COBUS CREEK WATERSHED DIAGNOSTIC STUDY

ELKHART AND ST. JOSEPH COUNTIES, INDIANA AND CASS COUNTY, MICHIGAN

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CREEK WATERSHED DIAGNOSTIC STUDY
EXECUTIVE SUMMARY

The Cobus Creek Diagnostic Study is a comprehensive examination of Cobus Creek and its surrounding watershed. In 2015, with funding from the Indiana Department of Natural Resources Lake and River Enhancement (LARE) Program, the St. Joseph River Basin Commission hired the team of Arion Consultants and Commonwealth Biomonitoring to conduct the study. The scope of the study included the following:

- Data review and mapping current conditions: Collection and review of historic studies, water quality and fisheries reports, and base mapping of watershed conditions.
- Public engagement and outreach: Completion of watershed walking and driving tours and landowner and public meetings.
- Watershed assessment: Completion stream water quality sampling, macroinvertebrate and fish community assessments, and habitat scoring.
- Analysis and data interpretation: Review of historic and current conditions, assessment of collected water quality data, and compilation of results and recommendations.

The Cobus Creek Watershed encompasses 23,412 acre (9,479 ha) of St. Joseph and Elkhart Counties, Indiana and Cass County, Michigan. The watershed is 40% row crop agriculture. Forested lands and wetlands account for 21% of the watershed land use, while urban land uses, including urban open space and low, medium, and high intensity developed areas, account for 32% of the watershed. Cobus Creek is one of Indiana's few coolwater streams supporting a mix of warmwater and coldwater fish species.

The study documented high levels of soluble and total phosphorus during base and storm flow conditions and elevated total suspended solids and *E. coli* concentrations during storm flow conditions. Four of the Cobus Creek Watershed sites Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake Inlet (Site 11) generally possessed poorer water quality conditions than the other stream reaches. The macroinvertebrate Index of Biotic Integrity (mIBI), an index which utilizes invertebrate community structure to measure water quality, documented a range of moderately impacted to slightly impaired macroinvertebrate communities. The coolwater Index of Biotic Integrity indicates that the fish community in Cobus Creek rates as good to poor. Habitat as assessed using the Qualitative Habitat Evaluation Index (QHEI) was also less than optimal for aquatic life uses at most sites. Additionally, several instream structures along Cobus Creek were identified as barriers to fish passage. Overall, the Cobus Creek mainstem provides adequate habitat to maintain good quality coolwater fish communities and only moderately impaired macroinvertebrate communities. The two main tributaries, Gast Ditch and the Cobus East Lateral A provide limited habitat and poor water quality during storm flow conditions resulting in poor quality fish and macroinvertebrate communities.

Over 200 land treatment or restoration projects are recommended to reduce soil erosion and improve the biological, chemical, and physical condition of streams throughout the study area. Priority subwatersheds identified Load reduction calculations were estimated for nitrogen, phosphorus and sediment based on the potential best management practices to be implemented within the Cobus Creek Watershed. If the Cobus Creek Watershed is blanketed with the proposed projects, pollutant loading will be reduced as follows: 9,692 lb. nitrogen (49%), 3,082 lb. phosphorus (54%), and 198,942 lb. sediment (43%).

ACKNOWLEDGMENTS

The Cobus Creek Watershed Diagnostic Study was performed with funding from the Indiana Department of Natural Resources Lake and River Enhancement Program , St. Joseph River Basin Commission, and several local partners. Local partners included: Ontwa Township, the Greater Elkhart County Stormwater Partnership, St. Joseph River Valley Fly Fishers, Elkhart Conservation Club, Friends of Cobus Creek, and City of Elkhart.

Arion Consultants in partnership with Commonwealth Biomonitoring documented the available historical information, completed tributary water chemistry, macroinvertebrate, and habitat sampling, calculated nutrient and sediment loading, documented existing watershed conditions, and identified potential water quality improvement projects. Daragh Deegan with the City of Elkhart completed fish and habitat assessments. Jeremy Reiman of the St. Joseph River Basin Commission gathered historical and GIS data, assisted with the watershed inventory, coordinated the watershed steering committee, and documented the public meetings. Contributors to this study include: the City of Elkhart, Elkhart County Drainage Board, Indiana Department of Natural Resources Division of Nature Preserves, and Indiana Department of Environmental Management. Authors of this report include Sara Peel of Arion Consultants and Greg Bright of Commonwealth Biomonitoring.

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COBUS CREEK WATERSHED DIAGNOSTIC STUDY
ELKHART AND ST. JOSEPH COUNTIES, INDIANA AND CASS COUNTY, MICHIGAN

1.0 INTRODUCTION

The Cobus Creek Watershed is located in south central Cass County, Michigan draining south through the northeast corner of St. Joseph County and northwest corner of Elkhart County, Indiana. The Cobus Creek Watershed contains Edwardsburg, Michigan and lies immediately northwest of the City of Elkhart, Indiana (Figure 1; HUC 040500012201). The watershed drains 23,412 acres (9,479 ha) and lies within Cleveland Township in Elkhart County, Harris Township in St. Joseph County, and Ontwa Township in Cass County, Michigan. The Cobus Creek Watershed is part of the 8-digit St. Joseph River Watershed (HUC 0405001). Water from Gast Ditch drains into Cobus Creek, which then drains south into the St. Joseph River entering the river at the Elkhart Conservation Club. The St. Joseph River drains west and north entering Lake Michigan at St. Joseph/Benton Harbor, Michigan.

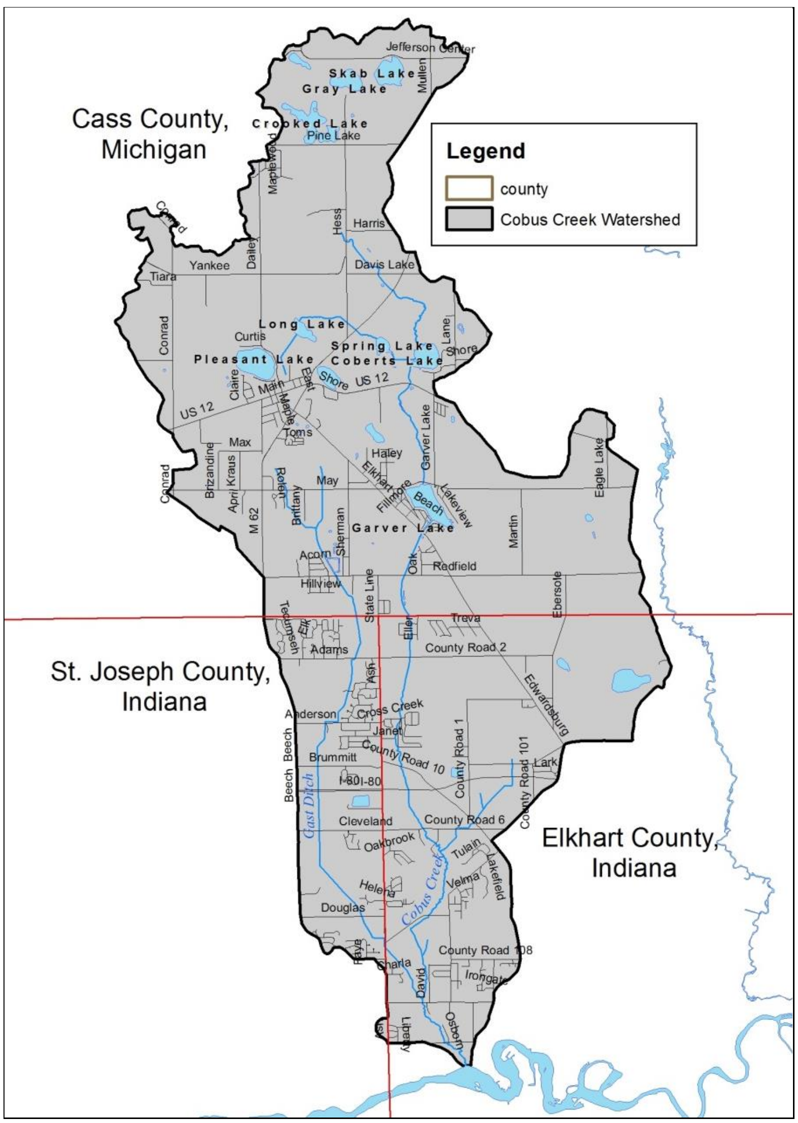

Figure 1. Cobus Creek Watershed location map.

1.1 Project Purpose

The purpose of the Cobus Creek Watershed Diagnostic Study is to describe historical trends and current conditions found within Cobus Creek and its watershed; identify potential nonpoint sources of water quality problems within Cobus Creek and its tributaries; prioritize potential Cobus Creek Watershed improvement projects; propose specific directions for future work within the Cobus Creek Watershed; and predict and assess factors for success of future work within the Cobus Creek Watershed.

1.2 Objectives

The Cobus Creek Watershed Diagnostic Study follows the Indiana Department of Natural Resources Lake and River Enhancement Program guidelines. The study consisted of four phases:

- Data review and mapping current conditions: Collection and review of historic studies, water quality and fisheries reports, and base mapping of watershed conditions.
- Public engagement and outreach: Completion of watershed walking and driving tours and landowner and public meetings.
- Watershed assessment: Completion stream water quality sampling, macroinvertebrate and fish community assessments, and habitat scoring.
- Analysis and data interpretation: Review of historic and current conditions, assessment of collected water quality data, and compilation of results and recommendations.

2.0 WATERSHED CHARACTERISTICS

2.1 Physical Characteristic

For the purpose of this study, the watershed was divided into eleven subwatersheds, which are detailed in Figure 2. Watershed division allows for the prioritization of portions of watersheds. This division will allow for the identification of both high and low quality portions of the watershed, as well as determination of locations where specific management practices may be implemented to generate a change in water quality in the future. Table 1 contains overview data for the Cobus Creek Watershed, including subwatershed area and boundaries. The total drainage, or the entire area which drains to each sample site, as well as the drainage from the next closest site upstream, or relative drainage to each sample site, are listed in Table 1.

Table 1. Watershed areas for the Cobus Creek Watershed.

each sample	**Subwatershed Name**	**Total Drainage (Acres/Hectares)**	**Relative Drainage (Acres/Hectares)**	**Percent of Watershed**
1	Cobus Creek Mouth	23,412.5 (9,478.8)	1,500.1 (607.1)	7%
2	Gast Ditch Mouth	5,517.2 (2,233.7)	3,263.1 (1,321.1)	14%
3	Cobus Creek Split	15,855.1 (5,419.1)	2,258.8 (914.5)	10%
4	Cobus East Lateral A	4,787.9 (1,938.5)	4,787.9 (1,938.5)	20%
5	Gast Ditch State Line	2,254.1 (912.6)	514.7 (208.4)	2%
6	Cobus Creek State Line	11,067.1 (4.480.6)	407.1 (164.8)	2%
7	Gast Ditch Headwaters	1,739.4 (704.2)	1,739.4 (704.2)	7%
8	Cobus Creek Headwaters	8,920.7 (3,611.6)	2,170.3 (878.6)	9%
9	Garver Lake Inlet	6,750.4 (2,733.0)	1,358.8 (550.1)	6%
10	Spring Lake Inlet	2,782.1 (1,126.3)	2,782.1 (1,126.3)	12%
11	Coberts Lake Inlet	2,609.5 (1,056.5)	2,609.5 (1,056.5)	11%

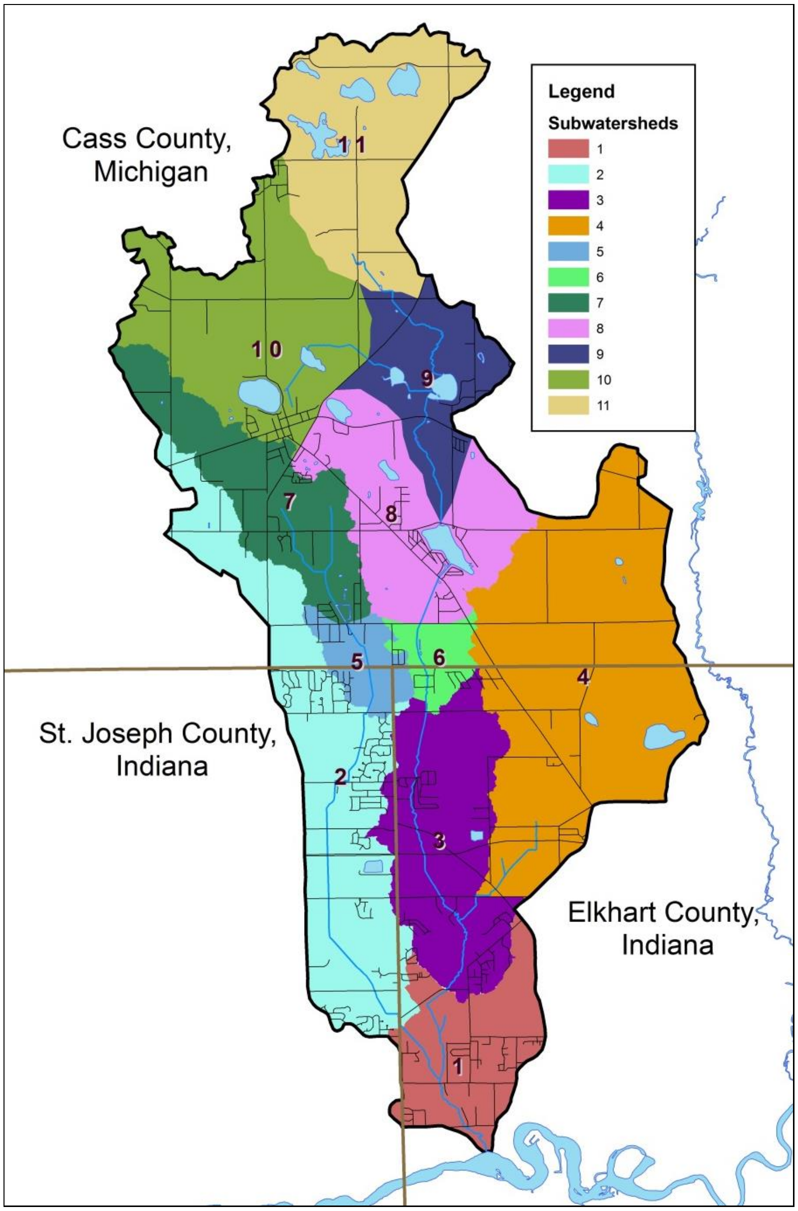

Figure 2. Cobus Creek subwatersheds.

2.2 Physical Setting and Topography

Cobus Creek is a coldwater, headwaters stream, which lies in the St. Joseph River Basin. The 23,412 acre (9,479 ha) Cobus Creek Watershed lies in the Great Lakes Watershed and is a tributary of the St. Jospeh River. The St. Joseph River carries water west and north into Lake Michigan.

The topography of the Cobus Creek Watershed reflects the geologic history of the watershed and is relatively flat. The highest elevation of the watershed is located along the northern edge of the watershed with elevation nearing 1033 feet (315.0 m) above mean sea level (msl). The lowest watershed elevation (695.5 ft or 212 m) msl occurs at the Cobus Creek outlet at the point where it flows into the St. Joseph River. Figure 3 details the elevations present in the Cobus Creek Watershed.

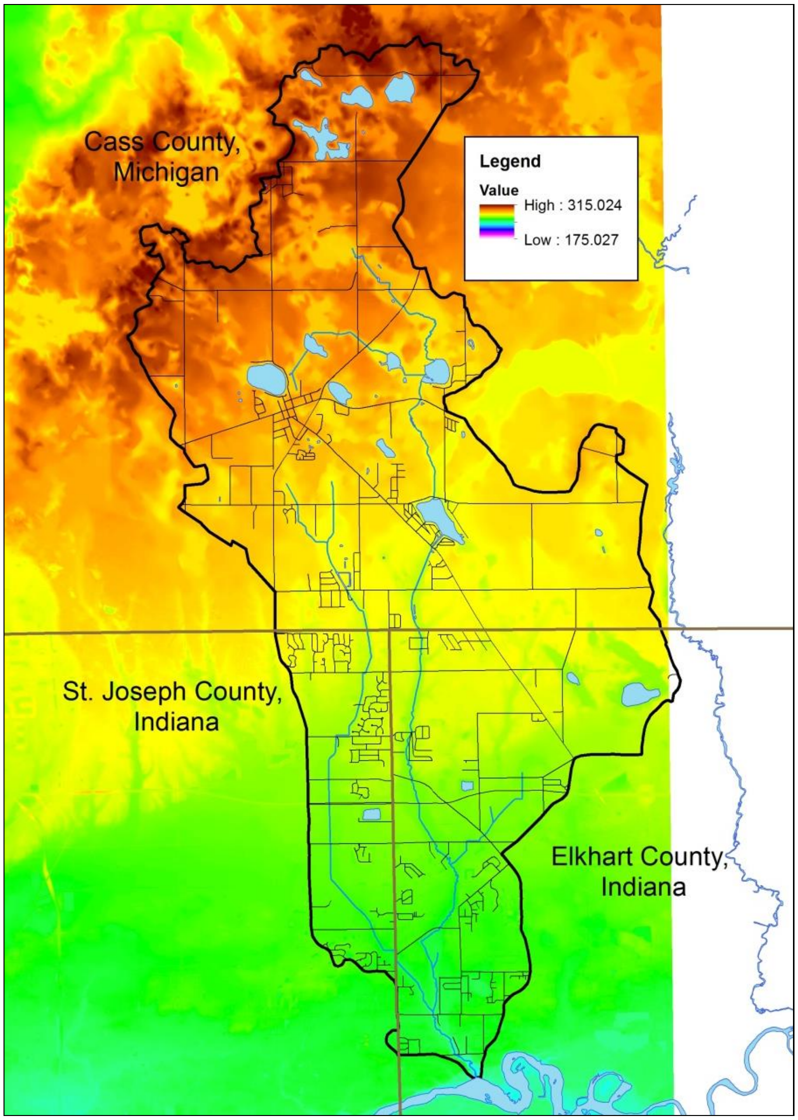

Figure 3. Elevations located throughout the Cobus Creek Watershed.

2.3 Climate

In general, Indiana has a temperate climate with warm summers and cool to cold winters. The Cobus Creek Watershed is no different. Climate in this watershed is characterized by four distinct seasons throughout the year. High temperatures measure approximately 84 °F (29 °C) in August, while low temperatures measure near freezing (17 °F/-8.3 °C) in January. The growing season typically extends from early April through late October. On average, 35.6 inches (90.4 cm) of precipitation occur within the Cobus Creek Watershed with precipitation occurring as small, frequent rain events spread almost evenly throughout the year.

2.4 Geology

The geology of the Cobus Creek Watershed is directly influenced by the advance and retreat of the Saginaw and Erie Lobes of the Wisconsinian glaciation. As the Michigan, Erie, and Saginaw lobes of the glaciers advanced and retreated, they laid thick material over two-thirds of the state. End moraines, such as the Valparaiso and Maxinkuckee moraines, ground moraines, and lake and outwash plains create a geologically diverse landscape across northern Indiana, including the Cobus Creek Watershed. Glacial drift, outwash plains, and ground moraines cover much of the Cobus Creek Watershed creating large, flat areas. Major rivers, like the St. Joseph River to the south of the Cobus Creek Watershed, cut through sand and gravel outwash plains. Garver, Coberts, Long, Pleasant and other lakes in the northern portion of the watershed are located within a series of kettle lakes that generally orient in a northwest-southeast direction. These occur along a plain associated with the Saginaw Lobe, which moved south out of Canada carrying a mixture of Canadian bedrock. These lakes formed from remnant ice chunks left by the Saginaw Lobe as it melted.

Surficial geology indicates that the Cobus Creek Watershed lies within undifferentiated glacial outwash and glacial till. Glacial drift covers the Cobus Creek Watershed to a depth of 300 to 400 feet (91.2 to 122 m; Wayne, 1966). Surficial geology within the Cobus Creek Watershed originates from silty clay loam and clay loam till materials. Ellsworth Shale underlies the entire Cobus Creek Watershed running from 90 to 350 feet (27.4 to 106.7 m) in depth. The underlying bedrock is comprised of Dekalb Lowland, which formed under Upper Devonian and Lower Mississippian shales (Wayne, 1966).

The Cobus Creek Watershed lies within Malott's Steuben Morainal Lakes Area of the Northern Moraine and Lakes Region. Schneider (1966) notes that the landforms common in this diverse physiographic region includes till knobs and ice-contact sand and gravel kames, kettle holes and lakes, meltwater channels lined with outwash deposits or organic sediment, valley plains, and meltwater channels exist within the Cobus Creek Watershed. Garver Lake, and the other lakes in the northern portion of the watershed, are good examples of kettle lakes lying in end moraines.

2.5 <u>Soils</u>

There are hundreds of different soil types located within the Cobus Creek 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, which are mapped in subsequent sections, are used for field-by-field management decisions. Some specific soil characteristics of interest in watershed management and water quality, including septic limitations and soil erodibility, are detailed below.

2.5.1 Soil Associations

The Cobus Creek Watershed is covered by three soil associations (Figure 4; Bowman, 1991; IHMST, 2002; McBurnett et al, 2004). The Oshtemo-Kalamazoo-Houghton association is limited to the northern and eastern edge of the Cobus Creek Watershed and is predominantly located in heavy agriculture areas. It is comprised of strongly sloping, well-drained, moderately course textured soils found on outwash plains and moraines. The Coloma-Spinks-Oshtemo association covers a majority of the Cobus Creek Watershed surrounding the northern lakes, Edwardsburg, and extending south through St. Joseph and Elkhart counties to northern Elkhart. Coloma-Spinks-Oshtemo soils are nearly level, poorly drained soils with limited filtering capacity found on outwash plains and terraces. Gilford-Maumee-Sparta soils are deep, nearly level, strongly sloping soils with moderate to coursed texture found on till plains, moraines, outwash plains and terraces. These soils are located in the southwestern portion of the watershed.

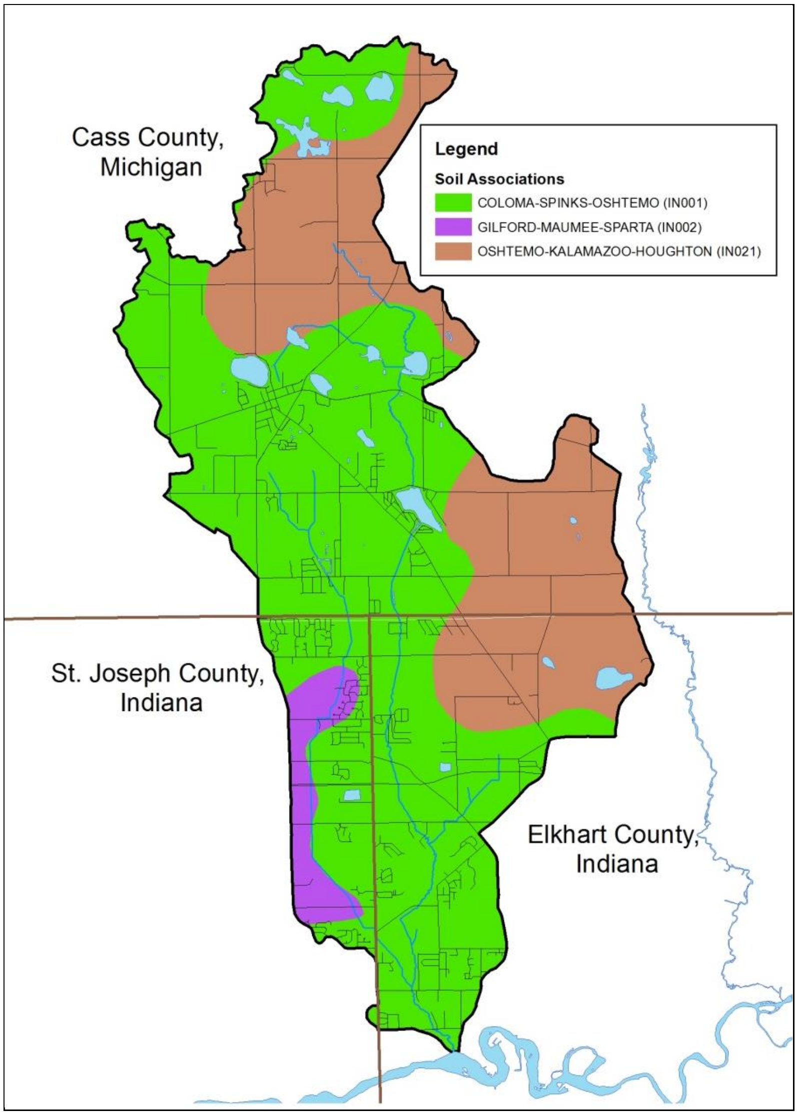

Figure 4. Soil associations in the Cobus Creek Watershed.

2.5.2 Soil Erodibility

Soils carry attached nutrients, pesticides, and herbicides; therefore, soils that move from the landscape to adjacent waterbodies result in degraded water quality, limited recreational use, and impaired aquatic habitat and health. The ability or likelihood for soils to move from the landscape to waterbodies is 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 non-erodible. The classification is based on an erodiblity index, which is determined by dividing the potential average annual rate of erosion by the soil unit's loss, or tolerance value (T). 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. Potentially highly erodible soil determinations are based on the slope steepness and length, in addition to the erodiblity index value.

Soils with elevated erodiblity cover 2,791.9 acres (1,130.4 ha) or 12% of the Cobus Creek Watershed. Highly erodible soils cover approximately 1% of the Cobus Creek Watershed and are located in the northern portion of the watershed. Potentially highly erodible soils are found throughout the watershed, including along the main stem of Cobus Creek, the northwestern edge of the watershed, and adjacent to Boot Lake (Figure 5). In these areas, special effort should be made to maintain constant vegetation on these soils.

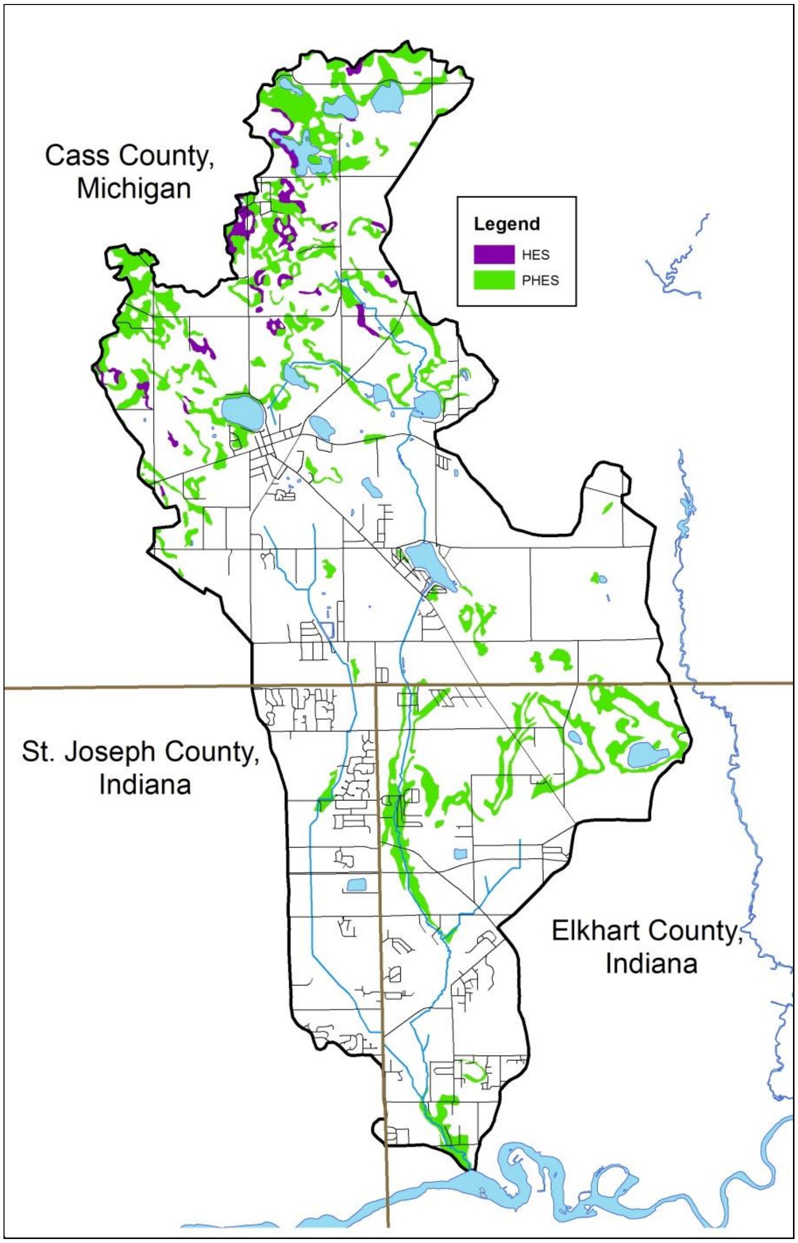

Figure 5. Highly erodible and potentially highly erodible soils in the Cobus Creek Watershed.

2.5.3 Hydric Soils

Hydric soils are those which remain saturated for a sufficient period of time, thereby generating a series of chemical, biological, and physical processes. After undergoing these processes, the soils maintain the resultant characteristics even after draining or use modification occurs. Approximately 2,359 acres (955 ha) or 10% of the watershed are covered by hydric soils (Figure 6). A majority of hydric soils found in the watershed are located along tributaries to Spring, Coberts, Pleasant, and Long lakes and along the mainstems of Gast Ditch and Cobus Creek. 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.

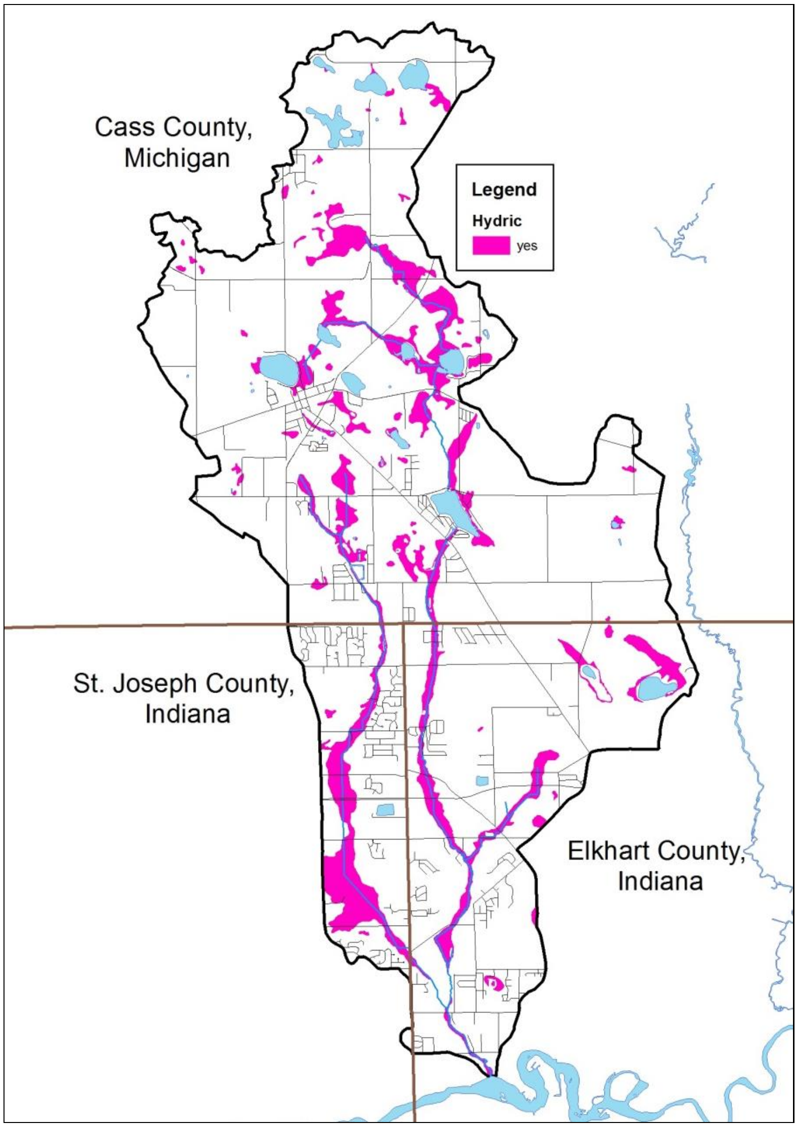

Figure 6. Hydric soils in the Cobus Creek Watershed.

2.5.4 Septic Tank Suitability

Throughout Indiana, including the Cobus Creek Watershed, households depend upon septic tank absorption fields in order to treat wastewater. 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 oversite. 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 flood elevation 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 (ISDH, 2001). Lee et al. (2005) estimates that 76,650 gallons (290,152 L) of untreated wastewater is expelled in the state of Indiana annually. The true impact of these systems on the water quality in the Cobus Creek Watershed cannot be determined without a complete survey of the systems. However, based on our understanding of soil characteristics, we can begin to identify regions in the watershed that would be most susceptible to septic system-related impacts.

Septic tanks require soil characteristics that allow for gradual movement of wastewater from the surface into the groundwater. 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. A variety of characteristics limit the ability of soils to adequately treat wastewater. High water tables, shallow soils, compact till, and course 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.

The NRCS ranks each soil series in terms of its limitations for use as a septic tank absorption field on a county-by-county and state-by-state basis. Each soil series is placed in one of three categories: severely limited, moderately limited, or slightly limited. Some soils are also unranked. "Severe limitations" delineate soils which 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 cost of installation and maintenance. Soils designated as "moderately limited" 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 soils with no known complications to the successful operation of a septic tank disposal field. Use of soils that are rated as moderately or severely limited generally require special design, planning, and maintenance to overcome limitations and ensure proper function.

In total, 14,529 acres (5,882 ha) or 62% of the Cobus Creek Watershed is covered by soils that are considered severely limited for use in septic tank absorption fields. An additional 1,769 acres (716 ha) of the watershed soils are considered moderately limited for septic tank absorption field use, while 6,136 acres (2,484 ha) are covered by slightly limited soils. The remaining 978 acres (395.8 ha) are not rated or are covered by water. Figure 7 details the septic tank suitability for soils throughout the Cobus Creek Watershed. It should be noted that Cass County in Michigan and St. Joseph and Elkhart counties in Indiana classify their soils differently. While the map shows abrupt changes in soil classification at the county and state boundaries, these differences are likely due to classification differences rather than true changes in soil type. Small residential lot sizes located on soils that are limited for septic use are located within subdivisions in the southern portion of Cobus Creek. These sites can negatively impact water quality within Cobus Creek and its tributaries. Efforts to convert these areas to sewer system or other alternatives to on-site treatment may be necessary to improve water quality within Cobus Creek.

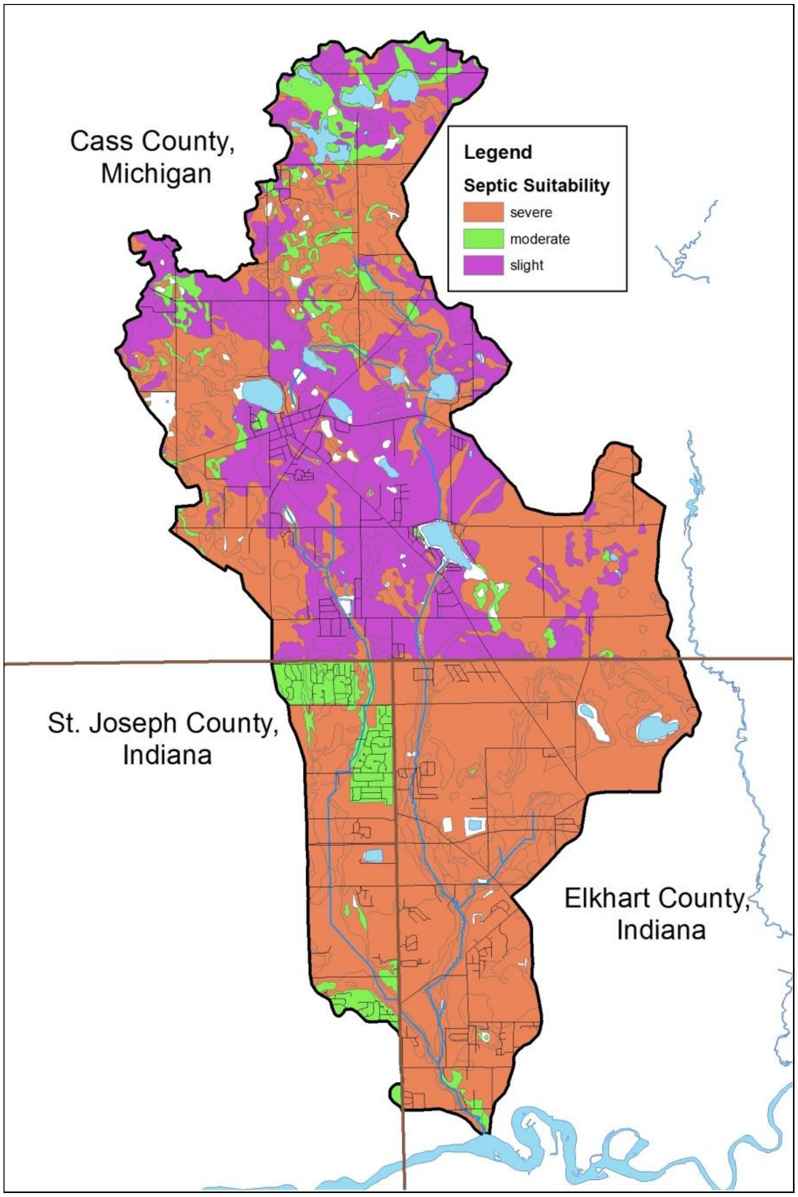

Figure 7. Suitability of soils for septic tank usage within the Cobus Creek Watershed.

2.6 Natural History

Geology, climate, geographic location, and soils all factor into shaping the native flora and fauna which occurs in a particular area. Deam (1921), Petty and Jackson (1966), Homoya et al. (1985), and Omernik and Gallant (1988) divided Indiana into several natural regions, or ecoregions, each with similar geographic history, climate, topography, and soils. Because the groupings are based on factors that ultimately influence the type of vegetation present in an area, these natural areas or ecoregions tend to support distinctive native floral and faunal communities. The Cobus Creek Watershed lies in Homoya's Northern Lakes Natural Region. The Cobus Creek Watershed also lies in the Southern Michigan/ Northern Indiana Till Pains Ecoregion as defined by Omernik and Gallant (1988). Petty and Jackson (1966) indicate that the Cobus Creek Watershed is within the Oak-Hickory Climax Forest Association.

Homoya et al. (1985) note that prior to European settlement, much of St. Joseph and Elkhart counties were covered by a mix of wetland land uses, including bog, fen, marsh, sedge meadow, swamp, seep, and spring, as well as a mix of lakes and deciduous forest. Upland areas were likely covered by red, white, and black oak; maple, and shagbark and pignut hickory. More wet areas were covered by beech, sugar maple, black maple, and tulip poplar. Historically, wet habitat mixed with upland habitat throughout the Cobus Creek Watershed. The hydric soils map indicates that wetland habitat was typically present along the mainstem of Cobus Creek and Gast Ditch, as well as adjacent to the shorelines of many of the lakes in the northern portion of the watershed.

2.7 Significant Natural Areas and Listed Species

The Indiana Natural Heritage Data Center, part of the Indiana Department of Natural Resources, Division of Nature Preserves, maintains a database documenting the presence of endangered, threatened, or rare species (ETR 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, fifteen observations of special species occurred within the Cobus Creek Watershed (Hellmich, personal communication; Figure 8). These include: one state endangered plant species, pipewort (1999); a state endangered bird, the sedge wren (2000); two state endangered turtles, the spotted turtle (1998) and Blanding's turtle (1994); and five state rare plants, Michaux's stitchwort (1945), robbins spikerush (1985), tall beaked-rush (1985), weakstalk bulrush (1984), and purple bladderwort (1985). Two state threatened species, dwarf umbrella sedge (2012) and long-beaked baldrush (2012) and three species of special concern, sandhill crane (2002), longnose dace (2014) and American badger (1989) are located within the Cobus Creek Watershed. One high quality natural area, muck flat, has been documented within the Cobus Creek Watershed. Boot Lake Nature Preserve, owned and managed by the City of Elkhart, and Cobus Creek Park, managed by the Elkhart County Parks Department, are also present within the watershed. Appendix A details the database results for the Cobus Creek Watershed and St. Joseph, Elkhart, and Cass counties. A similar databased documenting ETR species and high quality natural communities in Michigan is maintained by Michigan State University Extension. However, the database was not analyzed due to budget conditions.

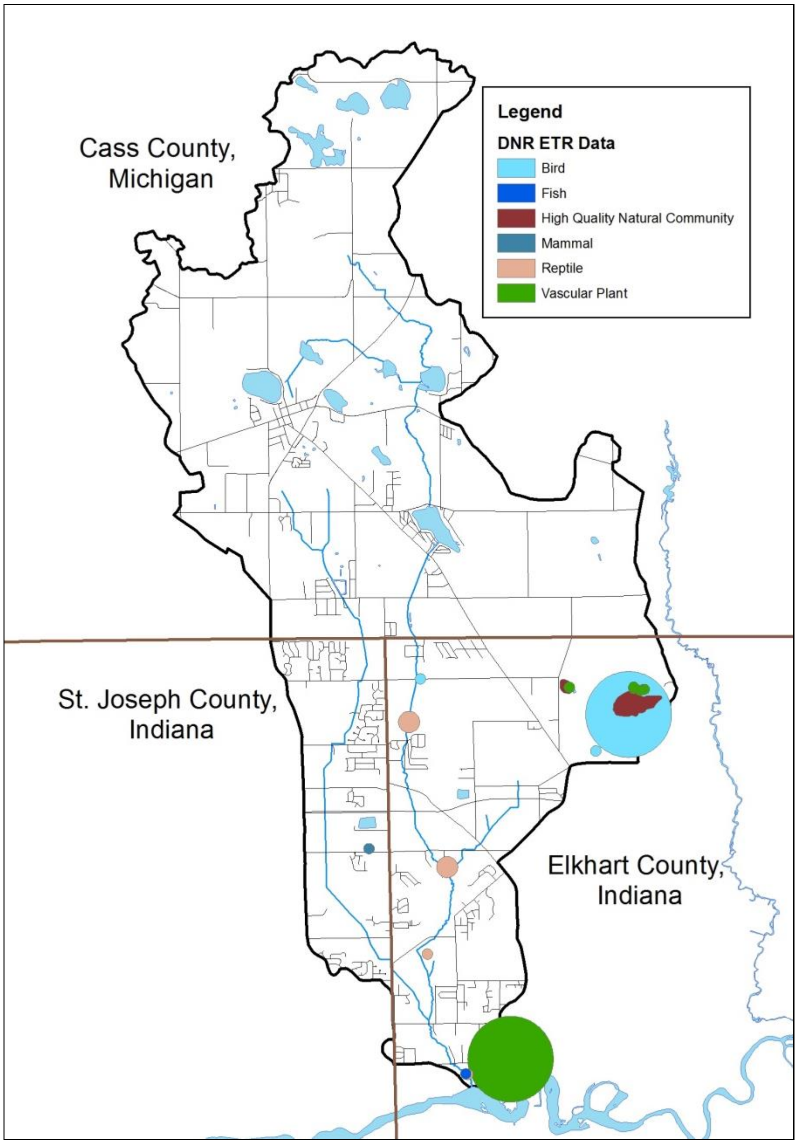

Figure 8. Locations of special species and high quality natural areas observed in the Indiana portion of the Cobus Creek Watershed.

2.8 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. A review of the historic land types present in the watershed will provide an idea of the types of restoration that could occur within the watershed and also a basis for the past uses of the land.

Agricultural land use dominates the Cobus Creek Watershed (Figure 9 and Table 2). In total 46% of the watershed is covered by agricultural row crop or pasture. Much of the agricultural land in St. Joseph and Elkhart counties, including the Cobus Creek Watershed, is utilized for corn and soybean production (USDA, 2012a; USDA, 2012b). County-wide tillage transect data for both counties provide an estimate of the portion of cropland in conservation tillage within the Cobus Creek Watershed. In Elkhart and St. Joseph counties, soybean producers utilize no-till methods on 66% and 86% of soybean fields and 13% and 26% of corn fields, respectively (ISDA, 2015). Six unregulated animal operations are located within the Cobus Creek Watershed. In total, these facilities house 11 horses and 40 cattle. Forested lands and wetlands account for 21% of the watershed land use, while urban land uses, including urban open space and low, medium, and high intensity developed areas, account for 32% of the watershed.

Table 2. Detailed land use in the Cobus Creek Watershed.

Land Use	Area (acres)	Area (hectares)	Percent of Watershed
Cultivated Row Crop	9,445.6	3824.1	40%
Developed Open Space	4,055.4	1641.9	17%
Developed Low Intensity	2,601.0	1053.0	11%
Deciduous Forest	2,297.6	930.2	10%
Woody Wetland	1,879.1	760.7	8%
Pasture	1,346.3	545.1	6%
Developed Medium Intensity	487.8	197.5	2%
Grassland	381.6	154.5	2%
Developed High Intensity	303.1	122.7	1%
Open Water	284.8	115.3	1%
Emergent Herbaceous Wetland	192.0	77.7	1%
Barren Land	72.8	29.5	0%
Mixed Forest	35.3	14.3	0%
Evergreen Forest	16.4	6.7	0%
Scrub-Shrub	13.0	5.3	0%
Watershed Total	**23,412.5**	**9,478.7**	**100%**

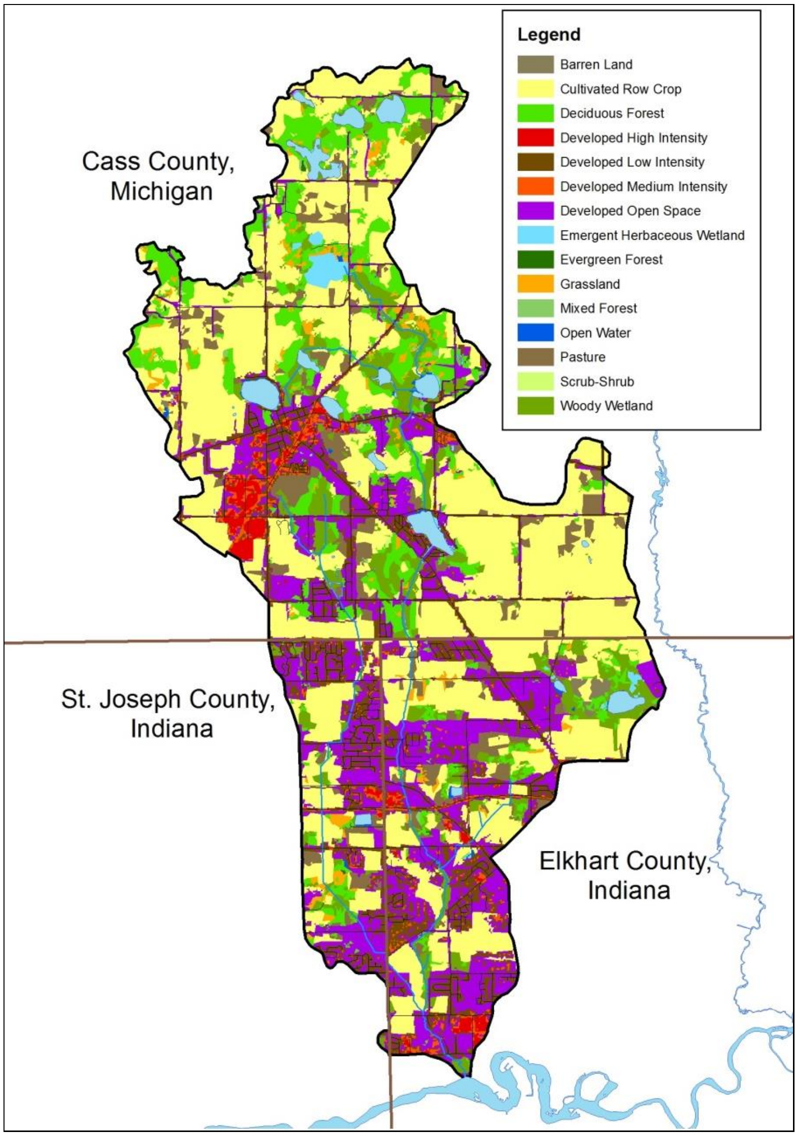

Figure 9. Land use in the Cobus Creek Watershed.

2.9 <u>Wetlands</u>

Because wetlands perform a variety of functions in a healthy ecosystem, they deserve special attention when examining watersheds. Functioning wetlands filter sediments and nutrients in runoff, store water for future release, provide an opportunity for groundwater recharge or discharge, and serve as nesting habitat for waterfowl and spawning sites for fish. By performing these roles, healthy, functioning wetlands often improve water quality and biological health of streams and lakes located downstream of wetlands.

The US Fish and Wildlife Service National Wetland Inventory map shows that wetlands cover 7.6% of the Cobus Creek Watershed (Table 3 and Figure 10). Large tracts of contiguous wetlands lie to north and south of Garver, Coberts, Spring and Long lakes in Michigan and Boot Lake in Elkhart County. The U.S. Fish and Wildlife Service estimates an average of 2.6% of the nation's wetlands were lost annually from 1986 to 1997 (Zinn and Copeland, 2005). The IDNR estimates that approximately 85% of the state's wetlands have been filled (IDNR, 1996). The greatest loss has occurred in the northern counties of the state such as St. Joseph and Elkhart counties. Friends of the St. Joseph River documented nearly 53% of basin-wide, pre-settlement wetlands were lost (FOTSJR, 2013).The last glacial retreat in these northern Indiana and southern Michigan counties left level landscapes dotted with wetland and lake complexes. Development of the land in these counties for agricultural purposes altered much of the natural hydrology, eliminating many of the wetlands.

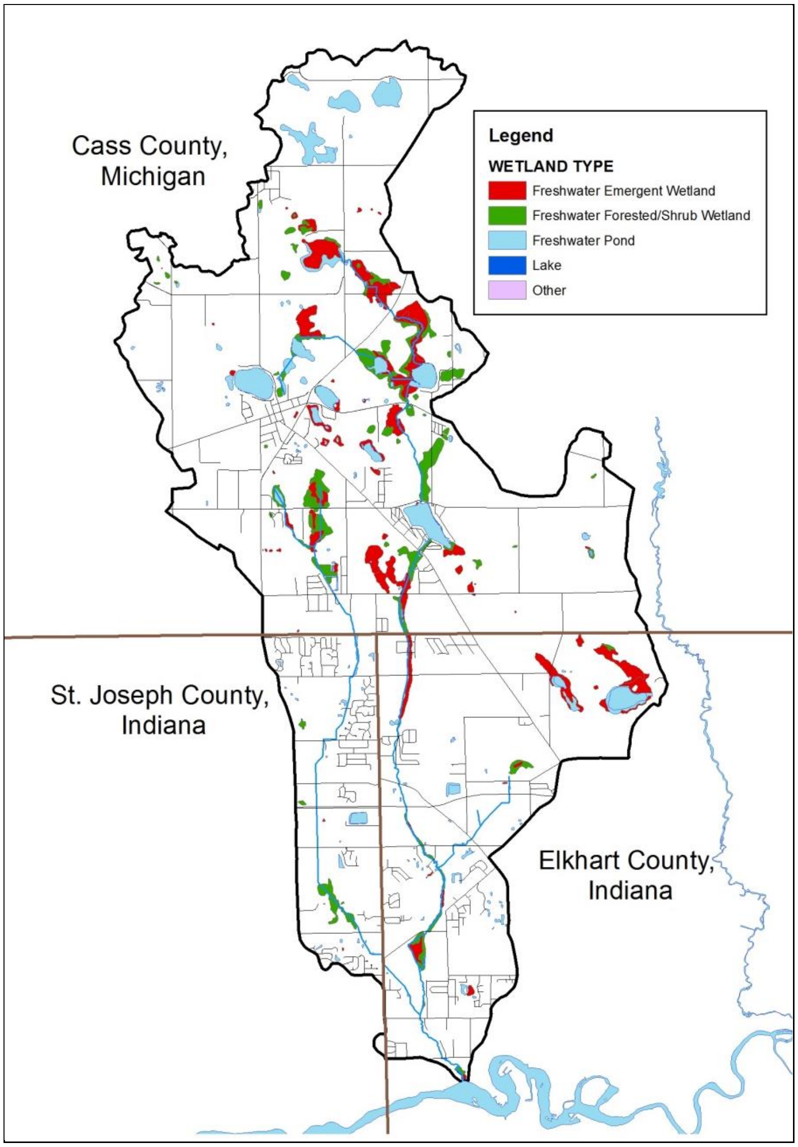

Figure 10. National Wetland Inventory wetlands in the Cobus Creek Watershed.

Table 3. Acreage and classification of wetland habitat in the Cobus Creek Watershed.

Wetland Type	Area (acres)	Area (ha)	Percent of Watershed
Freshwater Emergent Wetland	745.7	301.9	3.2%
Freshwater Forested/Shrub Wetland	539.2	218.3	2.3%
Freshwater Pond	286.2	115.9	1.2%
Lake	218.9	88.6	0.9%
Total	**1,789.9**	**724.7**	**7.6%**

Conversion of wetlands to agricultural land uses has undoubtedly reduced wetland acreages in the Cobus Creek Watershed. Historic hydric soils cover much of the area along the mainstem of Gast Ditch and Cobus Creek (Figure 6). Hydric soils, which formed under wetland conditions, cover 2,359 acres (955 ha) of the watershed, including the lake basins. When compared to the acreage of wetlands mapped by the US Fish and Wildlife Service (1,790 acres, 725 ha), approximately 25% of wetlands within the Cobus Creek Watershed have been lost. This is better than the basin-wide average (53%) and the statewide average (85%).

2.10 Floodplains and Riparian Zones

Flooding is one of the most common hazards throughout northern Indiana and southern Michigan and can be localized or occur region or basin wide. The Federal Emergency Management Agency developed the Flood Insurance Rate Maps (FIRM) to allow landowners and governmental entities to assess the flood risk in specific areas. FIRMs detail suggested insurance rates that property owners should pay to develop properties within risk areas. Special flood hazard area in Zone A, which is subject to a 1% annual chance of flooding, covers 121.7 acres (49.3 ha). The majority of regulated floodplain areas are located along the southern mainstem of Cobus Creek (Figure 11). Additional floodplain is located around the Toll Road-Cobus Creek intersection.

