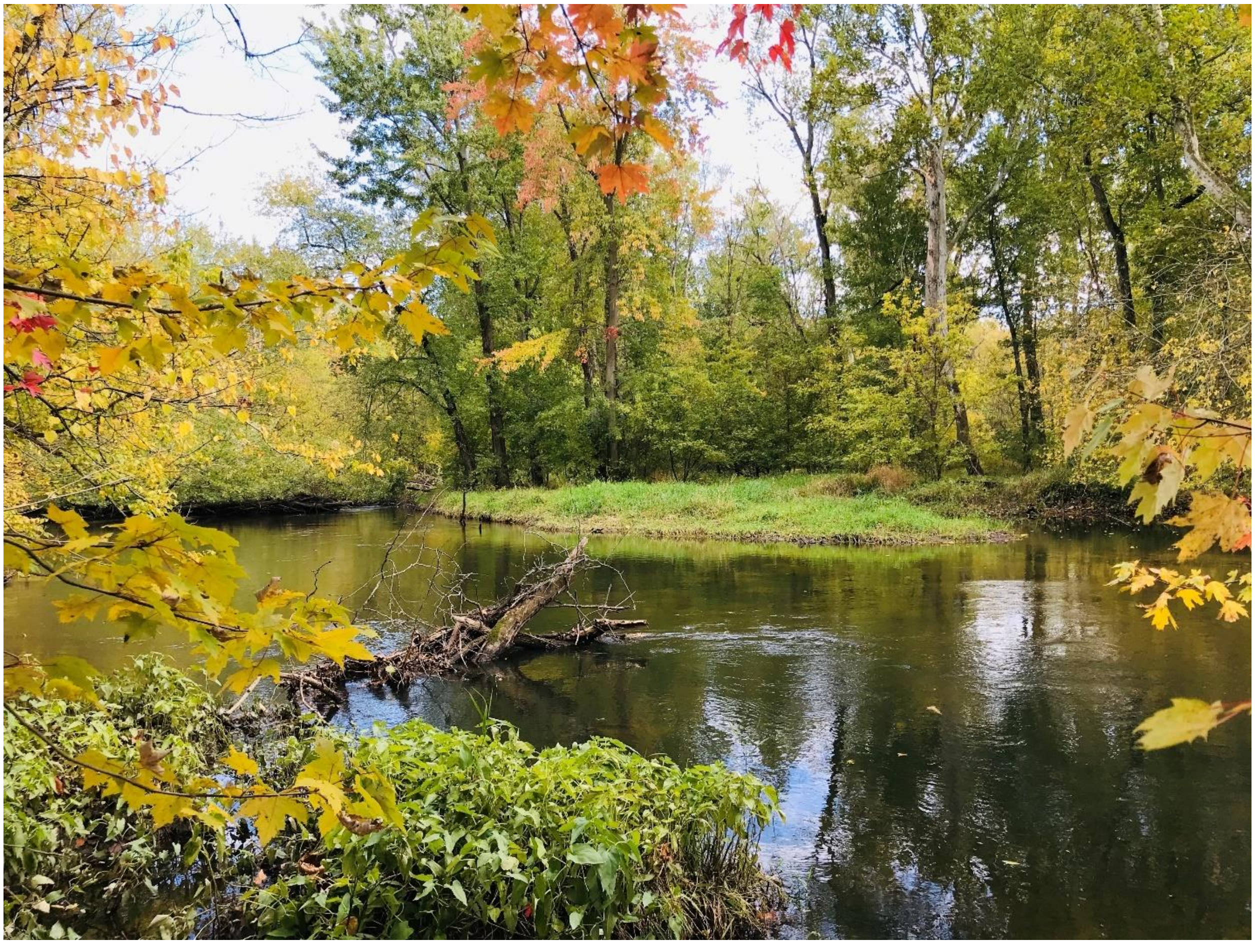
UPPER ELKHART RIVER WATERSHED MANAGEMENT PLAN

ELKHART, KOSCIUSKO, LAGRANGE AND NOBLE COUNTIES, INDIANA

2 JANUARY 2024



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UPPER ELKHART RIVER WATERSHED MANAGEMENT PLAN
ELKHART, KOSCIUSKO, LAGRANGE 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 lives in 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 Upper Elkhart River Watershed receives water from the North Branch Elkhart River, South Branch Elkhart River and Solomon Creek (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 Cities of Ligonier and Kendallville. The 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 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).

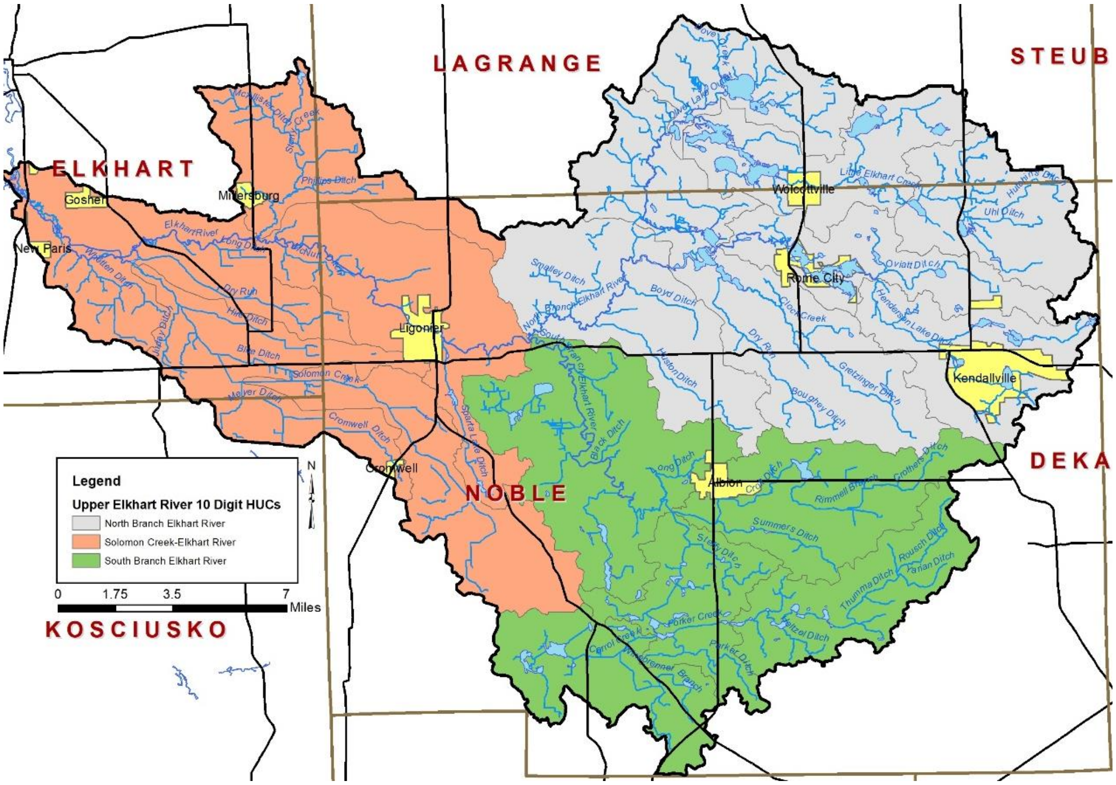


Figure 1. The Upper Elkhart River Watershed.

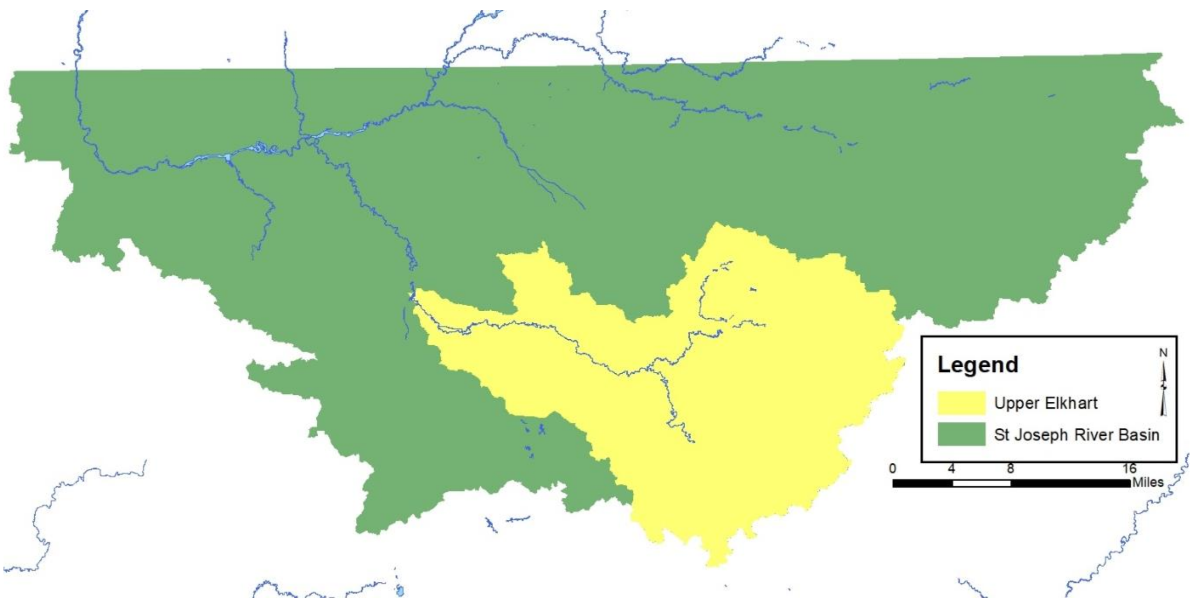


Figure 2. The St. Joseph River Basin highlighting the Upper Elkhart River Watershed.

1.2 Project History

The Upper Elkhart River Project launched in late 2021 as a result from a Section 319 grant awarded to update the 2008 Elkhart River Watershed Management Plan. 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. Specifically, since the 2008 WMP was completed, there have been observable changes in land use with development focused throughout Elkhart County, cities and towns in the watershed, including Albion, Ligonier, Kendallville, and others and around the watershed's lakes with residents converting houses to larger, more permanent structures. In total, nearly 56 square miles of the watershed has been converted from natural (forest, wetland) and agricultural land uses into urban and urbanizing land uses over the last 14 years. 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 focused their water quality assessments on the Upper Elkhart River Watershed listing 185 miles of impaired waterbodies – more than 100 stream miles added since the 2008 plan was completed. Impaired stream concerns include elevated pathogen (E. coli) and nutrient levels, low dissolved oxygen levels, and impaired biotic communities, while nutrient limitations 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 Upper Elkhart River Watershed, which includes the North and South Branches of the Elkhart River and Solomon Creek drainages. The Upper Elkhart River Watershed includes a variety of land uses including agricultural, forest and natural areas, including nature preserves local parks, as well as urban and urbanizing land uses. Much of the watershed is dominated by agricultural land use with intact forested riparian areas especially adjacent to the mainstem of the Elkhart River. Urban and urbanizing land is found adjacent to the many watershed lakes and in its cities and towns including the Cities of Ligonier and Kendallville and Towns of Wolcottville, Millersburg, New Paris, Rome City, Albion and Cromwell. The mix of land uses generates a variety of concerns including: nutrient, sediment and pathogen runoff; flooding and loss of floodplain impacts; fish community impacts; algal blooms in watershed lakes and streams and more.

Based on these concerns, ERRA approached community groups and individuals throughout the watershed that might be interested in working with them to assess and improve water quality and quantity within Upper Elkhart River and its tributaries. Identified potential stakeholders included: Elkhart, Kosciusko, Lagrange and Noble County SWCD and NRCS staff; City of Kendallville and Elkhart County MS4s; City of Ligonier; Town of Wolcottville; Indiana DNR; Indiana State Department of Agriculture; Elkhart, Kosciusko, Lagrange and Noble County surveyors, parks departments, health departments and Purdue Extension; Goshen College faculty, students and staff; St. Joseph River Basin Commission; local landowners, educators 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 Upper 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 Upper 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 comprised the steering committee. The steering committee has met quarterly to develop the WMP starting in January 2022. Table 1 identifies the steering committee members and their affiliation.

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

Individual	Organization(s) Represented
Carolyn Moeller	Adams Lake Conservation Club
Sue McGee, Trevor Hampshire	City of Kendallville, City of Kendallville MS4
Jeff Boyle, Kenny Sprague, Ken Schuman	City of Ligonier
Donny Aleo	Elkhart County Parks
John Heiliger	Elkhart County MS4
Wes Krug, Troy Manges	Elkhart County NRCS
Jeff Burbrink	Elkhart County Purdue Extension
Philip Barker	Elkhart County Surveyor
Jim Hess	Elkhart County SWCD
Nancy Brown, Jason Kauffman	ERRA
Pete Kelly, Gary Brazel	Five Lakes
Jonathan Schramm	Goshen College
Kristi Todd	Indiana Department of Environmental Management
Chad Shotter	Kosciusko County NRCS
Kelly Heckaman	Kosciusko County Purdue Extension
Mike Kissinger	Kosciusko County surveyor
Tashina Lahr-Manifold	Kosciusko County SWCD
Robbie Miller	Lagrange County Floodplain Admin
Jennifer Walker	Lagrange County NRCS
Steve Engleking	Lagrange County Purdue extension
Zach Holsinger	Lagrange County surveyor
Martin Franke, Kyle Burchett	Lagrange County SWCD
Anita Hess	Noble County commissioner; SJRBC
Teresa Tackett	Noble County planning director
Russell Baker	Noble County NRCS
Ann Kline	Noble County Purdue Extension
Randy Sexton	Noble County surveyor
Patrick Wiltshire, Lynn Bowen	Olin-Oliver- Martin Lakes
Leigh Pranger	Rome City Conservancy District
Matt Meersman, Kate Barrett	St. Joseph River Basin Commission
Nancy Lough	Skinner Lake HOA
Scott Stienecker	Sylvan Lake
Steve Cords	Town of Wolcottville
Diann Scott	West Lakes

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 17, 2022 and was hosted as a drop in and chat meeting. In total, 22 people attended the meeting providing their input on water quality, water quantity, recreation and high-quality areas. Individuals noted their personal concerns and identified both high quality and problem areas on maps provided. These comments formed the initial basis of the stakeholder concerns list.

The second meeting occurred on September 25, 2023 with 37 people in attendance. The meeting provided an overview of the project and decisions made along the way and focused on gathering feedback on critical areas, practices selected for implementation and the likelihood of meeting project goals gathered. The draft watershed management plan was posted following the meeting and attendees and stakeholders were encouraged to provide feedback and/or comments.

1.4 Public Input

Throughout the planning process, project stakeholders, the steering committee, and the general public listed concerns for the Upper Elkhart River Watershed including the Elkhart River, its tributaries, and its watershed. Public and committee meetings were the primary mechanism of 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
Maintaining drainage and floodplain
Recreational use of the river and lakes
Water quantity
Poor water quality (sediment, nutrients, pathogens)
Elevated turbidity, phosphorus and E. coli and impacts on water quality
Fish community impacts
Sediment accumulation in river and lakes
In lake water quality – poor transparency, elevated nutrient levels
Property value impacts to lakeside residents (poor water quality)

Maintenance of previously installed best management practices
Streambank and bed erosion
Stormwater impacts
Building cohesion with groups across the basin
Blue green algae blooms on lakes
Flooding
Too much water received in Rome City during storm events
Explore the need for dam removal – Elkhart County Parks Baintertown and Benton dam removal feasibility study ongoing
Maintaining natural areas and providing access to local residence
Maintain outfall for regulated drains to keep the Elkhart River healthy (keep the river clean by keeping tributaries clean)
Be holistic and work across the watershed with the goal of no negative impact to any other area of the basin
Engaging agricultural and urban landowners to implement BMPs
Livestock accessing streams
Agricultural BMP implementation is needed
Impacts of City of Kendallville wastewater treatment plant impacts on Henderson Lake and Sylvan Lake
Excessive Sediment Load
Stream bank deterioration caused by severe erosion as general observed, 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 to reduce sediment loading (two stage, buffer strip incentives) – examples – see Kosciusko
Non-point source pollution (agricultural row crop and animal runoff & septic)
Nutrient loading due to the use of (lawn, agriculture) fertilizers
Vegetation growth due to eutrophication in lakes and streams
Illicit Discharge
Mercury and PCBs in fish tissue
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)
Livestock access to surface waters within the Watershed
Loss of habitat with increased development
Increases in impervious surface in the Watershed
Development/encroachment on the floodplain
Combined Sewer Overflows – E. coli, nutrients – long term control. All CSOs have been eliminated per city of Kendallville
Preserve a natural buffer along the water. Need proper planning of developments
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
Preservation of wetlands upstream, to protect floodplain areas
Loss of habitat for endangered, threatened and rare (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
Addressing beaver dams and logjams for recreation, flood storage and flow conveyance
Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage
Perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns.
Fish consumption advisories
Concerned over attempts to make the Elkhart River a legal drain: concern over drainage policy in general
Logjams
The Wolcottville town dam to historic recreation opportunities with pond, beach and more post failure in the 1950s – maintain and manage (10 feet of fall between Wolcottville and Witmer Lake) – 3 dams, 2 private, 1 public
Septic systems, maintenance needed, density, straight pipes, small leach beds
Wetland loss
Eve Lake still has a cisco population (others?)
Henderson Lake – very high nutrient levels/dead lake – suggested no swimming/bodily contact by City of Kendallville
Floodplain development
In lake boating/shallow lake boating impacts
Nutrient impacts from yard waste
Confined feeding operations, concentrated animal feeding operation impacts
Manure volume produced from unregulated, animal operations and CFO/CAFO in the watershed
Increased intensity and duration of rain events
Heavy metal releases from in lake treatment – need a better understanding of heavy metal accumulation in lake sediment and potential impacts
Watershed lake overuse (bass tournaments, boat density, lack of facilities as access points)
Impediments to navigation (barbed wire, low head dams)
Limited recreation access points

2.0 WATERSHED INVENTORY I: WATERSHED DESCRIPTION

2.1 Watershed Location

The Upper Elkhart River includes three 10-digit hydrologic unit codes (HUCs): 0405000115 (North Branch Elkhart River), 0405000116 (South Branch Elkhart River) and 0405000118 (Solomon Creek) and covers portions of Elkhart, Lagrange, Noble and Kosciusko counties (Figure 1). The Upper Elkhart River Watershed includes all the land that enters Elkhart River, Solomon Creek, Stony Creek, Little Elkhart Creek, North and South Branch Elkhart River upstream of New Paris and their drainage. The watershed includes drainage from The Towns of Wolcottville, Millersburg, Rome City, Albion and Cromwell and Cities of Ligonier and Kendallville. 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 east of New Paris. 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.

2.2 Subwatersheds

In total, seventeen 12-digit Hydrologic Unit Codes are contained within the Upper 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 Upper Elkhart River Watershed.

Subwatershed Name	Hydrologic Unit Code	Area (acres)	Percent of Watershed
Tamarack Lake-Little Elkhart Creek	040500011501	12,395	5%
Dallas Lake-Little Elkhart Creek	040500011502	13,311	5%
Oliver Lake-Little Elkhart Creek	040500011503	10,126	4%
Waterhouse Ditch-Henderson Lake Ditch	040500011504	12,788	5%
Oviate Ditch-Middle Branch Elkhart River	040500011505	11,052	4%
Jones Lake-North Branch Elkhart River	040500011506	26,049	10%
Huston Ditch-North Branch Elkhart River	040500011507	18,488	7%
Rivir Lake-Forker Creek	040500011601	11,960	5%
Winebrenner Branch-Carrol Creek	040500011602	11,799	5%
Skinner Lake-Croft Ditch	040500011603	15,890	6%
Muncie Lake-South Branch Elkhart River	040500011604	10,527	4%
Diamond Lake-South Branch Elkhart River	040500011605	22,904	9%
Phillips Ditch-Stony Creek	040500011801	13,017	5%
Indian Lake-Elkhart River	040500011802	20,182	8%
Headwaters Solomon Creek	040500011803	15,158	6%
Hire Ditch-Solomon Creek	040500011804	14,189	5%
Whetten Ditch-Elkhart River	040500011805	18,207	7%
	Entire Watershed	**258,040.9**	**100%**

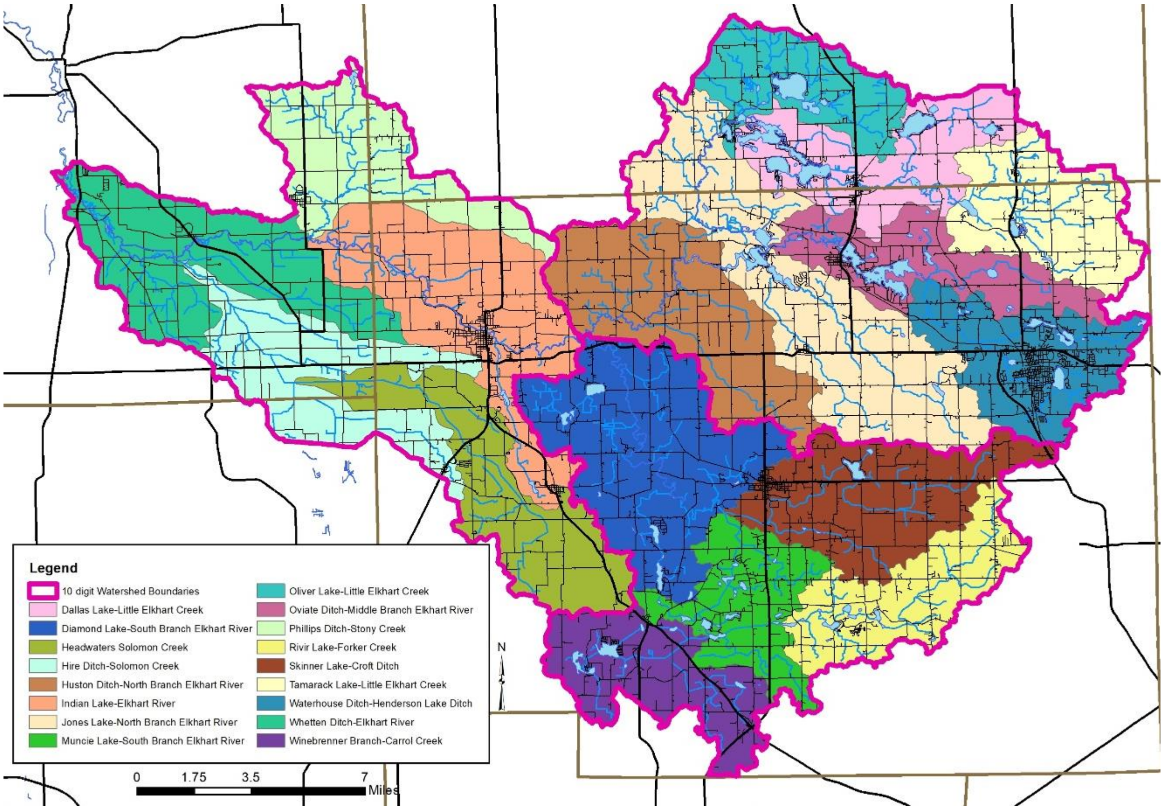


Figure 3. 12-digit Hydrologic Unit Code subwatersheds in the Upper Elkhart River Watershed.

2.3 Climate

In general, Indiana has a temperate climate with warm summers and cool or cold winters. Climate in the Upper 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. Rainfall intensity and timing affect watershed response to precipitation. NOAA's climate at a glance website (1895-present) indicate rainfall varies from 25 to over 50 inches annually (Figure 4). Christopher B. Burke Engineering Limited (CBBEL) calculated the 10-year moving average as between 30 and 40 inches/year. The Purdue Climate Change Research Center 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 Upper Elkhart River Basin. This likely results in more water moving through the system which impacts the watershed's lakes, streams and wetlands.

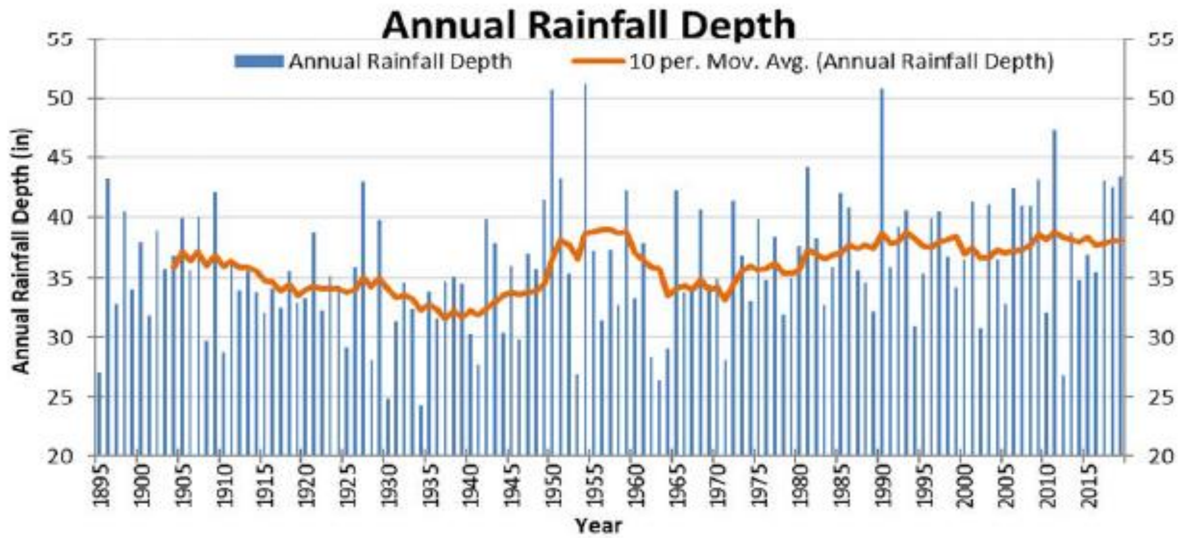


Figure 4. Annual rainfall depth for Noble County (CBBEL, 2020).

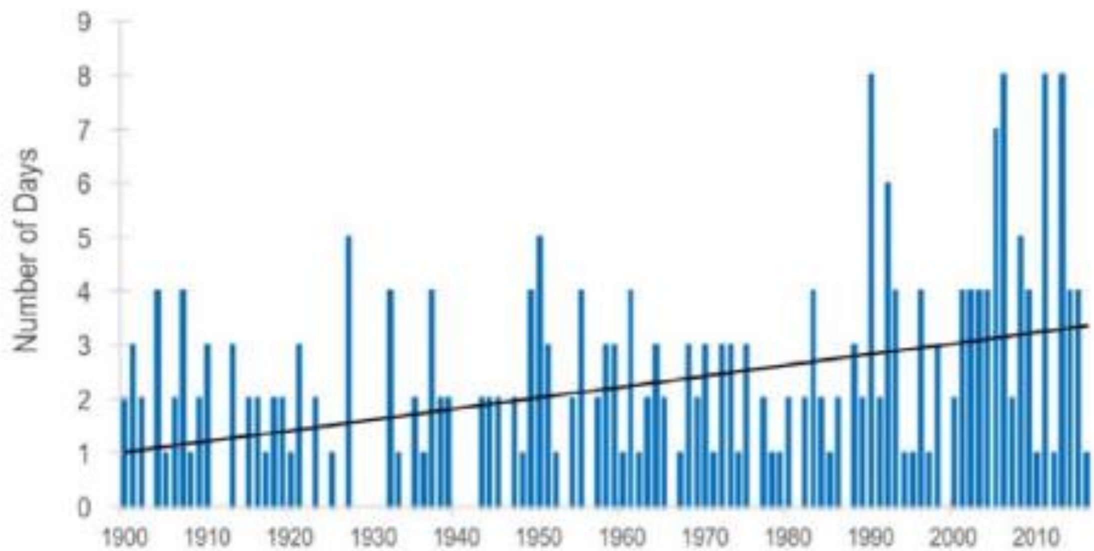


Figure 5 Number of days with extreme precipitation (ie events exceeding 99th percentile for Indiana (PCCRC from CBBEL, 2020).

2.4 Geology and Topography

Bedrock deposits within much of the Upper 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 three major types of Devonian Era Shale, with a small amount of Muscatatuck Group present in the southernmost outcrop of the watershed. Antrim Shale bedrock covers most of the southern portion of the Upper Elkhart River Watershed covering much of the South Branch of the Elkhart River drainage. The main stem of the Elkhart River flows through Ellsworth Shale. Coldwater Shale deposits cover much of the northeastern portion where lakes predominate in the Little

Elkhart Creek (Figure 6). Most of the Upper Elkhart River Watershed 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). Sand and gravel deposits found along all major and many minor streams originate from the Wisconsinan outwash. Lacustrine deposits found in the watershed's headwaters originate from the Illinoian till (Figure 7). Sand and gravel are readily available resources along watershed stream floodplains.

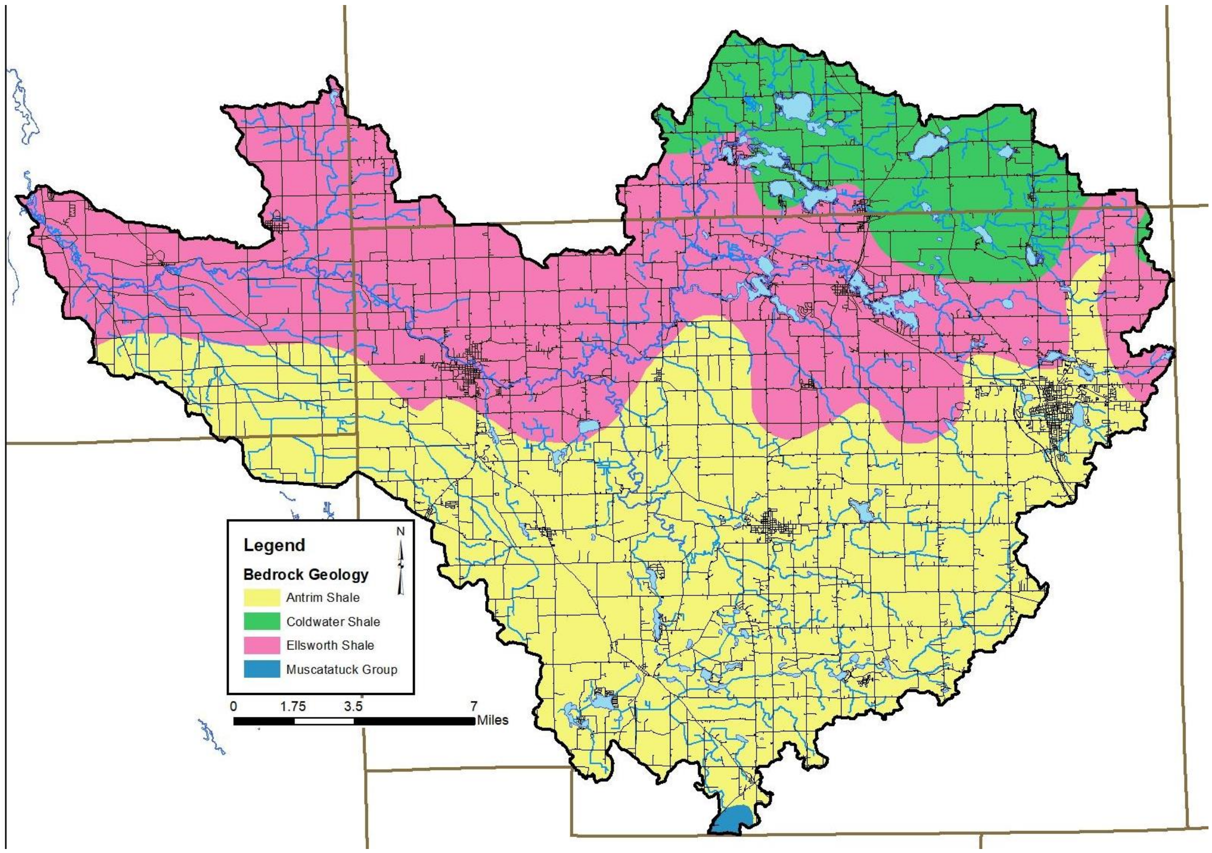


Figure 6. Bedrock in the Upper Elkhart River Watershed.

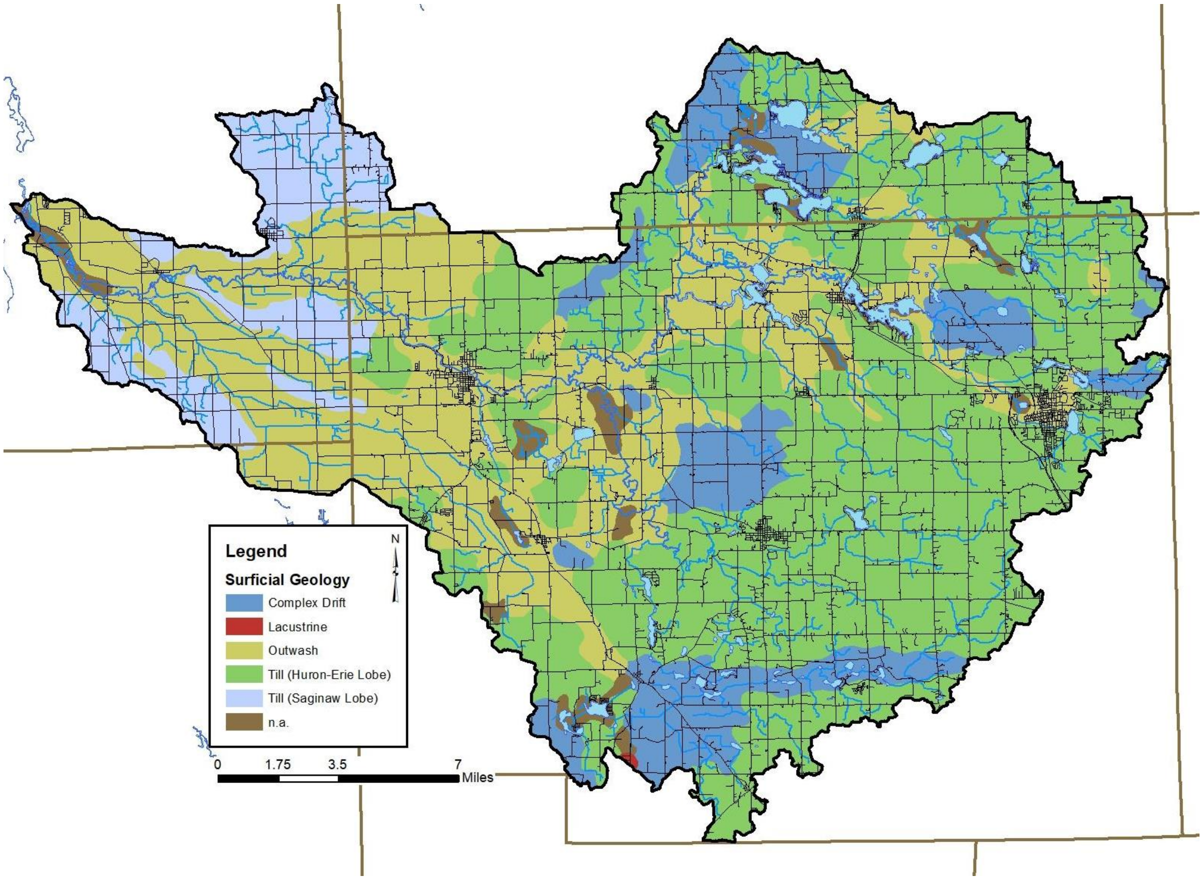


Figure 7. Surficial geology throughout the Upper Elkhart River Watershed.

The topography of the Upper Elkhart River Watershed ranges from flat rolling agricultural fields to undulating hills and valleys (Figure 8). The landscape changes from steeply sloped to rolling terrain in the Tamarack Lake-Little Elkhart Creek Subwatershed, Waterhouse Ditch-Henderson Lake Ditch Subwatershed, Skinner Lake-Croft Ditch Subwatershed and Rivir Lake-Forker Creek Subwatershed drainages (eastern edge of the watershed) to gently rolling terrain and relatively flat plains along the main stem of the Elkhart River. The lowest elevation (790 feet msl) occurs at the watershed outlet near Waterford Mills, which is located in the Whetten Ditch-Elkhart River subwatershed. The Upper Elkhart River Watershed elevation is highest measuring 1075 feet mean sea level (msl) just south of Kendallville in the eastern portion of the watershed and in the town of South Milford in the northeastern portion of the watershed. Steep valleys surround many of the Upper Elkhart River Watershed streams in the eastern portion of the watershed.

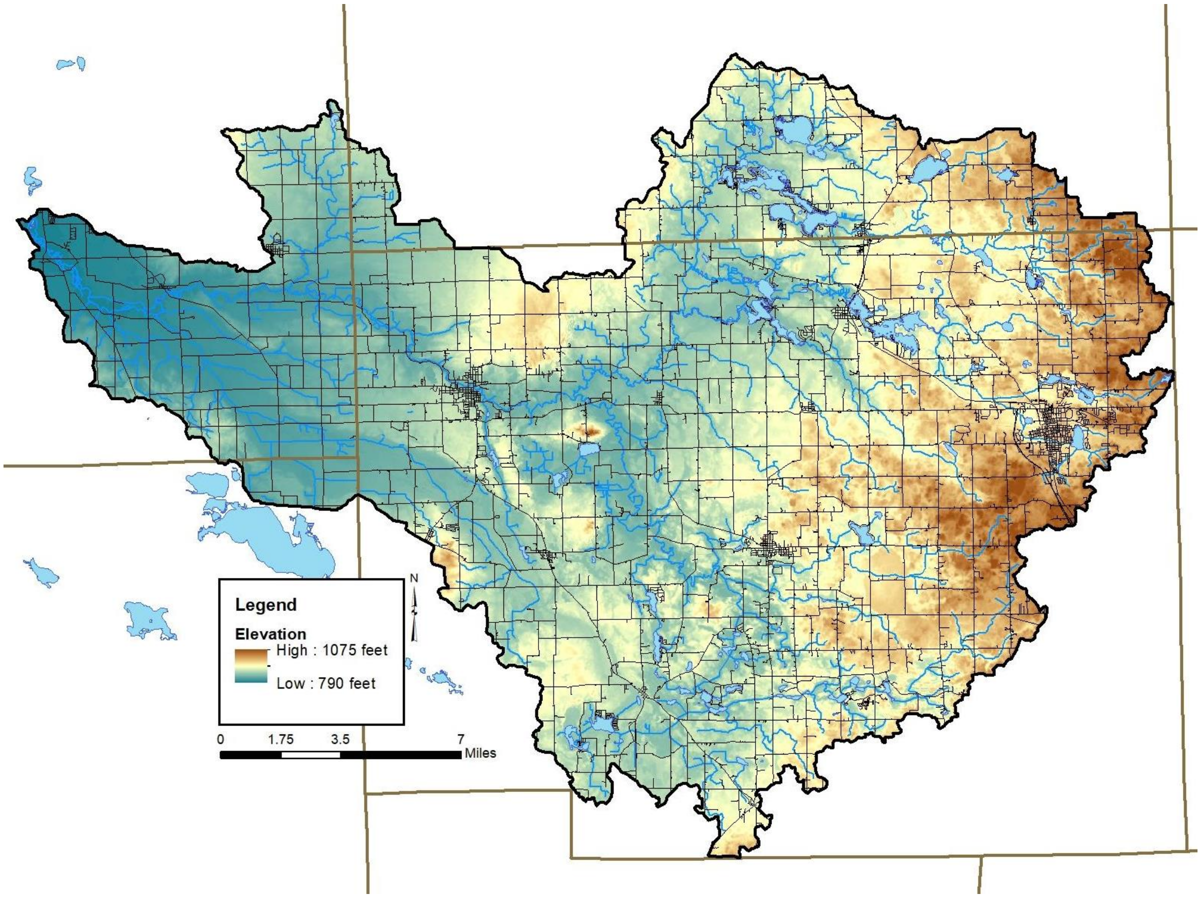


Figure 8. Surface elevation in the Upper Elkhart River Watershed.

2.5 Soil Characteristics

There are hundreds of different soil types located within the Upper 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. The vast majority of the Upper 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 C soils (28%) followed by category B soils (27%), category D soils (25%) and category A soils (15%). While the majority of soils are nearly evenly split by C, B, and D soil types, the location of each hydrologic soil group is important. C soils dominate the southern and eastern portions of the watershed, whereas B soils dominate much of the rest of the watershed (Figure 9). Category B soils are moderately deep and well drained, while

Category C soils are finer and allow for slower infiltration. A soils are abundant in the northern section of the watershed around Olin, Oliver, and Martin Lakes. While A soils can be found in this region of the watershed, overall, the watershed is not heavily represented by A soil types. Elkhart County's hydrologic soils are dominated by D soils, which differ greatly from the remainder of the watershed, 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.

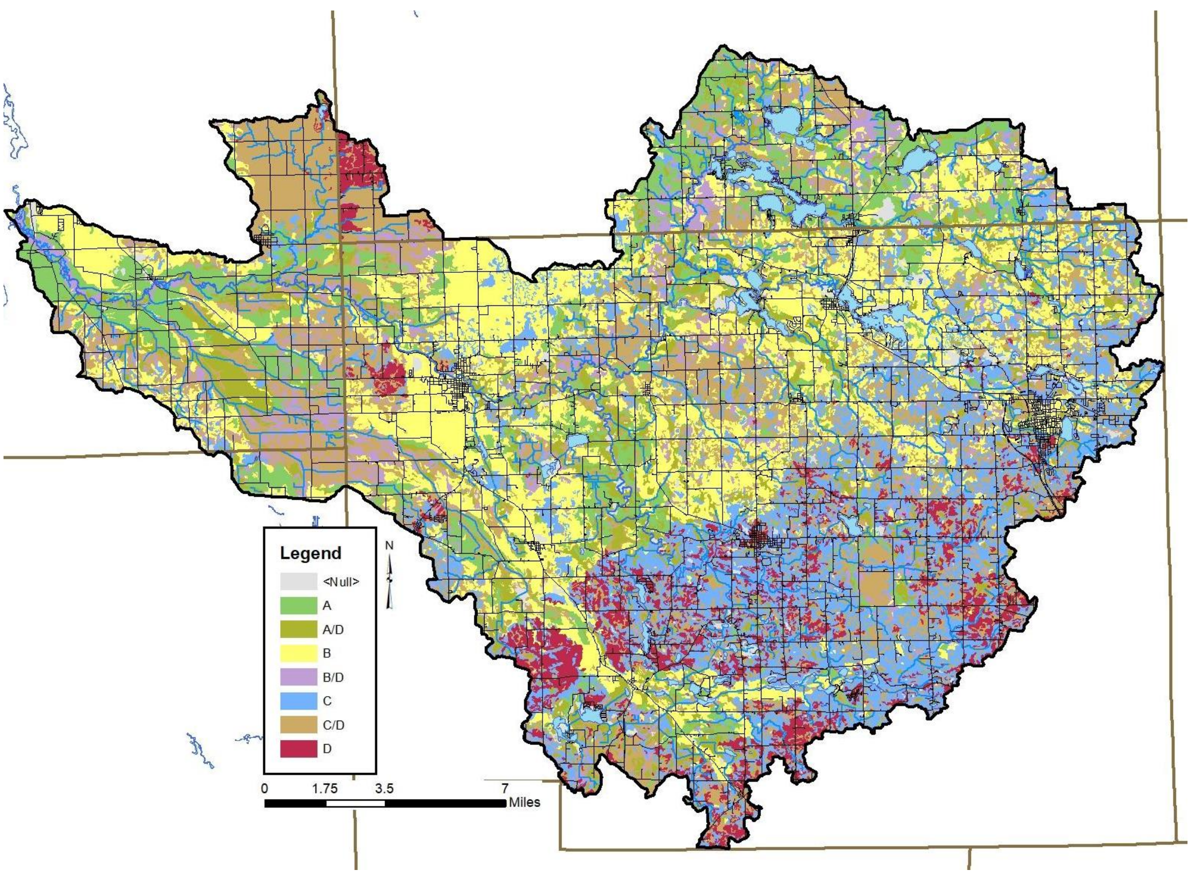


Figure 9. Hydrologic Soil Groups in the Upper Elkhart River Watershed.

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 Upper Elkhart River Watershed. Highly erodible soils cover 45% of the watershed or 116,889 acres. Highly erodible soils are found throughout the watershed with no discernable pattern of location. However, it should be noted that there is limited highly erodible soils coverage in the Solomon Creek basin.

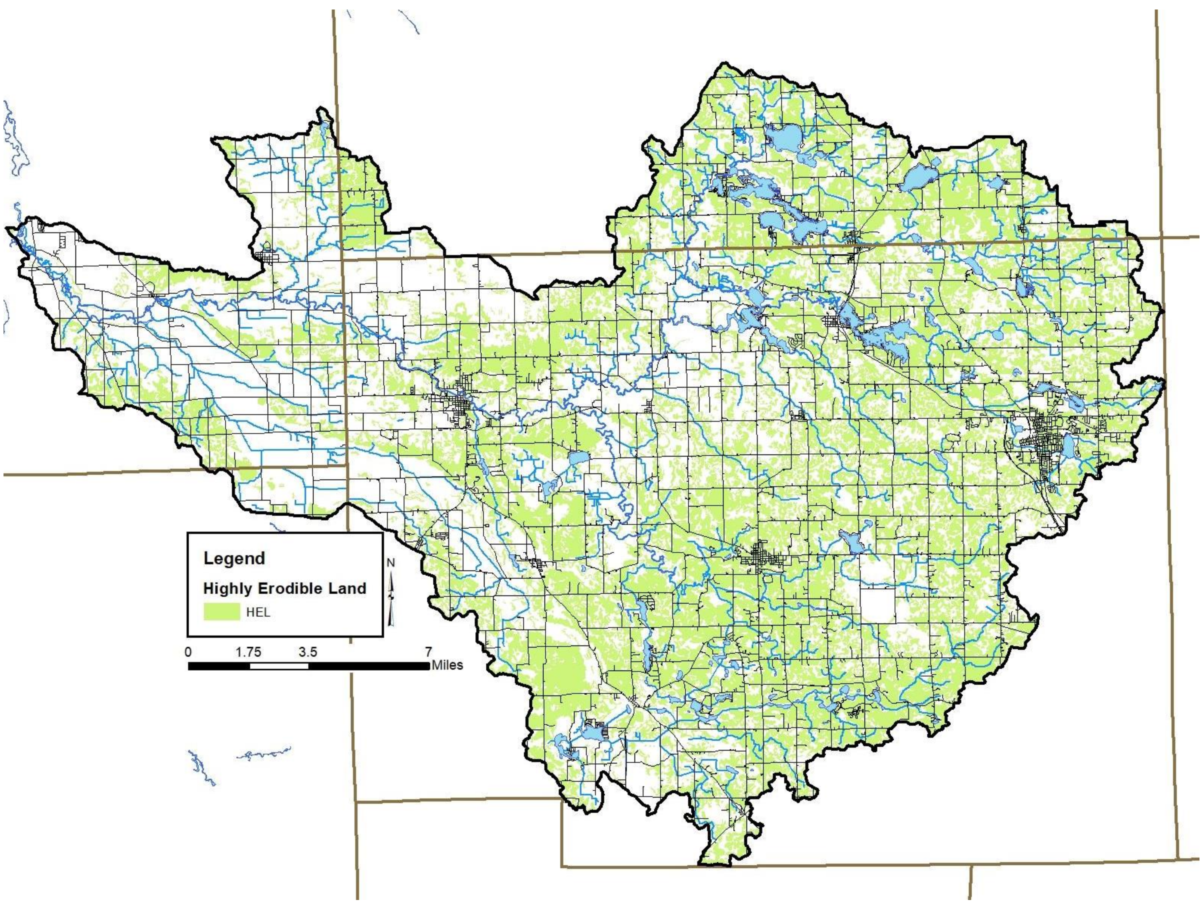


Figure 10. Highly erodible land in the Upper Elkhart River Watershed.

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 soils maintain the resultant characteristics even after draining or use modification occurs. Approximately 73,254 acres (28%) of the watershed was covered by hydric soils (Figure 11). While much of western Noble County has limited hydric soils, they cover much of eastern Noble County and much of Lagrange County. Hydric soils are more densely packed along the Elkhart River and Solomon Creek floodplains. They are also 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.

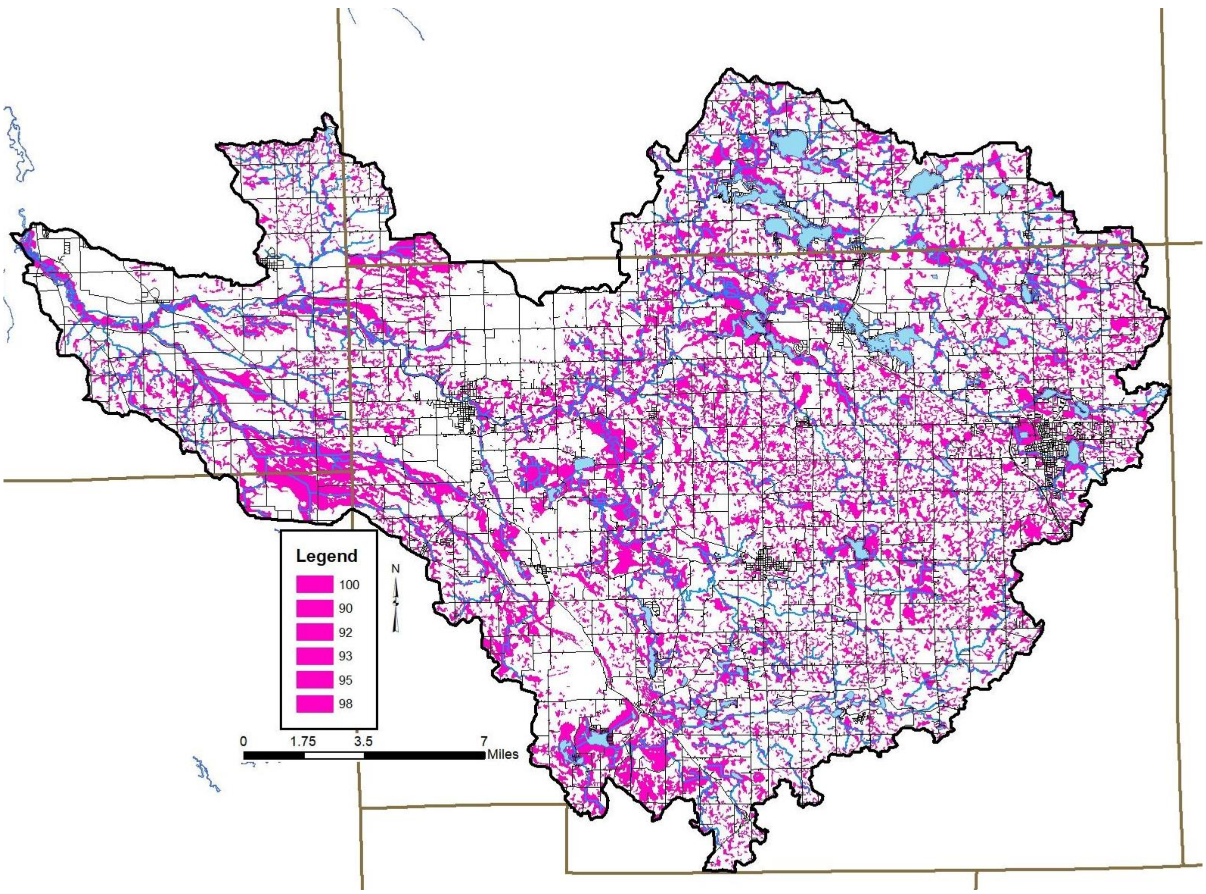


Figure 11. Hydric soils in the Upper Elkhart River Watershed.

2.5.4 Tile-Drained Soils

Soils drained by tile drains cover 94,092 acres or 36% of the Upper 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 a naturally poorly drained watershed like the North Branch Elkhart River 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 eastern boundary of Elkhart County and in much of Noble County. Tile-drained soils can also be found along the mainstem of the Elkhart River and Solomon Creek in Elkhart and Kosciusko counties (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.

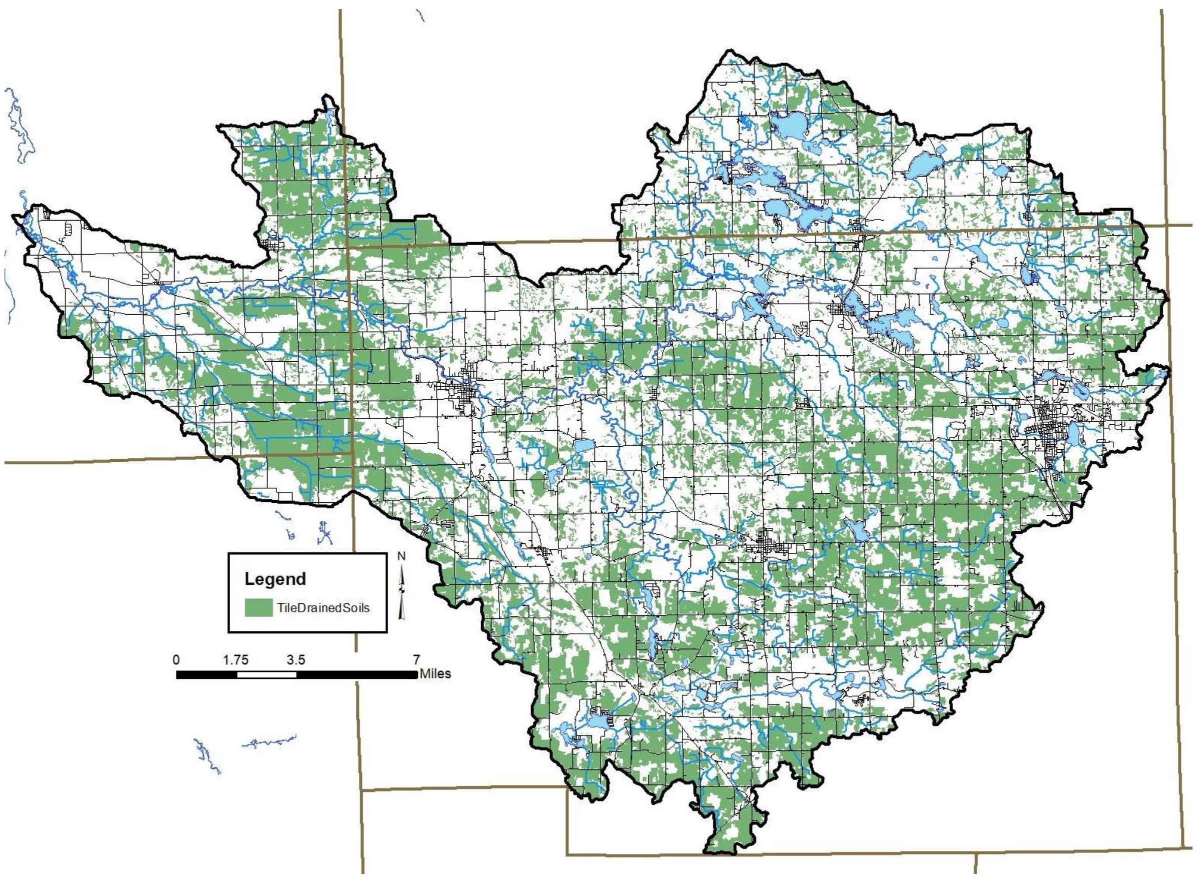


Figure 12. Tile-drained soils in the Upper Elkhart River Watershed.

2.6 Wastewater Treatment

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 241,951 acres or 94% of the watershed is covered by soils that are considered very limited for use in septic tank absorption fields. Nearly 182,374.4 (2%) acres are somewhat limited meaning that these soils are generally suitable for septic systems. The remaining 10,724 acres (4%) not rated for septic usage as it is not generally industry standard to install a septic system in these geographic locations.

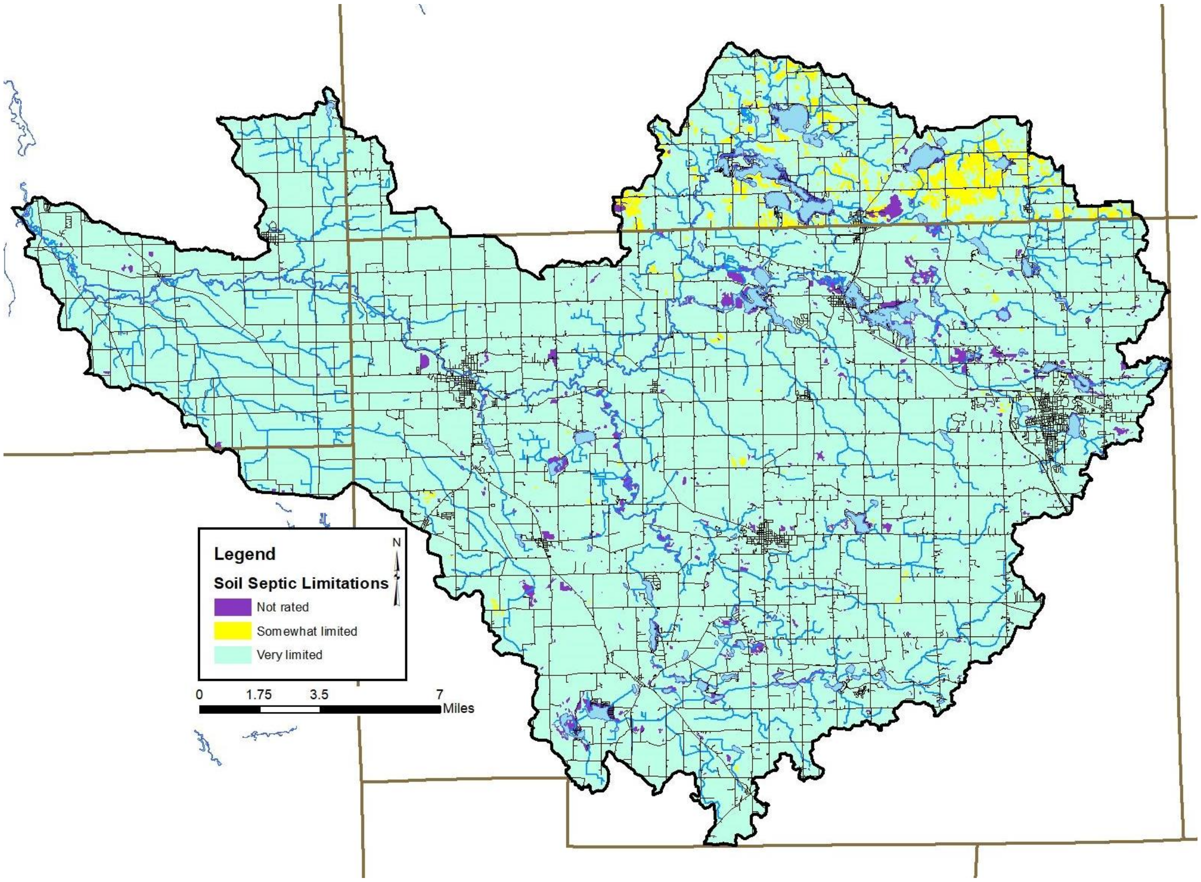


Figure 13. Suitability of soils for septic tank usage in the Upper Elkhart River Watershed.

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 business and can be significant sources of pathogens and nutrients.

A comprehensive database of septic systems within the Upper 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 123,300 individuals live in rural residences within the Upper 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 and 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 ranging in size from small, local plants to larger, publicly owned facilities and school facilities. In total, 14 NPDES-regulated facilities are located within the watershed (Figure 14). Wastewater treatment plant septage sludge is not applied to the land in the Upper Elkhart River Watershed. Table 5 details the NPDES facility name, activity, and permit number. More detailed information for each wastewater facility is discussed below.

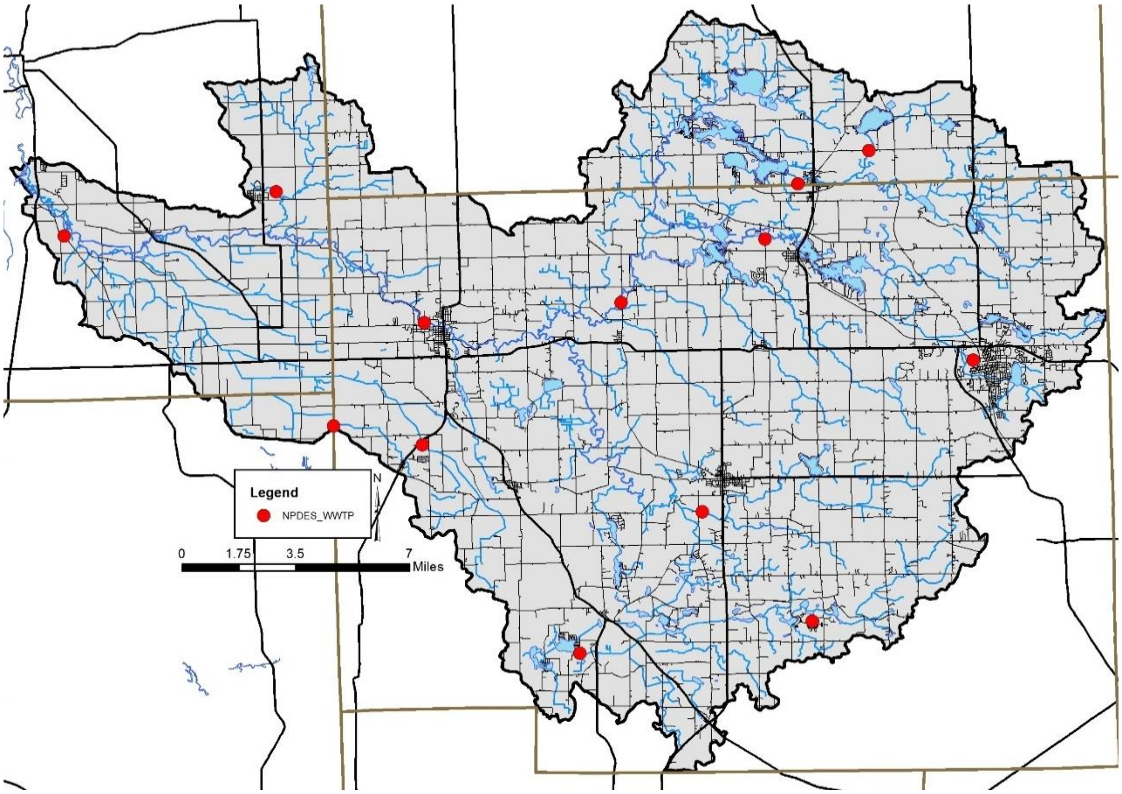


Figure 14. NPDES-regulated facilities in the Upper Elkhart River Watershed.

Table 5. NPDES-regulated facility information.

NPDES ID	Facility Name	Volume (MGD)
IN0055123	ADAMS LAKE RSD	0.069
IN0022144	ALBION WWTP	0.34
IN0038822	BEAR HIGH WOLF LAKE RSD	0.125
IN0030333	CHAIN-O-LAKES STATE PARK	0.06
IN0021814	CROMWELL WWTP	0.15
IN0020656	KENDALLVILLE WWTP	2.68
IN0023582	LIGONIER WWTP	1.5
IN0040363	MILLERSBURG WWTP	0.12
IN0058025	NEW PARIS CONSERVANCY WWTP	0.36
IN0040541	ROME CITY WWTP	0.15
IN0045802	TURKEY CREEK RSD	0.37
IN0063088	WEST LAKES RSD	0.145
IN0021229	WOLCOTTVILLE WWTP	0.25

2.6.3 Municipal Wastewater Treatment

There are 14 wastewater treatment facilities or regional sewer districts located within and discharging to waterbodies in the Upper Elkhart River Watershed including Adams Lake Regional Sewer District (RSD), Albion Waste Water Treatment Plant (WWTP), Bear High Wolf Lake RSD, Cromwell WWTP, Kendallville WWTP, Ligonier WWTP, Millersburg WWTP, New Paris Conservancy WWTP, Rome City WWTP, Skinner Lake RSD, Turkey Creek RSD, West Lakes RSD, Wolcottville WWTP and Chain-O-Lakes State Park as well as three corporate dischargers (Figure 15). The City of Kendallville WWTP facility possesses one combined sewer overflow (CSO) as stated on their website.

Adams Lake RSD currently operates a Class I-SP, 0.069 MGD (Millions of Gallons per Day) waste stabilization lagoon facility operating in controlled discharge mode. The waste stabilization lagoon facility consists of a two-cell lagoon covering 8.68 acres and holding up to 13.9 million gallons with influent and effluent flow measurement and a stream gauge. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. In January of 2021, it was noted that the Adams Lake RSD's Self-Monitoring Program was rated as unsatisfactory. At the time of the inspection, it was identified that a sample log is not being maintained. They began to rectify the monitoring issue the following week and have not been cited since.

The Town of Albion currently operates a Class I-SP, 0.34 MGD controlled discharge waste stabilization lagoon treatment facility. The facility consists of a stream gauge, an influent flow meter, a grit chamber, a fine screen, a primary treatment lagoon, two secondary treatment lagoons with fine- bubble aeration, chlorination/dechlorination facilities and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers by design with one Sanitary Sewer Overflow (SSO) and no bypass points. In August of 2021, the Town of Albion began an improvement project on their wastewater lagoons to add diffusers and additional air to Cell No. 1, relocating the inlet pipe to avoid short-circuiting and installing a baffler to further avoid short-circuiting and increase detention time. Over the course of the first quarter of 2022, the town's ammonia-nitrogen levels were higher than is allowed by their NPDES permit. There was also an instance of effluent limitation violation in January of 2022.

Bear, High and Wolf lakes currently operate a regional sewer district. The RSD is a Class I, 0.125 MGD extended aeration treatment facility consisting of screening, flow equalization, secondary clarification, post-aeration, ultraviolet light disinfection and an effluent flow meter. Sludge handling includes aerobic digestion and storage in a holding tank. Final biosolids are landfilled. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. In April of 2022, their 2019 permit was reissued to accommodate an increase in volume. The plant has a design rating of 0.125 MGD but was only permitted for 0.100 MGD. The permit was modified to reflect the design of the plant. The plant treats sustained peaks of 250,000 gallons per day with hourly peaking capabilities up to 648,000 gallons. There are currently no maintenance issues or concerns at the Bear Lake, High Lake, or Wolf Lake RSDs.

Chain-O-Lakes State Park currently operates a Class I, 0.06 MGD extended aeration treatment facility consisting of a fine screen, a bar screen, phosphorus removal, two aeration tanks, two secondary clarifiers, a sludge holding tank, ultraviolet light (UV) disinfection, an ultrasonic effluent flow meter and post-aeration. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. There are currently no maintenance issues or concerns at the Chain-O-Lakes State Park.

The Town of Cromwell currently operates a Class I, 0.15 MGD oxidation ditch-type treatment facility consisting of a bar screen, an influent flow meter, an oxidation ditch, two secondary clarifiers, post aeration, an ultraviolet light disinfection unit and an effluent flow meter. Sludge handling includes two aerobic digesters and two sludge drying beds. Biosolids are hauled to nearby permitted agricultural land for land application. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. There are currently no maintenance issues or concerns at the Town of Cromwell's WWTP.

The City of Kendallville currently operates a Class III, 2.68 MGD single-stage nitrification activated sludge plant consisting of grit removal, bar screening, primary clarification, aeration, secondary clarification, phosphorus removal, ultraviolet light disinfection, and post aeration. Sludge is to be treated by anaerobic and aerobic digesters. Sludge will be de-watered via a screw press. Final sludge is landfilled. The collection system is comprised of combined sanitary and storm sewers with one CSO location. The permit identifies the CSO overflow location as 002 and has been identified and prohibited in Attachment A of the permit. The collection system is composed of approximately 35 miles of separate storm sewers, 53 miles of separate sanitary sewers and four miles of combined sanitary and storm sewers. There is one privately owned facility near Kendallville, owned by Kraft Heinz Global Inc. (INRM00599).

As of April 2022, the Kendallville Wastewater facility had several violations and an unsatisfactory rating due to effluent discharge. There are multiple instances in the last year of high flow events, as well as trends of unhealthy biomass dating to November 2021. There was also a spike in effluent TSS and ammonia levels in February of 2022 due to the screw press being inoperable for a period of time. Due to the screw press event, the plant biology couldn't fully convert all available nitrogen, and as a result higher levels of nitrates were present in the subsequent sample. Based on the ongoing communications between the City of Kendallville WWTP and IDEM, this is not a new problem. Inspection reports noted continued BOD and TSS loading rates entering the plant which exceed the plant design criteria. These elevated loading rates cause major issues in the treatment process. IDEM and the City of Kendallville traced the issue to Kraft-Heinz which is continually discharging to Kendallville. IDEM and the City of Kendallville are working to formulate a plan to minimize loading, increase treatment capacities to treat the wastewater stream and remain in consistent compliance with the City of Kendallville NPDES permit.

The Lagrange County Regional Sewer District serves the entire county with the exception of four towns, which each have their own sewer system. The plant and discharge are located outside of the Upper Elkhart River Watershed and are therefore not detailed here. However, 646 residences and businesses around Oliver, Martin, Dallas, Hackenburg and Atwood lakes are connected to the Lagrange County RSD.

The City of Ligonier currently operates a 1.5 MGD Class III plant with grit removal, primary clarification, trickling filters, secondary clarifications, phosphorus removal by ferric chloride with a flocculation tank, post aeration and UV disinfection. Anaerobic digested biosolids are thickened by sludge drying beds. Plant design peak flow is 5.33 MGD. The Public Owned Treatment Works also serves Advanced Metal Etching (INP000119) and Carlex Glass of Indiana (INP000631). There are currently no compliance issues for the City of Ligonier's WWTP.

The Town of Millersburg currently operates a Class I, 0.12 MGD dual package extended aeration wastewater treatment facility consisting of a plant lift station, an influent flow meter, a communicator with bar screen bypass and a flow splitter box which divides the flow into two parallel aeration basins. The flow from the aeration basins flows to a common secondary clarifier, a chlorine contact tank, a sulfur dioxide gas dechlorination unit and an effluent flow meter. Sludge handling units include an aerobic digester and two reed-type sludge drying beds. Biosolids are hauled to nearby permitted agricultural land for land application. The collection system consists of 100% separate sanitary sewers by design with no overflow or bypass points. The Millersburg WWTP was cited with a compliance issue in May of 2021 when it was found that their flow meter had not been calibrated since November 2019, when it should be recalibrated every 12 months. Recalibration occurred and the Millersburg WWTP is back in compliance.

The New Paris Conservancy District currently operates a Class II, 0.36 MGD extended aeration treatment facility consisting of an influent flow meter, a fine screen auger, four extended aeration tanks, clarifiers, ultraviolet light disinfection, an effluent flowmeter, digesters and four reed beds. Final solids are hauled off-site to a landfill or are land applied. The collection system consists of 100% separate sanitary sewers by design with no overflow or bypass points. There are currently no maintenance issues or concerns at the New Paris Conservancy District's WWTP.

The Town of Rome City currently operates a Class I, 0.15 MGD aerated lagoon treatment facility consisting of two aerated primary lagoons, chemical feed phosphorus removal, two parallel sludge settling basins, one aerated tertiary pond with tertiary drum filter, ultraviolet light disinfection and influent and effluent flow meters. The collection system consists of 100% separate sanitary sewers by design with no overflow or bypass points. There are currently no maintenance issues or concerns at the Town of Rome City's WWTP.

Turkey Creek Regional Sewer District currently operates Class I, 0.37 MGD oxidation ditch treatment facility consisting of an influent flow-meter, a grinder, grit removal, two oxidation ditches, three secondary clarifiers, chemical addition for phosphorus removal, two aerobic digesters, a septic sludge receiving tank, sand drying beds, ultraviolet light disinfection, post aeration and an effluent flow meter. Much of the Turkey Creek RSD's treatment area is located outside of the Upper Elkhart River Watershed. Waste sludge is land applied. The facility is currently undergoing upgrades which include replacement of the existing grinder with a new mechanical fine screen, addition of a second grit removal tank, addition of a fourth secondary clarifier and installation of an additional pump in the influent lift station to increase the peak hourly design flow of the facility from 1.2 MGD to 1.5 MGD. The average design flow and plant capacity rating will remain 0.37 MGD. It is also proposed to reroute flows from three lift stations within the collection system to divert flows currently conveyed to the Syracuse (approximately 0.074 MGD) and send to this facility. This work was approved under Construction Permit No. 22590 on June 18, 2018, and no permits have been published since.

The West Lakes Regional Sewer District currently operates a Class I, 0.145 MGD extended aeration treatment facility consisting of an influent flow meter, a comminutor, two extended aeration units with fine bubble diffusers, two circular secondary clarifiers, ultraviolet light disinfection, cascade post-aeration and an effluent flow meter. Sludge handling includes an aerobic digester and two sludge drying beds. Final sludge is hauled off-site and landfilled. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. The West Lakes RSD has 400 connections, all of which are located adjacent to the West Lakes. There are currently no maintenance issues or concerns at the West Lakes RSD.

The Town of Wolcottville currently operates a operate a Class II, 0.25 MGD activated sludge treatment facility consisting of fine screens, a surge tank, a two aeration tanks, two secondary clarifiers, ultraviolet light disinfection, cascade post aeration, an effluent pump station, an effluent flow meter, and aerobic sludge digestion. Sludge is hauled off-site to be disposed of at a landfill. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. The facility does have the capability to bypass the aeration tank at the surge tank to the secondary clarifiers; however, it is anticipated to only occur in emergency situations. In October of 2020, paperwork was submitted to propose the relocation of an outfall from the current discharges to the North Branch of Elkhart River. The proposed outfall would be relocated to discharge to an unnamed tributary to West Lakes, which are within two miles downstream of the proposed outfall. The Wolcottville WWTP has had incidences of overflow in the last year, with overflows into a wetland and a private home basement, and are working on improving facility structures to rectify the issue and prevent future overflows.

2.6.4 Unsewered Areas

Approximately 2,307.5 acres of unsewered areas were identified within the watershed (Figure 15). Areas that have at least 25 houses within a square mile outside of the sanitary district boundaries were classified as dense, unsewered areas.

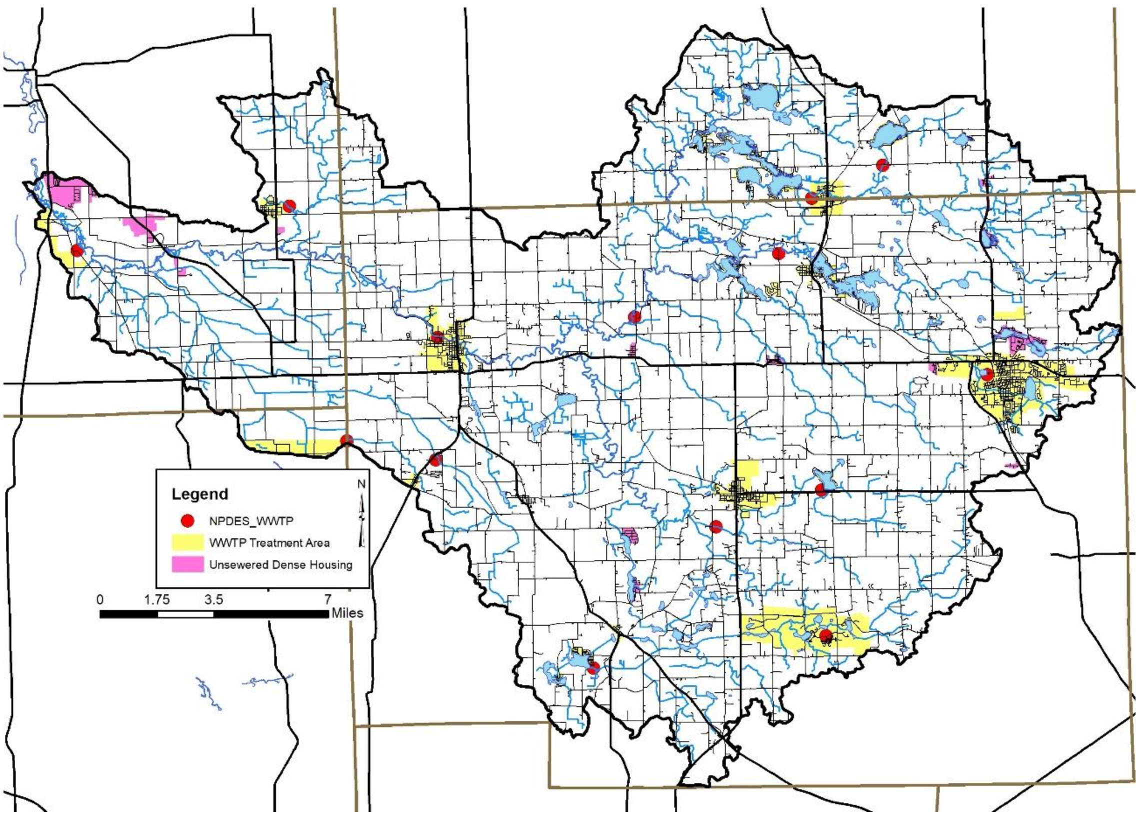


Figure 15. WWTP Treatment Areas and Unsewered Dense Housing in the Upper Elkhart Watershed.

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 Upper Elkhart River Watershed contains approximately 540 miles of perennial streams, regulated drains and artificial paths. Of these, approximately 198 miles are regulated drains, while 131 miles are artificial flow paths which flow through lakes throughout the watershed. The majority of streams in the Upper Elkhart River Watershed are not regulated. 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.

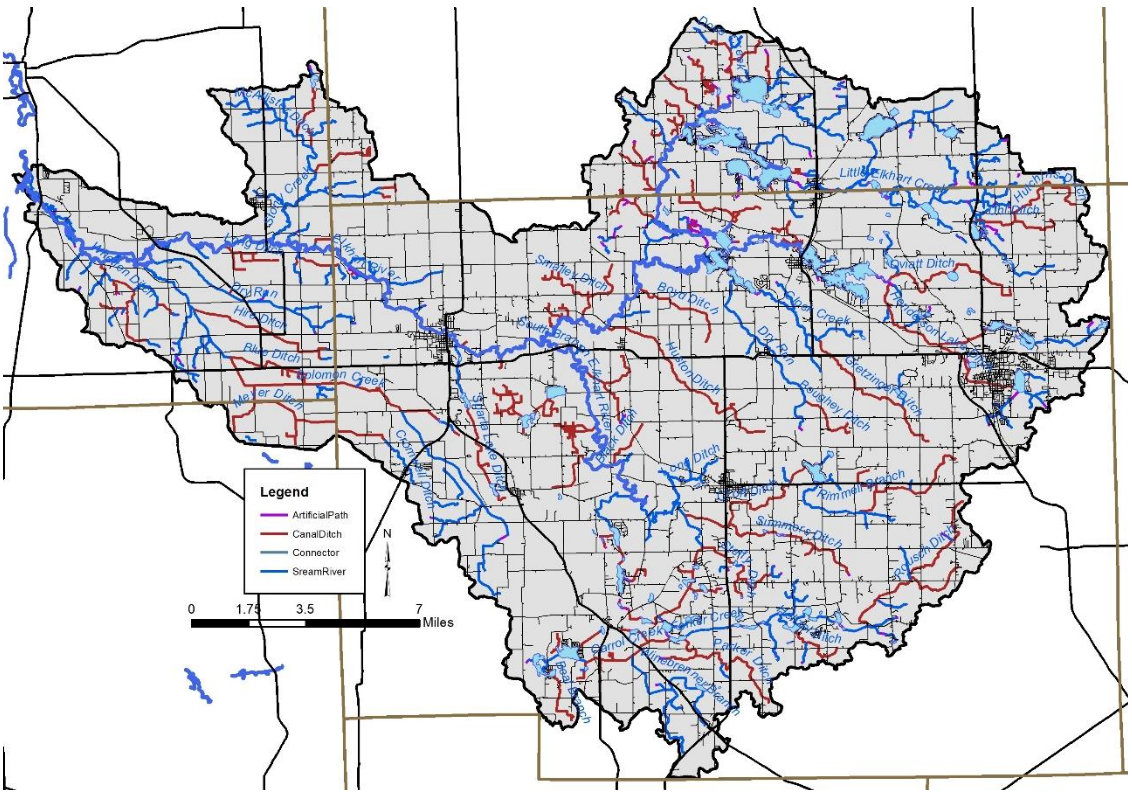


Figure 16. Waterbodies by type in the Upper Elkhart River Watershed.

The North Branch Elkhart River begins downstream of Waldron Lake and flows 18.9 miles. The South Branch Elkhart River flows begins at Port Mitchell Lake and flows 19.8 miles. When the two branches meet west of Wawaka/east of Ligonier, their confluence forms the main stem of the Elkhart River. The Elkhart River flows 26.2 miles from this point to the end of this watershed. The major tributaries to Upper Elkhart River include the North Branch Elkhart River, South Branch Elkhart River, Solomon Creek, Little Elkhart Creek, Dry Run, Huston Ditch, and Stony Creek (Table 6). The Elkhart River is used for recreational kayaking and canoeing as well as fishing, swimming and aesthetic enjoyment. Several tributaries to Upper Elkhart River Creek are also used for canoeing, kayaking, fishing and aesthetic enjoyment.

Table 6. Streams in the Upper Elkhart River Watershed.

Steam Name	Length (mi)	Stream Name	Length (mi)
Beal Branch	1.9	Long Ditch	5.2
Bixler Lake Ditch	1.8	McAllister Ditch	3.9
Black Ditch	1.7	McNutt Ditch	2.1
Blue Ditch	2.6	Meyer Ditch	3.0
Bollinger Ditch	0.9	North Branch Elkhart River	18.9
Boughey Ditch	2.1	Oliver Lake Outlet	1.5
Boyd Ditch	3.4	Oviatt Ditch	2.4
Brown Ditch	0/9	Parker Ditch	4.0
Carrol Creek	3.2	Phillips Ditch	2.1
Clock Creek	5.0	Rimmell Branch	5.2
Croft Ditch	5.6	Rousch Ditch	3.7
Cromwell Ditch	5.0	Schwab Ditch	1.9
Crothers Ditch	2.3	Smalley Ditch	2.0
Dove Creek	2.6	Solomon Creek	16.0
Dry Run	14.0	South Branch Elkhart River	19.8
Elkhart River	26.2	Sparta Lake Ditch	2.7
Forker Creek	1.5	Steffy Ditch	2.8
Gandy Ditch	1.3	Stony Creek	7.0
Gretzinger Ditch	5.4	Summers Ditch	5.1
Heltzel Ditch	2.0	Thumma Ditch	2.8
Henderson Lake Ditch	4.3	Turkey Creek	0.02
Hire Ditch	4.4	Uhl Ditch	3.0
Huston Ditch	7.0	Waterhouse Ditch	1.6
Hutchins Ditch	3.5	Whetten Ditch	1.5
Iden Branch	1.4	Winebrenner Branch	3.5
Jacobs Ditch	0.8	Worley Ditch	2.7
Juday Ditch	3.1	Yarian Ditch	2.1
Little Elkhart Creek	8.1	Unnamed Tributary	291.1

CBBEL (2020) notes that while most Indiana watersheds are dominated by surface water flows, the hydrology of the North Branch Elkhart River is dominated by groundwater. As detailed above in the geology section, 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. CBBEL (2020) completed a mass balance of yearly rainfall, evapotranspiration and infiltration. Their calculations indicate that of the 38 inches of rainfall received annually, less than 2 inches is available for runoff. When runoff occurs, much of it flows through muck soils which absorbs the available water. This results in the North Branch Elkhart River being a groundwater driven system creating a more stable flow of water reaching the mainstem of the Elkhart River. Peak flows are likely mitigated by this flow pattern meaning flows are never as low or as high as they would be with a runoff driven, surface water system. Additionally, CBBEL (2020) notes that the stable, non-flashy flow in the North Branch Elkhart River leads to low erosion rates except in highly disturbed areas.

Elkhart River from Whetten Ditch to the confluence of the South Branch and North Branch of the Elkhart River is recognized as an outstanding river. The South Branch Elkhart River is also recognized as an outstanding river. These rivers are categorized as outstanding as the Elkhart River is: 1) One of 1,524 river segments identified by the National Park Service as part of the 1982 Nationwide River Inventory; 2) An outstanding river identified as part of a state assessment; 3) Considered a state heritage program site; 4) A state-designated canoe/boating route; 5) Considered a national landmark river as designated by the National Natural Landmarks; and 6) a state study river proposed for state protection or designation (NRC, 1997; Figure 17). Stakeholders are concerned with maintaining the recreational value of the Elkhart River and its tributaries due to watershed streams designated as impaired by IDEM for E. coli, nutrients, impaired biotic communities and PCBs.

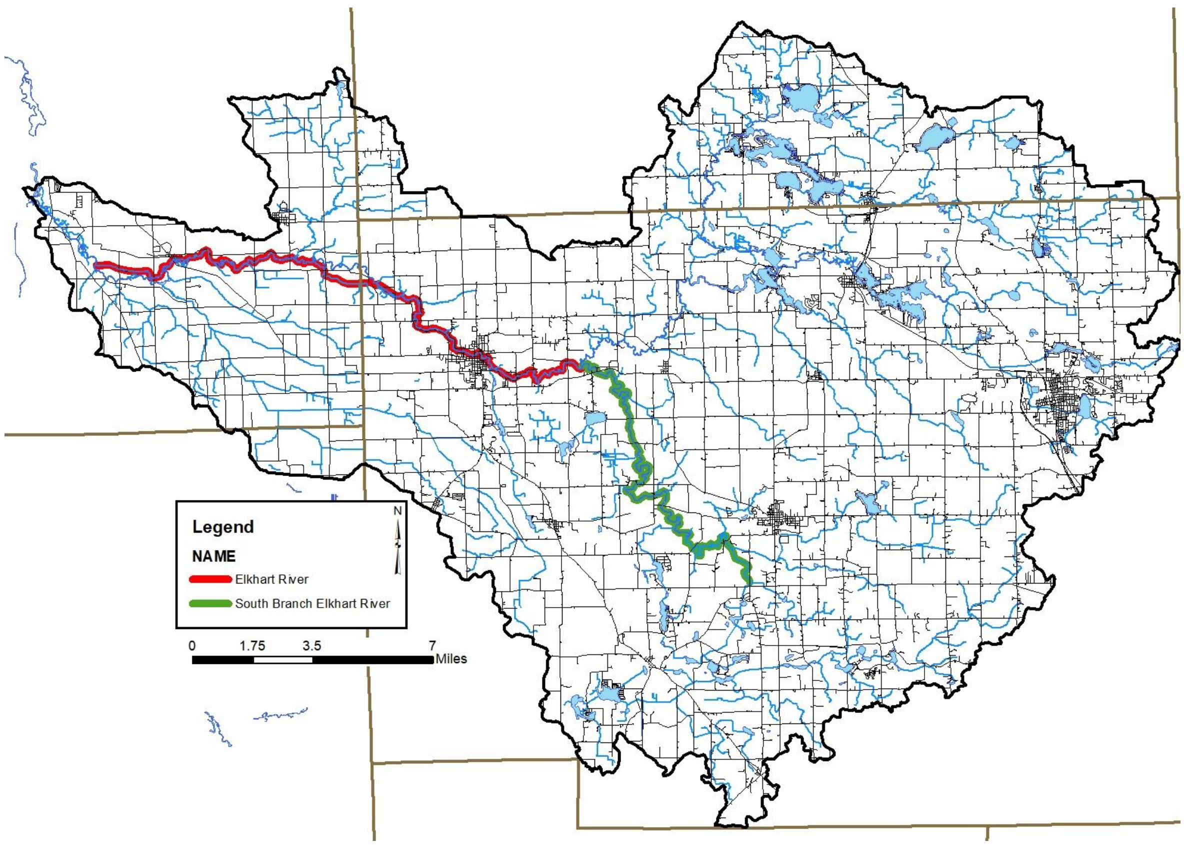


Figure 17. Outstanding rivers in the Upper Elkhart River Watershed.

2.7.2 Lakes, Ponds and Impoundments

Nearly 100 lakes and ponds dot the Upper Elkhart River Watershed landscape. The largest of these include Sylvan Lake, Dallas Lake, Waldron Lake, Oliver Lake, Adams Lake and Witmer Lake, all of which measure 200 or more acres. In total, four dam structures create Lake Maxler, Richard Greiger Lake, Lake Barbara and Sylvan Lake (Figure 18). Many other lakes in the Upper 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. Seven lakes are used by the Indiana BASS Federation for fishing tournaments.

These lakes include the four lakes in the West Lakes chain, Diamond Lake, Sylvan Lake, and Waldron Lake. There are also three low head dams in the Upper Elkhart Watershed, the Baintertown and Benton Dams, both of which are being considered for removal by Elkhart County Parks, and Wolcottville Town Dam.

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

Lake Name	Area (acres)	Lake Name	Area (acres)
Adams Lake	295.3	Long Lane	35.9
Atwood Lake	167.0	Lower Long Lane	61.7
Bear Lake	131.1	Messick Lake	65.1
Beck Lake	9.0	Olin Lake	87.9
Bixler Lake	119.91	Oliver Lake	384.3
Blackman Lake	68.8	Pleasant Lake	18.9
Cree Lake	77.1	Round Lake	95.4
Dallas Lake	396.7	Sand Lake	43.9
Diamond Lake	106.5	Silver Lake	29.5
Engle Lake	40.7	Skinner Lake	120.4
Fish Lake	34.7	Sylvan Lake	628.9
Hackenburg Lake	33.3	Tamarack Lake	82.6
High Lake	102.9	Upper Long Lake	79.8
Indian Lake	13.7	Waldron Lake	395.4
Kuhns Lake	6.3	Witmer Lake	233.1
Latta Lake	37.5	Wolf Lake	13.4
Little Long Lake	71.6		

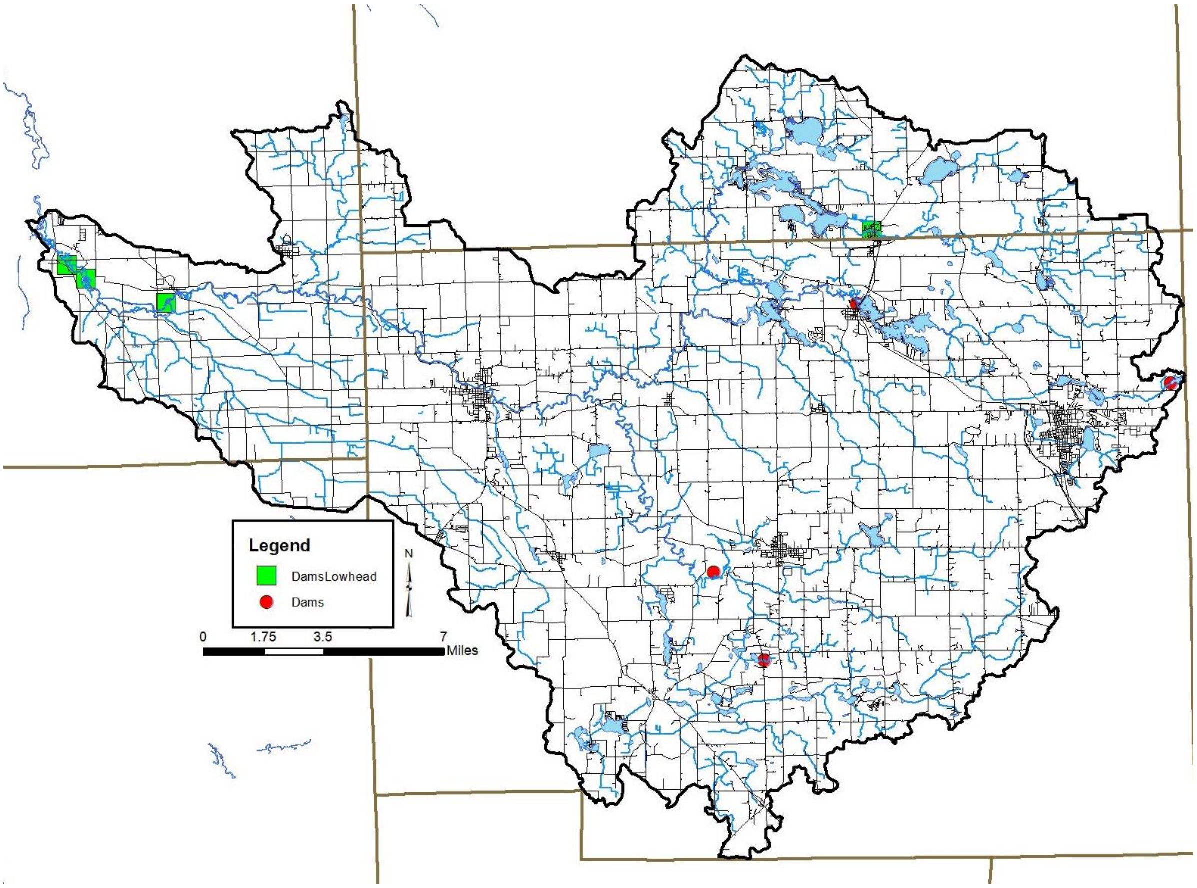


Figure 18. Dams including lowhead dams located in the Upper Elkhart River Watershed.

In an effort to assess stream flow capacity of the North Branch Elkhart River and its floodplain, CBBEL (2020) developed a model to detail how flow moves through the system. CBBEL notes that the North Branch is a groundwater flow system and thus their surface water model is a substitute for a groundwater system. While all details of their effort are not repeated here, it should be noted that each lake reduces the peak discharge flowing from the lake which allows the lake to act as flood storage. In total, more than 2,100 acre-feet of flood storage is provided by the Oliver Lake Chain, Indian or Five Lakes Chain, Sylvan Lake and the West Lakes Chain. Additionally, CBBEL reviewed annual peak flow rates from the Cosperville stream gage noting it varies from 200 to 900 cfs with the last five years of record measuring higher than any other time during the 50 years of record (Figure 19). Additionally, CBBEL reviewed the number of days that lakes measure one foot or more above the legal lake level for both the West Lakes and Indian/Five Lakes Chain (Figure 20). CBBEL notes that the volume of rainfall does not correlate with the number of days above legal lake level.

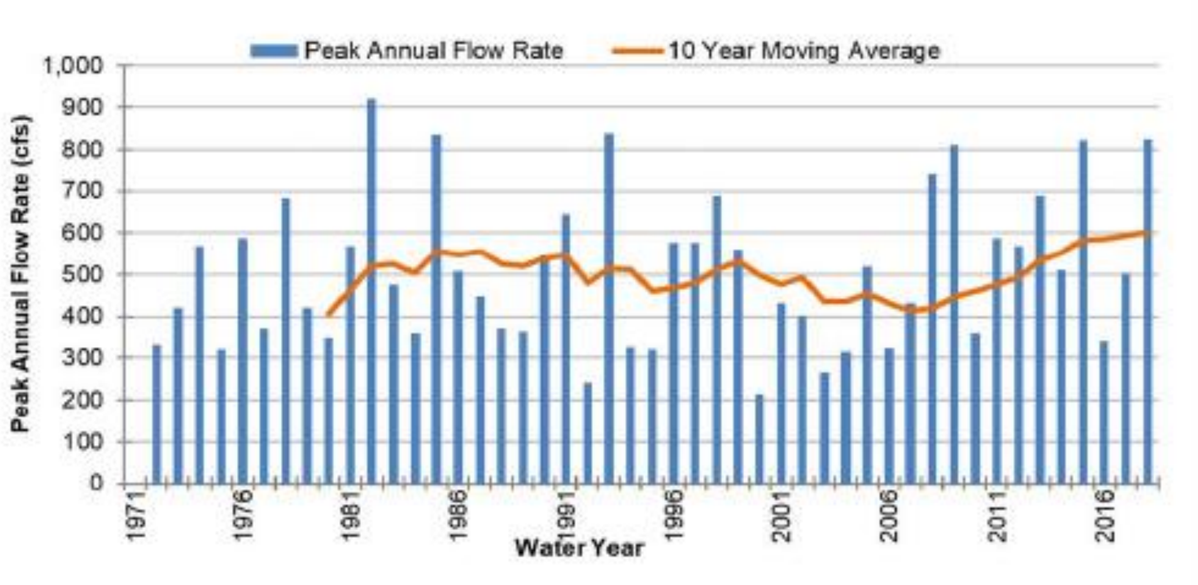


Figure 19. Peak annual flow rate at North Branch Elkhart River at Cosperville, IN USGS gage (CBBEL, 2020).

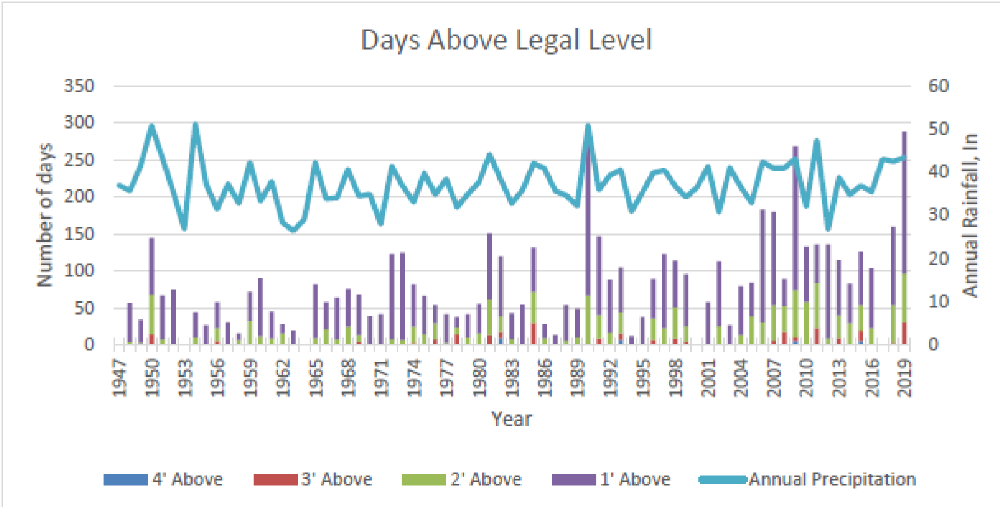


Figure 18: West Lakes Chain - Number of Days above Legal Lake Level

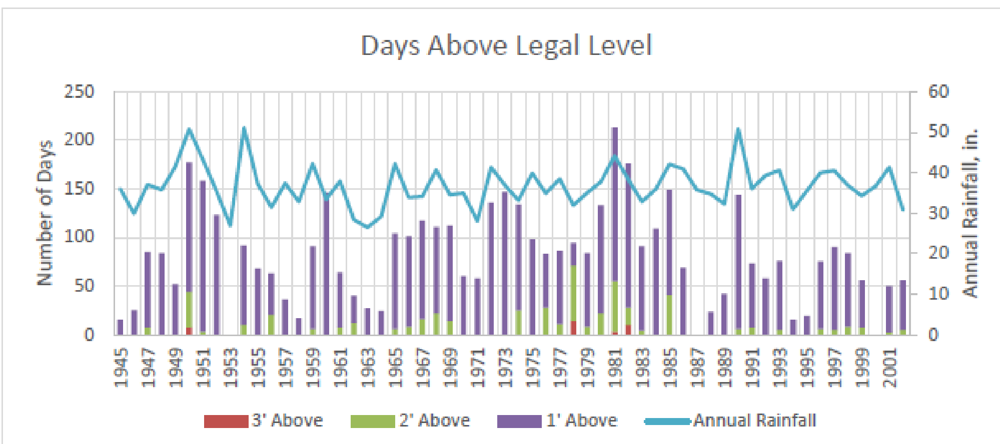


Figure 19: Indian Lakes Chain - Number of Days above Legal Lake Level

Figure 20. Days above legal lake level in the West Lakes Chain and Indian Lakes Chain (CBBEL, 2020).

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 Upper 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 21 details the locations of floodplains within the Upper Elkhart River Watershed. Narrow floodplains lie adjacent to Little Elkhart Creek, Solomon Creek, the mainstem of the Elkhart River, South Branch Elkhart River, Bixler Lake, Sylvan Lake, Tamarack Lake, West Lakes, and several unnamed tributaries. The widest floodplain lies adjacent to the South Branch Elkhart River's confluence with the North Branch Elkhart River. Approximately 8% (19,780 acres) of the Upper Elkhart River Watershed lies within the 100-year floodplain (Figure 21). 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 5,064 acres (2%) of the Upper Elkhart River Watershed floodplain 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 14,716 acres (6%) of the Upper Elkhart River Watershed floodplain is 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.

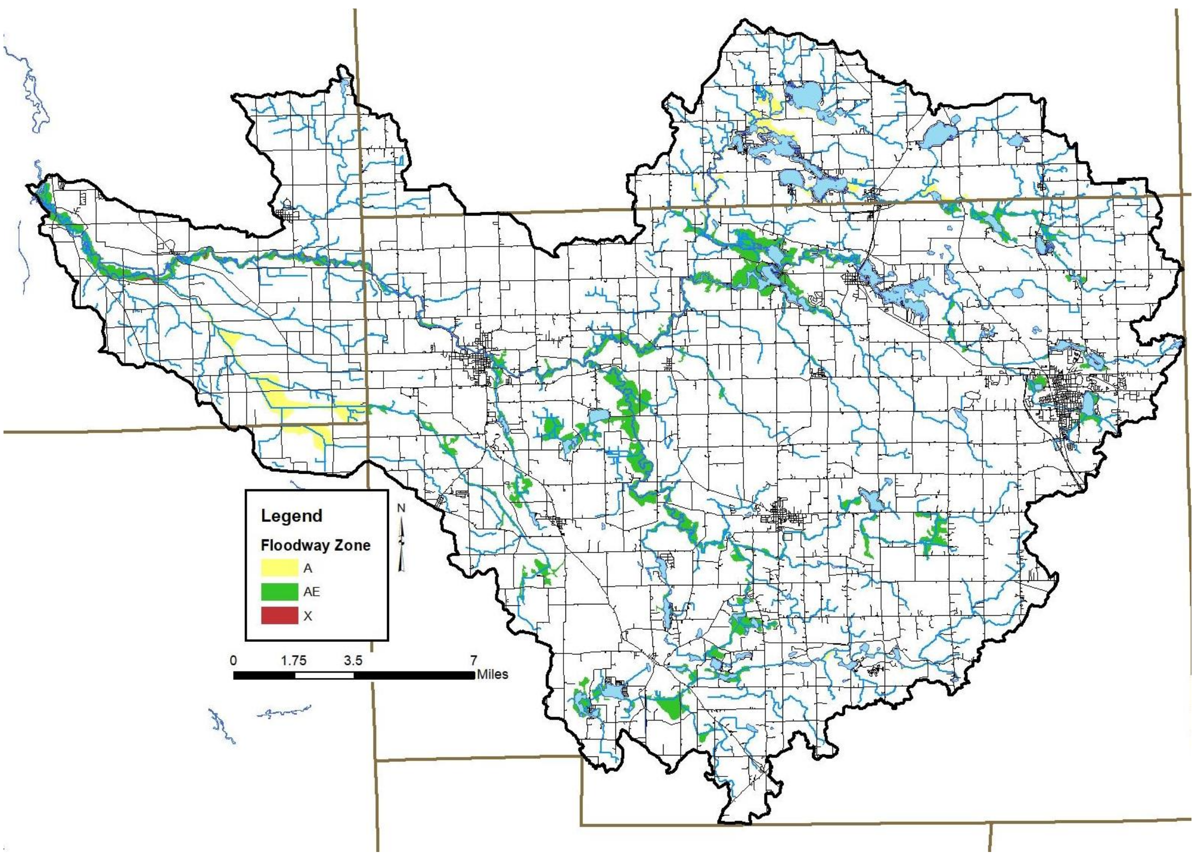


Figure 21. Floodplain locations within the Upper Elkhart River Watershed.

