintenance and reforestation program targeting urban residential and commercial and row crop agricultural areas.	$50,000 annually + individual site specific costs, as needed	PP: SWCDs, lake associations, parks departments, cities and counties, SJRBC, Purdue Extension TA: SWCDs, NRCS, engineering firms, SJRBC
			Identify high quality riparian lands and their owners.		
			Work with riparian landowners to protect high quality riparian lands via conservation easements, reforestation and/or restoration.		
			Conserve and protect open space networks and implement stormwater management and low impact development.		

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Flooding, Habitat; Nutrients, Sediment, *E. coli*	Reduce peak flows from urban sources	Landowners, cities, towns, elected officials	Work with MS4 communities (Goshen, Elkhart, Nappanee, Elkhart County) to implement their minimum control measures.	$5,000 annually staffing	PP: SWCDs, parks departments, cities and counties, SJRBC, Purdue Extension TA: SWCDs, NRCS, engineering firms, SJRBC
			Identify individual residents who can serve as ambassadors for residential BMP implementation, identify funding opportunities and implement a residential BMP demonstration program.		
			Per the City of Goshen Climate Vulnerability Assessment, collaborate with up/downstream communities to foster regional resilience toward climate change and natural disasters; convene a working group to evaluate barriers and opportunities for implementing green infrastructure and LID.		
			Work with the City of Goshen to implement their Climate Action Plan which focuses to 1) develop/update the long term land use plans for city-owned properties; 2) incorporate canopy goal objectives and tree maintenance practices; 3) develop city-wide landscape maintenance policies; 4) incorporate long-term climate projections as part of land use planning; 5) implement the flood resilience plan and 6) preserve, enhance and acquire existing floodplains.		
Flooding; Nutrients, Sediment, *E. coli*	Increase storage and filtration	Landowners, cities, towns, elected officials, parks departments	Increase stormwater storage capacity through agricultural storage, wetland restoration and reforestation efforts.	$150,000 annually + individual site specific costs, as needed	PP: SWCDs, lake associations, parks departments, cities and counties, SJRBC, Purdue Extension TA: SWCDs, NRCS, engineering firms, SJRBC
			Minimize impacts of flooding by diverting or retaining stormwater on site using green infrastructure practices per the Elkhart County multi-hazard mitigation plan.		
			Maintain channels and regulated drains to prevent localized flooding per the Elkhart County multi-hazard mitigation plan.		
			Create regional floodwater and storage locations with the goal of providing stormwater pretreatment, restoring areas to native plantings and improving local habitat.		

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
See above	Increase storage and filtration (continued)		Work with the City of Goshen to meet their Climate Action Plan goals to 1) protect current city-owned forests; 2) update Urban Tree Canopy Assessments every 5 years; collaborate with landowner to promote long-term protection of forested land and 4) update tree ordinances.	See above	See above
			Follow recommendations for mitigating potential impacts of high hazard (Goshen Dam Pond) and low hazard (Upper Watershed) dam failures per the Elkhart County multi-hazard mitigation plan (2016). Follow the Incident and Emergency Action Plan for the Goshen Dam Pond (2007).		
			Increase tree canopy cover across the watershed. City of Goshen identifies tree mitigation (5:1) to be implemented.		
Nutrients, Sediment, *E. coli*	Monitor annual loading rates and consider options for delisting streams currently on IDEM's impaired list.	Elected officials, local government, general public	Establish an annual volunteer or professional monitoring program to assess nutrient and sediment impacts to the Lower Elkhart River Watershed. Involve previously trained Hoosier Riverwatch volunteers and encourage them to actively monitor.	$5,000 annually volunteer-based monitoring; additional cost for professional or snapshot monitoring	PP: SWCDs, lake associations, parks departments, cities and counties, SJRBC, Purdue Extension, MS4, Health Department, Hoosier Riverwatch volunteers, RSDs TA: SWCDs, NRCS, engineering firms, SJRBC
			Build cohesive monitoring data set across the Lower (and consider Upper) Watershed. Compile data no less than annually. Consider options for communicating data, results and overall water quality to the general public.		
			Collect *E. coli* samples no less than every 5 years with the goal of calculating the geometric mean (5 samples over 30 days).		
			Investigate Izaak Walton League's salt watch monitoring program to assess salt impacts locally.		
Flooding, Nutrients, Sediment	Improve water quality and habitat to obtain mIBI, IBI, and QHEI scores and delist streams currently on IDEM's impaired list.	Elected officials, local government, general public	Implement BMPs noted above targeting sediment, nutrients and *E. coli* reductions, flood mitigation and riparian habitat improvement.	$20,000 for each fish/ macroinvertebrate assessment	PP: same as above TA: SWCDs, NRCS, engineering firms, SJRBC, City of Elkhart Biology
			Build cohesive monitoring data set across the Lower (and consider Upper) Watershed. Compile data no less than annually.		
			Monitor fish and macroinvertebrate populations every five years and habitat annually.		

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Education; *E. coli*	Work with contractors and Health Depts to increase septic system maintenance and installation awareness	Septic installers, local elected officials, homeowners	Produce and distribute septic maintenance brochures at local events, field days, city festivals and county fairs. Offer cost-share incentives to producers providing voluntary septic maintenance. Explore options for future septic system maintenance or upgrade assistance funding. Provide these (and all education materials) in English and Spanish and post in publicly available locations.	$5,000 annually staffing	PP: Health department, ISDH, IDEM, contractors, installers TA: same as PP, CCCW, Purdue Extension
Education	Work with local entities to establish an inorganic pollution education program	Businesses, commercial entities, General public, waste haulers	Continue to promote trash pickup, annual clean up events and identify new opportunities (adopt a road, community corrections clean up events, student engagement) to reduce trash pollution. Establish an annual reporting mechanism to determine how much trash was saved from entering and removed from Lower Elkhart River streams.	$5,000 annually staffing	PP: Landfill, SWMD, EEC, MS4, SWCD, cities, parks TA: auto shops, SWCD, MS4, EEC, DNR, waste haulers
Education	Create a cohesive education and outreach program focused on increasing public awareness and building a sense of place and watershed connectivity.	General public, schools (K-12), youth organizations (4H, scouts, youth groups), Amish and Mennonite community	Identify opportunities to highlight where you live, where your water flows, connection along the entire Elkhart River. Implement sense of place and watershed connectivity education programming. Work with other local groups which provide education programming including but not limited to county SWCDs and parks, lake associations, WACF, ERRA, cities and towns and others. Promote local natural areas which provide access to Lower Elkhart River and its tributaries. Highlight options to engage with or get out onto water. Provide multi-lingual literature, signage and educational programming. Identify local partners and volunteers to assist with EASL translation and event staffing.	$5,000 annually	PP/TA: DNR, SWCDs, NRCS, IDEM, HOAs, lake associations, Goshen College, ERRA, local radio stations, El Puerte, Paddle Michiana

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Education	Educate Lower Elkhart River Project stakeholders about soil erosion, increase awareness about applicable urban and ag BMPs, pollution and cost share opportunities	Producers, local residents, seawall installers, engineers, HOAs, businesses and commercial entities, Amish and Mennonite communities	Develop an education plan targeting each practice identified above by 2025 (Table 87).	$15,000 annually	PP: SWCDs, NRCS, MS4, EEC, HOAs, lake associations, CCCW TA: Engineers, city & county employees, IDEM, DNR, Purdue Extension
			Create mechanism to promote each practice and their maintenance using methods including but not limited to press releases; workshops; field days; stream clean up; float trip; stream, field or pasture walk; website creation; local events; county fair booth; educational booth; and public meetings.		
			Develop funding mechanisms for education efforts.		
			The education program should include educational efforts which includes but is not limited to the following: all practices identified by the steering committee and noted in tables above; septic system use, maintenance and care; green infrastructure/LID; high quality natural areas; wetland protection and preservation, general stream processes.		
			Provide employee training on green infrastructure, low impact development and climate change mitigation and adaptation. Note the City of Goshen provides this and it should be expanded to parks, city and county staff per the MS4 permit requirements.		
			Meet the community where they are (Latino Fest, other events) to reach both English and Spanish speakers.		
			Continue to maintain a project-based website and social media to promote events, cost share fund availability and build project awareness.		

Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Education; Habitat; Flooding	Work with partners to identify and promote hands-on opportunities to improve natural areas and habitat in the watershed.	Producers, local residents, HOAs, businesses Amish and Mennonite communities	Identify partner organizations which host field days, workdays, and clean-up events.	$5,000 annually staffing	PP/TA: DNR, SWCDs, NRCS, IDEM, HOAs, lake associations, Goshen College, ERRA, local radio stations, El Puerte, Paddle Michiana
			Annually, identify partners for river clean-ups, float trips, invasive species control, trash removal, illegal dumping or habitat restoration opportunities and promote throughout the watershed.		
			Create watershed-wide green infrastructure map.		
			Provide one-stop shopping for river information, blue trail details, travel time on the river, river safety, dam locations and more.		
Education	Annually build a regional calendar of education events and activities to provide one stop shopping for information and build cohesion.	Producers, local residents, HOAs, businesses Amish and Mennonite communities	Coordinate an annual partner meeting (January/February) to review event dates and identify activity and date overlap.	$5,000 annually staffing	PP/TA: DNR, SWCDs, NRCS, IDEM, HOAs, lake associations, Goshen College, ERRA, local radio stations, El Puerte, Paddle Michiana
			Identify areas of need which have been missed by individual planning and activity scheduling.		
			Consider options to build a social or public calendar and/or social media platform to share events and relevant dates.		
			Share local resources to reach more local residents, watershed stakeholders and regional entities.		

11.0 FUTURE ACTIVITIES

The next steps for the project include starting implementation of the Lower Elkhart River Watershed Management Plan. The Elkhart River Restoration Association in partnership with the project steering committee and other regional partners will consider options for submitting implementation-focused grant applications for IDEM Section 319 funds, Great Lakes Restoration Initiative Funds, DNR LARE, Clean Water Indiana and other funds. If funded, this grant would provide funds for a cost-share program to install BMPs, promotion of the cost-share program, and an education and outreach program. If the grant is awarded, the steering committee will develop a cost-share program that will include steps to meet the goals and management strategies of this plan. The anticipated cost-share program will use a ranking system to fund applications that will have the most impact in improving water quality. Factors such as location within watershed (priority areas), distance from streams, number of resource concerns addressed, and number of practices planned will be considered as part of the ranking process to further prioritize BMPs. It is anticipated that implementation efforts will target high priority critical areas and focus on the implementation of short-term goals.

11.1 Tracking Effectiveness

Implementation of policies, programs, and practices will improve water quality and watershed conditions within the Lower Elkhart River Watershed, helping reach goal statements by 2054 (Table 91). For each practice identified which the committee deemed familiar and routinely utilized in the Lower Elkhart River Watershed and for which a load reduction calculation is readily available, an annual target for the acres or number of each BMP implemented is included in Table 92. Measurement of the success of implementation is a necessary part of any watershed project (Table 91). Water quality data will be used to measure observable changes following implementation. In order to track the project's progress of reaching goals and improving water quality, information and data will need to be continually collected during implementation.

The tracking strategies illustrated in Table 91 will be used to document changes and aid in the plan re-evaluation. The steering committee listed potential partners and technical assistance providers as both unless otherwise noted. Activities to be completed as part of this watershed management plan are identified in the action register (Table 90). Table 92 identifies the annual target for the number or acres of BMPs to be installed during each implementation phase. Work completed toward each goal/objective documented will include scheduled and completed activities, numbers of individuals attending or efforts completed toward each objective, and load calculations for each goal, objective, and strategy. Overall, project progress will be tracked by measurable items such as workshops held, BMPs installed, meetings held, number of attendees, etc. Load reductions will be calculated for each BMP installed. These values and associated project details including BMP type, location, dimensions, load reductions, and more will be tracked over time and documented on the Indiana State Department of Agriculture Conservation Tracking sheet. Individual landowner contacts and information will be tracked for both identified and installed BMPs. The Elkhart River Restoration Association will be responsible for keeping the mentioned records.

Table 91. Strategies for and indicators of tracking goals and effectiveness of implementation.

Tracking Strategy	Frequency	Total Estimated Cost (Staff Time Included)	Partners/Technical Assistance
BMP Count	Continuous	$5,000	SWCDs, NRCS, ISDA, MS4
BMP Load Reductions	Continuous	$5,000	SWCDs, NRCS, ISDA, MS4
Attendance at Workshops/Field Days	Yearly	$500/workshop	N/A
Post Workshop Surveys for Effectiveness	Yearly	$250/workshop	SWCD, NRCS, Purdue Extension
Number of Educational Programs/students reached	Yearly	$250/program	N/A
Windshield Surveys	Every 4-5 years	$2,500 annually	SWCDs, Committee, ISDA
Tillage/Cover Crop Transects	Yearly	$20,000 in SWCD and ISDA staff time	SWCDs, NRCS, ISDA Staff
Number of educational publications/press releases	Yearly	$500/release	SWCD
IDEM Probabilistic Monitoring	Every 9 years	N/A (IDEM provides staff and funding)	IDEM

Table 92. Annual targets for best management practices.