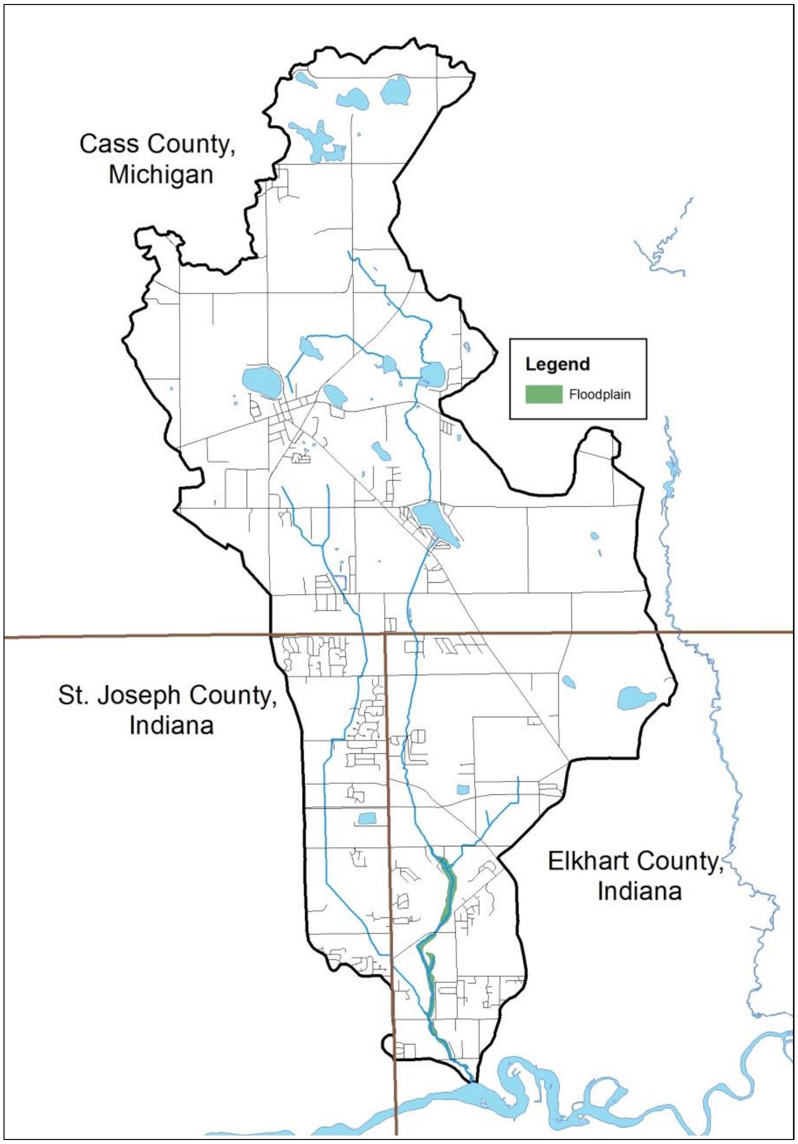

Figure 11. Floodplain mapped within the Cobus Creek Watershed.

3.0 HISTORIC WATER QUALITY ASSESSMENTS

A variety of water quality assessment projects have been completed within the Cobus Creek Watershed (Figure 12). Statewide assessments and listings include the integrated water monitoring assessment, the impaired waterbodies assessment, and fish consumption advisories. Additionally, the Indiana Department of Environmental Management (IDEM) and Michigan Department of Natural Resources (MDNR) have both completed assessments within the watershed. The Elkhart County Health Department, City of Elkhart Aquatic Biology Program, and Hoosier Riverwatch volunteers also completed regional watershed assessments.

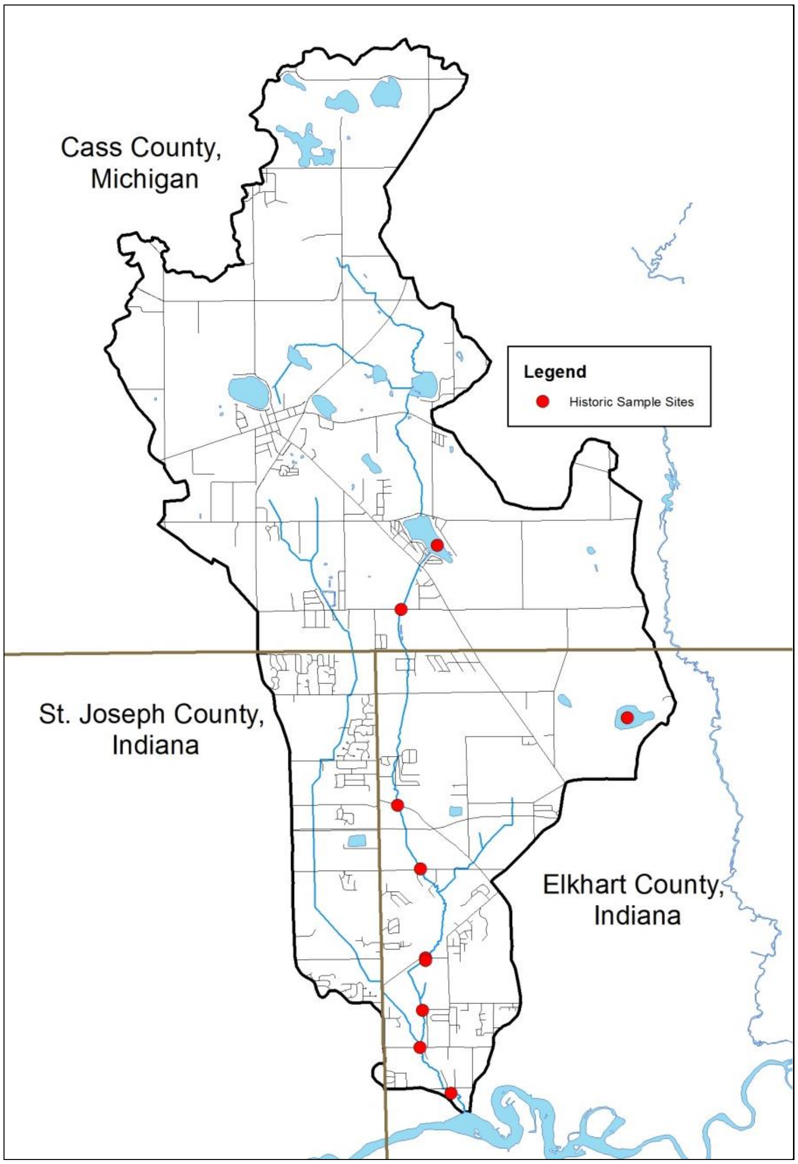

Figure 12. Historic water quality assessment locations in the Cobus Creek Watershed.

3.1.1 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. While there are limitation in these data which creates a reluctance to draw too many conclusions based on a single sampling event, there is a need to compare historically collect and current water quality assessments to standard values. Table **4** identifies a standard suite of parameters and the benchmark utilized to evaluate collected water quality data.

Table 4. Water quality benchmarks used to assess water quality from historic and current water quality assessments.

Parameter	Water Quality Benchmark	Source
Temperature	Monthly standard	Indiana Administrative Code
Dissolved oxygen	>6 mg/L	Indiana Administrative Code
Biological oxygen demand	<2 mg/L good; 3-5 fair mg/L; 6-9 poor mg/L; >10 mg/L very poor	Hoosier Riverwatch (2015)
Conductivity	1,000-1360 µmhos/cm	Indiana Administrative Code
pH	<6 or >9	Indiana Administrative Code
Turbidity	<1.7 NTU	USEPA (2000)
Chloride	<250 mg/L	Kaushal et al.(2005)
Nitrate-nitrogen	<2.0 mg/L	Dodds et al. (1998)
Ammonia-nitrogen	0.0-0.21 mg/L	Indiana Administrative Code
Total Kjeldahl nitrogen	<0.54 mg/L	USEPA (2000)
Orthophosphorus	<0.005 mg/L	Correll (1998)
Total phosphorus	<0.075 mg/L	Dodds et al. (1998)
Total suspended solids	<25 mg/L	Waters (1995)
Total dissolved solids	<750 mg/L	Indiana Administrative Code
E. coli	<235 colonies/100 mL	Indiana Administrative Code
Chlorophyll a	<1.5 µg/L	USEPA (2000)

3.2 Integrated Water Monitoring Assessment

The Indiana Department of Environmental Management (IDEM) is the primary agency tasked with monitoring surface water quality within the state of Indiana. Chapter 305(b) of the Clean Water Act requires that the state report on the quality of waterbodies throughout the state on a biannual basis. These assessments are known as the Integrated Water Monitoring Assessment (IWMA) or the 305(b) Report. The most recent draft report was delivered to the USEPA in 2016 (IDEM, 2016b). To complete this report, the 305(b) coordinator reviews all data collected by IDEM and selected high-quality data collected by other organizations on a waterbody basis. Each assessed waterbody is then assigned a water quality rating based on its ability to meet Indiana's water quality standards (WQS). WQS are set at a level to protect Indiana waters' designated uses of swimmable, fishable, and drinkable. Waterbodies that do not meet their designated uses are proposed for listing on the impaired waterbodies list. The 2016 IWMA does not include any waterbodies from the Cobus Creek Watershed. This suggests that waterbodies within the Cobus Creek Watershed are meeting their designated uses; however, it should be noted that IDEM has completed only limited assessments of the Cobus Creek Watershed.

3.3 Impaired Waterbodies List

Neither Cobus Creek nor any of its tributaries have been listed on the Indiana or Michigan impaired waterbodies lists (IDEM, 2016a, MDEQ, 2016).

3.4 Fish Consumption Advisory

In Indiana, three state agencies collaborate annually to compile the Indiana Fish Consumption Advisory (FCA). The Indiana Department of Natural Resources, Indiana Department of Environmental Management, and Indiana State Department of Health have worked together since 1972 on this effort. Samples are collected through IDEM's rotating basin assessment for bottom feeding, mid-water column feeding, and top feeding fish. Fish tissue samples are then analyzed for heavy metals, PCBs, and pesticides. Advisories listings are as follows:

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

The Indiana FCA does not contain any listings for the Cobus Creek Watershed (ISDH, 2016a; ISDA, 2016b).

3.5 IDEM Rotational Basin Assessment

Through the Indiana Department of Environmental Management's rotational basin assessment program, IDEM scientists collected water samples in the Cobus Creek Watershed at two sites. One site, Cobus Creek at County Road 8, was sampled one time in 1990.The other site, Cobus Creek at David Drive, was sampled nine times in 2010. Based on the rotational basin sampling data, the following conclusions can be drawn:

- Dissolved oxygen, temperature, pH, conductivity, hardness, alkalinity, metals, and turbidity measurements were all within standard ranges during the 1990 and 2010 assessments.
- Total phosphorus, nitrate-nitrogen, and ammonia-nitrogen all measured below target concentrations.
- One of five E. coli samples exceeded the state standard (235 col/100 ml) during the 2010 assessment.

3.6 Michigan Department of Natural Resources

Michigan DNR assessed Cobus Creek at four locations: Redfield Road, Elkhart Road, May Road, and US Highway 12, in September 2014. Based on the MDNR assessments, the following conclusions can be drawn:

- Field measurements, including dissolved oxygen, temperature, and hardness measured within standard ranges at all four sites.
- Nutrients, including total phosphorus, nitrate-nitrogen, ammonia-nitrogen, and total Kjeldahl nitrogen all measured below target concentrations.
  Differences in nutrient concentrations measured at each site were not statistically significant.

3.7 Elkhart County Health Department

The Elkhart County Health Department assessed Cobus Creek at County Road 10 biweekly from April to September in 2014 and 2015. Based on the ECHD assessments, the following conclusions can be drawn:

- Field measurements, including temperature, dissolved oxygen, conductivity, and pH were all within standard ranges.
- Total phosphorus concentrations exceed target concentrations (0.08 mg/L) during 33 of 48 samples or in nearly 70% of collected samples. Concentrations measured as high as 3.34 mg/L during April 2015. Concentrations measured in 2015 are on average more than double those measured in 2014 and concentrations appear to be increasing; however, variations in total phosphorus concentration could be due to climatic conditions rather than a result of declining water quality (Figure 13).

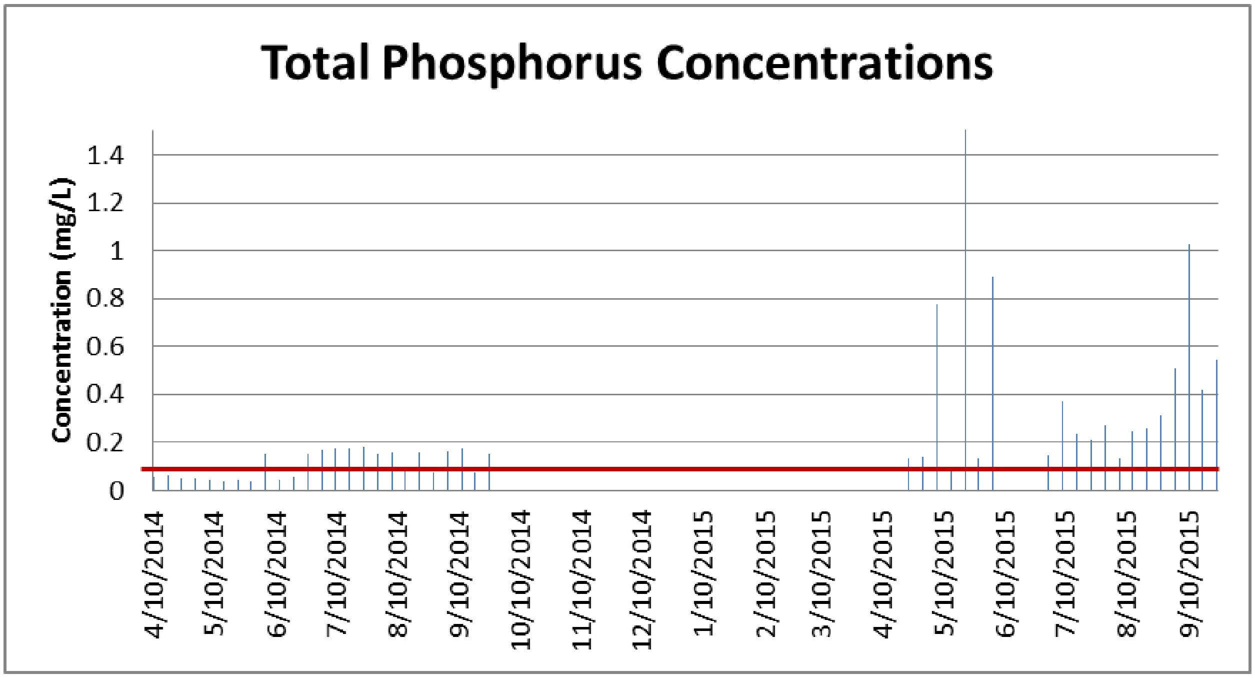

Figure 13. Total phosphorus concentrations measured by the Elkhart County Health Department from April to September in 2014 and 2015 compared with target concentration (0.08 mg/L).

- Nitrate-nitrogen, chloride, and total suspended solids concentrations measure within below target concentrations.
- E. coli concentrations exceeded state standards (235 col/100 mL) in 21 of 48 collected samples. Concentrations in excess of state standards measured between 236 and 1140 colonies/100 mL.

3.8 City of Elkhart – Aquatic Biology Program

The City of Elkhart Aquatic Biology Program assessed the fish community in Cobus Creek at the following locations, historically:

- County Road 8 twice annually from 1998 through 2014;
- Cobus Creek at County Road 10 once in 2000;
- Cobus Creek at County Road 12 once annually in 2010, 2013, and 2014;
- Cobus Creek at Cross Creek Drive once in 2003;

- Cobus Creek at Old US Highway 20 once annually in 1998 and 2002;
- Cobus Creek at the Elkhart Conservation Club once annually in 1999, 2001, 2005, 2013, and twice in 2014.

Additionally, qualitative (2013) and quantitative (2010) macroinvertebrate assessments occurred in Cobus Creek at County Road 8.

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

- Water temperatures typically measured less than 20 degrees C (68 degrees F) during City of Elkhart assessments throughout Cobus Creek. This indicates that Cobus Creek has typically met requirements for coldwater streams (Lyons et al., 1996).
- In total, 42 fish species have been identified within Cobus Creek. Creek chub, white sucker, mottled sculpin, and blacknose dace were the most common species identified.
- Longnose dace and brown trout were collected by the City of Elkhart in 2014. Longnose dace are a state species of special concern, while the presence of brown trout is significant as a coldwater stream. Cobus Creek can serve as a nursery for brown trout populations within the St. Joseph River Basin.
- Index of Biotic Integrity scores generally indicated that fish populations in Cobus Creek rate as "good", scoring between 29 and 34 at all sites during all assessment events. The 2013 assessment at the Elkhart Conservation Club fell outside of this range scoring 49, which indicates a higher quality community present at this location during this assessment. During the 2014 assessment, all IBI scores measured above the target IBI score of 32 (IDEM, 2016).
- Habitat data indicated high quality conditions during each of these assessments, with scores ranging from 67 to 88.5. These QHEI assessments indicated that Cobus Creek meets aquatic life use designation for habitat at these locations during their assessments.
- Qualitative and quantitative macroinvertebrate assessments indicated high species diversity, with 33 and 39 species identified, respectively.

3.9 Hoosier Riverwatch

In 2002, 2003, and 2016, volunteers trained through the Hoosier Riverwatch program assessed two sites within the Cobus Creek Watershed. Assessments occurred once annually in 2002 and 2003 at the Elkhart Conservation Club and in 2016 at multiple locations within the Cobus Creek County Park. In 2002 and 2003, 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. In 2016, students used the Citizen's QHEI to assess habitat along Cobus Creek within the Cobus Creek County Park. Based on these data, the following conclusions can be drawn:

- 2002 and 2003 data indicated high quality conditions and a high Pollution Tolerance Index during both assessments.
- Habitat assessments completed by students in 2016 indicated high quality habitat is present along Cobus Creek within the Cobus Creek County Park; however, it should be noted that assessment occurred along the recently stabilized portion of the stream. This could result in artificially increasing the CQHEI scores.

4.0 WATER QUALITY ASSESSMENT

4.1 Introduction

The water quality assessment portion of the Cobus Creek Diagnostic Study consisted of water chemistry sampling during base flow and during a storm event, macroinvertebrate and fish community assessments, and a habitat assessment. Sampling was conducted at 11 sites within in the Cobus Creek Watershed and at one reference site on Christiana Creek. The water quality assessment provides information on water quality, aquatic community health, and habitat availability. The data also assist in guiding the prioritization of management actions and direction of those actions towards the most critical areas.

4.1.1 Sample Locations

Eleven stream sample sites were strategically chosen throughout the Cobus Creek Watershed (Figure 14; Table 5). These sites were selected based on accessibility and input from the St. Joseph River Basin Commission. Sample sites correspond with major tributaries including, Gast Ditch, the Coberts Lake inlet, the Spring Lake inlet, and Cobus East Lateral A (Figure 14). Additional sites are located along Cobus Creek and Gast Ditch upstream and downstream of the Indiana-Michigan state line, at the mouth of Gast Ditch, and at the outlet of Cobus Creek to the St. Joseph River. The water quality assessment protocol also includes sampling at a reference site for comparative purposes. An ideal reference site for comparison of macroinvertebrate communities would occur in a relatively undisturbed watershed and would meet all criteria listed in Table 6. Additionally, as Cobus Creek contains a cool-water fishery, the ideal reference site should also support a similar fishery. Based on these criteria, Christiana Creek, trout stream which contains warmer water, was selected as the reference site.

Table 5. Detailed sampling location information for the Cobus Creek Watershed sampling sites.

Site	Stream Name	Road Crossing	Latitude	Longitude
1	Cobus Creek	County Road 12	41.69535	-86.0537
2	Gast Ditch	County Road 8	41.70481	-86.0621
3	Cobus Creek	County Road 8	41.71000	-86.0522
4	Cobus East Lateral A	County Road 6	41.72439	-86.0457
5	Gast Ditch	Adams Road	41.75346	-86.0682
6	Cobus Creek	County Road 2	41.75349	-86.0556
7	Gast Ditch	Redfield Road	41.76749	-86.0719
8	Cobus Creek	Redfield Road	41.76732	-86.0567
9	Garver Lake inlet	May Street	41.78303	-86.0522
10	Spring Lake inlet	M 62	41.80873	-86.0670
11	Coberts Lake inlet	M 62	41.81536	-86.0586
Reference	Christiana Creek	SR 19/Bristol Street	41.70241	-86.97996

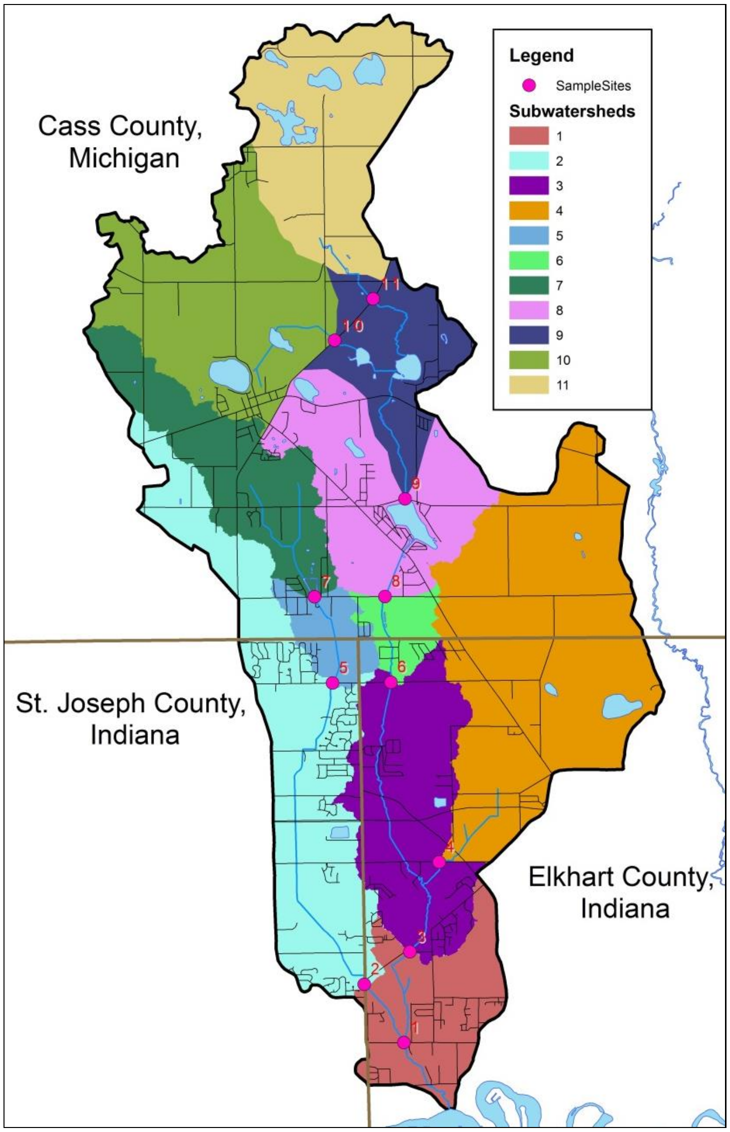

Figure 14. Cobus Creek stream sample sites.

Table 6. Minimum criteria for stream reference sites.

Reference Site Criteria
• pH>6 • Dissolved oxygen >4 mg/L • Nitrate<16.5 mg/L • Urban land use <20% of catchment area • Forest land use >25% of catchment area • Instream habitat rating optimal or suboptimal • Riparian buffer width >15 meters • No channelization • No point source discharges

Source: Plafkin et al., 1989.

4.2 Water Chemistry Assessment

4.2.1 Methods

The LARE sampling protocol requires assessing water quality of each stream site once during base flow and once during storm flow. Base flow sampling provides an understanding of the typical conditions in the streams. Following storm events, increased overland flow results in increased erosion of soil and nutrients from the land. Stream concentrations of nutrients and sediment are typically higher following storm events. Storm event sampling provides a “worst case” scenario picture of watershed pollutant loading.

Base flow samples were collected May 20, 2016 following a period of little precipitation. Storm event samples were collected June 23, 2016 following a 24-hour 1.25 inch rain event. Base flow and stormwater runoff samples included measurements of physical, chemical, and bacteriological parameters. Conductivity, temperature, and dissolved oxygen were measured in situ at each stream site. Water velocity was measured using a Marsh-McBirney Flo-Mate current meter. Cross-sectional areas of the stream channel at each site were measured and discharge calculated by multiplying water velocity by the cross-sectional areas. In addition, water samples were collected from just below the water surface using a cup sampler and analyzed for the following parameters:

- Temperature
- Dissolved oxygen
- Biological Oxygen Demand
- Conductivity
- pH
- Turbidity
- Chloride
- Nitrate-nitrogen
- Ammonia-nitrogen
- Total Kjeldahl nitrogen
- Orthophosphorus
- Total phosphorus
- Total suspended solids
- Total dissolved solids
- E. coli
- Chlorophyll a

Following collection, samples were stored on ice until analysis at the Commonwealth Biomonitoring laboratory in Indianapolis, Indiana. All sampling techniques and laboratory analysis methods were performed in accordance with the procedures in *Standard Methods for the Examination of Water and Wastewater*, *20th Edition* (APHA, 1998).

The comprehensive evaluation of streams requires collecting data on the different water parameters listed above. A brief description of each parameter follows:

Temperature Temperature can determine the form, solubility, and toxicity of a broad range of aqueous compounds. Likewise, water temperature regulates the species composition and activity of life associated with the aquatic environment. Since essentially all aquatic organisms are cold-blooded, the temperature of the water regulates their metabolism and ability to survive and reproduce effectively (USEPA, 1976). The Indiana Administrative Code (327 IAC 2-16) sets maximum temperature limits to protect aquatic life for Indiana streams. For example, temperatures during the months of June and July should not exceed 90 °F by more than 30 °F. The code also states that the “maximum temperature rise at any time or place… shall not exceed 50 °F in streams…”

Dissolved Oxygen (DO) DO is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. Fish need water to possess a DO concentration of at least 3-5 mg/L of DO. Coldwater fish such as trout generally require higher concentrations of DO than warmwater fish

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such as bass or bluegill. The IAC sets minimum DO concentrations at 6 mg/L for coldwater fish. DO enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Excessive algae growth can over-saturate (greater than 100% saturation) the water with DO. Waterbodies with large populations of algae and plants (macrophytes) often exhibit supersaturation due to the high levels of photosynthesis. Dissolved oxygen is consumed by respiration of aquatic organisms, such as fish, and during bacterial decomposition of plant and animal matter. **Biological or Biochemical oxygen demand (BOD)** is the amount of dissolved oxygen required by these organisms to decompose, or break down, organic matter. Water temperature, nutrient concentrations, and enzymes available determine the time and oxygen required to complete decomposition.

Conductivity Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions: on their total concentration, mobility, and valence (APHA, 1998). During low flows, conductivity is higher than it is following a storm water runoff because the water moves more slowly across or through ion containing soils and substrates during base flow conditions. Carbonates and other charged particles (ions) dissolve into the slow-moving water, thereby increasing conductivity levels. Rather than setting a conductivity standard, the Indiana Administrative Code sets a standard for dissolved solids (750 mg/L). Multiplying a dissolved solids concentration by a conversion factor of 0.55 to 0.75 µmhos per mg/L of dissolved solids roughly converts a dissolved solids concentration to specific conductance (Allan, 1995). Thus, converting the IAC dissolved solids concentration standard to specific conductance by multiplying 750 mg/L by 0.55 to 0.75 µmhos per mg/L yields a specific conductance range of approximately 1000 to 1360 µmhos. This report presents conductivity measurements at each site in µmhos.

pH The pH of stream water describes the concentration of acidic ions (specifically H+) present in the water. The pH also determines the form, solubility, and toxicity of a wide range of other aqueous compounds. The IAC establishes a range of 6-9 pH units for the protection of aquatic life.

Turbidity Turbidity (measured in Nephelometric Turbidity Units or NTUs) is a measure of water coloration and particles suspended in the water itself. It is generally related to suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. According to the Hoosier Riverwatch, the average turbidity of an Indiana stream is 11 NTU with a typical range of 4.5-17.5 NTU. Turbidity measurements >20 NTU have been found to cause undesirable changes in aquatic life (Walker, 1978). The U.S. Environmental Protection Agency developed recommended water quality criteria as part work to establish numeric criteria for nutrients on an ecoregion basis. Recommended turbidity concentrations for this ecoregion are 1.7 NTUs (USEPA, 2000).

Chloride Chloride is a naturally occurring, dissolved, inorganic chemical found in soils and freshwater. In non-saline systems, chloride typically occurs at low concentration averaging 7 mg/L (Freedman, 2014). Chloride is also commonly found in salt compounds, such as sodium chloride, which readily dissolves in water. De-icing salts, like those applied in northern Indiana and southern Michigan, routinely contain sodium chloride and other salts. Research completed in Maryland indicates that nearly 55% of chloride-based deicing salts dissolve in melting snow, which is then transported via surface runoff into adjacent waterbodies (Church and Friesz, 1993). In land applications, chloride concentrations as low as 30 mg/L resulted in damage to plants, while chronic chloride concentrations measuring 250 mg/L in aquatic systems prove harmful to freshwater biota and limit human consumption as drinking water (Sprague et al., 2002).

Nitrogen Nitrogen is an essential plant nutrient found in fertilizers, human and animal wastes, yard waste, and the air. About 80% of the air we breathe is nitrogen gas. Nitrogen gas diffuses into water where it can be "fixed", or converted, by blue-green algae to ammonia for their use. Nitrogen can also enter lakes and streams as inorganic nitrogen and ammonia. Because of this, there is an abundant supply of available nitrogen to aquatic systems. The three common forms of nitrogen are:

- **Nitrate-nitrogen (NO3-N)** Nitrate is an oxidized form of dissolved nitrogen that is converted to ammonia by algae. It is found is streams and runoff when dissolved oxygen is present, usually in the surface waters. Ammonia applied to farmland is rapidly oxidized or converted to nitrate and usually enters surface and groundwater as nitrate. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams classified as warmwater habitat (WWH) was 1.0 mg/l. Warmwater habitat refers to those streams which possess minor modifications and little human influence. These streams typically support communities with healthy, diverse warmwater fauna. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams classified as modified warmwater habitat (MWH) was 1.6 mg/L. Modified warmwater habitat was defined as: the aquatic life use assigned to streams that have irretrievable, extensive, man-induced modification that precludes attainment of the warmwater habitat use designation; such streams are characterized by species that are tolerant of poor chemical quality (fluctuating dissolved oxygen) and habitat conditions (siltation, habitat amplification) that often occur in modified streams (Ohio EPA, 1999).

  Gast Ditch, the Coberts Lake inlet, the Spring Lake inlet, and the Cobus East Lateral A could all be considered modified warmwater habitat streams. Cobus Creek is considered a coolwater stream and thus does not meet either the warmwater habitat or modified warmwater habitat criteria used by the Ohio EPA; however, the warmwater habitat criteria is likely the most reasonable for comparison to Cobus Creek. The U.S. Environmental Protection Agency developed recommended nitrate-nitrogen criterion as part of work to establish numeric criteria for nutrients on an ecoregion basis. The recommended nitrate-nitrogen concentration for the ecoregion is 0.63 mg/l (USEPA, 2000). Nitrate-nitrogen concentrations exceeding 10 mg/1 in drinking water are considered hazardous to human health (Indiana Administrative Code IAC 2-1-6).

- **Ammonia-nitrogen (NH3-N)** Ammonia-nitrogen is a form of dissolved nitrogen that is the preferred form for algae use. Bacteria produce ammonia as they decompose dead plant and animal matter. Ammonia is the reduced form of nitrogen and is found in water where dissolved oxygen is lacking. Important sources of ammonia include fertilizers and animal manure. Both temperature and pH govern the toxicity of ammonia for aquatic life. According to the IAC, maximum ionized ammonia concentrations for the study streams should not exceed approximately 1.94 to 7.12 mg/L, depending on the water's pH and temperature.

- **Organic Nitrogen** Organic nitrogen includes nitrogen found in plant and animal materials. It may be in dissolved or particulate form. The most commonly measured form used to calculate organic nitrogen is total Kjeldahl nitrogen (TKN). Organic nitrogen is TKN minus ammonia. The U.S. Environmental Protection Agency developed TKN criterion as part work to establish numeric criteria for nutrients on an ecoregion basis. The recommended total Kjeldahl nitrogen concentration for this ecoregion is 0.540 mg/l (USEPA, 2000).

Phosphorus Phosphorus is an essential plant nutrient and the one that most often controls aquatic plant (algae and macrophyte) growth. It is found in fertilizers, human and animal wastes, and in yard waste. There are few natural sources of phosphorus to streams other than that which is attached to soil particles; there is no atmospheric (vapor) form of phosphorus. For this reason, phosphorus is often a limiting nutrient in aquatic systems. This means that the relative scarcity of phosphorus may limit the ultimate growth and production of algae and rooted aquatic plants. Management efforts often focus on reducing phosphorus inputs to receiving waterways because: (a) it can be managed and (b) reducing phosphorus can reduce algae production. Two common forms of phosphorus are:

- **Soluble reactive phosphorus (SRP)** SRP or orthophosphorus is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae themselves. Because phosphorus is cycled so rapidly through biota, SRP concentrations as low as 0.005 mg/l are enough to maintain eutrophic or highly productive conditions in lake systems (Correll, 1998). Sources of SRP include fertilizers, animal wastes, and septic systems.

- **Total phosphorus (TP)** TP includes dissolved and particulate phosphorus. TP concentrations greater than 0.03 mg/1 (or 30µg/L) can cause algal blooms in lake systems. In stream systems, Dodd et al., 1998 suggests that streams with a total phosphorus concentration greater than 0.075 mg/L are typically characterized as productive or eutrophic. TP is often a problem in agricultural watersheds because TP concentrations required for eutrophication control are as much as an order of magnitude lower than those typically measured in soils used to grow crops (0.2-0.3 mg/L). The Ohio EPA (1999) found that the median TP concentration in wadeable streams that support WWM for fish was 0.10 mg/L, while wadeable streams that support MWH for fish was 0.28 mg/L. The U.S. Environmental Protection Agency recommended TP criterion for this ecoregion is 0.033 mg/L (USEPA, 2000).

Total Suspended Solids (TSS) A TSS measurement quantifies all particles suspended in stream water. Closely related to turbidity, this parameter quantifies sediment particles and other solid compounds typically found in stream water. In general, the concentration of suspended solids is greater during high flow events due to increased overland flow. The increased overland flow erodes and carries more soil and other particulates to the stream. The State of Indiana does not have a TSS standard. In general, TSS concentrations greater than 80 mg/L have been found to be deleterious to aquatic life; concentrations of 15 mg/L are often targeted as levels necessary for quality fishery production (Waters, 1995).

Total Dissolved Solids (TDS) A TDS measurement qualifies the total amount of mobile, charged ions, such as salt, minerals, and metals, dissolved in stream water. TDS essentially measures anything in water except the water itself and any materials suspended in the water, such as chloride, sodium, phosphates, calcium, and potassium. Dissolved solids originate from runoff, road salts, fertilizers and pesticides, leaching from sediment and rock, and from lead or copper leaching from drainage pipes. The USEPA recommends a maximum concentration of 500 mg/L (USEPA, no date).

E. coli and Fecal Coliform Bacteria E. coli is one member of a group of bacteria that comprise the fecal coliform bacteria and is used as an indicator organism to identify the potential presence of pathogenic organisms in a water sample. Pathogenic organisms can present a threat to human health by causing a variety of serious diseases, including infectious hepatitis, typhoid, gastroenteritis, and other gastrointestinal illnesses. E. coli can come from the feces of any warm-blooded animal. Wildlife, livestock, and/or domestic animal defecation, manure fertilizers, previously contaminated sediments, and failing or improperly sited septic systems are common sources of the bacteria. The IAC sets the maximum standard at 235 colonies/100 ml in any one sample within a 30-day period.

Chlorophyll a The plant pigments in algae consist of the chlorophylls (green color) and carotenoids (yellow color). Chlorophyll *a* is by far the most dominant chlorophyll pigment and occurs in great abundance. Thus, chlorophyll *a* is often used as a direct estimate of algal biomass. In general, chlorophyll *a* concentrations below 2 µg/L are considered low, while those exceeding 10 µg/L are considered high and indicative of poor water quality. The USEPA recommended a numeric criterion of 1.5 µg/L as a target concentration for streams in Aggregate Nutrient Ecoregion VII (USEPA, 2000).

4.2.2 Water Chemistry Results and Discussion

Introduction

There are two useful ways to report water quality data in flowing water. Concentrations describe the mass of a particular material contained in a unit of water, for example, milligrams of phosphorus per liter (mg/l). Mass loading (in units of kilograms per day) on the other hand describes the mass of a particular material being carried per unit of time. For example, a high concentration of phosphorus in a stream with very little flow will deliver a smaller total amount of phosphorus to the receiving waterway than will a stream with a low concentration of phosphorus but a high flow of water. It is the total amount (mass) of phosphorus, solids, and bacteria actually delivered from the watershed that is most important when considering the effects of these materials downstream. Because consideration of concentration and mass loading data is important, the following three sections will discuss 1) physical parameter concentrations, 2) chemical and bacterial parameter concentrations, and 3) chemical and sediment parameter mass loading.

Physical Concentrations and Characteristics

Physical parameter results measured during base and storm flow sampling are presented in Table 7. Each physical parameter is addressed in the following discussion.

Table 7. Physical parameter data collected during the stream chemistry sampling events in the Cobus Creek Watershed on May 20 and June 23, 2016. Shaded squares indicate those samples that measure above Indiana State Standards ( ) or recommended target values (; Correll, 1998; Dodds et al., 1998; Waters, 1998; USEPA, 2000).

Site Number	Flow Condition	Flow (cfs)	Temp (deg C)	DO (mg/L)	pH	Turb (NTU)	Cond (µS)	BOD (mg/L)	Chloride (mg/L)
1	Base	18.0	13.6	10.5	7.9	1	530	1	42
	Storm	36.0	18.6	9.8	7.5	1	320	3	30
2	Base	2.8	13.8	9.8	7.9	1	505	1	38
	Storm	9.0	20.2	7.3	7.4	3	210	5	24
3	Base	11.0	14.9	9.8	8.0	1	480	7	36
	Storm	15.0	18.6	9.5	7.5	1	320	4	30
4	Base	0.9	14.2	10.2	7.8	1	430	2	34
	Storm	2.5	20.4	8.6	7.3	18	160	5	18
5	Base	4.0	17.3	9.6	8.0	1	510	2	40
	Storm	8.0	20.1	8.2	7.6	1	380	5	24
6	Base	9.0	18.0	9.7	8.1	1	370	1	32
	Storm	11.0	21	8.4	7.4	1	220	4	12
7	Base	2.0	16.2	9.5	7.8	1	530	8	42
	Storm	8.0	19.5	7.6	7.3	1	310	5	24
8	Base	6.0	18.6	9.1	8.0	1	380	13	32
	Storm	11.0	21.2	8.1	7.3	1	240	6	12
9	Base	5.0	16.6	9.1	8.0	1	410	11	34
	Storm	9.0	19.6	8.2	7.5	1	250	6	18
10	Base	0.1	13.7	9.4	7.5	1	320	3	30
	Storm	0.2	19.2	7.9	7.2	1	450	12	12
11	Base	2.0	18.2	8.8	7.8	1	560	1	44
	Storm	3.0	18.3	8.3	7.4	1	330	4	24
Reference	Base	79.0	17.7	9.4	8.1	1	500	1	40
	Storm	94.0	20.5	8.7	7.5	1	370	5	24

Temperature: Water temperature varied with sample timing. As expected, Cobus Creek Watershed streams were warmer in June than in May. During base flow sampling, the Cobus Creek Watershed streams exhibited a water temperature range of 56.5 °F (13.6 °C) at the Cobus Creek outlet (Site 1) to 65.5 °F (18.6 °C) at the Cobus Creek at Redfield Road (Site 8); during storm flow, the temperature range was 64.9 °F (18.3 °C) at Coberts Lake inlet (Site 11) to 70.2 °F (21.2°C) in Cobus Creek at Redfield Road (Site 8). Cobus Creek at Redfield Road (Site 8) exhibited the highest temperatures during both base and storm flow sampling. All temperatures were within ranges suitable for aquatic life and all measured below the coolwater standard (22 °C or 71.6 °F). Those sites with cooler temperatures likely had a greater proportion of groundwater flowing in them. Streamside vegetation that provides shading to the water can also prevent heat gain. The higher temperatures measured in the mainstem are likely due to the lack of riparian and overhanging vegetation, lack of tree canopy, lower proportion of groundwater inputs, and/or higher proportions of surface or point source inputs.

Dissolved Oxygen & Biological Oxygen Demand: Dissolved oxygen (DO) concentrations in Cobus Creek Watershed streams varied from 7.3 mg/l in Gast Ditch (Site 2; storm flow) to 10.5 mg/l in Cobus Creek at the outlet (Site 1; base flow). DO in all streams exceeded the Indiana state minimum standard of 6 mg/l for coldwater streams, indicating the oxygen levels were sufficient to support aquatic life. During base flow conditions biological oxygen demand (BOD) levels were generally low, ranging from 1 mg/L at the Cobus Creek outlet (Site 1), Gast Ditch (Site 2), Cobus Creek at CR 2 (Site 6), and the Coberts Lake inlet (Site 11) to 13 mg/L in Cobus Creek at Redfield Road (Site 8).BOD concentrations in Cobus Creek at CR 8 (Site 3) and Gast Ditch at Redfield Road (Site 7) rated as poor or moderately polluted, while Cobus Creek at Redfield Road (Site 8) and Garver Lake Inlet (Site 9) BOD concentrations rated as very poor or highly polluted during base flow conditions. During storm flow conditions, BOD levels ranged from 3 mg/L at the Cobus Creek outlet (Site 1) to 12 mg/L in the Spring Lake inlet (Site 10). Cobus Creek at Redfield Road (Site 8) and Garver Lake Inlet (Site 9) BOD concentrations rated as poor and the Spring Lake inlet (Site 10) BOD concentration rated as very poor under these conditions.

Conductivity: In general, conductivity values fell within acceptable ranges. Conductivity values in Cobus Creek Watershed streams ranged from from 320 µmhos at the Spring Lake inlet (Site 10) to 560 µmhos at Coberts Lake inlet (Site 11) during base flow and from 160 µmhos at the Cobus East Lateral A (Site 4) to 450 µmhos at Spring Lake inlet (Site 10) during storm flow . All of the measurements fell below the lower end of the range obtained by converting the IAC dissolved solids standard into specific conductance.

pH: pH values in Cobus Creek Watershed streams ranged from 7.5 at Spring Lake inlet (Site 10) to 8.1 at Cobus Creek at CR 2 (Site 6) during base flow and from 7.2 at Spring Lake inlet (Site 10) to 7.6 at Gast Ditch at Adams Road (Site 5) during storm flow. These pH values are within the range of 6-9 units established as acceptable by the Indiana Administrative Code for the protection of aquatic life.

Turbidity: Turbidity levels at one site, Cobus Creek Lateral A (Site 4; 18 NTUs), exceeded the turbidity levels commonly found in Indiana streams (4.5-17.5 NTUs; White, unpublished). The high turbidity concentration at this site occurred during storm flow conditions. Elevated turbidity was also noted in Gast Ditch at CR 8 (Site 2) during storm flow conditions. Storm flow samples at both sites, Gast Ditch at CR 8 (Site 2) and the Cobus Creek Lateral A (Site 4), exceeded the USEPA recommended turbidity concentration (1.7 NTU; USEPA, 2000). Turbidity at all other streams sites was overall low, measuring 1 NTU during both base and storm flow conditions. The increase in turbidity following storm events in Cobus Creek Lateral A and Gast Ditch suggests that stormwater in these tributaries carries larger amounts of dissolved and suspended solids than is present during base flow conditions.

Chloride: Chloride concentrations measured low when compared with acute and chronic aquatic life use protection levels (210 mg/L; Kaushal et al., 2005). Chloride measured between 30 mg/L in the Spring Lake inlet (Site 10) and 44 mg/L in the Coberts Lake inlet (Site 11) during base flow and from 12 mg/L in Cobus Creek at CR 2, Cobus Creek at Redfield Road, and the Spring Lake inlet (Site 6, site 8, and Site 10, respectively) and 30 in the Cobus Creek outlet and Cobus Creek at CR 8 (Site 1 and Site 3, respectively).

Chemical and Bacterial Concentrations

Chemical and bacterial concentration data for the Cobus Creek Watershed streams and the reference stream are listed by site in Table 8. Figure 15 to Figure 23 present concentration information graphically.

Table 8. Chemical and bacterial characteristics of the Cobus Creek Watershed streams on May 20 and June 23, 2016. Shaded squares indicate those samples that measure above Indiana State Standards (yellow) or recommended target values (blue; Correll, 1998; Dodds et al., 1998; Waters, 1998; USEPA, 2000).

Site Number	Flow Condition	NO_3 (mg/L)	NH_3 (mg/L)	TKN (mg/L)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	TDS (mg/L)	E. coli (col/100 ml)	Chl a (μg/L)
1	Base	0.75	0.06	0.60	0.09	0.11	1	510	41	42
	Storm	0.65	0.04	0.50	0.09	0.12	42	350	1610	30
2	Base	0.43	0.06	0.70	0.10	0.12	1	500	46	38
	Storm	0.55	0.06	0.6	0.13	0.14	104	240	2230	24
3	Base	0.43	0.05	0.70	0.08	0.10	1	480	72	36
	Storm	0.85	0.05	0.60	0.09	0.12	32	330	741	30
4	Base	1.50	0.05	0.60	0.07	0.08	1	450	55	34
	Storm	0.80	1.00	2.10	0.18	0.10	68	200	1840	18
5	Base	0.57	0.06	0.70	0.09	0.12	1	510	48	40
	Storm	1.10	0.06	0.50	0.15	0.17	53	400	2960	24
6	Base	0.23	0.04	0.80	0.05	0.07	1	380	49	32
	Storm	0.65	0.04	0.50	0.08	0.1	60	250	733	12
7	Base	0.50	0.05	0.60	0.10	0.13	1	520	42	42
	Storm	0.8	0.04	0.50	0.15	0.16	21	230	2710	24
8	Base	0.25	0.05	0.50	0.08	0.09	1	390	90	32
	Storm	0.38	0.05	0.6	0.11	0.13	31	270	617	12
9	Base	0.43	0.06	0.60	0.07	0.08	1	420	64	34
	Storm	0.60	0.05	0.50	0.17	0.19	29	280	398	18
10	Base	0.24	0.06	0.50	0.11	0.13	1	340	1	30
	Storm	0.45	1.10	2.4	0.24	0.26	63	460	990	12
11	Base	3.50	0.06	0.70	0.08	0.10	3	560	10	44
	Storm	1.3	0.06	0.7	0.13	0.14	62	360	451	24
Ref.	Base	0.95	0.05	0.60	0.06	0.08	4	500	46	40
	Storm	2.1	0.06	0.7	0.14	0.16	38	390	212	24

Nitrate-nitrogen: Nitrate-nitrogen concentrations during base and storm flow conditions measured relatively low with only one sample, the Coberts Lake inlet (Site 11) during base flow conditions, exceeding target concentrations (Figure 15). Base flow concentrations ranged from 0.23 mg/L at Cobus Creek at CR 2 (Site 6) to 3.5 mg/L at the Coberts Lake Inlet (Site 11), while storm flow nitrate-nitrogen concentrations ranged from 0.38mg/L at Cobus Creek at Redfield Road (Site 8) to 1.3 mg/L at the Coberts Lake Inlet (Site 11). The Coberts Lake inlet exhibited the highest nitrate-nitrogen concentration during both base and storm flow sampling. Nitrate-nitrogen concentrations observed at the Coberts Lake inlet during both base and storm flow were higher than the median nitrate-nitrogen concentration observed in Ohio streams (1.0 mg/l) known to support healthy warmwater fauna (Ohio EPA, 1999). None of the nitrate-nitrogen concentration measured greater than 10 mg/l, the concentration set by the Indiana Administrative Code for safe drinking water.

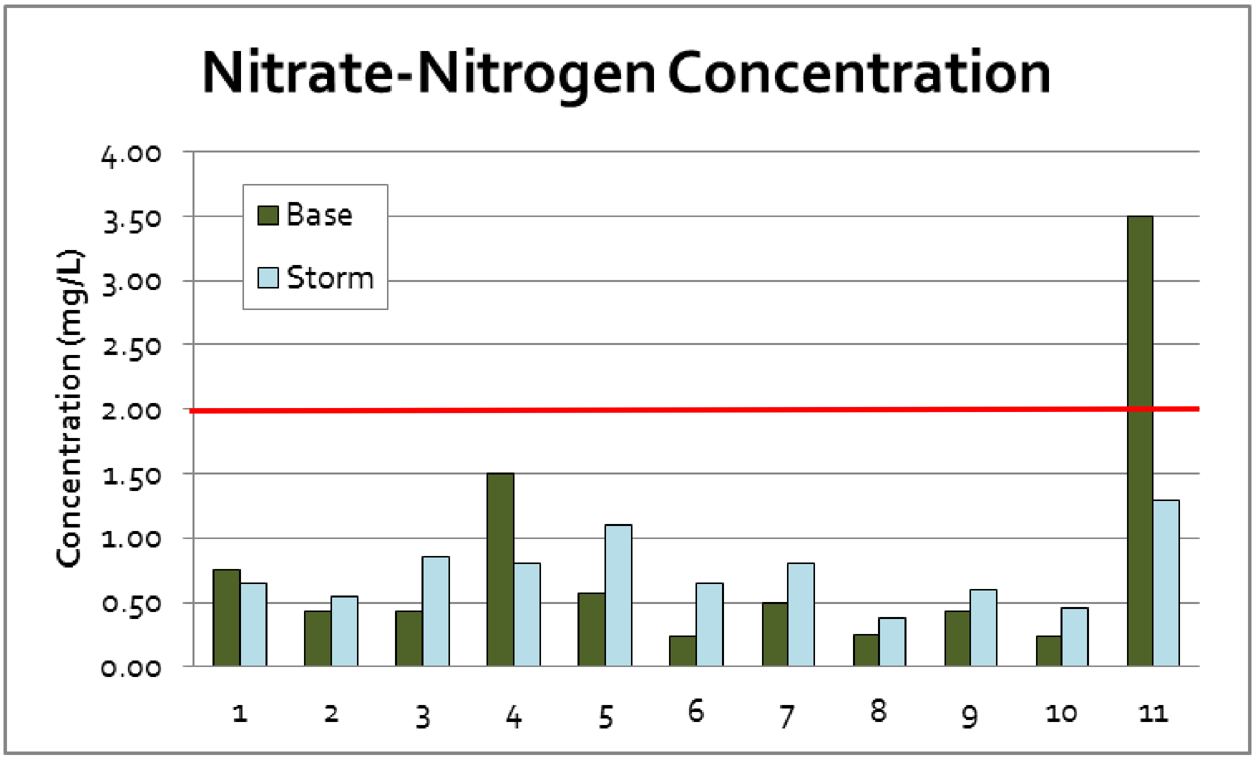

Figure 15. Nitrate-nitrogen concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (2 mg/L; Dodds et al., 1998).

Ammonia-nitrogen: Similar to nitrate-nitrogen concentrations, ammonia-nitrogen concentrations measured relatively low at all sites during base and storm flow sampling (Figure 16). Concentrations ranged from 0.04 mg/L at Cobus Creek at CR 12 (Site 1 base), Cobus Creek at CR 2 (Site 6 base and storm), and Gast Ditch at Redfield Road (Site 7 storm) to 1.1 mg/L at the Spring Lake inlet (Site 10 storm). None of the samples collected during base or storm flow exceeded the IAC ammonia-nitrogen standard for the protection of aquatic life. However, Cobus East Lateral A (Site 4) and the Spring Lake inlet (Site 10) showed drastically elevated levels of ammonia-nitrogen during storm flow.

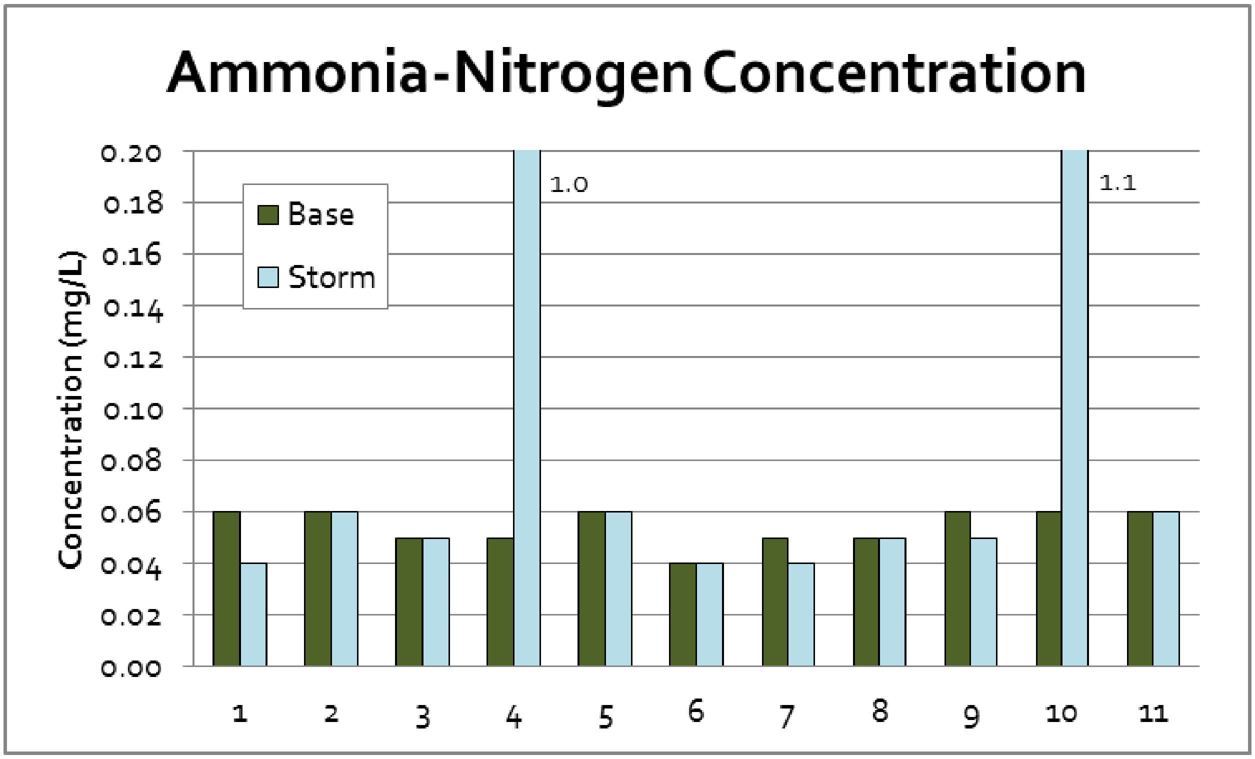

Figure 16. Ammonia-nitrogen concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams.

Total Kjeldahl Nitrogen: Total Kjeldahl nitrogen (TKN) concentrations in the study streams measured relatively low for Indiana streams (Figure 17). Base flow concentrations ranged from 0.5 mg/L at Cobus Creek at Redfield Road (Site 8) and the Spring Lake inlet (Site 10) to 0.8 mg/L at Cobus Creek at CR 2 (Site 6). Storm flow TKN concentrations ranged from 0.04 mg/L at Cobus Creek at CR 12 (Site 1), Cobus Creek at CR 2 (Site 6), and Gast Ditch at Redfield Road (Site 7), to 2.4 mg/L in the Spring Lake inlet (Site 10). High TKN concentration at the Cobus East Lateral A (Site 4) and the Coberts Lake inlet (Site 10) suggest the presence of organic matter at these sites. TKN levels exceeded USEPA recommended concentration (0.54 mg/l) at all sites except Cobus Creek at CR 12 (Site 1 storm), Gast Ditch at Adams Road (Site 5 storm), Cobus Creek at CR 2 (Site 6 base), Gast Ditch at Redfield Road storm (Site 7), Cobus Creek at Redfield Road (Site 8 base), Garver Lake Inlet (Site 9 storm), and the Spring Lake inlet (Site 10 base); however, these TKN concentrations are typical or even low for Indiana streams.

