CHAPTER 3
KANKAKEE SUB-BASIN

HUC 07120001

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Kankakee Sub-Basin

3.1 Part I- Watershed Inventory

3.1.1 Overview

The Kankakee sub-basin (HUC 07120001) covers nearly 3,029 mi² of Michigan, Indiana, and Illinois. Within Indiana, the project area drains approximately 1,605 mi² of predominately agricultural land in St. Joseph, Marshall, Starke, LaPorte, Jasper, Porter, Newton, and Lake Counties (Figure 1). Of the 2,073 miles of stream and ditch that drain this landscape, nearly 450 miles (22%) are impaired (303d List of Impaired Waterbodies- IDEM, 2008). The most common impairments include *E. coli* (230 miles) and Impaired Biotic Communities (158 miles). In some cases multiple impairments exist within the same reach (127 miles). Some of the major streams and ditches in the sub-basin include the Kankakee River, Little Kankakee River, Heinold Ditch, Mill Creek, Singleton Ditch, Cedar Creek and West Creek.

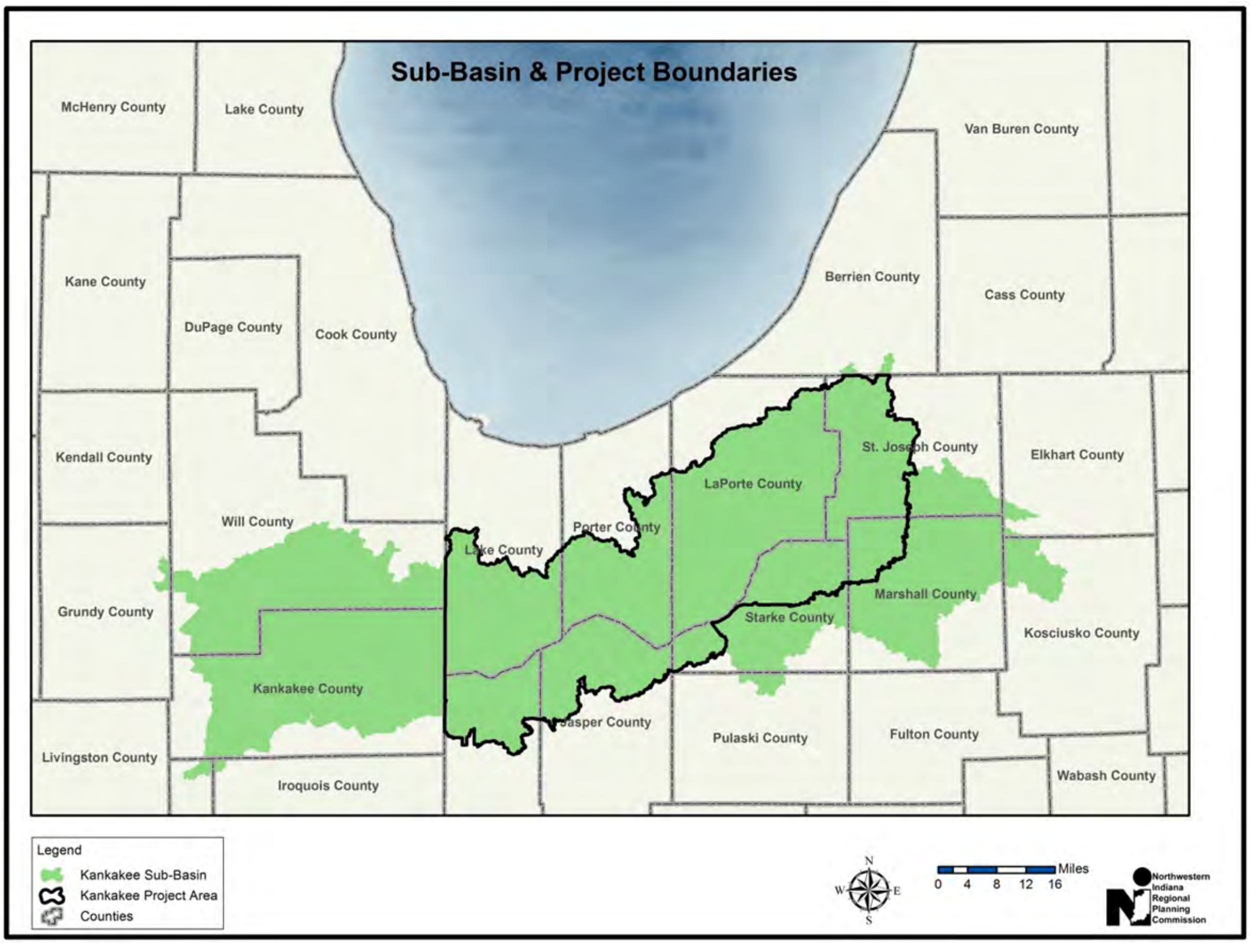

Figure 1. Kankakee Sub-Basin & Project Boundaries

3.1.2 Geology/Topography

The topography of the Kankakee Sub-basin is almost entirely the result of erosional and depositional action from the last glaciation. The Valparaiso Moraine, a remnant from the Wisconsinan glacial period, forms much of the drainage divide between the Little Calumet-Galien to the north and Kankakee to the south (IDNR, 1994). The sub-basin grades away from a high of 950 feet along the Valparaiso Moraine to a low of 519 feet near the Kankakee River (Figure 2).

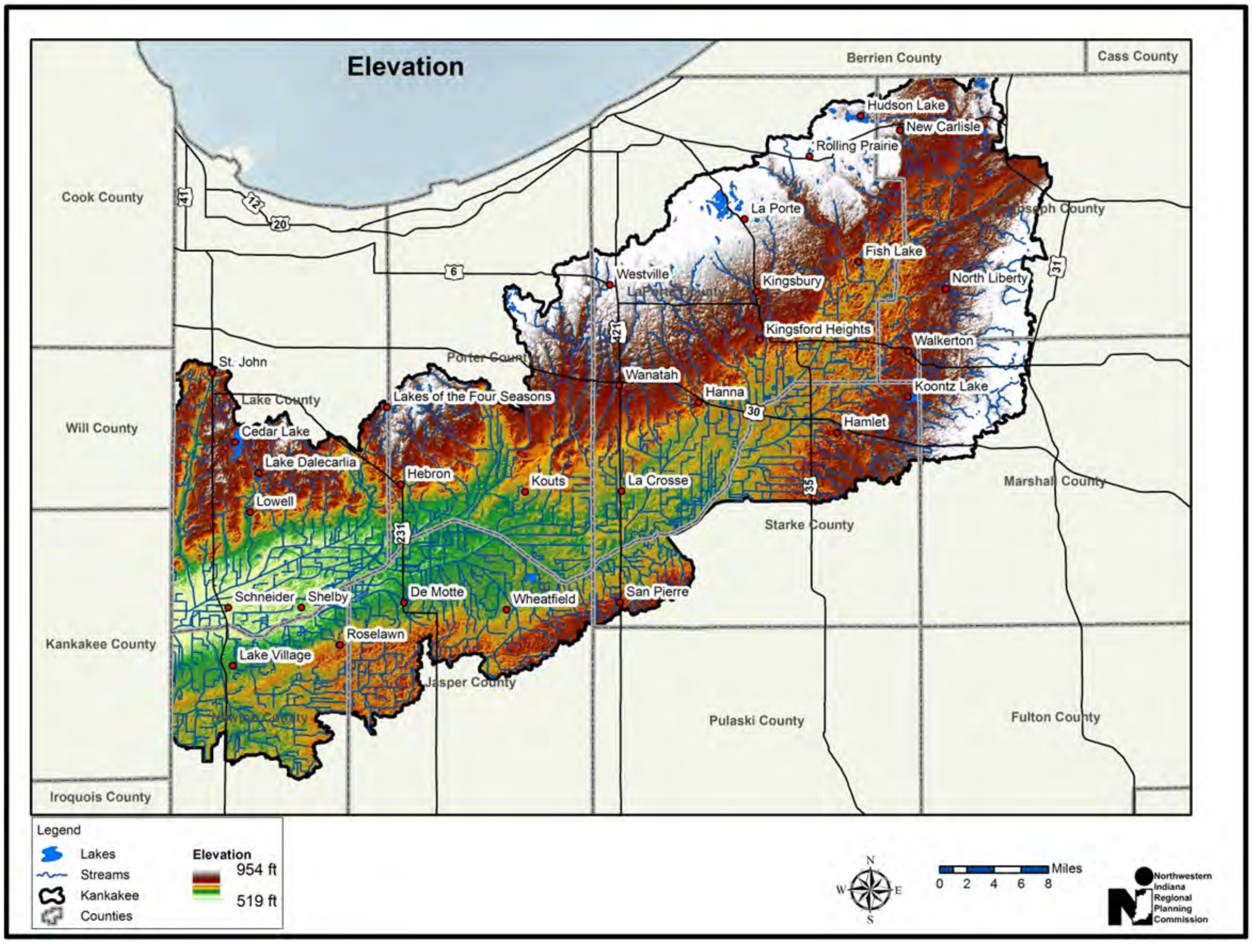

Figure 2. Elevation

The sub-basin is positioned across three physiographic regions including the Valparaiso Morainal Complex, the Kankakee Drainageways, and the Plymouth Morainal Complex (Figure 3). Physiographic regions are based on topography and the effect of glaciers on the landscape.

The Valparaiso Morainal Complex forms a 13-20 mile wide band that is roughly concentric with the Lake Michigan shoreline. Its most dominate land forms are moraines and alluvial fans that grade to the southeast. Lakes can be found in depressions of till areas and tunnel valleys. Few natural lakes exist in the depressions of the alluvial fans because of their sandy nature and low water table. The Kankakee Drainageways is an extensive flat and poorly drained sectioned bordered to the north by the Valparaiso Morainal Complex. Extensive shallow lakes once occupied broad depressions while crescent shaped dunes formed across drier areas. About 100 years ago the area was drained for farming but much of the land remains somewhat poorly drained. The Plymouth Morainal Complex is bound to the west by the Kankakee Drainageways. The complex was created by three different ice lobes that competed against one another leading to overriding deposits. The area is characterized by discontinuous ridges and unorganized hummocky topography of moderate relief. Lakes occupy ice block depressions and other low spots (IGS, 2000).

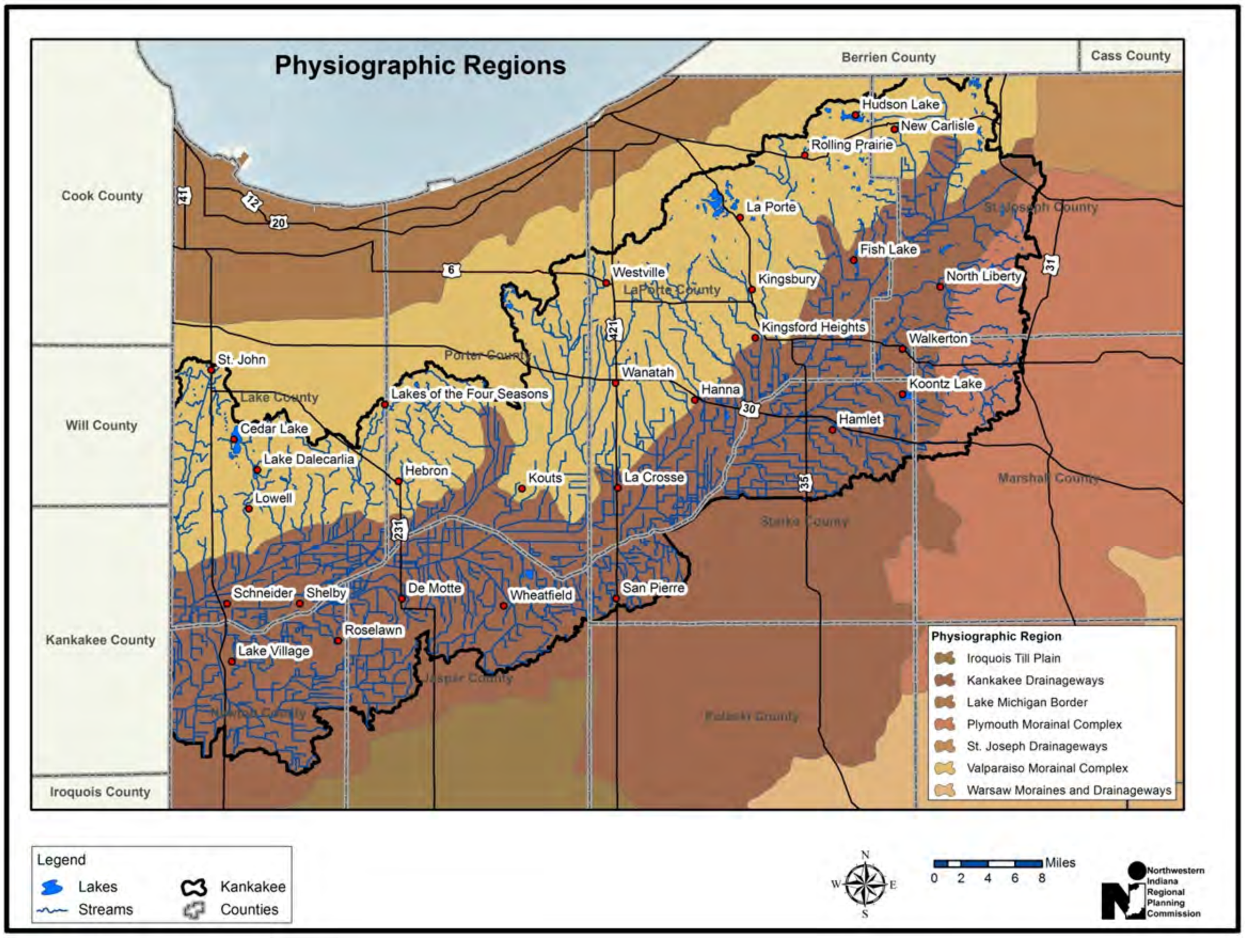

Figure 3. Physiographic Regions

Rain fall or snow melt on steeply-sloped land runs off more quickly than on flat land. The increase in runoff velocity makes areas with steep slopes more prone to erosion depending on a number of factors including soil type and plant cover. Additionally slope affects the shape, form and stability of streams. An analysis of percent slope was done by NIRPC using the 30-meter resolution elevation data from the National Elevation Dataset and ArcMap 10's Spatial Analyst. The steepest slopes in the sub-basin are located in the headwaters of the Valparaiso Moraine and the Plymouth Morainal Complex (Figure 4). Some of the most extreme slopes approach nearly 23%. In 2007, IDEM published the Indiana Storm Water Quality Manual which defined "steep" slopes as those exceeding 15% (www.in.gov/idem/4899.htm). The manual recommended prohibiting development on these steep slopes because of the high potential for soil erosion, degradation of surface water, and excessive stormwater runoff.

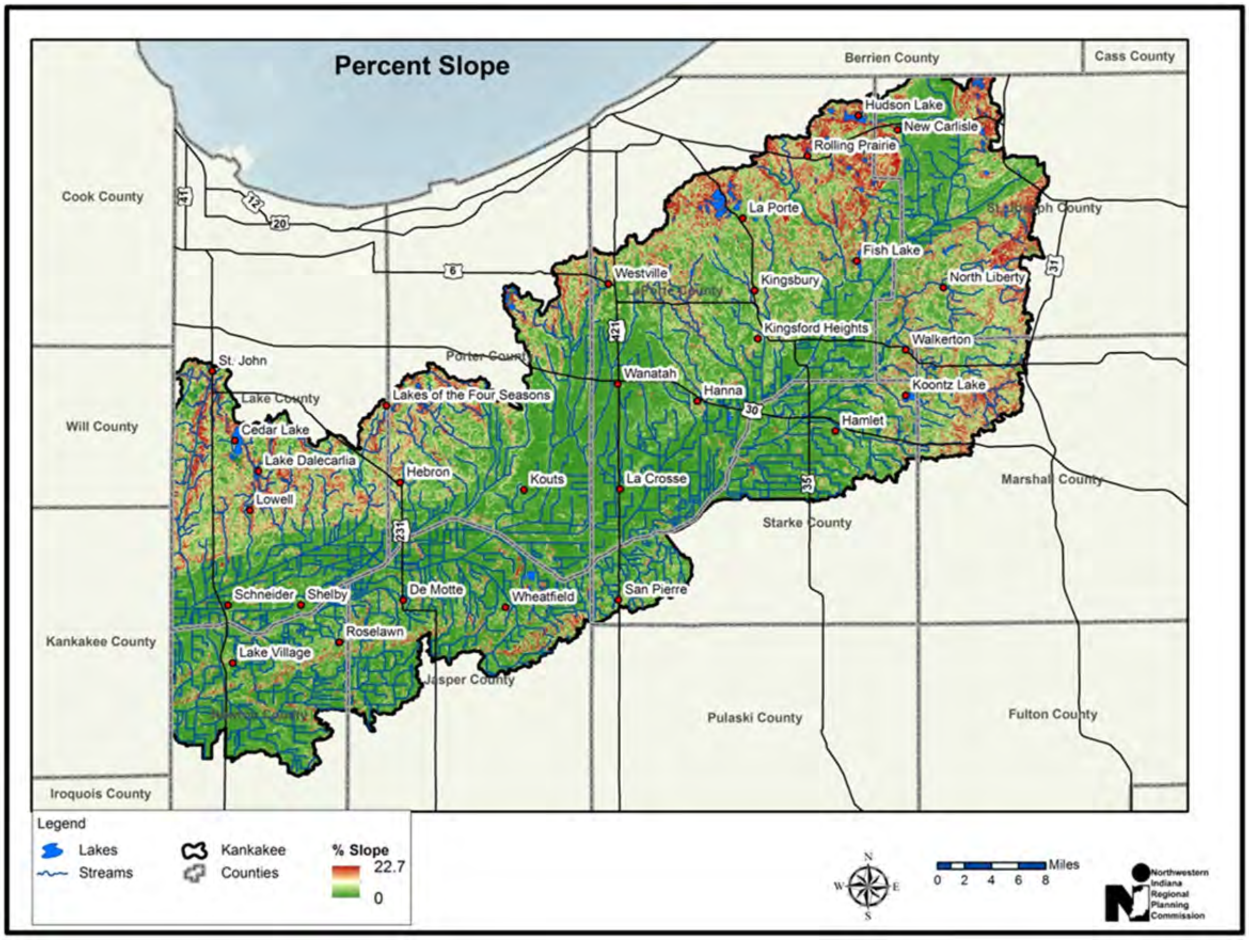

Figure 4. Percent Slope

3.1.3 Hydrology

Hydrology in the sub-basin has undergone significant changes since the region was first settled in the 1800's. Drainage of the Grand Kankakee Marsh and channelization of the Kankakee River dramatically changed the hydrology of the main river valley. Tillage, farm field tilling and ditching have further altered the local and regional hydrology.

Today approximately 2,073 miles of stream and ditch drain the landscape based on information from USGS National Hydrography Dataset (Figure 5). Some of the major streams and ditches in the sub-basin include the Kankakee River, Little Kankakee River, Heinold Ditch, Mill Creek, Singleton Ditch, Cedar Creek and West Creek. An extensive network of ditches and streams drain the landscape to these waterbodies.

Many of the sub-basin's natural lakes were probably formed in depressions left by glacial action or by melting blocks of isolated glacial ice buried in the ground. In total there are approximately 312 lakes/ponds covering a combined surface area of 7,393 acres with a mean size of 23.7 acres (NIRPC analysis, 2011). Some of the larger named lakes include Flint Lake (88 ac), Upper and Lower Fish Lakes (133 ac and 125 ac respectively), Koontz Lake (319 ac), Pine Lake (544 ac) and Cedar Lake (755 ac). An unknown number of lakes have been destroyed or greatly reduced in size due to artificial drainage (DNR, 1990).

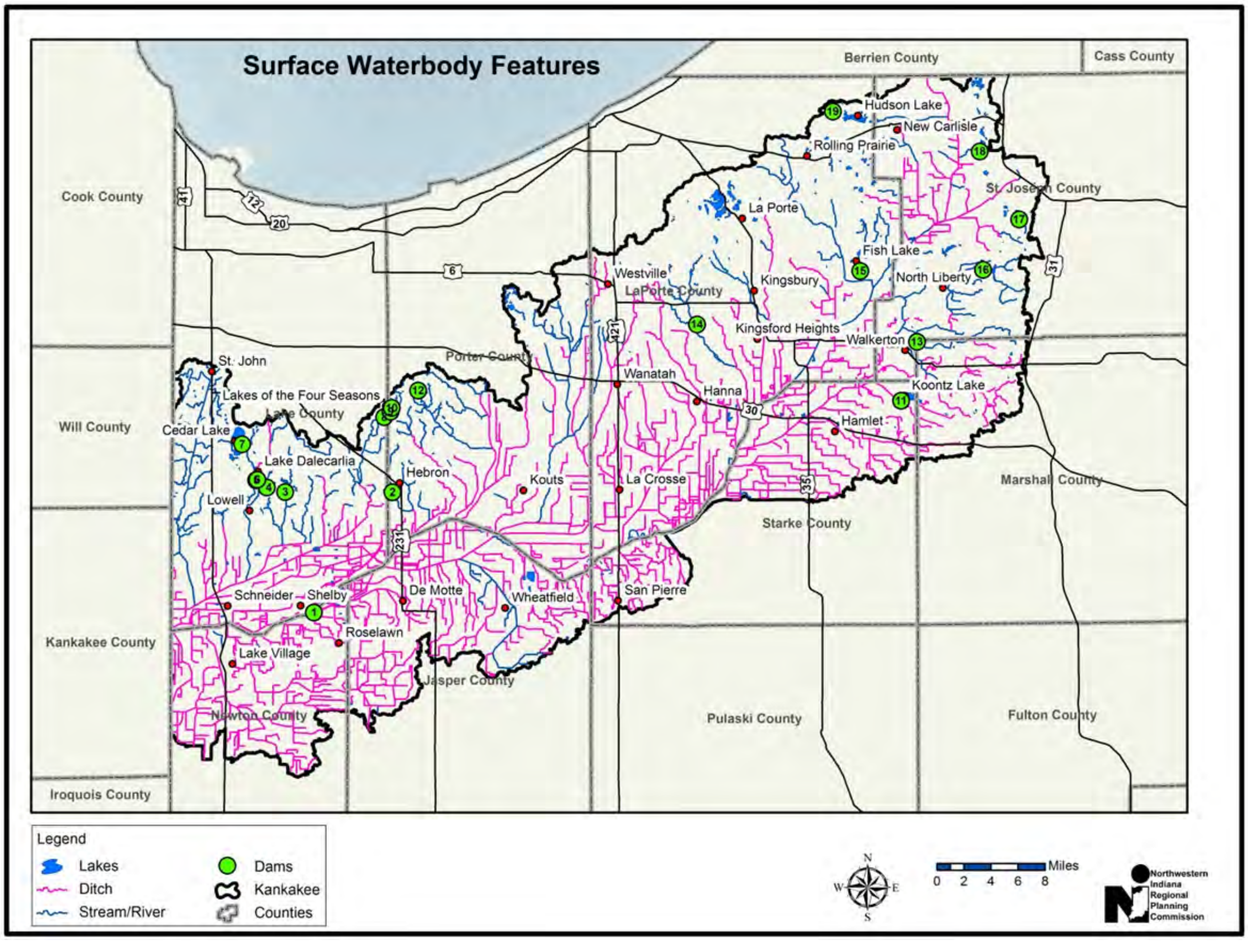

Figure 5. Surface Waterbody Features.

The lakes and rivers of the sub-basin provide many recreational opportunities including boating, fishing, swimming and nature watching. In total 75 total miles of river and stream pass through local, state, and federal park boundaries within the sub-basin (NIRPC analysis, 2011). Additionally, the Kankakee River is designated by the State as a navigable waterway. The Department of Natural Resources (DNR) maintains a web-based mapping application that shows the locations and features of public access and fishing areas throughout the state. It is available at http://www.in.gov/dnr/fishwild/3591.htm.

In total there are X miles of regulated drain within the sub-basin (Figure 6). A regulated drain (a.k.a. legal drain) is an open channel or closed tile/sewer that is subject to the provisions of the Indiana drainage code, I.C.-36-9-27. Under this code, a drainage board has the authority to construct, maintain, reconstruct or vacate a regulated drain. The board can maintain the regulated drain by dredging, clearing, tile repair, obstruction removal or other work necessary to keep the drain in proper working order based on its original specifications.

Figure 6. Regulated Drains

Dams are another common source of hydromodification in the sub-basin. Many dams were built to store and provide water for mechanical power generation (e.g., waterwheels to mill grain) and recreation (e.g., boating and fishing). However, dams can also be associated with a number of negative impacts including changes to hydrology, water quality, habitat, and river morphology. Human activities, such as agricultural and urban land uses, can contribute to contaminant and sediment loads to the impoundments by these dams (EPA, 2007).

There are 19 dams located within the sub-basin based upon information obtained from Indiana Map (http://www.indianamap.org/index.html). General location information, drainage area, impoundment surface area and the drainage area to surface area ratio is presented in Figure 5 and Table 1. The largest dam by storage capacity is the Potato Creek dam in St. Joseph County. Impoundments with larges drainage areas and small surface areas are prone to nonpoint source pollution impacts.

#	Name	County	Drainage Area	Surface Area	DA/SA Ratio
1	South Marsh (In-Channel) Dam	Newton	36.6		
2	Dog Lake Control Structure	Porter	0.0		

#	Name	County	Drainage Area	Surface Area	DA/SA Ratio
3	Spring Run Ditch Dam	Lake	5.4		
4	Lakewood Estates Dam	Lake	0.5		
5	Lake Dalecarlia Dam (West)	Lake	20.1		
6	Lake Dalecarlia Dam (East)	Lake	20.1		
7	Cedar Lake Control Structure	Lake	0.0		
8	Lake Of The Four Seasons (Lower) C	Lake	3.6		
9	Lake Of Four Seasons (Dam B)	Porter	2.2		
10	Lake Of Four Seasons (Dam A)	Porter	2.2		
11	Koontz Lake Dam	Starke	6.3		
12	Lake Eliza Control Structure	Porter	1.7		
13	Little Long Control Structure	Noble	0.0		
14	Union Mills Dam	LaPorte	19.2		
15	Lower Fish Lake Control Structure	LaPorte	0.0		
16	Potato Cr. Dam No. E3-331	St. Joseph	11.8		
17	Warton Lake (Goodman) Control Structure	St. Joseph	0.0		
18	South Chain Lake Control Structure	St. Joseph	0.0		
19	Saugany Lake Control Structure	LaPorte	0.0		

Table 1. Dams

3.1.4 Soils

Hydric Soils

Hydric soils are one of three characteristics used to identify wetlands. The National Technical Committee for Hydric Soils (NTCHS) defines hydric soils as *soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part*. These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic (water-loving) vegetation. Areas where hydric soils are present but wetlands no longer exist can be useful in identifying potential wetland restoration opportunities. Hydric soils data from the Natural Resources Conservation Services (NRCS) are shown for the sub-basin project area in Figure 7. In total there are approximately 123 mi^2 of hydric soils.