Suggested BMPs:	Annual BMP Targets High	Annual BMP Targets Medium	Annual BMP Targets Low	Units
Conservation Cover (327)	333	333	333	acre
Cover Crop (340)	3,000	3,000	3,000	acre
Drainage Water Management (554)	33	33	33	units
Filter Strip (393)	833	833	833	acre
Grassed Waterway (412)	333	333	333	acre
Grade Stabilization Structure (410)	20	20	20	count
Heavy Use Area Protection (561)	17	17	17	acre
Livestock Restriction (Alt Watering System, Access Control)	1,500	1,500	1,500	feet; units
Nutrient/Pest Management (590)^	3,000	3,000	3,000	acres
Prescribed Grazing (582)	1,200	1,200	1,200	acres
Pollinator Planting (CP42)	100	100	100	acres
Residue and Tillage Management (329)	4,000	4,000	4,000	acres
Two-Stage Ditch (582)	12	12	12	feet
Wetland Creation/Enhancement/Restoration (658,657,659)	100	100	100	acre
Urban practices	33	33	33	Unit

11.2 Indicators of Success

Water quality, social, and administrative indicators will be used to monitor progress towards successful achievement of the goals for the high and medium priority critical areas. Water quality indicators will include monitoring total phosphorus, nitrate-nitrogen, total suspended solids and *E. coli*. Monitoring will occur as part of the Hoosier Riverwatch volunteer program, at a minimum. If local laboratory partners will continue to analyze collected samples as an in-kind service, laboratory data will be utilized as an indicator for each parameter. Administrative indicators will be listed with each strategy included in the action register.

Reduce Nutrient Loading

- Water Quality Indicator: Nitrate-nitrogen and total phosphorus will be measured monthly at the IDEM fixed station monitoring sites. After five years of implementation, water quality samples will show a decreasing trend, with more samples annually meeting the target level for nitrate-nitrogen of 1.0 mg/L and for total phosphorus of 0.08 mg/L.
- Administrative Indicator: The number of BMPs that can reduce nitrate-nitrogen and total phosphorus will be tracked annually. The total number of acreage will be compared against 30-year targets identified in Table 92. Individual load reductions calculated for each BMP will be reviewed to determine if cumulative loading rates for nitrate-nitrogen and phosphorus are sufficient to meet the target reductions.

Reduce Sediment Loading

- Water Quality Indicator: Total suspended solids will be measured monthly at the IDEM fixed station monitoring sites. After five years of implementation, water quality samples will show a decreasing trend, with more samples annually meeting the target level for total suspended solids of 15 mg/L.
- Administrative Indicator: The number of BMPs that can reduce total suspended solids will be tracked annually. The total number of acreage will be compared against 30-year targets targets identified in Table 92 Individual load reductions calculated for each BMP will be reviewed to determine if the cumulative loading rate for total suspended solids is sufficient to meet the target reduction.

Reduce *E. coli* Loading

- Water Quality Indicator: *E. coli* will be measured by volunteers on the same schedule as IDEM rotational basin sampling. After five years of implementation, water quality samples will show a decreasing trend, with more samples annually meeting the state standard.
- Administrative Indicator: The number of BMPs that can reduce *E. coli* will be tracked annually. The total number of acres will be compared against 30-year targets identified in Table 92.

Reduce Flooding Impacts

- Administrative Indicator: Wetland acreage, floodplain land cover acreage and coverage of poorly drained and very poorly drained soils will be calculated using each new National Land Cover Dataset, which is released approximately every six years. After six years of implementation, wetland, floodplain land cover and poorly drained/very poorly drained cover acreage will measure higher than the measurement which occurred during the previous assessment. Total acreage of wetland, floodplain land cover and poorly drained/very poorly drained cover will be compared with previous total. If LIDAR data is available, this calculation will occur using these data.

Recreational Access

- Administrative Indicator: The number of people who annually recreate on the Elkhart River and its tributaries will be tracked. A baseline paddler count will be established in 2024. River and lake access points and the acreage of natural land will be mapped annually in the project GIS database. After five years, the number of access points and acreage protected will show an increasing trend with more access points available for public use and more land protected for recreation purposes.

Habitat Alteration/Habitat Loss

- Administrative Indicator: Complete flooding assessment and annual review of QHEI scores for sites assessed by the City of Elkhart along the Elkhart River and other locations. After six years, the acreage protected will be measured to assess changes in habitat preservation every five years with the goal of no net loss of terrestrial habitat and riparian function. Additionally, annual QHEI scores will be compared with scores from the same site from the previous year to assess positive or negative changes and note any difference due to climate change/instream flows or other conditions.

Increase Public Awareness and Participation

- Administrative Indicator: The number of people who attend education and outreach events will be tracked. The percentage of targeted households reached will increase annually.
- Social Indicator: Pre and post surveys of attendees will be conducted at workshops to determine changes in individuals' knowledge of the topic as a result of attending the workshop. It would be expected that 75% of workshop attendees would have a better understanding of the topic after the workshop.

11.3 NEPA Concerns and Compliance

The National Environmental Policy Act (NEPA) was signed into law in 1970. The law requires federal agencies to assess the environmental impacts of their proposed actions prior to making decisions. This law also applies to watershed planning activities. As part of the planning process the NRCS is required to evaluate the individual and cumulative effects of proposed actions. Any project that has significant environmental impacts must be evaluated with an Environmental Assessment (EA) or Environmental Impact Statement (EIS) unless the activities are eligible under a categorical exclusion or already covered by an existing EA or EIS. The NRCS utilizes a planning process that incorporates an evaluation of potential environmental impacts using an Environmental Evaluation Worksheet. There are several NRCS conservation practices and activities that fall under a categorical exclusion. A categorical exclusion is a category of actions that do not normally create a significant individual or cumulative effects on the human environment. There are 21 NRCS approved conservation or restoration categorical exclusions identified in GM190 §410.6. These categorical exemptions include practices that reduce soil erosion, involve planting vegetation and restoring areas to natural ecological systems.

This watershed plan calls for conservation practices that control soil erosion and runoff from agricultural fields and structural practices to address runoff and waste management issues. Many of these practices are covered by either a categorical exclusion or may be included in an existing environmental assessment. A list of practices likely to be used to implement the plan is listed in Table 86.

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Prior to practice implementation with USDA NRCS assistance, an NRCS CPA 52 Environmental Evaluation form will be completed for each practice. Using this form, each planned practice and practices system will be evaluated to determine if it meets the criteria of categorical exclusions and any existing Environmental assessments. Any adverse impacts from practices will first try to be avoided then minimized or mitigated as necessary. If resource concerns are found, NRCS will contact the agency with responsibility for the resource. Agencies will include but are not limited to the US Fish and Wildlife Service and the State Historic Preservation Office. It is not anticipated that the practices planned for the Lower Elkhart River Watershed will require an Environmental Assessment or an Environmental Impact Statement.

11.4 Outreach Plan

Based on steering committee knowledge, a multi-tiered strategy will be required to fully implement the Lower Elkhart River Watershed Management Plan. The plan will use targeted outreach to agricultural producers which will encourage the adoption of conservation practices to avoid, control and trap nutrients and sediment. Additional associated landowners will receive information about the project with the goal of raising awareness and informing the local community. For the targeted producers, outreach methods will include but not be limited to the following:

- Targeted landowner and producer mailings to announce the program and encourage the adoption of conservation practices. Mailings will occur no less than once but may occur annually, as needed.
- Practice specific field days and workshops. No less than 2 workshops or field days will occur annually.
- Newsletters. The Lower Elkhart River steering committee will work with partners to distribute information on a quarterly basis within partner newsletters including SWCD, county extension, FSA, and others.
- Post information at public locations such as farm and garden centers.
- Work with regional CCAs to provide information about the program.
- Maintain a project website which will be used to promote project events, announce fund availability and detail funding deadlines. Updates will be made to the project website no less than monthly or when education and engagement events occur, cost share funds are available or project-based meetings or other activities can be highlighted.
- Social media posts will occur on project social media no less than monthly and will be shared across partner social media as well.
- Radio announcements (PSAs) and news releases will occur no less than quarterly to local media.
- Additional options such as billboards, videos, tabling at community events, and others will be considered by the technical committee.

The following partners will be engaged as part of the outreach efforts:

- Natural resources conservation service (NRCS) conservationists provide technical assistance and expertise, coordinate conservation planning and distribute financial assistance for local producers. The Elkhart, Kosciusko, and Noble County service centers provide assistance for the Lower Elkhart River Watershed.
- Elkhart, Kosciusko, and Noble SWCD offices assist producers with conservation choices via farm planning assistance as well as targeted education and outreach.
- Indiana State Department of Agricultural staff provides technical assistance and expertise with conservation practice design and assessment.

- The Lower Elkhart River Watershed Project will provide education and outreach assistance and assist with program promotion.

11.5 Adapting Strategies in the Future

Due to the uncertainty of watershed management planning, an adaptive management strategy will be implemented to improve the project's success. While much thought and expertise has been put into the planning process, not all scenarios can be foreseen. Oftentimes there are changes such as a shift in community attitude/behavior, changes in resource concerns, development of new information or accomplishing a goal sooner or later than expected. By implementing an adaptive management strategy, the Lower Elkhart River Project Steering Committee can adjust the watershed management plan to ensure project success. A four-step adaptive management strategy has been outlined for the Lower Elkhart River Watershed Project and can be found below.

Step 1: Planning The planning process used to develop the Lower Elkhart River WMP follows the IDEM 2009 Watershed Management Checklist. The project coordinator worked in concert with and was guided by the Lower Elkhart River Project Steering Committee to develop the WMP using knowledge of the watershed, inputs from stakeholders, new data from water monitoring and windshield surveys, and historical data. This plan includes goals, action register, and schedule outlining how and when to achieve the defined goals.

Step 2: Implementation The action register and schedule will be implemented to achieve the goals of the Lower Elkhart River Watershed Project objectives and goals. Partnering agencies such as NRCS, SWCD, ISDA, and IDEM will carry out the implementation. Implementation will include a cost-share program and education events targeting both youth and adults. Practices implemented through the cost-share program will follow the NRCS Field Office Technical Guide (FOTG) Practice Standards or other technical standards as detailed in the cost-share program, once developed. The cost-share program will include but will not be limited to practices such as cover crops, watering facilities, fencing, conservation buffers, grassed waterways, and nutrient and pest management plans. Cost-share funding will be implemented in priority areas. A ranking system will be used to prioritize applications that will have the greatest impact on water quality improvement.

Step 3: Evaluate & Learn Evaluations of indicators identified above and in Table 91 will occur often to check the progress being made toward the project goals. The steering committee will annually review progress and determine if the project is on track to meet interim and project end goals outlined in the Action Plan (Table 90) and goals. Factors evaluated will include but will not be limited to numbers of BMPs installed, calculated/estimated load reductions of installed BMPs, number of individuals reached through outreach, etc. The evaluations will be conducted by the Lower Elkhart River Project Steering Committee. The group will then provide recommendations that will improve project success. Progress against the watershed management plan will be reviewed no less than every two years (i.e. 2024, 2026, etc.).

Step 4: Alter Strategy The project's implementation and management strategy will be adjusted to improve the project's success. If progress is not made proportionate to the time into the project (i.e. at the end of year 3, approximately 30% (3/10) of 10-year goals should be met), the steering committee will have the opportunity to alter their strategy in order to meet the goals of the project. Adjustments will be based off of recommendations from the Evaluate and Learn step. Once the adjustments are agreed upon by the steering committee, the project will revert back to Implementation (Step 2) to continue with the

Adaptive Management strategy (steps 2-4) until all goals have been met or all conservation opportunities have been exhausted.

The Lower Elkhart River Project coordinated by the ERRA, is responsible for maintaining records for the project including tracking plan successes and failures and any necessary watershed management plan revisions. The plan will be re-evaluated at the end of Year 5 and every 5 years after that. For updates and information, contact the Elkhart River Restoration Association president. Their contact information is available at www.elkhartriver.org.

Appendix 1: Endangered, Threatened, and Rare Species Data

April 28, 2023

INDIANA HERITAGE DATA WITHIN:

Lower Elkhart River Watershed Management Plan, Kosciusko, Noble, and Elkhart Counties

Sci. Name	Com. Name	State	Fed.	Date	Site	Comments
Amphibian						
Acris blanchardi	Blanchard's cricket frog	SSC		2021	TRI-COUNTY FISH AND WILDLIFE AREA	
Hemidactylium scutatum	four-toed salamander	SSC		2006	TRI-COUNTY FWA	
Necturus maculosus	common mudpuppy	SSC		2002	LAKE WAWASEE	
Necturus maculosus	common mudpuppy	SSC		2009	DEWART LAKE	
Bird						
Bartramia longicauda	Upland Sandpiper	SE		1938		
Botaurus lentiginosus	American Bittern	SE		1982		
Botaurus lentiginosus	American Bittern	SE		1952	GOSHEN	
Chlidonias niger	Black Tern	SE		1949	DEWART LAKE	
Cistothorus stellaris	sedge wren	SE		2000		
Haliaeetus leucocephalus	bald eagle			2016	DEWART LAKE	NEST SITE
Haliaeetus leucocephalus	bald eagle			2020	GOSHEN	NEST SITE
Haliaeetus leucocephalus	bald eagle			2020	DEWART LAKE WEST	NEST SITE
Haliaeetus leucocephalus	bald eagle			2020	GOSHEN EAST	NEST SITE
Haliaeetus leucocephalus	bald eagle			2021	GOSHEN NE	NEST SITE
Ixobrychus exilis	Least Bittern	SE		1950		
Ixobrychus exilis	Least Bittern	SE		1950	DEWART LAKE	NEST
Lanius ludovicianus	loggerhead shrike	SE		1938	NORTHEAST OF GOSHEN COLLEGE	
Pandion haliaetus	Osprey	SSC		2021	NEST PLATFORM, LAKE WAWASEE	NEST SITE
Pandion haliaetus	Osprey	SSC		2016	CELL TOWER, NW OF NORTH WEBSTER	NEST SITE
Pandion haliaetus	Osprey	SSC		2021	TRI-COUNTY BARREL-AND-A-	NEST SITE