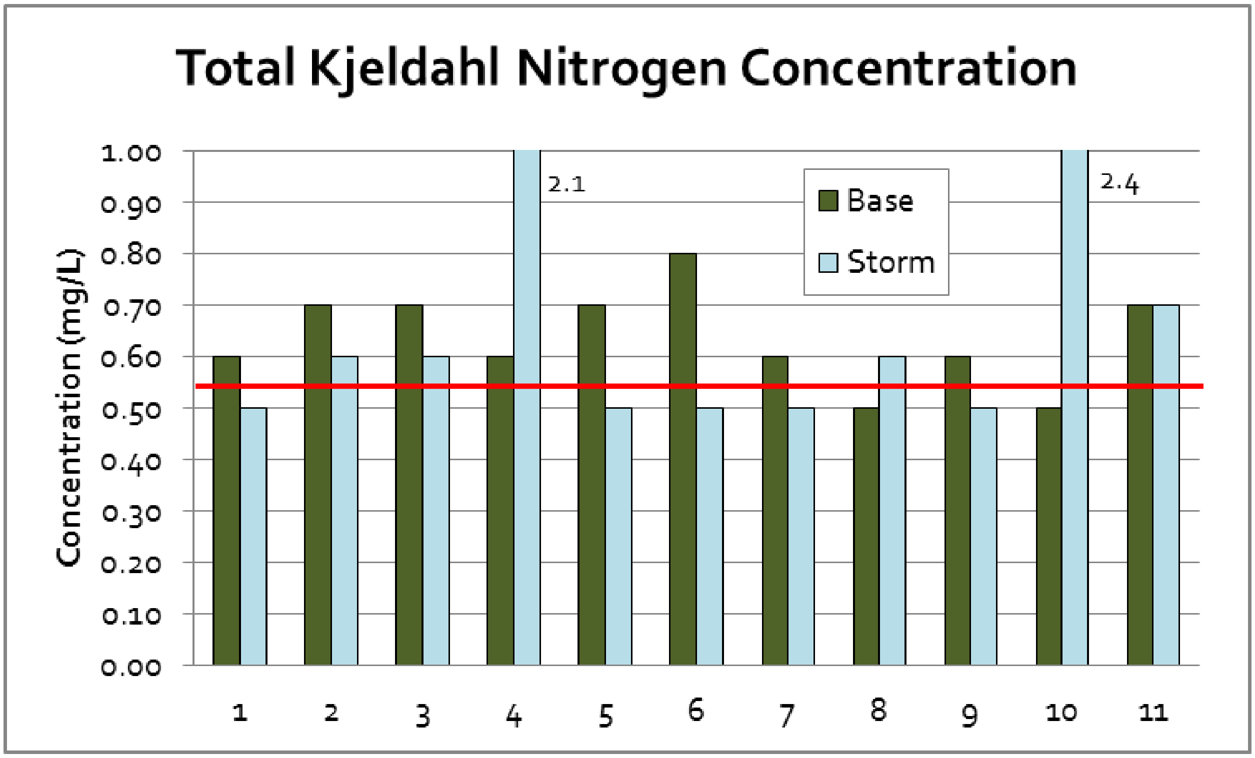

Figure 17. Total Kjeldahl nitrogen concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (0.54 mg/L; USEPA, 2000).

Orthophosphorus: Storm flow orthophosphorus (OP), or soluble phosphorus, concentrations exceeded concentrations measured during base flow at all sites except Cobus Creek at CR 12 (Site 1; Figure 18). During base flow conditions, Cobus Creek at CR 2 (Site 6) contained the lowest OP concentration (0.05 mg/L), while the Spring Lake inlet (Site 10) contained the highest (0.11 mg/L). During storm flow conditions, Cobus Creek at CR 2 (Site 6) possessed the lowest OP concentration (0.08 mg/L), while the Spring Lake inlet (Site 10) exhibited the highest OP concentration (0.24 mg/L).

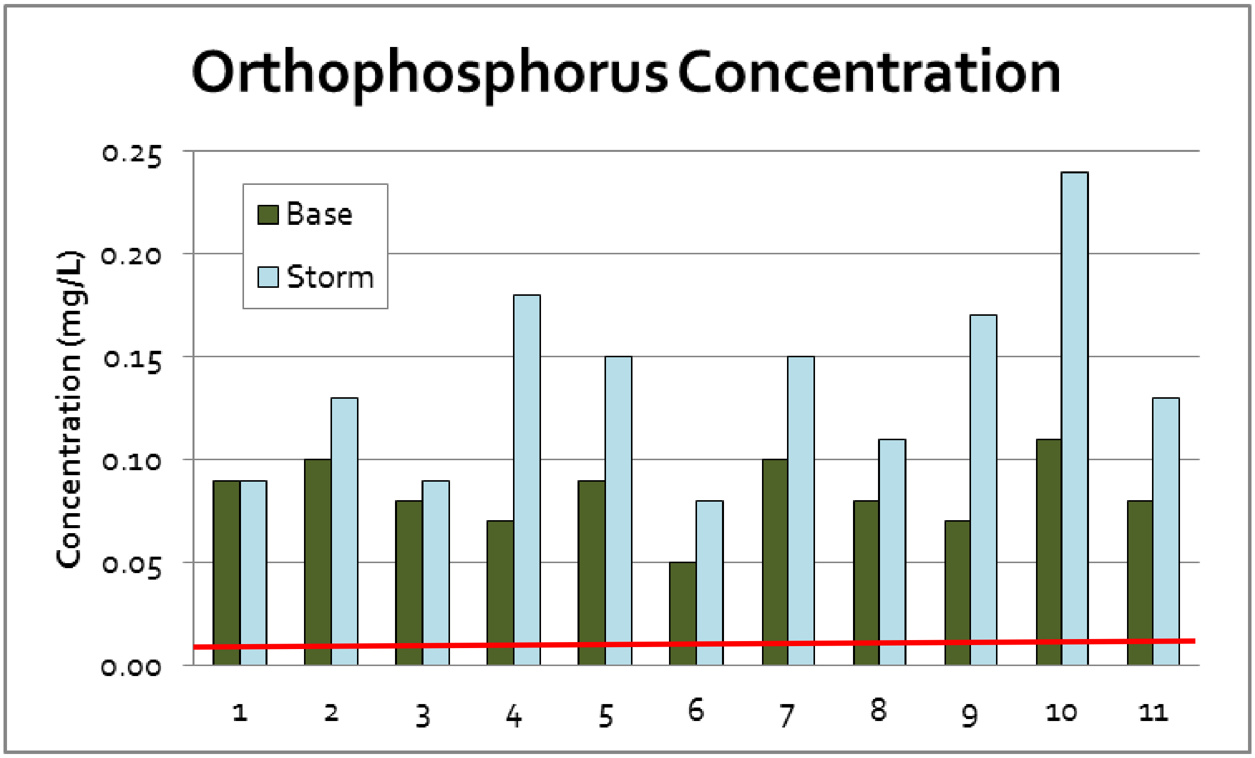

Figure 18. Orthophosphorus concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (0.005 mg/L; Correll, 1998).

Samples from most streams revealed that the soluble phosphorus fraction measured more than 75% of the total phosphorus concentration, suggesting that most phosphorus loading was dissolved, available phosphorus, not particulate soil-associated phosphorus (Figure 19). During storm flow conditions, the soluble phosphorus fractions in Gast Ditch at CR 8 (Site 2), Cobus East Lateral A (Site 4), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake inlet (Site 11) increased, suggesting that more phosphorus loading occurring under storm flow conditions was dissolved. Cobus East Lateral A during storm flow possessed an OP concentration that exceeded the respective total phosphorus concentration. This may be a result of limitations involved with laboratory sample analysis or field sampling procedure.

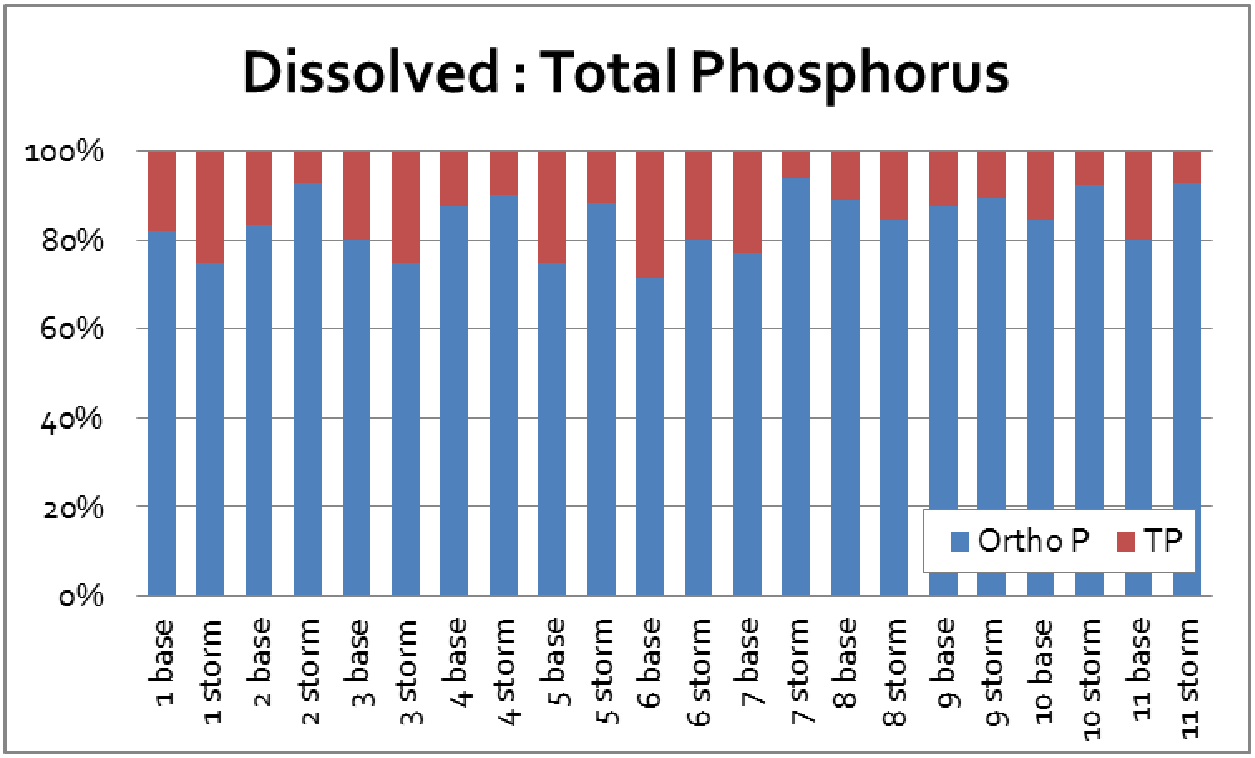

Figure 19. Fraction of dissolved to particulate phosphorus during base and storm flow sampling of Cobus Creek Watershed streams.

Total Phosphorus: Total phosphorus (TP) concentrations measured during storm flow sampling exceeded those measured during base flow at all sites (Figure 20). During base flow conditions, Cobus Creek at CR 2 (Site 6) possessed the lowest total phosphorus concentration (0.07 mg/L), while Gast Ditch at Redfield Road (Site 7) and the Spring Lake inlet (Site 10) contained the highest concentration (0.13 mg/L). Cobus East Lateral A (Site 4) and Cobus Creek at CR 2 (Site 6) possessed the lowest TP concentrations (0.1 mg/L) during storm flow, with the Spring Lake inlet (Site 10; 0.26 mg/L)containing the highest concentrations. All sites, except Cobus Creek at CR 2 (Site 6) during base flow, possessed TP concentrations that exceed the USEPA recommended criterion (0.033 mg/l) for the ecoregion (USEPA, 2000) and possessed concentrations above the level found by Dodd et al. (0.075 mg/l; 1998) to mark the boundary between mesotrophic and eutrophic concentrations. This suggests that with relation to TP, Cobus Creek has the ability to be extremely productive or eutrophic.

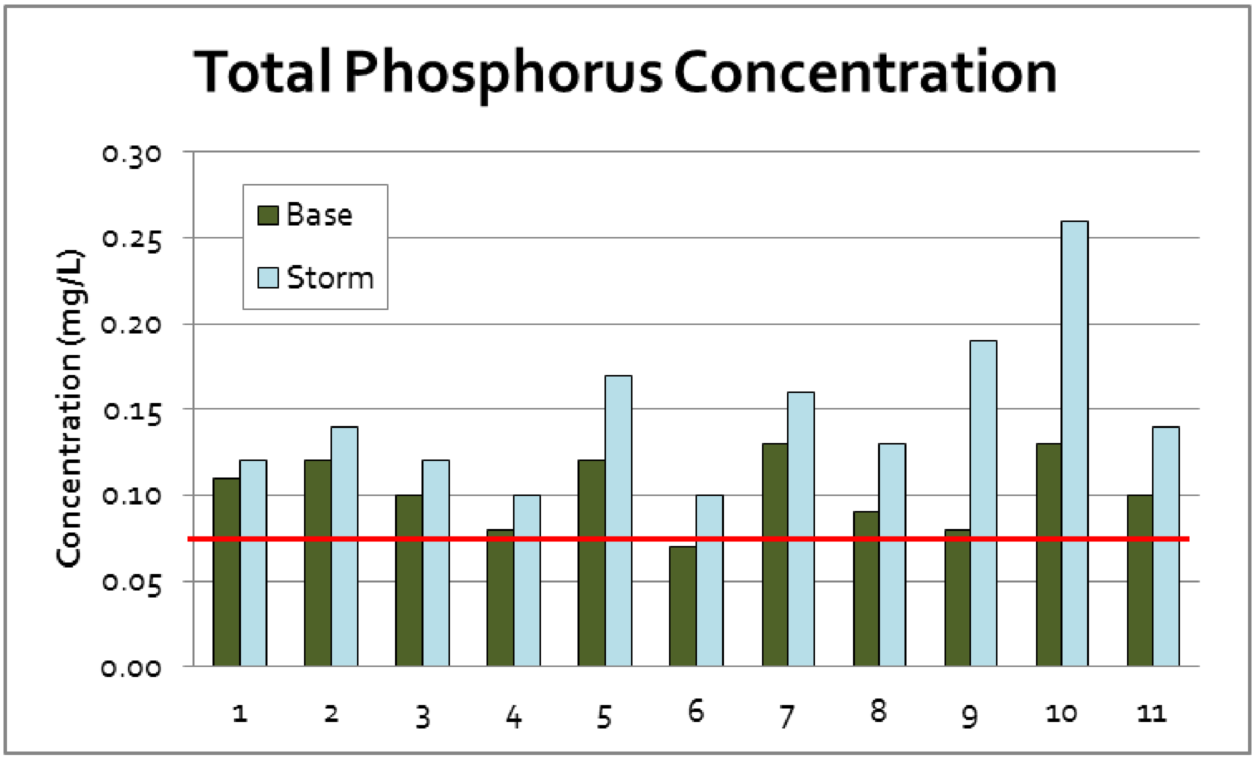

Figure 20. Total phosphorus concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (0.075 mg/L; Dodds et al., 1998).

Total Suspended Solids: Total suspended solids (TSS) concentration measured during storm flow exceeded concentrations measured during base flow samples at all sample sites (Figure 21). Higher overland flow velocities typically result in an increase in sediment particles in runoff. Additionally, greater streambank and streambed erosion typically occurs during high flow. Therefore, higher concentrations of suspended solids are typically measured in storm flow samples. During base flow, only the Coberts Lake inlet (Site 11) possessed a TSS concentration greater than 1 mg/L. During storm flow conditions, samples collected at Gast Ditch at CR 8 (Site 2; 104 mg/L) and Cobus East Lateral A (Site 4; 68 mg/L) exhibited the highest TSS concentrations. All Cobus Creek sites during storm flow conditions contained TSS concentrations that exceed the concentration found to be deleterious to aquatic life (25 mg/L; Waters, 1995); however, it should be noted that the flashy nature of Cobus Creek combined with the barely detectable total suspended solids concentrations present during base flow conditions likely mitigate the heavy in stream sediment levels present during storm flow conditions.

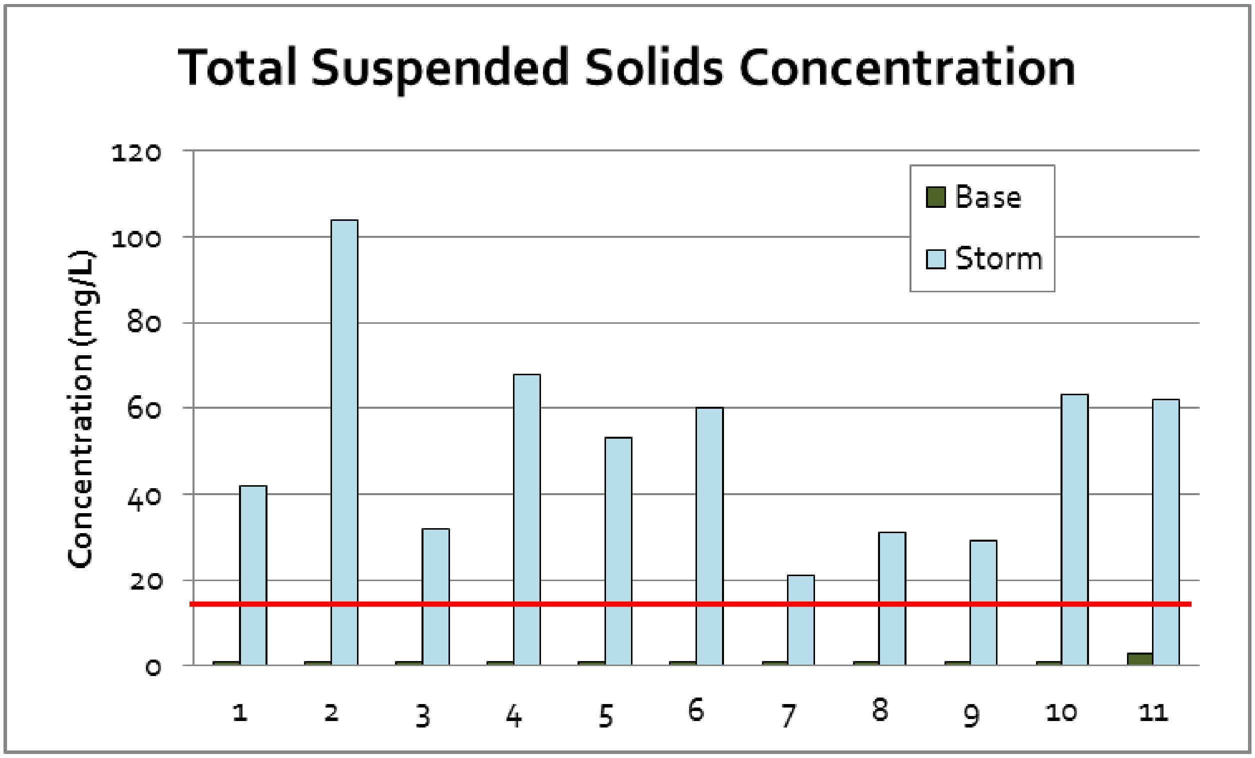

Figure 21. Total suspended solids concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (15 mg/L; Waters, 1995).

Total Dissolved Solids: Total dissolved solids concentrations measured during base flow exceeded concentrations measured during storm flow samples at all sample sites except the Spring Lake inlet (Site 10; Figure 22). During base flow, the Spring Lake inlet (Site 10) possessed the lowest total dissolved solids concentration (340 mg/L) but contained the highest total dissolved solids concentration under storm flow conditions (460 mg/L). None of the sites exceeded the state standard for total dissolved solids (750 mg/L).These data suggest that the Spring Lake inlet carries a routine dissolved sediment concentration regardless of flow conditions. Cobus East Lateral A (Site 4) contained the lowest total dissolved solids concentration under storm flow conditions (200 mg/L). These data suggest that most of the sediment moving through Cobus East Lateral A is in particulate form, especially under storm flow conditions.

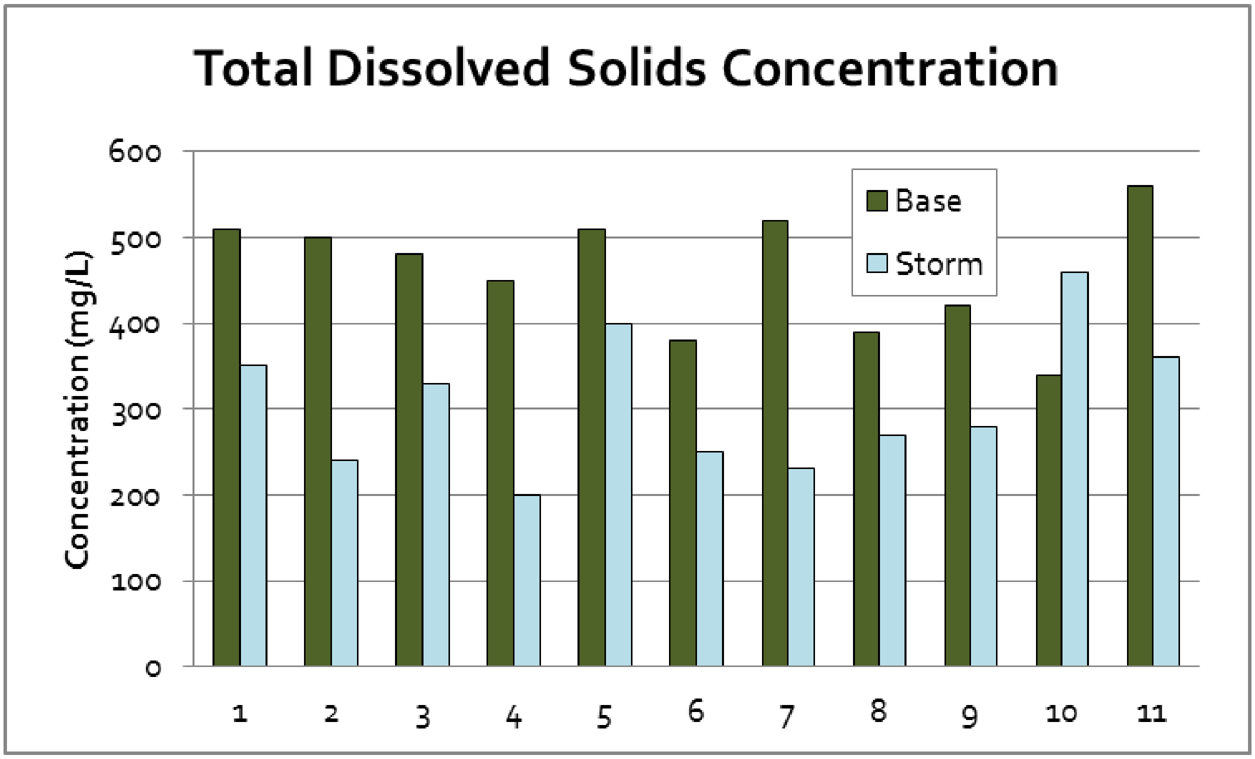

Figure 22. Total dissolved solids concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams.

E. coli: Figure 23 displays the *E. coli* concentration data for Cobus Creek Watershed streams. *E. coli* concentrations exceeded the Indiana state standard (235 colonies/100 ml) for state waters at all sites under storm flow conditions, but measured below the state standard during base flow at all sites. The Spring Lake inlet (Site 10) contained the lowest *E. coli* concentrations under base flow conditions, measuring 1 col/100 mL. Under storm flow conditions, the Garver Lake inlet (Site 9) contained the lowest *E. coli* concentration (398 col/100 mL) which measured 1.5 times the state standard. Storm flow concentrations measured at the Gast Ditch at Adams Road (Site 5) measured the highest with concentrations approximately 12 times the state standard (2960 col/100 mL). These pathogens may impair the biota in the Cobus Creek Watershed and limit human use of the streams. The precise sources of *E. coli* in the Cobus Creek Watershed have not been identified; however, wildlife, livestock, and/or domestic animal defecation; manure-based fertilizers; previously contaminated sediments; and failing or improperly sited septic systems are common sources of the bacteria in this region.

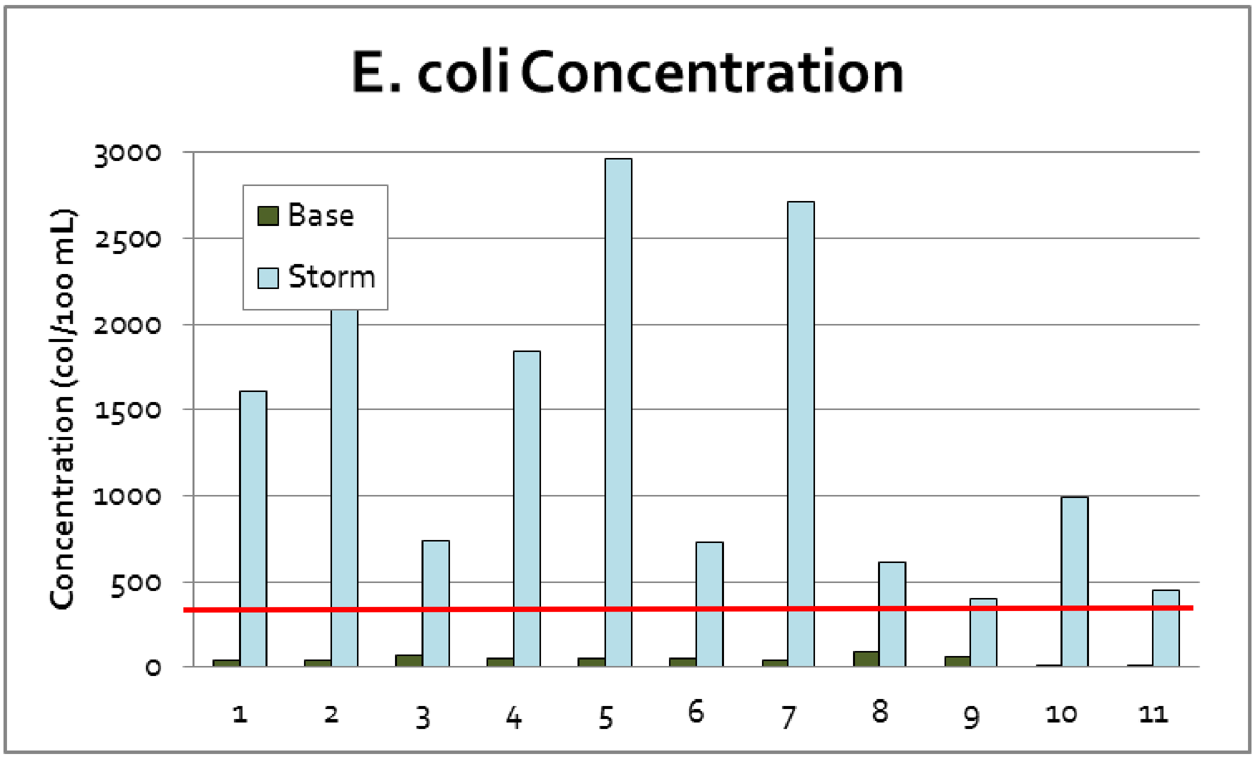

Figure 23. E. coli concentration measurements during base and storm flow sampling of Cobus Creek Watershed streams. The red line indicates the target concentration (235 col/mL; IAC).

Sediment and Chemical Loading

Table 9 lists the chemical and sediment mass loading data for Cobus Creek Watershed by site. Figure 24 to Figure 29 present mass loading information graphically. Under base and storm flow conditions, Cobus Creek at CR 12 (Site 1) possessed the greatest loads for all parameters except ammonia-nitrogen under storm flow conditions. Cobus Creek at CR 8 (Site 3) contained the second highest loading rates for all parameters except nitrate-nitrogen under base flow conditions and rated second or third highest for all parameters except total suspended solids under storm conditions. These results are to be expected; since these sites are located the furthest downstream, they receives pollutants from all other sites (Site 1) and a majority of the watershed (Site 3) and contain the largest drainage areas.

The Cobus East Lateral A (Site 4) contained the highest ammonia-nitrogen loading rate under storm flow conditions, while the Garver Lake inlet (Site 9) contained the second highest total Kjeldahl nitrogen loading rate and the Coberts Lake inlet (Site 11) contained the second highest nitrate-nitrogen loading rate during storm flow conditions. The Spring Lake inlet (Site 10) contained the lowest loading rates for all parameters under base and storm flow conditions except ammonia-nitrogen under storm flow. This is also not surprising given the rather limited drainage area and natural land uses present within the Spring Lake inlet drainage area. The natural land cover, small drainage area, and relatively low gradient create little runoff within the Spring Lake inlet subwatershed. The flows present at this site were an order of magnitude lower than all other stream sites during both base and storm flow conditions, which results in the very low loading rates at the Spring Lake inlet (Site 10).

Table 9. Sediment and chemical loading data for Cobus Creek Watershed streams. Red highlights the highest loading rates during base and storm flow conditions, while orange highlights the second highest loading rates during base and storm flow conditions.

Site Number	Flow Condition	NO3 Load (kg/yr)	NH3 Load (kg/yr)	TKN Load (kg/yr)	OP Load (kg/yr)	TP Load (kg/yr)	TSS Load (kg/yr)	TDS Load (kg/d)
1	Base	12,048.33	963.87	9,638.66	1,445.80	1,767.09	16,064.44	8,192,863.58
	Storm	20,883.77	1,285.16	16,064.44	2,891.60	3,855.47	1,349,412.83	11,245,106.88
2	Base	1,074.53	149.93	1,749.24	249.89	299.87	2,498.91	1,249,456.32
	Storm	4,417.72	481.93	4,819.33	1,044.19	1,124.51	835,350.80	1,927,732.61
3	Base	4,221.38	490.86	6,872.01	785.37	981.72	9,817.16	4,712,235.26
	Storm	11,378.98	669.35	8,032.22	1,204.83	1,606.44	428,385.02	4,417,720.56
4	Base	1,204.83	40.16	481.93	56.23	64.26	803.22	361,449.86
	Storm	1,784.94	2,231.17	4,685.46	401.61	223.12	151,719.70	446,234.40
5	Base	2,034.83	214.19	2,498.91	321.29	428.39	3,569.88	1,820,636.35
	Storm	7,853.73	428.39	3,569.88	1,070.96	1,213.76	378,406.77	2,855,900.16
6	Base	1,847.41	321.29	6,425.78	401.61	562.26	8,032.22	3,052,243.30
	Storm	6,381.15	392.69	4,908.58	785.37	981.72	589,029.41	2,454,289.20
7	Base	892.47	89.25	1,070.96	178.49	232.04	1,784.94	928,167.55
	Storm	5,711.80	285.59	3,569.88	1,070.96	1,142.36	149,934.76	1,642,142.59
8	Base	1,338.70	267.74	2,677.41	428.39	481.93	5,354.81	2,088,376.99
	Storm	3,730.52	490.86	5,890.29	1,079.89	1,276.23	304,331.86	2,650,632.34
9	Base	1,918.81	267.74	2,677.41	312.36	356.99	4,462.34	1,874,184.48
	Storm	4,819.33	401.61	4,016.11	1,365.48	1,526.12	232,934.36	2,249,021.38
10	Base	21.42	5.35	44.62	9.82	11.60	89.25	30,343.94
	Storm	80.32	196.34	428.39	42.84	46.41	11,245.11	82,107.13
11	Base	6,247.28	107.10	1,249.46	142.80	178.49	5,354.81	999,565.06
	Storm	3,480.63	160.64	1,874.18	348.06	374.84	165,999.20	963,866.30

Some stream systems can process or assimilate pollutants rather than transporting them downstream. The drop in ammonia-nitrogen concentration between Gast Ditch at Redfield Road (Site 7) and the Gast Ditch at Adams Road (Site 5) under base flow conditions may be due to the conversion of ammonia to nitrate. Ammonia readily oxidizes to nitrate in the presence of oxygen. The minimal riffle habitat present at the Gast Ditch at Adams Road (Site 5) likely provides an opportunity for oxygen to diffuse into the water column.

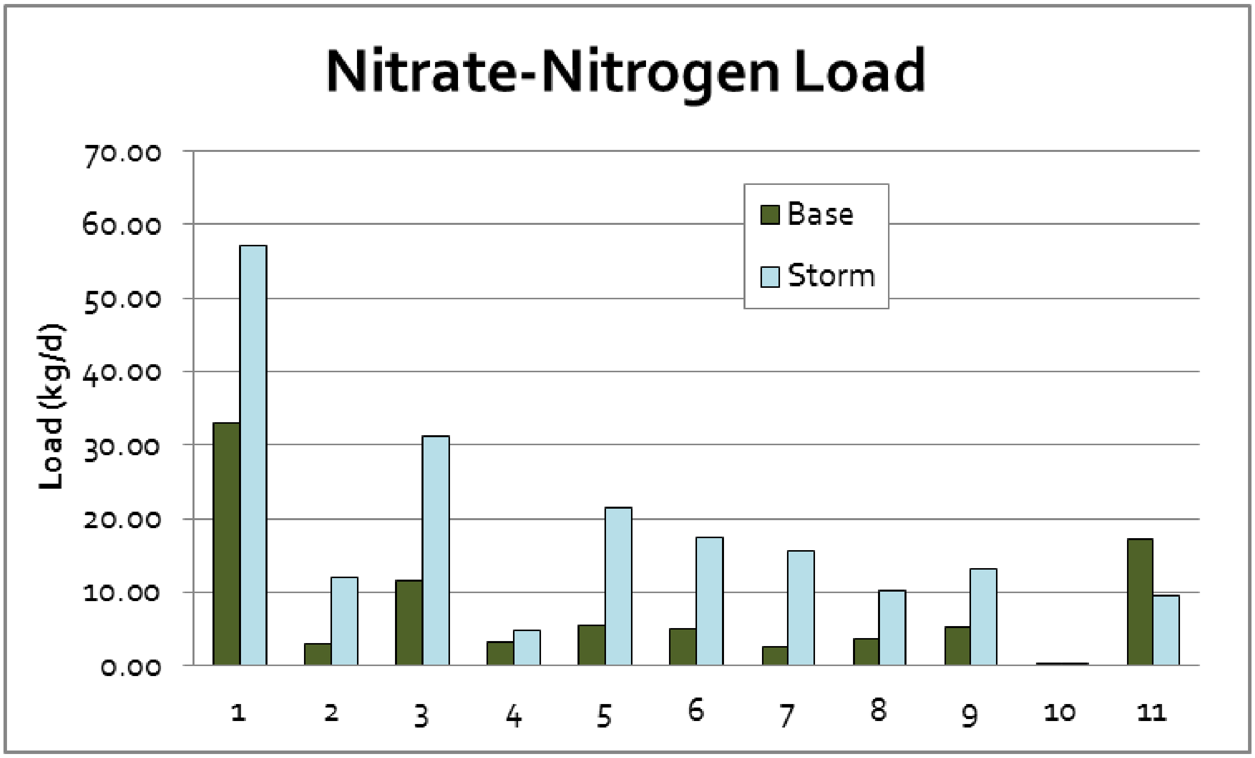

Figure 24. Nitrate-nitrogen loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams.

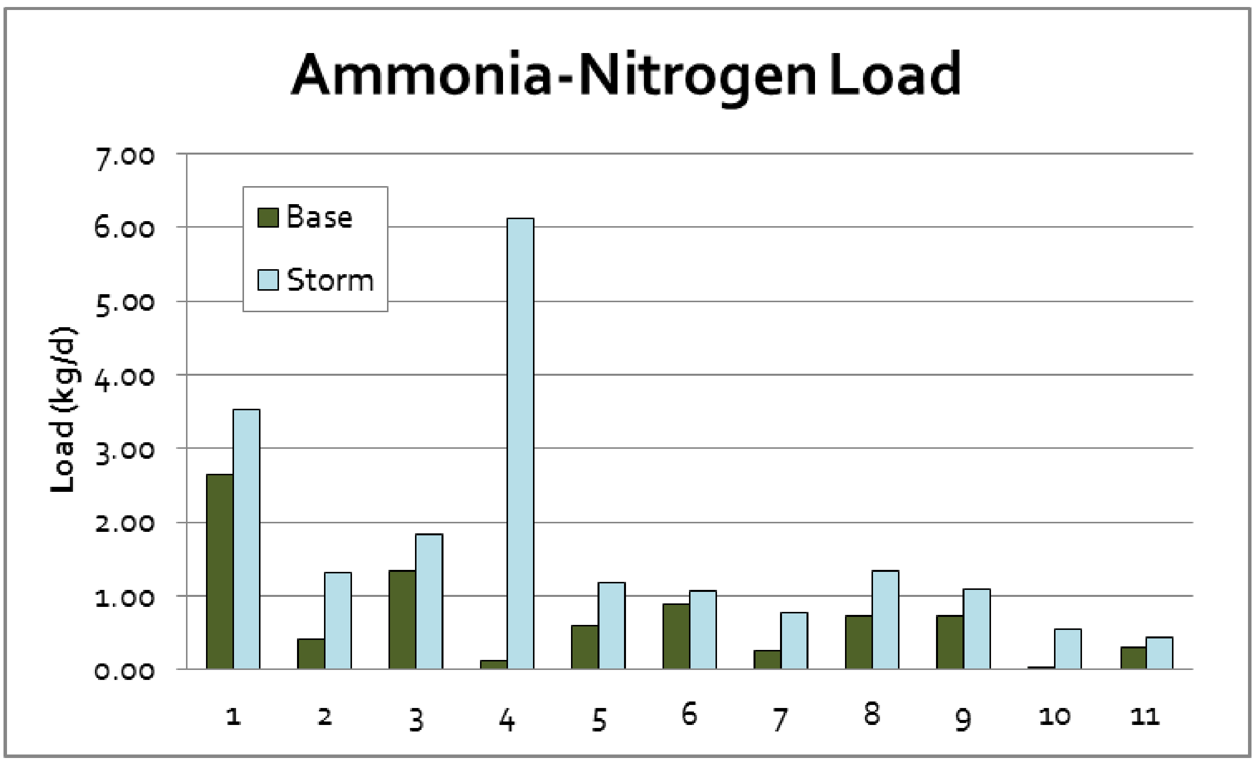

Figure 25. Ammonia-nitrogen loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams.

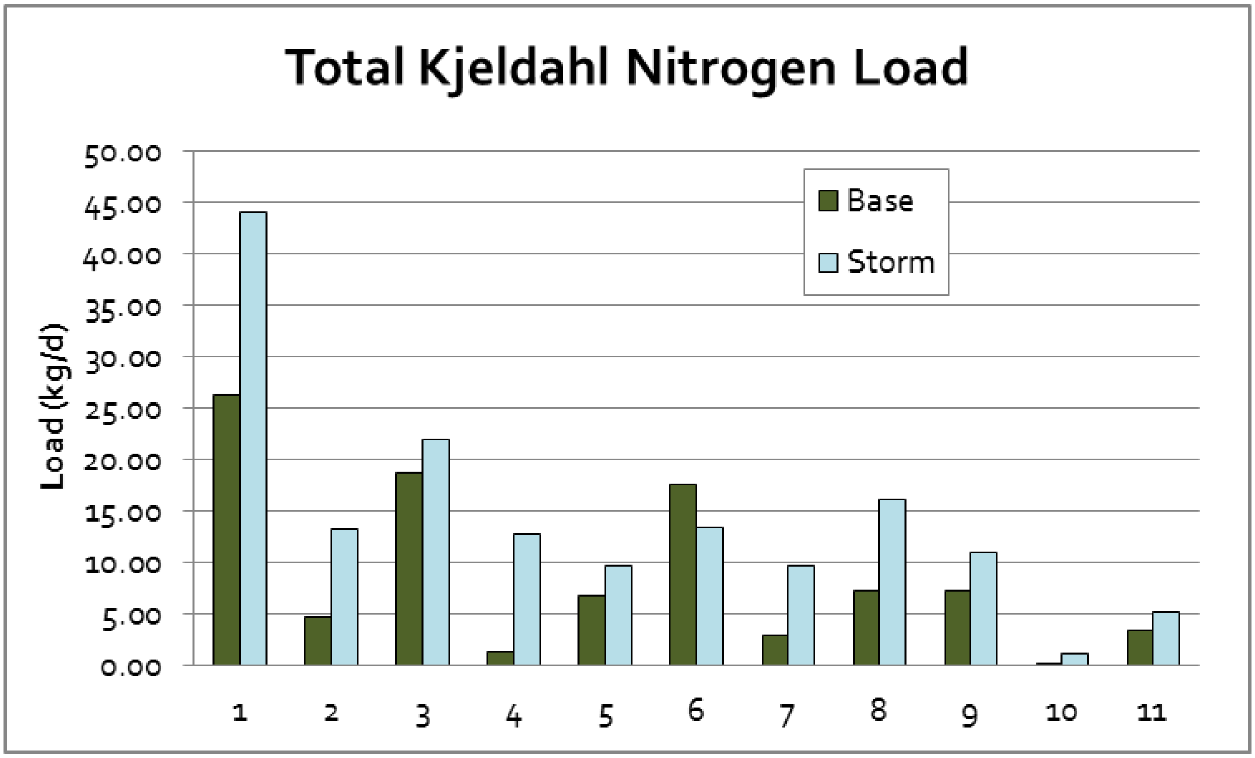

Figure 26. Total Kjeldahl nitrogen loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams.

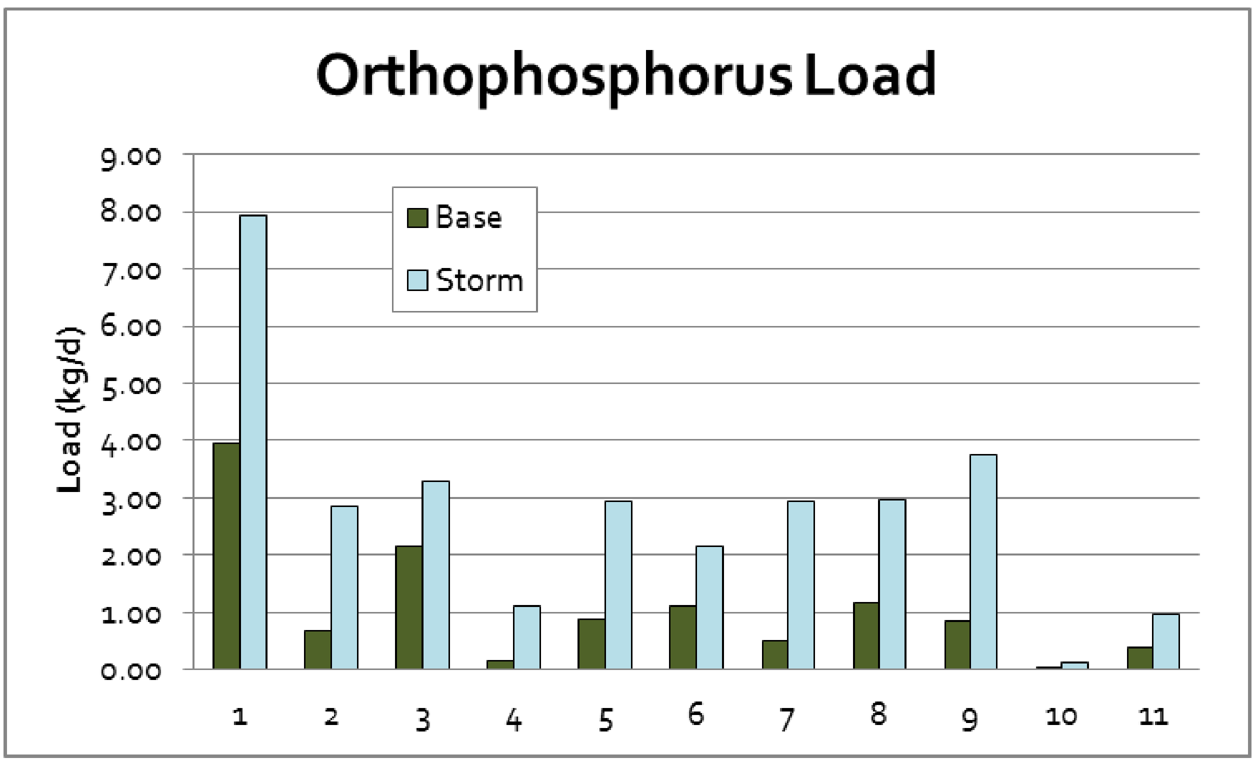

Figure 27. Orthophosphorus loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams.

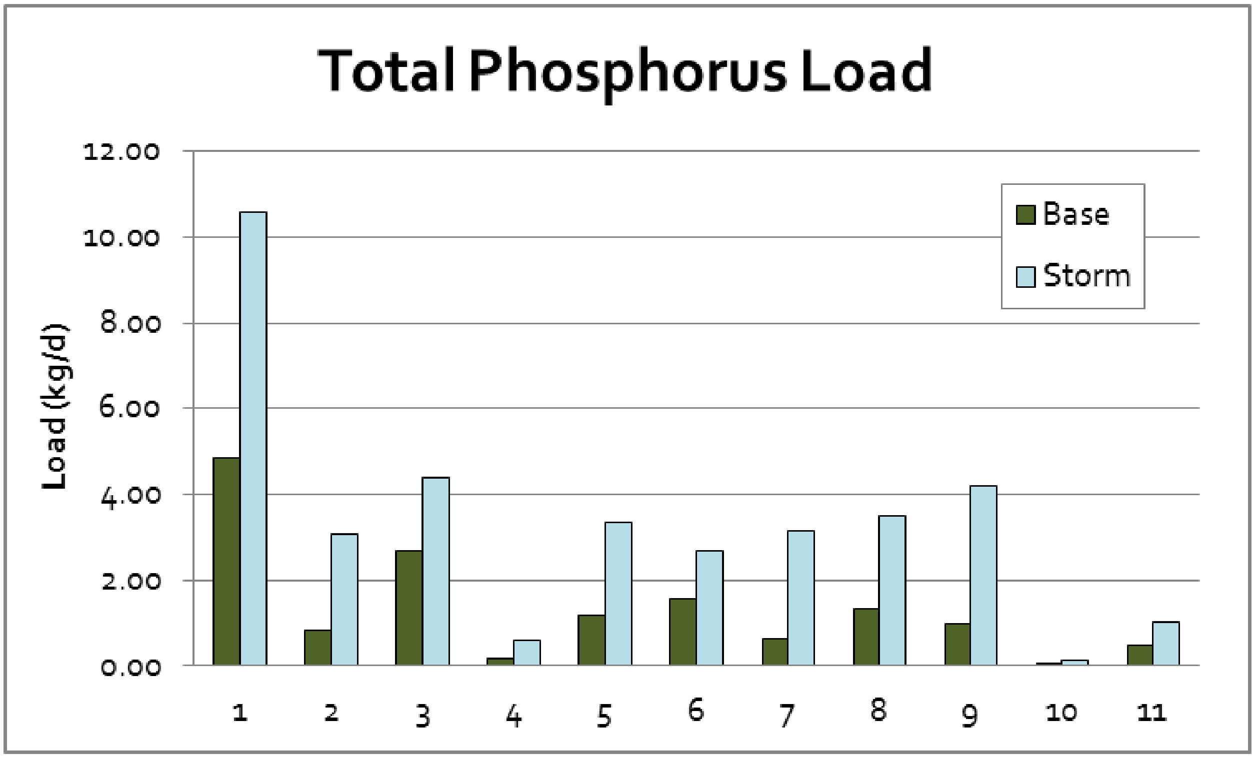

Figure 28. Total phosphorus loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams.

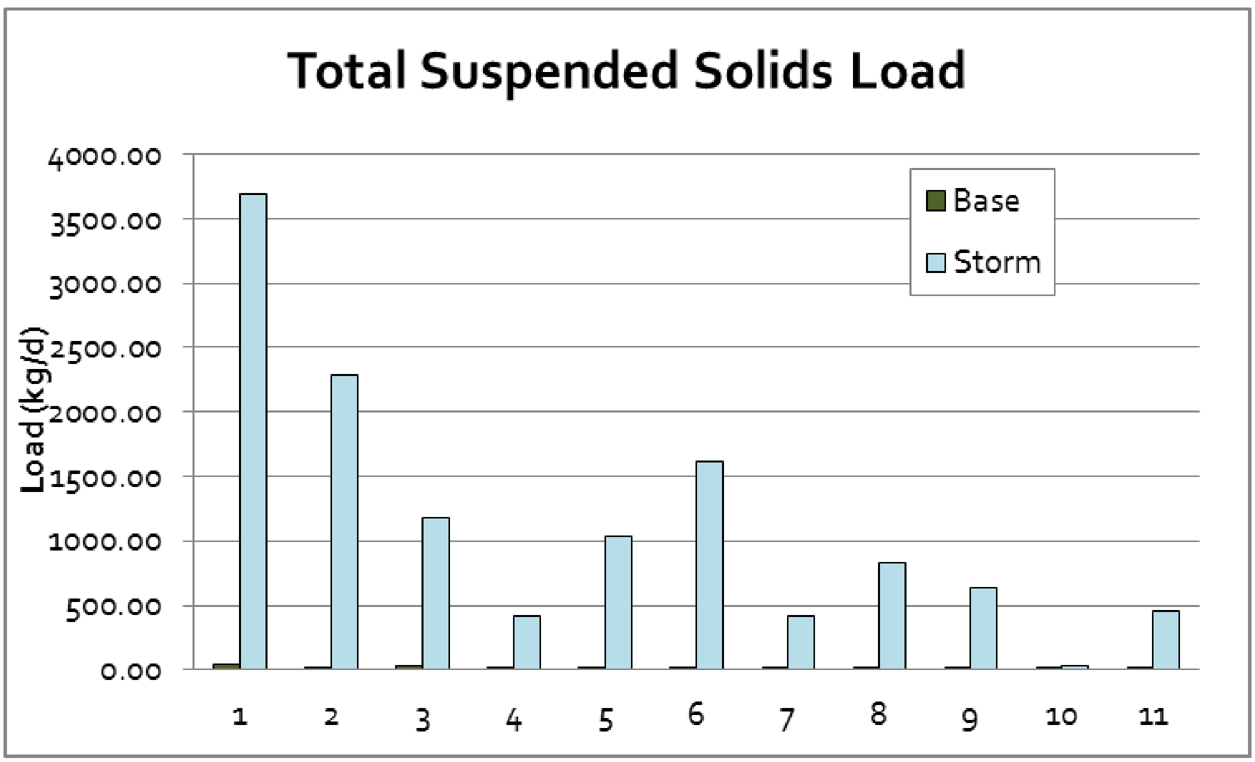

Figure 29. Total suspended solids loading rates measured during base and storm flow sampling of Cobus Creek Watershed streams

Yield or Areal Loading

In an effort to normalize the nutrient and sediment loading rates, the rates were divided by subwatershed size above each sampling site. This means that Cobus Creek mainstem acreages combine the entire portion of the Cobus Creek Watershed that drains through the respective sampling site. For instance, Cobus Creek at the Garver lake inlet receives water from both the Spring Lake and Coberts Lake inlets; therefore, the acreage used to calculate areal loading was the combination of both of these subwatersheds (Table 10).

Table 10. Areal loading of sediment and nutrients by subwatershed based on base and storm flow sampling events in the Cobus Creek Watershed. Red highlights the highest areal loading rates during base and storm flow conditions, while orange highlights the second highest areal loading rates during base and storm flow conditions.

Site Number	Flow Condition	NO3 Load (kg/yr-ac)	NH3 Load (kg/yr-ac)	TKN Load (kg/yr-ac)	OP Load (kg/yr-ac)	TP Load (kg/yr-ac)	TSS Load (kg/yr-ac)
1	Base	514.61	41.17	411.69	61.75	75.48	686.15
	Storm	891.99	54.89	686.15	123.51	164.68	5,7636.37
2	Base	194.76	27.18	317.05	45.29	54.35	452.93
	Storm	800.71	87.35	873.50	189.26	203.82	15,1407.48
3	Base	266.25	30.96	433.43	49.53	61.92	619.18
	Storm	717.69	42.22	506.60	75.99	101.32	27,018.78
4	Base	251.64	8.39	100.65	11.74	13.42	167.76
	Storm	372.79	465.99	978.59	83.88	46.60	31,687.53
5	Base	902.71	95.02	1,108.59	142.53	190.04	15,83.70
	Storm	3,484.14	190.04	1,583.70	475.11	538.46	167,872.28
6	Base	166.93	29.03	580.62	36.29	50.80	725.78
	Storm	576.59	35.48	443.53	70.96	88.71	53,223.50
7	Base	513.09	51.31	615.71	102.62	133.40	1,026.18
	Storm	3,283.76	164.19	2,052.35	615.71	656.75	86,198.75
8	Base	150.07	30.01	300.14	48.02	54.02	600.27
	Storm	418.19	55.02	660.30	121.05	143.06	34,115.37
9	Base	284.25	39.66	396.63	46.27	52.88	661.05
	Storm	713.93	59.49	594.94	202.28	226.08	34,506.74
10	Base	7.70	1.92	16.04	3.53	4.17	32.08
	Storm	28.87	70.57	153.98	15.40	16.68	4,041.99
11	Base	2,394.06	41.04	478.81	54.72	68.40	2,052.06
	Storm	1,333.84	61.56	718.22	133.38	143.64	63,613.71

Generally, sediment and nutrient areal loading was lower during low flow conditions than during storm flow conditions for all subwatersheds. Gast Ditch at Adams Road (Site 5) and Redfield Road(Site 7) contributed the highest ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphorus, total phosphorus and total dissolved solids areal loading or yield during base flow conditions, while the Coberts Lake inlet (Site 11) contributed the highest nitrate-nitrogen and total suspended solids yields. During storm flow, Gast Ditch at Adams and Redfield roads (Sites 5 and 7 respectively) contributed the highest nitrate-nitrogen, total Kjedahl nitrogen, orthophosphorus, total phosphorus, and total and dissolved solids, while the Cobus East Lateral A (Site 4) contributed the highest ammonia-nitrogen. This indicates that on a regular basis, Gast Ditch contained the highest per unit area loads of nitrogen, phosphorus and sediment and that Gast Ditch delivers more sediment and sediment-attached pollutants per unit area to the Cobus Creek Watershed than most of the rest of the watershed. This also suggests that Cobus East Lateral A is a source is ammonia-nitrogen and total Kjeldahl nitrogen during storm flow conditions.

4.2.3 Water Chemistry Summary

In general, physical and chemical parameter data collected from streams in the Cobus Creek Watershed indicate the potential for water quality degradation when compared with ideal conditions. Dissolved and particulate phosphorus concentrations were elevated throughout the watershed under all sampling conditions. Orthophosphorus, or dissolved phosphorus, comprised a majority of the phosphorus present within the system. This indicates that phosphorus is readily available by for use by plants and algae. Total Kjeldahl nitrogen concentrations measured above EPA target concentrations; however, concentrations were generally low throughout the Cobus Creek Watershed. Cobus East Lateral A and the Spring Lake inlet both contained elevated total Kjeldahl nitrogen and ammonia-nitrogen concentrations during storm flow conditions, suggesting that these tributaries may be sources of particulate nitrogen. Nitrate-nitrogen concentrations were also low throughout the watershed, with only the Coberts Lake inlet exceeding levels at which high productivity (eutrophication) can occur. Total suspended solids and E. coli concentrations measured low under base flow conditions but exceeded TSS targets and E. coli state standards at all sites under storm flow conditions.

Under storm flow conditions, Cobus Creek at its two most downstream locations, CR 12 and CR 8, possessed the greatest loads for all parameters except ammonia-nitrogen and total suspended solids. Under base flow conditions, these sites also contained the highest loading rates for nitrate-nitrogen. These results are to be expected; since these sites are located the furthest downstream.

While some subwatersheds per unit area delivered low nutrient and sediment loads, others delivered significant loads of the parameters particularly during the storm event. Gast Ditch at Adams and Redfield roads (Sites 5 and 7, respectively) contributed the highest ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphorus, total phosphorus, and total dissolved solids during base flow conditions, while the Coberts Lake inlet contributed the highest nitrate-nitrogen and total suspended solids. During storm flow, Gast Ditch at Adams and Redfield roads contributed the highest nitrate-nitrogen, total Kjedahl nitrogen, orthophosphorus, total phosphorus, and total and dissolved solids, while the Cobus East Lateral A contributed the highest ammonia-nitrogen.