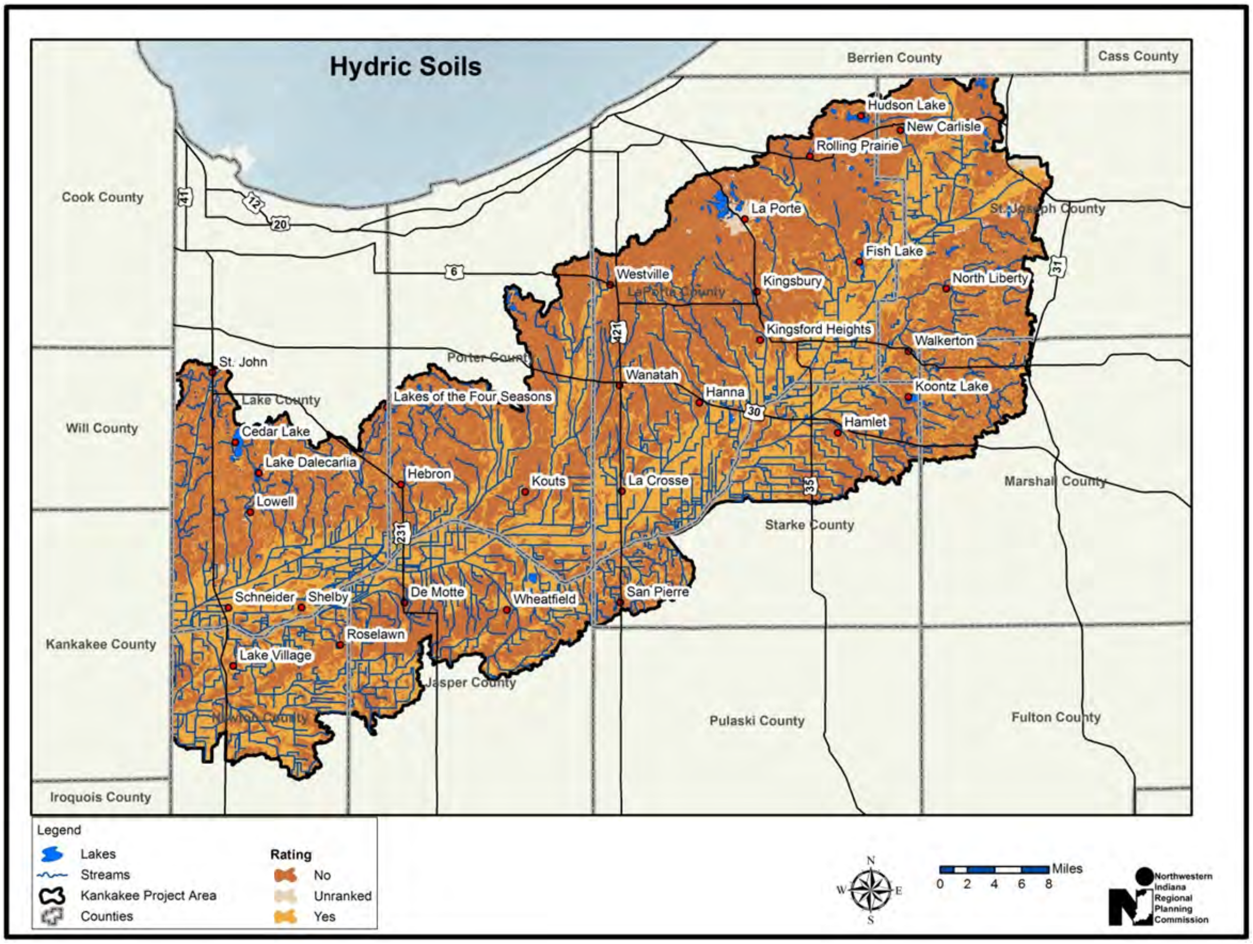

Figure 7. Hydric Soils.

Hydrologic Groups

A hydrologic group, as defined by the NRCS, is a group of soils that have similar runoff potential under similar storm and cover conditions. The influence of ground cover is treated independently and the slope of the soil surface is also not considered in assigning hydrologic soil groups. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. This information is useful in identifying nonpoint source pollutant contributions areas coupled with land use and prioritizing implementation measures to reduce pollutant loading from runoff.

The hydrologic soil groups found in the sub-basin are displayed in Figure 8 and are described as follows:

> Group A- Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. They account for 48% of the sub-basin.
>
> Group B- Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. They account for 33% of the sub-basin.
>
> Group C- Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. They account for 16% of the sub-basin.

Group D- Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. They account for 1% of the sub-basin.

Unclassified- Soils are highly disturbed such as in urban areas. They account for 2% of the sub-basin.

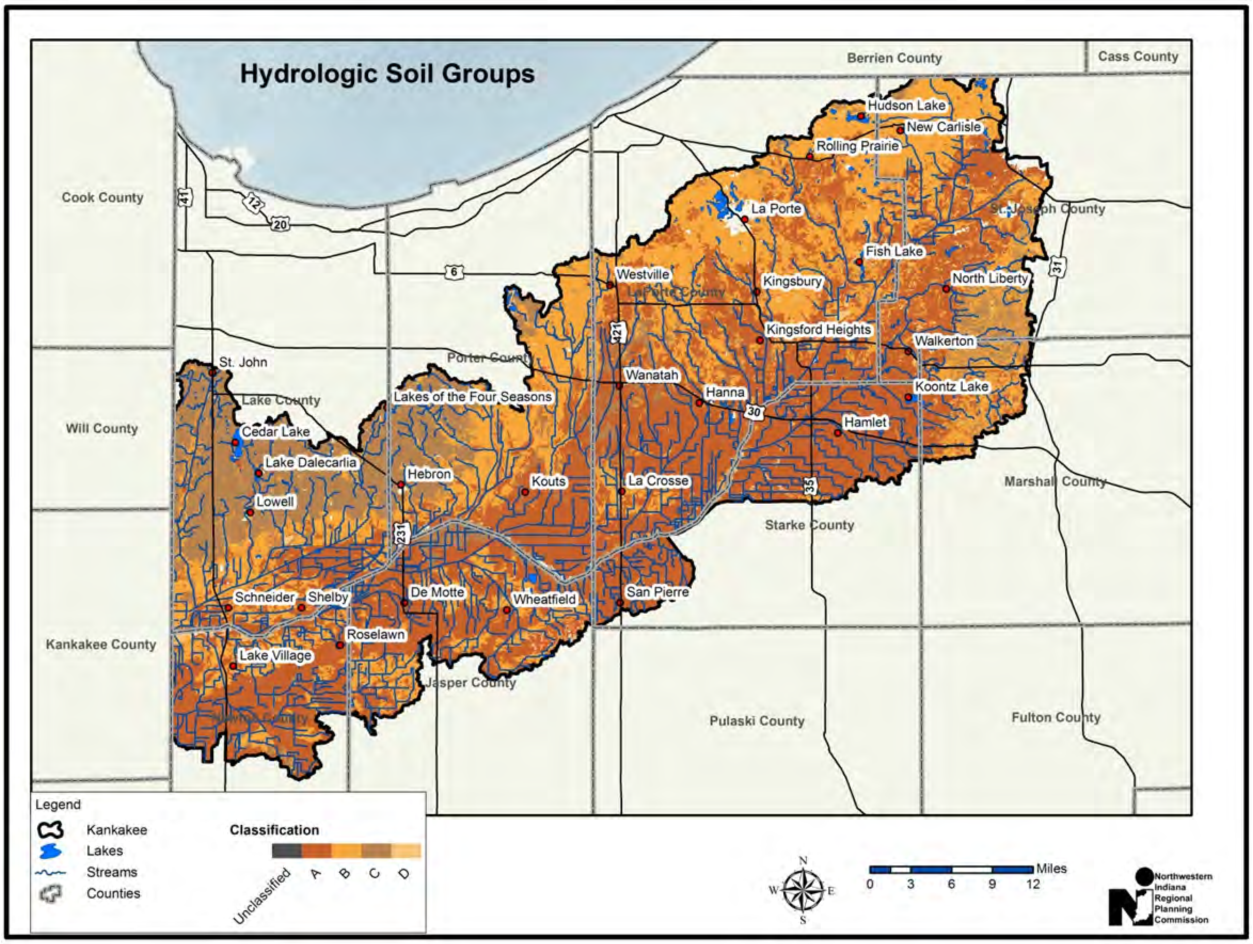

Figure 8. Hydrologic Soil Groups

Septic System Suitability

Conventional onsite sewage disposal systems (a.k.a. septic systems), while common, are not suitable for all areas. Among the limitations which might preclude installation of a conventional system are: high groundwater tables; shallow limiting layers of bedrock or fragipan; very slowly or rapidly permeable soils; topography; and lot size.

Soil limitations within the sub-basin for conventional septic systems that use absorption fields for treatment are displayed in Figure 9. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. The data used to generate this figure was obtained from the NRCS SSURGO datasets for each county and processed in ArcMap with the NRCS Soil Viewer Tool http://soils.usda.gov/sdv/ with assistance from the DNR Lake Michigan Coastal Program. The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

The rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. These include:

> “Not rated”- Soils are highly disturbed such as in urban areas. They account for 1% of the sub-basin.
>
> “Not limited”- Soils have features that are very favorable for the specified use. Good performance and very low maintenance can be expected. They account for 0% of the sub-basin.
>
> "Somewhat limited" - Soils have features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. They account for approximately 3% of the sub-basin.
>
> "Very limited" - Soils have one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. They account for approximately 96% of the sub-basin.

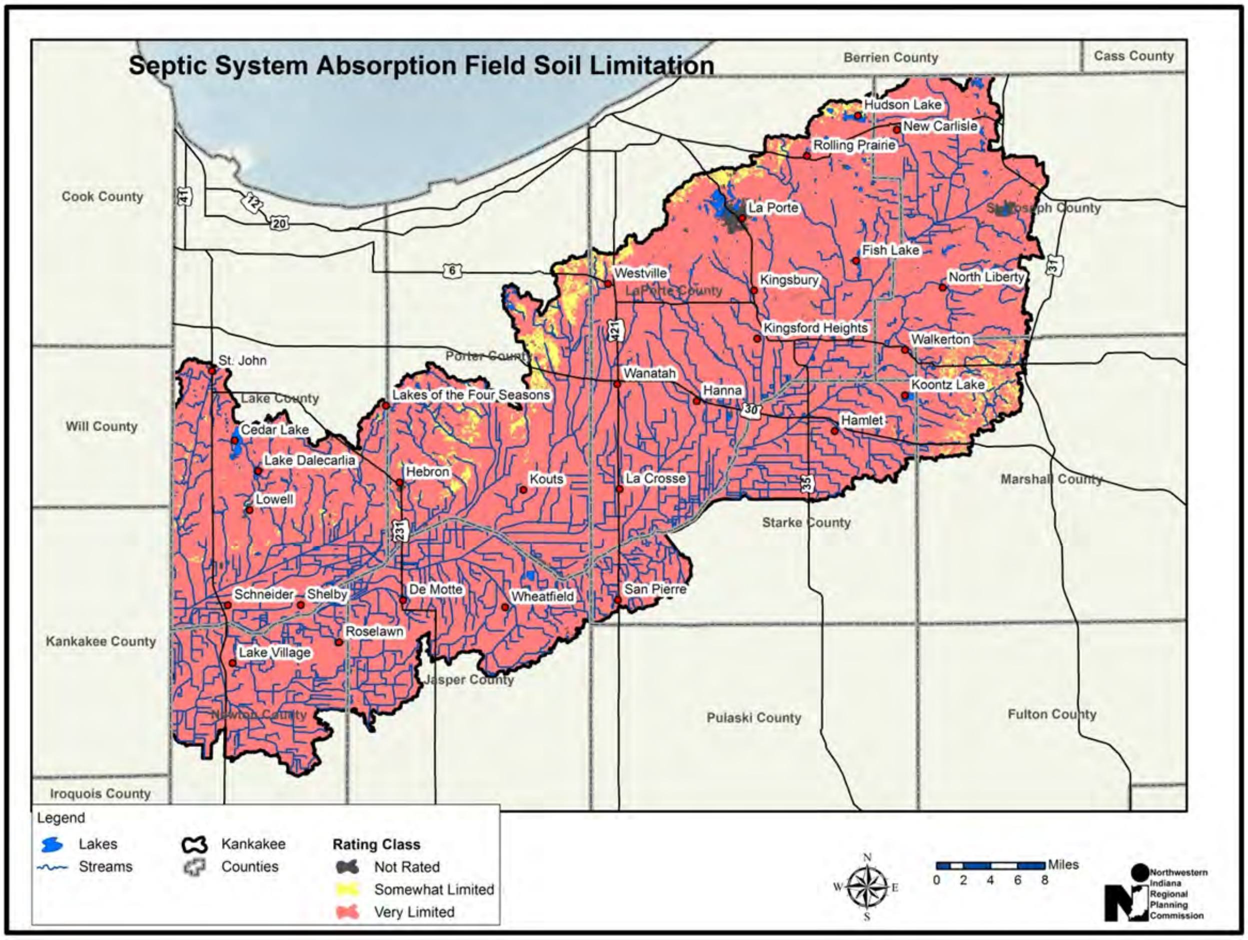

Figure 9. Septic System Absorption Field Suitability

Highly Erodible Land

Highly Erodible Land (HEL) soils for the sub-basin are displayed in Figure 10. Soils data used to generate the figure were downloaded for each county from the NRCS Geospatial Data Gateway (http://datagateway.nrcs.usda.gov) on May 17, 2011. A query provided by Rick Neilson with the NRCS was used in Microsoft Access to identify HEL soils. The basis that NRCS uses for identifying highly erodible land is the erodibility index of a soil map unit. The erodibility index of a soil is determined by dividing the potential erodibility for each soil by the soil loss tolerance (T) value established for the soil. The T-value represents the maximum annual rate of soil erosion that could take place without causing a decline in long-term productivity. Approximately 28% of the soils in the sub-basin are classified as HEL soils based on query results. The highest concentration exists in the headwaters of the Valparaiso Morainal Complex.

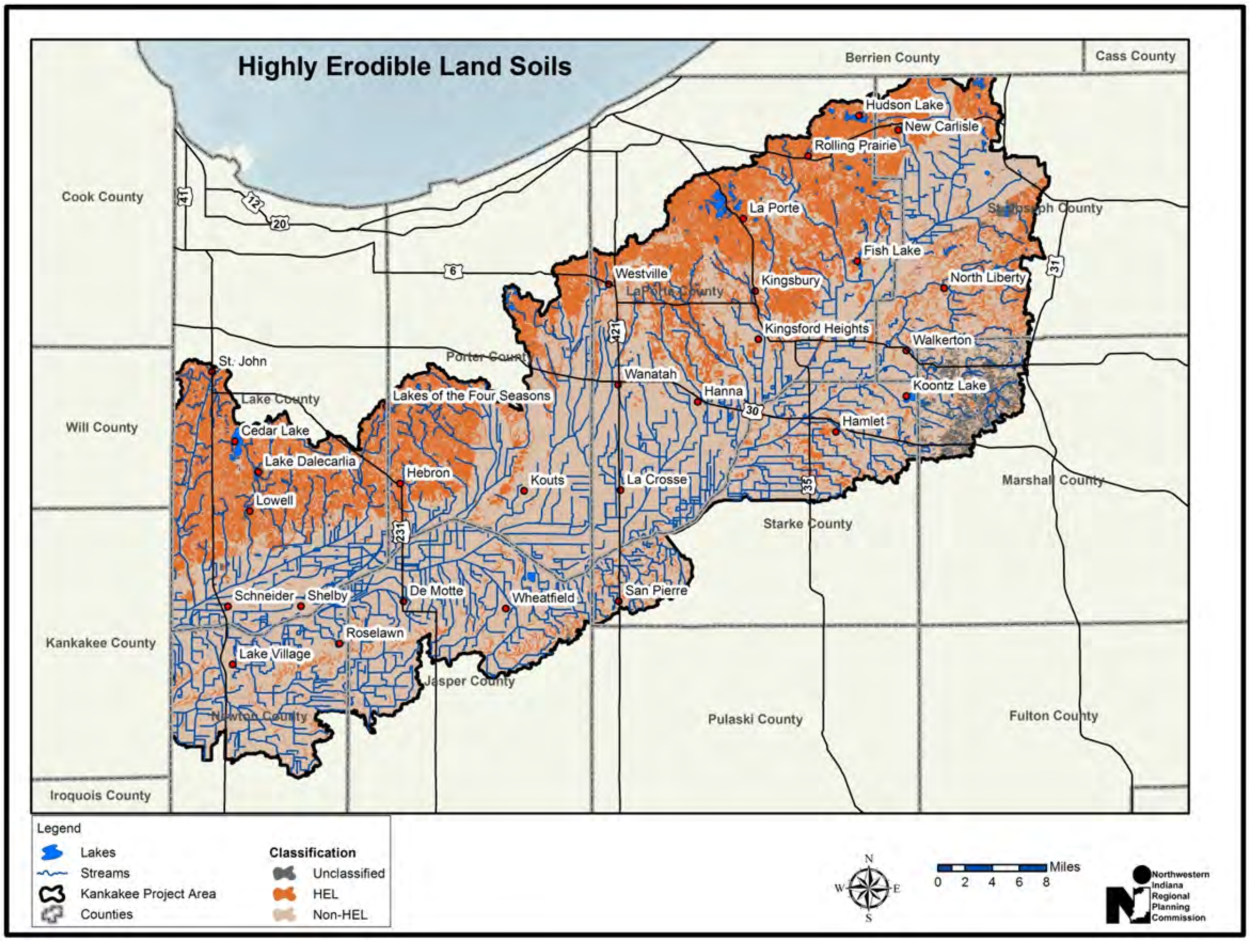

Figure 10. Highly Erodible Land Soils

Soil Drainage Class

The soil drainage classes identify the natural drainage condition of the soil and refer to the frequency and duration of periods when the soil is free of saturation. Figure 11 displays drainage classes within the sub-basin. This information can be of value when trying to identify where field drain tiles may exist in agricultural lands.

The rating classes are described as follows:

> "Excessively drained"- Water is removed very rapidly. The occurrence of internal free water commonly is very rare or very deep. The soils are commonly coarse-textured and have very high hydraulic conductivity or are very shallow. They account for 3% of the sub-basin.
>
> "Somewhat excessively drained"- Water is removed from the soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured and have high saturated hydraulic conductivity or are very shallow. They account for 1% of the sub-basin.
>
> "Well drained"- Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth

of roots for significant periods during most growing seasons. The soils are mainly free of features that are related to wetness. They account for 24% of the sub-basin.

“Moderately well drained”- Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1 m, periodically receive high rainfall, or both. They account for 11% of the sub-basin.

“Somewhat poorly drained”- Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall. They account for 17% of the sub-basin.

“Poorly drained”- Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these. They account for 26% of the sub-basin.

“Very poorly drained”- Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater. They account for 18% of the sub-basin.

“Not rated”- Soils have characteristics that show extreme variability from one location to another. Often these areas are urban land complexes or miscellaneous areas. An on-site investigation is required to determine soil conditions present at the site. They account for <1% of the sub-basin.

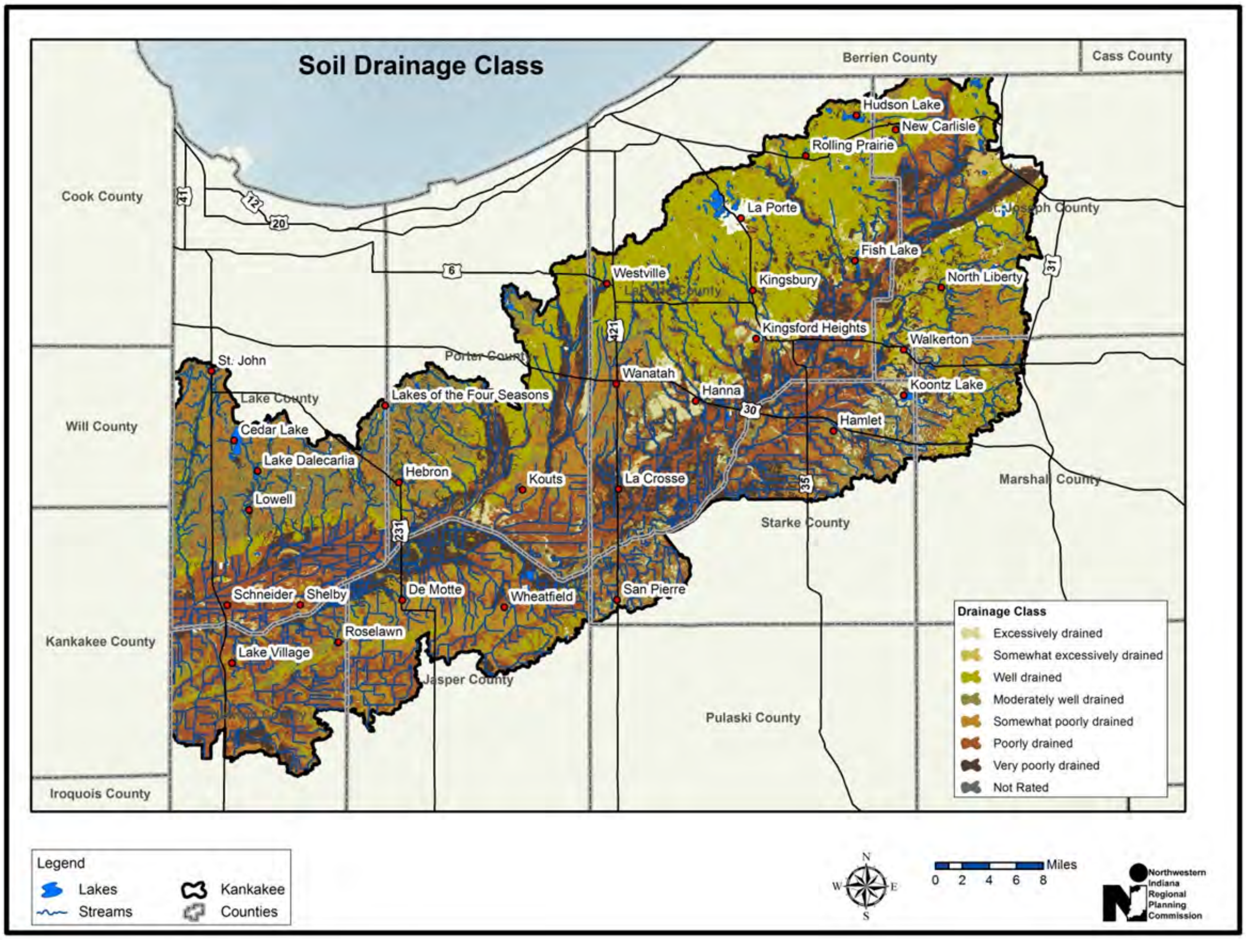

Figure 11. Soil Drainage Class

3.1.5 Land Use & Land Cover

Land use and cover within a watershed can have a profound impact on both water quality and habitat. Natural land cover such as forests, wetlands, and grasslands help protect or improve water quality and aquatic habitats. Alteration of natural land cover for human use almost inevitably leads to increased runoff which can carry pollutants to nearby waterbodies. The pollutants generated are dependent on the land uses within the given watershed. Some of the common pollutants generated in urbanized areas include excess nutrients, sediment, metals, pathogens, and toxins. In agricultural areas common pollutants can include excess nutrients, sediment, pathogens, herbicides and pesticides. For this reason having an understanding of what land uses are present in a watershed can help determine what factors may be contributing to water quality or habitat problems.

Several figures within this section have been generated using land cover data to help characterize the subwatersheds within the sub-basin study area. The intent of these figures is to assist stakeholders in identifying and prioritizing critical areas for restoration or preservation within the sub-basin.

Land cover data from 2006 is shown in Figure 12. Data used to generate this figure was obtained from NOAA's Coastal Change Analysis Program (CCAP) data. CCAP produces a nationally standardized database of land cover and land change information for the coastal regions of the United States. It provides inventories of wetlands and adjacent uplands with the goal of monitoring these habitats by updating the land cover maps every five years. Data is developed using multiple dates of remotely sensed imagery and consist of land cover maps, as well as a changes that have occurred between these dates and where the changes were located. CCAP data for Indiana was available for 1996, 2001, and 2006 during the writing of this version of the Framework. It is available for down or viewing via the CCAP Land Cover Atlas at www.csc.noaa.gov/digitalcoast/data/ccapregional/index.html.