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 45,018 acres, or 17%, of the watershed. When hydric soil coverage is used as an estimate of historic wetland coverage, it becomes apparent that more than 39% of wetlands have been modified or lost over time. This represents more than 28,200 acres of wetland loss within the Upper 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 22 shows the current extent of wetlands within the Upper Elkhart River Watershed. Wetlands displayed in Figure 22 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.

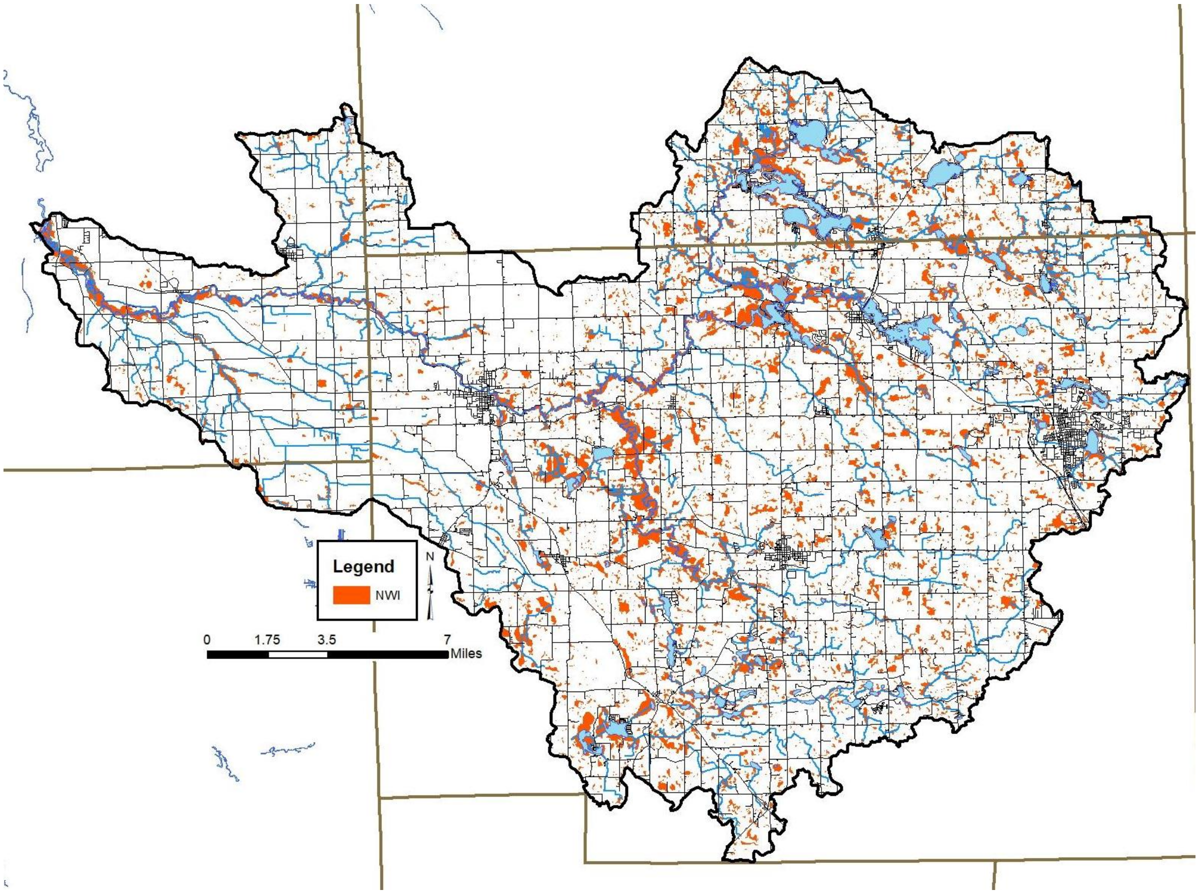


Figure 22. Wetland locations within the Upper Elkhart River Watershed. Source: USFWS, 2017.

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 two municipal separate storm sewer systems (MS4) in the Upper Elkhart River Watershed: City of Kendallville and Elkhart County. 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 23 details the MS4 boundaries for the City of Kendallville MS4 and the Elkhart County MS4.

The City of Kendallville MS4 covers incorporated Kendallville. The Elkhart County MS4 is managed by the Elkhart County Stormwater Partnership which is a cooperative effort covering the town of Bristol, the City of Elkhart, the City of Goshen and Greater Elkhart County. Both the City of Kendallville and Elkhart County Stormwater Partnership have 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 24,714 acres of the Upper Elkhart River Watershed are located in one of the two designated MS4s (Table 8).

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

MS4 Community	Permit ID	Area (Acres)
City of Kendallville	INR040012	3,688
Elkhart County Stormwater Partnership	INR040137	36,147

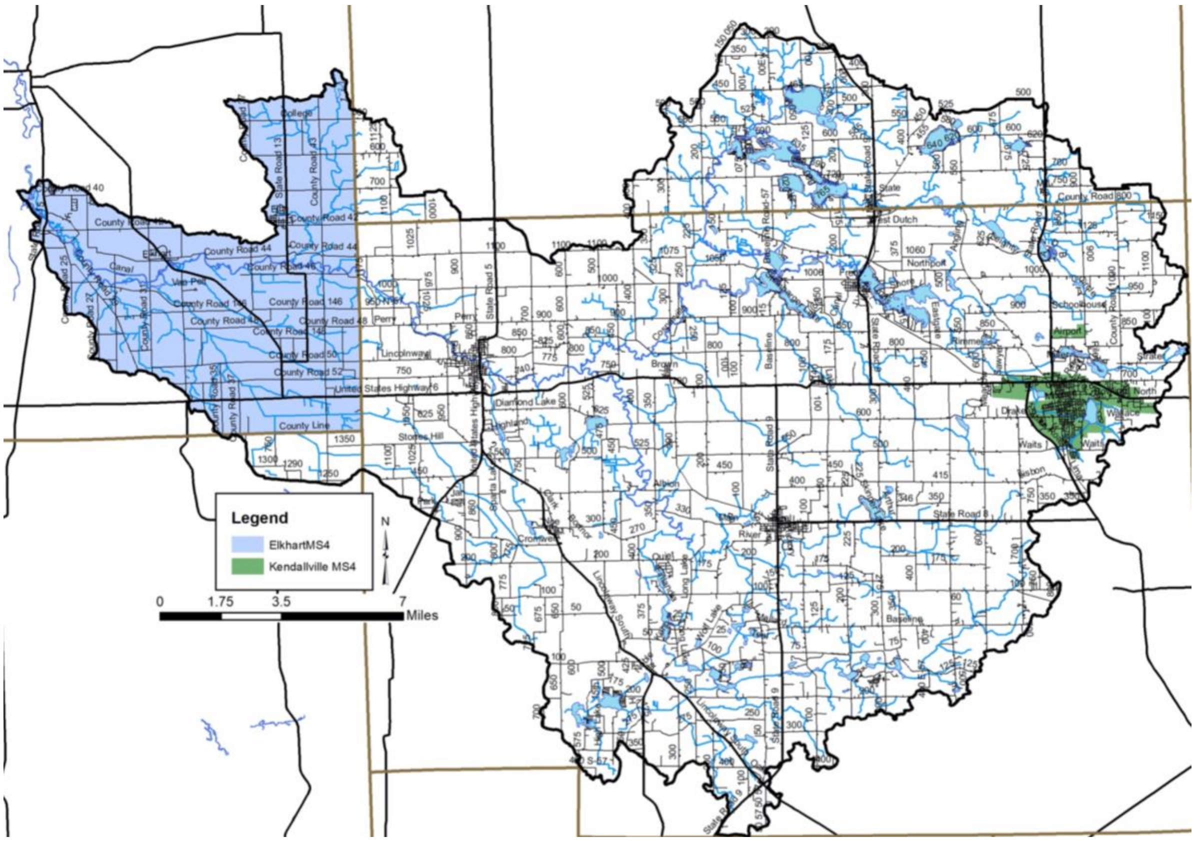


Figure 23. MS4 boundaries for the City of Kendallville and the Elkhart County Stormwater Partnership located within the Upper Elkhart River Watershed.

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 Upper 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 Upper Elkhart River Watershed.

County	PWSID	System Name	Population
Elkhart	5220015	Millersburg Water Company	907
Lagrange	5244010	Wolcottville Water Works	1,035
Noble	5257001	Albion Water & Sewer	2,349
Noble	5257004	Cromwell Water Works	550
Noble	5257006	Eagles Nest Estates	350
Noble	5257008	Kendallville Water Department	9,905
Noble	5257010	Ligonier Water Works	4,405
Noble	5257011	Northport Mobile Home Park	47
Noble	5257016	Sunset Vue Mobile Home Park	51
Noble	5257022	Lakeland Manor Mobile Home Park	66
Noble	5257023	Chain-O-Lakes Correctional Facility	186
Noble	5257024	Rome city Housing Auth. – Warrener Court	94
Noble	5257026	Leisure Lane Mobile Home Park	31

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 Upper Elkhart River Watershed lies within the Northern Lakes Section Region (Figure 24). The Northern Lakes section natural region is best identified by the numerous freshwater lakes of glacial origin which were formed by the Wisconisian 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 Upper 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 northeastern 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.

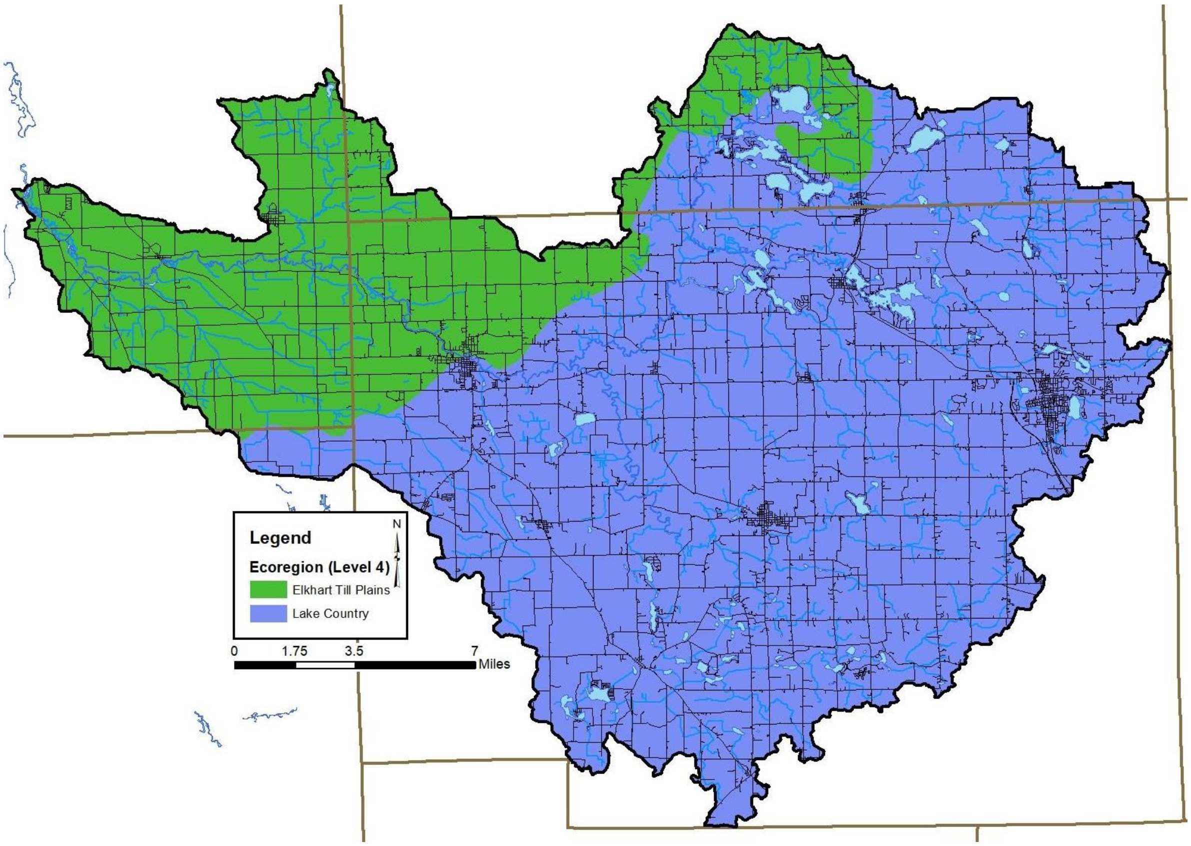


Figure 24. Level 3 eco-regions in the Upper Elkhart River Watershed.

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 Upper 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 for the Upper Elkhart River Watershed was not completed, dog and cat populations were estimated for the watershed as part of the Upper Elkhart River Watershed Management Plan. Statistics reported in the 2012 U.S. Pet Ownership & Demographics Sourcebook were used to find these figures. Specifically, the Sourcebook reports that on average 36.5 percent of households own dogs and 30.4 percent of households own cats. Typically, the average number of pets per household is 1.6 dogs and 2.1 cats. However, pets are likely only a significant source of E. coli in population centers including Kendallville, Albion, Rome City and Ligonier. The estimated number of domestic pets in the Upper 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 91,997 cats and 91,433 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; 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, 296 observations of listed species and/or high-quality natural communities occurred within the Upper Elkhart River Watershed (Figure 25; Davis, personal communication). These observations include three invertebrates, 79 vascular plants, 35 vertebrate animals, including two bat species, 18 birds, two turtle and three snake species, as well as 55 terrestrial high quality natural terrestrial communities including Mesic Floodplain Forest, wet Floodplain Forest, Wet-mesic Floodplain Forest, Northern Lakes Dry-mesic Upland Forest, Northern Lakes Dry Upland Forest, Lake, Pond, Marl Beach, Acid Bog, Circumneutral Bog, Fen, Forested Fen, Marsh, Sedge Meadow, Forested Swamp, and Shrub Swamp. State endangered species include the Upland Sandpiper, American Bittern, Henslow's Sparrow, barn owl, cisco (fish), Dorcas Copper (insect), Indiana Bat, Evening bat, spotted turtle, Blanding's turtle, copperbelly water snake, eastern massasauga, Butler's garter snake, bristly sarsaparilla, wild calla, softleaf sedge, mud sedge, Clinton's woodfern, horse-tail spikerush, purple avens, American water-pennywort, pale vetchling peavine, smooth veiny pea, green adder's-mouth orchid, yellow fringe orchid, Eastern prairie white-fringed orchid, Oakes' pondweed, hooded ladies'-tresses, horned bladderwort, northeastern bladderwort, northern wild-raisin, highbush-cranberry. While state threatened species include red baneberry, bog rosemary, white camas, cuckoo flower, Bebb's sedge, thinleaf sedge, scarlet hawthorn, small white lady's-slipper, small yellow lady's slipper, Hickey's clubmoss, tree clubmoss, Leiberg's witchgrass, spoon-leaved sundew, Robbins' spikerush, slender cotton-grass, green-keeled cotton-grass, bog bedstraw, yellow gentian, great St.John's-wart, tamarack, tall millet-grass, whorled water-milfoil, leafy northern green orchid, small purple-fringe orchid, bog bluegrass, white-stem pondweed, redheadgrass, straight-leaf pondweed, fire cherry, alderleaf buckthorn, autumn willow, purple pitcher-plant, shining lady's-tresses, rushlike aster, false asphodel, lesser bladderwort, small cranberry. State rare species include: midwestern fen buckmoth. These species are found in high quality natural areas identified in the Upper Elkhart River Watershed as well as in forests, wetlands and other natural areas throughout the watershed. Appendix A includes the database results for the Upper Elkhart River Watershed, as well as County-wide listings for Elkhart, Noble, Kosciusko, and Lagrange counties.

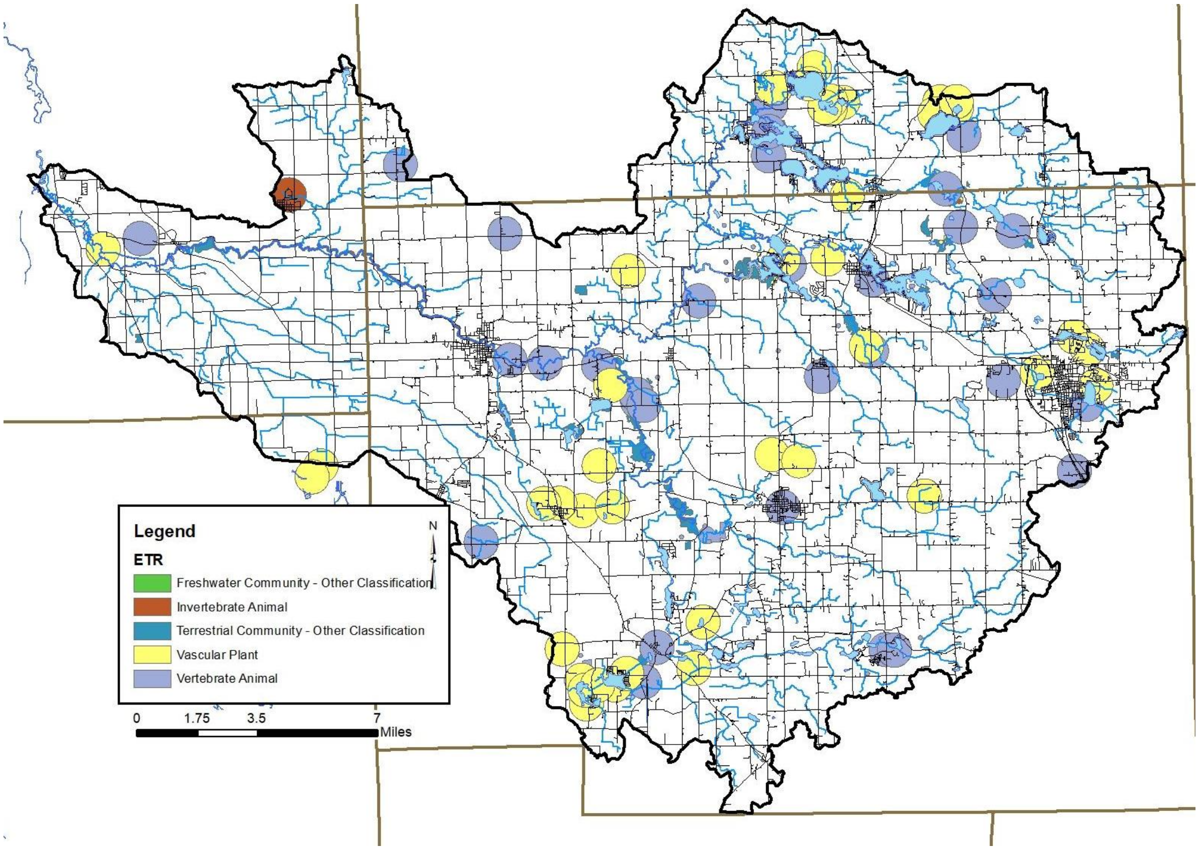


Figure 25. Locations of special species and high quality natural areas observed in the Upper Elkhart River Watershed. Source: Davis, 2021.

2.8.4 Recreational Resources and Significant Natural Areas

A variety of recreational opportunities and natural areas exist within the Upper Elkhart River Watershed. Recreational opportunities include state and local parks, fish and wildlife areas, nature preserves, fairgrounds, golf courses and school grounds (Table 11, Figure 26). There are several significant natural areas located within the Upper Elkhart River Watershed. The Indiana DNR, The Nature Conservancy, ACRES Trust, Lagrange County, Cromwell, Kendallville, Rome City and Ligonier 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 Upper Elkhart River Watershed.

Natural Area	County	Organization	Access
Adams Lake Public Access Site	Lagrange	DNR Fish & Wildlife Division	Open
Atwood Lake Public Access Site	Lagrange	DNR Fish & Wildlife Division	Open
Bear Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Bender (Lloyd W.) Managed Area	Noble	ACRES Land Trust, Inc	Restricted
Bender (Lloyd W.) Nature Preserve	Noble	ACRES Land Trust, Inc	Open
Chain O' Lakes State Park	Noble	DNR State Parks & Reservoirs	Open
Clock Creek	Noble	The Nature Conservancy	Restricted
Cree Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Cromwell Park	Noble	Cromwell Park Board	Open

Natural Area	County	Organization	Access
Curtis Wetland Conservation Area	Noble	DNR Fish & Wildlife Division	Open
Dallas Lake Park	Lagrange	Lagrange Co. Parks & Rec.	Open
Eagle Lake Wetlands Conservation Area	Noble	DNR Fish & Wildlife Division	Restrictions
Engle Lake Access Site	Noble	DNR Fish & Wildlife Division	Open
Fish Lake (Elkhart) Public Access Site	Elkhart	DNR Fish & Wildlife Division	Open
Gene Stratton Porter State Historic Site	Noble	DNR State Museum & Historic Sites	Open
Hammer (Art) Wetlands Addition	Noble	ACRES Land Trust, Inc	Open
Hammer (Art) Wetlands Nature Preserve	Noble	ACREA Land Trust, Inc	Open
Kelly Street Park	Noble	Rome City Park Board	Open
Kendallville Fairgrounds	Noble	Kendallville Park Board	Open
Leacock Woods	Elkhart	The Nature Conservancy	Open
Little Long Lake Public Access Site	Noble	Unknown	Unknown
Lonidaw Nature Preserve	Noble	ACRES Land Trust, Inc	Open
Mainland Park	Noble	Rome City Park Board	Open
Mallard Roost Wetland Conservation Area	Noble	DNR Fish & Wildlife Division	Restrictions
Martin Kenny Memorial Park	Noble	Ligonier Park Board	Open
Martin Lake Nature Preserve	Lagrange	ACRES Land Trust, Inc	Open
Mendenhall Wetland Conservation Area	Noble	DNR Fish & Wildlife Division	Restrictions
Merry Lea Nature Preserve	Noble	Goshen College	Open
Northport Feeder Dam	Noble		Restricted
Olin Lake (Raber Tract TNC)	Lagrange	The Nature Conservancy	Restricted
Olin Lake Managed Area	Lagrange	DNR Nature Preserves	Restricted
Olin Lake Nature Preserve	Lagrange	DNR Nature Preserves	Open
Oliver Lake Access Site	Lagrange	DNR Fish & Wildlife Division	Open
Rome City Wetland Conservation Area	Noble	DNR Fish & Wildlife Division	Restrictions
Round Lake Wetlands	Noble	ACRES Land Trust, Inc	Open
Sacarider Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Skinner Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Skinner Lake Surplus Parcel	Noble	DNR Fish & Wildlife Division	Restricted
Sparta Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Spurgeon (Edna W.) Nature Preserve	Noble	ACRES Land Trust, Inc	Open
Swamp Angel Nature Preserve	Noble	The Nature Conservancy	Restricted
Sylvan Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Upper Long Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open
West Lakes Conservacy Inc Tract	Elkhart	DNR Fish & Wildlife Division	Restrictions
Westler Lake Public Access Site	Lagrange	DNR Fish & Wildlife Division	Open
Whirledge Wetlands Conservation Area	Noble	DNR Fish & Wildlife Division	Restrictions
William Malle Memorial Public Access Site	Noble	DNR Fish & Wildlife Division	Open
Wolf Lake Public Access Site	Noble	DNR Fish & Wildlife Division	Open

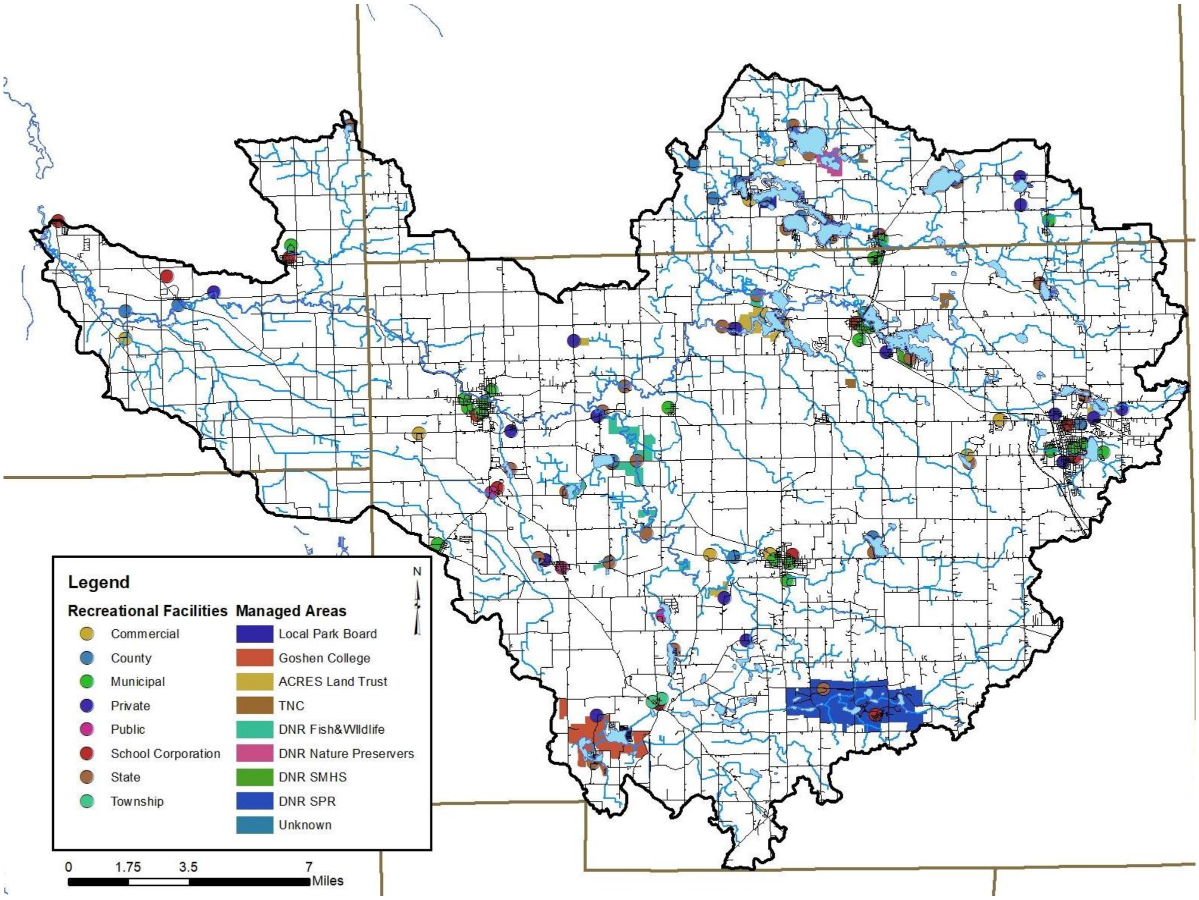


Figure 26. Recreational opportunities and natural areas in the Upper Elkhart River Watershed.

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 Upper Elkhart River Watershed is covered by agricultural land uses (173,561.6 acres or 67%; (Table 12, Figure 27) which consists of pastureland (18,689.3 acres or 7%) and row crop agriculture (154,872.3 acres or 60%). Nearly 16% of the watershed is mapped in open water and wetlands. Developed open space and low, medium and high density developed land covers 8% of the watershed, while forest and grassland covers the remaining 8% of the watershed.

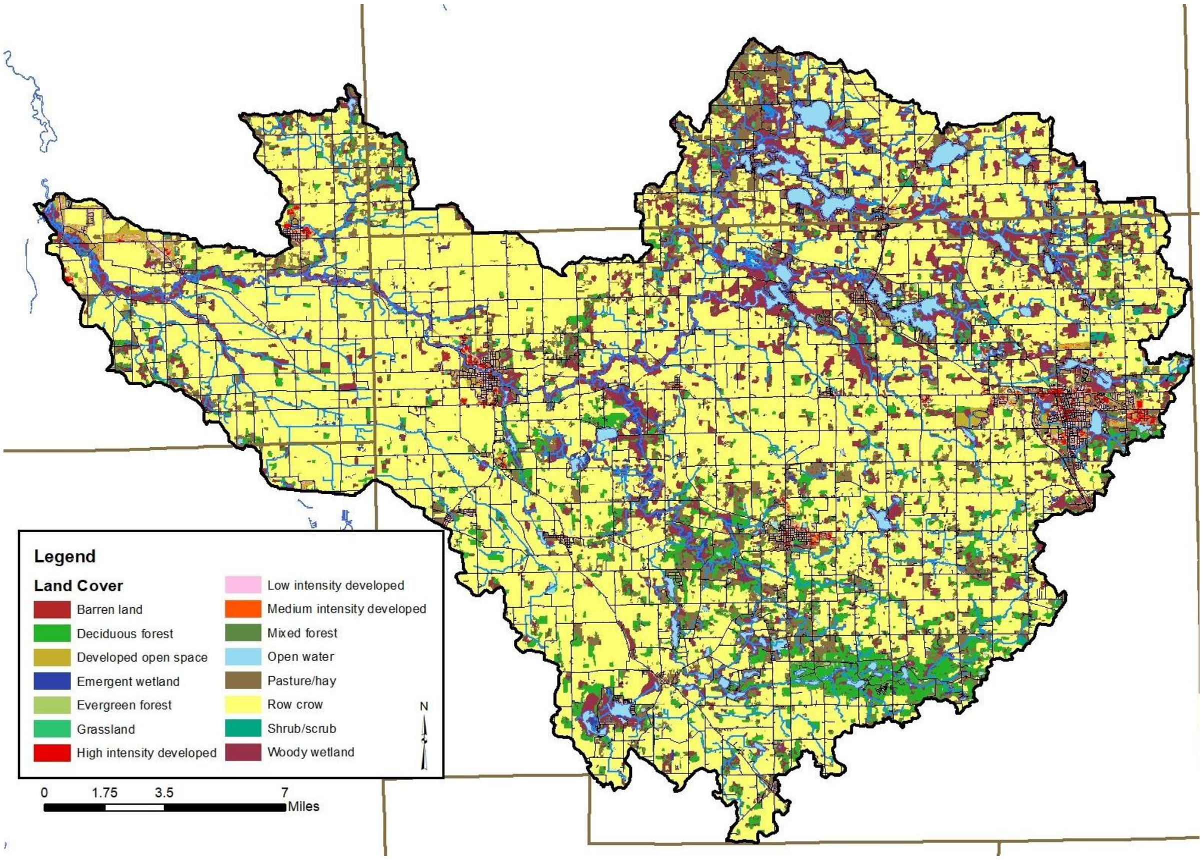


Figure 27. Land use in the Upper Elkhart River Watershed. Source: NLCD, 2016.

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

Classification	Area (acres)	Percent of Watershed
Cultivated crop	154,872	60%
Woody wetland	34,781	14%
Pasture/hay	18,690	7%
Deciduous forest	17,701	7%
Developed open space	12,320	5%
Open water	6,125	2%
Low intensity developed	5,987	2%
Emergent wetland	2,657	1%
Medium intensity developed	1,520	0.6%
Mixed forest	1,270	0.5%
Shrub/scrub	1,399	0.5%
High intensity developed	717	0.2%
Grassland	398	0.1%
Evergreen forest	386	0.1%
Barren land	125	0.0%
Entire Watershed	258,948	100%

Source: USGS, 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, Lagrange and Noble counties was compiled for 2021 (Table 13; ISDA, 2023 A-B). As reported by ISDA, 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, 2023).

County	Corn (%)	Soybeans (%)
Elkhart	51%	68%
Kosciusko	33%	52%
Lagrange	52%	73%
Noble	83%	92%

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, 2021). These data indicate that corn (297,996 acres planted in Elkhart, Lagrange, Kosciusko and Noble counties) and soybeans (233,750 acres planted in Elkhart, Lagrange, 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 21,962 tons of nitrogen and 10,864 tons of phosphorus are applied annually within the counties in which the Upper Elkhart River Watershed is located (Table 14).

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

Nutrient	Acres of Corn	% of Area Applied	Applications (#/year)	Rate/Application (lb/acre)	Total Applied/Year (tons)
Nitrogen	297,996	100	2.2	67	21,962
Phosphorus	297,996	93	1.4	56	10,864

Source: NASS, 2007; NASS, 2021

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 a little over 185 tons of atrazine and approximately 174 tons of glyphosate are applied to cropland in the Upper Elkhart River Watershed counties annually (Table 15).

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

Crop	Acres	Application Rate (lb/acre)	Total Applied (lbs)	Total Applied/Year (tons)
Corn (Atrazine)	297,996	1.24	369,515	185
Corn (Glyphosate)	297,996	0.60	178,798	89
Soybeans (Glyphosate)	233,750	0.73	170,637	85

Source: NASS, 2006; NASS, 2021

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 Upper 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 operation 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 13 CAFOs and 25 CFOs located in the watershed (Figure 28). In total, these facilities are permitted to house up to 127,726 pigs, 259 beef cattle, 6,630 dairy cattle, 262,105 chickens, 100 sheep and 194 horses. In total, 794 small, unregulated animal farms containing more than 13,170 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 410,188 animals per year are housed in CAFOs, CFOs and on unregulated farms in the watershed, generating approximately 963,298 tons of manure per year spread over the watershed. This volume of manure contains approximately 8,692,474 pounds of nitrogen, 6,883,014 pounds of phosphorus and 5.49E+19 col of E. coli.

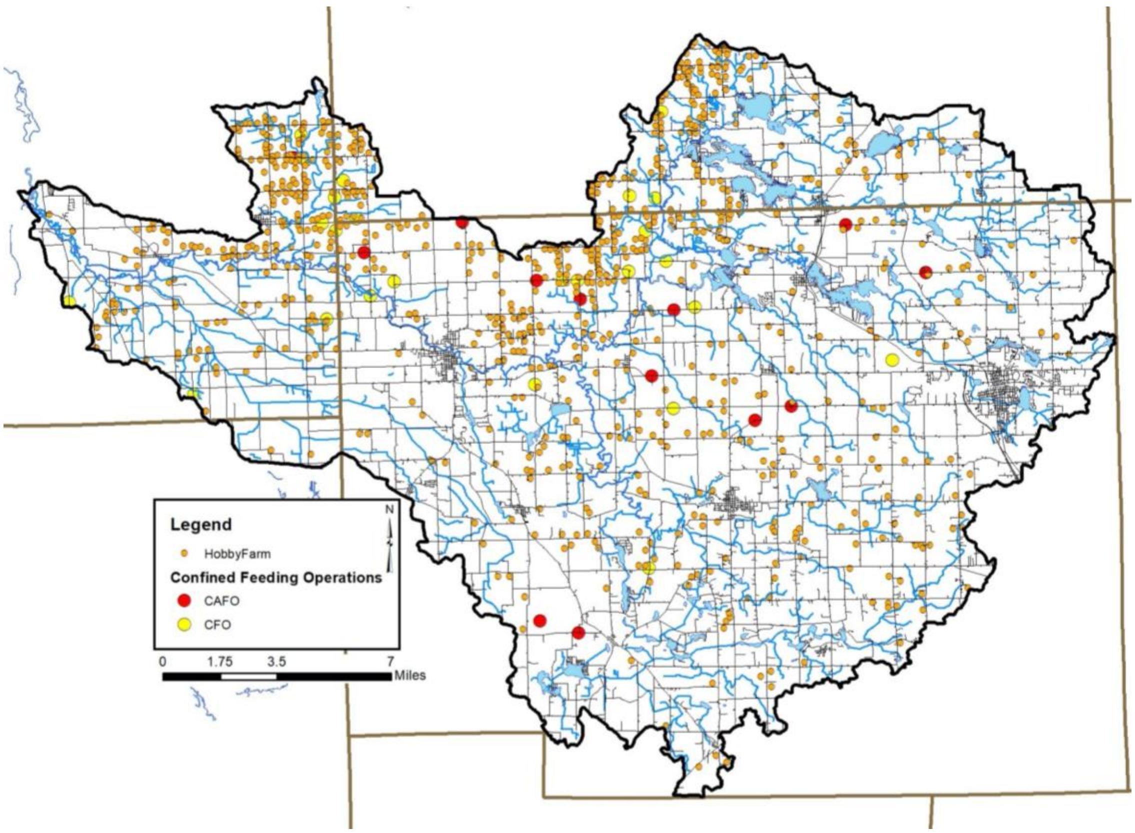


Figure 28. Confined feeding operation and unregulated animal farm locations within the Upper Elkhart River Watershed.

2.9.3 Natural Land Use

Natural land uses including forest, wetlands, and open water cover approximately 25% of the watershed. Approximately 18,917 acres or 7% 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 20,544 acres or 8% of the watershed (Table 12). Most developed areas are associated with the Cities of Kendallville and Ligonier, as well as the various lake communities in the northern 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.

2.9.5 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 two MS4 Communities in the watershed, covering more than 24,713 acres of the Upper Elkhart River Watershed.

2.9.6 Legacy Pollutant Remediation Sites

Remediation sites including industrial waste, leaking underground storage tanks (LUST), open dumps and brownfields are present throughout the Upper Elkhart River Watershed (Figure 29). Most of these sites are located within the developed areas of the watershed including Wolcottville, Ligonier, Albion, Rome City and Kendallville. In total, 32 industrial waste sites (RCRA), 150 underground storage tanks of which 67 are considered LUST facilities, five voluntary remediation project (VRP) locations, three solid waste sites and six brownfields are present within the watershed.

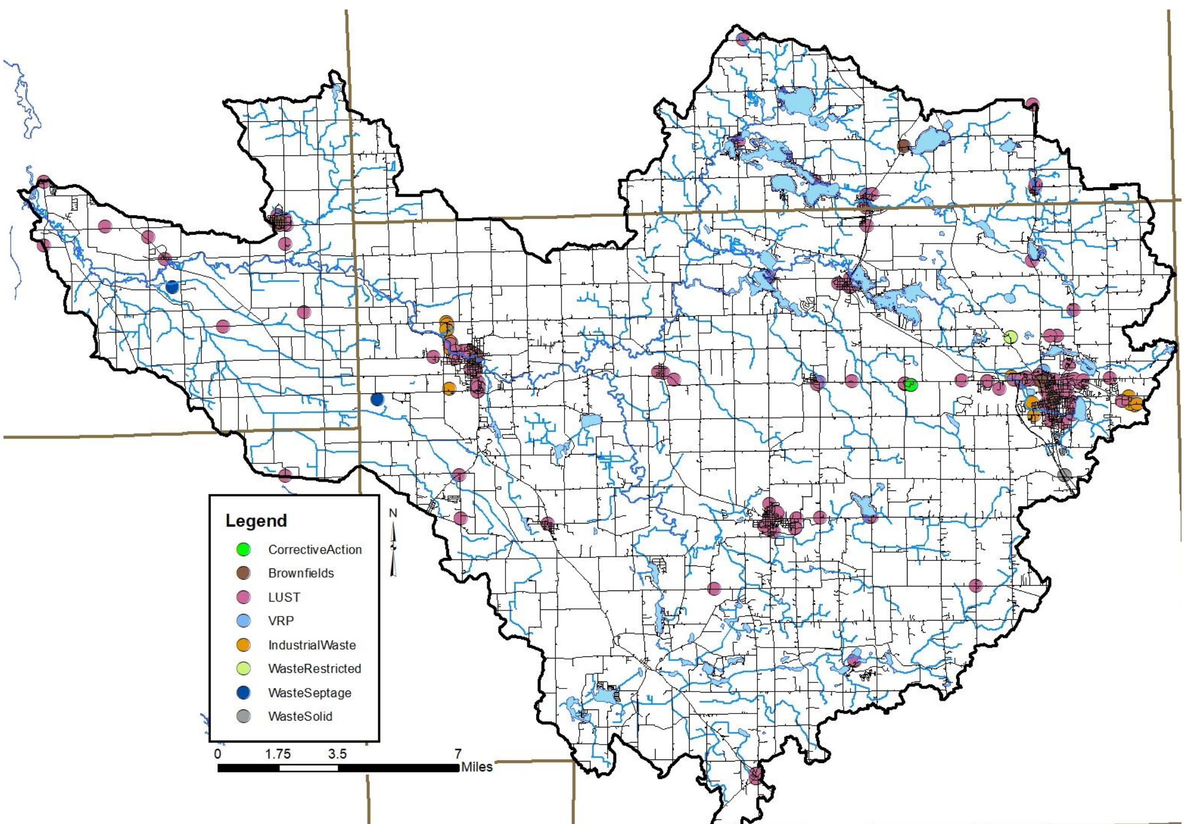


Figure 29. Industrial remediation and waste sites within the Upper Elkhart River Watershed.

2.10 Population Trends

The Upper Elkhart River Watershed is a mix of relatively sparsely populated areas and urban centers in general. The City of Kendallville, City of Ligonier and Town of Albion house the highest density populations. Table 16 details the population of each County in the Upper Elkhart River Watershed. These data indicate that three of the counties, Elkhart, Kosciusko and Lagrange, are growing; however, Noble County saw a 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 Upper Elkhart River Watershed.

County	2000	2010	2020
Elkhart	182,791	197,559	207,047
Kosciusko	74,057	77,358	80,240
Lagrange	34,909	37,128	40,446
Noble	46,275	47,536	47,457

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 Upper Elkhart River Watershed indicate that 86% of the population is rural residents while 14% 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 Upper 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	207,047	28,987	0	28,987	14.0%
Kosciusko	80,240	883	0	883	1.1%
Lagrange	40,446	5,096	957	4,139	12.6%
Noble	47,457	34,311	19,832	14,479	72.3%
Total	**375,190**	**69,277**	**20,789**	**48,488**	**100%**

2.11 Planning Efforts in the Watershed

Multiple plans have encompassed portions of the Upper 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 Upper 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

Bixler Lake Feasibility Study (1990)

In May of 1990, International Science & Technology, Inc. (IS&T) submitted a report to the Kendallville Parks and Recreation Department concerning the restoration of Bixler Lake. This glacially formed water body experienced accelerated sedimentation in the late 1980s. In 1986, IDEM placed Bixler Lake in its Class Two category of intermediate quality lakes. The water bodies in this class are known to be adversely impacted by human activities and are moving slowly toward moderate to advanced stages of eutrophication. Recommendations created by IS&T concluded through this study included:

- Review wastewater treatment and park runoff management plans to ensure adequate capacity for peak use periods and implement appropriate maintenance routines; and install any new septic systems in appropriate soil types, with adequate distance buffers between leach fields and lake/tributary systems.
- Apply BMPs including encouraging the use of agricultural BMPs, protecting wetland areas (especially along tributaries) that act as sediment/nutrient filters for incoming pollutants, implementing effective erosion control measures at construction sites and in residential areas and developing and enforcing appropriate zooming and development planning regulations for controlling the production of off-site pollutants.
- Perform in-lake restoration as needed including aquatic plan treatment only to impact navigational problems, following management recommendations for aquatic plants and assessing the lake's fishery to monitor carp population growth as needed.

Sylvan Lake Feasibility (1990)

In May of 1990, Crisman submitted a feasibility report to the Sylvan Lake Improvement Association. Sylvan Lake is a eutrophic lake in Noble County composed of four interconnected basins. Water quality began to deteriorate early in the 20th century associated with untreated sewage from the town of Kendallville so that by the 1930's, management problems were apparent for algal and macrophytes and the gamefish population was being altered. The lake has been the subject of several management investigations including a series of winter drawdowns during the 1970s and a fish eradication program in 1984. The most dramatic improvement to water quality occurred as a result of the latter, and macrophytes have begun to recolonize the lake after a prolonged period of near total absence. Crisman (1990) noted that the principal contributing factors for the eutrophication of Sylvan Lake has been the sewage from the town of Kendallville and runoff from agricultural areas of the watershed. Together, these factors contribute an estimated 59% of total phosphorous loading annually to Sylvan Lake. Crisman (1990) recommended the following:

- Expand the wetland at the eastern end of Gravel Put Basin to serve as a nutrient trap for the principal streams entering the lake.
- Identify additional wetland construction sites along Henderson Lake Ditch to trap nutrients from the town of Kendallville.
- Consider restoration of Henderson Lake in any future lake or watershed planning efforts as this lake receives the sewage from Kendallville it has becoming increasingly infilled in recent years and will act as a significant nutrient load to Sylvan Lake for decades via sediment release of phosphorus even if the nutrient loading from Kendallville is totally eliminated.

Cree and Schockopee Feasibility Study (1990)

In October of 1990, IS&T submitted a report to the Cree Lake Association of Kendallville concerning the restoration of Cree and Schockopee Lakes. Cree Lake experienced accelerated loss of depth and severe plant grown problems in the canal system located along the lake's southeastern shore. Schockopee Lake, also glacially formed, is situated directly upstream from Cree Lake and exerts considerable influence on the quality of the Cree system. In the 1970's, IDEM placed both lakes in its Class Two category of intermediate-quality lakes. The water bodies in this class are known to be adversely impacted by human activities and are moving slowly toward moderate to advanced stages of eutrophication. Recommended actions created by IS&T included:

- Become familiar with agricultural BMPs and work with the local NRCS District Conservationist, Noble County SWCD, and IDNR to encourage area farmers to install appropriate BMPs in locations deemed critical for preserving the quality of the lake resources.
- Homeowners along the main body and canal system of Cree Lake should review alternatives to the current septic system arrangement.
- Initiate a design study for the removal of the organic sediments in the Cree Lake canal system. It is recommended that the canals be dredged down to the original hard bottom.

Ten Lakes Feasibility Study (1992)
In February 1993, F. X. Browne Associates, Inc. (FXBrowne) prepared a feasibility study for the South-Central Lagrange County Water Quality commission. This report presents the water quality and modeling results for the LARE T by 2000 studies of ten Indiana chain lakes in Lagrange County. These ten lakes include Adams Lake, Atwood Lake, Dallas Lake, Hackenburg Lake, Martin Lake, Messick Lake, Olin Lake, Oliver Lake, Westler Lake and Witmer Lake. Watershed-wide recommendations include:

- A watershed management district serving the entire ten Lagrange County lakes should be established. The watershed management district would be responsible for overseeing all activities that may impact the water quality of all of ten lakes.
- Implement agricultural best management practices, homeowner best management practices, wastewater management practices and stabilization practices for both roadways and streambanks.
- Establish erosion control and stormwater runoff ordinances within the boundaries of the ten Lagrange County lakes watershed.
- Failing septic systems should be identified and action taken to repair or replace them.
    - A wastewater treatment facility feasibility study should be initiated at Atwood Lake, where septic systems contribute an estimated 22 percent of the annual phosphorus load to the lake.
    - Loading from septic systems is only a small percentage of the annual budgets on the remaining lakes excluding Adams Lake. An effort to reduce septic impacts should be investigated.
- The watershed management district should apply for funding to implement agricultural BMP's.
- Assess the impacts of the county landfill on the water quality of Dove Creek including investigating existing groundwater and stream water quality data collected near this landfill.
- Consider the use of benthic barriers for macrophyte control around private docks should be implemented wherever possible.
- Consider spot dredging areas of sediment accumulation within all lakes including in lake channels.
- The use of alum for nutrient inactivation and aeration are recommended for some lakes if land treatment fails to improve water quality in the lake. Specifically, FXBrowne recommended these techniques for Adams Lake (alum), Atwood Lake (aeration), Messick Lake (dredging), Oliver Lake (dredging), Martin Lake (aeration), Oliver Lake (dredging), Westler Lake (aeration) and Witmer Lake (alum).

Upper Long Lake Diagnostic Study (1998)
In April of 1998, Gensic & Associates and Environmental Testing released a diagnostic study of the restoration of the Upper Long Lake Watershed. The study was funded by the Upper Long Lake Association with the aid of a grant from the IDNR, Division of Soil Conservation “T-by-2000” LARE program.

Members of the Upper Long Lake Association became increasingly concerned with the perceived deterioration of lake water quality. Principal areas of concern included aquatic plant density and algal blooms, quality of runoff water in inflowing ditches and tiles, sediment deposition at inlets and a declining fishery. The growing environmental awareness of local residents, and the desire to reverse the causes of cultural eutrophication of the lake were primary factors for the authorization of the study. Recommendations for watershed improvement include:

- Institutional actions by the Upper Long Lake Property Owners Association to better enable the organization to deal with environmental and lake and watershed management issues.
- Implementation of best management practices in both agricultural areas and developed lake shorelines areas of the watershed.
- Restoration or construction of wetland areas or construction of detention ponds in the watershed to reduce peak runoff flows and alleviate sedimentation.

Indian Lakes Improvement Project (2001)
In January of 2001, Commonwealth Biomonitoring conducted a feasibility study to assist the Five Lakes Conservation Club. This study was funded by a grant from the IDNR Division of Soil Conservation through the Indiana Lake and River Enhancement (LARE) Program. All available information on lake quality was assembled. Then new information was gathered on lake water budgets, rare biological resources, watershed land use, stormwater management, property ownership, wetland quality, sediment nutrient values, wastewater treatment and bacteria. The new information was used to identify problems in the lakes and work toward economical solutions. Excessive phosphorus loading was identified as the major impediment to water quality in the Indian Lakes chain. Four major phosphorus control treatments were identified:

- Sediment removal in lake channels receiving off-site drainage and from the Mill Pond on Little Elkhart Creek including removing 200 cubic meters of sediment from the southeast Witmer Lake, southwest Witmer Lake, north Witmer Lake and northeast Westler Lake tributaries, 240 cubic meters of sediment from the main Westler Lake tributary and 1360 cubic meters of Witmer Lake channels. In total 2400 kg/year of phosphorus would be removed at an estimated cost of $40,000 for dredging and project oversight.
- Continue to implement the on-going watershed land treatment project in partnership with the DNR LARE program ($54,000 in 1999).
- Consider additional wastewater treatment at the Adams Lake Regional Sewer District.
- Implement stormwater runoff treatment in the Town of Wolcottville.
- Consider creating a volunteer program of algae harvesting.

Whetten Ditch, Solomon Creek and Dry Run Watersheds Diagnostics Study (LARE, 2002)
In August of 2002, J.F. New & Associates (JFNew) released a diagnostic study for the Whetten Ditch, Solomon Creek and Dry Run Watersheds that was developed through funding from the IDNR LARE Program and the Elkhart County SWCD. A windshield and aerial survey was conducted as a part of the study (Figure 30). These watersheds are part of the Upper Elkhart River Watershed. Recommendations of this study include:

- Apply for LARE Watershed Land Treatment Funds to implement recommended BMPs and projects discussed for each subwatershed based on subwatershed priority. Some of these projects include: wetland restoration, filter strip installation, allowing for natural riparian vegetation growth, bank stabilization, livestock fencing, information and education efforts,

buffer zone establishment, revegetation of exposed areas, and grassed waterway construction. This work should focus on interested landowners in identified critical areas first.
- Extend management to the watershed-level including addressing potential project sites identified as part of the diagnostic study (Figure 30).
- Develop a watershed or land use management plan.
- Work with a bulk seed distributor to make native plant seed available in large quantities at low prices.
- Work with the Elkhart County Health Department to ensure proper siting and engineering of septic systems. The use of alternative technology should be encouraged when conditions may compromise proper waste treatment.
- Working with landowners that have drainage tiles that directly convey water to streams in the watershed to install treatment wetlands or filter areas so that drainage water receives both mechanical and chemical treatment prior to discharge.
- Scheduling meetings with active land developers in the area to encourage the use of conservation design when planning new development areas.
- Working with New Paris Speedway owners and operators to ensure that best septic system management practices are used, and that racetrack runoff is properly controlled.

The DNR LARE program provided six years of watershed land treatment funding to implement the watershed diagnostic study. An assessment of which projects remain to be implemented occurred planned to occur as part of this planning process. In total, 105 individual projects were identified through various LARE planning projects. After review of LARE reports and discussions with local lake associations and SWCD and NRCS staff, it was determined that approximately 74% of these projects have not been completed to date.

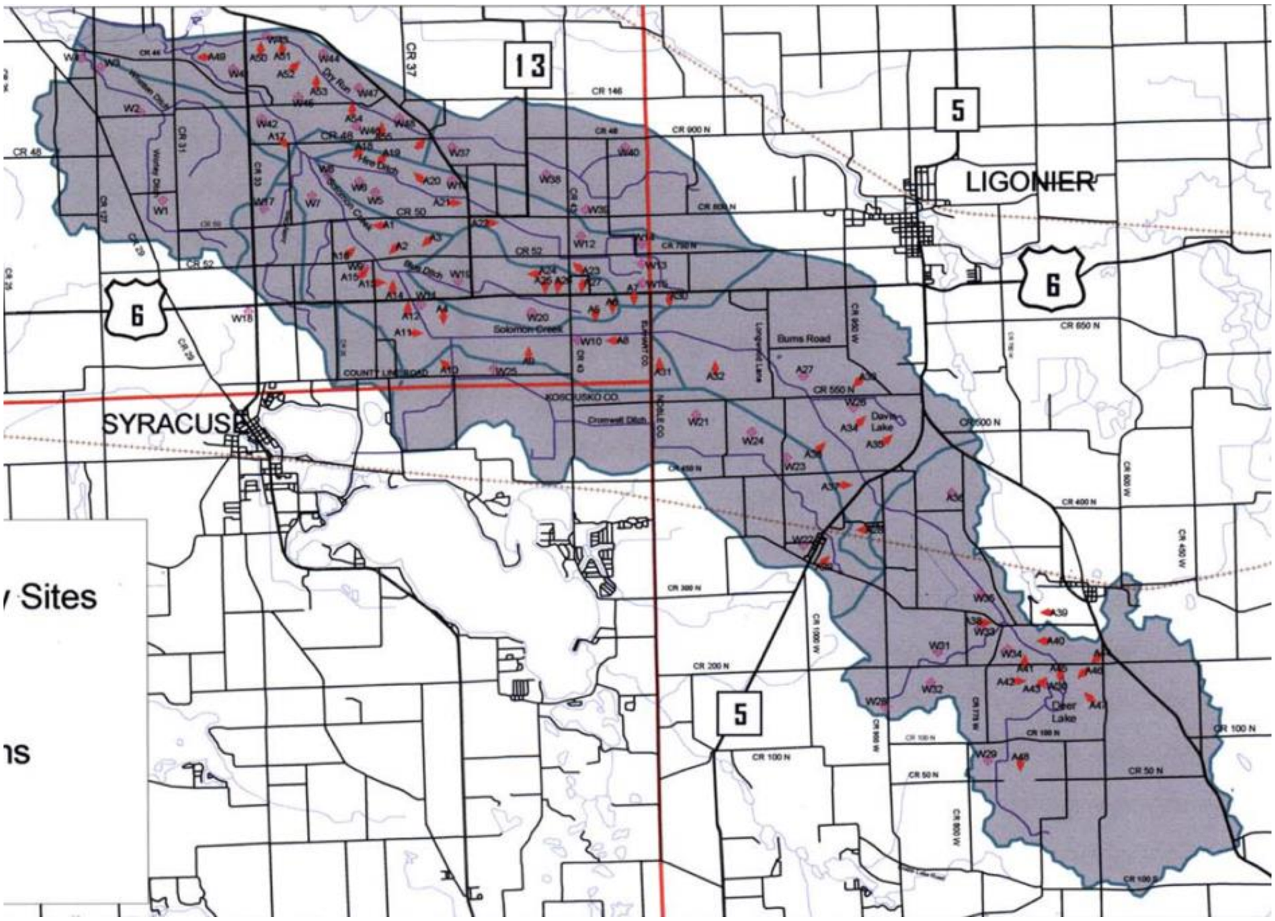


Figure 30. Aerial and windshield survey site location map from the Whetten Ditch, Solomon Creek and Dry Run Watersheds Diagnostic Study.

Chain O' Lakes Watershed Diagnostic Study (2002)

In October of 2002, Gensic & Associates released a diagnostic study targeting implementation of land conservation practices in the Chain O' Lakes Watershed. The study was funded by the Noble County SWCD with the aid of a grant from the IDNR LARE program. The Noble County SWCD identified that the Chain O' Lakes Watershed was one of the most potentially erodible areas in Noble County. It was deemed a priority area for developing a watershed management plan, implementing best land use management practices and developing a follow up program to assure long term effectiveness.

Gensic determined that problems in the Chain O' Lakes Watershed stemmed primarily from erosion due to agricultural practices on erodible land adjacent to open drainage channels. Other land management problems included livestock in open channels, gully erosion in fields, gravel roads, side ditches, terraces and inlets in cultivated erodible areas, concentrated livestock, yards and streambank erosion in meandering open channels. Land management problem areas were distributed throughout the Chain O'Lakes Watershed. Common recommendations within this report include:

- Install vegetative filter strips between erodible cropland and open drainage channels.
- Install grassed waterways and rock chutes in eroded gullies.
- Complete livestock exclusion fencing and streambank protection.

Five Lakes Engineering Feasibility Study (2004)

In July of 2004, JFNew released an Engineering Feasibility Study for Witmer, Dallas, Hackenburg, Messick and Westler Lakes (Five Lakes). The study specifically targets the immediate watershed of the lakes including Little Elkhart Creek from Witmer Lake upstream to the town of Wolcottville and several smaller tributaries in the immediate vicinity of the lakes. Three potential projects listed below were identified during the course of this study (Figure 31). Potential water quality improvement projects investigated during the study include:

- Project 1: Grade control and sediment trap construction along Little Elkhart Creek, Witmer Lake. The project was considered feasible, pursued and agreements made with landowners to secure access for construction.
- Project 2: Livestock fencing along J.J. Charles Drain to Hackenburg Lake. This project was considered feasible, pursued and agreements made with landowners to secure access for construction.
- Project 3: Sediment and sediment-attached pollutant load reduction from the unnamed southern tributary, Witmer Lake. This project was considered feasible but was not recommended for future design and construction.

Recommendations of this project were:

- Apply for LARE grant funding in 2004 for construction of the sediment trap and grade control structure along Little Elkhart Creek. Begin construction of the project in the Fall of 2004 following the crop removal.
- Apply for LARE grant funding in 2004 for livestock fencing. Construction of the fence and tree planting can occur in the fall of 2004.
- Pursue project recommendations from the Five Lakes Watershed Management Plan that was concurrently developed.

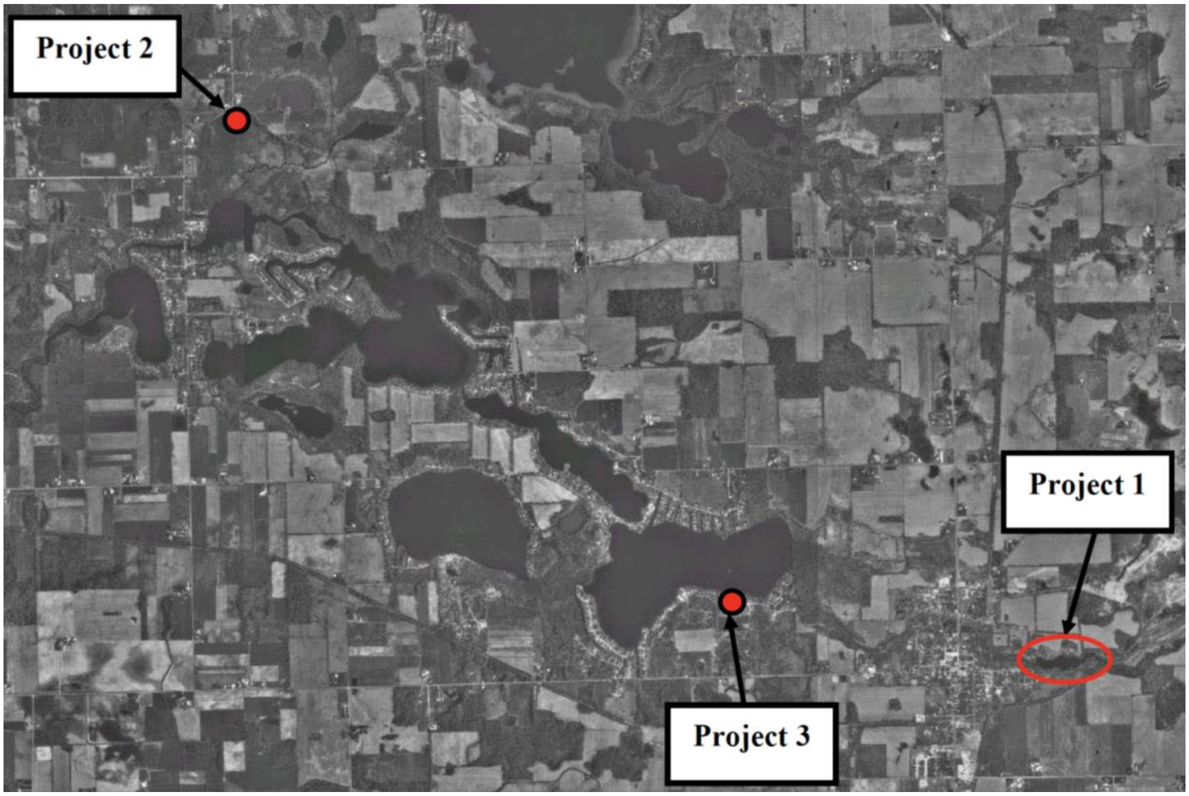


Figure 31. Engineering feasibility/design proposed locations from the Five Lakes Feasibility Study.

Pettit Mill Pond Sediment Control Project Design Project (2004)

In July of 2004, JFNew released a design report for the sediment control project on Pettit Mill Pond. The Five Lakes Conservation Association received funding for the design report through the IDNR LARE program. The design project addressed the problem of accumulation of sediment and sediment-attached pollutants in the Mill Pond and the general state of disrepair of the Mill Pond's failed dam structure, which pose water quality concerns to Little Elkhart Creek and its receiving waterbody, Witmer Lake. The project design was to capture sediment and sediment-attached pollutants from the Little Elkhart Creek Watershed and to stabilize the existing Mill Pond structure by installing a grade control structure.

The design recommendations include moving the existing failed dam structure at the outlet of the Mill Pond on Little Elkhart Creek and replacing this structure with a grade control structure to maintain the Mill Pond at its existing water level. Designers indicated that leaving Mill Pond at the existing water level would prevent the release of sediment and sediment-attached nutrients trapped in the Mill Pond (Figure 32). A sediment trap and dewatering basin were included in the design strategy to reduce sediment inputs. Permits were filed for the construction of the design. Construction began in late 2004 following the removal of crops from the agricultural field where the sediment dewatering basin was constructed.

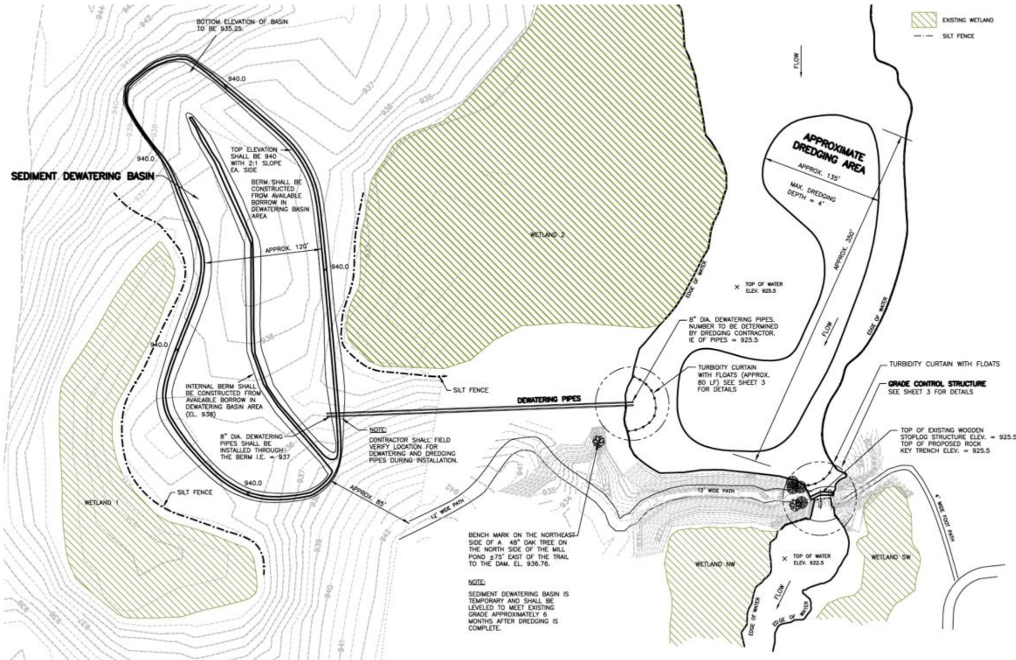


Figure 32. Site Plan for Petit Mill Pond sediment control project.

Five Lakes WMP (2006)

In July of 2006, D.J. Case & Associates and JFNew released a watershed management plan for the Five Lakes Watershed. The plan detailed the current and historical condition of the watershed through a review of historical reports and included sampling the biological, chemical, and physical condition of waterbodies in the watershed. More importantly, the planning process provided a forum for watershed stakeholders to discuss their water quality concerns related to the waterbodies in the Five Lakes Watershed and develop an action plan to address those concerns. This plan documents the stakeholders' concerns and vision for the future of the Five Lakes Watershed. It outlines the stakeholders' strategies and action items selected to achieve their vision. Finally, the plan includes methods for measuring stakeholders' progress toward achieving their vision and timeframes for periodic refinement of the plan. Ultimately, the plan serves to guide and educate the stakeholders on the importance of improving water quality in the Five Lakes watershed. These goals and objectives are as follows:

- Reduce phosphorus loads to streams from 2004 levels by 50% to reach recommended phosphorus concentrations of <0.075 mg/L (Dodd et al., 1998) by 2015.
- Reduce total suspended solid loads to streams from 2004 levels by 50% by 2015.
- Reduce E. coli concentrations in waterbodies in the Five Lakes Watershed so that water within the streams and lakes meet the Indiana state standards of 235 colonies/100 ml by 2015.
- Within four years, 50% of landowners within the Five Lakes Watershed will learn and/or implement at least one water quality improvement practice/technique on his/her own property.
- Maintain and improve the recreational setting of the Five Lakes Watershed by developing and implementing a recreational management plan within five years.

In addition to goals and objectives, eight areas of concern were identified within the watershed. Suggestions on implementing BMPs such as grassed waterways, buffer strips, the installation of WASCOBs, and stream bank stabilization were provided on a case-by-case basis (Table 18).

Table 18. Concerns and sources of pollutants associated with the water quality sites sampled as part of Five Lakes watershed plan development and suggested management practices.

Site	Concern/Source	Suggested Management Practice
S1	-Eroding waterways and use of improper tillage methods -Sediment and nutrient and phosphorous input from gravel roads, fields and impaired wetlands	-Grass waterways and use correct tillage methodology -Wetland restoration below corn field -Install a berm to reduce sediment input into creek/stream from road -WASCOB to check flow off field; use grass waterways as well -Install buffer strip and restore wetland -Restore 8 wetland areas to reduce flow velocities at upper end and restore two wetlands at scattered sites
S2	Erosion	-Install buffer strips -Limit impact of gravel roads to streams at crossings
S3	- Manure and erosion due to sheep and cattle access to stream - P-loading of Cree Lake and potential problems with septic systems on the lake (11) -Stream bank erosion	- Review grazing management for cattle and sheep - Potential installation of mounded septic systems - Stream bank stabilization - Installation of grassed water ways and grade control structures - Maintain no-till or mulch-till and haying practices in this area -Install a WASCOB on drainage to Shockopee
S4	-Stormwater issues	-Determine stormwater/wastewater impacts from South Milford -Implement stormwater BMPs as necessary
S5	No specific concerns identified	-All practices installed upstream in S1-S4 subwatersheds should positively impact water quality -Identify additional projects (wetland restoration)
S6	-Ditch problems through barn yard	-Install grassed waterways in fields to Blackman Lake - Review BMP for buffalo in this area
S7	-No specific problems identified	
S8	-No specific projects identified	-Determine potential impact of old landfill -Review impact of development of shoreline areas (Oliver, Olin, Martin lakes)

Skinner Lake Engineering Feasibility Study Noble County, Indiana (2007) and Rimmell Ditch Design-Build (2009)

The Skinner Lake Homeowners Association (SLHOA) received an IDNR LARE grant to complete an engineering feasibility study of lake improvement projects. The goal of the feasibility study was to analyze potential project sites where sources of pollution may exist, suggest projects that may address pollution, and examine the feasibility of project design and construction. In April of 2007, JFNew released an Engineering Feasibility Study for Skinner Lake. This study examined the feasibility of five projects and sediment mapping within the Skinner Lake Watershed. The projects included:

- Shoreline stabilization along the northern shoreline of Skinner Lake.
- Bed and bank stabilization along the length of Rimmel Ditch.
- Five minor projects within the Rimmel Ditch Watershed.

- Documentation of the serpentine filter's history and identification of potential solutions.
- Wetland restoration at four potential sites throughout the Watershed.

The study revealed that neither the sediment mapping nor the wetland restoration projects were deemed feasible at this time. JFNew recommended that the Skinner Lake Homeowners Association complete design and construction work on the shoreline stabilization project in 2007 and apply for additional LARE grant funds to address other projects along Rimmell Ditch.

In 2009, JFNew and the Noble County Drainage Board completed several projects along Rimmell Ditch (Figure 33). The projects that were completed by JFNew included the installation of two pipe drop structures, three grassed waterways, two grade control structures, 40 feet of streambank stabilization, a rock-line chute, and culvert erosion stabilization. The Noble County Drainage Board completed the installation of a culvert to replace a deteriorating bridge. They also performed bottom dipping, channel re-alignment, bank re-sloping, bank stabilization, spoils leveling, and seeding on approximately 5,600 feet of the Rimmell Open/ Melvin System.

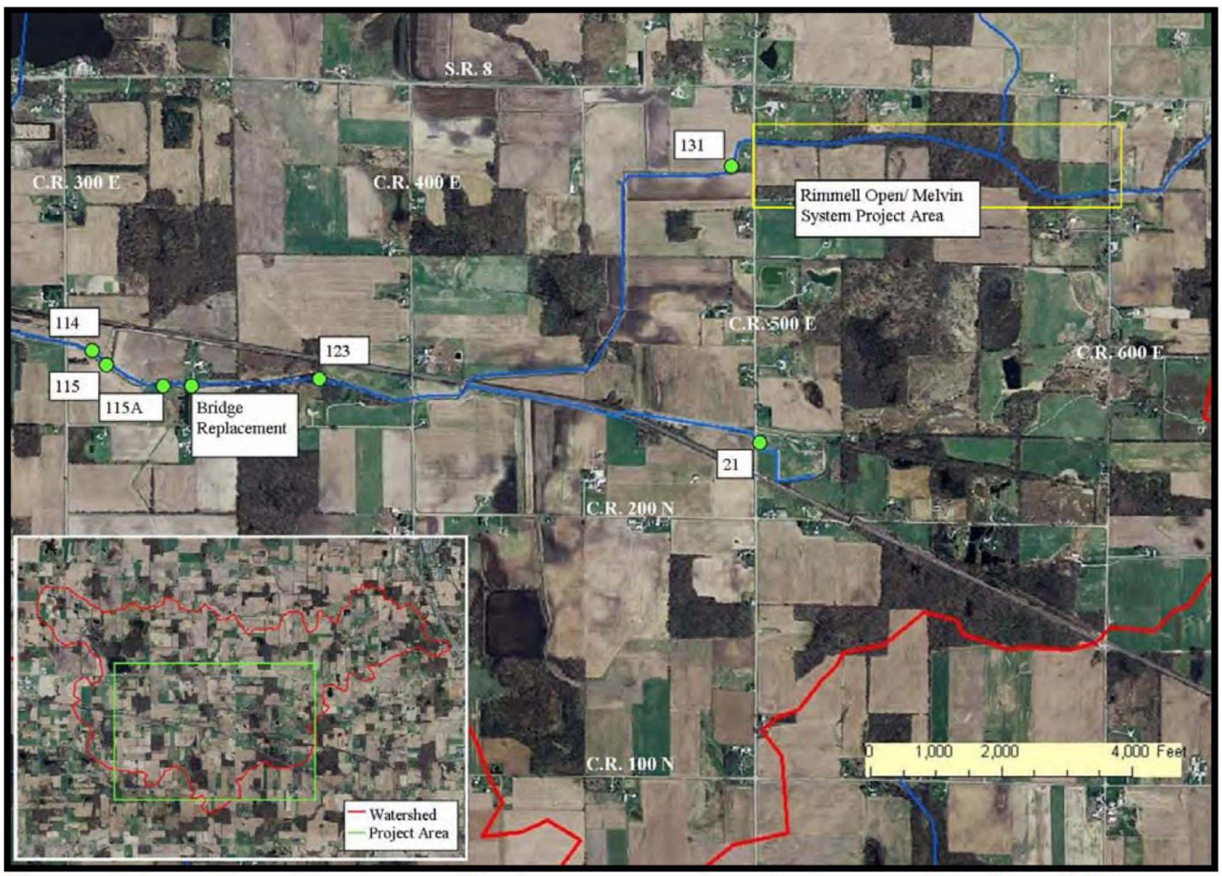


Figure 33. Location of water quality improvement projects completed by JFNew and Noble County Drainage Board within the Rimmell Ditch watershed.

Skinner Lake Shoreline Stabilization Design-Build (2009)

In April of 2009, JFNew released the design/build report for the Rimmel Ditch shoreline stabilization project, which was included in the 2007 Skinner Lake Engineering Feasibility study. Due to heavy rains and flooding in spring 2008, an additional erosion area was identified, and funding was requested to design and implement shoreline treatment. An agreement was made to modify the original contract by replacing work on two smaller project sites with the implementation of the design/build for the newly identified site.

Due to County funding issues and unforeseen projects, an agreement was made to shift from the originally identified in-kind projects to other projects within the Rimmell Ditch drainage area. These projects met the same criteria in reducing sedimentation and nutrient loading and provided water quality benefits to Skinner Lake.

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.

Oliver, Olin, and Martin Lakes Diagnostic Study (2009)
In October of 2009, JFNew released a Diagnostic Study for Oliver, Olin and Martin lakes. These lakes have historically exhibited good water quality and are considered one of Indiana's least developed lake chains.

The combination of low nutrient levels and overall morphology of the three lakes limit the potential for the establishment and flourishing of aquatic plant communities in the chain. In general, the area within the lakes able to support a rooted plant community is between one-fourth and one-third the total area of each lake.

The following list summarizes the recommendations for maintaining and improving Oliver, Olin, and Martin lakes' chemical, biological, and physical condition. Each of the following recommendations should be implemented and will help maintain the lakes' good water quality (Figure 34).

- Implement agricultural best management practices such as restoring existing failed structures, installing and increasing stream buffer width, and repairing and installing grassed waterways.
- Stabilize the eroding ravines on the IDNR's Olin Lake Nature Preserve to reduce sediment and nutrient loading to Olin and Oliver lakes. This project has a high probability of success to protect water quality because the project is located on property owned and managed by the Department of Natural Resources.
- Implement individual property owner management techniques. These apply to all watershed property owners rather than simply those who live immediately adjacent to Oliver and Martin lakes.

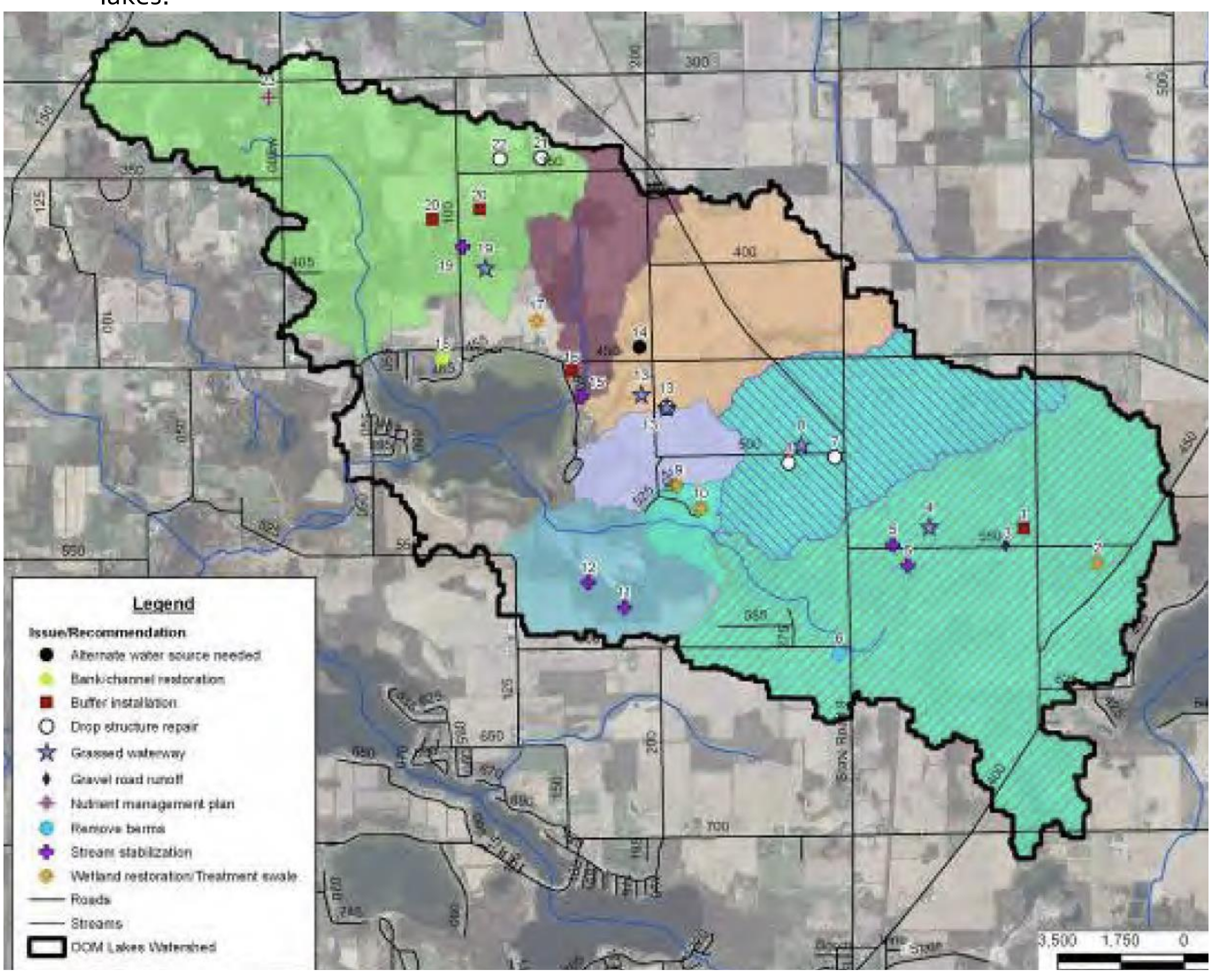


Figure 34. Areas in the Oliver, Olin, and Martin lakes watershed that would benefit from watershed management technique installation.

Engineering Feasibility and Design Study for Oliver, Olin, and Martin Lakes Watershed (2014)
The Olin, Oliver and Martin Lakes Feasibility Study was funded by an IDNR LARE grant with a match provided by the Oliver and Martin Lakes Conservation and Improvement Association (OMLCIA). OMLCIA retained Davey Resource Group and Gensic Engineering to conduct the study to investigate the feasibility of implementing projects that will reduce sediment, nutrients and other pollutants from reaching Oliver, Olin, and Martin Lakes.

The purpose of the study was to investigate the feasibility of implementing six projects; the first five were previously identified in the Oliver, Olin and Martin Lakes Watershed and a sixth project was added as a result of issues raised during public meetings. The study designed plans for two specific projects (Projects 3 and 5). The proposed projects are as follows:

- Project 1: Erosion control along a ditch adjacent to CR 550 South. The project was considered highly feasible.
- Project 2: Erosion control on a ditch bank southwest of the intersection of SR 9 and CR 600 South.
- Project 3: Streambank erosion control on a stream located at the Olin Lake Nature Preserve owned by IDNR. Stabilization of the eroding stream channel within the Olin Lake Nature Preserve is highly feasible.
- Project 4: Erosion control on a ditch located south of CR 450 South, north of Oliver Lake. The erosion can be easily addressed by planting native shrubs along the stream edge to anchor soils.
- Project 5: Hydrological enhancement to a degraded wetland on property owned by The Nature Conservancy east of Martin Lake. Davey indicated that the proposed project had the potential to result in significant pollutant reduction reaching the Oliver Lake chain. The proposed project is costly; however, there are multiple potential funding sources that may aid in implementation. As the property was undergoing acquisition by ACRES at the time of the study, it was recommended that OMLCIA begin coordinating with IDNR LARE Program staff and ACRES to pursue funding once acquisition is complete.
- Project 6: Minimize sediment reaching the lake from an agricultural field north of Oliver Lake. The landowner and agricultural producer currently farming the field expressed support for installation of the grass waterway and associated drop box outlet and have been working with the Lagrange County SWCD and NRCS regarding the project.

Skinner Lake Diagnostic Study (2021)
The Skinner Lake Diagnostic Study is a comprehensive examination of Skinner Lake and its surrounding watershed (Arion Consultants, 2022). In 2021, with funding from the IDNR LARE Program, the Skinner Lake Homeowners Association hired Arion Consultants to conduct the study. Arion Consultants concluded that all of the subwatersheds within the Skinner Lake Watershed could benefit from soil health and targeted stormwater retention strategies as already described in detail above. However, based on loading calculations and field observations, efforts should target the Rimmel Ditch drainage first followed by the Hardendorf Drain drainage and/or shoreline projects. Finances, time, volunteer time, and other restraints make it impossible to implement all of these management techniques at once. Recommendations for the Skinner Lake Watershed were developed as follows:

- Work with the Noble County Surveyors Office to improve the current conditions of previously installed rock chutes and check dams along Rimmel Ditch. These structures are in disrepair and are no longer functioning as designed. This results in additional sediment and nutrients erosion from the channel cutting caused by the poorly maintained structures. The structures were designed to reduce the gradient of the stream and minimize instream head cutting.

- Consider dredging the mouth of Rimmel Ditch and other inlets to help reduce the volume of sediments flowing into Skinner Lake. Based on assessments completed as part of the Skinner Lake Feasibility Study (JFNew, 2007), between 1.6 and 2.9 feet of accumulated sediment is present at Skinner Lake inlets.
- Reduce total suspended solids concentrations in streams throughout the watershed. Best management practice implementation to reduce TSS loading to the streams, including streambank stabilization, cover crop planting, conservation tillage, and streambank erosion and lakeshore erosion practices should be the focus.
- Reduce E. coli concentrations in streams throughout the watershed. The specific sources of E. coli in the Skinner Lake Watershed have not been identified; however, wildlife, livestock and/or domestic animal defecations; manure fertilizers; previously contaminated sediments; and failing or improperly sited septic systems are common sources of the bacteria. Livestock restriction, manure management planning, septic inspection and maintenance can all address pathogen issues in the Skinner Lake Watershed.
- Reduce total phosphorus concentrations in streams throughout the watershed. Best management practice implementation to reduce phosphorus loading to the streams, including livestock fencing, septic system inspection and maintenance, sewer maintenance, rock chute and check dam maintenance, streambank stabilization, rain garden and rain barrel installation, and filter strips should be targeted.
- Apply for LARE funds to best management practices. LARE watershed land treatment funds could be utilized to address agricultural BMPs, including filter strips, livestock distribution, and soil health-focused conservation tillage and cover crop planting.
- Target best management practice implementation on non-protected parcels mapped as highly erodible land. Efforts for these parcels should focus on enrolling tracts of land mapped as highly erodible in the conservation reserve program.

Benton and Baintertown Dam Feasibility Study (2022)
The Elkhart County Parks Department received an IDNR LARE grant to determine the feasibility of removing or modifying the Benton and Baintertown Dams (Cardno, 2022). Low-head dams present a number of concerns primarily related to safety, aquatic passage, and recreational paddling. Multiple alternatives were identified for each dam including: no action, dam removal, and dam modification. The focus of the study was to assess the feasibility of each of these identified alternatives and ultimately present a manageable number of recommended alternatives for consideration by the Elkhart County Parks Board. The feasibility assessment included field investigation, land availability, cultural resource impacts, water resource impacts, regulatory requirements, wetland and vegetation impacts, environmental impacts, upstream sediment characterization, public outreach and communication, unusual physical and/or social costs and potential for funding. Based on the feasibility assessment, Cardno now Stantec, in communication with the Elkhart County Parks Department, selected two recommended alternatives for each dam. These recommended alternatives were determined to be feasible based on assessments completed for this report.

Recommended Alternatives for Benton Dam include modifying the Dam by implementing a full rock riffle, or rows of boulders and rocks installed downstream of a dam to resemble natural rapids or modifying of the dam to include partial lowering and rock riffle. The no action alternative for Benton Dam was also determined to be feasible but if funding can be secured for one of the recommended alternatives, then Stantec recommends this be pursued.

Recommended Alternatives for Baintertown Dam include dam removal or no action other than installation of safety signage. Final design and permitting could be initiated at any time. Stantec recommended that outside funding be secured before permitting is initiated.

2.11.2 Flow-based Assessments and Plans

North Branch Elkhart River West Lakes Task Team Report (2010)

In May of 2010, the Indiana Silver Jackets partnered with the recently formed Flood Focus Committee of the Elkhart River Alliance to form a voluntary multi-agency group and author a report that shared data and improvement recommendations from federal, state, and regional governmental perspectives (Indiana Silver Jackets, 2010). The Flood Focus Committee was created after an extended period of above normal precipitation resulted in multiple flooding events in 2008 and 2009 throughout Indiana. The pertinent findings include:

- The North Branch Elkhart River watershed/drainage basin is a fairly unique system. The extensive, naturally existing storage and the natural regional relationships between precipitation, geology, topography, stream flow, the groundwater resource, lake levels, and flooding have not been altered dramatically.
- Water level issues exist in many previously developed areas around lakes within the basin. These issues range from seasonal high-water levels that persist over extended time frames and limit road access to existing homes, to infrequent but potentially devastating flood levels that could cause extensive property damage.
- Over several decades, studies have stated that flood damage in the watershed can be attributed to a combination of factors, with a major cause being the construction of structures in the floodplain, many at or below the minimum recommended elevation.
- Data show that during normal conditions, Waldron Lake's outlet channel carries a large rate of flow, and it responds with a substantial increase in flow during flooding events.

Recommendations include the following:

- Pursue Federal and State grants to initiate a volunteer home acquisition and relocation program for homes located in the most vulnerable flood prone areas.
- Continue to work with homeowners to properly elevate flood prone homes and pursue additional funding opportunities for this activity.
- Reinvigorate the existing flood warning system. Routinely test, educate residents about, and seek opportunities to expand the system. Develop an Emergency Flood Response Plan, including evacuation planning, to be tested with the Sylvan Lake Emergency Action Plan.
- Seek to provide education regarding the national flood insurance program. Explain typical costs, benefits, flood risks, and attempt to dispel myths regarding this type of insurance.
- Work with homeowners, local health officials, or local zoning officials, to upgrade protection for water well heads located in a flood hazard area.
- Work with homeowners, local zoning officials, and local energy providers to anchor propane tanks located in floodplain areas.
- Inventory and prioritize those areas where seasonal road access difficulties exist.
- Prepare a plan to reduce the access issue for the more vulnerable areas.
- Create an inventory of natural areas that currently and historically provided natural storage and detention in the watershed/drainage basin.
- Seek funding and partnership opportunities to protect and/or restore these areas from future development.

- Work with landowners, homeowners, land management contractors, public utilities, and local agriculture agency officials to seek, construct, and implement conservation practices to limit fertilizer, nutrient and sediment loading.
- This is especially important for streams and drains discharging directly into the "transition area" identified in the report.
- Once the source of nutrients is addressed, contact regulatory agencies to discuss authorizations needed to conduct in-channel aquatic vegetation removal at the "transition area" identified in the report.
- Work with local officials, adjoining property owners, recreation groups, and volunteer groups to fund and/or conduct routine stream maintenance and drainage projects consistent with the Indiana Drainage Handbook.
- Create and/or strengthen an existing local group to be regional administrator of floodplain management practices (covering the communities and counties that are part of the North Branch Elkhart River watershed/drainage basin).
- Develop consistent basin wide practices, seek, and be the local administrator for grant opportunities. Installing and maintaining new gages to expand the coverage of documentation could prove useful to a broad base of stakeholders. Discuss partnering opportunities with the U.S. Geological Survey and the National Weather Service.
- Organize a flood related public education and outreach event for the NBR Elkhart River watershed/drainage basin stakeholders. Provide a forum-style question and answer area with information tables, displays, staff from various Federal, State, Regional, and Local water resource agencies, and local officials. Routinely provide public outreach and education activities.
- Develop a long-term strategic improvement plan to begin reducing flood risk for the basin. The strategic planning process would be founded upon a review of the North Branch Elkhart River basin's strengths, opportunities, weaknesses, and threats. A typical strategic plan would then identify and prioritize goals with measurable objectives set for each goal.
- Yearly action steps would then be outlined to begin addressing the many likely objectives. To be effective, the strategic planning creation, vision, and implementation must have the involvement and commitment of the local stakeholders.
- Seek funding to create a detailed, calibrated, basin-wide hydrologic and hydraulic engineering computerized flow and flood level prediction model.
- Ensure consistent regional use of floodplain management and storm water ordinances. Seek to strengthen these ordinances to incorporate best management practices.
- To minimize future disruption to local business and area employment, seek to locate future economic growth opportunities in pre-planned, low risk zones where natural hazards such as floods would not jeopardize the local business growth. Limit and, if possible, prohibit construction of new critical structures and utilities in flood hazard areas.

North Branch Elkhart River Corridor Flood Risk Management Plan (2020)

To begin addressing the St Joseph River Basin Commission's need for a comprehensive understanding of the overall functional health of the North Branch Elkhart River Basin in northeast Indiana, Christopher B. Burke Engineering, LLC (CBBEL) was asked to develop a flood risk management plan for the North Branch Elkhart River (CBBEL, 2020). The flood risk management plan is based on investigation of overall stream function and flooding in the mainstem North Branch Elkhart River from its headwaters on the far east side of Noble County to the confluence with the South Branch Elkhart River near Ligonier. Some of the recommendations given based on this study include:

- Develop and adopt location-specific Smart Growth flood resilience strategies including identification of river corridor impact areas, undeveloped high flood hazard and storage areas, moderate flood hazard areas, vulnerable developed areas, safer areas and the entire drainage areas. Consider adoption strategies for each area as detailed in the report.
- Update stormwater and floodplain regulations to include storage and detention, retention, compensatory floodplain storage, strict prohibitions on floodway development and disturbance and encourage Low Impact Development and Green Infrastructure.
- Encourage county drainage boards to consider the impact of agricultural drainage impact mitigation measures and require/provide compensation for impacts of farm drainage and county drainage board ditch improvements.
- Investigate the feasibility of and construct a 2-stage ditch system along a 4-mile reach of Henderson Lake Ditch through and near Kendallville.
- Consider initiating additional studies and models to better understand the groundwater/surface water interaction.
- Preserve the existing USGS gages and commission additional stream gages at Sylvan Lake near CR 600 N south of Rimmel Road, upstream of Hackenburg Lake near SR 3 and between Indian Lakes and West Lakes and reestablish lake gages on developed lakes.
- Consider requiring a higher flood protection grade when permitting new construction.
- Establish a Flood Resilience Planning Team in each county and/or community within the watershed including the basin commission director, city and county elected officials, council members and officials who are responsible for land use decisions, planning and engineering staff.
- Consider a facilitator or consultant to conduct meetings among Flood Resilience Planning Team members and identify and agree on strategies for each area.
- Work with various communities within the watershed to help the adoption and implementation of agreed upon flood resilience strategies and implementation of other study recommendations.

2.11.3 Comprehensive Plans

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 WQS for E. coli. Problems, therefore, were not restricted to the St. Joseph River itself, but were being exacerbated by inputs from tributaries. Data from the report 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's WQS 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. This is how the standard is defined in the State's WQS. 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.

Chain O' Lakes States Park Interpretive Master Plan (2010)

In response to new management, and the resulting opportunity to assess and evaluate, the IDNR Division of State Parks and Reservoirs developed an Interpretive Master Plan for Chain O' Lakes State Park in 2010. The plan provides a resource overview of the park's natural and cultural resources and a summary of existing conditions for interpretation. Key elements of the Interpretive Master Plan include:

- The management issues of historic preservation and lake eutrophication.
- Full-time staff to ensure program expansion, evaluation and long-term high quality with less turnover. This includes a Resource Manager.
- Identifying and managing invasive species including autumn olive, bush honeysuckle, multiflora rose, privet and garlic mustard.

- Preserving species such as the Henslow's Sparrow and protecting ash trees from the Emerald Ash Borer.
- Maintaining physical structures such as Stanley School House and the Iron Bridge.

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, as well as the subsequent paragraphs for the City of Ligonier, City of Kendallville, and Town of Albion.

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 sewer 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 in order 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.

Town of Albion Comprehensive Plan (2019)
In 2019, Noble County drafted a new county-wide comprehensive plan as well as new plans for its major cities. 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 in the Noble County section (2019), goals and policies that are specific to Albion include:

- Encourage traditional neighborhood development that prioritizes people.
- Prioritize incremental development in town instead of largescale development further away from towns.
- Mix land uses in communities to promote walkable neighborhoods where one's needs can be met within a twenty-minute walk.
- Provide consistent and predictable land use decisions through well-articulated and implemented policy.
- Modify land use regulations to allow for easier division of smaller building sites in town.
- Strictly limit impervious surfaces that do not mitigate their own ill effects.
- Support the Noble County Parks Board and Town of Albion Parks Board in establishing recreation opportunities, especially through their Master Plan.
- Build a multi-modal trail between Albion and Chain O' Lakes State Park.
- Build a multi-modal trail between Albion and West Noble Schools.

City of Kendallville Comprehensive Master Plan (2019)
In 2019, the City of Kendallville worked with Ground Rules Company to create a new Comprehensive Plan. This plan replaced the City's 1963 Comprehensive Plan. The plan has six broad goals, two of which pertain to environmental quality including 1.) Manage Land Use and Growth and 2.) Nurture Environmental Quality. These two goals can be further defined as follows:

- Manage Land Use and Growth.
    - Update the Kendallville Zoning Ordinance to accommodate and support infill, redevelopment, and compact form.
    - Promote redevelopment by placing an equal priority on providing improved infrastructure and services to vacant lots in need of infill development and areas in need of redevelopment.
    - Utilize the Comprehensive Plan and Future Land Use Classification Map when considering development proposals and rezoning petitions.
    - Recognize that small deviations from this Plan and the Future Land Use Classification Map will accumulate and have a negative impact on the City's future.
    - Update, utilize, and enforce the Kendallville Zoning Ordinance, Kendallville Subdivision Control Ordinance, and other applicable ordinances.
    - Ensure an adequate quantity of suitable land exists for all desired land uses.
    - Develop policies to help evaluate the expansion of the Kendallville City Limits through annexation.
    - Explicitly permit existing agricultural operations to continue at current levels.
    - Buffer residential and other sensitive land uses from commercial and industrial development or redevelopment.
- Nurture Environmental Quality.
    - Allow flexibility for new developments to preserve (i.e. avoid developing) existing high quality natural features and habitats.
    - Require buffers to filter surface water before it reaches a lake, creek, or ditch.

  - Integrate open space in future developments to provide recreational amenities and natural habitats.
  - Require suitable soils as a prerequisite for development.
  - Work through the Noble County Surveyor and appropriate state agencies to strengthen and enforce regulations that minimize soil erosion and prevent pollution at construction sites.
  - Monitor changes in State and Federal laws dealing with groundwater supplies and comply with applicable requirements.
  - Manage stormwater runoff to maintain and enhance water quality of lakes and streams.
  - Denote wellhead protection areas around the community's wells and protect them from uses that can contaminate drinking water.
  - Reduce discharges of non-point source pollutants through education, storm water management, and reduction of impervious surfaces.
  - Require buildings and impervious surfaces to be set back from the top of the bank of a stream or ditch.
  - Utilize native or prairie grasses and other absorption plant materials along regulated ditches.
  - Participate in State and Federal programs to conserve, sustain, and restore natural areas.
  - Support the newly created Tree Commission in its efforts to achieve "Tree City USA" status.
  - Require appropriate landscaping be installed, especially canopy trees, when new development occurs.
  - Encourage new development to preserve existing natural areas through the use of development incentives.
  - Support efforts to make trails accessible, reliable, safe, convenient, and an attractive alternative to vehicular transportation.

City of Ligonier Comprehensive Plan (2019)
In 2019, Noble County drafted a new county-wide comprehensive plan as well as new plans for its major cities. 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 Ligonier include:

- Encourage smart growth and self-sustaining development with low barriers to entry.
- Improve quality of life and quality of place through strategic community investments.
- Prioritize incremental development in town instead of large-scale development further away from towns.
- Provide consistent and predictable land use decisions through well-articulated and implemented policy.
- Limit the use of suburban development patterns that are financially insolvent.
- Mix land uses in communities to promote walkable neighborhoods where one's needs can be met within a twenty-minute walk.
- Maintain historic properties as productive land uses and prevent disuse.
- Modify land use regulations to allow for easier division of smaller building sites in town.
- Strictly limit impervious surfaces that do not mitigate their own ill effects.
- Support the Noble County Parks Board and City of Ligonier Parks Board in establishing recreation opportunities, especially through their Master Plan.

Noble County Parks Plan (2019)
The Noble County 2019-2024 Parks Plan was created in order 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.

Lagrange County Comprehensive Plan (2021)
As of spring 2022, Lagrange County is continuing to draft their comprehensive plan. Lagrange County Together is a community-driven process to prepare a comprehensive plan for the county, the towns of Lagrange, Shipshewana, Topeka and Wolcottville, and all unincorporated areas. The 16-month process is a blend of technical analysis and community engagement.

Kosciusko County Comprehensive Plan (2022)
As of spring 2022, Kosciusko County is in the midst of updating their county plan as well as each town plan. More information will be added as it becomes available.

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 Upper Elkhart River Watershed have a direct correlation to water quality. Approximately 45% of the Upper 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 Upper 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 45,018 acres, or 17% of the watershed. When hydric soil coverage (73,254 acres) is used as an estimate of historic wetland coverage, it becomes apparent that more than 39% of wetlands have been modified or lost over time. Additionally, it is estimated that more than 198 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 Upper 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. It should be noted that the outstanding rivers identified in the Upper Elkhart River Watershed are listed for the contiguous wetland complexes which exist within the river's floodplain.

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

Much of the watershed's population is located within unincorporated areas outside cities and towns in the Upper 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. 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 Upper 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.

2.12.4 High-quality Habitat and ETR Species

Many high-quality communities occur throughout the Upper 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 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 Upper 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 monitoring committee identified a standard suite of parameters and parameter benchmarks. Table 19 details the selected parameters and the benchmark utilized to evaluate collected water quality data.

Table 19. 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 or <12 mg/L	Indiana Administrative Code
pH	>6 or <9	Indiana Administrative Code
Temperature	Monthly standard	Indiana Administrative Code
Conductivity	<1050 μmhos/cm	Indiana Administrative Code
E. coli	<235 colonies/100 mL	Indiana Administrative Code
Nitrate-nitrogen	<1 mg/L	Dodds et al. (1998)
Ammonia-nitrogen	Varies by pH/temp	Indiana Administrative Code
Total Kjeldahl nitrogen	2.18 mg/L	USEPA (2000)
Total phosphorus	<0.08 mg/L	Dodds et al. (1998)
Orthophosphorus	<0.005 mg/L	Dunne and Leopold (1978)
Total suspended solids	<15 mg/L	Waters (1995)
Turbidity	<6.36 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 Stream Historic Water Quality Sampling Efforts

A variety of water quality assessment projects have been completed within the Upper Elkhart River Watershed (Figure 35). Statewide assessments and listings include the impaired waterbodies assessment and fish consumption advisories. The Indiana Department of Environmental Management (IDEM), St. Joseph River Basin Commission (SJRBC), Lagrange County Lakes Council (LCLC), Elkhart County, and several consulting firms which used DNR Lake and River Enhancement Program and/or IDEM Section 319 grant funds have all completed assessments within the watershed. Additionally, volunteer-based sampling of water quality through the Hoosier Riverwatch program also provide water quality data with which the watershed can be characterized. A summary of each assessment methodology and general results are discussed below. Specific data results are detailed within subwatershed discussions in subsequent section.

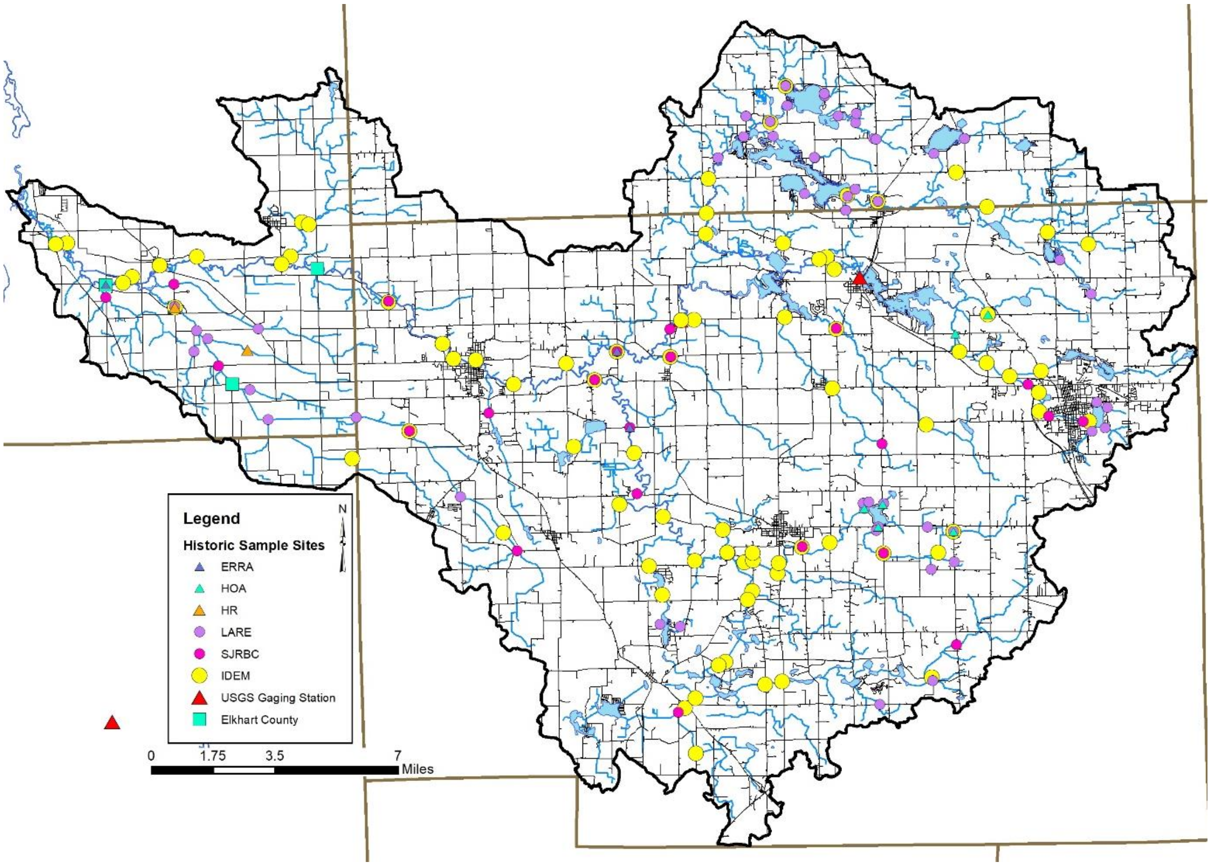


Figure 35. Historic stream water quality assessment locations.