4.3 Macroinvertebrate Assessment

4.3.1 Macroinvertebrate Methods

Data from macroinvertebrate sampling at each of the 11 sites in the Cobus Creek Watershed and the Christiana Creek reference site were used to calculate a macroinvertebrate index of biotic integrity. Aquatic macroinvertebrates are important indicators of environmental change. The macroinvertebrate community composition reflects water quality. Research shows that different macroinvertebrate orders and families react differently to pollution sources. Thus, indices of biotic integrity are valuable because aquatic biota integrate cumulative effects of sediment and nutrient pollution (Ohio EPA, 1995).

Macroinvertebrates were collected during base flow conditions on July 27 and August 3, 2016 using the multihabitat approach detailed in the USEPA Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd ed. (Barbour et al. 1999). The macroinvertebrate samples were processed using the laboratory processing protocols detailed in the IDNR LARE macroinvertebrate sample collection and index calculation protocol. Organisms were identified to the genus level.

Macroinvertebrate data were used to calculate the modified Hilsenhoff Biotic Index (HBI). The HBI uses the macroinvertebrate community to assess the level of organic pollution in a stream. The HBI is based on the premise that different families of aquatic insects possess different tolerance levels to organic pollution. Hilsenhoff assigned each aquatic insect family a tolerance value from 1 to 10; those genera with lower tolerances to organic pollution were assigned lower values, while those families that were more tolerant of organic pollution were assigned higher values. Calculation of the HBI involves applying assigned macroinvertebrate family tolerance values to all taxa that have an assigned HBI tolerance value, multiplying the number of organisms present by their family tolerance value, summing the products, and dividing by the total number of organisms present (Hilsenhoff, 1988). Benthic communities dominated by organisms that are tolerant of organic pollution will exhibit higher HBI scores compared to benthic communities dominated by intolerant organisms.

In addition to the HBI, macroinvertebrate results were analyzed using the IDNR LARE scoring criteria (IDNR, 2013). IDNR's mIBI is a multi-metric (8 metrics) index designed to provide a complete assessment of a stream's biological integrity. Karr and Dudley (1981) define biological integrity as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization compared to the best natural habitats within the region". Metrics include number of taxa; *Ephemeroptera*, *Plecoptera* and *Trichoptera* (EPT) Index, percent dominant taxa, ratio of EPT to *Chironomidae*, ratio of scrapers to filtering collectors, ratio of shredders to total, community loss index, and the modified HBI. Each metric is scored as detailed in Table 11. Cumulative mIBI scores for each site are them compared with the mIBI score calculated for the reference site and the biological condition assigned as detailed in Table 12.

Table 11. mIBI metric scoring criteria for genus level identification.

Metric	6	4	2	0
Number of taxa	>80%	60-80%	40-60%	<40%
EPT Index	>90%	80-90%	70-80%	<70%
Percent dominant taxa	<20%	20-30%	30-40%	>40%
Ratio EPT: *Chironomid* Abundance	>75%	50-75%	25-50%	<25%
Modified Hilsenhoff Biotic Index	>85%	70-85%	50-70%	<50%
Ratio of Scrapers: Filter Collectors	>50%	35-50%	20-35%	<20%
Ratio Shredders: Non-shredders	>50%	35-50%	20-35%	<20%
Community Loss Index (CLI)	<0.5	0.5-1.5	1.5-4.0	>4.0

Table 12. Biological condition category resulting from comparison of stream site data with reference site data.

Percent Comparison to Reference	Biological Condition Category
>83%	Non-impaired
54-79%	Slightly impaired
21-50%	Moderately impaired
<17%	Severely impaired

4.3.2 Macroinvertebrate Results

In general, Gast Ditch at Adams Road (Site 5) and Cobus Creek at CR 2 (Site 6) supported more diverse communities than other sites in the Cobus Creek Watershed (Figure 30, Table 13). Cobus Creek at CR 12 (Site 1) and Gast Ditch at CR 8 (Site 2) contained the most pollution intolerant communities, while the Cobus East Lateral A (Site 4) and the Spring Lake inlet (Site 10) contained the most pollution tolerant communities. The Spring Lake Inlet (Site 10) possessed high numbers of individuals from the genera *Chironomus*, while the Cobus East Lateral A (Site 2) possessed high numbers of individuals from the family *Physidae*, two high pollution tolerant families. Both sites contained low numbers of individuals from the more sensitive EPT families. The Spring Lake Inlet (Site 10) and Gast Ditch at CR 8 (Site 2) contained the lowest number of taxa (4 and 6, respectively). Cobus Creek at CR 2 (Site 6) and Cobus Creek at CR 8 (Site 3) possessed more sensitive taxa and greater EPT index scores compared to other sites. Members of the EPT taxa dominated the benthic community at the Cobus Creek at CR 2 (Site 6), Cobus Creek at CR8 (Site 3), and Cobus Creek at CR 12 (Site 1) accounting for more than half of the total sub-sample. Additionally, Cobus Creek at CR 2 (Site 6) was the only one to harbor members of the *Plecopteran* order, which is arguably the most sensitive order. Appendix B details the macroinvertebrate species collected at each sample site.

Table 13. Metric classification scores and mIBI score for the Cobus Creek Watershed sample sites as sampled July 27 and August 3, 2016.

Metric	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10	Site11
Number of Taxa	2	0	4	2	6	6	2	4	2	0	6
EPT Index	0	0	6	0	0	6	0	0	0	0	0
% Dominant	2	0	2	0	6	6	0	2	0	0	4
EPT: Chironomid	6	2	6	4	0	6	0	6	0	0	0
Modified HBI	6	6	6	2	2	6	4	2	6	2	4
Scrapers/Collectors	0	0	0	6	0	2	6	4	0	0	2
% Shredders	4	0	0	6	0	6	2	0	2	6	6
CLI	2	0	4	2	6	6	2	2	2	0	6
Total Score	**22**	**8**	**28**	**22**	**20**	**44**	**16**	**20**	**12**	**8**	**28**
Percent of Reference	52%	19%	67%	52%	48%	105%	38%	48%	29%	19%	67%
Category	Mod	Mod	Slight	Mod	Mod	Non	Mod	Mod	Mod	Mod	Slight

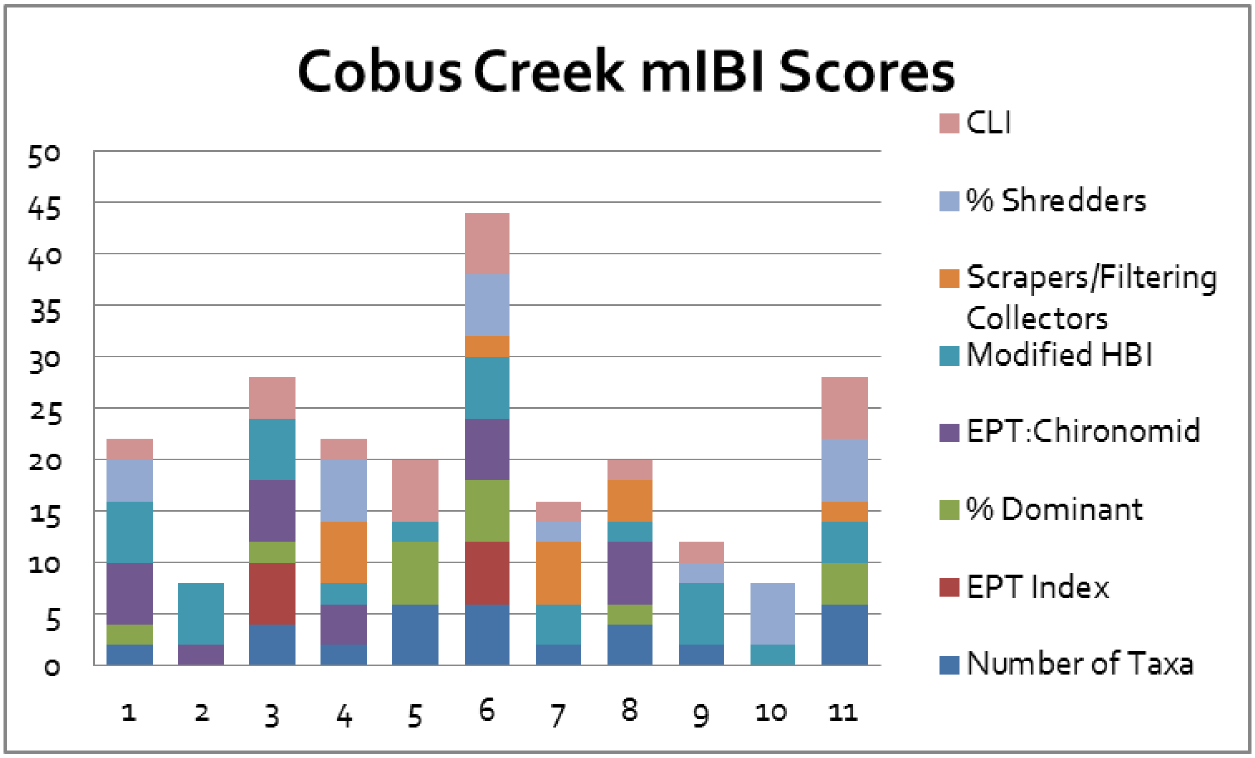

Figure 30. Cumulative metrics used to calculate mIBI scores for Cobus Creek Watershed streams.

Cobus Creek at CR 2 (Site 6) macroinvertebrate community rates at non-impaired, while the macroinvertebrate communities in Cobus Creek at CR 8 (Site 3) and the Coberts Lake Inlet (Site 11) rate as slightly impaired. The remaining site mIBI scores indicate the macroinvertebrate communities in these stream reaches are moderately impaired (Table 13). Most indices of biotic integrity are developed to ensure that there is a statistically significant difference between impairment categories (Karr and Chu, 1999). As such, the macroinvertebrate survey results suggest there is a significant difference between the biological integrity of the macroinvertebrate communities in Cobus Creek at CR 2, the biological communities at Cobus Creek at CR 8 and the Coberts Lake Inlet and the macroinvertebrate communities in Cobus Creek at CR 12, Redfield Road and May Street; Gast Ditch at CR 8, Adams Road, and Redfield Road; the Cobus East Lateral A; and the Spring Lake Inlet.

The mIBI scores support the hypothesis that poor water quality in the Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), and Gast Ditch at Redfield Road (Site 7) may be impairing these streams' biological integrity. Elevated nutrient and total suspended solid concentrations and loads were recorded at the Cobus East Lateral A and Gast Ditch at Adams and Redfield roads (Sites 5 and 7, respectively) during both base and storm flow sampling. Gast Ditch at Adams Road (Site 5) possessed the highest ammonia, total Kjeldahl nitrogen, total dissolved solids, orthophosphorus, and total phosphorus yields during base flow and highest nitrate-nitrogen and total suspended and dissolved solids yields during storm flow. While Gast Ditch at Redfield Road (Site 7) loaded the highest amount of total Kjeldahl nitrogen, orthophosphorus, and total phosphorus per unit area (yield) during storm flow.Cobus East Lateral A (Site 4) yielded the highest ammonia-nitrogen concentration during storm flow. These same waterbodies exhibited mIBI scores indicating the greatest biotic integrity impairment of the watershed streams. These results are consistent with results observed in Ohio (Ohio EPA, 1999).

When the macroinvertebrate communities at each sampling site are evaluated using the HBI, the HBI scores reflect the relative differences in macroinvertebrate communities previously noted (Table 14). Cobus Creek at CR 12 (Site 1) and Gast Ditch at CR 8 (Site 2) contained lower (better) HBI scores compared to sites throughout the Cobus Creek Watershed. HBI scores at these sites suggest that the streams possessed good to excellent water quality and that organic pollution rated unlikely to somewhat probable. Conversely, HBI scores indicate that water quality in the Cobus East Lateral A (Site 4) and the Spring Lake Inlet (Site 10) possessed very poor water quality. HBI scores also suggest that the level of organic pollution in these streams is fairly substantial to very high.

Table 14. HBI scores for Cobus Creek Watershed streams.

Site	Modified HBI	Rating
1	4.30	Good: Some organic pollution probable
2	4.17	Very good: Possible slight organic pollution
3	5.27	Fair: Fairly substantial pollution likely
4	8.06	Very poor: Severe organic pollution likely
5	6.79	Poor: Very substantial pollution likely
6	4.98	Good: Some organic pollution probable
7	6.02	Fairly poor: Substantial pollution likely
8	6.79	Poor: Very substantial pollution likely
9	4.85	Good: Some organic pollution probable
10	8.40	Very poor: Severe organic pollution likely
11	5.94	Fairly poor: Substantial pollution likely

4.4 Fish Community Assessment

4.4.1 Fish Community Methods

Data from fish community sampling at each of the 10 sites in the Cobus Creek Watershed were used to calculate the Indiana Biological Survey's index of biotic integrity developed for coolwater streams (Indiana Biological Survey, 2007). The Spring Lake inlet (Site 10) was not assessed as part of the fish community assessment. Additionally, the fish community in Gast Ditch was sampled at Douglas Road rather than CR 8 (Site 2). Owen and Karr (1978) found that natural streams support fish communities of high species diversity. Fish communities in natural streams are seasonally more stable than the fish communities of modified streams. "Structurally diverse natural streams typically have a great deal of buffering capacity: meanders tend to moderate the effect of floods, pools offer excellent refuges for fishes during dry periods, and tree shade decreases heat loads and minimizes the oxygen-robbing effect of decomposing and extensive algal blooms" (Karr and Schlosser, 1977). Many endangered species are restricted to specific habitat complexes within streams and have become endangered as a result of habitat loss, fragmentation, or pollution. The coolwater IBI was developed to characterize streams and rivers in Indiana with daily maximum temperatures ranging from 22 to 26 ^{o}C (71.6 to 78.8 ^{o}F).

Fish were collected during base flow conditions during two sampling periods in 2016: spring on May 26, June 14 and June 15 and summer on July 6, July 11 and July 26. Each sampling reach measured 15 times the streams' wetted width with sampling occurring over no less than 50 m (164 ft.). Fish were collected using tote barge electrofishing equipment. All fish encountered were collected, identified to species, measured, and returned to the water. Fish species and abundance information was recorded at each site. Length and width measurements were recorded for game fish species.

The coolwater IBI is a multi-metric (12 metrics) index designed to provide a complete assessment of a stream's biological integrity. Metrics include number of native species; number of darters, madtoms, and sculpins; percent headwater species; percent coolwater species; percent sensitive and intolerant species; percent tolerant species; percent detritivores; percent invertivores; person pioneers; catch per unit effort; percent simple lithophils; and percent DELT anomalies. Each metric is scored as detailed in Table 15 . Appendix C details the fish species collected at each sample site.

Table 15. Coolwater IBI metric scoring criteria for stream classes in the Cobus Creek Watershed.

Metric	5	3	1
Number of native species	>12	10-20	<9
Number of darters, madtom, sculpin species	>7	3-6	0-2
Percent headwater	>67%	33-67%	<33%
Percent *Catastomidae*	>60%	30-60%	<30%
Percent coolwater species	>66%	33-66%	<33%
Percent sensitive and intolerant	>66%	33-66%	<33%
Percent tolerant	<33%	33-66%	>66%
Percent detrivores	<22%	22-44%	>44%
Percent invertivores	>66%	33-66%	<33%
Percent pioneer species	<33%	33-66%	>66%
Number of individuals (minus tolerant)	>400	200-400	<200
Percent simple lithophils	>60%	30-60%	<30%
Percent DELT anomalies	<0.1%	0.1-1.3%	>1.3%

4.4.2 Fish Community Results

Fish community data collected during sampling indicate that Cobus Creek at CR 12 (Site 1) rates as fair quality (scores of 35-44;Table 16 and Table 17). Cobus Creek at CR 8 (Site 3), Gast Ditch at Redfield Road (Site 7), Cobus Creek at Redfield Road (Site 8), and Garver Lake Inlet (Site 9) during both the spring and summer assessments and Gast Ditch at Redfield Road (Site 5) during the spring rate as poor (23-34). Cobus Creek at CR 2 (Site 6) during the spring and summer rated as very poor (12-22). Fish communities present at Gast Ditch at CR 8 (Site 2), Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5) during the summer, and the Coberts Lake Inlet (Site 11) did not score high enough to earn a rating. The Cobus East Lateral A contained only two fish during the summer assessment.

The highest mean IBI scores occurred at Cobus Creek at CR 12 (Site 1) and Cobus Creek at CR 8 (Site 3; Figure 31). The lowest mean IBI scores occurred at the Cobus East Lateral A (Site 4) and Gast Ditch at Redfield Road (Site 7). Both Gast Ditch at Adams Road (Site 5) and the Cobus East Lateral A (Site 4) contained poorer quality fish communities during the summer than those present during the spring assessment. These sites represent streams impacted by changing water conditions and poor instream habitat. A total of 25 fish species were collected during both sampling periods. Cobus Creek at CR 12 (Site 1) contained the highest diversity with 12 species identified during each sampling period. Cobus Creek at CR 8 (Site 3) contained 11 species during the spring and nine species during the summer sampling period. Only one species was identified in Gast Ditch at CR 8 (Site 2) and Cobus East Lateral A (Site 4) during the summer.

Table 16. Metric classification scores and IBI scores for the Cobus Creek Watershed sample sites sampled during the spring (May 26, June 14 and 15) sampling period.

Metrics	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site11
# of Native Species	3	1	1	1	1	1	1	1	1	1
Number of DMS	1	0	1	0	0	0	0	0	1	0
% Headwater	5	1	3	1	1	1	1	1	1	1
% Coolwater	5	1	5	1	5	5	1	3	5	1
% Sensitive & Intolerant	1	0	1	0	0	0	0	0	1	0
% Tolerant	1	1	1	1	1	1	1	3	3	1
% Detritivore	5	1	5	1	5	5	1	5	5	1
% Invertivore	5	**0**	3	1	3	1	1	3	3	1
% Pioneers	5	1	5	1	3	1	1	5	5	1
Number of individuals	1	0	1	0	1	0	1	1	1	1
% Simple lithophils	3	0	3	0	3	1	1	1	1	1
% DELT anomalies	5	1	5	1	5	5	1	5	5	1
Total	**40**	**7**	**34**	**8**	**28**	**21**	**10**	**28**	**32**	**10**

Table 17. Metric classification scores and IBI scores for the Cobus Creek Watershed sample sites sampled during the summer (July 6, 11 and 26) sampling period.

Metrics	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site11
# of Native Species	3	1	3	0	1	1	1	1	1	1
Number of DMS	1	0	1	0	0	1	0	0	1	0
% Headwater	5	1	3	0	1	1	1	1	1	1
% Coolwater	5	1	5	0	1	5	1	3	3	1
% Sensitive & Intolerant	1	0	1	0	1	0	0	0	1	1
% Tolerant	1	1	1	0	1	1	1	3	3	1
% Detritivore	5	1	5	0	1	5	1	5	5	1
% Invertivore	5	1	3	0	**1**	1	1	3	5	1
% Pioneers	5	1	3	0	1	1	1	5	5	1
Number of individuals	1	0	1	0	1	1	1	1	1	1
% Simple lithophils	3	1	3	0	1	1	0	0	0	0
% DELT anomalies	5	1	5	0	1	3	1	5	5	1
Total	**40**	**9**	**34**	**0**	**11**	**21**	**9**	**27**	**31**	**10**

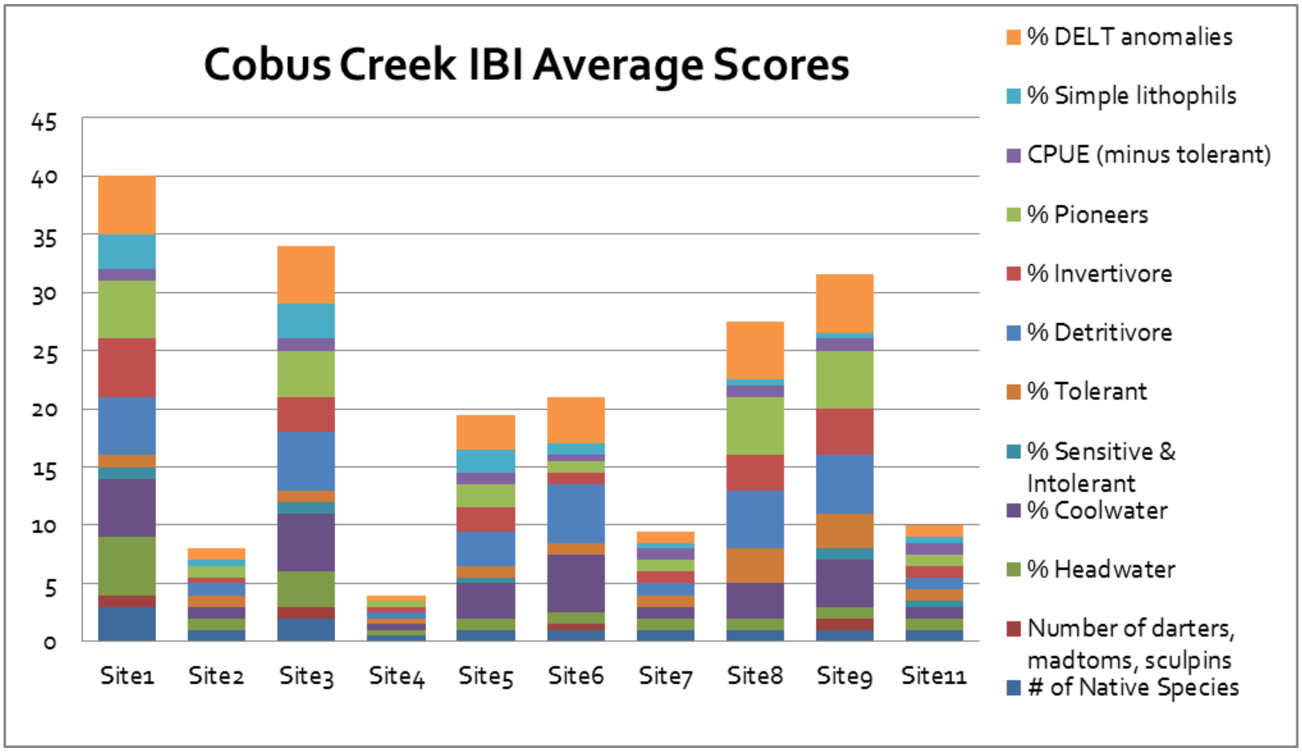

Figure 31. Average cumulative metrics used to calculate IBI scores for Cobus Creek Watershed streams.

4.5 Habitat Assessment

4.5.1 Habitat Methods

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the stream and riparian zone habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates; amount and quality of instream cover; channel morphology; extent and quality of riparian vegetation; pool, run, and riffle development and quality; and gradient are some of the metrics used to determine the QHEI score. The QHEI score ranges from 20 to 100.

Substrate type(s) and quality are important factors of habitat quality and the QHEI score is partially based on these characteristics. Sites that have greater substrate diversity receive higher scores as they can provide greater habitat diversity for benthic organisms. The quality of substrate refers to the embeddedness of the benthic zone. Small particles of soil and organic matter will settle into small pores and crevices in the stream bottom. Many organisms can colonize these microhabitats, but high levels of silt in a streambed can result in the loss of habitat within the substrate. Thus, sites with heavy embeddedness and siltation receive lower QHEI scores for the substrate metric.

Instream cover, another metric of the QHEI, represents the type(s) and quantity of habitat provided within the stream itself. Examples of instream cover include woody logs and debris, aquatic and overhanging vegetation and root wads extending from the stream banks. The channel morphology metric evaluates the stream's physical development with respect to habitat diversity. Pool and riffle development within the stream reach, the channel sinuosity and other factors that represent the stability and direct modification of the site are evaluated to comprise this metric score.

A wooded riparian buffer is a vital functional component of riverine ecosystems. It is instrumental in the detention, removal, and assimilation of nutrients. According to the Ohio EPA (1999), riparian zones govern the quality of goods and services provided by riverine ecosystems. Riparian zone and bank erosion were examined at each site to evaluate the quality of the buffer zone of a stream, the land use within the floodplain that affects inputs to the waterway, and the extent of bank erosion, which can reflect insufficient vegetative stabilization of the stream banks. For the purposes of the QHEI, a riparian buffer is a zone that is forest, shrub, swamp, or woody old field vegetation. Typically, weedy, herbaceous vegetation does not offer as much infiltration potential as woody components and does not represent an acceptable riparian zone type for the QHEI (Ohio EPA, 1989).

The fifth QHEI metric evaluates the quality of pool/glide and riffle/run habitats in the stream. These zones in a stream, when present, provide diverse habitat and in turn can increase habitat quality and availability. The depth of pools within a reach and the stability of riffle substrate are some factors that affect the QHEI score in this metric.

The final QHEI metric evaluates the topographic gradient in a stream reach. This is calculated using topographic data. The score for this metric is based on the premise that both very low and very high gradients will have negative effects on habitat quality and the biota in the stream. Moderate gradients receive the highest score, 10, for this metric. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar.

QHEI scores from hundreds of stream segments in Ohio have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 typify habitat conditions that have the ability to support exceptional warmwater faunas (Ohio EPA, 1999). IDEM indicates that QHEI scores above 64 suggest the habitat is capable of supporting a balanced warmwater community; scores between 51 and 64 are only partially supportive of a stream's aquatic life use designation, while scores less than 51 are deemed non-supporting the stream's aquatic life use designation (IDEM, 2000).

4.5.2 Habitat Results

Table 18 lists the QHEI scores for the Cobus Creek Watershed sites. The Spring Lake inlet (Site 10) was not assessed as part of the fish community assessment; therefore, habitat assessments occurred at this site only during the macroinvertebrate community assessment. The assessment occurred at Douglas Road on May 26 and July 11, while the July 27 assessment occurred at CR 6. May 26 and July 6 assessments occurred upstream of the road-stream crossing, while the July 27 assessment occurred downstream of the road-stream crossing.

Table 18. QHEI scores for Cobus Creek Watershed sample sites sampled during spring fish community assessments (May 26, June 14 and 15), summer fish community assessments (July 6, 11 and 26) and macroinvertebrate community assessments (July 27 and August 3).

Site	Date	Substrate	Cover	Channel	Riparian	Pool	Riffle	Gradient	Total
1	6/15/2016	14.5	15	11	8.5	7	2	6	64
	7/26/2016	14	15	7	6.5	8	3	6	59.5
	7/27/2016	19	14	15	9	7	4	6	74
2	5/26/2016	9	7	6	7.5	4	1	6	40.5
	7/11/2016	7	2	4	5	0	0	6	24
	7/27/2016	14	6	8	6	4	2	6	46
3	6/14/2016	11.5	15	14	10	6	1	6	63.5
	7/26/2016	12	15	15	10	4	2	6	64
	7/27/2016	18	11	16	9	7	4	6	71
4	5/26/2016	8	12	4	5.5	0	1	4	34.5
	7/6/2016	4	13	4	5.5	3	0	4	33.5
	7/27/2016	2	1	4	3	0	0	4	14
5	5/26/2016	16	13	13	5.5	8	2	4	61.5
	7/6/2016	12	12	10	6	7	0	4	51
	7/27/2016	8	2	5	5	0	0	4	24
6	5/26/2016	13	13	10	6	5	2	6	55
	7/6/2016	9	13	7	7	4	0	6	46
	7/27/2016	13	11	12	5	5	4	6	56
7	5/26/2016	9	11	7	7.5	4	1	4	43.5
	7/11/2016	9	7	4	7	0	0	4	31
	8/3/16	12	4	8	9	3	2	4	42
8	6/1/2016	2	14	6	10	4	0	4	40
	7/11/2016	1	15	6	10	6	0	4	42
	8/3/16	16	11	13	6	5	3	4	58
9	6/24/2016	9	12	7	9	3	1	4	45
	7/26/2016	11	11	10	7.5	2	2	4	47.5
	8/3/16	14	8	13	7	4	2	4	52
10	8/3/16	0	3	7	8	1	0	4	23
11	6/24/2016	13	11	9	9.5	2	2	6	52.5
	8/2/2016	11	7	7	10	0	1	6	42
	8/3/16	14	7	14	7	4	2	4	52

Site 2's habitat was assessed in Gast Ditch at Douglas Road during the fish community assessment and in Gast Ditch at CR 8 during the macroinvertebrate assessment. Cobus Creek at CR 12 (Site 1), Cobus Creek at CR 8 (Site 3), and the Coberts Lake inlet (Site 11) received the highest average scores with habitat rated as good (55-69). Stable substrate, well developed channel morphology, available instream and canopy cover, and developed pools and riffles characterize these reaches. Gast Ditch at Redfield Road (Site 5), Cobus Creek at CR 2 (Site 6), Cobus Creek at Redfield Road (Site 8), Garver Lake Inlet

(Site 9), and the Spring Lake inlet (Site 10) rated as fair (43-54). Gast Ditch at CR 8 (Site 2) and Gast Ditch at Redfield Road (Site 7) generally contained limited habitat and rated as poor (30-42). Cobus East Lateral A (Site 4) received the lowest average score, 27.3 of a possible 100 rating as very poor (<30; Figure 32). Poor instream and canopy cover, lack of well-developed pools and riffles, and poor substrate limited the available habitat at this reach. The low QHEI scores suggest that these reaches may not be capable of supporting healthy aquatic communities. Appendix D details the habitat assessment conducted at each sample site.

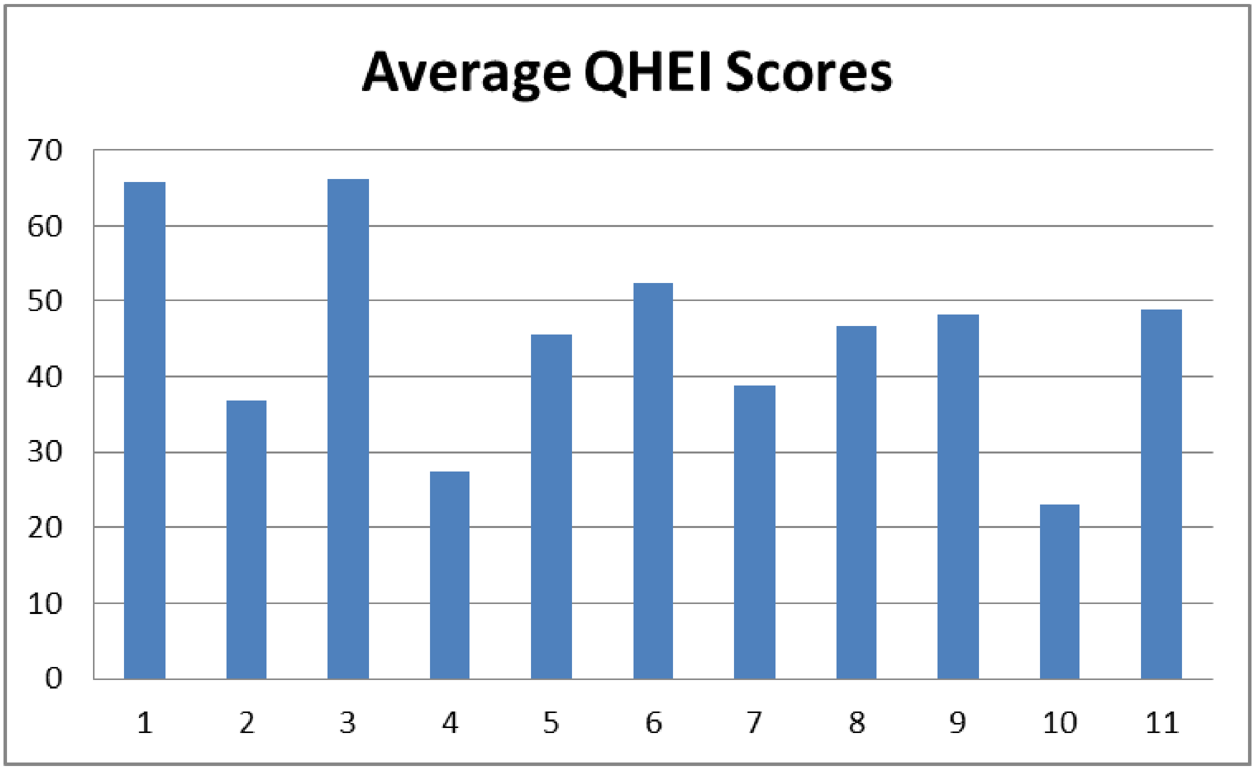

Figure 32. QHEI scores for Cobus Creek Watershed sample sites sampled during spring fish community assessments (May 26, June 14 and 15), summer fish community assessments (July 6, 11 and 26) and macroinvertebrate community assessments (July 27 and August 3).

On average, the highest habitat scores occurred at Cobus Creek at CR 2 (Site 3). This site also scored the second highest macroinvertebrate and fish community assessments. Cobus Creek at CR 12 (Site 1) contained the second highest habitat score and contained the highest rated fish communities during both the spring and summer assessments; however, the macroinvertebrate community only rated as moderately impaired when compared with the reference site. Conversely, the Coberts Lake Inlet (Site 11) contained the third best habitat rating scoring an average of 57.2 points; however, the fish community present at this site rated as one of the poorest during both the spring and summer assessments, suggesting that water quality rather than habitat may be limiting the fish community present at this site. Elevated nitrate-nitrogen concentrations present during both base and storm flow conditions and elevated base flow total dissolved solids, nitrate-nitrogen, and total suspended solids yields may limit the biological community at this site. Likewise, the Cobus East Lateral A (Site 4) possessed the poorest rated habitat scoring on average 27.3 points out of a possible 100. This site's macroinvertebrate community rated as moderately impaired tying with Cobus Creek at CR 12 (Site 1), while the fish community present at this site rated as the second poorest during the spring assessment and poorest during the summer assessment.

4.6 Biological Community and Habitat Site Discussion

Cobus Creek at County Road 2 (Site 1): The QHEI score average 65.8 out of a possible 100 points, the second highest habitat score of sites within the Cobus Creek Watershed. Substrate composition at this site was predominately cobble and gravel with some sand, muck/silt, and detritus. Silt cover was normal, while substrate embeddedness was low. Instream conditions were good with low substrate embeddedness, good pool depth early in the season, and limited riffle/run development. Overhanging vegetation, aquatic macrophytes, woody debris, boulders, shallows in slow water, undercut banks, and rootwads provided good instream cover (Figure 33). The site was surrounded by forest on one side and open pasture or row crop on the other. The riparian zone measured narrow to moderate up to 164.5 feet (50 meters) from either streambank. Bank stability was good with little to no erosion present. No sinuosity was observed in the stream reach with recent to no recovery from channelization. The mIBI score for this site was 22 scoring 52% of the reference site on Christiana Creek indicating that the stream is "moderately impaired." The moderately tolerant mayfly *Baetis hageni* dominated the macroinvertebrate community. A high EPT: Chironomid ratio, a high modified HBI score, low numbers of EPT species and low numbers of scrapers and collectors generate the moderate mIBI score. Cobus Creek at CR 2 scored the highest coolwater IBI score rating 40, or good, during both the spring and summer assessments. Blacknose dace dominated the fish community during both assessments.

Figure 33. Site 1 sampling location on Cobus Creek.

Gast Ditch at County Road 8 (macroinvertebrates) and Douglas Road (fish; Site 2): This site received a QHEI score of 36.8 of a possible 100, the second lowest of all sites assessed. The substrate composition at the site was a combination of sand and gravel. Substrate embeddedness was moderate. Shallows in slow water, rootmats, and logs or woody debris, provided sparse levels of instream cover. Low sinuosity was present with evidence of recent recovery from channelization (Figure 34). The riparian zone extended between 16.2 and 32.4 feet (5 to 10 meters) on either side of the streambank. Shrubs or old field dominated the riparian vegetation. Both stream banks were moderately eroded. Pool/ riffle development was fair with the presence of moderately deep pools, which possessed slow flows. The mIBI score was 8 rating 19% of reference site score on Christiana Creek, which is indicative of the "moderately impaired" condition at this site. The most abundant macroinvertebrates at this site were the moderately tolerant *Gammarus pseudolimnaeus*, accounting for 91% of the macroinvertebrate community present in this reach of Gast Ditch. A low number of taxa, low number of EPT taxa, high dominance by one species, low numbers of scrapers and collectors, low percent shredders, and a low community loss index characterized the macroinvertebrate community at this site. IBI scores also rated poorly at this reach scoring 7 and 9, respectively, or very poor during the spring and summer assessments. Only two individuals, one bluegill and one golden shiner, were found during the spring assessment and fifteen individuals from one species, creek chub, were found during the summer assessment. Gast Ditch at Douglas Road was nearly dry during the July 27 assessment. These data suggest that habitat likely limits the biological community present in Gast Ditch at County Road 2.

Figure 34. Site 2 sampling location on Gast Ditch.

Cobus Creek at County Road 8 (Site 3): This site received the highest QHEI score of any of the Cobus Creek Watershed sites scoring an average of 66.2 of a possible 100. Cobble and gravel dominated the substrate; sand, detritus, muck, and silt were also present. Silt levels were normal with normal levels of substrate embeddedness. Shallows in slow waters, rootmats, aquatic macrophytes, and logs of woody debris provided moderate levels of instream cover. Moderately well-developed pools and riffles with moderate embeddedness provide additional habitat at this site. The stream possessed moderate sinuosity with no observed evidence of channelization (Figure 35). The riparian buffer was moderate, extending between 32.4 and 164.2 feet (10 to 50 meters) on either side of the stream. Forest was the predominant vegetation type in the riparian buffer. The stream is considered to be "slightly impaired" with an mIBI score of 28, which rated 67% of the reference site's score. The macroinvertebrate community was dominated by the moderately tolerant caddisfly species, *Hydropsyche simulans.* Moderate taxa richness and high EPT index and EPT:Chironomid scores characterize the macroinvertebrate community in this reach of Cobus Creek. The fish community rated as good scoring 34 during the spring and summer assessments. Blacknose dace and creek chub were equally dominant during both assessments.

Figure 35. Site 3 sampling location on Cobus Creek.

Cobus East Lateral A (Site 4): The Cobus East Lateral A received a QHEI score of 27.3, the lowest of any sites assessed in the Cobus Creek Watershed. Silt and muck dominated the substrate. The substrate was extensively embedded with heavy levels of silt cover. Instream cover present in moderate levels in early June with overhanging vegetation, shallows in slow water, deep pools, aquatic macrophytes, and logs or woody debris providing moderate cover. However, as water levels dropped throughout the summer, instream cover was nearly absent (*Figure 36*). Moderate bank erosion was present throughout the reach creating low channel stability. Stream sinuosity was absent with no pool/riffle development. The riparian buffer was limited with residential areas adjacent to both banks. Pool/ riffle development was poor; no deep pools were observed at this site, while shallow, gravel and sand riffles predominated. The mIBI score (22) indicated that the macroinvertebrate community was slightly impaired, rating 67% of the reference site's score. A low number of taxa, low community loss index, low modified HBI score, and high EPT: Chironomid ratio, high percent of shredders, and good numbers of scrapers and collectors characterize this site. The dominance of the community by the right handed snail family, *Physidae*, and the absence of members of the *Chironomidae* family generates a relatively good macroinvertebrate community score for the Cobus Creek Watershed. The fish community reflects the poor habitat present at this site scoring 7 and 0, or very poor, respectively during the spring and summer assessments. Seven species were present in relatively low density during the spring assessment, while no fish were observed during the summer assessment.

Figure 36. Site 4 sampling location on the Cobus East Lateral A.

Gast Ditch at Adams Road (Site 5): This site received a QHEI score of 45.5 out of a possible 100 points. Like other sites along Gast Ditch, habitat quality rated better earlier in the season and as water levels declined, pool/riffle habitat and instream cover accessibility decreased resulting in poorer habitat scores in late July. Sand dominated the substrate at this reach, with gravel present early in the season and muck present later in the summer. In total, sand, gravel, muck, silt, detritus, and artificial substrates were present at this site. Silt levels were normal with normal substrate embeddedness. Overhanging vegetation, shallows in slow water, deep pools, aquatic macrophytes, and logs or woody debris provided moderate levels of instream cover during the June assessment, while only logs or woody debris were present during the late July assessment (Figure 37). Channel sinuosity was low. The stream possessed moderate pool/riffle development during the June assessment and moderate riffles and nearly absent pools during the late July assessment. Narrow riparian zones with residential development extend less than 32.4 feet (10 meters) on both streambanks. The mIBI score indicated that this site was moderately impaired scoring 20, or 48%, of the reference site score. The macroinvertebrate community was comprised of highly intolerant worm, *Oligochaeta*, biting midges, *Paracladopelma loganae*, and the damselfly genus, *Argia.* A relatively high number of taxa, limited dominance by any one species, a good community loss index, and a poor (high) modified HBI score characterize the community in this reach of Gast Ditch. The fish community is similarly limited scoring 28, or fair, during the spring assessment and only 11, or very poor, during the summer assessment. Relatively limited density and diversity of fish characterized this site during both assessments. The limited habitat present as well as declining water levels likely negatively impact the fish community throughout the summer in this reach of Gast Ditch.

Figure 37. Site 5 sampling location on Gast Ditch.

Cobus Creek at County Road 2 (Site 6): Cobus Creek at CR 2 rated an average QHEI score of 52.3 of 100 possible points. Sand and gravel dominated the substrate composition with muck and silt also present. Silt levels were normal with normal substrate embeddedness. Shallows in slow water, rootmats, rootwads, and aquatic macrophytes provided moderate levels of instream cover. Deep pools were present during the June assessment but disappeared as water levels dropped throughout the season. The banks exhibited little to no erosion and this reach was recovered from previous channelization; however, sinuosity of the stream was low. The riparian buffer was very narrow, limited to less than 16.4 feet (5 meters). The vegetation in the riparian zone was predominantly old field or shrubs and residential land uses (Figure 38). Pool/riffle development was fair to poor. The mIBI score was the highest of all sites assessed scoring 44 or 105% of the reference site indicating that the community was slightly impaired. The macroinvertebrate community possessed high taxa richness, high numbers of EPT taxa, relatively low numbers of Chironomids, a good community loss index score, good modified HBI score, and high percent shredders. The macroinvertebrate community was dominated by the beetle, *Stenacron interpunctatum* and the caddisfly genus, *Cheumatopsyche*. Despite the high quality macroinvertebrate community present in this reach of Cobus Creek, the fish community rated as poor scoring 21 during both the spring and summer assessments. Creek chub accounted for more than 80% of the community present during the spring survey and nearly 90% of the community during the summer survey. Sampling during the fish assessments occurred upstream of the road-stream crossing, while sampling during the macroinvertebrate assessment occurred downstream of the road-stream crossing. While the resulting QHEI scores are relatively similar, this could explain the disparity in macroinvertebrate and fish community ratings.

Figure 38. Site 6 sampling location on Cobus Creek.

Gast Ditch at Redfield Road (Site 7): This reach of Gast Ditch scored a QHEI score of 38.8 of a possible 100 points. Substrate composition was a mixture of sand and gravel with the presence of detritus, muck, artificial, and silt substrates also present. The level of substrate embeddedness was moderate with moderate silt cover. Instream cover was sparse to nearly absent containing a mixture of rootmats, boulders, overhanging vegetation, and logs or woody debris (Figure 39). Stream banks showed minimal signs of erosion with low channel stability. The stream reach possessed a low level of sinuosity evidence of recovery from previous channelization. The riparian buffer along both sides of the streambed was moderate extending up to 162.4 feet (50 meters) from the streambanks. The riparian vegetation along the stream consisted of a forest or swamp. Pool/riffle development at the site was minimal with the presence of limited pools and unstable fine gravel or sand riffles. The mIBI score (16) rated as moderately impaired scoring 38% of the reference site's score. The macroinvertebrate community consisted of a moderately diverse group of genera, most of which were moderately tolerant to intolerant to pollution. The predominant macroinvertebrates found at the site were midges, *Paracladopelma loganae*, and worms of the *Oligochaeta* genera. A modest number of taxa, poor EPT diversity, low percent shredders, a poor community loss index, and low EPT: Chironomid index characterize this reach of Gast Ditch. The fish community reflects the limited habitat present in this reach of Gast Ditch and mimic the poor macroinvertebrate community rating 10 and 9, or very poor, during the spring and summer surveys, respectively. Thirteen individuals from three species comprised the spring fish community, while seven individuals representing five species comprised the summer fish community. The community was dominated by non-coolwaters, moderately tolerant species common to wide, ponded stream reaches like Gast Ditch at Redfield Road.

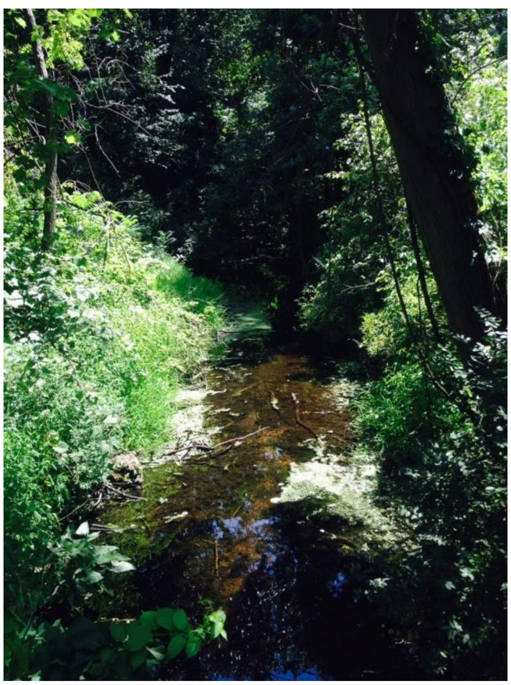

Figure 39. Site 7 sampling location on Gast Ditch.

Cobus Creek at Redfield Road (Site 8): The QHEI score for this stream reach averaged 46.7. The substrate composition was a blend of silt, sand, and gravel with a normal level of substrate embeddedness and normal silt levels. The site contained moderate instream cover consisting of shallows in slow water, rootmats, aquatic macrophytes, and logs or woody debris present throughout the reach (Figure 40). Erosion was absent along this reach and the banks were moderately stable. No apparent channelization was observed and the stream channel was relatively straight with low sinuosity. The riparian buffer along each bank was very narrow, extending less than 16.4 feet (five meters) from the streambanks. Pool/ riffle development at the site was moderately poor with limited pool depth and unstable sand and gravel riffles. The macroinvertebrate community rated moderately impaired, scoring 20 or 48% of the reference site score. The macroinvertebrate community was dominated by the amphiphod genera *Hyallela,* which comprised nearly 40% of the community. Low taxa diversity, limited EPT taxa presence, a modest modified HBI score, low number so scrapers and collectors, low community loss index, and low percent shredders characterize the community. The fish community rated good scoring 28 and 27, respectively during the spring and summer assessments. Grass pickerel dominated the community present in this reach of Cobus Creek during both assessments.

Figure 40. Site 8 sampling location on Cobus Creek.

Garver Lake Inlet (Site 9): This reach of Cobus Creek rated an average QHEI score of 48.2. The streambed was predominantly gravel and sand with normal silt levels and normal embeddedness. The site contained sparse instream cover with overhanging vegetation, shallows in slow water, rootmats, aquatic macrophytes, and logs or woody debris. Erosion along the stream banks was absent, leaving the banks moderately stable. Channel sinuosity was low with no evidence of prior channelization (Figure 41). The riparian zone along the banks was very narrow extending to a distance of 32.4 feet (10 meters). Vegetation in the riparian buffer zone was a shrub or old field and residential lawn. Pool and riffle development at the site was moderate with unstable, gravel and sand riffles and shallow pools present. The mIBI score (12) for the site was the third lowest of the Cobus Creek Watershed sites. *Gammarus pseudolimnaeus* comprised 50% of the macroinvertebrate community. Highly pollution tolerant macroinvertebrate families dominated the site; this coupled with low taxa richness, low number of EPT taxa, a poor modified HBI score, and low community loss index result in the moderately impaired mIBI rating. Conversely, the fish community rated fair scoring 32 during the spring assessment and 31 during the summer assessment. Iowa darters dominated the spring fish community, while central mudminnows dominated the summer fish community.

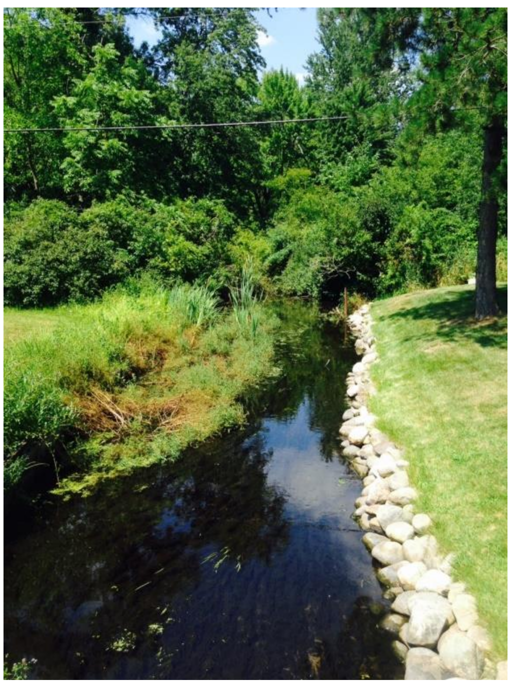

Figure 41. Site 9 sampling location on Cobus Creek.

Spring Lake Inlet (Site 10): The Spring Lake Inlet scored 52.5 on the QHEI assessment rating the fourth highest of any reaches assessed in the Cobus Creek Watershed (Figure 42). The habitat at this site was only assessed once occurring in concert with the macroinvertebrate community assessment. Muck and silt were the dominant substrate components. The level of substrate embeddedness was heavy, with an extensive amount of silt cover. Instream cover was nearly absent and was comprised of shallows in slow water and logs or woody debris. Erosion along the banks was absent; bank stability was low, with no sinuosity and the signs or recovering from previous channelization. The riparian buffer zone was classified as narrow with widths of 16.2 to 32.4 feet (5 to 10 meters). Pool and riffle development metric scores were low because the reach lacked deep pools and possessed unstable, fine gravel and sand riffles. Despite the relatively high quality habitat present at this site, the macroinvertebrate community was moderately impaired, receiving a mIBI score of 8 or 19% of the reference site score. *Chironomus* species composed nearly 60% of the macroinvertebrate community. Limited taxa diversity, poor numbers of EPT taxa, high number of Chironomids, a poor modified HBI score, high number of shredders, and a poor community loss index score characterize the macroinvertebrate community present at the Spring Lake Inlet. The fish community was not assessed at this site due to accessibility issues.

Figure 42. Site 10 sampling location on the Spring Lake Inlet.

Coberts Lake Inlet (Site 11): The Coberts Lake Inlet scored an average QHEI of 57.2, the third highest rated habitat of the Cobus Creek Watershed sites. Gravel and sand were the dominant substrate components; detritus, muck, and sand were also present along this reach. The level of substrate embeddedness was normal with a normal amount of silt cover. Instream cover was sparse and comprised of overhanging vegetation, shallows in slow water, rootmats, logs or woody debris, and aquatic macrophytes. Erosion along the banks was absent, in part controlled by grasses growing on the banks (Figure 43). Bank stability was also moderate. The surrounding land use was dominated by forest and the riparian buffer zone was classified as very narrow with widths of less than 16.2 feet (5 meters). Pool and riffle development metric scores were low because the reach lacked deep pools and possessed unstable, fine gravel and sand riffles. The macroinvertebrate community was slightly impaired, receiving an mIBI score of 28 or 67% of the reference site score. The moderately tolerant Amphipod genus Hyalella dominated the macroinvertebrate community. High taxa richness, low EPT taxa richness, low EPT: Chironomid ratio, low number of scrapers and collectors, and moderate modified HBI score characterize the macroinvertebrate community present at the Coberts Lake Inlet. Conversely, the fish community rated as very poor, rating an IBI score of 11 during the spring and 10 during the summer assessments. Central mudminnows dominated the spring and summer fish communities. Coolwater species were absent from this stream reach.

Figure 43. Site 11 sampling location on the Coberts Lake Inlet.

Christiana Creek (Reference Site): The reference site along Christiana Creek was assessed as part of the macroinvertebrate scoring mechanism. Its habitat was assessed to ensure it meets the requirements for reference sites. This site scored 77 of a possible 100 points. This is nearly 11 points higher than any of the Cobus Creek Watershed streams. Gravel and cobble were the dominant substrate components; the stream was silt free with no embeddedness. Overhanging vegetation, shallows in slow water, rootmats, deep pools, rootwads, aquatic macrophytes, and logs or woody debris composed the instream cover which rated moderate (Figure 44). Erosion was absent; bank stability was high with fair development and moderate sinuosity. The surrounding land use was residential land uses. The riparian buffer zone was classified as narrow pool and riffle development metric scores were high due to deep pools and moderately stable, large gravel riffles. The macroinvertebrate community was highly diverse containing 24 taxa, 8 of which were EPT taxa.

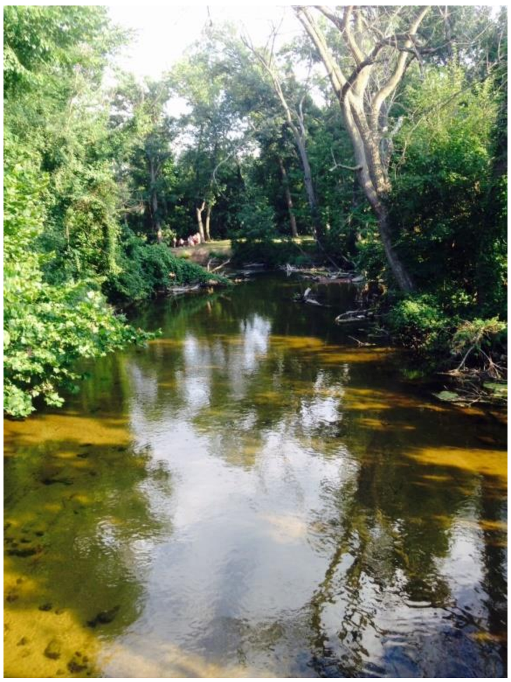

Figure 44. Reference sampling location on Christiana Creek.

4.7 Biological and Habitat Discussion

The overall evaluation of biotic health and habitat quality in the Cobus Creek Watershed indicates that these waterways are slightly to moderately degraded (Table 19). Many of the study 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 from each site describe moderate substrate quality throughout streams in the Cobus Creek Watershed. Additionally, QHEI scores generally reflected the moderate pool and riffle development in watershed streams; there was almost a complete absence of sufficient pool-riffle development within the Cobus East Lateral A (very poor) and Gast Ditch at County Road 8 (Site 2) and at Redfield Road (Site 7) where habitat rated as poor. Channel alterations and minimal riparian buffer zones reduce Cobus Creek's resilience to agricultural runoff. These factors are critical for habitat diversity and biological integrity in the stream ecosystems.

Table 19. Biological and habitat assessment summary for Cobus Creek Watershed streams. Green shading indicates the highest rates stream reaches, while red indicates the poorest rated reaches.