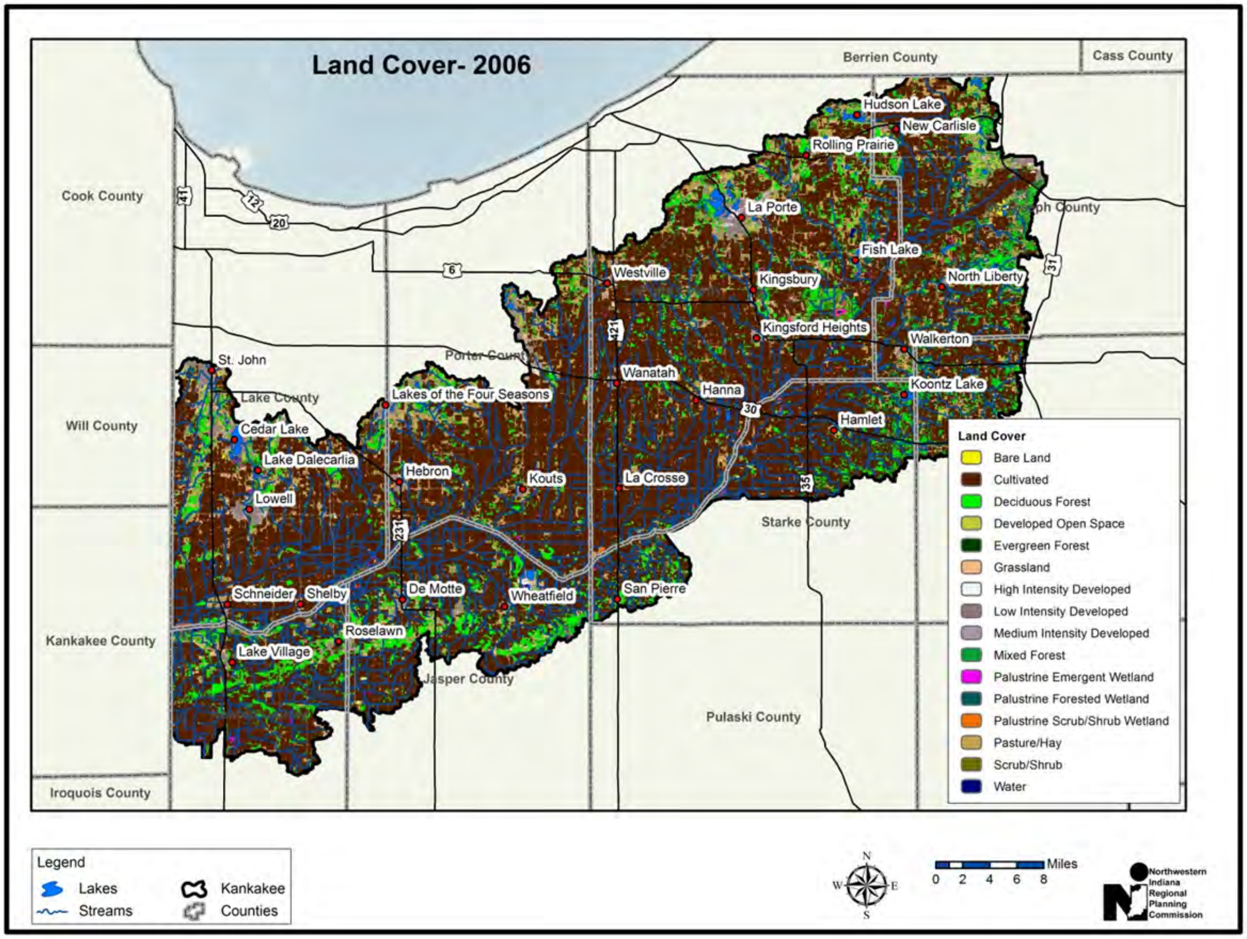

Figure 12. Land Cover (2006)

Figure 13 displays the 2006 land cover data as a percentage of the sub-basin area. Similar cover types have been grouped into generalized cover classes for display purposes. As can be seen in the figure, agriculture (cultivated and pasture/hay) is the dominant land cover followed by forest (deciduous, evergreen, and mixed) and developed (high, medium, low, open space).

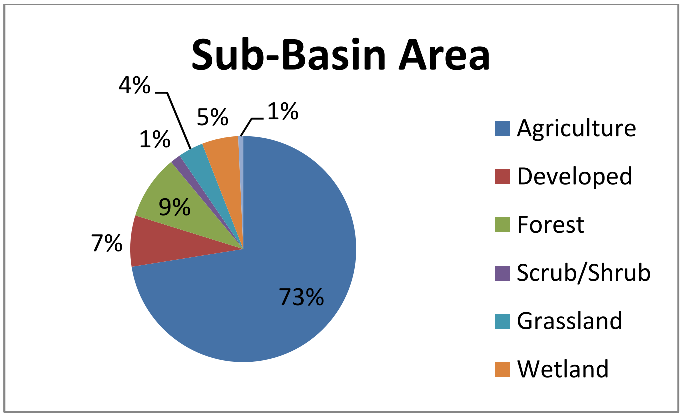

Figure 13. Sub-Basin Land Cover Percentage (2006)

Land cover change between 1996 and 2006 sub-basin wide appeared relatively stable based on the data displayed in Figure 14. Small increases in developed land cover classes along with losses in agricultural land cover were observed over this period.

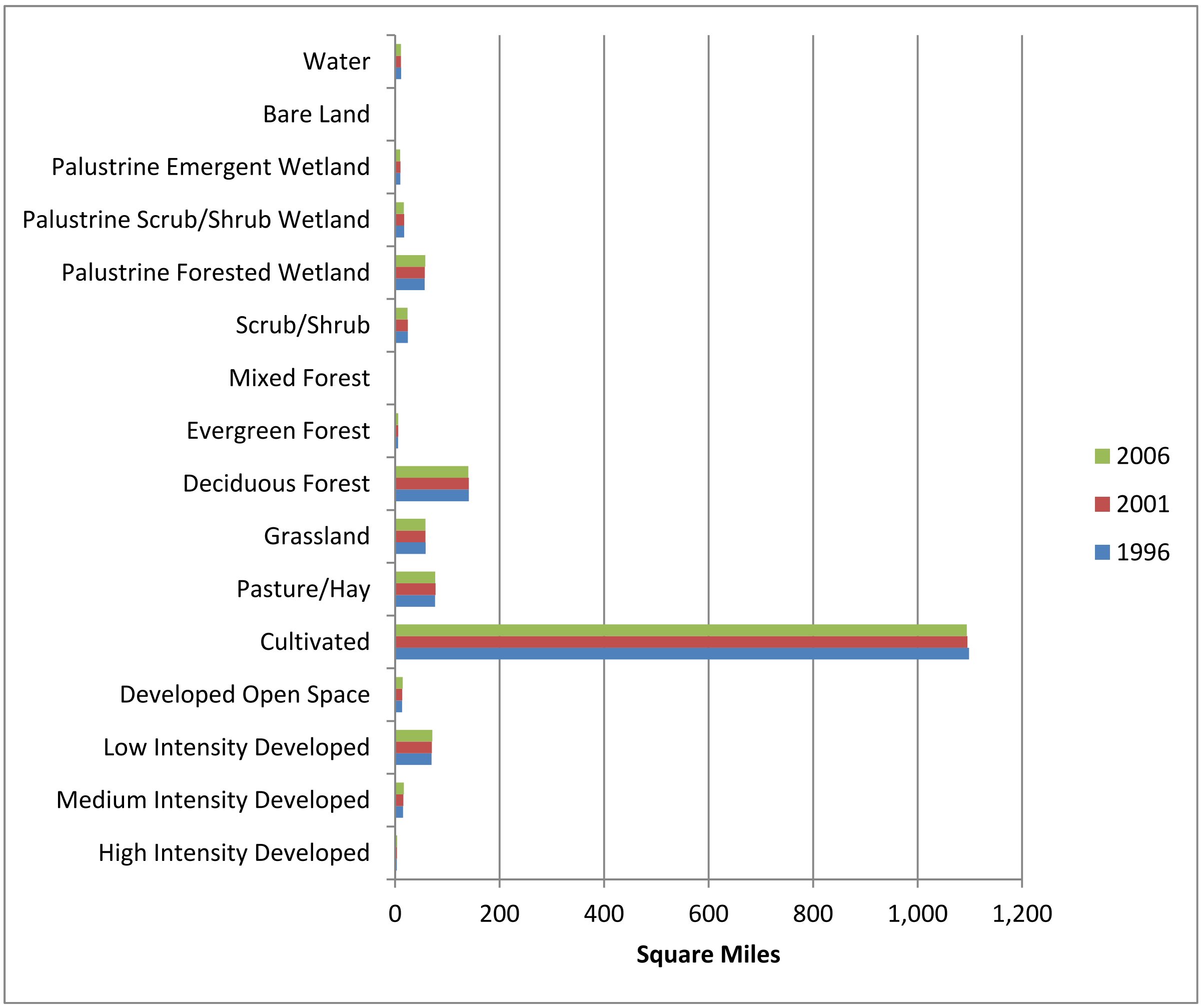

Figure 14. Distribution of Land Cover Classes (1996-2006)

Developed

In 2006 approximately 107 mi² or 7% of land in the sub-basin was classified as developed. Between 1996 and 2006 approximately 5 mi² of land was converted to development. This equates to a 5% increase across the sub-basin project area. Areas of recent growth are shown in Figure 15. The areas of greatest change, although relatively small, occurred around St. John, Crown Point and Cedar Lake in Lake County. The figure was generated by superimposing 1996 CCAP developed land cover classes (high, medium, and low intensity development and developed open space) over 2006 CCAP data.

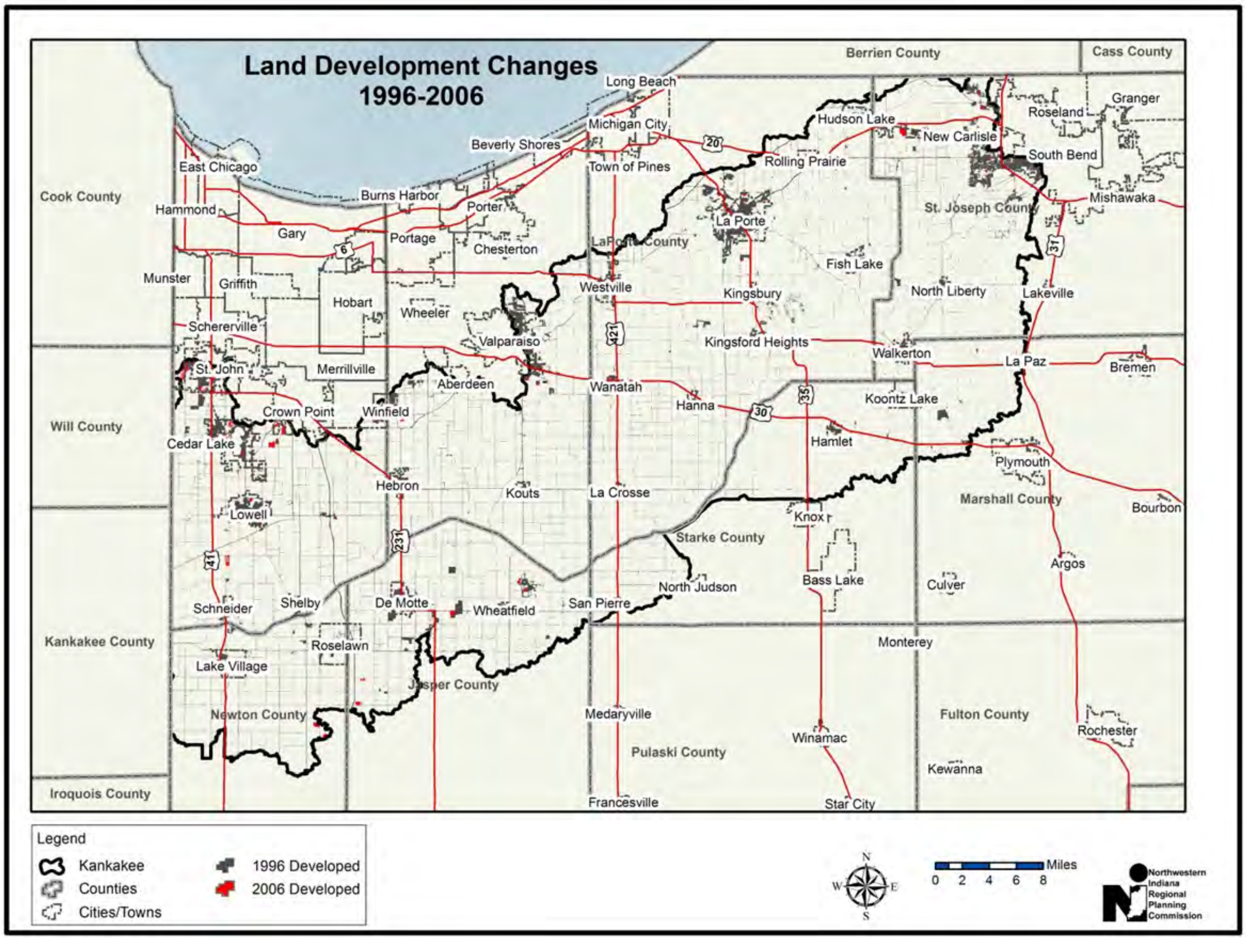

Figure 15. Land Development Changes (1996-2006)

A majority of the new growth observed in the sub-basin took place on agricultural lands (Figure 16). Nearly 2,500 acres of agricultural land was converted for development purposes.

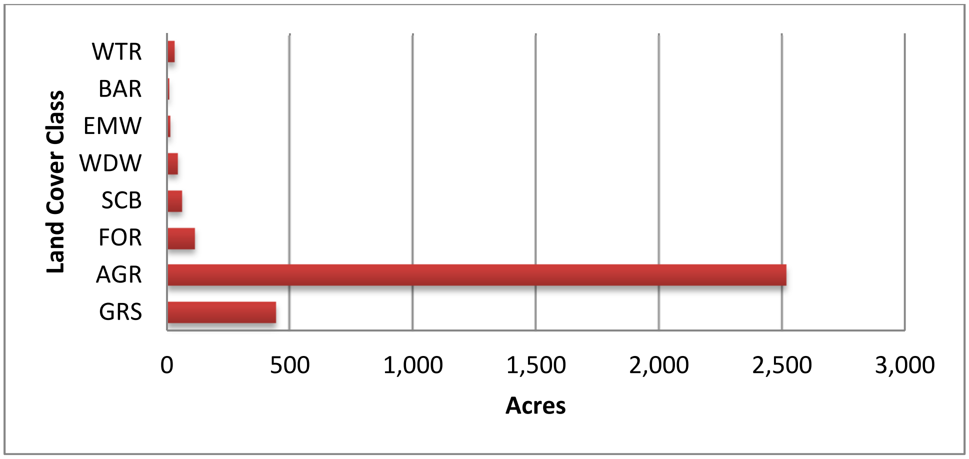

Figure 16. Distribution of Areas Lost to Development by Land Cover

Jenks Natural Breaks was used in ArcMap10 to classify the percentage of developed land within each subwatershed (Figure 17). While still overwhelmingly an agricultural area, a number of subwatersheds show a fair amount of developed land. Generally these subwatersheds exist on the fringes of larger municipalities in the Little Calumet-Galien where growth is expanding to the south. In St. Joseph County these subwatershed exist on the fringe of South Bend.

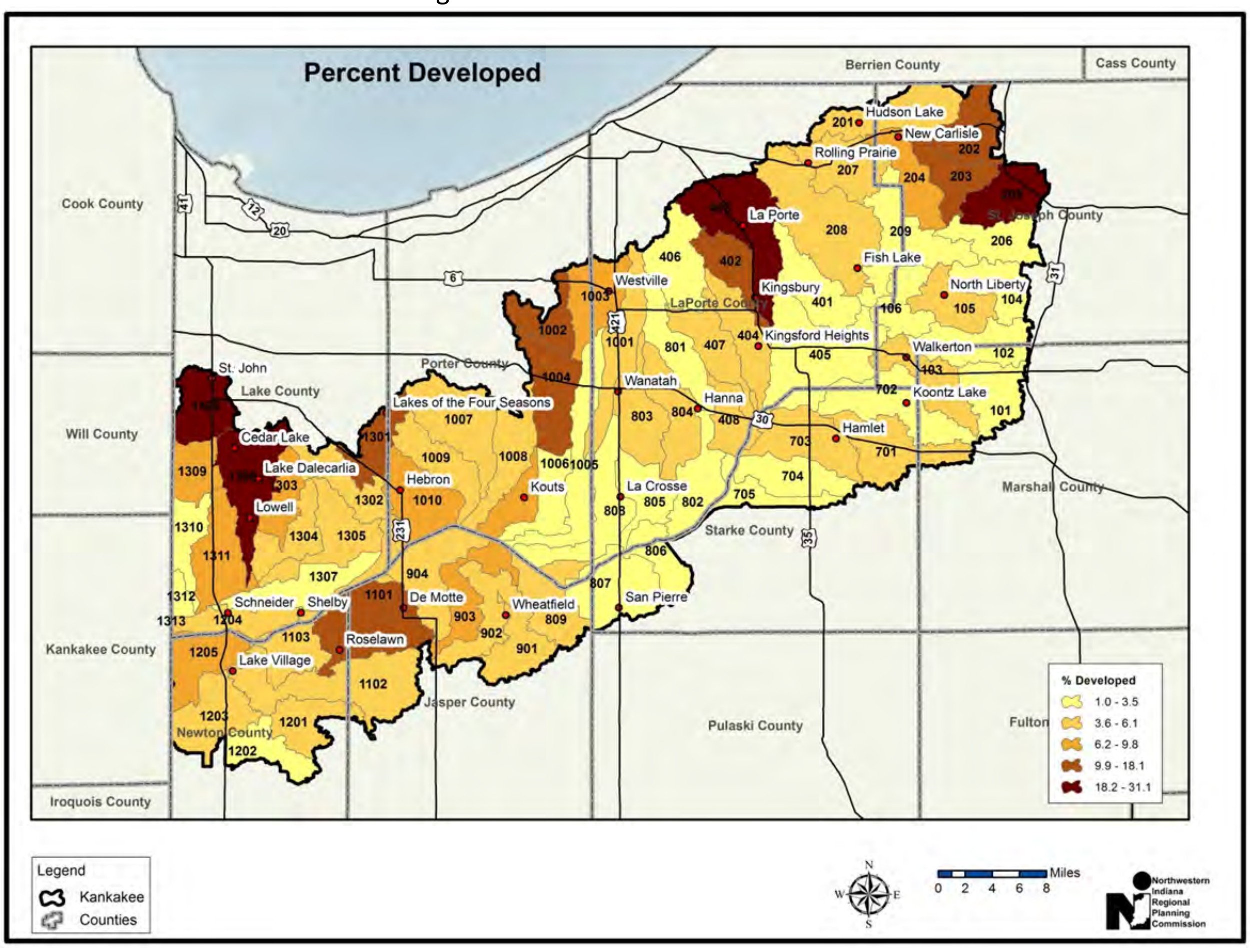

Figure 17. Percent Developed by Subwatershed

A considerable amount of research has been done to evaluate the direct impact of urbanization on streams. Much of this research has focused on hydrologic, physical and biological indicators. In recent years, impervious cover (IC) has emerged as a way to explain and sometimes predict how severely these indicators change in response to varying levels of watershed development. The Center for Watershed Protection (CWP) has integrated research findings into a general watershed planning model, known as the impervious cover model (ICM). The ICM predicts that most stream quality indicators decline when watershed IC exceeds 10%, with severe degradation expected beyond 25% IC (CWP, 2003).

NOAA CCAP 2006 land cover data was used to calculate percent impervious cover for each subwatershed (Figure 18). Lacking impervious cover coefficients for the region, coefficients developed by the Nonpoint Education for Municipal Officials (NEMO) program in Connecticut were used http://nemo.uconn.edu/tools/impervious_surfaces/data/isat_coeff.htm. An IC coefficient was assigned to each CCAP land cover class. Using the Zonal Statistics tool in ArcMAP 10, percent impervious cover was calculated for each subwatershed.

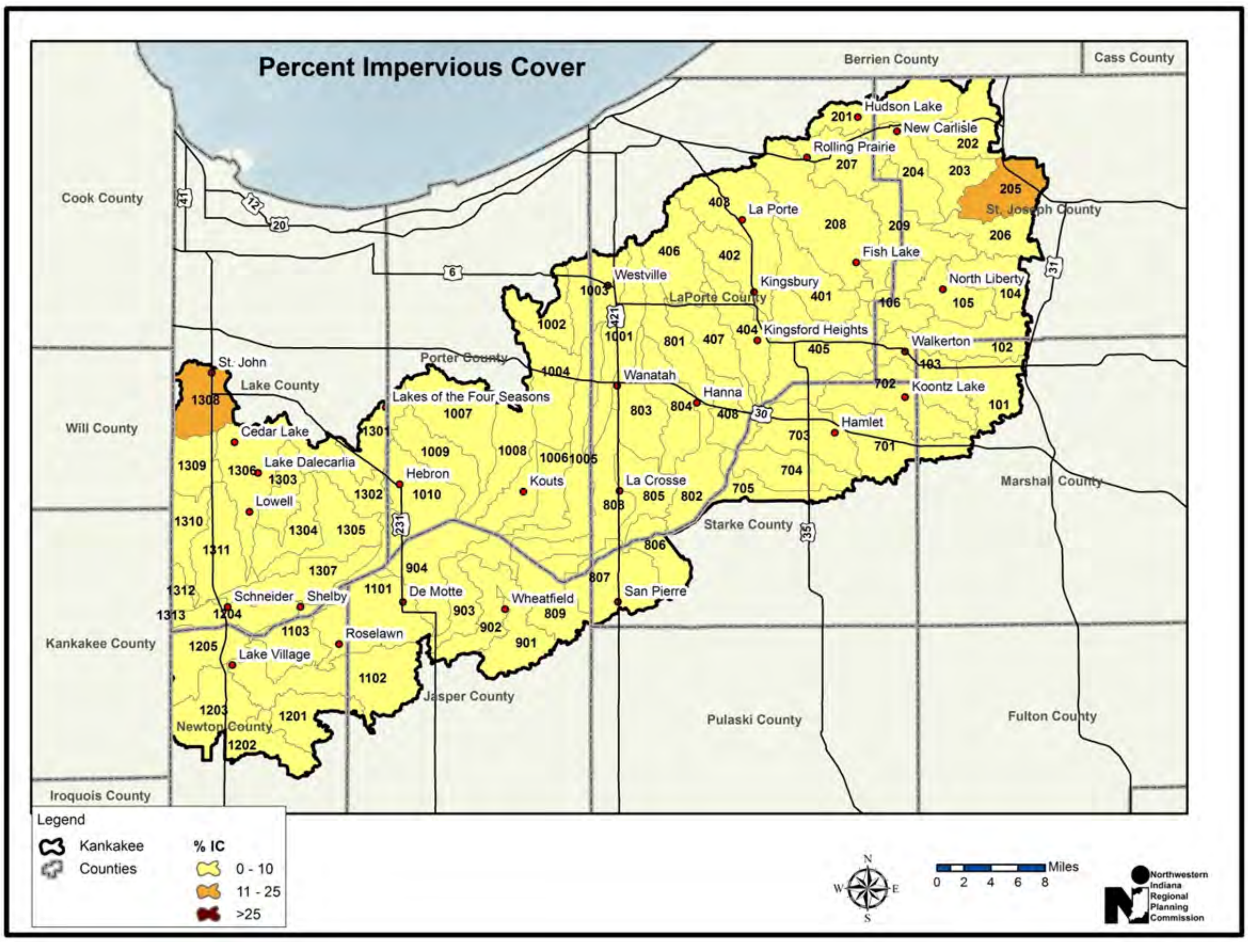

Figure 18. Percent Impervious Cover by Subwatershed

The impervious cover analysis showed that impervious cover was of greatest concern in the Bull Run-West Creek subwatershed (HUC 071200011308) near St. John in Lake County and the Dixon West Place Ditch subwatershed (HUC 071200010205) which includes part of South Bend in St. Joseph County. Based on the ICM, streams within these subwatersheds are susceptible to streambank erosion, down cutting and widening, and degraded water quality. The remainder of the sub-basin has a low percentage of impervious cover due the amount of land in row crop production.

Agriculture

Agriculture is the dominant land use in the sub-basin. In 2006 approximately 1,171 mi^2 (73%) of the sub-basin was devoted to agriculture. Cultivated land accounted for 93% of agricultural use (CCAP, 2006) with corn and soybeans being the predominant crops (USDA Agricultural Census, 2007). Pasture/hay accounted for the remaining 7% of agricultural land use. The percentage of agricultural land for each subwatershed of the sub-basin is shown in Figure 19.

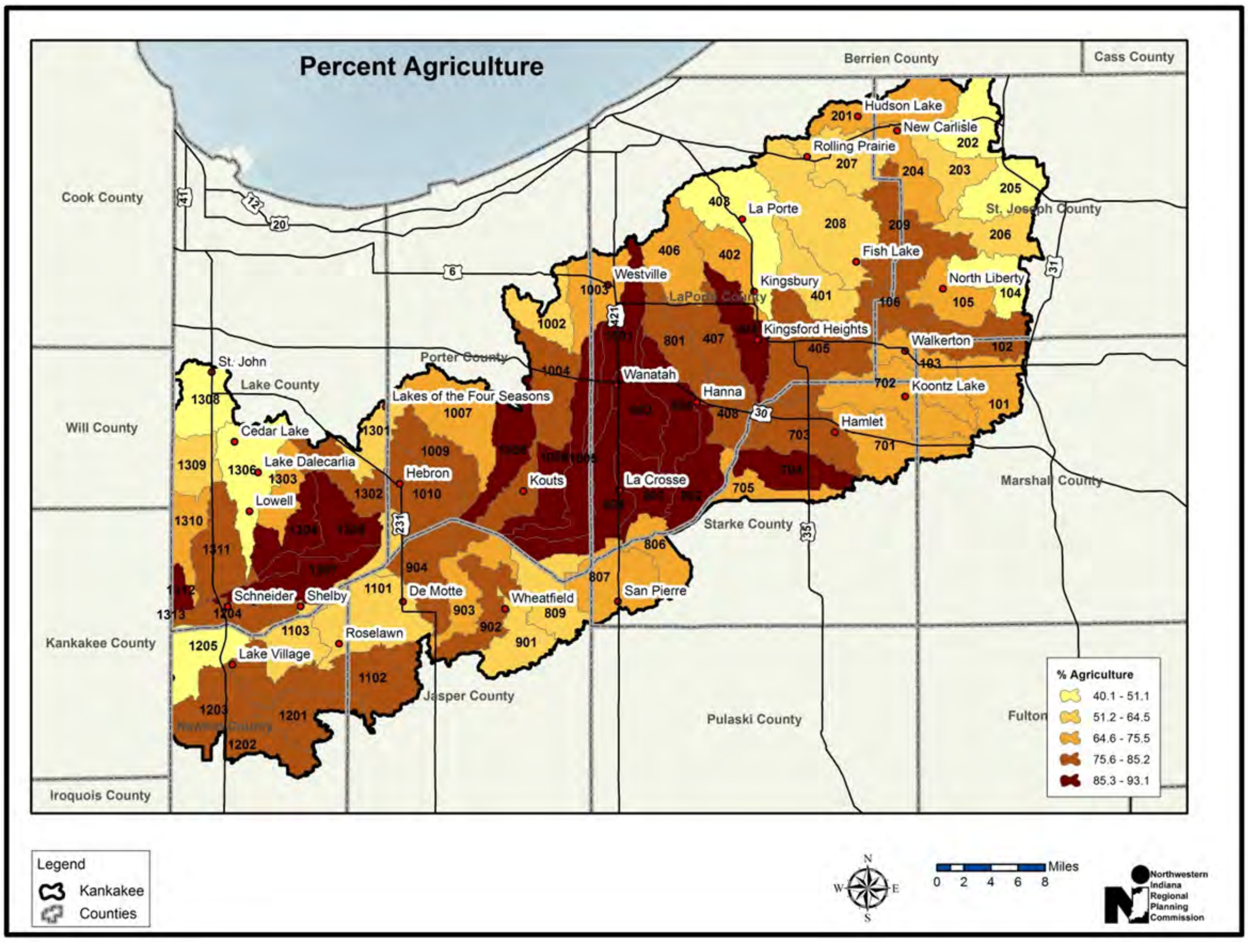

Figure 19. Percent Agriculture by Subwatershed

In cultivated areas, tillage practices can have a major effect on water quality. Conventional tillage leaves the soil surface bare and loosens soils particles making them susceptible to wind and water erosion. Conservation tillage reduces erosion by leaving at least 30 percent of the soil surface covered with crop residue after planting. Residues protect the soil surface from the impact of raindrops and act like a dam to slow water movement. Rainfall stays in the crop field allowing the soil to absorb it. With conservation tillage less soil and water leave a field.