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. In total, 48 stream segments and 19 lakes within the Upper Elkhart River Watershed are included on the list of impaired waterbodies (IDEM, 2018). Figure 35 details the listings in the watershed, while Figure 36 maps the segments and their locations within the watershed. Waterbodies are listed as impaired for E. coli (184 miles), nutrients/total phosphorus (10.2 miles), impaired biotic communities (5.3 miles), dissolved oxygen (16.9 miles), chloride (10.2 miles) and mercury (0.5 miles) and PCBs (9.7 miles) in fish tissue. More than 597 acres of lakes are impaired for biological integrity, 24 acres for mercury in fish tissue, 1,173 acres for PCBs in fish tissue and 313 acres for total phosphorus.

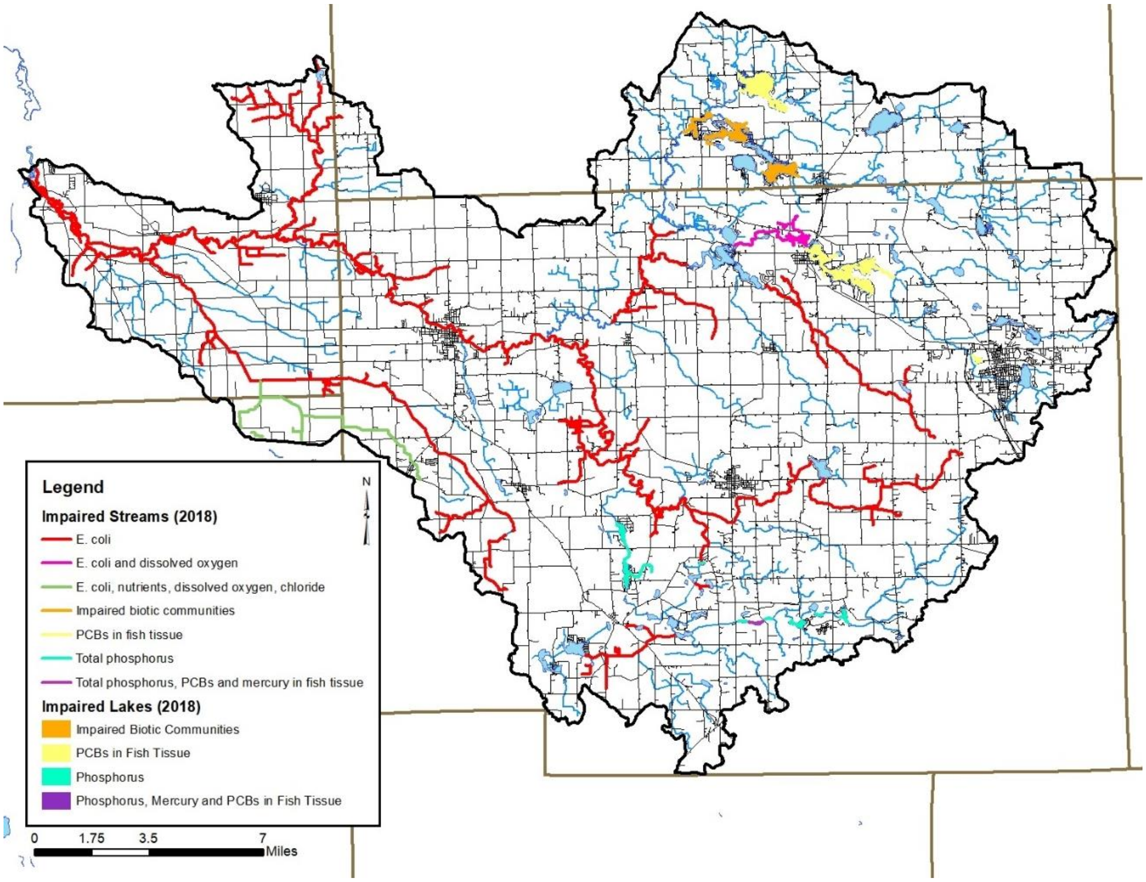


Figure 36. Impaired waterbody locations in the Upper Elkhart River Watershed. Source: IDEM, 2018.

Table 20. Impaired waterbodies in the Upper Elkhart River Watershed 2018 IDEM 303(d) list.

Waterbody Name	Assessment Unit	Impairment	Miles/ Acres
ELKHART RIVER, MIDDLE BRANCH	INJ01F5_02	BI, DO, E. coli	4.71
ELKHART RIVER, MIDDLE BRANCH	INJ01F5_03	BI, DO, E. coli	2.09
GRETZINGER DITCH	INJ01F6_T1010	BI, E. coli	11.35
GRETZINGER DITCH	INJ01F6_T1010A	BI, E. coli	0.61
ELKHART RIVER, NORTH BRANCH	INJ01F7_02	E. coli	4.29
ELKHART RIVER, NORTH BRANCH	INJ01F7_03	E. coli	2
ELKHART RIVER, NORTH BRANCH - UNNAMED TRIBUTARY	INJ01F7_T1001	E. coli	1.72
BOYD DITCH	INJ01F7_T1002	E. coli	3.39
CARROL CREEK	INJ01G2_02	BI, E. coli	2.37
CARROL CREEK	INJ01G2_03	BI, E. coli	1.35
CUB LAKE INLET	INJ01G2_T1006	BI, E. coli	0.67
CARROL CREEK - UNNAMED TRIBUTARY	INJ01G2_T1007	BI, E. coli	1.05
DEEP LAKE OUTLET	INJ01G2_T1010	BI, E. coli	0.48
DEEP LAKE INLET	INJ01G2_T1010A	BI, E. coli	0.33
CROFT DITCH	INJ01G3_02	E. coli	4.81
CROFT DITCH	INJ01G3_03	E. coli	0.74

Waterbody Name	Assessment Unit	Impairment	Miles/ Acres
CROFT DITCH	INJ01G3_04	E. coli	0.67
RIMMELL BRANCH	INJ01G3_T1001	BI, E. coli	10.84
ELKHART RIVER, SOUTH BRANCH	INJ01G4_04	BI, E. coli	2.05
ELKHART RIVER, SOUTH BRANCH	INJ01G4_05	BI, E. coli	0.55
ELKHART RIVER, SOUTH BRANCH	INJ01G4_05	E. coli	0.55
ELKHART RIVER, SOUTH BRANCH	INJ01G5_02	E. coli	4.92
ELKHART RIVER, SOUTH BRANCH	INJ01G5_03	E. coli	10.26
ELKHART RIVER, SOUTH BRANCH	INJ01G5_04	E. coli	5.81
ELKHART RIVER, SOUTH BRANCH	INJ01G5_T1004	E. coli	4.8
STONY CREEK	INJ01I1_01	BI, E. coli	3.68
STONY CREEK	INJ01I1_02	E. coli	1.95
MCALLISTER DITCH	INJ01I1_T1001	E. coli	9.25
MCALLISTER DITCH - UNNAMED TRIBUTARY	INJ01I1_T1002	E. coli	1.87
FISH LAKE INLET	INJ01I1_T1002A	E. coli	0.33
ELKHART RIVER	INJ01I2_01	E. coli	4.54
ELKHART RIVER	INJ01I2_02	E. coli	2.2
ELKHART RIVER	INJ01I2_03	E. coli	12.31
ELKHART RIVER - UNNAMED TRIBUTARY	INJ01I2_T1004	E. coli	1.89
SOLOMON CREEK	INJ01I3_01	BI, E. coli	6.59
SOLOMON CREEK	INJ01I3_02	BI, E. coli	8.66
IDEN BRANCH	INJ01I3_T1001	E. coli	2.94
SOLOMON CREEK	INJ01I4_02	E. coli	5.29
SOLOMON CREEK	INJ01I4_03	E. coli	2.47
CROMWELL DITCH	INJ01I4_T1005	BI, Chloride, DO, E. coli, Nutrients	3.48
CROMWELL DITCH	INJ01I4_T1006	BI, Chloride, DO, E. coli, Nutrients	6.69
ELKHART RIVER	INJ01I5_01	E. coli	7.76
ELKHART RIVER	INJ01I5_02	E. coli	6.41
ELKHART RIVER	INJ01I5_03	BI, E. coli	2.86
ELKHART RIVER	INJ01I5_04	E. coli	4.32
LONG DITCH	INJ01I5_T1001	E. coli	3.55
ELKHART RIVER HYDRAULIC CANAL	INJ01I5_T1004	BI, E. coli	2.25
ELKHART RIVER - UNNAMED TRIBUTARY	INJ01I5_T1006	E. coli	1.12
DALLAS LAKE	INJ01P1263_00	BI	283
DOCK LAKE	INJ01P1228_00	TP	16
HACKENBURG LAKE	INJ01P1262_00	BI	42
HENDERSON LAKE	INJ01P1240_00	PCBS in fish tissue	22
LONG LAKE (CHAIN O' LAKES)	INJ01P1232_00	TP	40
LONG LAKE (LOWER)	INJ01P1208_00	TP	66
MESSICK LAKE	INJ01P1261_00	BI	68

Waterbody Name	Assessment Unit	Impairment	Miles/ Acres
MILLER LAKE (CHAIN O'LAKES SP)	INJ01P1222_00	TP	11
MUD LAKE (CHAIN O' LAKES)	INJ01P1224_00	TP	8
OLIN LAKE	INJ01P1026_00	PCBS in fish tissue	103
OLIVER LAKE	INJ01P1025_00	PCBS in fish tissue	394
PORT MITCHELL LAKE	INJ01P1211_00	TP	15
RIVIR LAKE	INJ01P1223_00	Mercury in fish tissue	24
RIVIR LAKE	INJ01P1223_00	PCBS in fish tissue	24
RIVIR LAKE	INJ01P1223_00	TP	24
SAND LAKE	INJ01P1226_00	TP	47
SYLVAN LAKE	INJ01P1248_00	PCBS in fish tissue	630
UPPER LONG LAKE (UPPER)	INJ01P1210_00	TP	86
WITMER LAKE	INJ01P1267_00	BI	204

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 by the ISDH 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.

Further, sensitive populations are defined as females under 50 except those no longer able to become pregnant, males under 15 or people with compromised immune systems, while general populations are defined as males over the age of 15 and women over the age of 50 or who are no longer capable of becoming pregnant.

Based on these listings, the following conclusions can be drawn:

- Consumption of all sizes bluegill, bullhead, common carp and largemouth bass from Skinner Lake should be limited for sensitive populations. The general population should also limit common carp and largemouth bass over 16 inches consumption to one meal per week,
- For sensitive populations, consumption of all sizes of bluegill and white sucker from Eagle Lake should be limited to one per week and largemouth bass should be limited to consumption of one meal per month. The general population should limit consumption to one meal per week.
- Sensitive populations should limit consumption of bullhead, largemouth bass, northern pike and walleye from Sylvan Lake to one meal per week and common carp should be limited to one meal per month. The general population should limit consumption of bullhead, northern pike and largemouth bass to one meal per week, while common carp consumption should be limited to one meal per month.

- Sensitive populations should limit bowfin, brown trout, common carp consumption from Oliver Lake to one meal per week and largemouth bass consumption to one meal per month. The general population should limit consumption of bowfin larger than 21 inches, brown trout and largemouth bass to one meal per week.
- Sensitive populations should limit consumption of channel catfish larger than 20 inches to one meal per year; channel catfish up to 20 inches, redhorse and white sucker larger than 16 inches to one meal per month and northern hogsucker, rock bass, smallmouth bass and walleye consumption should be limited to one meal per week from the Elkhart River in Elkhart County. The general population should limit redhorse species, smallmouth bass and walleye consumption to one meal per week, catfish up to 20 inches to one meal per month and those over 20 inches to one meal per year.

3.2.3 IDEM Rotational Basin Assessments (1991-2021)

IDEM sampled water chemistry, macroinvertebrates, fish and habitat at several locations in the Upper Elkhart River Watershed via their rotational basin, watershed assessment, and source ID assessment programs between 1991 and 2020. Additionally, one site on the Elkhart River at Benton (US Highway 33) is sampled monthly as part of IDEM's fixed station monitoring program. A few of the assessments which occurred via various IDEM assessment program included a single sample event with most assessments including five sample events and a few assessments including up to 12 events. Based on the water chemistry assessments, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 52% of samples collected in the Upper Elkhart River Watershed.
- Nitrate-nitrogen concentrations exceeded target concentrations in 98% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 34% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 16% of samples collected in the Upper Elkhart River Watershed.
- Turbidity levels routinely exceed the recommended standard in 65% of samples collected in the Upper Elkhart River Watershed.
- Further, 6% of conductivity, 13% of dissolved oxygen and 1% of pH samples also exceeded water quality standards.

Based on the fish and macroinvertebrate community and habitat assessments, the following conclusions can be drawn:

- Macroinvertebrate community assessments indicate that the Elkhart River and its tributaries rate as moderately impaired to slightly impaired using the kick net sampling procedure with scores ranging from 2.2 to 5. Only two of the 27 sites sampled using the multimetric habitat approach rate as impaired scoring 36 points or less.
- Fish community assessments indicate that the Elkhart River and its tributaries rate as very poor (16) to excellent (56). Only two of 21 sampling events rated below the level at which IDEM states the fish community supports its aquatic life use designation.
- Habitat assessments completed along the Elkhart River and its tributaries indicate that habitat is generally fully support for aquatic life uses with QHEI scores ranging from 24 to 81 during fish community assessments and from 30 to 87 during macroinvertebrates. In total, 13 of 30 habitat assessments rate below the aquatic life use designation rating for Indiana (51).

3.2.4 St Joseph River Basin Commission (2014-2015)

The SJRBC completed monthly sampling at 22 sites in the Upper Elkhart River Watershed in an effort to characterize water quality in the basin. Based on the water chemistry assessments, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 13% of samples collected in the Upper Elkhart River Watershed.
- Nitrate-nitrogen concentrations exceeded target concentrations in 59% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 51% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 18% of samples collected in the Upper Elkhart River Watershed.
- Turbidity levels routinely exceed the recommended standard in 26% of samples collected in the Upper Elkhart River Watershed.
- Further, 2% of conductivity and 22% of dissolved oxygen samples also exceeded water quality standards.

3.2.5 Elkhart County (1997-2007)

Elkhart County agencies including the Health Department and MS4 sampled five Upper Elkhart River Watershed sites every two weeks during the growing season. Based on the assessments completed since 1997, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 31% of samples collected in the Upper Elkhart River Watershed.
- Nitrate-nitrogen concentrations exceeded target concentrations in 76% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 86% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 6% of samples collected in the Upper Elkhart River Watershed.
- Further, 1% of conductivity and 9% of dissolved oxygen samples also exceeded water quality standards.

3.2.6 Lagrange County Lakes Council (LCLC)

The Lagrange County Lakes Department have sampled nine lake inlets since 2013. Sampling occurred under various patterns most often occurring twice per summer. Based on assessments completed, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 3% of samples collected in the Upper Elkhart River Watershed.
- Nitrate-nitrogen concentrations exceeded target concentrations in 25% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 47% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 16% of samples collected in the Upper Elkhart River Watershed.
- Further, 2% of pH and 4% of dissolved oxygen samples also exceeded water quality standards.

3.2.7 Oliver Lake Sampling

In 2022, the Greater Olin Lake Conservancy initiated assessment of their stream inlets sampling five stream sites four times in 2022 following storm events. Based on the assessments, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 75% of samples collected in the Upper Elkhart River Watershed. Concentrations collected during the July sampling event were elevated at all sample sites.
- Nitrate-nitrogen concentrations exceeded target concentrations in 70% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 35% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 30% of samples collected in the Upper Elkhart River Watershed.

3.2.8 Sylvan Lake Monitoring (2021)

The City of Kendallville, Sylvan Lake Association and other partners initiated a three-year monitoring project in 2019. As part of the project, two stream gaging stations and continuous samplers were installed on Sylvan Lake's inlet streams and one at the lake's outlet. Based on the report for data collected in 2021, the following conclusions can be drawn:

- Sylvan Lake is a hypereutrophic lake with excess phosphorus which causes regular summer algal blooms.
- Average TP concentrations at both lake sampling points exceeds water quality targets set by the project.
- Henderson Lake Ditch is the largest source of TP to the lake loading an excess of 19,250 lb/year to Sylvan Lake.

3.2.9 IDNR Lake and River Enhancement Program Projects

Several IDNR LARE-funded projects have been completed in the Upper Elkhart River Watershed since 1988. Each project and their stream monitoring efforts are detailed below.

Preliminary Investigation of 24 Lakes, Lagrange County, Indiana (1989)

In 1988, the Lagrange County Commissioners completed an assessment of 24 Lagrange County lakes including 10 lakes located in the Upper Elkhart River Watershed. Sampling of five stream sites occurred as part of this assessment. Based on assessments completed, the following conclusions can be drawn:

- Nutrient concentrations are elevated in Lagrange County lake inlet streams with 40% of nitrate, 70% of orthophosphorus and 84% of total phosphorus samples exceeding water quality targets.

Feasibility Study for Cree and Shockopee Lakes (1990)

In 1989, International Science and Technology (IS&T) completed an assessment of Cree and Shockopee lakes. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- Under storm flow conditions, nutrients including nitrate, orthophosphorus, and total phosphorus were elevated. Overall, 25% of nitrate and ammonia, 50% of orthophosphorus, 75% of total phosphorus samples and 100% of TKN samples exceeded water quality targets.
- TSS samples were also elevated under storm flow conditions with 75% of samples exceeding targets.

Feasibility Study on the Restoration of Bixler Lake (1990)
In 1989, International Science and Technology (IS&T) completed an assessment of Bixler Lake for the Kendallville Park and Recreation Department. Sampling occurred at four locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:
- Under storm flow conditions, nutrients including nitrate, orthophosphorus, and total phosphorus were elevated. Overall, 50% of sampled exceeded water quality targets.
- Total Kjeldahl nitrogen concentrations were elevated in all samples exceeding water quality targets in 100% of collected samples.
- TSS samples were also elevated under storm flow conditions with 50% of samples exceeding targets.

Feasibility Study of Ten Lagrange County Lakes (1992)
In 1991, FXBrowne completed an assessment of 10 Lagrange County lakes located in the Upper Elkhart River Watershed. Sampling of 22 stream sites occurred as part of this assessment. Based on assessments completed, the following conclusions can be drawn:
- Nutrient concentrations are elevated in Lagrange County lake inlet streams with 18% of nitrate, 82% of orthophosphorus and 59% of total phosphorus samples exceeding water quality targets.
- Elevated total Kjeldahl nitrogen (36%) and total suspended solids (18%) suggest that sediment attached nutrients and sediment itself are also of concern under high flow conditions.

Feasibility Study for Cree and Shockopee Lakes (1990)
In 1989, International Science and Technology (IS&T) completed an assessment of Cree and Shockopee lakes. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:
- Under storm flow conditions, nutrients including nitrate, orthophosphorus, and total phosphorus were elevated. Overall, 50% of sampled exceeded water quality targets.
- Total Kjeldahl nitrogen concentrations were elevated in all samples exceeding water quality targets in 100% of collected samples.
- TSS samples were also elevated under storm flow conditions with 50% of samples exceeding targets.

Chain o' Lakes Diagnostic Study (2002)
In 2002, Gensic and Associates completed the water quality portion of the assessment of the Chain of Lakes state park lakes and their inlet streams. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:
- Under storm flow conditions, dissolved nutrients including nitrate and orthophosphorus were elevated. Overall, 50% of sampled exceeded water quality targets.
- TKN, TP and TSS concentrations were elevated in all samples exceeding water quality targets in 100% of collected samples.
- E. coli concentrations exceeded state standards in 25% of collected samples.
- QHEI scores ranged from 56 to 66 with both sites scoring above Indiana's aquatic life use designation and one site scoring below the level at which the Ohio EPA indicates is conducive to warmwater fauna.
- mIBI scores were low for all watershed streams ranging from moderate to severe impairment with scores ranging from 3.25 to 3.75.

Whetten Ditch, Solomon Creek and Dry Run Watersheds Diagnostic Study (2002)

The Whetten Ditch, Solomon Creek and Dry Run Watersheds drain approximately 36,242 acres in Elkhart, Noble and Kosciusko Counties. As part of the project, JFNew sampled nine stream sites across the watershed. Based on assessments completed in 2001, the following conclusions can be drawn:

- Physical and chemical parameter data indicate moderate to severe degradation when compared with ideal conditions.
- Nutrient concentrations measure higher than median nutrient concentrations observed in modified Ohio streams known to support healthy modified warmwater habitat for aquatic life.
- Stormflow runoff conditions generated nutrient and bacteria concentrations that violated human and aquatic biota health targets and standards. Overall, 94% of nitrate, 61% of orthophosphorus and total phosphorus samples exceed water quality targets.
- Sediment loading rates were variable but high ranging from 1 to 5845 kg/d depending on flow regime and location. More than 39% of samples collected exceed TSS targets.
- The Juday Ditch subwatershed delivered more sediment, phosphorus and E. coli than any other subwatershed during storm conditions per unit area.
- Juday Creek, Blue Ditch, Solomon Creek east, Dry Run and Whetten Ditch could be considered impaired based on water chemistry data.
- Poor pool-riffle development, excessive siltation/substrate embeddedness, channel alterations from ditching and dredging and very narrow riparian buffers limit habitat present at each sampled reach. QHEI scores ranged from 25.5 to 54.5 with only one site scoring above Indiana's aquatic life use designation and all sites scoring below the level at which the Ohio EPA indicates is conducive to warmwater fauna.
- mIBI scores were low for all watershed streams ranging from moderate to severe impairment with scores ranging from 0.75 to 6.

Feasibility Study for Cree and Shockopee Lakes (1990)

In 1989, International Science and Technology (IS&T) completed an assessment of Cree and Shockopee lakes. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- Under storm flow conditions, nutrients including nitrate, orthophosphorus, and total phosphorus were elevated. Overall, 50% of sampled exceeded water quality targets.
- Total Kjeldahl nitrogen concentrations were elevated in all samples exceeding water quality targets in 100% of collected samples.
- TSS samples were also elevated under storm flow conditions with 50% of samples exceeding targets.

Feasibility Study for Sylvan Lake Improvement Association (1990)

In 1988, Crisman completed an assessment of Sylvan Lake and its watershed. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- Nitrate concentration (2 mg/L) in Henderson Lake Ditch measured 10 times greater than in Waterhouse Ditch or any of the lake stations during both the May and August assessments with concentrations measuring lower in August than in May. Overall, 33% of samples exceeded water quality targets.
- Ammonia, TKN, orthophosphorus and TP concentrations were also elevated in Henderson Lake Ditch compared to Waterhouse Ditch or the lake stations. Ammonia concentrations in Henderson Lake Ditch exceeded state standards during all assessments. More than 75% of TKN

samples, more than 67% of orthophosphorus and more than 50% of TP samples exceeded water quality targets.

Upper Long Lake Watershed Diagnostic Study (1998)

In 1998, Gensic and Associates completed an assessment of Upper Long Lake and its watershed. Sampling occurred at two locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- TKN and TP samples exceeded water quality targets in 100% of collected samples.
- TSS measured low with none of the samples exceeding targets during the assessment.

Oliver, Olin and Martin Lakes Diagnostic Study (2009)

In 2008, JFNew completed an assessment of Olin, Oliver and Martin lakes and their inlet streams. Sampling occurred at four locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- Nutrients including nitrate, orthophosphorus, and total phosphorus were elevated with 100% of nitrate samples, 50% of TKN samples, 33% of total phosphorus, 67% of orthophosphorus and 17% of ammonia samples exceeding water quality targets.
- TSS samples were also elevated; however, only 33% of samples exceeding targets.
- Dissolved oxygen levels measured low with 17% of samples measuring below the lower state water quality standard.
- E. coli concentrations were elevated with 75% of samples exceeding the state standard.
- QHEI scores ranged from 31.5 to 66 with only one sites scoring above Indiana's aquatic life use designation (51) and all but one site scoring below the level at which the Ohio EPA indicates is conducive to warmwater fauna (60).
- mIBI scores were low for all watershed streams ranging from 2 to 4.4 indicating that macroinvertebrate communities are moderately to severely impaired.

Skinner Lake Diagnostic Study (2022)

In 2021, Arion Consultants completed an assessment of Skinner Lake and its watershed. Sampling occurred at 10 locations under base and storm flow conditions. Based on assessments completed, the following conclusions can be drawn:

- In general, physical and chemical parameter data collected from streams in the Skinner Lake Watershed indicate the potential for water quality degradation when compared with ideal conditions. In total, 10% of dissolved oxygen samples exceed state water quality standards measuring lower than state standards.
- Particulate phosphorus concentrations were elevated throughout the watershed under all sampling conditions. Nearly 80% of TP samples exceed water quality targets while only 15% of orthophosphorus concentrations exceed targets.
- Total Kjeldahl nitrogen concentrations measured above EPA target concentrations; however, concentrations were generally low throughout the Skinner Lake Watershed. Nearly 90% of TKN samples exceed water quality targets.
- Nitrate-nitrogen concentrations were also low throughout the watershed during base flow conditions; however, all sites exceeded levels at which high productivity (eutrophication) can occur during storm flow conditions. This suggests that nitrate-nitrogen is loaded to the system during storm events. More than 70% of nitrate samples exceed water quality targets.

- Total suspended solids concentrations measured low under base flow conditions but exceeded targets at all sites during storm flow conditions. Nearly 30% of TSS samples exceed water quality targets.
- E. coli concentrations exceeded state standards during base flow and at all but two sites under storm flow conditions. Overall, 71% of E. coli samples exceed water quality targets.
- The overall evaluation of biotic health and habitat quality in the Skinner Lake Watershed indicates that stream sites are slightly to moderately degraded. Many of the sites lacked at least one of the key elements of natural, healthy stream habitats. These missing key elements limit the functionality of these systems. The QHEI evaluations generally reflected the moderate pool and limited to moderate riffle development in watershed streams; there was almost a complete absence of sufficient pool-riffle development within most sites where habitat scored poorly. Channel alterations and minimal riparian buffer zones reduce streams' resilience to agricultural runoff. These factors are critical for habitat diversity and biological integrity in the stream ecosystems. Further, instream cover is limited at almost all sites. As these streams are all legal drains, the modification of their habitat is not unexpected.

3.2.10 Elkhart River Watershed Management Plan (2008)

V3 assessed five Elkhart River sites during development of the Elkhart River Watershed Management Plan. Three of those sites are located in the Upper Elkhart River Watershed. Based on assessments completed in 2007, the following conclusions can be drawn:

- E. coli concentrations exceeded the state standard in 33% of samples collected in the Upper Elkhart River Watershed.
- Nitrate-nitrogen concentrations exceeded target concentrations in 33% of samples collected in the Upper Elkhart River Watershed.
- Total phosphorus concentrations exceeded the recommended criteria in 17% of samples collected in the Upper Elkhart River Watershed.
- Total suspended solids concentrations exceeded the recommended criteria in 33% of samples collected in the Upper Elkhart River Watershed.
- Turbidity, pH, and conductivity samples did not exceed water quality standards or targets. However, 17% of dissolved oxygen samples measured below the lower state water quality standard.
- QHEI scores ranged from 55.5 to 79 with all sites scoring above Indiana's aquatic life use designation (51) and above the level at which the Ohio EPA indicates is conducive to warmwater fauna (60).
- mIBI scores were low for all watershed streams ranging from moderate impairment with scores ranging from 2.2 to 4.8.

3.2.11 Hoosier Riverwatch Sampling (2002-2014)

From 2002 to 2014, volunteers trained through the Hoosier Riverwatch program assessed two sites in the Upper Elkhart River Watershed. Volunteers monitored stream stage, flow rate, and discharge; collected water chemistry samples for analysis using HACH test kits; assessed instream habitat using the Citizen's QHEI; and surveyed the stream's macroinvertebrate community. Using the chemical data, the Water Quality Index (WQI) was calculated. Volunteers calculated a Pollution Tolerance Index (PTI) using the biological data. Based on these data, the following conclusions can be drawn:

- When measured, E. coli concentrations were elevated in 71% of samples. Concentrations above the state standard ranged from 250 to 915 col/100 ml.

- Nitrate concentrations ranged from 0.15 to 22 mg/L with 50% of samples exceeding the water quality target.
- Orthophosphorus concentrations were elevated in 100% of samples.
- Turbidity levels were elevated across all sample sites with 35% of samples exceeding the transparency which indicates poor water quality (29 cm).

3.3 <u>In-Lake Monitoring</u>

A variety of lake assessment projects have been completed within the Upper Elkhart River Watershed with sampling occurring at more than 93 lakes in the basin (Figure 37). The Indiana Clean Lakes Program and their volunteer monitors are the primary collectors of data. A summary of each assessment methodology and general results are discussed below. Specific data results are detailed within subwatershed discussions in subsequent sections.

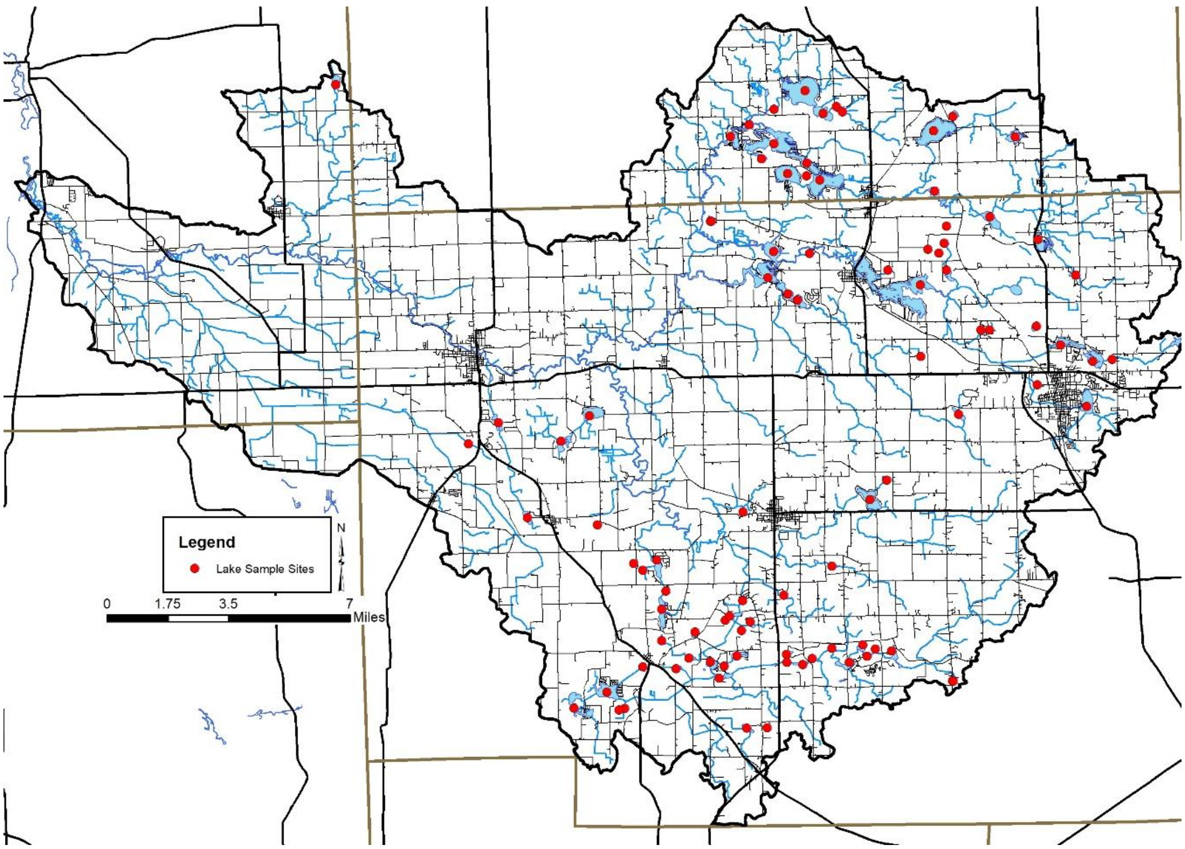


Figure 37. Historic lake assessment locations.

3.3.1 Indiana Clean Lakes Program

Since 1989, the Indiana Clean Lakes Program assessed water quality in 52 lakes in the Upper Elkhart River Watershed. Soluble and dissolved nitrogen, soluble and dissolved phosphorus, chlorophyll a, dissolved oxygen, temperature and plankton counts were collected at the deepest point of each lake. Based on these data, the following conclusions can be drawn:

- In total, 237 transparency measurements were collected and nearly 48% of these measures lower than the median transparency measured for Indiana lakes (5.6 feet).
- Nearly 237 total phosphorus samples were collected with 99% of the average surface and bottom water samples concentrations exceeding the median concentration for Indiana lakes (51 mg/L).

- More than 114 chlorophyll a samples were collected with 57% exceeding the median concentration for Indiana lakes (4.92 mg/L).
- Plankton samples indicate blue-green algae typically dominate samples collected from lakes in the Upper Elkhart River Watershed. Nearly 65% of lakes sampled possess plankton communities which are dominated by blue-green algae.

3.3.2 Indiana Clean Lakes Program Volunteers

Since 1989, volunteers trained through the Indiana Clean Lakes Program assessed water quality in 16 lakes in the Upper Elkhart River Watershed. Volunteers at all lakes monitored secchi disk transparency and assessed total phosphorus, total nitrogen and chlorophyll a concentrations four times each summer in five lakes. Based on these data, the following conclusions can be drawn:

- In total, 2303 transparency measurements were collected and nearly 35% of these measures lower than the median transparency measured for Indiana lakes (5.6 feet).
- Nearly 364 total phosphorus samples were collected with 15% of these concentrations exceeding the median concentration for Indiana lakes (51 mg/L).
- More than 345 chlorophyll a samples were collected with 19% exceeding the median concentration for Indiana lakes (4.92 mg/L).
- Nearly 55 total nitrogen samples were collected with 87% of these concentrations exceeding the median concentration for Indiana lakes (1.069 mg/L).

3.3.3 Global Lake Ecological Observatory Network (GLEON) Volunteers

The Water Quality Portal shows that GLEON volunteers sampled 93 lakes in the Upper Elkhart River Watershed. However, only six results are available in the portal. Based on these few data, all six lakes possess secchi disk transparencies which measure higher than the average transparency for Indiana lakes.

3.4 <u>Current Water Quality Assessment</u>

3.4.1 Water Quality Sampling Methodologies

As part of the current project, the Upper 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 Upper Elkhart Watershed Management Plan approved on January 21, 2022. Sites sampled through this program are displayed in Figure 39. Sample sites were selected based on watershed drainage and correspond with sites sampled by IDEM in the past. The monthly sampling regimen was enacted to create a baseline of water quality data.

Stream Flow

Stream flow was calculated by scaling stream flow measured at the U.S. Geological Survey (USGS) stream gages to subwatershed drainage area. The Shatto Ditch near Mentone (USGS 03331224) and Cedar Creek at Auburn (USGS 04179520) gages were used for tributary stream sites, while the Elkhart River at Goshen (USGS 04100500) was used to scale flow for the mainstem Elkhart River sites. As shown in Figure 38, stream flows dropped from February 2022 through November 2022. Field observations suggest that many of the tributary streams experienced limited watershed runoff throughout the sampling due to low precipitations levels across the Upper Elkhart River Watershed. The early summery of 2022 was identified by NOAA as abnormally dry, while the fall of 2022 was identified as a moderate drought for northern Indiana (NOAA, 2023).

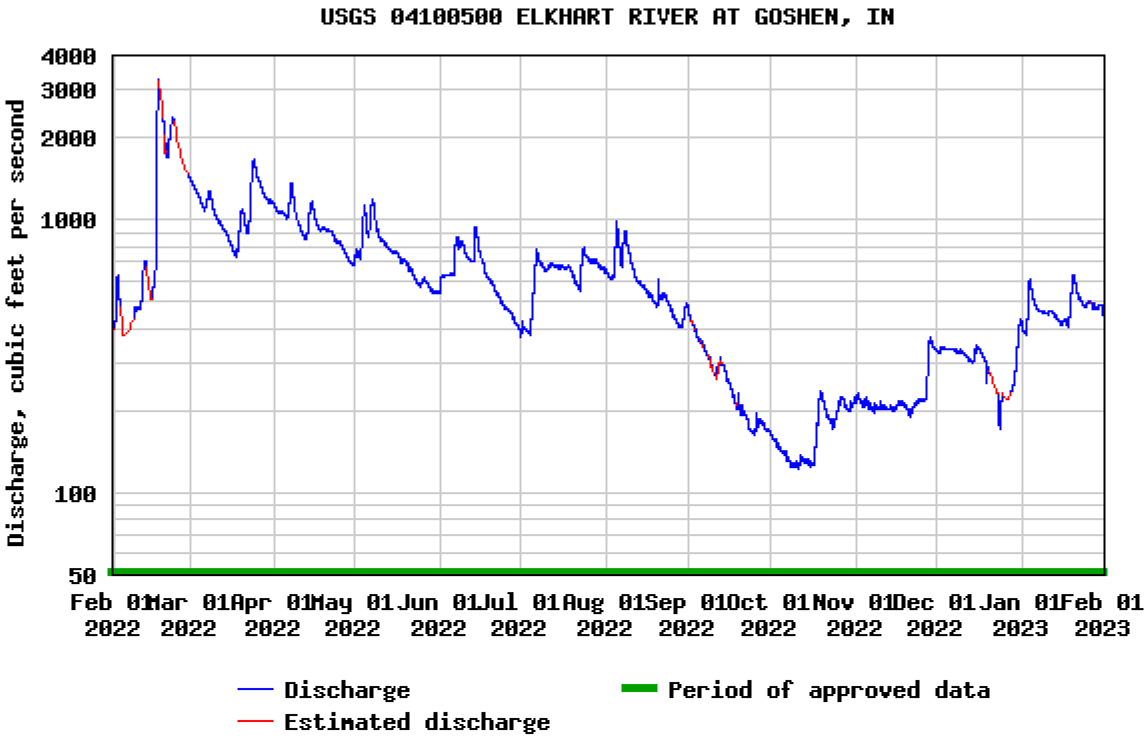


Figure 38. Stream flow measured during the sampling period at the Elkhart River at Goshen USGS stream gage.

Field and Laboratory Chemistry Parameters

The Upper Elkhart River Watershed Project established twenty 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 2022 through January 2023.

Biological Community and Habitat

The physical habitat at each of the 20 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 17 of 20 sites assessed October 7, 2022.

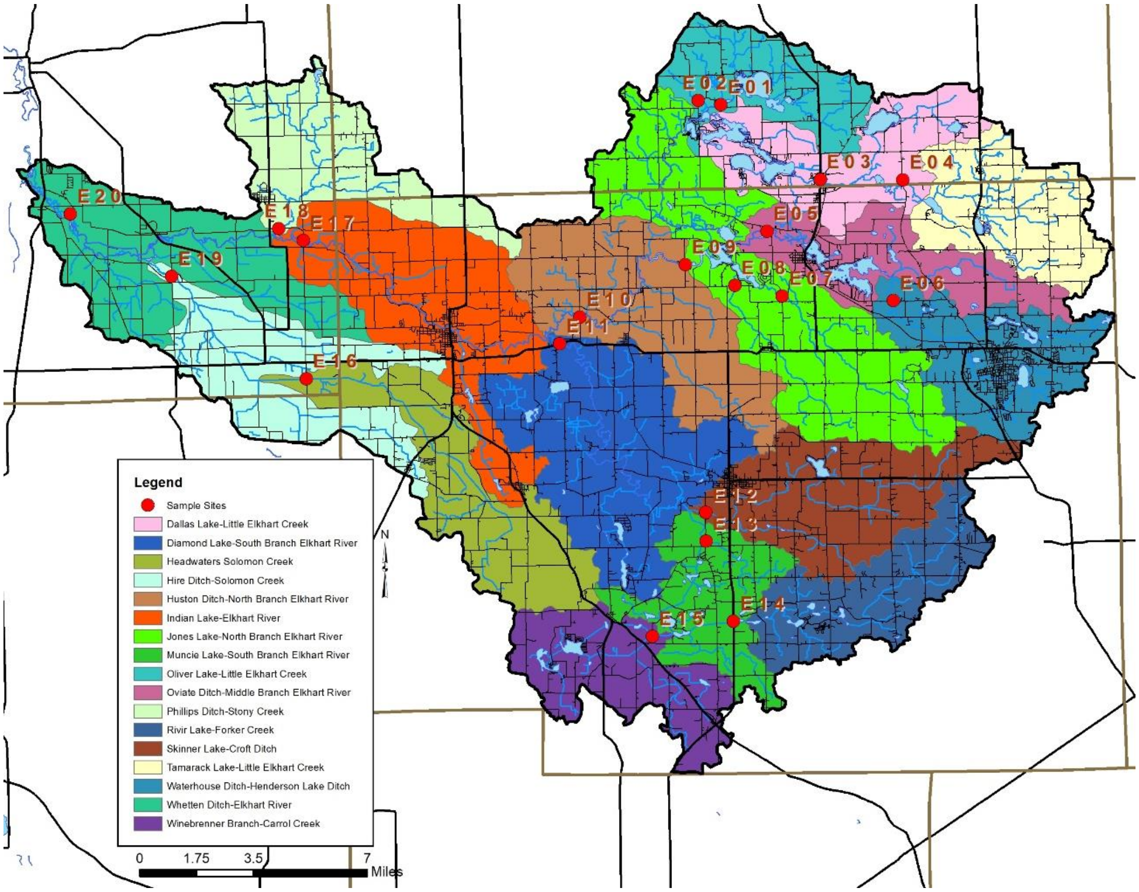


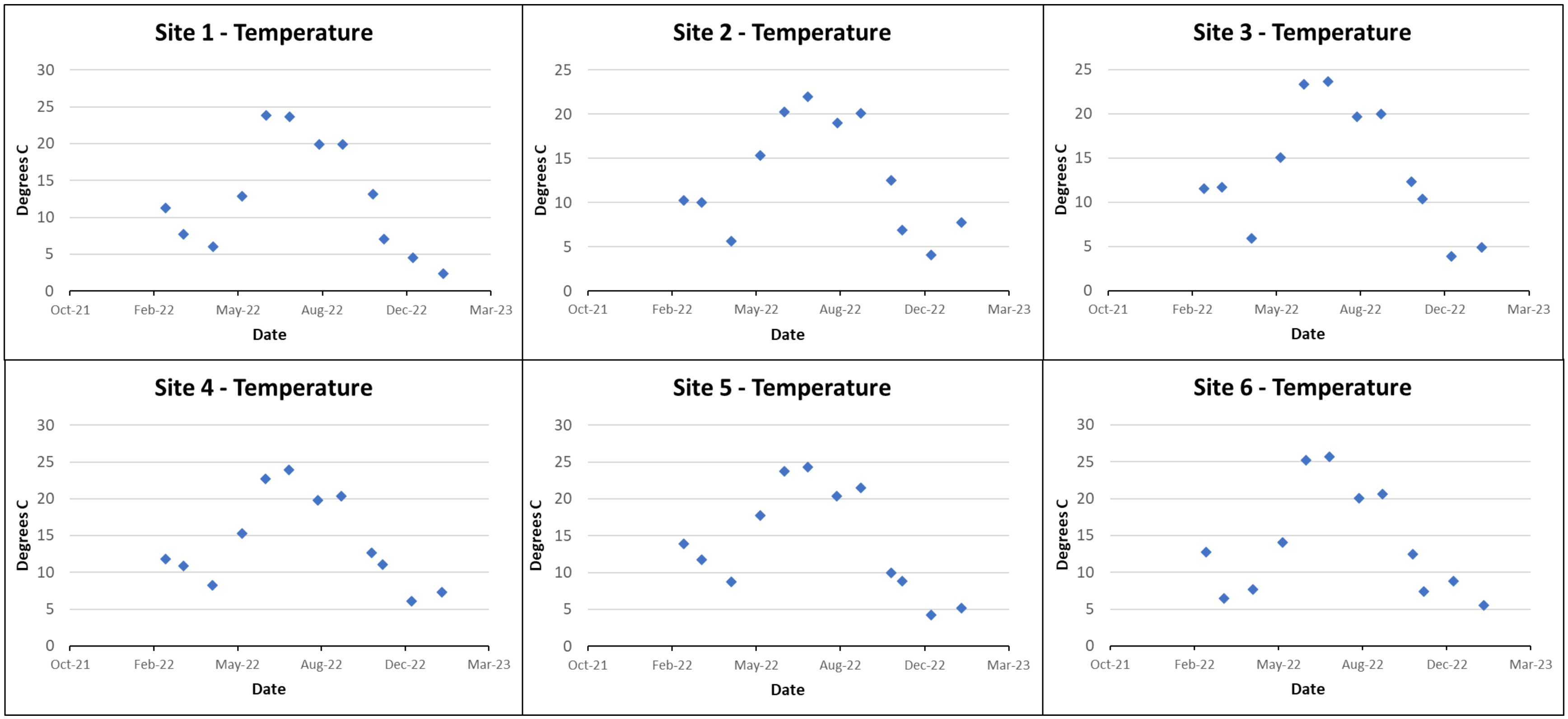
Figure 39. Sites sampled as part of the Upper Elkhart River Watershed Management Plan.

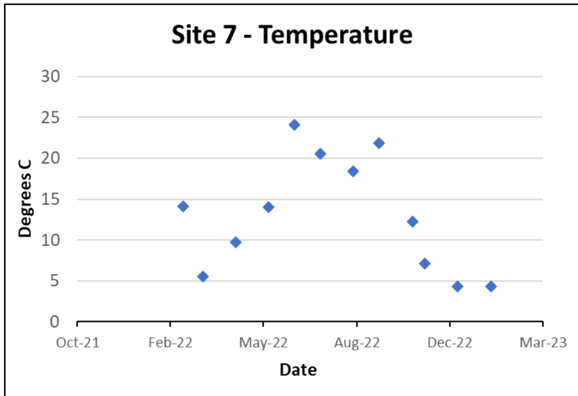
3.4.2 Field Chemistry Results

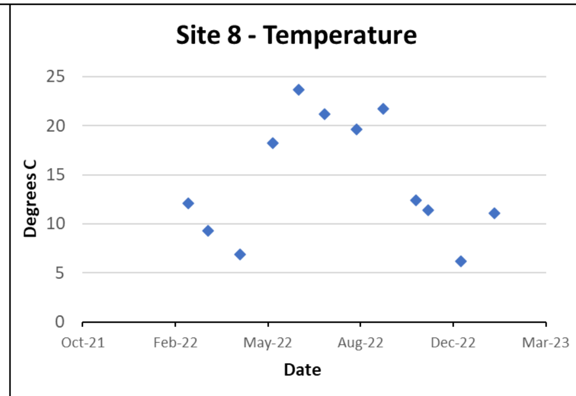
Figure 40 through Figure 44 displays results for non-nutrient field chemistry data collected monthly at the twenty sample sites. At each of the stream sites, a multi-parameter probe was deployed during each sampling event. The probe collects data for temperature, dissolved oxygen, specific conductivity, and pH. Water chemistry data are detailed in Appendix B.

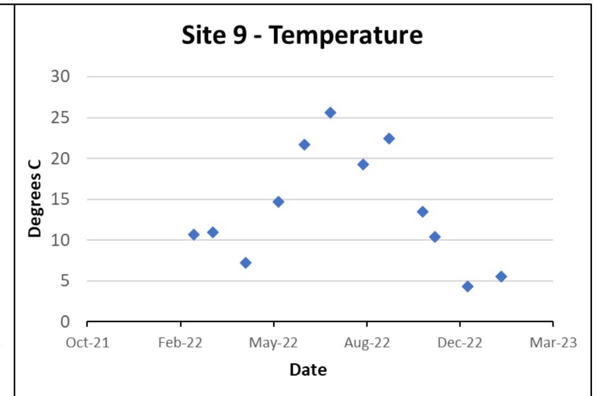
Temperature

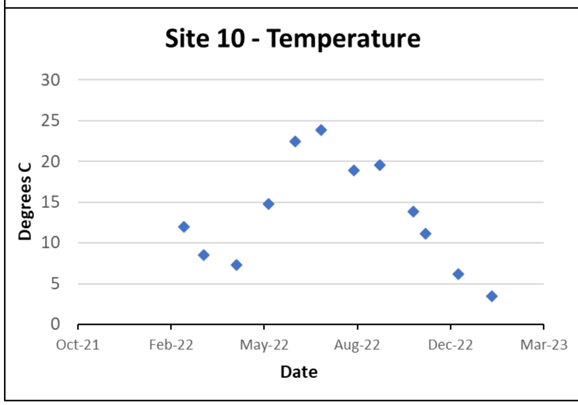
Figure 40 illustrates monthly temperatures in the watershed streams. As shown, temperatures measure approximately the same in each of the twenty stream sites with seasonal changes in temperature creating major differences in temperatures throughout the sampling period. Temperatures measured between 2.38 to 25.71 °C in all streams. The highest temperatures occurred during the June and July sampling events depending on riparian cover and stream depth present at each location.

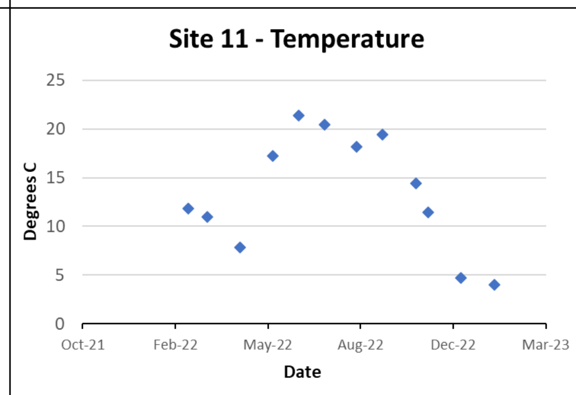


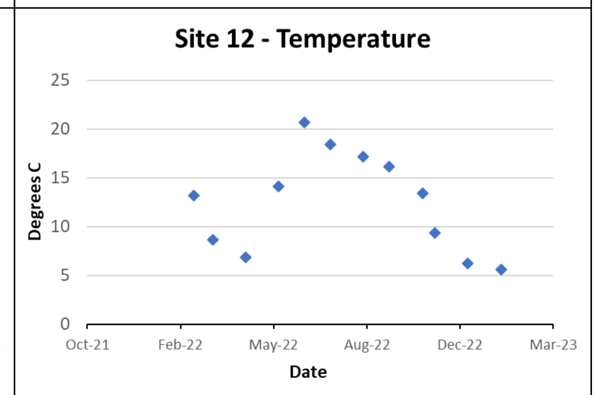

Site 7 - Temperature
Degrees C
0
5
10
15
20
25
30
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date

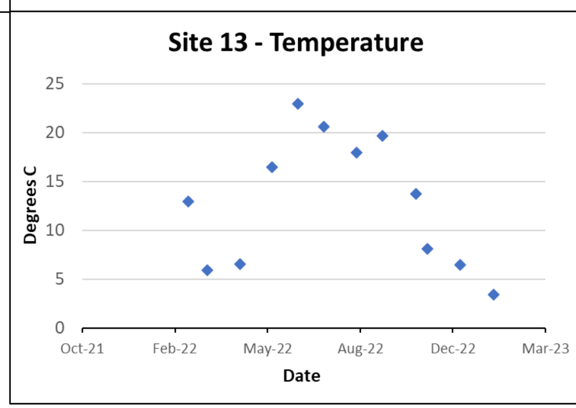

Site 8 - Temperature
Degrees C
0
5
10
15
20
25
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 9 - Temperature
Degrees C
0
5
10
15
20
25
30
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 10 - Temperature
Degrees C
0
5
10
15
20
25
30
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 11 - Temperature
Degrees C
0
5
10
15
20
25
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 12 - Temperature
Degrees C
0
5
10
15
20
25
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 13 - Temperature
Degrees C
0
5
10
15
20
25
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date

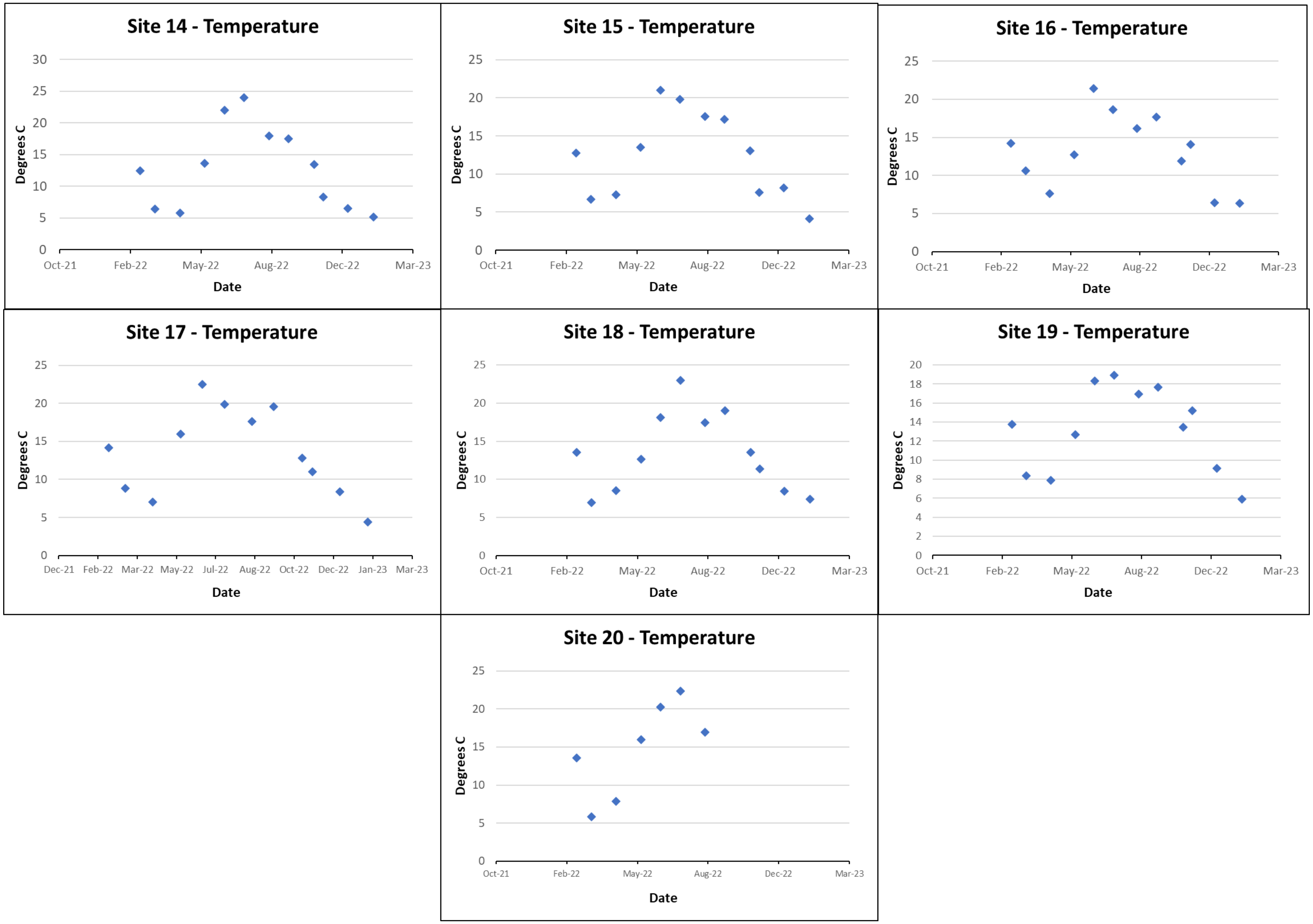
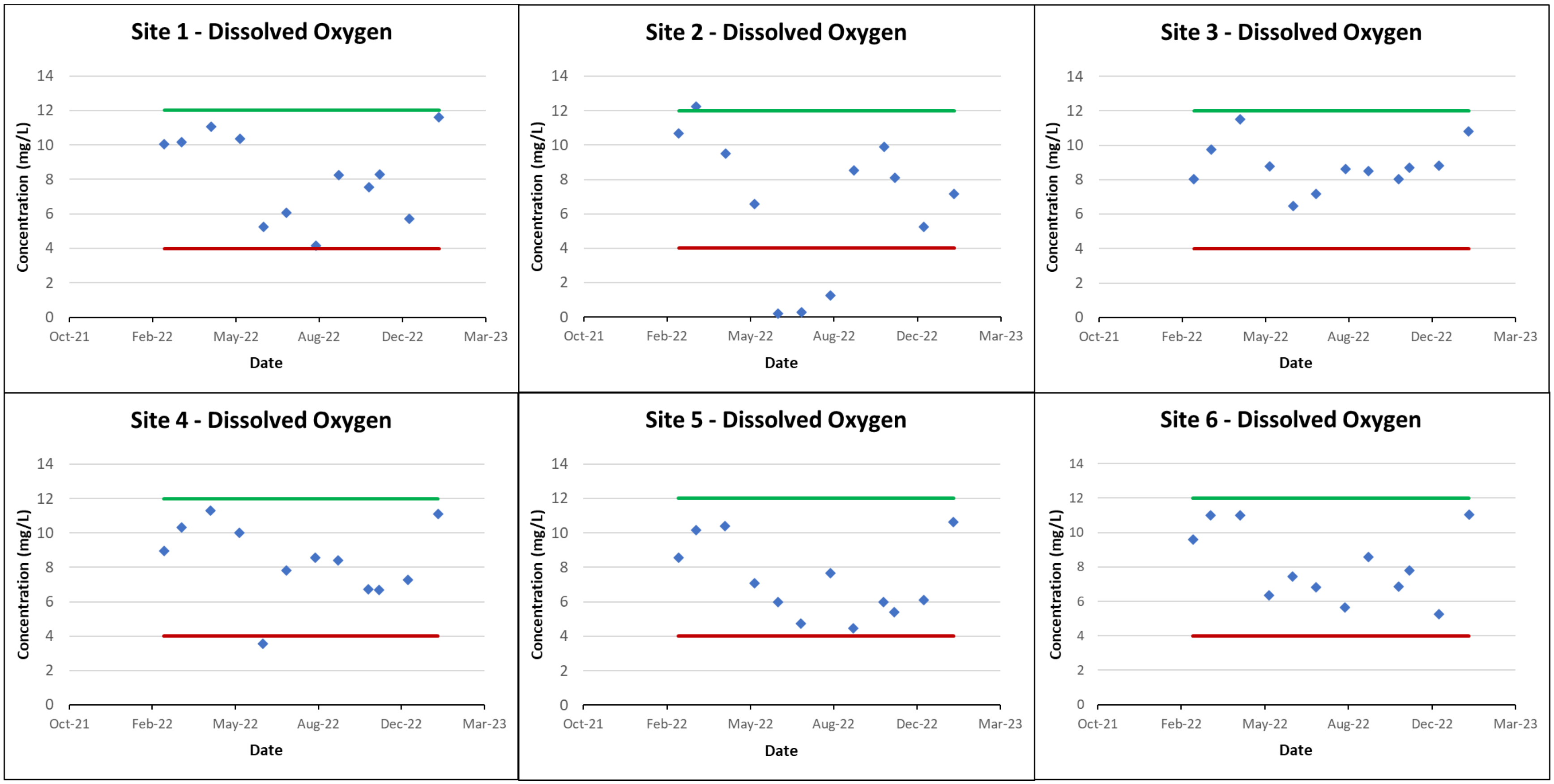
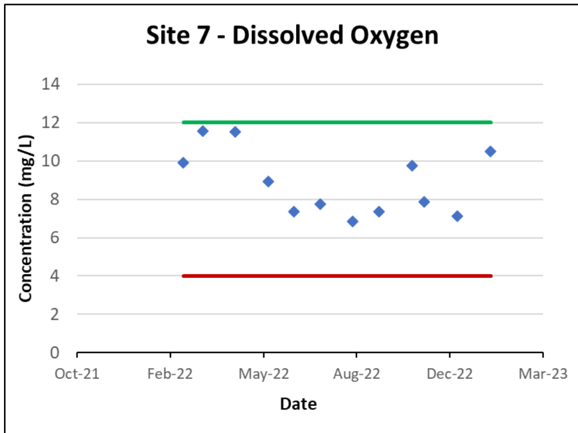


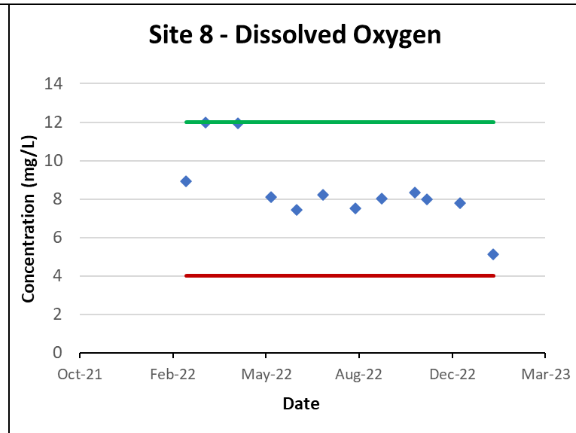
Figure 40. Temperature measurements in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note difference in scale along the concentration (y) axis.

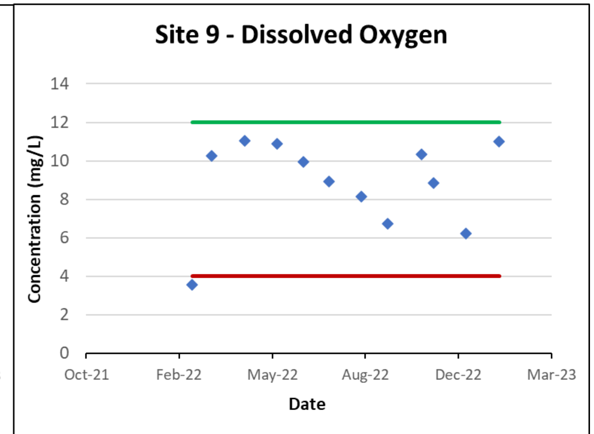
Dissolved Oxygen

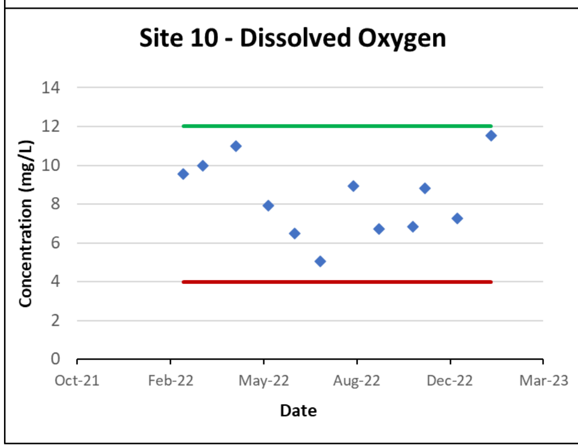
Dissolved oxygen concentrations mostly displayed seasonal changes as observed in temperature with the highest dissolved oxygen levels measured when temperatures were typically lowest (
Figure **41**). The lowest and highest dissolved oxygen concentration occurred at the Hackenburg Lake inlet (Site 2) with the lowest occurring during June 2022 with a concentration level of 0.22 m/g/Land the highest occurring during March 2022 with a concentration level of 12.24 m/g/L. In total, 5% of samples (13 of 280) measured below or above the lower and higher dissolved oxygen state standard (4 m/g/L and 12 m/g/L). Exceedances occurred at the Hackenburg Lake inlet (Site 2), Little Elkhart Creek (Site 4), North Branch Elkhart River downstream of West Lakes (Site 9), South Branch Elkhart River (Site 11) and Rivir Lake tributary (Site 14).

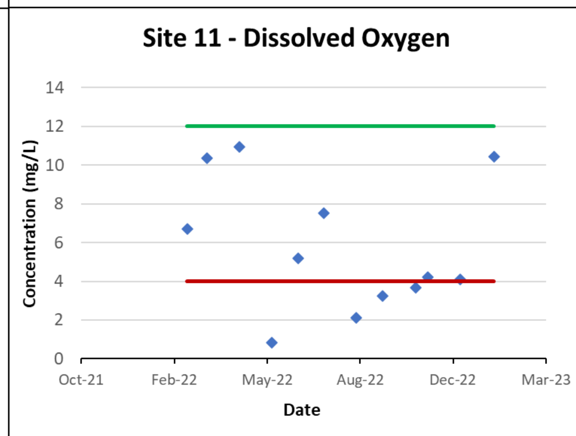


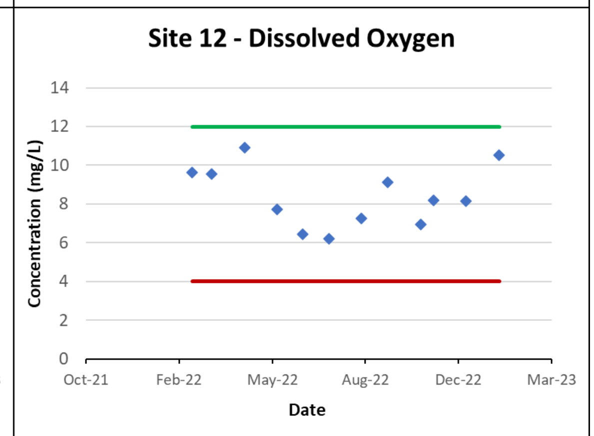

Site 7 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date

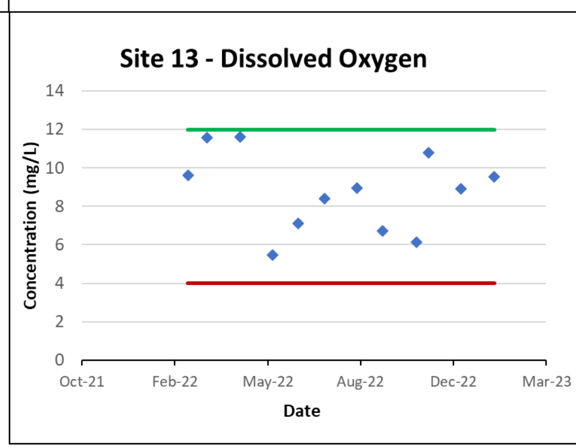

Site 8 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 9 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 10 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 11 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 12 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date


Site 13 - Dissolved Oxygen
Concentration (mg/L)
0
2
4
6
8
10
12
14
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date

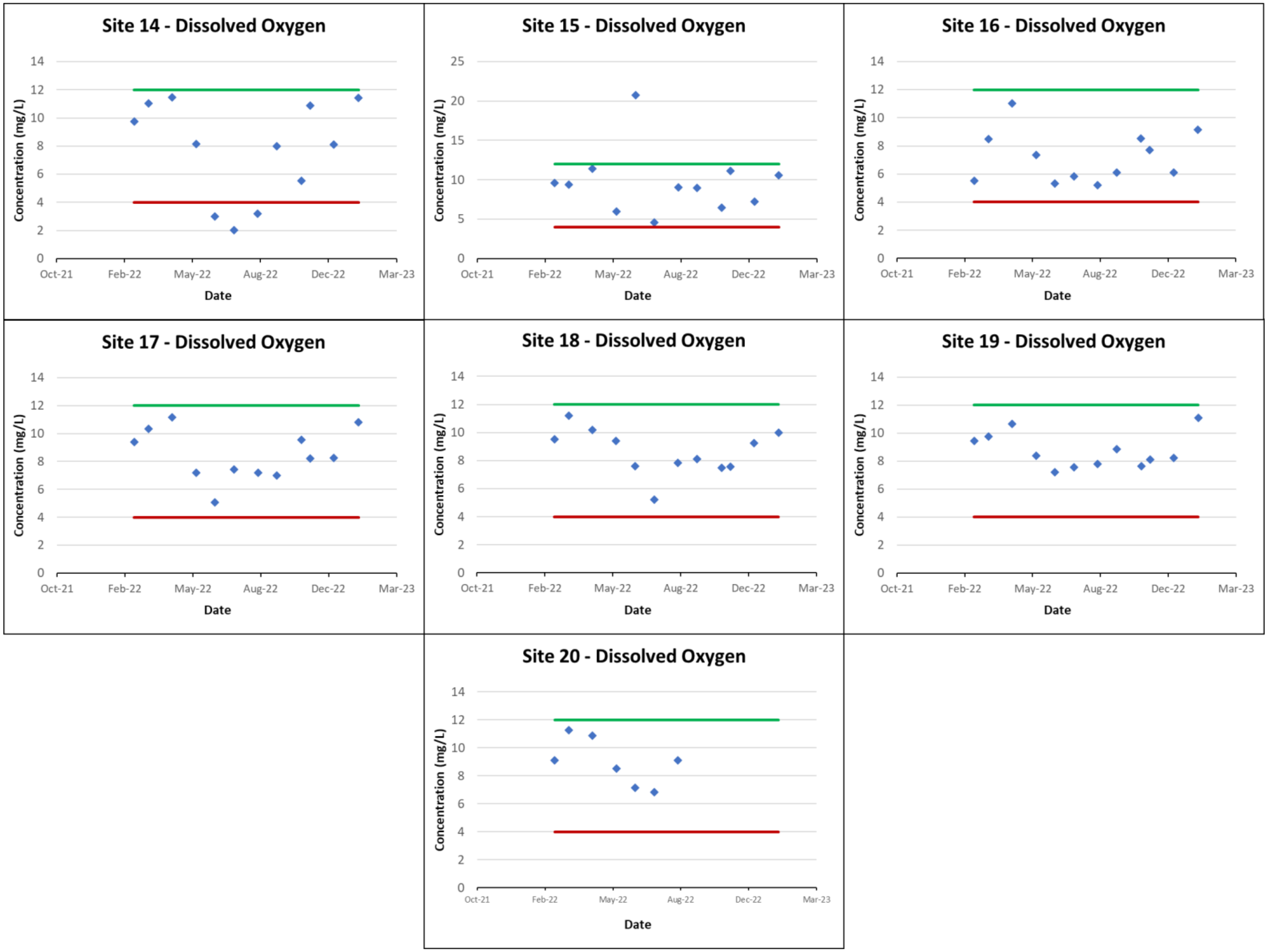
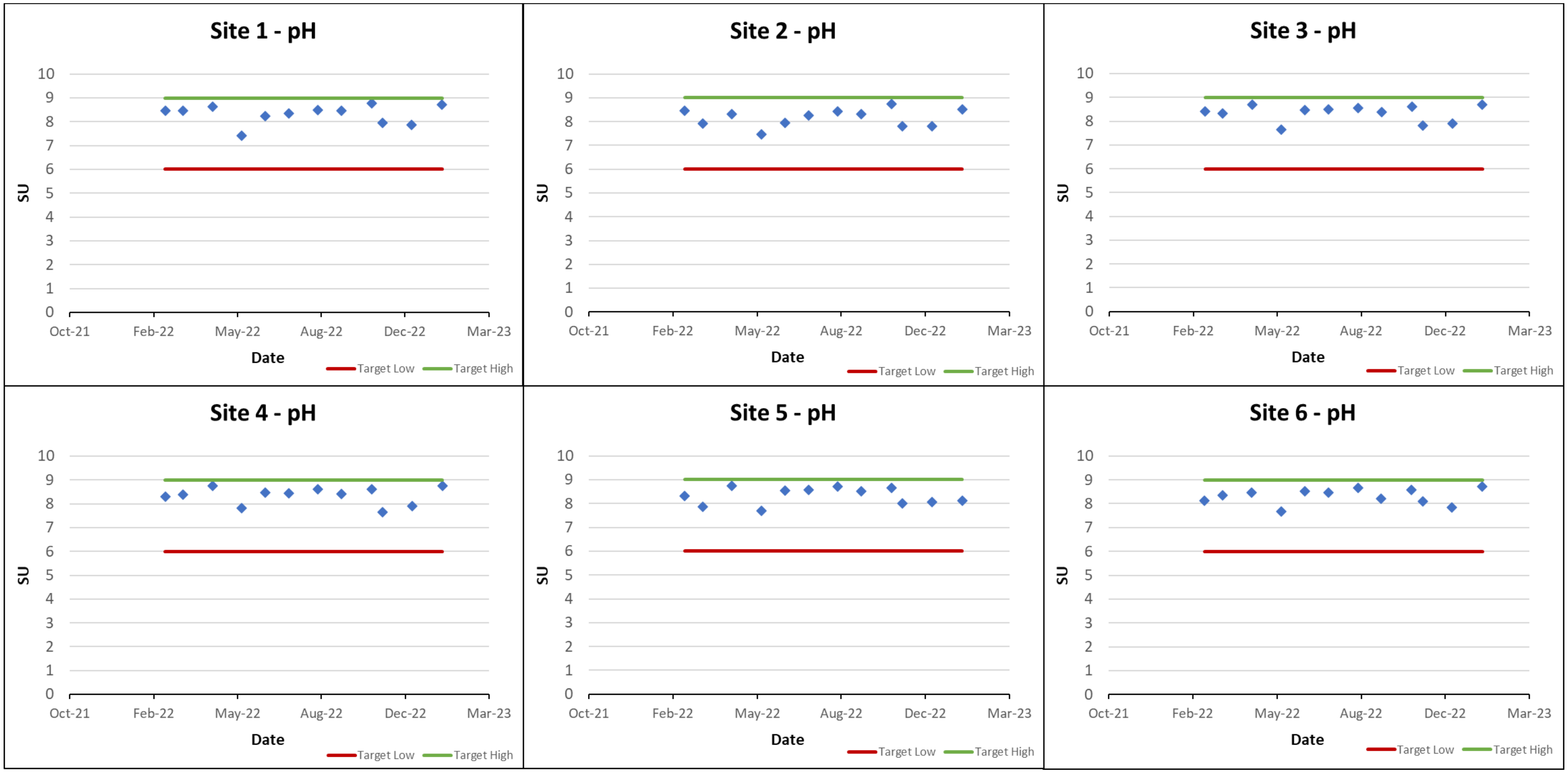
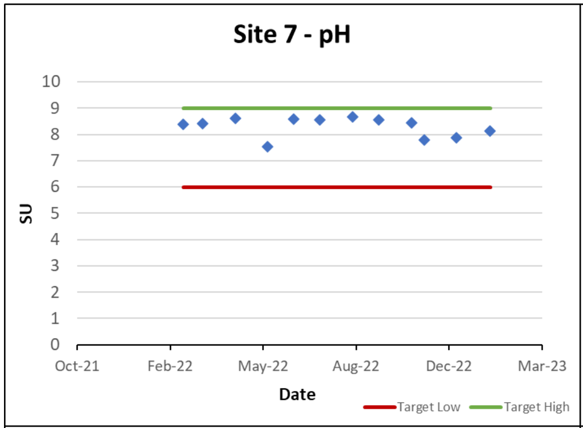


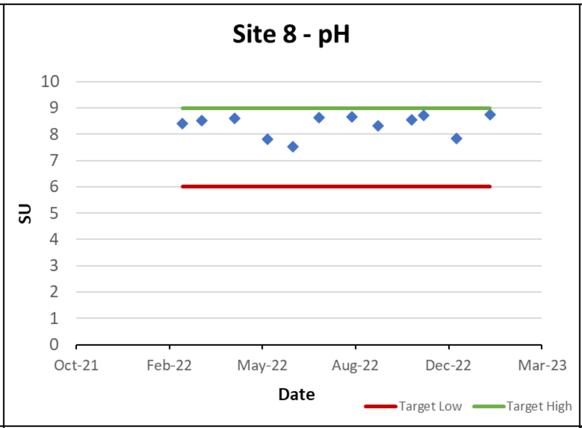
Figure 41. Dissolved oxygen measurements in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note the differences in scale along the concentration (y) axis.

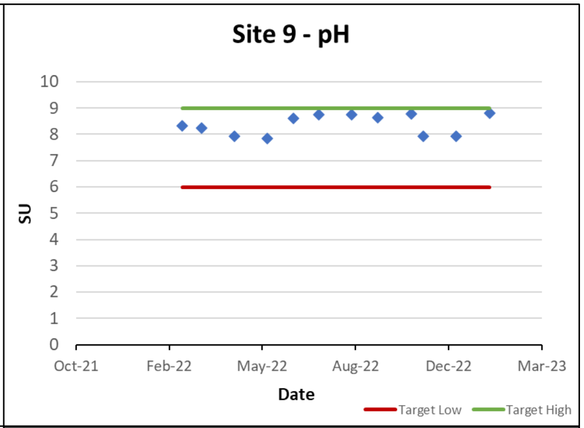
pH

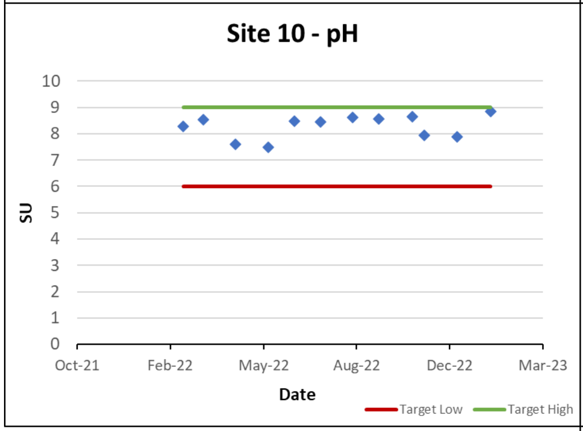
Throughout the sampling period, pH remained in an acceptable range in all watershed streams (Figure 42). The highest pH level occurred in South Branch Elkhart River (Site 13) during August 2022 sampling period with a level of 8.88. The lowest pH level occurred in Solomon Creek (Site 16) during April 2022 sampling period with a level of 7.05. In general, the pH levels show a consistent pattern in all watershed streams between early summer and late fall.

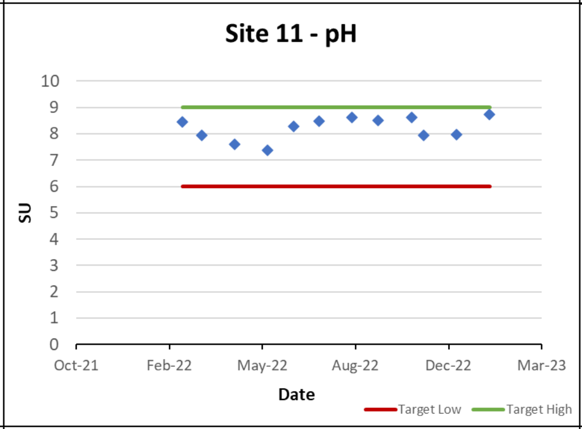


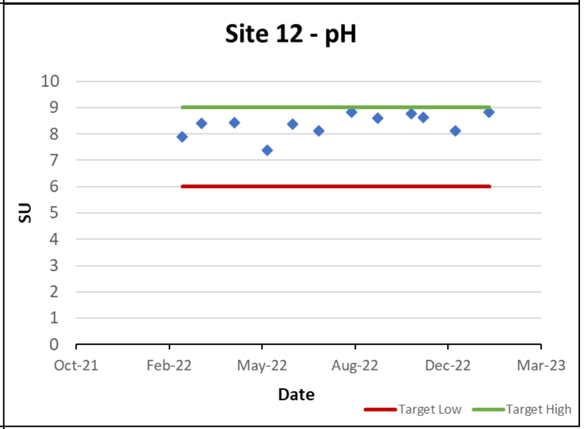

Site 7 - pH
SU
Date
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Target Low
Target High

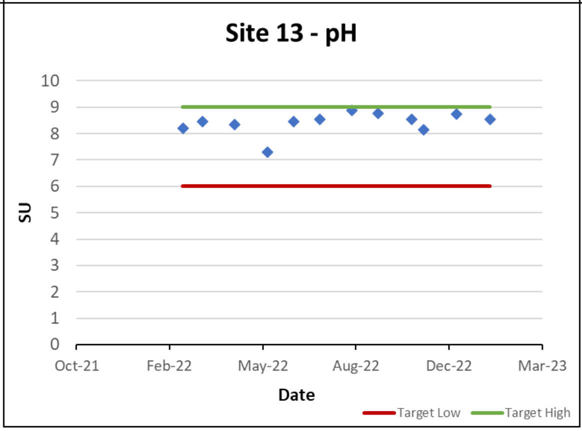

Site 8 - pH
SU
Date
Target Low
Target High


Site 9 - pH
SU
Date
Target Low
Target High


Site 10 - pH
SU
Date
Target Low
Target High


Site 11 - pH
SU
Date
Target Low
Target High


Site 12 - pH
SU
Date
Target Low
Target High


Site 13 - pH
SU
Date
Target Low
Target High

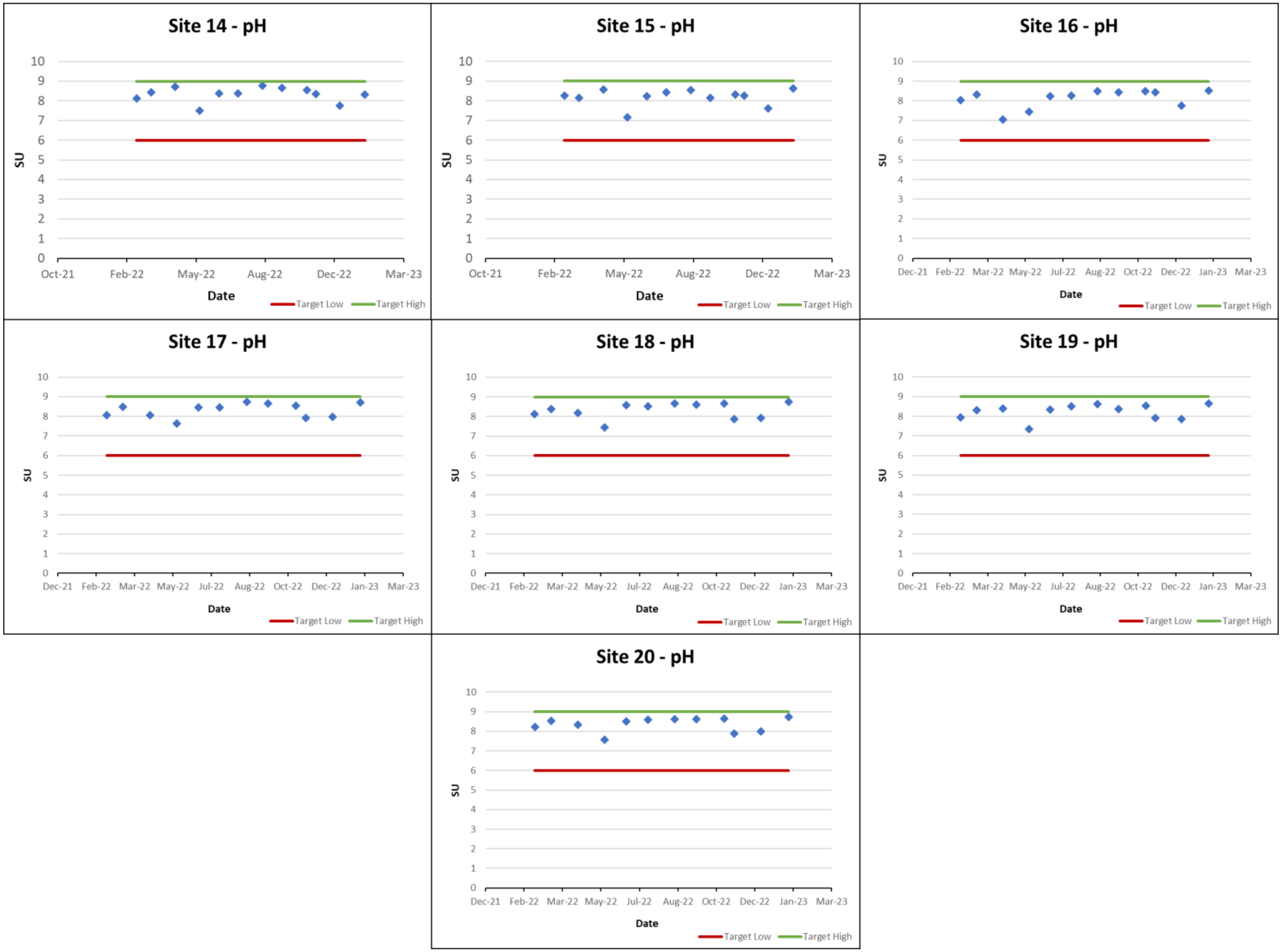
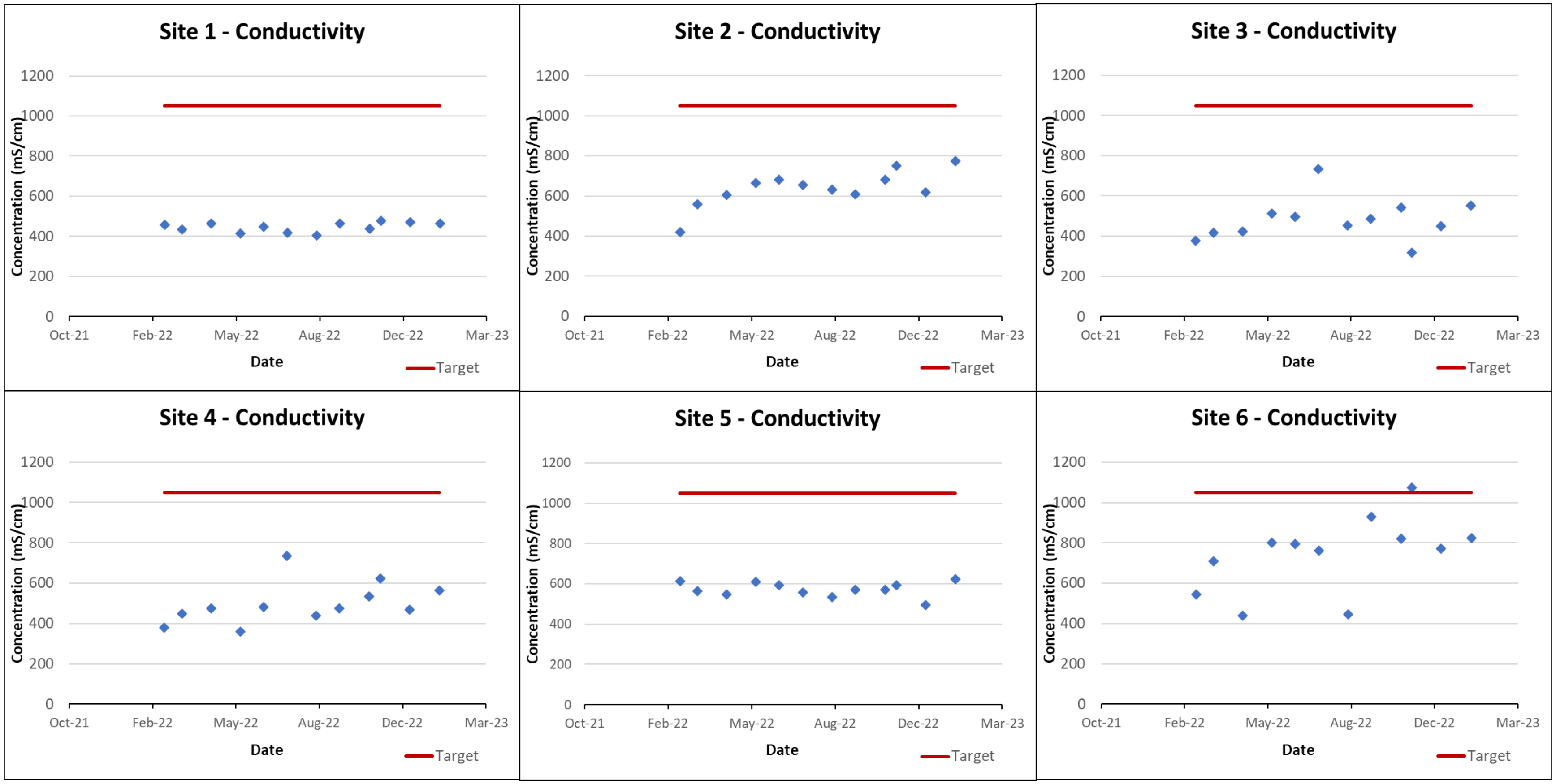
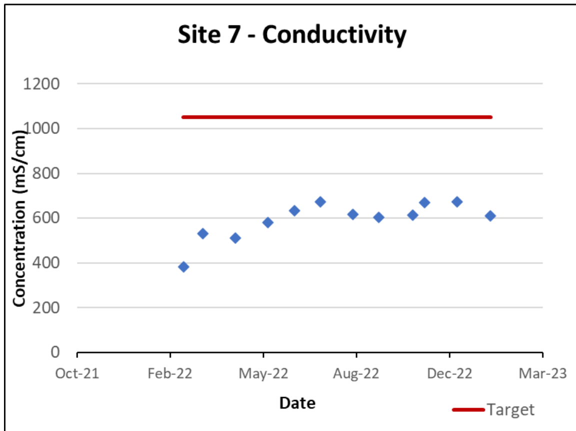


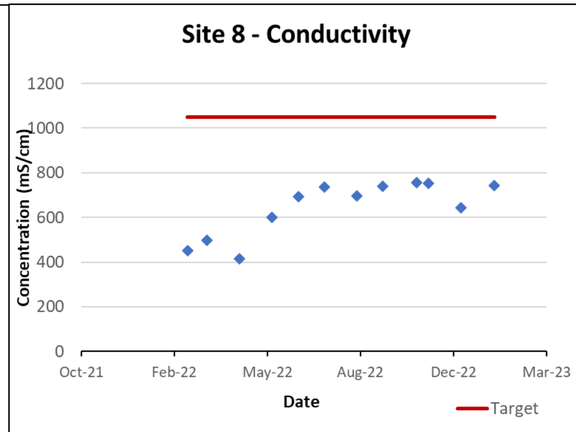
Figure 42. pH measurements in Upper Elkhart River Watershed sample sites from February 2022-January 2023.

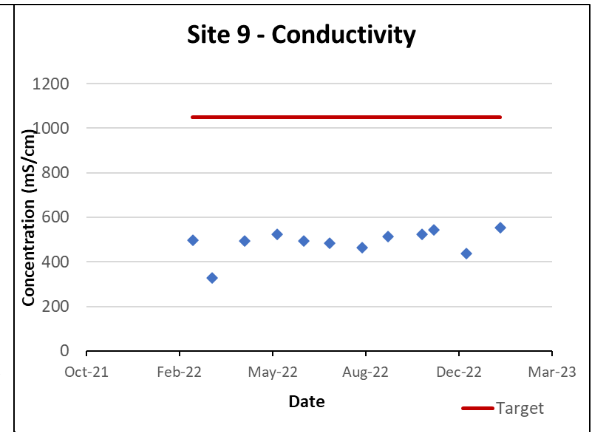
Specific Conductivity

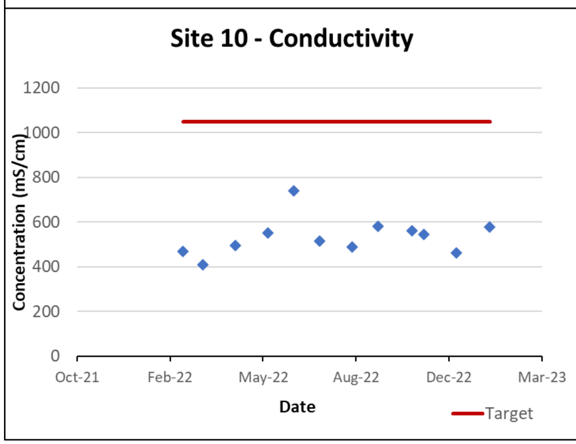
In general, conductivity measurements varied over the sampling period, but mostly remained below the conductivity target of 1050 µS/cm (Figure 43). Only 1 of 240 sample periods (0.4%) exceeded the state standard. Henderson Lake Ditch (Site 6) exceeded the water quality target during the November 2022 sampling event with a level of 1074 µmhos/cm.

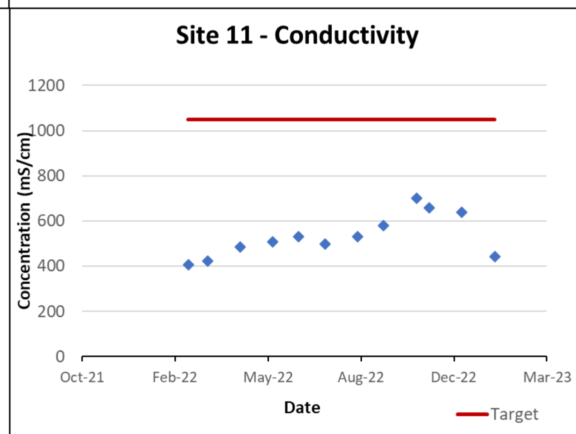


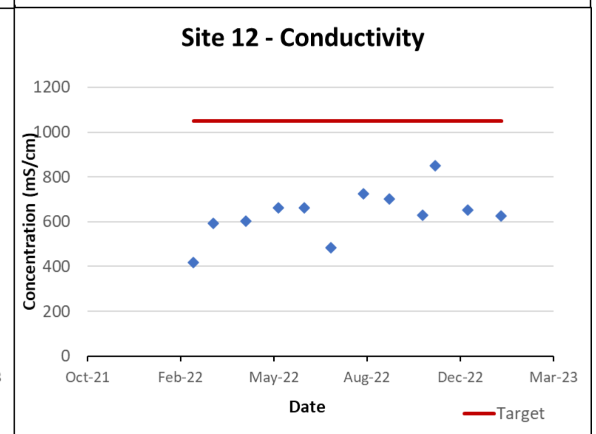

Site 7 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

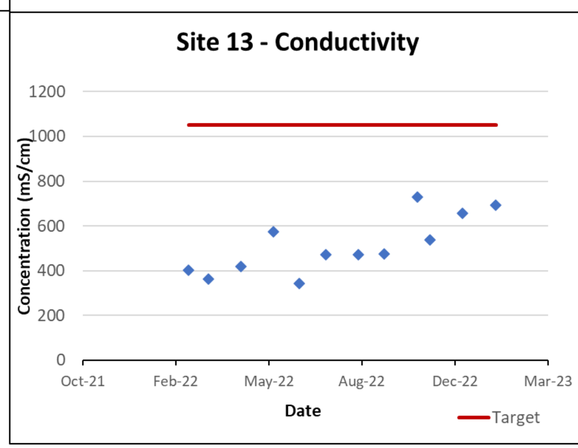

Site 8 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 9 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 10 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 11 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 12 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 13 - Conductivity
Concentration (mS/cm)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

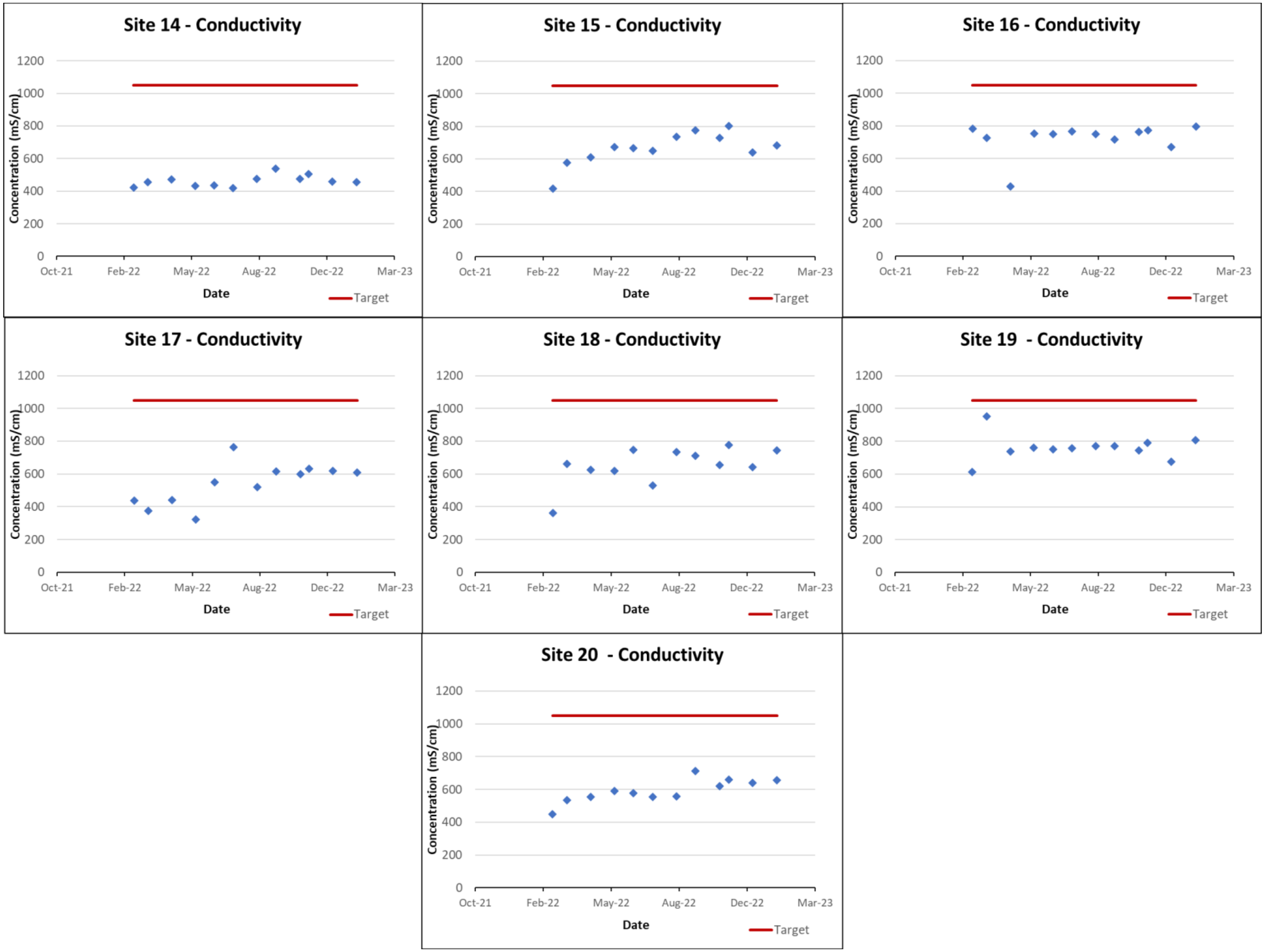
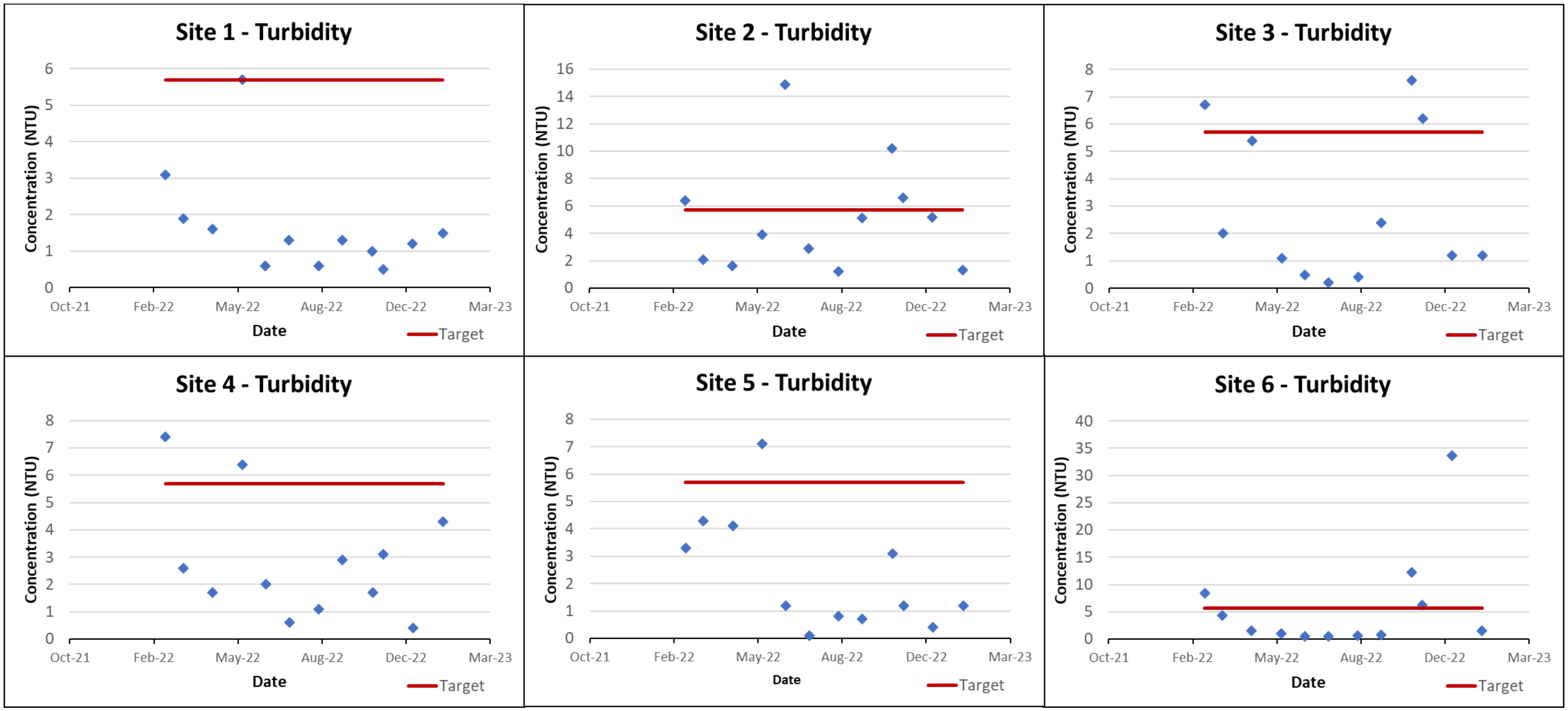
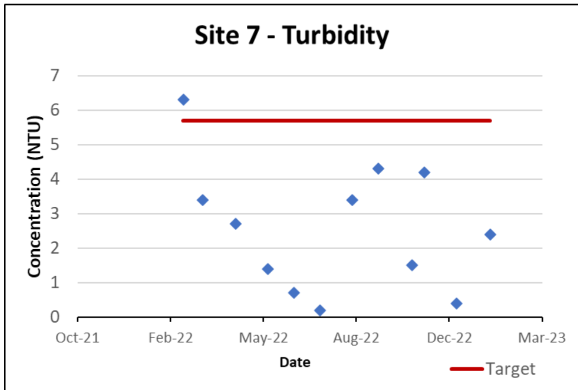


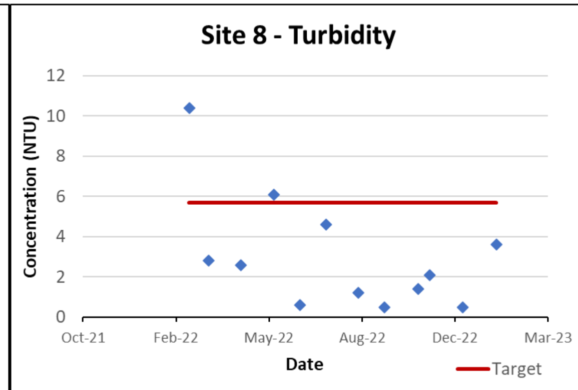
Figure 43. Conductivity measurements in Upper Elkhart River Watershed sample sites from February 2022-January 2023.