Site	mIBI	IBI (Spring/Summer)	QHEI
1	Moderate Impairment	Fair/Fair	Good
2	Moderate Impairment	Not rated/Not rated	Poor
3	Slight Impairment	Poor/Poor	Good
4	Moderate Impairment	Not rated/Not rated	Very Poor
5	Moderate Impairment	Poor/Not Rated	Fair
6	No impairment	Very Poor/Very Poor	Fair
7	Moderate Impairment	Not rated/Not rated	Poor
8	Moderate Impairment	Poor/Poor	Fair
9	Moderate Impairment	Poor/Poor	Fair
10	Moderate Impairment	--	Fair
11	Slight Impairment	Not rated/Not rated	Good

Moderate to heavy sediment loading was an apparent factor in the degradation of substrate quality in the study streams. Several of the sites, including Gast Ditch at CR 2 (Site 2), the Cobus East Lateral A (Site 4), Gast Ditch at Redfield (Site 7), and the Spring Lake Inlet (Site 10) have experienced moderate to heavy silt sedimentation levels. Moderate to extensive substrate embeddedness severely limits habitat diversity within the stream channel by filling in and closing off porous areas that offer refuge for a variety of aquatic organisms. This heavy sediment loading is reflected in the poor substrate scores of the QHEI evaluation. The range of substrate scores was 5 to 14.7 out of a possible 20. The direct supply of sediment transport typically originates from the streambed and bank (Richards, 1982). Gast Ditch at CR 2 (Site 2) and the Cobus East Lateral A (Site 4) show at least moderate bank erosion; therefore, a source of silt and sediment could be autochthonous (originating from within the stream), stressing the importance of bank stability. However, since many of the Cobus Creek Watershed sites experience little to no streambank erosion, erosion of watershed soils is ultimately the original source of sediment. Further, the surrounding land use most likely plays a role in the dominant contribution of allochthonous (originating from outside the stream) sources of sediment loading. Row crop agriculture, pastured land, and residential development, the predominant land uses through the middle of the watershed, are typical sources of sediment and sediment-attached pollutants.

Typically in watersheds throughout northern Indiana and southern Michigan, stream channel morphology is greatly manipulated, jeopardizing the integrity of the biological communities. Pool development and quality is determined by the sorting of particles in that stream reach. Pools provide deeper areas with slower velocity for various macroinvertebrates, diversifying habitat. The lack of deep pool development is likely associated with land use alterations and the activity of increased erosion and siltation of the streambed, which then interferes with typical sorting of particles that form both riffles and pools (Allan, 1995). This scenario explains why typical riffle-pool patterns are lacking at all stream sites except Cobus Creek at CR 12 (Site 1) and at CR 8 (Site 3), where moderately deep pools and moderately stable riffles are present, but does not make a strong correlation within the watershed between the morphological characteristics and biological integrity.

Another important aspect of good habitat quality that is conspicuously missing from many of the study sites, especially headwater sites, Gast Ditch, and the Cobus East Lateral A, is an effective riparian zone to buffer stream systems from the surrounding land use. Stable, woody vegetation zones that naturally form adjacent to streams and other waterways provide distinct functions that enhance habitat quality (Ohio EPA, 1999). Primarily, this zone slows run off, collects sediment, and stores nutrients and sediment that would otherwise be loaded into the stream system. Poor QHEI and mIBI scores are also probably related to riparian zone absence. Extensive woody vegetation around streams provides additional habitat in the form of logs and woody debris, overhanging vegetation, and submerged root wads. Riparian vegetation also provides canopy cover that shades the stream and minimizes thermal inputs. Shade can also limit extensive, nuisance levels of aquatic vegetation that are dependent upon sufficient levels of solar radiation. Unfiltered nutrient-rich runoff can also promote vegetation and algal growth. Mowed grassy vegetation adjacent to streams does little to slow runoff flows into the stream, and therefore, is less capable of trapping sediments and nutrients. Based on observations made during sampling events, the quality and quantity of riparian zones are moderately to severely limited throughout the watershed.

Each of these physical factors contributes to habitat quality, and their absence or degradation at most of the sites is related to the macroinvertebrate and fish community structures. Overall, the mIBI scores indicated slight to moderate impairment; Cobus Creek at CR 2 (Site 6), Cobus Creek at CR 8 (Site 3), and the Coberts Lake Inlet (Site 11) possessed the highest quality macroinvertebrate communities (Table 19). Cobus Creek at CR 12 (Site 1), Cobus Creek at CR 8 (Site 3), Cobus Creek at Redfield Road (Site 8), and the Garver Lake Inlet (Site 9) possessed the highest quality fish community (Table 19). In a healthy stream system, a community of both tolerant and intolerant taxa is expected. Impacts of degradation will tend to limit or eliminate organisms that are incapable of persisting in such systems. In general, tolerant taxa dominated the macroinvertebrate communities at Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), Cobus Creek at Redfield Road (Site 8), and the Spring Lake Inlet (Site 10) leading to lower mIBI scores. Similarly low density and diversity of fish communities were present at the Cobus East Lateral A (Site 4), Gast Ditch at CR 8 (Site 2), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake Inlet (Site 11) with these communities rating as very poor. The coolwater IBI may not be the most appropriate index to utilize for modified, more warmwater streams, like the Cobus East Lateral A and Gast Ditch, or the low gradient, wetland streams like the Coberts Lake inlet, which is more influenced by the lakes and wetlands and therefore likely do not qualify as coolwater streams (Deegan, personal communication).

Water quality data further suggest that the Cobus East Lateral A, Gast Ditch at Redfield Road, and the Coberts Lake Inlet may be further impacted by high nutrient and sediment concentrations and loads. These same sites possessed the highest ammonia-nitrogen and total Kjeldahl nitrogen concentrations (Cobus East Lateral A), nitrate-nitrogen concentrations (Coberts Lake Inlet), orthophosphorus and total phosphorus (Gast Ditch at Redfield Road). Additionally, Gast Ditch at Redfield Road yielded the highest ammonia-nitrogen (base), total Kjeldahl nitrogen (base and storm), orthophosphorus (base and storm), total phosphorus (base and storm), Cobus East Lateral A yielded the highest ammonia-nitrogen (storm), and the Coberts Lake Inlet yielded the highest nitrate-nitrogen (base) and total suspended solid (base).

4.8 <u>Trend Comparison with Historical Water Quality Data</u>

Historical data that documented water chemistry, macroinvertebrate and fish community structure, and habitat availability throughout the Cobus Creek Watershed was discussed in the Historical Water Quality Assessment Section of this report. Very little of the data collected throughout the watershed corresponds with current sampling sites; therefore, it is difficult to draw direct comparison between historical data and data collected during the current study.

Historically, water quality samples collected throughout the watershed have documented elevated orthophosphorus, total phosphorus, and *E. coli* concentrations. The Elkhart County Health Department documented elevated orthophosphorus, total phosphorus, and E. coli concentrations in Cobus Creek at CR 10. These are in line with concentrations measured along the Cobus Creek mainstem in Elkhart County as part of this project. Additionally, IDEM measured elevated *E. coli* concentrations in Cobus Creek at CR 8 in one of their five samples. Similar conditions were observed during the current assessment with *E. coli* concentration elevated during storm flow conditions.

The City of Elkhart rated habitat using the QHEI and assessed the fish community using the coolwater IBI at six reaches along Cobus Creek from 1998 through 2014. These six reaches were located throughout Elkhart County with two, Cobus Creek at CR 12 and CR 8, occurring at sites sampled during the current study. All reaches received higher QHEI scores (67 to 88.5) than any of the sites scored during this study (27.3-66.2). The two sites assessed during the current study received higher scores historically than those assessed during the current study. This may be due to lower water levels present during the current assessment, which tends to reduce instream habitat and pool and riffle development scores. Additionally, it may be due to more fine sand present in Cobus Creek at CR 8 (Deegan, personal communication). IBI scores rated between 29 and 34, or fair to good, historically. Scores rated similarly during the current assessment scoring 34 and 40 in Cobus Creek at CR 8 and CR 12, respectively.

4.9 <u>Water Quality Assessment Summary</u>

High orthophosphorus and total phosphorus concentrations during base and storm flow conditions, elevated total suspended solids concentrations during storm flow conditions, and E. coli concentrations that exceeded the state standard during storm conditions were the water chemistry issues of most concern in Cobus Creek Watershed streams. Four of the Cobus Creek Watershed sites: Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake Inlet (Site 11) generally possessed poorer water quality conditions than the other stream reaches (Figure 45). These watersheds should be the first targeted for projects aimed at reducing instream nutrient, sediment, and pathogen concentrations and loading to the Cobus Creek Watershed.

Nutrient and Sediment Concentrations: All of the Cobus Creek streams possessed orthophosphorus concentrations greater than the target concentration (0.03 mg/L) and most possessed total phosphorus concentrations higher than the level at which eutrophication occurs (0.08 mg/L; Table 8). The Cobus East Lateral A (Site 4) and the Spring Lake inlet (Site 10) showed drastically elevated levels of ammonia-nitrogen during storm flow. Additionally, all sites contained total suspended solids concentrations that exceeded the target concentration (15 mg/L) during storm flow conditions.

Pathogen Concentrations: E. coli concentrations exceeded the Indiana state standard (235 colonies/100 ml) at all sites during storm flow. At sites where elevated concentrations were observed, concentrations were 1.6 to 12.6 times the state standard (235 colonies/100 mL). Additionally, bacteria levels were high when compared with other watersheds in Indiana. The specific sources of E. coli in the Cobus Creek 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. Many of these issues were documented historically and/or observed at multiple sites throughout the watershed during the windshield tour. Efforts to reduce phosphorus and *E. coli* concentrations within the watershed streams should target nutrient management planning and septic system failure identification and subsequent improvements.

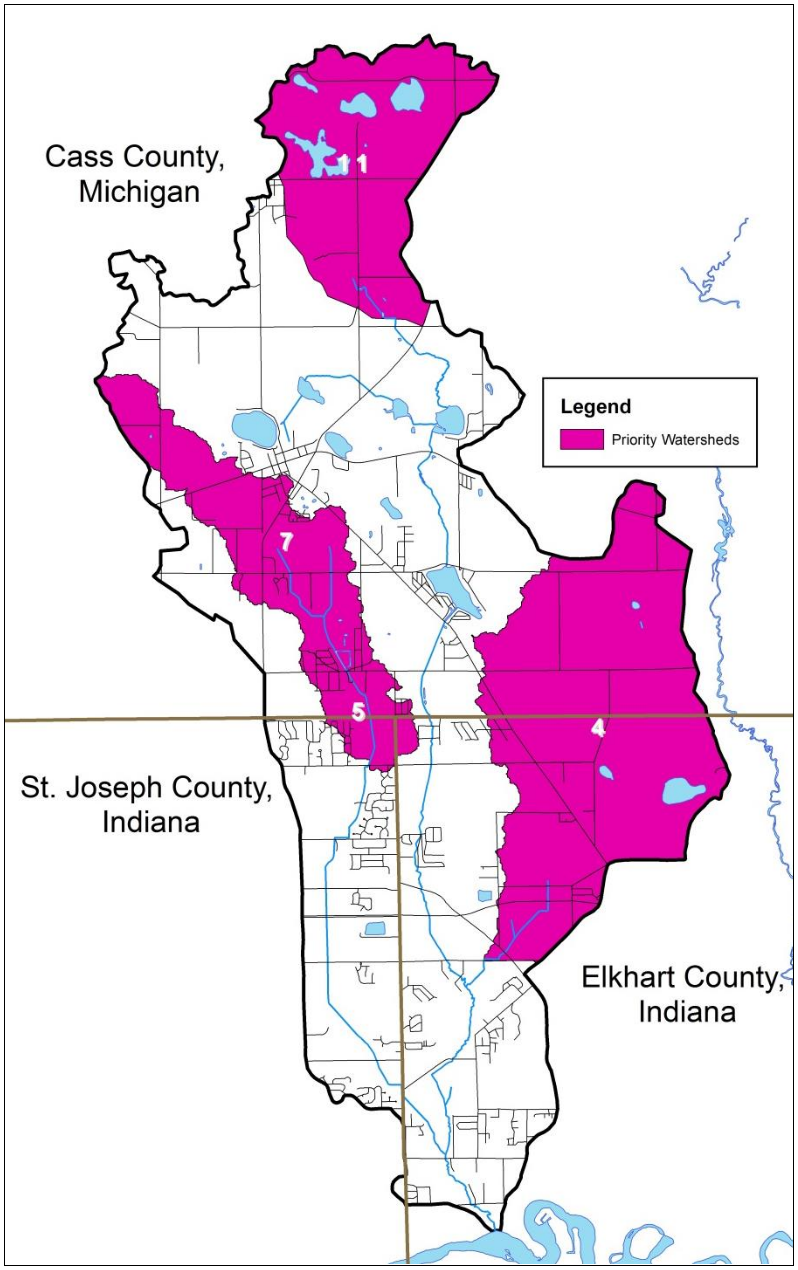

Figure 45. Priority subwatersheds identified for the Cobus Creek Watershed.

Four of the Cobus Creek Watershed sites; Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake Inlet (Site 11), generally possessed poorer water quality conditions than the other stream reaches (Figure 45).

- The Cobus East Lateral A (Site 4) possessed the highest ammonia-nitrogen and total Kjeldahl nitrogen (TKN) concentrations during storm flow and loaded more ammonia-nitrogen and TKN per unit area during storm flow than any of the other subwatersheds.
- Gast Ditch at Adams Road (Site 5) possessed the highest E. coli concentration during storm flow and yielded the highest ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphorus,

total phosphorus, and total dissolved solids during base flow and the highest nitrate-nitrogen, total suspended solids, and total dissolved solids during storm flow.

- Gast Ditch at Redfield Road (Site 7) contained the highest orthophosphorus concentrations during base and storm flow conditions, the highest total phosphorus concentration during storm flow, and yielded the highest ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphorus, total phosphorus, and total dissolved solids during base flow and the highest total Kjeldahl nitrogen, orthophosphorus, and total phosphorus during storm flow.
- The Coberts Lake Inlet (Site 11) contained the highest nitrate-nitrogen concentrations during base and storm flow, the highest total dissolved solids concentration during base flow, and yielded the highest total suspended solids and nitrate-nitrogen levels during base flow.

All four sites contained poor habitat ratings and scored too low to earn an IBI rating for their fish communities. QHEI scores indicate that habitat at all four sites is poorer than the value (60) observed to be conducive to supporting warmwater fauna in Ohio streams (Ohio EPA, 1999). The relatively poor water quality combined with poor habitat contributes to the moderately impaired macroinvertebrate and very poorly rated fish communities observed in these streams.

Instream flows appear to negatively impact instream habitat conditions, which likely negatively impacts the fish and macroinvertebrate communities present in the Cobus Creek Watershed. Limited rain events coupled with high levels of irrigation throughout the watershed are likely resulting in reduced instream flows. As water levels fall, pool depth is reduced as is the access to riparian habitat, including overhanging vegetation, rootwads, and other streamside vegetation. This limited habitat can negatively impact the fish and macroinvertebrate community resulting in alterations to the community under varying flow regimes. Variations in QHEI scores from spring to late summer support this theory, although some change may also be due to variations in scoring from different observers.

5.0 NON-POINT SOURCE MODELING

Nonpoint source pollution is generated from diffuse sources found on public and private lands. The USEPA details sources of nonpoint pollution to include: urban runoff, construction activities, manmade modifications to stream hydrology, agriculture, irrigation pumping and water returns, solid waste disposal, atmospheric deposition, streambank erosion, and more. The critical sources identified within the Cobus Creek Watershed are detailed in the Watershed Inventory Section. These data were generated using available watershed maps and watershed inventory information and are generally useful for detailing water quality problems as a supplement to available water quality monitoring data.

Another mechanism for determining sources of nonpoint pollution is hydrologic simulation models. Hydrologic models detail the transport of pollutants across the land surface as surface runoff. Rain water flows over the land and through the groundwater collecting pollutants, including sediment and nutrients as it moves. The soil characteristics and land uses influence the way that water moves through the system and each hydrologic model simulates the movement in a different way. These computer models provide useful information that can serve as a baseline for future land use changes. They also serve as a check on the water chemistry samples and GIS-based watershed data.

Watershed loading rates can be estimated using a variety of loading models for a variety of parameters. A tabular-based nonpoint source pollution loading model (L-THIA) was used to assess the nonpoint source pollution of four of the pollutants of concern: total nitrogen, total phosphorus, total suspended solids, and fecal coliform. The L-THIA Estimate Nonpoint Source Pollutant model (L-THIA) provides a basis for comparison of runoff for these pollutants within each subwatershed. In total, 5,710 pounds of phosphorus, 19,702 pounds of nitrogen, 234 tons of sediment, and 549,867 million colonies of fecal coliform loading occurs in the Cobus Creek Watershed annually (Table 20). Based on L-THIA results, the Cobus East Lateral A contains the highest loading rates for nitrogen, phosphorus, sediment, and fecal coliform. The Spring Lake Inlet contains the second highest loading rates, while the Gast Ditch mouth contains the third highest loading rates for all parameters. In general, the mainstem of Cobus Creek contains the lowest loading rates, followed by Gast Ditch and then the Cobus East Lateral A (Figure 46 to Figure 49).

Loading data generally compare well with water chemistry results suggesting that Cobus Creek provides lower loading rates than its tributary subwatersheds. Cobus Creek mainstem sites contained lower measured loading rates for most parameters than those observed in Gast Ditch and the Cobus East Lateral A (Table 9). Similarly, load calculations indicate that the Cobus Creek mainstem subwatershed generally load lower concentrations of nutrients, sediment, and pathogens to the watershed that the tributary subwatersheds. Gast Ditch at Adams and Redfield roads (Sites 5 and 7, respectively) contributed the highest ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphorus, total phosphorus, and total dissolved solids during base flow conditions. During storm flow, Gast Ditch at Adams and Redfield roads contributed the highest nitrate-nitrogen, total Kjeldahl nitrogen, orthophosphorus, total phosphorus, and total and dissolved solids, while the Cobus East Lateral A contributed the highest ammonia-nitrogen (Table 9). Load calculations indicate that the Cobus East Lateral A (Site 4) and Gast Ditch mouth (Site 2) contribute the highest loading rates for all parameters (Table 20). However, modeled results may not fully mimic water quality monitoring results for the following reasons:

- The L-THIA model uses soil and land use information to evaluate surface runoff and is unaware of increased nitrogen transport rates due to tile drainage located in the agricultural portions of the Cobus Creek Watershed.

- Sediment and phosphorus generated from overland is accounted for in the L-THIA model; however, non-field sediment and phosphorus, such as that originating from streambank erosion or channel erosion, are not accounted for using the L-THIA model.

Table 20. Estimated annual loads for each Cobus Creek Subwatershed using L-THIA. The three highest loading rates are designated by red, green, and yellow, respectively.

Site Number	Subwatershed Name	Nitrogen Load (kg/yr)	Phosphorus Load (kg/yr)	Sediment Load (kg/yr)	Fecal Coliform (mil col/yr)
1	Cobus Creek Mouth	288.89	81.41	6,558.74	19,824.21
2	Gast Ditch Mouth	1,417.35	401.65	32,544.20	91,362.21
3	Cobus Creek Split	271.91	78.70	6,527.86	16,319.27
4	Cobus East Lateral A	3,705.11	1,083.07	88,868.91	223,886.55
5	Gast Ditch State Line	74.59	22.01	1,803.24	4,904.12
6	Cobus Creek State Line	70.96	20.92	1,722.38	4,185.22
7	Gast Ditch Headwaters	341.89	100.52	8,090.71	24,298.50
8	Cobus Creek Headwaters	731.25	214.29	17,616.11	45,051.31
9	Garver Lake Inlet	110.38	32.29	2,666.82	6,480.00
10	Spring Lake Inlet	1,684.13	484.92	40,023.92	98,312.00
11	Coberts Lake Inlet	259.09	75.93	6,273.64	15,244.00
Total		**8,955.56**	**2,595.71**	**212,696.53**	**549,867.38**

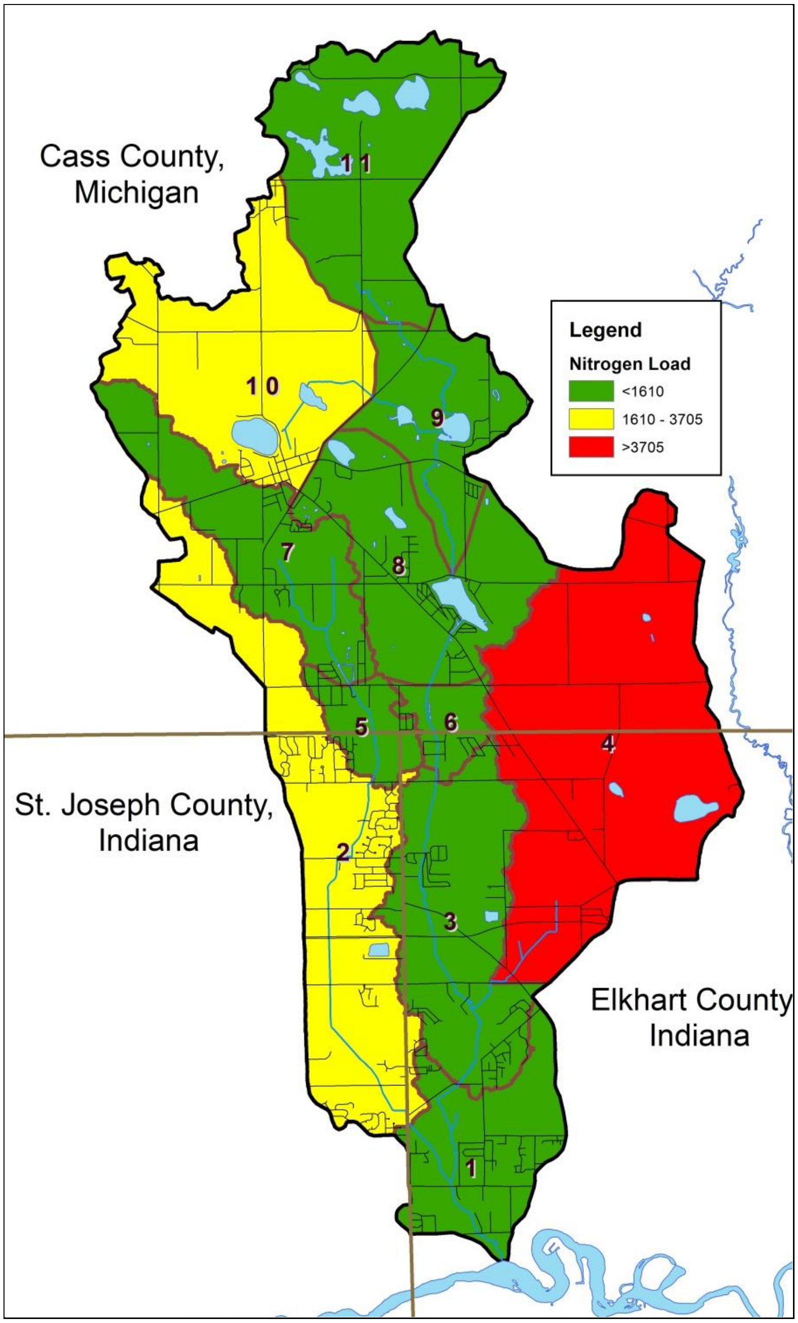

Figure 46. Total nitrogen loading estimate using L-THIA.

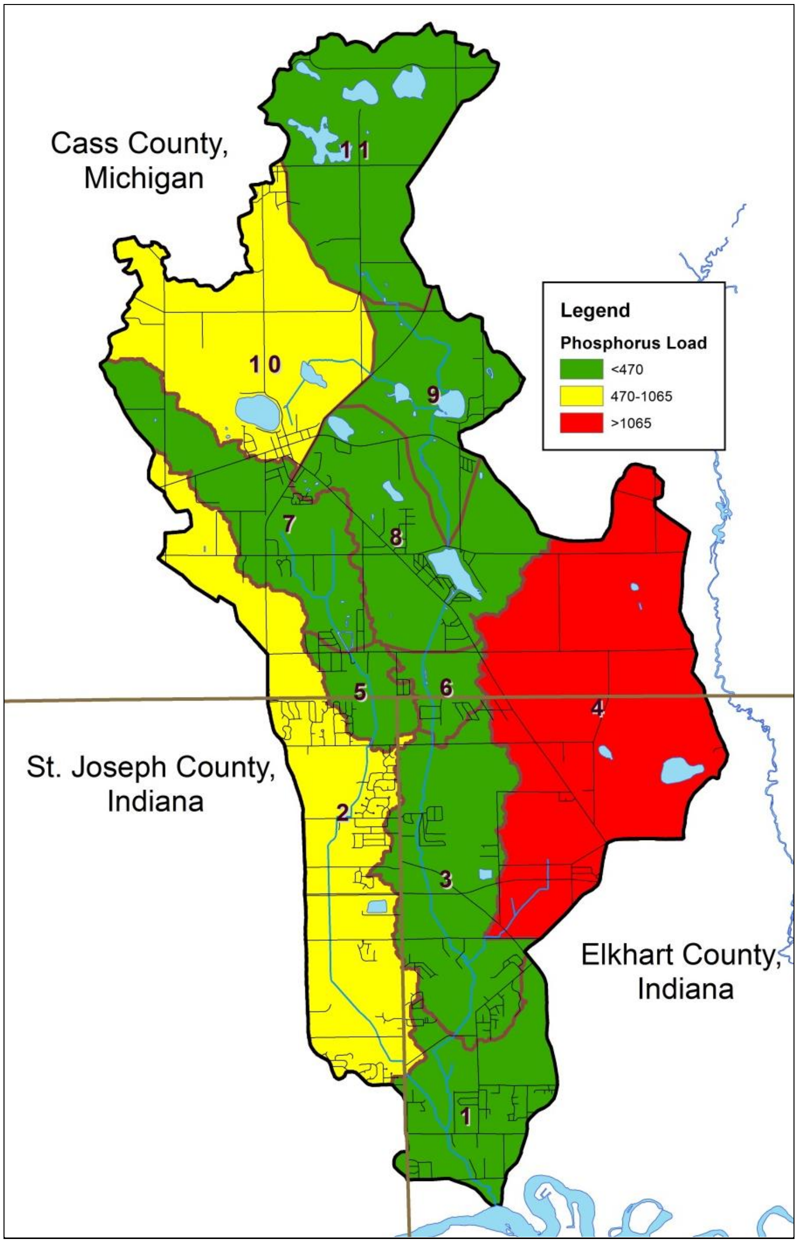

Figure 47. Total phosphorus loading estimate using L-THIA.

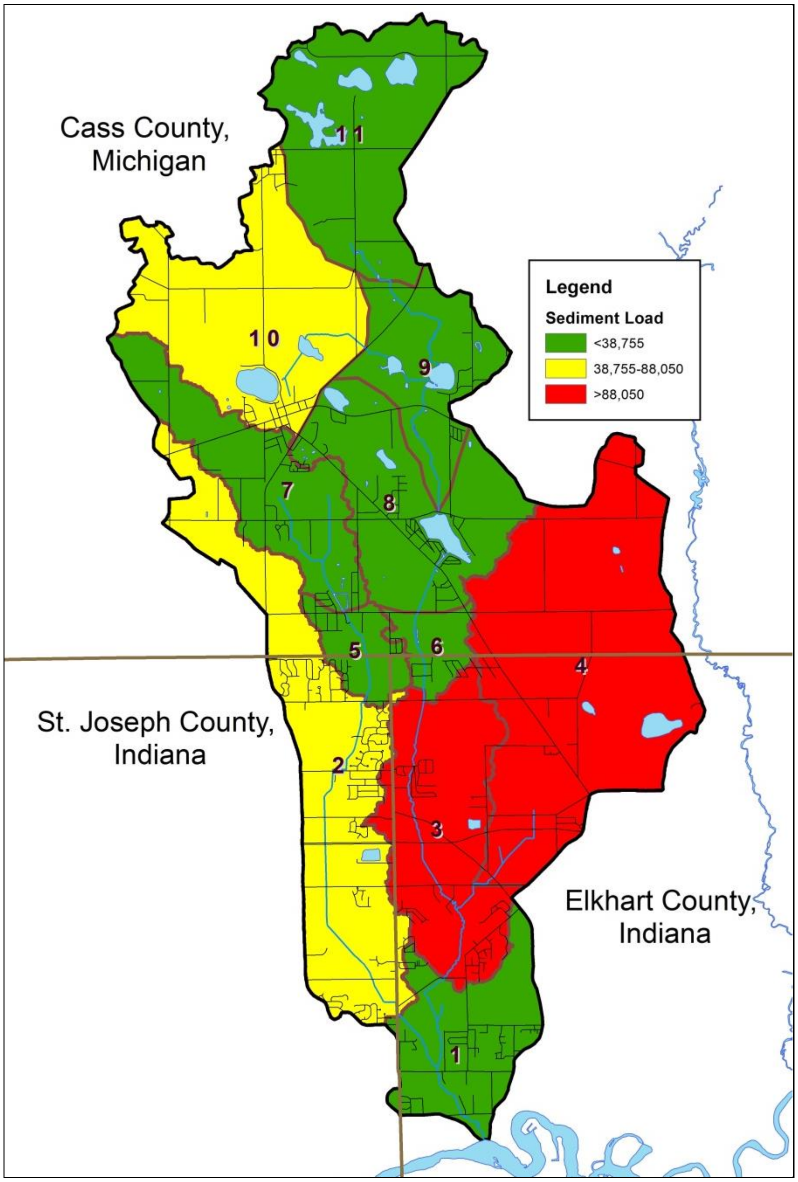

Figure 48. Total suspended sediments loading estimate using L-THIA.

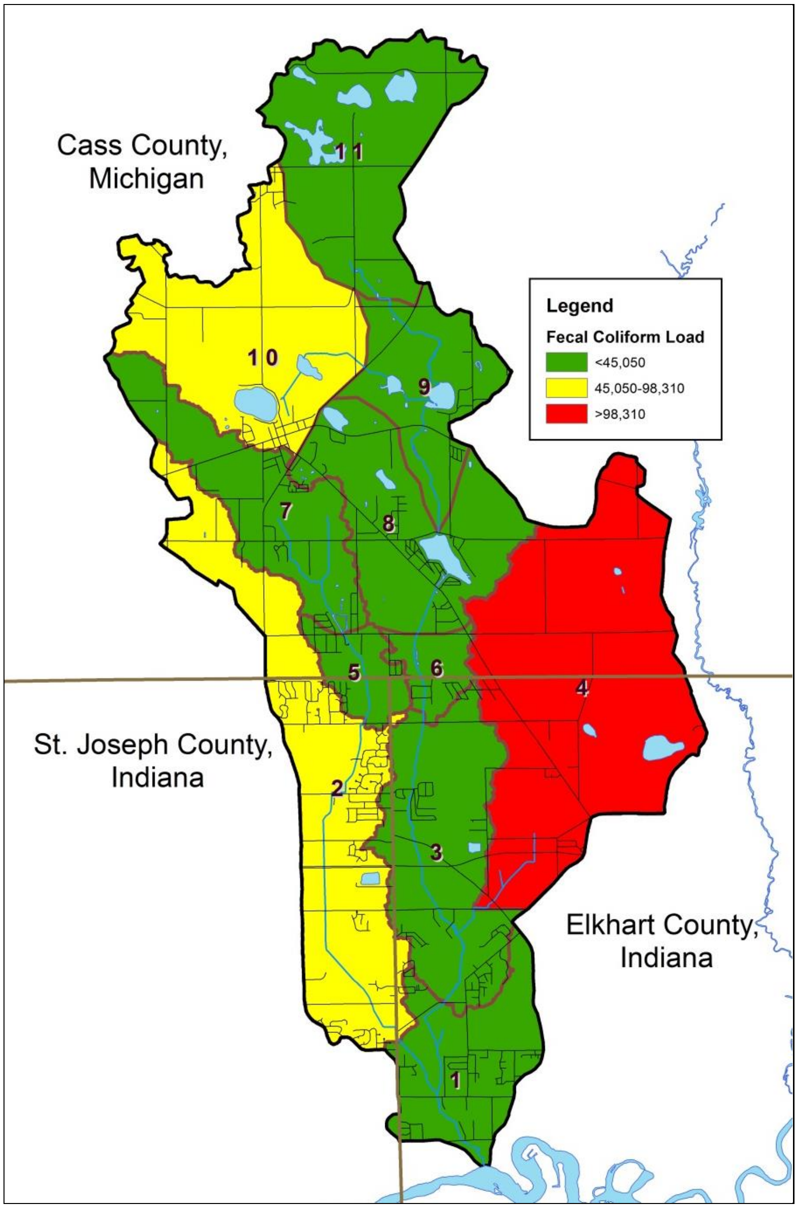

Figure 49. Fecal coliform loading estimate using L-THIA.

6.0 WATERSHED INVENTORY

6.1 Introduction

Identifying areas of concern and selecting sites for future management are the goals of the visual watershed inspection. Figure 50 offers a summary of observations made during the windshield survey efforts.

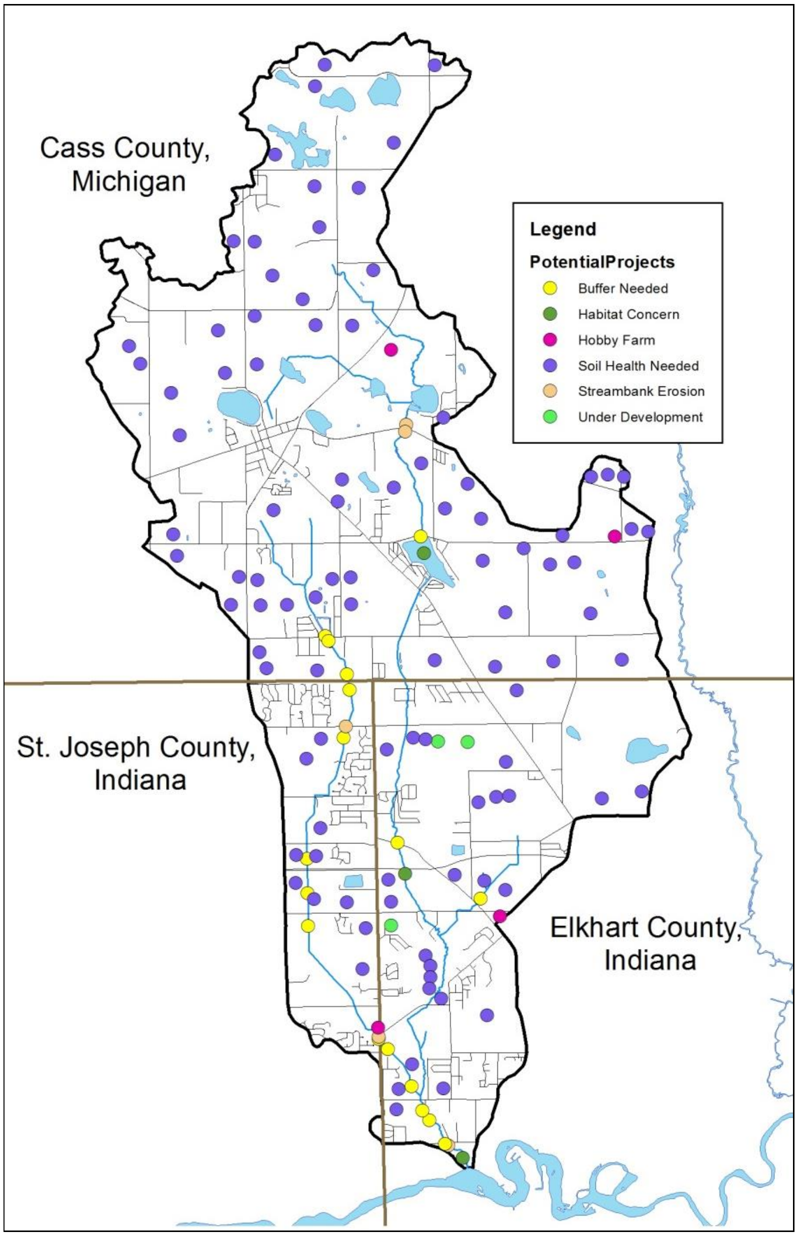

Figure 50. Potential problem areas identified in the Cobus Creek Watershed through watershed inventory and public input processes.

Attendees at the first Cobus Creek public meeting provided input on potential problem areas. An assessment of point source impacts to the Cobus Creek Watershed was completed as part of a desktop review of the watershed. The Cobus Creek Watershed was toured by vehicle on February 25, 2016 after most crops were removed. Each road-stream crossing was assessed April 16, 2016 with a focus on identifying erosion areas and cataloging stream buffer conditions. On September 14, 2016, an assessment of stream culverts was conducted to assess fish passage concerns. The observations made during these surveys are presented below.

6.2 Point Source Impacts

Point sources of pollution are those that originate from a defined location such as a pipe, conduit, concentrated animal feeding operation, or other conveyance from which pollutants can be discharged. Agricultural runoff from field tiles, irrigation water returns, and stormwater pipes are not considered point sources. The Cobus Creek Watershed does not contain any active facilities permitted through the National Pollution Discharge Elimination System (NPDES). Four previously permitted facilities are located within the watershed (Table 21). These include three facilities in Edwardsburg, Michigan and one in Elkhart County, Indiana. While these facilities are no longer under permit, this does not mean that these facilities are no longer in operation. During their operation, all facilities maintained quality operations and were not in violation of their water quality-based permits. Additionally, 18 leaking underground storage tanks are located within the Cobus Creek Watershed (IDEM, 2015; MDEQ, 2014 Figure 51).

Table 21. Previously-permitted NPDES facilities located in the Cobus Creek Watershed.

Facility Name	NPDES	Date Permitted
Edwardsburg-Cass MS4	MIG610236	12/2/2003-4/1/2008
Service Oil Company	MIG080855	12/18/2000-4/1/2005
MDEQ-RRD-Edwardsburg	MI0051764	5/18/2007-10/1/2011
INDOT Toll Road Area 5 North	ING080059	10/16/2000-1/31/2006

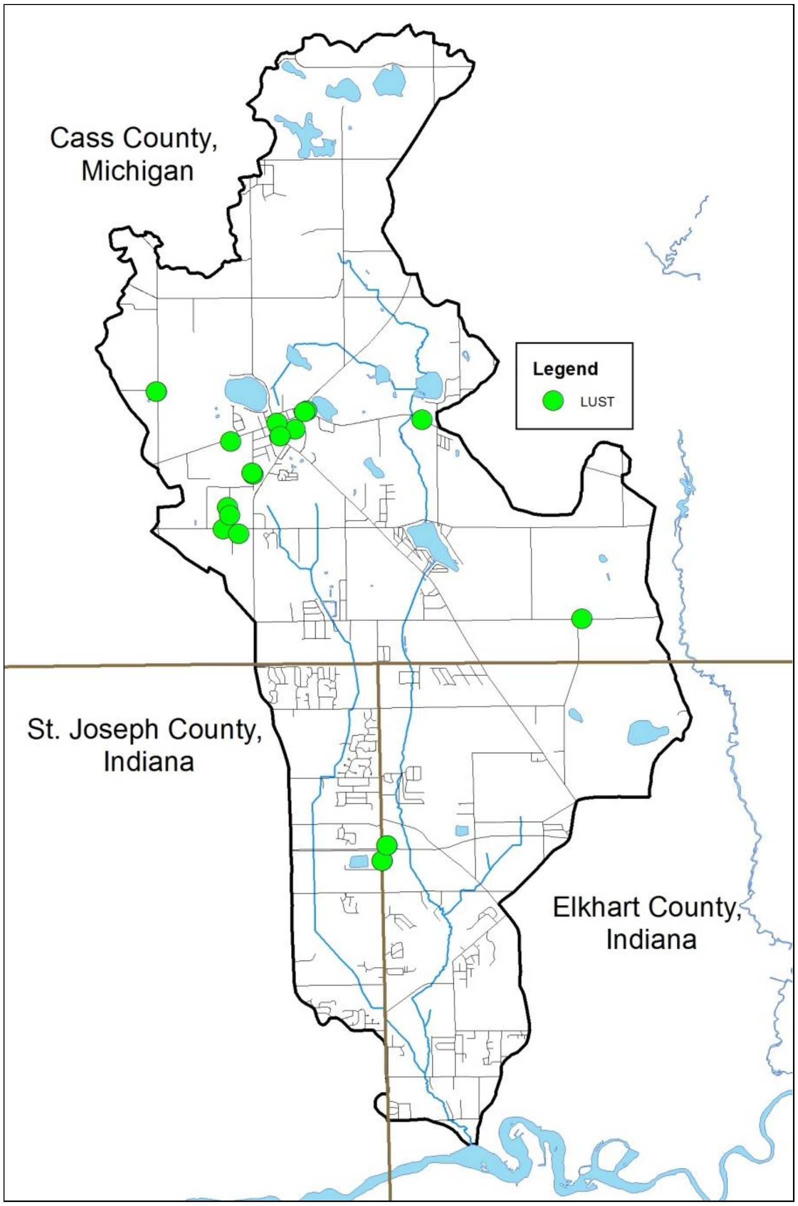

Figure 51. Leaking underground storage tanks located throughout the Cobus Creek Watershed.

6.3 Agricultural Impacts

Non-point source pollution originates from land runoff, atmospheric deposition, hydrologic modification, drainage and other diffuse sources. Agricultural impacts within the Cobus Creek Watershed generally originate from two sources: row crop agriculture (Figure 52) and irrigation.

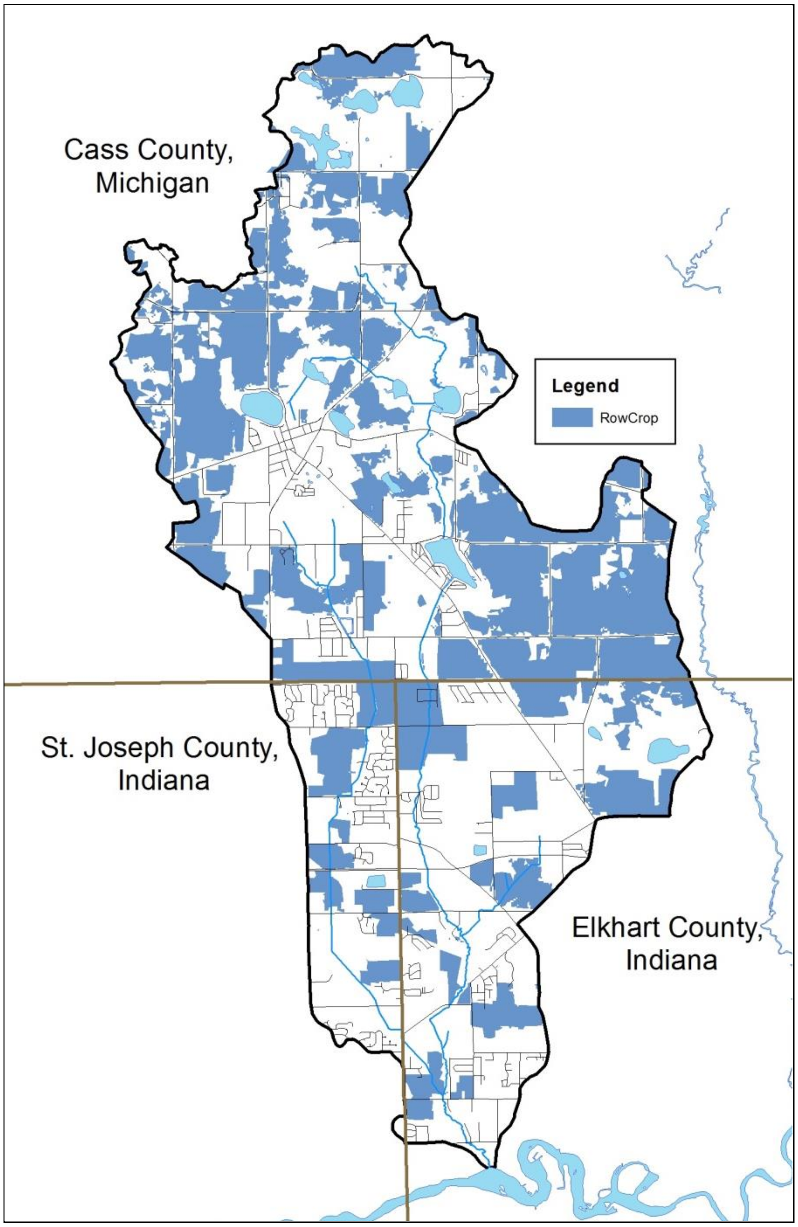

Figure 52. Row crop agriculture fields which would benefit from a soil health-focused program.

Specifically, the volume of exposed soil entering adjacent waterbodies, the prevalence of tiled fields, the transport of chemicals into waterbodies, the use of agricultural chemicals, and the volume of nutrients and manure applied to agricultural fields throughout the Cobus Creek Watershed. Nearly 40% of the watershed is covered by row crow agriculture. In total, 8,720 acres (3,528.9 ha) of row crop agriculture would benefit from a soil health-focused program. Such a program would promote the use of conservation tillage, including reduced till, no till, and strip till methods, and cover crops.

In total, 6.03 million gallons per day of permitted water withdrawals occur within Indiana through the significant water withdrawal facilities program; Michigan data are not available for permitted facilities. Nonetheless, aerial photographs indicate that point irrigation occurs on 1,935 acre (783.1 ha) within the Cobus Creek Watershed. Instream impacts, including decreased water levels later in the summer and reduced accessibility of instream habitat, can likely be associated with irrigation throughout the watershed. Additional agricultural impacts may result from the three hobby animal farms identified within the watershed. While the volume of manure generated from the approximately 25 horses and cows observed is relatively small, the mechanism for storing manure at these individual small farms is unknown. The storage and distribution of the manure should be reviewed for each site to ensure material is properly covered and located away from direct conduits to Cobus Creek and its tributaries.

6.4 Urban Development Impacts

Urban non-point source pollution impacting the Cobus Creek Watershed includes failing septic systems, high density septic systems located on soils unable to maintain sufficient treatment, and active construction and/or development. The following sections detail the impacts of these potential pollution sources on the Cobus Creek Watershed.

As previously detailed, households throughout Indiana depend upon septic tank absorption fields to treat wastewater. The true impact of these systems on the Cobus Creek Watershed is unknown; however, based on soil mapping, 14,529 acres (5,882 ha) are severely limited for septic usage, while 1,769 acres (716 ha) are moderately limited for septic usage. These limitations are particularly concerning in areas of unsewered, dense housing where more than 400 housing units are located within one square mile. This density of houses has been correlated with an increase in dissolved solids by about 60 mg/L; if the density increases to 900 houses per square mile, a 130 mg/L increase in dissolved solids has been observed (Zenone and Anderson, 1978). Figure 53 details the four locations within the Cobus Creek Watershed where housing densities of residences not on sewer systems exceed the 400 houses/square mile. Housing does not reach the 900 houses/square mile density in the Cobus Creek Watershed.

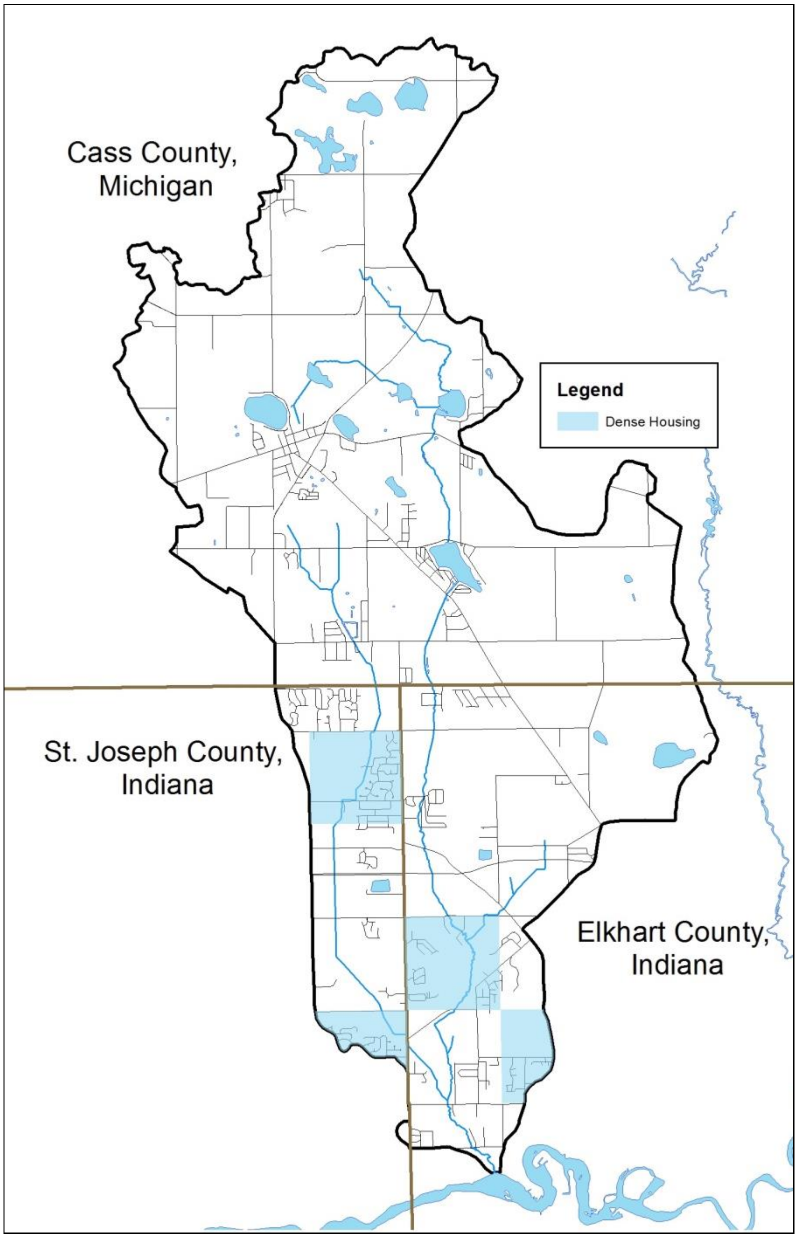

Figure 53. Unsewered, dense housing locations within the Cobus Creek Watershed.

Urbanization of the Cobus Creek Watershed continues to move south from the Indiana-Michigan line towards the City of Elkhart. Three active construction sites were observed during the windshield survey. Future development of pre-built subdivisions is on-going within the Cobus Creek Watershed as well. As development continues, agricultural and forested land will be converted to residential and commercial entities and impervious surface quantities will increase within the Cobus Creek Watershed. Impervious surfaces are hard surfaces, which limit surface water from infiltrating into the land surface to become groundwater. These impervious surfaces create high overland flow rates due to the lack of infiltration. Hard surfaces include concrete, asphalt, compacted soils, rooftops, buildings, and structures. In developed areas like Lafayette and West Lafayette, land which was once permeable has been covered by hard, impervious surfaces. This results in rain which once absorbed into the surface running off of rooftops and over pavement to enter the Wabash River with not only higher velocity. but also higher quantities of pollutants.

Overall, much of the watershed is covered by low levels of impervious surfaces; however, high impervious densities are present in subdivisions and other developments near the City of Elkhart. A high density of impervious surfaces are also found along Garver and Spring lakes and within Edwardsburg in Michigan, with lower densities occurring along roads throughout the watershed. Estimates indicate that nearly 244 acres (98.7 ha or <1%) of the watershed are 75% or more covered by hard surfaces, while 2,812 acres (1,137.2 ha or 12%) of the watershed are 10% or more covered by hard surfaces. Elvidge et al. (2004) indicated that streams in watersheds with greater than 10% impervious surfaces clearly exhibited degradation. The Center for Watershed Protection (CWP) identified similar impacts from impervious surface density on water quality. The CWP study indicates that stream ecology degradation begins with only 10% impervious cover in a watershed. This suggests that Cobus Creek residents should be concerned about the potential impact of impervious surfaces, especially as development continues throughout the watershed. Higher impervious surface coverage results in further impairments including water quality problems, increased bacteria concentrations, higher levels of toxic chemicals, high temperatures, and lower dissolved oxygen concentrations (CWP, 2003). Opportunities to increase stormwater infiltration from impervious surfaces through the implementation of a residential rain barrel, rain garden, native tree, and native planting campaign should be explored.

6.5 Stream Impacts

Observers identified four areas of streambank erosion totaling 1.8 miles (2,896.2 m) during the windshield survey (Figure 54). Additional erosion areas may be present along Cobus Creek and its tributaries in areas that were inaccessible during the windshield survey. Most erosion areas measure approximately 0.1 mile (160.9 m) in length and occur along banks that measure less than 7 feet (2.1 m) in height. An additional 11.4 miles (18,346.5 m) of stream possess a narrow stream buffer (Figure 55). Many areas with narrow buffer are adjacent to maintained lawns or agricultural fields, where installing a narrow, native plant-based stream buffer or widening an existing buffer would improve filtration of overland flow.

Figure 54. Streambank erosion observed thrughout the Cobus Creek Watershed.

Figure 55. Areas with narrow buffers observed thrughout the Cobus Creek Watershed.

The City of Elkhart and St. Joseph River Basin Commission (SJRBC) staff completed a fish passage assessment along Cobus Creek in September 2016 utilizing the methods detailed in Potawatomi RC&D (2011; Figure 56). Each site was documented in terms of ownership (federal, state, county, etcetera), road surface (paved, gravel, sand), road width, and road fill depth . Additionally, the structure shape and size, water velocity, water depth, structure length and depth, and any potential impediments to or notations of fish passage were detailed. Each structure location was recorded with a GPS and the passability rated from 0-1 based on previously recorded information (Potawatomi RC&D, 2011). Six locations included structures which most fish species could not pass during most flows as noted in red, while four locations were rated as some species could pass (orange), and two locations were rated as barriers during high flow conditions (yellow). Sites which rated as barriers to fish passage should continue to be monitored and mitigation plans to improve fish access developed in concert with the City of Elkhart and SJRBC.

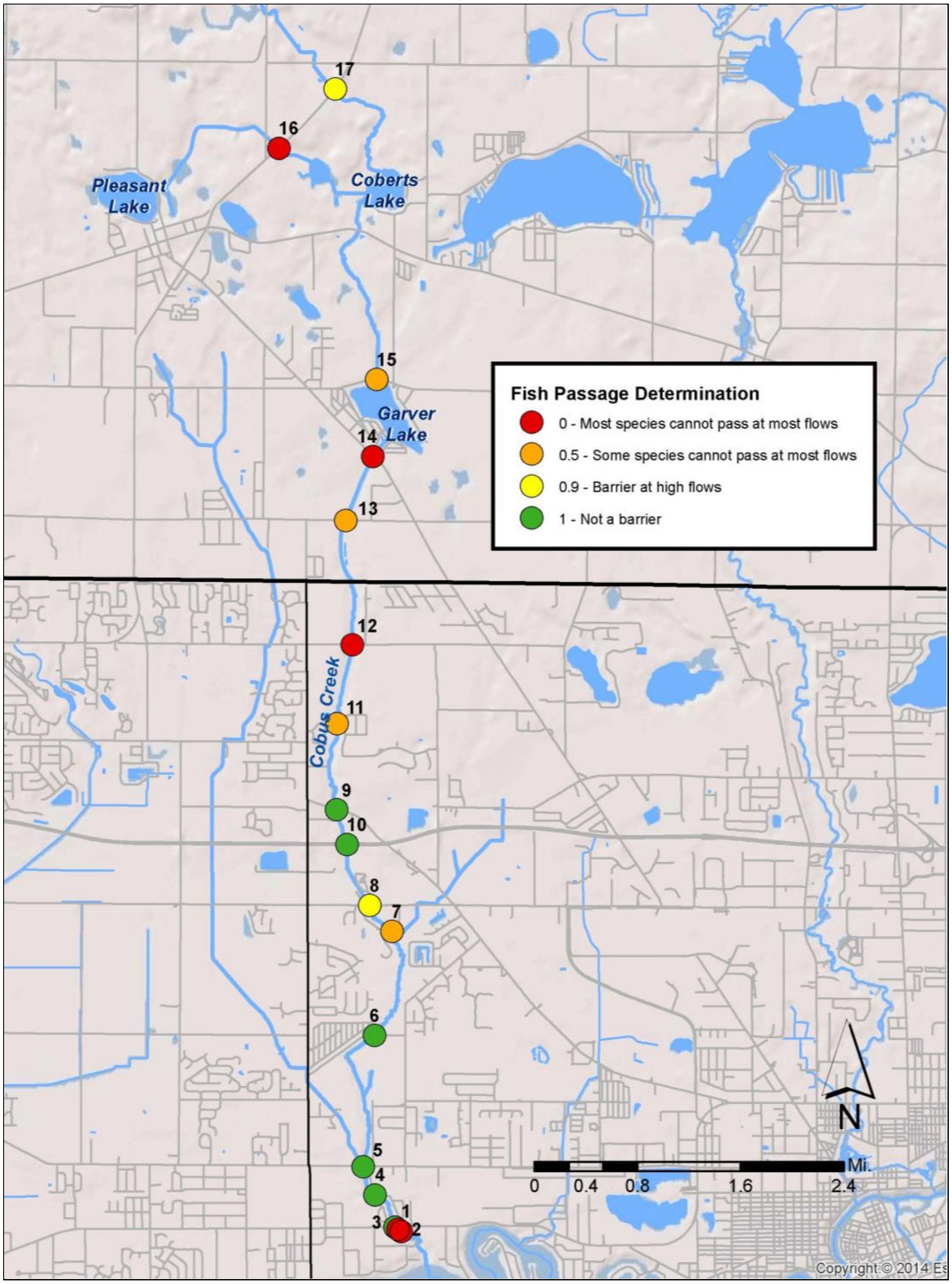

Figure 56. Fish passage determination made in September 2016 by the City of Elkhart and SJRBC staff.