While there is no data specifically available for conservation tillage practices by Hydrologic Unit Code, the Indiana State Department of Agriculture (ISDA) does provide data by county. Cropland tillage data for 2009 for both corn and soybean are displayed in Figure 20 and Figure 21. Conventional tillage for corn production was much more prevalent in Lake and Porter Counties compared to the other counties in the sub-basin especially when compared to Starke, St. Joseph, and LaPorte Counties. For soybeans, conservation tillage practices are more often used in all eight counties.

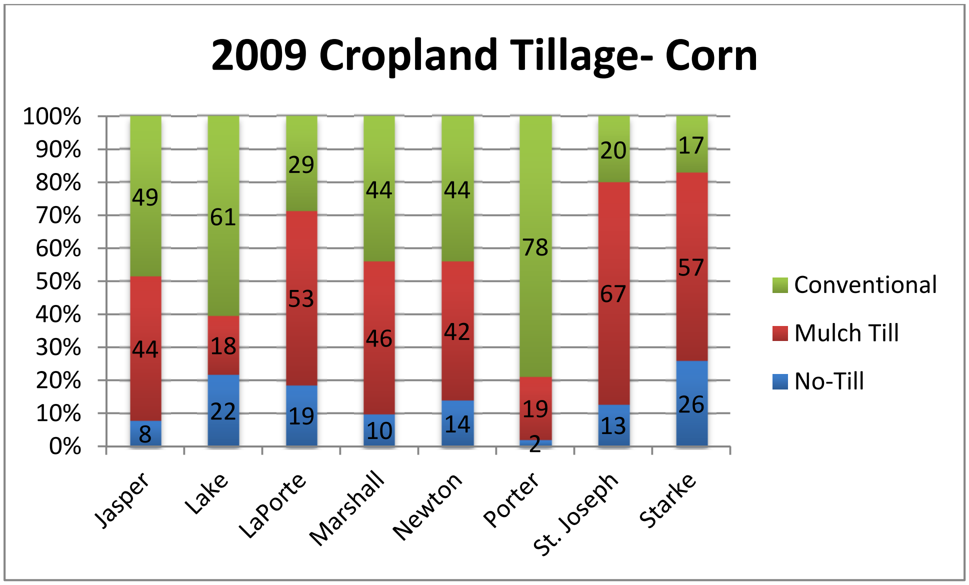

Figure 20. Cropland Tillage Data- Corn (2009)

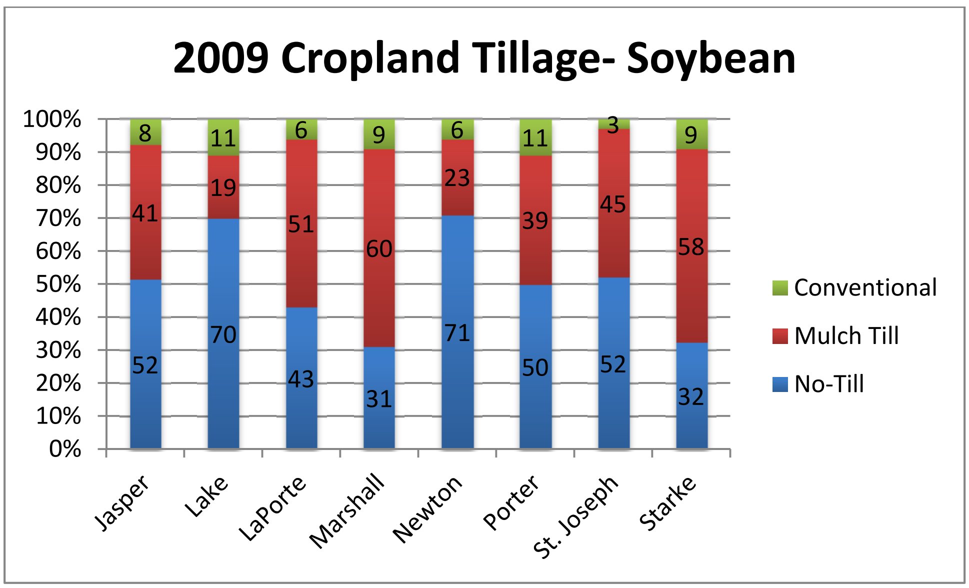

Figure 21. Cropland Tillage Data- Soybean (2009)

No-till: Any direct seeding system including strip preparation with minimal soil disturbance.

Mulch till: Any tillage system leaving greater than 30% of the crop residue after planting, excluding no-till.

Conventional: Any tillage system leaving less than 30% crop residue cover after planting.

There are 81 Confined Feeding Operation (CFO) facilities in the sub-basin based on IDEM data accessed from Indiana Map (www.indianamap.org/index.html) on May 27, 2011. Their locations are displayed in Figure 22. IDEM regulates these facilities, as well as smaller operations which have violated water pollution rules or laws, under IC 13-18-10, the Confined Feeding Control Law. Due to size or historical compliance issues some confined feeding operations are defined as concentrated animal feeding operations (CAFOs). The CAFO regulation contains more stringent operational requirements and slightly different application requirements.

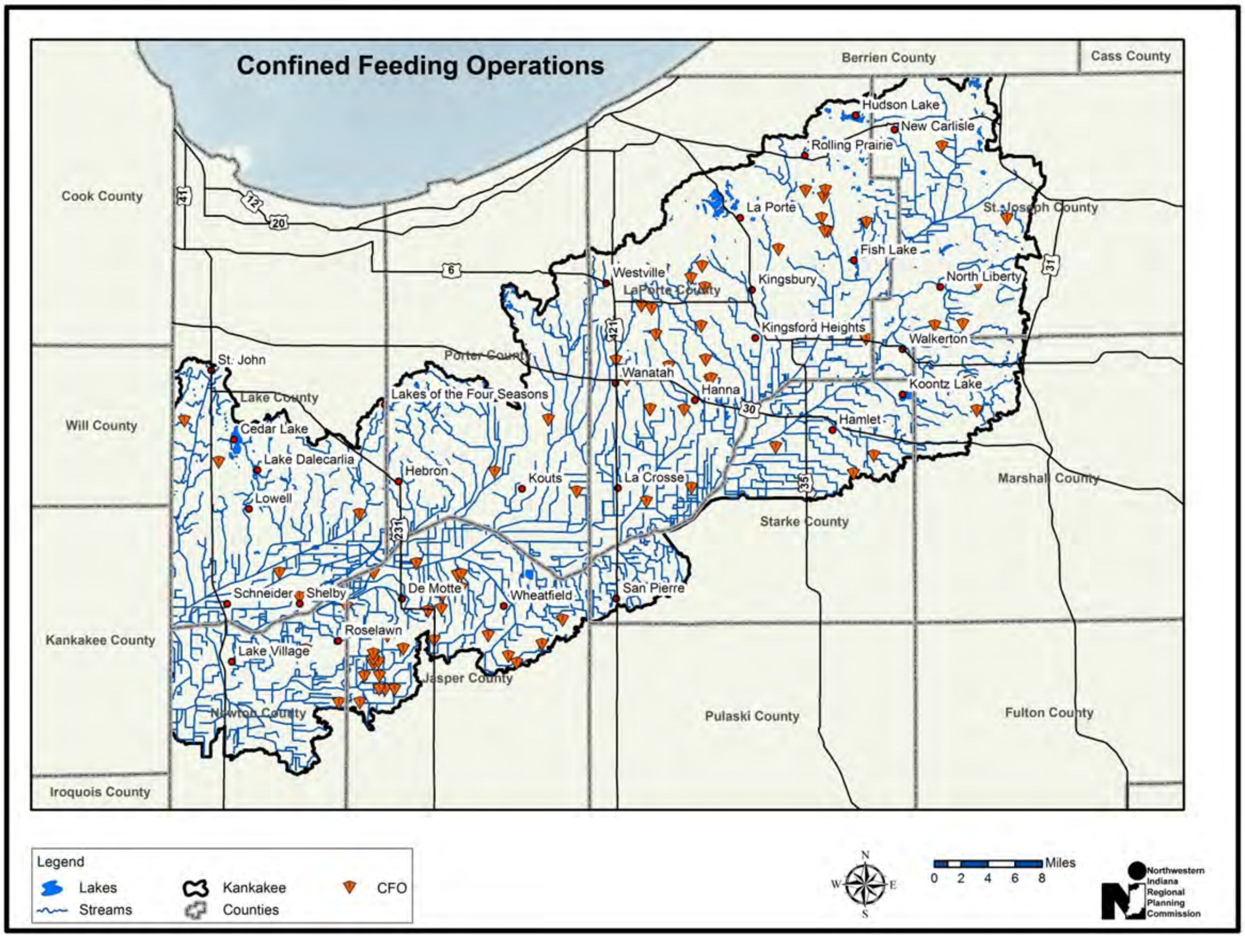

Figure 22. Confined Feeding Operations

Animals raised in confined feeding operations produce manure and wastewater which is collected and stored in pits, tanks, lagoons and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial reuse provides a natural source of nutrients for crop production. It also lessens the need for fuel and other resources that are used in the production of commercial fertilizer.

Confined feeding operations, however, can also pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons or tanks
- Improper application of manure to the land can impair surface or ground water quality

Indiana law defines a CFO as any animal feeding operation engaged in the confined feeding of at least 300 cattle, or 500 horses, or 600 swine or sheep, or 30,000 fowl, such as chickens and turkeys. The IDEM CFO/CAFO approval/permit program is based on the Confined Feeding Control Law administered through regulations adopted under the Water Pollution Control Board. The focus of the regulations is to protect water quality. The program is intended to provide an oversight process to assure that waste storage structures are designed, constructed and maintained to be structurally sound and that manure is handled and land applied in an environmentally acceptable manner.

Forest

Forests play a critical role in the health of a watershed. Forest cover reduces stormwater runoff and flooding by intercepting rainfall and promoting infiltration into the ground. Trees growing along streambanks help prevent erosion by stabilizing the soil with their root systems. They help improve water quality by filter sediment and associated pollutants from runoff. Forests provide cover for both terrestrial and aquatic life. Forests also reduce summer air and water temperatures and improve regional air quality (www.forestsforwatersheds.org/urban-watershed-forestry/).

Based on 2006 CCAP data, overall there is approximately 148 mi^2 of forest cover within the sub-basin. This accounts for about 9% of the entire land area of the sub-basin. A further breakdown of percent forest cover by subwatershed is presented in Figure 23. Only about 9% of the forestland in the sub-basin exists within the protective boundaries of managed lands and another 7% within municipal boundaries. The remainder exists in unincorporated areas.

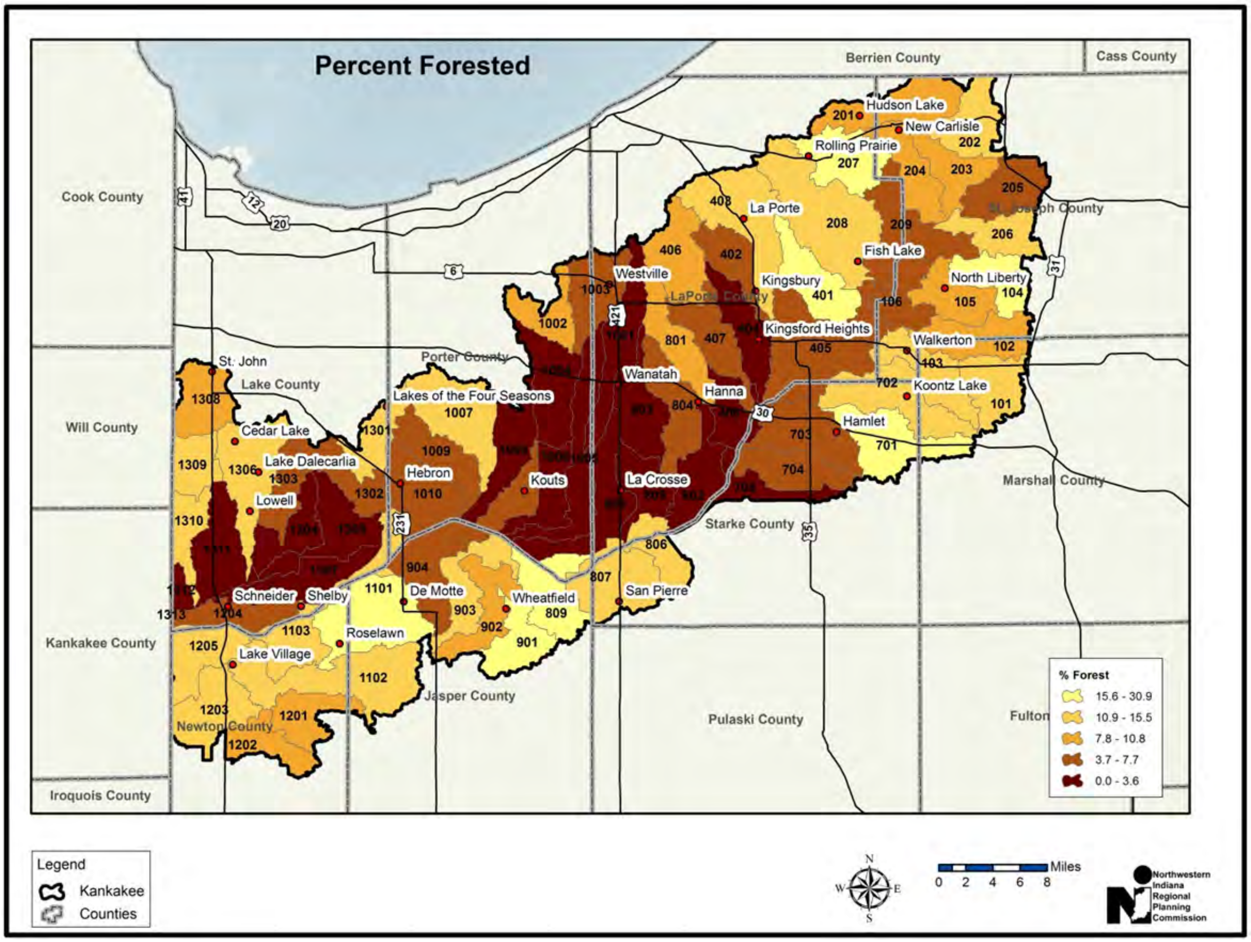

Figure 23. Percent Forested by Subwatershed

While it is important to have a general understanding of how much forest cover exists in a watershed, it is also at least equally as important to understand the quality and location of that forest cover. Forest fragmentation occurs when large, contiguous stands of mature forest are divided into smaller isolated patches known as "forest fragments." Forest fragmentation is caused by human activities, such as road construction, agricultural clearing, and urbanization, or by natural processes that include fire and climate change. Forest fragmentation is considered a useful indicator of forest ecosystem health. The degradation of core forest into fragments can cause biological diversity loss of native flora and fauna species, alterations to water cycles, and adverse impacts on air and water quality. Forests weakened by fragmentation become more susceptible to damage from insects and diseases, and this stress often degenerates into a condition of chronic ill health (www.csc.noaa.gov/digitalcoast/data/ccapregional/index.html).

Figure 24 and Figure 25 display NOAA CCAP forest fragmentation data for the sub-basin. Core forest area decreased <1% between 1996 and 2006 while patch forest area increased nearly 2.5% over the same time period.

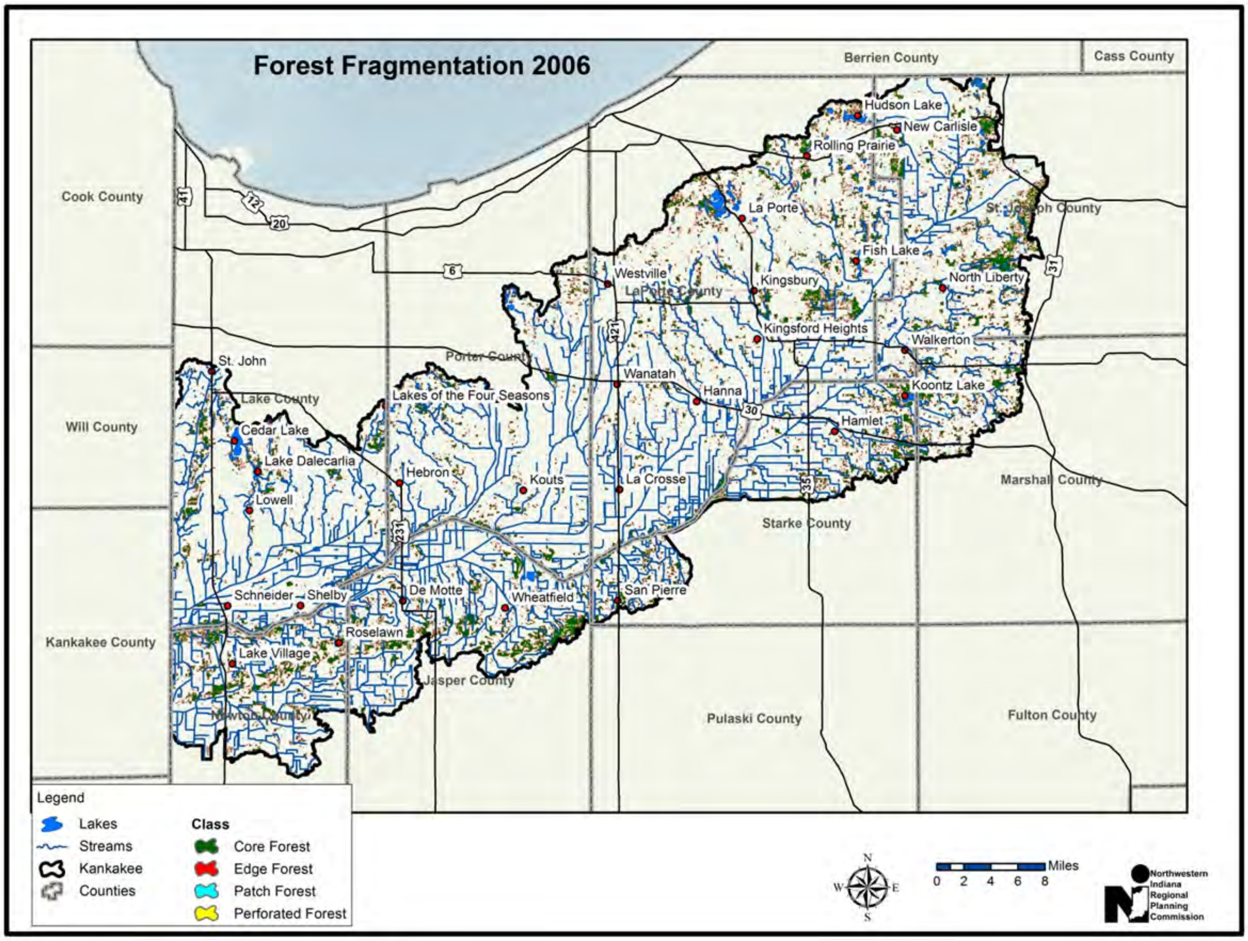

Figure 24. Forest Fragmentation

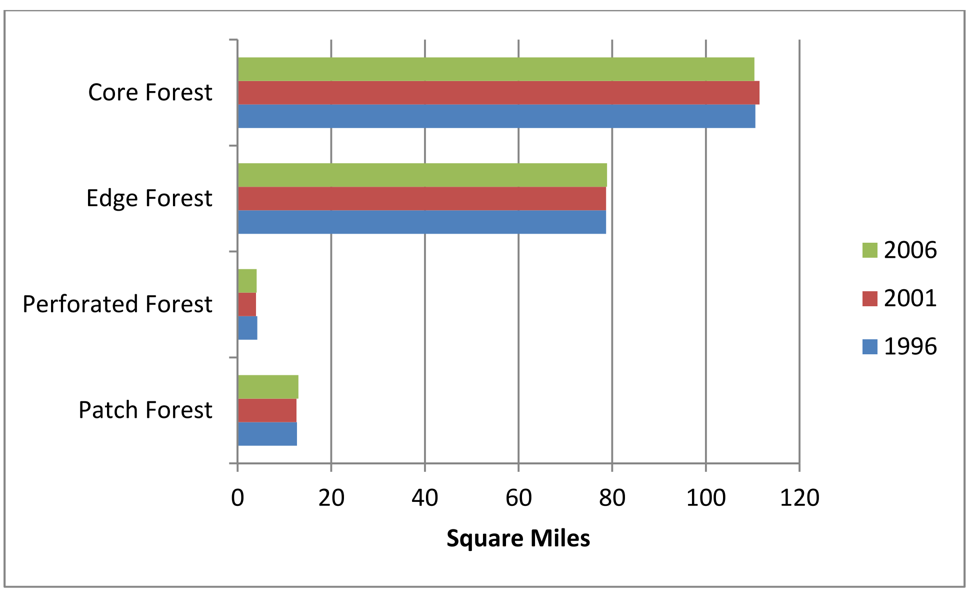

Figure 25. Distribution of Forest Fragmentation by Type (1996-2006)

Wetlands

Like forests, wetlands also play a critical role in watershed health. Wetlands function in flood control by storing and slowly releasing water. Wetlands capture and help filter out sediment and associated pollutants. They provide vital habitats for fish and wildlife, including threatened and endangered species. Wetlands also provide recreational opportunities and economic benefits (www.epa.gov/bioindicators/aquatic/importance.html).

Within the sub-basin there are approximately 84 mi² of Palustrine wetland based on 2006 CCAP data. This accounts for roughly 5% of the sub-basin land area. Due to data collection methodology this estimate of wetland area varies from the National Wetland Inventory estimate of 77 mi². Figure 26 shows percent wetland area by subwatershed. The Beaver Lake Ditch-Kankakee River (HUC 071200011205), Brown Levee Ditch-Kankakee River (HUC 071200011103), and Laramore Ditch-Kankakee River (HUC 071200010705) subwatersheds have the greatest percentage of wetland cover within the study area.

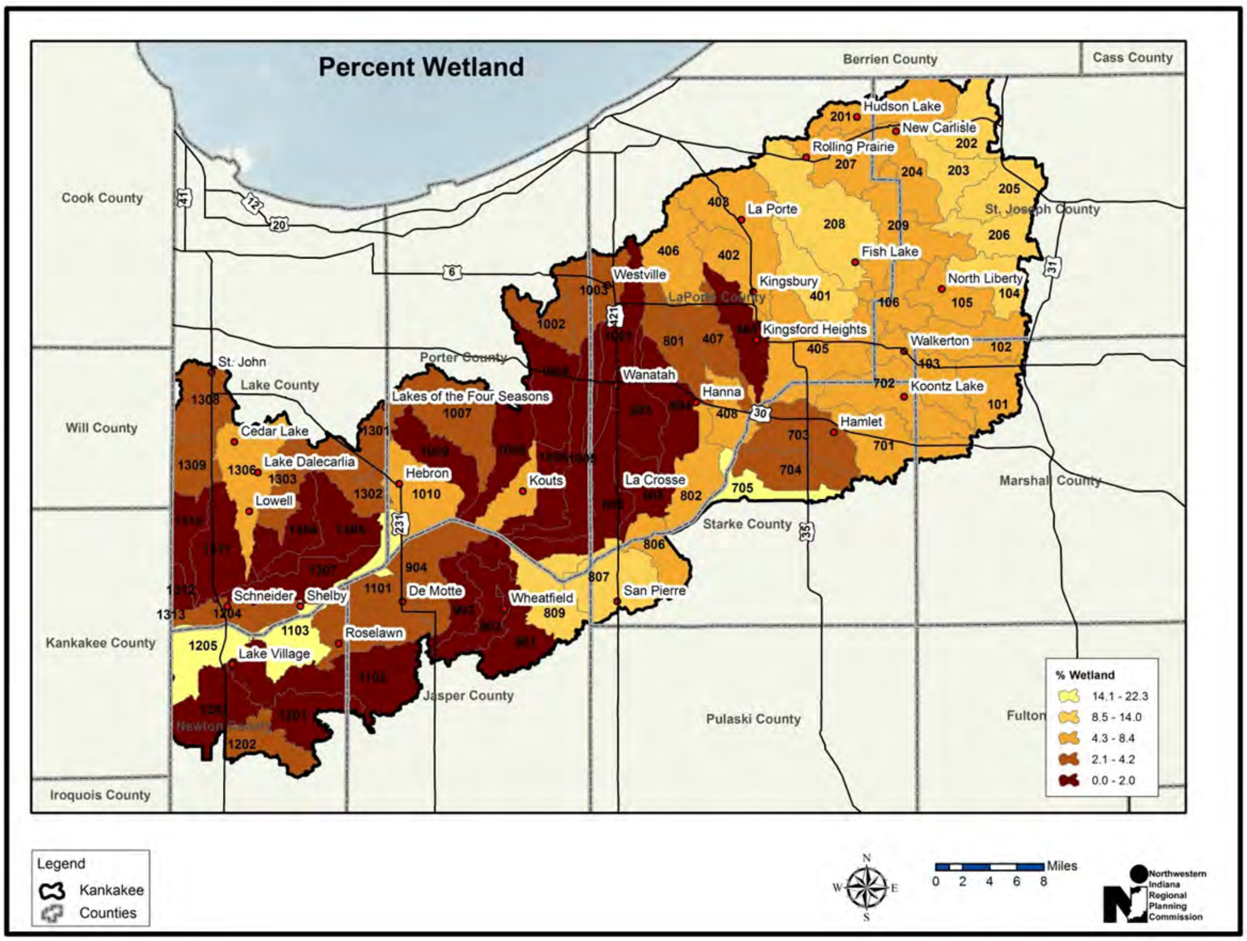

Figure 26. Percent Wetland by Subwatershed

Hydric soils data shows that nearly 617 mi² or 88% of the sub-basins historical wetland area has been lost. Figure 27 displays percent wetland change by subwatershed. The data used to create the figure was extracted from hydric soils data and 2006 CCAP wetland acreage data for each subwatershed using ArcMap10 Spatial Analyst. Seventy one of seventy two subwatersheds showed wetland loss. The only subwatershed showing a gain was the Clear Lake Basin subwatershed (HUC 071200010207). A closer review of the data reveals that wetlands do occur on soils classified as non-hydric in the sub-basin. This helps in part explain the wetland gain observed in the Clear Lake Basin subwatershed.