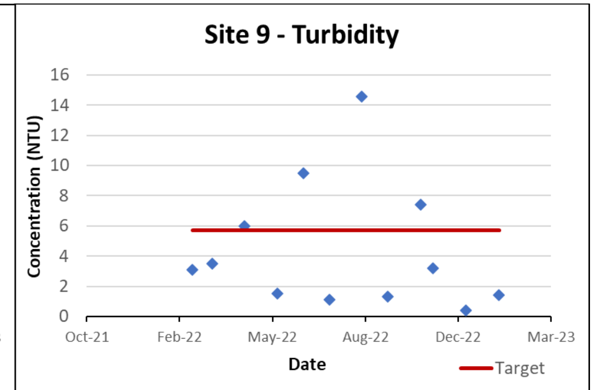
Turbidity

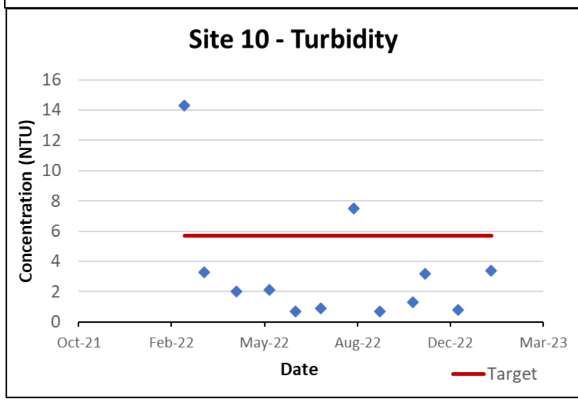
Turbidity measurements varied greatly over the sampling period (Figure 44). In total, 54 of 240 samples (23%) exceeded turbidity targets of6.36 NTU during the sampling period. The highest conductivity level occurred during the November 2022 sampling period. The highest turbidity level occurred at Henderson Lake Ditch (Site 6) with a level of 33.6 NTU. The lowest turbidity level occurred at North Branch Elkhart River downstream of Sylvan (Site 5) with a level of 0.1 NTU during the July 2022 sampling event. In total, 17 of 20 (85%) sites possessed turbidities in excess of water quality targets during the February 2022 sampling event. While there are no other discernable patterns at sites with exceedance levels, South Branch Elkhart River (Site 13) and Solomon Creek (Site 16) exceeded turbidity targets in 50% or more of collected samples.

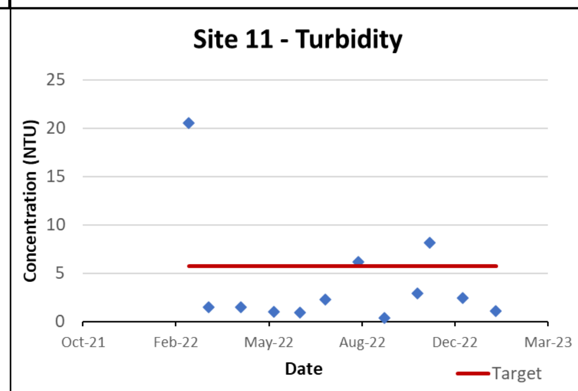


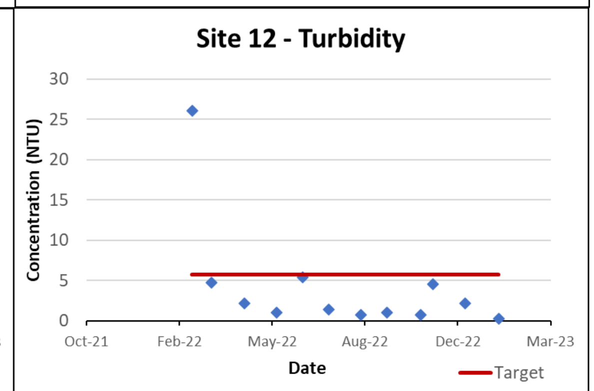

Site 7 - Turbidity
Concentration (NTU)
0 1 2 3 4 5 6 7
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target

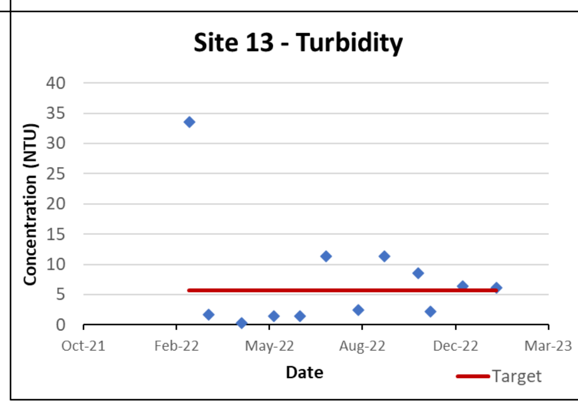

Site 8 - Turbidity
Concentration (NTU)
0 2 4 6 8 10 12
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target


Site 9 - Turbidity
Concentration (NTU)
0 2 4 6 8 10 12 14 16
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target


Site 10 - Turbidity
Concentration (NTU)
0 2 4 6 8 10 12 14 16
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target


Site 11 - Turbidity
Concentration (NTU)
0 5 10 15 20 25
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target


Site 12 - Turbidity
Concentration (NTU)
0 5 10 15 20 25 30
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target


Site 13 - Turbidity
Concentration (NTU)
0 5 10 15 20 25 30 35 40
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target

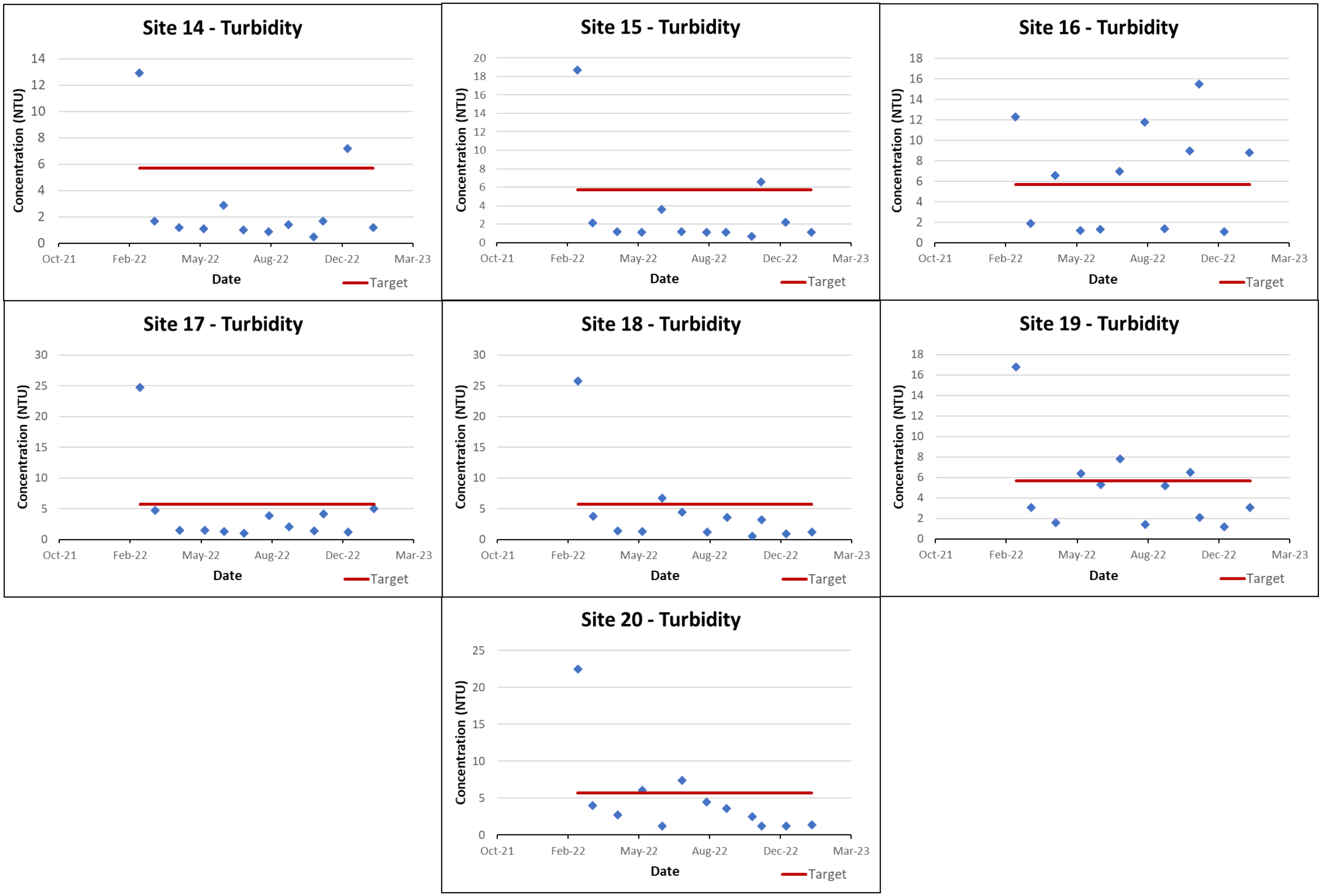


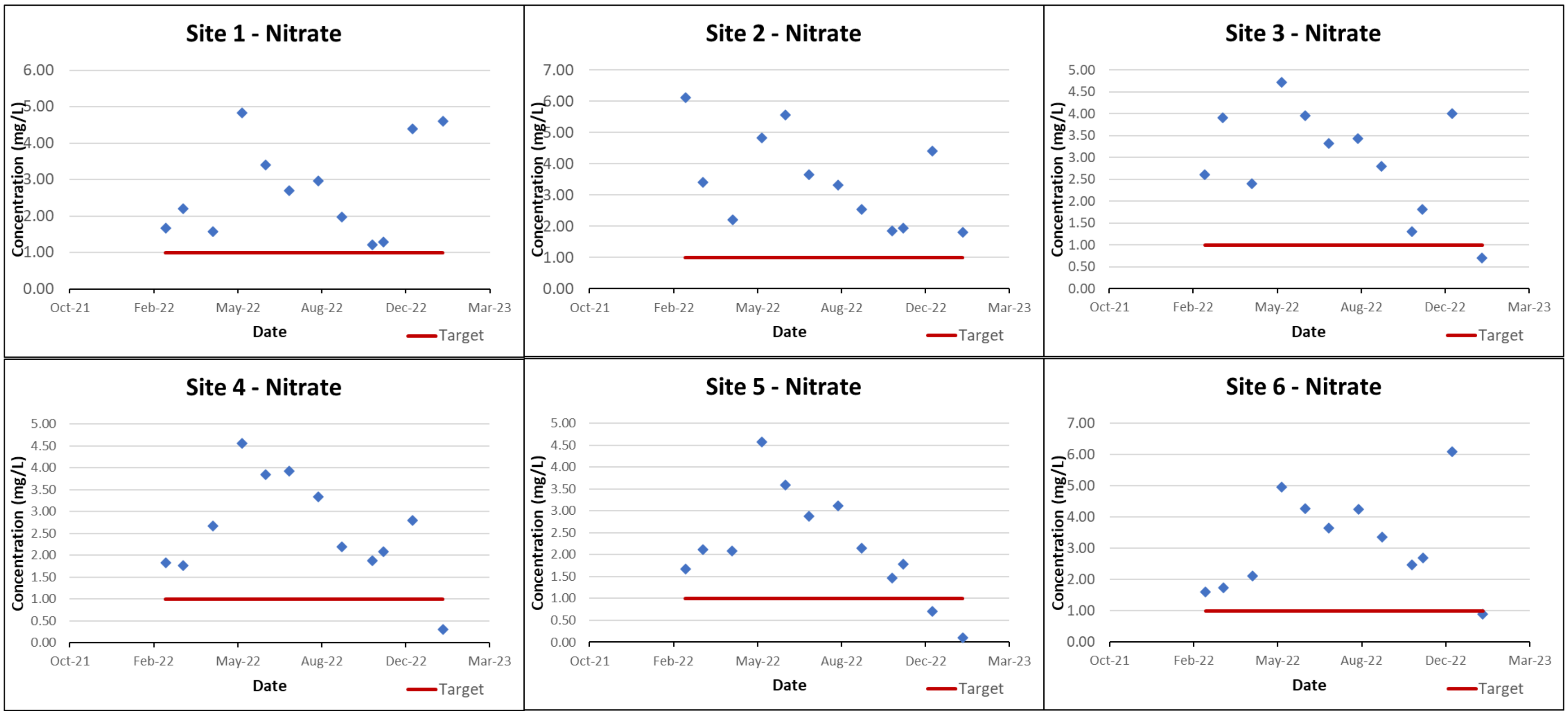
Figure 44. Turbidity measurements in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note differences in scale along the concentration (y) axis.

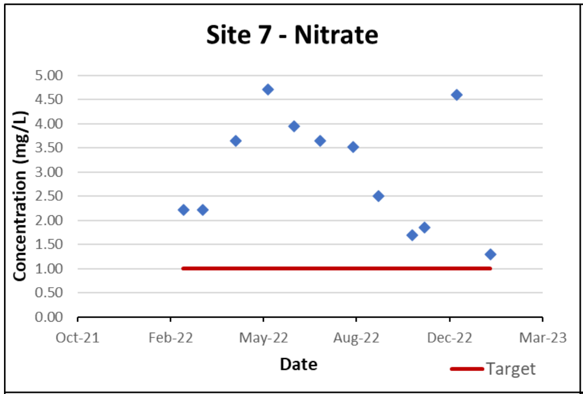
3.4.3 Water Chemistry Results

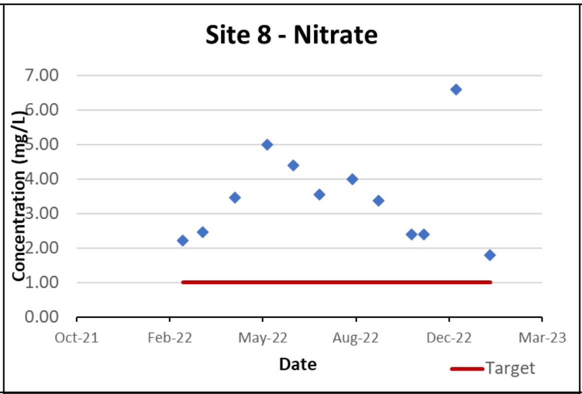
Figure 45 to Figure 48 display results for nitrate-nitrogen, total phosphorus, total suspended solids, and *E. coli* collected monthly from twenty locations in the Upper Elkhart River Watershed. Data are displayed in comparison to target concentration and on load duration curves during the sample period.

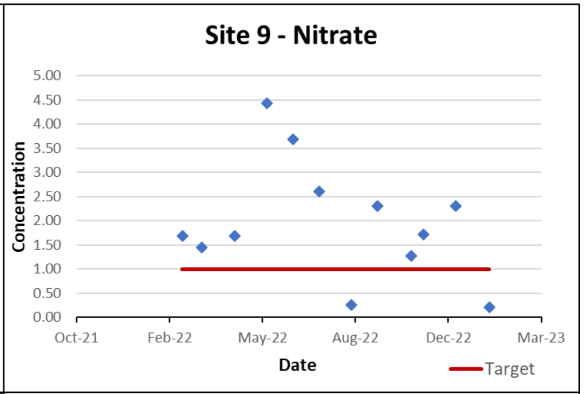
Nitrate-nitrogen

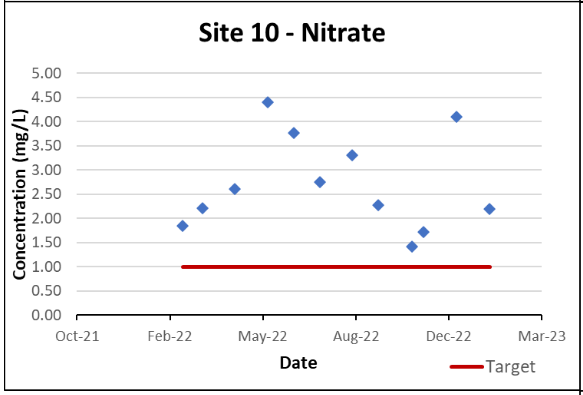
Figure 45 displays nitrate-nitrogen concentrations compared to target levels (1 mg/L). As displayed below, nitrate-nitrogen concentrations exceeded target levels in 230 of 240 collected samples (96%). The lowest concentrations occurred during the December 2022 and January 2023 sampling events with less than 10% of samples exceeding targets. The Oliver Lake Outlet (Site 1), Hackenburg Lake inlet (Site 2), Clock Creek (Site 7), Dry Run (Site 8), North Branch Elkhart River (Sites 10 and 11), South Branch Elkhart River (Site 13), Rivir Lake Tributary (Site 14), Solomon Creek (Site 16), Elkhart River (Sites 17 and 20) and Solomon Creek outlet (Site 19) exceeded target levels 100% of the time.

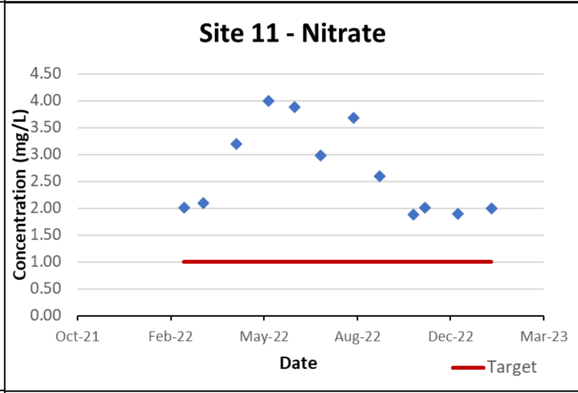


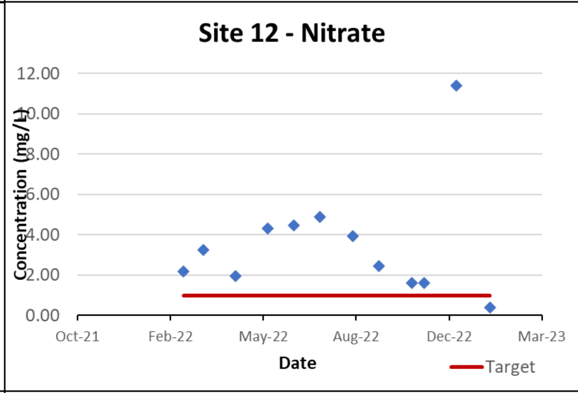

Site 7 - Nitrate
Concentration (mg/L)
Date
Target

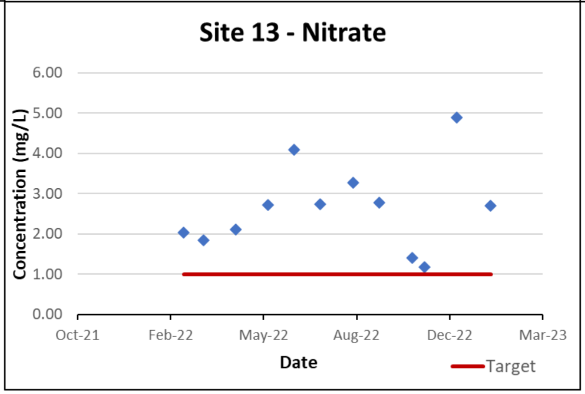

Site 8 - Nitrate
Concentration (mg/L)
Date
Target


Site 9 - Nitrate
Concentration
Date
Target


Site 10 - Nitrate
Concentration (mg/L)
Date
Target


Site 11 - Nitrate
Concentration (mg/L)
Date
Target


Site 12 - Nitrate
Concentration (mg/L)
Date
Target


Site 13 - Nitrate
Concentration (mg/L)
Date
Target

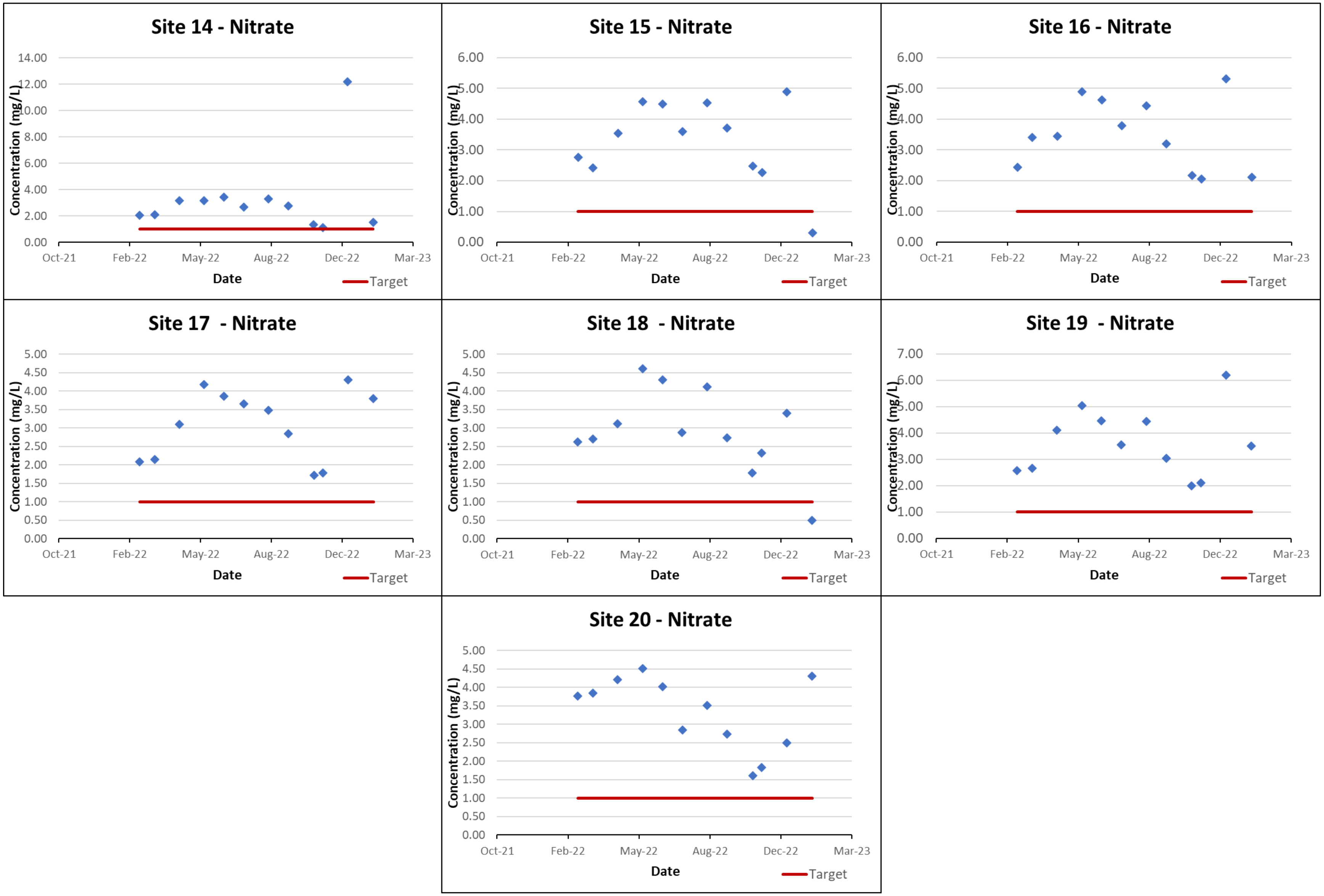
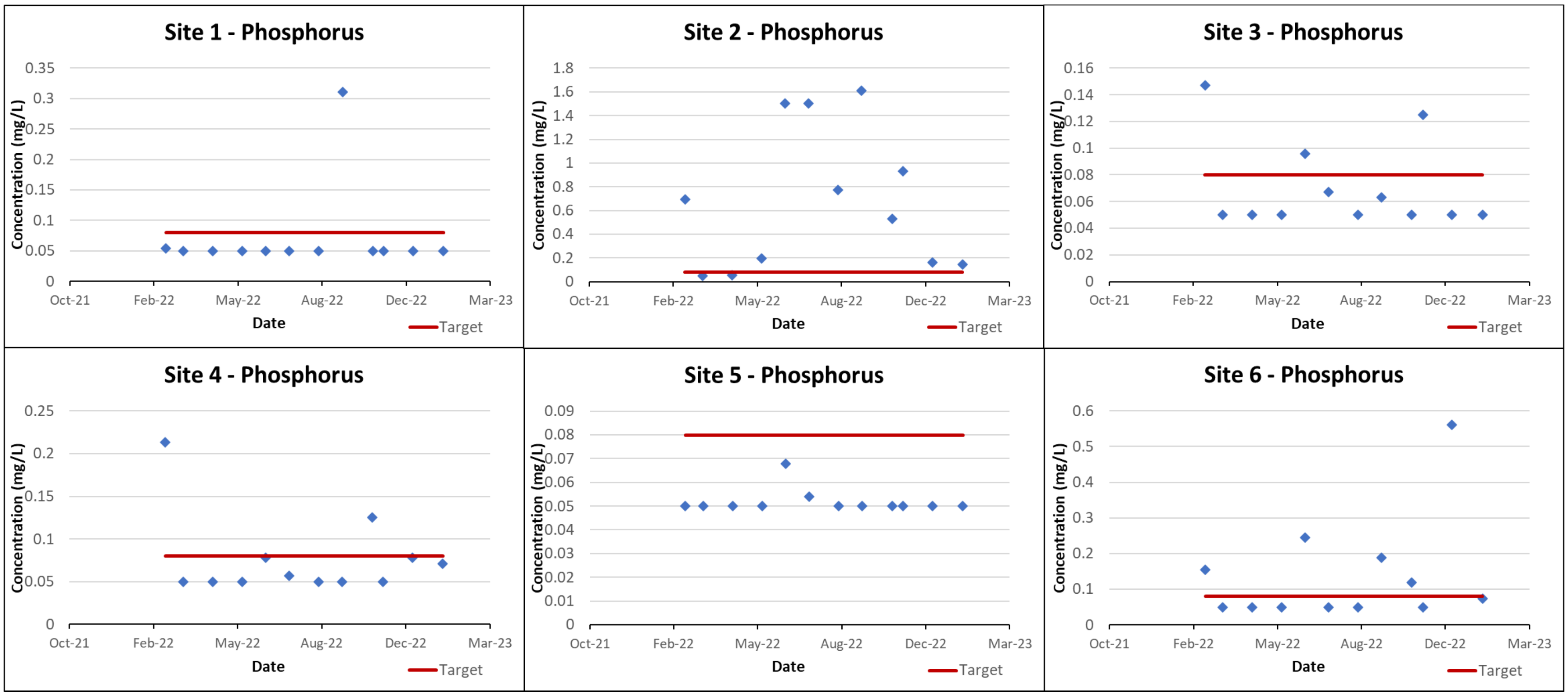
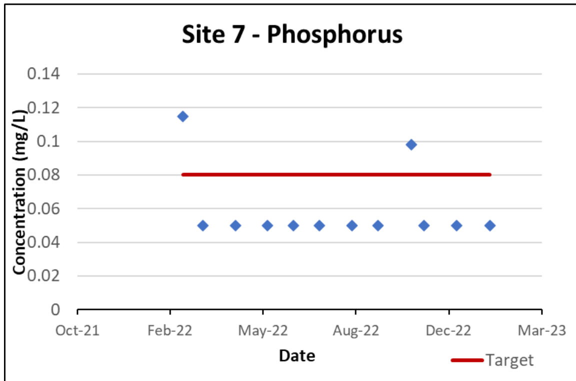


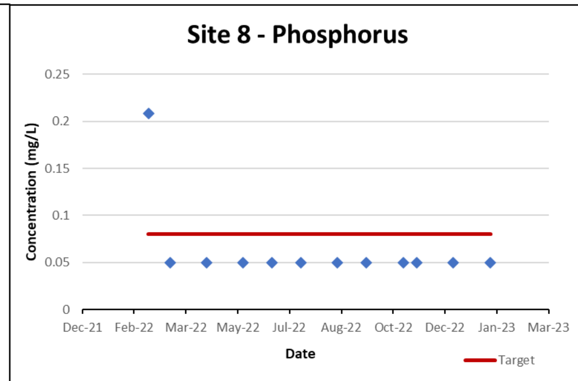
Figure 45. Nitrate-nitrogen concentrations measured in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note differences in scales along the concentration (y) axis.

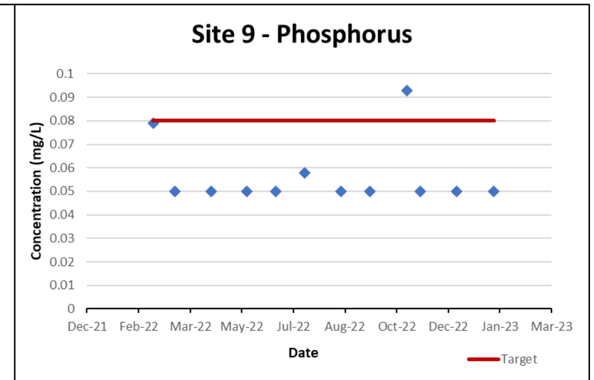
Total Phosphorus

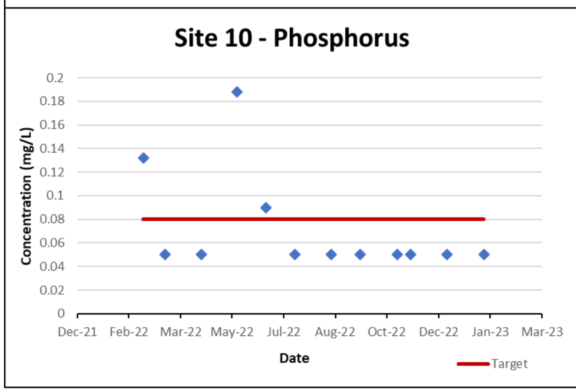
Total phosphorus concentrations exceeded the target concentration of 0.08 mg/L in 63 of 240 sample sites (26%, Figure 46). Stony Creek (Site 18) possessed the highest total phosphorus average concentration (0.203 mg/L), while Solomon Creek (Site 16) possessed the lowest average concentration (0.051 mg/L). Only North Branch Elkhart River downstream of Sylvan Lake (Site 5) and Solomon Creek (Site 16) never exceeded target concentrations during sampling events. In total, six sites possess average total phosphorus concentrations in excess of the level at which biological impairments occur (0.08 mg/L) including the Hackenburg Lake inlet (Site 2), Henderson Lake Ditch (Site 6), South Branch Elkhart River (Site 11), Croft Ditch (Site 12), Elkhart River (Site 17) and Stony Creek (Site 18).

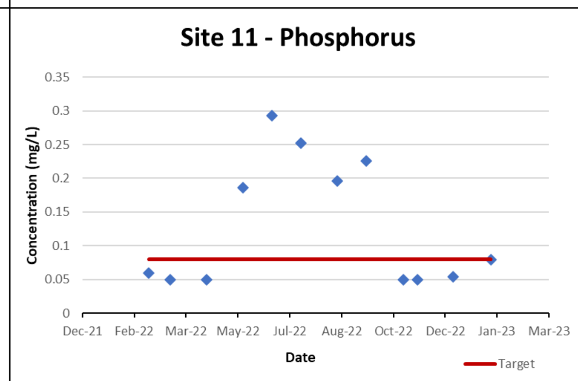


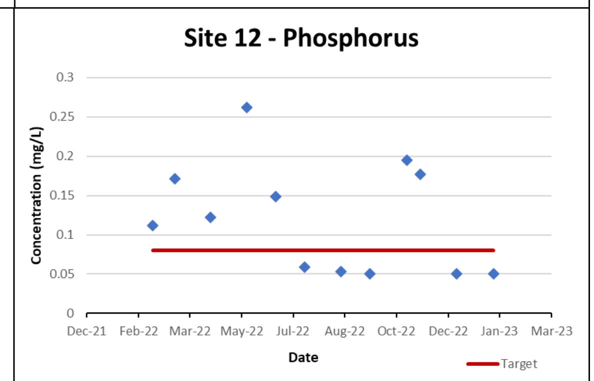

Site 7 - Phosphorus
Concentration (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Oct-21 Feb-22 May-22 Aug-22 Dec-22 Mar-23
Date
Target

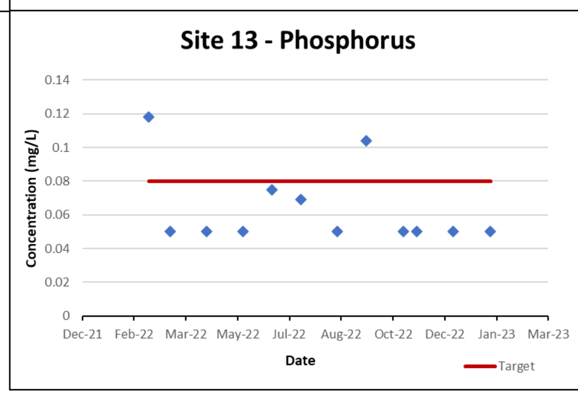

Site 8 - Phosphorus
Concentration (mg/L)
0.25
0.2
0.15
0.1
0.05
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target


Site 9 - Phosphorus
Concentration (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target


Site 10 - Phosphorus
Concentration (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target


Site 11 - Phosphorus
Concentration (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target


Site 12 - Phosphorus
Concentration (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target


Site 13 - Phosphorus
Concentration (mg/L)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Dec-21 Feb-22 Mar-22 May-22 Jul-22 Aug-22 Oct-22 Dec-22 Jan-23 Mar-23
Date
Target

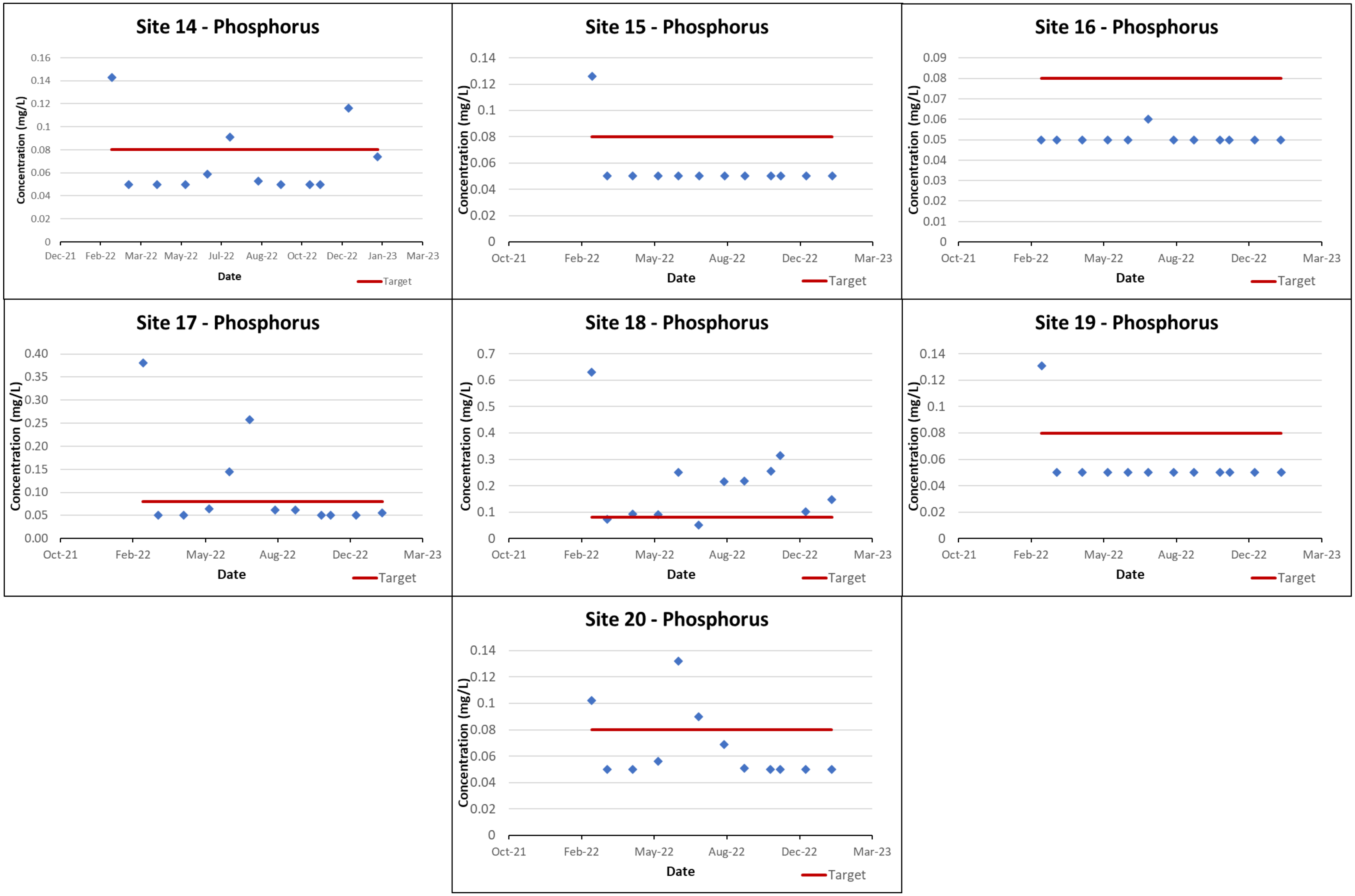
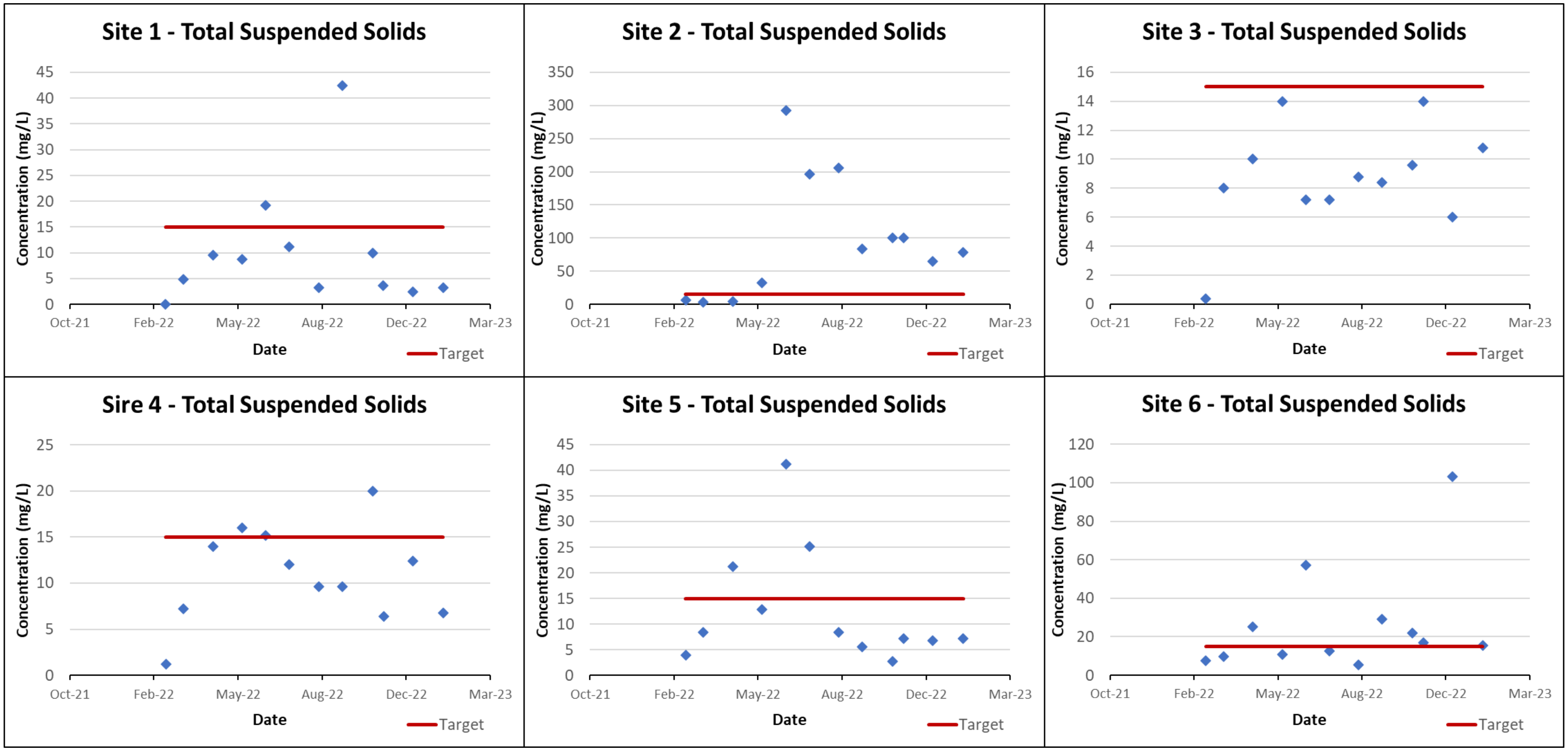
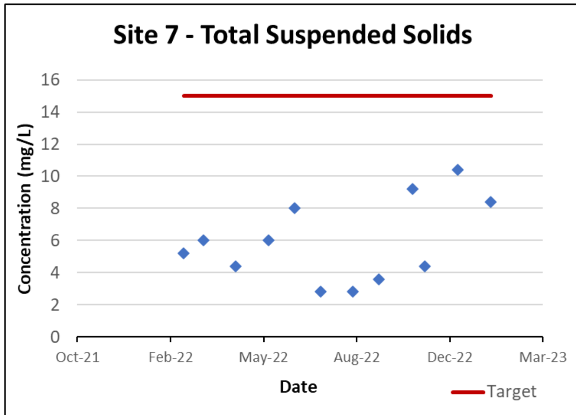


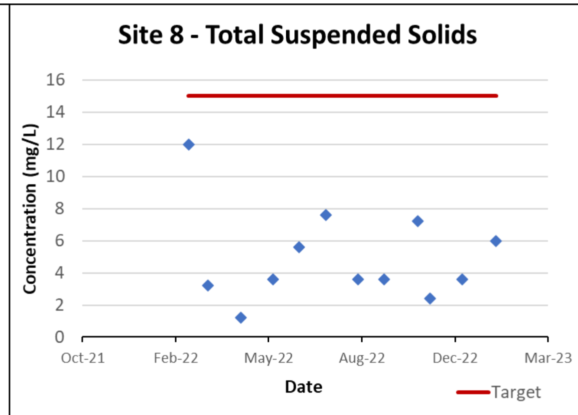
Figure 46. Total phosphorus concentrations measured in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note differences in scale along the concentration (y) axis.

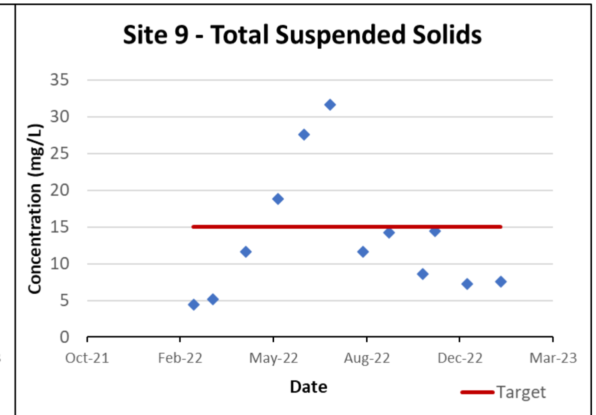
Total Suspended Solids

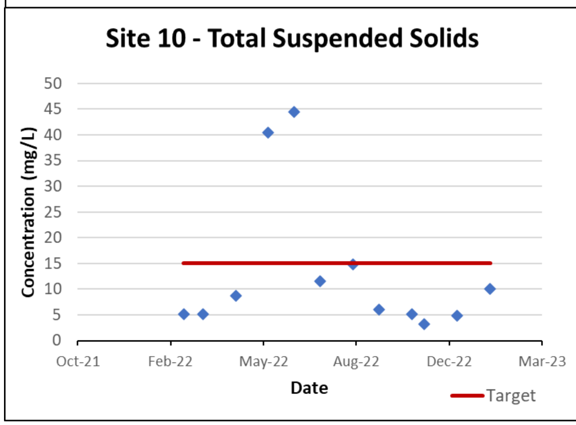
Total suspended solids (TSS) levels measured above target levels in 45 of 240 samples (19%, Figure 47). In total, four of 20 sites had average concentrations greater than the target concentration of 15 mg/L including the Hackenburg Lake Outlet (Site 2), Henderson Lake Ditch (Site 6), South Branch Elkhart River (Site 13) and Solomon Creek (Site 16). The Hackenburg Lake Outlet (Site 2) possessed the highest site average (97.3 mg/L). Clock Creek (Site 7), Dry Run (Site 8), South Branch Elkhart River (Site 11), Croft Ditch (Site 12), Rivir Lake Tributary (Site 14), Elkhart River (Site 17) and Stony Creek (Site 18) never exceeded target levels during any sampling event.

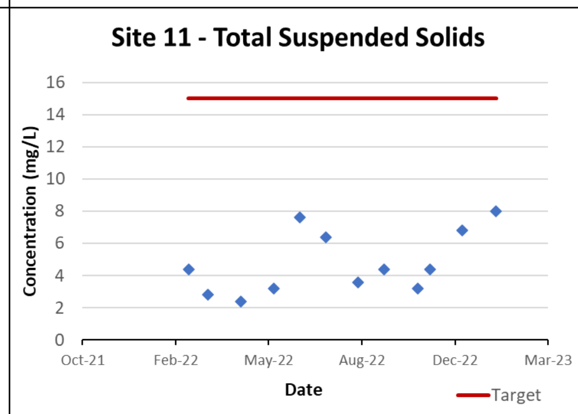


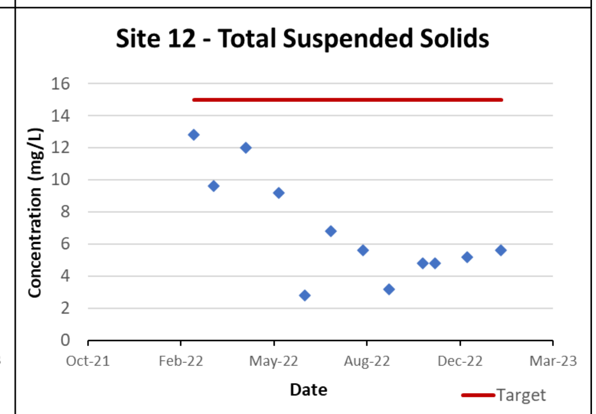

Site 7 - Total Suspended Solids
Concentration (mg/L)
16
14
12
10
8
6
4
2
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

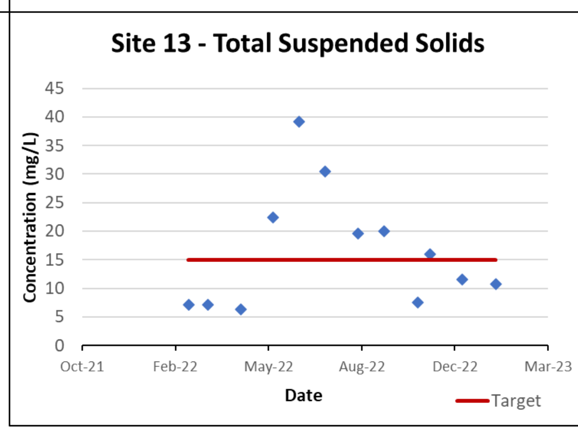

Site 8 - Total Suspended Solids
Concentration (mg/L)
16
14
12
10
8
6
4
2
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 9 - Total Suspended Solids
Concentration (mg/L)
35
30
25
20
15
10
5
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 10 - Total Suspended Solids
Concentration (mg/L)
50
45
40
35
30
25
20
15
10
5
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 11 - Total Suspended Solids
Concentration (mg/L)
16
14
12
10
8
6
4
2
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 12 - Total Suspended Solids
Concentration (mg/L)
16
14
12
10
8
6
4
2
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 13 - Total Suspended Solids
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

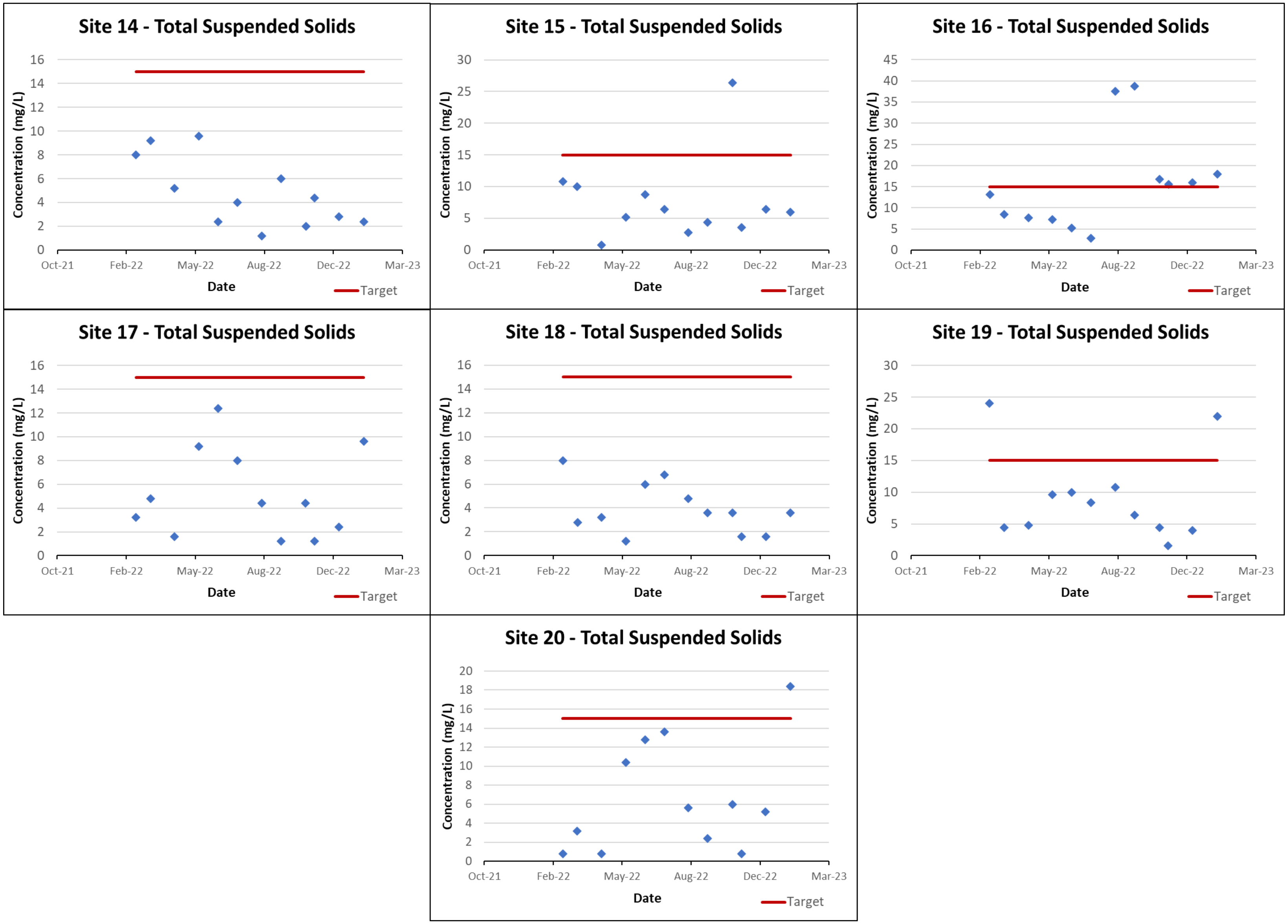
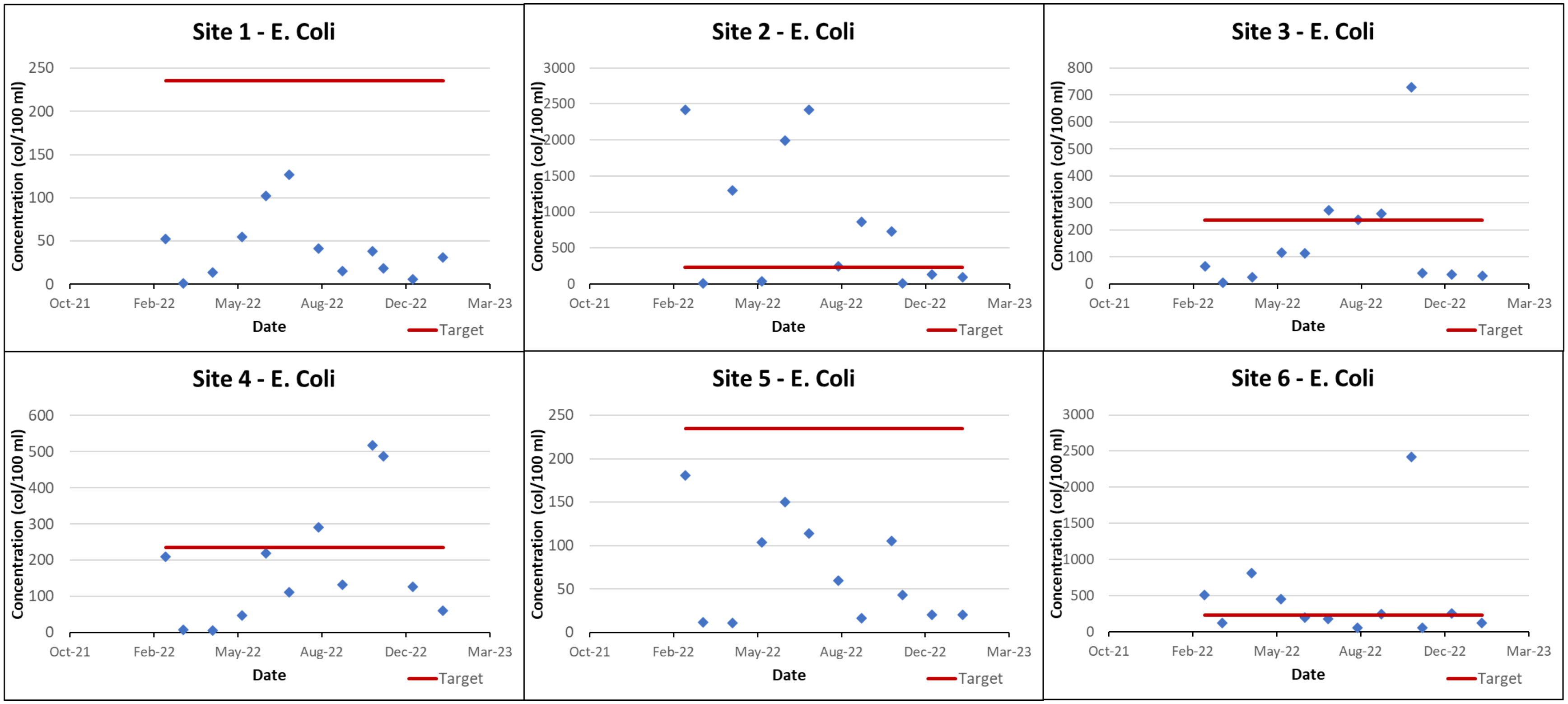
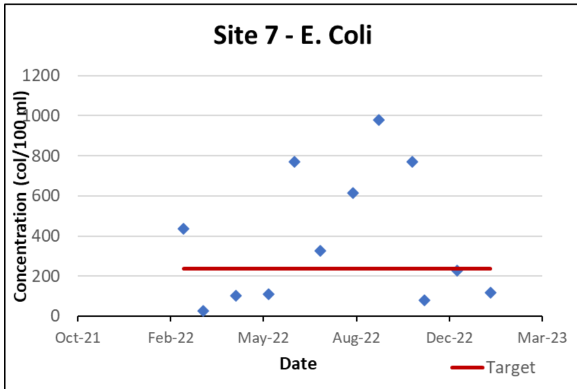


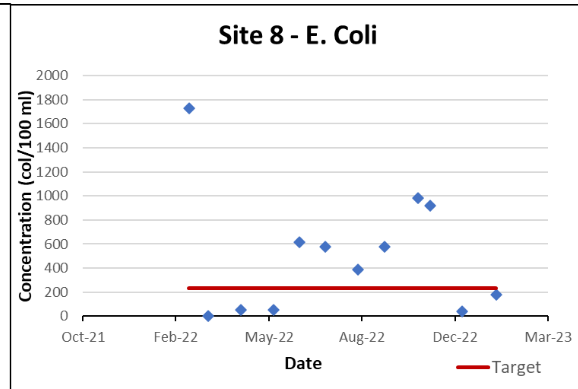
Figure 47. Total suspended solids concentrations measured in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note Difference in scale along the concentration (y) axis.

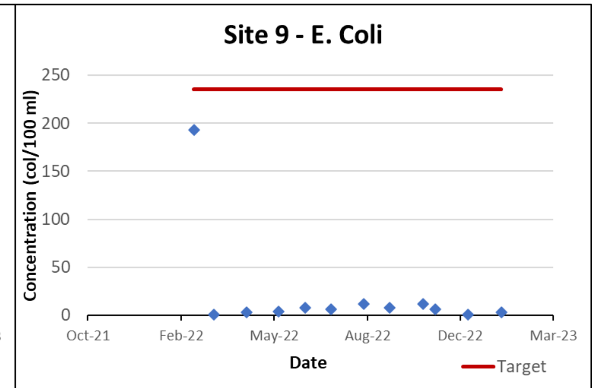
E. coli

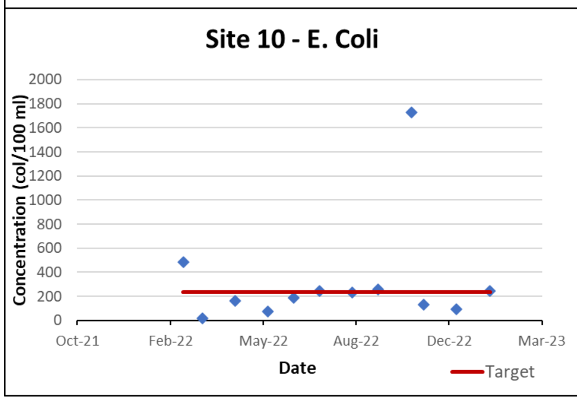
E. coli concentrations observed at Upper Elkhart River Watershed sites are shown in Figure 48. *E. coli* concentrations exceed state standards (235 col/100 mL) in 79 of 240 samples (33%). Half (10 of 20) of the sample sites average possessed concentrations in excess of state standards. Only Site 1 (Oliver Lake Outlet) and Sites 5 and 9 (North Branch Elkhart River) did not exceed the state standard during any sampling event.

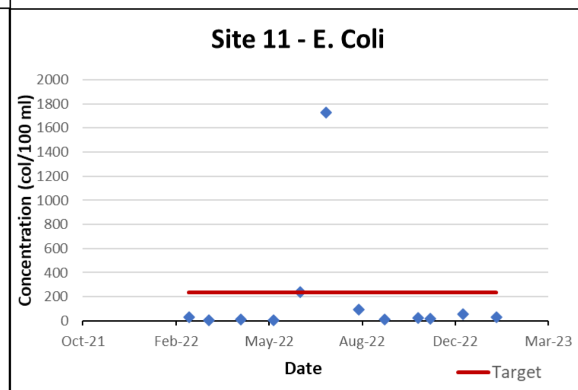


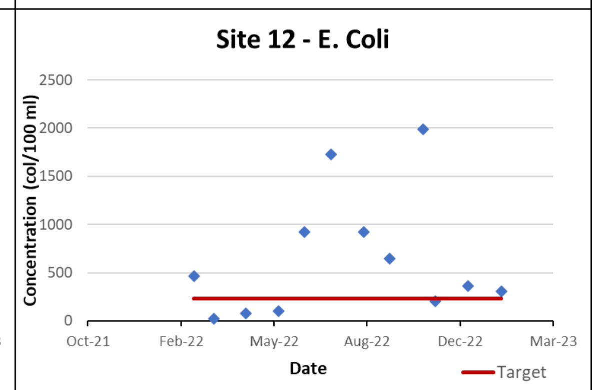

Site 7 - E. Coli
Concentration (col/100 ml)
0
200
400
600
800
1000
1200
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

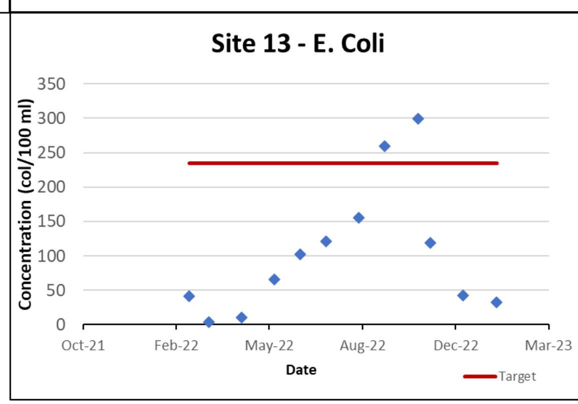

Site 8 - E. Coli
Concentration (col/100 ml)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 9 - E. Coli
Concentration (col/100 ml)
0
50
100
150
200
250
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 10 - E. Coli
Concentration (col/100 ml)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 11 - E. Coli
Concentration (col/100 ml)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 12 - E. Coli
Concentration (col/100 ml)
0
500
1000
1500
2000
2500
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target


Site 13 - E. Coli
Concentration (col/100 ml)
0
50
100
150
200
250
300
350
Oct-21
Feb-22
May-22
Aug-22
Dec-22
Mar-23
Date
Target

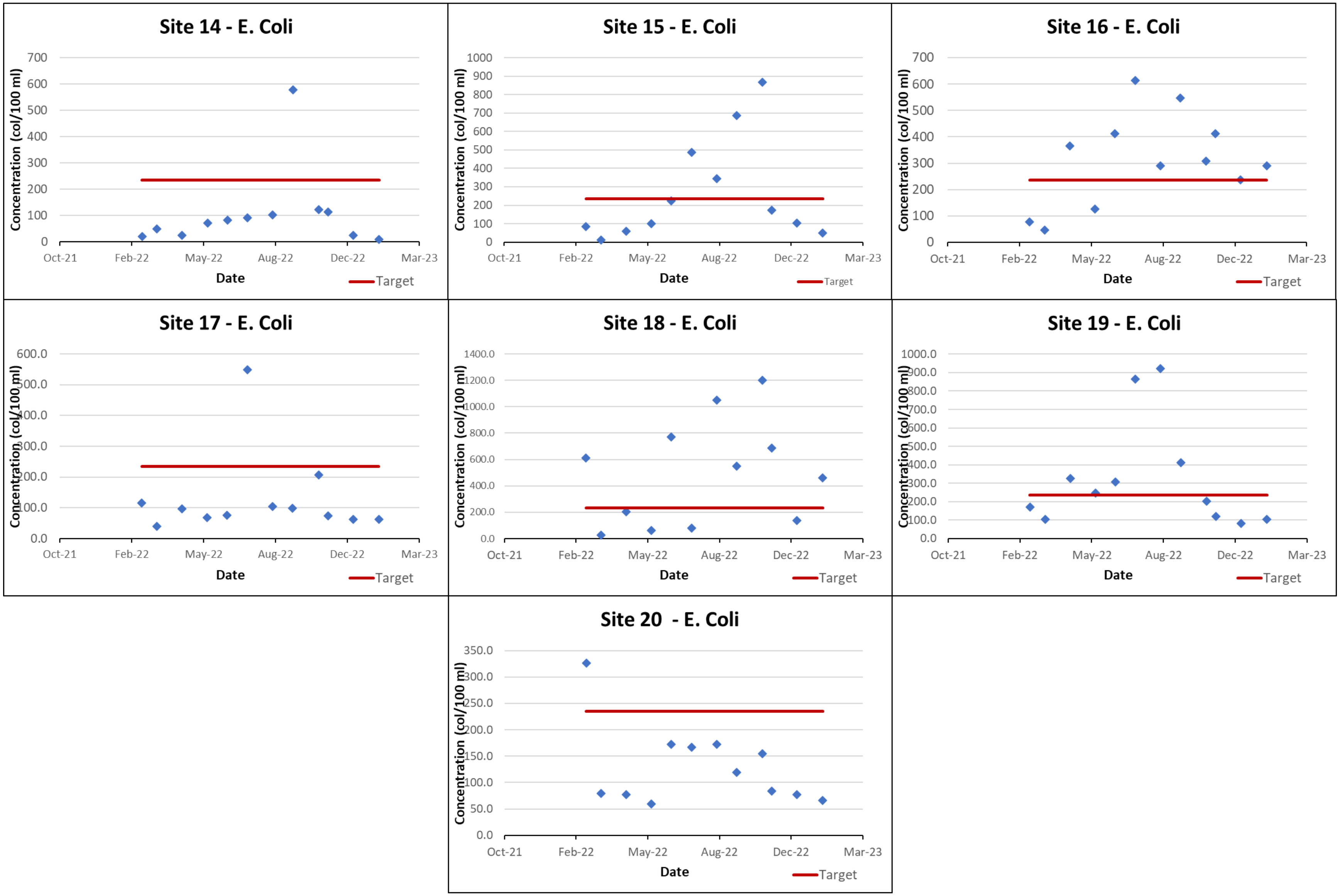


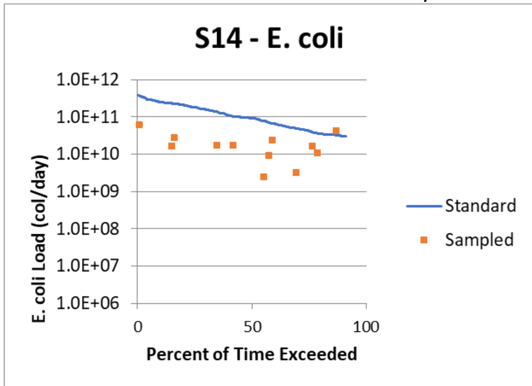
Figure 48. *E.coli* concentrations measured in Upper Elkhart River Watershed sample sites from February 2022-January 2023. Note differences in scale along the concentration (y) axis.

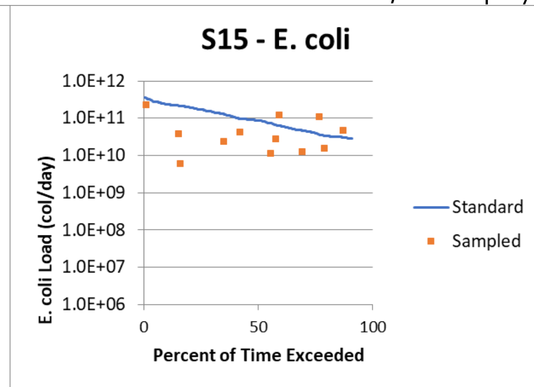
3.4.4 Load Duration Curves

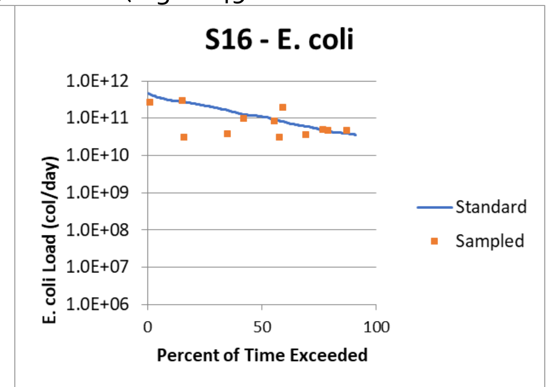
Load duration curves allow for comparison of instream loading with stream flow so that conditions of concern can be identified. The load duration curves present the flow characteristics for twenty sample sites during the time of study from February 2022 to January 2023. Shatto Ditch near Mentone (USGS 03331224) was used to scale the flow for the Oliver Lake-Little Elkhart Creek sites (Site 1 and 2), the North Branch Elkhart River Cosperville (USGS 04100222) gage was used to scale flow for all other tributary stream sites (Sites 3-16, 18-19), while the Elkhart River at Goshen (USGS 04100500) was used to scale flow for the mainstem Elkhart River sites (Sites 17 and 20). Stream flow measured at the U.S. Geological Survey gauge was scaled to watershed size for each of the twenty monitoring stations as follow:

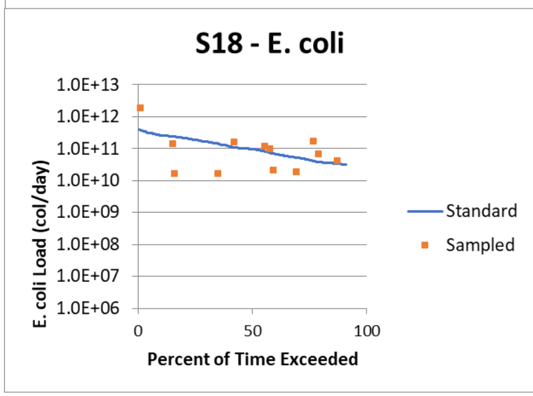
observed flow (cfs)) x (conversion factor) x (target concentration or state criteria) = total load /day

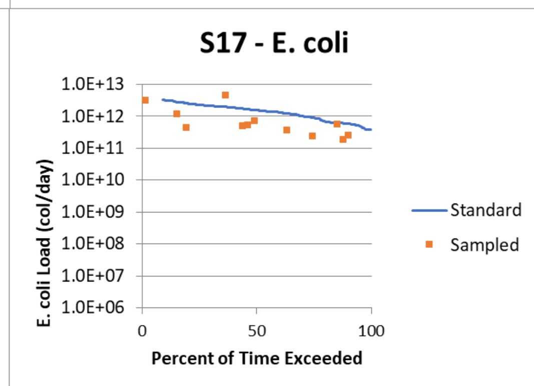
The individual load duration curves, also known as the allowable load curves, are displayed below (Figure 49 to

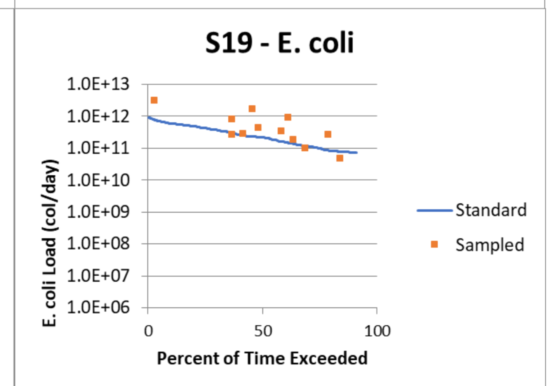












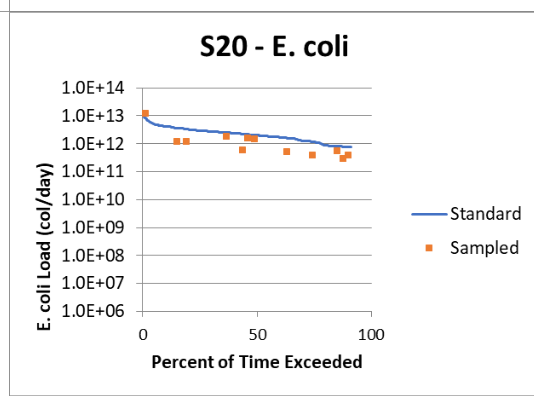
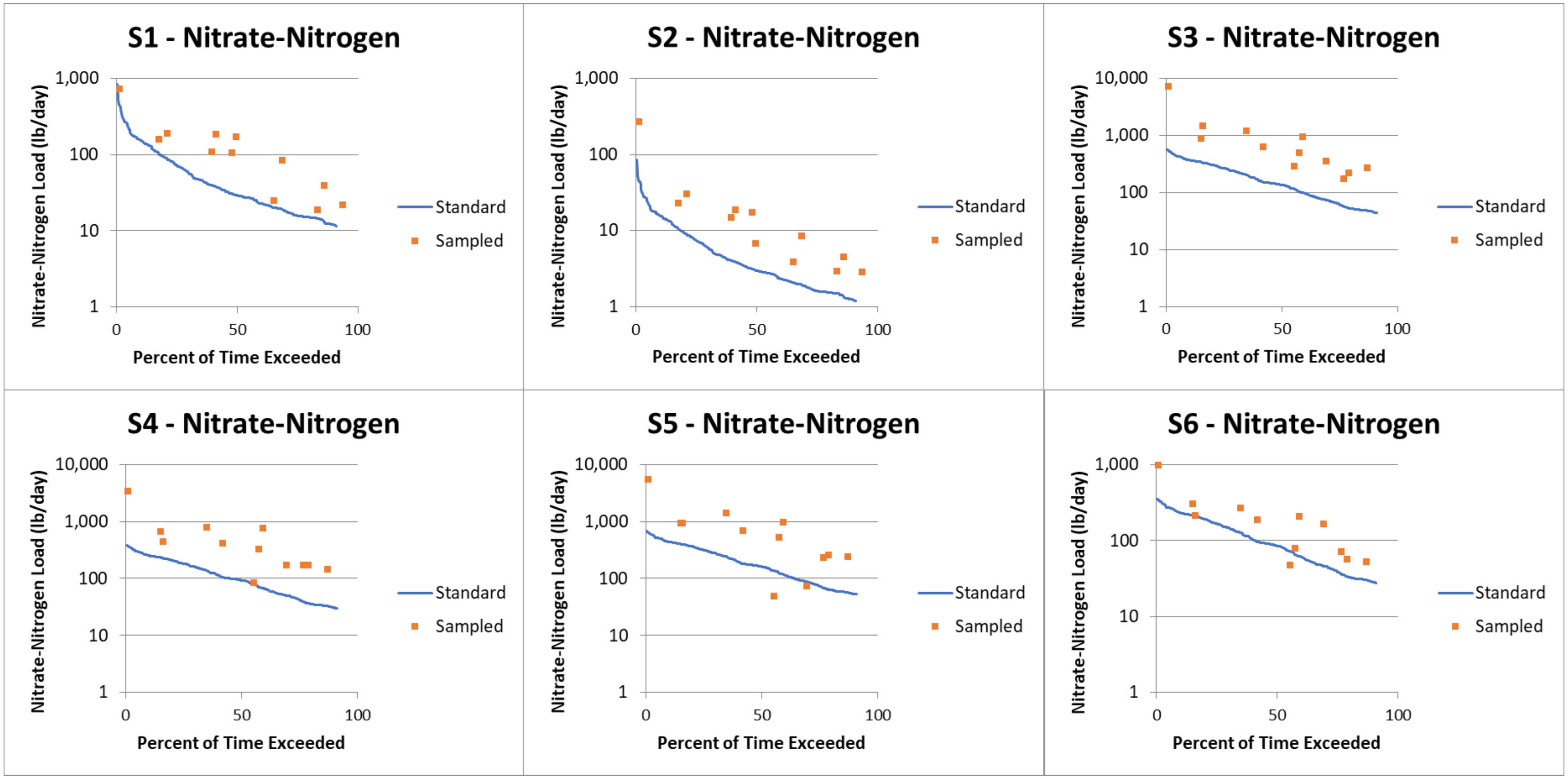
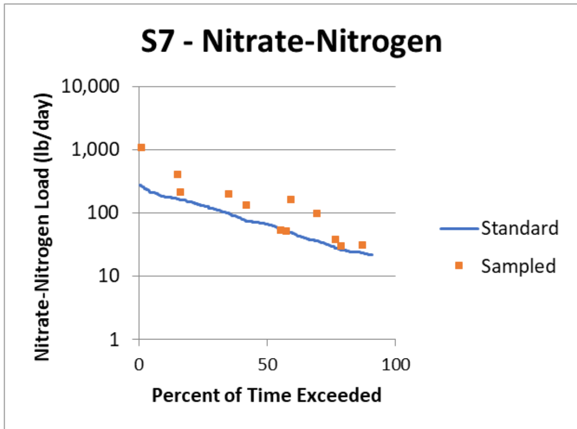


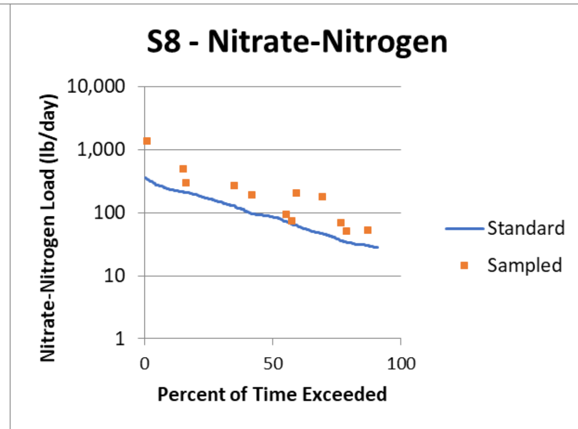
Figure 52 Figure 52). In the graphs, the total daily load of each contaminant sample results (points) is plotted against the "percent time exceeded" for the day of sampling (curve). The time exceeded refers to instream flow conditions. Those points above the curve exceed the state criterion or target 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 (0-10), 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. Load duration curve data are detailed in Appendix C.

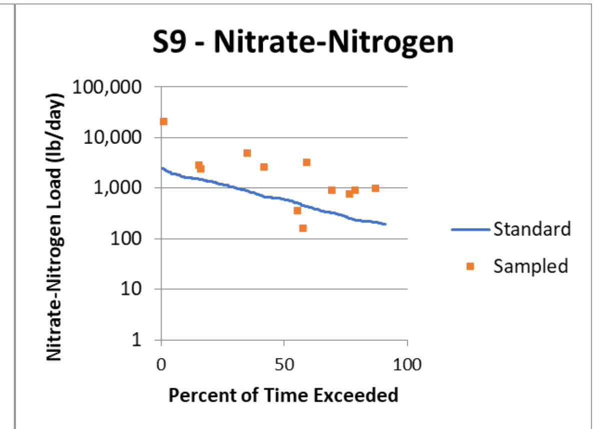
Nitrate-nitrogen Load Duration Curves

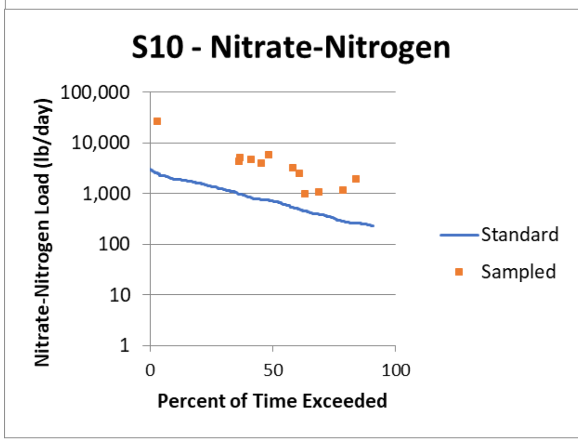
Nitrate-nitrogen loads measure higher than target loads at most sites during all conditions. In total, 13 sites exceeded target loads 100% of the time (Figure 49). The remaining seven sites exceeded target loads more than 80% of the time. This suggests that a steady stream of nitrate-nitrogen is available within these subwatersheds. Further, nitrate-nitrogen concentrations at all sites are highest during high flow conditions (0% of the time) and lower during low flow conditions (100% of the time). Most of the loads that remained under the target measured within the 40-60 flow ranges. The sites that measured above target at all times (Sites 3, 4, 8, 10, 11, 13, 16, 17, 19, and 20) indicate sources of nitrate-nitrogen to these streams under all flow conditions, suggesting that nitrate-nitrogen loads into the streams during both high flow, high runoff conditions and 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.

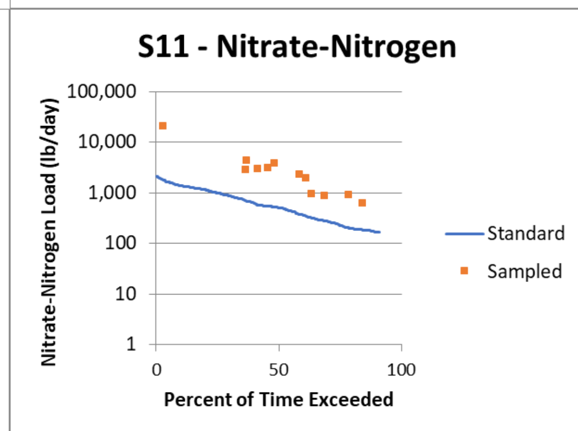


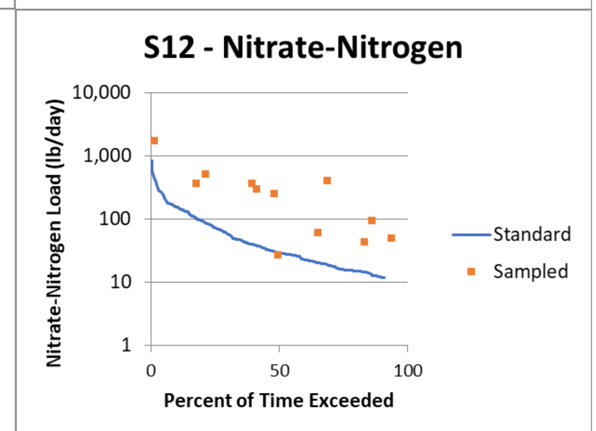

S7 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled

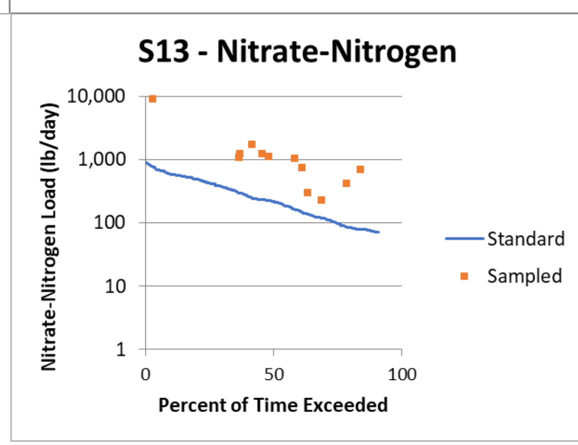

S8 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S9 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S10 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S11 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S12 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S13 - Nitrate-Nitrogen
Nitrate-Nitrogen Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled

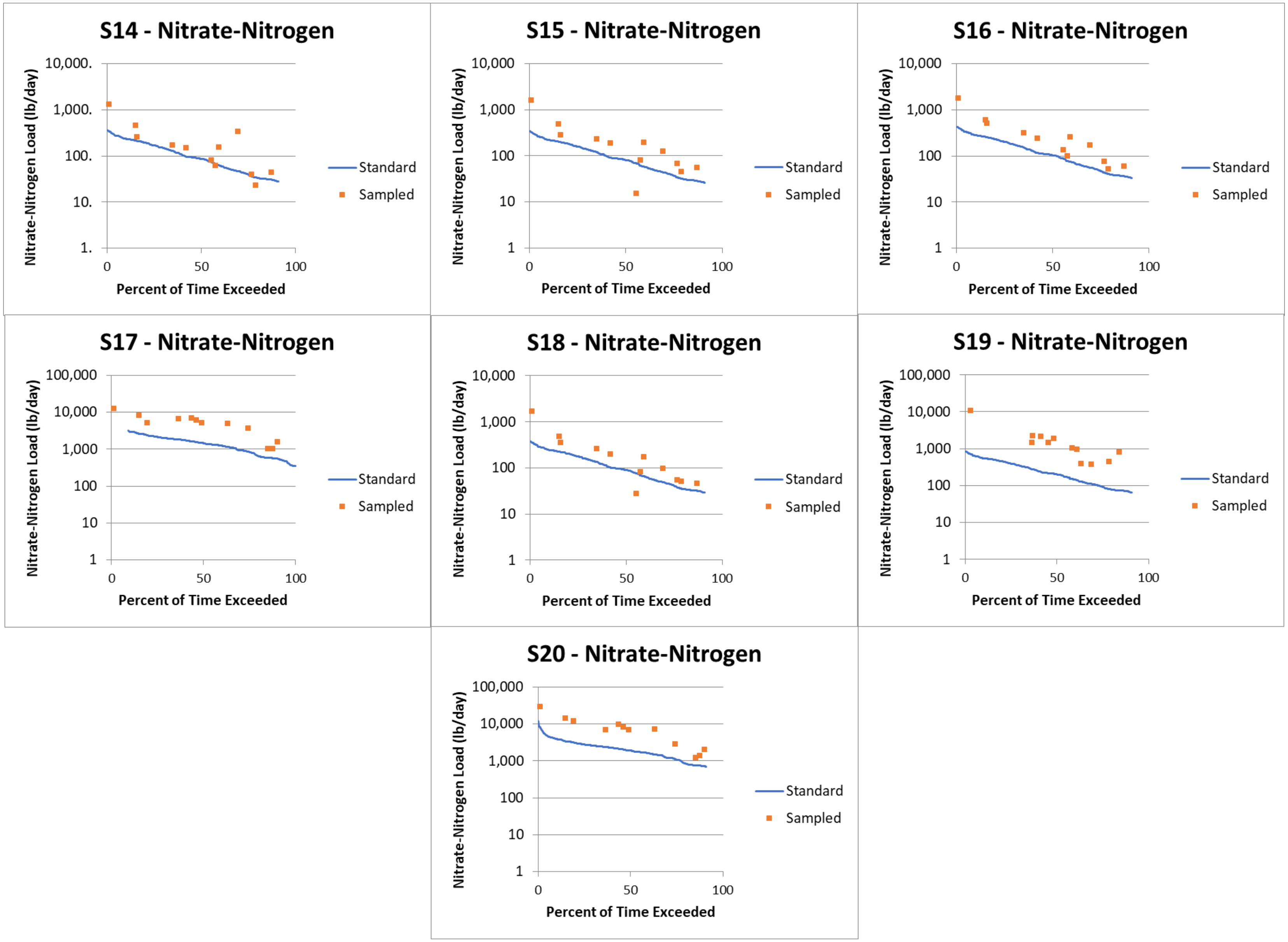
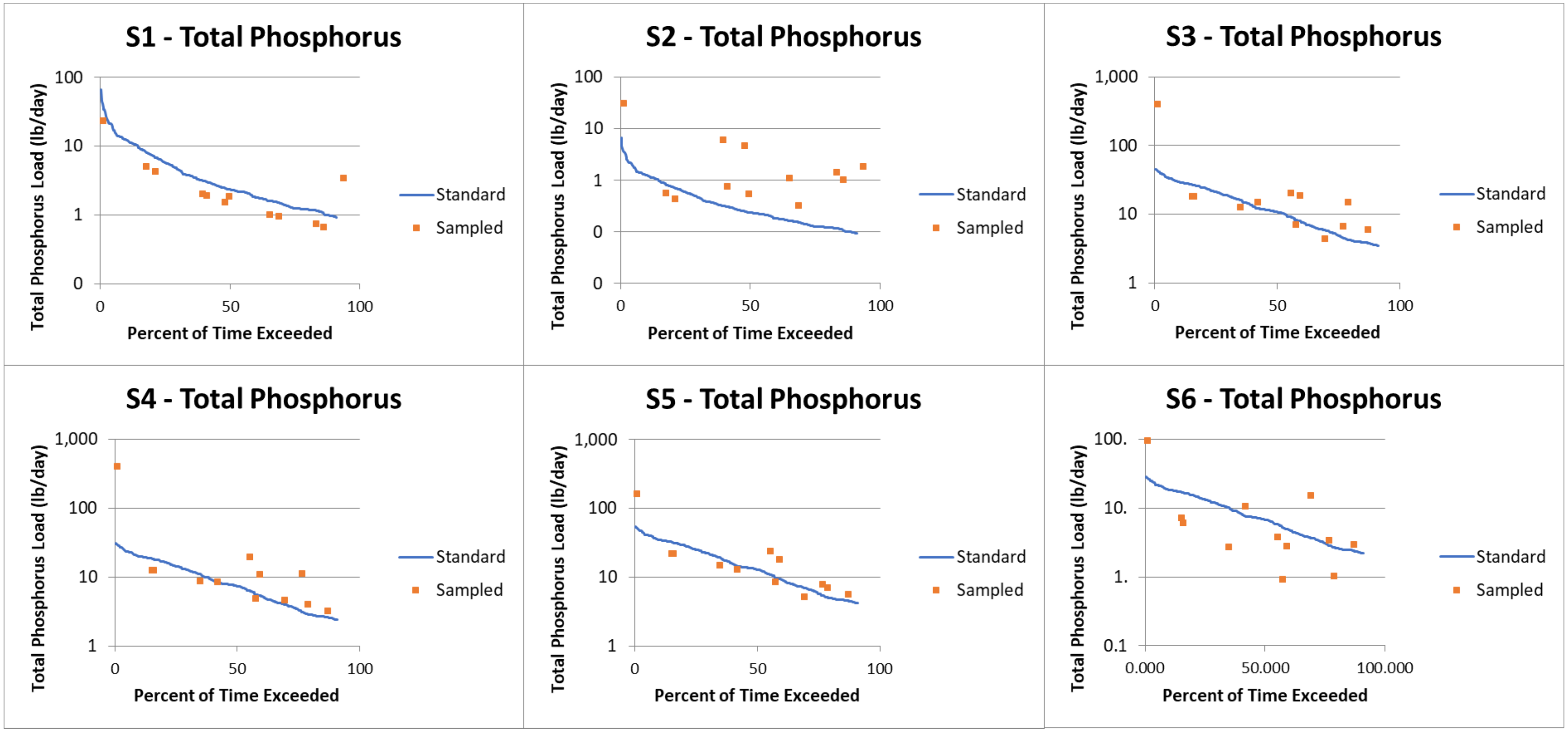
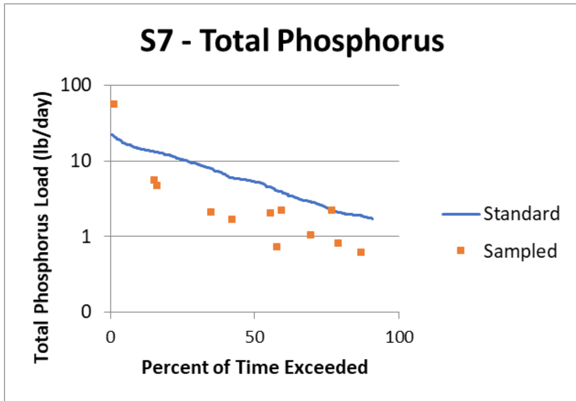


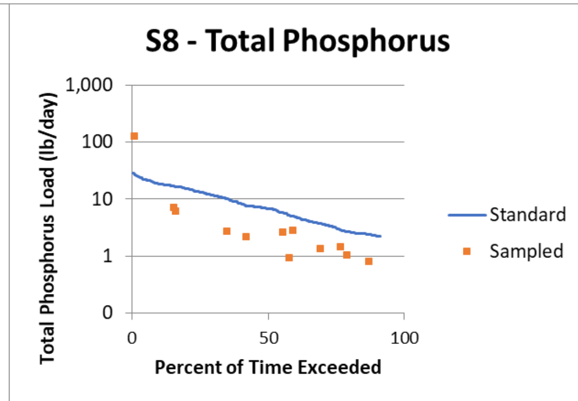
Figure 49. Nitrate-nitrogen load duration curves for Upper Elkhart River Watershed sample sites from February 2022-January 2023.

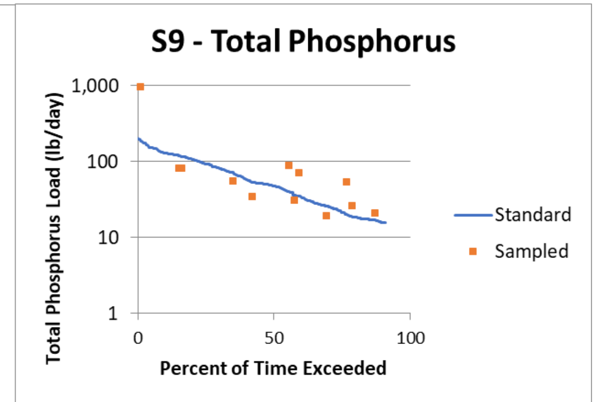
Total Phosphorus Load Duration Curves

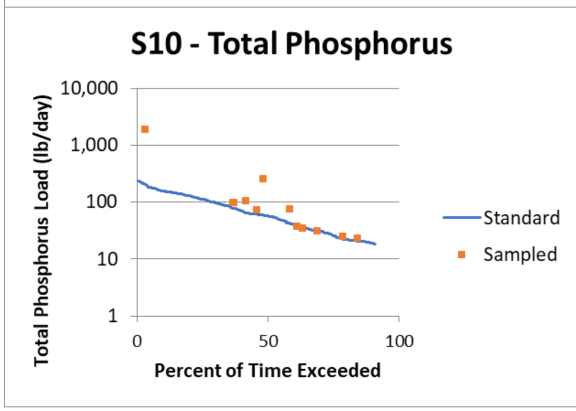
Total phosphorus levels generally measured at or above target levels under varying flow conditions (Figure 50). Most sites had levels that consistently measured at or around load target levels. Most exceedances occurred during high flow conditions or between mid-range to dry conditions. Several sites (4, 5, 10, 11, 13 and 20) possessed exceedances that occurred during all flow conditions. Exceedances of the target levels that occur under storm flow conditions (10-40) suggest erosion or runoff may be the cause of exceedance values. More than half of the sites exceeded target levels under high flow conditions. Under low flow conditions, more than half of the sites had measurements remain at or near the target load level. This suggests that a heavier stream of total phosphorus is more present under higher flow conditions than lower flow conditions in the Upper Elkhart River Watershed.

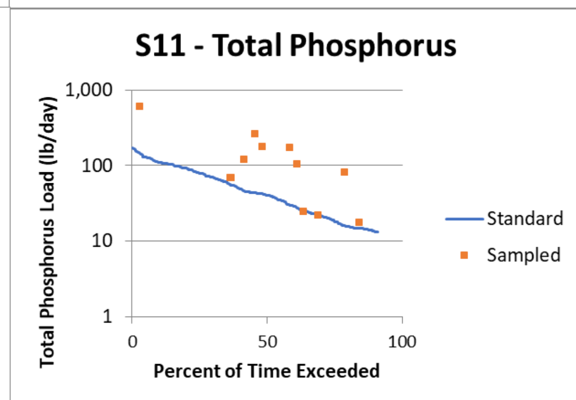


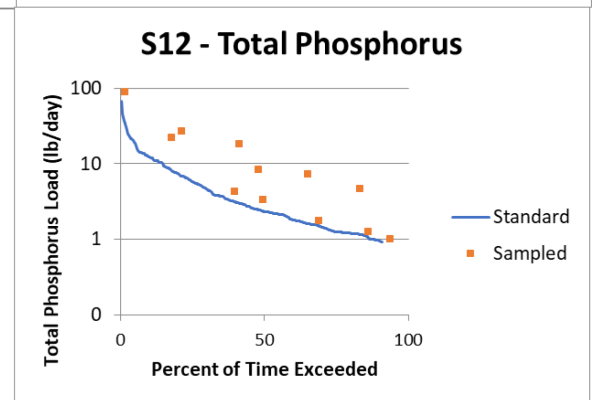

S7 - Total Phosphorus
Total Phosphorus Load (lb/day)
100
10
1
0
0
50
100
Percent of Time Exceeded
Standard
Sampled

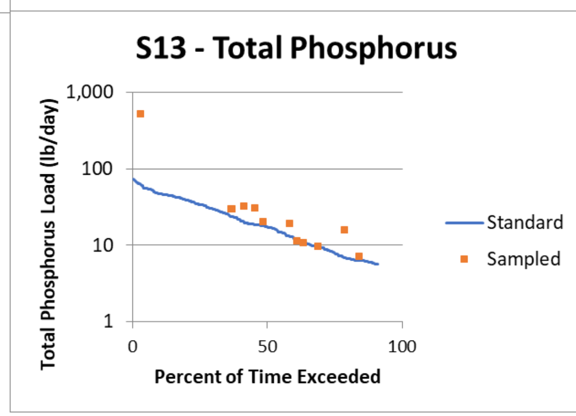

S8 - Total Phosphorus
Total Phosphorus Load (lb/day)
1,000
100
10
1
0
0
50
100
Percent of Time Exceeded
Standard
Sampled


S9 - Total Phosphorus
Total Phosphorus Load (lb/day)
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S10 - Total Phosphorus
Total Phosphorus Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S11 - Total Phosphorus
Total Phosphorus Load (lb/day)
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S12 - Total Phosphorus
Total Phosphorus Load (lb/day)
100
10
1
0
0
50
100
Percent of Time Exceeded
Standard
Sampled


S13 - Total Phosphorus
Total Phosphorus Load (lb/day)
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled

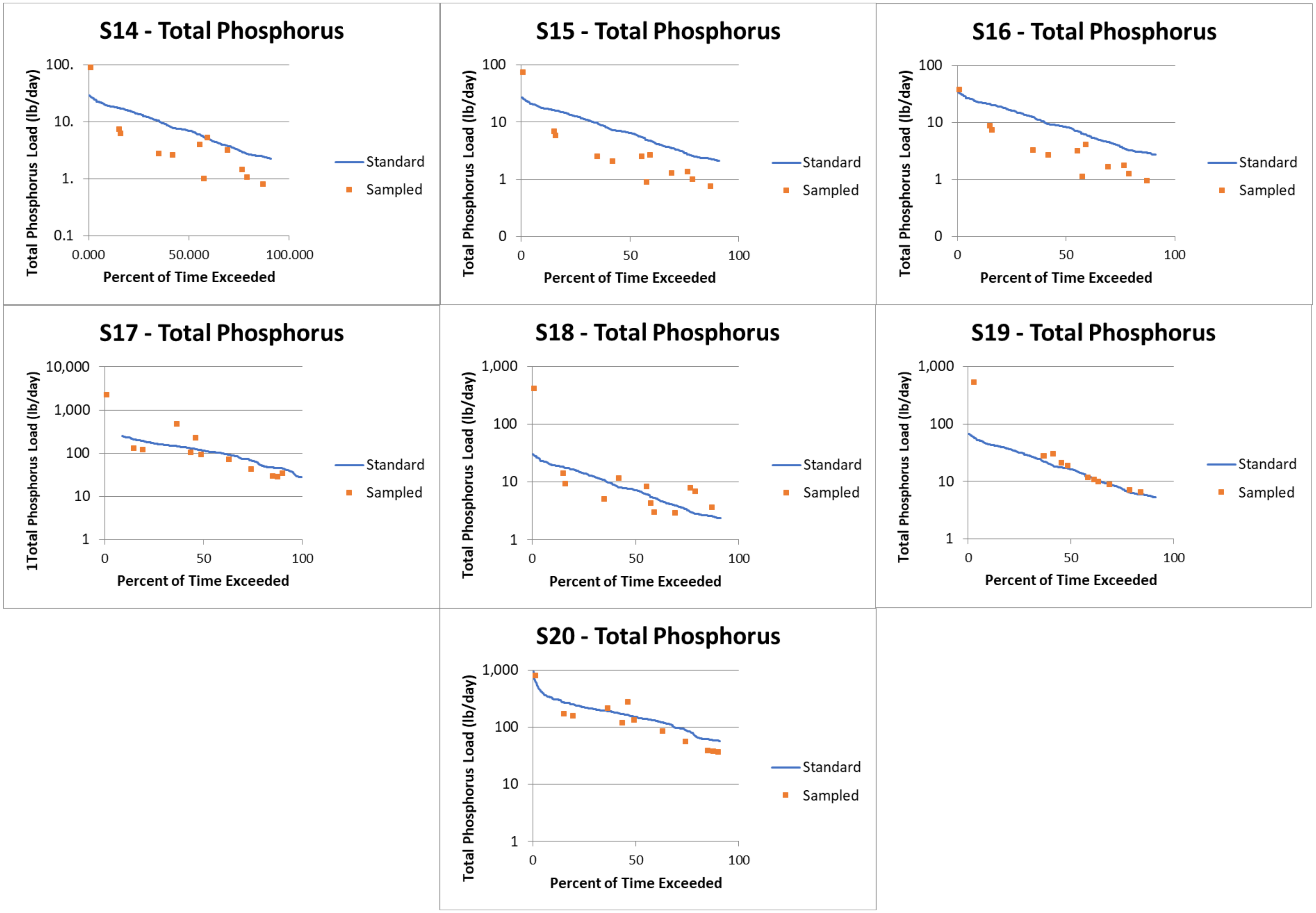
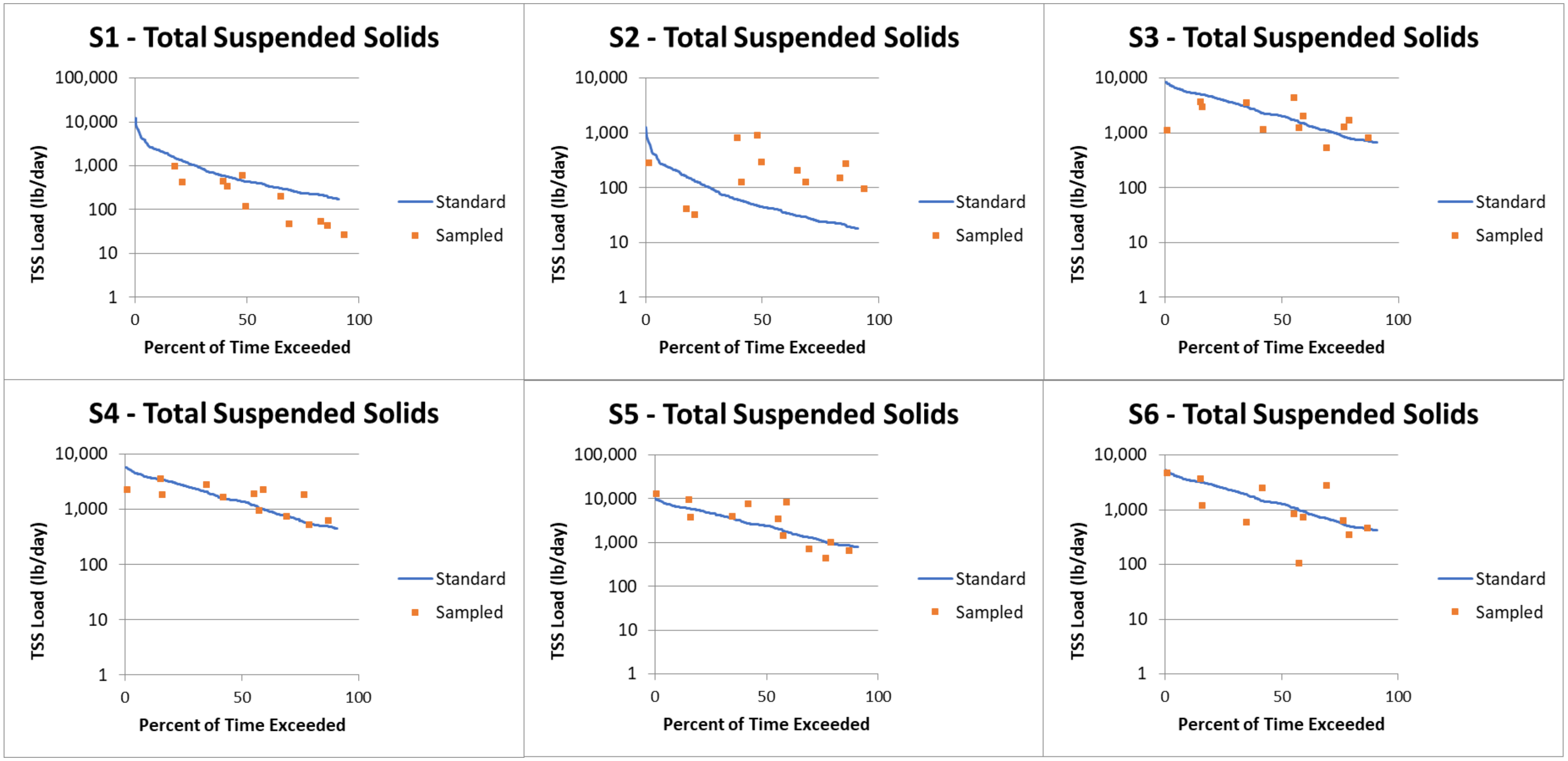
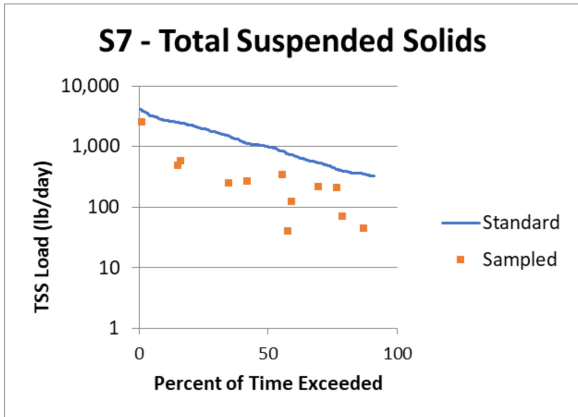


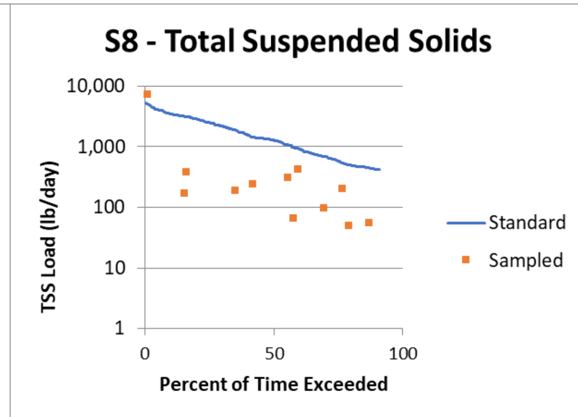
Figure 50. Total phosphorus load duration curves for Upper Elkhart River Watershed sample sites from February 2022-January 2023.