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Sci. Name	Com. Name	State	Fed.	Date	Site	Comments
					HALF LAKE, NEST PLATFORM	
Pandion haliaetus	Osprey	SSC		2015		NEST SITE
Pandion haliaetus	Osprey	SSC		2020	CELL TOWER, NW OF SYRACUSE	NEST SITE
Rallus elegans	King Rail	SE		1918		
Rallus limicola	Virginia Rail	SE		1933	EAST OF GOSHEN COLLEGE	
Setophaga cerulea	Cerulean Warbler	SE		1994		
Fish						
Acipenser fulvescens	Lake Sturgeon	SE		1991	LAKE WAWASEE	
Coregonus artedi	cisco	SE		1990	DILLARD'S PIT (CAMELOT LAKE)	
Coregonus artedi	cisco	SE		1955	INDIAN VILLAGE LAKE	
Coregonus artedi	cisco	SE		1971	WABEE LAKE	
Coregonus artedi	cisco	SE		1975	KNAPP LAKE	
Coregonus artedi	cisco	SE		1990	GORDY LAKE	
Coregonus artedi	cisco	SE		1975	HINDMAN LAKE	
Coregonus artedi	cisco	SE		1955	SHOCK LAKE	
Ichthyomyzon fossor	Northern Brook Lamprey	SSC		2016	ELKHART RIVER	
Moxostoma valenciennesi	Greater Redhorse	SE		2010	ELKHART RIVER	
Rhinichthys cataractae	Longnose Dace	SSC		2014	YELLOW CREEK	
Rhinichthys cataractae	Longnose Dace	SSC		2012	YELLOW CREEK	
Rhinichthys cataractae	Longnose Dace	SSC		2008	YELLOW CREEK	
Rhinichthys cataractae	Longnose Dace	SSC		2007	ELKHART RIVER	
High Quality Natural Community						
Forest - upland mesic Northern Lakes	Northern Lakes Mesic Upland Forest	SG		1980		
Lake - lake	Lake	SG		1980	LAKE WAWASEE	
Wetland - bog circumneutral	Circumneutral Bog	SG		1984	NOBLE CO. NOTABLE #83A	
Wetland - marsh	Marsh	SG		1980	LAKE WAWASEE	
Wetland - meadow	Sedge Meadow	SG		1980	LAKE WAWASEE	

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Sci. Name	Com. Name	State	Fed.	Date	Site	Comments
sedge						
Wetland - meadow sedge	Sedge Meadow	SG		0	KOSCIUSKO COUNTY NOTABLE #125 (TURKEY CREEK WETLAND)	
Wetland - swamp shrub	Shrub Swamp	SG		1982		
Wetland - swamp shrub	Shrub Swamp	SG		1982	REDMON PARK	
Insect Coleoptera						
Nicrophorus americanus	American Burying Beetle	SX	E	1917		
Insect Lepidoptera						
Lycaena helloides	Purplish Copper	SR		1968	CAMP ALEXANDER MACK	
Mammal						
Condylura cristata	Star-nosed Mole	SSC		1991		
Condylura cristata	Star-nosed Mole	SSC		1971		
Condylura cristata	Star-nosed Mole	SSC		1959		
Myotis sodalis	Indiana Bat	SE	E	2018	ALBION TO GUARDIAN LINE STUDY	BAT ROOST SITE
Myotis sodalis	Indiana Bat	SE	E	1955		BAT HISTORICAL COLLECTION
Nycticeius humeralis	Evening Bat	SE		2018	ALBION TO GUARDIAN LINE STUDY	BAT SUMMER CAPTURE
Taxidea taxus	American Badger	SSC		1993		
Taxidea taxus	American Badger	SSC		2010	PIONEER TRAILS CAMP	
Taxidea taxus	American Badger	SSC		1983		
Taxidea taxus	American Badger	SSC		2002		
Mollusk						
Venustaconcha ellipsiformis	Ellipse			2003	TURKEY CREEK	HISTORICAL; 2003: WEATHERED DEAD. (FISHER, 2004).
Venustaconcha ellipsiformis	Ellipse			2003	YELLOW RIVER	HISTORICAL; 2003: WEATHERED DEAD. (FISHER, 2004).
Venustaconcha	Ellipse			2013	ELKHART RIVER	2013:

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Sci. Name	Com. Name	State	Fed.	Date	Site	Comments
ellipsiformis						WEATHERED DEAD (FISHER AND DAVIS)
Venustaconcha ellipsiformis	Ellipse			2005	ELKHART RIVER	2005: FRESH DEAD. (FISHER, BRIGGS AND SLADE, 2006).
Venustaconcha ellipsiformis	Ellipse			2004	ELKHART RIVER	WEATHERED DEAD. (FISHER, BRIGGS, AND FOY, 2004).
Venustaconcha ellipsiformis	Ellipse			2004	ELKHART RIVER	2004: FRESH DEAD. (FISHER, BRIGGS, AND FOY, 2004).
Other						
Acroneuria lycorias	Boreal Stonefly	SE		2018	ST JOSEPH AND ELKHART RIVERS	
Pteronarcys dorsata	American Salmonfly	SE		2018	ST JOSEPH AND ELKHART RIVERS	
Reptile						
Clemmys guttata	spotted turtle	SE	C	1984	DEWART LAKE	
Clemmys guttata	spotted turtle	SE	C	1953	LAKE WAWASEE	
Emydoidea blandingii	Blanding's turtle	SE	C	1997	DEWART LAKE	
Emydoidea blandingii	Blanding's turtle	SE	C	1989	LAKE WAWASEE	
Emydoidea blandingii	Blanding's turtle	SE	C	2014	OX BOW COUNTY PARK	
Emydoidea blandingii	Blanding's turtle	SE	C	2021	GOSHEN	
Emydoidea blandingii	Blanding's turtle	SE	C	2022	ABSHIRE PARK - ROCK RUN CREEK	
Emydoidea blandingii	Blanding's turtle	SE	C	0	LAKE WAWASEE	
Sistrurus catenatus	eastern massasauga	SE	T	1957		
Vascular Plant						
Bidens beckii	Beck's water-marigold	SE		1979	PRICE LAKE	
Bidens beckii	Beck's water-marigold	SE		1985	WYLAND LAKE	
Bidens beckii	Beck's water-marigold	SE		1962		
Bidens beckii	Beck's water-marigold	SE		1941	DEWART LAKE	
Calla palustris	wild calla	SE		1938	W OF WOLF LAKE	
Cypripedium acaule	pink lady's-slipper	SE		1927	ELKHART COUNTY	

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Sci. Name	Com. Name	State	Fed.	Date	Site	Comments
Cypripedium acaule	pink lady's-slipper	SE		1924		
Dendrolycopodium hickeyi	Hickey's clubmoss	ST		1979		
Eriophorum viridicarinatum	green-keeled cotton-grass	ST		1912	LEESBURG SWAMP	
Geranium bicknellii	Bicknell's northern cranesbill	SE		1931	NOBLE CO. NOTABLE #83A	
Geranium robertianum	herb-Robert	ST		1982		
Geranium robertianum	herb-Robert	ST		1942		
Juglans cinerea	butternut	ST		0	GREIDER'S WOODS NATURE PRESERVE	
Juniperus communis var. depressa	ground juniper	ST		1932		
Linnaea borealis	twinflower	SX		1916	NOBLE CO. NOTABLE #83A	
Matteuccia struthiopteris	ostrich fern	ST		1984	NOBLE CO. NOTABLE #83A	
Myriophyllum verticillatum	whorled water-milfoil	ST		1985	JOHNSON BAY LAKE WAWASEE	
Potamogeton friesii	Fries' pondweed	SE		1962	BARREL AND HALF LAKE	
Potamogeton friesii	Fries' pondweed	SE		1962	PRICE LAKE	
Potamogeton oakesianus	Oakes' pondweed	SE		1985	JOHNSON BAY LAKE WAWASEE	
Potamogeton richardsonii	redheadgrass	ST		1985	JOHNSON BAY LAKE WAWASEE	
Potamogeton strictifolius	straight-leaf pondweed	ST		1934	LAKE WAWASEE	
Potamogeton strictifolius	straight-leaf pondweed	ST		1963	SPEAR LAKE	
Potamogeton strictifolius	straight-leaf pondweed	ST		1935	LAKE WAWASEE	
Pyrola americana	American wintergreen	ST		1984	NOBLE CO. NOTABLE #83A	
Scheuchzeria palustris ssp. americana	American scheuchzeria	SE		1938	BAUSE LAKE	
Schoenoplectus subterminalis	water bulrush	ST		1934	LAKE WAWASEE	
Spiranthes lucida	shining ladies'-tresses	ST		1968	ALONG ELKHART RIVER - GOSHEN	
Triantha glutinosa	false asphodel	ST		0		
Triglochin palustris	marsh arrow-grass	ST		1938	GILBERT LAKE	
Utricularia cornuta	horned bladderwort	SE		1938	GILBERT LAKE	

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Appendix 2A: Water Chemistry Data

Date	SITE	Subshed	Temp (C)	DO	pH	TURB	Conductivity	Phos.	Nitrate	TSS	E.coli (MPN)
2/13/2023	1		8.58	9.51	8.92	1.2	551	0.05	2.40	14	30
3/7/2023	1		6.25	10.54	8.89	1.1	446.4	0.05	4.20	26.8	90
4/11/2023	1		11.67	8.31	8.77	4.3	542.3	0.05	4.20	28.4	80
5/16/2023	1		14.50	7.83	8.33	9.89	386	0.05	0.92	4.8	160.0
6/13/2023	1		15.20	5.74	7.78	8.04	568	0.05	1.51	2.4	710.0
7/11/2023	1		21.20	2.69	7.54	13.87	514	0.05	1.38	6	530.0
8/22/2023	1		22.30	3.41	7.69	2.08	521	0.05	1.69	2.8	365.0
9/12/2023	1		18.50	2.21	7.72	3.81	546	0.050	2.29	4.4	199.0
10/17/2023	1		10.40	6.89	7.92	7.49	594	0.069	2.89	12.8	238.0
11/6/2023	1		7.70	9.09	8.07	2.34	582	0.050	2.95	8.4	105.0
12/18/2023	1		4.30	10.72	8.05	8.78	557	0.050	5.01	12.0	86.0
1/9/2024	1		2.40	10.88	8.26	10.02	539	0.050	8.58	16.8	89.0
2/13/2023	2		3.07	12.79	9.17	1.9	357.2	0.05	5.70	4.4	20
3/7/2023	2		5.62	11.54	9.05	0.6	362.7	0.05	9.40	12.8	10
4/11/2023	2		9.97	10.84	9.34	0.8	402.2	0.05	4.20	15.4	140
5/16/2023	2		14.10	8.82	8.62	6.30	1859	0.05	6.30	4	50.0
6/13/2023	2		18.30	8.29	8.27	6.37	362.8	0.05	0.55	4	40.0
7/11/2023	2		25.10	7.43	8.43	6.22	736.5	0.05	0.54	3.2	390.0
8/22/2023	2		25.30	7.76	8.47	2.61	340	0.05	1.65	20	70.0
9/12/2023	2		18.10	6.35	7.75	2.44	459	0.050	0.96	4.0	173.0
10/17/2023	2		12.10	3.05	7.60	7.61	595	0.050	0.99	14.0	291.0
11/6/2023	2		9.70	8.83	8.01	3.71	420	0.050	0.94	5.2	34.0
12/18/2023	2		4.50	11.55	8.53	3.02	374	0.050	2.95	3.6	2.0
1/9/2024	2		2.60	11.17	8.52	4.05	387	0.050	5.48	4.0	4.0
2/13/2023	3		10.34	9.42	9.04	2.9	483.5	0.05	1.60	8.4	330
3/7/2023	3		6.38	11.42	8.84	1.1	572	0.05	1.30	11.6	150
4/11/2023	3		13.06	9.41	8.71	1	591.1	0.05	6.20	9.2	10
5/16/2023	3		17.10	8.43	7.11	3.97	363	0.05	1.20	2	120.0
6/13/2023	3		17.90	7.66	8.27	16.89	613	0.05	1.51	7.6	680.0
7/11/2023	3		23.00	7.01	8.32	12.30	594	0.05	1.42	25.2	620.0
8/22/2023	3		22.30	7.32	8.28	9.03	561	0.05	2.21	8	866.0
9/12/2023	3										dry
10/17/2023	3										dry
11/6/2023	3										dry
12/18/2023	3										dry
1/9/2024	3										dry
2/13/2023	4		10.16	9.73	8.58	4.1	498.2	0.05	1.40	8	150
3/7/2023	4		5.18	11.53	8.75	44.7	441.6	0.05	3.70	16	140
4/11/2023	4		9.76	8.76	8.91	4.9	683.4	0.05	2.60	11.2	80
5/16/2023	4		14.60	7.48	7.96	7.74	484	0.05	3.62	2.4	300.0
6/13/2023	4		14.10	7.78	7.95	6.52	691	0.05	1.35	2	470.0
7/11/2023	4		20.20	7.03	7.93	7.31	595	0.05	1.31	4.8	890.0
8/22/2023	4		21.90	6.51	8.01	4.93	550	0.05	2.02	7.2	548.0
9/12/2023	4		17.10	7.16	8.02	0.92	865	0.050	10.77	2.4	2420.0
10/17/2023	4		10.70	9.11	8.11	5.17	905	0.050	9.12	4.0	236.0
11/6/2023	4		9.00	9.98	8.16	3.83	838	0.074	6.07	4.4	199.0
12/18/2023	4		5.00	11.08	8.15	0.85	688	0.050	6.36	2.4	146.0
1/9/2024	4		2.70	11.39	8.26	5.84	595	0.050	9.58	8.4	2420.0
2/13/2023	5		9.64	7.83	8.71	1.6	848	0.05	7.20	9.6	130
3/7/2023	5		8.17	7.73	8.51	8.2	856.2	0.05	5.60	6.4	10
4/11/2023	5		10.99	8.25	8.74	1.4	521.6	0.05	1.20	4.4	280
5/16/2023	5		13.60	7.37	7.82	24.20	508	0.05	3.81	18	140.0
6/13/2023	5		13.20	7.21	7.78	19.77	870	0.05	1.76	8.4	200.0
7/11/2023	5		17.60	6.20	7.77	12.70	870	0.05	2.08	2	580.0
8/22/2023	5		19.50	5.52	7.79	2.97	856	0.05	2.62	2	687.0
9/12/2023	5		16.60	6.04	7.86	4.97	840	0.05	3.88	1.2	921.0
10/17/2023	5		10.60	8.43	7.97	3.70	869	0.050	4.37	0.8	96.0
11/6/2023	5		9.80	9.27	8.03	4.69	866	0.050	4.03	4.0	50.0
12/18/2023	5		6.20	9.88	7.95	7.85	858	0.050	7.05	5.6	40.0
1/9/2024	5		4.20	11.58	7.57	1.36	827	0.050	10.75	8.4	68.0
2/13/2023	6		7.99	9.14	8.67	5.4	640.1	0.05	2.70	10.8	380
3/7/2023	6		5.11	11.29	8.66	8.1	531	0.05	2.70	17.6	70
4/11/2023	6		11.71	7.92	8.28	1.4	464.2	0.05	0.80	10.8	220
5/16/2023	6		14.40	7.07	7.19	15.50	415	0.05	2.62	6.8	260.0
6/13/2023	6		13.90	7.63	7.94	16.51	780	0.05	1.25	4.4	310.0
7/11/2023	6		19.40	6.73	7.89	9.47	719	0.05	1.39	7.2	390.0
8/22/2023	6		21.20	6.37	7.92	4.13	677	0.05	2.35	4.8	613.0
9/12/2023	6		16.90	7.78	7.99	1.36	794	0.050	4.01	2.4	548.0