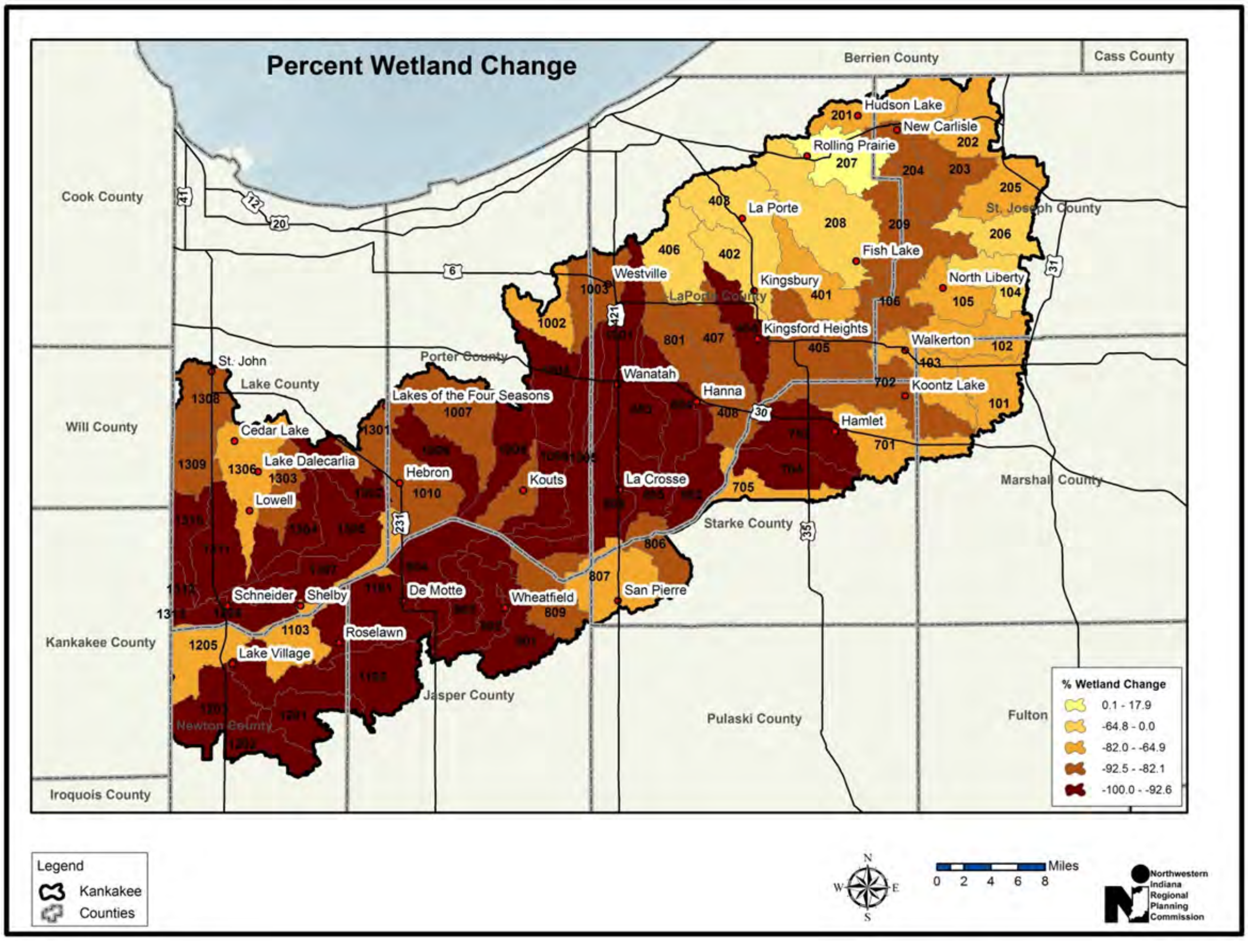

Figure 27. Percent Wetland Change by Subwatershed

3.1.6 Other Planning Efforts

Kankakee River Watershed Restoration Action Strategy

The Kankakee River Watershed Restoration Action Strategy (WRAS) (IDEM, 2001) is broken into two sections. The overall goal and purpose of Part I of the WRAS is to provide a reference point and roadmap to assist with improving water quality. It includes a compilation of information, facts, and local concerns in for the sub-basin within Indiana. It was intended to serve as a reference document, to be revised when updated information was available, for watershed groups and others involved in the assessment and planning of watershed restoration activities.

Part II of the WRAS discusses the water quality concerns identified by stakeholder groups and state and federal agencies. Additionally it recommends management strategies to address those concerns.

Stakeholder concerns identified at public meetings coordinated by the SWCD's in the sub-basin and Kankakee River Basin Commission included:

- Monitor surface water quality
- Facilitate communication between agriculture and urban
- Education and information on septic systems
- Assist farmers in removing livestock from drainage ways
- Drainage and flood control
- Wetland loss
- Irrigation
- Loss of fish and wildlife habitat
- Increasing development
- Wind and water erosion/lack of control
- Lack of stewardship ethic
- Lack of manure management
- Urban sprawl/farmland preservation
- Pesticide management
- Animal/fertilizer runoff
- Lack of funding, political will, enforcement
- Ground and surface water quality related to septic and wells
- Recreational opportunities

The Kankakee River WRAS is available for viewing or download from IDEM at www.in.gov/idem/nps/2964.htm.

Combined Sewer Overflow (CSO) Long Term Control Plans

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a waterbody. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other waterbodies. These overflows, called combined sewer overflows (CSOs), contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris.

CSO communities are required to submit Long Term Control Plans to IDEM as an NPDES permit requirement. IDEM's CSO program augments the NPDES municipal permitting program by implementing a strategy for the maintenance and management of combined sewer collection systems. The primary objective of this group is to insure the minimization of impacts to waters of the state from CSOs. Based upon information from IDEM's Municipal NPDES Permits Section, LTCP's have been submitted by the LaPorte Municipal Sewage Treatment Plant (STP) and Lowell Municipal STP. Further information about CSO permitting and LTCP status information is available from IDEM at www.in.gov/idem/4897.htm.

Municipal Separate Storm Sewer System (MS4)

MS4s are defined as a storm water conveyances owned by a state, city, town, or other public entity that discharges to waters of the United States. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels and conduits. The Clean Water Act requires storm water discharges from certain types of urbanized areas to be permitted under the National Pollutant Discharge Elimination System (NPDES) program. Under Phase II, 327 IAC 15-13 (Rule 13) was written to regulate most MS4 entities (cities, towns, universities, colleges, correctional facilities, hospitals, conservancy districts, homeowner's associations and military bases) located within mapped urbanized areas, as delineated by the United States Census Bureau, or, for those MS4 areas outside of urbanized areas, serving an urban population greater than 7,000 people.

MS4 conveyances within urbanized areas have one of the greatest potentials for polluted storm water runoff. The Federal Register Final Rule explains the reason as: "urbanization alters the natural infiltration capacity of the land and generates...pollutants...causing an increase in storm water runoff volumes and pollutant loadings." Urbanization results "in a greater concentration of pollutants that can be mobilized by, or disposed into, storm water discharges."

A review of MS4 entities data from IDEM (www.in.gov/idem/5437.htm) shows there are twelve entities including seven municipalities within the sub-basin that are designated MS4s (Table 2 and Figure 28). This includes portions of Lake, Porter, LaPorte, and St. Joseph Counties.

County	MS4 Entity	Permit Number
Lake	Lakes of the Four Seasons POA	INR040007
Lake	Lowell, Town of	INR040046
Lake	St. John, Town of	INR040047
Lake	Crown Point, City of	INR040054
Lake	Cedar Lake, Town of	INR040075
Lake	Lake County	INR040124
LaPorte	LaPorte County; LaPorte, City of; Michigan City, City of; Trail Creek, Town of; Long Beach, Town of	INR040107 Co-Permittees
Porter	Valparaiso Lakes Conservancy District	INR040103
Porter	Porter County	INR040140
Porter	(Abderdeen) Nature Works CD	INR040149
Porter	Valparaiso, City of; Valparaiso University	INR04073
St. Joseph	St. Joseph County, Town of Osceola, Town of Roseland	INR040041

Table 2. Designated MS4 Entities

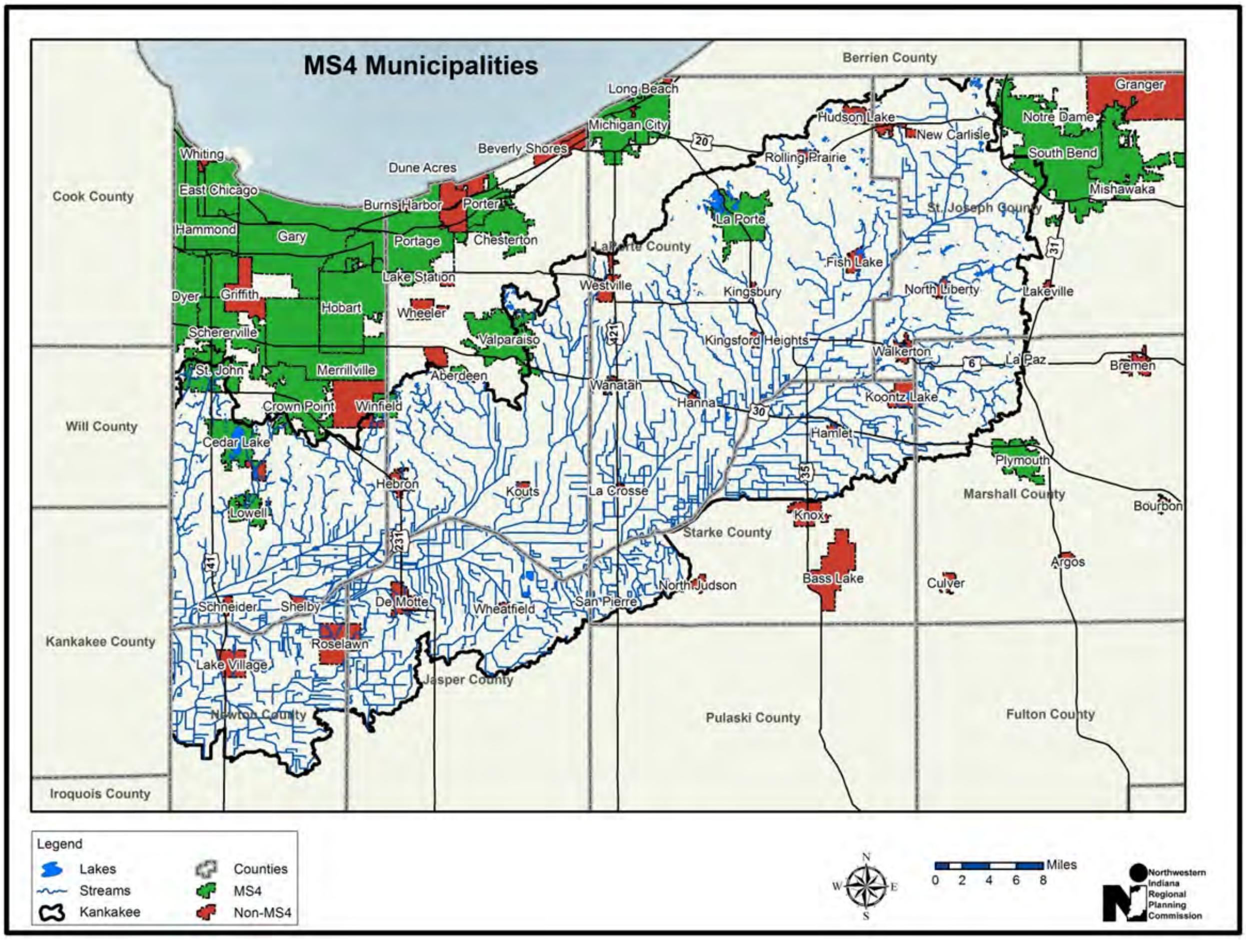

Figure 28. Designated MS4 Communities

MS4s are required to develop and implement a Storm Water Quality Management Plan (SWQMP). One of the most important aspects of MS4 to watershed management practitioners is Part C of the SWQMP. Part C outlines the priorities, goals, and implementation strategies that the MS4 will utilize to improve water quality. Each MS4 must address six minimum control measures in their Part C. These include:

- Public education and outreach
- Public participation and involvement
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water runoff control
- Municipal operations pollution prevention and good housekeeping

Any request for watershed implementation funding through Section 319 must clearly go “above and beyond” these requirements. Further information about permitting under Rule 13 is available at www.in.gov/idem/4900.htm. Additional details about Rule 13 and Section 319 is available at www.in.gov/idem/nps/.

Wellhead Protection Program

IDEM's Ground Water Section administers the Wellhead Protection Program, which is a strategy to protect ground water drinking supplies from pollution. The Safe Drinking Water Act and the Indiana Wellhead Protection Rule (327 IAC 8.4-1) mandates a wellhead program for all Community Public Water Systems.

The Wellhead Protection Programs consists of two phases. Phase I involves the delineation of a Wellhead Protection Area (WHPA), identifying potential sources of contamination, and creating management and contingency plans for the WHPA. Phase II involves the implementation of the plan created in Phase I, and communities are required to report to IDEM how they have protected ground water resources.

Due to recent legislation wellhead protection areas are no longer available. However, IDEM does respond to site specific inquiries into whether a property is located within or outside of an IDEM approved Wellhead Protection Area by completing a Wellhead Protection Proximity Determination Request form. Additionally IDEM maintains a listing of the due dates for all Community Public Water Supply Systems with Wellhead Protection Plans. This listing is sorted by County and includes the Community's PWSID, population, Phase I approval date, Phase II due date, and a contact name and phone number. This database is available to anyone and can be accessed to determine the status of a community's plan at www.in.gov/idem/4289.htm#description.

Source Water Assessment Program

The Source Water Assessment Program (SWAP) fulfills an EPA requirement to identify the areas that are sources of public drinking water, assess the susceptibility of water-supply systems to contamination, and inform the public of the results. The SWAP includes both ground water and surface water systems. Source water assessments are provided to public water systems by IDEM and are intended to provide basic information to public water suppliers regarding where their drinking water comes from and the susceptibility to which the drinking water source may be impacted by potential sources of contamination. IDEM's susceptibility determination for public water systems can be viewed or downloaded at www.in.gov/idem/4288.htm.

Total Maximum Daily Load (TMDL) Reports

Total Maximum Daily Load (TMDL) reports are assessments of water quality in rivers, lakes, and streams in a given watershed where impairments exist. The report contains an overview of the waterbodies, the sources of pollutants, the methods used to analyze data, reductions in levels of pollutants needed to restore water quality, actions that need to be taken to reduce pollutant levels and actions that are being taken to improve water quality.

A TMDL calculates the maximum amount of a pollutant that can enter a waterbody and still have that waterbody meet water quality standards. The load for the particular pollutant (ex. *E. coli*) is allocated towards point sources and nonpoint sources. It also includes a margin of safety to account for uncertainty. The following formula is used to calculate the TMDL

$$\mathbf{TMDL = \Sigma WLA + \Sigma LA + MOS}$$

where WLA is the sum of wasteload allocations (point sources), LA is the sum of load allocations (nonpoint sources and background), and MOS is the margin of safety.

Within the sub-basin project area a TMDL report for *E. coli* was completed for the Kankakee\Iroquois Watershed in 2009. It is available for viewing or download at IDEM's Watersheds & Nonpoint Source Water Pollution website at www.in.gov/idem/nps/2652.htm.

Watershed Management Planning & Implementation

No state approved watershed management plans have been completed within the sub-basin study area however; several IDNR Lake & River Enhancement (LARE) Program projects have been completed. Table 3 provides a list of the lake diagnostic studies that have been completed within the study area and have reports available on the LARE website at www.in.gov/dnr/fishwild/3303.htm.

Report Title	Month	Year	Category	County	Waterbody	URL
Cedar Lake Diagnostic Feasibility Study	April	2001	Lake Diagnostic Study	Lake	Cedar	View Report
DRAFT Diagnostic Study of Koontz Lake Indiana Conducted by SEC, Inc for US Army COE	October	1999	Lake Diagnostic Study	Marshall	Koontz	View Report
Feasibility Study on Water Quality and Sedimentation in Flint Lake	December	1991	Lake Diagnostic Study	Porter	Flint	View Report
Hudson Lake Diagnostic Study	June	2008	Lake Diagnostic Study	LaPorte	Hudson	View Report
LaPorte Lakes Diagnostic Study for the City of LaPorte	May	2007	Lake Diagnostic Study	LaPorte	Clear, Harris, Lily, Lower, Pine, Stone	View Report
The Cultural Eutrophication of Koontz Lake	December	1988	Lake Diagnostic Study	Marshall, Starke	Koontz	View Report
Union Mills: A Study for the Improvement, Restoration, and Protection of Mill Pond	February	1990	Lake Diagnostic Study	LaPorte	Mill Pond	View Report

Table 3. LARE Program ProjectsTable

Indiana Statewide Forest Assessment & Strategy

The Indiana Statewide Forest Strategy was developed by the IDNR in coordination with natural-resource professionals, landowners, conservationists, land stewards and forest stakeholders. It recognizes the most important issues that increasingly threaten the sustainability and ecological capacity of Indiana's forests to provide the benefits of clean air, carbon sequestration, soil protection, wildlife habitat, wood products and other values, goods and services. The plan addresses a limited forest base being fragmented or converted to other land uses, like subdivision housing, paved surfaces or row crop agriculture. The plan will enhance Indiana forests' ability to conserve soil and water resources by protecting existing targeted forest cover in watersheds and promoting reforestation along key streams and rivers. It will guide and improve efforts to control and combat the economically and ecologically disastrous effects of invasive plants in woodlands and make dramatic strides in the preservation of biological diversity by assuring that increasingly simplified and one-dimensional forests become more diverse and connected with one another.

The following long-term strategies were identified:

1. Conserve, manage, and protect existing forests. Especially large patches.
2. Restore and connect forests, especially in riparian areas.
3. Expand Best Management Practices, with special attention to invasive species.
4. Coordinate education, training, and technical assistance, especially to develop strategic partnerships.
5. Maintain and expand markets for Indiana hardwoods, especially those that are sustainably certified and are for local use.

The forest priority data displayed Figure 29 was generated by the IDNR as part of the Indiana Statewide Forest Assessment to prioritize and reflect the relative importance of Indiana forest issues. The figure was created by compositing forest issues and assigning a relative weighting score based on stakeholder feedback.

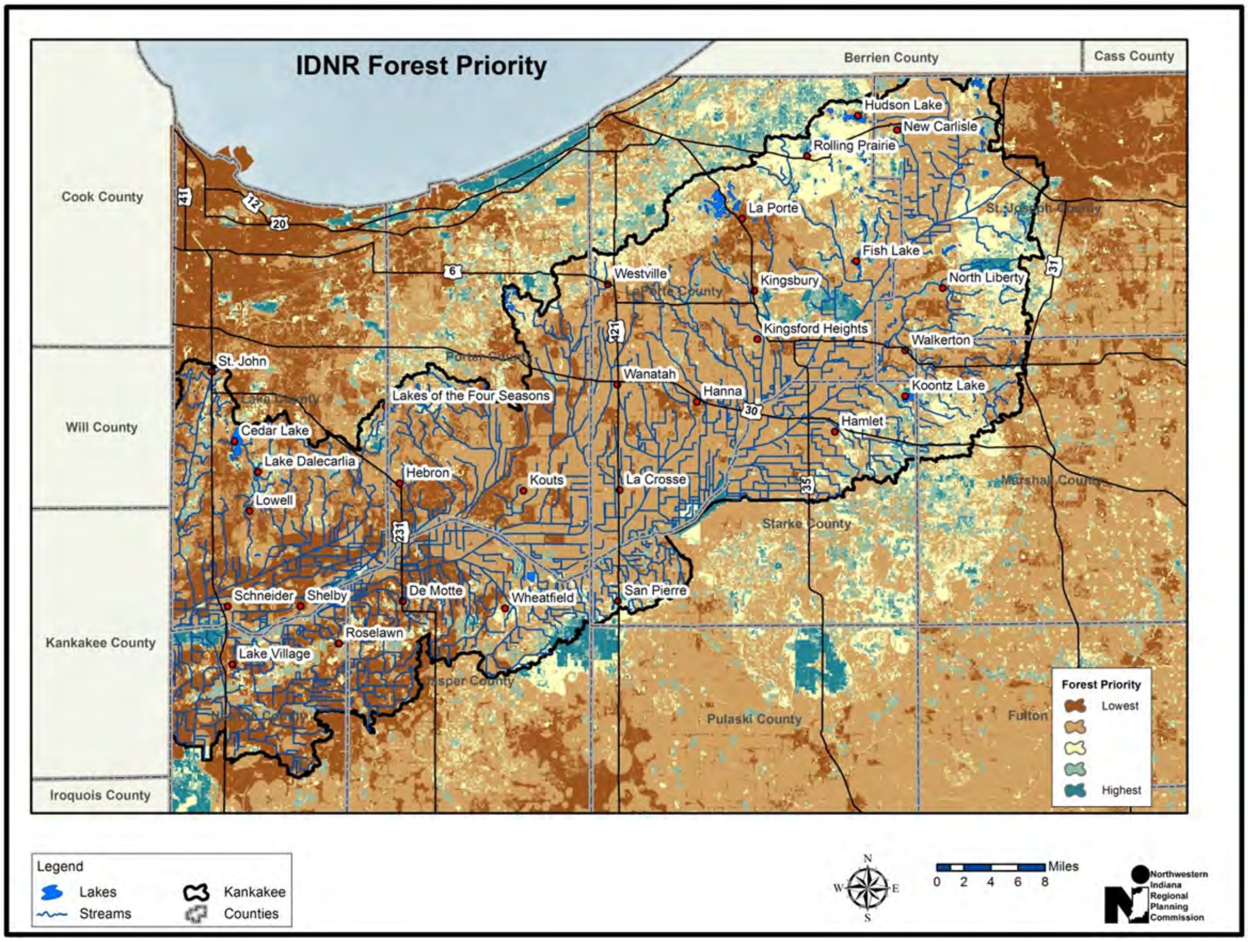

Figure 29. IDNR Forest Priority Areas

Indiana Wetlands Conservation Plan

The purpose of the Indiana Wetlands Conservation Plan (IWCP) is to achieve wetland conservation in a manner that is mutually beneficial. The IWCP serves as a framework for discussion and problem solving while establishing common ground on which progress of wetland conservation can be made. It also sets specific actions to achieve progress. While the IWCP does not specifically identify priority areas it does provide the following recommendations regarding prioritization.

1. Given that 85% of Indiana's wetlands have been lost, all remaining wetlands are important and should be considered important for conservation. However, a system for prioritizing wetlands for conservation must be developed.

2. Priorities for conserving wetlands based on water quality, flood control, and groundwater benefits should be made at the watershed or subwatershed level.

3. Special concerns for water quality, flood control, and groundwater should be identified for each watershed.

4. Statewide priorities for conserving wetlands based on biological and ecological functions should be developed based on the following criteria:

a. Rarity of wetland type

b. Presence of endangered, threatened, or rare species

c. Presence of endangered, threatened, or rare species habitat, but species not yet identified at the site

d. Diversity of native species

e. Diversity of wetland community types

f. Proximity of other valued ecosystem types

g. Natural quality (amount of disturbance/degradation)

h. Irreplaceability (can the wetland type be re-created)

i. Recoverability (can the wetland type recover from disturbance it has experienced)

j. Size

k. Location

The priorities should be identified based on the natural regions currently used by the Indiana Department of Natural Resources, Division of Nature Preserves and many other agencies and organizations.

5. Historical and recreational benefits of wetlands should be considered in identifying priorities.

6. Based on the statewide biological and ecological priorities, a process should be developed to assist in identifying wetland priorities at the watershed or subwatershed level.

7. Better information on Indiana's wetland resources is needed to more effectively identify scientifically based priorities described in Appendix G.

For more information about the IWCP please visit www.in.gov/dnr/fishwild/3350.htm.

Indiana Comprehensive Wildlife Strategy

The Indiana Comprehensive Wildlife Strategy (CWS) was developed by the Indiana Department of Natural Resources (IDNR) in coordination with conservation partners across the state to protect and conserve habitats and associated wildlife at a landscape scale. It provides a comprehensive overview of conservation in Indiana and identifies needs and opportunities for helping prevent species from becoming threatened or endangered in the future. Species of greatest conservation need (SGCN) were identified utilizing the most current published list of federally endangered, threatened or candidate species and Indiana's list of endangered species and species of special concern. The Indiana CWS was developed using an information system designed to link SGCN to all wildlife species and the habitats on which they depend. This was done by using a set of representative species as surrogates for guilds including the SGCN and which were reflective of habitat needs for all wildlife species. Major habitat categories included agricultural lands, aquatic systems, barren lands, developed lands, forest lands, grasslands, subterranean systems, and wetlands.

The CWP provides implementation guidance organized by habitat focus areas. The possible threats as determined by technical experts to the SGCN and their habitat are listed. Indiana's priority conservation actions and implementation guidance are presented for both the SCGN and their habitats. While too numerous to list here for each habitat category, the following common elements are reoccurring.