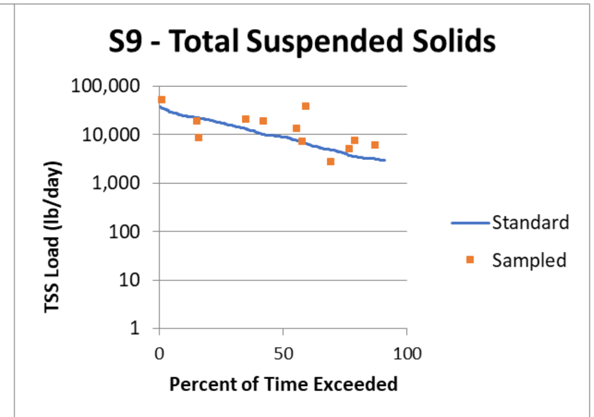
Total Suspended Solids Load Duration Curves

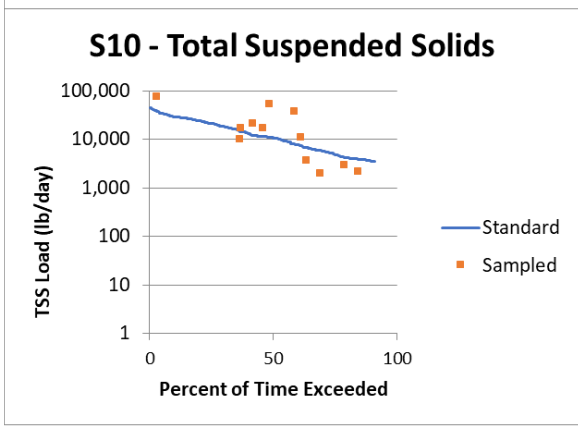
Total suspended solids (TSS) levels varied at all stream sites (Figure 51). Many of the sites exceeded target levels either half or more than half the time. Several sites (Site 4, 5, 9 and 10) exceeded load targets 100% of the time. Exceedances occurred during all flow conditions, but mostly during mid-range or dry conditions. This suggests total suspended solids enter the stream under mostly any flow condition. 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.

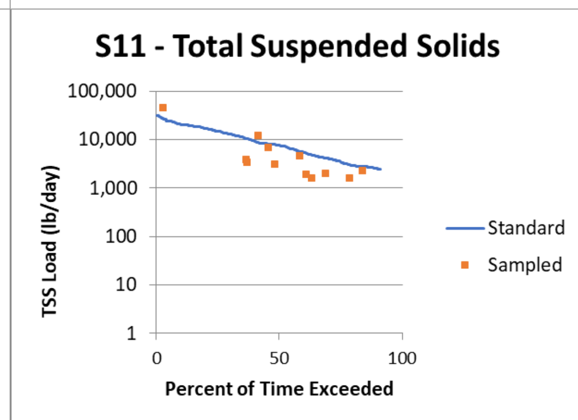


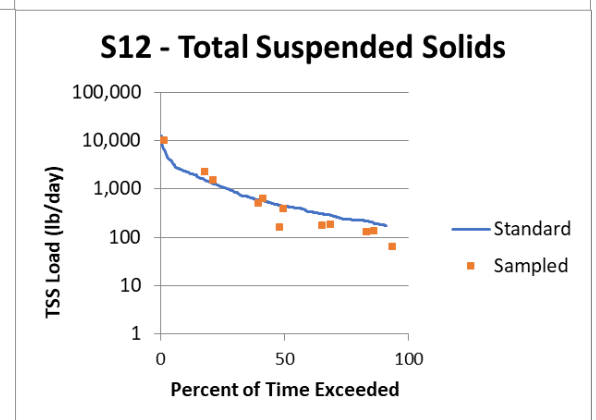

S7 - Total Suspended Solids
TSS Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled

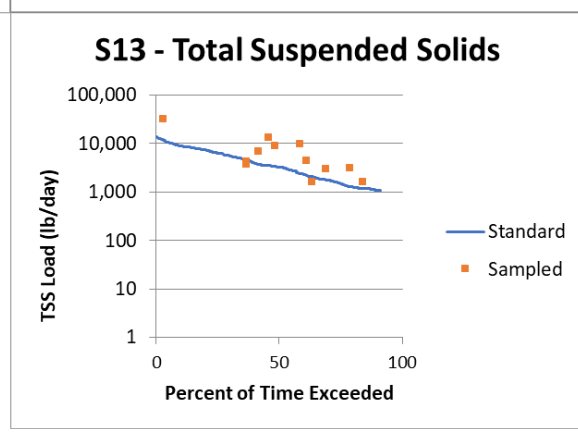

S8 - Total Suspended Solids
TSS Load (lb/day)
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S9 - Total Suspended Solids
TSS Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S10 - Total Suspended Solids
TSS Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S11 - Total Suspended Solids
TSS Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S12 - Total Suspended Solids
TSS Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled


S13 - Total Suspended Solids
TSS Load (lb/day)
100,000
10,000
1,000
100
10
1
0
50
100
Percent of Time Exceeded
Standard
Sampled

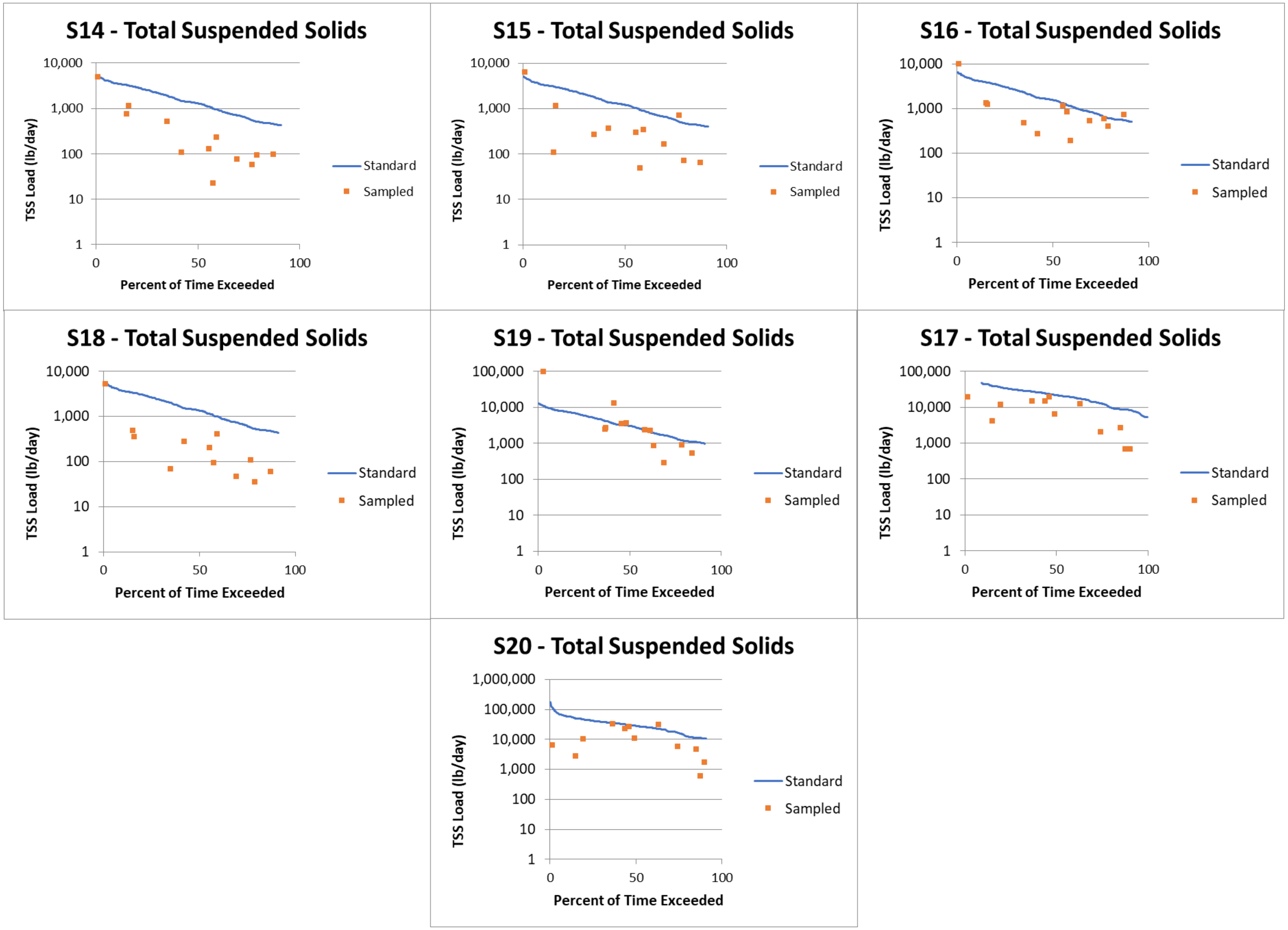
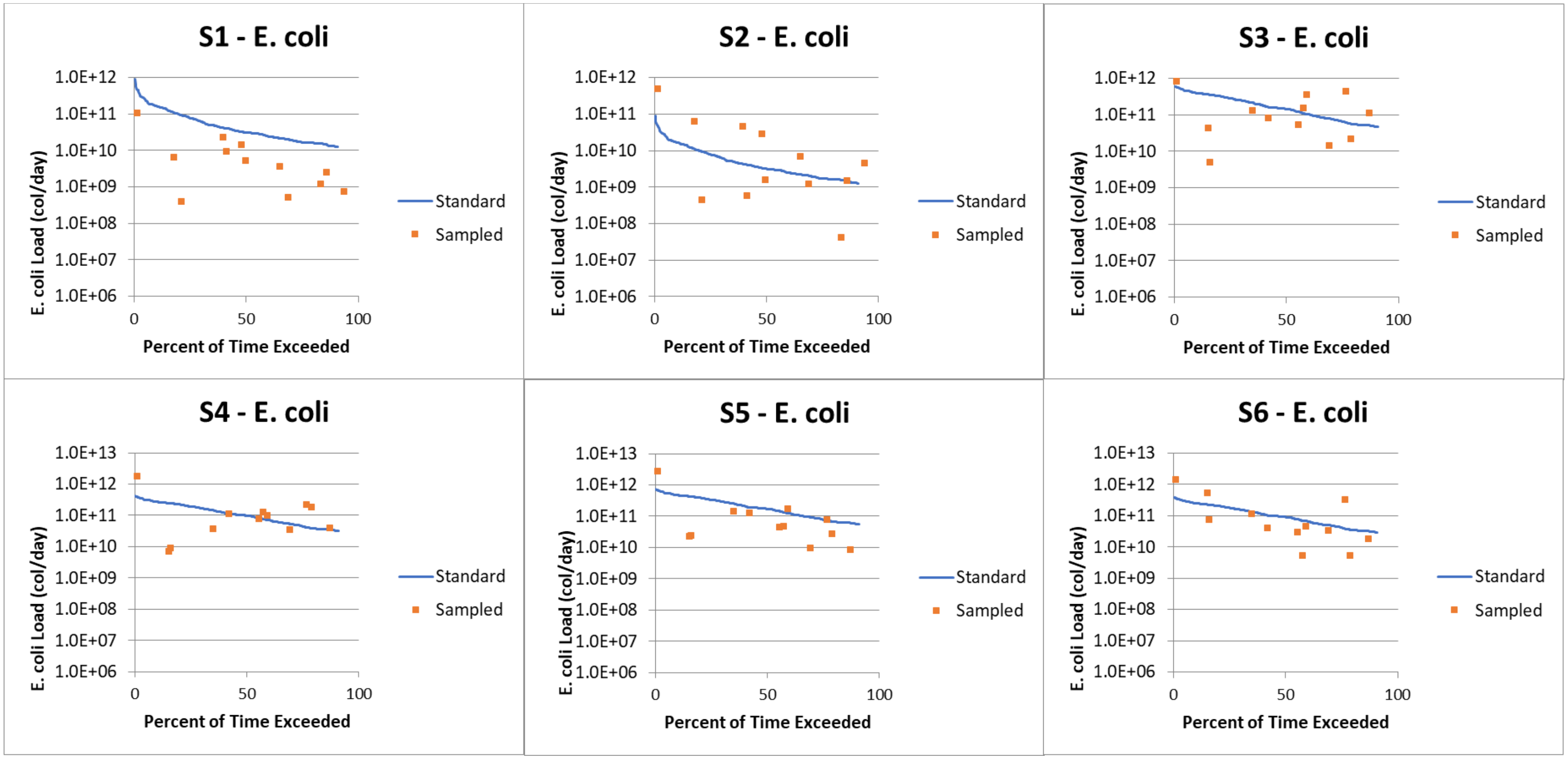
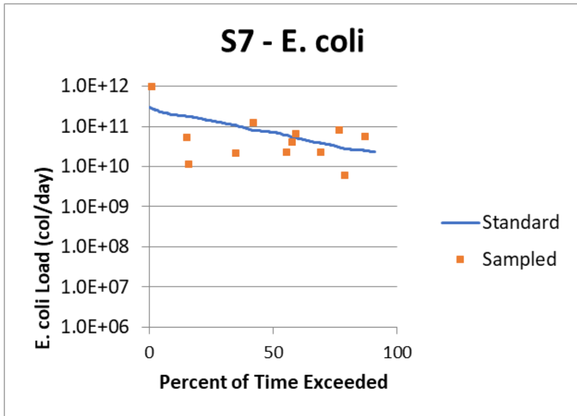


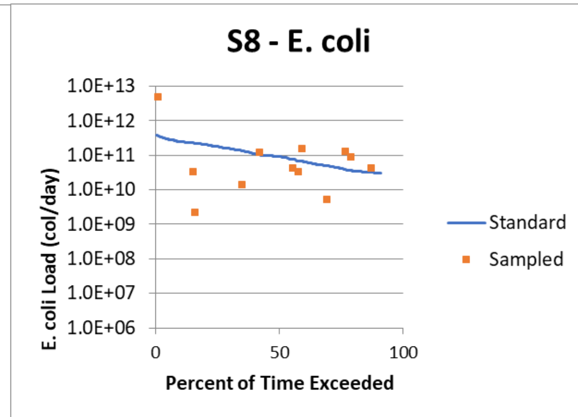
Figure 51. Total suspended solids load curves for Upper Elkhart River Watershed samples sites from February 2022-January 2023.

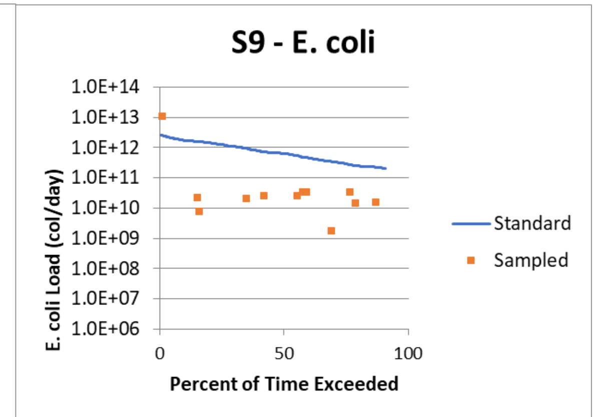
E. coli Load Duration Curves

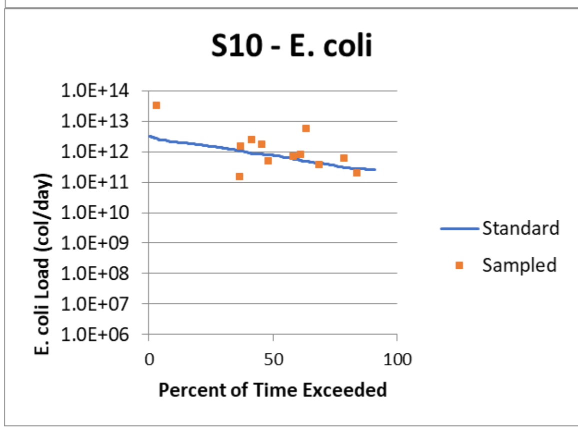
E. coli curves indicate that levels exceed targets during all flow conditions (Figure 52). Half of the sites measured at or above target levels. When targets were exceeded, they varied during flow conditions. Most exceedances occurred between mid-range to low conditions, with some exceedances during high flow conditions. These data suggest a nearly continuous source of *E. coli* within these streams under most flow conditions.

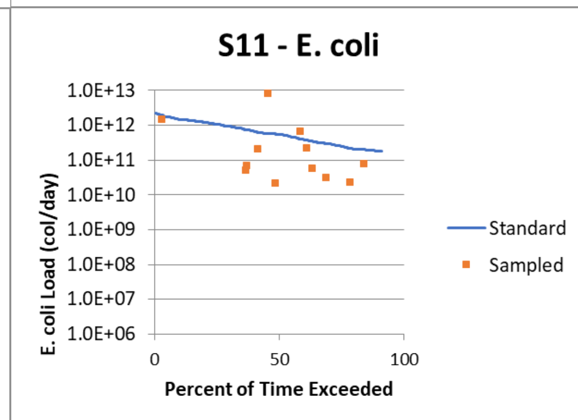


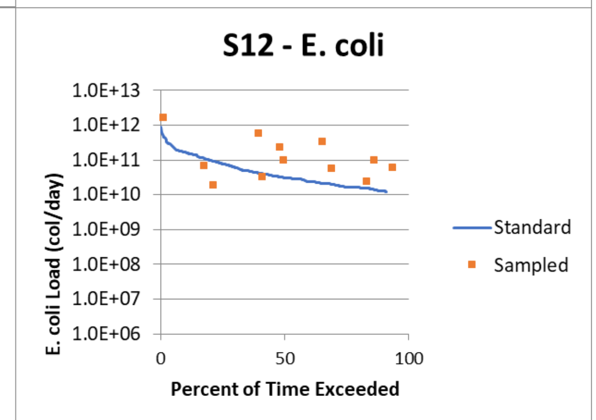

S7 - E. coli
E. coli Load (col/day)
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled

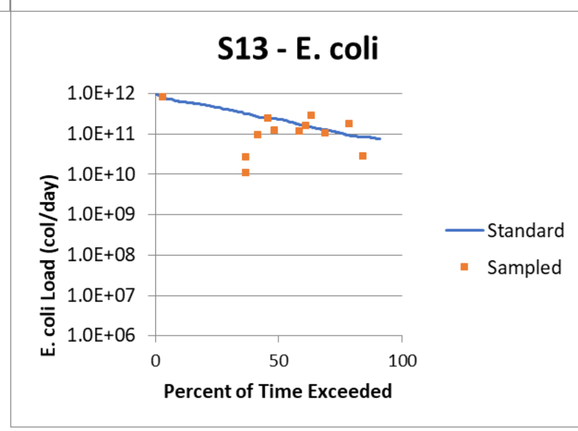

S8 - E. coli
E. coli Load (col/day)
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled


S9 - E. coli
E. coli Load (col/day)
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled


S10 - E. coli
E. coli Load (col/day)
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled


S11 - E. coli
E. coli Load (col/day)
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled


S12 - E. coli
E. coli Load (col/day)
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled


S13 - E. coli
E. coli Load (col/day)
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
50
100
Percent of Time Exceeded
Standard
Sampled

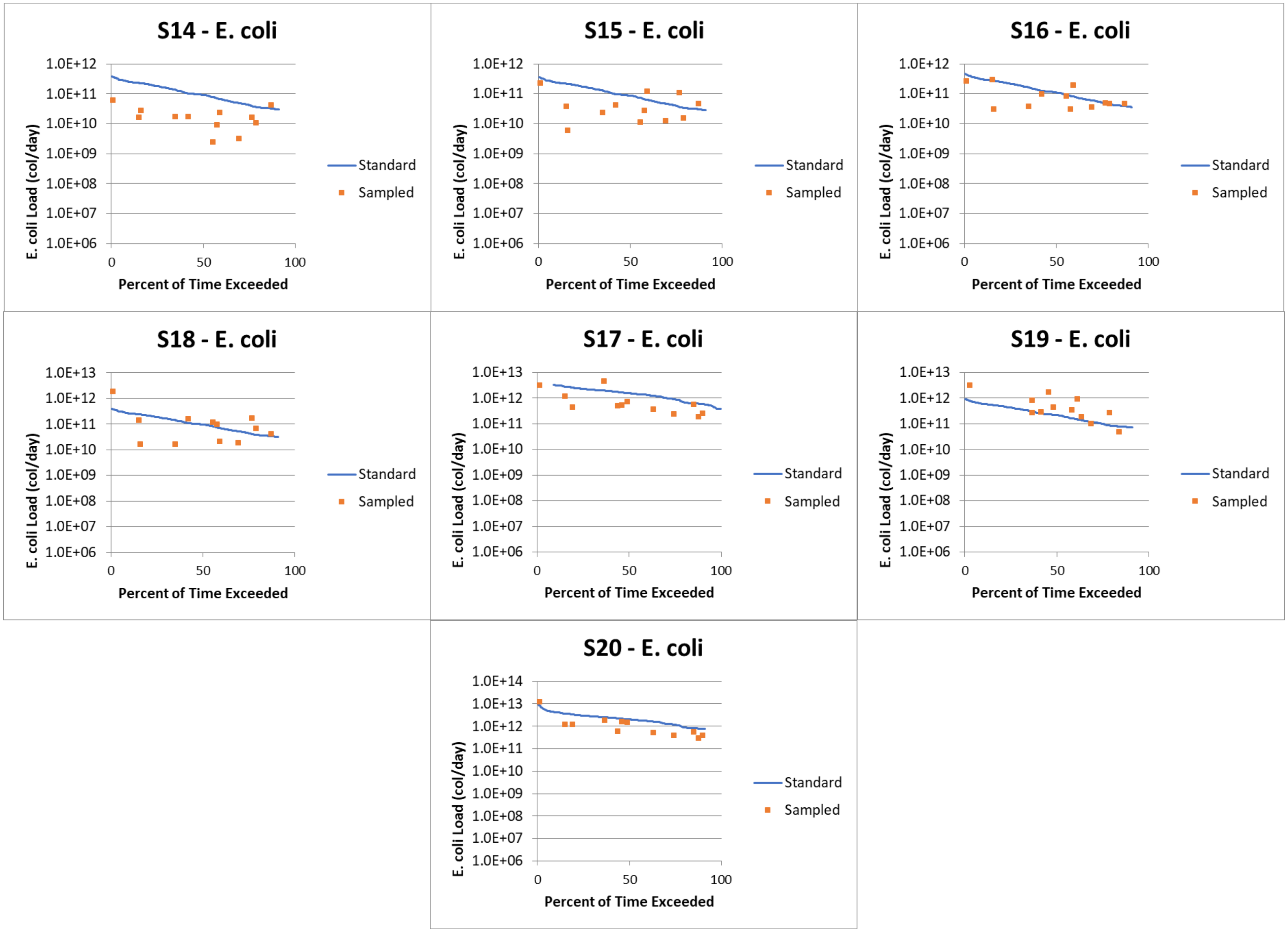


Figure 52. ***E. coli*** **load duration curves for Upper Elkhart River Watershed sample sites from February 2022-January 2023.**

3.4.5 Macroinvertebrate Community Assessment

Clock Creek (Site 7) and Croft Ditch (Site 12) supported the most diverse communities compared to the other sites in the Upper Elkhart River Watershed with 31 taxa and 24 taxa observed, respectively (Table 21, Figure 53). Additionally, Clock Creek (Site 7) possessed the greatest mIBI score and Croft Ditch (Site 12) and Elkhart River (Site 17) possessed the second highest mIBI scores, with Clock Creek having a score of 44 and Croft Ditch having a score of 42. It is important to note, however, that *no* intolerant species were observed at both Site 7 (Clock Creek) and Site 12 (Croft Ditch). Rather, Clock Creek (Site 7) had 12% of species observed classified as tolerant while Site 12 (Croft Ditch) had 35% classified as tolerant. Like Site 12 (Croft Ditch), the Elkhart River (Site 17) also had an mIBI score of 42. Elkhart River (Site 17) had the greatest percentage of intolerant species observed (33%) with only 3% of observed taxa classified as tolerant. Additionally, the Elkhart River (Site 17) had the most observed EPT taxa (11 individuals). Site 10 (North Branch Elkhart River) had the greatest percentage of tolerant species, with 91% of observed taxa identified as tolerant. Site 2 (Hackenburg Lake inlet) had the lowest mIBI score with a score of 22. Hackenburg Lake inlet (Site 2) also had the lowest number of sensitive EPT taxa observed with 0 individuals collected. Macroinvertebrate data are detailed in Appendix B.

Table 21. Metric classification scores and mIBI score for the Upper Elkhart River Watershed sample sites as sampled in 2022.

Metrics Scoring	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 10	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17	Site 18	Site 19	Site 20
Total Taxa Score	1	3	1	1	1	3	3	1	3	1	1	3	1	3	1	1	1
Total # Individuals Score	1	5	5	5	5	5	1	5	5	5	5	5	5	5	5	5	5
#EPT Taxa Score	1	3	1	1	1	3	1	3	1	1	3	1	1	3	3	3	3
% Orthoclads &Tanytarsids Score	5	5	5	5	3	3	5	5	5	5	5	5	5	5	5	5	5
% Non-Insects Score	1	5	1	1	5	5	5	1	5	5	1	3	1	5	1	5	3
# Dipteran Taxa Score	1	1	3	1	1	3	3	1	3	3	1	3	1	1	1	3	3
% Intolerant Score	1	3	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1
% Tolerant Score	1	5	1	1	1	5	1	1	1	1	1	1	5	5	5	5	5
%Predators Score	1	1	3	3	5	1	1	1	5	3	1	1	1	1	1	1	1
%Shredders & Scrapers Score	5	5	5	1	1	5	5	5	5	5	1	1	1	5	1	5	3
% Collector-Filterers Score	3	1	3	5	1	5	3	5	3	5	1	3	5	3	1	1	3
% Sprawlers Score	1	1	5	5	5	5	1	1	5	5	3	5	1	1	1	1	1
mIBI Score	**22**	**38**	**34**	**30**	**30**	**44**	**30**	**30**	**42**	**40**	**24**	**32**	**28**	**42**	**26**	**36**	**34**
Rating	**VP**	**F**	**P**	**P**	**P**	**F**	**P**	**P**	**F**	**F**	**P**	**P**	**P**	**F**	**P**	**F**	**P**

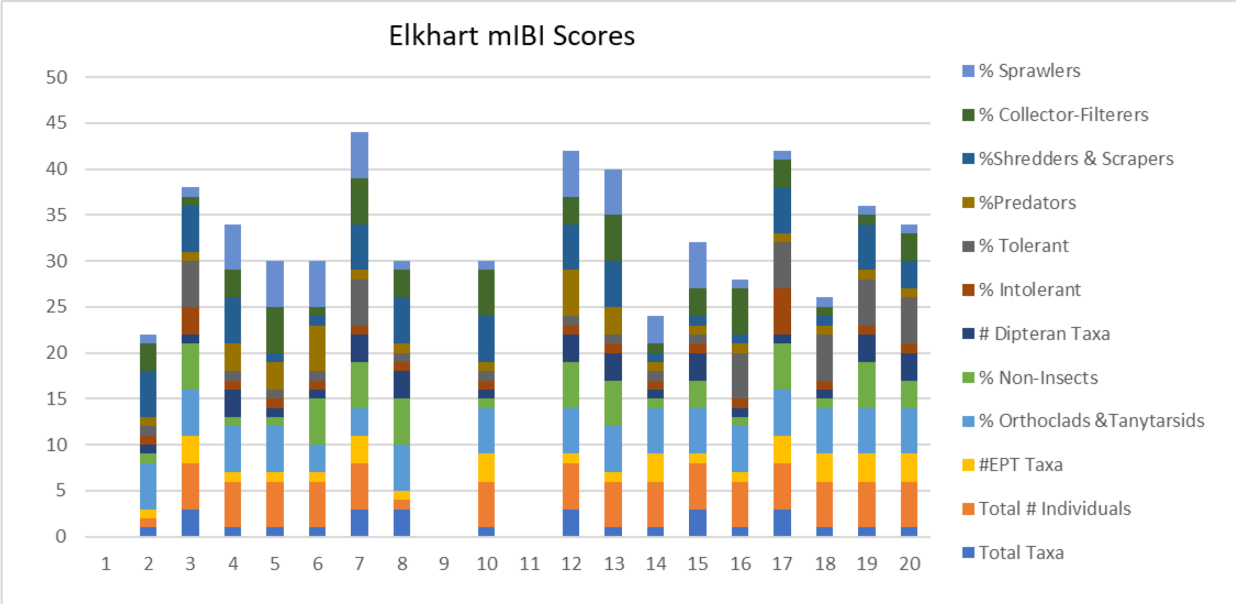


Figure 53. Cumulative metrics used to calculate mIBI scores for Upper Elkhart River Watershed streams in 2022.

As shown in Figure 54, Site 2 (Hackenburg Lake inlet), Site 4 (Little Elkhart Creek) , Site 5 (North Branch downstream of Sylvan Lake), Site 6 (Henderson Lake Ditch), Site 8 (Dry Run), Site 10 (North Branch Elkhart River), Site 14 Rivir Lake Tributary), Site 15 (Carrol Lake), Site 16 (Solomon Creek), Site 18 (Stony Creek) and Site 20 (Elkhart River) possessed mIBI scores which rated as impaired. Site 3 (North Branch Elkhart River downstream of Five Lake), Site 7 (Clock Creek), Site 12 (Croft Ditch), Site 13 (South Branch Elkhart River), Site 17 (Elkhart River) and Site 19 (Solomon Creek) possessed mIBI scores which rated as not impaired.

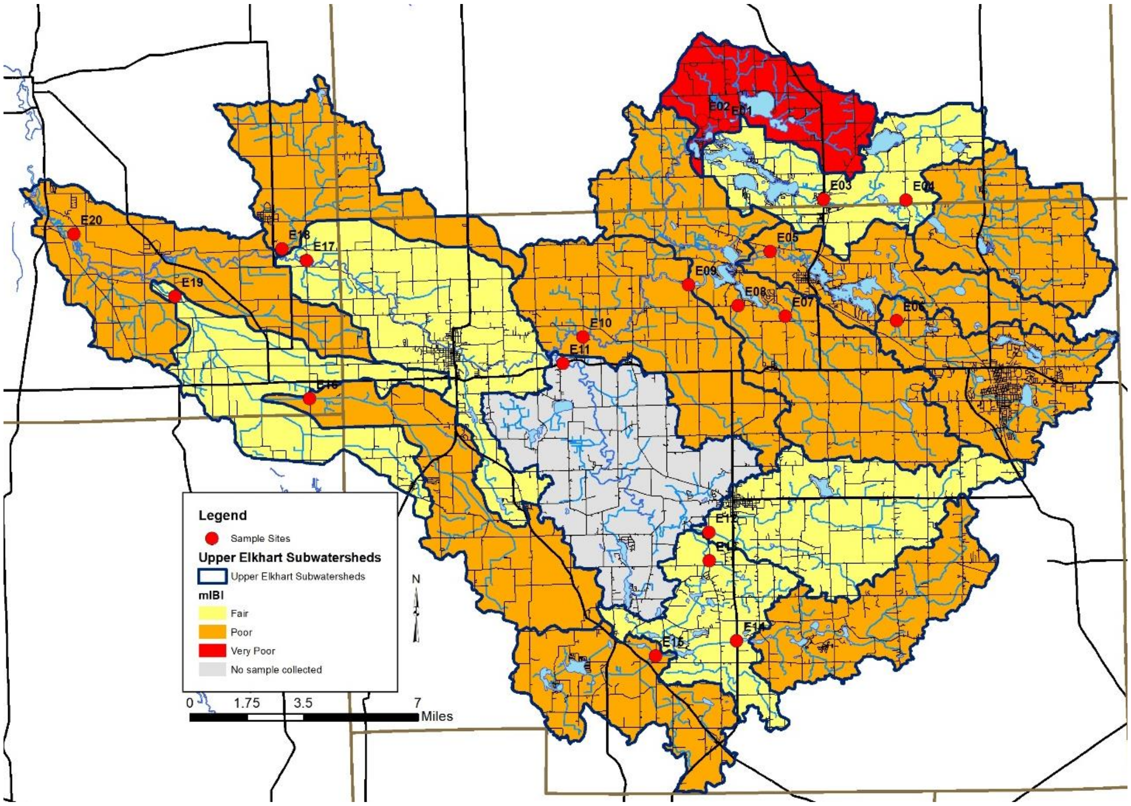


Figure 54. mIBI ratings for Upper Elkhart River Watershed stream sites.

3.4.6 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 22 presents the results of QHEI assessments at each of the 20 stream sites sampled in the Upper Elkhart Watershed during October 2022. Figure 55 details metric and total scores for all sites. Only the Elkhart River (Site 17) rated as excellent, while North Branch Elkhart River downstream of Five Lakes (Site 3), South Branch Elkhart River (Site 13), Stony Creek (Site 18), Solomon Creek (Site 19) and Elkhart River (Site 20) rated as good. For these sites, pool/riffle development scores, stream substrate, instream cover, and gradient were relatively good for Indiana streams contributing to overall high quality QHEI scores. Clock Creek (Site 7), Dry Run (Site 8) and North Branch Elkhart River (Site 10) rated as fair. Little Elkhart Creek (Site 4), North Branch Elkhart River downstream of Sylvan Lake (Site 5), Henderson Lake Ditch (Site 6), Croft Ditch (Site 12) and Solomon Creek (Site 16) rated poor while Hackenburg Lake inlet (Site 2), Rivir Lake tributary (Site 14) and Carrol Creek (Site 15) rated very poor. The lowest scores occurred at sites which possessed poor substrate, poor instream cover, limited riparian quality and lacked pool/riffle complexes. Habitat data are detailed in Appendix B.

Table 22. Qualitative Habitat Evaluation Index (QHEI) scores measured in the Upper Elkhart River Watershed.

Site	Substrate	Cover	Channel	Riparian	Pool Quality	Riffle/Run Quality	Gradient	Total Score	Rating
1	Habitat not assessed.								
2	0	3	4	3	3	0	2	15	Very poor
3	14	12	14	4	7	3	4	58	Good
4	4.5	8	13	3.5	8	0	2	39	Poor
5	4	15	10	3	9	0	2	43	Poor
6	5	7	4	4	6	1	4	31	Poor
7	5.5	14	12	5.5	9	2	2	50	Fair
8	12	11	9	4	7	2	4	49	Fair
9	Habitat not assessed.								
10	10	9	16	6	7	2	2	52	Fair
11	Habitat not assessed.								
12	5.5	7	6	4	6	0	4	32.5	Poor
13	14	20	13	4	9	5	4	69	Good
14	0.5	8	5	3.5	3	0	2	22	Very poor
15	0.5	7	4	3.5	6	0	6	27	Very poor
16	1	8	5	3	8	0	6	31	Poor
17	13	17	15	9	8	5	6	73	Excellent
18	15	14	15	6	9	4	2	65	Good
19	15	13	16	6	5	4	4	63	Good
20	6	17	13	8.5	9	0	4	57.5	Good

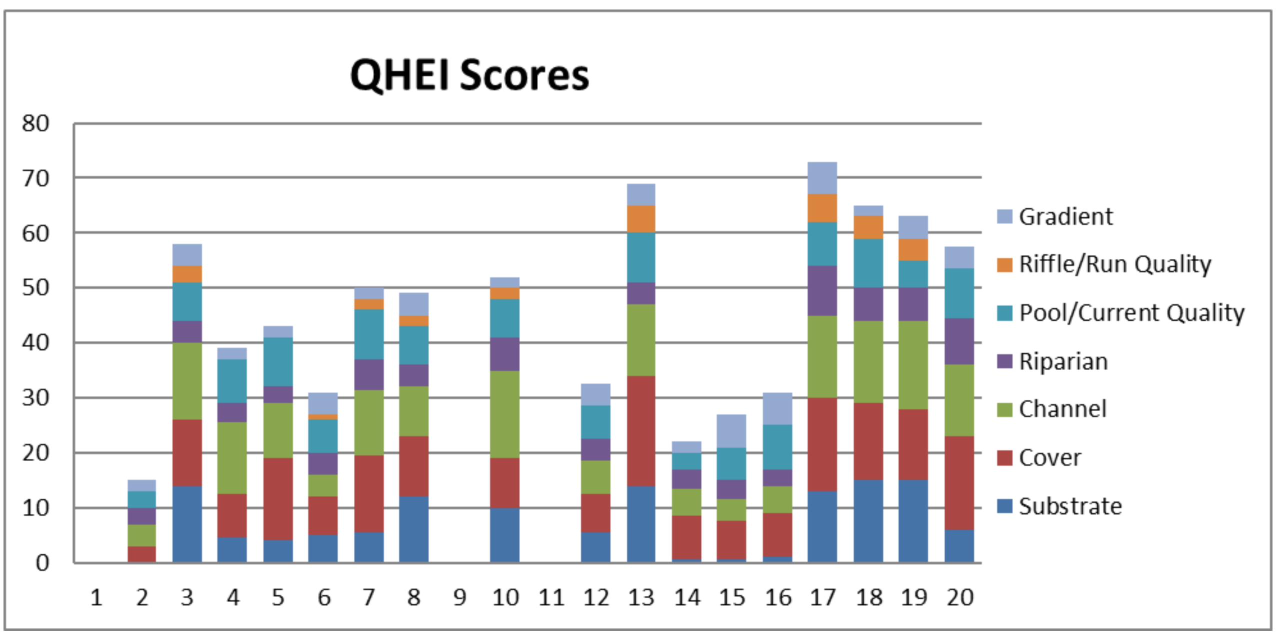


Figure 55. Cumulative metrics used to calculate QHEI scores for Upper Elkhart River Watershed streams in 2022.

As shown in Figure 56, Site 2 (Hackenburg Lake inlet), Site 14 (Rivir Lake Tributary), Site 15 (Carrol Creek) rated as very poor. Site 4 (Little Elkhart River), Site 5 (North Branch d/s Sylvan Lake), Site 6 (Henderson Lake Ditch), Site 12 (Croft Ditch), Site 16 (Solomon Creek) rated as poor. Site 7 (Clock Creek), Site 8 (Dry Run), Site 10 (North Branch Elkhart River) rated as fair. Site 3 (North Branch Elkhart River d/s Five Lake), Site 13 (South Branch Elkhart River), Site 18 (Stony Creek Outlet), Site 19 (Solomon Creek Outlet), Site 20 (Elkhart River) rated as good. Site 17 (Elkhart River) rated as excellent.

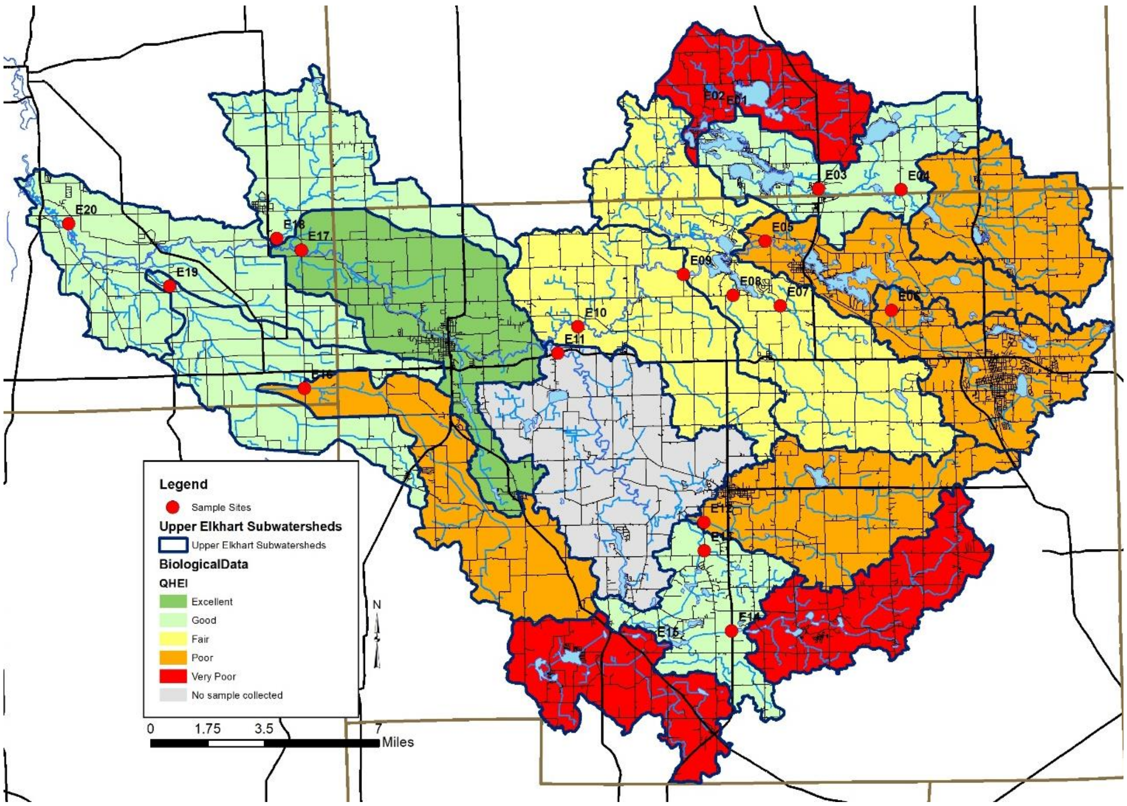


Figure 56. QHEI ratings for Upper Elkhart River Watershed stream sites.

3.5 <u>Watershed Inventory Assessment</u>

3.5.1 Watershed Inventory Methodologies

Volunteers completed windshield surveys throughout the Upper Elkhart River Watershed in spring 2021. Volunteers conducted surveys by driving all accessible roads throughout the watershed. Large maps with aerial photographs, road and stream names, and public property labels were provided to each volunteer group. Volunteers recorded observations on the provided maps and data sheets, documented field conditions with photographs, and provided all notes 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.)

3.5.2 Watershed Inventory Results

All accessible road-stream crossings were inventoried. A majority of issues identified fall into five categories: stream buffers limited in width or lacking altogether, areas of livestock access, streambank erosion, dumping areas, and unregulated farms. Figure 57 details locations throughout the Upper Elkhart River Watershed where problems were identified. Much of the watershed is not visible from the road and additional assessments will be on-going; therefore, those identified in Figure 57 should not be considered exhaustive. Nearly 63.8 miles of streams possessed limited buffers, nearly 20.6 miles of streambank were eroded, and livestock had access to nearly 3.5 miles of streams. Note that these data are preliminary and additional inventory efforts will augment this map as the project moves forward.

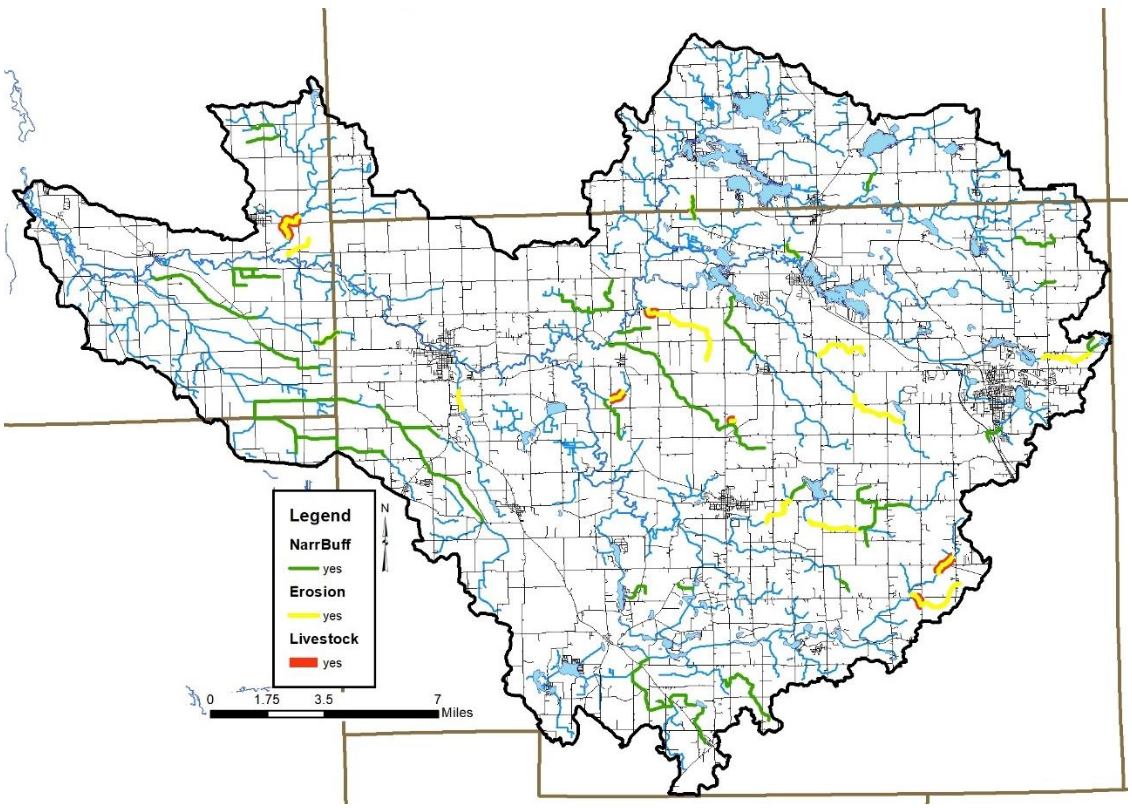


Figure 57. Stream-related watershed concerns identified during watershed inventory efforts.

4.0 WATERSHED INVENTORY II-B: SUBWATERSHED DISCUSSIONS

To gather more specific, localized data, the Upper Elkhart River Watershed was divided into seventeen (17) subwatersheds with each subwatershed reflecting one 12-digit Hydrologic Unit Code (HUC; Figure 58). 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. Subwatershed data are detailed in Appendix D.

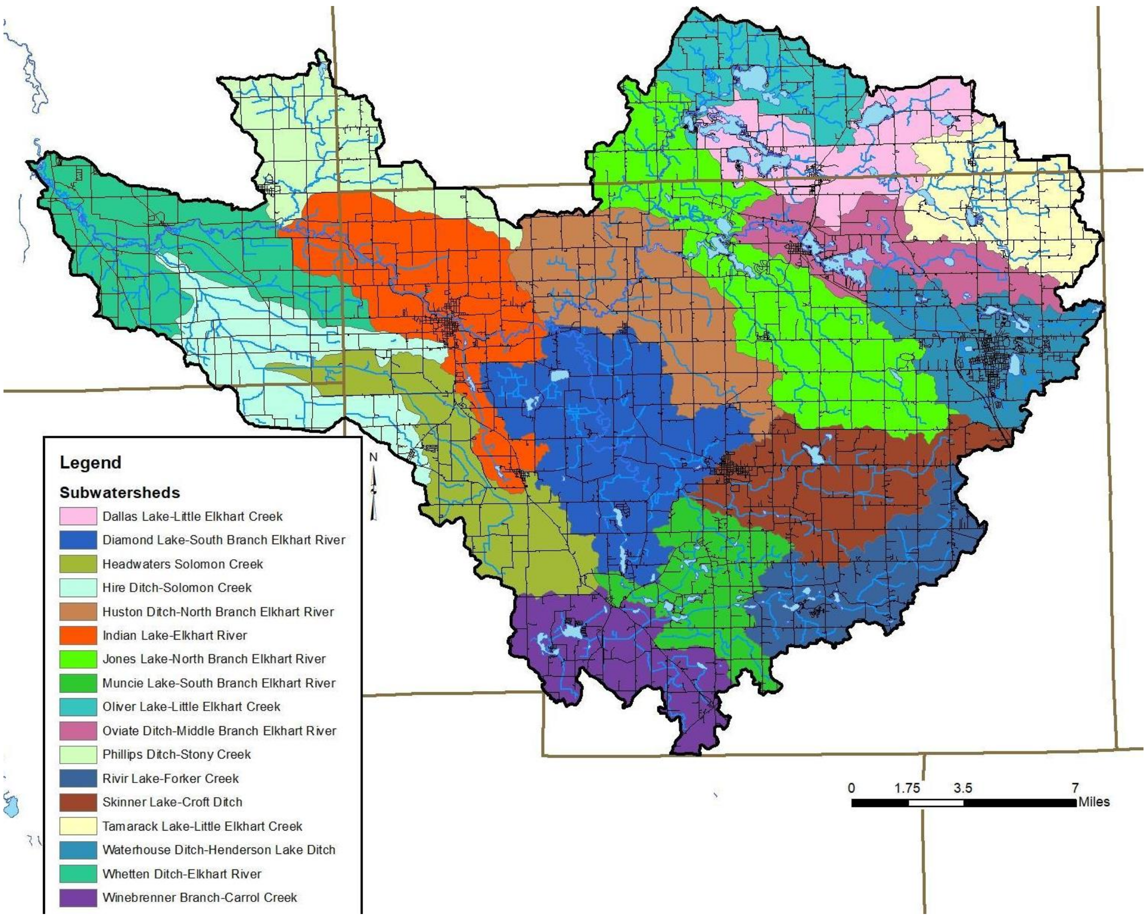


Figure 58. 12-digit Hydrologic Unit Codes subwatersheds in the Upper Elkhart River Watershed.

4.1 Tamarack Lake-Little Elkhart Creek subwatershed

The Tamarack Lake-Little Elkhart Creek Subwatershed forms a portion of the northeast boundary of the Upper Elkhart River Watershed and lies within Lagrange and Noble counties (Figure 59). It encompasses one 12-digit HUC watershed: 040500011501. This subwatershed drains 12,395 acres or 19.4 square miles. The Tamarack Lake-Little Elkhart Creek subwatershed accounts for 5% of the total watershed area. There are 28.5 miles of stream. There are no recorded impairments for the Tamarack Lake-Little Elkhart Creek subwatershed.

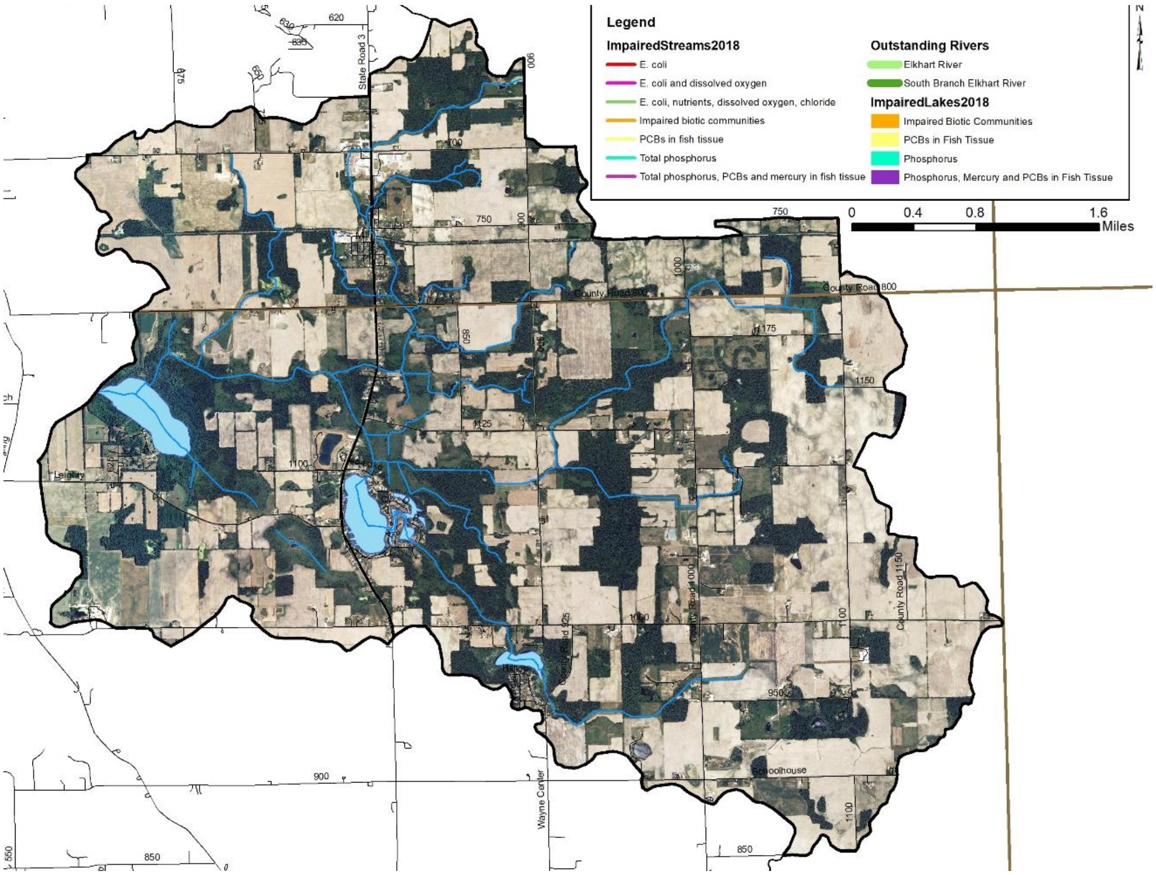


Figure 59. Tamarack Lake-Little Elkhart Creek subwatershed.

4.1.1 Soils

Hydric soils cover 3,675.8 acres or 30% of the subwatershed; wetlands currently cover 26% (3,272.3 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils are prevalent throughout the subwatershed covering 7,107.0 acres or 57% of the subwatershed. Nearly all of the subwatershed, 90% (11,189.2 acres), has soils which are very limited for septic use. The majority of the Tamarack Lake-Little Elkhart Creek subwatershed is rural, indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.1.2 Land Use

Agricultural land use dominates the Tamarack Lake-Little Elkhart Creek subwatershed with 63% (7,813.5 acres) mapped as row crop and pastureland. Wetlands, open water and grassland cover 3,272.3 acres, or 26% of the subwatershed. Urban land use is the next largest use of the subwatershed, but only accounts for 6% (720.1 acres) of use. Forest land makes up just 0.2% (26.6 acres) of the subwatershed.

4.1.3 Point Source Water Quality Issues

There are three leaking underground storage tanks. There are no open dumps, brownfields, corrective action sites, NPDES-permitted facilities, or industrial waste facilities located within the Tamarack Lake-Little Elkhart Creek subwatershed (Figure 60).

4.1.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Tamarack Lake-Little Elkhart Creek subwatershed. As a result, various small animal operations and pastures are also present (Figure 60). Seven unregulated animal operations housing more than 31 cows, horses and sheep which were identified during the windshield survey. Livestock do not have access to streams in the Tamarack Lake-Little Elkhart Creek subwatershed streams based on observations during the windshield survey. Manure from small animal operations total over 431 tons per year, which contains almost 449 pounds of nitrogen, 217 pounds of phosphorus and 9.91E+13 col of E. coli. A lack of buffers is also a concern in the subwatershed. Approximately 2.2 miles (8%) of narrow buffer were identified within the subwatershed (Figure 60).

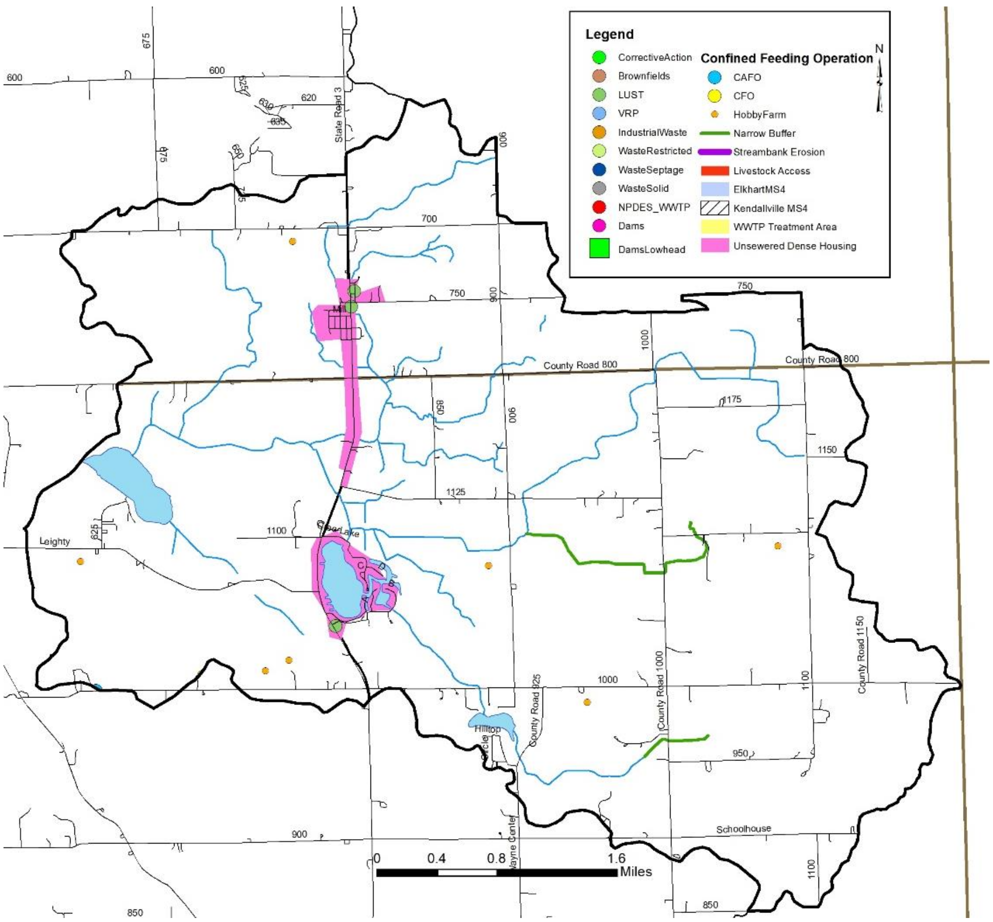


Figure 60. Potential point and non-point sources of pollution and suggested solutions in the Tamarack Lake-Little Elkhart Creek subwatershed.

4.1.5 Water Quality Assessment

Waterbodies within the Tamarack Lake-Little Elkhart Creek subwatershed have been sampled at four locations (Figure 61). Assessments include collection of water chemistry data by IDEM (2 sites) and by IS&T as part of the Cree and Shockopee Lakes Feasibility Study (2 sites). One site in the Tamarack Lake-Little Elkhart Creek subwatershed is being sampled as part of the current project (shown as Upper Sample Sites). No stream gages are in the Tamarack Lake-Little Elkhart Creek subwatershed.

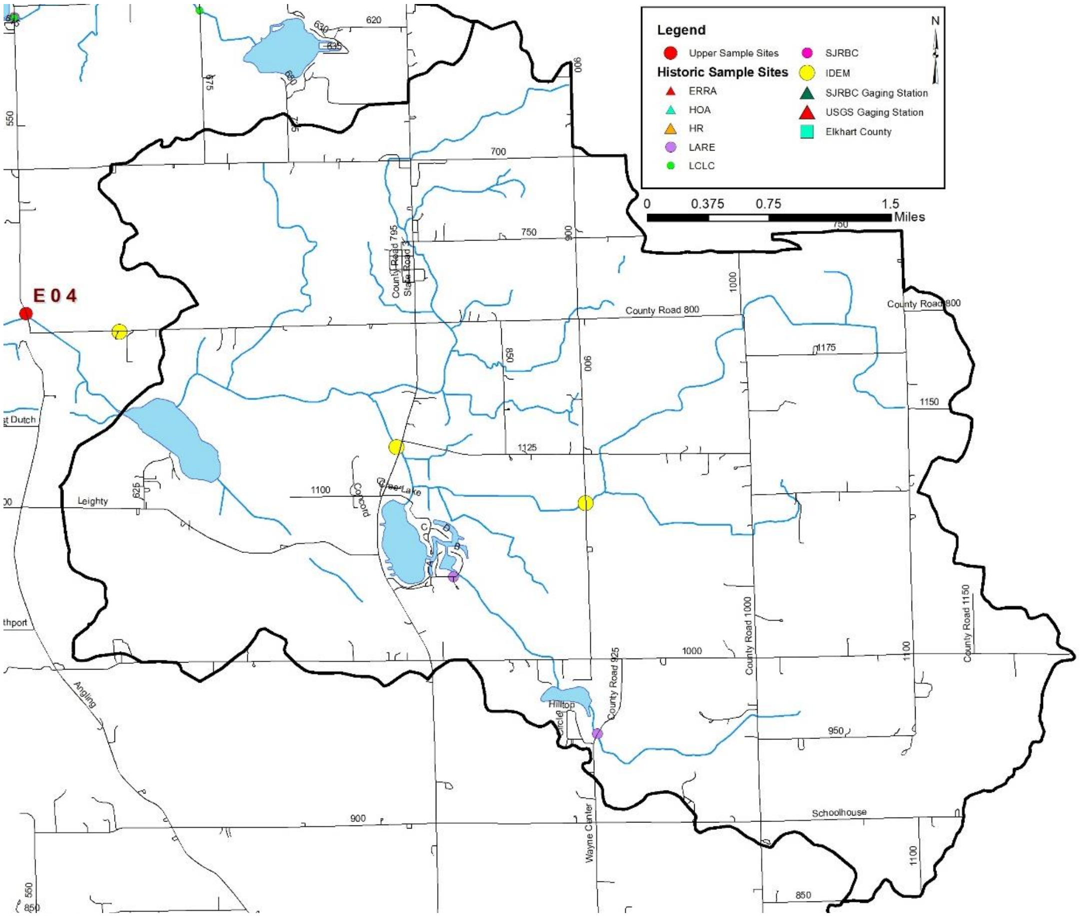


Figure 61. Locations of historic and current water quality data collection in the Tamarack Lake-Little Elkhart Creek subwatershed.

Table 23 details water chemistry data collected in the Tamarack Lake-Little Elkhart Creek subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 80% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 80% of samples. Total suspended solids exceed water quality targets (15 mg/L) in 25% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 100% of samples.

Table 23. Tamarack Lake-Little Elkhart Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	564	715	0	3	0%
Dissolved Oxygen	6.5	11	0	7	0%
Ammonia-Nitrogen	0.01	0.23	1	4	25%
Nitrate-Nitrogen	0.41	8	4	5	80%
pH	7.55	8.32	0	7	0%
Total Kjeldahl Nitrogen	1.6	8.02	5	5	100%
Total Phosphorus	0.07	1.05	4	5	80%
Total Suspended Solids	0.11	120	2	5	20%
Turbidity	13	21	2	2	100%

Table 24 details water quality data collected in the Tamarack Lake-Little Elkhart Subwatershed at Little Elkhart Creek stream (Site 4). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 25% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 17% 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 17% of samples. Dissolved oxygen concentrations exceed water quality standards in 8% of samples collected from this site.

Table 24. Tamarack Lake-Little Elkhart Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
4	Min	6.11	3.57	7.66	358.60	0.40	0.30	0.05	1.20	6.00
	Median	12.23	8.49	8.43	474.95	2.30	2.43	0.05	10.80	130.00
	Max	23.95	11.31	8.75	734.40	7.40	4.56	0.21	20.00	517.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		1	0	0	2	11	2	3	3
	% Exceed	0%	8%	0%	0%	17%	92%	17%	25%	25%

The only biological assessment in the Tamarack Lake-Little Elkhart Creek subwatershed occurred as part of the current project. Little Elkhart Creek's macroinvertebrate community rated as impaired, and the habitat rated as poor.

4.2 Dallas Lake-Little Elkhart Creek subwatershed

The Dallas Lake-Little Elkhart Creek subwatershed is one of the northernmost subwatershed of the Upper Elkhart River Watershed forming part of the northeastern border of the watershed. The Dallas Lake-Little Elkhart Creek subwatershed lies in LaGrange and Noble counties (Figure 62). It encompasses one 12-digit HUC watershed: 040500011502. This subwatershed drains 13,311 acres or 20.8 square miles and accounts for 5% of the total watershed area. There are 30.5 miles of stream. IDEM has classified 3.81 miles of stream as impaired for impaired biotic communities. IDEM classified Dallas and Witmer Lakes as impaired for biological communities.

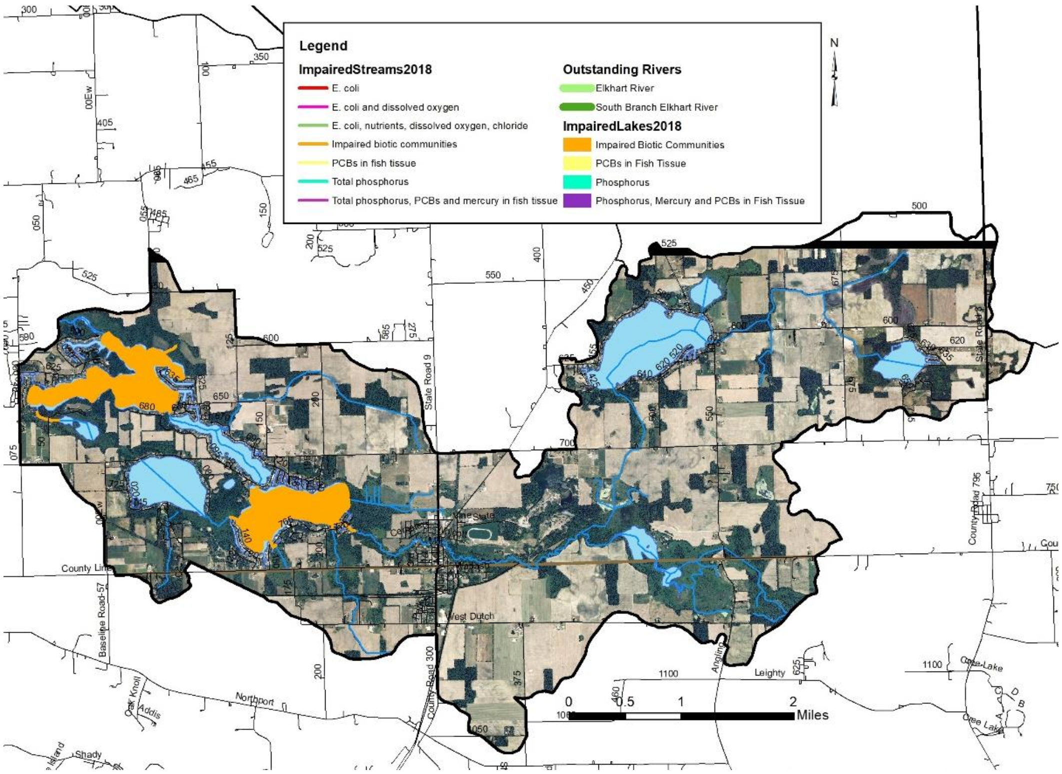


Figure 62. Dallas Lake-Little Elkhart Creek subwatershed.

4.2.1 Soils

Hydric soils cover 2,953.1 acres or 22% of the subwatershed; wetlands cover 35% (4,621.9 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils are prevalent throughout the subwatershed covering 6,899.2 acres or 52% of the subwatershed. Nearly two-thirds of the subwatershed, 67% (8,855.2 acres), has soils which are very limited for septic use. The majority of the Dallas Lake-Little Elkhart Creek Subwatershed is rural, indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.2.2 Land Use

Agricultural land use dominates the Dallas Lake-Little Elkhart Creek subwatershed with 55% (13,315.1 acres) mapped with row crop and pastureland. Wetlands, open water and grassland cover 4,621.9 acres, or 35% of the subwatershed. Urban land use is the next largest use of the subwatershed, but only accounts for 8% (1,090.5 acres) of use. Forest land makes up just 2% (290.7 acres) of the subwatershed.

4.2.3 Point Source Water Quality Issues

There are seven underground storage tanks, two of which are listed as leading underground storage tanks, located in the subwatershed and there is one NPDES-permitted facility (Wolcottville WWTP). The Lagrange County Regional Sewer District also handles effluent from businesses and residences around several subwatershed lakes. The Wolcottville WWTP has had incidences of overflow in the last year including overflows into a wetland and a private home basement. The Wolcottville WWTP is working on facility structure improvements to rectify the issue and prevent future overflows. There are no open dumps, brownfields, corrective action sites or industrial waste facilities located within the Dallas Lake-Little Elkhart Creek subwatershed (Figure 63).

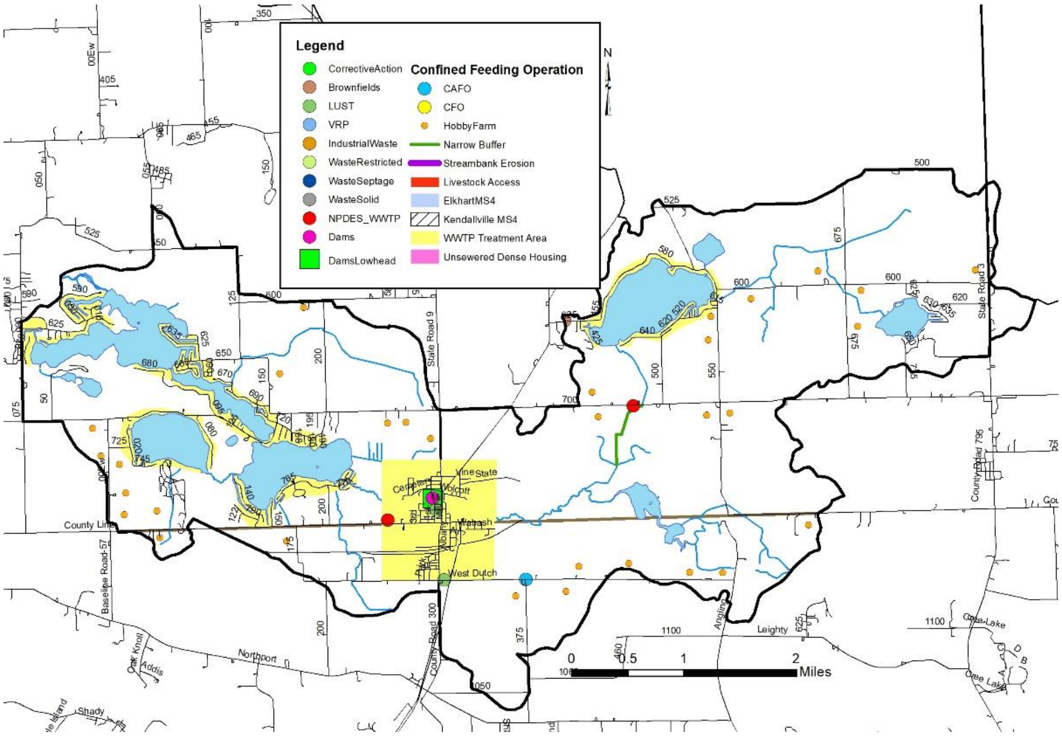


Figure 63. Potential point and non-point sources of pollution and suggested solutions in the Dallas Lake-Little Elkhart Creek subwatershed.

4.2.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Dallas Lake-Little Elkhart Creek subwatershed. As a result, various small animal operations, CAFOs, and pastures are also present (Figure 63). There are 31 unregulated animal operations housing more than 475 cows, horses, bison and goats which were identified during the windshield survey. One CAFO housing 1,000 cows is located in the subwatershed. Livestock do not have access to streams in the Dallas Lake-Little Elkhart Creek subwatershed streams based on observations during the windshield survey. Manure from small animal operations and the CAFO total over 30,179 tons per year, which contains almost 15,804 pounds of nitrogen, 7,876 pounds of phosphorus and 8.88E+14 col of E. coli. A lack of buffers is also a concern in the subwatershed. Approximately 0.7 miles (2%) of narrow buffers were identified within the subwatershed (Figure 63).

4.2.5 Water Quality Assessment

Waterbodies within the Dallas Lake-Little Elkhart Creek subwatershed have been sampled at 22 locations (Figure 64). Assessments include collection of water chemistry and by IDEM (4), by FX Browne (11 sites), by Tri State University (3 sites) and as part of the Five Lakes Feasibility Study (JFNew, 4 sites). One site in the Dallas Lake-Little Elkhart Creek subwatershed is being sampled as part of the current project (noted as Upper sample sites). No USGS stream gages are in the Dallas Lake-Little Elkhart Creek subwatershed.

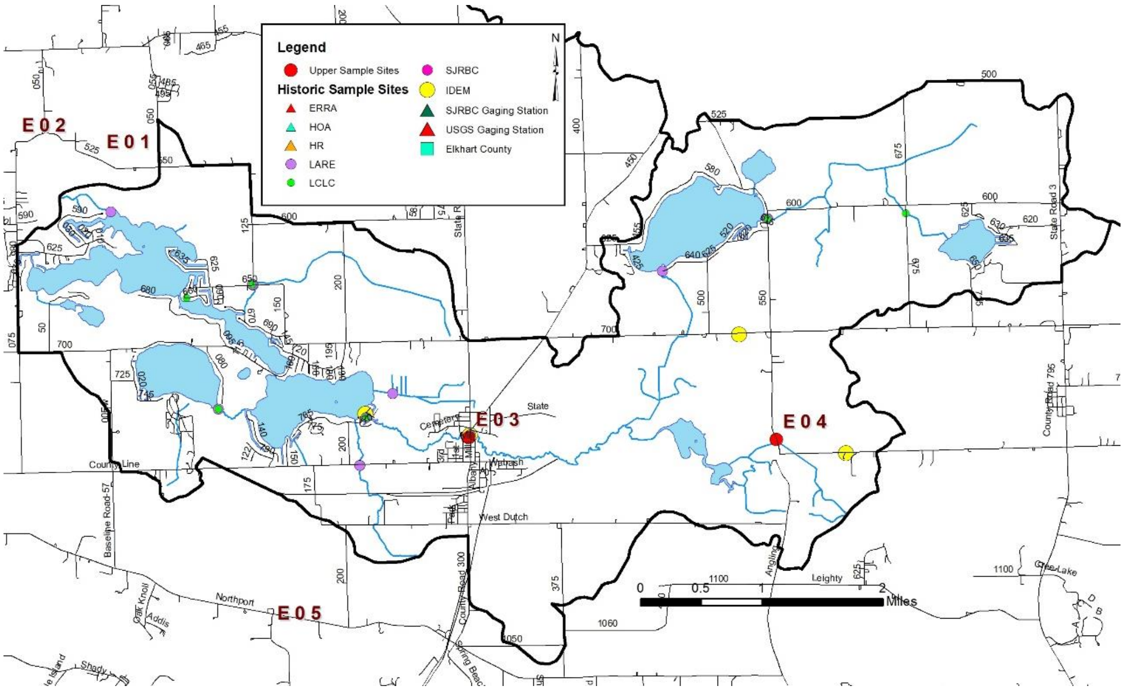


Figure 64. Locations of historic water quality data collection and impairments in the Dallas Lake-Little Elkhart Creek subwatershed.

Table 25 details historic water quality data. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm). E. coli samples exceed state grab sample standards (235 col/100 ml) in 100% of samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 7% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 13% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 54% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 67% of samples. Total suspended solids exceed water quality targets (15 mg/L) in 19% of samples.

Table 25. Dallas Lake-Little Elkhart Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	251	679	0	11	0%
Dissolved Oxygen	3.1	10.3	1	15	7%
E. coli	1,060	1,840	2	2	100%
Ammonia-Nitrogen	0.12	0.18	0	11	0%
Nitrate-Nitrogen	0.03	1.7	2	15	13%
Dissolved Phosphorus	0.02	1.14	9	17	53%
pH	7.3	8.3	0	26	0%
Total Kjeldahl Nitrogen	0.17	1.3	7	13	54%
Total Phosphorus	0.01	0.59	14	21	67%
Total Suspended Solids	0.2	29	3	16	19%

Table 26 details water quality data collected in the Dallas Lake-Little Elkhart Creek Subwatershed at North Branch Elkhart River downstream of Five Lakes stream (Site 3). As shown in the table, *E. coli* samples exceed state 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 phosphorus concentrations exceed water quality targets (0.08 mg/L) in 25% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 25% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 26. Dallas Lake-Little Elkhart Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (μmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
3	Min	3.90	6.48	7.66	317.10	0.20	0.70	0.05	0.40	3.00
	Median	12.01	8.66	8.44	468.45	1.60	3.06	0.05	8.60	88.20
	Max	23.68	11.52	8.71	734.90	7.60	4.72	0.15	14.00	727.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	3	11	3	0	4
	% Exceed	0%	0%	0%	0%	25%	92%	25%	0%	33%

The only biological data collected in the Dallas Lake-Little Elkhart Creek subwatershed occurred as part of the current project. The North Branch Elkhart River's macroinvertebrate community rated as not impaired, and the habitat rated as good.

4.3 Oliver Lake-Little Elkhart Creek subwatershed

The Oliver Lake-Little Elkhart Creek subwatershed is the northernmost subwatershed of the Upper Elkhart River Watershed and lies fully within LaGrange County (Figure 65). It encompasses one 12-digit HUC watershed: 040500011503. This subwatershed drains 10,126 acres (15.8 square miles) and accounts for 4% of the total watershed area. There are 31 miles of stream. IDEM has classified 3.79 miles of stream as impaired for PCBs in fish tissue and 1.33 miles of stream as impaired for impaired biotic communities. IDEM classified Oliver Lake as impaired for PCBs in fish tissue and Hackenburg and Messick Lakes as impaired for biological communities.

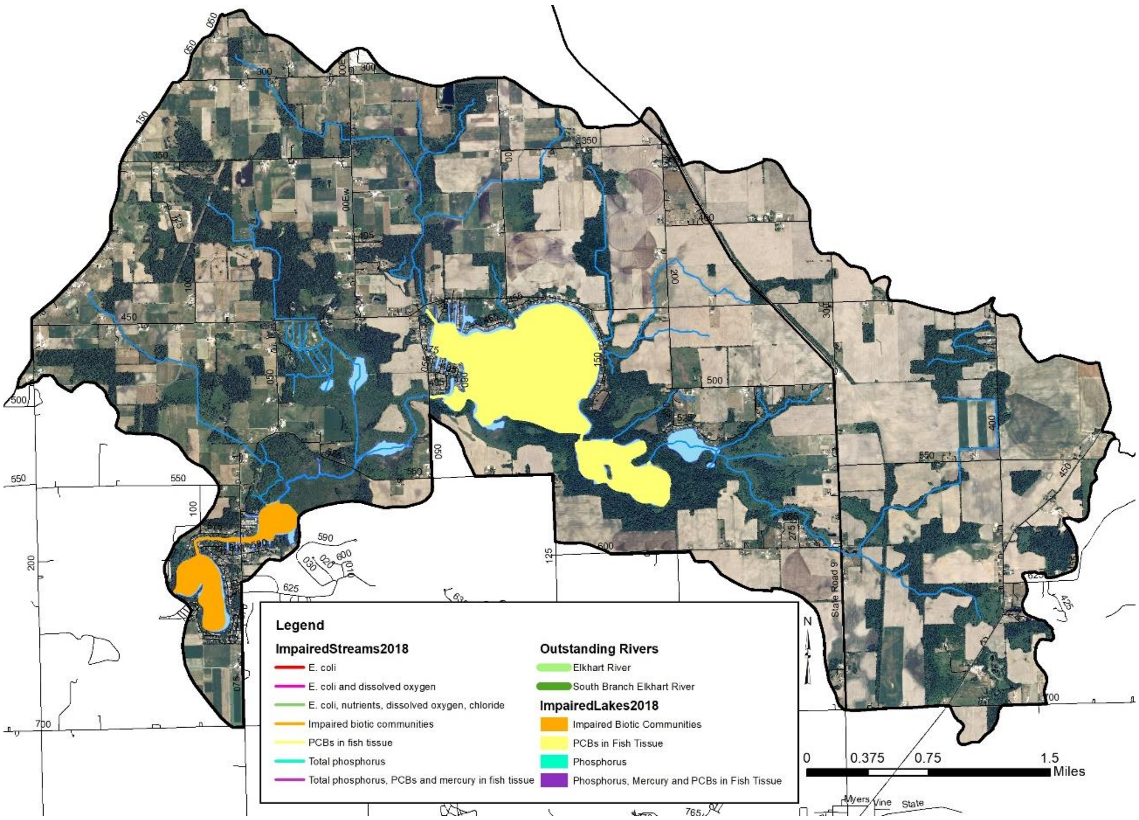


Figure 65. Oliver Lake-Little Elkhart Creek subwatershed.

4.3.1 Soils

Hydric soils cover 2,922.6 acres or 29% of the subwatershed; wetlands currently cover 31% (3,106.0 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils are prevalent throughout the subwatershed covering 5,268.7 acres or 52% of the subwatershed. A majority of the subwatershed, 84% (8,452.2 acres), has soils which are very limited for septic use. The majority of the Oliver Lake-Little Elkhart Creek Subwatershed is rural, indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.3.2 Land Use

Agricultural land use dominates the Oliver Lake-Little Elkhart Creek subwatershed with 61% (6,156.3 acres) mapped with row crop and pastureland. Wetlands, open water and grassland cover 3,106 acres, or 31% of the subwatershed. Urban land use is the next largest use of the subwatershed but only accounts for 6% (619.1 acres) of use. Forest land makes up just 3% (248.3 acres) of the subwatershed.

4.3.3 Point Source Water Quality Issues

There are few point sources of water pollution in the subwatershed (Figure 66). There are three underground storage tanks, two of which are designated as leaking underground storage tanks (LUST). There are no open dumps, brownfields, corrective action sites, voluntary remediation sites, NPDES-permitted facilities, or industrial waste facilities located within the Oliver Lake-Little Elkhart Creek subwatershed (Figure 66). It should be noted that the Lagrange County Regional Sewer District provides wastewater services for several lakes in the subwatershed.

4.3.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Oliver Lake-Little Elkhart Creek subwatershed. As a result, various small animal operations and pastures are also present (Figure 66). There are 77 unregulated animal operations housing more than 1,147 cows, horses and sheep which were identified during the windshield survey. Livestock do not have access to streams in the Oliver Lake-Little Elkhart Creek subwatershed based on observations during the windshield survey. Manure from small animal operations total over 21,692 tons per year, which contains almost 13,795 pounds of nitrogen, 6,833 pounds of phosphorus and 1.50E+15 col of E. coli. A lack of buffers and streambank erosion are not a concern within the subwatershed based on observations during the windshield survey (Figure 66).

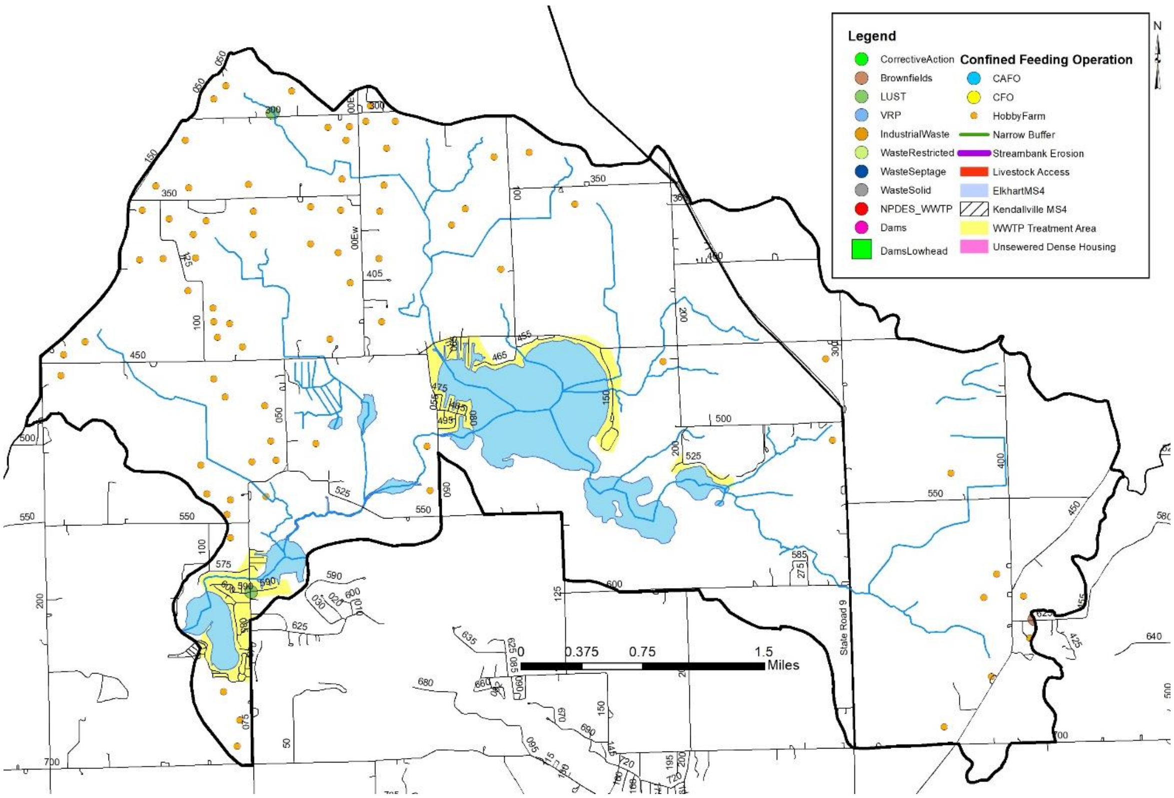


Figure 66. Potential point and non-point sources of pollution and suggested solutions in the Oliver Lake-Little Elkhart Creek subwatershed.

4.3.5 Water Quality Assessment

Waterbodies within the Oliver Lake-Little Elkhart Creek subwatershed have been sampled at 19 locations (Figure 67). Assessments include collection of water chemistry data as part of multiple LARE projects including the Ten Lakes Chain Feasibility Study (FXBrowne, 11 sites), by Tri State University (3 sites), the Five Lakes Feasibility Study (JFNew, 2 sites), the Oliver Lakes Chain Diagnostic Study (JFNew, 4 sites) and through recent HOA-funded, storm-event focused sampling. Two IDEM sampling locations are shown on the map; however, data are not available for these sites. Additionally, biological monitoring occurred at two sites as part of the LARE-funded Oliver Lakes Chain Diagnostic Study. Two sites in the Oliver Lake-Little Elkhart Creek subwatershed is being sampled as part of the current project (shown as Upper Sample sites). No stream gages are located in the Oliver Lake-Little Elkhart Creek subwatershed.

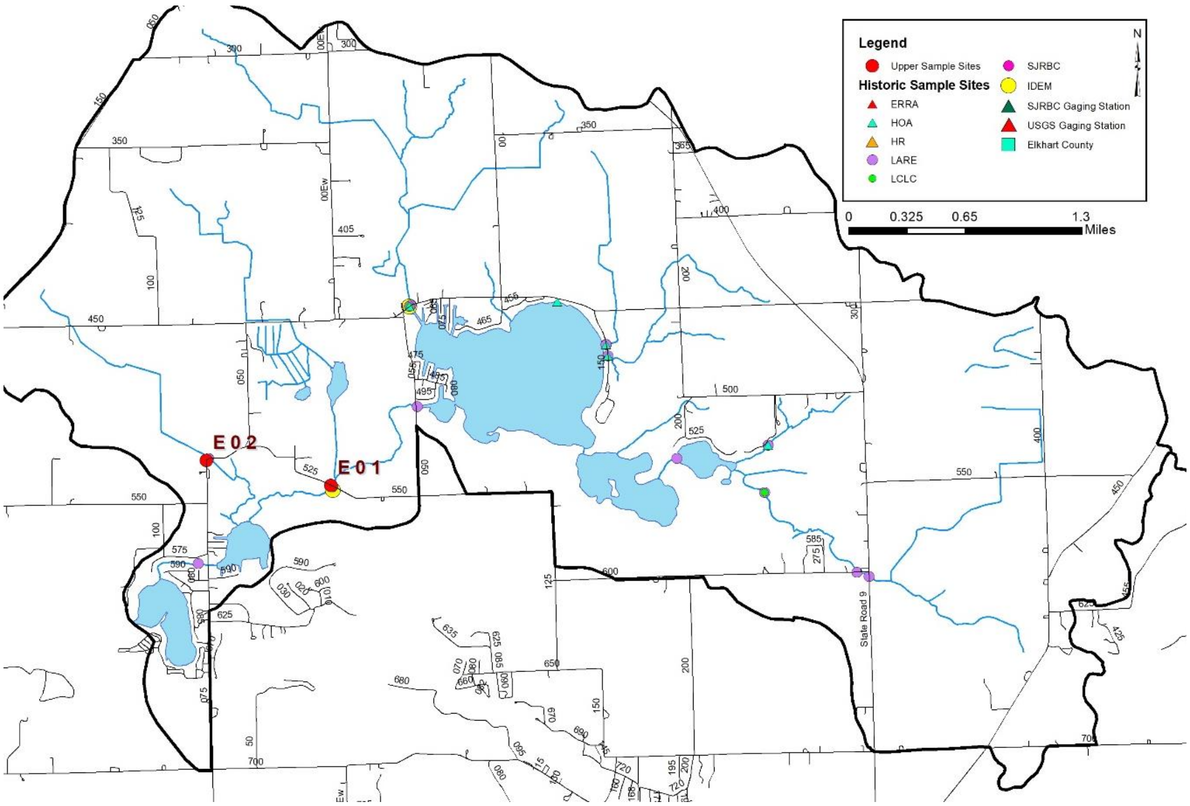


Figure 67. Locations of historic and current water quality data collection in the Oliver Lake-Little Elkhart Creek subwatershed.

Table 27 details historic water chemistry data collected in the Oliver Lake-Little Elkhart Creek subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm). Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 8% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 80% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 48% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 42% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 66% of samples. Total suspended solids 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.

Table 27. Oliver Lake-Little Elkhart Creek Subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	402	756	0	16	0%
Dissolved Oxygen	2.9	10	1	12	8%
E. coli	64	10,100	8	10	80%
Ammonia-Nitrogen	0.03	0.35	2	16	13%
Nitrate-Nitrogen	0.01	8.81	10	21	48%
Dissolved Phosphorus	0.01	0.32	10	24	42%
pH	7.2	8.3	0	22	0%
Total Kjeldahl Nitrogen	0.05	1.7	8	18	42%
Total Phosphorus	0.01	0.7	19	29	66%
Total Suspended Solids	0	560	4	23	17%
Turbidity	2.5	16	2	6	33%

Table 28 details water quality data collected in the Oliver Lake-Little Elkhart Creek Subwatershed (Site 1 and 2). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 0% of samples collected in Site 1 and 58% in Site 2. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples in Site 1 and Site 2. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% of samples in Site 1 and 83% of samples in Site 2. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples in Site 1 and 75% of samples in Site 2. Turbidity levels exceed water quality targets (5.7 NTU) in 0% of samples in Site 1 and 33% of samples in Site 2. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from Site 1. Dissolved oxygen concentrations exceed water quality standards in 33% of samples collected from Site 2.

Table 28. Oliver Lake-Little Elkhart Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
1	Min	2.38	4.15	7.41	404.70	0.50	1.22	0.05	0.00	1.00
	Median	12.09	8.28	8.47	451.65	1.30	2.45	0.05	6.80	34.50
	Max	23.83	11.62	8.77	478.00	5.70	4.83	0.31	42.40	127.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	0	12	1	2	0
	% Exceed	0%	0%	0%	0%	0%	100%	8%	17%	0%
2	Min	4.10	0.22	7.46	420.90	1.20	1.80	0.05	3.60	6.00
	Median	11.39	7.63	8.29	642.15	4.50	3.36	0.61	80.80	487.50
	Max	22.01	12.24	8.73	773.00	14.90	6.11	1.61	292.00	2420.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		4	0	0	4	12	10	9	7
	% Exceed	0%	33%	0%	0%	33%	100%	83%	75%	58%

JFNew assessed the biological community at 2 sites for macroinvertebrates and habitat. One site was assessed as part of the current project. Habitat scores ranged from 22 to 66 with 67% of sites scoring below the state target (51). Macroinvertebrate assessments rated moderately to severely impaired using the kick sampling method with 100% of sites not meeting their aquatic life use designation and rated as impaired using the multihabitat method with 100% of sites not meeting their aquatic life use designation (Table 29).

Table 29. Oliver Lake-Little Elkhart Creek subwatershed historic and current biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	22	66	2	3	67%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	2.0	4.4	2	2	100%
Macroinvertebrates (mIBI, Multi Habitat)	22	22	1	1	100%

4.4 Waterhouse Ditch-Henderson Lake Ditch subwatershed

The Waterhouse Ditch-Henderson Lake Ditch subwatershed forms a portion of the eastern boundary of the Upper Elkhart River Watershed and lies fully within Noble County (Figure 68). It encompasses one 12-digit HUC watershed: 040500011504. This subwatershed drains 12,788 acres or 20 square miles, and accounts for 5% of the total watershed area. There are 22.3 miles of stream. IDEM has classified 0.3 miles of stream as impaired for PCBs in fish tissue. IDEM classifies Henderson Lake as impaired for PCBs in fish tissue.

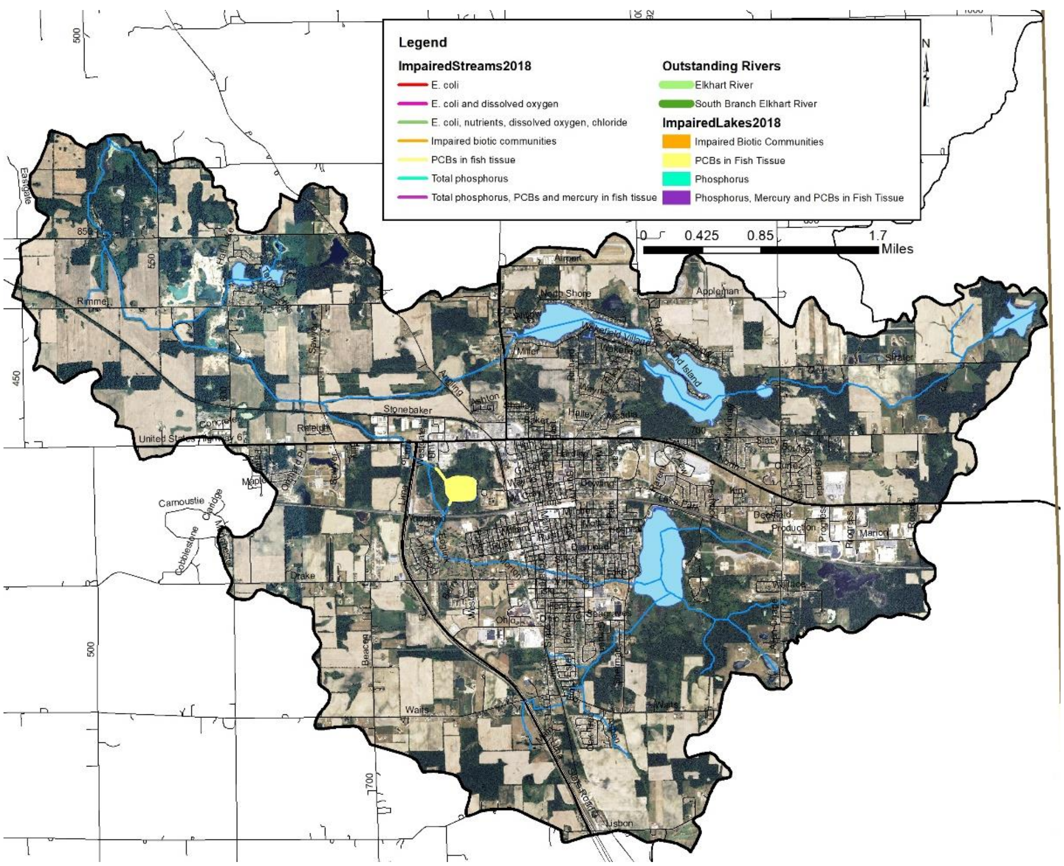


Figure 68. Waterhouse Ditch-Henderson Lake subwatershed.

4.4.1 Soils

Hydric soils cover 3,679.8 acres or 29% of the subwatershed; wetlands currently cover 23% (2,879.8 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils are prevalent throughout the subwatershed covering 7,524.2 acres or 59% of the subwatershed. A majority of the subwatershed, 92% (11,773.5 acres), has soils which are very limited for septic use. The majority of the Waterhouse Ditch-Henderson Lake Ditch subwatershed is also rural, indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.4.2 Land Use

Agricultural land use is the predominant land use of the Waterhouse Ditch-Henderson Lake Ditch subwatershed with 45% (5,767.7 acres) mapped as row crop and pastureland. Urban land use is the next largest use of the watershed covering 2,086.8 acres, or 16% of the subwatershed, with the City of Kendallville residing in the subwatershed. Wetlands, open water and grassland are the next largest use of the subwatershed accounting for 31% (3,952.7 acres) of use. Forest land makes up 8% (984.2 acres) of the subwatershed.

4.4.3 Point Source Water Quality Issues

There are 56 leaking underground storage tanks sites and one NPDES-permitted facility (Kendallville Wastewater Treatment Plant). The City of Kendallville is a regulated MS4 community. There are multiple instances in the last year of high flow events, as well as trends of unhealthy biomass dating to November 2021. There was also a spike in effluent TSS and ammonia levels in February of 2022 due to the screw press being inoperable for a period of time. Due to the Screw Press event, the plant biology could not fully convert all available nitrogen, and as a result, higher nitrate levels were present in the subsequent sample. No open dumps, brownfields, industrial waste facilities, solid waste facilities, superfund sites, corrective action sites or voluntary remediation sites are located within the Waterhouse Ditch-Henderson Lake Ditch subwatershed (Figure 69).

4.4.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Waterhouse Ditch-Henderson Lake Ditch subwatershed. Additionally, a number of small animal operations, pastures and one confined feeding operation are also present. In total, seven unregulated animal operations housing more than 87 horses, sheep and goats which were identified during the windshield survey. There is one active confined feeding operation located within the Waterhouse Ditch-Henderson Lake Ditch subwatershed, which is permitted to house 994 pigs. In total, manure from small animal operations and one CFO total over 4,297 tons per year, which contains almost 13,803 pounds of nitrogen, almost 9,965 pounds of phosphorus and 6.36E+14 colonies of E. coli. Based on windshield survey observations, livestock do not appear to have access to the subwatershed streams. Streambank erosion is a concern in the subwatershed. Approximately 1.8 miles (8%) of streambank erosion were identified within the subwatershed. Additionally, 1.6 miles (7%) of subwatershed streams were observed to have narrow buffers (Figure 69).

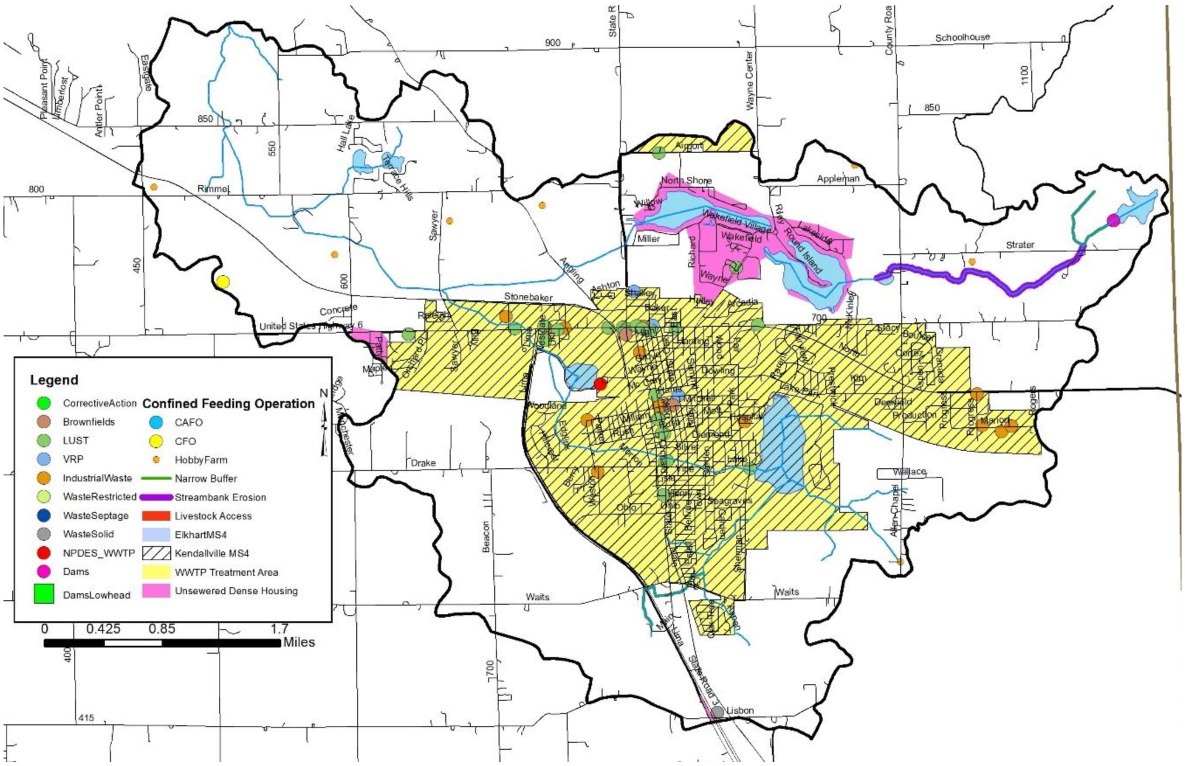


Figure 69. Potential point and non-point sources of pollution and suggested solutions in the Waterhouse Ditch-Henderson Lake Ditch subwatershed.