6.6 High Profile Demonstration Opportunities

Several locations that could provide urban best management practice demonstration locations were identified during the watershed inventory. Cobus Creek County Park, MSA Park, Horizon Elementary

School, Discovery Middle School, Harris Township Park, Cleveland Township Little League Fields, the Cleveland Branch of the Elkhart Public Library, the Elkhart Conservation Club, and the Elkhart Community School's planned education farm all provide opportunities to engage with the public to connect them with Cobus Creek. Many of these facilities offer opportunities to install demonstration water quality improvement projects which could increase stormwater infiltration in urbanizing areas of the watershed. These locations also offer opportunities to engage youth-based organizations with Cobus Creek as outdoor classroom spaces.

7.0 MANAGEMENT

A wide variety of practices are available for on-the-ground implementation. Many of these practices will result in the reduction of sediment, nutrient, and pathogen loading to Cobus Creek and its watershed. A list of the most appropriate and most likely to successfully produce improved nutrient, sediment and pathogen levels within the Cobus Creek Watershed were selected. The selected best management practices are categorized as agricultural or urban. It should be noted that the following practice list is not exhaustive and that additional techniques may be both possible and necessary to reach water quality goals. Potential load reductions associated with the implementation of each practice type are also detailed below.

7.1 Best Management Practices

7.1.1 Agricultural Best Management Practices

Agricultural best management practices are implemented on agricultural lands, typically row crop agricultural lands, in order to protect water resources and aquatic habitat while improving land resources and quality. These practices control nonpoint source pollutants reducing their loading to Cobus Creek by minimizing the volume of available pollutants. Potential agricultural best management practices designed to control and trap agricultural nonpoint sources of pollution include:

- Buffer or Filter Strip
- Conservation Tillage
- Cover Crop
- Manure Management Planning
- Nutrient/Pest Management Planning
- Wetland Construction or Restoration

Buffer Strip/Filter Strip

Installing natural buffers or filter strips along major and minor drainages in the watershed helps reduce the nutrient and sediment loads reaching surface waterbodies. This land use practice is used throughout the Cobus Creek Watershed but could be utilized in additional locations or expanded to provide additional filtration. In total, narrow or limited stream buffers are present along 11.4 miles (18,346.5 m) of Cobus Creek and its tributaries. Buffers provide many benefits including restoring hydrologic connectivity, reducing nutrient and sediment transport, improving recreational opportunities and aesthetics, and providing wildlife habitat. Sediment, nutrients, and pathogens 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.

Both filter strips and buffer 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.

Conservation Tillage

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, zero till, slot plant, row till, direct seeding, or 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). Conservation tillage can be implemented as part of a soil health-focused program, which works to avoid, control and trap nutrients in their current location. Nearly 8,720 acres (3,528.9 ha) of the Cobus Creek Watershed would benefit from the usage of soil health practices, including conservation tillage.

Cover Crop

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 from both wind and water erosion. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops meaning that nutrients are readily available for the next season's crop. Nearly 8,720 acres (3,528.9 ha) of the Cobus Creek Watershed would benefit from the usage of soil health practices, including cover crops.

Nutrient/Pest Management Planning

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. 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.

Manure Management Planning

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.

Small volumes of manure are generated by small, unregulated animal operations throughout the Cobus Creek Watershed. It is unknown at this time how many of these entities have manure management plans in place and/or 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.

Wetland Construction or Restoration

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. Visual observation and historical records indicate at least a portion of the Cobus Creek 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.

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.

7.1.2 Urban Best Management Practices

Development and the spread of impervious surfaces are occurring throughout the Cobus Creek Watershed. The highest concentrations of development are located adjacent to and north of the City of Elkhart and continue to spread north toward the Michigan state line. As impervious surfaces continue to spread throughout the watershed, the volume and velocity of stormwater entering Cobus Creek and its tributaries will also increase. The best way to mitigate stormwater impacts is to infiltrate, store, and treat stormwater onsite before it can run off into adjacent waterbodies through the use of urban best management practices. Urban best management practices designed to complete these actions are as follows:

- Rain Barrel
- Rain Garden
- Pervious Pavement
- Detention Basin Retrofit
- Green Roof
- Infrastructure Retrofit
- Pet Waste Control
- Phosphorus-free Fertilizers
- Trash Control and Removal
- Urban Wildlife Population Control

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.

More than 3,680 parcels measuring less than one acre (0.4 ha) are in the Indiana portion of the Cobus Creek Watershed. An estimated 1,500 parcels of similar size are located in the Michigan portion of the watershed. This suggests that if one rain barrel were installed per household, more than 5,000 rain barrels could be installed at residences throughout the Cobus Creek Watershed. These barrels would retain more than 6,500,000 gallons of stormwater annually.

Rain Garden
Rain gardens are small-scale bioretention systems that be can be used as landscape features and small-scale stormwater management systems for single-family homes, townhouse units, some small commercial development, and to treat parking lot or building runoff. Rain gardens provide a landscape feature for the site and reduce the need for irrigation, and can be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event. Additionally, rain gardens can be designed to provide a significant improvement in the quality of the stormwater runoff.

Rain gardens should be targeted for installation at demonstration locations, such as the Cobus Creek County Park, MSA Park, Horizon Elementary School, Discovery Middle School, Harris Township Park, Cleveland Township Little League Fields, the Cleveland Branch of the Elkhart Public Library, and the Elkhart Conservation Club. After demonstration installations have been completed, residential rain gardens targeting some of the nearly 5,000 residences within the Cobus Creek Watershed should occur.

Pervious Pavement
Pervious pavement could be utilized on the 2,812 acres (1,137.2 ha) or 12% of the watershed, which is 10% or more covered by hard surfaces. 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.

Detention Basin Retrofit
Traditionally, detention basins are large, open, unvegetated basins designed to hold water for short periods of time following a rain event (dry detention basin) or continuously (wet detention basin).. Retrofits of detention basins are redesigned to hold water for longer periods of time with the goal of reducing sediment and nutrient flow from the basin or provide filtration of stormwater before it enters the basin through the use of urban pond buffers. Additionally, oils, grease, nutrients, and pesticides can also settle in the retrofitted basin. The nutrients are then used by the plants for growth and development. Numerous existing detention basins were identified in the Cobus Creek Watershed; however, these basins have not been assessed to determine which basins would benefit from retrofits. It is anticipated that retrofitting detention basins within Cobus Creek Watershed subdivisions will result in additional sediment and nutrient retention within the basins.

Green Roof
A green roof is a building partially or completely covered with vegetation and a growing medium planted on top of a waterproof membrane. Irrigation and drainage systems carry water from the roof through the plant material and medium to the building drainage system. Green roofs absorb rainwater, provide installation, reduce air temperatures, and provide habitat for wildlife. Green roofs can retain up to 75% of rainwater gradually releasing it via condensation and transpiration while retaining sediment and nutrients. Green roofs can be installed on any type of roof – slanting to flat – with an ideal slope of 25%. While particular buildings where green roof installation should occur have not been identified within the Cobus Creek Watershed, there are numerous opportunities to retrofit roof structures to install a green roof. Watershed developers should consider green roof installation in any new construction as well.

Infrastructure Retrofit
Typical stormwater infrastructure includes pipe and storm drains, or hard infrastructure, to convey water away from hard surfaces and into the stormwater system. Many of the Cobus Creek Watershed subdivisions as well as portions of the Town of Edwardsburg include hard surfaces which drain to a storm drain system, then into an adjacent waterbody. Retrofitting these structures throughout the Cobus Creek Watershed to implement low impact development techniques, use green practices, and introduce plants and filters to reduce sediment and nutrient concentrations contained in stormwater. Many of the treatments listed in the in this section can be utilized to retrofit infrastructure, including pervious pavement, green roofs, constructed wetlands, rain gardens, and more. In order for the installation to meet a "retrofit" requirement, existing infrastructure must already be in place, subsequently removed, and replaced with green infrastructure.

Pet Waste Control
Pet waste is not the predominant waste product within a watershed nor the one that produces the greatest impact. Rather wildlife, humans, and livestock likely provide a greater impact that pets to Cobus Creek and its tributaries. Nonetheless, the cumulative impact of pet waste within a watershed can produce a major impact on water quality. Pet waste contains bacteria and parasites, organic matter, phosphorus, nitrogen, and E. coli and can carry diseases including *Campylobacteriosis*, *Salmonellosis*, and *Toxocarisis*. Studies indicate that the average dog produces 13 pounds of nitrogen, 2 pounds of phosphorus, and 1,200 pounds of sediment annually (Miles, 2007). The AVMA estimates that 36.5% of US households own one or more dogs (2012). Given the estimated number of dogs within the Cobus Creek Watershed (4,084), the impact of this volume of nutrients and sediment on Cobus Creek could be detrimental.

Many options for managing pet waste are available with most efforts focusing on educational options to turn pet waste from an 'out of sight, out of mind' issue to one that every pet owner considers for their pet. Pet waste can be flushed, resulting in waste traveling to the wastewater treatment plant or through the septic system for treatment, buried, where it gradually breaks down over time with nutrients entering the soil and microorganisms converting diseases and bacteria into less benign forms, or trashed, resulting in potential landfill issues. Options for in home handling of pet waste should be included in educational materials provided to homeowners throughout the Cobus Creek Watershed. Ordinances, signage, and public education are needed to inform the community about options for treating pet waste issues. Signs detailing the impacts of pet waste should be posted in publicly accessible areas adjacent to Cobus Creek including the Elkhart Conservation Club, Cobus Creek Park, and sports fields, public libraries, and other public facilities.

Phosphorus-free Fertilizers

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 (2010) program estimates that a one acre lawn fertilized with traditional fertilizer supplies 7.8 pounds of phosphorus to local waterbodies annually. Established lawns take their nutrients from the soil in which they grow and need little additional nutrients to continue plant growth. Fertilizers are manufactured in a variety of forms including that without phosphorus. Phosphorus-free fertilizer should be considered for use in areas of the Cobus Creek Watershed where grass is already established.

Trash Control and Removal

Trash and debris located throughout urbanizing areas indicate that these materials can have a significant negative impact on water quality within Cobus Creek. A majority of trash observed occurs adjacent to streets, road right of ways, and sidewalks throughout the urbanizing portions of the watershed. Surveys in larger urban areas indicate that plastic bottles, Styrofoam cups, and paper are the most common trash items found in or adjacent to storm drains.

Urban Wildlife Population Control

Wildlife populations located within urban areas can negatively impact water quality. Deer, Canada geese, raccoons, squirrels, and other animals can reach nuisance levels within urban areas. To control the population, a survey of the types of animals present, the volume of each species, the health and wellness of the populations, and habitat availability must be surveyed. Within Cobus Creek Watershed, large populations of Canada geese and other wildlife were observed in various locations during the watershed tour. Populations were noted along the several headwater lakes as well as adjacent to Cobus Creek and its tributaries especially in locations where native vegetation has been replaced with turf grass. Control of the goose population by habitat modification and relocation are the most likely scenarios for control.

7.1.3 Instream and Habitat-Based Practices

The protection of open space, preservation of habitat corridors, and mitigation of impacts from watershed-wide impacts are important management practices. These practices can be used throughout the Cobus Creek Watershed in locations where specific conditions occur. Potential management practices designed to address these issues are as follows:

- Fish Passage Improvement

- Streambank Stabilization
- Instream Restoration
- Septic System Care and Maintenance
- Low-impact Development
- Protecting Open Space and Natural Areas
- Habitat Corridor Identification and Improvement
- Threatened and Endangered Species Protection

Fish Passage Improvement

Fish passage issues are typically considered of utmost importance for salmonid and trout species within the Cobus Creek watershed. Existing highway culverts are the primary source of fish passage restriction. Many of these structures were installed prior to the consideration of impacts of barriers to fish passage or the needs of fish species. Specific locations where fish passage barriers exist were mapped during a fish passage assessment conducted by the St. Joseph River Bain Commission and City of Elkhart on September 14, 2016. Details of their finds are included in the Watershed Inventory. As these bridges are slated for improvement or repair, discussion of fish passage mitigation should be included. During fish community assessments of Cobus Creek in 2014, the Elkhart City Aquatic Biology program documented 27 species below the most downstream dam at the Elkhart Conservation Club, while only 11 species were collected at the next station upstream at CR 12. The small lowhead dams at the ECC appear to prevent numerous species from migrating into Cobus Creek. Fish passage options at the ECC might be considered to enhance the fish communities in Cobus Creek.

Streambank Stabilization and Restoration

Streambank stabilization or stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. Erosion areas were identified along 1.8 miles (2,896.2 m) of Cobus Creek waterbodies. The most feasible restoration options return the stream to natural stream conditions without restoring the stream to its original condition. In these cases, the current conditions are addressed to reduce streambank erosion using natural stone and native vegetation; however, stabilization methods will likely never fully match the original, pre-settlement instream conditions. 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.

Instream Restoration

Instream restoration techniques have been utilized at the Elkhart Conservation Club and the Cobus Creek County Park in the past with a goal of improved instream stability and providing adequate fish community habitat. Like streambank stabilization, instream restoration techniques are used to improve stream conditions so they more closely mimic historic instream conditions while providing habitat necessary for coolwater fish species. The installation of riffle and deep pool complexes, creation of nearshore habitat utilizing LUNKERS or other overhanging structures, and cabling of trees to streambanks to create rootwad habitat are all options for continuing to increase instream habitat. Additionally, remeandering small stream reaches within the mainstem of Cobus Creek and its tributaries where sinuosity rated low could provide additional habitat, reduce bed and bank erosion, and serve as a potential nutrient sink rather than a source of sediment and nutrients to the watershed.

Septic System Care and Maintenance

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment outside of incorporated areas throughout the Cobus Creek Watershed. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will likely 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, polluting the water and posing 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.

Low Impact Development

Low Impact Development (LID) is a land development or re-development process that works in concert with nature to manage stormwater at the source, or as close as possible to the source. . This technique uses a suite of practices highlighted above including bioretention, rain gardens, green or vegetated roofs, rain barrels, pervious pavement, and more. LID can be used anywhere as part of a new development, redevelopment, or retrofit of existing development or infrastructure. If used correctly, LID can restore a watershed's hydrologic and ecological function. As development of the Cobus Creek Watershed continues, preservation of open space, recreation of natural landscape features, reduction of impervious surface coverage, and utilization of on-site drainage to treat stormwater will be the key features required to meet water quality goals.

Protecting Open Space and Natural Areas

Several techniques can be used for protecting natural areas and open space in both public and private ownership throughout the Cobus Creek Watershed. Several entities throughout the watershed assist with the transfer of lands into protective status including Elkhart County Parks Department and the City of Elkhart. Other open space can be protected using conservation design development techniques, and is more likely to be managed by homeowner associations. These areas offer unique opportunities to provide education and install demonstration projects for Cobus Creek Watershed residents.

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.

While much of the length of Cobus Creek lies within a forested or wetland buffer, narrow habitat corridors occur along much of Gast Ditch and within short stretches along Cobus Creek. Most long-term corridor protection will require land transfer into protected status. There are several options for land transfer ranging from donation to fee simple land purchase. Donations can be solicited and encouraged through incentive programs. Outright purchase of property offers a secondary option and is frequently the least complicated and most permanent protection technique, but is also the costliest. A conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Threatened and Endangered Species Protection

Threatened and endangered species are those plant and animal species whose survival is in peril. Threatened species are those that are likely to become endangered in the foreseeable future. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana. Federally and state listed species identified within the Cobus Creek Watershed are highlighted in the Watershed Inventory. In total, fifteen observations of special species occurred within the Cobus Creek Watershed including plants, birds, and turtles on the state endangered list; plants on the threatened list; and birds, mammals, and fish on the species of special concern list.

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. Any efforts to protect endangered, threatened, and rare species within the Cobus Creek Watershed should occur in concert with the Michigan or Indiana DNR with consultation from the US Fish and Wildlife Service.

7.2 <u>Non-point Source Load Reductions</u>

Load reduction calculations were estimated for nitrogen, phosphorus and sediment based on the potential best management practices to be implemented within the Cobus Creek Watershed. Table 22 details the volume of each practice to be installed in the Cobus Creek Watershed and the expected load reductions for each best management practice. Practices to be installed and volumes of each are based on the potential problem areas and potential projects sites identified as part of the watershed inventory. If the Cobus Creek Watershed is blanketed with the proposed projects, pollutant loading will be reduced as follows: 9,692 lb. nitrogen (49%), 3,082 lb. phosphorus (54%), and 198,942 lb. sediment (43%).

Table 22. Potential load reduction achieved by installation of each best management practice or strategy within the Cobus Creek Watershed.

BMP/Strategy	Volume	Nitrogen (lb)	Phosphorus (lb)	Sediment (lb)
Filter Strip	42 acres	10	2	291
Cover Crop	8,720 acres	3,662	1,151	104,640
Conservation Tillage	8,720 acres	3,296	1,151	43,600
Rain Barrel	3,600	1,361	389	25,200
Rain Garden	3,600	1,361	389	25,200
Streambank Stabilization	2 acres	2	0	11
Original Load		19,702	5,711	467,932
Total Load Reduction		9,692	3,082	198,942
% Reduction		49%	54%	43%

Implementation of best management practices within the Cobus Creek Watershed should be multipronged with focus on the implementation of a soil health program targeting cover crop and conservation tillage in agricultural areas and a rain barrel and rain garden program targeting residential and commercial locations. Filter strip planting, streambank stabilization and urban retrofits should also be targeted; however, due to limited landowner willingness and cost to benefit ratios, these practices should be given lower priority.

7.3 Implementation Costs

The total estimated cost for implementing the above recommendations is $25,934,330.00. Total costs are detailed in Table 23. The majority of these costs are associated with streambank stabilization costs, which will need to be refined for each potential project site once a feasibility assessment is complete. Soil health and filter strip costs represent true costs for implementation and do not reflect potential cost share or incentive payment amounts, which are available from the Natural Resources Conservation Serve and Lake and River Enhancement Program. Rain barrel and rain garden installation costs are estimated based on local suggestions for costs. The Greater Elkhart County Stormwater Partnership (www.stormwaterelkco.org) offers incentive payments for both rain garden and rain barrel installation.

Table 23. Estimated costs associated with each strategy.

BMP/Strategy	Volume	Cost/Unit	Total Cost
Filter Strip	42 acres	$700/acre	$29,050.00
Cover Crop	8,720 acres	$42/acre	$366,240.00
Conservation Tillage	8,720 acres	$32/acre	$279,040.00
Rain Barrel	3,600	$100/barrel	$360,000.00
Rain Garden	3,600	$3,000/garden	$10,800,000.00
Streambank Stabilization	9,400 feet	$1,500/lineal foot	$14,100,000.00
Total Cost			**$ 25,934,330.00**

7.4 Potential Funding Sources

There are several cost-share grants available from both state and federal government agencies specific to watershed management. Community groups and/or Soil and Water Conservation Districts can apply for the majority of these grants. The main goal of these grants and other funding sources is to improve water quality though the use of specific BMPs. As public awareness shifts towards watershed management, these grants will become more and more competitive. Therefore, any association interested in improving water quality through the use of grants must become active soon. Once an association is recognized as a "watershed management activist" it will become easier to obtain these funds repeatedly. The following are some of the possible major funding sources available to lake and watershed associations for watershed management. Potential funding sources are detailed in Appendix E.

8.0 INSTITUTIONAL RESOURCES

Successful implementation of the Cobus Creek Watershed Diagnostic Study requires participation of several key groups within the watershed. A variety of institutional resources exist in the watershed to aid in water quality improvement and implementation efforts. These range from local government offices to state and federal agency personnel and programs as well as non-profit conservation organizations. The follow sections detail various resources and provide contact information.

8.1 Local Government Offices

8.1.1 Soil and Water Conservation and Soil Conservation Districts

Indiana's Soil and Water Conservation Districts (SWCDs) were established by the Indiana Conservation Action (IC 14-32). SWCDs are chartered, legal subdivisions of the State Government whose territories are aligned with county boundaries. SWCDs develop and implement conservation programs based on a set of priorities and channel resources from all levels of government into action at the local and county level. Indiana's SWCDs are each governed by a board of supervisors, consisting of three local elected supervisors and two appointed supervisors who maintain their permanent residence in the district.

The SWCD exists to serve all the citizens of Elkhart and St. Joseph counties, including landowners, schools, youth organizations, wildlife organizations, and agricultural related businesses. Partnering with other agencies is also important to the success of the SWCD's activities. Partners include US Department of Agriculture, Natural Resource Conservation Service; Farm Service Agency; LaGrange County Purdue Extension; and Pheasants Forever.

The Elkhart County Soil & Water Conservation District Board of Supervisors holds a board meeting at 7:00pm on the third Monday of each month. The meetings are held at Elkhart County Purdue Extension Conference Room at the Elkhart County Fair Grounds. The St. Joseph County SWCD meets on the third Tuesday monthly at 7:00 pm at the Centre Township Branch of the St. Joseph Public Library. Meetings are open to the public. The Cass County Conservation District Board of Supervisors holds its board meeting at 8:30 am the second Wednesday monthly at the District Office.

Similar to Indiana SWCDs, Michigan's Soil Conservation Districts (SCD) are chartered governmental subdivision of the state and were established in 1927 by Public Act 297. In 1994, the Conservation District Law was made part of the Compiled Environmental Code (Part 93, Public Act 451). The Cass County SCD work to inform, educate and provide leadership in conservation and stewardship of soil, water and related natural resources.

For questions regarding any of county SWCD or SCD's programs contact:

Elkhart County
17746-B County Road 34
Goshen, Indiana 46528
Phone: (574) 533-4383 ext. 3

Cass County
1127 E. State Street
Cassopolis, Michigan 49031
(269) 445-8641 ext. 5

St. Joseph County
2903 Gary Drive
Plymouth, Indiana 46563
(574) 936-2024 ext. 4

8.1.2 Surveyors, Drain Commissioners and Drainage Board

County surveyors, drain commissioners, and drainage boards play a critical role in the implementation of streamside BMPs, as well as potential restoration efforts that may involve the manipulation of current above or below ground drainage infrastructure. The Indiana Drainage Code of 1965 sets forth the authority to create a Drainage Board in each County. The Drainage Board consists of either the County Commissioners or a citizen board with one Commissioner as a member. The County Surveyor sits on the Board as an Ex-Officio Member. This position is a non-voting position, and the County Surveyor serves as a technical advisor to the Board. In Michigan, drain commissioners serve the same role as Indiana county surveyors and are responsible for the administration of the Drain Code of 1956 as amended. Their duties include construction and maintenance of drains, determining drainage districts, apportioning drain costs and receiving bids and awarding contracts for drain construction and maintenance.

In Indiana, the Drainage Board has the authority to construct, maintain, reconstruct or vacate a regulated drain. They may also create new regulated drains if so petitioned by landowners. The Board is in charge of maintaining drains by putting the drain back to its original specifications by dredging, repair tile, clearing, removing obstructions or other work necessary to keep the drain in proper working order. The County surveyors are often the best contact for drainage projects or concerns, or to coordinate with the Drainage Boards.

The Surveyor's and Drain Commissioner's offices are also typically task with establishing, reestablishing and recording all section corners throughout the county; supervising all civil engineering work of the county; recording the location of legal surveys; supervising construction, reconstruction and maintenance of drains and ditches; developing drainage studies and specifications, issues drainage related permits; and calculating drainage assessments.

The Elkhart County Drainage Board meets on the second Tuesday of each month at 9:30 am in Room A of the Elkhart County Public Services Building. The St. Joseph County Drainage Board meets the third Tuesday monthly at 10 am on the 4th floor of the County-City Building. For questions about the drainage board and the future of legal drains in the Cobus Creek Watershed including Gast Ditch and the Cobus East Lateral A contact:

Elkhart County Surveyor
4230 Elkhart Road
Goshen, Indiana 46526
Phone: (574) 971-4677

St. Joseph County Surveyor
227 W. Jefferson Blvd.
South Bend, Indiana 46601
Phone: (574) 235-9554

Cass County Drain Commissioner
120 N. Broadway Suite 215
Cassopolis, Michigan 49031

8.1.3 Planning and Zoning Authorities

County-wide Comprehensive Plans can provide a significant amount of information on both natural resources in an area, as well as population statistics, traffic plans, and current and future land use zoning. Such zoning designations, if enforced, often drive where future residential and commercial/industrial growth will occur. The authority to rezone land into different land use categories and the power to grant variances from local ordinances related to development, often lie with local Zoning Boards or Plan Commissions.

Elkhart County's comprehensive plan was updated 2006, while St. Joseph County updated their comprehensive plan in 2000.Cass County updated their master plan in 2014. The Elkhart County plan develops objectives for future development, provides policies for land use development and identifies future public land and structure development. The St. Joseph County plan addresses transportation planning and land use planning, as well as identifies residential land use targets. The Cass County plan establishes strategies of managing growth that protects and enhances the unique character of Cass County with an emphasis of quality of life.

In addition to drafting plans and ordinances, the Plan Commission also has the authority to approve and deny land subdivisions based on the subdivision control ordinance. The Board of Zoning Appeals hears petitions and appeals regarding the zoning of land and is task with granting variances or special exceptions for specific land use types.

St. Joseph County Planning and Development
227 W. Jefferson
South Bend, Indiana 46601
Phone: (574) 235-9571

Elkhart County Planning and Development
4230 Elkhart Road
Goshen, Indiana 46526
Phone: (574): 971-4578

8.1.4 Health Department

In order, to protect, promote, maintain, and improve the health and quality of life for Elkhart, St. Joseph, and Cass County citizens, the health department offers a number of health protection programs. Assessment and reduction of human health risks is accomplished through investigations, inspections and regulatory enforcement of these programs. Programs include, but are not limited to: drinking water monitoring, food sanitation, sewage treatment, animal and vector control, and housing sanitation and safety.

The construction of a septic system requires several procedures and permits from the county. These procedures are in place to prevent diseases that could be spread by improperly managed sewage. For environmental health and septic system questions and information contact:

Elkhart County Health Department
Environmental Services
5230 Elkhart Road
Elkhart, Indiana 46516
Phone: (574) 971-4600

Environmental Health Specialist
St. Joseph County Health Department
227 W. Jefferson Blvd.
South Bend, Indiana 46601
Phone: (574) 235-9721

VanBurent/Cass District Health Department
302 S. Front Street
Dowagiac, Michigan 49047
Phone: (269) 782-0064

8.2 State and Federal Offices Local

8.2.1 Indiana DNR and DEM

The Indiana Department of Natural Resources (IDNR) and the Indiana Department of Environmental Management (IDEM) have a variety of programs and staff dedicated to water quality assessments and watershed planning initiatives. The most relevant contacts at these agencies to assist local leaders in water quality planning efforts are listed below. While there are countless specialists at these agencies, the below staff should be able to guide local questions to appropriate personnel.

Indiana Department of Natural Resources Division of Fish & Wildlife – Lake and River Enhancement Program (LARE)
Greg Biberdorf, LARE Program Specialist
402 W Washington St, W-273
Indianapolis, IN 46204
Phone: (317) 233-1484
gbiberdorf@dnr.in.gov

Indiana Department of Environmental Management Office of Water Quality
Jessica Faust, Watershed Specialist
100 N. Senate Ave.
Indianapolis, IN 46204
Phone: (317) 308-3194
jfaust@idem.in.gov

8.2.2 Michigan DEQ and DNR

The Michigan Department of Environmental Quality (MDEQ) and the Michigan Department of Natural Resources (MDNR) have a variety of programs and staff dedicated to water quality assessments and watershed planning initiatives. The most relevant contacts at these agencies to assist local leaders in water quality planning efforts are listed below. While there are countless specialists at these agencies, the below staff should be able to guide local questions to appropriate personnel.

MDEQ Nonpoint Source Staff
7953 Adobe Road
Kalamazoo, Michigan 49009
(269) 568-2681

MDNR Unit Manager
621 N. 10th Street
Plainwell, Michigan 49080
(269) 685-6851 ext 145

8.2.3 Indiana State Department of Agriculture

The Division of Soil Conservation belongs to the Indiana Conservation Partnership; however, it is situated in the State Department of Agriculture (ISDA). As part of the Partnership, ISDA provides technical, educational, and financial assistance to citizens to solve erosion and sediment-related problems occurring on the land or impacting public waters. The Division of Soil Conservation is divided into Conservation Implementation Teams (CIT) that cover specific counties. These teams can deliver advice to landowners regarding best management practices, assist with engineering design, and secure/coordinate associated project permits and cost share amounts. Contact your local team:

ISDA Regional Office
1252 E 100S, Suite D
Rochester, IN 46975
Phone: (574) 223-3220 ext 3

8.2.4 Michigan Department of Agriculture and Rural Development

The MDARD works closely with conservation districts and local entities to implement the conservation reserve enhancement program, improve farmland preservation, prevent agricultural pollution, oversee the private forestlands initiative and Michigan's Agriculture Environmental Assurance Program, as well as implement wildlife preservation and the habitat incentive program. To learn more about MDARD's environmental programs visit their website (http://www.michigan.gov/mdard/0,4610,7-125-1568_51684---,00.html).

8.2.5 Natural Resources Conservation Service

The NRCS is a Federal agency that works with landowners and managers to conserve their soil, water, and other natural resources. NRCS employees provide technical assistance based on a customer's specific needs in such areas as animal husbandry and clean water, ecological sciences, engineering, resource economics, and social sciences. They also provide financial assistance for many conservation activities. The NRCS programs are all voluntary participation programs.

Amanda Kautz
Elkhart County
17746-B County Road 34
Goshen, Indiana 46528
Phone: (574) 533-4383 ext. 3
amanda.kautz@in.usda.gov

Cass County
1127 E. State Street
Cassopolis, Michigan 49031
(269) 445-8643

Deb Knepp
St. Joseph County
2903 Gary Drive
Plymouth, Indiana 46563
(574) 936-2024 ext. 4
deb.knepp@in.usda.gov

8.2.6 US Geological Survey

The USGS is a multi-disciplinary science organization focused on biology, geography, geology, geospatial information, and water. They work to study our landscape, our natural resources, and the natural hazards that threaten us.

Indiana-Kentucky Water Science Center
5957 Lakeside Boulevard
Indianapolis, IN 46278
Phone: (317) 290-3333

Michigan Water Science Center
6520 Mercantile Way, Suite 5
Lansing, Michigan 48911

8.3 Non-profit Organizations

8.3.1 Resource Conservation and Development Council

Resource Conservation and Development Councils (RC&D) are non-profit organizations established to address natural resource needs and cultivate opportunities in economic, environmental, and social areas. The primary natural resource focus is on air, water, land, woods, plants, and wildlife. The combined efforts of the community and volunteers look to achieve four primary goals:

- Promote Better Land Conservation
- Strengthen Water Quality and Quantity Management
- Expand Rural Community Development
- Stimulate Land Protection and Management

The Northwest RC&D serves Elkhart, Lake and Porter Counties,. The Northwest Territory RC&D is located at 3001 Leonard Drive in Valparaiso, Indiana And can be contacted at (219) 669-7862 for more information.

The Wood-Land-Lakes RC&D serves Steuben, Lagrange, Noble, Dekalb, Whitley, and Elkhart Counties and can be contacted at 155 Lane 101 West Otter Lake Angola, IN 46703, by phone at (260) 665-7723, or email at office@wood-land-lakes.org. For more information, visit www.wood-land-lakes.org.

The Sauk Trails RC&D serves Cass County, Michigan, however does not appear to be operational at this time. If they initiate operation again, they can be reached at 1035 E. Michigan Ave. PawPaw, Michigan 49079 or at (269) 657-3388 or www.sauktrailrcd.org.time.

8.3.2 The Nature Conservancy

The Nature Conservancy's mission is to preserve the plants, animals and natural communities that represent the diversity of the life on Earth by protecting the lands and waters they need to survive.

Indiana Field Office
Efroymson Conservation Center
620 East Ohio Street
Indianapolis, IN 46202
(317) 951-8818
Mary McConnell, State Director
mmcconnell@tnc.org

Michigan Field Office
101 E. Grand River Ave.
Lansing, Michigan 48916
(517) 316-0300
Helen Taylor, State Director
Michigan@tnc.org

8.3.3 Pheasants Forever

Pheasants Forever is a nationwide organization dedicated to the conservation of pheasants, quail, and other wildlife. Conservation of these species occurs through habitat improvements, public awareness, education and land management. Pheasants Forever enables local and county chapters to decide how 100 percent of their locally raised conservations funds will be allocated. There are more than 600 chapters across the United States and Canada.

Cass County Pheasants Forever
Chapter 589
www.casscountypf.org
casscountypf@gmail.com

Elkhart County Pheasants Forever
https://www.facebook.com/ElkhartCountyPheasantsForever/

9.0 PUBLIC ENGAGEMENT

The public was engaged within the Cobus Creek Watershed Diagnostic Study in a variety of manners. These included two public meetings, coordination of a project steering committee by the St. Joseph River Basin Commission, and creation of an informational fact sheet.

9.1 Public Meetings

Two public meetings were held as part of the Cobus Creek Watershed Diagnostic Study. The first occurred on January 25, 2016 and the second occurred on November 15, 2016. The goal of the first meeting was to introduce the project, review data collected to that point, and gather input from attendees on their knowledge and concerns about the watershed. The goal of the second meeting was to review the data collected throughout the project, highlight potential future work and project areas, and allow attendees to prioritize recommendations for the future of Cobus Creek and its watershed.

9.1.1 Meeting 1: January 25, 2016

Approximately 50 individuals attended the first public meeting. Jeremy Reiman with the Michiana Area Council of Governments and St. Joseph River Basin Commission started the meeting with a power point presentation. The presentation covered the following points:

- Defining what a watershed is and why water quality is important
- Information on Cobus Creek Watershed and it's unique resources
- The purpose of the study is to assess the conditions and trends of water quality within Cobus Creek watershed and to further prioritize future projects that would benefit the watershed and its citizens within it
- The scope of work for the study entails:
    - mapping current watershed conditions
    - collecting habitat, chemical, and biological data on surface waters
    - modeling pollution in surface waters
    - prioritizing potential projects
    - producing a final document
- The study will be available for public comment towards the end of 2016
- The final approved document will be available to the public in early 2017
- The study is funded by the Indiana Department of Natural Resources Lake and River Enhancement Program as well as through various forms of support from over a dozen local partners
- Attendees were encouraged to keep up to date with the project by filling out a questionnaire on each attendees desired level of involvement. Persons can also go to www.sjrbc.com/cobuscreek or email the St. Joseph River Basin Commission at sjrbcdir@macog.com to receive updates.

Sara Peel with Arion Consultants presented the findings of the initial data collection on Cobus Creek watershed. The presentation covered the following points

- Based on 2011 land-use data, the majority of land-use in the watershed is agriculture. The next most popular land use is developed-open space which it is believed that much has since been developed into subdivisions
- A large portion of the watershed has been deemed not suitable for septic tanks, based on NRCS soils data.
- There are a significant amount of wetlands in the Michigan portion of the watershed surrounding the lakes

- Soils data suggests that there were once several wetlands along the banks of Cobus Creek and Gast Ditch in Indiana
- Several organizations, including the EPA, have completed different types of data sampling in the watershed
- The study will have 11 different sample sites in the watershed; 5 in Michigan and 6 in Indiana. The sites will be sampled twice for water chemistry and once for fish and macroinvertebrate. Sampling will occur during the spring and summer.

All attendees then transitioned into an activity to document areas of interest in the watershed. Maps were laid out on tables and attendees were encouraged to mark:

- High quality locations
- Areas of concern
- Where water quality or stream projects had occurred
- Areas of recreation
- Any general information about resources within the watershed

Below is a summary of the information gathered from the activity:

- Flow data on Cobus Creek has recently been collected in the Michigan portion of the creek
- Locals are interested in the potential of protecting Skab Lake from development. If it's shoreline is developed, they would like to see policies in place to ensure the water quality is projected (i.e. sewer systems, setback ordinances).
- Garver Lake and Pleasant Lake communities as well as the Village of Edwardsburg are connected to City of Elkhart sewers.
- Coberts Lake community is not connected to a sewer system.
- Outlet of Garver Lake has a small dam structure that dumps into a small wetland complex. Unclear whether this structure is necessary to maintain lake levels or built for aesthetics.
- There are several wetland complexes south of the Garver Lake outlet structure that appear to be high quality habitat. Some of the wetland vegetation has recently been cut down along the shoreline by property owners.
- Cobus Creek between Redfield Road and approximately the Toll Road tends to run dry in dry summers. Flows through this area are very flashy.
- New subdivisions are being developed along Cobus Creek in the northern portion of Elkhart County. Local citizens are working with developers to protect habitat bordering the creek
- Elkhart Community Schools owns property at the southeast corner of County Road 2 and Ash Road. They intend to develop the property to teach K-12 students about farming practices.
- Boot Lake Nature Preserve is a high quality area that supports several endangered plant/animal species.
- Invasive plant species are a consistent issue on Garver Lake.
- There is excellent fishing within Cobus Creek. Attendees identified the Elkhart Conservation Club, Cobus Creek County Park, and even some private spots further upstream as key fishing locations.
- Gast Ditch appears to have consistent flow patterns.
- Several portions of Cobus Creek and its banks have been modified by private landowners.

The information collected from this meeting was compiled into a GIS layer indicating areas of interest in the watershed and are mapped as part of the watershed concerns map detailed in the Watershed Inventory Section (Figure 50).

9.1.2 Meeting 2: November 15, 2016

Approximately 40 individuals were in attendance. Jeremy Reiman with the Michiana Area Council of Governments and St. Joseph River Basin Commission started the meeting with a powerpoint presentation. The presentation covered the following points:

- The purpose of the study is to assess the conditions and trends of water quality within Cobus Creek watershed and to further prioritize future projects that would benefit the watershed and its citizens within it.
- The study will be available for public comment towards the end of 2016
- The final approved document will be available to the public in early 2017.
- The study is funded by the Indiana Department of Natural Resources Lake and River Enhancement Program as well as through various forms of support from over a dozen local partners.

The preliminary data findings were presented as follows:

Watershed Characteristics

- Agriculture is the primary landuse in the watershed, however, development of subdivisions has increased significantly in the past decade in the northwest corner of Elkhart County
- There are a significant amount of wetlands in the Michigan portion of the watershed surrounding the lakes
- Soils data suggests that there were once several wetlands along the banks of Cobus Creek and Gast Ditch in Indiana
- Several organizations, including the EPA, have completed different types of data sampling in the watershed
- Gast Ditch, Cobus Creek Lateral, tributaries between Pleasant, Spring, Coberts, and Garver lake have never been sampled for water quality prior to this study

Water Quality Data

- Physical, chemical, fish, macroinvertebrate, and habitat data were all collected at 11 sites across the watershed in 2016 – all data can be used as indicators of water quality (Map of sites attached to document)
- During regular stream flow
  - all sites showed elevated phosphorus levels
  - all other pollutant levels were very low and within recreational standards at all sites
- After heavy rain events
  - E. coli and sediment levels were highly elevated at all sites
  - All sites showed elevated phosphorus levels
  - Cobus Creek East Lateral A and the inlet to Spring Lake had higher ammonia and nitrates
- Twenty-five (25) species of fish collected – including several pollution intolerant species
  - Cobus Creek main stem closest to the St. Joseph River demonstrated healthier fish community
  - 1 rare species identified – Iowa darter
  - Presence of large brown trout and natural trout reproduction

- Several limitations for aquatic communities were identified
  - Channelization and modification of natural stream conditions
  - Limited pools and riffles – highly quality habitat
  - Several barriers (low-head dams and road stream crossings) for fish migration exist along Cobus Creek

Analysis & Findings

- Cobus Creek is a fairly healthy stream, but has flashy pollutant tendencies
- Highest loading of pollutants in the watershed occurs at tributaries draining into Cobus Creek (Cobus Creek East Lateral A, Gast Dtich, inlet to Spring Lake)
  - Focusing improvement projects in these regions would likely show the biggest improvement in water quality in Cobus Creek
- Implementing best management practices (BMPs) to reduce phosphorus concentrations would be an ideal priority
  - Septic system maintenance
  - Rain barrel/rain garden installs
  - Stream bank stabilization
- Implementing BMPs that focus on stormwater retention and sediment cover would help with elevated pollutants during storm flow conditions
  - Agricultural BMPs – cover crops, conservation tillage, filter strips
  - Urban BMPs –temporary seeding on construction sites, rain barrel/rain gardens
- Fish communities are health in particular spots on Cobus Creek, however, habitat improvement/connectivity projects are necessary to improve fish and macroinvertebrate communities

All attendees then transitioned into an activity to provide input on what types of improvement projects they value as most important to the watershed. All potential project recommendations were displayed on poster boards and participants were asked to vote on which projects they would like to see implemented. Attendees were also able suggest potential projects not on the original list. This information be used to help prioritize project recommendations listed in the final study. The results of activity are found below:

Table 24. Cobus Creek potential project prioritization during the November 2016 public meeting.

Cobus Creek Potential Projects – Voting Results	
Zoning & Ordinances – overlay zone for septic/sewer	25
Target BMPs to reduce sediment inputs	20
Target BMPs to reduce pathogen (*E. coli*) concentrations	19
Implement a landowner education program to educate individuals on their impact to Cobus Creek	17
Target BMPs to address phosphorus concentrations	12
Improve and restore instream habitat	11
Coordinate education efforts with local schools	11
Work with local health department to ensure proper septic system permitting , citing, maintenance	4
Reduce fish passage limitations	3
Implement high profile urban BMP demonstration projects to showcase potential solutions	1
Monitor and manage invasive species	1

9.2 Cobus Creek Steering Committee

The St. Joseph River Basin Commission established a steering committee to guide the development of the Cobus Creek Watershed Diagnostic Study. Local and state agency personnel as well as interested residents served on the project steering committee. Individuals representing the Cass County SCD, Elkhart and St. Joseph County SWCDs, City of Elkhart, Elkhart Conservation Club, Elkhart School Corporation, Elkhart County parks and Recreation, Elkhart Planning and Development, Friends of the St. Joseph River, the Greater Elkhart County Stormwater Partnership, Ontwa Township, the Pokagon Band of the Potawatomi, St. Joseph County Health Department, Friends of Cobus Creek, St. Joseph Area Plan Commission, St. Joseph Department of Works, St. Joseph River Valley Fly Fishers, Michigan and Indiana DNR, Michigan DEQ and Indiana DEM attended at least one meeting of the steering committee. The committee met twice during the project in January and April 2016. The committee provided information about Cobus Creek and its watershed, highlighted available water quality data, and documented problem and interest areas. During the second meeting, the SJRBC provided an update on the project, highlighting data collected to date and reviewing future work plans and project goals.

9.3 Informational Fact Sheet

The informational fact sheet will be finalized following the final public meeting where attendees will prioritize recommendations. Once complete, the fact sheet will be included in Appendix E.

10.0 RECOMMENDATIONS

All of the subwatersheds within the Cobus Creek Watershed could benefit from soil health and targeted stormwater retention strategies as already described in detail above. Finances, time, manpower, and other restraints make it impossible to implement all of these management techniques at once. Thus, it is necessary to prioritize the recommendations.

The prioritizations and recommendations listed below as prioritized by stakeholders attending the final public meeting. These conditions may change as land use within the watershed changes. Management efforts may need to be prioritized differently based on project feasibility and individual landowner willingness to participate. To ensure maximum participation in any management effort, all watershed stakeholders should be allowed to participate in prioritizing the management efforts in the watershed in the future.

It is also important to note that even if all stakeholders agree that this is the best prioritization to meet their needs, action need not be taken in this order. Some of the smaller, less expensive recommendations may be implemented while funds are raised to implement some of the larger projects. Many of the larger projects will require feasibility work to ensure landowner willingness to participate in the project. In some cases, it may be necessary to attain regulatory approval as well. Landowner endorsement and regulatory approval, along with stakeholder input, may ultimately determine the prioritization of management efforts.

Results from the mapping exercises, the windshield survey, water quality sampling, biological sampling, habitat sampling, and the modeling exercise were used to provide data to the individuals attending the second public meeting. They used these data as well as personal preference to prioritize recommendations for future work. Additional general recommendations, like innovative riparian management system use and recommended practices for homeowners, follow the primary recommendations section. Many of these recommendations may already be in practice; however, for the sake of thoroughness, they are reiterated here.

10.1 Primary Recommendations

Four of the Cobus Creek Watershed sites Cobus East Lateral A (Site 4), Gast Ditch at Adams Road (Site 5), Gast Ditch at Redfield Road (Site 7), and the Coberts Lake Inlet (Site 11) generally possessed poorer water quality conditions than the other stream reaches. These watersheds should be the first targeted for projects aimed at reducing instream nutrient, sediment, and pathogen concentrations and loading to the Cobus Creek Watershed (Figure 45).

1. Implement a lakes overlay zoning district or consider an ordinance that will require Cobus Creek Watershed residents to utilize sewer systems to treat their wastewater effluent. A zoning overlay could protect the lakes in the Michigan portion of the watershed and could be extended south to include the entirety of the Cobus Creek Watershed to protect the coolwater stream from septic inputs.

2. Reduce total suspended solids concentrations in streams throughout the watershed.
   TSS concentrations were elevated and exceeded the target concentration (15 mg/l) during storm flow at all sample sites. Best management practice implementation to reduce TSS loading to the streams, including streambank stabilization, cover crop planting, conservation

tillage, and urban best management practices aimed at reducing impacts from hardscape, such as rain barrel, rain gardens, and pervious pavement should be the focus.

3. Reduce *E. coli* concentrations in streams throughout the watershed.
   E. coli concentrations exceeded the state standard at all sites during storm flow with concentrations measuring 1.6 to 12.6 times the state standard (235 colonies/100 ml). Historic data documents high *E. coli* concentrations in Cobus Creek at CR 8 and CR 10. The sources of *E. coli* in the Cobus Creek 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 maintenance, sewer implementation, and the creation of pet waste pick up programs can all address pathogen issues in the Cobus Creek Watershed.

4. Reduce soluble and total phosphorus concentrations in streams throughout the watershed.
   Soluble and total phosphorus concentrations were elevated at all watershed streams during both base and storm flow. Concentrations in the tributaries exceeded recommended target concentrations for orthophosphorus (0.03 mg/L) and total phosphorus (0.08 mg/L). Historic water quality data collected throughout the watershed also document elevated phosphorus concentrations. Best management practice implementation to reduce phosphorus loading to the streams, including livestock fencing, septic system inspection and maintenance, and sewer installation, streambank stabilization, rain garden and rain barrel installation, and filter strips should be targeted.

5. Implement a landowner education program to educate landowness on their impacts to Cobus Creek. Homeowners in the watershed should:
   a. Avoid lawn fertilizing near the stream's edge.
   b. Examine all drains that lead from roads, driveways, or rooftops to the stream, and consider alternate routes for these drains that would filter pollutants before they reach the water.
   c. Keep organic debris like lawn clippings, leaves, and animal waste out of the water.
   d. Avoid mowing up to the stream's edge;
   e. Restore riparian habitat.
   f. Properly maintain on-site wastewater treatment systems. Systems should be pumped regularly and leach fields should be properly cared for. Undue pressure on systems may be alleviated by water conservation practices as well.
   g. Maintain field drainage tiles and use filter strips around tile risers.

6. Continue to monitor instream flows and stream habitat to assess the long-term impacts of low flow on fish and macroinvertebrate communities in the Cobus Creek Watershed. If low flow conditions continue to be an issue, investigate opportunities to infiltrate more stormwater through urban BMP implementation and/or improve instream habitat through the creation of deep pools.
   Instream flows appear to negatively impact instream habitat conditions, which likely negatively impacts the fish and macroinvertebrate communities present in the Cobus Creek Watershed. Limited rain events coupled with high levels of irrigation throughout the watershed are likely

resulting in reduced instream flows. As water levels fall, pool depth is reduced as is the access to riparian habitat, including overhanging vegetation, rootwads, and other streamside vegetation. This limited habitat can negatively impact the fish and macroinvertebrate community resulting in alterations to the community under varying flow regimes.

7. Work with the Elkhart, St. Joseph, and Cass County Health Departments to ensure proper permitting, siting, and engineering of septic systems.
   The use of alternative technology should be encouraged when conditions may compromise proper waste treatment. IDNR and ISDH soil scientists in the area are a valuable resource for expertise in characterizing soils for septic use. Their knowledge could be tapped for future building and siting of systems. If building is necessary on a site where conditions are not suitable for a traditional system, alternative technology could be constructed and the site used as a demonstration and education/outreach tool.

8. Continue to monitor fish passage issues and identify potential solutions to address high priority locations where fish passage is most limited.
   At a minimum, work with the county or state to address fish passage concern areas when road and bridge structures are replaced. Additionally, the small lowhead dams at the Elkhart Conservation Club appear to prevent numerous species from migrating into Cobus Creek. Fish passage options at the Conservation Club might be considered to enhance the fish communities in Cobus Creek.

9. Implement high profile urban best management practices to showcase potential solutions for watershed residents. Cobus Creek County Park, MSA Park, Horizon Elementary School, Discovery Middle School, Harris Township Park, Cleveland Township Little League Fields, the Cleveland Branch of the Elkhart Public Library, the Elkhart Conservation Club, and the Elkhart Community School's planned education farm all provide opportunities to engage with the public to connect them with Cobus Creek.

10. Monitor and manage invasive species throughout the Cobus Creek Watershed. Invasive speices can negatively impact terrestrial and riverine communities throughout the watershed. While a survey of invasive species present in the watershed has not been completed, ongoing efforts target treatment of Eurasian watermilfoil in Cobus Creek Watershed lakes.

10.2 General Recommendations

1. Apply for Lake and River Enhancement (LARE) Watershed Land Treatment funds to implement recommended agricultural BMPs, including filter strips and soil health-focused conservation tillage and cover crop planting.
   This work should focus on interested landowners in identified critical areas first. Additional funding can be obtained from a variety of sources such as the Conservation Reserve Program, Clean Water Indiana, and the Environmental Quality Incentives Program. These funds can be used separately or in conjunction with LARE Watershed Land Treatment funds.

2. <u>Apply for Lake and River Enhancement Feasibility Study funds to begin assessment of potential streambank stabilization, urban buffer strip planting, and rain garden demonstration installation projects.</u>
High profile locations for rain garden demonstration installation should be targeted first, while all identified streambank erosion locations and all narrow buffers located on residential land should be reviewed to determine their feasibility. Potential locations to demonstrations include: Cobus Creek County Park, MSA Park, Horizon Elementary School, Discovery Middle School, Harris Township Park, Cleveland Township Little League Fields, the Cleveland Branch of the Elkhart Public Library, and the Elkhart Conservation Club.

3. <u>Target best management practice implementation on non-protected parcels mapped as highly erodible land.</u>
Approximately 12% of the watershed (2,791.9 acres 1,130.4 ha) is mapped as potentially highly erodible or highly erodible land. Efforts for these parcels should focus on enrolling tracts of land mapped as highly erodible in the conservation reserve program (Figure 5).

4. <u>Coordinate the projects referenced above with the county drainage board to ensure that the project meets the goals of both the Soil and Water Conservation District (SWCD)/Soil Conservation District (SCD) and the drainage board/drain commissioner.</u>
For example, a SWCD tree-planting project in an area that is scheduled for drainage project de-brushing will not result in the optimum use of resources. In fact, a landowner may be more willing to participate in a cost-share program following ditch maintenance projects. Gast Ditch is a regulated drain and as such is under the jurisdiction of the St. Joseph County Drainage Board. Likewise, Cobus East Lateral A is a legal drain maintained by the Elkhart County Drainage Board. Cobus Creek is not a regulated drain.

   If any maintenance projects occur in the Cobus Creek Watershed, implementation of conservation practices along watershed streams and drains and in their immediate watersheds is strongly encouraged to prevent the need for such maintenance projects in the future. It is recommended that the SWCD work closely with the drainage boards to ensure that conservation practices advocated in the Indiana Drainage Handbook (Burke, 1996) are followed when planning and implementing projects. These conservation practices recommend tree preservation, vegetative stabilization and seeding, stream environment enhancement, and tree replacement even near regulated drains.

5. <u>Extend management to the watershed level.</u>
Although streamside localized BMPs are important, research conducted in Wisconsin shows that the biotic community mostly responds to large-scale watershed influences rather than local riparian land use changes (Weigel et al., 2000). An example of working at the watershed-level is coordinating with producers to implement nutrient, pesticide, tillage, and coordinated resource management plans. It is important to note that the LARE Program (Indiana only) and NRCS program will provide cost-share incentives for large-scale land practices like conservation tillage. Large-scale reductions in agricultural non-point source pollutions are necessary for stream health improvement (Osmond and Gale, 1995).

6. Provide information about streams within the Cobus Creek Watershed to local landowners. Landowners will be more likely to conserve and protect the creeks if they understand their value. The outreach program could include pointers on how landowners themselves can help protect the waterways.

7. Before initiating watershed treatment projects, consider conducting a survey of landowners in the watershed to determine landowners' concern for water quality problems, to evaluate landowners' opinions of management systems, and to quantify the value of surface and groundwater quality improvement.
   Use this information to work with interested landowners to formulate individual Resource Management Plans.

8. Reach out to a school or other volunteer group to begin volunteer monitoring at additional sites within the watershed through the Hoosier Riverwatch Program.
   This data will be valuable resource by which to evaluate the success of projects implemented in the area.

9. Invite producers and other landowners to visit successful project sites.
   There is no better advertisement than a success story. Focus on information dissemination and transfer by scheduling on-site field days during non-busy seasons.

10. Work with a bulk seed distributor and local native plant nurseries to make native plant and seeds available in large quantities at low prices for native plant and stream buffer plantings.