- Habitat protection through regulation
- Habitat protection and restoration on public lands
- Habitat protection and restoration incentives
- Exotic/invasive species control
- Protection of adjacent buffer zone
- Pollution reduction
- Corridor development and protection
- Artificial habitat creation
- Cooperative land management agreements
- Adaptive management

For more information about the Indiana Comprehensive Wildlife Strategy please visit www.in.gov/dnr/fishwild/files/CWS_MANUSCRIPT.pdf

Indiana Nonpoint Source Management Plan

The Indiana Nonpoint Source Management Plan, prepared by the Indiana Department of Environmental Management (IDEM) Office of Water, reflects the current goals and direction of Indiana's Nonpoint Source Management Program. It documents the methods the state will use to meet the state's long-term goal of measurable improvements in water quality through education, planning, and implementation while also meeting United States Environmental Protection Agency's (U.S. EPA's) criteria. As required by Section 319(h), each state's Nonpoint Source Management Program Plan describes the state program for nonpoint source management and serves as the basis for how funds are spent. Three activity funding categories have been established by IDEM to provide a cost-effective approach to insuring pollutant load reductions at the local watershed scale. While the plan does not specifically identify critical areas it does identify where IDEM feels the greatest water quality improvements can be realized given limited Section 319 funding.

Category 1: Categories with this ranking are eligible for inclusion in Section 319 grant applications as the category historically has produced reliable load reductions, potentially has a high impact on water quality, and can reasonably be addressed at a local watershed level. Activities in the given category would be chosen first to address NPS pollution in critical areas.

Category 2: Categories with this ranking are potentially eligible for inclusion in Section 319 grant applications, provided applicants can demonstrate within a given watershed that all Category 1 priorities have been addressed by previous activities. The high cost of individual projects in these categories, when compared with Category 1 projects, makes these categories less desirable. IDEM will consider funding of these on a case-by-case basis.

Category 3: Categories with this ranking are likely not eligible for inclusion in a Section 319 application, even if applicants can demonstrate within a given watershed that all Category 1 and 2 projects have been addressed by previous activities. Many NPS sources in these categories are the responsibility of other state agencies or programs, or will require statewide solutions or expenditures of funds that far exceed the capacity of the 319 program. These categories could be counted as match towards grant activities, provided load reductions are ensured and a clear link is documented between the activity and the NPS problem that will be addressed.

Project activity categories:

- Agricultural Management (Category 1)
- Atmospheric Deposition (Category 3)
- Closed Landfills and Solid Waste Disposal Sites (Category 3)
- Ground Water (Category 2)
- Land Application of Non-Agricultural Wastes (Category 3)
- Urban Issues (Category 1)
- Natural Resource Extraction (Category 2)
- On-Site Sewage Disposal (Categories 1 & 3)
- Sediment Removal (Category 3)
- Stream Bank/Shoreline Erosion (Category 2)
- Timber Management (Category 2)
- Transportation (Category 2)

For more information about the Indiana Nonpoint Source Management Plan please visit www.in.gov/idem/5970.htm.

2040 Comprehensive Regional Plan for Northwest Indiana

The 2040 Comprehensive Regional Plan (CRP) was developed as a comprehensive, citizen-based regional vision that will guide the development of land use and transportation programming in Northwest Indiana. It is a policy program with strong coordination and implementation elements. The CRP deals largely with multijurisdictional needs and opportunities that no single agency can manage or effect on its own. The means of enhancing the region's prosperity and quality of life, improving mobility, supporting communities and realizing environmental justice were among the key considerations during the CRP's development.

While the CRP's vision, goals and objectives provide a critical policy framework for the CRP, the Growth and Revitalization Vision presents a physical expression of the vision and goals combined. The Growth and Revitalization Vision was developed through the CRP's scenario planning process. The rationale behind the development of the Growth and Revitalization Vision and, by extension, the growth of Northwest Indiana through 2040, is based on the following principles:

- Support urban reinvestment
- Ensure environmental justice/social equity
- Protect natural resources and minimize impact to environmental features and watersheds
- Integrate transportation and land use

For more information about the 2040 Comprehensive Regional Plan for Northwest Indiana please visit http://nirpc.org/.

3.1.7 Endangered, Threatened, and Rare (ETR) Species

Figure 30 shows high concentration areas or "hot spots" of ETR occurrences within the sub-basin project area. Data used to generate this figure was provided by the IDNR Indiana Natural Data Center. The Indiana Natural Data Center represents a comprehensive attempt to determine the state's most significant natural areas. Included in the figure are high quality natural areas and endangered, threatened and rare species occurrences for both state and federally listed species. Further information about the program and a list of ETR species by county is available at http://www.in.gov/dnr/naturepreserve/4746.htm.

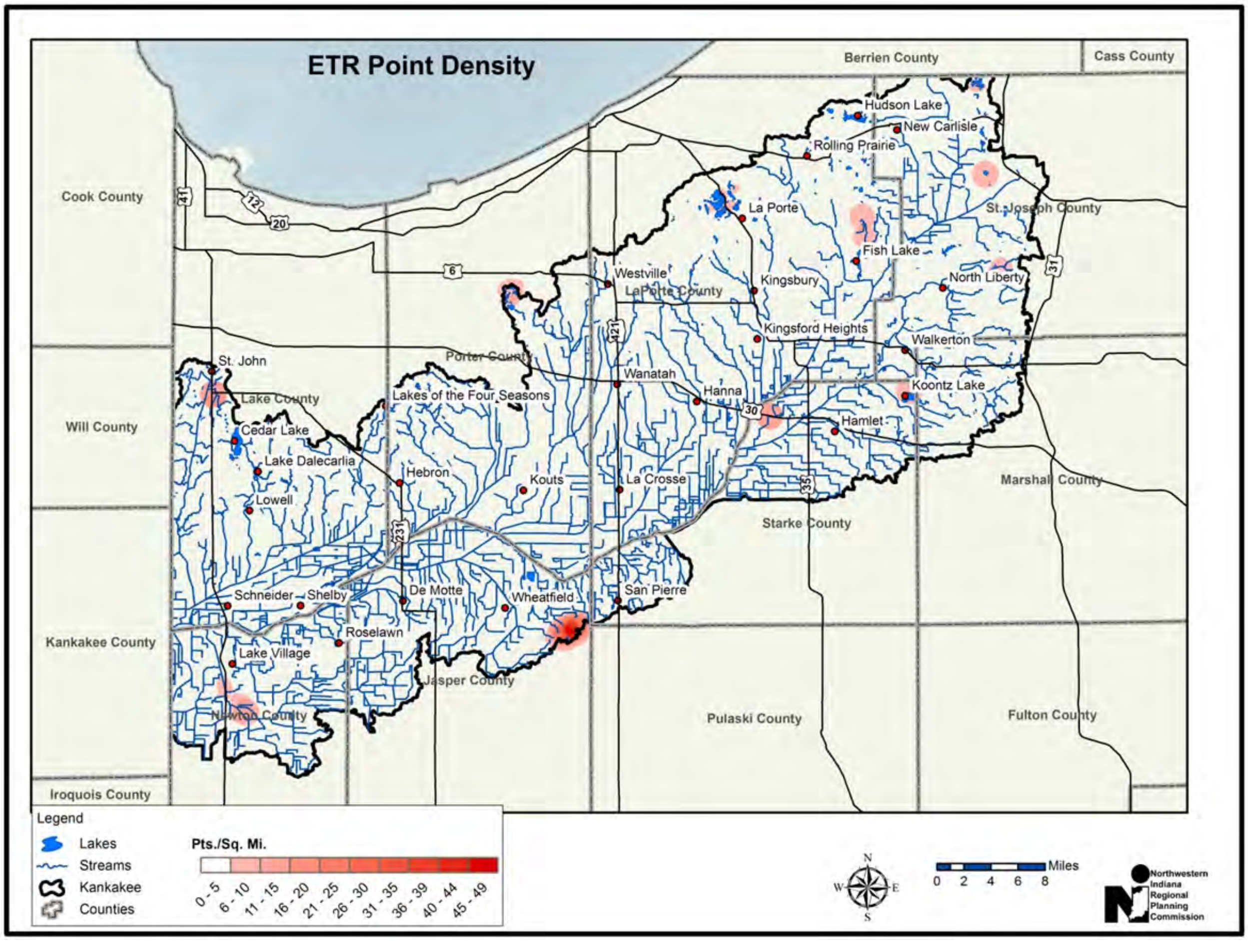

Figure 30. ETR Point Density

3.1.8 Relevant Relationships

Cultivated Land & Poorly Drained Soils

Many poorly drained soils in the state have been improved for row crop production by the installation of drain tiles. Drain tiles alter the natural flow of ground water by draining seasonally high ground water tables and excess soil moisture in the unsaturated zone to nearby streams or ditches. In so doing, nutrients and herbicides can more readily reach receiving waterbodies. The location of drain tiles is unknown in the sub-basin however the existence of cultivated lands on poorly drained soils can be a good indication of their existence. Cultivated lands from the 2006 CCAP dataset existing on all "poorly drained" soil classes were extracted using ArcMap 10 Spatial Analyst. This data is displayed in Figure 31. In total, there are approximately 738 mi² of cultivated land on all poorly drained soil classes in the sub-basin.

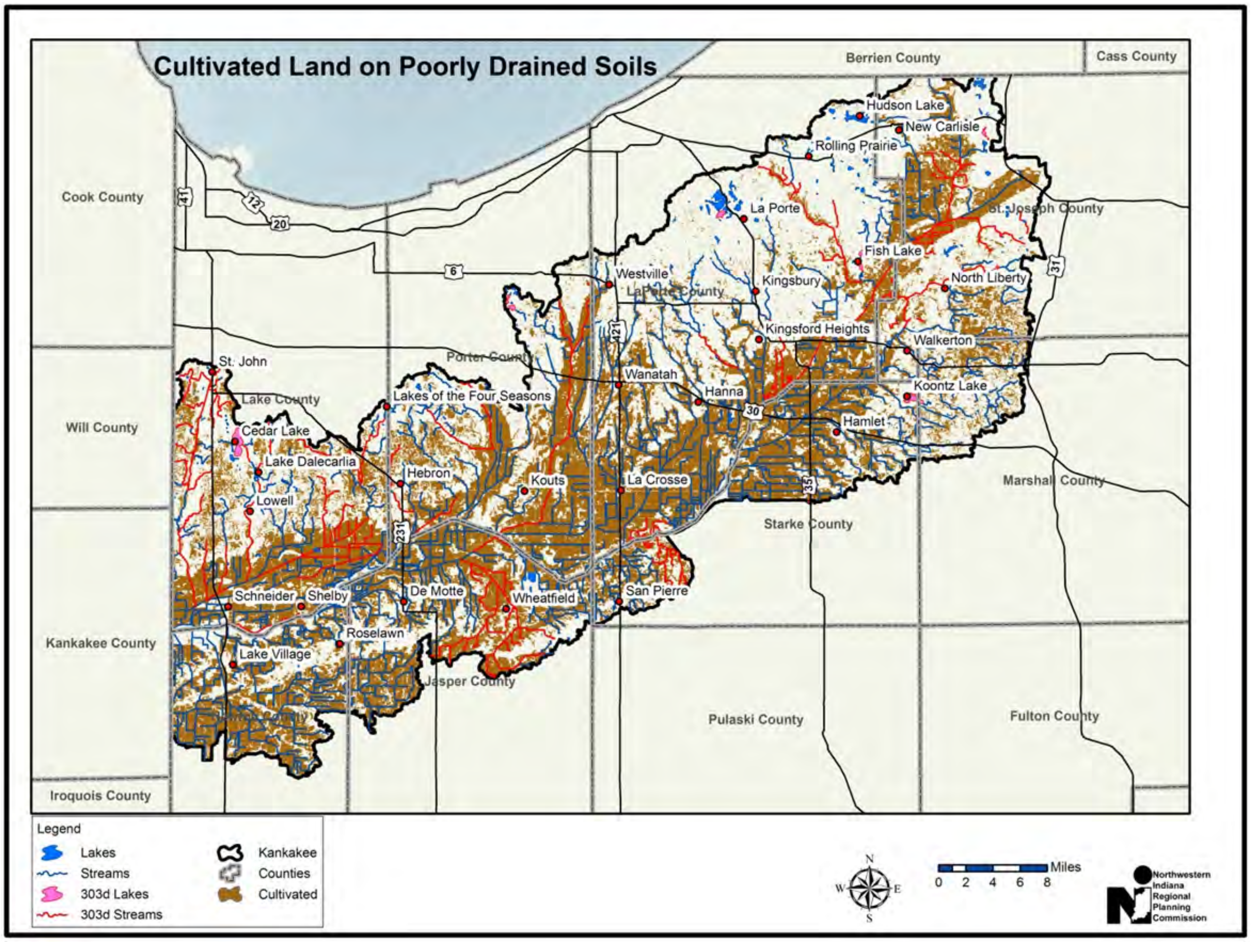

Figure 31. Cultivated Land on Poorly Drained Soils

Hydric Soils and Wetlands

Hydric soils are one of three characteristics used to identify wetlands. Areas where hydric soils are present but wetlands no longer exist due to conversion can be useful in identifying potential wetland restoration opportunities. Figure 32 shows the general locations of wetlands identified by the Ducks Unlimited NWI update overlain on soils identified as hydric by the NRCS. In total there are approximately 84 mi² of wetland and 702 mi² of hydric soils within the sub-basin. This equates to an 88% loss in wetland area.

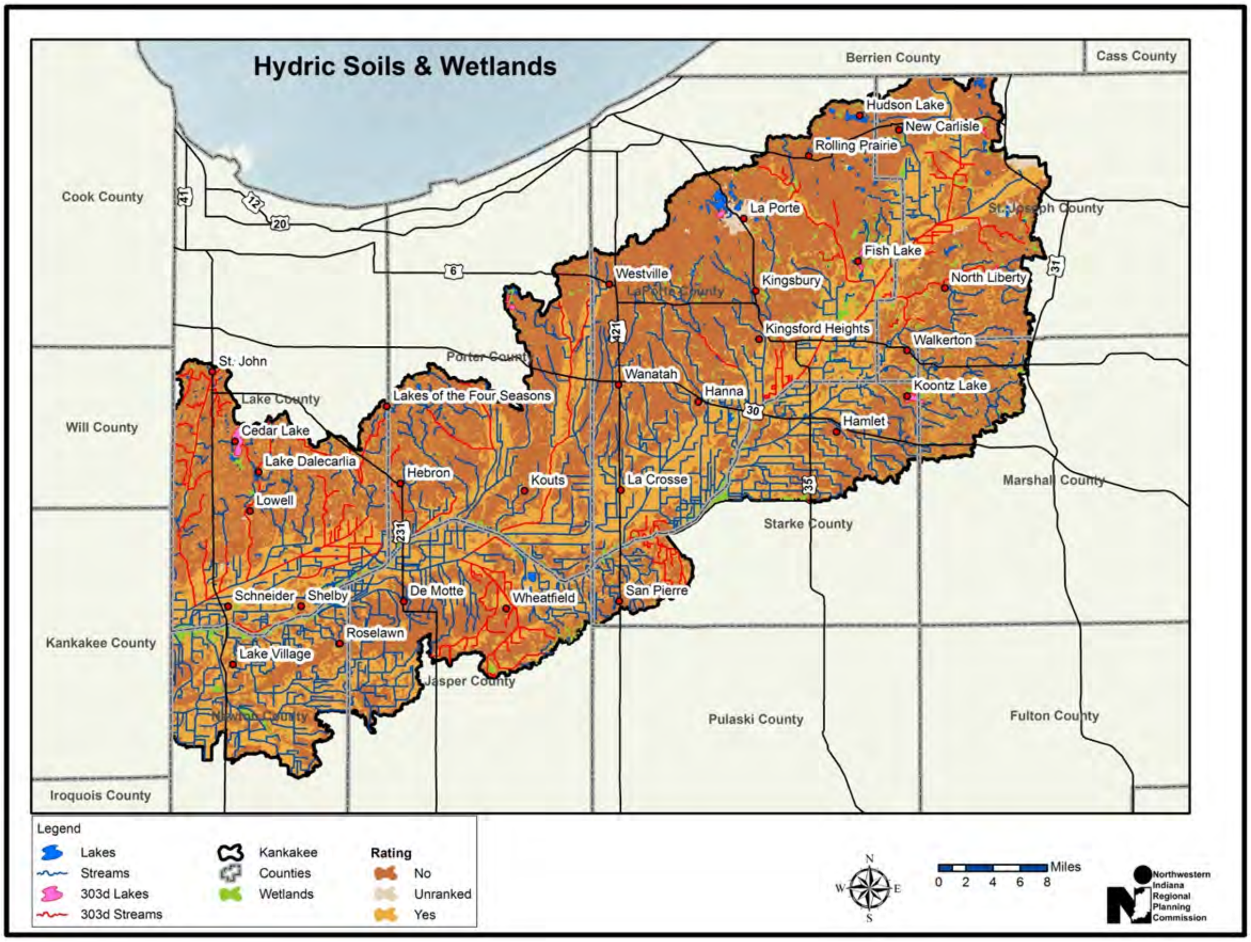

Figure 32. Hydric Soils & Wetlands

Land Cover & HEL Soils

Approximately 28% of the soils in the sub-basin are classified as HEL soils. The highest concentration exists in the headwaters of the Valparaiso Morainal Complex. Figure 33 displays 2006 CCAP land cover classes that exist on HEL soils. Row crop production occurring on these soils may need additional measures to reduce erosion and runoff. Preserving natural land cover occurring on these soils may be a way of preventing erosion and additional pollutant loading to nearby waterbodies. New development occurring on these soils may require additional erosion control measures.

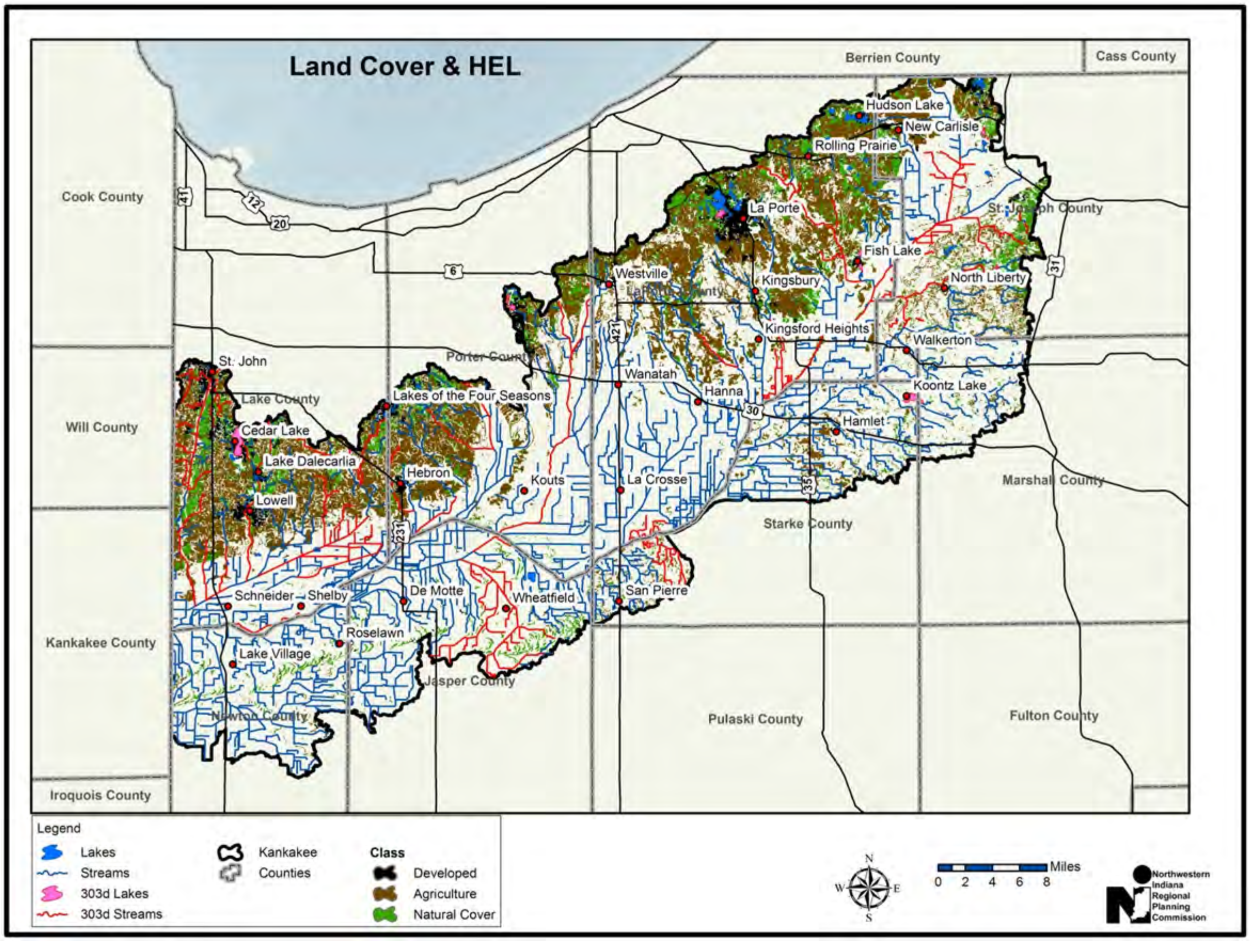

Figure 33. Land Cover & HEL Soils

3.2 Part II- Watershed Inventory

3.2.1 Data & Targets

Historical water quality data was requested from IDEM for the time period of 1990 to 2010 for the sub-basin. IDEM provided spreadsheets with water chemistry, biological assessment, and habitat assessment data along with site coordinates. Based on recommendations in the Watershed Management Checklist Instructions (2009) for data older than 10-years, data was filtered to only include information from 1999 to 2010. Watershed changes based on land cover were relatively stable over this time period. Site locations and sampling data were imported into ArcMap 10 for analysis. Figure 34 displays sample locations and sampling intensity (i.e. number of observations). Displaying the data in this way is useful to determine where additional sampling may be needed for future watershed management planning efforts. Water quality data from IDEM is included in the appendices.

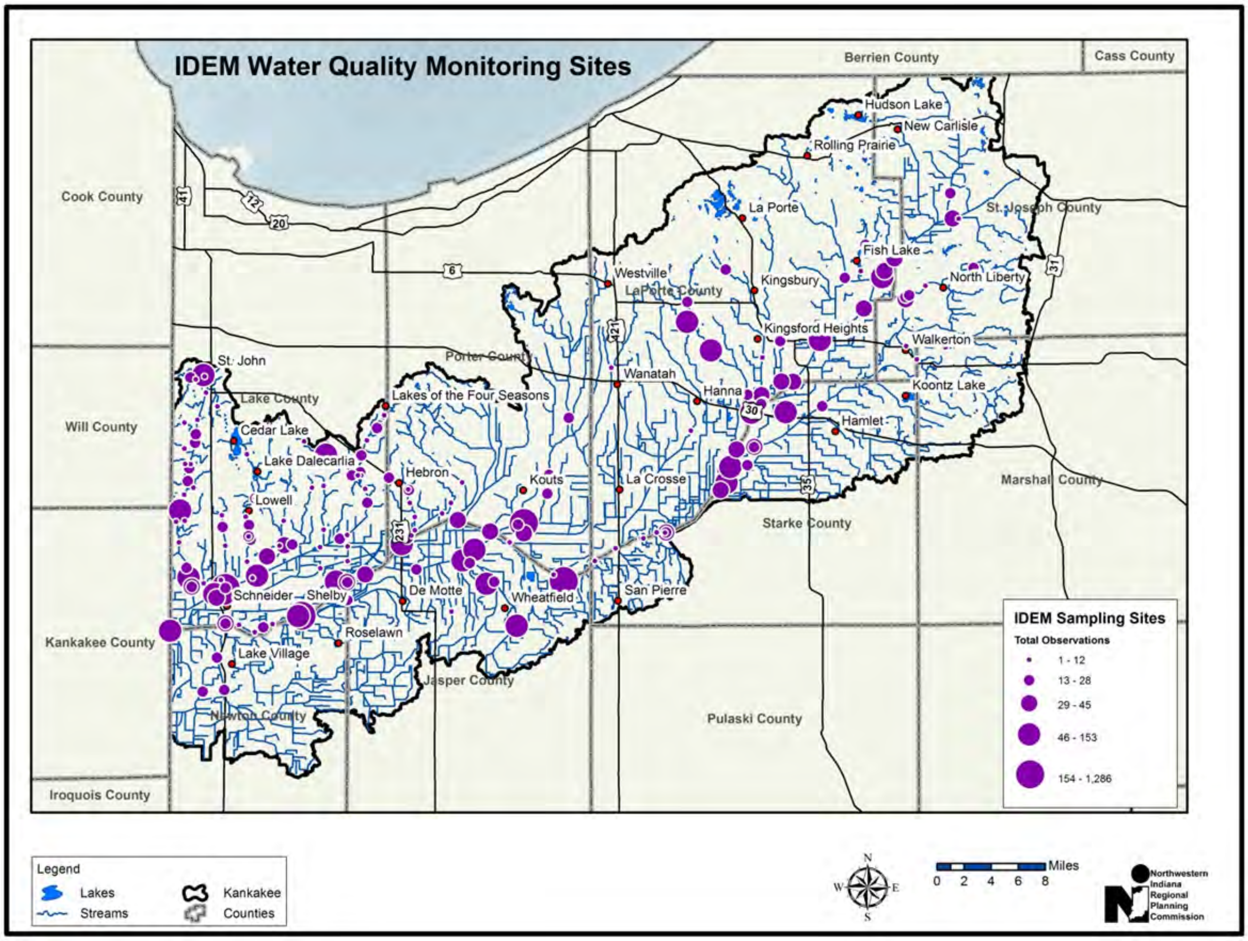

Figure 34. IDEM Water Quality Monitoring Sites

IDEM's Office of Water Quality, Assessment Branch Monitoring Program protocols are available at http://monitoringprotocols.pbworks.com/w/page/21630005/IDEM-Office-of-Water-Quality,-Assessment-Branch-Monitoring-Programs. In general water chemistry analysis included a combination of field and laboratory methods. Fish and benthic macroinvertebrate sampling data were used to calculate the Index of Biotic Integrity (IBI) and macroinvertebrate Index of Biotic Integrity (mIBI) respectively. Both of which are measures of the biological health of watershed. Qualitative habitat assessments were done using the Qualitative Habitat Evaluation Index (QHEI).

The following information on identifying water quality targets comes from IDEM www.in.gov/idem/6242.htm.