4.4.5 Water Quality Assessment

Waterbodies within the Waterhouse Ditch-Henderson Lake subwatershed have been sampled at 15 locations (Figure 70). Assessments include collection of water chemistry data by IDEM (7 sites), by the St. Joseph River Basin Commission (3 sites), as part of the LARE-funded Bixler Lake Feasibility Study (4 sites) and through an on-going project of the Sylvan Lake HOA, City of Kendallville and other partners (mapped as HOA). One site in the Waterhouse Ditch-Henderson Lake Ditch subwatershed is being sampled as part of the current project (shown us Upper sample sites). No USGS stream gages are located in the Waterhouse Ditch-Henderson Lake Ditch subwatershed; however, the Sylvan Lake Project is operating one stream gage and the SJRBC are operating one stream gage in the Waterhouse Ditch-Henderson Lake subwatershed.

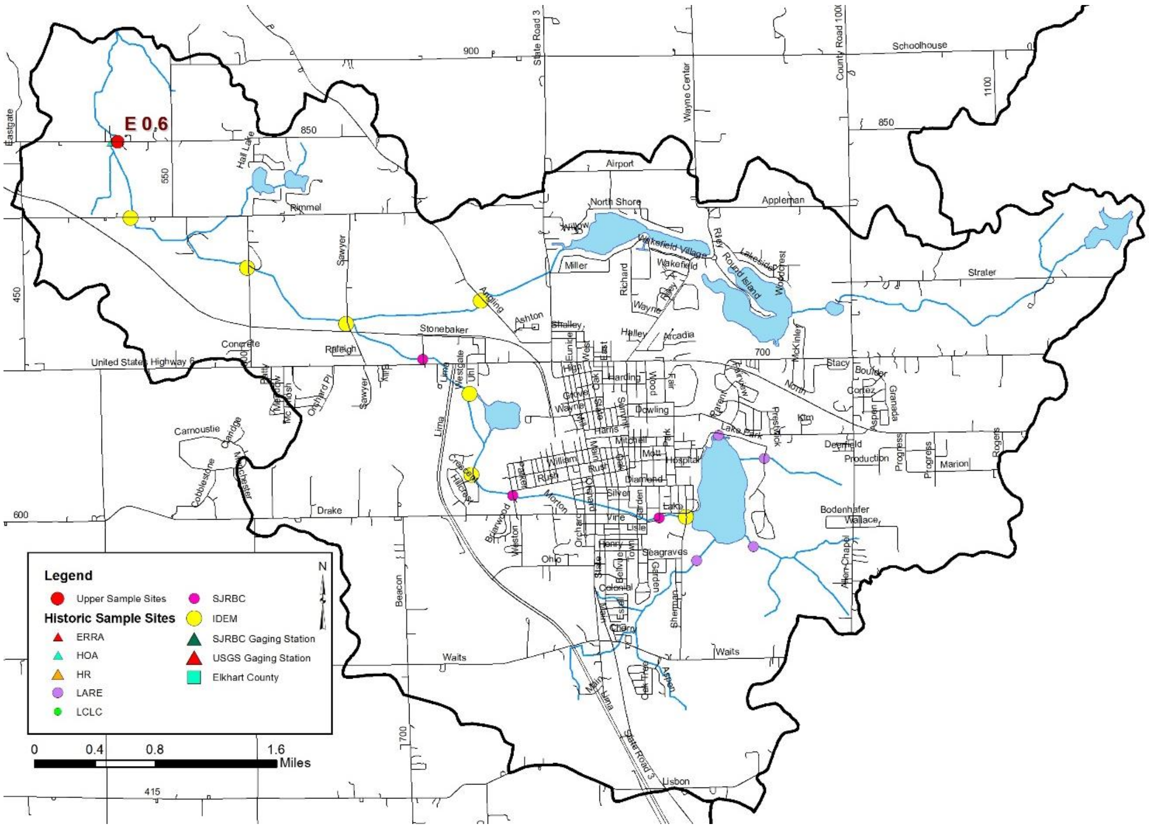


Figure 70. Locations of historic and current water quality data collection in the Waterhouse Ditch-Henderson Lake Ditch subwatershed.

Table 30 details data collected by IDEM, the SJRBC and via the IS&T. As shown in the table, conductivity samples exceed state standards (1050 µmhos/cm) in 14% of collected samples. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 10% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 6% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 60% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 80% of collected samples. Similarly, total suspended solids exceed water quality targets (15 mg/L) in 25% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 36% of samples.

Table 30. Waterhouse Ditch-Henderson Lake Ditch subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	425	1,356	5	36	14%
Dissolved Oxygen	2.1	17.4	6	59	10%
E. coli	0	500	2	36	6%
Ammonia-Nitrogen	0.02	0.35	1	4	25%
Nitrate-Nitrogen	0	9.7	24	40	60%
Dissolved Phosphorus	0.01	0.12	2	4	50%
pH	6.79	8.78	0	59	0%
Total Kjeldahl Nitrogen	1.1	1.78	4	4	100%
Total Phosphorus	0.04	0.77	32	40	80%
Total Suspended Solids	0.8	70.9	10	40	25%
Turbidity	0	45	13	36	36%

Table 31 details water quality data collected in the Waterhouse Ditch-Henderson Lake Subwatershed at North Branch d/s Sylvan Lake stream (Site 6). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 50% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 42% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 58% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 33% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 31. Waterhouse Ditch-Henderson Lake Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
6	Min	5.51	5.26	7.67	437.30	0.50	0.90	0.05	5.60	56.00
	Median	12.60	7.63	8.41	784.00	1.50	3.03	0.06	16.20	223.50
	Max	25.71	11.05	8.72	1074.00	33.60	6.10	0.56	103.20	2420.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	1	4	11	5	7	6
	% Exceed	0%	0%	0%	8%	33%	92%	42%	58%	50%

The only biological data collected in the Waterhouse Ditch-Henderson Lake Ditch subwatershed occurred as part of the current project. Henderson Lake Ditch's macroinvertebrate community rated as impaired and the habitat rated as poor.

4.5 Oviate Ditch-Middle Branch Elkhart River subwatershed

The Oviate Ditch-Middle Branch Elkhart River subwatershed lies fully within Noble County (Figure 71). It encompasses one 12-digit HUC watershed: 040500011505. This subwatershed drains 11,052 acres (17.3 square miles) and accounts for 4% of the total watershed area. There are 20.2 miles of stream. IDEM has classified 6.8 miles of stream as impaired for E. coli and DO and 5.14 miles of stream as impaired for PCBs in fish tissue.

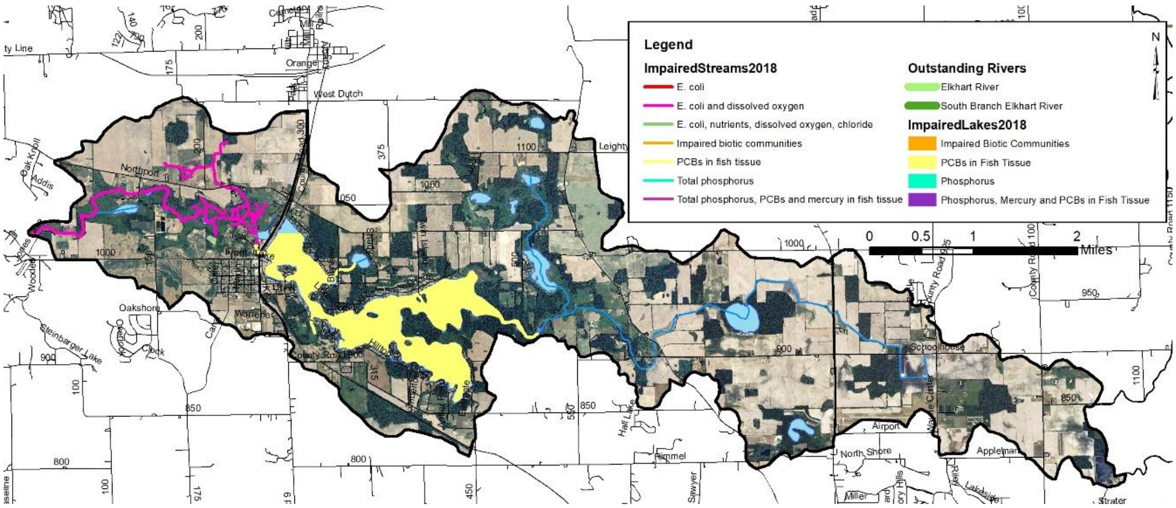


Figure 71. Oviate Ditch-Middle Branch Elkhart River subwatershed.

4.5.1 Soils

Hydric soils cover 2,538.5 acres (23%) of the subwatershed. Wetlands currently cover 32% (3,565.1 acres) of the subwatershed. Highly erodible soils cover just over half of the subwatershed at 54% (5,910.3 acres). A majority of the subwatershed soils (9,542 acres or 86%) are identified as very limited for septic use. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity.

4.5.2 Land Use

Agricultural land use covers over half of the Oviate Ditch-Middle Branch Elkhart River subwatershed with 55% (6,113.8 acres) of the subwatershed mapped in row crop and pastureland. In total, 494.9 acres or 5% of the subwatershed are in forested land uses. An additional 33% of the watershed (3,565.1 acres) is in wetlands, open water and grassland. Urban land uses cover 881.6 acres, or 8%, of the subwatershed.

4.5.3 Point Source Water Quality Issues

There are eight underground storage tanks, one of which is listed as a LUST site, and one NPDES-permitted facility (Rome City WWTP). In January of 2021, it was noted that the Adams Lake RSD's self-monitoring program was rated as unsatisfactory. At the time of the inspection, IDEM determined that a sample log was not being maintained. The Adams Lake RSD began to rectify the monitoring issue the following week and have not been cited since. There are no open dumps, brownfields, corrective action sites, voluntary remediation sites, industrial waste facilities or industrial waste facilities located within the Oviate Ditch-Middle Branch Elkhart River subwatershed (Figure 72).

4.5.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Oviate Ditch-Middle Branch Elkhart River subwatershed. There is one active concentrated animal feeding operation located within the Waterhouse Ditch-Henderson Lake Ditch subwatershed, which is permitted to house 1,415 dairy cows. Additionally, a number of small animal operations and pastures are also present. In total, 16 unregulated animal operations housing more than 102 cows, horses and goats which were identified during the windshield survey. In total, manure from small animal operations and the CAFO total over 33,050 tons per year, which contains almost 15,767 pounds of nitrogen, 7,741 pounds of phosphorus and 9.32E+14 colonies of E. coli. Based on windshield survey observations, livestock do not appear to have access to the subwatershed streams. Streambank erosion is a concern in the subwatershed. Approximately 0.6 miles

(3%) of streambank erosion were identified within the subwatershed. Additionally, 0.6 miles (3%) of the subwatershed streams were found to have narrow buffers (Figure 72).

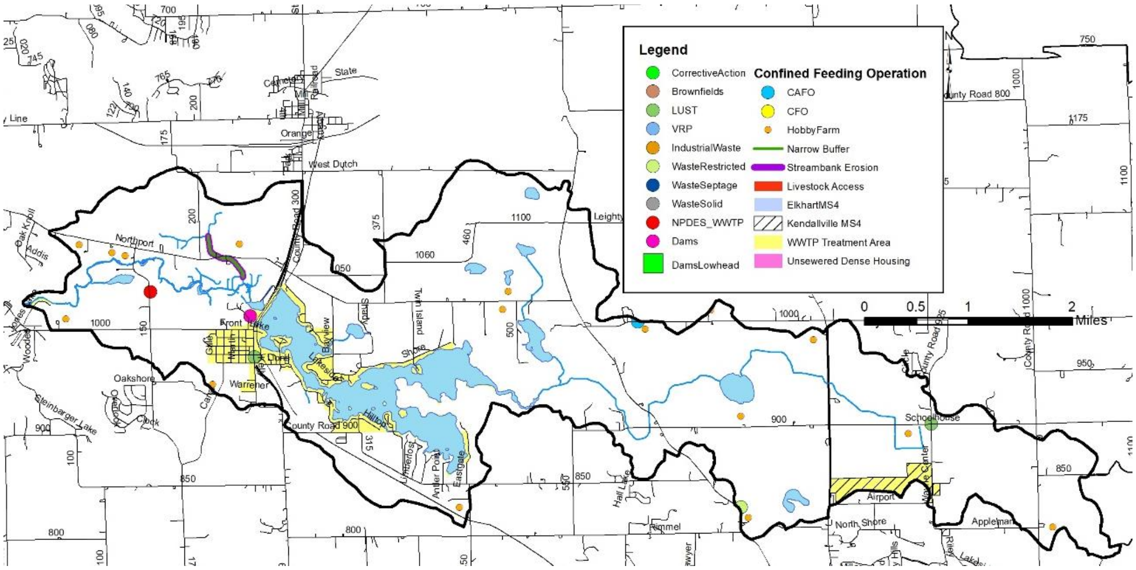


Figure 72. Potential point and non-point sources of pollution and suggested solutions in the Oviate Ditch-Middle Branch Elkhart River subwatershed.

4.5.5 Water Quality Assessment

Waterbodies within the Oviate Ditch-Middle Branch Elkhart River subwatershed have been sampled at four locations (Figure 73). Assessments include collection of water chemistry data by IDEM (4 sites) and one site, which is being monitored by the Sylvan Lake HOA-City of Kendallville project. One site in the Oviate Ditch-Middle Branch Elkhart River subwatershed is being sampled as part of the current project (shown as Upper Sample sites). One USGS stream gage and one gage collecting data for the Sylvan Lake Project is located at the Sylvan Lake outlet.

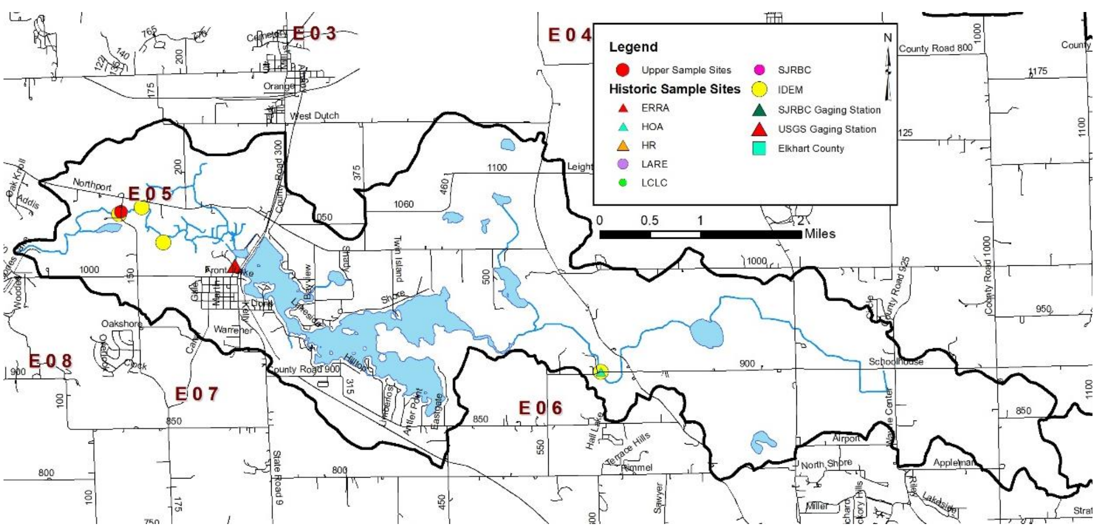


Figure 73. Locations of historic and current water quality data collection in the Oviate Ditch-Middle Branch Elkhart River subwatershed.

Table 32 details historic water chemistry data collected in the Oviate Ditch-Middle Branch Elkhart River subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm). Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 26% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 60% of samples collected. Nitrate-nitrogen concentrations do not exceed water quality targets (1 mg/L). Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 33% of samples. Total suspended solids do not exceed water quality targets (15 mg/L), while turbidity levels exceed water quality targets (5.7 NTU) in 30% of samples.

Table 32. Oviate Ditch-Middle Branch Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	390	641	0	11	0%
Dissolved Oxygen	2.3	12.6	6	23	26%
E. coli	186	396.8	3	5	60%
Ammonia-Nitrogen	0.1	0.2	0	3	0%
Nitrate-Nitrogen	BDL	0.3	0	3	0%
pH	7.21	8.1	0	23	0%
Total Kjeldahl Nitrogen	1.1	1.4	3	3	100%
Total Phosphorus	0.06	0.09	1	3	33%
Total Suspended Solids	BDL	10	0	3	0%
Turbidity	1	7.3	3	10	30%

BDL = Below Detection Limit

Table 33 details water quality data collected in the Oviate Ditch-MB Elkhart Creek Subwatershed at Little Elkhart Creek stream (Site 5). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 0% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 83% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 0% 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 8% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 33. Oviate Ditch-Middle Branch Elkhart Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
5	Min	4.20	4.48	7.69	496.00	0.10	0.10	0.05	2.80	11.00
	Median	12.81	6.60	8.41	571.10	1.20	2.10	0.05	7.80	51.50
	Max	24.30	10.64	8.75	621.60	7.10	4.58	0.07	41.20	181.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	1	10	0	3	0
	% Exceed	0%	0%	0%	0%	8%	83%	0%	25%	0%

IDEM assessed the biological community at one site including one habitat assessment, one fish community assessment and two macroinvertebrate community assessments. One site was assessed as part of the current project. Habitat scored 43 with 100% of sites scoring below the state target (51). The fish community assessment rated excellent with 100% of assessments meeting the state aquatic life use designation. Macroinvertebrate assessments scored 30 to 34 during all assessments with 100% of multihabitat sites not meeting their aquatic life use designation (Table 34).

Table 34. Oviate Ditch-Middle Branch Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	43	43	2	2	100%
Fish (IBI)	57	57	0	1	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	30	34	3	3	100%

4.6 Jones Lake-North Branch Elkhart River subwatershed

The Jones Lake-North Branch Elkhart River subwatershed forms part of the northwest border of the Elkhart River watershed and sits in both Noble and LaGrange counties (Figure 74). It encompasses one 12-digit HUC watershed: 040500011506. This subwatershed drains 26,049 acres (40.7 square miles) and accounts for 10% of the total watershed area. There are 62.3 miles of stream. IDEM has classified 11.98 miles of stream as impaired for E. coli and 0.16 miles of stream as impaired for impaired biotic communities.

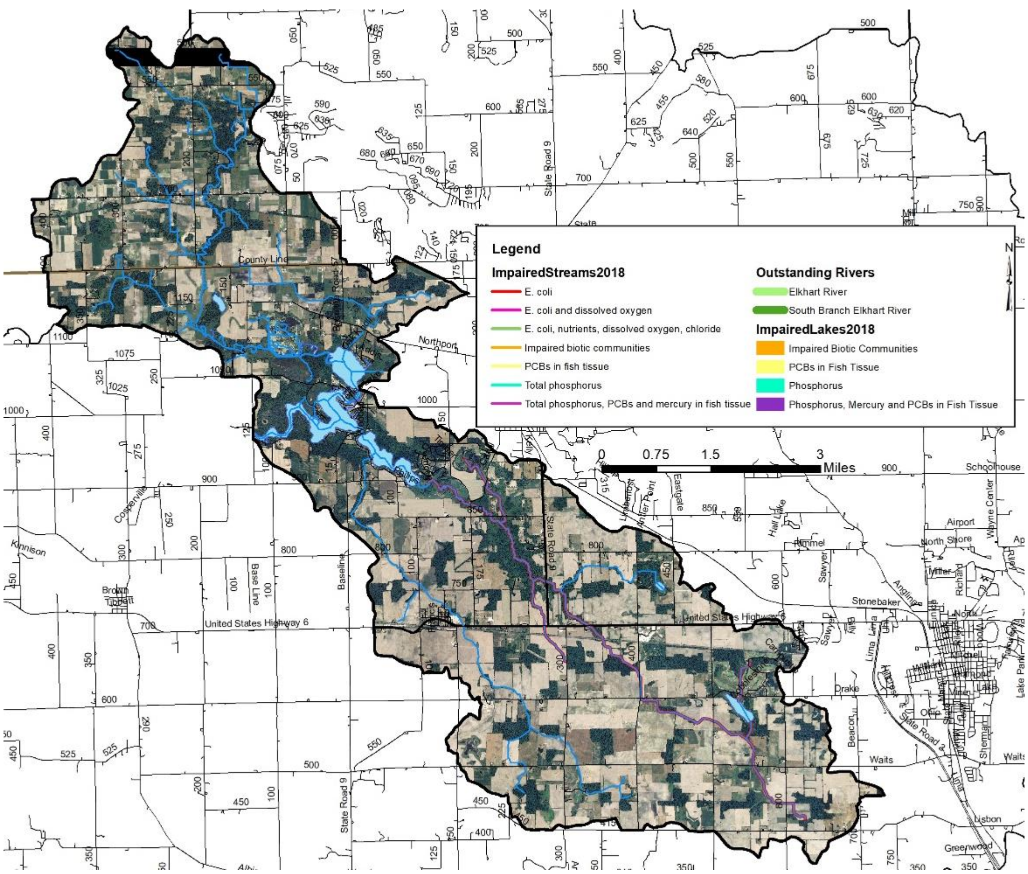


Figure 74. Jones Lake-North Branch Elkhart River subwatershed.

4.6.1 Soils

Hydric soils cover 8,574.3 acres or 33% of the subwatershed; wetlands currently cover 24% (6,181.6 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils are found in nearly half of the subwatershed covering 12,847.3 acres or 49%. A majority of the subwatershed, 94% (24,355.1 acres), has soils which are very limited for septic use. The majority of the Jones Lake-North Branch Elkhart River Subwatershed is also rural, indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.6.2 Land Use

Agricultural land use dominates the Jones Lake-North Branch Elkhart River subwatershed with 66% (17,110.1 acres) mapped in row crop and pasture and 24% (6,181.6 acres) in wetlands, open water and grassland. Urban land uses cover 1,606.9 acres, or 6%, of the subwatershed. In total, 1,160.1 acres or 5% of the subwatershed are in forested land uses.

4.6.3 Point Source Water Quality Issues

There are seven LUST sites located in the subwatershed (Figure 75). There are no open dumps, brownfields, corrective action sites, voluntary remediation sites, NPDES-permitted sites, industrial waste facilities, or industrial waste facilities located within the Jones Ditch-North Branch Elkhart River subwatershed (Figure 75).

4.6.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Jones Lake-North Branch Elkhart River subwatershed. There are four active CFOs and one active CAFOs located within the Jones Lake-North Branch Elkhart River subwatershed, which are permitted to house more than 75,962 cows, chickens, pigs and turkeys. Additionally, 90 unregulated animal operations housing more than 1,322 cows, horses, sheep and goats which were identified during the windshield survey. In total, manure from small animal operations and CFO/CAFOs total over 109,397 tons per year, which contains almost 1,761,761 pounds of nitrogen, almost 1,410,210 pounds of phosphorus and 1.21E+19 colonies of E. coli. Based on windshield survey observations, livestock do not have access to Jones Lake-North Branch Elkhart River subwatershed streams. Streambank erosion and lack of buffers is a concern in the subwatershed. Approximately 4.6 miles (7%) of streambank erosion and 3.1 miles (5%) of narrow buffers were identified within the subwatershed (Figure 75).

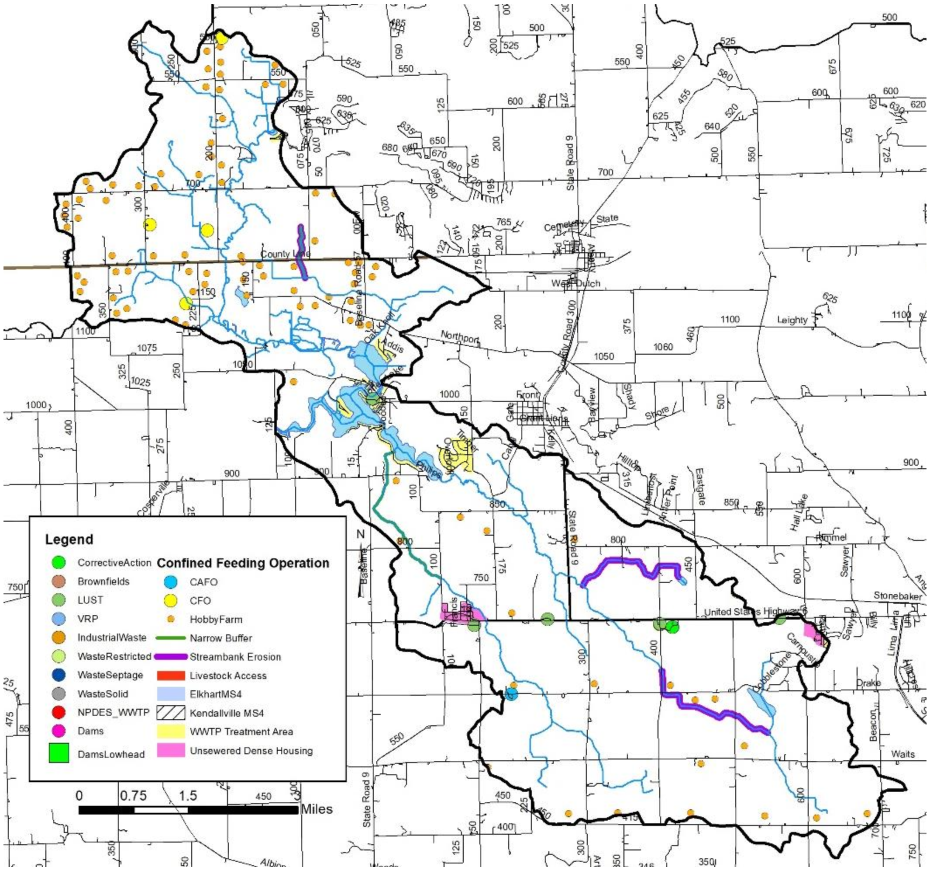


Figure 75. Potential point and non-point sources of pollution and suggested solutions in the Jones Lake-North Branch Elkhart River subwatershed.

4.6.5 Water Quality Assessment

Waterbodies within the Jones Lake-North Branch Elkhart River subwatershed have been sampled at 10 locations (Figure 76). Assessments include collection of water chemistry data by IDEM (8 sites) and the SJRBC (2 sites). Additionally, IDEM assessed one site for fish and macroinvertebrates (twice) and two sites for habitat. Three sites in the Jones Lake-North Branch Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). There are no USGS stream gages in the Jones Lake-North Branch Elkhart River subwatershed.

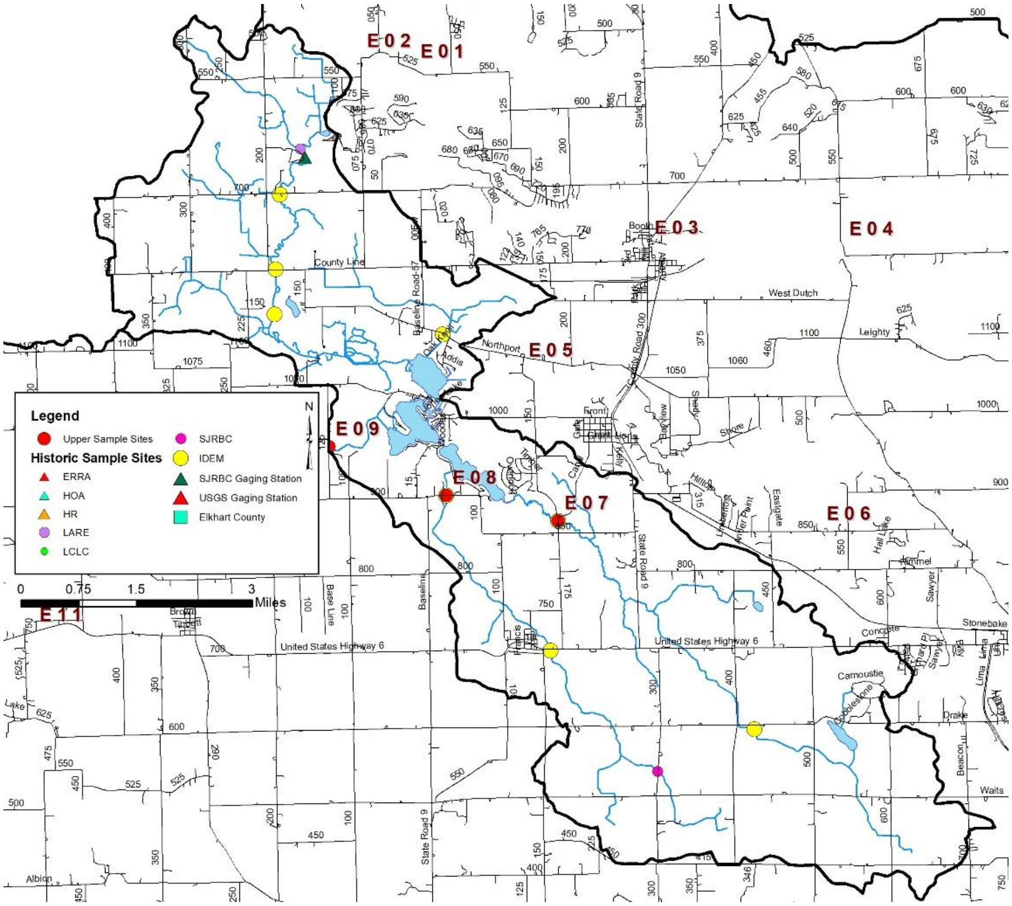


Figure 76. Locations of historic and current water quality data collection in the Jones Lake-North Brank Elkhart River subwatershed.

Table 35 details water chemistry data collected in the Jones Lake-North Branch Elkhart River subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm). Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 10% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 29% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 79% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 83% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 65% of samples. Total suspended solids exceed water quality targets (15 mg/L) in 15% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 28% of samples.

Table 35. Jones Lake-North Branch Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	300	869	0	34	0%
Dissolved Oxygen	2.44	12.8	5	48	10%
E. coli	BDL	8400	8	28	29%
Ammonia-Nitrogen	BDL	0.20	0	6	0%
Nitrate-Nitrogen	BDL	23	23	29	79%
pH	6.16	8.63	0	48	0%
Total Kjeldahl Nitrogen	BDL	2.6	5	6	83%
Total Phosphorus	BDL	0.86	17	26	65%
Total Suspended Solids	BDL	62	4	26	15%
Turbidity	0	65	9	32	28%

BDL = Below Detection Limit

Table 36 details water quality data collected in the Jones Lake-NB Elkhart River Subwatershed (Site 7, Site 8, Site 9). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 50% of samples collected in Site 7, 58% of samples collected in Site 8 and 0% of samples collected in Site 9. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples in Site 7 and Site 8 and in 83% of samples collected in Site 9. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 17% of samples collected in Site 7 and in 8% of samples collected in Site 8 and Site 9. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples collected in Site 7 and Site 8 and 25% of samples collected in Site 9. Turbidity levels exceed water quality targets (5.7 NTU) in 8% of samples collected in Site 7, 17% of samples collected in Site 8 and 33% of samples collected in Site 9. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from Site 7 and Site 8. Dissolved oxygen concentrations exceed water quality standards in 8% of samples collected from Site 9.

Table 36. Jones Lake-North Branch Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
7	Min	4.30	6.86	7.52	383.40	0.20	1.30	0.05	2.80	26.00
	Median	13.11	8.40	8.43	611.00	2.55	3.01	0.05	5.60	277.00
	Max	24.09	11.57	8.68	674.20	6.30	4.70	0.12	10.40	980.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	1	12	2	0	6
	% Exceed	0%	0%	0%	0%	8%	100%	17%	0%	50%
8	Min	6.20	5.12	7.52	414.40	0.50	1.80	0.05	1.20	4.00
	Median	12.25	8.07	8.53	694.10	2.35	3.41	0.05	3.60	483.00
	Max	23.70	11.97	8.74	756.20	10.40	6.60	0.21	12.00	1730.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	2	12	1	0	7
	% Exceed	0%	0%	0%	0%	17%	100%	8%	0%	58%
9	Min	4.31	3.55	7.84	326.90	0.40	0.20	0.05	4.40	1.00
	Median	12.19	9.44	8.47	496.20	3.15	1.70	0.05	11.60	6.00
	Max	25.64	11.04	8.81	552.00	14.60	4.43	0.09	31.60	193.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		1	0	0	4	10	1	3	0
	% Exceed	0%	8%	0%	0%	33%	83%	8%	25%	0%

IDEM assessed the biological community at two sites including two sites assessed for macroinvertebrates, one site assessed for fish and two sites assessed for habitat. Two sites were assessed as part of the current project. Habitat scores ranged from 49 to 67 with 50% of sites scoring below the state target (51). Fish community assessments rated good (50) with all assessments meeting the state aquatic life use designation. Macroinvertebrate assessments rated moderately impaired using the kick sampling method with all sites meeting their aquatic life use designation and from 30 to 56 with 75% of multihabitat samples not meeting their aquatic life use designation (Table 37).

Table 37. Jones Lake-North Branch Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	49	67	2	4	50%
Fish (IBI)	50	50	0	1	0%
Macroinvertebrates (mIBI, Kick)	4.6	4.6	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	30	56	3	4	75%

4.7 Huston Ditch-North Branch Elkhart River subwatershed

The Huston Ditch-North Branch Elkhart River subwatershed is very central to the watershed and forms the northern boundary of the Upper Elkhart River Watershed (Figure 77). It encompasses one 12-digit HUC watershed: 040500011507. This subwatershed drains 18,488 acres or 28.9 square miles and accounts for 7% of the total watershed area. There are 32.1 miles of stream. IDEM has classified 11.31 miles of stream impaired for E. coli.

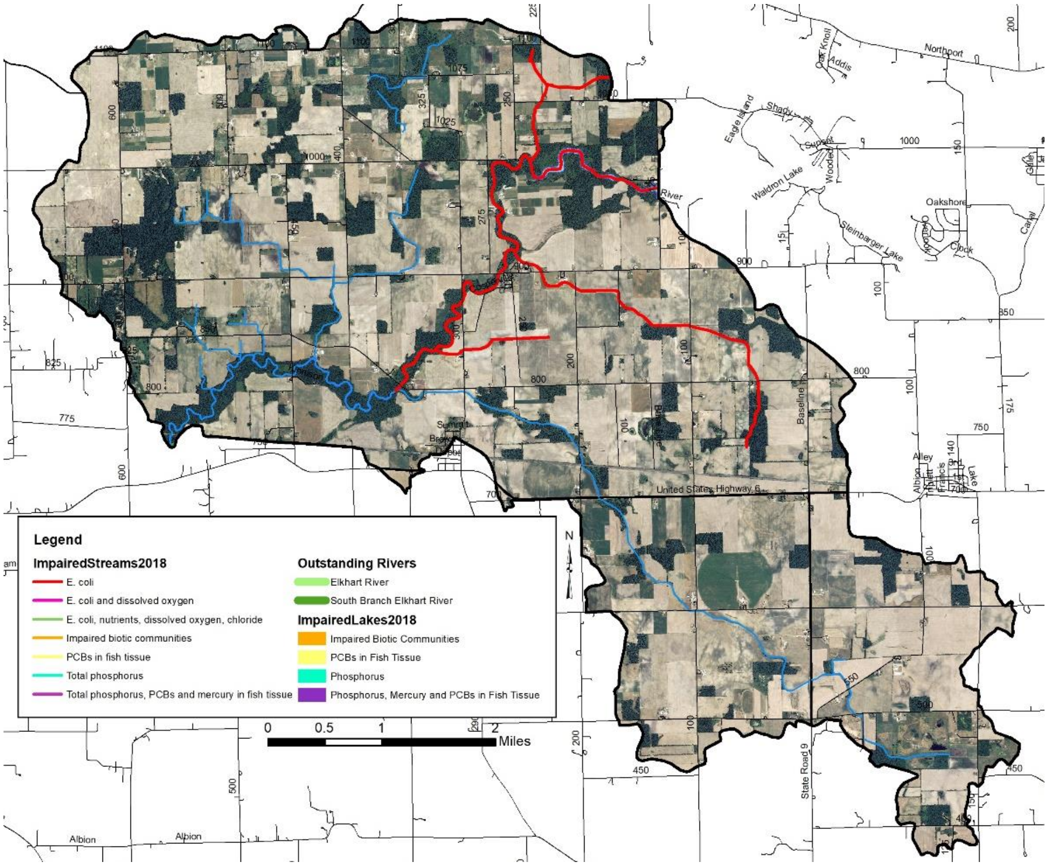


Figure 77. Huston Ditch-North Branch Elkhart River subwatershed.

4.7.1 Soils

Hydric soils cover 5,767.6 acres (31%) of the subwatershed. Wetlands currently cover 13% (2,400.8 acres) of the subwatershed. Highly erodible soils nearly cover 6,877.4 acres (37%) of the subwatershed. In total, 18,204.4 acres (99%) of the subwatershed are identified as very limited for septic use. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. 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 dominates the Huston Ditch-North Branch Elkhart River subwatershed with 79% (14,549.6 acres) mapped in row crop and pasture. An additional 13% (2,400.8 acres) in mapped as wetlands, open water and grassland. Urban land uses make up 857.8 acres, or 5%, of the subwatershed. Forested land uses cover just 686.8 acres or 4% of the subwatershed.

4.7.3 Point Source Water Quality Issues

There is one leaking underground storage tank site (Figure 78) and one NPDES-permitted facility in the subwatershed, the West Lakes RSD. There are no open dumps, brownfields, corrective action sites, voluntary remediation sites or industrial waste facilities located within the Huston Ditch-North Branch Elkhart River (Figure 78).

4.7.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Huston Ditch-North Branch Elkhart River subwatershed. There are six active CFOs and four active CAFOs which are permitted to house 41,847 cows, chickens, pigs, horses and sheep located within the Huston Ditch-North Branch Elkhart River subwatershed. Nearly 106 unregulated animal operations housing more than 4,821 cows, horses, goats and sheep which were identified during the windshield survey. Livestock have access to 0.6 miles (2%) of Huston Ditch-North Branch Elkhart River streams. In total, livestock located on small animal operations and the CFO/CAFOs produce more than 287,891 tons of manure per year, which contains almost 566,533 pounds of nitrogen, almost 410,845 pounds of phosphorus and 1.04E+16 colonies of E. coli. Streambank erosion is a concern in the subwatershed. Approximately 3.3 miles (10%) of streambank erosion and 11.4 miles (36%) of narrow buffers were identified within the subwatershed (Figure 78).

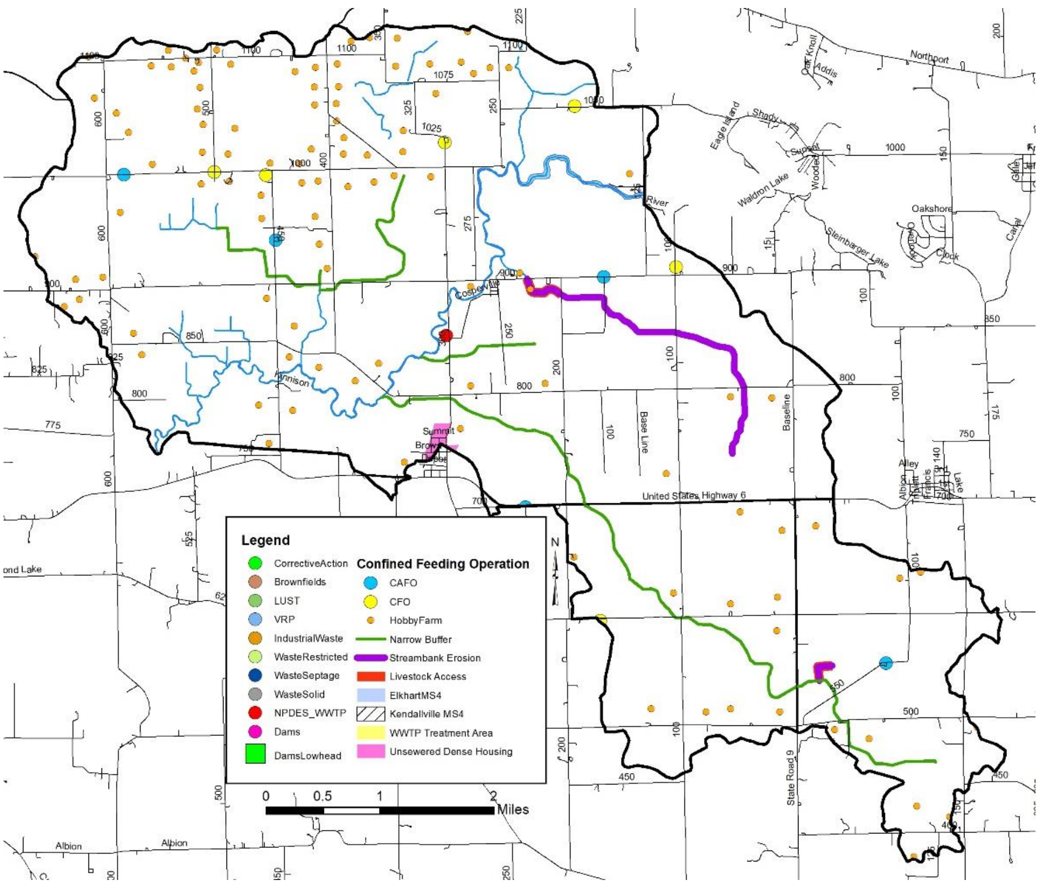


Figure 78. Potential point and non-point sources of pollution and suggested solutions in the Huston Ditch-North Branch Elkhart River subwatershed.

4.7.5 Water Quality Assessment

Waterbodies within the Huston Ditch-North Branch Elkhart River subwatershed have been sampled at eight locations (Figure 79). Assessments include collection of water chemistry data by IDEM (4 sites), by the SJRBC (3 sites) and as part of the 2008 ERRA Elkhart River WMP (1 site). Additionally, IDEM assessed the macroinvertebrate and fish communities and habitat at one site. One site in the Huston Ditch-North Branch Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are in the Huston Ditch-North Branch Elkhart River subwatershed.

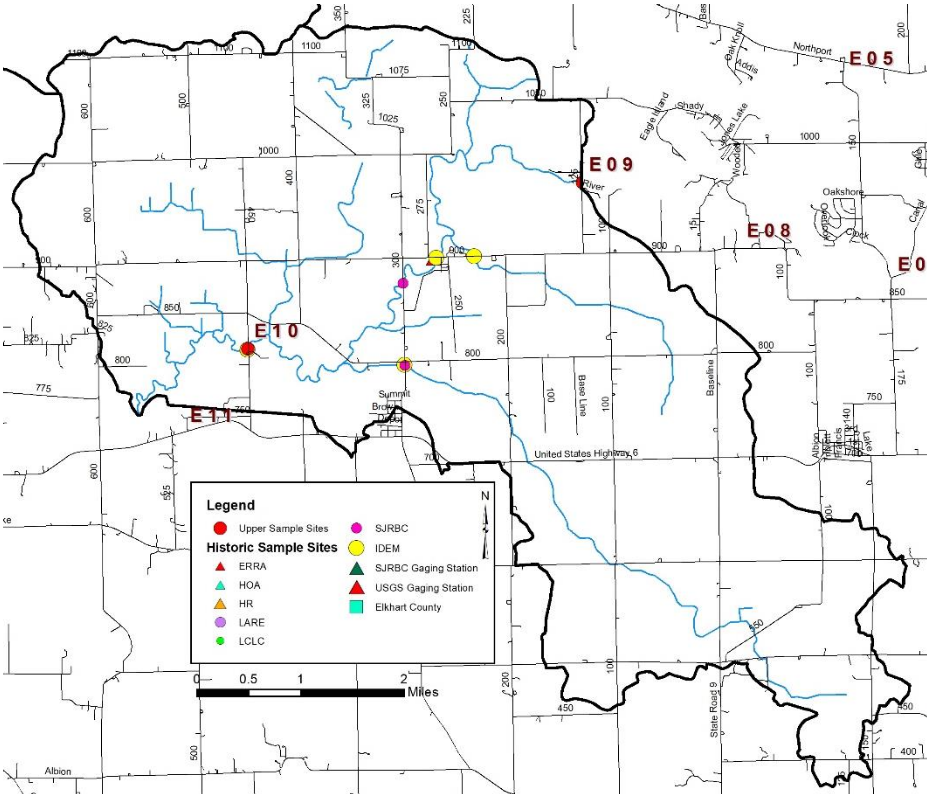


Figure 79. Locations of historic and current water quality data collection in the Huston Ditch-North Branch Elkhart River subwatershed.

Table 38 details water chemistry data collected in the Huston Ditch-North Branch Elkhart River subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm). Dissolved oxygen concentrations measure both above the upper state standard (12 mg/L) and below the lower state standards (4 mg/L) in 6% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 21% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 80% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 78 of samples. Total suspended solids exceed water quality targets (15 mg/L) in 30% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 43% of samples.

Table 38. Huston Ditch-North Branch Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	30	766	0	63	0%
Dissolved Oxygen	4.35	14.83	5	77	6%
E. coli	50	500	9	43	21%
Ammonia-Nitrogen	0.16	0.28	1	2	50%
Nitrate-Nitrogen	0.1	4.2	33	41	80%
pH	7.16	8.51	0	77	0%
Total Kjeldahl Nitrogen	1.2	1.4	3	3	100%
Total Phosphorus	0.04	0.54	32	41	78%
Total Suspended Solids	2	31	12	40	30%
Turbidity	1	31.39	26	61	43%

Table 39 details water quality data collected in the Huston Ditch-North Branch Elkhart River Subwatershed at North Branch Elkhart River stream (Site 10). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 42% of samples collected. Nitrate-nitrogen concentrations also exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 25% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 17% of samples, while turbidity levels also exceed water quality targets (5.7 NTU) in 17% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 39. Huston Ditch-North Branch Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
10	Min	3.42	5.04	7.50	408.40	0.70	1.42	0.05	3.20	17.00
	Median	12.87	8.37	8.47	529.10	2.05	2.44	0.05	7.40	209.00
	Max	23.89	11.54	8.85	741.00	14.30	4.40	0.19	44.40	1730.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	2	12	3	2	5
	% Exceed	0%	0%	0%	0%	17%	100%	25%	17%	42%

IDEM assessed the biological community at one site including two macroinvertebrate assessments, one fish assessment and one habitat assessment. V3 assessed the macroinvertebrate community and habitat at one site as part of the Elkhart River WMP. One site was assessed as part of the current project. Habitat scores ranged from 52 to 81 with 0% of sites scoring below the state target (51). Fish community assessments rated excellent with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments rated 2.8 to 4.8 using the kick sampling method and 30 to 46 using the multihabitat assessment with 50% of assessments meeting their aquatic life use designation (Table 40).

Table 40. Huston Ditch-North Branch Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	52	81	0	3	0%
Fish (IBI)	81	81	0	1	0%
Macroinvertebrates (mIBI, Kick)	2.8	4.8	0	2	0%
Macroinvertebrates (mIBI, Multi Habitat)	30	46	1	2	50%

4.8 Rivir Lake-Forker Creek subwatershed

The Rivir Lake-Forker Creek subwatershed forms the southeastern corner of the Upper Elkhart River Watershed and sits fully in Noble County (Figure 80). It encompasses one 12-digit HUC watershed: 040500011601. This subwatershed drains 11,960 acres or 18.7 square miles and accounts for 5% of the total watershed area. There are 25.6 miles of stream. IDEM has classified 0.46 miles of stream between Rivir and Mud lakes as impaired for PCBs in fish tissue. IDEM classified Mud, Sand, Dock and Long Lakes as impaired for phosphorus and Rivir Lake as impaired for phosphorus and mercury and PCBs in fish tissue.

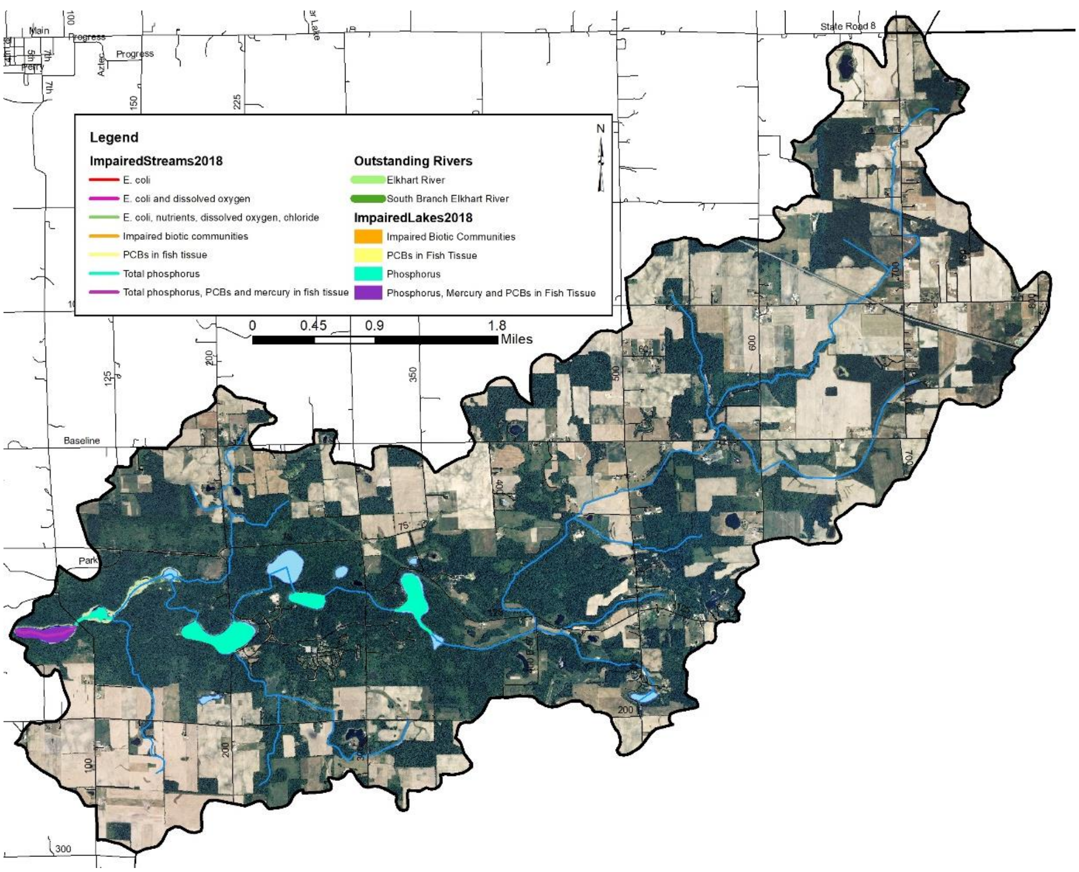


Figure 80. Rivir Lake-Forker Creek subwatershed.

4.8.1 Soils

Hydric soils cover 2,637.2 acres (22%) of the Rivir Lake-Forker Creek subwatershed. Wetlands currently cover 10% (1,188.3 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils cover over two-thirds of the subwatershed (69%). In total, 11,638.4 acres (97%) of the subwatershed are identified as very limited for septic use. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. 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.

4.8.2 Land Use

Agricultural land use makes up just over half of the Rivir Lake-Forker Creek subwatershed with 52% (6,162.2 acres) in agricultural land uses, including row crop and pasture. An additional 31% (3,739.2acres) of the subwatershed is in forested land use. Wetlands, open water and grassland cover 1,188.3 acres, or 10%, of the subwatershed. Urban land use accounts for 4% of the subwatershed as well (532.1 acres). Chain O'Lakes State Park is located in this subwatershed accounting for a portion of the natural land uses (wetlands, open water, forest).

4.8.3 Point Source Water Quality Issues

While there are only three point sources of water pollution in the subwatershed, the Chain O' Lakes State Park WWTP facility and two underground storage tanks.

4.8.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land uses in the Rivir Lake-Forker Creek subwatershed. A number of small animal operations and pastureland are also present (Figure 81). In total, 18 unregulated animal operations housing more than 242 cows, goats, horses and sheep which were identified during the windshield survey. No active confined feeding operations are located within the Rivir Lake-Forker Creek subwatershed. In total, manure from small animal operations total over 3,870 tons per year, which contains almost 2,604 pounds of nitrogen, almost 1,271 pounds of phosphorus and 3.67E+14 colonies of E. coli. Livestock appear to have access to 1 mile (4%) the subwatershed streams based on windshield survey observations. Approximately 2.9 miles (11.2%) of streambank erosion and 1.0 miles (4%) of livestock access were identified within the subwatershed (Figure 81).

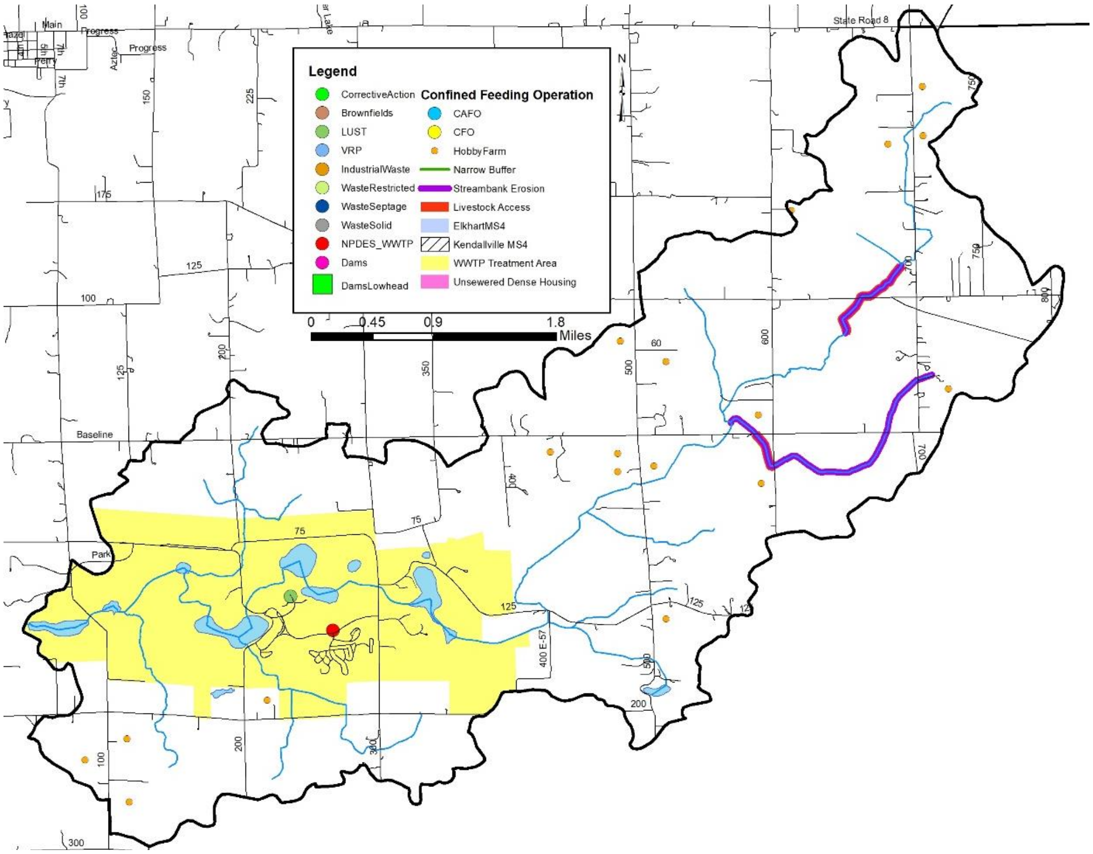


Figure 81. Potential point and non-point sources of pollution and suggested solutions in the Rivir Lake-Forker Creek subwatershed.

4.8.5 Water Quality Assessment

Waterbodies within the Rivir Lake-Forker Creek subwatershed have been sampled at four locations (Figure 82). Assessments include collection of water chemistry data by IDEM (one site), by SJRBC (one site) and at two sites as part of the LARE-funded Chain O'Lakes Diagnostic Study. One site in the Rivir Lake-Forker Creek subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are in the Rivir Lake-Forker Creek subwatershed.

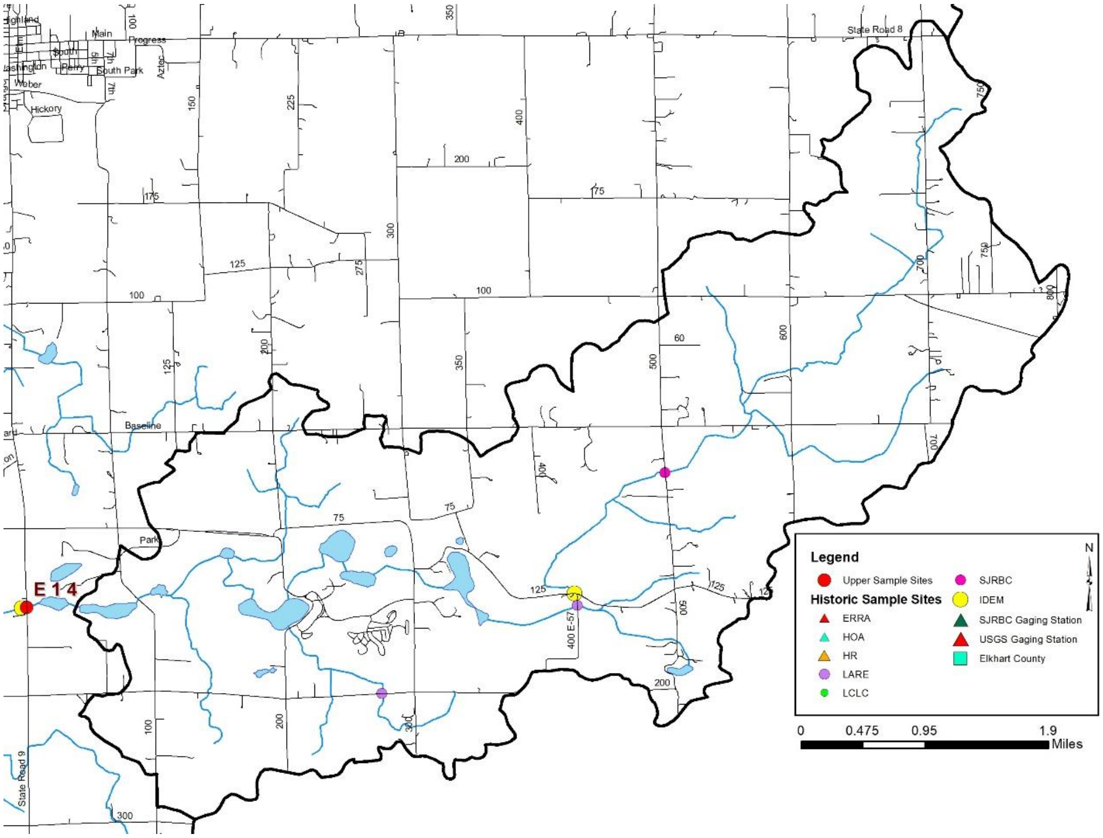


Figure 82. Locations of historic and current water quality data collection in the Rivir Lake-Forker Creek subwatershed.

Table 41 details water chemistry data. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 19% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 69% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 81% of samples. Total suspended solids exceed water quality targets (15 mg/L) in 25% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 33% of samples.

Table 41. Rivir Lake-Forker Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	300	660	0	17	0%
Dissolved Oxygen	5.9	11.59	0	19	0%
E. coli	0	4,080	3	16	19%
Nitrate-Nitrogen	0.5	5.8	11	16	69%
Dissolved Phosphorus	0.02	0.25	2	4	50%
pH	7.59	8.3	0	19	0%
Total Kjeldahl Nitrogen	1.36	4.2	4	4	100%
Total Phosphorus	0.06	0.91	13	16	81%
Total Suspended Solids	2	278	4	16	25%
Turbidity	1	57	4	12	33%

Table 42 details water quality data collected in the Rivir Lake-Forker Creek Subwatershed at Rivir Lake Tributary stream (Site 14). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 8% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 25% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 17% of samples. Dissolved oxygen concentrations exceed water quality standards in 25% of samples collected from this site.

Table 42. Rivir Lake-Forker Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
14	Min	5.16	2.02	7.51	417.70	0.50	1.11	0.05	1.20	10.00
	Median	12.94	8.13	8.37	458.25	1.30	2.72	0.05	4.20	77.50
	Max	24.01	11.45	8.78	540.00	12.90	12.20	0.14	9.60	579.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		3	0	0	2	12	3	0	1
	% Exceed	0%	25%	0%	0%	17%	100%	25%	0%	8%

IDEM assessed the biological community at one site twice including macroinvertebrate community and habitat assessments. Commonwealth Biomonitoring assessed macroinvertebrates and habitat at two sites as part of the Chain of Lakes diagnostic study. One site was assessed as part of the current project. Habitat scores ranged from 22 to 66 with 20% of sites scoring below the state target (51). Macroinvertebrate assessments rated moderately impaired using the kick sampling method with all sites meeting their aquatic life use designation and scoring 24 using the multihabitat samples with 100% of sites not meeting their aquatic life use designation (Table 43).

Table 43. Rivir Lake-Forker Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	22	66	1	5	20%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	3.3	4.0	0	4	0%
Macroinvertebrates (mIBI, Multi Habitat)	24	24	1	1	100%

4.9 Winebrenner Branch-Carrol Creek subwatershed

The Winebrenner Branch-Carrol Creek subwatershed forms the southernmost tip of the Upper Elkhart River Watershed and sits in Noble County (Figure 83). It encompasses one 12-digit HUC watershed: 040500011602. This subwatershed drains 11,799 acres (18.4 square miles) and accounts for 5% of the total watershed area. There are 24.2 miles of stream. IDEM classifies 6.23 miles of stream as impaired for E. coli.

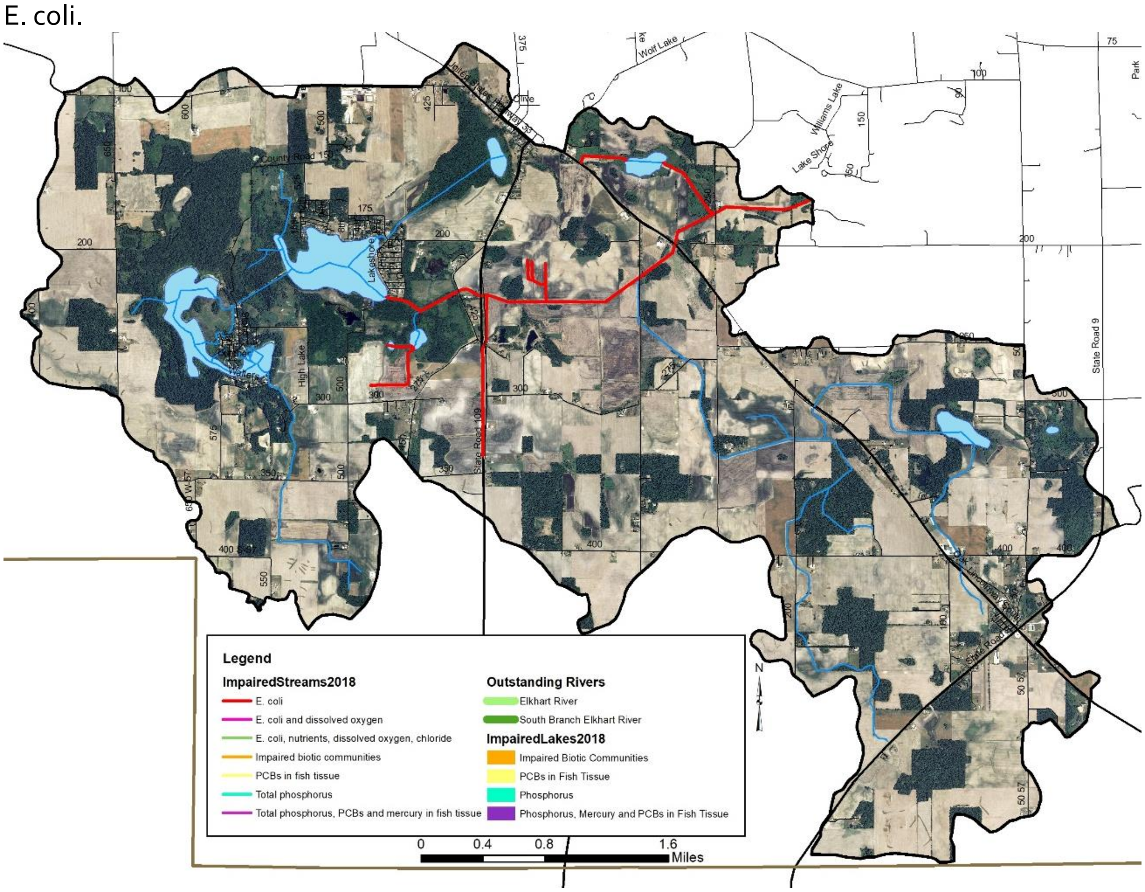


Figure 83. Winebrenner Branch-Carrol Creek subwatershed.

4.9.1 Soils

Hydric soils cover 4588.8 acres (39%) of the subwatershed. Wetlands currently cover 16% (1,870.2 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils cover 4,869.5 acres (41%) of the subwatershed. In total, 11,064.2 acres (94%) of the subwatershed are identified as very limited for septic use. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. 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.

4.9.2 Land Use

Agricultural land use dominates the Winebrenner Branch-Carrol Creek subwatershed with 68% (7,994.9 acres) in agricultural land uses, including row crop and pasture. An additional 16% (1,870.2 acres) of the subwatershed is mapped as wetlands, open water and grassland. Forest covers 1,192.3 acres, or 10%, of the subwatershed. Urban land use accounts for 6% of the subwatershed as well (746.6 acres).

4.9.3 Point Source Water Quality Issues

There are three leaking underground storage tank sites (Figure 84) and one NPDES-permitted facility in the subwatershed, the Bear-High-Wolf Lake RSD. There are no open dumps, brownfields, corrective action sites, voluntary remediation sites or industrial waste facilities located within the Winebrenner Branch-Carrol Creek subwatershed.

4.9.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Winebrenner Branch-Carrol Creek subwatershed. Additionally, a number of small animal operations and pastures are also present (Figure 84). In total, five unregulated animal operations housing more than 95 cows and horses which were identified during the windshield survey. No active confined feeding operations are located within the Winebrenner Branch-Carrol Creek subwatershed. In total, manure from small animal operations total over 2,068 tons per year, which contains almost 997 pounds of nitrogen, almost 491 pounds of phosphorus and 5.74E+13 colonies of E. coli. Livestock do not appear to have access to the subwatershed streams based on windshield survey observations. Lack of buffer is a concern in the subwatershed. Approximately 5.7 miles (24%) of narrow buffer were identified within the subwatershed (Figure 84).

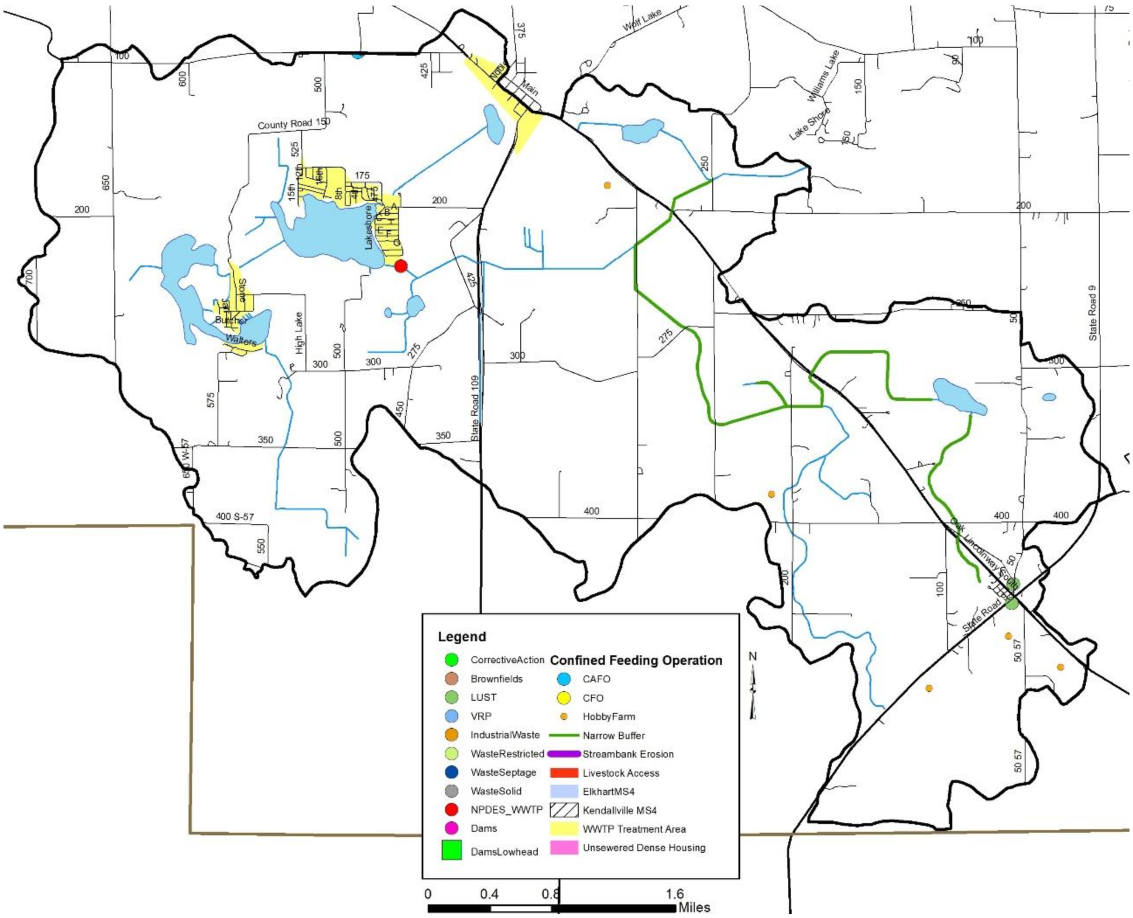


Figure 84. Potential point and non-point sources of pollution and suggested solutions in the Winebrenner Branch-Carrol Creek subwatershed.

4.9.5 Water Quality Assessment

Waterbodies within the Winebrenner Branch-Carrol Creek subwatershed have been sampled at four locations (Figure 85). Assessments include collection of water chemistry data by IDEM (3 sites) and by SJRBC (1 site). One site in the Winebrenner Branch-Carrol Creek subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are in the Winebrenner Branch-Carrol Creek subwatershed.

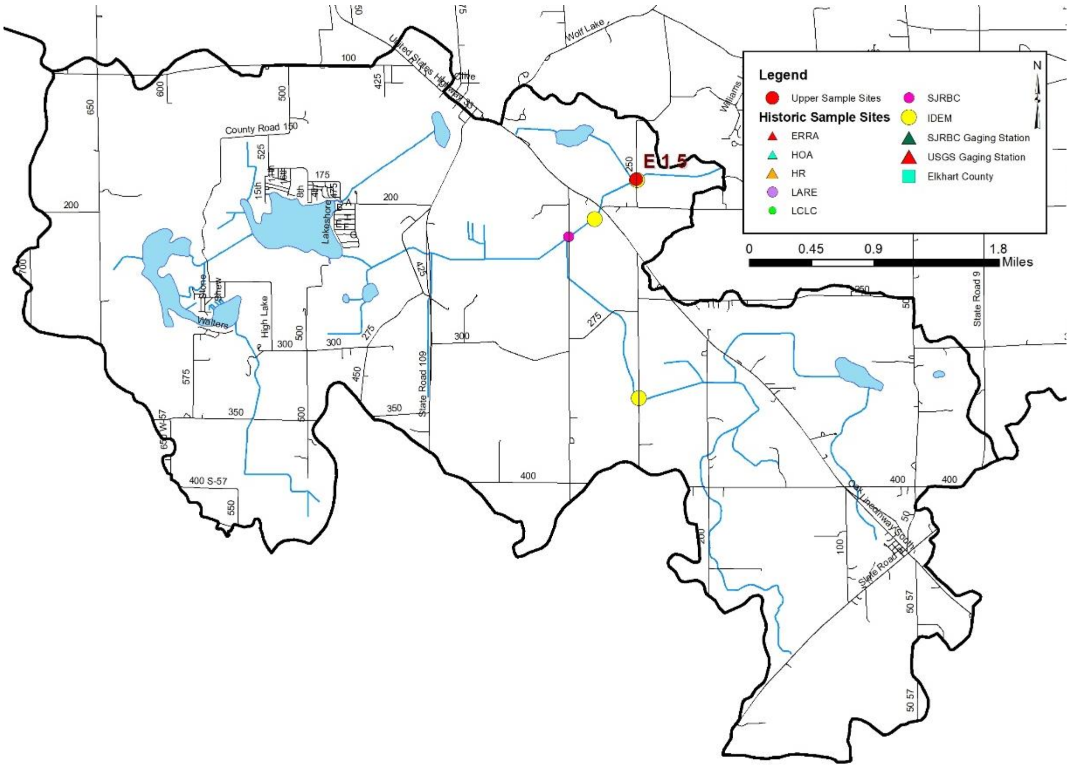


Figure 85. Locations of historic and current water quality data collection in the Winebrenner Branch-Carrol Creek subwatershed.

Table 44 details water chemistry data in the Winebrenner Branch-Carrol Creek subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 16% of samples collected. Dissolved oxygen measure higher than the upper (12 mg/L) or lower than the lower (4 mg/L) state standards in 11% of samples. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 81% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 33% collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 75% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 13% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 26% of samples.

Table 44. Winebrenner Branch-Carrol Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	30	766	0	75	0%
Dissolved Oxygen	2.47	14.83	10	89	11%
E. coli	50	500	9	55	16%
Ammonia-Nitrogen	BDL	0.24	1	3	33%
Nitrate-Nitrogen	0.1	13.4	13	16	81%
pH	7.22	8.64	0	32	0%
Total Kjeldahl Nitrogen	BDL	0.7	1	3	33%
Total Phosphorus	0.06	1.13	12	16	75%
Total Suspended Solids	BDL	73	2	16	13%
Turbidity	0	56	6	23	26%

BDL = Below Detection Limit

Table 45 details water quality data collected in the Winebrenner Branch-Carrol Creek Subwatershed at Carrol Creek stream (Site 15). As shown in the table, *E. coli* samples exceed state 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 phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% 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 17% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 45. Winebrenner Branch-Carrol Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
15	Min	4.13	4.57	7.17	418.50	0.70	0.30	0.05	0.80	11.00
	Median	12.92	9.19	8.26	668.20	1.20	3.57	0.05	6.20	138.50
	Max	21.03	20.78	8.62	802.00	18.70	4.90	0.13	26.40	866.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	2	11	1	1	4
	% Exceed	0%	0%	0%	0%	17%	92%	8%	8%	33%

IDEM assessed the biological community at three sites including three sites assessed for macroinvertebrates, one site assessed for fish and three sites assessed for habitat. One site was assessed as part of the current project. Habitat scores ranged from 24 to 31 with 100% of sites scoring below the state target (51). Fish community assessments rated poor with all assessments not meeting the aquatic life use designation. Macroinvertebrate assessments rated moderately impaired using the kick sampling method with all sites meeting their aquatic life use designation and scoring 32 to 34 using the multihabitat samples with 100% of sites not meeting their aquatic life use designation (Table 46).

Table 46. Winebrenner Branch-Carrol Creek Subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	24	31	4	4	100%
Fish (IBI)	33	33	1	1	100%
Macroinvertebrates (mIBI, Kick)	2.4	2.4	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	32	34	3	3	100%

4.10 Skinner Lake-Croft Ditch subwatershed

The Skinner Lake-Croft Ditch subwatershed is in the southern half of the watershed and forms a portion of the eastern border of the watershed. The Skinner Lake-Croft Ditch subwatershed lies entirely within Noble County (Figure 86). It encompasses one 12-digit HUC watershed: 040500011603. This subwatershed drains 15,890 acres or 24.8 square miles and accounts for 6% of the total watershed area. There are 25.3 miles of stream. IDEM has classified 17.1 miles of stream as impaired for E. coli.

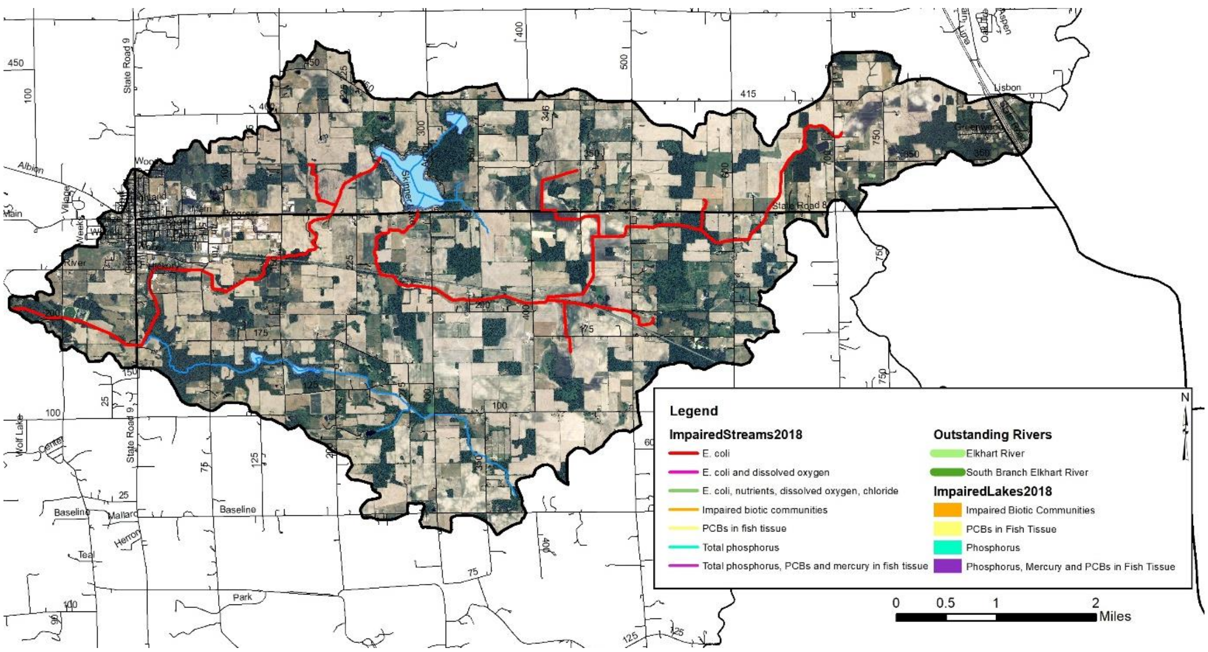


Figure 86. Skinner Lake-Croft Ditch subwatershed.

4.10.1 Soils

Hydric soils cover 4,736.6 acres or 30% of the subwatershed; wetlands currently cover 11% (1,784.2 acres) of the subwatershed. Highly erodible soils are found throughout the subwatershed covering 8,912.9 acres or 56% of the subwatershed. Nearly all of the subwatershed, 97% (15,464 acres), has soils which are very limited for septic use.

4.10.2 Land Use

Agricultural land use dominates the Skinner Lake-Croft Ditch subwatershed at 70% (11,169.2 acres) of the watershed mapped with row crops and pastureland. Wetlands, open water and grassland is the next largest use of the subwatershed, but only accounts for 11% (1,784.2 acres) of use. Forest land makes up just 10% (1,658.9 acres) of the subwatershed. Urban land uses cover just 1,282.8 acres, or 8%, of the subwatershed with the town of Albion residing in the subwatershed.

4.10.3 Point Source Water Quality Issues

There are 17 leaking underground storage tanks listed in this watershed and two NPDES-permitted facility: the Town of Albion and the Skinner Lake wastewater treatment plant. Over the course of the first quarter of 2022, the town's ammonia-nitrogen levels were higher than is allowed by their NPDES permit. There was also an instance of effluent limitation violation in January of 2022. No open dumps, superfund sites, corrective action sites or voluntary remediation sites are located within the Skinner Lake-Croft Ditch subwatershed (Figure 87).

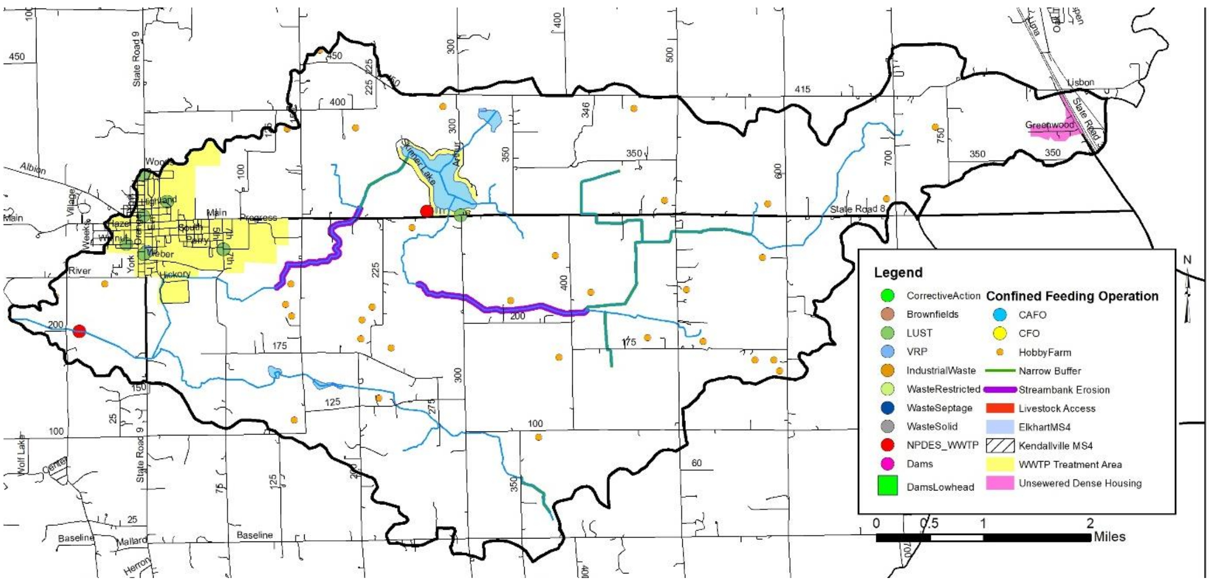


Figure 87. Potential point and non-point sources of pollution and suggested solutions in the Skinner Lake-Croft Ditch subwatershed.

4.10.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Skinner Lake-Croft Ditch subwatershed. As a result, various small animal operations and pastures are also present (Figure 87). There are 32 unregulated animal operations housing more than 514 cows, goats and horses which were identified during the windshield survey. Livestock do not have access to the Skinner Lake-Croft Ditch subwatershed streams based on observations during the windshield survey. There are no active CFOs in the subwatershed. In total, manure from small animal operations total over 10,163 tons per year, which contains almost 5,626 pounds of nitrogen, 2,960 pounds of phosphorus and 3.24E+14 colonies of E. coli. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 5.4 miles (21%) of insufficient stream buffers and 3.1 miles (12%) of streambank erosion were identified within the subwatershed (Figure 87).

4.10.5 Water Quality Assessment

Waterbodies within the Skinner Lake-Croft Ditch subwatershed have been sampled at 26 locations (Figure 88). Assessments include collection of water chemistry data by IDEM (10 sites), by the Skinner Lake HOA (4 sites), by the SJRBC (2 sites) and at 10 sites as part of the LARE-funded Skinner Lake Diagnostic Study. One site in the Skinner Lake-Croft Ditch subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Skinner Lake-Croft Ditch subwatershed.

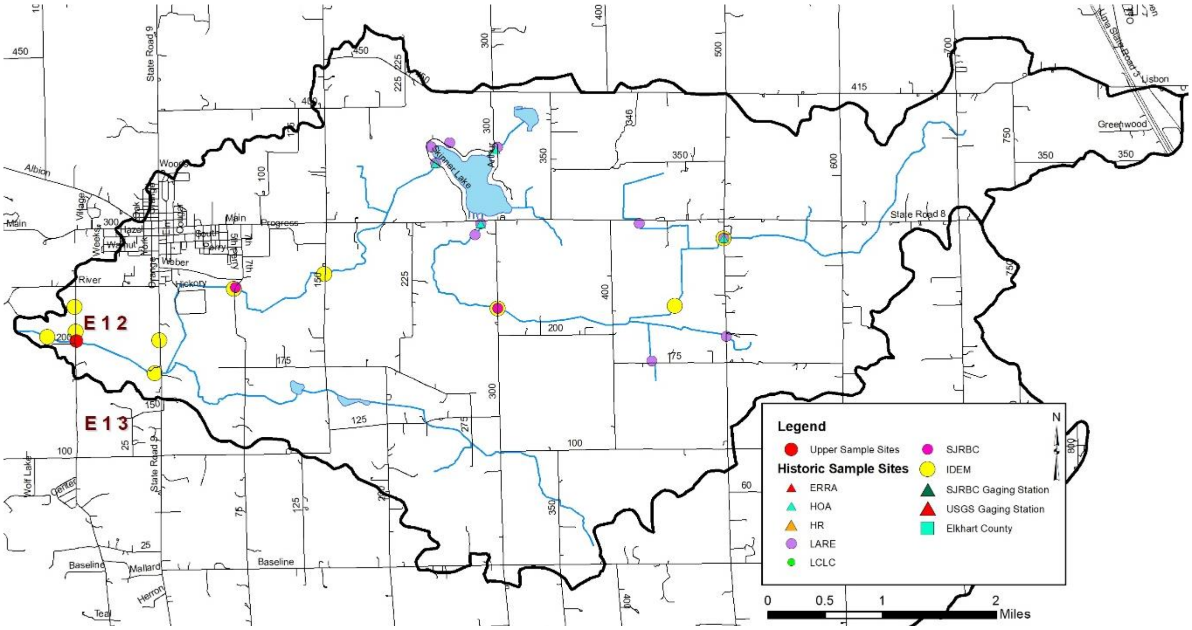


Figure 88. Locations of historic and current water quality data collection in the Skinner Lake-Croft Ditch subwatershed.

Table 47 details water chemistry data collected in the Skinner Lake-Croft Ditch subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. Dissolved oxygen concentrations measure above the upper (12 mg/L) or below the lower (4 mg/L) state standard in 18% of samples. E. coli samples exceed state grab sample standards (235 col/100 ml) in 59% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 76% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 92% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 84% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 36% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 60% of samples.

Table 47. Skinner Lake-Croft Ditch subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	226	893	0	64	0%
Dissolved Oxygen	2.84	14.33	15	84	18%
E. coli	BDL	8,100	34	58	59%
Ammonia-Nitrogen	0.01	0.75	1	26	4%
Nitrate-Nitrogen	BDL	14	41	54	76%
Dissolved Phosphorus	0.02	0.05	3	20	15%
pH	6.58	8.47	0	84	0%
Total Kjeldahl Nitrogen	0.5	40.9	24	26	92%
Total Phosphorus	0.05	1.7	42	50	84%
Total Suspended Solids	BDL	215	18	50	36%
Turbidity	1	190	37	62	60%

BDL = Below Detection Limit

Table 48 details water quality data collected in the Skinner Lake-Croft Ditch Subwatershed at Croft Ditch stream (Site 12). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 67% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 92% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 58% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 8% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 48. Skinner Lake-Croft Ditch Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
12	Min	5.57	6.21	7.38	419.40	0.30	0.40	0.05	2.80	26.00
	Median	13.27	8.17	8.41	640.55	1.80	2.85	0.12	5.60	413.00
	Max	20.69	10.92	8.84	851.00	26.10	11.40	0.26	12.80	1990.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	1	11	7	0	8
	% Exceed	0%	0%	0%	0%	8%	92%	58%	0%	67%

IDEM assessed the biological community at three sites, while Arion Consultants assessed the biological community at four sites. One site was assessed as part of the current project. Assessments included six sites assessed for macroinvertebrates (10 assessments), one site assessed for fish and six sites assessed for habitat (nine assessments). Habitat scores ranged from 32 to 60 with 90% of sites scoring below the state target (51). Fish community assessments rated fair with the only assessment meeting the aquatic life use designation. Macroinvertebrate assessments rated moderately impaired using the kick sampling method with all sites meeting their aquatic life use designation and scoring 28 to 42 using the multihabitat samples with 67% of sites not meeting their aquatic life use designation (Table 49).

Table 49. Skinner Lake-Croft Ditch subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	32	60	9	10	90%
Fish (IBI)	37	37	0	1	0%
Macroinvertebrates (mIBI, Kick)	2.3	4.4	0	7	0%
Macroinvertebrates (mIBI, Multi Habitat)	28	42	2	3	67%

4.11 <u>Muncie Lake-South Branch Elkhart River subwatershed</u>

The Muncie Lake-South Branch Elkhart River subwatershed is in the southern half of the watershed with a portion of it making up the eastern border of the watershed. The Muncie Lake-South Branch Elkhart River subwatershed lies entirely within Noble County (Figure 89). It encompasses one 12-digit HUC watershed: 040500011604. This subwatershed drains 10,527 acres or 16.4 square miles. The Muncie Lake-South Branch Elkhart River subwatershed accounts for 4% of the total watershed area. There are 25.3 miles of stream. IDEM has classified 2.59 miles as impaired for E. coli. In the Muncie Lake-South Branch Elkhart River subwatershed, 1.99 miles of the South Branch of the Elkhart River is designated as an outstanding river. IDEM classified Miller and Port Mitchell lakes as impaired for phosphorus.

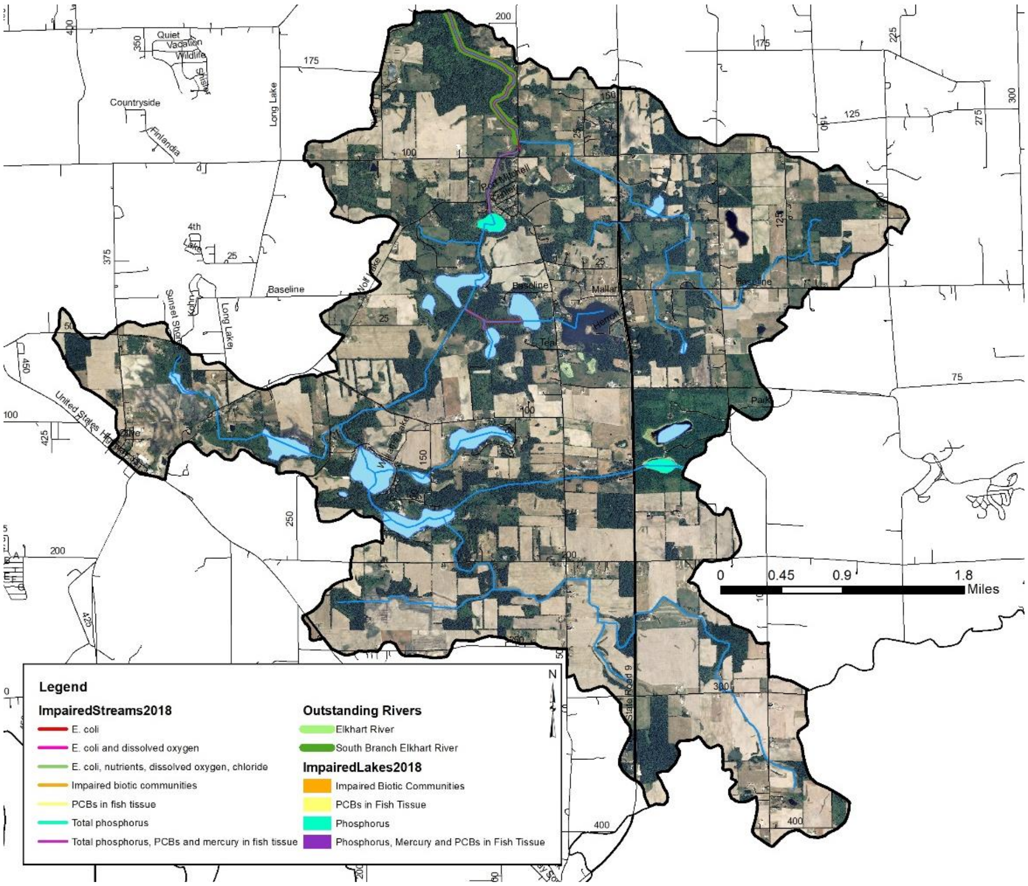


Figure 89. Muncie Lake-South Branch Elkhart River subwatershed.

4.11.1 Soils

Hydric soils cover 2,732.0 acres or 26% of the subwatershed. Wetlands currently cover 16% (1,639.6 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils cover just over two-thirds of the subwatershed (65%) or 6,822.9 acres. In total, 9,953.2 acres or 95% of the subwatershed is identified as very limited for septic use. The majority of the Muncie Lake-South Branch Elkhart River subwatershed is rural indicating many homes utilize on-site septic systems. Based on the soil septic suitability, maintenance and inspection of septic systems is important to ensure proper function and capacity.

4.11.2 Land Use

Agricultural land use dominates the Muncie Lake-South Branch Elkhart River subwatershed with 63% (6,595 acres) mapped in row crop and pastureland. Forested land use accounts for 16% (1,667 acres) of the subwatershed land use. Wetlands, open water and grassland also cover 16% (1,784.2 acres) of the subwatershed. Wetlands, open water, and grassland cover just 628.3 acres, or 6%, of the subwatershed.

4.11.3 Point Source Water Quality Issues

There is one potential source of water pollution in the subwatershed: one underground storage tank. No open dumps, superfund sites, corrective action sites, NPDES facilities or voluntary remediation sites are located within the Muncie Lake-South Branch Elkhart River subwatershed (Figure 90).

4.11.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Muncie Lake-South Branch Elkhart River subwatershed. Additionally, a number of small animal operations and pastures are also present. In total, 14 unregulated animal operations housing more than 110 cows and horses which were identified during the windshield survey (Figure 90). Based on windshield survey observations, livestock do not appear to have access to streams in the Muncie Lake-South Branch Elkhart River subwatershed. There are no active confined feeding operations in the subwatershed. Small animal operations produce more than 2,382 tons of manure annually which contains more than 1,163 pounds of nitrogen, 574 pounds of phosphorus and more than 6.48E+13 colonies of E. coli. Lack of buffer is also a concern in the subwatershed. Approximately 3.4 miles (14%) of narrow buffer were identified within the subwatershed (Figure 90).

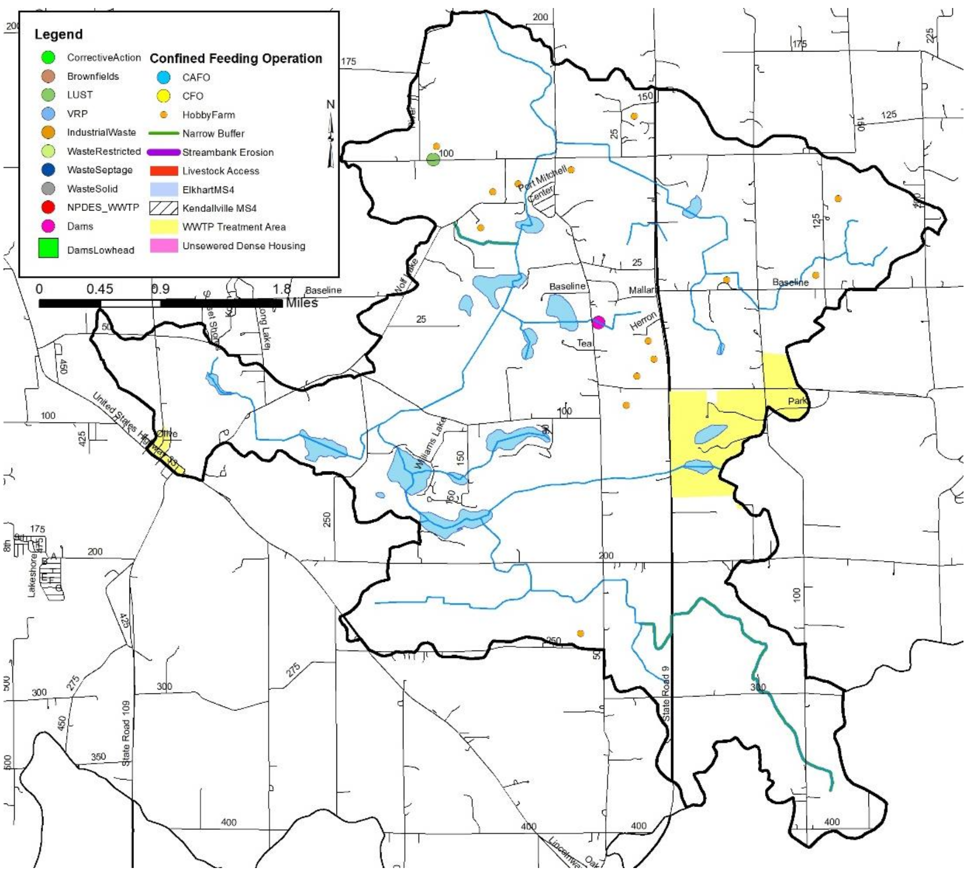


Figure 90. Potential point and non-point sources of pollution and suggested solutions in the Muncie Lake-South Branch Elkhart River subwatershed.

4.11.5 Water Quality Assessment

Waterbodies within the Muncie Lake-South Branch Elkhart River subwatershed have been sampled at 10 locations (Figure 91). Assessments include collection of water chemistry data by IDEM (6 sites) and the SJRBC (2 sites). One site in the Muncie Lake-South Branch Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are in the Muncie Lake-South Branch Elkhart River subwatershed.

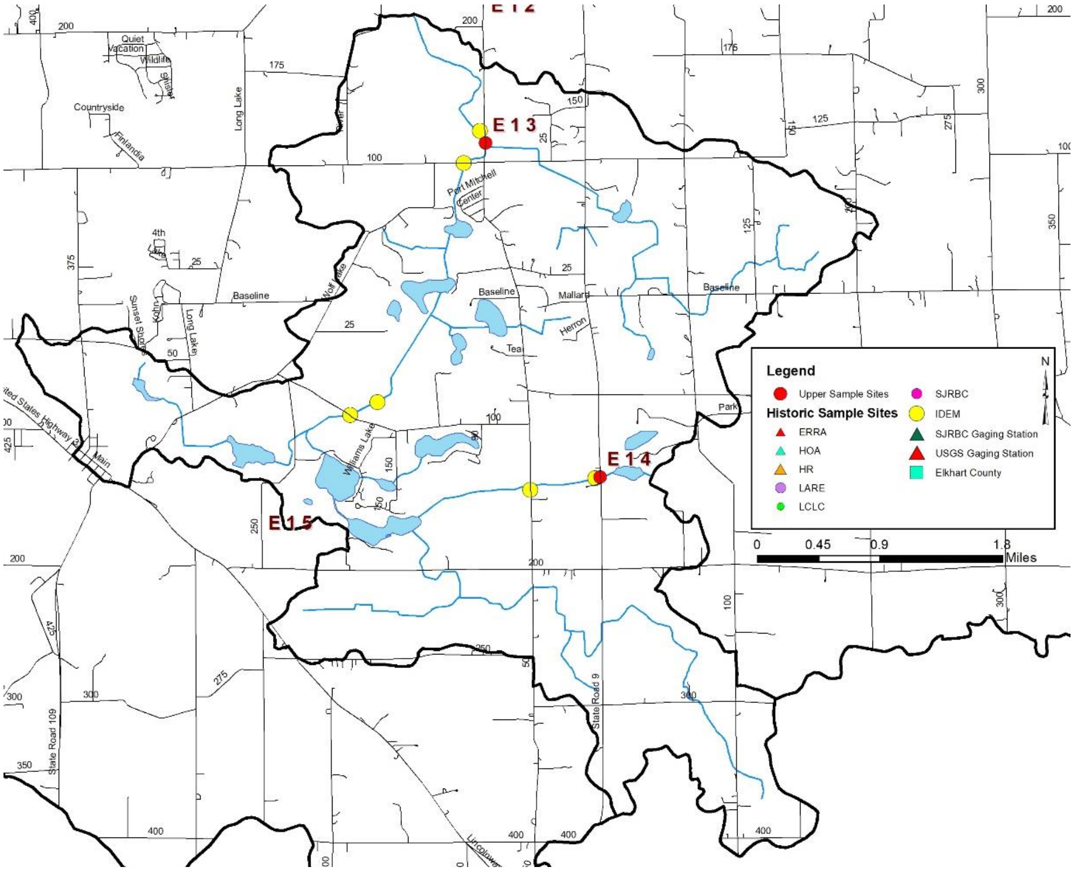


Figure 91. Locations of historic and current water quality data collection in the Muncie Lake-South Branch Elkhart River subwatershed.

Table 50 details water chemistry data collected in the Muncie Lake-South Branch Elkhart River subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 9% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 20% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 50% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 83% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 33% of samples. Total suspended solids samples exceed water quality targets (15 mg/L) in 17% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 80% of samples.

Table 50. Muncie Lake-South Branch Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	448	604	0	20	0%
Dissolved Oxygen	3.7	13.29	3	32	9%
E. coli	5.2	435.2	2	10	20%
Ammonia-Nitrogen	BDL	0.1	0	6	0%
Nitrate-Nitrogen	BDL	1.6	3	6	50%
pH	5.14	8.17	1	32	3%
Total Kjeldahl Nitrogen	BDL	1.4	5	6	83%
Total Phosphorus	BDL	0.12	2	6	33%
Total Suspended Solids	BDL	16	1	6	17%
Turbidity	3.34	29.1	16	20	80%

BDL = Below Detection Limit

Table 51 details water quality data collected in the Muncie Lake-SB Elkhart River Subwatershed at South Branch Elkhart River stream (Site 13). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 17% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 17% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 50% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 50% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 51. Muncie Lake-South Branch Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (μmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
13	Min	3.41	5.46	7.31	343.40	0.30	1.17	0.05	6.40	4.00
	Median	13.34	8.94	8.49	474.80	4.25	2.72	0.05	13.80	84.00
	Max	22.97	11.61	8.88	729.20	33.60	4.90	0.12	39.20	299.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	6	12	2	6	2
	% Exceed	0%	0%	0%	0%	50%	100%	17%	50%	17%

IDEM assessed the biological community at two sites with both sites assessed for fish and macroinvertebrate communities and habitat. One site was assessed as part of the current project. Habitat scores ranged from 41 to 69 with 67% of sites scoring below the state target (51). Fish community assessments rated fair to good with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments scored 34 to 40 using the multihabitat samples with 28% of sites not meeting their aquatic life use designation (Table 52).