Date	SITE	Subshed	Temp (C)	DO	pH	TURB	Conductivity	Phos.	Nitrate	TSS	E.coli (MPN)
10/17/2023	6		10.40	8.79	8.11	6.63	824	0.050	3.47	5.6	158.0
11/6/2023	6		8.80	8.83	8.10	4.69	833	0.050	3.50	4.4	68.0
12/18/2023	6		5.36	10.40	8.09	6.39	761	0.050	5.81	5.2	89.0
1/9/2024	6		3.30	11.03	8.15	5.24	694	0.050	12.48	9.2	866.0
2/13/2023	7		8.76	10.27	8.47	6.6	798.1	0.099	4.80	6.4	820
3/7/2023	7		4.95	9.09	8.62	22.7	552.2	0.209	1.50	36	5490
4/11/2023	7		8.02	8.17	8.28	1.2	859.2	0.05	1.40	10	640
5/16/2023	7		13.90	7.85	7.68	7.69	695	0.096	1.22	2.8	340.0
6/13/2023	7		15.40	9.47	8.01	9.92	1130	0.1	12.31	2	110.0
7/11/2023	7		23.30	4.90	7.81	11.67	1053	0.307	12.21	11.2	500.0
8/22/2023	7		22.20	1.61	7.67	5.02	848	0.19	10.57	8.8	210.0
9/12/2023	7		17.50	4.91	7.87	39.10	1228	0.219	38.75	62.8	2420.0
10/17/2023	7		10.30	7.49	7.88	10.59	800	0.163	12.26	6.8	219.0
11/6/2023	7		8.20	9.85	8.08	2.00	938	0.075	14.33	2.8	219.0
12/18/2023	7		3.10	10.71	7.92	5.37	954	0.050	24.34	6.4	548.0
1/9/2024	7		2.70	11.28	8.11	3.02	1009	0.153	4.85	8.4	411.0
2/13/2023	8		11.11	10.01	8.63	1.2	592.6	0.05	1.30	4	10
3/7/2023	8		6.89	10.92	8.92	2.4	422.2	0.05	5.20	14.4	1180
4/11/2023	8		9.36	8.88	8.94	1.1	734.1	0.05	2.10	5.6	110
5/16/2023	8		14.70	7.46	8.23	11.17	1599	0.05	2.20	5.2	320.0
6/13/2023	8		14.30	7.84	8.07	12.68	690	0.05	1.49	2.4	400.0
7/11/2023	8		20.50	5.99	7.93	6.85	595	0.05	1.32	3.6	610.0
8/22/2023	8		22.20	6.32	8.01	7.59	530	0.05	1.91	9.6	461.0
9/12/2023	8		17.50	7.31	8.18	1.52	790	0.050	4.25	4.4	488.0
10/17/2023	8		10.20	9.42	8.26	2.03	778	0.050	3.78	2.0	299.0
11/6/2023	8		8.80	9.89	8.31	0.50	791	0.050	3.76	2.0	71.0
12/18/2023	8		4.60	10.98	8.18	3.19	664	0.050	6.81	4.0	411.0
1/9/2024	8		2.70	10.79	8.33	9.12	516	0.050	8.61	6.8	276.0
2/13/2023	9		4.92	11.38	8.81	0.2	676.2	0.05	1.80	13.6	260
3/7/2023	9		7.58	10.63	8.77	13.8	543.2	0.098	1.30	25.2	730
4/11/2023	9		11.22	9.1	7.98	1.3	773.2	0.05	2.20	6.4	150
5/16/2023	9		15.40	7.46	7.96	12.20	413	0.05	2.11	5.6	280.0
6/13/2023	9		14.50	7.92	8.09	14.77	782	0.05	2.45	4	150.0
7/11/2023	9		20.80	6.92	8.05	9.24	723	0.05	2.41	3.2	1070.0
8/22/2023	9		21.10	6.93	8.08	0.72	694	0.05	3.22	3.2	201.0
9/12/2023	9		17.90	7.71	8.23	0.10	655	0.050	3.90	1.2	365.0
10/17/2023	9		10.90	8.95	8.19	2.19	786	0.050	5.12	2.0	249.0
11/6/2023	9		10.40	8.62	8.15	0.29	827	0.050	0.29	1.2	101.0
12/18/2023	9		5.60	11.13	8.09	4.43	796	0.050	10.17	6.4	172.0
1/9/2024	9		3.80	11.06	8.33	8.57	741	0.050	7.73	11.2	770.0
2/13/2023	10		4.33	11.27	8.91	0.7	628.2	0.05	1.20	14	130
3/7/2023	10		5.51	11.46	8.81	11.2	492.3	0.088	0.60	15.2	210
4/11/2023	10		12.32	9.74	8.14	0.9	603.7	0.05	0.60	8.4	60
5/16/2023	10		16.60	7.73	8.03	22.10	499	0.05	1.12	14.8	150.0
6/13/2023	10		15.70	8.16	8.25	14.51	665	0.05	1.94	8	120.0
7/11/2023	10		21.40	6.89	8.15	19.56	642	0.05	1.83	13.6	910.0
8/22/2023	10		21.80	7.35	8.22	5.46	618	0.05	3.21	11.6	299.0
9/12/2023	10		16.70	7.19	8.08	3.21	782	0.050	5.78	3.2	687.0
10/17/2023	10		11.20	9.49	8.36	3.38	639	0.050	3.78	3.2	210.0
11/6/2023	10		9.60	9.29	8.28	1.40	672	0.050	3.71	2.0	99.0
12/18/2023	10		5.00	10.38	8.39	5.97	666	0.050	6.36	4.4	99.0
1/9/2024	10		2.70	11.18	8.43	11.89	661	0.050	4.38	11.6	93.0
2/13/2023	11		4.51	11.38	8.99	2.1	823.6	0.086	3.10	10.8	1140
3/7/2023	11		6.74	11.33	8.18	52.3	541.2	0.294	1.70	72.4	1670
4/11/2023	11		13.56	9.41	8.99	0.9	777.4	0.05	0.60	8.4	140
5/16/2023	11		14.20	8.53	7.92	12.50	721	0.05	0.98	4	610.0
6/13/2023	11		13.00	8.16	7.99	20.70	899	0.05	1.45	8.4	388.0
7/11/2023	11		19.50	7.14	7.87	16.17	969	0.234	2.06	6.4	620.0
8/22/2023	11		19.60	7.35	8.03	4.97	918	0.05	2.53	6.8	816.0
9/12/2023	11		17.10	7.34	7.97	6.18	610	0.05	2.46	6	461.0
10/17/2023	11		10.80	8.50	8.03	2.40	916	0.150	5.01	3.2	261.0
11/6/2023	11		10.10	9.35	8.14	3.92	928	0.050	4.88	1.6	40.0
12/18/2023	11		5.16	10.80	8.18	5.43	908	0.050	10.13	3.6	64.0
1/9/2024	11		3.10	11.40	8.21	11.04	1183	0.058	23.44	9.6	110.0
2/13/2023	12		6.4	10.43	8.9	6.1	731.5	0.068	1.30	11.6	250
3/7/2023	12		5.41	11.49	8.68	22.6	541.2	0.337	2.10	33.2	1120
4/11/2023	12		13.65	9.62	8.6	1.1	459.6	0.05	3.40	2.4	250
5/16/2023	12		13.50	8.22	8.06	13.39	632	0.05	2.12	7.6	680.0

Date	SITE	Subshed	Temp (C)	DO	pH	TURB	Conductivity	Phos.	Nitrate	TSS	E.coli (MPN)
6/13/2023	12		14.20	8.49	8.14	10.97	744	0.05	3.46	4.4	510.0
7/11/2023	12		18.80	7.59	8.11	11.11	738	0.05	3.30	6.8	1330.0
8/22/2023	12		18.30	7.88	8.11	2.57	735	0.085	4.69	5.6	1050.0
9/12/2023	12		16.80	8.23	8.04	7.26	687	0.050	5.45	4.4	2420.0
10/17/2023	12		11.30	8.73	8.15	2.44	747	0.050	5.42	2.0	276.0
11/6/2023	12		10.70	9.21	8.16	1.87	760	0.050	5.29	1.6	52.0
12/18/2023	12		6.20	10.96	8.32	4.39	756	0.050	11.39	6.0	105.0
1/9/2024	12		4.10	10.96	8.31	13.13	756	0.050	22.61	10.8	276.0
2/13/2023	13		4.86	11.3	8.95	1.5	728.2	0.055	2.40	12.8	160
3/7/2023	13		7.84	10.75	8.71	21.2	534.6	0.322	1.10	35.6	930
4/11/2023	13		11.06	10.44	8.09	3.4	741.3	0.05	2.90	1.6	410
5/16/2023	13		13.60	8.30	8.05	13.35	445	0.05	1.20	6	2490.0
6/13/2023	13		13.90	8.41	8.20	12.39	749	0.05	3.54	4.4	360.0
7/11/2023	13		19.60	7.28	8.16	12.97	736	0.05	2.99	2	650.0
8/22/2023	13		19.20	7.88	8.21	7.91	729	0.05	9.76	7.2	1990.0
9/12/2023	13		16.60	8.12	8.11	11.35	628	0.050	3.95	12.8	866.0
10/17/2023	13		11.20	9.42	8.31	4.19	758	0.050	5.65	2.4	131.0
11/6/2023	13		10.50	9.30	8.31	1.19	764	0.050	5.05	1.6	70.0
12/18/2023	13		5.90	11.01	8.41	2.08	752	0.050	11.28	4.4	81.0
1/9/2024	13		3.4	11.33	8.35	22.1	1033	0.05	20.67	15.6	179
2/13/2023	14		12.31	9.62	8.53	1.71	677.3	0.094	1.40	24.8	140
3/7/2023	14		5.77	10.88	8.88	9.5	715	0.171	3.90	37.6	1350
4/11/2023	14		13.05	9.71	8.17	4.7	652.3	0.05	2.20	10.8	200
5/16/2023	14		16.60	7.74	8.09	12.80	556	0.05	1.11	8	600.0
6/13/2023	14		16.40	7.79	8.20	11.47	714	0.05	1.85	6.4	200.0
7/11/2023	14		22.10	6.86	8.23	9.71	697	0.054	2.51	2.4	800.0
8/22/2023	14		21.80	6.92	8.19	8.71	675	0.271	4.04	10.8	101.0
9/12/2023	14		18.20	7.39	8.21	1.44	734	0.050	4.91	5.2	435.0
10/17/2023	14		11.30	9.19	8.30	2.68	717	0.050	4.43	5.6	111.0
11/6/2023	14		9.70	9.59	8.35	1.32	747	0.050	5.66	4.0	41.0
12/18/2023	14		5.10	11.13	8.39	0.12	741	0.100	13.62	5.2	75.0
1/9/2024	14		3.01	10.82	8.45	23.80	802	0.050	22.57	14.4	387.0
2/13/2023	15		6.29	10.88	8.65	3.7	818	0.137	3.20	7.2	1220
3/7/2023	15		5.77	11.62	8.56	13.4	623.6	0.14	1.30	26	7220
4.11/2023	15		10.57	10.38	8.34	1	895.2	0.05	4.20	2	4000
5/16/2023	15		13.40	6.48	7.87	5.37	804	0.085	5.37	4	230.0
6/13/2023	15		14.70	5.28	7.78	4.65	1054	0.313	14.65	2	280.0
7/11/2023	15		19.50	5.34	7.81	10.44	1086	0.305	18.31	2.8	680.0
8/22/2023	15		20.80	6.08	7.96	7.33	1160	0.053	32.68	12.4	219.0
9/12/2023	15		18.50	7.71	7.99	3.25	1013	0.241	43.09	25.2	2420.0
10/17/2023	15		11.60	8.38	8.04	1.50	775	0.115	19.04	2.8	88.0
11/6/2023	15		10.01	9.02	8.11	2.08	1164	0.162	32.11	1.2	313.0
12/18/2023	15		4.90	11.55	8.08	1.66	1017	0.050	44.02	2.8	365.0
1/9/2024	15		4.40	11.21	8.15	117.80	1313	0.323	53.29	114.4	1120.0
2/13/2023	16		8.56	9.71	8.82	0.7	742	0.08	1.00	20.4	110
3/7/2023	16		7.18	11.11	8.61	23.4	530.2	0.347	1.20	31.2	1210
4/11/2023	16		15.11	8.69	8.92	0.6	708.6	0.05	2.20	4.4	40
5/16/2023	16		12.60	8.42	7.91	23.40	621	0.05	2.11	31.2	480.0
6/13/2023	16		13.20	8.37	7.90	9.28	760	0.05	3.11	6.4	760.0
7/11/2023	16		16.40	6.35	7.76	11.21	769	0.05	2.20	4.8	1040.0
8/22/2023	16		17.40	6.91	7.84	6.02	777	0.05	4.27	3.2	411.0
9/12/2023	16		16.90	6.32	7.81	1.96	664	0.050	4.24	12.4	2420.0
10/17/2023	16										inaccessible
11/6/2023	16		10.70	11.21	8.35	4.77	798	0.050	8.90	1.2	28.0
12/18/2023	16		4.90	11.02	8.29	8.31	796	0.050	7.69	3.6	135.0
1/9/2024	16		2.70	11.29	8.36	153.60	1250	0.139	32.56	106.8	210.0
2/13/2023	17		12.25	9.42	8.66	1.50	723	0.05	5.20	64	70.0
3/7/2023	17		5.27	10.56	8.63	2.70	665.1	0.05	0.80	14	40.0
4/11/2023	17		12.03	10.17	8.05	0.90	779	0.05	1.20	2	40.0
5/16/2023	17		14.10	8.07	8.01	9.48	438	0.05	1.21	4.8	640.0
6/13/2023	17		15.10	8.37	7.22	19.78	644	0.05	0.93	18.8	260.0
7/11/2023	17		20.80	7.11	8.11	18.52	576	0.05	1.29	27.2	900.0
8/22/2023	17		21.10	6.89	8.09	7.10	613	0.05	1.66	4.4	866.0
9/12/2023	17		18.10	7.45	8.13	3.17	552	0.05	1.86	13.2	921.0
10/17/2023	17		11.00	9.01	8.24	2.60	652	0.05	1.29	7.2	167.0
11/6/2023	17		10.70	8.95	8.28	2.21	684	0.05	1.66	2.4	68.0
12/18/2023	17		3.40	10.98	8.30	1.04	711	0.05	3.10	3.6	42.0
1/9/2024	17		1	11.47	8.38	14.02	667	0.05	7.26	18.4	40.0