> *The IDEM Watershed Management Plan (WMP) Checklist (2009) requires groups to identify targets for water quality parameters of concern. A target is defined as the desired measured level of a water quality or habitat/biological parameter that a group has decided streams in the watershed should meet.*
>
> *Where an Indiana Water Quality Standard or TMDL exists for a parameter of concern, the watershed group must, at a minimum, set the target to meet the respective standard or the loading limit set in the TMDL. Groups obviously are welcome to set more stringent*

targets if they wish. Table 4 shows water quality parameters watershed groups are often concerned with and which have an Indiana Water Quality Standard. A complete list of Indiana's Water Quality Standards can be found in the Indiana Administrative Code.

Many of the water quality parameters watershed groups are concerned with do not have a standard. In these instances groups are free to set whatever target they deem appropriate, but that freedom can be overwhelming given the myriad of targets being used across the county. This guidance does not attempt to tell watershed groups what targets to choose, but rather, lists in Table 5 several targets used by other watershed groups in Indiana and the source of those targets. IDEM hopes this information helps watershed groups wisely choose water quality targets for their specific watershed.

Parameter	Target	Reference/Other Information
Total Ammonia (NH3)	Range between 0.0 and 0.21 mg/L depending upon temperature and pH	Indiana Administrative Code (327 IAC 2-1-6)
Atrazine	Max: 3.0 ppb	U.S. EPA Drinking Water Standard
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (327 IAC 2-1-6)
	Min: 6.0 mg/L in coldwater fishery streams	Indiana Administrative Code (327 IAC 2-1.5-8)
	Min: 7.0 mg/L in spawning areas of coldwater fishery streams	Indiana Administrative Code (327 IAC 2-1.5-8)
E. coli	Max: 235 CFU/ 100mL in a single sample	Indiana Administrative Code (327 IAC 2-1.5-8)
	Max: Geometric Mean of 125 CFU/ 100mL from 5 equally spaced samples over a 30-day period	Indiana Administrative Code (327 IAC 2-1.5-8)
Nitrate	Max: 10 mg/L in waters designated as a drinking water source	Indiana Administrative Code (327 IAC 2-1-6)
Nitrite	Max: 1 mg/L in waters designated as a drinking water source	Indiana Administrative Code (327 IAC 2-1-6)
Nitrate-N + Nitrate-N	Max: 10 mg/L in waters designated as a drinking water source	Indiana Administrative Code (327 IAC 2-1-6)
Temperature	Dependent on time of year and whether stream is designated as a cold water fisheries	Indiana Administrative Code (327 IAC 2-1-6)

Table 4. Water Quality Standards

Parameter	Target	Reference/Other Information
Nitrate-nitrogen (NO3)	Max: 0.633 mg/L	U.S. EPA recommendation *
	Max: 1.0 mg/L	Ohio EPA recommended criteria for Warm Water Habitat (WWH) headwater streams in Ohio EPA Technical Bulletin MAS//1999-1-1 [PDF]
	1.5 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodds, W.K. et al., 1998, Table 1, pg. 1459, and in EPA-822-B-00-002 [PDF], p 27.)
	10.0 mg/L	IDEM draft TMDL target based on drinking water targets
Ortho-Phosphate also known as Soluble reactive phosphorus (SRP)	Max: 0.005 mg/L	Wawasee Area Conservancy Foundation recommendation for lake systems, NESWP344
Suspended Sediment Concentration (SSC)	Max: 25.0 mg/L	U.S. EPA recommendation for excellent fisheries
	Range: 25.0-80.0 mg/L	U.S. EPA recommendation for good to moderate fisheries
Total Kjeldahl Nitrogen (TKN)	Max: 0.591 mg/L	U.S. EPA recommendation *
Total Phosphorus (TP)	Max: 0.076 mg/L	U.S. EPA recommendation
	0.07 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodds, W.K. et al., 1998, Table 1, pg. 1459, and in EPA-822-B-00-002 [PDF], p 27.)
	Max: 0.08 mg/L	Ohio EPA recommended criteria for Warm Water Habitat (WWH) headwater streams in Ohio EPA Technical Bulletin MAS//1999-1-1 [PDF]
	Max: 0.3 mg/L	IDEM draft TMDL target
Total Suspended Solids (TSS)	Max: 80.0 mg/L	Wawasee Area Conservancy Foundation recommendation to protect aquatic life in lake systems
	Max: 30.0	IDEM draft TMDL target from NPDES rule for lake dischargers in 327 IAC 5-10-4 re: monthly average for winter limits for small sanitary

Parameter	Target	Reference/Other Information
	mg/L	treatment plants
	Range: 25.0-80.0 mg/L	Concentrations within this range reduce fish concentrations (Waters, T.F.,, 1995). Sediment in streams: sources, biological effects and control. American Fisheries Society, Bethesda, MD. 251 p.
	Max: 40.0 mg/L	New Jersey criteria for warm water streams
	Max: 46.0 mg/L	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
Turbidity	Max: 25.0 NTU	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
	Max: 10.4 NTU	U.S. EPA recommendation

Table 5. Water Quality Targets

3.2.2 Water Quality Information

The Indiana Department of Environmental Management regularly assesses and compiles surface water quality data under the provisions of the Clean Water Act. The results of this work are used by IDEM to create the 303d List of Impaired Waterbodies based upon the waterbodies' designated uses. The "designated" uses of a waterbody are an expression of goals for the water, such as supporting aquatic life and human activities, including recreation and use as a public water supply. The 303d List shows which waterbodies do not or are not expected to meet those uses. The concept of a water body having designated uses is central to establishing appropriate water quality standards.

The following uses are designated by the Indiana Water Pollution Control Board (327 IAC 2-1-3) and apply to all stream segments in the Kankakee River watershed (IDEM, 2001):

- Surface waters of the state are designated for full-body contact recreation during the recreational season (April through October).
- All waters, except limited use waters, will be capable of supporting a well-balanced, warm water aquatic community.
- All waters, which are used for public or industrial water supply, must meet the standards for those uses at the point where water is withdrawn.
- All waters, which are used for agricultural purposes, must meet minimum surface water quality standards.
- All waters in which naturally poor physical characteristics (including lack of sufficient flow), naturally poor or reversible man-induced conditions, which came into existence prior to January 1, 1983, and having been established by use attainability analysis, public comment period, and hearing may qualify to be classified for limited use and must be evaluated for restoration and upgrading at each triennial review of this rule.

- All waters, which provide unusual aquatic habitat, which are an integral feature of an area of exceptional natural beauty or character, or which support unique assemblages of aquatic organisms may be classified for exceptional use.

All waters of the state, at all times and at all places, including the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges:

- that will settle to form putrescent or otherwise objectionable deposits,
- that are in amounts sufficient to be unsightly or deleterious,
- that produce color, visible oil sheen, odor, or other conditions in such degree as to create a nuisance,
- which are in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill aquatic life, other animals, plants, or humans, or
- which are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair designated uses.

Impaired waterbodies included on the 2008 303d list for the sub-basin are displayed in Figure 35 and presented in Table 6. Of the 2,073 miles of stream and ditch that drain the project area's landscape, nearly 450 miles (22%) are impaired. The most common impairments are *E. coli* (230 miles) and Impaired Biotic Communities (158 miles). Additionally, 127 miles of stream and ditch have multiple impairments within the same reach.

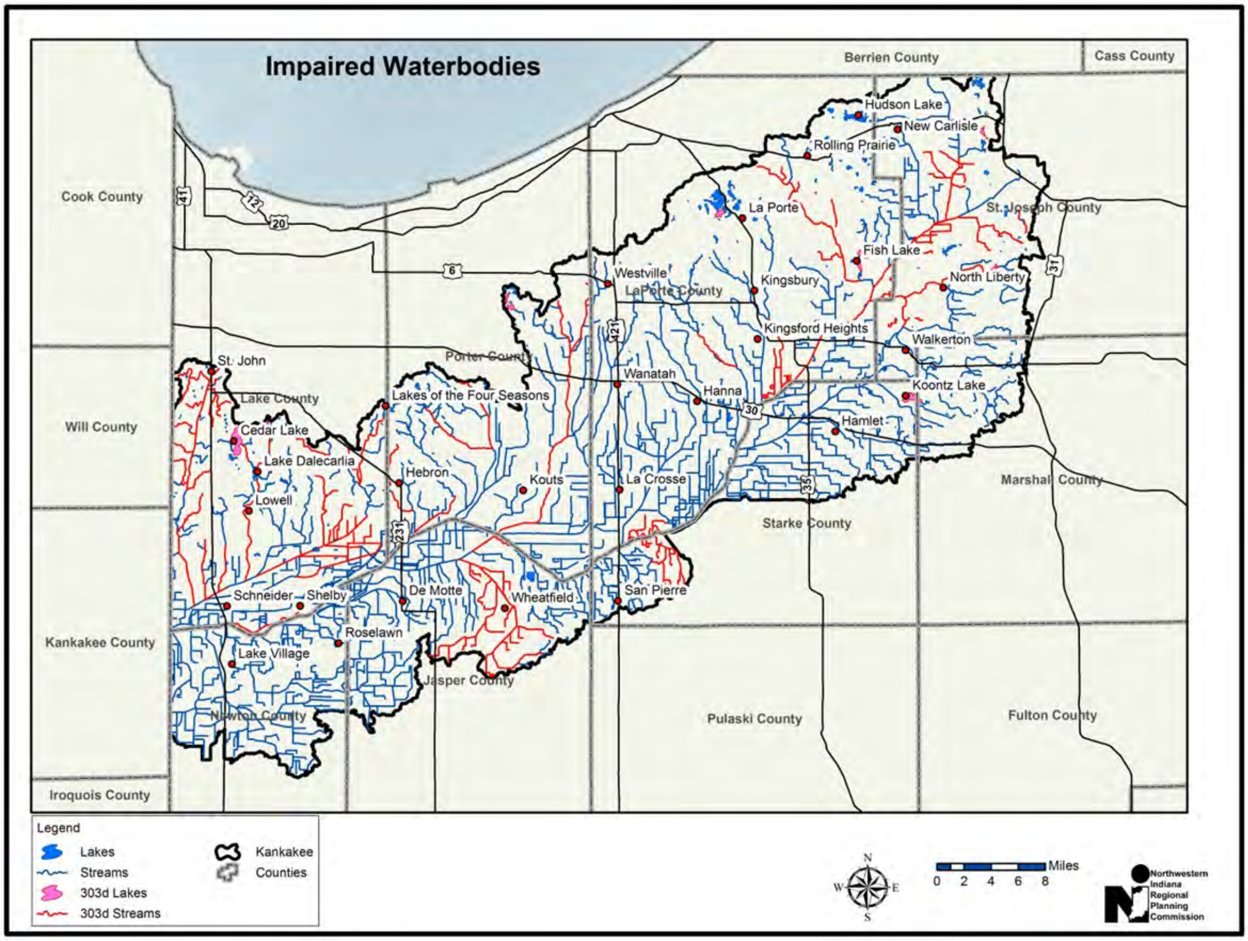

Figure 35. Impaired Waterbodies.

Waterbody	County	Reason
Aldrich Ditch - Schang Ditch	St. Joseph	E. coli
Bailey Ditch	Lake	IBC
Breyfogel Ditch	Porter	IBC
Brown Ditch	Lake	IBC
Bruce Ditch	Lake	IBC
Bryant Ditch	Lake	E. coli, IBC
Bryant Ditch - Unnamed Tributary	Lake	E. coli
Bull Run Basin	Lake	E. coli, IBC, Nutrients, TDS
Cedar Creek	Lake	IBC

Waterbody	County	Reason
Cedar Creek (Downstream of Cedar Lake)	Lake	IBC
Cobb Creek - Unnamed Tributary	Porter	IBC
Cobb Ditch (Downstream Of Selvers Ditch)	Porter	E. coli, IBC
Collins Ditch	LaPorte	E. coli, IBC
Collins Ditch - Unnamed Tributary	LaPorte	E. coli, IBC
Crooked Creek	Porter	IBC, PCB-FT
Crooked Creek, West Branch	Porter	IBC
Foss Ditch	Lake	IBC
Geyer Ditch - Gordon Airport/ Crumstown	St. Joseph	PCB-FT
Hodge Ditch (Downstream Of James Ditch)	Jasper	DO, E. coli
Kankakee River	Lake, LaPorte, Newton, Porter	E. coli, PCB-FT
Kankakee River- English Lake	LaPorte	E. coli, IBC, PCB-FT
Kankakee River- Long Ditch	LaPorte	E. coli
Kankakee River- Mainstem	LaPorte	E. coli, IBC, PCB-FT
Kankakee River- Origer Ditch	LaPorte	E. coli
Kankakee River- Sousley Lake- Tascher Ditch	St. Joseph	PCB-FT
Lateral No. 77	Jasper	PCB-FT
Little Ditch	Lake	E. coli
Little Ditch - Unnamed Tributary	Lake	E. coli
Little Kankakee River-Byron	LaPorte	E. coli
Ludington Ditch	Porter	E. coli, IBC
Mill Creek (Downstream Of Union Mills)	LaPorte	E. coli
Pine Creek-Horace Miller Ditch	LaPorte	E. coli

Waterbody	County	Reason
Potato Creek	St. Joseph	E. coli, PCB-FT
Potato Creek (Downstream Of Worster Lake)	St. Joseph	PCB-FT
Schrader Ditch - Unnamed Tributary	Jasper	PCB-FT
Scrader Ditch	Jasper	PCB-FT
Singleton Ditch	Lake	E. coli
Singleton Ditch - Unnamed Tributaries	Lake	E. coli
Singleton Ditch (Downstream of Bryant Ditch)	Lake	E. coli, IBC
Singleton Ditch (upstream of Bryant Ditch)	Lake	E. coli
Stony Run Headwater	Lake	E. coli, IBC
Stony Run, East Branch	Lake	IBC
Stony Run, Middle Branch	Lake	Chloride, Nutrients, TDS
Vannatti Ditch	Lake	E. coli
West Creek- Bull Run	Lake	IBC
West Creek - Unnamed Tributary	Lake	IBC
West Creek (Lower Watershed)	Lake	E. coli
West Creek (Middle Watershed)	Lake	IBC
West Creek (North of 165th Ave)	Lake	IBC
Williams Ditch	Lake	IBC, PCB-FT
Wolf Creek-Hickam Lateral	Jasper	PCB-FT
Wolf Creek - Unnamed Tributary	Jasper	PCB-FT
Wolf Creek - Unnamed Tributary (Wheatfield)	Jasper	PCB-FT
Wolf Creek (Downstream Of SR 49)	Jasper	E. coli, PCB-FT
Wolf Creek (Upstream Of SR 49)	Jasper	E. coli, PCB-FT

Table 6. 303d Listing (2008)

E. coli

Escherichia coli (*E. coli*) is a bacteria commonly found in the intestines of warm blooded animals and humans. It presence in water is a strong indicator of recent sewage or animal waste contamination. While not necessarily pathogenic in itself, *E. coli* is relatively easy to test for and is used as an indicator of other more severe waterborne disease causing organisms. The single sample water quality standard of 235 CFU/100 ml is used to protect human health during the recreational period (full body contact) of April through October.

Between 1999 and 2010, IDEM collected 192 *E. coli* samples from 31 different stations in the sub-basin project area. Using 235 CFU/100 ml in a single sample as a target value (Table 4), 27 of the 31 stations (87%) sampled exceeded the water quality standard at least once and 77 of the 192 total samples (40%) collected exceeded the water quality standard. Figure 36 shows the sample locations and the location in which the single sample target value of 235 CFU/100ml was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for *E. coli*.

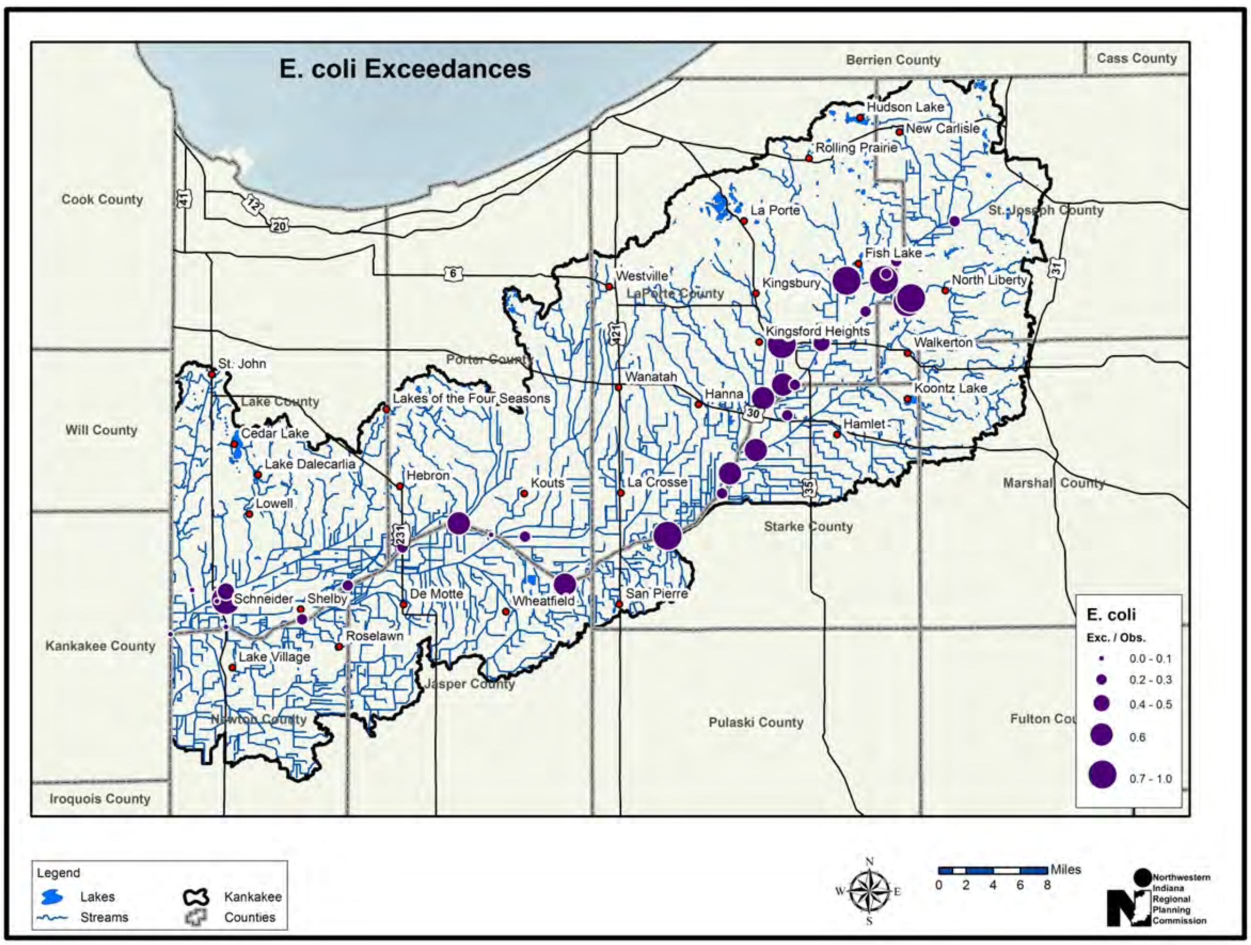

Figure 36. E. coli Exceedances.

E. coli water quality duration curves were prepared for two sampling stations as part of the Kankakee/Iroquios Watershed TMDL Report within the sub-basin project area; KR-117 which is located on the Kankakee River in the Upper Kankakee subwatershed; and KR-68 which is located on the Kankakee River in the Middle Kankakee subwatershed (Figure 37).

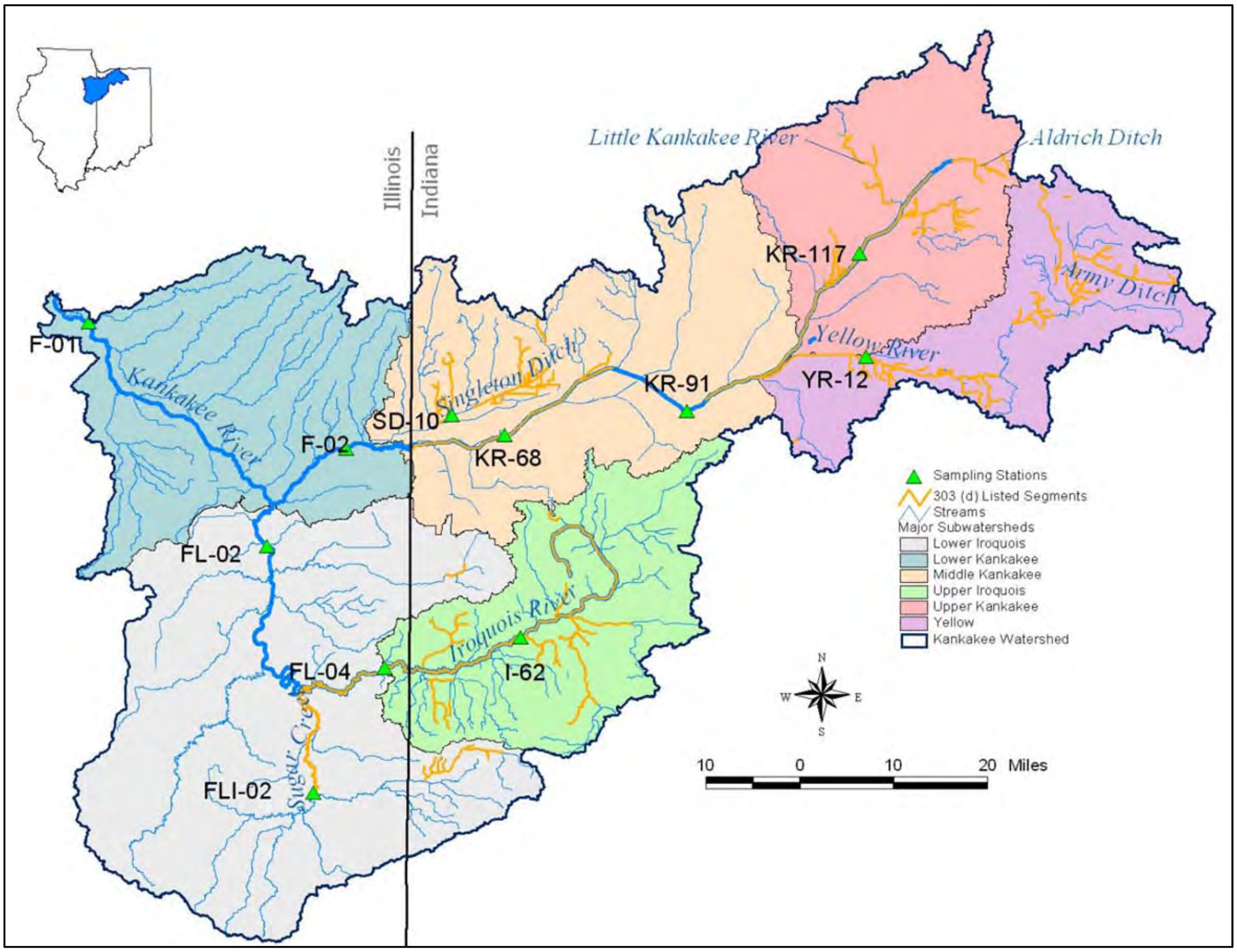

Figure 37. Key Sampling Location from Kankakee/Iroquois Watershed TMDL

Stream flows displayed on water quality duration curves were grouped into the following five "hydrologic zones":

- High flow zone: flows that plot in the 0 to 10-percentile range, related to flood flows.
- Moist zone: flows in the 10 to 40-percentile range, related to wet weather conditions.
- Mid-range zone: flows in the 40 to 50 percentile range, median stream flow conditions;
- Dry zone: flows in the 60 to 90-percentile range, related to dry weather flows.
- Low flow zone: flows in the 90 to 100-percentile range, related to drought conditions.

The duration curve approach was used to help to identify issues surrounding the *E. coli* impairment and to roughly differentiate between sources. Table 3-7 from the Kankakee/Iroquois Watershed TMDL Report summarizes the general relationship between the five hydrologic zones and potential contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. The duration curve approach also considers critical conditions and seasonal variation in the TMDL development as required by the Clean Water Act.

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
On-site wastewater systems/Unsewered areas	M	M-H	H	H	H
Urban stormwater/CSOs	H	H	H		
Agricultural runoff	H	H	M		
Bacterial re-suspension from stream sediments	H	M			
Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)					

Table 7 General Relationship between Duration Curve Zone and Contributing Sources

The water quality duration curve for station KR-117 indicates that E. coli frequently exceeds 235 CFU/100 ml during high flows, moist conditions, mid-range flows and dry conditions (Figure 38). The geomean of all the samples collected during low flows is less than 235 CFU/100 ml. Bacteria sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban stormwater/CSOs, runoff from agricultural areas, and bacterial re-suspension from the streambed. Under dry conditions bacteria sources include WWTP's, livestock, wildlife and failing onsite wastewater systems.