Table 52. Muncie Lake-South Branch Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	41	69	2	3	67%
Fish (IBI)	45	48	0	3	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	34	40	2	7	28%

4.12 Diamond Lake-South Branch Elkhart River subwatershed

The Diamond Lake-South Branch Elkhart River subwatershed sits in the center of the Upper Elkhart River Watershed and lies entirely in Noble County (Figure 92). It encompasses one 12-digit HUC watershed: 040500011605. This subwatershed drains 22,904 acres or 35.8 square miles. The Diamond Lake-South Branch Elkhart River subwatershed accounts for 9% of the total watershed area. There are 50.5 miles of stream. IDEM has classified 25.81 miles as impaired for E. coli and 3.14 miles between Upper and Lower Long lakes as impaired for nutrients. In the Diamond Lake-South Branch Elkhart River subwatershed, 12.82 miles of the South Branch of the Elkhart River is designated as an outstanding river. IDEM classified Upper and Lower Long lakes as impaired for phosphorus.

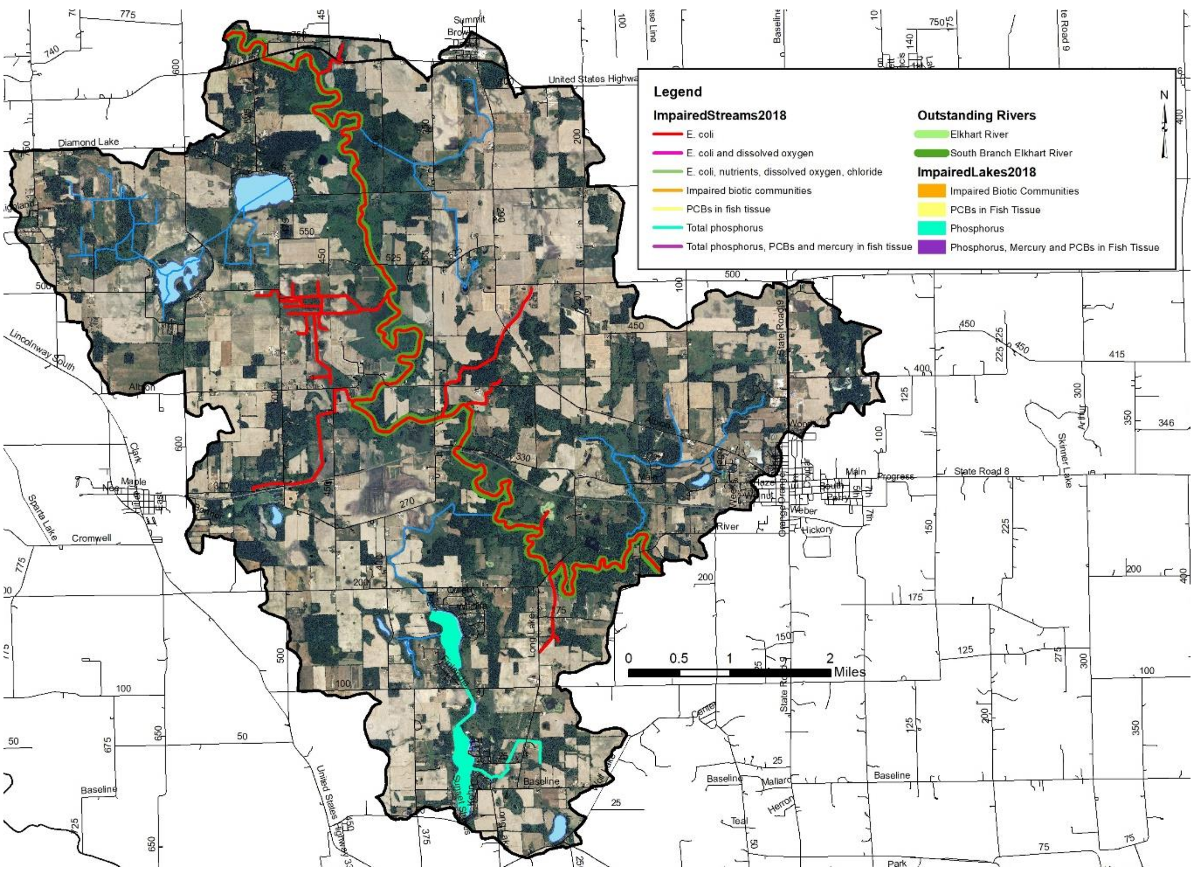


Figure 92. Diamond Lake-South Branch Elkhart River subwatershed.

4.12.1 Soils

Hydric soils cover 7,507.8 acres (33%) of the subwatershed. Wetlands currently cover 21% (4,754.4 acres) of the subwatershed. Hydric soils totals do not include land covered by lakes. Highly erodible soils cover 52% of the subwatershed (11,907 acres). Nearly the entire subwatershed, 21,710 acres (95%) is identified as very limited for septic use. The majority of the Diamond Lake-South Branch Elkhart River subwatershed is rural, indicating homes pump to an on-site wastewater system. Maintenance and inspection of these septic systems are important to ensure proper function and capacity.

4.12.2 Land Use

Agricultural land use covers more than half of the Diamond Lake-South Branch Elkhart River subwatershed with 61% (14,051.1 acres) in row crop and pasture. The next largest land use in the subwatershed is wetlands, open water and grassland, which makes up 21% (4,754.4 acres) of the Diamond Lake-South Branch Elkhart River subwatershed. Forested land use covers 2,868.7 acres (13%) of the subwatershed. Urban land use covers just 5% of the subwatershed (1,239.4 acres).

4.12.3 Point Source Water Quality Issues

There are two underground storage tanks in the Diamond Lake-South Branch Elkhart River subwatershed. There are no open dumps, superfund sites, corrective action sites or voluntary remediation sites located within the Diamond Lake-South Branch Elkhart River subwatershed (Figure 93).

4.12.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Diamond Lake-South Branch Elkhart River subwatershed. There is one active CFO and one active CAFO housing up to 8,573 pigs and cows in the subwatershed. Additionally, 57 unregulated animal operations housing more than 730 goats, sheep, horses and cows, which were identified during the windshield survey. In total, manure from these animal operations total over 49,215 tons per year, which contains almost 113,798 pounds of nitrogen, 83,797 pounds of phosphorus and 1.01E+15 colonies of E. coli. Based on windshield survey observations, livestock have access to 0.5 miles (0.9%) of Diamond Lake-South Branch Elkhart River subwatershed streams. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 2.4 miles (5%) of insufficient stream buffers and 0.5 miles (0.9%) of streambank erosion were identified within the subwatershed as part of the windshield survey. These are likely underestimates of these issues (Figure 93).

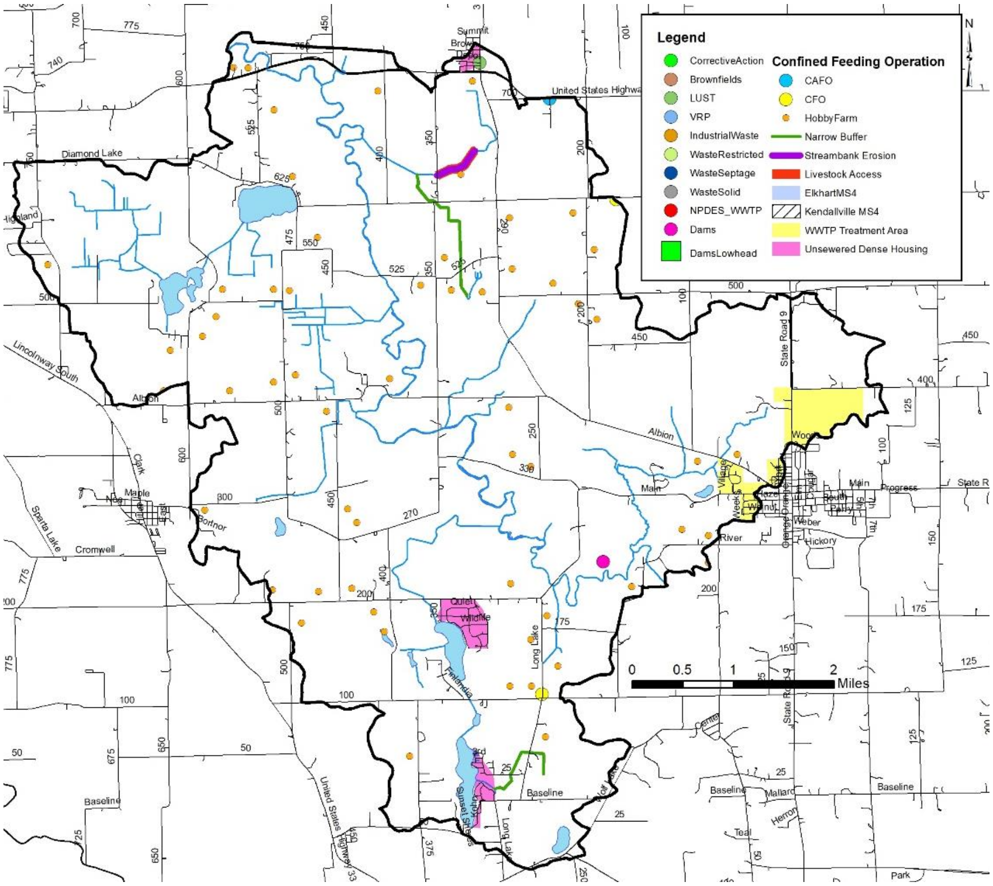


Figure 93. Potential point and non-point sources of pollution and suggested solutions in the Diamond Lake-South Branch Elkhart River subwatershed.

4.12.5 Water Quality Assessment

Waterbodies within the Diamond Lake-South Branch Elkhart River subwatershed have been sampled at 16 locations (Figure 94). Assessments include collection of water chemistry data by IDEM (10 sites), the SJRBC (3 sites), as part of the 2008 ERRA Elkhart River WMP (1 site) and as part of the LARE-funded Upper Long Lake Feasibility Study (2 sites). One site in the Diamond Lake-South Branch Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Diamond Lake-South Branch Elkhart River subwatershed.

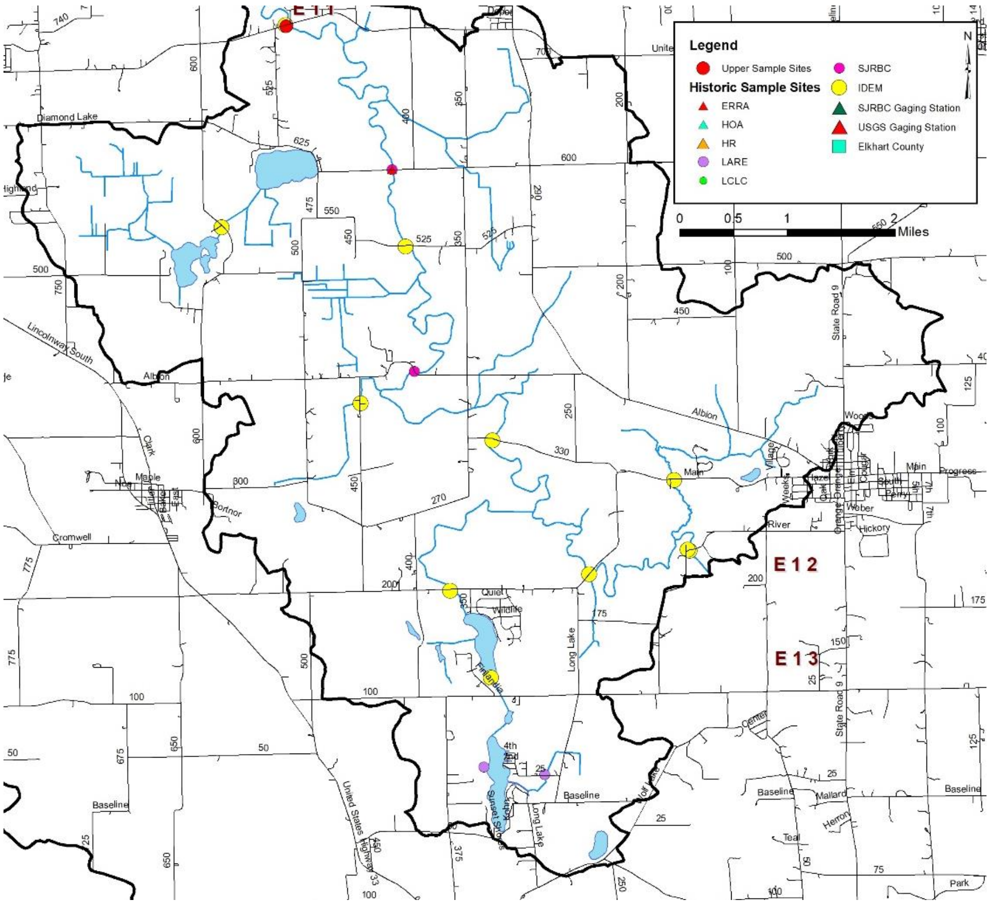


Figure 94. Locations of historic and current water quality data collection in the Diamond Lake-South Branch Elkhart River subwatershed.

Table 53 details water chemistry data for the Diamond Lake-South Branch Elkhart River subwatershed. As shown in the table, conductivity samples do not exceed state standards (1050 µmhos/cm) in any samples collected. Dissolved oxygen measures above the upper (12 mg/L) or below the lower (4 mg/L) state standard in 19% of samples. 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 36% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 100% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 47% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 10% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 23% of samples.

Table 53. Diamond Lake-South Branch Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	451	683	0	43	0%
Dissolved Oxygen	2.16	12.49	14	75	19%
E. coli	0.00	1,203.31	7	41	17%
Ammonia-Nitrogen	BDL	0.11	0	2	0%
Nitrate-Nitrogen	0.1	5.2	10	28	36%
pH	6.56	8.7	0	75	0%
Total Kjeldahl Nitrogen	1	9	4	4	100%
Total Phosphorus	BDL	0.76	14	30	47%
Total Suspended Solids	BDL	34	3	29	10%
Turbidity	0	42	10	43	23%

BDL = Below Detection Limit

Table 54 details water quality data collected in the Diamond Lake-SB Elkhart River Subwatershed at South Branch Elkhart River stream (Site 11). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 17% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 42% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 25% of samples. Dissolved oxygen concentrations exceed water quality standards in 33% of samples collected from this site.

Table 54. Diamond Lake-South Branch Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
11	Min	4.01	0.83	7.37	407.20	0.40	1.87	0.05	2.40	5.00
	Median	13.14	4.71	8.36	518.20	1.90	2.35	0.07	4.40	27.50
	Max	21.40	10.94	8.75	701.20	20.50	4.00	0.29	8.00	1730.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		4	0	0	3	12	5	0	2
	% Exceed	0%	33%	0%	0%	25%	100%	42%	0%	17%

V3 assessed the macroinvertebrate community and habitat quality once as part of the 2008 Elkhart River WMP development. Habitat scored 55.5 rating above the state target (51). The macroinvertebrate community rated as moderately impaired scoring 2.2 meeting the site's aquatic life use designation (Table 55).

Table 55. Diamond Lake-South Branch Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	55.5	55.5	0	1	0%
Fish (IBI)	--	--	--	--	--
Macroinvertebrates (mIBI, Kick)	2.2	2.2	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	--	--	--	--	--

4.13 <u>Phillips Ditch-Stony Creek subwatershed</u>

The Phillips Ditch-Stony Creek subwatershed is in the northern portion of the Upper Elkhart River Watershed and lies within Elkhart, LaGrange, and Noble counties (Figure 95). It encompasses one 12-digit HUC watershed: 040500011801. This subwatershed drains 13,017 acres or 20.3 square miles and accounts for 5% of the total watershed area. There are 26.4 miles of stream in the Phillips Ditch-Stony Creek subwatershed. IDEM has classified 17.1 miles of stream as impaired for E. coli.

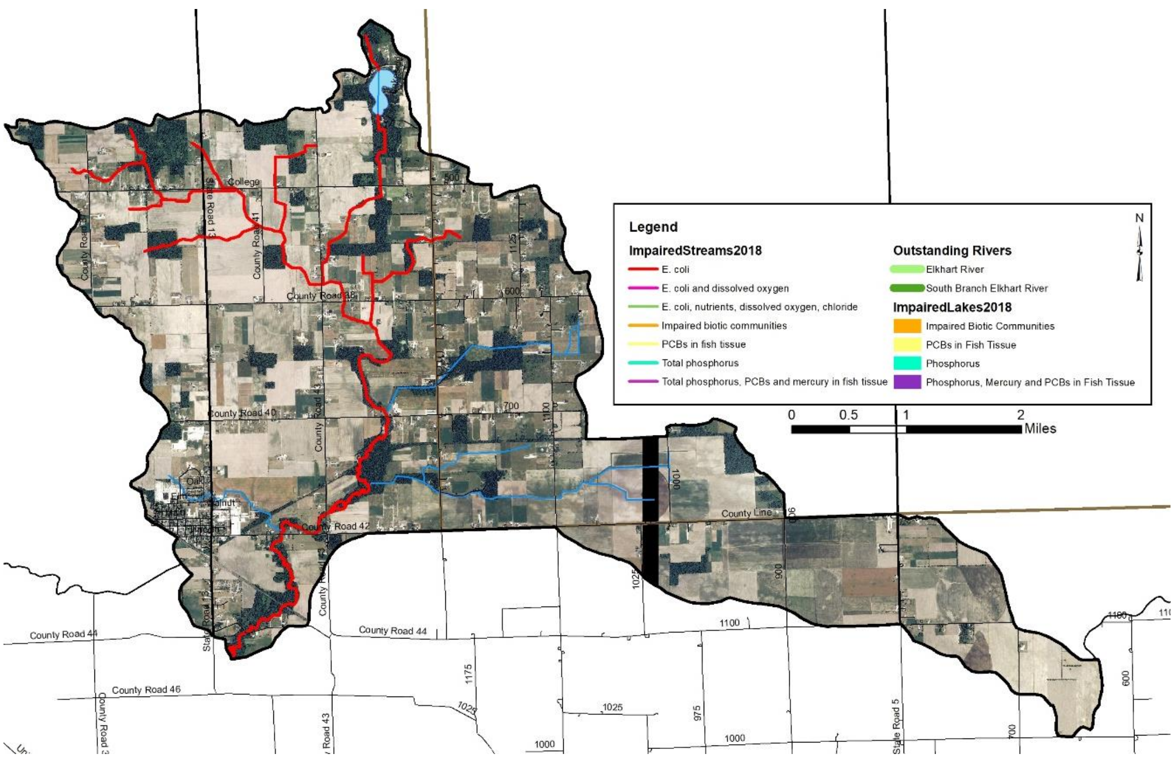


Figure 95. Phillips Ditch-Stony Creek subwatershed.

4.13.1 Soils

Hydric soils cover 2,843.1 acres or 22% of the subwatershed. Wetlands currently cover 9% (1,210.9 acres) of the subwatershed. Highly erodible soils cover 27% of the subwatershed or 3,461.1 acres. In total, 12,979.1 acres or nearly 100% of the subwatershed is identified as very limited for septic use. Maintenance and inspections of septic systems in the Phillips Ditch-Stony Creek subwatershed is important to ensure proper function and capacity.

4.13.2 Land Use

Agricultural land use dominates the Phillips Ditch-Stony Creek subwatershed with 80% (10,433.5 acres) mapped in row crops and pastureland. Wetlands, open water and grassland are the next largest use of the subwatershed, accounting for 9% (1,210.9 acres) of use. Urban land uses account for 7% (917.9 acres). Forest covers just 461.3 acres, or 4%, of the subwatershed.

4.13.3 Point Source Water Quality Issues

There are eight underground storage tanks and one NPDES-permitted facility, the Millersburg WWTP. The Millersburg WWTP was cited with a compliance issue in May of 2021 when it was found that their flow meter had not been calibrated since November 2019. Normal operations require flow meter calibration every 12 months. There are no open dumps, superfund sites, corrective action sites or voluntary remediation sites located within the Phillips Ditch-Stony Creek subwatershed (Figure 96).

4.13.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land uses in the Phillips Ditch-Stony Creek subwatershed. There are five active CFOs and two CAFOs housing up to 68,456 cows, chickens, horses, bison and pigs in the subwatershed. Additionally, a number of small animal operations and pastures are also present. Surveyors observed 158 unregulated animal operations housing more than 2,084 cows, goats, horses and sheep during the windshield survey (Figure 96). Animals produce more than 119,367 tons of manure annually which contains more than 1,569,535 pounds of nitrogen, 1,248,895 pounds of phosphorus and more than 1.05E+19 colonies of E. coli. Based on windshield survey observations, livestock have access to 1.4 miles (5%) of the Phillips Ditch-Stony Creek subwatershed streams. Streambank erosion and lack of buffers are a concern in the subwatershed. Approximately 1.4 miles (5%) of insufficient stream buffers and 1.8 miles (7%) of streambank erosion were identified within the Phillips Ditch-Stony Creek subwatershed (Figure 96).

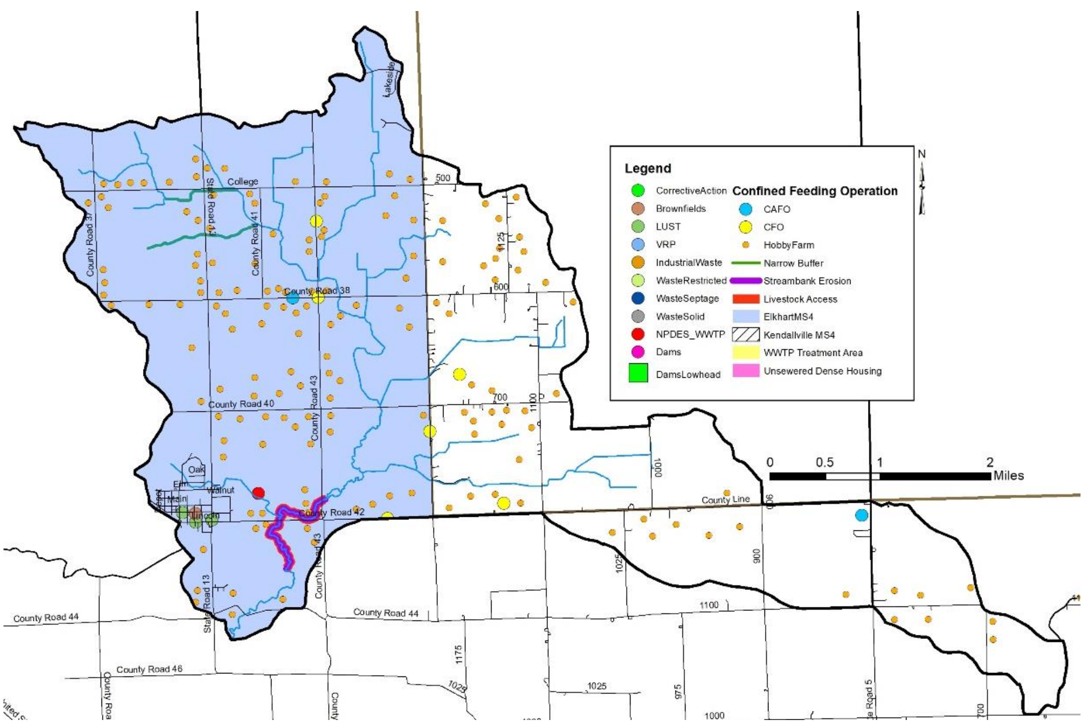


Figure 96. Potential point and non-point sources of pollution and suggested solutions in the Phillips Ditch-Stony Creek subwatershed.

4.13.5 Water Quality Assessment

Waterbodies within the Phillips Ditch-Stony Creek subwatershed have been sampled at 3 locations by IDEM (Figure 97). One site in the Phillips Ditch-Stony Creek subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Phillips Ditch-Stony Creek subwatershed.

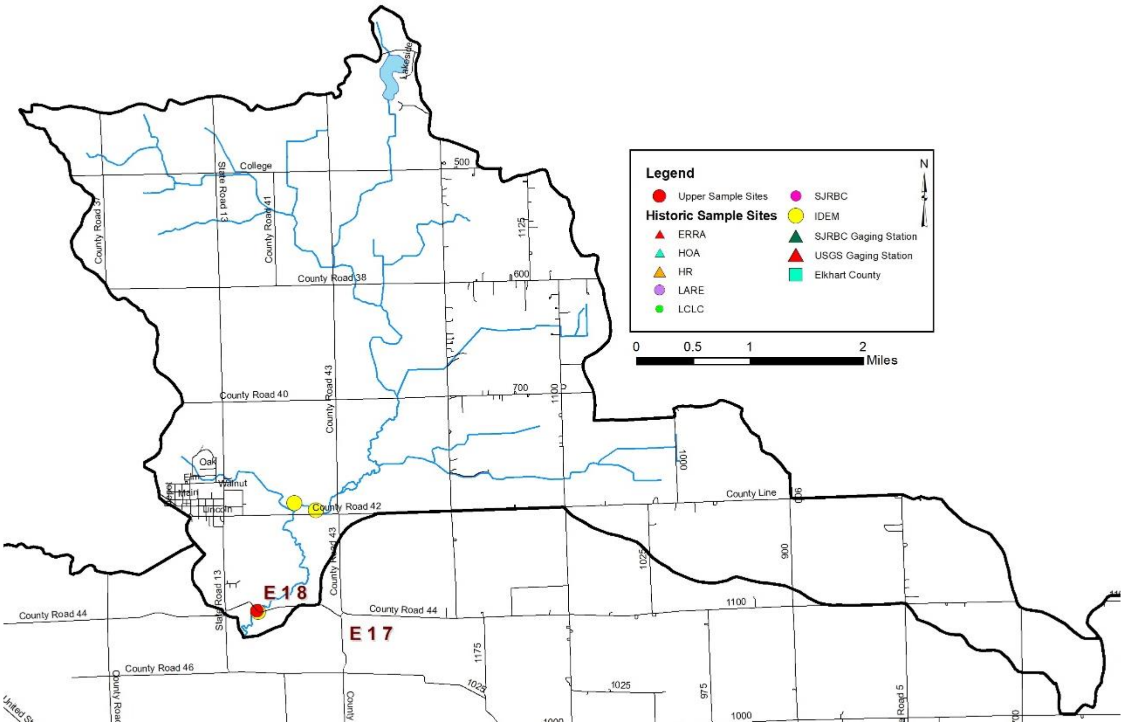


Figure 97. Locations of historic and current water quality data collection in the Phillips Ditch-Stony Creek subwatershed.

Table 56 details water chemistry data collected in the Phillips Ditch-Stoney Creek subwatershed. As shown in the table, conductivity samples exceeded state standards (1050 µmhos/cm) in 12% of samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 16% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 60% 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 (0.57mg/L) in 50% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 67% of samples. Total suspended solids no not exceed water quality targets (15 mg/L), while turbidity levels exceed water quality targets (5.7 NTU) in 52% of samples.

Table 56. Phillips Ditch-Stony Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	358	1,484	3	25	12%
Dissolved Oxygen	5.93	18.07	4	25	16%
E. coli	BDL	15,531	9	15	60%
Ammonia-Nitrogen	BDL	0.11	0	6	0%
Nitrate-Nitrogen	BDL	14.2	5	6	83%
pH	7.06	9.08	1	25	4%
Total Kjeldahl Nitrogen	BDL	0.78	3	6	50%
Total Phosphorus	0.052	0.1	4	6	67%
Total Suspended Solids	BDL	11	0	6	0%
Turbidity	2	1,000	13	25	52%

BDL = Below Detection Limit

Table 57 details water quality data collected in the Philips Ditch-Stony Creek Subwatershed at Stony Creek Outlet stream (Site 18). As shown in the table, *E. coli* samples exceed state 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 phosphorus concentrations exceed water quality targets (0.08 mg/L) in 83% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 0% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 17% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 57. Philips Ditch-Stony Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (mg/L)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
18	Min	6.94	5.23	7.45	362.80	0.50	0.50	0.05	1.20	28.00
	Median	13.07	8.69	8.45	657.30	2.30	2.80	0.18	3.60	504.50
	Max	23.01	11.21	8.75	777.00	25.80	4.61	0.63	8.00	1200.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	2	11	10	0	7
	% Exceed	0%	0%	0%	0%	17%	92%	83%	0%	58%

IDEM assessed the biological community at two sites including assessing macroinvertebrates, fish and habitat at both sites. One site was assessed as part of the current project. Habitat scores ranged from 46 to 63 with 33% of sites scoring below the state target (51). Fish community assessments rated good to excellent with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments scored 26 to 42 using the multihabitat samples with 67% of samples not meeting their aquatic life use designation (Table 58).

Table 58. Philips Ditch-Stony Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	46	63	1	3	33%
Fish (IBI)	54	68	0	3	0%
Macroinvertebrates (mIBI, Kick)	--	--	--	--	--
Macroinvertebrates (mIBI, Multi Habitat)	26	42	4	6	67%

4.14 Indian Lake-Elkhart River subwatershed

The Indian Lake-Elkhart River subwatershed lies within Noble and Elkhart counties (Figure 98). It encompasses one 12-digit HUC watershed: 040500011802. This subwatershed drains 20,182 acres or 31.5 square miles and accounts for 8% of the total watershed area. There are 31.7 miles of stream. IDEM has classified 20.9 miles of stream as impaired for E. coli. In the Indian Lake-Elkhart River subwatershed, 12.47 miles of the Elkhart River is designated as an outstanding river.

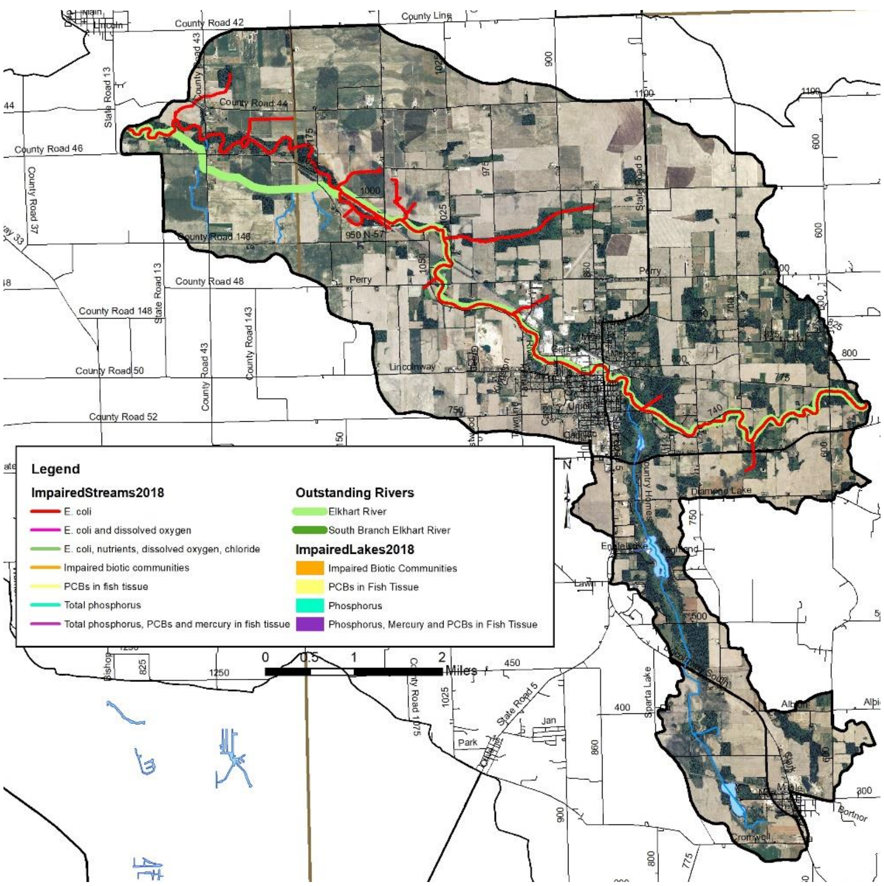


Figure 98. Indian Lake-Elkhart River subwatershed.

4.14.1 Soils

Hydric soils cover 4,431 acres (22%) of the subwatershed. Wetlands currently cover 11% (2,280.7 acres) of the subwatershed. Highly erodible soils cover over a third of the subwatershed (37%). In total, 19,780.5 miles (98%) of the subwatershed are identified as very limited for septic use. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. 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.

4.14.2 Land Use

Agricultural land use covers the majority of the Indian Lake-Elkhart River subwatershed with 75% (15,0881 acres) in row crop and pasture. Wetlands, open water and grassland cover 2,280.7 acres, or 11%, of the subwatershed. Urban land use makes up the next largest use of land with 2,107.3 acres, or 10% with the town of Ligonier sitting in this subwatershed. Lastly, forested land use makes up just 4% (715.3 acres) of the subwatershed.

4.14.3 Point Source Water Quality Issues

There are 21 underground storage tank sites (Figure 99) in the subwatershed, 13 industrial waste facilities and one NPDES-permitted site (Ligonier WWTP). There are no open dumps, brownfields, corrective action sites or voluntary remediation sites located within the Indian Lake-Elkhart River subwatershed (Figure 99).

4.14.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land use in the Indian Lake-Elkhart River subwatershed. During the windshield survey, 75 unregulated animal operations housing more than 579 cows, horses, goats and sheep were identified. Based on observations during the windshield survey, livestock do not have access to Indian Lake-Elkhart River streams. There are three active CFOs and one active CAFOs located within the Indian Lake-Elkhart River subwatershed which are permitted to house 62,166 cows, chickens, horses and pigs. In total, manure from small animal operations and CFOs total over 117,999 tons per year, which contains almost 1,331,535 pounds of nitrogen, 1,059,893 pounds of phosphorus and 8.38E+18 colonies of E. coli. Streambank erosion is a concern in the subwatershed. Approximately 1.5 miles (5%) of streambank erosion was identified within the subwatershed (Figure 99).

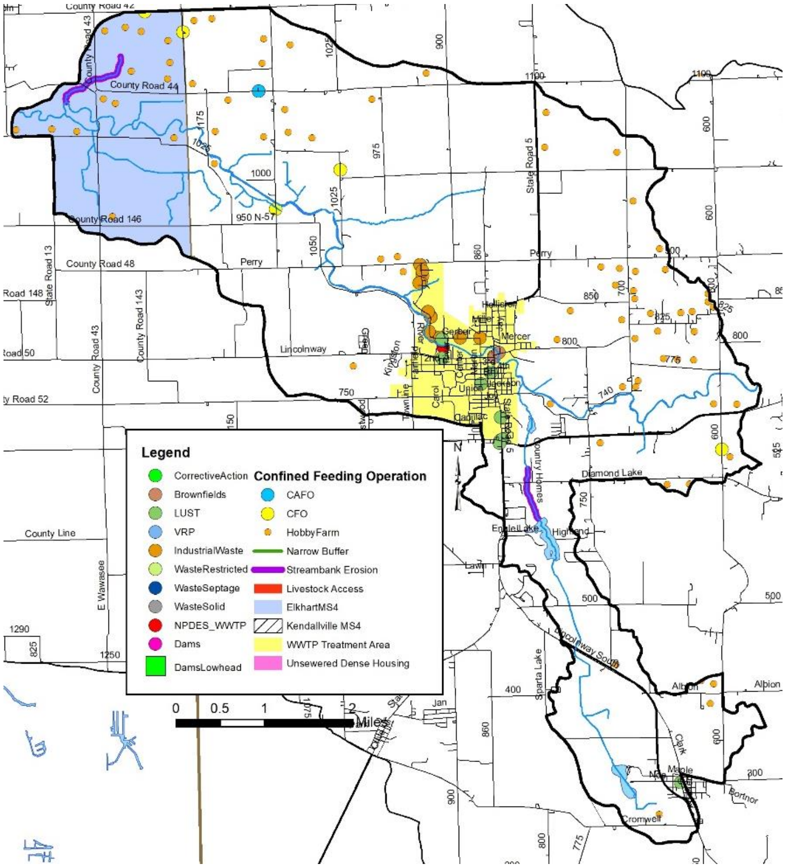


Figure 99. Potential point and non-point sources of pollution and suggested solutions in the Indian Lake-Elkhart River subwatershed.

4.14.5 Water Quality Assessment

Waterbodies within the Indian Lake-Elkhart River subwatershed have been sampled at nine locations (Figure 100). Assessments include collection of water chemistry data by IDEM (6 sites), by SJRBC (2 sites) and by Elkhart County (1 site). One site in the Indian Lake-Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Indian Lake-Elkhart River subwatershed.

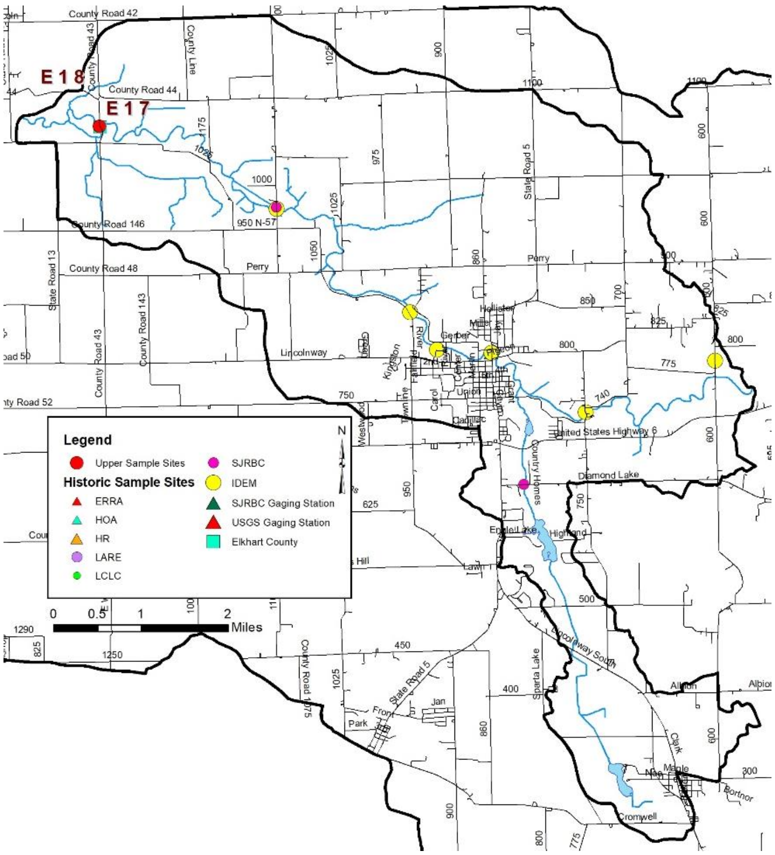


Figure 100. Locations of historic and current water quality data collection in the Indian Lake-Elkhart River subwatershed.

Table 59Table 56 details water chemistry data collected in the Indian Lake-Elkhart River subwatershed. As shown in the table, conductivity samples exceed state standards (1050 µmhos/cm) in 4% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 28% of samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 5% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 59% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57mg/L) in 50% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 86% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 6% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 48% of samples.

Table 59. Indian Lake-Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	78	1,360	10	248	4%
Dissolved Oxygen	3.94	14.79	14	256	5%
E. coli	5	7,000	66	237	28%
Ammonia-Nitrogen	BDL	0.61	3	5	60%
Nitrate-Nitrogen	0.023	14.4	127	215	59%
pH	6.56	8.69	0	256	0%
Total Kjeldahl Nitrogen	BDL	1.7	3	6	50%
Total Phosphorus	0.01	9.48	187	218	86%
Total Suspended Solids	BDL	40	6	100	6%
Turbidity	1	74.3	29	60	48%

BDL = Below Detection Limit

Table 60details water quality data collected in the Indian Lake-Elkhart River Subwatershed at Elkhart River stream (Site 17). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 8% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 0% 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 8% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 60. Indian Lake-Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (mg/L)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
17	Min	**4.42**	**5.07**	**7.63**	**323.20**	**1**	**1.72**	**0.05**	**1.20**	**40.00**
	Median	13.50	8.24	8.47	574.45	1.80	3.29	0.06	4.40	85.50
	Max	22.50	11.16	8.73	762.20	24.70	4.30	0.38	12.40	548.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	1	12	3	0	1
	% Exceed	0%	0%	0%	0%	8%	100%	25%	0%	8%

IDEM assessed the biological community at two sites including assessments for macroinvertebrates, fish and habitat at both sites. One site was assessed as part of the current project. Habitat scores ranged from 71 to 72 with 0% of sites scoring below the state target (51). Fish community assessments rated excellent with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments rated slightly impaired using the kick sampling method with all sites meeting their aquatic life use designation and scoring 34 to 56 using the multihabitat samples with 25% of samples not meeting their aquatic life use designation (Table 61).

Table 61. Indian Lake-Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	71	73	0	3	0%
Fish (IBI)	67	72	0	2	0%
Macroinvertebrates (mIBI, Kick)	4.2	4.2	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	34	56	1	4	25%

4.15 Headwaters Solomon Creek subwatershed

The Headwaters Solomon Creek subwatershed sits in the western half of the Upper Elkhart River Watershed and lies in Noble, Elkhart, and Kosciusko counties (Figure 101). It encompasses one 12-digit HUC watershed: 040500011803. This subwatershed drains 15,158 acres or 23.7 square miles. The Headwaters Solomon Creek subwatershed accounts for 6% of the total watershed area. There are 22.7 miles of stream. IDEM has classified 18.2 miles as impaired for E. coli.

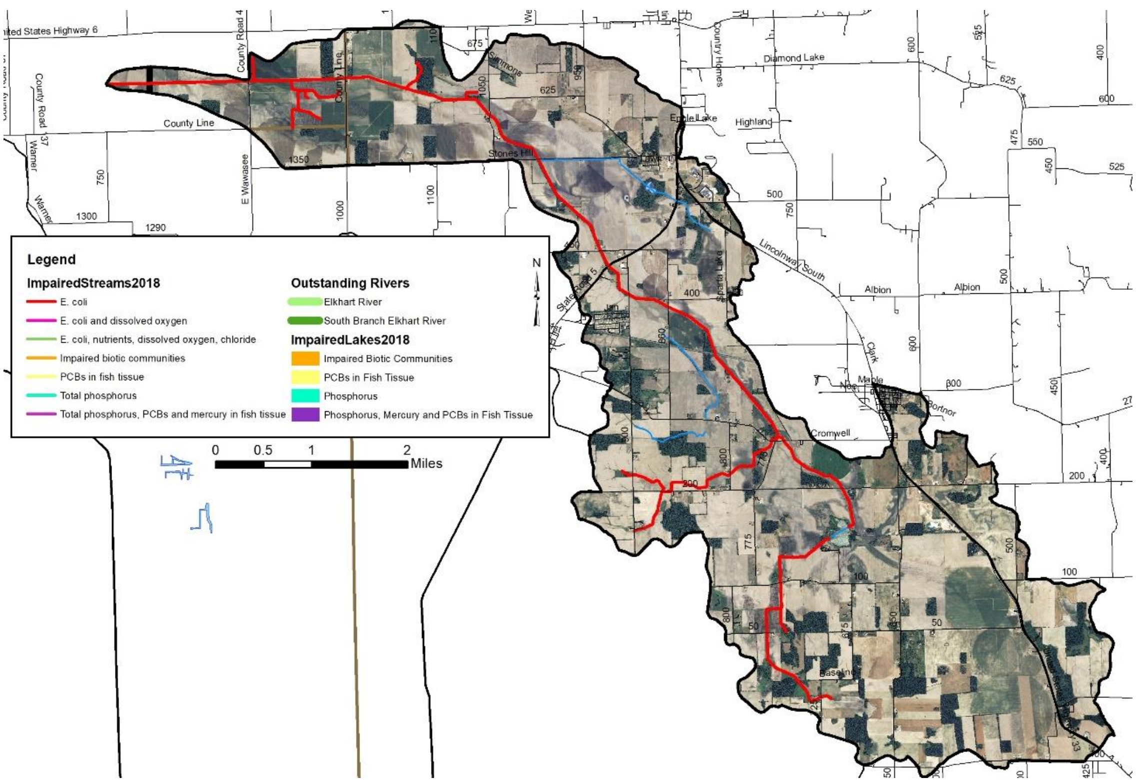


Figure 101. Headwaters Solomon Creek subwatershed.

4.15.1 Soils

Hydric soils cover 4,712.4 acres (31%) of the subwatershed. Currently, wetlands cover 5% (700.7 acres) of the subwatershed. Highly erodible soils cover 41% of the subwatershed (6,232.9 acres). Nearly all subwatershed soils, 14,896.8 acres (98%) are identified as very limited for septic use. The majority of the Headwaters Solomon Creek subwatershed is rural, indicating homes pump to an on-site wastewater system. Maintenance and inspection of these septic systems are important to ensure proper function and capacity.

4.15.2 Land Use

Agricultural land use makes up a majority of the Headwaters Solomon Creek subwatershed with 84% (12,756.9 acres) in row crop and pasture. The next largest land use in the subwatershed is forest, which covers 6% (895.7 acres) of the Headwaters Solomon Creek subwatershed. Urban land use makes up 812 acres (5%) of the subwatershed. Wetland, open water and grassland also cover 5% of the subwatershed (700.7 acres).

4.15.3 Point Source Water Quality Issues

There are two underground storage tanks, one NPDES facility (Cromwell WWTP) and one waste facility in the Headwaters Solomon Creek subwatershed. There are no open dumps, superfund sites, corrective action sites or voluntary remediation sites are located within the Headwaters Solomon Creek subwatershed (Figure 102).

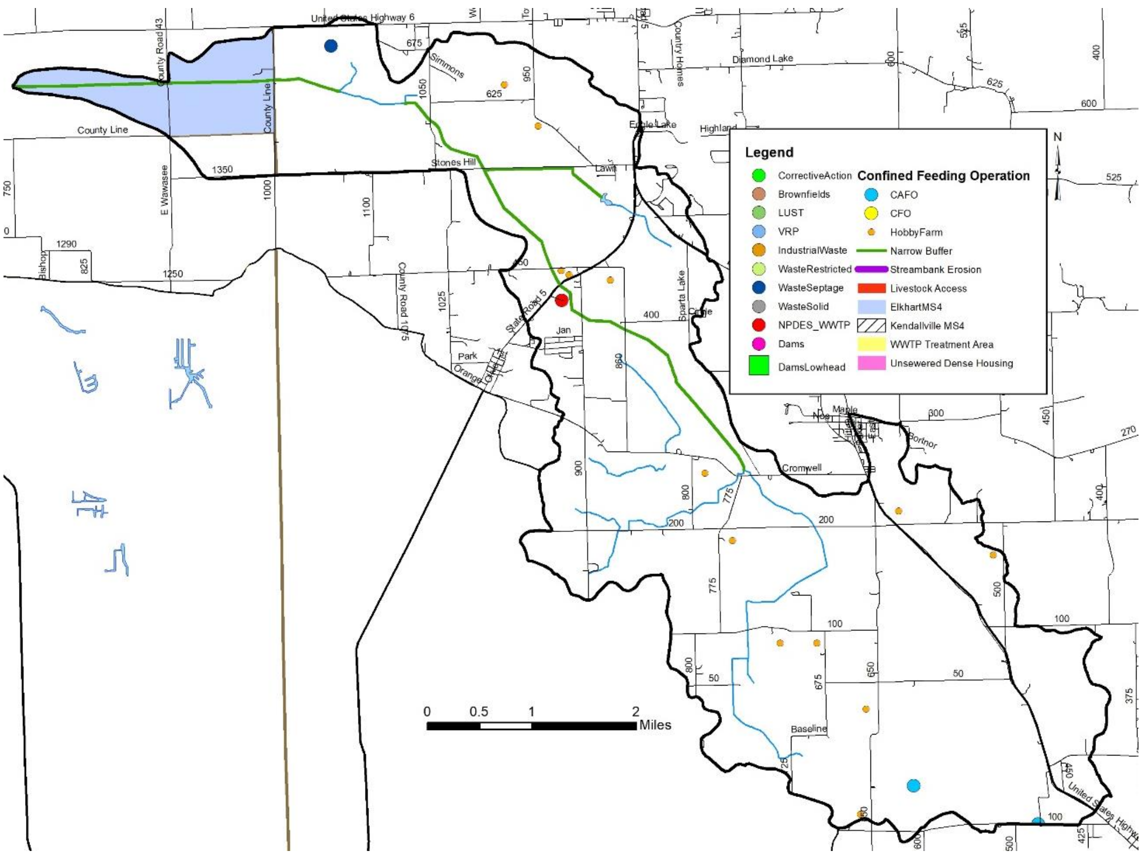


Figure 102. Potential point and non-point sources of pollution and suggested solutions in the Headwaters Solomon Creek subwatershed.

4.15.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Headwaters Solomon Creek subwatershed. There are two active CAFOs housing up to 20,305 pigs and cows in the subwatershed. Additionally, 13 unregulated animal operations housing more than 181 horses and cows which were identified during the windshield survey. In total, manure from these animal operations total over 131,036 tons per year, which contains almost 246,988 pounds of nitrogen, 179,433 pounds of phosphorus and 1.64E+15 colonies of E. coli. Based on windshield survey observations, livestock do not have access to Headwaters Solomon

Creek subwatershed streams. Lack of buffers are a concern in the subwatershed. Approximately 9.5 miles (42%) of insufficient stream buffers were identified within the subwatershed (Figure 102).

4.15.5 Water Quality Assessment

Waterbodies within the Headwaters Solomon Creek subwatershed have been sampled at five locations (Figure 103). Assessments include collection of water chemistry data by IDEM (2 sites), by the SJRBC (2 sites) and as part of the LARE-funded Whetten Ditch, Solomon Creek, Dry Run Diagnostic study (1 site). One site in the Headwaters Solomon Creek subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Headwaters Solomon Creek subwatershed.

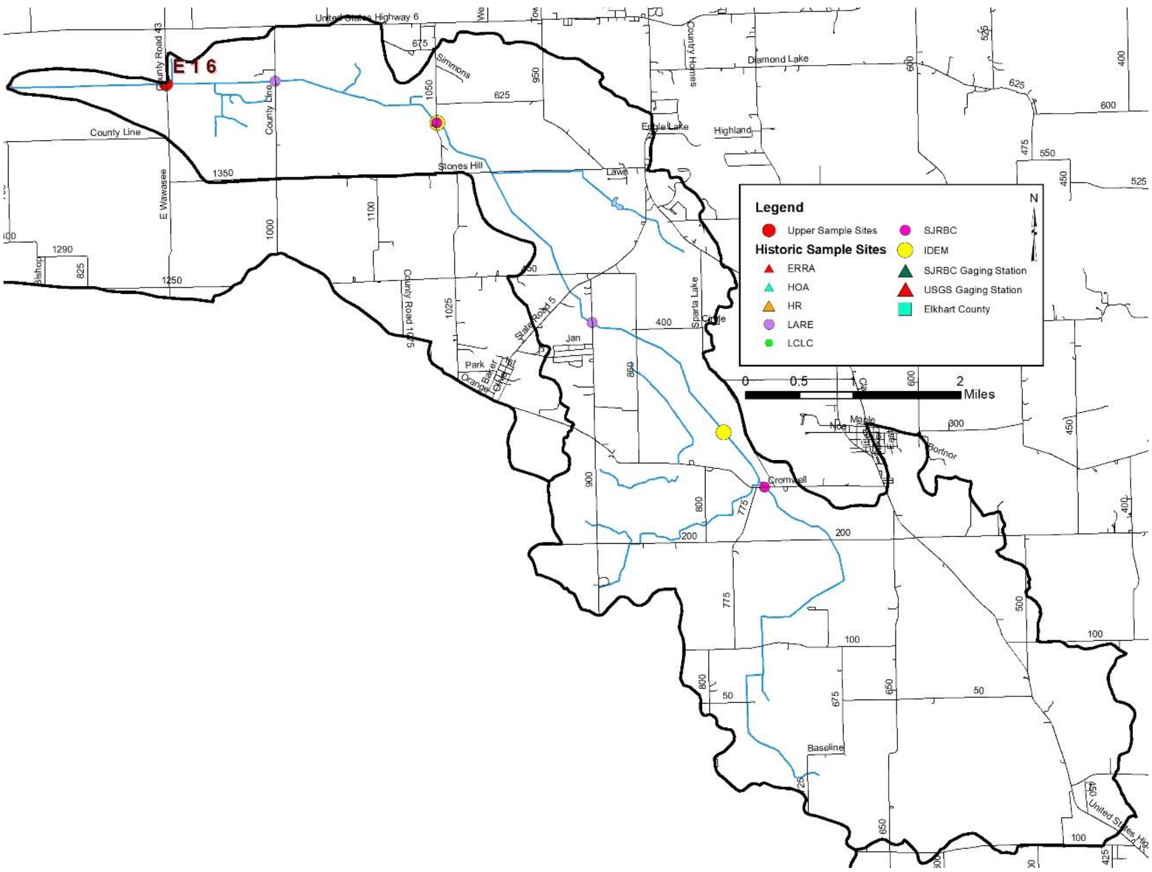


Figure 103. Locations of historic and current water quality data collection in the Headwaters Solomon Creek subwatershed.

Table 62 details water chemistry data collected in the Headwaters Solomon Creek subwatershed. As shown in the table, conductivity samples exceed state standards (1050 µmhos/cm) in 2% of samples collected. Dissolved oxygen measures above the upper (12 mg/L) or below the lower (4 mg/L) state standards in 22% of samples. 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 34% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 38% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 31% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 19% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 44% of samples.

Table 62. Headwaters Solomon Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	524	1,950	1	50	2%
Dissolved Oxygen	5.5	14.97	11	50	22%
E. coli	38.4	2,419.6	12	36	33%
Ammonia-Nitrogen	BDL	0.1	0	6	0%
Nitrate-Nitrogen	BDL	1.9	11	32	34%
Dissolved Phosphorus	0.01	0.05	1	2	50%
pH	6.97	8.24	0	50	0%
Total Kjeldahl Nitrogen	BDL	1.2	3	8	38%
Total Phosphorus	BDL	0.18	10	32	31%
Total Suspended Solids	BDL	28	6	32	19%
Turbidity	1	31.7	22	50	44%

BDL = Below Detection Limit

Table 63 details water quality data collected in the Headwaters Solomon Ditch Subwatershed at Solomon Creek stream (Site 16). As shown in the table, *E. coli* samples exceed state 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 phosphorus concentrations exceed water quality targets (0.08 mg/L) in 0% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 50% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 58% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 63. Headwaters Solomon Ditch Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm)	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
16	Min	6.32	5.19	7.05	427.10	1.10	2.06	0.05	2.80	46.00
	Median	13.40	6.73	8.30	751.30	6.80	3.43	0.05	14.40	299.50
	Max	21.44	11.02	8.53	794.60	15.49	5.30	0.06	38.80	613.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	7	12	0	6	9
	% Exceed	0%	0%	0%	0%	58%	100%	0%	50%	75%

IDEM assessed the biological community at three sites including three sites assessed for macroinvertebrates, two sites assessed for fish and one site assessed for habitat. JFNew assessed one site for macroinvertebrates and habitat. One site was assessed as part of the current project. Habitat scores ranged from 31 to 41 with 100% of sites scoring below the state target (51). Fish community assessments rated poor to fair with 50% of assessments meeting the aquatic life use designation. Macroinvertebrate assessments rated moderately impaired using the kick sampling method with all sites meeting their aquatic life use designation and scoring 18 to 30 using the multihabitat samples with 100% of sites not meeting their aquatic life use designation (Table 64).

Table 64. Headwaters Solomon Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	28	41	3	3	100%
Fish (IBI)	26	41	1	2	50%
Macroinvertebrates (mIBI, Kick)	4	4	0	1	0%
Macroinvertebrates (mIBI, Multi Habitat)	18	31	4	4	100%

4.16 Hire Ditch-Solomon Creek subwatershed

The Hire Ditch-Solomon Creek forms part of the west border of the watershed and lies within Elkhart, Kosciusko, and Noble counties (Figure 104). It encompasses one 12-digit HUC watershed: 040500011804. This subwatershed drains 14,189 acres or 22.2 square miles and accounts for 5% of the total watershed area. There are 31.5 miles of stream. IDEM has classified 17.9 miles of stream as impaired for E. coli and 10.2 miles of stream as impaired for nutrients, E. coli, dissolved oxygen and chloride.

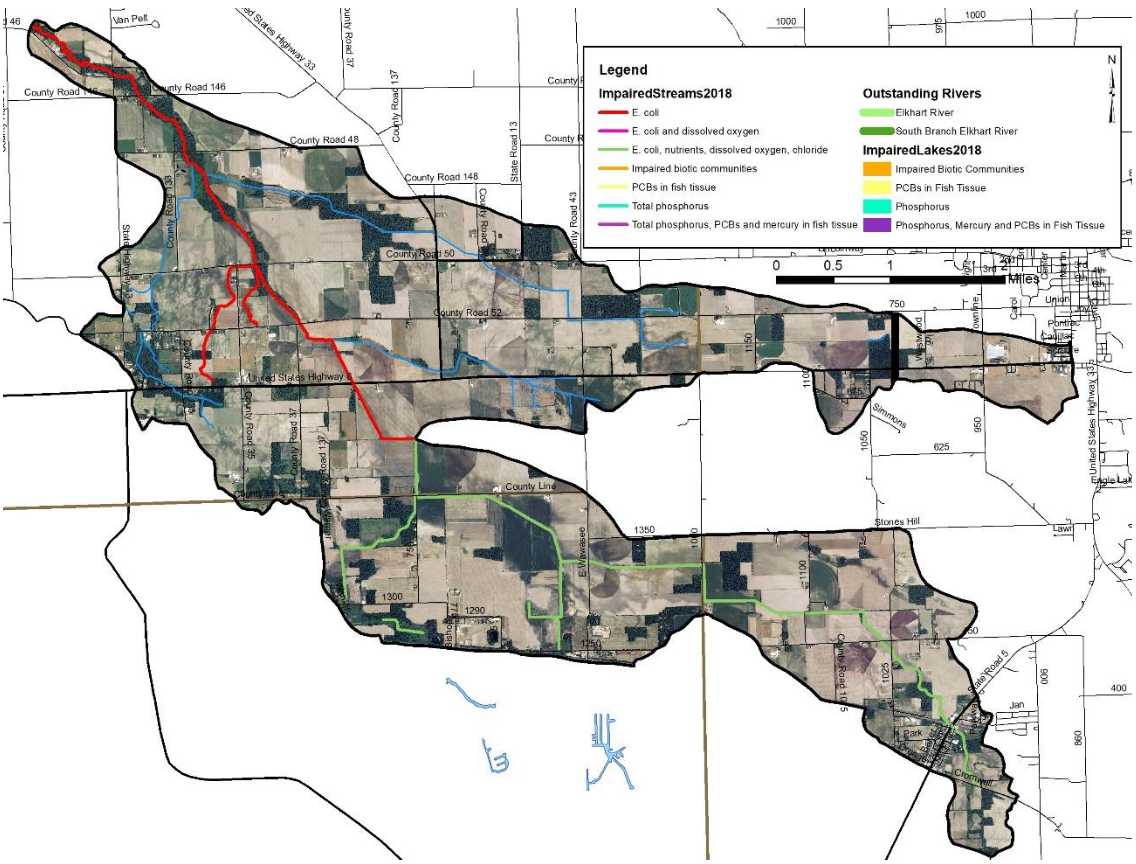


Figure 104. Hire Ditch-Solomon Creek subwatershed.

4.16.1 Soils

Hydric soils cover 5,254.6 acres or 37% of the subwatershed; wetlands currently cover 8% (1,099.9 acres) of the subwatershed. Highly erodible soils are found throughout the subwatershed covering 2,844.4 acres or 20% of the subwatershed. Nearly all of the subwatershed, 100% (14,114.6 acres), has soils which are very limited for septic use.

4.16.2 Land Use

Agricultural land use, including row crop and pasture, dominates the Hire Ditch-Solomon Creek subwatershed (82% or 11,661.3 acres). Wetlands, open water and grassland is the next largest use of the subwatershed, but only account for 8% (1,099.9 acres) of use. Urban land covers 7% (937.3 acres) of the subwatershed. Forested land uses cover just 497.3 acres, or 4%, of the subwatershed.

4.16.3 Point Source Water Quality Issues

There are two underground storage tanks listed in this watershed, one industrial waste site and one NPDES-permitted facility: the Turkey Creek WWTP. No open dumps, superfund sites, corrective action sites or voluntary remediation sites are located within the Hire Ditch-Solomon Creek subwatershed (Figure 105).

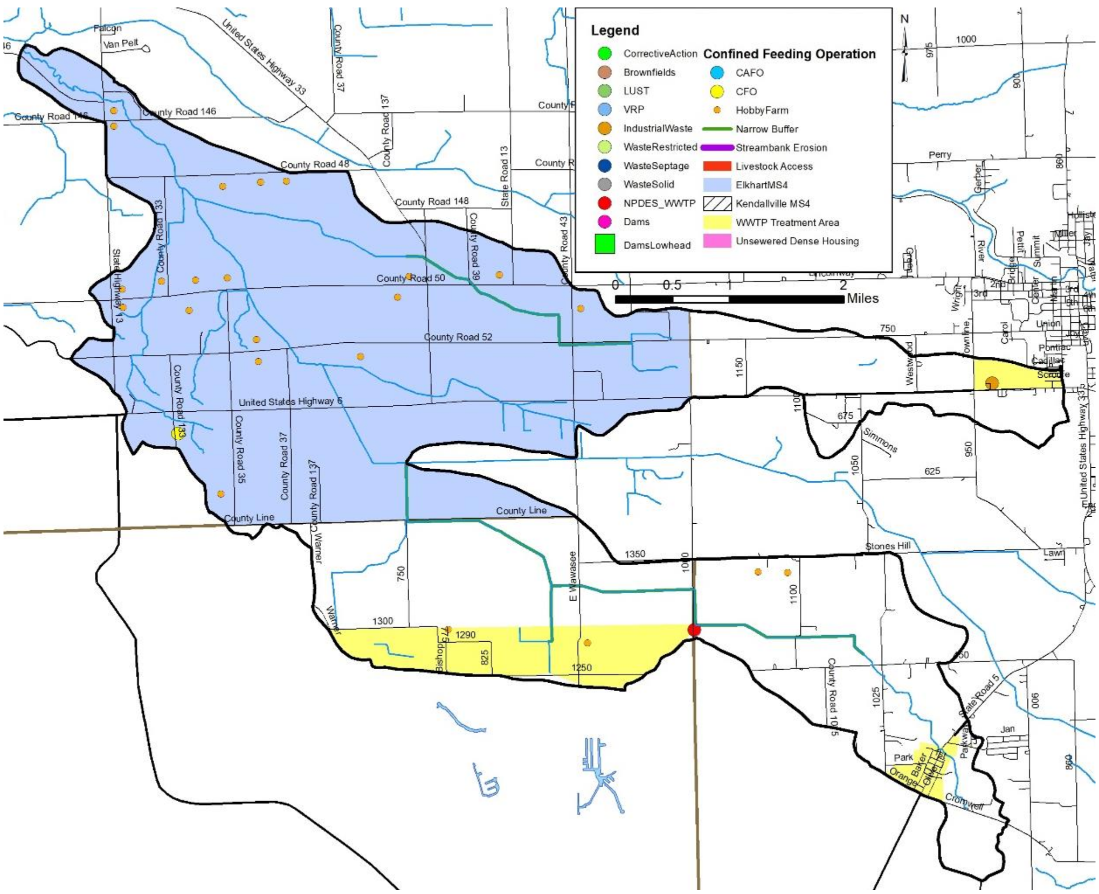


Figure 105. Potential point and non-point sources of pollution and suggested solutions in the Hire Ditch-Solomon Creek subwatershed.

4.16.4 Non-Point Source Water Quality Issues

Agricultural land uses are the predominant land use in the Hire Ditch-Solomon Creek subwatershed. As a result, various small animal operations and pastures are also present (Figure 105). There are 23 unregulated animal operations housing more than 133 cows, goats and horses which were identified during the windshield survey. There is one active CFO in the subwatershed, which houses up to 2,280 pigs. In total, manure produced from small animal operations and the CFO total more than 11,951 tons per year, which contains almost 29,436 pounds of nitrogen, 21,906 pounds of phosphorus and 5.97E+13 colonies of E. coli. Lack of buffers are a concern in the subwatershed; however, livestock do not have access to the Hire Ditch-Solomon Creek subwatershed streams based on observations during the windshield survey. Approximately 8.1 miles (26%) of insufficient stream buffers were identified within the subwatershed (Figure 105).

4.16.5 Water Quality Assessment

Waterbodies within the Hire Ditch-Solomon Creek subwatershed have been sampled at 14 locations (Figure 106). Assessments include collection of water chemistry data by IDEM (2 sites), by the SJRBC (1 site), by Elkhart County (2 sites), as part of the LARE-funded Whetten Ditch, Solomon Creek, Dry Run Diagnostic Study (JFNew, 7 sites) and by Hoosier Riverwatch volunteers (2 sites). One site in the Hire Ditch-Solomon Creek subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Hire Ditch-Solomon Creek subwatershed.

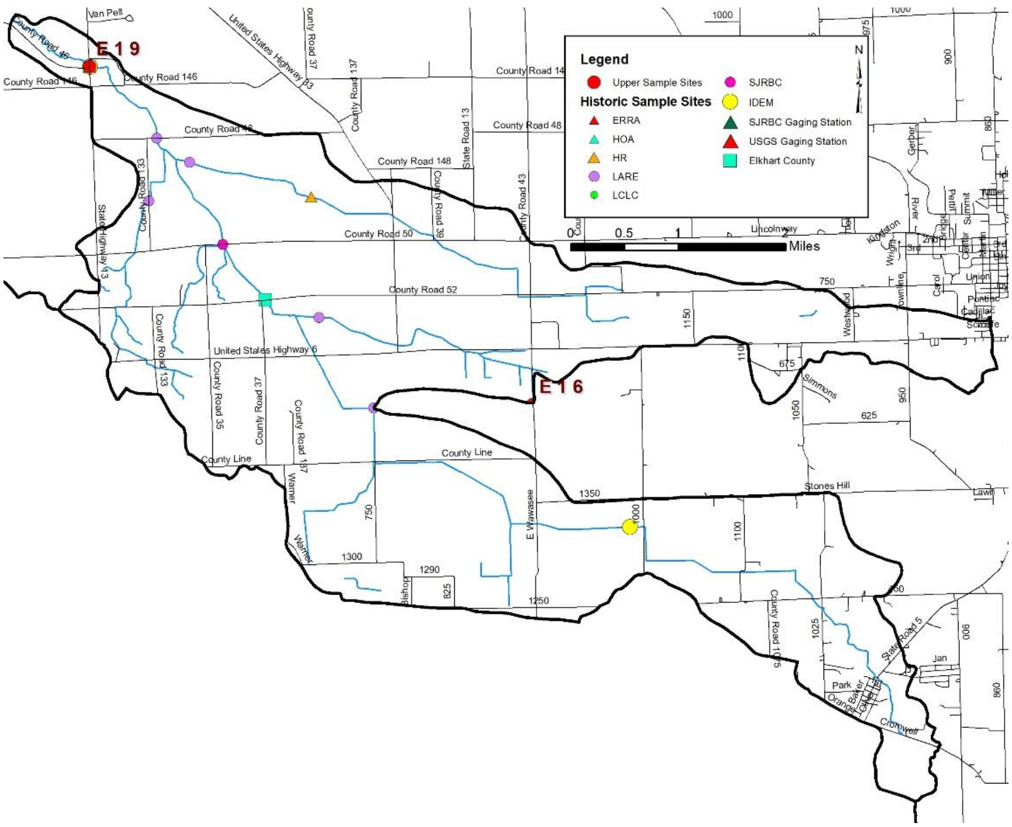


Figure 106. Locations of historic and current water quality data collection in the Hire Ditch-Solomon Creek subwatershed.

Table 65 details water chemistry data collected in the Hire Ditch-Solomon Creek subwatershed. As shown in the table, conductivity exceed state standards (1050 µmhos/cm) in 11% of samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 6% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 42% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 88% of samples, while total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 41% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 60% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 12% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 38% of samples.

Table 65. Hire Ditch-Solomon Creek subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	150	2,720	15	136	11%
Dissolved Oxygen	3.74	14.94	8	138	6%
E. coli	30	9,400	63	149	42%
Ammonia-Nitrogen	BDL	0.33	1	3	33%
Nitrate-Nitrogen	0.15	24	108	123	88%
Dissolved Phosphorus	0	0.079	8	15	53%
pH	7.2	9.13	2	137	1%
Total Kjeldahl Nitrogen	BDL	2.9	7	17	41%
Total Phosphorus	0.03	7.68	73	121	60%
Total Suspended Solids	BDL	91	9	74	12%
Turbidity	0.55	290	24	63	38%

BDL = Below Detection Limit

Table 66 details water quality data collected in the Hire Ditch-Solomon Creek Subwatershed at Solomon Creek Outlet stream (Site 19). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 50% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 8% 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 did not exceed water quality standards in samples collected from this site.

Table 66. Hire Ditch-Solomon Creek Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (µmhos/cm	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
19	Min	5.93	7.19	7.34	611.00	1.20	1.99	0.05	1.60	82.00
	Median	13.62	8.31	8.36	759.65	4.15	3.53	0.05	7.40	224.50
	Max	18.94	11.10	8.65	951.10	16.80	6.20	0.13	24.00	921.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	4	12	1	2	6
	% Exceed	0%	0%	0%	0%	33%	100%	8%	17%	50%

IDEM assessed the biological community at two sites while JFNew assessed the biological community at seven sites. Assessments included nine sites assessed for macroinvertebrates, one site assessed for fish and nine sites assessed for habitat. One site was assessed as part of the current project. Habitat scores ranged from 25.5 to 63 with 70% of sites scoring below the state target (51). Fish community assessments rated fair with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments rated severely impaired to not impaired using the kick sampling method with 77% sites meeting their aquatic life use designation and scoring 20 to 36 using the multihabitat samples with 67% of sites not meeting their aquatic life use designation (Table 67).

Table 67. Hire Ditch-Solomon Creek subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	25.5	63	7	10	70%
Fish (IBI)	40	40	0	1	0%
Macroinvertebrates (mIBI, Kick)	1	6	2	9	23%
Macroinvertebrates (mIBI, Multi Habitat)	20	36	2	3	67%

4.17 <u>Whetten Ditch-Elkhart River subwatershed</u>

The Whetten Ditch-Elkhart River subwatershed forms the northwestern tip of the Upper Elkhart River Watershed and sits in Elkhart and Noble counties (Figure 107). It encompasses one 12-digit HUC watershed: 040500011805. This subwatershed drains 18,207 acres or 28.4 square miles and accounts for 7% of the total watershed area. There are 49.8 miles of stream. IDEM has classified 28.3 miles of stream impaired for E.coli. In the Whetten Ditch-Elkhart River subwatershed, 7.04 miles of the Elkhart River is designated as an outstanding river.

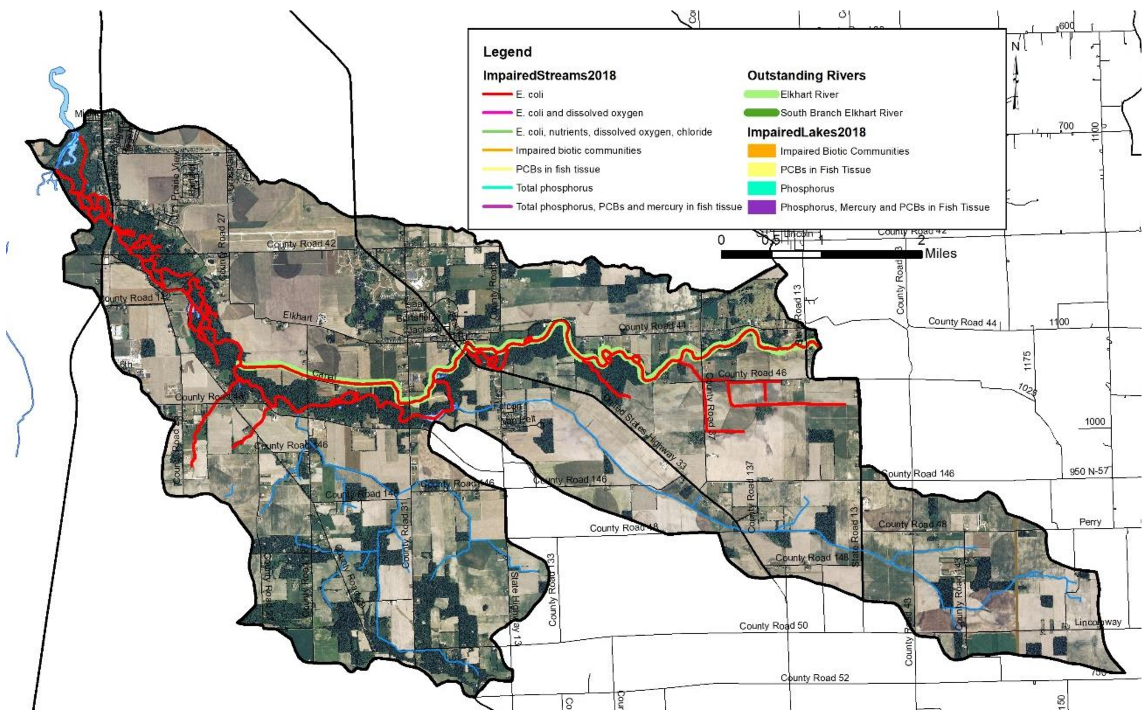


Figure 107. Whetten Ditch-Elkhart River subwatershed.

4.17.1 Soils

Hydric soils cover 3,699.2 acres (20%) of the Whetten Ditch-Elkhart River subwatershed. Wetlands currently cover 14% (2,461.6 acres) of the subwatershed. Highly erodible soils cover 20% of the subwatershed (3,688.1 acres). In total, 17,978.6 acres (99%) of the subwatershed are identified as very limited for septic use. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. 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.

4.17.2 Land Use

Agricultural land use makes up 70% of the Whetten Ditch-Elkhart River subwatershed with 12,826.3 acres in agricultural land uses, including row crop and pasture. An additional 14% (2,461.6 acres) of the subwatershed is in wetlands, open water and grassland. Urban land use covers 2,270.1 acres, or 13%, of the subwatershed. Forest land use accounts for 4% of the subwatershed (659 acres).

4.17.3 Point Source Water Quality Issues

There are six underground storage tanks and one NPDES-permitted site: The New Paris Conservancy WWTP. There are no open dumps, brownfields, corrective action sites, voluntary remediation sites or industrial waste facilities located within the Whetten Ditch-Elkhart River subwatershed (Figure 108).

4.17.4 Non-Point Source Water Quality Issues

Agricultural land use is the predominant land uses in the Whetten Ditch-Elkhart River subwatershed. Additionally, a number of small animal operations and pastures are present (Figure 108). In total, 65 unregulated animal operation housing more than 521 cows, goats, horses and sheep were identified during the windshield survey. There are two active CFOs located within the Whetten Ditch-Elkhart River subwatershed which house up to 114,016 chickens and horses. In total, manure from small animal operations and the CFO/CAFO total over 28,253 tons per year, which contains almost 3,004,598 pounds of nitrogen, almost 2,431,426 pounds of phosphorus and 2.39E+19 colonies of E. coli. Livestock do not appear to have access to the subwatershed streams based on windshield survey observations. Streambank erosion and lack of buffer are concerns in the subwatershed, with streambank erosion present in 0.9 miles (2%) of stream, and narrow buffers found along 7.8 miles (16%) of Whetten Ditch-Elkhart River subwatershed streams (Figure 108).

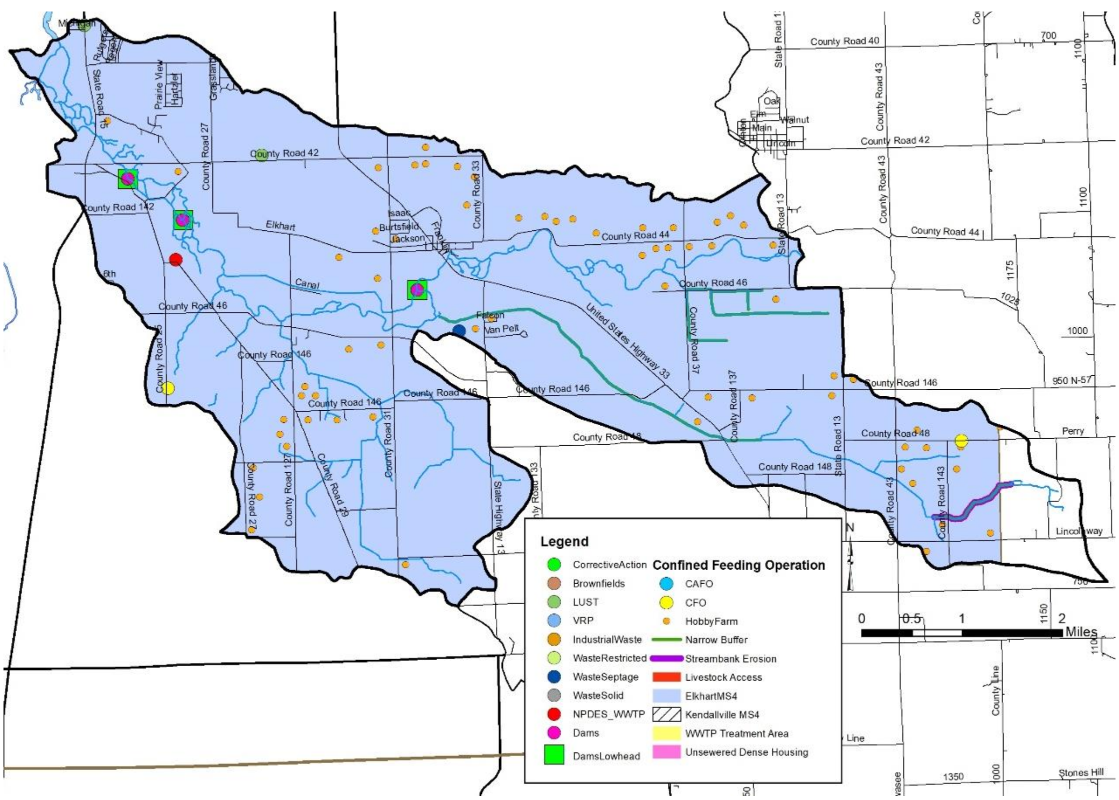


Figure 108. Potential point and non-point sources of pollution and suggested solutions in the Whetten Ditch-Elkhart River subwatershed.

4.17.5 Water Quality Assessment

Waterbodies within the Whetten Ditch-Elkhart River subwatershed have been sampled at 13 locations (Figure 109). Assessments include collection of water chemistry data by IDEM (7 sites), by the SJRBC (2 sites), by Elkhart County (2 sites), as part of the LARE-funded Whetten Ditch, Solomon Creek, Dry Run Diagnostic Study (1 site) and as part of the 2008 ERRA Elkhart River WMP (1 site). The only IDEM fixed monitoring station in the Upper Elkhart River Watershed is located in the Whetten Ditch-Elkhart River subwatershed. One site in the Whetten Ditch-Elkhart River subwatershed is being sampled as part of the current project (shown as Upper sample sites). No USGS stream gages are located in the Whetten Ditch-Elkhart River subwatershed.

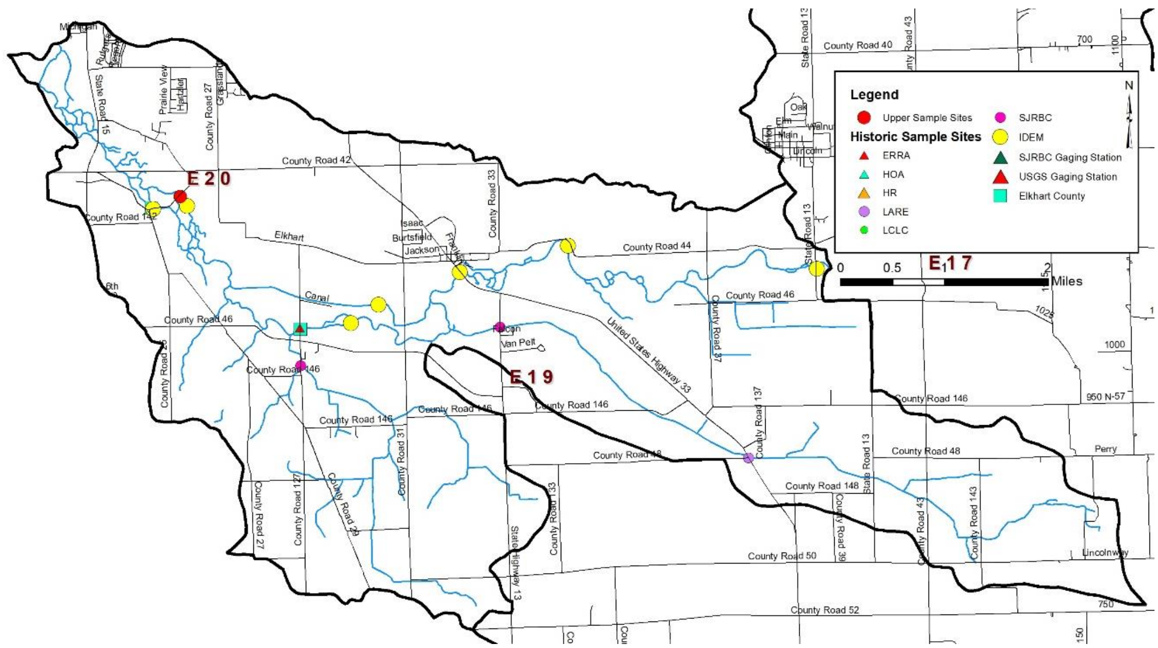


Figure 109. Locations of historic and current water quality data collection in the Whetten Ditch-Elkhart River subwatershed.

Table 68 details water chemistry data collected in the Whetten Ditch-Elkhart River subwatershed. As shown in the table, conductivity levels exceed state standards (1050 µmhos/cm) in 1% samples collected. Dissolved oxygen concentrations measure higher than the upper (12 mg/L) and lower than the lower (4 mg/L) state standards in 21% of samples collected. E. coli samples exceed state grab sample standards (235 col/100 ml) in 29% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 82% of samples. Total Kjeldahl nitrogen concentrations exceed water quality targets (0.57 mg/L) in 84% of collected samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 79% of samples. Total suspended solids concentrations exceed water quality targets (15 mg/L) in 18% of samples, while turbidity levels exceed water quality targets (5.7 NTU) in 67% of samples.

Table 68. Whetten Ditch-Elkhart River subwatershed historic water quality data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Conductivity	106	1,516	4	405	1%
Dissolved Oxygen	0.32	14.5	85	404	21%
E. coli	BDL	2,100	39	134	29%
Ammonia-Nitrogen	BDL	0.28	1	258	0%
Nitrate-Nitrogen	0.19	28	300	366	82%
Dissolved Phosphorus	0.02	0.12	1	2	50%
pH	6.19	9.45	4	555	1%
Total Kjeldahl Nitrogen	BDL	13.09	221	262	84%
Total Phosphorus	BDL	14.1	289	364	79%
Total Suspended Solids	BDL	408	59	337	18%
Turbidity	0.09	163	215	322	67%

BDL = Below Detection Limit

Table 69 details water quality data collected in the Whetten Ditch-Elkhart River Subwatershed at Elkhart River stream (Site 20). As shown in the table, *E. coli* samples exceed state standards (235 col/100 ml) in 8% of samples collected. Nitrate-nitrogen concentrations exceed water quality targets (1 mg/L) in 100% of samples. Total phosphorus concentrations exceed water quality targets (0.08 mg/L) in 25% 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 25% of samples. Dissolved oxygen concentrations did not exceed water quality standards in samples collected from this site.

Table 69. Whetten Ditch-Elkhart River Subwatershed water quality data summary.

Site		Temp (C)	DO (mg/L)	pH	Cond (μmhos/cm	Turb (NTU)	Nitrate (mg/L)	TP (mg/L)	TSS (mg/L)	*E. coli* (col/100 ml)
20	Min	5.88	6.84	7.56	450.00	1.20	1.60	0.05	0.80	60.00
	Median	13.77	8.48	8.53	583.65	3.15	3.65	0.05	5.40	101.50
	Max	22.33	11.25	8.72	711.00	22.50	4.52	0.13	18.40	326.00
	Count	12	12	12	12	12	12	12	12	12
	Exceed		0	0	0	3	12	3	1	1
	% Exceed	0%	0%	0%	0%	25%	100%	25%	8%	8%

IDEM assessed the biological community at five sites, JFNew assessed the biological community at one site and V3 assessed the biological community at one site. One site was assessed as part of the current project. Assessments included seven sites assessed for macroinvertebrates, four sites assessed for fish and seven sites assessed for habitat. Habitat scores ranged from 34.5 to 79 with 10% of sites scoring below the state target (51). Fish community assessments rated as good to excellent with all assessments meeting the aquatic life use designation. Macroinvertebrate assessments rated severely impaired to not impaired using the kick sampling method with 25% of sites meeting their aquatic life use designation and scoring 16 to 52 using the multihabitat samples with 36% of sites not meeting their aquatic life use designation (Table 70).

Table 70. Whetten Ditch-Elkhart River subwatershed biological assessment data summary.

Parameter	Minimum	Maximum	Number Exceeding Target	Number of Samples	Percent Exceeding
Habitat (QHEI)	34.5	79	1	10	10%
Fish (IBI)	51	80	0	5	0%
Macroinvertebrates (mIBI, Kick)	0.8	5.0	1	4	25%
Macroinvertebrates (mIBI, Multi Habitat)	16	52	4	11	36%

5.0 WATERSHED INVENTORY III: WATERSHED INVENTORY SUMMARY

Several important factors and relationships become apparent when the Upper 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 by the Indiana Department of Environmental Management (IDEM), St. Joseph River Basin Commission (SJRBC), Lagrange County Lakes Council (LCLC), Elkhart County, several consulting firms which used DNR Lake and River Enhancement Program and/or IDEM Section 319 grant funded projects 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 71 highlights those locations within the Upper 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 71 summarizes where historic samples were outside the target values and are grouped by subwatershed. Figure 110 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.

Table 71. Percent of samples historically collected in Upper Elkhart River subwatersheds which measured outside target values.

Subwatershed	Cond	pH	Turb	DO	E coli	TKN	Nitrate	OP	TP	TSS
Tamarack Lake-Little Elkhart Creek	0%	0%	100%	0%	--	100%	80%	--	80%	20%
Dallas Lake-Little Elkhart Creek	0%	0%	--	7%	100%	54%	13%	53%	67%	19%
Oliver Lake-Little Elkhart Creek	0%	0%	33%	8%	80%	42%	48%	44%	66%	17%
Waterhouse-Henderson Lake Ditch	14%	0%	36%	10%	6%	100%	60%	50%	80%	25%
Oviate Ditch-MB Elkhart River	0%	0%	30%	26%	60%	100%	0%	--	33%	0%
Jones Lake-NB Elkhart River	0%	0%	28%	10%	29%	83%	79%	--	65%	15%
Huston Ditch-NB Elkhart River	0%	0%	43%	6%	21%	100%	80%	--	78%	30%
Rivir Lake-Forker Creek	0%	0%	33%	0%	19%	100%	69%	50%	81%	25%
Winebrenner Branch-Carrol Creek	0%	0%	26%	11%	16%	33%	81%	--	75%	13%
Skinner Lake-Croft Ditch	0%	0%	60%	18%	59%	92%	76%	15%	84%	36%
Muncie Lake-SB Elkhart River	0%	3%	80%	9%	20%	83%	50%	--	33%	17%
Diamond Lake-SB Elkhart River	0%	0%	23%	22%	19%	100%	36%	--	47%	10%
Phillips Ditch-Stony Creek	12%	4%	52%	16%	60%	50%	83%	--	67%	0%
Indian Lake-Elkhart River	4%	0%	48%	5%	28%	50%	59%	--	86%	6%
Headwaters Solomon Creek	2%	0%	44%	22%	33%	38%	34%	50%	31%	19%
Hire Ditch-Solomon Creek	11%	1%	38%	6%	42%	41%	88%	53%	60%	12%
Whetten Ditch-Elkhart River	1%	1%	67%	21%	29%	84%	82%	50%	79%	18%

Historic nitrate-nitrogen concentrations sampled in the Tamarack Lake-Little Elkhart Creek, Waterhouse Ditch-Henderson Lake Ditch, Jones Lake-North Branch Elkhart River, Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Winebrenner Branch-Carrol Creek, Skinner Lake-Croft Ditch, Phillips Ditch-Stony Creek, Indian Lake-Elkhart River, Hire Ditch-Solomon Creek, and Whetten Ditch-Elkhart River subwatersheds exceeded targets in more than 50% of samples collected. Total phosphorus concentrations in the Tamarack Lake-Little Elkhart Creek, Dallas Lake-Little Elkhart Creek, Oliver Lake-Little Elkhart Creek, Waterhouse Ditch-Henderson Lake Ditch, Jones Lake-North Branch Elkhart River, Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Winebrenner Branch-Carrol Creek, Skinner Lake-Croft Ditch, Philips Ditch-Stony Creek, Indian Lake-Elkhart River, Hire Ditch-Solomon Creek and Whetten Ditch-Elkhart River exceeded water quality targets in more than 50% of samples collected. Total Kjeldahl nitrogen concentrations in Tamarack Lake-Little Elkhart Creek, Dallas Lake-Little Elkhart Creek, Waterhouse-Henderson Lake Ditch, Oviate Ditch-Middle Branch Elkhart River, Jones Lake-North Branch Elkhart River, Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Skinner Lake-Croft Ditch, Muncie Lake-South Branch Elkhart River, Diamond Lake-South Branch Elkhart River and Whetten Ditch-Elkhart River exceeded water quality targets in more than 50% of samples collected. E. coli concentrations measured in Dallas Lake-Little Elkhart Creek, Oliver Lake-Little Elkhart Creek, Oviate Ditch-Middle Branch Elkhart River, Skinner Lake-Croft Ditch and Phillips Ditch-Stony Creek exceeded state standards in more than 50% of samples collected. A limited number of pH exceedances occurred in the Muncie Lake-South Branch Elkhart River, Philips Ditch-Stony Creek, Hire Ditch-Solomon Creek and Whetten Ditch-Elkhart River subwatershed all of which measured above the upper level and suggest an algal bloom occurred at the time of sample collection. Dissolved oxygen exceedances occurred in all but the Tamarack Lake-Little Elkhart Creek and Rivir Lake-Forker Creek subwatersheds with all exceedances measuring both lower than the lower and higher than the upper dissolved oxygen state standard at the time of sampling. Conductivity exceedances occurred a limited number of times in the Waterhouse Ditch-Henderson Lake Ditch, Philips Ditch-Stony Creek, Indian Lake-Elkhart River, Headwaters Solomon Creek, Hire Ditch-Solomon Creek and Whetten Ditch-Elkhart River subwatersheds.

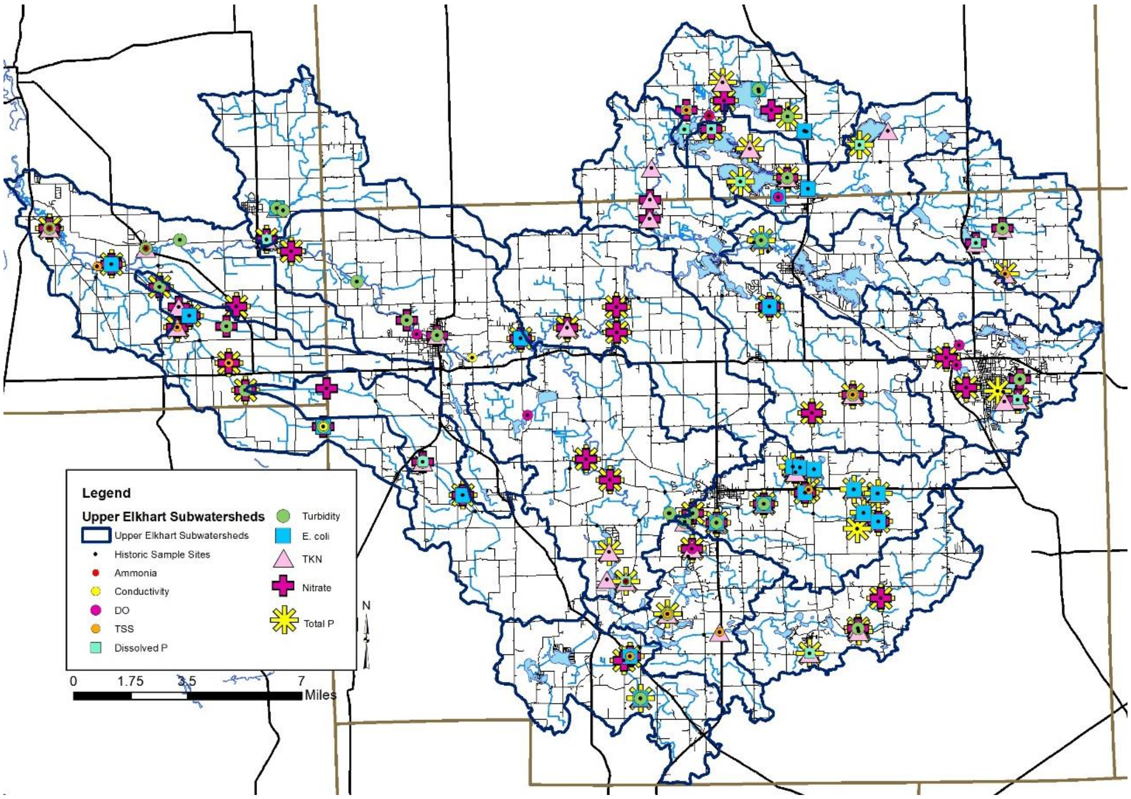


Figure 110. Upper Elkhart River Watershed historical sampling sites that exceed target values.

Table 72 summarizes current samples which measured outside the target values during the current assessment. Figure 111 provides a map of current sampling sites that exceed target values. Elevated nitrate-nitrogen concentrations were observed at all sample sites with 12 sample sites exceeding nitrate-nitrogen target concentrations during all sampling events. In total, 96% of collected samples throughout the watershed exceeded nitrate-nitrogen target concentrations. Elevated total phosphorus concentrations were observed at all sample sites except the sites in the Oviate Ditch-Middle Branch Elkhart River and Headwaters Solomon Creek subwatersheds with concentrations exceeding total phosphorus targets in 26% of collected samples. Elevated total suspended solids concentrations were observed at a majority of sites with 19% of all samples exceeding targets. Four sites exceeded target TSS concentrations in half or more than half of collected samples. TSS concentrations generally measured low then increased to concentrations higher than targets during storm flow events. *E. coli* concentrations that exceeded the state grab sample standard were measured at a majority of sites. Exceedances were most common at Headwaters Solomon Creek, Philips Ditch-Stony Creek and Skinner Lake-Croft Ditch sites. In total, 33% of samples exceed state standards.

Only five sample sites exceeded dissolved oxygen state standards – these occurred in the Oliver Lake-Little Elkhart Creek, Tamarack Lake-Little Elkhart Creek, Jones Lake-North Branch Elkhart River, Diamond Lake-South Branch Elkhart River and Rivir Lake-Forker Creek subwatersheds. Specific conductivity exceeded targets at one site in the Waterhouse Ditch-Henderson Lake Ditch subwatershed. pH concentrations did not exceed targets during the sampling events.

Table 72. Percent of samples collected in the Upper Elkhart River Watershed during the 2022-2023 sample collection which measured outside target values.

Site	Subwatershed	DO (mg/L)	Turb (NTU)	Cond (µmhos/cm)	TP (mg/L)	Nitrate (mg/L)	TSS (mg/L)	Ecoli (col/100 ml)
1	Oliver Lake-Little Elkhart Creek	0%	0%	0%	8%	100%	17%	0%
2	Oliver Lake-Little Elkhart Creek	33%	33%	0%	83%	100%	75%	58%
3	Dallas Lake-Little Elkhart Creek	0%	25%	0%	25%	92%	0%	33%
4	Tamarack Lake-L Elkhart Creek	8%	17%	0%	17%	92%	25%	25%
5	Oviate Ditch-MB Elkhart River	0%	8%	0%	0%	83%	25%	0%
6	Waterhouse-Henderson Lake	0%	33%	8%	42%	92%	58%	50%
7	Jones Lake-NB Elkhart River	0%	8%	0%	17%	100%	0%	50%
8	Jones Lake-NB Elkhart River	0%	17%	0%	8%	100%	0%	58%
9	Jones Lake-NB Elkhart River	8%	33%	0%	8%	83%	25%	0%
10	Huston Ditch-NB Elkhart River	0%	17%	0%	25%	100%	17%	42%
11	Diamond Lake-SB Elkhart River	33%	25%	0%	42%	100%	0%	17%
12	Skinner Lake-Croft Ditch	0%	8%	0%	58%	92%	0%	67%
13	Muncie Lake-SB Elkhart River	0%	50%	0%	17%	100%	50%	17%
14	Rivir Lake-Forker Creek	25%	17%	0%	25%	100%	0%	8%
15	Winebrenner Branch-Carrol Creek	0%	17%	0%	8%	92%	8%	33%
16	Headwaters Solomon Creek	0%	58%	0%	0%	100%	50%	75%
17	Indian Lake-Elkhart River	0%	8%	0%	25%	100%	0%	8%
18	Philips Ditch-Stony Creek	0%	17%	0%	83%	92%	0%	58%
19	Hire Ditch-Solomon Creek	0%	33%	0%	8%	100%	17%	50%
20	Whetten Ditch-Elkhart River	0%	25%	0%	25%	100%	8%	8%

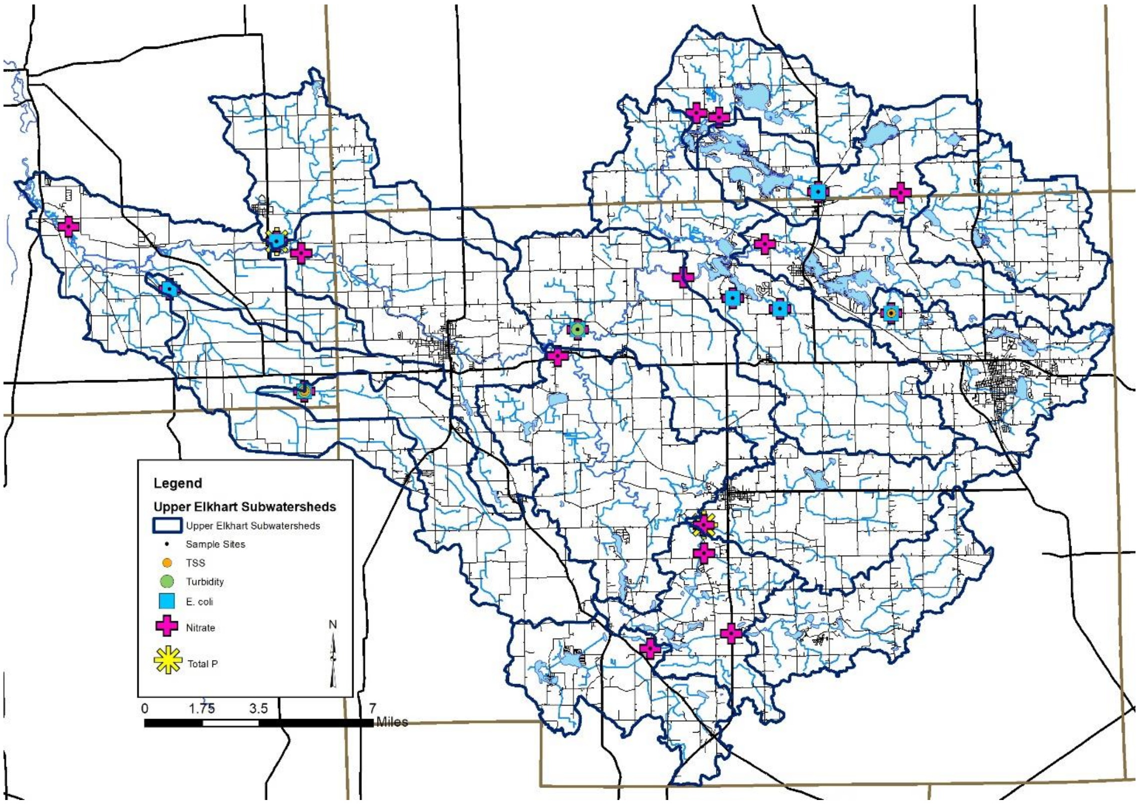


Figure 111. Upper Elkhart River Watershed sampling sites that exceed target values during the current sampling period.

Biological assessments of the macroinvertebrate community and an associated habitat assessment occurred once during the project. There is no pattern between habitat and macroinvertebrate community ratings for most sites (Table 73). A majority of sites – 11 sites – possessed mIBI scores which rated as poor or very poor. Oliver Lake-Little Elkhart Creek (Site 2) rated as very poor while Rivir Lake-Forker Creek (Site 14), Philips Ditch-Stony Creek (Site 18), Headwaters Solomon Ditch (Site 16), Oviate Ditch-Middle Branch Elkhart River (Site 5), Waterhouse Ditch-Henderson Lake (Site 6), Clock Creek (Site 7), Jones Lake-North Branch Elkhart River (Site 8), Huston Ditch-North Branch Elkhart River (Site 10), Winebrenner Branch-Carrol Creek (Site 15), Tamarack Lake-Little Elkhart Creek (Site 4) and Whetten Ditch-Elkhart River Site 20) rated as poor. In total, six stream sites' habitat scored above the QHEI target (51). The Elkhart River (Site 17) rated as excellent, while North Branch-Elkhart River (Site 3), South Branch Elkhart River (Site 13), Stony Creek (Site 18), Solomon Creek (Site 19) and the Elkhart River (Site 20) rated as good.

Table 73. Biological and habitat assessment summary for Upper Elkhart River Watershed streams. Green shading indicates the highest rated stream reaches, while red indicates the poorest rated reaches.

Site	Subwatershed	QHEI Rating and Score		mIBI Rating and Score	
1	Oliver Lake-Little Elkhart Creek	Not assessed			
2	Oliver Lake-Little Elkhart Creek	Very Poor	15	Very poor	22
3	Dallas Lake-Little Elkhart Creek	Good	58	Fair	38
4	Tamarack Lake-L Elkhart Creek	Poor	39	Poor	34
5	Oviate Ditch-MB Elkhart River	Poor	43	Poor	30
6	Waterhouse-Henderson Lake	Poor	31	Poor	30
7	Jones Lake-NB Elkhart River	Poor	50	Fair	44
8	Jones Lake-NB Elkhart River	Poor	49	Poor	30
9	Jones Lake-NB Elkhart River	Not assessed			
10	Huston Ditch-NB Elkhart River	Fair	52	Poor	30
11	Diamond Lake-SB Elkhart River	Not assessed			
12	Skinner Lake-Croft Ditch	Poor	32.5	Fair	42
13	Muncie Lake-SB Elkhart River	Good	69	Fair	40
14	Rivir Lake-Forker Creek	Very Poor	22	Poor	24
15	Winebrenner Branch-Carrol Creek	Very Poor	27	Poor	32
16	Headwaters Solomon Creek	Poor	31	Poor	28
17	Indian Lake-Elkhart River	Excellent	73	Fair	42
18	Philips Ditch-Stony Creek	Good	65	Poor	26
19	Hire Ditch-Solomon Creek	Good	63	Fair	36
20	Whetten Ditch-Elkhart River	Good	57.5	Poor	34

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 damages. Sediment deposition in streams reduces channel capacity and result in flooding damages. The water storage capacity of a reservoirs 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 of the construction 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 112 details the sediment delivery ratio for each agricultural field in the Upper 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.