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Appendix A: ETR Data

SNAME	Species/Community	GRAN	SRAN	SPRO	Year	
Cistothorus platensis	Sedge Wren	G5	S3B	SE	2000-07-22	
Clemmys guttata	Spotted Turtle	G5	S2	SE	1998	
Emydoidea blandingii	Blanding's Turtle	G4	S2	SE	1994-06-05	
Eriocaulon aquaticum	Pipewort	G5	S1	SE	1999-08-18	A
Wetland - flat muck	Muck Flat	G2	S2	SG	2009-09-23	AB
Arenaria stricta	Michaux's Stitchwort	G5	S2	SR	1945-06-17	H
Eleocharis robbinsii	Robbins Spikerush	G4G5	S2	SR	1985-07-30	
Rhynchospora macrostachya	Tall Beaked-rush	G4	S2	SR	1985-07-30	
Scirpus purshianus	Weakstalk Bulrush	G4G5	S1	SR	1984-08-24	
Utricularia purpurea	Purple Bladderwort	G5	S2	SR	1985-07-30	
Grus canadensis	Sandhill Crane	G5	S2B-S1N	SSC	2002-07-25	
Rhinichthys cataractae	Longnose Dace	G5	S2	SSC	2014-08-07	
Taxidea taxus	American Badger	G5	S2	SSC	1989-08-18	
Fuirena pumila	Dwarf Umbrella-sedge	G4	S2	ST	2012-08-03	A
Rhynchospora scirpoides	Long-beaked Baldrush	G4	S2	ST	2012-08-03	CD

Indiana County Endangered, Threatened and Rare Species List

County: Elkhart

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Venustaconcha ellipsiformis	Ellipse		SSC	G4	S2
Mollusk: Gastropoda					
Campeloma decisum	Pointed Campeloma		SSC	G5	S2
Insect: Coleoptera (Beetles)					
Nicrophorus americanus	American Burying Beetle	LE	SX	G2G3	SX
Insect: Hymenoptera (Ants)					
Formica ulkei				GNR	S1
Insect: Lepidoptera (Moth)					
Apamea lignicolora	The Wood-colored Apamea		ST	G5	S1S2
Apamea nigrior	Black-dashed Apamea		SR	G5	S2S3
Capis curvata	A Noctuid Moth		ST	G4	S2S3
Catocala praeclara	Praeclara Underwing		SR	G5	S2S3
Crambus girardellus	Orange-striped Sedge Moth		SR	GNR	S2S3
Dasychira cinnamomea	A Moth		SR	G4	S1
Exyra rolandiana	Pitcher Window Moth		SE	G4	S1S2
Iodopepla u-album	A Noctuid Moth		SR	G5	S2
Leucania multilinea			SR	G5	S1S2
Macrochilo absorptalis	A Moth		SR	G4G5	S2S3
Macrochilo hypocritalis	A Noctuid Moth		SR	G4	S2
Melanomma auricinctaria	Huckleberry Eye-spot Moth		SR	G4	S2S3
Papaipema appassionata	The Pitcher Plant Borer Moth		SE	G4	S1
Papaipema speciosissima	The Royal Fern Borer Moth		ST	G4	S2S3
Insect: Odonata (Dragonflies)					
Sympetrum semicinctum	Band-winged Meadowhawk		SR	G5	S2S3
Insect: Tricoptera (Caddisflies)					
Setodes oligius	A Caddisfly		SE	G5	S1
Fish					
Coregonus artedi	Cisco		SSC	G5	S2
Moxostoma valenciennesi	Greater Redhorse		SE	G4	S2
Rhinichthys cataractae	Longnose Dace		SSC	G5	S2
Reptile					
Clemmys guttata	Spotted Turtle		SE	G5	S2
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Macrochelys temminckii	Alligator Snapping Turtle		SE	G3G4	SNA
Sistrurus catenatus catenatus	Eastern Massasauga	C	SE	G3G4T3Q	S2
Bird					
Bartramia longicauda	Upland Sandpiper		SE	G5	S3B

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting

State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list

GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank

SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Indiana County Endangered, Threatened and Rare Species List

County: Elkhart

Species Name	Common Name	FED	STATE	GRANK	SRANK
Botaurus lentiginosus	American Bittern		SE	G4	S2B
Certhia americana	Brown Creeper			G5	S2B
Circus cyaneus	Northern Harrier		SE	G5	S2
Cistothorus palustris	Marsh Wren		SE	G5	S3B
Cistothorus platensis	Sedge Wren		SE	G5	S3B
Empidonax alnorum	Alder Flycatcher			G5	S2B
Grus canadensis	Sandhill Crane	No Status	SSC	G5	S2B,S1N
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Lanius ludovicianus	Loggerhead Shrike		SE	G4	S3B
Rallus elegans	King Rail		SE	G4	S1B
Rallus limicola	Virginia Rail		SE	G5	S3B
Mammal					
Condylura cristata	Star-nosed Mole		SSC	G5	S2?
Mustela nivalis	Least Weasel		SSC	G5	S2?
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Actaea rubra	Red Baneberry		SR	G5	S2
Amelanchier humilis	Running Serviceberry		SE	G5	S1
Andromeda glaucophylla	Bog Rosemary		SR	G5	S2
Arabis drummondii	Drummond Rockcress		SE	G5	S1
Arabis missouriensis var. deamii	Missouri Rockcress		SE	G5T3?Q	S1
Arenaria stricta	Michaux's Stitchwort		SR	G5	S2
Aster borealis	Rushlike Aster		SR	G5	S2
Besseya bullii	Kitten Tails		SE	G3	S1
Cabomba caroliniana	Carolina Fanwort		SX	G3G5	SX
Carex bebbii	Bebb's Sedge		ST	G5	S2
Carex debilis var. rudgei	White-edge Sedge		SR	G5T5	S2
Carex straminea	Straw Sedge		ST	G5	S2
Chimaphila umbellata ssp. cisatlantica	Pipsissewa		ST	G5T5	S2
Eleocharis equisetoides	Horse-tail Spikerush		SE	G4	S1
Eleocharis robbinsii	Robbins Spikerush		SR	G4G5	S2
Epigaea repens	Trailing Arbutus		WL	G5	S3
Eriocaulon aquaticum	Pipewort		SE	G5	S1
Eriophorum gracile	Slender Cotton-grass		ST	G5	S2
Eriophorum viridicarinatum	Green-keeled Cotton-grass		SR	G5	S2
Fuirena pumila	Dwarf Umbrella-sedge		ST	G4	S2
Geranium robertianum	Herb-robert		ST	G5	S2
Gnaphalium macounii	Winged Cudweed		SX	G5	SX
Iliamna remota	Kankakee Globe-mallow		SE	G1Q	S1
Juniperus communis	Ground Juniper		SR	G5	S2

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting

State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list

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Indiana County Endangered, Threatened and Rare Species List

County: Elkhart

Species Name	Common Name	FED	STATE	GRANK	SRANK
Linum striatum	Ridged Yellow Flax		WL	G5	S3
Lycopodium hickeyi	Hickey's Clubmoss		SR	G5	S2
Lycopodium obscurum	Tree Clubmoss		SR	G5	S2
Malaxis unifolia	Green Adder's-mouth		SE	G5	S1
Matteuccia struthiopteris	Ostrich Fern		SR	G5	S2
Milium effusum	Tall Millet-grass		SR	G5	S2
Pinus strobus	Eastern White Pine		SR	G5	S2
Platanthera leucophaea	Prairie White-fringed Orchid	LT	SE	G2G3	S1
Platanthera psycodes	Small Purple-fringe Orchis		SR	G5	S2
Poa paludigena	Bog Bluegrass		WL	G3	S3
Pyrola rotundifolia var. americana	American Wintergreen		SR	G5	S2
Quercus prinoides	Dwarf Chinquapin Oak		SE	G5	S1
Rhynchospora macrostachya	Tall Beaked-rush		SR	G4	S2
Rhynchospora scirpoides	Long-beaked Baldrush		ST	G4	S2
Scirpus purshianus	Weakstalk Bulrush		SR	G4G5	S1
Selaginella rupestris	Ledge Spike-moss		ST	G5	S2
Spiranthes lucida	Shining Ladies'-tresses		SR	G5	S2
Stipa avenacea	Blackseed Needlegrass		SR	G5	S2
Tofieldia glutinosa	False Asphodel		SR	G5	S2
Utricularia cornuta	Horned Bladderwort		ST	G5	S2
Utricularia minor	Lesser Bladderwort		ST	G5	S1
Utricularia purpurea	Purple Bladderwort		SR	G5	S2
Vaccinium oxycoccos	Small Cranberry		ST	G5	S2
Xyris difformis	Carolina Yellow-eyed Grass		ST	G5	S2
High Quality Natural Community					
Forest - floodplain mesic	Mesic Floodplain Forest		SG	G3?	S1
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3
Lake - lake	Lake		SG	GNR	S2
Prairie - sand dry-mesic	Dry-mesic Sand Prairie		SG	G3	S3
Wetland - beach marl	Marl Beach		SG	G3	S2
Wetland - bog acid	Acid Bog		SG	G3	S2
Wetland - bog circumneutral	Circumneutral Bog		SG	G3	S3
Wetland - fen	Fen		SG	G3	S3
Wetland - flat muck	Muck Flat		SG	G2	S2
Wetland - flat sand	Sand Flat		SG	G2	S1
Wetland - marsh	Marsh		SG	GU	S4
Wetland - swamp shrub	Shrub Swamp		SG	GU	S2

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Indiana County Endangered, Threatened and Rare Species List

County: St. Joseph

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Gastropoda					
Campeloma decisum	Pointed Campeloma		SSC	G5	S2
Lymnaea stagnalis	Swamp Lymnaea		SSC	G5	S2
Insect: Odonata (Dragonflies)					
Sympetrum semicinctum	Band-winged Meadowhawk		SR	G5	S2S3
Fish					
Moxostoma valenciennesi	Greater Redhorse		SE	G4	S2
Rhinichthys cataractae	Longnose Dace		SSC	G5	S2
Amphibian					
Acris blanchardi	Northern Cricket Frog		SSC	G5	S4
Ambystoma laterale	Blue-spotted Salamander		SSC	G5	S2
Hemidactylium scutatum	Four-toed Salamander		SSC	G5	S2
Lithobates pipiens	Northern Leopard Frog		SSC	G5	S2
Reptile					
Clemmys guttata	Spotted Turtle		SE	G5	S2
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Nerodia erythrogaster neglecta	Copperbelly Water Snake	PS:LT	SE	G5T3	S2
Sistrurus catenatus catenatus	Eastern Massasauga	C	SE	G3G4T3Q	S2
Bird					
Accipiter striatus	Sharp-shinned Hawk	No Status	SSC	G5	S2B
Ammodramus henslowii	Henslow's Sparrow		SE	G4	S3B
Bartramia longicauda	Upland Sandpiper		SE	G5	S3B
Botaurus lentiginosus	American Bittern		SE	G4	S2B
Buteo platypterus	Broad-winged Hawk		SSC	G5	S3B
Certhia americana	Brown Creeper			G5	S2B
Chlidonias niger	Black Tern		SE	G4	S1B
Cistothorus palustris	Marsh Wren		SE	G5	S3B
Cistothorus platensis	Sedge Wren		SE	G5	S3B
Dendroica cerulea	Cerulean Warbler		SE	G4	S3B
Dendroica virens	Black-throated Green Warbler			G5	S2B
Empidonax alnorum	Alder Flycatcher			G5	S2B
Falco peregrinus	Peregrine Falcon		SSC	G4	S2B
Grus canadensis	Sandhill Crane	No Status	SSC	G5	S2B,S1N
Haliaeetus leucocephalus	Bald Eagle		SSC	G5	S2
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Lanius ludovicianus	Loggerhead Shrike		SE	G4	S3B
Lophodytes cucullatus	Hooded Merganser			G5	S2S3B
Mniotilta varia	Black-and-white Warbler		SSC	G5	S1S2B
Pandion haliaetus	Osprey		SE	G5	S1B

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Indiana County Endangered, Threatened and Rare Species List

County: St. Joseph

Species Name	Common Name	FED	STATE	GRANK	SRANK
Rallus limicola	Virginia Rail		SE	G5	S3B
Vermivora chrysoptera	Golden-winged Warbler		SE	G4	S1B
Wilsonia citrina	Hooded Warbler		SSC	G5	S3B
Mammal					
Condylura cristata	Star-nosed Mole		SSC	G5	S2?
Mustela nivalis	Least Weasel		SSC	G5	S2?
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Spermophilus franklinii	Franklin's Ground Squirrel		SE	G5	S2
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Actaea rubra	Red Baneberry		SR	G5	S2
Amelanchier humilis	Running Serviceberry		SE	G5	S1
Arabis drummondii	Drummond Rockcress		SE	G5	S1
Arabis glabra	Tower-mustard		WL	G5	S2
Arabis missouriensis var. deamii	Missouri Rockcress		SE	G5T3?Q	S1
Arenaria stricta	Michaux's Stitchwort		SR	G5	S2
Armoracia aquatica	Lake Cress		SE	G4?	S1
Botrychium matricariifolium	Chamomile Grape-fern		SR	G5	S2
Carex alopecoidea	Foxtail Sedge		SE	G5	S1
Carex atherodes	Awned Sedge		SE	G5	S1
Carex atlantica ssp. atlantica	Atlantic Sedge		ST	G5T4	S2
Carex bebbii	Bebb's Sedge		ST	G5	S2
Carex crawei	Crawe Sedge		ST	G5	S2
Carex debilis var. rudgei	White-edge Sedge		SR	G5T5	S2
Carex flava	Yellow Sedge		ST	G5	S2
Carex pedunculata	Longstalk Sedge		SR	G5	S2
Carex retrorsa	Retrorse Sedge		SE	G5	S1
Carex scabrata	Rough Sedge		SE	G5	S1
Carex seorsa	Weak Stellate Sedge		SR	G4	S2
Carex sparganioides var. cephaloidea	Thinleaf Sedge		SE	G5	S1
Carex straminea	Straw Sedge		ST	G5	S2
Ceratophyllum echinatum	Prickly Hornwort		SR	G4?	S2
Chrysosplenium americanum	American Golden-saxifrage		ST	G5	S2
Cirsium hillii	Hill's Thistle		SE	G3	S1
Cypripedium candidum	Small White Lady's-slipper		WL	G4	S2
Deschampsia cespitosa	Tufted Hairgrass		SR	G5	S2
Dichanthelium sabulorum var. thinium	Hemlock Panic-grass		SR	G5T5	S2
Diervilla lonicera	Northern Bush-honeysuckle		SR	G5	S2
Drosera intermedia	Spoon-leaved Sundew		SR	G5	S2
Eleocharis melanocarpa	Black-fruited Spike-rush		ST	G4	S2

Indiana County Endangered, Threatened and Rare Species List

County: St. Joseph

Species Name	Common Name	FED	STATE	GRANK	SRANK
Eleocharis robbinsii	Robbins Spikerush		SR	G4G5	S2
Eriocaulon aquaticum	Pipewort		SE	G5	S1
Eriophorum angustifolium	Narrow-leaved Cotton-grass		SR	G5	S2
Fuirena pumila	Dwarf Umbrella-sedge		ST	G4	S2
Geranium robertianum	Herb-robert		ST	G5	S2
Gnaphalium macounii	Winged Cudweed		SX	G5	SX
Juglans cinerea	Butternut		WL	G4	S3
Juncus militaris	Bayonet Rush		SE	G4	S1
Juncus pelocarpus	Brown-fruited Rush		SE	G5	S2
Lathyrus maritimus var. glaber	Beach Peavine		SE	G5T4T5	S1
Lathyrus venosus	Smooth Veiny Pea		ST	G5	S2
Linum sulcatum	Grooved Yellow Flax		SR	G5	S2
Ludwigia sphaerocarpa	Globe-fruited False-loosestrife		SE	G5	S1
Lycopodium hickeyi	Hickey's Clubmoss		SR	G5	S2
Lycopodium obscurum	Tree Clubmoss		SR	G5	S2
Malaxis unifolia	Green Adder's-mouth		SE	G5	S1
Matteuccia struthiopteris	Ostrich Fern		SR	G5	S2
Myriophyllum pinnatum	Cutleaf Water-milfoil		SE	G5	S1
Oryzopsis racemosa	Black-fruit Mountain-ricegrass		SR	G5	S2
Panax trifolius	Dwarf Ginseng		WL	G5	S2
Panicum commonsianum var. addisonii	Commons' Panic-grass		SE	G5TNR	S2
Panicum verrucosum	Warty Panic-grass		ST	G4	S2
Pinus strobus	Eastern White Pine		SR	G5	S2
Platanthera dilatata	Leafy White Orchis		SE	G5	S1
Platanthera leucophaea	Prairie White-fringed Orchid	LT	SE	G2G3	S1
Poa alsodes	Grove Meadow Grass		SR	G4G5	S2
Poa paludigena	Bog Bluegrass		WL	G3	S3
Polygonum hydropiperoides var. opelousanum	Northeastern Smartweed		ST	G5TNRQ	S2
Polygonum hydropiperoides var. setaceum	Swamp Smartweed		SE	G5	S1
Populus balsamifera	Balsam Poplar		SE	G5	S1
Potamogeton bicupulatus	Snail-seed Pondweed		SE	G4	S1
Pyrola virens	Greenish-flowered Wintergreen		SX	G5	SX
Rhynchospora macrostachya	Tall Beaked-rush		SR	G4	S2
Rhynchospora scirpoides	Long-beaked Baldrush		ST	G4	S2
Rubus enslenii	Southern Dewberry		SE	G4G5Q	S1
Rubus setosus	Small Bristleberry		SE	G5	S1
Salix serissima	Autumn Willow		ST	G4	S2
Scheuchzeria palustris ssp. americana	American Scheuchzeria		SE	G5T5	S1
Schoenoplectus smithii	Smith's Bulrush		SE	G5?	S1
Scirpus purshianus	Weakstalk Bulrush		SR	G4G5	S1

Indiana County Endangered, Threatened and Rare Species List

County: St. Joseph

Species Name	Common Name	FED	STATE	GRANK	SRANK
Scirpus subterminalis	Water Bulrush		SR	G4G5	S2
Selaginella apoda	Meadow Spike-moss		WL	G5	S1
Silene regia	Royal Catchfly		ST	G3	S2
Sorbus decora	Northern Mountain-ash		SX	G4G5	SX
Sparganium androcladum	Branching Bur-reed		ST	G4G5	S2
Stipa avenacea	Blackseed Needlegrass		SR	G5	S2
Strophostyles leiosperma	Slick-seed Wild-bean		ST	G5	S2
Tofieldia glutinosa	False Asphodel		SR	G5	S2
Triglochin palustris	Marsh Arrow-grass		SR	G5	S2
Utricularia cornuta	Horned Bladderwort		ST	G5	S2
Utricularia purpurea	Purple Bladderwort		SR	G5	S2
Vaccinium oxycoccos	Small Cranberry		ST	G5	S2
Valeriana uliginosa	Marsh Valerian		SE	G4Q	S1
Valerianella chenopodiifolia	Goose-foot Corn-salad		SE	G5	S1
Viburnum cassinoides	Northern Wild-raisin		SE	G5T5	S1
Viola primulifolia	Primrose-leaf Violet		ST	G5	S2
Xyris difformis	Carolina Yellow-eyed Grass		ST	G5	S2
High Quality Natural Community					
Forest - floodplain wet-mesic	Wet-mesic Floodplain Forest		SG	G3?	S3
Forest - upland dry-mesic	Dry-mesic Upland Forest		SG	G4	S4
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3
Lake - pond	Pond		SG	GNR	SNR
Prairie - wet	Wet Prairie		SG	G3	S1
Wetland - fen	Fen		SG	G3	S3
Wetland - flat muck	Muck Flat		SG	G2	S2
Wetland - marsh	Marsh		SG	GU	S4
Wetland - meadow sedge	Sedge Meadow		SG	G3?	S1
Wetland - swamp forest	Forested Swamp		SG	G2?	S2
Wetland - swamp shrub	Shrub Swamp		SG	GU	S2

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Appendix B: Macroinvertebrate Data

Site Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Baetis flavistriga	4		2	1								9
B. intercalaris												6
B. pygmaeus						8		1				
B. hageni	32	3	10	2								
Baetis sp.						8						
Heterocloeon sp.			1									
Pseudocloeon sp.						5						
Cloeon sp.					7							
Stenonema mediopunctatum												3
S. pulchellum			1									3
S. vicarium			2			2		1				
S. terminatum			7									
Stenacron interpunctatum						1		15	1			
Tricorythodes sp.						11						5
Caenis sp.				1	6						1	
Hydropsyche aerata												1
H. betteni						5						
H. simulans	11		34	4		6					5	2
Cheumatopsyche sp.	5		6	2		11		16	5		5	
Oecitis sp.												1
Helicopsyche borealis						7						
Ochrotrichia sp.						2						
Glossoma sp.			1									
Perlesta sp,	2											
Stenelmis sp.			8		1	6			1		5	3
Macronychus glabratus	6		2			2	1	7	1		6	1
Dubiraphia sp.					1			1			3	
Optioservus fastiditus												
Psephenus herricki												2
Helodidae												2
Gyrinidae												1
Haliplidae											1	
Hydrophilidae									3	1		
Pyralidae												1
Boyeria sp.				2	1						1	

Site Number	1	2	3	4	5	6	7	8	9	10	11	12
Hetaerina sp.								6				
Argia sp.						1						
Enallagma sp.				1	14			1				
Libellulidae					1							
Ranatra sp.					2							
Antocha sp.												2
Tipula sp.		1										
Simulium sp.	6		4			1					1	
Empididae											1	
Ceratopogonidae					1							
Culicidae					1					2		
Chironomidae												
Pagastia sp.	17											
Ablabesmyia mallochi									5			
Thienemannimyia sp.			6		3	8	2	3	15		11	3
Pentaneura inconspicua				6			10				3	
Procladius sp.					3			2				1
Labrundinia pilosella					2							
Eukiefferiella dicoloripes			2								2	
Nanocladius sp.					2		1					
Orthocladius obumbratus						3					3	1
Parametriocnemus lundbeckii	1	3										
Thienemanniella xena						1			6			
Chironomus sp.					3					59		
Cryptochironomus fulvus					9	1					2	
Microtendipes caelum						1			5			
Paracladopelma loganae					14			1				
Polypedilum convictum						6	1	1	2	38	3	4
Stenochironomus sp.											1	3
Cladotanytarsus sp.						1						
Paratanytarsus sp.									5		3	
Tanytarsus guerlus					5	1					1	1
Gammarus pseudolimnaeus	13	91	12	3	7				50		17	43
Hyallela azteca							1	39				
Caecidotea sp.	3			9			1				23	1
Decapoda			1		1							1

Site Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Turbellaria							79					
Hiurdinea			1	1				1	1		2	
Oligochaeta		1			14			3				
Physidae		1		65	1	1						
Planorbidae				3	1			1				
Viviparus georgianus							2					
Sphaeridae						1	2	1				
Total	102	104	106	108	110	112	114	116	118	120	122	124

Appendix C: Fish Data

Site	1	2	3	4	5	6	7	8	9	11	1	2	3	4	5	6	7	8	9	11
Species	**1247**	**1228**	**1245**	**1229**	**1230**	**1231**	**1232**	**1235**	**1251**	**1252**	**1279**	**1265**	**1278**	**1257**	**1258**	**1259**	**1263**	**1264**	**1280**	**1286**
Species	1	2	3	4	5	6	7	8	9	11	1	2	3	4	5	6	7	8	9	11
American Brook Lamprey	16		4						5		4		2		1					7
Blacknose Dace	167		165		13	9					141	1	111			110				
Bluegill	1						3	5		8								1	16	
Bluntnose Minnow									1											
Bowfin								2										3		
Brown Bullhead								1												
Brown Trout	24		5								14		2							
Central Mudminnow	3		4	9	1	3		5	7	11	2		1				2	6	20	11
Chesnut Lamprey											1									
Common Shiner	1									2										
Creek Chub	27	15	117		21	94			1		51		125		8	542			3	2
Creek Chubsucker															3					
Golden Shiner									1			1				2		2		
Grass Pickerel	4		5		2		1	7			13		14		6	2	10	11	6	
Green Sunfish	4				3		1				1		1		2		1			
Hornyhead Chub																			1	2
Iowa Darter									11				1						11	
Lake Chubsucker								1										3		
Largemouth Bass							1	3	1	1						4		3	4	
Mottled Sculpin	28		38								58		63			4				
Rainbow Trout	2										1									
Rock Bass	11		2										1							
Striped Shiner											1									
White Sucker			29				1	4	2		5		25		2					
Yellow Bullhead								1							2			7		
Total	**289**	**17**	**372**	**13**	**45**	**112**	**14**	**37**	**38**	**33**	**293**	**4**	**349**	**4**	**29**	**670**	**20**	**44**	**70**	**33**

Appendix D: Habitat Data

Ohio EPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 74

Stream & Location: Cobus Creek *RM:* _ _ _._ *Date:* 7/27/16
Site 1 CR 12 *Scorers Full Name & Affiliation:* ____
River Code: _ _ _-_ _ _-_ _ _ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) _ _ . _ _ _ _ _ /8_ . _ _ _ _ _ *Office verified location* ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present. Check ONE (Or 2 & average)

BEST TYPES (POOL RIFFLE)
- ☐ ☐ BLDR /SLABS [10]
- ☐ ☑ BOULDER [9]
- ☐ ☑ COBBLE [8]
- ☐ ☑ GRAVEL [7]
- ☐ ☐ SAND [6]
- ☐ ☐ BEDROCK [5]

OTHER TYPES (POOL RIFFLE)
- ☐ ☐ HARDPAN [4]
- ☐ ☐ DETRITUS [3]
- ☐ ☐ MUCK [2]
- ☐ ☐ SILT [2]
- ☐ ☐ ARTIFICIAL [0]

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0]

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT:
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☑ FREE [1]

EMBEDDEDNESS:
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ NONE [1]

Comments

Substrate 19 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ✓ UNDERCUT BANKS [1]
- ✓ OVERHANGING VEGETATION [1]
- ✓ SHALLOWS (IN SLOW WATER) [1]
- ✓ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ✓ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ✓ AQUATIC MACROPHYTES [1]
- ✓ LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☑ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover 14 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☑ MODERATE [3]
- ☐ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☐ GOOD [5]
- ☑ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☑ NONE [6]
- ☐ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☐ HIGH [3]
- ☑ MODERATE [2]
- ☐ LOW [1]

Comments

Channel 15 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average). River right looking downstream.

EROSION (L R)
- ☐ ☑ NONE / LITTLE [3]
- ☐ ☐ MODERATE [2]
- ☐ ☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐ ☐ WIDE > 50m [4]
- ☐ ☑ MODERATE 10-50m [3]
- ☐ ☐ NARROW 5-10m [2]
- ☐ ☐ VERY NARROW < 5m [1]
- ☐ ☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐ ☑ FOREST, SWAMP [3]
- ☐ ☐ SHRUB OR OLD FIELD [2]
- ☐ ☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐ ☐ FENCED PASTURE [1]
- ☐ ☐ OPEN PASTURE, ROWCROP [0]
- ☐ ☐ CONSERVATION TILLAGE [1]
- ☐ ☐ URBAN OR INDUSTRIAL [0]
- ☐ ☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian 9 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)
- ☐ > 1m [6]
- ☑ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 7 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☑ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☑ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☑ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☑ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run 4 (Maximum 8)

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)
- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient 6 (Maximum 10)

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 46

Stream & Location: East Ditch Site 2 *RM:* ___ *Date:* 7/27/06 16

Scorers Full Name & Affiliation: ___

River Code: ___ - ___ - ___ *STORET #:* ___ *Lat./Long.: (NAD 83 - decimal °)* ___ . ___ /8_ . ___ Office verified location ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☑ GRAVEL [7]			☐☐ SILT [2]		
☐☑ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN		QUALITY
☐ LIMESTONE [1]	SILT	☐ HEAVY [-2]
☐ TILLS [1]		☑ MODERATE [-1]
☑ WETLANDS [0]		☐ NORMAL [0]
☐ HARDPAN [0]		☐ FREE [1]
☐ SANDSTONE [0]	EMBEDDEDNESS	☐ EXTENSIVE [-2]
☐ RIP/RAP [0]		☑ MODERATE [-1]
☐ LACUSTURINE [0]		☐ NORMAL [0]
☐ SHALE [-1]		☐ NONE [1]
☐ COAL FINES [-2]		

Substrate: 14 (Maximum 20)

2] INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]	___ POOLS > 70cm [2]	___ OXBOWS, BACKWATERS [1]
✓ OVERHANGING VEGETATION [1]	___ ROOTWADS [1]	___ AQUATIC MACROPHYTES [1]
✓ SHALLOWS (IN SLOW WATER) [1]	___ BOULDERS [1]	✓ LOGS OR WOODY DEBRIS [1]
✓ ROOTMATS [1]		

AMOUNT — Check ONE (Or 2 & average)

- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☑ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 6 (Maximum 20)

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☑ RECOVERED [4]	☐ MODERATE [2]
☑ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☑ LOW [1]
☐ NONE [1]	☑ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 8 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE

Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☑ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☑ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☑ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 6 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)	CHANNEL WIDTH — Check ONE (Or 2 & average)	CURRENT VELOCITY — Check ALL that apply	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☑ SLOW [1]
☐ 0.7-<1m [4]	☑ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☑ 0.4-<0.7m [2]	☐ POOL WIDTH > RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☒ 0.2-<0.4m [1]		☐ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]			

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☑ BEST AREAS 5-10cm [1]	☑ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☑ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☑ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 2 (Maximum 8)

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 6 (Maximum 10)

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 71

Stream & Location: Cobus Creek Site 3 *RM:* ___.__ *Date:* 7/27/06/16

Scorers Full Name & Affiliation: ______

River Code: ___-___-___ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) __.____ /8_.____ *Office verified location* ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☑ COBBLE [8]			☐☐ MUCK [2]		
☐☑ GRAVEL [7]			☐☐ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☑ 4 or more [2] ☐ 3 or less [0]

Comments

Check ONE (*Or 2 & average*)

ORIGIN
- ☐ LIMESTONE [1]
- ☑ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☑ NORMAL [0]
- ☐ NONE [1]

Substrate 18 *Maximum 20*

2] INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- ✓ SHALLOWS (IN SLOW WATER) [1]
- ✓ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ✓ AQUATIC MACROPHYTES [1]
- ✓ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (*Or 2 & average*)
- ☐ EXTENSIVE >75% [11]
- ☑ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover 11 *Maximum 20*

3] CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☑ NONE [6]	☐ HIGH [3]
☑ MODERATE [3]	☑ GOOD [5]	☐ RECOVERED [4]	☑ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel 16 *Maximum 20*

4] BANK EROSION AND RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ☐☑ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☑ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☐ VERY NARROW < 5m [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☑ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian 9 *Maximum 10*

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check **ONE** (*ONLY!*)
- ☐ > 1m [6]
- ☑ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (*Or 2 & average*)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☑ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☑ MODERATE [1]
- ☑ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 7 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*).

☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☑ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☑ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☑ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☑ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run 4 *Maximum 8*

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient 6 *Maximum 10*

EPA 4520 06/16/06

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 14

Stream & Location: Tributary @ CR 6 ***RM:*** ___._ ***Date:*** 7 / 27 / 16
Site 4 ***Scorers Full Name & Affiliation:*** ______
River Code: ___-___-___ ***STORET #:*** ______ ***Lat./ Long.:*** (NAD 83 - decimal °) __._____ /8_._____ Office verified location ☐

1] *SUBSTRATE*
Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☑ MUCK [2]		
☐☐ GRAVEL [7]			☐☑ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☑ 3 or less [0]

Comments

Check ONE (*Or 2 & average*)

ORIGIN: ☐ LIMESTONE [1] ☐ TILLS [1] ☑ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY
SILT: ☑ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]
EMBEDDEDNESS: ☑ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate 2 *Maximum 20*

2] *INSTREAM COVER*
Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1] ___ POOLS > 70cm [2] ___ OXBOWS, BACKWATERS [1]
___ OVERHANGING VEGETATION [1] ___ ROOTWADS [1] ___ AQUATIC MACROPHYTES [1]
___ SHALLOWS (IN SLOW WATER) [1] ___ BOULDERS [1] ___ LOGS OR WOODY DEBRIS [1]
___ ROOTMATS [1]

AMOUNT Check ONE (*Or 2 & average*)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☒ NEARLY ABSENT <5% [1]

Comments

Cover 1 *Maximum 20*

3] *CHANNEL MORPHOLOGY*
Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☒ LOW [1]
☒ NONE [1]	☒ POOR [1]	☒ RECENT OR NO RECOVERY [1]	

Comments

Channel 4 *Maximum 20*

4] *BANK EROSION AND RIPARIAN ZONE*
Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☒ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☒ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	*Indicate predominant land use(s) past 100m riparian.*
	☐☒ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Comments

Riparian 3 *Maximum 10*

5] *POOL / GLIDE AND RIFFLE / RUN QUALITY*

MAXIMUM DEPTH Check ONE (*ONLY!*)	CHANNEL WIDTH Check ONE (*Or 2 & average*)	CURRENT VELOCITY Check ALL that apply	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☐ SLOW [1]
☐ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☒ POOL WIDTH > RIFFLE WIDTH [0]	☐ FAST [1]	☒ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]		☐ MODERATE [1]	☐ EDDIES [1]
☒ < 0.2m [0]		*Indicate for reach - pools and riffles.*	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 0 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*). ☐ **NO RIFFLE [metric=0]**

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☒ BEST AREAS < 5cm [metric=0]		☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run 0 *Maximum 8*

6] *GRADIENT* (ft/mi)
DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient 4 *Maximum 10*

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 24

Stream & Location: Gast Ditch CR 2 Site 5 *RM:* ___ . ___ *Date:* 7/27/06 16

Scorers Full Name & Affiliation: ______

River Code: ___-___-___ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) __.______ /8_.______ *Office verified location* ☐

1] SUBSTRATE

Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☒ MUCK [2]		
☐☐ GRAVEL [7]			☐☐ SILT [2]		
☐☒ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☐ TILLS [1]
- ☒ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☒ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☒ NORMAL [0]
- ☐ NONE [1]

Substrate 8 *Maximum 20*

2] INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- X LOGS OR WOODY DEBRIS [1]

AMOUNT

Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☐ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☒ NEARLY ABSENT <5% [1]

Comments

Cover 2 *Maximum 20*

3] CHANNEL MORPHOLOGY

Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☒ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☒ LOW [1]
☐ NONE [1]	☒ POOR [1]	☒ RECENT OR NO RECOVERY [1]	

Comments

Channel 5 *Maximum 20*

4] BANK EROSION AND RIPARIAN ZONE

Check **ONE** in each category for **EACH BANK** (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☐ ☒ NONE / LITTLE [3]
- ☐ ☐ MODERATE [2]
- ☐ ☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐ ☐ WIDE > 50m [4]
- ☐ ☐ MODERATE 10-50m [3]
- ☐ ☐ NARROW 5-10m [2]
- ☐ ☒ VERY NARROW < 5m [1]
- ☐ ☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐ ☐ FOREST, SWAMP [3]
- ☐ ☐ SHRUB OR OLD FIELD [2]
- ☐ ☒ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐ ☐ FENCED PASTURE [1]
- ☐ ☐ OPEN PASTURE, ROWCROP [0]
- ☐ ☐ CONSERVATION TILLAGE [1]
- ☐ ☐ URBAN OR INDUSTRIAL [0]
- ☐ ☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian 5 *Maximum 10*

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☒ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH

Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☒ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY

Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☐ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☒ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current 0 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5-10cm [1]
- ☒ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☒ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run 0 *Maximum 8*

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )

%RUN: ( ) %RIFFLE: ( )

Gradient 4 *Maximum 10*

green sunfish

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** *QHEI Score:* 56

Stream & Location: Cobus CREEK @ CR 2 *RM:* ___._ *Date:* 7/27/06/16
Site 6 *Scorers Full Name & Affiliation:* ______
River Code: ___-___-___ *STORET #:* ______ *Lat./Long.:* (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☒ GRAVEL [7]			☐☐ SILT [2]		
☐☒ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]			(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]
Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☒ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY:
SILT: ☐ HEAVY [-2] ☐ MODERATE [-1] ☒ NORMAL [0] ☐ FREE [1]
EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☐ MODERATE [-1] ☒ NORMAL [0] ☐ NONE [1]

Substrate 13 Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
X SHALLOWS (IN SLOW WATER) [1]
X ROOTMATS [1]
___ POOLS > 70cm [2]
X ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
X AQUATIC MACROPHYTES [1]
___ LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☒ MODERATE 25-75% [7]
☒ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments
Cover 11 Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☒ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☒ RECOVERED [4]	☐ MODERATE [2]
☒ LOW [2]	☒ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments
Channel 12 Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check **ONE** in each category for *EACH BANK* (Or 2 per bank & average)
River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	
☐☒ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☒ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☒ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.
Comments
Riparian 5 Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)
☐ > 1m [6]
☐ 0.7-<1m [4]
☒ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☒ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply
☐ TORRENTIAL [-1] ☒ SLOW [1]
☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
☐ FAST [1] ☐ INTERMITTENT [-2]
☒ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments
Pool / Current 5 Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☒ NONE [2]
☒ BEST AREAS 5-10cm [1]	☒ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments
Riffle / Run 4 Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)
☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient 6 Maximum 10

EPA 4520 06/16/06

Fusconaia flava – live
Crayfish

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 42

Stream & Location: Cobus Creek (Gast Ditch) **RM:** ___ **Date:** 8/3/2016
Site 7 Redfield Rd **Scorers Full Name & Affiliation:** GRB
River Code: __-__-__ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.____ /8__.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☒ GRAVEL [7]			☐☐ SILT [2]		
☐☒ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☒ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY:
- SILT: ☐ HEAVY [-2] ☒ MODERATE [-1] ☐ NORMAL [0] ☐ FREE [1]
- EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☒ MODERATE [-1] ☐ NORMAL [0] ☐ NONE [1]

Substrate: 12 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
___ SHALLOWS (IN SLOW WATER) [1]
X ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
X BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
X LOGS OR WOODY DEBRIS [1]

AMOUNT — Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☒ NEARLY ABSENT <5% [1]

Comments

Cover: 4 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☒ RECOVERED [4]	☐ MODERATE [2]
☒ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☒ LOW [1]
☐ NONE [1]	☒ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 8 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☐☒ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☒ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☐ VERY NARROW < 5m [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☒ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 9 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☐ 0.4-<0.7m [2]
- ☒ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH — Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☒ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY — Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☒ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 3 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☒ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☒ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☒ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run: 2 (Maximum 8)

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 4 (Maximum 10)

EPA 4520 06/16/06

Ohio EPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 58

Stream & Location: Cobus Creek
Site 8 - Redfield Rd **RM:** ___.__ **Date:** 8/3/16
Scorers Full Name & Affiliation: GRB
River Code: __-___-___ **STORET #:** ______ **Lat./Long.:** (NAD 83 - decimal °) __.______ /8_.______ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☒ GRAVEL [7]			☐☒ SILT [2]		
☐☒ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☒ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTURINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☒ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☒ NORMAL [0]
- ☐ NONE [1]

Substrate: 16 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- X SHALLOWS (IN SLOW WATER) [1]
- X ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- X AQUATIC MACROPHYTES [1]
- X LOGS OR WOODY DEBRIS [1]

AMOUNT
Check ONE (Or 2 & average)
- ☐ EXTENSIVE >75% [11]
- ☒ MODERATE 25-75% [7]
- ☐ SPARSE 5-<25% [3]
- ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 11 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☒ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☒ MODERATE [2]
☒ LOW [2]	☒ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 13 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☐☒ NONE / LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY / SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☒ VERY NARROW < 5m [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☐ FOREST, SWAMP [3]
- ☐☒ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING / CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 6 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH
Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7-<1m [4]
- ☒ 0.4-<0.7m [2]
- ☐ 0.2-<0.4m [1]
- ☐ < 0.2m [0]

CHANNEL WIDTH
Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☒ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY
Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☒ MODERATE [1]
- ☒ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 5 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:
Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☒ BEST AREAS 5-10cm [1]
- ☐ BEST AREAS < 5cm [metric=0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☒ MAXIMUM < 50cm [1]

RIFFLE / RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE / RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☒ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Comments

Riffle / Run: 3 (Maximum 8)

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2-4]
- ☐ MODERATE [6-10]
- ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 4 (Maximum 10)

Ohio EPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 52

Stream & Location: Cobus Creek **RM:** ___._ **Date:** 8/3/16

Site 9 @ Garver Lake **Scorers Full Name & Affiliation:** GRB

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present. Check ONE (Or 2 & average)

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐[x] GRAVEL [7]			☐☐ SILT [2]		
☐[x] SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] [x] 3 or less [0]

ORIGIN: ☐ LIMESTONE [1] · [x] TILLS [1] · ☐ WETLANDS [0] · ☐ HARDPAN [0] · ☐ SANDSTONE [0] · ☐ RIP/RAP [0] · ☐ LACUSTURINE [0] · ☐ SHALE [-1] · ☐ COAL FINES [-2]

QUALITY — SILT: ☐ HEAVY [-2] · ☐ MODERATE [-1] · [x] NORMAL [0] · ☐ FREE [1]

QUALITY — EMBEDDEDNESS: ☐ EXTENSIVE [-2] · ☐ MODERATE [-1] · [x] NORMAL [0] · ☐ NONE [1]

Comments

Substrate: 13 (14) — Maximum 20

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]	___ POOLS > 70cm [2]	___ OXBOWS, BACKWATERS [1]
X OVERHANGING VEGETATION [1]	___ ROOTWADS [1]	X AQUATIC MACROPHYTES [1]
X SHALLOWS (IN SLOW WATER) [1]	___ BOULDERS [1]	X LOGS OR WOODY DEBRIS [1]
X ROOTMATS [1]		

AMOUNT — Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] · ☐ MODERATE 25-75% [7] · [x] SPARSE 5-<25% [3] · ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 8 — Maximum 20

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	[x] NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	[x] MODERATE [2]
[x] LOW [2]	[x] FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 13 — Maximum 20

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average). River right looking downstream.

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐[x] NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐[x] SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐[x] NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 7 — Maximum 10

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH — Check ONE (ONLY!)	CHANNEL WIDTH — Check ONE (Or 2 & average)	CURRENT VELOCITY — Check ALL that apply	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	[x] SLOW [1]
☐ 0.7-<1m [4]	[x] POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☐ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
[x] 0.2-<0.4m [1]		[x] MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]			

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 — Maximum 12

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
[x] BEST AREAS 5-10cm [1]	[x] MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		[x] UNSTABLE (e.g., Fine Gravel, Sand) [0]	[x] MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 2 — Maximum 8

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4] · ☐ MODERATE [6-10] · ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___
%RUN: ___ %RIFFLE: ___

Gradient: 4 — Maximum 10

OhioEPA

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 23

Stream & Location: Cohus Creek Site 10 **RM:** ___._ **Date:** 8/3/16

Scorers Full Name & Affiliation: GRB

River Code: __-___-___ **STORET #:** ______ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☒ MUCK [2]		
☐☐ GRAVEL [7]			☐☒ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN		QUALITY
☐ LIMESTONE [1]	SILT	☒ HEAVY [-2]
☐ TILLS [1]		☐ MODERATE [-1]
☒ WETLANDS [0]		☐ NORMAL [0]
☐ HARDPAN [0]		☐ FREE [1]
☐ SANDSTONE [0]	EMBEDDEDNESS	☒ EXTENSIVE [-2]
☐ RIP/RAP [0]		☐ MODERATE [-1]
☐ LACUSTURINE [0]		☐ NORMAL [0]
☐ SHALE [-1]		☐ NONE [1]
☐ COAL FINES [-2]		

Substrate: 0 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
X SHALLOWS (IN SLOW WATER) [1]
___ ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
___ AQUATIC MACROPHYTES [1]
X LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☒ NEARLY ABSENT <5% [1]

Comments

Cover: 3 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☒ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☒ LOW [1]
☒ NONE [1]	☒ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 7 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐☒ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☒ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☒ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 8 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☒ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☐ POOL WIDTH = RIFFLE WIDTH [1]
☒ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
☐ TORRENTIAL [-1] ☒ SLOW [1]
☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
☐ FAST [1] ☐ INTERMITTENT [-2]
☐ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 1 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☒ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☒ BEST AREAS < 5cm [metric=0]		☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☒ EXTENSIVE [-1]

Comments

Riffle / Run: 0 (Maximum 8)

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)
☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient: 4 (Maximum 10)

deep silt!

52

OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** **QHEI Score:** [5̶0̶ 52]

Stream & Location: Cobus Creek **RM:** ___._ **Date:** 8/3/16
Site 11 **Scorers Full Name & Affiliation:** GRB
River Code: __-__-__ **STORET #:** ____ **Lat./ Long.:** (NAD 83 - decimal °) __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☐ COBBLE [8]			☐☐ MUCK [2]		
☐☒ GRAVEL [7]			☐☐ SILT [2]		
☐☒ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☒ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☒ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY
SILT: ☐ HEAVY [-2] ☐ MODERATE [-1] ☒ NORMAL [0] ☐ FREE [1]
EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☐ MODERATE [-1] ☒ NORMAL [0] ☐ NONE [1]

Substrate: 14 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

___ UNDERCUT BANKS [1]
___ OVERHANGING VEGETATION [1]
X SHALLOWS (IN SLOW WATER) [1]
X ROOTMATS [1]
___ POOLS > 70cm [2]
___ ROOTWADS [1]
___ BOULDERS [1]
___ OXBOWS, BACKWATERS [1]
X AQUATIC MACROPHYTES [1]
X LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☒ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover: 7 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☒ NONE [6]	☐ HIGH [3]
☒ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☒ MODERATE [2]
☐ LOW [2]	☒ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 14 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐☒ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☒ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☒ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 7 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!)
☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☒ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average)
☐ POOL WIDTH > RIFFLE WIDTH [2]
☒ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
☐ TORRENTIAL [-1] ☒ SLOW [1]
☐ VERY FAST [1] ☐ INTERSTITIAL [-1]
☐ FAST [1] ☐ INTERMITTENT [-2]
☒ MODERATE [1] ☐ EDDIES [1]
Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 4 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☒̶ NONE [2]
☐ BEST AREAS 5-10cm [1]	☒ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☒ BEST AREAS < 5cm [metric=0]		☒ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☒ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 2 (Maximum 8)

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)
☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ( ) %GLIDE: ( )
%RUN: ( ) %RIFFLE: ( )

Gradient: 4 (Maximum 10)

OhioEPA — Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: 77

Stream & Location: Christianna Cr @ Bristol St. Site 12 **RM:** ___ **Date:** 7/27/06/16
Scorers Full Name & Affiliation: ______
River Code: ___-___-___ **STORET #:** ______ **Lat./Long.: (NAD 83 - decimal °)** __.____ /8_.____ Office verified location ☐

1] SUBSTRATE
Check ONLY Two substrate TYPE BOXES; estimate % or note every type present

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]			☐☐ HARDPAN [4]		
☐☐ BOULDER [9]			☐☐ DETRITUS [3]		
☐☒ COBBLE [8]			☐☐ MUCK [2]		
☐☒ GRAVEL [7]			☐☐ SILT [2]		
☐☐ SAND [6]			☐☐ ARTIFICIAL [0]		
☐☐ BEDROCK [5]					

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☒ 4 or more [2] ☐ 3 or less [0]

Comments

Check ONE (Or 2 & average)

ORIGIN: ☐ LIMESTONE [1] ☒ TILLS [1] ☐ WETLANDS [0] ☐ HARDPAN [0] ☐ SANDSTONE [0] ☐ RIP/RAP [0] ☐ LACUSTURINE [0] ☐ SHALE [-1] ☐ COAL FINES [-2]

QUALITY:
- SILT: ☐ HEAVY [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☒ FREE [1]
- EMBEDDEDNESS: ☐ EXTENSIVE [-2] ☐ MODERATE [-1] ☐ NORMAL [0] ☒ NONE [1]

Substrate: 20 (Maximum 20)

2] INSTREAM COVER
Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- ___ UNDERCUT BANKS [1]
- X OVERHANGING VEGETATION [1]
- X SHALLOWS (IN SLOW WATER) [1]
- X ROOTMATS [1]
- X POOLS > 70cm [2]
- X ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- X AQUATIC MACROPHYTES [1]
- X LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average): ☐ EXTENSIVE >75% [11] ☒ MODERATE 25-75% [7] ☐ SPARSE 5-<25% [3] ☐ NEARLY ABSENT <5% [1]

Comments

Cover: 14 (Maximum 20)

3] CHANNEL MORPHOLOGY
Check ONE in each category (Or 2 & average)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☒ NONE [6]	☒ HIGH [3]
☒ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☒ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel: 15 (Maximum 20)

4] BANK EROSION AND RIPARIAN ZONE
Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐☒ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☒ NARROW 5-10m [2]	☐☒ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian: 6 (Maximum 10)

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH Check ONE (ONLY!): ☒ > 1m [6] ☐ 0.7-<1m [4] ☐ 0.4-<0.7m [2] ☐ 0.2-<0.4m [1] ☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (Or 2 & average): ☐ POOL WIDTH > RIFFLE WIDTH [2] ☒ POOL WIDTH = RIFFLE WIDTH [1] ☐ POOL WIDTH > RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply: ☐ TORRENTIAL [-1] ☐ VERY FAST [1] ☐ FAST [1] ☒ MODERATE [1] ☒ SLOW [1] ☐ INTERSTITIAL [-1] ☐ INTERMITTENT [-2] ☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current: 9 (Maximum 12)

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☒ BEST AREAS > 10cm [2]	☒ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☒ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run: 7 (Maximum 8)

6] GRADIENT (ft/mi) DRAINAGE AREA (mi²)
☐ VERY LOW - LOW [2-4] ☐ MODERATE [6-10] ☐ HIGH - VERY HIGH [10-6]

%POOL: ___ %GLIDE: ___ %RUN: ___ %RIFFLE: ___

Gradient: 6 (Maximum 10)

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [61]**

Stream Cobus Creek Station CR 12 S.k 2
Date 6/15/16 Form completed by MEB

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present) **Substrate Score: 14.5**

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [✓] Gravel(7)	/
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	/
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ / ✓
[ ] [ ] Muck/Silt(2)	✓ /	[ ] [ ] Artificial(0)	/

Total number of substrates present: Check ONE [ ] >4(2) [✓] <=4(0) 6+6.5+1+1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [✓] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [ ] Silt moderate(-1)
- [✓] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [ ] Moderate – 50-75% (-1)
- [ ] Low – 25-50% (0)
- [✓] None – <25% (1)

Comments:

2-INSTREAM COVER (20)
Cover Score: 8

TYPE (check ALL that apply)
- [✓] Undercut banks(1)
- [✓] Overhanging vegetation(1)
- [✓] Shallows (in slow water)(1)
- [✓] Deep pools(2)
- [✓] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [✓] Aquatic macrophytes(1)
- [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [✓] Moderate 75-25% (7)
- [ ] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE) **Channel Score: 11**

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [ ] Low(2) (1-2 poorly defined outside bends)
- [✓] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [✓] Good(5) (defined pools and riffles)
- [ ] Fair(3) (riffles poor or absent/pools developed)
- [ ] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [✓] Recovering(3)
- [ ] Recent or no recovery(1)

Stability
- [ ] High(3)
- [✓] Moderate(2)
- [ ] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Impound
- [ ] Relocation
- [ ] Islands
- [ ] Canopy removal
- [ ] One side channel modifications
- [ ] Bank Shaping
- [ ] Levied
- [ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking **downstream** **Riparian: 8.5**

Riparian width (check one box per bank) L R
- [ ] [✓] Wide > 50m(4)
- [✓] [ ] Moderate 10-50m(3)
- [ ] [ ] Narrow 5-10m(2)
- [ ] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

3.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average) L R
- [ ] [✓] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [✓] [ ] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

2

Bank Erosion (check one box per bank) L R (check one box per bank)
- [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

3

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)
Pool Score: 7 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [✓] 0.7-1m(4)
- [ ] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
- [ ] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
- [ ] Torrential(-1)
- [✓] Fast(1)
- [✓] Moderate(1)
- [✓] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [✓] Generally 5-10cm(1)
- [ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [ ] Moderate – 50-75% (0)
- [✓] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)
Gradient Score: 10

Gradient: ______(ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ______(m) % Pool ____

Average Depth: ______(m) % Riffle ____

Maximum Depth: ______(m) % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) — QHEI SCORE: [63.5]

Stream: Cobus Creek   Station: CR 12   Sk 1
Date: 7-26-11   Form completed by: BJF

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) — Substrate Score: 14

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [✓] Gravel(7)	/
[ ] [ ] Boulder(9)	/	[✓] [ ] Sand(6)	/
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓/✓
[ ] [ ] Muck/Silt(2)	✓/	[ ] [ ] Artificial(0)	/

Total number of substrates present: Check ONE [ ] >4(2) [✓] <=4(0)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply): [ ] Limestone(1) [✓] Tills(1) [ ] Sandstone(0) [ ] Shale(-1) [ ] Rip/Rap(0) [ ] Hardpan(0) [ ] Coal fines(-2)

Silt Cover (check one): [ ] Silt heavy(-2) [ ] Silt moderate(-1) [✓] Silt normal(0) [ ] Silt free(1)

Extent of Embeddedness (check one): [ ] Extensive – >75% (-2) [ ] Moderate – 50-75% (-1) [✓] Low – 25-50% (0) [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20) — Cover Score: 15

TYPE (check ALL that apply)

[✓] Undercut banks(1) [✓] Overhanging vegetation(1) [✓] Shallows (in slow water)(1) [✓] Deep pools(2) [✓] Rootwads(1) [ ] Boulders(1) [ ] Oxbows(1) [✓] Aquatic macrophytes(1) [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE): [ ] Extensive >75% (11) [✓] Moderate 75-25% (7) [ ] Sparse 25-5% (3) [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) — Channel Score: 7

Sinuosity: [ ] High(4) (>=2 well defined outside bends) [ ] Moderate(3) (1 well defined outside bend) [ ] Low(2) (1-2 poorly defined outside bends) [✓] None(1) (straight)

Development: [ ] Excellent(7) (must have best pool/riffle) [ ] Good(5) (defined pools and riffles) [✓] Fair(3) (riffles poor or absent/pools developed) [ ] Poor(1) (riffles absent or shallow)

Channelization: [ ] None(6) [ ] Recovered(4) [ ] Recovering(3) [✓] Recent or no recovery(1)

Stability: [ ] High(3) [✓] Moderate(2) [ ] Low(1)

Modifications/Other: [ ] Snagging [ ] Impound [ ] Relocation [ ] Islands [ ] Canopy removal [ ] One side channel modifications [ ] Bank Shaping [ ] Levied [ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream — Riparian: 6.5

Riparian width (check one box per bank) L R: [ ] [ ] Wide > 50m(4) [✓] [✓] Moderate 10-50m(3) [ ] [ ] Narrow 5-10m(2) [ ] [ ] Very Narrow 1-5m(1) [ ] [ ] None(0) — 3

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average) L R: [ ] [ ] Forest, Swamp(3) [ ] [✓] Open pasture/Rowcrop(0) [✓] [ ] Residential, Park, New field(1) [ ] [ ] Fenced pasture(1) [ ] [ ] Urban or Industrial(0) [ ] [ ] Shrub or Old field(2) [ ] [ ] Conservation tillage(1) [ ] [ ] Mining, Construction(0) — 0.5

Bank Erosion (check one box per bank) L R: [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding) [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding) [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding) — 3

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) — Pool Score: 8 (max score = 12)

Max pool depth (check one): [ ] >1m(6) [✓] 0.7-1m(4) [ ] 0.4-0.7m(2) [ ] <0.4m(1) [ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one): [✓] Pool width > riffle width(2) [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present) [ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply): [ ] Torrential(-1) [ ] Fast(1) [✓] Moderate(1) [✓] Slow(1) [ ] Eddies(1) [ ] Interstitial(-1) [ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 3 (max score = 8)

Riffle/Run depth (check one): [ ] Generally > 10cm, Max > 50cm(4) [ ] Generally > 10cm, Max < 50cm(3) [✓] Generally 5-10cm(1) [ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one): [ ] Stable- eg. cobble, boulder(2) [✓] Mod. Stable- eg. pea gravel(1) [ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one): [ ] Extensive – >75% (-1) [ ] Moderate – 50-75% (0) [✓] Low – 25-50% (1) [ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10) — Gradient Score: 10

Gradient: ____ (ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ____ (m)   % Pool ____
Average Depth: ____ (m)   % Riffle ____
Maximum Depth: ____ (m)   % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) — QHEI SCORE: [45.5]