Date	SITE	Subshed	Temp (C)	DO	pH	TURB	Conductivity	Phos.	Nitrate	TSS	E.coli (MPN)
2/13/2023	18		8.32	10.72	8.61	1.50	664.2	0.05	0.70	3.2	680.0
3/7/2023	18		7.79	10.32	8.86	27.60	413.9	0.107	6.10	18.4	18.0
4/11/2023	18		13.82	9.49	8.62	1.20	422	0.05	0.80	30.4	1850.0
5/16/2023	18		12.60	9.13	8.22	7.66	585	0.05	3.11	2.8	9610.0
6/13/2023	18										dry
7/11/2023	18										dry
8/22/2023	18										dry
9/12/2023	18										dry
10/17/2023	18										dry
11/6/2023	18										dry
12/18/2023	18										dry

Appendix 2B: Macroinvertebrate & Habitat Data

			1	2	3	4	5	6	7	8	9	10
Ephemeroptera	Baetidae	Baetis flavistriga						2		1		
		B. intercalaris		6				1		1	16	
		B. pygmaeus				5	25					
		B. propinquus								1		
		Callibaetis sp.	1									10
		Heterocloeon sp.					2	12		2	3	
		Pseudocloeon sp.										
	Caenidae	Caenis sp.									1	
	Ephemerellidae	Serratella sp.										
	Heptageniidae	Stenacron interpuctatum									2	
		Stenonema mediopunctatum								1		
		S. vicarium										
		Heptagenia sp.										
	Leptohyphidae	Tricorythodes sp.			1							
Trichoptera	Brachycentridae	Brachycentrus sp.					1					
	Hydropsychidae	Cheumatopsyche sp.		70						4	4	
		Ceratopsyche bifida				2		3		6	2	
		C. sparna										
		Hydropsyche betteni			1					1		
	Hydroptilidae	Hydroptila sp.										
		Ochrotrichia sp.										
	Lepidostomatidae	Lepidostoma sp.		2								
	Phryganeidae	Bankisola sp.			4							
Coleoptera	Elmidae	Ancyronyx variegatus									5	
		Dubiraphia sp.										
		Macronychus glabratus			1			1		8		
		Optioservus fastiditus										
		Stenelmis sp.			5					11		
	Gyrinidae	Gyrinus sp.				1						
	Haliplidae	Pelodytes sp.										
	Helodidiae					1					1	
	Hydrophilidae											
		Berosus sp.										
Odonata	Aeshnidae	Boyeria sp.				1	2			1		1
	Calopterygidae	Calopteryx sp.				3		8		32		
		Hetaerina sp.										
	Coenagrionidae	Argia sp.								2		
		Ischnura sp.	25		3	27	35	3	85	4		27
	Corduliidae	Tetragoneuria sp.		1								
	Gomphidae	Dromogomphus sp.								2		
		Hagenius brevistylus								1		

			1	2	3	4	5	6	7	8	9	10
	Libellulidae	Sympetrum sp.	2									
Hemiptera	Belostomatidae	Belostoma sp.				2						1
	Corixidae						2					5
	Veliidae			1		1						1
Lepidoptera	Pyralidae	Paragyractis sp.	1			3	2			1		
Megaloptera	Corydalidae	Corydalus cornutus										
Diptera	Culicidae					1						
	Ephyridae			1								
	Simuliidae	Simulium sp.		1				5		3		
	Tabanidae					1						
	Chironomidae											
		Ablabesmyia mallochi								2		
		A. parajanta			8	1						
		Labrundinia sp.	2									
		Natarsia sp.										
		Pentaneura sp.	2	1			3	5			2	
		Procladius sp.	1			5		15			2	
		Thienemmannimyia sp.			1	5				3	2	
		Brillia sp.										
		Cricotopus bicinctus						1				
		Coryoneura taris			3							
		Eukiefferiella discoloripes										
		Parametriocnemus lundbeckii										
		Stilocladius sp.										
		Thienemanniella similis										
		T.xena										
		Chironomus sp.						1			6	
		Cryptochironomus fulvus			1					1	2	
		Cryptotendipes sp.										
		Dicrotendipes sp.			1							
		Endochironomus nigricans	1								8	
		Microtendipes sp.								2		
		Paratendipes sp.			3						6	
		Phaenopsectra sp.			4							
		Polypedilum convictum	2			2		3		1	14	
		Polypedilum sp.								1		
		Stictochironomus sp.			1							
		Micropsectra sp.								2		
		Paratanytarsus sp.	2									5
		Rheotanytarsus sp.			1	5	2				2	
		Tanytarsus sp.	1		11			1			4	

			1	2	3	4	5	6	7	8	9	10
Decapoda												
Amphipoda		Gammarus sp.		15	49	33	19	37		6	13	50
		Hyalella azteca	56						7			
Isopoda		Caecidotea sp.						2			5	
		Lirceus sp.										
Platyheminthes	Turbellaria	Dugesia sp.					1					
Annelida	Hirudinea					1			1			
	Oligochaeta						2		3			
Mollusca	Physidae						2					
	Planorbidae		3		1		2		1			
	Hydrobiidae		1						1			
	Pleuroceridae								1			
	Sphaeriidae			2	1				1			
Total			102	104	106	108	110	112	114	116	118	120

Metrics values										
Number of Taxa	16	12	21	21	16	18	10	28	22	10
Number of Individuals	>258	>258	>258	>258	>258	>258	>258	>258	>258	>258
Number of EPT Taxa	1	2	2	2	3	4	0	8	6	1
% Orthocladinae + Tanytarsini of chironomids	27.27273	0	44.11765	27.77778	40	7.692308	0	16.66667	12.5	100
%non-insects minus Decapoda	60	17	51	34	26	39	15	6	18	50
Number of diptera taxa	7	3	10	7	2	7	0	8	10	1
% Intolerant	0	2	0	1	5	12	0	5	3	1
% Tolerant	84	0	14	35	39	21	97	7	23	27
% Predators	32	3	13	48	43	31	86	48	8	35
% Shredders + Scrapers	8	3	14	5	8	16	3	17	27	0
% Collectors-Filterers	3	73	14	7	3	9	1	18	12	5
% Sprawlers	9	1	10	11	3	20	0	7	9	5
Metrics scoring										
Number of Taxa	1	1	1	1	1	1	1	3	1	1
Number of Individuals	5	5	5	5	5	5	5	5	5	5
Number of EPT Taxa	1	1	1	1	1	1	1	3	3	1
% Orthocladinae + Tanytarsini of chironomids	3	5	3	3	3	5	5	5	5	1
%non-insects minus Decapoda	1	5	1	3	3	1	6	6	3	1
Number of diptera taxa	3	1	3	3	1	3	1	3	3	1
% Intolerant	1	1	1	1	1	1	1	1	1	1
% Tolerant	1	5	3	1	1	3	1	5	3	1
% Predators	3	1	1	5	5	3	5	5	1	3
% Shredders + Scrapers	1	1	3	1	1	3	1	3	5	1
% Collectors-Filterers	5	1	3	5	5	5	5	3	3	5
% Sprawlers	5	1	5	5	3	5	1	5	5	3
Total	30	28	30	34	30	36	33	47	38	24

			11	12	13	14	15	16	17
Ephemeroptera	Baetidae	Baetis flavistriga	4	20	1	2			
		B. intercalaris			1	11			
		B. pygmaeus							
		B. propinquus							
		Callibaetis sp.							
		Heterocloeon sp.				8			
		Pseudocloeon sp.				3			
	Caenidae	Caenis sp.							
	Ephemerellidae	Serratella sp.				3			
	Heptageniidae	Stenacron interpuctatum			2				
		Stenonema mediopunctatum							
		S. vicarium				2			
		Heptagenia sp.				2			
	Leptohyphidae	Tricorythodes sp.				13			
Trichoptera	Brachycentridae	Brachycentrus sp.							
	Hydropsychidae	Cheumatopsyche sp.	13	2		13	2		4
		Ceratopsyche bifida	18		6	2			
		C. sparna	11			1			1
		Hydropsyche betteni	4	1					
	Hydroptilidae	Hydroptila sp.				1			
		Ochrotrichia sp.		1					
	Lepidostomatidae	Lepidostoma sp.							
	Phryganeidae	Bankisola sp.							
Coleoptera	Elmidae	Ancyronyx variegatus							
		Dubiraphia sp.							8
		Macronychus glabratus							2
		Optioservus fastiditus	6	1	3				
		Stenelmis sp.	6		2	5			
	Gyrinidae	Gyrinus sp.							
	Haliplidae	Pelodytes sp.						10	
	Helodidiae								
	Hydrophilidae							1	
		Berosus sp.				2			1
Odonata	Aeshnidae	Boyeria sp.						1	
	Calopterygidae	Calopteryx sp.			4				12
		Hetaerina sp.				1	1		
	Coenagrionidae	Argia sp.							2
		Ischnura sp.		7		3	18	6	7
	Corduliidae	Tetragoneuria sp.							
	Gomphidae	Dromogomphus sp.							
		Hagenius brevistylus							

			11	12	13	14	15	16	17
	Libellulidae	Sympetrum sp.							
Hemiptera	Belostomatidae	Belostoma sp.						1	
	Corixidae							1	
	Veliidae								
Lepidoptera	Pyralidae	Paragyractis sp.							
Megaloptera	Corydalidae	Corydalus cornutus							1
Diptera	Culicidae								
	Ephyridae								
	Simuliidae	Simulium sp.	1		1	1			
	Tabanidae								
	Chironomidae								
		Ablabesmyia mallochi							
		A. parajanta							
		Labrundinia sp.							
		Natarsia sp.							5
		Pentaneura sp.							
		Procladius sp.		2					
		Thienemmannimyia sp.	1	16	2		6		5
		Brillia sp.						1	
		Cricotopus bicinctus	1		1	1		3	
		Coryoneura taris						1	
		Eukiefferiella discoloripes				3			
		Parametriocnemus lundbeckii	1						
		Stilocladius sp.			1				
		Thienemanniella similis					1		
		T.xena							1
		Chironomus sp.		16				1	
		Cryptochironomus fulvus		2					
		Cryptotendipes sp.							10
		Dicrotendipes sp.			1				
		Endochironomus nigricans			3			2	
		Microtendipes sp.	2	5	1		6		
		Paratendipes sp.		9	1		2	1	
		Phaenopsectra sp.							
		Polypedilum convictum	3	7	3	1	8		3
		Polypedilum sp.							
		Stictochironomus sp.					10	9	1
		Micropsectra sp.							
		Paratanytarsus sp.							
		Rheotanytarsus sp.					4		3
		Tanytarsus sp.			9				5