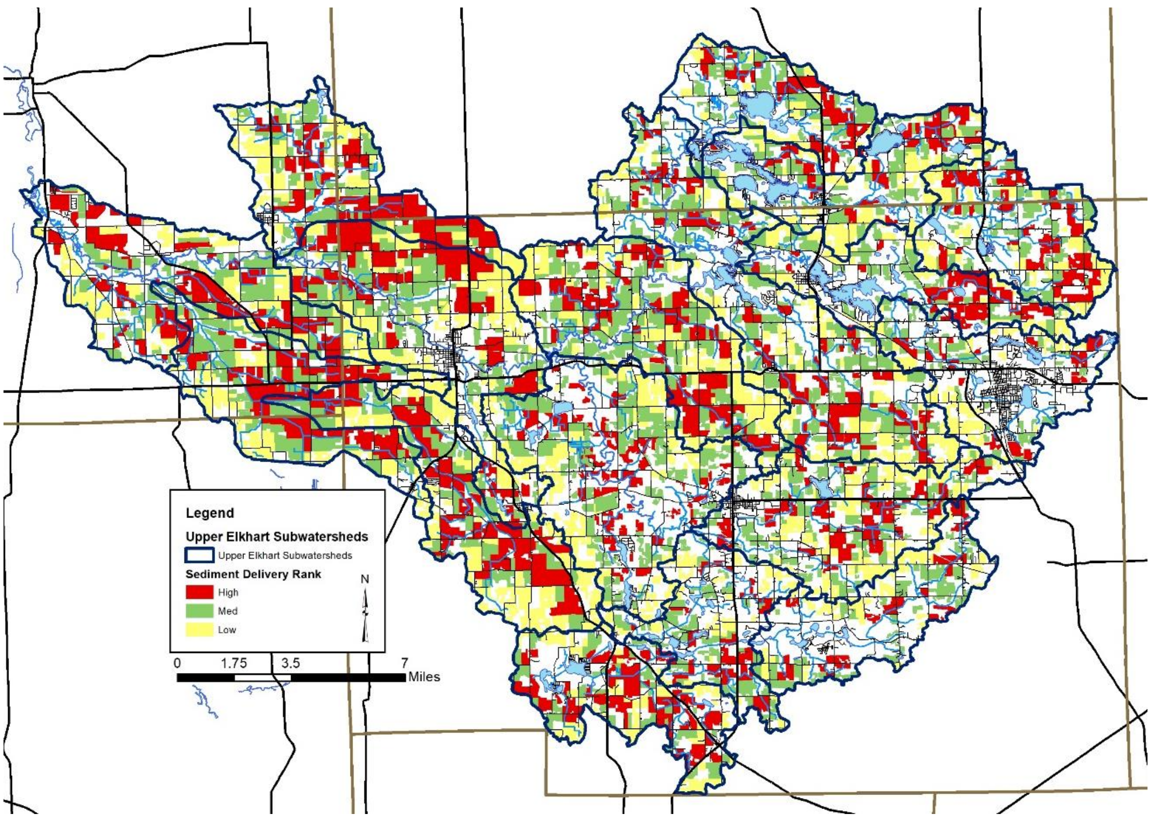


Figure 112. Sediment delivery ratio developed using ACPF for the Upper Elkhart River Watershed.

Similarly, runoff risk calculates the direct runoff contribution to stream channels in the watershed. Runoff risk prioritize 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 113 details the runoff risk for farm fields in the Upper 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.

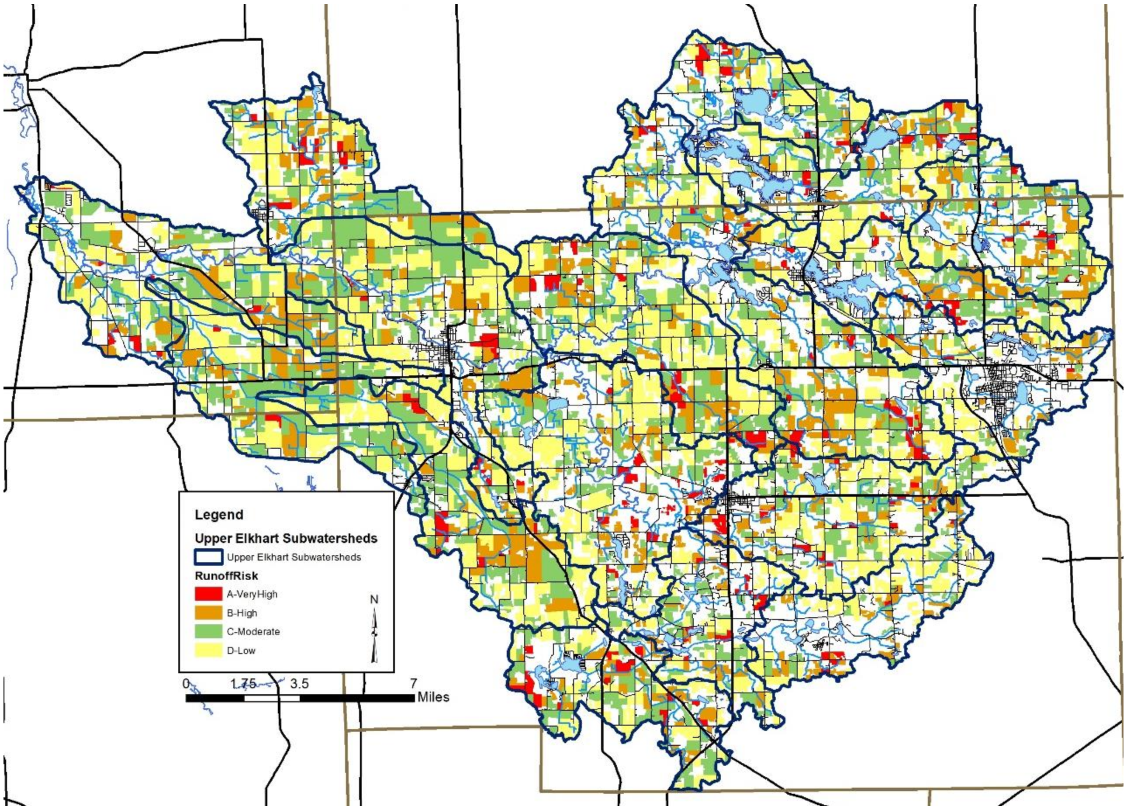


Figure 113. Runoff risk ratio developed using ACPF for the Upper Elkhart River Watershed.

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 74. 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:

- Property value impacts to lakeside residents (poor water quality).
- Growing Canada goose, mute swan population.
- Fish kills after heavy rains (pollutants in the runoff).
- The Wolcottville town dam provided historic recreation opportunities with pond, beach and more post failure in the 1950s – maintain and manage as it was historically.
- Combined Sewer Overflows – E. coli, nutrients – long term control- concern noted that Kendallville may have CSOs however their CSOs have been mitigated.
- Concerned over attempts to make the Elkhart River a legal drain: concern over drainage policy in general.
- Heavy metal accumulation in lake bottom sediments – more data are needed to determine if this is an issue on which the committee should focus.

Table 74. Analysis of stakeholder concerns identified in the Upper Elkhart River Watershed.

<table>
<tr><th>Concern</th><th>Supported by our data?</th><th>Evidence</th><th>Able to Quantify?</th><th>Outside Scope?</th><th>Group wants to focus on?</th></tr>
<tr><td>Poor water quality (sediment, nutrients, pathogens)</td><td rowspan="3">Yes</td><td rowspan="3">18% of TSS, 29% of TP, 99% of nitrate and 35% of E. coli samples collected (Feb-Sept) during the WMP monitoring exceed water quality targets.

33% of E. coli, 18% of TSS samples, 62% of TP, 71% of nitrate samples collected historically exceed water quality targets.

13.3 miles of stream are impaired for nutrients, 184.3 miles are impaired for E. coli, 5.3 miles are impaired for biotic communities, 17 miles are impaired for DO.</td><td rowspan="3">Yes</td><td rowspan="3">No</td><td rowspan="3">Yes</td></tr>
<tr><td>Excessive sediment load</td></tr>
<tr><td>Elevated turbidity, phosphorus and E. coli and impacts on water quality</td></tr>
<tr><td>Sediment accumulation in river and lakes</td><td>Yes</td><td>While data have not been collected for all lakes, sediment removal plans developed for the Goshen Dam Pond (downstream of the Upper watershed), Adams, Bixler, West & Five Lakes and others indicate more than 62 ac of dredging to remove more than 975,000 cu yds of accumulated sediment are needed. This sediment originated from the watershed.</td><td>Yes</td><td>No</td><td>Yes</td></tr>
<tr><td>In lake water quality – poor transparency, elevated nutrient levels</td><td>Yes</td><td>ICLP data collected in the last 10 years indicate that 35% of transparency, 15% of TP, 19% of chlorophyll α and 87% of nitrate samples exceed the average level for Indiana lakes.

Poor DO levels</td><td>Yes</td><td>No</td><td>Yes</td></tr>
<tr><td>Property value impacts to lakeside residents (poor water quality)</td><td>No</td><td>Local data are not available. However, research indicates that values for lake property increase when water quality is better (deeper transparency, lower nutrient levels).</td><td>No</td><td>Yes</td><td>No</td></tr>
</table>

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Vegetation growth due to eutrophication in lakes and streams	Yes	Adams, Atwood, Cree, Five Lakes, Oliver-Olin, Sylvan and West Lakes completed an aquatic vegetation management plan since 2009. All plans note the increase in aquatic plant growth and presence of invasive species (Eurasian watermilfoil, curly leaf pondweed) and need to vegetation control. Sylvan Lake shows low plant growth in areas which is of concern. Seeking advice from DNR.	Yes	No	Yes
Blue green algae blooms on lakes	Yes	HAB data have not been collected; however, regional data indicate algal blooms are increasing in rate and duration. ICLP data indicate that 65% of lakes sampled possess plankton communities which are dominated by blue-green algae.	Yes	No	Yes
Nutrient loading due to the use of (lawn, agriculture) fertilizers	Yes	NASS estimates (2005) indicates that approximately 22,000 tons of atrazine and 10,800 tons of glyphosate are applied to cropland in the Upper Elkhart Watershed counties annually. IN state chemists office documents 136,090 tons of fertilizer used in 2015 (most recent data). No data are available for residential use.	Yes	No	Yes
Illicit Discharge	Yes	The City of Kendallville and Elkhart County MS4s maintain illicit discharge lists for locations within their jurisdiction. City of Kendallville working to compile data related to IDDE. Data not available as of November 2023.	Yes	No	Yes
Livestock access to surface waters within the watershed	Yes	Livestock have access to 3.5 miles of stream. Additional access is likely present but was not observed during the windshield survey.	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Non-point source pollution (agricultural row crop, yard waste, animal runoff & septic) Confined feeding operations, concentrated animal feeding operation impacts Manure volume produced from unregulated, animal operations and CFO/CAFO in the watershed	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 3.5 miles of watershed streams. Additional access is likely present but was not observed during the windshield survey. 397,000 animals are permitted on CFOs in the watershed producing more than 716,764 tons of manure annually.	Yes	No	Yes
Impacts of City of Kendallville WWTP impacts on Henderson Lake and Sylvan Lake	Yes	As recently as April 2022, the Kendallville WWTP had an unsatisfactory rating due to effluent discharge. Multiple violations occurred in 2021-2022 including high flow events, unhealthy biomass dating. IDEM and the City of Kendallville are working to formulate a plan to minimize loading, increase treatment capacities to treat the wastewater stream and remain in consistent compliance with the City of Kendallville NPDES permit.	Yes	No	Yes
Streambank and bed erosion Concerns about unregulated drain erosion, working with private landowners Streambank deterioration, especially along legal drains, caused by severe erosion.	Yes	20.6 miles of stream were noted to have streambank erosion in the windshield survey. Additional erosion is likely present but was not observed during the windshield survey.	Yes	No	Yes
Henderson Lake – very high nutrient levels/dead lake – suggested no swimming/bodily contact by City of Kendallville	Yes	ICLP data indicate transparency measures 1.3 feet, elevated conductivity (1600 µmhos/cm), nitrate concentrations more than	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Combined Sewer Overflows – E. coli, nutrients – long term control- Kendallville may have CSOs.	Yes	500 times that average for IN lakes, TP concentrations 6 times the level at which eutrophication occurs and elevated plankton density and chlorophyll α concentrations. The City of Kendallville notes that one CSO remains on their system which overflows to Henderson Lake. This outfall discharges into the stream that runs directly into Henderson Lake. This Lake is designated a no contact body of water. Swimming is not permitted, and it is NOT a source of drinking water.	Yes	No	Yes
Growing Canada goose, mute swan population	No	Population density data are not available. Anecdotal evidence based on communication with lake residents. Committee would like to source assess E.coli to determine if birds are an issue. Current project does not allow for this as a fund allocation.	No	Yes	No, unless E. Coli source tracking indicates geese are an issue
Septic systems, maintenance needed, density, straight pipes, small leach beds	Yes	94% of the watershed is covered by soils that are considered very limited for use in septic tank absorption fields. Maintenance data are not available but anecdotal information suggests that straight pipes and facility maintenance is an issue in the watershed.	Yes	No	Yes
Increases in impervious surface in the watershed	Yes	Current estimates indicate 8% urban land cover in the Upper Elkhart, which contains mostly small-medium sized towns and cities.	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Stormwater impacts Increased intensity and duration of rain events	Yes	Urban land use covers 8% of the watershed. Two MS4 communities, City of Kendallville and Elkhart County, are present. Approximately 36% of the watershed uses tile drains to move water off of agricultural land. 39% of historic wetlands have been modified based on hydric soils coverage. 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.	Yes	No	Yes
Fish community impacts of poor water quality (streams)	Yes	Only 2 of 21 fish community assessments indicate that the fish community does not meet its aquatic life use designation. However, anecdotal information suggests a decline in fish community.	Yes	No	Yes
Fish consumption advisories Mercury and PCBs in fish tissue	Yes	Consumption advisories for sensitive populations are in place for Skinner Lake, Sylvan Lake, Oliver Lake and the Elkhart River in Elkhart County. 9.7 stream miles and 1,173 lake acres are listed as impaired for PCBs in fish tissue and 0.5 stream miles and 24 lake acres are listed for mercury in fish tissue.	Yes	Yes	Yes, education only
Fish kills after heavy rains (pollutants in the runoff)	No	Kendallville fish kills 2020, 2021 – caused by water quantity not quality as fish moved into an area and died due to dropping water level.	Yes	Yes	No
Floodplain development Development/encroachment on the floodplain	Yes	Floodplain covers 8% of the watershed. 73% of floodplain is mapped in forest, wetland or open water; 3% is developed and 22% is used for agricultural row crop or pastureland.	Yes	No	Yes

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 36% of the watershed. Nearly 200 miles of regulated drains are located in the watershed.	Yes	No	Yes
Too much water received in waterbodies during storm events; inability of the watershed to absorb additional quantities of water					
Maintaining drainage and floodplain					
Water quantity					
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)					
Continue sewer development on pace with development; Areas that are developed but are not sewered needs to be mapped	Yes	14 WWTP/RSDs provide treatment including Adams Lake RSD, Albion WWTP, Bear High Wolf Lake RSD, Cromwell WWTP, Kendallville WWTP, Lagrange County Regional Sewer District, Ligonier WWTP, Millersburg WWTP, New Paris Conservancy WWTP, Rome City WWTP, Skinner Lake RSD, Turkey Creek RSD, West Lakes RSD, Wolcottville WWTP and Chain-O-Lakes State Park	Yes	No	Yes
The Wolcottville town dam provided historic recreation opportunities with pond, beach and more post failure in the 1950s – maintain and manage as it was historically	No	Anecdotal data indicates historic recreational activity was prevalent at this location.	No	Yes	No
Explore the need for dam removal – Elkhart County Parks Baintertown and Benton dam	Yes	Benton and Baintertown Dam Feasibility Study identifies options for dam removal and structure replacement. ECP is working through funding sources at this time which will likely focus on partial removal and rock riffle placement at Baintertown and full removal at Benton.	Yes	No	Yes
Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage					

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Interest in making drains more natural, install buffer strips between agricultural land	Yes	63.8 miles of streams with narrow buffer and 20.8 miles of streambank erosion were observed during the windshield survey.	Yes	No	Yes
Managing drains to reduce sediment loading (two stage, buffer strip incentives)	Combine with above	Local and regional data indicate that drain management can reduce sediment loading to adjacent waterbodies.			
Maintain discharge for drains to keep the Elkhart River healthy (keep the river clean by keeping the tributaries clean)	No	Perception among the drainage community that more instream flow, less downed wood improves instream condition.	No	Yes	Yes, education
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.	Yes	No	Yes
Look at irrigation data/well sensitivity, runoff from irrigated areas	Yes	Data from the IN Chamber indicates that 56.8 MGD of water is used for irrigation in Upper Elkhart River Counties. Interest in completing a water study for the Upper Elkhart (St Joe) River.	Yes	No	Yes
Long-term viability of the watershed as an irrigation source (both surface and ground water quantity issues)					
Recreational use of the river and lakes	Yes	The DNR, TNC, ACRES, Lagrange County, Cromwell, Kendallville, Rome City and Ligonier Park Boards and Goshen College maintain, preserve and protect natural areas in the watershed. 16 river and lake public access sites are located within the watershed.	Yes	No	Yes
Loss of habitat for ETR species					
Maintaining natural areas and providing access to local residents					
Wetland loss	Yes	Wetlands cover 17% of the watershed. It is estimated that 39% of wetlands have been modified or lost over time. More than 198 miles of surface drains have been constructed in the watershed.	Yes	No	Yes
Loss of habitat with increased development					
Preservation of wetlands to protect floodplain areas					
Eve Lake still has a cisco population - how can we protect this, are there other lakes with cisco still present?	Yes	ETR data indicate cisco populations resided in Eve, Martin, Olin, Oliver, Hackenburg, Messick, Atwood and Witmer Lakes. The most recent ETR data (1990) indicated cisco were present in Eve Lake.	Yes	No	Consider when prioritizing critical /priority areas

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Preserve a natural buffer along the water. Need proper planning of developments	Yes	63.8 miles of streams with narrow buffer.	Yes	No	Yes
Maintaining natural areas and providing access to local residents		55 terrestrial high quality natural terrestrial communities including Mesic Floodplain Forest, wet Floodplain Forest, Wet-mesic Floodplain Forest, Northern Lakes Dry-mesic Upland Forest, Northern Lakes Dry Upland Forest, Lake, Pond, Marl Beach, Acid Bog, Circumneutral Bog, Fen, Forested Fen, Marsh, Sedge Meadow, Forested Swamp, and Shrub Swamp were identified as part of the ETR database search. Access sites, trails data needs added – interest in adding access in Pettite Park in Ligonier			
Logjams	Yes	Logjams were identified during the windshield inventory. Ash trees continue to die and fall into rivers and streams. Anecdotal information documents the presence of logjams. Anecdotal information documents the impacts of beavers in the watershed. No data have been collected on their impacts.	Yes	No	Yes
Addressing beaver dams and logjams for recreation, flood storage and flow conveyance					
Invasive species	Yes	Anecdotal information documents the presence of invasive species. However, lists have not been generated.	Yes	No	Yes
Agricultural BMP implementation is needed	Yes	ICP data indicate that agricultural BMP adoption is occurring within the watershed.	Yes	No	Yes
Engaging agricultural and urban landowners to implement BMPs	Yes	Anecdotal evidence based on communication with stakeholders.	Yes	No	Yes
Maintenance of previously installed best management practices					

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Be holistic and work across the watershed with the goal of no negative impact to any other area of the basin Building cohesion with groups across the basin	Yes	Supporting efforts across the basin is a necessary part of watershed planning	Yes	No	Yes
Perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns.	No	Anecdotal evidence based on communication with stakeholders.	No	No	Yes, education
Watershed lake overuse (bass tournaments, boat density, lack of facilities as access points)	Yes	Five Lakes, West Lakes, Sylvan Lake and others host multiple BASS tournaments per summer with 18 listed on these lakes in July 2023 alone.	Yes	No	Yes
Impediments to navigation (barbed wire, low head dams)	Yes	Anecdotal evidence based on personal observation/communication with stakeholders	Yes	No	Yes
Limited recreation access points	Yes	Public access sites are readily available for most public freshwater lakes in the watershed; however, stream access points are limited.	Yes	No	Yes
In lake boating/shallow boating impacts	Yes	Anecdotal information indicates shallow lake boating resuspends sediment and increases nutrient levels.	Yes	No	Yes
Heavy metal release from in lake treatment.	No	A better understanding of heavy metal accumulation in lake sediment and its potential impact is needed.	No	Yes	More data needed

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 75. Problems represent the condition that exists due to a particular concern or group of concerns, then details potential causes of problems identified.

Table 75. Problems and causes identified for the Upper Elkhart River watershed based on stakeholder and inventory concerns.

Concern(s)	
• Poor water quality (sediment, nutrients, pathogens) • Elevated turbidity, phosphorus and E. coli and impacts on water quality • In lake water quality – poor transparency, elevated nutrient levels • Livestock access to surface waters within the Watershed • Streambank and bed erosion • Concerns about unregulated drain erosion, working with private landowners • Stream bank deterioration, especially along legal drains, caused by severe erosion. • Stormwater impacts • Increases in impervious surface in the watershed • 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) • Development/encroachment on the floodplain • Perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns. • Excessive sediment load • Sediment accumulation in river and lakes • Managing regulated drains to reduce sediment loading (two stage, buffer strip incentives) • In lake/shallow lake boating impacts • Maintain outfall for regulated drains to keep the Elkhart River healthy (keep the river clean by keeping the tributaries clean)	**Problem** Sediment: area streams are cloudy/turbid **Cause(s)**: Suspended Sediment concentration levels exceed the target set by this project
• Poor water quality (sediment, nutrients, pathogens) • Elevated turbidity, phosphorus and E. coli and impacts on water quality • In lake water quality – poor transparency, elevated nutrient levels • Vegetation growth due to eutrophication in lakes and streams • Blue green algae blooms on lakes	**Problem** Nutrients: Area streams have nutrient levels exceeding the target set by this project **Cause(s)**: Nutrient levels exceed the target set by this project Targeted nutrient reduction education does not exist

Concern(s)	
• Non-point source pollution (agricultural row crop and animal runoff & septic) • Nutrient loading due to the use of (lawn, agriculture) fertilizers • Impacts of City of Kendallville WWTP impacts on Henderson Lake and Sylvan Lake • Henderson Lake – very high nutrient levels/dead lake – suggested no swimming/bodily contact by City of Kendallville • Illicit Discharge • Livestock access to surface waters within the Watershed • Streambank and bed erosion • Concerns about unregulated drain erosion, working with private landowners • Stream bank deterioration, especially along legal drains, caused by severe erosion. • Septic systems, maintenance needed, density, straight pipes, small leach beds • Stormwater impacts • Increases in impervious surface in the watershed • 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) • Development/encroachment on the floodplain • Continue sewer development on pace with development- areas that are developed but are not sewered needs to be mapped • Perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns. • Confined feeding operations, concentrated animal feeding operation impacts • Manure volume produced from unregulated, animal operations and CFO/CAFO in the watershed • In lake/shallow lake impacts • Nutrient impacts from yard waste • Maintain outfall for regulated drains to keep the Elkhart River healthy (keep the river clean by keeping the tributaries clean)	

<table>
<tr><th>Concern(s)</th><th></th></tr>
<tr><td rowspan="2">Poor water quality (sediment, nutrients, pathogens)
Elevated turbidity, phosphorus and E. coli and impacts on water quality
In lake water quality – poor transparency, elevated nutrient levels
Livestock access to surface waters within the Watershed
Confined feeding operations, concentrated animal feeding operation impacts
Manure volume produced from unregulated, animal operations and CFO/CAFO in the watershed
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)
Perception of health of river, lakes and streams - E coli, cryptosporidium, harmful algal blooms other aquatic health concerns.
Non-point source pollution (agricultural row crop and animal runoff & septic)
Impacts of City of Kendallville WWTP impacts on Henderson Lake and Sylvan Lake
Illicit Discharge
Septic systems, maintenance needed, density, straight pipes, small leach beds
Continue sewer development on pace with development- areas that are developed but are not sewered needs to be mapped</td><td>Problem: E. coli: Area streams are impaired for recreational contact by IDEM’s 303(d) list</td></tr>
<tr><td>Cause(s): E.coli levels exceed the water quality standard</td></tr>
<tr><td rowspan="2">Flooding
Too much water received in Rome City during storm events
Water quantity
Maintaining drainage and floodplain
Wetland loss
Preservation of wetlands upstream, to protect floodplain areas
Floodplain and riparian development
Loss of habitat with increased development
Increased intensity and duration of rain events
Look at irrigation data/well sensitivity, runoff from irrigated areas</td><td>Problem: Reduced water storage, retention and infiltration</td></tr>
<tr><td>Cause(s): Potential Cause(s):
-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.</td></tr>
</table>

Concern(s)	
• Long-term viability of the Watershed as an irrigation source (both surface and ground water quantity issues)	-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.
• Loss of habitat with increased development • Explore the need for dam removal – Elkhart County Parks Baintertown and Benton dam • Evaluate dam removal or dam modifications to assist with upstream and downstream fish passage • Recreational use of the river and lakes • Interest in making legal drains more natural, install buffer strips between agricultural • Loss of habitat for ETR species • Maintaining natural areas and providing access to local residence • Preserve a natural buffer along the water. Need proper planning of developments • Eve Lake still has a cisco population - how can we protect this population as well as any other lakes where cisco are still present • Invasive species • Addressing beaver dams and logjams for recreation, flood storage and flow conveyance • Logjams • Watershed lake overuse (bass tournaments, boat density, lack of facilities as access points) • Impediments to navigation (barbed wire, low head dams) • Limited recreation access points	**Problem**: Need to promote and maintain recreation on lakes and rivers; preserve natural areas and access to parks **Cause(s)**: -Unsafe water for swimming and boating -Concern for long term negative impacts to recreation

Concern(s)	
• Building cohesion with groups across the basin Agricultural and urban BMP implementation is needed • Engaging agricultural and urban landowners to implement BMPs for land use and construction • Maintenance of previously installed best management practices • Be holistic and work across the watershed with the goal of no negative impact to any other area of the basin Heavy metal releases from in lake treatment – need a better understanding of heavy metal accumulation in lake sediment and potential impacts	**Problems:** - Unified group for the entire watershed does not exist - Education and outreach is needed **Cause(s):** -No effort to educate local officials, foundations, and other funding sources on the importance of watershed protection -Lack of public awareness of watershed issues and opportunities to implement agricultural and urban BMPs -Lack of unified government strategy about watershed management

7.0 SOURCE IDENTIFICATION AND LOAD CALCULATION

7.1 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 the pollutants of concern in the Upper 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 Upper 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)

7.1.1 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 Upper Elkhart River Watershed. Appendix D contains tables detailing each potential source within each subwatershed. Table 76 through Table 81 summarizes the magnitude of potential sources of pollution for each problem identified in the Upper 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 76. Potential sources causing sediment problems.

Problems:	Area streams are cloudy and turbid.
Potential Causes:	Suspended sediments and/or turbidity exceed target values set by this project.
Potential Sources:	• 20.6 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization found Skinner Lake-Croft Ditch, Rivir Lake-Forker Creek, Huston Ditch-North Branch Elkhart River, Waterhouse Ditch-Henderson Lake Ditch and Jones Lake-North Branch Elkhart River subwatersheds. • Livestock access (3.5 miles of streams) was observed in the Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Diamond Lake-South Branch Elkhart River and Philips Ditch-Stony Creek Subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 63.8 miles of stream lack adequate buffers with the highest percent of stream miles lacking buffer Headwaters Solomon Creek, Huston Ditch-North Branch Elkhart River, Hire Ditch-Solomon Creek, Winebrenner Branch-Carrol Creek, Skinner Lake-Croft Ditch and Whetten Ditch-Elkhart River subwatersheds. • 52-92% of soybean fields and 33-83% of corn fields are under conservation tillage on a county-wide basis. • Nearly 13,175 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Huston Ditch-North Branch Elkhart River, Oliver Lake-Little Elkhart Creek and Philips Ditch-Stony Creek subwatersheds. These operations can be sources due to livestock defecating in or near streams, soil compaction, streambank erosion, and improper manure storage and spreading. • 116,889 acres (45%) of highly erodible land occur within the watershed. The highest density of HES occurs in Rivir Lake-Forker Creek, Muncie Lake-South Branch Elkhart River, Waterhouse Ditch-Henderson Lake Ditch, Tamarack Lake-Little Elkhart Creek, Skinner Lake-Croft Ditch, Oviate Ditch-Middle Branch Elkhart River, Oliver Lake-Little Elkhart Creek, Diamond Lake-South Branch Elkhart River and Dallas Lake-Little Elkhart Creek subwatersheds. • The City of Kendallville and Elkhart County MS4s lie partially within the Upper Elkhart River Watershed.

Table 77. Potential sources causing nutrient problems.

Problems:	Area streams have nutrient levels exceeding the target set by this project.
Potential Causes:	Nutrient concentrations exceed target values set by this project. Targeted nutrient reduction education does not exist.
Potential Sources:	• 20.6 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization found Skinner Lake-Croft Ditch, Rivir Lake-Forker Creek, Huston Ditch-North Branch Elkhart River, Waterhouse Ditch-Henderson Lake Ditch and Jones Lake-North Branch Elkhart River subwatersheds. • Livestock access (3.5 miles of streams) was observed in the Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Diamond Lake-South Branch Elkhart River and Philips Ditch-Stony Creek Subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 63.8 miles of stream lack adequate buffers with the highest percent of stream miles lacking buffer Headwaters Solomon Creek, Huston Ditch-North Branch Elkhart River, Hire Ditch-Solomon Creek, Winebrenner Branch-Carrol Creek, Skinner Lake-Croft Ditch and Whetten Ditch-Elkhart River subwatersheds. • 52-92% of soybean fields and 33-83% of corn fields are under conservation tillage on a county-wide basis. • Nearly 13,175 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Huston Ditch-North Branch Elkhart River, Oliver Lake-Little Elkhart Creek and Philips Ditch-Stony Creek 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 397,015 animals are permitted on confined feeding and concentrated animal feeding operations in the watershed. Animals are most dense in the Whetten Ditch-Elkhart River, Philips Ditch-Stony Creek, Jones Lake-North Branch Elkhart River, Huston Ditch-North Branch Elkhart River and Indian Lake-Elkhart River subwatersheds. • Animals in the watershed produce more than 963,282 tons of manure annually which produces 8,694,744 tons of nitrogen, 6,884,748 tons of phosphorus and 5.49xE19 colonies of E. coli annually. • 116,889 acres (45%) of highly erodible land occur within the watershed. The highest density of HES occurs in Rivir Lake-Forker Creek, Muncie Lake-South Branch Elkhart River, Waterhouse Ditch-Henderson Lake Ditch, Tamarack Lake-Little Elkhart Creek, Skinner Lake-Croft Ditch, Oviate Ditch-Middle Branch Elkhart River, Oliver Lake-Little Elkhart Creek, Diamond Lake-South Branch Elkhart River and Dallas Lake-Little Elkhart Creek subwatersheds. • Soils which are severely limited for septic use cover 241,951 or 94% of the Upper Elkhart River Watershed. Failing septic systems could contribute *E. coli* to the system within the rural portion of the watershed. • The City of Kendallville and Elkhart County MS4s lie partially within the Upper Elkhart River Watershed.

Table 78. Potential sources causing *E. coli* problems.

Problems:	Area streams are listed by IDEM as impaired for recreational contact by IDEM's 303(d) list.
Potential Causes:	*E. coli* concentrations exceed target values and the state standard.
Potential Sources:	• 20.6 miles of stream lack adequate stabilization, with the highest percent of stream miles lacking stabilization found Skinner Lake-Croft Ditch, Rivir Lake-Forker Creek, Huston Ditch-North Branch Elkhart River, Waterhouse Ditch-Henderson Lake Ditch and Jones Lake-North Branch Elkhart River subwatersheds. • Livestock access (3.5 miles of streams) was observed in the Huston Ditch-North Branch Elkhart River, Rivir Lake-Forker Creek, Diamond Lake-South Branch Elkhart River and Philips Ditch-Stony Creek Subwatersheds. This does not mean livestock do not have access at other locations, but rather they were not observed during the windshield survey. • 63.8 miles of stream lack adequate buffers with the highest percent of stream miles lacking buffer Headwaters Solomon Creek, Huston Ditch-North Branch Elkhart River, Hire Ditch-Solomon Creek, Winebrenner Branch-Carrol Creek, Skinner Lake-Croft Ditch and Whetten Ditch-Elkhart River subwatersheds. • Nearly 13,175 animals were observed on unregulated animal operations throughout the watershed. The highest density of animals was identified in the Huston Ditch-North Branch Elkhart River, Oliver Lake-Little Elkhart Creek and Philips Ditch-Stony Creek 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 397,015 animals are permitted on confined feeding and concentrated animal feeding operations in the watershed. Animals are most dense in the Whetten Ditch-Elkhart River, Philips Ditch-Stony Creek, Jones Lake-North Branch Elkhart River, Huston Ditch-North Branch Elkhart River and Indian Lake-Elkhart River subwatersheds. • Animals in the watershed produce more than 963,282 tons of manure annually which produces 8,694,744 tons of nitrogen, 6,884,748 tons of phosphorus and 5.49xE19 colonies of E. coli annually. • Soils which are severely limited for septic use cover 241,951 or 94% of the Upper Elkhart River Watershed. Failing septic systems could contribute *E. coli* to the system within the rural portion of the watershed.

Table 79. 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 80. 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 81. Potential sources causing education and cohesion problems.

Problems:	Unified group for the entire watershed does not exist. Education and outreach is needed.
Potential Causes:	No effort to educate local officials, foundations, and other funding sources on the importance of watershed protection. Lack of public awareness of watershed issues and opportunities to implement agricultural and urban BMPs. Lack of unified government strategy about watershed management.
Potential Sources:	N/A

7.2 Load Estimates

Nonpoint source pollution is generated from a variety of sources found on public and private lands. The US EPA 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 76 to Table 81 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 Upper 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. The steering committee considered the monitoring data to draft long term goals and critical areas. The fixed station data were used to calculate potential draft goals and then after discussion, were used to set long term and interim term goals as well as determine critical areas.

As discussed in Section 3.4, 20 monitoring sites were sampled monthly from February 2022 to January 2023. There is clear value in using these measurements from the Upper 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 three USGS gages were used to approximate flow. The Shatto Ditch near Mentone (USGS 03331224) was used to scale the flow for the Oliver Lake-Little Elkhart Creek sites (Site 1 and 2), the North Branch Elkhart River Cosperville (USGS 04100222) gage was used to scale flow for all other tributary stream sites (Sites

3-16, 18-19), while the Elkhart River at Goshen (USGS 04100500) was used to scale flow for the mainstem Elkhart River sites (Sites 17 and 20). Appendix C details loading rate calculations. As discussed in Section 3.1, the steering committee selected water quality benchmarks that will significantly improve water quality in Upper Elkhart River (Table 15). However, due drought conditions observed across the watershed which resulted in low volumes of surface and groundwater runoff, average concentrations for most parameters at most sites already meet the target concentrations originally selected by the steering committee. With this in mind, the steering committee set revised target concentrations (Table 82).

Table 82. Revised water quality benchmarks used to assess water quality from historic and current water quality assessments.

Parameter	Water Quality Target
E. coli	<125 colonies/100 mL
Nitrate-nitrogen	<1 mg/L
Total phosphorus	<0.05 mg/L
Total suspended solids	<5 mg/L

Target loads needed to meet these revised benchmarks were calculated for each subwatershed for each parameter. Sample site data from the subwatershed's pour point sampling site was used to calculate annual loading rates and load reductions. The load reduction needed was then calculated for each subwatershed, which corresponds to each sample site, in pounds or colonies per year and as a percent of the current load (Table 83 to Table 86). 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. To calculate the loading rate for the Oliver Lake-Little Elkhart Creek subwatershed, two watershed streams were sampled – the outlet of Hackenburg Lake and the outlet of Oliver Lake – and thus the loading rates for these two sampling locations were added to calculate the subwatershed's loading rate. As the loading rates are calculated based on the full drainage area to the sample point, Site 20 in the Whetten Ditch-Elkhart River subwatershed represents the total watershed loading rates.

Table 83. Estimated nitrogen load reduction by subwatershed needed to meet water quality target concentrations in the Upper Elkhart River Watershed.

Subwatershed	Sample Site	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	Percent Reduction
Tamarack Lake-Little Elkhart Creek	E04	106,572	43,416	63,156	59%
Dallas Lake-Little Elkhart Creek	E03	191,290	63,529	127,760	67%
Oliver Lake-Little Elkhart Creek	E01+E02	61,021	25,450	35,571	58%
Waterhouse Ditch-Henderson Lake	E06	105,783	40,010	65,773	62%
Oviate Ditch-MB Elkhart River	E05	164,575	75,543	89,032	54%
Jones Lake-NB Elkhart River	E09	535,390	280,201	255,189	48%
Huston Ditch-NB Elkhart River	E10	887,265	335,232	552,033	62%
Rivir Lake-Forker Creek	E14	117,813	40,600	77,212	66%
Winebrenner Branch-Carrol Creek	E15	118,508	37,983	80,524	68%
Skinner Lake-Croft Ditch	E12	160,574	23,097	137,477	86%
Muncie Lake-SB Elkhart River	E13	252,284	102,252	150,031	59%
Diamond Lake-SB Elkhart River	E11	638,377	238,160	400,217	63%
Philips Ditch-Stony Creek	E18	123,905	42,368	81,537	66%
Indian Lake-Elkhart River	E17	1,872,355	609,104	1,263,251	67%
Headwaters Solomon Ditch	E16	166,061	48,616	117,445	71%
Hire Ditch-Solomon Creek	E19	340,484	95,247	245,238	72%
Whetten Ditch-Elkhart River	E20	2,951,983	793,549	2,158,434	73%
Upper Elkhart River Watershed		**2,951,983**	**793,549**	**2,158,434**	**73%**

Table 84. Estimated phosphorus load reduction by subwatershed needed to meet water quality target concentrations in the Upper Elkhart River Watershed.

Subwatershed	Sample Site	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	Percent Reduction
Tamarack Lake-Little Elkhart Creek	E04	3,678	2,171	1,507	41%
Dallas Lake-Little Elkhart Creek	E03	4,669	3,176	1,493	32%
Oliver Lake-Little Elkhart Creek	E01+E02	2,488	1,273	1,216	49%
Waterhouse Ditch-Henderson Lake	E06	4,362	2,001	2,361	54%
Oviate Ditch-MB Elkhart River	E05	3,872	3,777	95	2%
Jones Lake-NB Elkhart River	E09	15,661	14,010	1,651	11%
Huston Ditch-NB Elkhart River	E10	26,587	16,762	9,825	37%
Rivir Lake-Forker Creek	E14	3,007	2,030	977	32%
Winebrenner Branch-Carrol Creek	E15	2,402	1,899	503	21%
Skinner Lake-Croft Ditch	E12	6,594	1,155	5,439	82%
Muncie Lake-SB Elkhart River	E13	6,750	5,113	1,637	24%
Diamond Lake-SB Elkhart River	E11	24,997	11,908	13,089	52%
Philips Ditch-Stony Creek	E18	9,073	2,118	6,954	77%
Indian Lake-Elkhart River	E17	91,349	30,455	60,894	67%
Headwaters Solomon Ditch	E16	2,450	2,431	19	1%
Hire Ditch-Solomon Creek	E19	6,108	4,762	1,346	22%
Whetten Ditch-Elkhart River	E20	58,220	39,677	18,542	32%
Upper Elkhart River Watershed		**58,220**	**39,677**	**18,542**	**32%**

Table 85. Estimated total suspended solids load reduction by subwatershed needed to meet water quality target concentrations in the Upper Elkhart River Watershed. NRN=No reduction needed

Subwatershed	Sample Site	Current Loading Rate (lb/year)	Target Loading Rate (lb/year)	Load Reduction (lb/year)	Percent Reduction
Tamarack Lake-Little Elkhart Creek	E04	409,887	217,080	192,807	47%
Dallas Lake-Little Elkhart Creek	E03	498,375	317,647	180,728	36%
Oliver Lake-Little Elkhart Creek	E01+E02	201,121	127,251	73,870	37%
Waterhouse Ditch-Henderson Lake	E06	827,783	200,052	627,731	76%
Oviate Ditch-MB Elkhart River	E05	991,156	377,716	613,441	62%
Jones Lake-NB Elkhart River	E09	3,227,459	1,401,004	1,826,456	57%
Huston Ditch-NB Elkhart River	E10	4,278,674	1,676,160	2,602,515	61%
Rivir Lake-Forker Creek	E14	242,823	203,002	39,821	16%
Winebrenner Branch-Carrol Creek	E15	255,380	189,917	65,463	26%
Skinner Lake-Croft Ditch	E12	457,041	115,483	341,558	75%
Muncie Lake-SB Elkhart River	E13	1,376,503	511,262	865,241	63%
Diamond Lake-SB Elkhart River	E11	1,025,069	1,190,800	NRN	NA
Philips Ditch-Stony Creek	E18	177,035	211,840	NRN	NA
Indian Lake-Elkhart River	E17	3,209,840	3,045,520	164,320	5%
Headwaters Solomon Ditch	E16	586,223	243,082	343,141	59%
Hire Ditch-Solomon Creek	E19	1,024,765	476,233	548,531	54%
Whetten Ditch-Elkhart River	E20	4,836,336	3,967,746	868,590	18%
Upper Elkhart River Watershed		**4,836,336**	**3,967,746**	**868,590**	**18%**

Table 86. Estimated E. coli load reduction by subwatershed needed to meet water quality target concentrations in the Upper Elkhart River Watershed. NRN=No reduction needed

Subwatershed	Sample Site	Current Loading Rate (col/year)	Target Loading Rate (col/year)	Load Reduction (col/year)	Percent Reduction
Tamarack Lake-Little Elkhart Creek	E04	2.21E+13	2.46E+13	NRN	NA
Dallas Lake-Little Elkhart Creek	E03	2.32E+13	3.60E+13	NRN	NA
Oliver Lake-Little Elkhart Creek	E01+E02	1.93E+13	1.44E+13	4.82E+12	25%
Waterhouse Ditch-Henderson Lake	E06	7.09E+13	2.27E+13	4.82E+13	68%
Oviate Ditch-MB Elkhart River	E05	2.40E+13	4.29E+13	NRN	NA
Jones Lake-NB Elkhart River	E09	4.76E+13	1.59E+14	NRN	NA
Huston Ditch-NB Elkhart River	E10	3.35E+14	1.90E+14	1.45E+14	43%
Rivir Lake-Forker Creek	E14	1.13E+13	2.30E+13	NRN	NA
Winebrenner Branch-Carrol Creek	E15	2.35E+13	2.16E+13	1.99E+12	8%
Skinner Lake-Croft Ditch	E12	9.30E+13	1.31E+13	7.99E+13	86%
Muncie Lake-SB Elkhart River	E13	2.55E+13	5.80E+13	NRN	NA
Diamond Lake-SB Elkhart River	E11	1.41E+14	1.35E+14	5.49E+12	4%
Philips Ditch-Stony Creek	E18	6.83E+13	2.40E+13	4.43E+13	65%
Indian Lake-Elkhart River	E17	3.72E+14	3.46E+14	2.62E+13	7%
Headwaters Solomon Ditch	E16	5.32E+13	2.76E+13	2.56E+13	48%
Hire Ditch-Solomon Creek	E19	1.17E+14	5.40E+13	6.32E+13	54%
Whetten Ditch-Elkhart River	E20	5.51E+14	4.50E+14	1.01E+14	18%
Upper Elkhart River Watershed		**5.51E+14**	**4.50E+14**	**1.01E+14**	**18%**

8.0 CRITICAL AND PRIORITY AREA DETERMINATION

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 E. 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. Each parameter's criterion is detailed in subsequent sections. Each subwatershed was scored based on the total number of criteria that were met (1=yes, 0=no) and the subwatersheds with the highest scores were prioritized as critical areas for each parameter. Appendix E includes these scoring details.

8.1 Critical Areas for Nitrate-Nitrogen and Total Phosphorus

Nitrate-nitrogen and total Kjeldahl nitrogen were the nitrogen form 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 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, the following datasets were priorities for nutrients critical areas:

- Manure N >100,000 lb/yr and manure P >20,000 lb/yr
- Nutrient impairments (303(d) listing) - any
- Historic nitrate >50% exceedance
- Historic TKN >50% exceedance
- Historic TP >50% exceedance
- Current Nitrate >50% exceedance
- Current TP>50% exceedance
- Agricultural land percentage >70%
- Urban land >10% of total

Critical subwatersheds were determined as follows: Tamarack Lake-Little Elkhart Creek (501), Waterhouse Ditch-Henderson Lake Ditch (504), Jones Lake-North Branch Elkhart River (506), Huston Ditch-North Branch Elkhart River (507), Skinner Lake-Croft Ditch (603), Diamond Lake-South Branch Elkhart River (605), Phillips Ditch-Stony Creek (801), Indian Lake-Elkhart River (802), Headwaters Solomon Creek (803), Hire Ditch-Solomon Creek (804), and Whetten Ditch-Elkhart River (802; Figure 114).

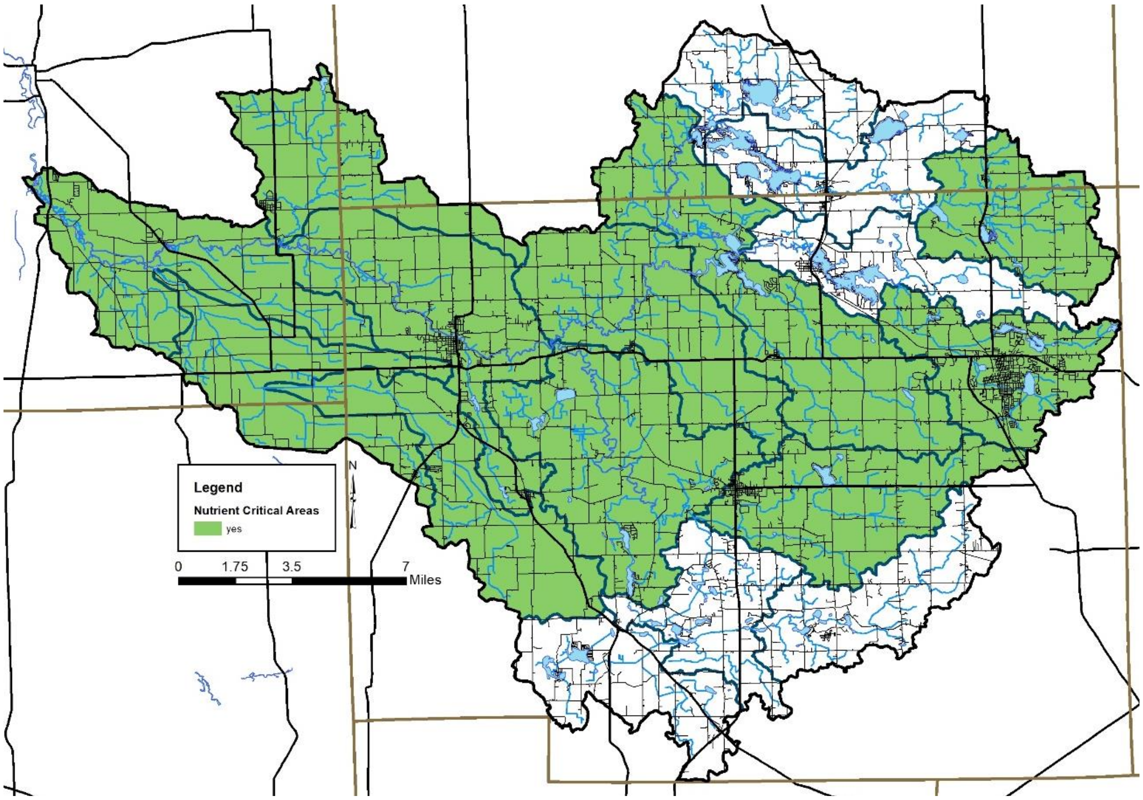


Figure 114. Critical areas for nutrients in the Upper Elkhart River Watershed.

8.2 Critical Areas for Sediment

Total suspended solids concentrations were used to determine sediment-based critical areas (Figure 115). Total suspended solids enter streams 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 the following datasets were priorities for sediment critical areas:

- HEL >50%
- Ag production >70%
- Streambank erosion >2%
- Narrow buffer >20%
- Historic TSS >30% exceedance
- Historic turbidity >50% exceedance
- Current TSS >25% exceedance
- Current turbidity >25% exceedance
- Urban land >10%

Critical subwatersheds were determined as follows: Waterhouse Ditch-Henderson Lake Ditch (504), Oviate Ditch-Middle Branch Elkhart River (505), Huston Ditch-North Branch Elkhart River (507), Skinner Lake-Croft Ditch (603), Muncie Lake-South Branch Elkhart River (604), Phillips Ditch-Stony Creek (801), Indian Lake-Elkhart River (802), Headwaters Solomon Creek (803), Hire Ditch-Solomon Creek (804), and Whetten Ditch-Elkhart River (805; Figure 115).

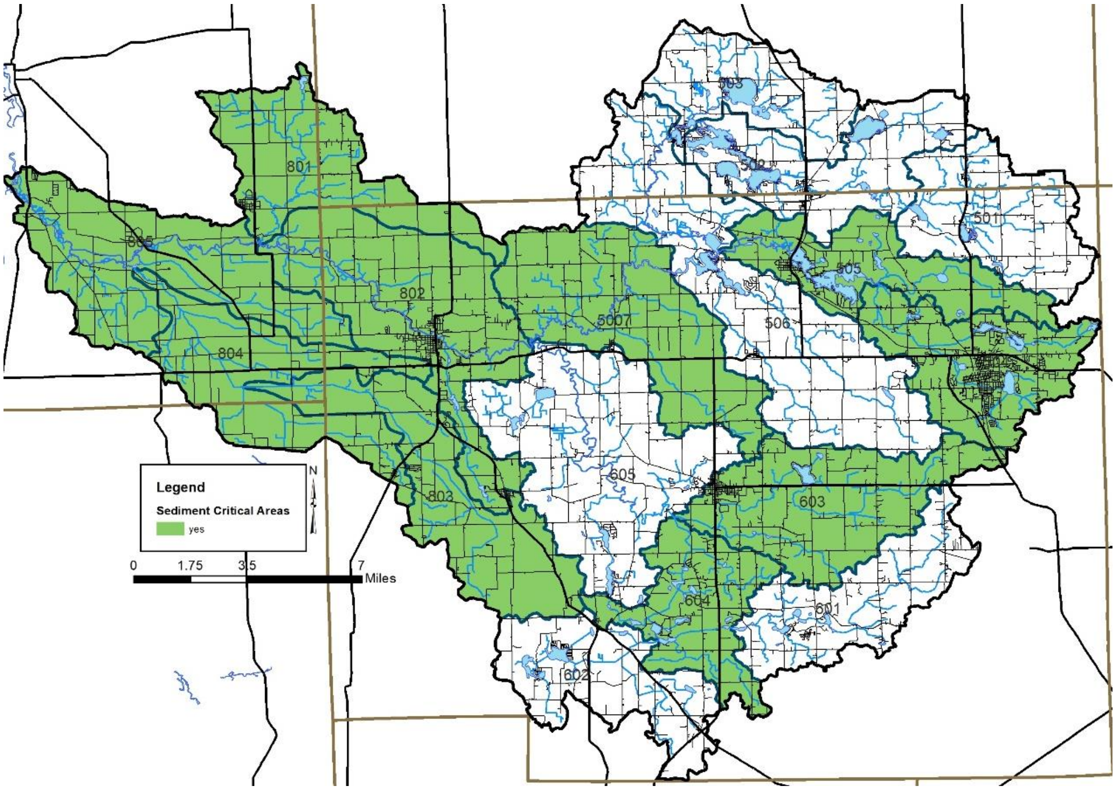


Figure 115. Critical areas for sediment in the Upper Elkhart River Watershed.

8.3 Critical Areas for *E. coli*

E. coli concentrations were used to determine *E. coli*-based critical areas (Figure 116). *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 the following datasets were priorities for sediment critical areas:

- E. coli impairment (303(d) listing) -any
- Manure volume>20,000 lb/year
- Historic E. coli >40% exceedance
- Current E. coli exceedance >50%
- Lack of sanitary sewer (number of address points not sewered/acre of subwatershed)>0.05 points/acre

Critical subwatersheds were determined as follows: Indian Dallas Lake-Little Elkhart Creek (502), Oliver Lake-Little Elkhart Creek (503), Waterhouse Ditch-Henderson Lake Ditch (504), Oviate Ditch-Middle Branch Elkhart River (505), Jones Lake-North Branch Elkhart River (506), Skinner Lake-Croft Ditch (603), Phillips Ditch-Stony Creek (801), Lake-Elkhart River (802), Solomon Creek (803), Hire Ditch-Solomon Creek (804) and Whetten Ditch-Elkhart River (805; Figure 116).

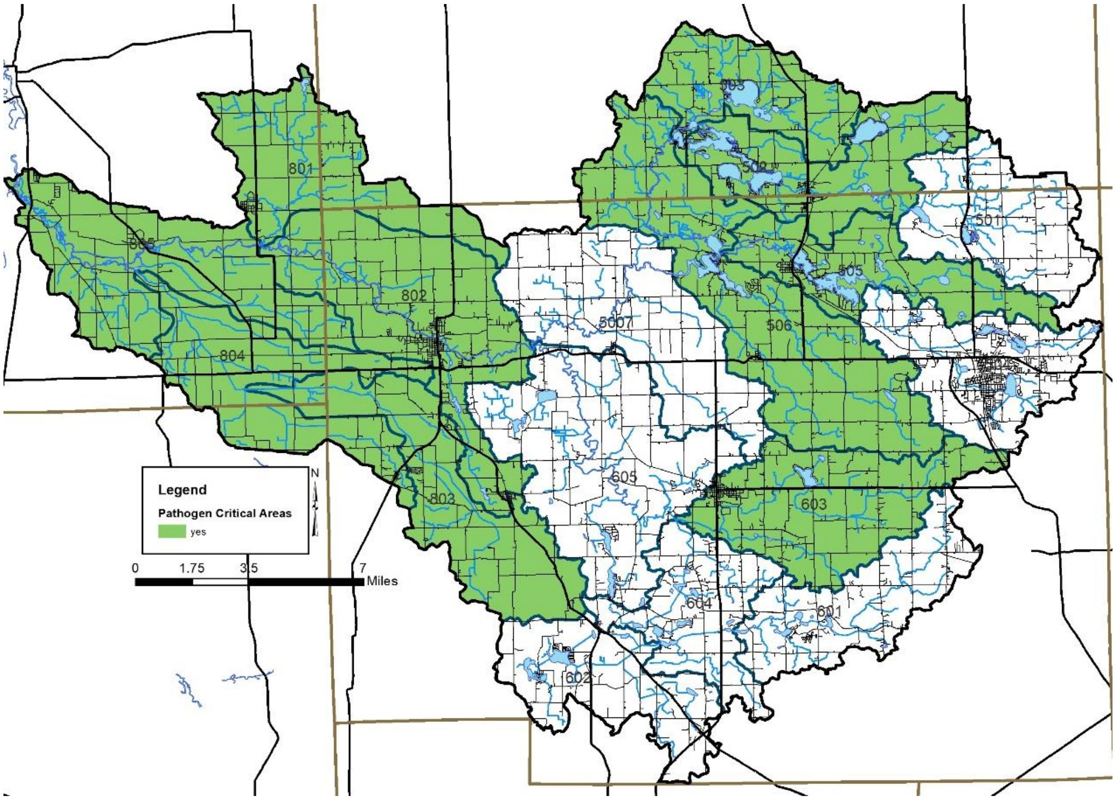


Figure 116. Critical areas for *E. coli* in the Upper Elkhart River Watershed.

8.4 Critical Areas Summary

The subwatersheds identified as critical areas for each parameter are summarized in Figure 114 to Figure 116 identify the highest priority subwatersheds, the steering committee decided to divide them into three tiers (high, medium and low priority), based on the number of parameters that were determined to be critical. The highest priority subwatersheds are those that were determined to be critical for three of the three potential parameters (nutrients, sediment, *E. coli*). The medium priority subwatersheds are those that were determined to be critical for two of three potential parameters. The lowest priority subwatersheds were critical for one of three potential parameters (Figure 117). Subwatersheds were prioritized as follows:

- High Priority: Skinner Lake-Croft Ditch (603), Phillips Ditch-Stony Creek (801), Indian Lake-Elkhart River (802), Headwaters Solomon Creek (803), Hire Ditch-Solomon Creek (804), Whetten Ditch-Elkhart River (805)
- Medium Priority: Waterhouse Ditch-Henderson Lake Ditch (504), Oviate Ditch-Middle Branch Elkhart River (505), Jones Lake-North Branch Elkhart River (506) and Huston Ditch-North Branch Elkhart River (507)
- Low Priority: Tamarack Lake-Little Elkhart Creek (501), Dallas Lake-Little Elkhart Creek (502), Oliver Lake-Little Elkhart Creek (503), Muncie Lake-South Branch Elkhart River (604) and Diamond Lake-South Branch Elkhart River (605)

Two subwatershed, Rivir Lake-Forker Creek (601) and Winebrenner Branch-Carrol Creek were not prioritized as critical areas meaning they were not identified as the areas of highest concern for any of the three parameters (nutrients, sediment, pathogen). 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 Upper 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.

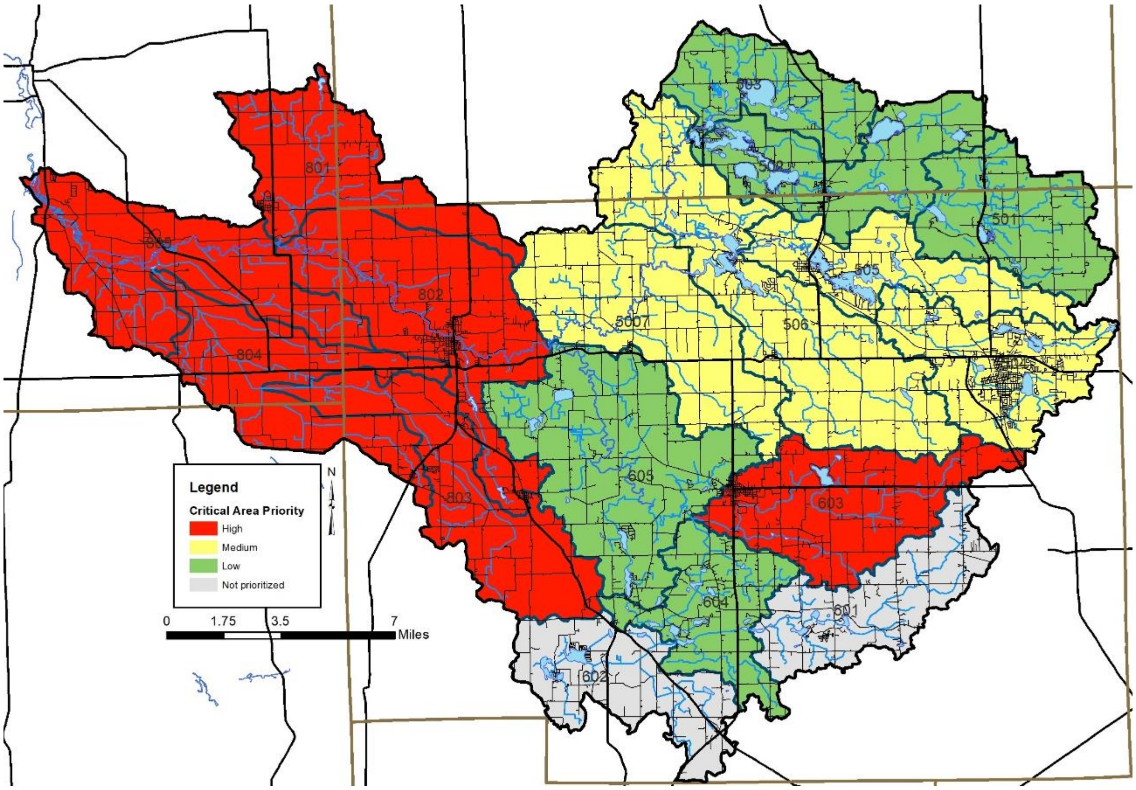


Figure 117. Prioritized critical areas in the Upper Elkhart River Watershed.

After setting initial goals, the steering committee reviewed the critical area map in light of the load reduction calculations which show that Headwaters Solomon Creek, Indian Lake-Elkhart River, Phillips Ditch-Stony Creek and Whetten Ditch-Elkhart River do not require sediment load reductions to meet water quality targets and Dallas Lake-Little Elkhart Creek, Headwaters Solomon Creek, Indian Lake-Elkhart River, Jones Lake-North Branch Elkhart River, Oliver Lake-Little Elkhart Creek and Whetten Ditch-Elkhart River do not require E. coli load reductions to meet the state standard and to determine if any areas might be missing from the critical areas map and/or if priority or protection areas needed to be established.

1. The steering committee reviewed historic water quality for sediment and E. coli and discussed resource concerns that were identified during initial critical area prioritization to determine whether critical area prioritization or loading rates should be the deciding factor for these critical areas.

   For sediment critical areas, the committee noted that streambank erosion, narrow buffers, agricultural land use and historic water quality data dominated prioritization of sediment critical areas for Philips Creek-Stony Creek, Indian Lake-Elkhart River and Whetten Ditch-Elkhart River. Additionally, current turbidity data exceeded targets for Headwaters Solomon Creek and

Whetten Ditch-Elkhart River and current TSS data exceeded targets for Headwaters Solomon Creek. The committee determined that these resource concerns are still present whether the sediment loading rates reflect these conditions or not and decided that these subwatersheds would rank as critical.

The committee further noted that E. coli impairments, lack of sanitary sewers, manure volumes estimated from CAFO/CFO and hobby farm counts and historic water quality data indicate that there are E. coli resource concerns present in Dallas Lake-Little Elkhart Creek, Headwaters Solomon Creek, Indian Lake-Elkhart River, Jones Lake-North Branch Elkhart River, Oliver Lake-Little Elkhart Creek and Whetten Ditch-Elkhart River subwatersheds. In total, more than 96 miles of streams are impaired for E. coli in these subwatersheds indicating that E. coli is reaching watershed streams but may have not been collected during the current monitoring effort. The committee determined that these resource concerns and impairments are still present whether E. coli loading rates reflect these conditions and decided that these subwatersheds would rank as critical.

2. The steering committee noted that the largest urban community in the watershed, the City of Kendallville, was located outside of the high priority critical areas. Committee members stressed the need to work with the predominantly urban community residents to address stormwater and wastewater concerns was imperative in the short term. Based on this input, the steering committee added the City of Kendallville as a high priority critical area. While the current city boundary is included to represent this critical area, the committee expressed a need to expand the critical area boundary with any changes to the City of Kendallville's boundaries in the future.

3. Additionally, the steering committee identified the need to protect current floodplains, natural areas and wetlands within the watershed. The committee stressed the need to protect these areas as little positive impact can occur to the Upper Elkhart Watershed if improvements to other areas occur but these areas are lost. Figure 118 shows the updated critical and priority areas highlighted by the Upper Elkhart River steering committee.

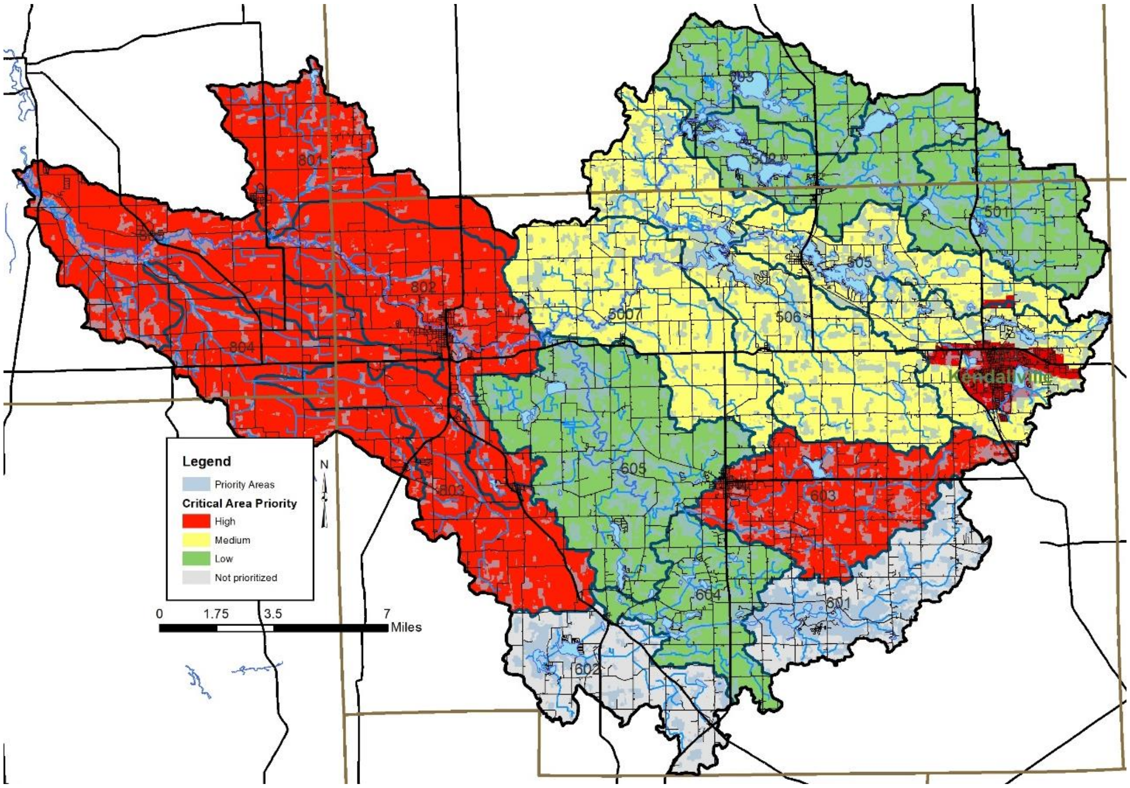


Figure 118. Critical areas prioritized via adaptive management in the Upper Elkhart River Watershed.

8.5 Reduced Water Storage, Retention and Infiltration

The Upper Elkhart River steering committee identified reduced water storage, retention and infiltration as a problem in the Upper Elkhart River Watershed. The causes associated with this problem include:

- 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.
- Lack of uniform drainage ordinance for the watershed.
- Lack of single government body that oversees the watershed.

The steering committee identified these items as problems across the watershed. Rather than tie quantity issues to a specific location within the watershed, these issues will be addressed in two manners: Where storage, retention and infiltration can be improved on the land, activities and BMP installation with target sediment, nutrient and/or pathogen reductions will be utilized. Based on the fact that these issues occur across the watershed, a specific critical areas map will not be utilized for these concerns. Implementation of water quantity projects will focus on problems at their source, as identified, and will not be targeted or limited to a specific subwatershed. Deregulation, cohesive regulation and cohesive drainage ordinances will be a focus for the entire Upper Elkhart River Watershed.

8.6 Critical Acre Determination

To be eligible for National Water Quality Initiative (NWQI) Funding, the Upper Elkhart River Watershed steering committee considered options for targeting all agricultural acreage within the watershed rather than limiting implementation efforts to specific 12-digit HUC subwatersheds. Table 87 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 limited 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 Upper Elkhart River Watershed (Figure 119). Upper Elkhart River Watershed stakeholders identified the need for soils with septic limitation to be targeted for septic treatment; however, this is not an NWQI targeted practice and is therefore not included in Table 87. 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.

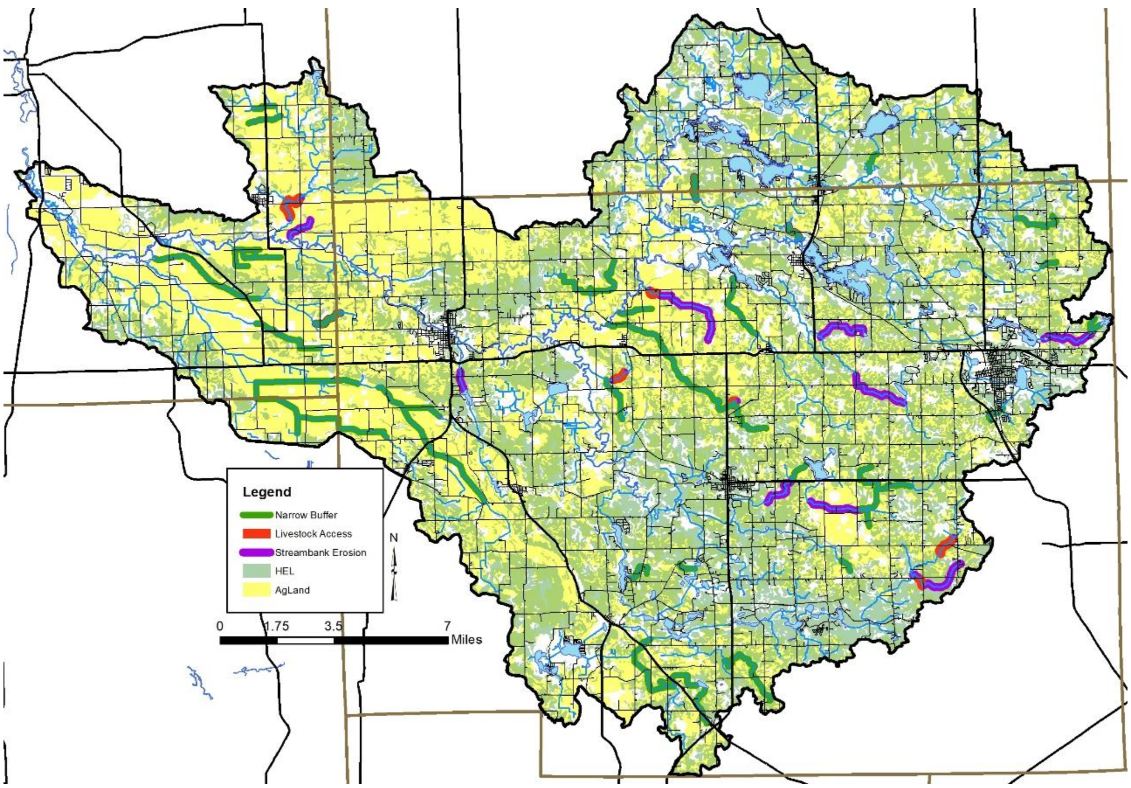


Figure 119. Critical acres in the Upper Elkhart River Watershed.

Table 87. Critical acres by subwatershed in the Upper Elkhart River Watershed.

Subwatershed Name	HUC	Ag Land (acres)	HEL (acres)	Manure Estimate (tons)	Livestock Access (miles)	Streambank Erosion (miles)	Narrow Buffer (miles)
Tamarack Lake-Little Elkhart Creek	040500011501	7,813.5	7,107.0	431	--	--	2.2
Dallas Lake-Little Elkhart Creek	040500011502	7,312.0	6,899.2	30,179	--	--	0.7
Oliver Lake-Little Elkhart Creek	040500011503	6,156.3	5,268.7	21,692	--	--	
Waterhouse Ditch-Henderson Lake Ditch	040500011504	5,767.7	7,524.2	4,305	--	1.8	1.6
Oviate Ditch-Middle Branch Elkhart River	040500011505	6,113.8	5,910.3	33,050	--	0.6	0.6
Jones Lake-North Branch Elkhart River	040500011506	17,110.1	12,847.3	109,397	--	4.6	3.1
Huston Ditch-North Branch Elkhart River	040500011507	14,549.6	6,877.4	287,891	0.6	3.3	11.4
Rivir Lake-Forker Creek	040500011601	6,162.2	8,296.3	3,903	1.0	2.9	--
Winebrenner Branch-Carrol Creek	040500011602	7,994.9	4,869.5	2,068	--	--	5.7
Skinner Lake-Croft Ditch	040500011603	11,169.2	8,912.9	10,163	--	3.1	5.4
Muncie Lake-South Branch Elkhart River	040500011604	6,595.0	6,822.9	2,382	--	--	3.4
Diamond Lake-South Branch Elkhart River	040500011605	14,051.1	11,907.1	49,215	0.5	0.5	2.4
Phillips Ditch-Stony Creek	040500011801	10,433.5	3,461.1	119,367	1.4	1.4	1.8
Indian Lake-Elkhart River	040500011802	15,088.1	7,419.8	117,999	--	1.5	--
Headwaters Solomon Creek	040500011803	12,756.9	6,232.9	131,036	--	--	9.5
Hire Ditch-Solomon Creek	040500011804	11,661.3	2,844.4	11,951	--	--	8.1
Whetten Ditch-Elkhart River	040500011805	12,826.3	3,688.1	28,253	--	0.9	7.8

8.7 Current Level of Treatment

Based on data from the Indiana Conservation Partnership, more than 27,500 acres of best management practices including but not limited to cover crops, conservation cover, fencing, firebreak installation, forage and biomass planting, residue tillage, water facility and heavy use protection area construction and more have been implemented over the last 5 years in the Upper Elkhart River Watershed. Table 88 details practices by acre.

Table 88. Practices installed from 2019-2021 in the Upper Elkhart River Watershed based on Indiana Conservation Partner data in acres.

Practice	501	502	503	504	505	506	507	601	602	603	604	605	801	802	803	804	805	Total
Conservation Cover	20.4	--	--	18.8	6.1	78.8	54.1	5.0	102.5	36.7	16.7	91.4	--	0.5	24.3	5.7	1,979	2,440.2
Cover Crop	1,127	1,502	1,086	959	651	2,417	607	469	644	506	714	1,542	660	493	1,584	4,895	--	19,587.0
Early Successional Habitat Dev-Mgmt	35.7	--	--	24.5	81.0	42.5	0.3	10.9	24.0	--	24.1	64.4	--	0.7	9.5	0.6	1.2	319.4
Fence	--	--	--	--	--	--	--	--	--	0.0	0.9	--	--	--	--	--	--	0.9
Field Border	0.4	--	--	7.3	--	3.7	1.3	6.9	--	5.7	--	--	--	--	--	--	--	25.3
Firebreak		--	--		1.1	--	--	--	1.2	--	--	--	--	--	--	--	--	2.3
Forage and Biomass Planting	36.4	6.0	--	--	17.5	48.3	113.1	25.8	34.2	62.2	76.4	183.2	--	17.0	--	--	--	620.1
Grassed Waterway	2.1	--	--	4.3	--	--	--	0.7	--	--	--	--	--	--	2.6	--	0.4	10.1
Heavy Use Area Protection	--	--	--	--	0.0	0.1	--	--	--	--	--	--	--	--	--	--	--	0.1
Residue and Tillage Management, No Till	6.0	389.5	546.0	113.8	--	875.7	--	--	24.7	--	--	--	176.4	--	--	1,512	243.9	3,887.8
Tree/Shrub Establishment	4.0	7.3	--	--	--	0.9	35.8	50.7	--	--	47.1	13.2		12.3	82.7	--	0.8	254.8
Upland Wildlife Habitat Management	2.6	20.7	--	12.0	8.5	4.0			5.0					1.4				54.2
Wetland Creation	4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.9
Wetland Restoration	63.0	--	--	--	4.6	8.6	--	--	--	--	10.0	--	--	--	--	--	--	86.2
Wildlife Habitat Planting	--	--	--	--	--	--	--	--	3.0	--	--	--	--	--	--	--	--	3.0
Windbreak/Shelterbelt Establishment	--	--	--	--	--	0.8	--	--	0.2	--	1.1	--	--	--	--	--	--	2.0

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 twenty sample sites and flow data from the North Branch Elkhart River Cosperville (USGS 04100222) gage for tributary stream sites and the Elkhart River at Goshen (USGS 04100500) for the mainstem Elkhart River sites. Flow data from the USGS gage was scaled to the drainage area for Upper Elkhart River sample sites. In an effort to scale goals to manageable levels, short term (10 year), medium term (20 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 Upper 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 20).
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 chose to utilize the watershed outlet's loading rates to calculate current and target loading rates and to set goals.
4. The steering committee selected a generational timeframe of 30 years. Once set, the ability to reach long term goals which will result in water quality nutrient, sediment and E. coli targets being met throughout the watershed in 30 years will be reviewed and adjusted as needed.
5. The steering committee set short term and medium-term goals for one-third of that timeframe or 10 years for each phased goal. With this in mind, short term goals will be met in 10 years (2033) and medium-term goals will be met in 20 years (2043). Current and target loading rates for each phase of implementation are based on the subwatershed loading rates calculated for each subwatershed (ie subwatersheds determined to be high priority were used to high priority, short term goals, medium priority subwatershed were used for medium priority, medium term goals and low priority subwatersheds were used for low priority, long term goals).
6. As some of the subwatershed sampling locations already meet water quality target concentrations, any negative loading rates were removed from the calculation.

Reduce Nutrient Loading

Based on collected water quality data summarized for Upper Elkhart River, the committee set the following goals for nitrate-nitrogen and total phosphorus: Reduce nitrate-nitrogen loading from 2,951,983 pounds per year to 793,549 pounds per year (73%) by 2053 and reduce total phosphorus loading from 58,220 pounds per year to 39,677 pounds per year (32%) by 2053 (Table 89 and Table 90).

Short term goal: Reduce total phosphorus inputs from 58,220 pounds per year to 52,039 pounds per year (11% reduction) and nitrate-nitrogen from 2,951,983 pounds per year to 2,232,505 pounds per year (24% reduction) in the Upper Elkhart River in 10 years (2033).

Medium term goal: Reduce total phosphorus inputs from 52,039 pounds per year to 45,858 pounds per year (12% reduction) and nitrate-nitrogen from 2,232,505 pounds per year to 1,513,027 pounds per year (32% reduction) in Upper Elkhart River in 10 years (2043).

Long term goal: Reduce total phosphorus inputs from 45,858 pounds per year to 39,677 pounds per year (13% reduction) and nitrate-nitrogen from 1,513,027 pounds per year to 793,549 pounds per year (48% reduction) in Upper Elkhart River in 10 years (2053).

Table 89. Nitrate-nitrogen short, medium, and long-term goal calculations for prioritized critical areas in Upper Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (10 years)	2,951,983	2,232,505	719,478	24%
Medium Term (20 years)	2,232,505	1,513,027	719,478	32%
Long Term (30 years)	1,513,027	793,549	719,478	48%

Table 90. Total phosphorus short, medium, and long-term goal calculations for prioritized critical areas in Upper Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (10 years)	58,220	52,039	6,181	11%
Medium Term (20 years)	52,039	45,858	6,181	12%
Long Term (30 years)	45,858	39,677	6,181	13%

Reduce Sediment Loading

Based on collected water quality data summarized for Upper Elkhart River, the committee set the following goal for total suspended solids: reduce total suspended solids loading from 4,836,336 pounds per year to 3,967,746 pounds year (18%) by 2053 (Table 91).

Short term goal: Reduce total suspended solids inputs from 4,836,336 pounds per year to 4,546,806 pounds per year (6% reduction) in Upper Elkhart River in 10 years (2033).

Medium term goal: Reduce total suspended solids inputs from 4,546,806 pounds per year to 4,257,276 pounds per year (6% reduction) in Upper Elkhart River in 10 years (2043).

Long term goal: Reduce total suspended solids inputs from 4,257,276 pounds per year to 3,967,746 pounds per year (7% reduction) in Upper Elkhart River in 10 years (2053).

Table 91. Total suspended solids short, medium, and long-term goal calculations for prioritized critical areas in Upper Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (10 years)	4,836,336	4,546,806	289,530	6%
Medium Term (20 years)	4,546,806	4,257,276	289,530	6%
Long Term (30 years)	4,257,276	3,967,746	289,530	7%

Reduce *E. coli* Loading
Based on collected water quality data summarized for Upper Elkhart River, the committee set the following goal for *E. coli*: reduce E. coli loading from 5.51E+14 to 4.50E+14 (18%) by 2053 (Table 92).

Short term goal: Reduce E. coli inputs from 5.51E+14 colonies per year to 5.18E+14 colonies per year (6% reduction) in Upper Elkhart River in 10 years (2033).

Medium term goal: Reduce E. coli inputs from 5.18E+14 per year to 4.84E+14 colonies per year (7% reduction) in Upper Elkhart River in 10 years (2043).

Long term goal: Reduce E. coli inputs from 4.84E+14 per year to 4.50E+14 colonies per year (7% reduction) in Upper Elkhart River in 10 years (2053).

Table 92. E. coli short, medium, and long-term goal calculations for prioritized critical areas in Upper Elkhart River.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
Short Term (10 years)	5.51E+14	5.18E+14	3.37E+13	6%
Medium Term (20 years)	5.18E+14	4.84E+14	3.37E+13	7%
Long Term (30 years)	4.84E+14	4.50E+14	3.37E+13	7%

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

Baseline in 2023 - Wetland acreage (NWI): 34,630.7 acres; floodplain land cover acreage: 19,858 acres; and coverage of poorly drained and very poorly drained soils: 72,591 acres.

Recreational Access
Long term: Increase recreational access through increased river access points, ability to paddle from the North Branch-South Branch confluence 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: By 2053, 70% of watershed households will be informed about practices that can be implemented to positively impact Upper Elkhart River and no less than 25% of individuals living and farming in the watershed will be engaged in the project within 30 years.

Baseline in 2023 - Property owners: 26,210 parcel addresses; Producers: 988 based on DTN contact list and producers who identified as such at public events for the Upper Elkhart River Watershed.

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 Upper 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 Upper Elkhart River steering committee. Committee members reviewed potential practices taking into account the identified resource concerns, watershed land uses, and Upper 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 Upper 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 Upper 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 Upper 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 Kendallville, Wolcottville, Rome City, Albion and other small towns as well as lakes and reservoirs present throughout the watershed. 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
- Drivable Grass
- 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
- Point Source Discharge Reduction
- Pollinator Planting
- Rain Barrels
- Regular Soil Tests
- Septic System Care and Maintenance
- Streambank Stabilization
- Subsurface Drain (Agricultural)
- Subsurface Infiltration (urban)
- Threatened and Endangered Species Protection
- 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.

Animal Morality Facility
An animal mortality facility is an on-farm facility for the treatment or disposal of animal carcasses due to routine mortality. This standard applies to livestock and poultry operations where routine animal carcass storage, treatment, or disposal is needed. This standard does not apply to catastrophic animal mortality.

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 Planting/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 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 cover crop vegetation recovers plant-available nutrients in the soil and recycles them through the plant biomass for succeeding crops.

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. Purposes include: 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 most costly. 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 space can be protected using conservation design development techniques and is more likely to be managed by homeowner associations.

Heavy Use Area Protection
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/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

Large volumes of manure are generated by both small, unregulated animal operations and by confined feeding operations located throughout the Big Pine 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.

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.

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. Given that 75% of urban residents within the Region of the Great Bend of the Wabash River Watershed indicate either limited knowledge or that they don't use phosphorus free fertilizers, there is great potential for reducing urban sources of phosphorus by targeting this practice. 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.

Prescribed Grazing
This practice where grazing and/or browsing animals are 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. Although a high percentage of urban residents indicated a general knowledge of rain barrels, only 3% of survey respondents indicate that they have installed a rain barrel. Furthermore, 75% of respondents indicate a willingness to consider installing a rain barrel.

Septic System Care, Maintenance, and Upgrades
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 Upper 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 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.

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.

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 the Upper 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.

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 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
When water is confined to stream or ditch channel it has the potential to cause bank erosion and channel down-cutting. Current ditch design generates narrow channels with steep sides. Water flowing through these systems often result in bank erosion, channel scour and flooding. A relatively new technique

focuses on mitigating these issues through an in-stream restoration called a two-stage ditch. The design of a two-stage ditch incorporates a floodplain zone, called benches, into the ditch by removing the ditch banks roughly 2-3 feet above the bottom for a width of about 10 feet on each side depending on the size of the channel. This allows the water to have more area to spread out on and decreases the velocity of the water. This not only improves the water quality, but also improves the biological conditions of the ditches where this is located.

The benefits of a two-stage ditch over the typical agricultural ditch include both improved drainage function and ecological function. The two-stage design improves ditch stability by reducing water flow and the need for maintenance, saving both labor and money. It also has the potential to create and maintain better habitat conditions. Better habitats for both terrestrial and aquatic species are a great plus when it comes to the two-stage ditch design. The transportation of sediment and nutrients is decreased considerably because the design allows the sorting of sediment, with finer silt depositing on the benches and coarser material forming the bed. A recent study by the University of Notre Dame found that the average two-stage ditch reduces the amount of sediment transported annually by over 100,000 pounds per half mile of two-stage (Tank, unpublished data).

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 Salt Creek 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 or Restoration
Visual observation and historical records indicate at least a portion of the Upper 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 93 details selected agricultural and urban 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 94 outlines suggested BMPs, estimated load reduction for nutrients and sediment (if available), and the target volume (area, length) of each practice, while Table 95 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 volume of BMPs necessary to meet project goals.

Table 93. Suggested Best Management Practices to address Upper Elkhart River critical areas. Note: BMPs were selected by the steering committee.

Practice	Nutrients	Sediment	Pathogens
Access Control/Fencing	X	X	X
Alternative Watering System	X		X
Animal Mortality Facility			X
Bioreactor	X		
Bioretention	X	X	X
Composting Facility			
Conservation Tillage	X	X	X
Cover Crop/Critical Area Planting/Conservation Cover	X	X	X
Diversion Structures	X	X	
Drainage Water Management	X	X	
Fencing	X	X	X
Field Border/Buffer Strip	X	X	X
Flow Splitter	X	X	X
Forage/Biomass Planting	X	X	X
Grade Stabilization Structure	X	X	
Grassed Waterway/Mulching/Subsurface Drain	X	X	X
Green Roof	X		
Greenways and Trails	X	X	
Habitat Corridor Identification and Improvement	X	X	
Heavy Use Area Protection	X	X	X
Lined Waterway or Outlet	X	X	X
Livestock Restriction/Pipeline; Prescribed Grazing	X	X	X
Manure Management Planning	X		X
Mulching	X	X	X
Nutrient/Pest Management	X		
Pervious Pavement	X	X	
Phosphorus Free Fertilizer	X		
Point Source Discharge Reduction			
Rain Barrel	X	X	
Septic System Care/Maintenance	X		X
Soil Testing	X	X	X
Streambank Stabilization	X	X	
Subsurface Drain (agricultural)			
Subsurface Infiltration (Urban)			
Tree Box Filter	X	X	
T&E Species Protection (Habitat Improvement)	X	X	
Tree/Shrub Establishment	X	X	
Two Stage Ditch	X	X	X
University Fertilization Recommendations/Soil Testing	X		
Variable Rate Application	X		

Practice	Nutrients	Sediment	Pathogens
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 not required to be implemented as the quantities suggest. 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 94 is met, then the target loading rates detailed in Table 89 through Table 92 will be achieved for high priority critical areas (Headwaters Solomon Creek, Hire Ditch-Solomon Creek, Huston Ditch-North Branch Elkhart River, Indian Lake-Elkhart River, Phillips Ditch-Stony Creek, Skinner Lake-Croft Ditch, Whetten Ditch-Elkhart River and City of Kendallville); medium priority critical areas (Jones Lake-North Branch Elkhart River, Oviate Ditch-Middle Branch Elkhart River, Tamarack Lake-Little Elkhart Creek and Waterhouse Ditch-Henderson Lake Ditch); and low priority critical areas (Dallas Lake-Little Elkhart Creek, Diamond Lake-South Branch Elkhart River, Muncie Lake-South Branch Elkhart River and Oliver Lake-Little Elkhart Creek). The steering committee realizes that the model's calculations are only an estimate, and actual reductions could be beyond the model's estimation. 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 94. Suggested Best Management Practices, target volumes, and their combined estimated load reduction per practice unit to meet high priority, medium priority and low priority goals for each 10 year implementation phase.

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)	5,000	5,000	5,000	acre	345,000	165,000	540,150
Cover Crop (340)	30,000	30,000	30,000	acre	1,350,000	630,000	18,000,000
Drainage Water Management (554)	100	100	100	feet	3,120		
Filter Strip (393)	500	500	500	acre	36,000	18,000	87,765
Forage and Biomass Planting (512)	2,000	2,000	2,000	acre	138,000	66,000	60,000
Grassed Waterway (412)	500	500	500	acre	349,350	174,600	151,950
Livestock Restriction (Alt Watering System, Access Control)	1,000	1,000	1,000	Feet; units	8,400	2,490	202,560
Nutrient/Pest Management (590)^	10,000	10,000	10,000	Acre	124,800	187,200	
Pollinator planting (CP42)	500	500	500	acres	34,500	16,500	54,015
Prescribed Grazing (528)	2,000	2,000	2,000	acre	102,000	54,000	136,860
Residue and Tillage Management (329)	10,000	10,000	10,000	acres	630,000	300,000	60,000,000
Streambank Stabilization*	100	100	100	feet	0	249	20,256
Two Stage Ditch (582)	300	300	300	acre	0	747	60,768
Wetland Creation/Restoration	5	5	5	acre	123	44	1,047
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)	100	100	100	unit	150	60	60
Total Load Reduction Targeted					3,121,443	1,614,890	79,315,431

^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 width of 5 feet.

Table 95. 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	$375,000	$375,000	$375,000
Cover Crop (340)	25	$750,000	$750,000	$750,000
Drainage Water Management (554)	$50	$5,000	$5,000	$5,000
Filter Strip (393)	75	$37,500	$37,500	$37,500
Forage and Biomass Planting (512)	75	$150,000	$150,000	$150,000
Grassed Waterway (412)	$5,000	$2,500,000	$2,500,000	$2,500,000
Livestock Restriction (Alt Watering System, Access Control)	$1,000	$1,000,000	$1,000,000	$1,000,000
Nutrient/Pest Management (590)	$4.00	$40,000	$40,000	$40,000
Pollinator planting (CP42)	$75	$37,500	$37,500	$37,500
Prescribed Grazing (528)	$15.00	$30,000	$30,000	$30,000
Residue and Tillage Management (329)	$15	$150,000	$150,000	$150,000
Streambank Stabilization	$1,000	$100,000	$100,000	$100,000
Two Stage Ditch (582)	$50	$15,000	$15,000	$15,000
Wetland Creation/Restoration	$5,000	$25,000	$25,000	$25,000
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)	varies	$84,000	$84,000	$84,000
Total Cost		**$5,299,000**	**$5,299,000**	**$5,299,000**

10.3 Action Register

All activities to be completed as part of the Upper Elkhart River Watershed management plan are identified in Table 96. 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 96. Action Register.

Project 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 2024.	Producers, homeowners, developers	Develop a cost-share program (2024).	$25,000 annually staffing	PP/TA: NRCS, SWCD, surveyors, ICP partner agencies
			Implement cost-share program (2024-2053).		
			Review more than 100 potential projects identified in previous studies/projects and determine if they still need to be implemented or if these concern areas have been addressed in another way (2025).		
			Annually, identify and apply for potential funding sources to augment cost-share program including NWQI, RCPP, LARE, CWI and others. Once received, implement cost-share program per program guidance (annually).		
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 (Table 93).	Contractors, builders, homeowners, producers, lake associations	Meet BMP targets detailed above (Table 93).	$2.3 million annually for 30 years for BMP implementation	PP: Planning and zoning staff, DNR, cities and towns, IDEM TA: NRCS, SWCD, FSA
			Annually increase adoption of conservation plans and nutrient (including manure management) plans.		
			Work with Kendallville and Elkhart County and any future MS4 communities, cities/towns and lakeshore residences to ensure that urban BMPs are implemented on new construction and retrofits are included as possible on lands already developed. Initiate annual review starting in 2025.		
			Achieve short-term load reductions: 74% reduction in nitrate loading, 47% reduction in total phosphorus loading, 65% reduction in total suspended solids loading and 64% reduction in E. coli loading by 2033.		
			Achieve medium-term load reductions: 76% reduction in nitrate loading, 68% reduction in total phosphorus loading, 53% reduction in total suspended solids loading and 40% reduction in E. coli loading by 2043.		
			Achieve long-term load reductions: 92% reduction in nitrate loading, 75% reduction in total phosphorus loading, 48% reduction in total suspended solids loading and 40% reduction in E. coli loading by 2053.		
			Reduce, or at a minimum, maintain nearshore impervious development in lake and stream riparian areas.		

Project 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	Homeowners, builders, Health Dept,RSDs, elected officials	Produce and distribute septic maintenance brochure at MS4 contractor workshops, local events, field days, city festivals and county fairs. Develop annual event list starting in 2024.	$5,000 annually	PP/TA: Contractors, IDEM, lake associations, local and state health dept, Purdue extension
			Offer cost-share incentives to producers providing voluntary septic maintenance as possible.		
			Explore options for future septic system maintenance or upgrade assistance funding starting in 2025.		
Education	Work with local entities to establish a (trash, sediment, microplastics) pollution education program	Local citizens, watershed visitors, lake associations	Continue to promote trash pick up, annual clean up events and identify new opportunities (adopt a road, community corrections clean up events, student engagement, trash traps) to reduce trash pollution.	$5,000 annually	PP/TA: Parks departments, cities and towns, local nonprofits, lake associations
			In 2025, establish an annual reporting mechanism to determine how much trash/sediment was saved from entering and removed from Upper Elkhart River streams.		
Flooding, Recreation access	Protect and restore floodplains and stream buffers	Producers, riparian landowners	By 2026, develop and implement a floodplain maintenance and reforestation program targeting urban residential and commercial and row crop agricultural areas.	$50,000 annually	PP/TA: surveyors, floodplain managers, DNR, Army Corps, SJRBC, cities and towns
			In 2026, 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.		
Flooding; Nutrients, Sediment, *E. coli*	Increase storage and filtration	Surveyors, landowners, producers, landowners	Implement findings from the NBER West Lakes Task Report and the NBER Corridor Flood Risk Management Plan as possible.	$150,000 annually	PP/TA: surveyors, floodplain managers, DNR, Army Corps, SJRBC, cities and towns, local/state land trusts, farm bureau, planning and zoning
			Increase tree canopy cover across the watershed. Create annual review process in 2025.		
			Increase stormwater storage capacity through agricultural storage, wetland restoration and reforestation efforts.		
			Continue efforts to implement the Benton and Baintertown Dam Feasibility Study.		
			Develop and deploy recommendations for nearshore lake construction and runoff infiltration.		

Project Goals	Objective	Target Audience	Milestone	Cost	Possible Partners (PP) & Technical Assistance (TA)
Education	Educate Upper Elkhart River Project stakeholders about soil erosion, increase awareness about applicable BMPs, inorganic pollution and cost share opportunities	Lake associations, homeowners, producers	Develop an education and ERRA/project branding plan targeting each practice identified above by 2024 (Table 93).	$5,000 annually	PP/TA: lake associations, SWCDs, Purdue extension, schools, conservancy districts, MS4s, SJRBC, local government ICP partner agencies
			In 2024, create mechanism to promote each practice using methods including but not limited to press releases; workshops; field days; stream clean up; float trip; stream, field or pasture walk; website creation; social media posts and ads; digital ads, videos; local events; county fair booth; educational booth; and public meetings.		
			Develop funding mechanism for education efforts (2025).		
			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; high quality natural areas; wetland protection and preservation and general stream processes.		
			Continue to maintain a project-based website and social media to promote events, cost share fund availability and build project awareness.		
Education	Create a cohesive education and outreach program focused on increasing public awareness and building a sense of place and watershed connectivity.	Lake property owners, residents, producers, users	In 2025, identify opportunities to highlight where you live, where your water flows, connection from Kendallville/ Wolcottville/Rome City to Goshen/Elkhart and all areas in between.	$5,000 annually	PP/TA: Parks departments, SWCDs, school systems, community learning center (adult ed centers), MS4s, DNR
			Implement sense of place and watershed connectivity education programming.		
			Promote local natural areas which provide access to Upper Elkhart River and its tributaries. Highlight options to engage with or get out onto water.		
			Consider options for establishing a water-based trail (blueway).		

Project Goals	**Objective**	**Target Audience**	**Milestone**	**Cost**	**Possible Partners (PP) & Technical Assistance (TA)**
Education; Recreation Access; Flooding	Work with partners to identify and promote hands-on opportunities to improve natural areas and habitat in the watershed.	Citizens, recreation users (lakes, parks, natural areas)	In 2024, identify partner organizations which host field days, work days, and clean-up events.	$5,000 annually	PP/TA: MS4s, SWCD, NRCS, DU, PF, parks departments, lake associations
			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.		
Nutrients, Sediment, *E. coli*	Monitor annual loading rates volunteer and professional monitoring programs and consider options for delisting streams currently on IDEM's 303(d) list for E. coli and nutrients	Local residents, producers, lake associations, cities and towns	In 2025, establish a Hoosier Riverwatch-based monitoring corps to collected data across the watershed. Monitoring may include snapshot (one day) event, monthly or quarterly monitoring and no less than annual training/refresher provided to volunteers.	$5,000 annually volunteer-based monitoring; additional cost for professional or snapshot monitoring	PP/TA: Lake associations, local residents, Hoosier Riverwatch trainers and volunteers, SWCDs, parks departments, SJRBC
			Establish an annual volunteer or professional monitoring program to assess nutrient and sediment impacts to the Upper Elkhart River Watershed.		
			Collect E. coli samples no less than every 5 years with the goal of calculating the geometric mean (5 samples over 30 days).		
			Maintain current and install additional stream flow monitoring gages throughout the watershed.		
Flooding, Nutrients, Sediment	Improve water quality and habitat to obtain passing mIBI, IBI, and QHEI scores and delist streams currently on IDEM's 303(d) list for IBC	Local residents, producers, lake associations, cities and towns	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: Lake associations, local residents, Hoosier Riverwatch volunteers, SWCDs, parks departments, SJRBC TA: Data collectors and owners.
			Monitor fish and macroinvertebrate populations every five years and habitat annually. Start monitoring in 2024.		
			Create mechanism for annual collection of water chemistry, fish and macroinvertebrate data. Collect, store and share data with target audience. Start monitoring in 2024.		

11.0 FUTURE ACTIVITIES

The next steps for the project include starting implementation of the Upper 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, National Water Quality 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 meeting 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 Upper Elkhart River Watershed, helping reach goal statements by 2053 (Table 97). For each practice identified which the committee deemed familiar and routinely utilized in the Upper 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 98. Measurement of the success of implementation is a necessary part of any watershed project (Table 97). Both social indicator and 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 97 will be used to document changes and aid in the plan re-evaluation. The steering committee listed potential partners and technical assistance provides as both unless otherwise noted. Activities to be completed as part of this watershed management plan are identified in the action register (
Table **96**). Table 98 identifies the annual target for the number or acres of BMPs to be installed during each implementation phase. Work completed towards 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 or their designee will be responsible for keeping the mentioned records.

Table 97. 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 98. Annual targets for best management practices.

Suggested BMPs:	Annual High Priority Targets	Annual Medium Priority Targets	Annual Low Priority Targets	Units
Conservation Cover (327)	500	500	500	acre
Cover Crop (340)	3,000	3,000	3,000	acre
Drainage Water Management (554)	10	10	10	Feet
Filter Strip (393)	50	50	50	Acre
Forage and Biomass Planting (512)	200	200	200	Acre
Grassed Waterway (412)	50	50	50	Feet
Livestock Restriction (Alt Watering System, Access Control)	100	0	100	Feet, unit
Nutrient/Pest Management (590)	1,000	1,000	1,000	acres
Pollinator planting (CP42)	50	50	50	acres
Prescribed Grazing (528)	200	200	200	acres
Residue and Tillage Management (329)	1,000	1,000	1,000	acres
Streambank Stabilization	10	10	10	Feet
Two Stage Ditch (582)	30	30	30	acres
Wetland Creation/Restoration	1	1	1	Acres
Urban BMPs (bioretention, rain barrel, rain garden, pervious pavement, treatments vaults, green roof)	10	10	10	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 no less than annually at the Upper Elkhart River outlet to the Lower Elkhart River. 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 annual targets identified in Table 98Table 98. 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 or turbidity will be no measured less than annually at the Upper Elkhart River outlet to the Lower Elkhart River. 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 or for turbidity of 6.36NTU.
- 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 annual targets identified in Table 98. 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 no less than annually at the Upper Elkhart River outlet to the Lower Elkhart River After ten years of implementation, water quality samples will show a decreasing trend, with more samples annually meeting the state standard (235 col/100 ml).
- Administrative Indicator: The number of BMPs that can reduce *E. coli* will be tracked annually. The total number of acres will be compared against annual targets identified in Table 98.

Increase Public Awareness and Participation

- Administrative Indicator: The number of people who attend education and outreach events will be tracked. The percent 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.

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.

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 93.

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 US Fish and Wildlife Service and the State Historic Preservation Office. It is not anticipated that the practices planned for the Upper Elkhart River Watershed will require an Environmental Assessment or an Environmental Impact Statement.

12.0 OUTREACH PLAN

Based on steering committee knowledge, a multi-tiered strategy will be required to fully implement the Upper 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 Upper 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.
- Connect people with the Elkhart River to create a sense of place including getting people on the river no less than twice annually.
- Continue to engage local youth via targeted educational field trips, classroom education and local events.
- Work with local partners including land trusts, farm bureau, MS4s and others to create cohesive educational messaging and deploy these messages across the Upper Elkhart Watershed.

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, Lagrange, Kosciusko and Noble County service centers provide assistance for Upper Elkhart River Watershed.
- Elkhart, Lagrange, Kosciusko and Noble County 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 Upper Elkhart River Watershed Project will provide education and outreach assistance and assist with program promotion.

12.1 Adapting Strategies in the Future

Due to the uncertainty of the 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 Upper 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 Upper Elkhart River Watershed Project and can be found below.

Step 1: Planning The planning process used to develop the Upper Elkhart River WMP follows the IDEM 2009 Watershed Management Checklist. The project coordinator worked in concert with and was guided by the Upper 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 Upper 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 97 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 96) 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 reach through outreach, etc. The evaluations will be conducted by the Upper 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. 2025, 2027, 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 Upper Elkhart River Project coordinated by the Elkhart River Restoration Association, are 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.