Stream: Gast Ditch — Station: Douglas Rd — 5/07 Site 2

Date: 5/26/16 — Form completed by: MEB

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 12

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	✓ / ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/ ✓
[ ] [ ] Hardpan(4)	/ ✓	[ ] [ ] Detritus(3)	✓ / ✓
[ ] [✓] Muck/Silt(2)	✓ / ✓	[ ] [ ] Artificial(0)	/

Total number of substrates present: Check ONE — [ ] >4(2) [ ] <=4(0)   12 + 1 − 1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [✓] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [✓] Silt moderate(-1)
- [ ] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [ ] Moderate – 50-75% (-1)
- [✓] Low – 25-50% (0)
- [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 7

TYPE (check ALL that apply)
- [ ] Undercut banks(1)
- [✓] Overhanging vegetation(1)
- [✓] Shallows (in slow water)(1)
- [ ] Deep pools(2)
- [ ] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [✓] Aquatic macrophytes(1)
- [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [ ] Moderate 75-25% (7)
- [✓] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE)

Channel Score: 6

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [ ] Low(2) (1-2 poorly defined outside bends)
- [✓] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [ ] Good(5) (defined pools and riffles)
- [✓] Fair(3) (riffles poor or absent/pools developed)
- [ ] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [ ] Recovering(3)
- [✓] Recent or no recovery(1)

Stability
- [ ] High(3)
- [ ] Moderate(2)
- [✓] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Relocation
- [ ] Canopy removal
- [ ] One side channel modifications
- [ ] Impound
- [ ] Islands
- [ ] Bank Shaping
- [ ] Levied
- [ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking downstream

Riparian: 7.5

Riparian width (check one box per bank) — L R
- [ ] [ ] Wide > 50m(4)
- [✓] [ ] Moderate 10-50m(3)
- [ ] [✓] Narrow 5-10m(2)
- [ ] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

2.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average) — L R
- [✓] [ ] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [ ] [✓] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

2

Bank Erosion (check one box per bank) — L R (check one box per bank)
- [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 4 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [ ] 0.7-1m(4)
- [✓] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
- [ ] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [✓] Moderate(1)
- [✓] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [✓] Generally 5-10cm(1)
- [ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [✓] Moderate – 50-75% (0)
- [ ] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______ (ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ______ (m) — % Pool ______

Average Depth: ______ (m) — % Riffle ______

Maximum Depth: ______ (m) — % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) QHEI SCORE: [24]

Stream Gast Ditch Station Douglas Site 2
Date 7/11/16 Form completed by CNQ

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) Substrate Score: 3

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	___/___	[ ] [ ] Gravel(7)	___/___	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	___/___	[✓] [ ] Sand(6)	___/___	[✓] Tills(1)	[✓] Silt moderate(-1)
[ ] [ ] Cobble(8)	___/___	[ ] [ ] Bedrock(5)	___/___	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	___/___	[ ] [ ] Detritus(3)	✓/___	[ ] Shale(-1)	[ ] Silt free(1)
[✓] [ ] Muck/Silt(2)	✓/___	[ ] [ ] Artificial(0)	___/___	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
				[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
				[ ] Coal fines(-2)	[✓] Moderate – 50-75% (-1)
					[ ] Low – 25-50% (0)
					[ ] None – <25% (1)

Total number of substrates present: Check ONE [ ] >4(2) [✓] <=4(0)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20) Cover Score: 2

TYPE (check ALL that apply)

[ ] Undercut banks(1) [ ] Deep pools(2) [ ] Oxbows(1)
[ ] Overhanging vegetation(1) [ ] Rootwads(1) [ ] Aquatic macrophytes(1)
[✓] Shallows (in slow water)(1) [ ] Boulders(1) [ ] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[ ] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[✓] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) Channel Score: 4

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[✓] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream Riparian: 5

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[✓] [✓] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [ ] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[✓] [✓] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)

L R
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) Pool Score: 0 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1) [ ] Eddies(1)
[ ] Fast(1) [ ] Interstitial(-1)
[ ] Moderate(1) [ ] Intermittent(-2)
[ ] Slow(1)

*[✓] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[✓] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10) Gradient Score: 10

Gradient: ______(ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool _____
Average Depth: ______(m) % Riffle _____
Maximum Depth: ______(m) % Run _____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI)

QHEI SCORE: [67.5]

Stream Cobus Creek   Station CR 8   Site 3
Date 6/14/16   Form completed by JLM

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 11.5

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [✓] Gravel(7)	✓ / ✓
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	✓ / ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ /
[ ] [ ] Muck/Silt(2)	✓ /	[ ] [ ] Artificial(0)	/

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0)   6+6.5+1-2

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
[ ] Limestone(1)
[✓] Tills(1)
[ ] Sandstone(0)
[ ] Shale(-1)
[ ] Rip/Rap(0)
[ ] Hardpan(0)
[ ] Coal fines(-2)

Silt Cover (check one)
[ ] Silt heavy(-2)
[✓] Silt moderate(-1)
[ ] Silt normal(0)
[ ] Silt free(1)

Extent of Embeddedness (check one)
[ ] Extensive – >75% (-2)
[✓] Moderate – 50-75% (-1)
[ ] Low – 25-50% (0)
[ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 15

TYPE (check ALL that apply)

[✓] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[✓] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 14

Sinuosity
[✓] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[ ] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[✓] Fair(3) (riffles poor or absent/pools developed)
[ ] Poor(1) (riffles absent or shallow)

Channelization
[✓] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging
[ ] Impound
[ ] Relocation
[ ] Islands
[ ] Canopy removal
[ ] One side channel modifications
[ ] Bank Shaping
[ ] Levied
[ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream

Riparian: 10

Riparian width (check one box per bank)
L R
[✓] [✓] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [✓] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 6 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[✓] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[✓] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[✓] Generally 5-10cm(1)
[ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[✓] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 10

Gradient: ______(ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m)   % Pool ____
Average Depth: ______(m)   % Riffle ____
Maximum Depth: ______(m)   % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [68]**

Stream Lobus Station 1R 8 St 3
Date 7-26-16 Form completed by GJF

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) Substrate Score: 12

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	✓ / ✓	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	/	[✓] Tills(1)	[✓] Silt moderate(-1)
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ / ✓	[ ] Shale(-1)	[ ] Silt free(1)
[ ] [ ] Muck/Silt(2)	✓ /	[ ] [ ] Artificial(0)	/	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
Total number of substrates present: [ ] >4(2)				[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
Check ONE [✓] <=4(0)		6+6+1-1		[ ] Coal fines(-2)	[ ] Moderate – 50-75% (-1)
					[✓] Low – 25-50% (0)
					[ ] None – <25% (1)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20) Cover Score: 15

TYPE (check ALL that apply)

[✓] Undercut banks(1) [✓] Deep pools(2) [ ] Oxbows(1)
[✓] Overhanging vegetation(1) [✓] Rootwads(1) [✓] Aquatic macrophytes(1)
[✓] Shallows (in slow water)(1) [ ] Boulders(1) [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) Channel Score: 15

Sinuosity	Development	Channelization	Stability	Modifications/Other		
[✓] High(4) (>=2 well defined outside bends)	[ ] Excellent(7) (must have best pool/riffle)	[✓] None(6)	[✓] High(3)	[ ] Snagging	[ ] Impound	[ ] Bank Shaping
[ ] Moderate(3) (1 well defined outside bend)	[ ] Good(5) (defined pools and riffles)	[ ] Recovered(4)	[✓] Moderate(2)	[ ] Relocation	[ ] Islands	[ ] Levied
[ ] Low(2) (1-2 poorly defined outside bends)	[✓] Fair(3) (riffles poor or absent/pools developed)	[ ] Recovering(3)	[ ] Low(1)	[ ] Canopy removal		[ ] Dredging
[ ] None(1) (straight)	[ ] Poor(1) (riffles absent or shallow)	[ ] Recent or no recovery(1)		[ ] One side channel modifications		

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking **downstream** Riparian: 10

Riparian width (check one box per bank)
L R
[✓] [✓] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)
4

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [✓] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
3

L R
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)
3

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) Pool Score: 4 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1) [ ] Eddies(1)
[ ] Fast(1) [ ] Interstitial(-1)
[✓] Moderate(1) [ ] Intermittent(-2)
[✓] Slow(1)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[✓] Generally 5-10cm(1)
[ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[✓] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10) Gradient Score: 10

Gradient: ______(ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool ______
Average Depth: ______(m) % Riffle ______
Maximum Depth: ______(m) % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI)

QHEI SCORE: [40.5]

Stream East Trib of Cobus   Station CR 6   Site 4

Date 5/26/16   Form completed by MEB

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 8

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [✓] Gravel(7)	/ ✓
[ ] [ ] Boulder(9)	/	[✓] [ ] Sand(6)	✓ / ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [✓] Detritus(3)	✓ / ✓
[ ] [ ] Muck/Silt(2)	✓ / ✓	[ ] [ ] Artificial(0)	✓ /

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0)

9 +1 −2

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [✓] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [✓] Silt moderate(-1)
- [ ] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [✓] Moderate – 50-75% (-1)
- [ ] Low – 25-50% (0)
- [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 12

TYPE (check ALL that apply)

- [ ] Undercut banks(1)
- [✓] Overhanging vegetation(1)
- [✓] Shallows (in slow water)(1)
- [ ] Deep pools(2)
- [✓] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [✓] Aquatic macrophytes(1)
- [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [✓] Moderate 75-25% (7)
- [ ] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE)

Channel Score: 4

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [ ] Low(2) (1-2 poorly defined outside bends)
- [✓] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [ ] Good(5) (defined pools and riffles)
- [ ] Fair(3) (riffles poor or absent/pools developed)
- [✓] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [ ] Recovering(3)
- [✓] Recent or no recovery(1)

Stability
- [ ] High(3)
- [ ] Moderate(2)
- [✓] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Impound
- [ ] Bank Shaping
- [ ] Relocation
- [ ] Islands
- [ ] Levied
- [ ] Canopy removal
- [ ] Dredging
- [ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking downstream

Riparian: 5.5

Riparian width (check one box per bank)

L R
- [ ] [ ] Wide > 50m(4)
- [ ] [ ] Moderate 10-50m(3)
- [ ] [ ] Narrow 5-10m(2)
- [✓] [✓] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)

L R
- [ ] [ ] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [✓] [ ] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [✓] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

1 + 1.5 + 3

Bank Erosion (check one box per bank)

L R (check one box per bank)
- [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 0 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [ ] 0.7-1m(4)
- [ ] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [✓] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
- [ ] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [ ] Moderate(1)
- [ ] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [✓] Generally 5-10cm(1)
- [ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [✓] Moderate – 50-75% (0)
- [ ] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 10

Gradient: ______ (ft/mi)

Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______ (m)   % Pool ______

Average Depth: ______ (m)   % Riffle ______

Maximum Depth: ______ (m)   % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [37.5]**

Stream Cobus Lateral A Station CR 6 Site 4
Date 7/6/16 Form completed by MEB

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) Substrate Score: 4

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	___/___	[ ] [ ] Gravel(7)	___/___
[ ] [ ] Boulder(9)	___/___	[ ] [ ] Sand(6)	___/___
[ ] [ ] Cobble(8)	___/___	[ ] [ ] Bedrock(5)	___/___
[ ] [ ] Hardpan(4)	___/___	[✓] [ ] Detritus(3)	___/✓
[ ] [ ] Muck/Silt(2)	✓/___	[ ] [ ] Artificial(0)	✓/___

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0) 3

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
[ ] Limestone(1)
[✓] Tills(1)
[ ] Sandstone(0)
[ ] Shale(-1)
[ ] Rip/Rap(0)
[ ] Hardpan(0)
[ ] Coal fines(-2)

Silt Cover (check one)
[ ] Silt heavy(-2)
[ ] Silt moderate(-1)
[✓] Silt normal(0)
[ ] Silt free(1)

Extent of Embeddedness (check one)
[ ] Extensive – >75% (-2)
[ ] Moderate – 50-75% (-1)
[✓] Low – 25-50% (0)
[ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20) Cover Score: 13

TYPE (check ALL that apply)
[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) Channel Score: 4

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[✓] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream Riparian: 5.5

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[✓] [✓] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[ ] [ ] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [✓] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[✓] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

1 1.5 3

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) Pool Score: 3 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[✓] <0.4m(1)
[ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10) Gradient Score: 10

Gradient: ______(ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool ____
Average Depth: ______(m) % Riffle ____
Maximum Depth: ______(m) % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [** 65.5 **]**

Stream Gast Ditch   Station CR 2 (Adams Rd) Site 5

Date 5/26/16   Form completed by MEB

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 16

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	___/___	[✓] [ ] Gravel(7)	✓/✓
[ ] [ ] Boulder(9)	___/___	[ ] [✓] Sand(6)	✓/✓
[ ] [ ] Cobble(8)	___/___	[ ] [ ] Bedrock(5)	___/___
[ ] [ ] Hardpan(4)	___/___	[ ] [ ] Detritus(3)	✓/✓
[ ] [ ] Muck/Silt(2)	✓/✓	[ ] [ ] Artificial(0)	✓/___

Total number of substrates present: [✓] >4(2)
Check ONE [ ] <=4(0)   13+2+1

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [✓] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [ ] Silt moderate(-1)
- [✓] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [ ] Moderate – 50-75% (-1)
- [✓] Low – 25-50% (0)
- [ ] None – <25% (1)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20)

Cover Score: 13

TYPE (check ALL that apply)
- [ ] Undercut banks(1)
- [✓] Overhanging vegetation(1)
- [✓] Shallows (in slow water)(1)
- [✓] Deep pools(2)
- [ ] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [✓] Aquatic macrophytes(1)
- [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [✓] Moderate 75-25% (7)
- [ ] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 13

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [✓] Moderate(3) (1 well defined outside bend)
- [ ] Low(2) (1-2 poorly defined outside bends)
- [ ] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [✓] Good(5) (defined pools and riffles)
- [ ] Fair(3) (riffles poor or absent/pools developed)
- [ ] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [✓] Recovering(3)
- [ ] Recent or no recovery(1)

Stability
- [ ] High(3)
- [✓] Moderate(2)
- [ ] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Impound
- [ ] Bank Shaping
- [ ] Relocation
- [ ] Islands
- [ ] Levied
- [ ] Canopy removal
- [ ] Dredging
- [ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream

Riparian: 5.5

Riparian width (check one box per bank)
L R
- [ ] [ ] Wide > 50m(4)
- [ ] [ ] Moderate 10-50m(3)
- [ ] [✓] Narrow 5-10m(2)
- [✓] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
- [ ] [ ] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [✓] [✓] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

1.5+1+3

Bank Erosion (check one box per bank)
L R (check one box per bank)
- [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 8 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [✓] 0.7-1m(4)
- [ ] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
- [✓] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [✓] Moderate(1)
- [✓] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [✓] Generally 5-10cm(1)
- [ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [ ] Moderate – 50-75% (0)
- [✓] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 10

Gradient: ______(ft/mi)

Gradient:
- [ ] Low
- [ ] Moderate
- [ ] High

Average Width: ______(m)   % Pool ____

Average Depth: ______(m)   % Riffle ____

Maximum Depth: ______(m)   % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [55]**

Stream ~~Little Heck~~ Gast Ditch Station Adams Road Site 5
Date 7-6-16 Form completed by ______

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present) **Substrate Score:** 12

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	/ ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ / ✓
[ ] [ ] Muck/Silt(2)	/	[ ] [ ] Artificial(0)	✓ /

Total number of substrates present: Check ONE [ ] >4(2) [ ] <=4(0) 6+6 +1 -1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
[ ] Limestone(1)
[✓] Tills(1)
[ ] Sandstone(0)
[ ] Shale(-1)
[ ] Rip/Rap(0)
[ ] Hardpan(0)
[ ] Coal fines(-2)

Silt Cover (check one)
[ ] Silt heavy(-2)
[✓] Silt moderate(-1)
[ ] Silt normal(0)
[ ] Silt free(1)

Extent of Embeddedness (check one)
[ ] Extensive – >75% (-2)
[ ] Moderate – 50-75% (-1)
[✓] Low – 25-50% (0)
[ ] None – <25% (1)

Comments: ______

2-INSTREAM COVER (20)
Cover Score: 12

TYPE (check ALL that apply)
[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[ ] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments: ______

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE) **Channel Score:** 10

Sinuosity
[✓] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[ ] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[✓] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[✓] Moderate(2)
[ ] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments: ______

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking **downstream** **Riparian:** 6

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[✓] [ ] Moderate 10-50m(3)
[✓] [ ] Narrow 5-10m(2)
[ ] [✓] Very Narrow 1-5m(1)
[ ] [ ] None(0)
1.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[ ] [ ] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [✓] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
1.5

L R
[ ] [ ] Urban or Industrial(0)
[✓] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)
3

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments: ______

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)
Pool Score: 7 (max score = 12)

Max pool depth (check **one**)
[ ] >1m(6)
[✓] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check **one**)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check **ALL** that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[✓] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments: ______

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check **one**)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check **one**)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check **one**)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments: No riffle

6-GRADIENT (10)
Gradient Score: 8

Gradient: ______(ft/mi)
Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ______(m) % Pool ______
Average Depth: ______(m) % Riffle ______
Maximum Depth: ______(m) % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI)

QHEI SCORE: [59]

Stream Cobus Creek   Station CR 2   5 to 6

Date 5/24/16   Form completed by MEB

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 15

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/ ✓
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	✓ / ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ / ✓
[ ] [✓] Muck/Silt(2)	✓ / ✓	[ ] [ ] Artificial(0)	✓ /

Total number of substrates present: [✓] >4(2)
Check ONE [ ] <=4(0)   12 + 2 + 1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
[ ] Limestone(1)
[✓] Tills(1)
[ ] Sandstone(0)
[ ] Shale(-1)
[ ] Rip/Rap(0)
[ ] Hardpan(0)
[ ] Coal fines(-2)

Silt Cover (check one)
[ ] Silt heavy(-2)
[ ] Silt moderate(-1)
[✓] Silt normal(0)
[ ] Silt free(1)

Extent of Embeddedness (check one)
[ ] Extensive – >75% (-2)
[ ] Moderate – 50-75% (-1)
[✓] Low – 25-50% (0)
[ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 13

TYPE (check ALL that apply)
[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 10

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[✓] Low(2) (1-2 poorly defined outside bends)
[ ] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[✓] Fair(3) (riffles poor or absent/pools developed)
[ ] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[✓] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[✓] Moderate(2)
[ ] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream

Riparian: 6

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[ ] [✓] Moderate 10-50m(3)
[✓] [✓] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[ ] [ ] Forest, Swamp(3)
[ ] [✓] Open pasture/Rowcrop(0)
[✓] [✓] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
L R
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

2 + 1 + 3

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 5 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

2 + 1 + 2

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[✓] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[✓] Generally 5-10cm(1)
[ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[✓] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______(ft/mi)

Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m)   % Pool ______

Average Depth: ______(m)   % Riffle ______

Maximum Depth: ______(m)   % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [46]**

Stream Cobus Creek Station CR 2 Site 6

Date 7/6/16 Form completed by ____________

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present) **Substrate Score: 7**

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	___/___	[ ] [ ] Gravel(7)	✓/___	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	___/___	[✓] [ ] Sand(6)	✓/___	[✓] Tills(1)	[ ] Silt moderate(-1)
[ ] [ ] Cobble(8)	___/___	[ ] [ ] Bedrock(5)	___/___	[ ] Sandstone(0)	[✓] Silt normal(0)
[ ] [ ] Hardpan(4)	✓/___	[ ] [ ] Detritus(3)	___/___	[ ] Shale(-1)	[ ] Silt free(1)
[ ] [ ] Muck/Silt(2)	✓/___	[ ] [ ] Artificial(0)	___/___	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
Total number of substrates present: [ ] >4(2)				[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
Check ONE [✓] <=4(0)		6+1		[ ] Coal fines(-2)	[ ] Moderate – 50-75% (-1)
					[✓] Low – 25-50% (0)
					[ ] None – <25% (1)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments: ____________

2-INSTREAM COVER (20)
Cover Score: 13

TYPE (check ALL that apply)

[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments: ____________

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE) **Channel Score: 7**

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[✓] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[✓] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[✓] Moderate(2)
[ ] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments: ____________

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking **downstream** **Riparian: 7**

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[ ] [✓] Moderate 10-50m(3)
[✓] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0) 2.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[ ] [ ] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[✓] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1) 1.5

L R
[ ] [ ] Urban or Industrial(0)
[ ] [✓] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0) 3

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments: ____________

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)
Pool Score: 4 (max score = 12)

Max pool depth (check **one**)
[ ] >1m(6)
[ ] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check **one**)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check **ALL** that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments: ____________

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check **one**)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[✓] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check **one**)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check **one**)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments: ____________

6-GRADIENT (10)
Gradient Score: 8

Gradient: ______(ft/mi)

Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool _____

Average Depth: ______(m) % Riffle _____

Maximum Depth: ______(m) % Run _____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI)

QHEI SCORE: [47.5]

Stream Gast Ditch Station Redfield Site 7
Date 5/26/16 Form completed by MFB

1-SUBSTRATE (20)
(check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 9

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	√ / √
[ ] [ ] Boulder(9)	/	[ ] [√] Sand(6)	√ / √
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[√] [ ] Hardpan(4)	√ /	[ ] [ ] Detritus(3)	√ / √
[√] [ ] Muck/Silt(2)	√ / √	[ ] [ ] Artificial(0)	√ /

Total number of substrates present: Check ONE [√] >4(2) [ ] <=4(0) 2+6+2+1-2

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [√] Limestone(1)
- [√] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [√] Silt moderate(-1)
- [ ] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [√] Moderate – 50-75% (-1)
- [ ] Low – 25-50% (0)
- [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 11

TYPE (check ALL that apply)
- [√] Undercut banks(1)
- [√] Overhanging vegetation(1)
- [√] Shallows (in slow water)(1)
- [ ] Deep pools(2)
- [ ] Rootwads(1)
- [ ] Boulders(1)
- [√] Oxbows(1)
- [√] Aquatic macrophytes(1)
- [√] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [√] Moderate 75-25% (7)
- [ ] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20)
(check ONLY one per category OR two and AVERAGE)

Channel Score: 7

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [ ] Low(2) (1-2 poorly defined outside bends)
- [√] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [ ] Good(5) (defined pools and riffles)
- [√] Fair(3) (riffles poor or absent/pools developed)
- [ ] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [√] Recovering(3)
- [√] Recent or no recovery(1)

Stability
- [ ] High(3)
- [√] Moderate(2)
- [ ] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Impound
- [ ] Bank Shaping
- [ ] Relocation
- [ ] Islands
- [ ] Levied
- [ ] Canopy removal
- [ ] Dredging
- [ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10)
*Left/Right banks looking downstream

Riparian: 7.5

Riparian width (check one box per bank)

L R
- [ ] [ ] Wide > 50m(4)
- [ ] [√] Moderate 10-50m(3)
- [√] [ ] Narrow 5-10m(2)
- [ ] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

2.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)

L R
- [ ] [√] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [√] [ ] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

2 3

Bank Erosion (check one box per bank)

L R (check one box per bank)
- [√] [√] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 4 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [ ] 0.7-1m(4)
- [√] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
- [ ] Pool width > riffle width(2)
- [√] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [√] Moderate(1)
- [√] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [√] Generally 5-10cm(1)
- [ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [√] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [√] Moderate – 50-75% (0)
- [ ] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient:______(ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ______(m) % Pool ____

Average Depth: ______(m) % Riffle ____

Maximum Depth: ______(m) % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) QHEI SCORE: [33]

Stream: Gast Ditch Station: Redfield Road Site 7
Date: 7/11/16 Form completed by: JLM

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 7

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	✓/	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	/	[✓] [ ] Sand(6)	✓/	[✓] Tills(1)	[ ] Silt moderate(-1)
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/	[ ] Sandstone(0)	[✓] Silt normal(0)
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓/	[ ] Shale(-1)	[ ] Silt free(1)
[ ] [ ] Muck/Silt(2)	✓/	[ ] [ ] Artificial(0)	/	[ ] Rip/Rap(0)	**Extent of Embeddedness (check one)**
				[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
				[ ] Coal fines(-2)	[ ] Moderate – 50-75% (-1)
					[✓] Low – 25-50% (0)
					[ ] None – <25% (1)

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0) 6 + 1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20)

Cover Score: 7

TYPE (check ALL that apply)

[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[ ] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[ ] Moderate 75-25% (7)
[✓] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 4

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[✓] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream

Riparian: 7

Riparian width (check one box per bank)
L R
[✓] [ ] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[✓] [ ] Narrow 5-10m(2)
[ ] [✓] Very Narrow 1-5m(1)
[ ] [ ] None(0)
2.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [ ] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [✓] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)
2

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [ ] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [✓] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)
2.5

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 0 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[ ] <0.4m(1)
[✓] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[ ] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[✓] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______ (ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______ (m)
Average Depth: ______ (m)
Maximum Depth: ______ (m)

% Pool ____
% Riffle ____
% Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [42]**

Stream Lobus Station Redfield STE 8
Date 6-1-11 Form completed by LTE

1-SUBSTRATE (20)

(check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 0

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/	[ ] Limestone(1)	[✓] Silt heavy(-2)
[ ] [ ] Boulder(9)	/	[ ] [ ] Sand(6)	✓ /	[✓] Tills(1)	[ ] Silt moderate(-1)
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	/	[✓] [ ] Detritus(3)	✓ /	[ ] Shale(-1)	[ ] Silt free(1)
[✓] [ ] Muck/Silt(2)	/	[ ] [ ] Artificial(0)	/	[ ] Rip/Rap(0)	

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0) 2.5 +1 -4

Note: Ignore sludge that originates from point sources; score based on natural substrates.

[ ] Hardpan(0)
[ ] Coal fines(-2)

Extent of Embeddedness (check one)
[✓] Extensive – >75% (-2)
[ ] Moderate – 50-75% (-1)
[ ] Low – 25-50% (0)
[ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 14

TYPE (check ALL that apply)

[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[✓] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20)

(check ONLY one per category OR two and AVERAGE)

Channel Score: 6

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[✓] Fair(3) (riffles poor or absent/pools developed)
[ ] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[✓] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10)

*Left/Right banks looking downstream

Riparian: 10

Riparian width (check one box per bank)
L / R
[✓] [✓] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [✓] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)

L R
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L, R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 4 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[✓] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______ (ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______ (m) % Pool ______
Average Depth: ______ (m) % Riffle ______
Maximum Depth: ______ (m) % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) QHEI SCORE: [46]

Stream: Cobus Creek Station: Redfield Site 8
Date: 7/11/16 Form completed by: CNR

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) Substrate Score: 1

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	___/___	[ ] [ ] Gravel(7)	___/___	[ ] Limestone(1)	[✓] Silt heavy(-2)
[ ] [ ] Boulder(9)	___/___	[✓] [ ] Sand(6)	___/___	[✓] Tills(1)	[✓] Silt moderate(-1)
[ ] [ ] Cobble(8)	___/___	[ ] [ ] Bedrock(5)	___/___	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	___/___	[ ] [ ] Detritus(3)	✓/___	[ ] Shale(-1)	[ ] Silt free(1)
[✓] [ ] Muck/Silt(2)	___/___	[ ] [ ] Artificial(0)	___/___	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
				[ ] Hardpan(0)	[✓] Extensive – >75% (-2)
				[ ] Coal fines(-2)	[ ] Moderate – 50-75% (-1)
					[ ] Low – 25-50% (0)
					[ ] None – <25% (1)

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0) 4 -1 -4

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20) Cover Score: 15

TYPE (check ALL that apply)

[✓] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[✓] Deep pools(2)
[✓] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)

[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) Channel Score: 6

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[ ] Low(2) (1-2 poorly defined outside bends)
[✓] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[✓] Fair(3) (riffles poor or absent/pools developed)
[ ] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[ ] Recovering(3)
[✓] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging
[ ] Impound
[ ] Bank Shaping
[ ] Relocation
[ ] Islands
[ ] Levied
[ ] Canopy removal
[ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream Riparian: 10

Riparian width (check one box per bank)
L R
[✓] [✓] Wide > 50m(4)
[ ] [ ] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [✓] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

4 3 3

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) Pool Score: 6 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[~~✓~~] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (STOP: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[✓] Pool width = riffle width(1) (check this ↑ if no riffle is present)
[ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (STOP: Pool Score = 0)

Comments:

Riffle Score: 0 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[ ] Generally 5-10cm(1)
[ ] Generally < 5 cm (STOP: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[ ] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[✓] No riffle (STOP: Riffle Score = 0)

Comments:

6-GRADIENT (10) Gradient Score: 8

Gradient: ______(ft/mi)
Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool ____
Average Depth: ______(m) % Riffle ____
Maximum Depth: ______(m) % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) QHEI SCORE: [49]

Stream Cobus Creek Station May St. Site 9

Date 6/24/16 Form completed by JLM

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 9

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	✓ / ✓	[✓] Tills(1)	[✓] Silt moderate(-1)
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ /	[ ] Shale(-1)	[ ] Silt free(1)
[✓] [ ] Muck/Silt(2)	✓ / ✓	[ ] [ ] Artificial(0)	/	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
				[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
				[ ] Coal fines(-2)	[✓] Moderate – 50-75% (-1)
					[ ] Low – 25-50% (0)
					[ ] None – <25% (1)

Total number of substrates present: [ ] >4(2)
Check ONE [✓] <=4(0) 4+6+1 -2

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20)

Cover Score: 12

TYPE (check ALL that apply)

[ ] Undercut banks(1)
[✓] Overhanging vegetation(1)
[✓] Shallows (in slow water)(1)
[ ] Deep pools(2)
[✓] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[✓] Aquatic macrophytes(1)
[✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)

[ ] Extensive >75% (11)
[✓] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 7

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[✓] Low(2) (1-2 poorly defined outside bends)
[ ] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[ ] Fair(3) (riffles poor or absent/pools developed)
[✓] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[✓] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[ ] Moderate(2)
[✓] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream

Riparian: 9

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[✓] [✓] Moderate 10-50m(3)
[ ] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[✓] [✓] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[ ] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L R (check one box per bank)
[✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 3 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[✓] 0.4-0.7m(2)
[ ] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[ ] Moderate(1)
[✓] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[✓] Generally 5-10cm(1)
[ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[✓] Moderate – 50-75% (0)
[ ] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______(ft/mi)

Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool ______

Average Depth: ______(m) % Riffle ______

Maximum Depth: ______(m) % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) QHEI SCORE: [55]

Stream Cobus Station Main Street Site 9

Date 7-26-16 Form completed by LTF

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present) Substrate Score: 11

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle	Substrate Origin (check all that apply)	Silt Cover (check one)
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/	[ ] Limestone(1)	[ ] Silt heavy(-2)
[ ] [ ] Boulder(9)	/	[√] [√] Sand(6)	/	[√] Tills(1)	[√] Silt moderate(-1)
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/	[ ] Sandstone(0)	[ ] Silt normal(0)
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	√ / √	[ ] Shale(-1)	[ ] Silt free(1)
[ ] [ ] Muck/Silt(2)	√ / √	[ ] [ ] Artificial(0)	/	[ ] Rip/Rap(0)	Extent of Embeddedness (check one)
Total number of substrates present:	[ ] >4(2)			[ ] Hardpan(0)	[ ] Extensive – >75% (-2)
Check ONE	[√] <=4(0)	6+6+1 – 2		[ ] Coal fines(-2)	[√] Moderate – 50-75% (-1)
					[ ] Low – 25-50% (0)
					[ ] None – <25% (1)

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Comments:

2-INSTREAM COVER (20) Cover Score: 11

TYPE (check ALL that apply)

[ ] Undercut banks(1)
[√] Overhanging vegetation(1)
[√] Shallows (in slow water)(1)
[ ] Deep pools(2)
[ ] Rootwads(1)
[ ] Boulders(1)
[ ] Oxbows(1)
[√] Aquatic macrophytes(1)
[√] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)

[ ] Extensive >75% (11)
[√] Moderate 75-25% (7)
[ ] Sparse 25-5% (3)
[ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE) Channel Score: 10

Sinuosity
[ ] High(4) (>=2 well defined outside bends)
[ ] Moderate(3) (1 well defined outside bend)
[√] Low(2) (1-2 poorly defined outside bends)
[ ] None(1) (straight)

Development
[ ] Excellent(7) (must have best pool/riffle)
[ ] Good(5) (defined pools and riffles)
[√] Fair(3) (riffles poor or absent/pools developed)
[ ] Poor(1) (riffles absent or shallow)

Channelization
[ ] None(6)
[ ] Recovered(4)
[√] Recovering(3)
[ ] Recent or no recovery(1)

Stability
[ ] High(3)
[√] Moderate(2)
[ ] Low(1)

Modifications/Other
[ ] Snagging [ ] Impound [ ] Bank Shaping
[ ] Relocation [ ] Islands [ ] Levied
[ ] Canopy removal [ ] Dredging
[ ] One side channel modifications

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking downstream Riparian: 7.5

Riparian width (check one box per bank)
L R
[ ] [ ] Wide > 50m(4)
[ ] [√] Moderate 10-50m(3)
[√] [ ] Narrow 5-10m(2)
[ ] [ ] Very Narrow 1-5m(1)
[ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)
L R
[ ] [√] Forest, Swamp(3)
[ ] [ ] Open pasture/Rowcrop(0)
[√] [ ] Residential, Park, New field(1)
[ ] [ ] Fenced pasture(1)
[ ] [ ] Urban or Industrial(0)
[ ] [ ] Shrub or Old field(2)
[ ] [ ] Conservation tillage(1)
[ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank)
L R (check one box per bank)
[√] [√] None or Little(3) (<25% of stream bank is stressed or eroding)
[ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
[ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

2 / 2.5 / 3

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20) Pool Score: 2 (max score = 12)

Max pool depth (check one)
[ ] >1m(6)
[ ] 0.7-1m(4)
[ ] 0.4-0.7m(2)
[√] <0.4m(1)
[ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
[ ] Pool width > riffle width(2)
[ ] Pool width = riffle width(1)
(check this ↑ if no riffle is present)
[√] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check ALL that apply)
[ ] Torrential(-1)
[ ] Fast(1)
[√] Moderate(1)
[√] Slow(1)
[ ] Eddies(1)
[ ] Interstitial(-1)
[ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
[ ] Generally > 10cm, Max > 50cm(4)
[ ] Generally > 10cm, Max < 50cm(3)
[√] Generally 5-10cm(1)
[ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
[ ] Stable- eg. cobble, boulder(2)
[ ] Mod. Stable- eg. pea gravel(1)
[√] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
[ ] Extensive – >75% (-1)
[ ] Moderate – 50-75% (0)
[√] Low – 25-50% (1)
[ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10) Gradient Score: 8

Gradient: ______(ft/mi)

Gradient: [ ] Low
[ ] Moderate
[ ] High

Average Width: ______(m) % Pool ______

Average Depth: ______(m) % Riffle ______

Maximum Depth: ______(m) % Run ______

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [54.5]**

Stream: Cobus Creek   Station: US of Coberts Lake Site 11

Date: 6/24/16   Form completed by: JLM

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 13

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	/	[ ] [ ] Gravel(7)	/ ✓
[ ] [ ] Boulder(9)	/	[✓] [✓] Sand(6)	✓ / ✓
[ ] [ ] Cobble(8)	/	[ ] [ ] Bedrock(5)	/
[ ] [ ] Hardpan(4)	/	[ ] [ ] Detritus(3)	✓ /
[ ] [ ] Muck/Silt(2)	✓ /	[ ] [ ] Artificial(0)	/

Total number of substrates present: [ ] >4(2) Check ONE [✓] <=4(0)   6+6+1

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [✓] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [ ] Silt moderate(-1)
- [✓] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [ ] Moderate – 50-75% (-1)
- [✓] Low – 25-50% (0)
- [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 11

TYPE (check ALL that apply)
- [ ] Undercut banks(1)
- [✓] Overhanging vegetation(1)
- [✓] Shallows (in slow water)(1)
- [ ] Deep pools(2)
- [ ] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [✓] Aquatic macrophytes(1)
- [✓] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [✓] Moderate 75-25% (7)
- [ ] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 9

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [✓] Low(2) (1-2 poorly defined outside bends)
- [ ] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [ ] Good(5) (defined pools and riffles)
- [✓] Fair(3) (riffles poor or absent/pools developed)
- [ ] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [✓] Recovering(3)
- [ ] Recent or no recovery(1)

Stability
- [ ] High(3)
- [ ] Moderate(2)
- [✓] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Relocation
- [ ] Canopy removal
- [ ] One side channel modifications
- [ ] Impound
- [ ] Islands
- [ ] Bank Shaping
- [ ] Levied
- [ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking **downstream**

Riparian: 9.5

Riparian width (check one box per bank)

L R
- [ ] [✓] Wide > 50m(4)
- [✓] [ ] Moderate 10-50m(3)
- [ ] [ ] Narrow 5-10m(2)
- [ ] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

3.5

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average)

L R
- [✓] [✓] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [ ] [ ] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

3

Bank Erosion (check one box per bank)

L R (check one box per bank)
- [✓] [✓] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

3

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 2 (max score = 12)

Max pool depth (check one)
- [ ] >1m(6)
- [ ] 0.7-1m(4)
- [ ] 0.4-0.7m(2)
- [✓] <0.4m(1)
- [ ] <0.2m (**STOP**: Pool Score = 0)

Morphology (check one)
- [ ] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [✓] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check **ALL** that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [ ] Moderate(1)
- [✓] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 2 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [✓] Generally 5-10cm(1)
- [ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [✓] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [ ] Moderate – 50-75% (0)
- [✓] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: ______(ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: ______(m)   % Pool ____

Average Depth: ______(m)   % Riffle ____

Maximum Depth: ______(m)   % Run ____

Date: 5/31/05

ELKHART PW&U SITE DESCRIPTION SHEET (based on Ohio EPA QHEI) **QHEI SCORE: [44]**

Stream: Cobus Creek Station: Upstream Colberts St 11

Date: 8/2/10 Form completed by: MFB

1-SUBSTRATE (20) (check ONE box per area OR two and AVERAGE; check all substrates present)

Substrate Score: 11

TYPE Pool/Riffle	Present Pool/Riffle	TYPE Pool/Riffle	Present Pool/Riffle
[ ] [ ] Boulder/Slabs(10)	__/__	[ ] [ ] Gravel(7)	__/__
[ ] [ ] Boulder(9)	__/__	[x] [x] Sand(6)	__/__
[ ] [ ] Cobble(8)	__/__	[ ] [ ] Bedrock(5)	__/__
[ ] [ ] Hardpan(4)	__/__	[ ] [ ] Detritus(3)	✓/✓
[ ] [ ] Muck/Silt(2)	✓/✓	[ ] [ ] Artificial(0)	__/__

Total number of substrates present: [ ] >4(2) Check ONE [x] <=4(0) 6+6+1-2

Note: Ignore sludge that originates from point sources; score based on natural substrates.

Substrate Origin (check all that apply)
- [ ] Limestone(1)
- [x] Tills(1)
- [ ] Sandstone(0)
- [ ] Shale(-1)
- [ ] Rip/Rap(0)
- [ ] Hardpan(0)
- [ ] Coal fines(-2)

Silt Cover (check one)
- [ ] Silt heavy(-2)
- [x] Silt moderate(-1)
- [ ] Silt normal(0)
- [ ] Silt free(1)

Extent of Embeddedness (check one)
- [ ] Extensive – >75% (-2)
- [x] Moderate – 50-75% (-1)
- [ ] Low – 25-50% (0)
- [ ] None – <25% (1)

Comments:

2-INSTREAM COVER (20)

Cover Score: 7

TYPE (check ALL that apply)
- [ ] Undercut banks(1)
- [x] Overhanging vegetation(1)
- [x] Shallows (in slow water)(1)
- [ ] Deep pools(2)
- [ ] Rootwads(1)
- [ ] Boulders(1)
- [ ] Oxbows(1)
- [x] Aquatic macrophytes(1)
- [x] Logs and woody debris(1)

Amount (check ONLY one OR two and AVERAGE)
- [ ] Extensive >75% (11)
- [ ] Moderate 75-25% (7)
- [x] Sparse 25-5% (3)
- [ ] Nearly absent <5% (1)

Comments:

3-CHANNEL MORPHOLOGY (20) (check ONLY one per category OR two and AVERAGE)

Channel Score: 7

Sinuosity
- [ ] High(4) (>=2 well defined outside bends)
- [ ] Moderate(3) (1 well defined outside bend)
- [x] Low(2) (1-2 poorly defined outside bends)
- [ ] None(1) (straight)

Development
- [ ] Excellent(7) (must have best pool/riffle)
- [ ] Good(5) (defined pools and riffles)
- [ ] Fair(3) (riffles poor or absent/pools developed)
- [x] Poor(1) (riffles absent or shallow)

Channelization
- [ ] None(6)
- [ ] Recovered(4)
- [x] Recovering(3)
- [ ] Recent or no recovery(1)

Stability
- [ ] High(3)
- [ ] Moderate(2)
- [x] Low(1)

Modifications/Other
- [ ] Snagging
- [ ] Relocation
- [ ] Canopy removal
- [ ] One side channel modifications
- [ ] Impound
- [ ] Islands
- [ ] Bank Shaping
- [ ] Levied
- [ ] Dredging

Comments:

4-RIPARIAN ZONE & BANK EROSION (10) *Left/Right banks looking **downstream**

Riparian: 10

Riparian width (check one box per bank) L R
- [x] [x] Wide > 50m(4)
- [ ] [ ] Moderate 10-50m(3)
- [ ] [ ] Narrow 5-10m(2)
- [ ] [ ] Very Narrow 1-5m(1)
- [ ] [ ] None(0)

Erosion/Runoff - Floodplain quality (most predominant per bank) (check one box per bank or two and average) L R
- [x] [x] Forest, Swamp(3)
- [ ] [ ] Open pasture/Rowcrop(0)
- [ ] [ ] Residential, Park, New field(1)
- [ ] [ ] Fenced pasture(1)
- [ ] [ ] Urban or Industrial(0)
- [ ] [ ] Shrub or Old field(2)
- [ ] [ ] Conservation tillage(1)
- [ ] [ ] Mining, Construction(0)

Bank Erosion (check one box per bank) L R (check one box per bank)
- [x] [x] None or Little(3) (<25% of stream bank is stressed or eroding)
- [ ] [ ] Moderate(2) (<50% of stream bank is stressed or eroding)
- [ ] [ ] Heavy or Severe(1) (>50% of stream bank is stressed or eroding)

Comments:

5-POOL/GLIDE & RIFFLE/RUN QUALITY (20)

Pool Score: 0 (max score = 12)

Max pool depth (check **one**)
- [ ] >1m(6)
- [ ] 0.7-1m(4)
- [ ] 0.4-0.7m(2)
- [ ] <0.4m(1)
- [x] <0.2m (**STOP**: Pool Score = 0)

Morphology (check **one**)
- [ ] Pool width > riffle width(2)
- [ ] Pool width = riffle width(1) (check this ↑ if no riffle is present)
- [ ] Pool width < riffle width(0)

Pool/Run/Riffle current velocity (check **ALL** that apply)
- [ ] Torrential(-1)
- [ ] Fast(1)
- [ ] Moderate(1)
- [ ] Slow(1)
- [ ] Eddies(1)
- [ ] Interstitial(-1)
- [ ] Intermittent(-2)

*[ ] No pool (**STOP**: Pool Score = 0)

Comments:

Riffle Score: 1 (max score = 8)

Riffle/Run depth (check one)
- [ ] Generally > 10cm, Max > 50cm(4)
- [ ] Generally > 10cm, Max < 50cm(3)
- [x] Generally 5-10cm(1)
- [ ] Generally < 5 cm (**STOP**: Riffle Score = 0)

Riffle/Run Substrate (check one)
- [ ] Stable- eg. cobble, boulder(2)
- [ ] Mod. Stable- eg. pea gravel(1)
- [x] Unstable- eg. sand, gravel(0)

Riffle/run embeddedness (check one)
- [ ] Extensive – >75% (-1)
- [x] Moderate – 50-75% (0)
- [ ] Low – 25-50% (1)
- [ ] None – <25% (2)

*[ ] No riffle (**STOP**: Riffle Score = 0)

Comments:

6-GRADIENT (10)

Gradient Score: 8

Gradient: _____ (ft/mi)

Gradient: [ ] Low [ ] Moderate [ ] High

Average Width: _____ (m) % Pool _____

Average Depth: _____ (m) % Riffle _____

Maximum Depth: _____ (m) % Run _____

Date: 5/31/05

Appendix E: Funding Sources

Potential Funding Sources

In-State Funding Opportunities

Lake and River Enhancement Program (LARE)

LARE is administered by the Indiana Department of Natural Resources, Division of Fish and Wildlife. The program's main goals are to control sediment and nutrient inputs to lakes and streams and prevent or reverse degradation from these inputs through the implementation of corrective measures. Under present policy, the LARE program may fund lake and watershed specific construction actions up to $100,000 for a single project. Cost-share approved projects require a 20% match, 10% of which can be in-kind. LARE also has a "watershed land treatment" component that can provide grants to SWCDs for multi-year projects. The funds are available on a cost-sharing basis with farmers who implement various BMPs. Both components of the LARE program are recommended as a project funding source for the Cobus Creek Watershed. More information about the LARE program can be found at http://www.in.gov/dnr/fishwild/2364.htm.

Clean Water Indiana Grants

The Clean Water Indiana (CWI) Program was established to provide financial assistance to landowners and conservation groups. The program supports the implementation of conservation practices, which will reduce nonpoint sources of water pollution through education, technical assistance, training, and cost share programs. The CWI fund is administered by the Division of Soil Conservation under the direction of the State Soil Conservation Board. Grant applications can be submitted via partner SWCD offices. Additional details are available at http://www.in.gov/isda/2374.htm.

Clean Water Act Section 319 Nonpoint Source Pollution Management Grant

In Indiana, the 319 Grant Program is administered by the Indiana Department of Environmental Management (IDEM), Office of Water Management, Watershed Management Section. In Michigan, the DEQ's Nonpoint Source Pollution program administers 319 funds. 319 is a federal grant made available by the Environmental Protection Agency (EPA). 319 grants fund projects that target nonpoint source water pollution. To qualify for funding in Indiana, the water body must meet specific criteria such as being listed in the state's 303(d) list or be listed as a high priority waterbody by IDEM. There is a 40% cash or in-kind match requirement. Michigan DEQ requirements are nearly identical to IDEM requirements. To qualify for implementation projects, there must be a watershed management plan for the receiving waterbody. This plan must meet all of the current 319 requirements. More information about the Section 319 program can be obtained from http://www.in.gov/idem/nps/2524.htm and from http://www.michigan.gov/deq/0,4561,7-135-3307_3515-314500--,00.html.

Community and Urban Forestry Grants

The Community and Urban Forestry Grant program provides financial, technical, and educational assistance to the Indiana Department of Natural Resources Division of Forestry to make communities better places to live and work. Grant funds are made available to Indiana communities for public tree inventories and management planning, tree planting, education and outreach materials, and other related projects depending of funding source priorities. More information can be found at http://www.in.gov/dnr/forestry/8303.htm.

Michigan Stream Cleanup Grants

The Michigan Volunteer River, Stream and Creek Cleanup Program provides small grants for local government-organized trash and debris removal from streams throughout the state. Funding is provided through the Great Lakes Commission to the Michigan DEQ. To learn more or apply for grants visit http://glc.org/projects/water-quality/streamclean/sc-grants/.

Nina Mason Pulliam Charitable Trust

The NMPCT awards various dollar amounts to projects that help people in need, protect the environment, and enrich community life. Prioritization is given to projects in the greater Phoenix, AZ and Indianapolis, IN areas, with secondary priority being assigned to projects throughout Arizona and Indiana. The trust awarded nearly $20,000,000 in funds in the year 2000. More information is available at http://www.ninapulliamtrust.org/.

Department of Interior Funding

National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is administered by the U.S. Department of the Interior. The program promotes healthy fish and wildlife populations and supports efforts to invest in conservation and sustainable use of natural resources. The NFWF targets six priority areas which are wetland conservation, conservation education, fisheries, neotropical migratory bird conservation, conservation policy, and wildlife and habitat. Several programs including Bring Back the Natives, Environmental Solutions for Communities, and the Five Star and Urban Waters Restoration Grant Programs could provide funding for Cobus Creek Watershed Projects. Learn more about NFWF program at http://www.nfwf.org/whatwedo/programs/Pages/home.aspx.

National Fish Passage Program

The US Fish and Wildlife service provides grant funding to address fish passage barriers throughout the nation. Since 1999, the NFPP funded the removal of more than 1,500 fish passages opening more than 21,000 miles of river to natural instream flows. The NFPP requires a 3:1 nonfederal match and requires that efforts in Cobus Creek be coordinated with the Great Lakes regional coordinator. To learn more about this program visit https://www.fws.gov/fisheries/whatwedo/nfpp/nfpp.html.

North American Wetland Conservation Act Grant Program

The North American Wetland Conservation Act Grant Program (NAWCA) is funded and administered by the U.S. Department of Interior. This program provides support for projects that involve long-term conservation of wetland ecosystems and their inhabitants including waterfowl, migratory birds, fish, and other wildlife. The match for this program is on a 1:1 basis. More information is available here: https://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php.

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife Program (PFWP) is funded and administered by the U.S. Department of the Interior through the U.S. Fish and Wildlife Service. The program provides technical and financial assistance to landowners interested in improving native habitat for fish and wildlife on their land. The program focuses on restoring wetlands, native grasslands, streams, riparian areas, and other habitats to natural conditions. The program requires a 10-year cooperative agreement and a 1:1 match. More details are available at https://www.fws.gov/partners/.

1.1.1 Great Lakes-Based Funding

Great Lakes Restoration Initiative

The Great Lake Restoration Initiative (GLRI) was launched in 2010 to focus protection and restoration of the Great lakes. GLRI funding decisions are made by the GLRI Task Force, which is comprised of 11 federal agencies as well as several partner groups. Funding focuses on cleaning up Great Lakes Areas of Concern, preventing and controlling invasive species, reducing nutrient runoff that contributes to harmful algal blooms, and restoring habitat to protect native species. Efforts in Cobus Creek which focus on reducing nutrient runoff could qualify for GLRI funding. To learn more about this program visit www.glri.us.

Great Lakes Commission

The Great Lakes Commission provides funding to reduce sediment and nutrient loading to the Great Lakes via their Sediment/Nutrient Reduction Program. Since 1991, more than 450 projects have been funded with a focus on demonstration techniques, education, restoration, and technical assistance. Fund requests are typically due in March annually. For more information visit http://keepingitontheland.net/apply-for-funding/.

Other Federal Grant Programs

The USDA and EPA award research and project initiation grants through the U.S. National Research Initiative Competitive Grants Program and the Agriculture in Concert with the Environment Program.

Conservation Reserve Program

As already discussed, the Conservation Reserve Program (CRP) is funded by the USDA and administered by the Farm Service Agency (FSA). CRP is a voluntary, competitive program designed to encourage farmers to establish vegetation on their property in an effort to decrease erosion, improve water quality, or enhance wildlife habitat. The program targets farmed areas that have a high potential for degrading water quality under traditional agricultural practices or areas that might make good wildlife habitat if they were not farmed. Such areas include highly erodible land, riparian zones, and farmed wetlands. Currently, the program offers continuous sign-up for practices like grassed waterways and filter strips. Participants in the program receive cost share assistance for any plantings or construction as well as annual payments for any land set aside. Contact your local NRCS office for more information.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary program designed to provide assistance to producers to establish conservation practices in target areas where significant natural resource concerns exist. Eligible land includes cropland, rangeland, pasture, and forestland, and preference is given to applications which propose BMP installation that benefits wildlife. EQIP offers cost-share and technical assistance on tracts that are not eligible for continuous CRP enrollment. Certain BMPs receive up to 75% cost-share. In return, the producer agrees to withhold the land from production for five years. Practices that typically benefit wildlife include: grassed waterways, grass filter strips, conservation cover, tree planting, pasture and hay planting, and field borders. Best fertilizer and pesticide management practices, innovative approaches to enhance environmental investments like carbon sequestration or market-based credit trading, and groundwater and surface water conservation are also eligible for EQIP cost-share. Contact your local NRCS office for more information.

U.S. Environmental Protection Agency Environmental Education Program

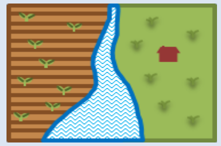
The USEPA Environmental Education Program provides funding for state agencies, non-profit groups, schools, and universities to support environmental education programs and projects. The program grants nearly $200,000 for projects throughout Illinois, Indiana, Michigan, Minnesota, Wisconsin, and Ohio. More information is available at https://www.epa.gov/education/environmental-education-ee-grants.

Watershed Protection and Flood Prevention Program

The Watershed Protection and Flood Prevention Program is funded by the U.S. Department of Agriculture and is administered by the Natural Resources Conservation Service. Funding targets a variety of watershed activities, including watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in small watersheds (250,000 or fewer acres). The program covers 100% of flood prevention construction costs or 50% of construction costs for agricultural water management, recreational, or fish and wildlife projects. Learn more about this program at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/.

Appendix F: Informational Handout

What Can You Do to Keep Cobus Creek Clean!



Quick & Easy Ideas:

Pick up pet waste

It has bacteria and nutrients that can be bad for the Wabash River.

Wash your car at a commercial car wash

These facilities can separate out oil and filter pollutants.

Use Phosphorus-free fertilizer

Soils in the Cobus Creek area are naturally high in phosphorus. Excess phosphorus can cause algae blooms and fish kills.

Properly discard hazardous waste items

Drop them off at the Elkhart County Solid Waste Management District (SWMD) at 59530 CR 7 South Elkhart or at the St. Joseph County SWMD at 929 Lincolnway East South Bend

Don't drain oil or antifreeze down a storm drain

These can weaken or kill organisms and accumulate in food chain.

Minimize pesticide use

Try attracting natural predators like ladybugs instead.

Water early in the morning or late in the evening

This is when it is the coolest and less water will evaporate.

Do not flush or throw away medicine

Take unused medicine to the Elkhart County SWMD the first Saturday of the month at 8 am and 3 pm or visit www.recycle.in.gov for additional drop off locations.

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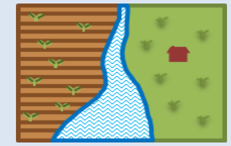

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Think About Installing...

Rain Barrels collect and store rain water from your roof that would otherwise be lost to runoff and diverted to storm drains, then into Gast Ditch or Cobus Creek.

Contact the Elkhart County Stormwater Partnership (ECSP) (www.stormwaterelkco.org) to purchase rain barrels—$50/barrel up to two per parcel or visit the St. Joseph County SWCD website (www.stjosephswcd.org) for rain barrel purchase locations.

Rain Gardens are bowl-shaped areas planted with beautiful wildflowers and grasses. Water from a roof, driveway, or lawn soaks into the garden rather than rushing to our streams. This keeps pollutants, such as fertilizers, from getting into Gast Ditch and Cobus Creek.

Contact the ECSP or St. Joseph SWCD for more information about installing rain gardens. The ECSP offers financial assistance for plant costs associated with rain garden installation.

Native plants are plants that have evolved over thousands of years in a particular region. Native plants are just as important to us as they are to bees and other wildlife of the Cobus Creek Watershed.

Native plants can be purchased at via local nurseries like Naturally Native Nursery (South Bend), Native Connections (Three Rivers), Cardno Native Plant Nursery (Walkerton) or Spence Nursery (Muncie). Both the Elkhart and St. Joseph County SWCDs host native tree sales.

FRIENDS OF COBUS CREEK
Elkhart Conservation Club

SJRBC
St. Joseph River Basin Commission

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