			11	**12**	**13**	**14**	**15**	**16**	**17**
Decapoda							1	8	
Amphipoda		Gammarus sp.	28		44	20		24	14
		Hyalella azteca					26		
Isopoda		Caecidotea sp.	1	10	14	1	2	5	
		Lirceus sp.						2	
Platyheminthes	Turbellaria	Dugesia sp.		1			4		
Annelida	Hirudinea								1
	Oligochaeta					1	1	1	1
Mollusca	Physidae							16	6
	Planorbidae							3	2
	Hydrobiidae								
	Pleuroceridae								
	Sphaeriidae						8	3	5
Total			122	124	126	128	130	132	134

Metrics values							
Number of Taxa	17	17	21	25	18	23	25
Number of Individuals	>258	>258	>258	>258	>258	100	>258
Number of EPT Taxa	5	4	4	12	1	0	2
% Orthocladinae + Tanytarsini of chironomids	25	0	50	80	13.51351	27.77778	27.27273
%non-insects minus Decapoda	29	11	58	22	41	54	29
Number of diptera taxa	6	7	10	4	7	7	8
% Intolerant	0	0	1	13	0	1	0
% Tolerant	1	37	18	5	57	42	21
% Predators	1	28	6	4	29	9	33
% Shredders + Scrapers	16	9	14	20	8	35	11
% Collectors-Filterers	49	8	17	17	20	3	18
% Sprawlers	2	20	2	0	6	0	10
Metrics scoring							
Number of Taxa	1	1	1	3	1	3	3
Number of Individuals	5	5	5	5	5	1	5
Number of EPT Taxa	3	3	3	5	1	1	3
% Orthocladinae + Tanytarsini of chironomids	3	5	1	1	5	3	3
%non-insects minus Decapoda	3	5	1	3	1	1	3
Number of diptera taxa	1	3	3	1	3	3	3
% Intolerant	1	1	1	1	1	1	1
% Tolerant	5	1	3	5	1	1	3
% Predators	1	3	1	1	3	1	3
% Shredders + Scrapers	3	1	3	5	1	5	3
% Collectors-Filterers	1	5	3	3	1	5	3
% Sprawlers	1	5	1	1	5	1	5
Total	28	38	26	34	28	26	38

Appendix 2C: Qualitative Habitat Evaluation Index Data

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 32

Stream & Location: Lower Elkhart Site 1 **RM:** ___ **Date:** 9/03/23

Scorers Full Name & Affiliation: RR Gosford

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE (Run)
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]	10	10
☐☐ COBBLE [8]			☑☐ MUCK [2]	30	30
☐☐ GRAVEL [7]			☐☑ SILT [2]	30	30
☐☐ SAND [6]	30	30	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (4)

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate: Ø — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
3 AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☑ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 8 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY: ☐ HIGH [4] ☐ MODERATE [3] ☐ LOW [2] ☐ NONE [1]

DEVELOPMENT: ☐ EXCELLENT [7] ☐ GOOD [5] ☐ FAIR [3] ☑ POOR [1]

CHANNELIZATION: ☐ NONE [6] ☑ RECOVERED [4] ☐ RECOVERING [3] ☐ RECENT OR NO RECOVERY [1]

STABILITY: ☐ HIGH [3] ☑ MODERATE [2] — macrophytes ☐ LOW [1]

Comments

Channel: 7 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION: ☑☑ NONE / LITTLE [3] ☐☐ MODERATE [2] ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH: ☐☑ WIDE > 50m [4] ☐☐ MODERATE 10-50m [3] ☐☐ NARROW 5-10m [2] ☑☐ VERY NARROW < 5m [1] ☐☐ NONE [0] — (2.5)

FLOOD PLAIN QUALITY: ☐☐ FOREST, SWAMP [3] ☐☑ SHRUB OR OLD FIELD [2] ☑☐ RESIDENTIAL, PARK, NEW FIELD [1] ☐☐ FENCED PASTURE [1] ☐☐ OPEN PASTURE, ROWCROP [0] ☐☐ CONSERVATION TILLAGE [1] ☐☐ URBAN OR INDUSTRIAL [0] ☐☐ MINING / CONSTRUCTION [0] — (1.5)

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 6 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!): ☑ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE (Run) WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential — Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current: 9 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run: Ø — Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

☑ VERY LOW - LOW [2-4] (2) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___ %RUN: ___ %RIFFLE: ___

Gradient: 2 — Maximum 10

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 39.5

Stream & Location: Lower Elkhart Site 2 **RM:** __.__ **Date:** 9/ 09 /23

Scorers Full Name & Affiliation: R R Goforth

River Code: ___-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]	5	
☐☐ COBBLE [8]	5	5	☐☐ MUCK [2]		
☐☑ GRAVEL [7]	10	20	☐☐ SILT [2]	5	3
☐☑ SAND [6]	75	75	☐☐ ARTIFICIAL [0]	52	52
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 13

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ NONE [1]

Substrate 14 Maximum 20

2] INSTREAM COVER

Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 1 BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- ___ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☑ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 5

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☐ MODERATE [3]
- ☐ LOW [2]
- ☑ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☐ GOOD [5]
- ☐ FAIR [3]
- ☑ POOR [1]

CHANNELIZATION
- ☑ NONE [6]
- ☐ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☐ HIGH [3]
- ☑ MODERATE [2]
- ☐ LOW [1]

Comments

Channel Maximum 20: 10

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION
- ☐☑ NONE / LITTLE [3]
- ☑☑ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH
- ☐☐ WIDE > 50m [4]
- ☑☑ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☐ VERY NARROW < 5m [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY
- ☐☐ FOREST, SWAMP [3]
- ☐☑ SHRUB OR OLD FIELD [2]
- ☑☑ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments 1.5 3

Riparian Maximum 10: 5.5

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☑ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☑ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT

GRADIENT (ft/mi) ☑ VERY LOW - LOW [2-4] 2

DRAINAGE AREA (mi²) ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___

%RUN: ___ %RIFFLE: ___

Gradient Maximum 10: 2

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 29

Stream & Location: Lower Elkhart Site 3 **RM:** ___ **Date:** 04/03/23

Scorers Full Name & Affiliation: RR Goforth

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☑ MUCK [2]	10	
☐☑ GRAVEL [7]	5	50	☑☐ SILT [2]	50	
☑☐ SAND [6]	40	40	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 9

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT:
- ☑ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS:
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate: 6 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]	___ POOLS > 70cm [2]	___ OXBOWS, BACKWATERS [1]
1 OVERHANGING VEGETATION [1]	___ ROOTWADS [1]	1 AQUATIC MACROPHYTES [1]
1 SHALLOWS (IN SLOW WATER) [1]	___ BOULDERS [1]	1 LOGS OR WOODY DEBRIS [1]
___ ROOTMATS [1]		

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☑ NEARLY ABSENT <5% [1]

Comments

Cover: 5 Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 9 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☑☐ WIDE > 50m [4]	☐☑ FOREST, SWAMP [3]	☐☑ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☑☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments 2 2.5 1.5

Riparian: 6 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☑ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 1 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☑ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run: Ø Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4] 2
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 2 Maximum 10

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 33.5

Stream & Location: Lower Elkhart Site 4 **RM:** ___._ **Date:** 09/03/23

Scorers Full Name & Affiliation: RR Goforth

River Code: ___-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE (Run)
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]	10	10
☑☑ GRAVEL [7]			☐☐ SILT [2]	20	20
☑☑ SAND [6]	70	70	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (12)

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate: 9 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ✓ UNDERCUT BANKS [1]
- ✓ OVERHANGING VEGETATION [1]
- ✓ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- 2 AQUATIC MACROPHYTES [1]
- ___ LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 7 Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 6 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☐ MODERATE [2]	☐☑ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☑☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☑☑ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments (1.5) (1)

Riparian: 4.5 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☑ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☐ POOL WIDTH = RIFFLE WIDTH [1] ☑ POOL WIDTH < RIFFLE WIDTH [0] (Run)

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

☑ VERY LOW - LOW [2-4] 3
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 3 Maximum 10

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 32

Stream & Location: Lower Elkhart Site 5 **RM:** ___ . ___ **Date:** 09/03/23

River Code: ___-___-___ **STORET #:** ______ **Scorers Full Name & Affiliation:** RR Goforth

Lat./ Long.: (NAD 83 - decimal °) ___ . ____ /8___ . ____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

Check ONE (Or 2 & average)

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE (Run)	ORIGIN	QUALITY
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]			☐ LIMESTONE [1]	☑ HEAVY [-2]
☐☐ BOULDER [9]			☐☐ DETRITUS [3]			☑ TILLS [1]	☐ MODERATE [-1]
☐☐ COBBLE [8]			☑☑ MUCK [2]	50	50	☐ WETLANDS [0]	☐ NORMAL [0]
☐☐ GRAVEL [7]			☑☑ SILT [2]	50	50	☐ HARDPAN [0]	☐ FREE [1]
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]			☐ SANDSTONE [0]	☑ EXTENSIVE [-2]
☐☐ BEDROCK [5]						☐ RIP/RAP [0]	☐ MODERATE [-1]
						☐ LACUSTURINE [0]	☐ NORMAL [0]
						☐ SHALE [-1]	☐ NONE [1]
						☐ COAL FINES [-2]	

SILT (rows FREE – EXTENSIVE); EMBEDDEDNESS (rows EXTENSIVE – NONE)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

(Score natural substrates; ignore sludge from point-sources)

Comments 4

Substrate Maximum 20: 0

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
2 OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
3 AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☑ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 9

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☑ RECOVERED [4]	☑ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments Macrophytes likely provide a lot of stability for fine seds.

Channel Maximum 20: 8

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☑☑ NONE [0]	☑☑ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments 2

Riparian Maximum 10: 2

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☑ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☑ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH < RIFFLE WIDTH [0]
Run

CURRENT VELOCITY Check ALL that apply
☐ TORRENTIAL [-1] ☑ SLOW [1]
☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
☑ FAST [1] ☐ INTERMITTENT [-2]
☑ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 10

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT (ft/mi)
☑ VERY LOW - LOW [2-4] 3
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient Maximum 10: 3

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: (38)

Stream & Location: Lower Elkhart Site 6 **RM:** ___ **Date:** 01/03/23

Scorers Full Name & Affiliation: ______

River Code: __-__-__ **STORET #:** ______ **Lat./Long.: (NAD 83 - decimal °)** __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL Run	RIFFLE	OTHER TYPES	POOL Run	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]	5	5
☐☑ GRAVEL [7]	5	5	☐☐ SILT [2]	5	5
☐☑ SAND [6]	80	80	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (13)

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☑ HEAVY [-2]
- ☑ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate Maximum 20: (10)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 UNDERCUT BANKS [1]
- 2 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- 1 POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- 2 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: (10)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: (6)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☑ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☑☑ NONE [0]	☑☑ OPEN PASTURE, ROWCROP [0]	

Comments

Riparian Maximum 10: (2)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☑ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

Ø

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☑ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: (7)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: (Ø)

6] GRADIENT (ft/mi)
- ☑ VERY LOW - LOW [2-4] (3)
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient Maximum 10: (3)

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 20

Stream & Location: Lower Elkhart Site 7 **RM:** ___.__ **Date:** 01/03/23

Scorers Full Name & Affiliation: ____________________

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES (POOL RIFFLE) Run		OTHER TYPES (POOL RIFFLE) Run		ORIGIN (Check ONE (Or 2 & average))	QUALITY
☐☐ BLDR /SLABS [10]		☐☐ HARDPAN [4]		☐ LIMESTONE [1]	☑ HEAVY [-2] (SILT)
☐☐ BOULDER [9]		☐☐ DETRITUS [3]		☑ TILLS [1]	☐ MODERATE [-1]
☐☐ COBBLE [8]		☐☐ MUCK [2]	25	☐ WETLANDS [0]	☐ NORMAL [0]
☐☑ GRAVEL [7]		☐☐ SILT [2]	25	☐ HARDPAN [0]	☐ FREE [1]
☑☑ SAND [6]	50	☐☐ ARTIFICIAL [0]		☐ SANDSTONE [0]	☑ EXTENSIVE [-2] (EMBEDDEDNESS)
☐☐ BEDROCK [5]		(Score natural substrates; ignore sludge from point-sources)		☐ RIP/RAP [0]	☐ MODERATE [-1]
				☐ LACUSTURINE [0]	☐ NORMAL [0]
				☐ SHALE [-1]	☐ NONE [1]
				☐ COAL FINES [-2]	

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 13

Substrate 3 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]	___ POOLS > 70cm [2]	___ OXBOWS, BACKWATERS [1]
1 OVERHANGING VEGETATION [1]	___ ROOTWADS [1]	2 AQUATIC MACROPHYTES [1]
___ SHALLOWS (IN SLOW WATER) [1]	___ BOULDERS [1]	___ LOGS OR WOODY DEBRIS [1]
___ ROOTMATS [1]		

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☑ NEARLY ABSENT <5% [1]

Comments

Cover 3 Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☑ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel 6 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☑ FENCED PASTURE [1]	
	☑☑ NONE [0]	☐☑ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian 2 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH (Check ONE (ONLY!))	CHANNEL WIDTH (Check ONE (Or 2 & average))	CURRENT VELOCITY (Check ALL that apply)	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☐ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☑ 0.4-<0.7m [2]	☐ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]	All run ∅	☑ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 4 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run ∅ Maximum 8

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)

- ☑ VERY LOW - LOW [2-4] 2
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient 2 Maximum 10

EPA 4520 06/16/06

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 34

Stream & Location: Lower Elkhart Site 8 **RM:** ___ **Date:** 9/03/23

Scorers Full Name & Affiliation: R R Goforth

River Code: ___-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE (Run)
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]	5	5
☐☐ GRAVEL [7]	10	10	☐☐ SILT [2]	10	10
☑☑ SAND [6]	75	75	☐☐ ARTIFICIAL [0]	212	212
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments: 12

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☑ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate: 9 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- 1 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☑ NEARLY ABSENT <5% [1]

Comments

Cover: 6 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 9 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☑ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☑☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☑☑ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments: 1.5 2.5

Riparian: 4 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☑ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 3 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average).

☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☑ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: Ø — Maximum 8

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)
- ☐ VERY LOW - LOW [2-4] 3
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 3 — Maximum 10

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 42.5

Stream & Location: Lower Elkhart 9 **RM:** ___ **Date:** 09 02 13

Scorers Full Name & Affiliation: R R Goforth

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL (Run)	RIFFLE	OTHER TYPES	POOL (Run)	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]	10	
☐☐ COBBLE [8]			☐☐ MUCK [2]	20	
☐☐ GRAVEL [7]			☐☑ SILT [2]	40	10
☐☑ SAND [6]	10	90	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (8)

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate: 5 — Maximum 20

2] INSTREAM COVER

Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 UNDERCUT BANKS [1]
1 OVERHANGING VEGETATION [1]
1 SHALLOWS (IN SLOW WATER) [1]
Ø ROOTMATS [1]
1 POOLS > 70cm [2]
1 ROOTWADS [1]
Ø BOULDERS [1]
Ø OXBOWS, BACKWATERS [1]
3 AQUATIC MACROPHYTES [1]
2 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 11 — Maximum 20

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☑ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 11 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☑☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☑☑ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☑ OPEN PASTURE, ROWCROP [0]	
	3	1.5	

Comments

Riparian: 6.5 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)	CHANNEL WIDTH Check ONE (Or 2 & average)	CURRENT VELOCITY Check ALL that apply	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☑ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☑ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]		☑ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential — Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current: 6 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: Ø — Maximum 8

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4] 3
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient: 3 — Maximum 10

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** **QHEI Score:** 47.25

Stream & Location: Lower Elk River Site 10 **RM:** ___.___ **Date:** 07/02/23

Scorers Full Name & Affiliation: ____________

River Code: ___-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.______ /8_.______ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present. Check ONE (Or 2 & average)

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE	ORIGIN	QUALITY
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]			☐ LIMESTONE [1]	☐ HEAVY [-2]
☐☐ BOULDER [9]			☐☐ DETRITUS [3]			☑ TILLS [1]	☑ MODERATE [-1] (SILT)
☐☐ COBBLE [8]			☐☐ MUCK [2]	15	15	☐ WETLANDS [0]	☐ NORMAL [0]
☐☑ GRAVEL [7]			☐☐ SILT [2]	15	15	☐ HARDPAN [0]	☐ FREE [1]
☑☑ SAND [6]	70	70	☐☐ ARTIFICIAL [0]			☐ SANDSTONE [0]	☑ EXTENSIVE [-2] (EMBEDDEDNESS)
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)			☐ RIP/RAP [0]	☐ MODERATE [-1]
						☐ LACUSTURINE [0]	☐ NORMAL [0]
						☐ SHALE [-1]	☐ NONE [1]
						☐ COAL FINES [-2]	

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 12

Substrate 10 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 0 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 1 POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 0 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 2 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover 9 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☑ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel 12 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☑☑ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☑☑ MODERATE 10-50m [3]	☐☑ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☑☑ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☑ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☑☐ OPEN PASTURE, ROWCROP [0]	

Comments 2.5 0.75

Riparian 6.25 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH (Check ONE (ONLY!))	CHANNEL WIDTH (Check ONE (Or 2 & average))	CURRENT VELOCITY (Check ALL that apply)	
☑ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☐ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☑ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]		☑ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 8 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run 0 — Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4] 2
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient 2 — Maximum 10

EPA 4520 06/16/06

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 58

Stream & Location: Lower Elkhart Site 11 **RM:** ___ **Date:** 8/1/23

Scorers Full Name & Affiliation: RR Goforth

River Code: __-__-__ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]	15	
☐☐ COBBLE [8]		5	☐☐ MUCK [2]	10	
☐☑ GRAVEL [7]		70	☐☐ SILT [2]	25	5
☑☐ SAND [6]	50	20	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 13

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate 9 Maximum 20

2] INSTREAM COVER

Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 3 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 2 POOLS > 70cm [2]
- 1 ROOTWADS [1]
- 0 BOULDERS [1]
- 1 OXBOWS, BACKWATERS [1]
- 0 AQUATIC MACROPHYTES [1]
- 2 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☑ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover 15 Maximum 20

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☑ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☑ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel 14 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☑ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☑ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☑☑ HEAVY / SEVERE [1]	☑☐ NARROW 5-10m [2]	☑☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments 1 2 2.5

Riparian 5.5 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☑ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☐ POOL WIDTH = RIFFLE WIDTH [1] ☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☑ VERY FAST [1] ☑ FAST [1] ☑ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 9 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☑ BEST AREAS > 10cm [2] ☑ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☑ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☑ MOD. STABLE (e.g., Large Gravel) [1] ☑ UNSTABLE (e.g., Fine Gravel, Sand) [0] 0.5

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☑ EXTENSIVE [-1]

Comments

Riffle / Run 2.5 Maximum 8

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

☑ VERY LOW - LOW [2-4] 3
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient 3 Maximum 10

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 33

Stream & Location: Lower Elkhart Site 12 **RM:** ___.___ **Date:** 09/02/23

Scorers Full Name & Affiliation: R R Goforth

River Code: ___-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☑ GRAVEL [7]	5	5	☐☐ SILT [2]	10	10
☑☑ SAND [6]	80	80	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 12

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate 9 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 UNDERCUT BANKS [1]
2 OVERHANGING VEGETATION [1]
0 SHALLOWS (IN SLOW WATER) [1]
0 ROOTMATS [1]
2 POOLS > 70cm [2]
0 ROOTWADS [1]
0 BOULDERS [1]
1 OXBOWS, BACKWATERS [1]
2 AQUATIC MACROPHYTES [1]
0 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☑ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 6

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY: ☐ HIGH [4] ☐ MODERATE [3] ☑ LOW [2] ☐ NONE [1]

DEVELOPMENT: ☐ EXCELLENT [7] ☐ GOOD [5] ☐ FAIR [3] ☑ POOR [1]

CHANNELIZATION: ☐ NONE [6] ☑ RECOVERED [4] ☑ RECOVERING [3] ☐ RECENT OR NO RECOVERY [1]

STABILITY: ☐ HIGH [3] ☐ MODERATE [2] ☑ LOW [1]

Comments

Channel Maximum 20: 8

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION: ☐☑ NONE / LITTLE [3] ☑☐ MODERATE [2] ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH: ☐☐ WIDE > 50m [4] ☐☐ MODERATE 10-50m [3] ☐☑ NARROW 5-10m [2] ☑☑ VERY NARROW < 5m [1] ☐☐ NONE [0]

FLOOD PLAIN QUALITY: ☐☐ FOREST, SWAMP [3] ☐☐ SHRUB OR OLD FIELD [2] ☐☐ RESIDENTIAL, PARK, NEW FIELD [1] ☐☐ FENCED PASTURE [1] ☑☑ OPEN PASTURE, ROWCROP [0] ☐☐ CONSERVATION TILLAGE [1] ☐☐ URBAN OR INDUSTRIAL [0] ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian Maximum 10: 3

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☑ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☐ POOL WIDTH = RIFFLE WIDTH [1] ☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☑ FAST [1] ☑ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential: Primary Contact / Secondary Contact (circle one and comment on back)

Comments

Pool / Current Maximum 12: 4

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☑ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 0

6] GRADIENT (ft/mi) ☑ VERY LOW - LOW [2-4] 3 ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ___ %GLIDE: ___ %RUN: ___ %RIFFLE: ___

Gradient Maximum 10: 3

OhioEPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 48.5

Stream & Location: Lower Elkhart Site 13 **RM:** __ . __ **Date:** 8/10/23

Scorers Full Name & Affiliation: R R Goforth

River Code: ___-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __ . ____ /8_ . ____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]	<1?	
☐☐ BOULDER [9]	<12	<12	☐☐ DETRITUS [3]	10	
☐☐ COBBLE [8]		10	☐☐ MUCK [2]		
☐☑ GRAVEL [7]		30	☐☐ SILT [2]	10	10
☑☐ SAND [6]	50	30	☑☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0]

Comments 13

ORIGIN (Check ONE (Or 2 & average)): ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY:
- SILT: ☐ HEAVY [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]
- EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate: 14 — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 UNDERCUT BANKS [1]
- 0 OVERHANGING VEGETATION [1]
- 0 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 0 POOLS > 70cm [2]
- 1 ROOTWADS [1]
- 1 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 0 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT (Check ONE (Or 2 & average)): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☑ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 8 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☑ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 10 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☐☑ WIDE > 50m [4]	☐☑ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☑☐ NARROW 5-10m [2]	☑☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Riparian width: 3 — Flood plain quality: 2.5

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 7.5 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH (Check ONE (ONLY!))	CHANNEL WIDTH (Check ONE (Or 2 & average))	CURRENT VELOCITY (Check ALL that apply)	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☐ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☑ POOL WIDTH < RIFFLE WIDTH [0]	☑ FAST [1]	☐ INTERMITTENT [-2]
☑ 0.2-<0.4m [1]		☑ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		Indicate for reach - pools and riffles.	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☑ BEST AREAS 5-10cm [1]	☑ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☑ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☑ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 2 — Maximum 8

6] GRADIENT (ft/mi)
☑ VERY LOW - LOW [2-4] 3
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient: 3 — Maximum 10

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 56

Stream & Location: Lower Elkhart Site 14 **RM:** ____ **Date:** 07/05/23

Scorers Full Name & Affiliation: R R Goforth

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE (Run)	OTHER TYPES	POOL	RIFFLE (Run)
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]	<1%	<1%	☐☐ DETRITUS [3]		
☐☐ COBBLE [8]	30%	30%	☐☐ MUCK [2]		
☐☑ GRAVEL [7]	30%	30%	☐☐ SILT [2]	5%	5%
☑☐ SAND [6]	20	30%	☐☐ ARTIFICIAL [0]	5%	5%
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0]

Comments 13

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY
SILT: ☐ HEAVY [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]
EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☑ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate Maximum 20: 14

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 0 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 1 POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 1 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 0 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

Comments

AMOUNT Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☑ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Cover Maximum 20: 9

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☑ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☑ MODERATE [2]
☐ LOW [2]	☑ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 14

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)
River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☑ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☑ CONSERVATION TILLAGE [1]
☑☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☐ URBAN OR INDUSTRIAL [0]
☑☑ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☑☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments 1.5

Riparian Maximum 10: 1.5

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
☑ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☐ POOL WIDTH = RIFFLE WIDTH [1]
☑ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
☐ TORRENTIAL [-1] ☑ SLOW [1]
☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
☑ FAST [1] ☐ INTERMITTENT [-2]
☑ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 10

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☑ BEST AREAS > 10cm [2]	☑ MAXIMUM > 50cm [2]	☑ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☑ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☑ MODERATE [0]
		1.5	☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: 5.5

6] GRADIENT (ft/mi)
☑ VERY LOW - LOW [2-4] 2
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient Maximum 10: 2

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 36.5

Stream & Location: Lower Elkhart Site 15 **RM:** ___ **Date:** 09/15/23

Scorers Full Name & Affiliation: R R Goforth

River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]	10		☐☐ MUCK [2]	5	
☐☑ GRAVEL [7]	20	70	☐☐ SILT [2]	5	10
☑☐ SAND [6]	60	20	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (13)

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☑ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate: 9 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 2 UNDERCUT BANKS [1]
- 2 OVERHANGING VEGETATION [1]
- 1 SHALLOWS (IN SLOW WATER) [1]
- 0 ROOTMATS [1]
- 0 POOLS > 70cm [2]
- 0 ROOTWADS [1]
- 0 BOULDERS [1]
- 0 OXBOWS, BACKWATERS [1]
- 1 AQUATIC MACROPHYTES [1]
- 1 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 8 Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☑ RECOVERED [4]	☑ MODERATE [2]
☑ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1] (1.5)
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 8.5 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☑ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☑☐ URBAN OR INDUSTRIAL [0]
☑☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☑☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	Indicate predominant land use(s) past 100m riparian.
	☐☐ NONE [0]	☐☑ OPEN PASTURE, ROWCROP [0]	

Comments (2)

Riparian: 3 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☑ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 5 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☑ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run: 0 Maximum 8

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4] 3
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___

%RUN: ___ %RIFFLE: ___

Gradient: 3 Maximum 10

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 29

Stream & Location: Lower Elkhart Site 16 **RM:** ___ **Date:** 9/02/23

Scorers Full Name & Affiliation: R R Goforth

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RUN	OTHER TYPES	POOL	RUN
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]	10	10
☐☐ GRAVEL [7]			☐☐ SILT [2]	10	10
☑☑ SAND [6]	80	80	☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments 12

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☑ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY — SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]

EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate 9 Maximum 20

2] INSTREAM COVER

Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 UNDERCUT BANKS [1]
1 OVERHANGING VEGETATION [1]
0 SHALLOWS (IN SLOW WATER) [1]
0 ROOTMATS [1]
1 POOLS > 70cm [2]
0 ROOTWADS [1]
0 BOULDERS [1]
0 OXBOWS, BACKWATERS [1]
1 AQUATIC MACROPHYTES [1]
0 LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☐ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☑ NEARLY ABSENT <5% [1]

Comments

Cover 6 Maximum 20

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY: ☐ HIGH [4] ☐ MODERATE [3] ☐ LOW [2] ☑ NONE [1]

DEVELOPMENT: ☐ EXCELLENT [7] ☐ GOOD [5] ☐ FAIR [3] ☑ POOR [1]

CHANNELIZATION: ☐ NONE [6] ☐ RECOVERED [4] ☐ RECOVERING [3] ☑ RECENT OR NO RECOVERY [1]

STABILITY: ☐ HIGH [3] ☐ MODERATE [2] ☑ LOW [1]

Comments

Channel 4 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION: ☐☐ NONE / LITTLE [3] ☐☐ MODERATE [2] ☑☑ HEAVY / SEVERE [1]

RIPARIAN WIDTH: ☐☐ WIDE > 50m [4] ☐☐ MODERATE 10-50m [3] ☐☐ NARROW 5-10m [2] ☑☑ VERY NARROW < 5m [1] ☐☐ NONE [0]

FLOOD PLAIN QUALITY: ☐☐ FOREST, SWAMP [3] ☐☐ SHRUB OR OLD FIELD [2] ☐☐ RESIDENTIAL, PARK, NEW FIELD [1] ☐☐ FENCED PASTURE [1] ☐☐ OPEN PASTURE, ROWCROP [0] ☐☐ CONSERVATION TILLAGE [1] ☑☑ URBAN OR INDUSTRIAL [0] ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments 1 1

Riparian 2 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!): ☐ > 1m [6] ☐ 0.7-<1m [4] ☑ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☑ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☑ MODERATE [1] ☑ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 5 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☑ NO RIFFLE [metric=0]

RIFFLE DEPTH: ☐ BEST AREAS > 10cm [2] ☐ BEST AREAS 5-10cm [1] ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH: ☐ MAXIMUM > 50cm [2] ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE: ☐ STABLE (e.g., Cobble, Boulder) [2] ☐ MOD. STABLE (e.g., Large Gravel) [1] ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS: ☐ NONE [2] ☐ LOW [1] ☐ MODERATE [0] ☐ EXTENSIVE [-1]

Comments

Riffle / Run 0 Maximum 8

6] GRADIENT (ft/mi) ☑ VERY LOW - LOW [2-4] 3 ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

DRAINAGE AREA (mi²)

%POOL: ☐ %GLIDE: ☐ %RUN: ☐ %RIFFLE: ☐

Gradient 3 Maximum 10

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 29.5

Stream & Location: Lower Elkhart Site 17 **RM:** ___ . ___ **Date:** 9/03/23

Scorers Full Name & Affiliation: RR Goforth

River Code: ___ - ___ - ___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __ . ____ /8_ . ____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]	10	10
☐☐ COBBLE [8]			☐☐ MUCK [2]	30	30
☐☐ GRAVEL [7]			☐☑ SILT [2]	30	30
☑☐ SAND [6]	25	25	☐☐ ARTIFICIAL [0]	5	5
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments (8)

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☑ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☑ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate Maximum 20: 5

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 UNDERCUT BANKS [1]
- 1 OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- 1 AQUATIC MACROPHYTES [1]
- 2 LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20: 7

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☑ NONE [1]	☑ POOR [1]	☑ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20: 4

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION	RIPARIAN WIDTH	FLOOD PLAIN QUALITY	
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☑☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☑☑ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☑ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☑☑ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments (2) (0.5) (1)

Riparian Maximum 10: 3.5

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☑ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12: 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☑ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8: Ø

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☑ VERY LOW - LOW [2-4] 3
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient Maximum 10: 3

Appendix 3: Subwatershed Data

Subwatershed Name	Berlin Ct. Ditch	Coppes Ditch-Turkey Creek	Dausman Ditch-Turkey Creek	Goshen Dam Pond-Elkhart River	Headwaters Yellow Creek	Hoopingarner Ditch-Turkey Creek	Hoover Ditch-Rock Run Creek	Horn Ditch-Rock Run Creek	Lake Wawasee	Omar-Neff Ditch-Turkey Creek	Swoveland Ditch-Turkey Creek	Village Lake-Turkey Creek	Wabee Lake-Hammond Ditch	MASTER	**TOTALS**
HUC	40500011706	40500011705	40500011708	40500011904	40500011903	40500011704	40500011901	40500011902	40500011702	40500011707	40500011709	40500011701	40500011703		
Area (acres)	11,899	14,412	19,014	23,262	21,157	13,613	13,673	14,153	14,276	11,982	11,748	10,172	10,120	189,481	189,481.0
% of Watershed	6%	8%	10%	12%	11%	7%	7%	7%	8%	6%	6%	5%	5%	100%	1.0
Stream (miles)	22.5	15.2	44.2	46.9	42.5	28.0	35.8	31.8	11.3	25.1	35.2	17.6	13.0	368.92	368.9
Impaired ECOLI 4A (miles)	7.7708	1.5746	35.2492	21.35	5.0529	27.5625	18.4617	8.3787		18.4661	10.8485			154.7115	154.7
Impaired Nutr 5A (miles)	7.7708													7.77	7.8
Impaired PCBs 5B (miles)															0.0
Impaired Fish Consumption (miles)				8.93										8.93	8.9
Impaired biotic comm (miles)	7.80	1.60	23.50		5.10					16.50	0.00				54.5
Impaired DO (miles)	7.7708													7.77	7.8
Impaired Lake Acreage									12 (Hammond Lake)			31 (Gordy Lake)			
Impaired Lake Acreage									3410 (Lake Wawasee)			13 (Hindman Lake)			
Impaired Lake Acreage									6 (Rothenberger Lake)			88 (Knapp Lake)			
Impaired Lake Acreage									12 (Barrel and a Half Lake)			11 (Village Lake)			
HEL (acres)	4,147.4	967.0	5,983.8	4,224.1	8,936.8	5,698.2	5,262.5	5,275.3	3,211.3	902.7	4813.596	5,334.5	4,752.1	59501	59,509.1
HEL (%)	34.9%	6.7%	31.5%	18.2%	42.2%	42%	38.5%	37.3%	22.5%	7.5%	41%	52.4%	47.0%	31%	31%
Hydric (acres)	1,191.8	3,879.0	2,074.4	1,122.3	2,155.0	3,029.3	1,506.8	1,160.1	2,692.4	6,276.4	1686.932	2,598.1	1,100.8	30,473	30,473.5
Hydric (%)	10.0%	26.9%	10.9%	4.8%	10.2%	22%	11.0%	8.2%	18.9%	52.4%	14%	25.5%	10.9%	16%	16%
Septic-VeryLimited	11,797.9	14,155.9	18,783.0	22,038.6	20,649.4	13,269.9	13,657.4	13,879.2	8,893.7	11,932.3	11600.0159	9,843.3	8,984.8	179485	179,485.4
Septic-VL (%)	99.2%	98.2%	98.8%	94.7%	97.6%	97%	99.9%	98.1%	62.3%	99.6%	99%	96.8%	88.8%	94%	95%
Floodplain (acres)	751	860	698	2,319	722	759.1	206	1,073	4,752	402	678.3211	664	969	14851	14,852.2
Floodplain (%)	6%	6%	4%	10%	3%	6%	2%	8%	33%	3%	6%	7%	10%	8%	8%
CFO (animals)	83,805	9,600	8,890		1,795	600.0	257,182	49,200		24,233	281038	83,900	7,670	797,241	807,913.0
CFO/CAFO animals/acre	7.04	0.67	0.47	0.00	0.08	0.04	18.81	3.48	0.00	2.02	23.92	8.25	0.76		
Hobby Farm (animals)	208	55	1,242	11	2,663	149.0	680	331	53	592	541	67	52	6,644	6,644.0
Hobby animals/acre	0.02	0.00	0.07	0.00	0.13	0.01	0.05	0.02	0.00	0.05	0.05	0.01	0.01		
Manure estimate (tons)	35,111	40,519	64,799	231	96,990	9,521	87,673	19,583	1,136	140576.6	98,925	4,987	32,206	560,288	632,257.3
Manure N estimate (lb)	21,935,710	118,674	122,418	121	46,677	22,818	6,641,034	1,280,751	568	3.01E+05	7,242,561	2,350,229	95,077	20,287,514	40,157,909.7
Manure P estimate (lb)	1,773,193	8.96E+04	88,773	61	22,899	16,731	5,370,062	1035350	282	221,730	5,856,572	1,963,745	71,688	16,418,073	16,510,664.7
Manure Ecoli Estimate (col)	1.74E+19	2.18E+16	2.09E+16	5.51E+12	2.95E+15	4.20E+15	5.21E+19	1.00E+19	2.96E+13	5.27472E+16	5.65E+19	2.90E+14	1.76E+16	1.36E+20	1.36E+20
Livestock Access (miles)					1.8		1.1				0.3764				3.3
Livestock Access (%)	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	3.1%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%		0.9%
Streambank Erosion (miles)	0.4		2.6		1.5		0.3	1.2		0.4	0.582	0.5			7.5
Streambank Erosion (%)	1.7%	0.0%	6.0%	0.0%	3.6%	0.0%	0.9%	3.8%	0.0%	1.6%	1.7%	2.8%	0.0%		2.0%
Narrow Buffer (miles)	1.3		0.7		0.4		0.2			0.2					2.9
Narrow Buffer (%)	6.0%	0.0%	1.5%	0.0%	0.9%	0.0%	0.7%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%		0.8%
Land Use (acres)	11,898.8	14,412.7	19,014.6	23,262.6	21,157.7	13,613.3	13,673.8	14,153.6	14,276.2	11,982.7	11,748.6	10,172.7	10,120.6		189,487.8
Ag - Row +Pasture	8,824.3	12,309.3	15,663.7	7,685.1	15,173.4	9670.0	11,327.3	8,074.2	4,309.1	11,002.5	9,032.5	7,252.6	6,755.0		127,079.0
Forest	621.4	688.7	952.9	1,125.7	1,566.5	1086.4	689.0	622.8	1,934.3	286.3	576.2	1,089.9	1,086.3		12,326.6
Wetland + Open water + grass	168.1	380.5	863.4	2,243.2	1,026.7	1241.4	693.5	950.5	5,548.0	192.0	1,052.0	1,136.6	1,506.3		17,002.3
Urban	2,285.0	1,034.2	1,534.6	12,208.5	3,391.1	1615.5	963.9	4,506.1	2,484.8	501.8	1,087.8	693.7	773.0		33,080.0
Land Use (%)															
Ag - Row +Pasture	74.2%	85.4%	82.4%	33.0%	71.7%	71.0%	82.8%	57.0%	30.2%	91.8%	76.9%	71.3%	66.7%	67.0%	67%
Forest	5.2%	4.8%	5.0%	4.8%	7.4%	8.0%	5.0%	4.4%	13.5%	2.4%	4.9%	10.7%	10.7%	7%%	7%
Wetland + Open water + grass	1.4%	2.6%	4.5%	9.6%	4.9%	9.1%	5.1%	6.7%	38.9%	1.6%	9.0%	11.2%	14.9%	9.0%	9%
Urban	19.2%	7.2%	8.1%	52.5%	16.0%	11.9%	7.0%	31.8%	17.4%	4.2%	9.3%	6.8%	7.6%	17.0%	17%
LUST	18	1	3	42	5	6.0		12	11		4	1		103	103.0
Underground Storage Tanks (not LU	32	11	4	103	16	12.0	1	49	22		10		2		262.0
NPDES	1 (Napanee)	1 (Milford)		1 (Goshen)					1 (Syracuse)						0.0
NPDES SSO															0.0
CSO				6											6.0
Superfund															0.0
VRP				8				2						5	10.0
Brownfields			1	37	2			6			2			48	48.0
Industrial Waste			2	33	1	6.0		10	2		1			55	55.0
Solid Waste					2									2	2.0
MS4	Napanee (1558 ac)		Elkhart (5.6 ac)	Elkhart (17088 ac)	Elkhart (2630 ac)		Elkhart (403 ac)	Elkhart (5668 ac)			Elkhart (1248 ac)				
Waste Restricted															0.0
Unsewered Dense Housing	311.023	288.4666	102.3099	3164.9684	1301.525	638.2536		149.5711	663.7166		128.8611	266.6703	1025.2148		8,040.6
Historic Water Quality Samples Exceeding Targets															
Ammonia	50%	0%	0%	2%	25%	0%			25%	40%	100%	0%	50%		
Conductivity	8%		16%	0%	4%			0%	0%		5%	0%			
DO	29%	11%	24%	12%	26%	0%	18%	1%	27%	50%	36%	3%	8%		
Ecoli	69%	100%	83%	36%	89%	60%	100%	90%	0%	73%	74%	70%	0%		
Nitrate	99%		83%	74%	82%			86%	29%	100%	83%	90%	100%		
Dissolved phosphorus			80%	63%				78%	62%			25%	0%		
pH	5%	0%	3%	0%	1%	0%	0%	0%	10%	0%	1%	11%	6%		
Total Kjeldahl nitrogen	100%	0%	67%	77%	80%		50%		50%	63%	80%	71%	50%		
Total phosphorus			99%	98%	99%			97%	1%		34%	21%	50%		
Total suspended solids	23%	0%	39%	15%	46%		50%	16%	7%	38%	26%	0%	50%		
Turbidity	33%	33%	57%	73%	65%	0%	9%	30%	4%	50%	42%	7%	50%		
Current Water Quality Samples Exceeding Targets															
Temp	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
DO	4%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	25%	0%		
pH	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%	0%	0%	14%		
Conductivity	46%	42%	42%	48%	50%	42%	58%	61%	33%	50%	50%	50%	43%		
Turbidity	33%	0%	0%	0%	8%	8%	0%	4%	8%	0%	0%	0%	0%		
Total Phosphorus	75%	0%	8%	17%	33%	0%	17%	13%	0%	0%	8%	0%	0%		
Nitrate	100%	100%	92%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		
Total Suspended Solids	21%	8%	8%	31%	8%	0%	8%	26%	17%	8%	8%	25%	14%		
E.coli	71%	46%	58%	48%	67%	75%	83%	57%	17%	58%	100%	33%	57%		