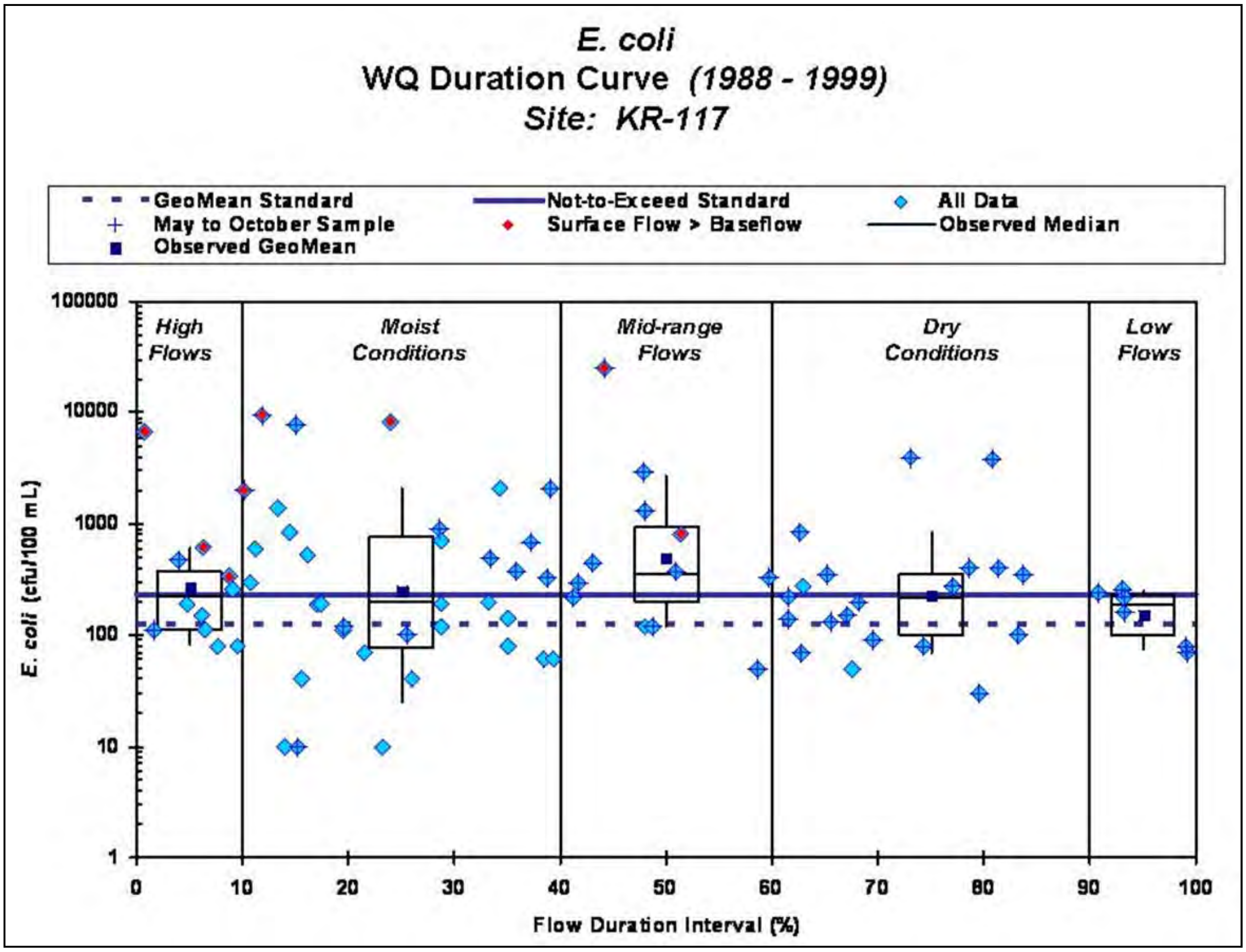

Figure 38. Water Quality Duration Curve KR-117

The water quality duration curve for station KR-68 indicates that *E. coli* frequently exceeds 235 CFU/100 mL during high flows, moist conditions and mid-range flows (Figure 39). Bacteria sources typically associated with these flows include failing onsite wastewater systems, urban stormwater/CSOs, runoff from agricultural areas, and bacterial re-suspension from the streambed. Most samples taken during dry conditions and low flows meet water quality standards. The observed median for each hydrologic zone was lower for site KR-68 compared to KR-117 indicating an improvement in water quality.

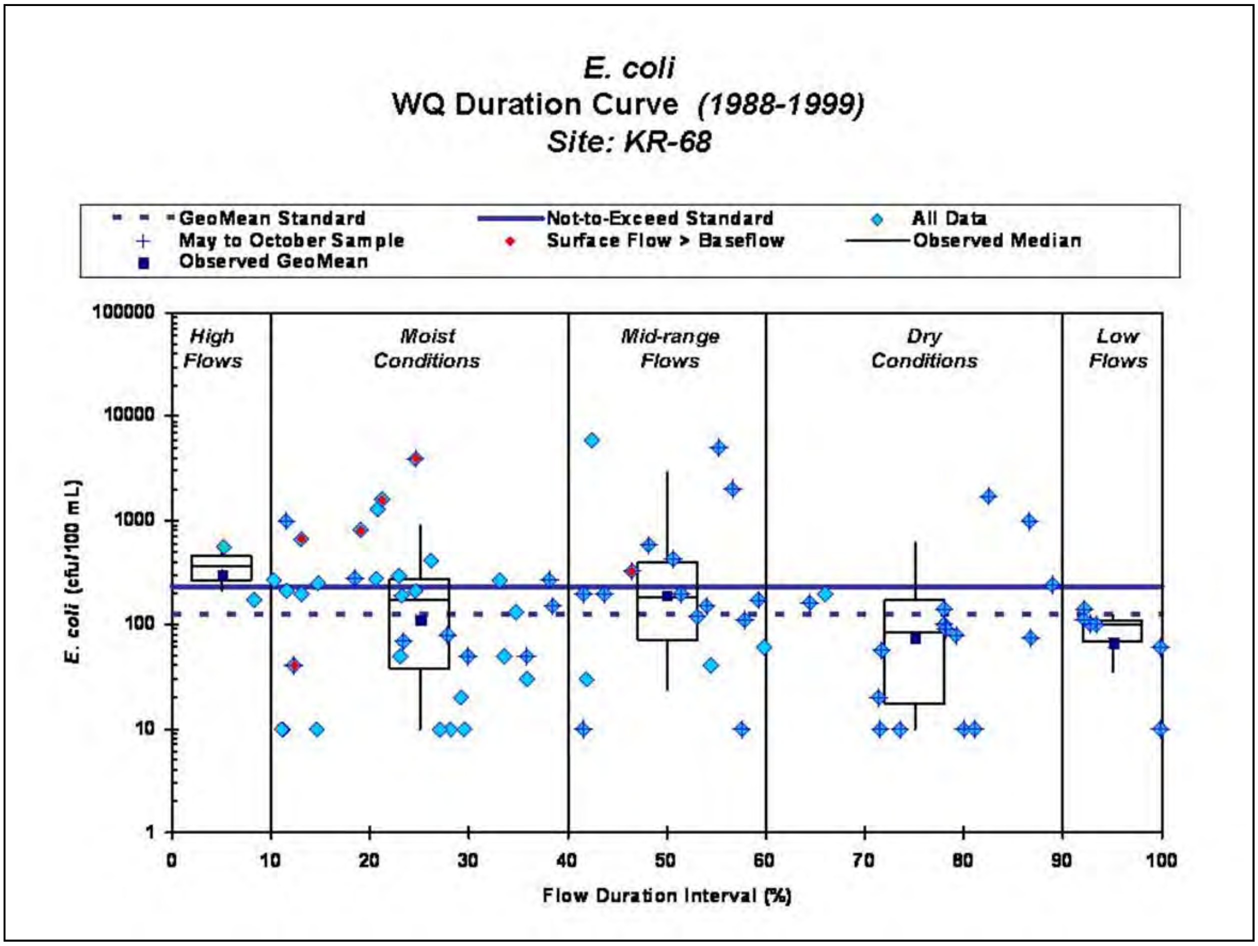

Figure 39. Water Quality Duration Curve KR-68

Nitrate-N + Nitrite-N

Nitrogen makes up about 80% of the air we breathe and is found in all living things. In water it occurs as nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3). Nitrate, an essential plant nutrient, is the most water-soluble and least attracted to soil particles form of nitrogen. Common sources include human and animal waste, decomposing organic matter, and fertilizer. Given it solubility in water, nitrate can move quite readily in runoff and through subsurface drainage (e.g. field tiles) to surface waters. In surface waters high nitrate levels can lead to excessive aquatic plant growth through a process known as eutrophication. Excessive algae growth can increase biochemical oxygen demand and turbidity which negatively affects water temperature and dissolved oxygen levels. In severe cases dissolved oxygen concentrations can drop below the levels needed to support aquatic life (<4 mg/l).

Indiana does not currently have nutrient water quality standards. However, Indiana Administrative Code (327 IAC 2-1-6) establishes a not to exceed value of 10 mg/l for Nitrate + Nitrite in waters designated as a drinking water source. Between 1999 and 2010, IDEM collected 783 Nitrate + Nitrite samples from 132 different stations in the sub-basin project area. Using 10 mg/l as a target value for Nitrate + Nitrite (Table 4), only one of the 132 stations (<1%) sampled had a target value exceedance and only two of 783 total samples (<1%) collected exceeded the target value. Figure 40 shows the sample locations and the location in which the target value of 10 mg/l was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for Nitrate + Nitrite.

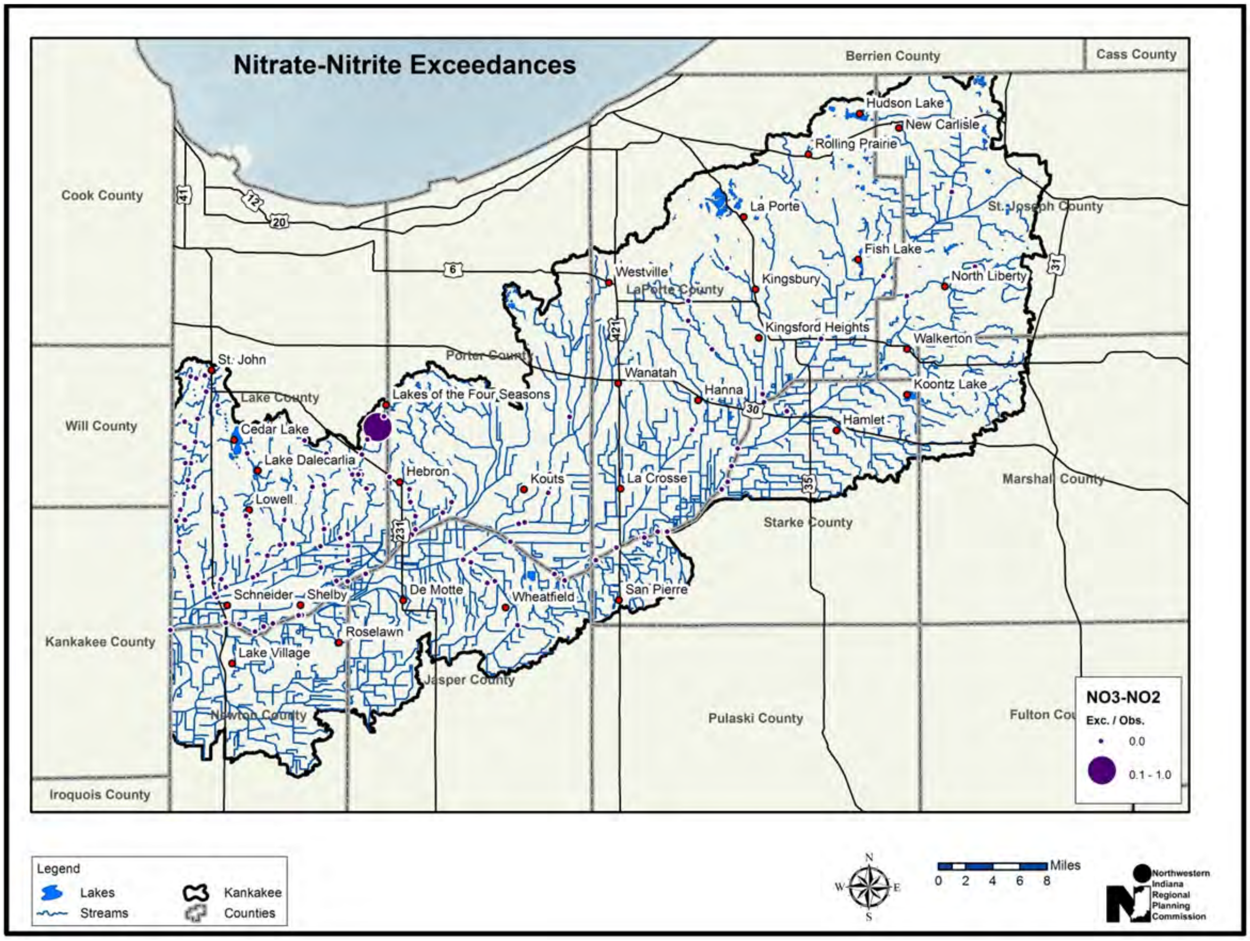

Figure 40. Nitrate-Nitrite Exceedances

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is the sum of all organic nitrogen and ammonia. Since Indiana does not currently have a water quality standard for TKN, the U.S. EPA recommendation of 0.591 mg/l was used as a target value (Table 5). Between 1999 and 2010, IDEM collected 793 TKN samples from 138 different stations in the sub-basin project area. Eighty nine of the 138 stations (64%) sampled had a target value exceedance and 457 of 793 total samples (58%) collected exceeded the target value. Figure 41 shows the sample locations and the location in which the target value of 0.591 mg/l was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for TKN.

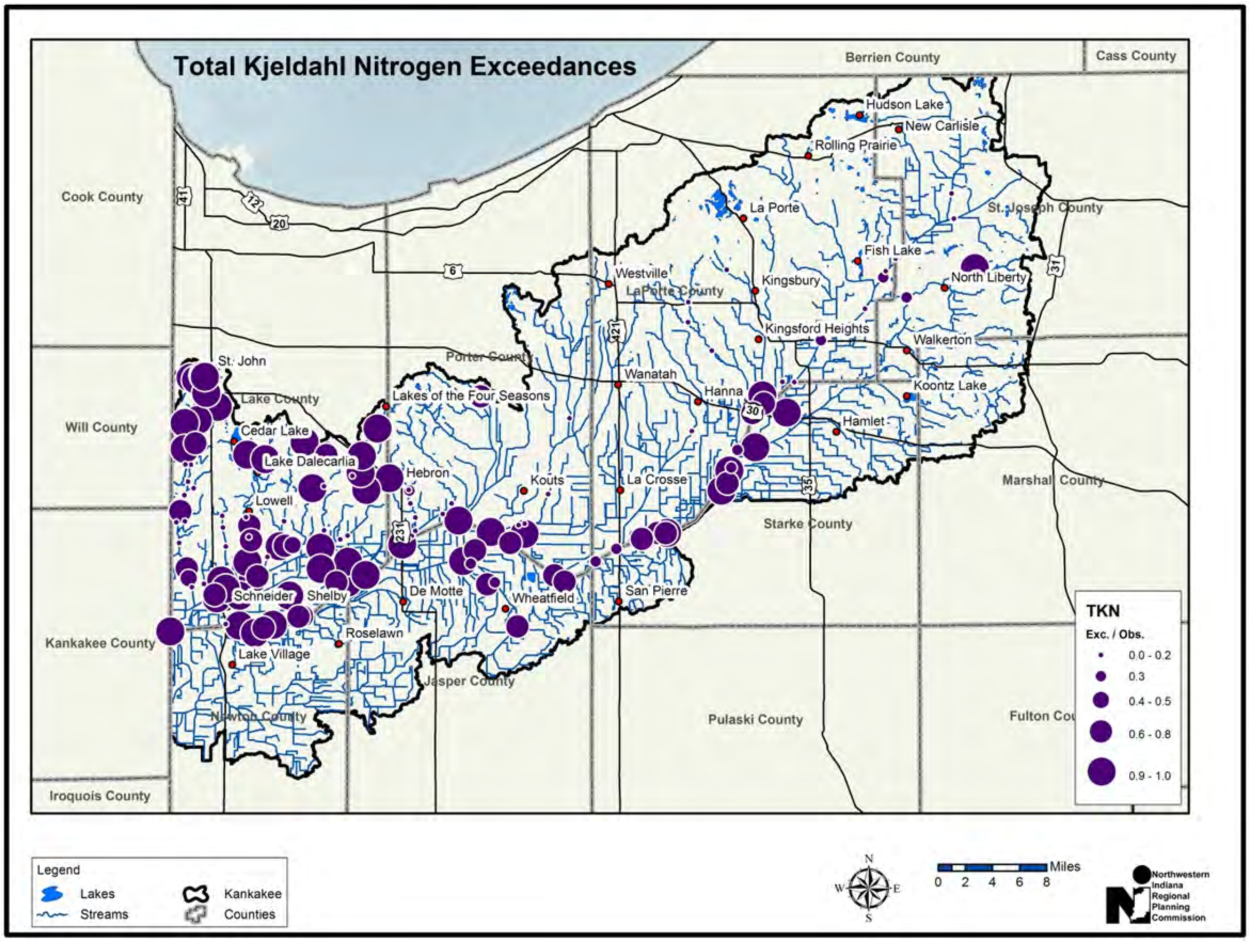

Figure 41. Total Kjeldahl Nitrogen Exceedances

Total Phosphorous

Like nitrogen, phosphorous is essential for plant and animal life. In aquatic systems phosphorous occurs as organic or inorganic phosphate. Organic phosphate is associated with organic material such as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic and is the form required by plants. Unlike nitrogen, phosphorous does not have a gaseous phase. Once it is in an aquatic system it remains there and cycles through different form unless physically removed (e.g. plant harvesting or dredging).

Phosphorus is usually in short supply in freshwater lakes and streams. So even a small increase can lead to a series of water quality problems including accelerated plant and algae growth, low dissolved oxygen levels, and fish kills. Sources of phosphorus, both natural and human, include soils and rocks, wastewater treatment plants, fertilizer runoff, failing septic systems, and runoff from pastures or animal manure storage areas.

Between 1999 and 2010, IDEM collected 805 Total Phosphorous (TP) samples from 144 different stations in the sub-basin project area. Since Indiana does not currently have a water quality standard for Total Phosphorous, IDEM's draft 0.3 mg/l for TMDL's was used as a target value (Table 5). Twenty three of the 144 stations (16%) sampled had a target value exceedance and 39 of the 805 total samples (5%) collected exceeded the target value. Figure 42 shows the sample locations and the location in which the target value of 0.3 mg/l was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for TP.

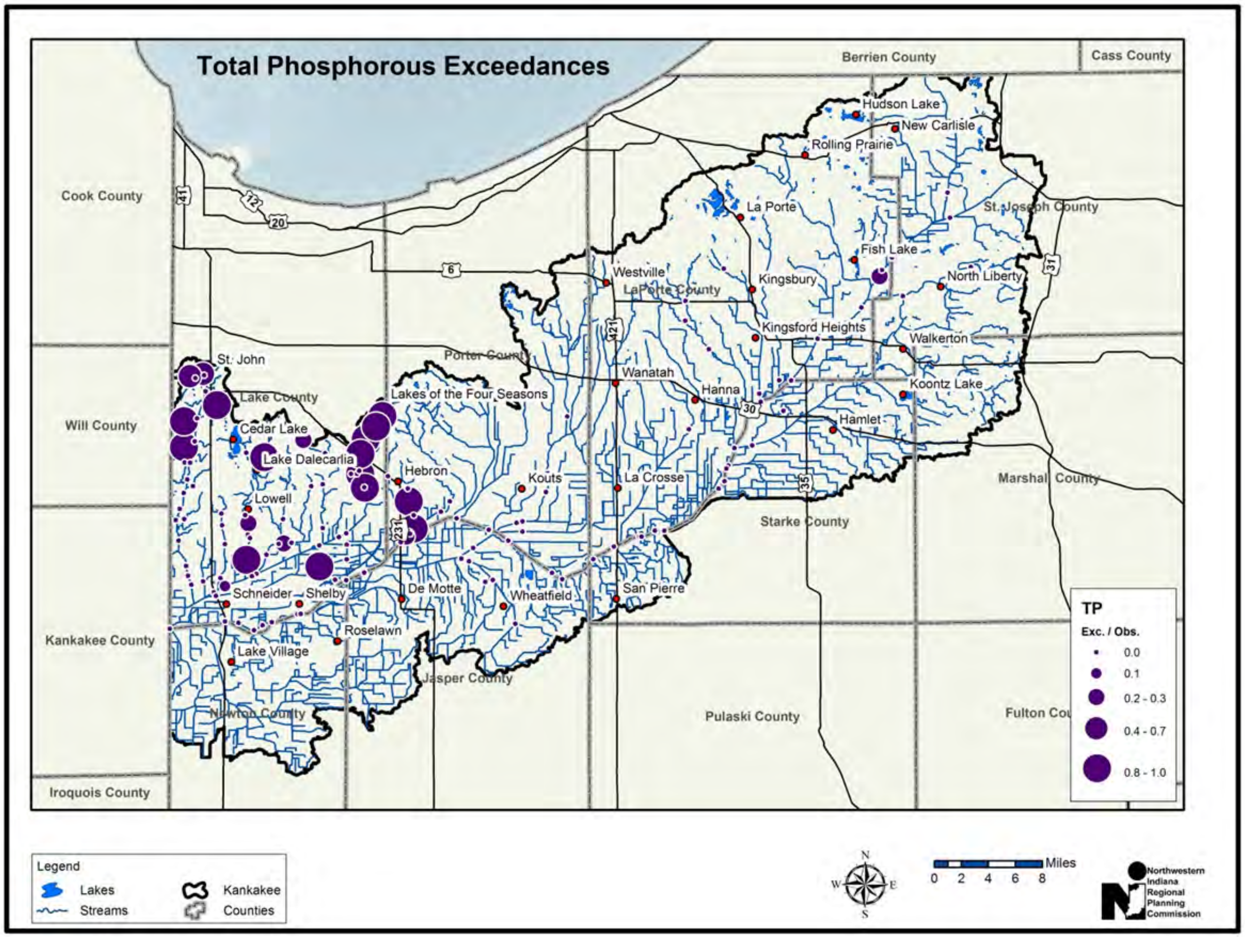

Figure 42. Total Phosphorous Exceedances

Total Suspended Solids

Total Suspended Solids (TSS) is a measure of solids in water that can be retained by a filter. TSS can include a variety of materials including silt, clay, and decaying plant and animal mater. Suspended solids absorb the suns energy causing increases in water temperature while also reducing the amount of sunlight reaching submerged vegetation. Both of which can lead to declines in dissolved oxygen levels. As stream velocity decreases suspended solids can settle to the bottom where they can smother critical benthic habitat.

Between 1999 and 2010, IDEM collected 801 TSS samples from 144 different stations in the sub-basin project area. Since Indiana does not currently have a water quality standard for TSS, IDEM's draft 30 mg/l for TMDL's was used as a target value (Table 5). Thirty eight of the 144 stations (26%) sampled had a target value exceedance and 146 of the 801 total samples (18%) collected exceeded the target value. Figure 3-43 shows the sample locations and the location in which the target value of 30 mg/l was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for TSS.

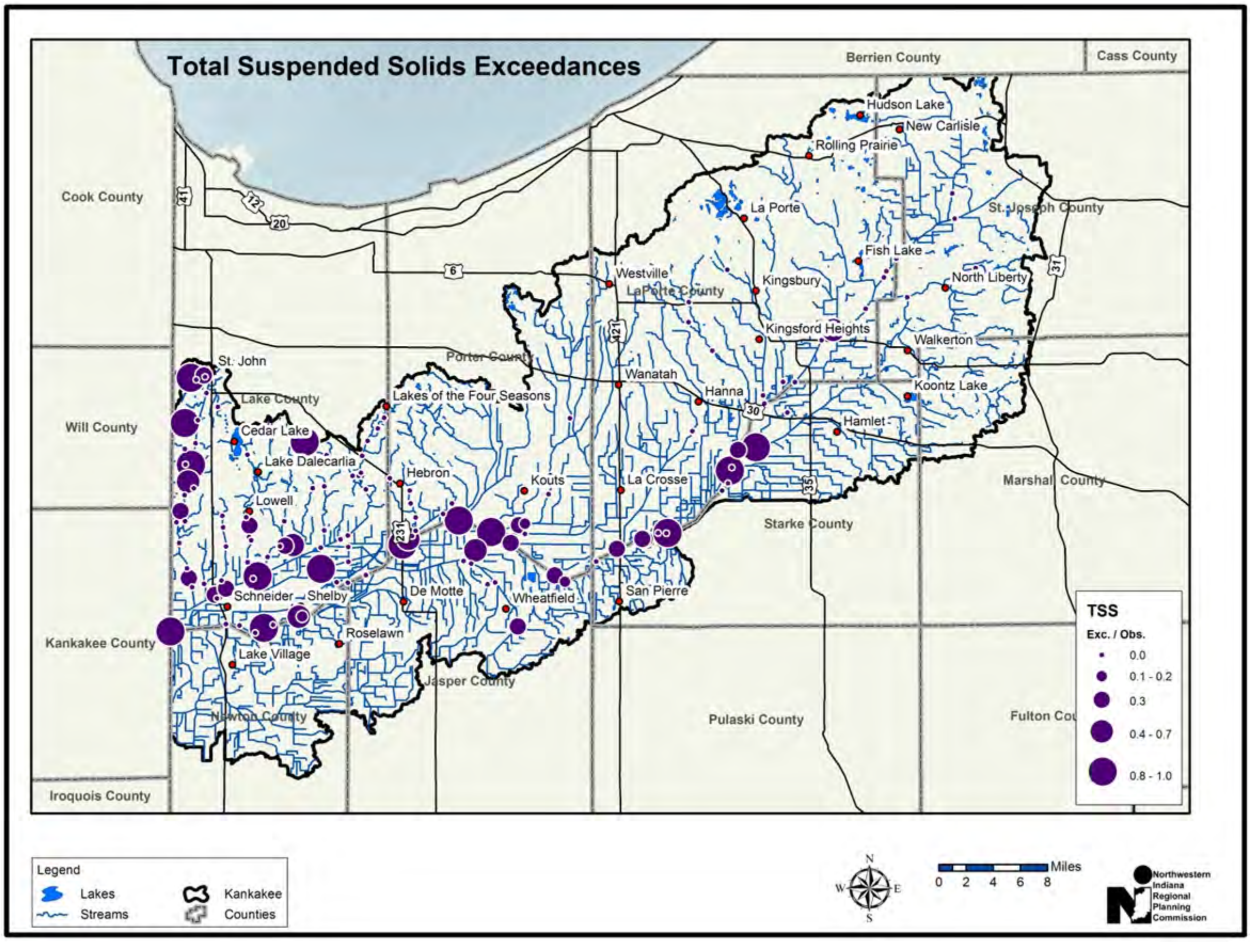

Figure 43. Total Suspended Solids Exceedances.

Dissolved Oxygen

Dissolved Oxygen (DO) is a critical measure of stream health as most aquatic life requires it for survival. DO is influenced by several factors including stream temperature and velocity, as well as total suspended solids, nutrient, and organic waste concentrations.

Between 1999 and 2010, IDEM collected 1,021 DO samples from 172 different stations in the sub-basin project area. Using 4 mg/l as a minimum and 12 mg/l as a maximum target value (Table 4), 36 of the 172 stations (21%) sampled exceeded the water quality standard at least once and 89 of the 1,021 total samples (9%) collected exceeded the water quality standard. Figure 44 shows the sample locations and the location in which the target values were exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for DO.

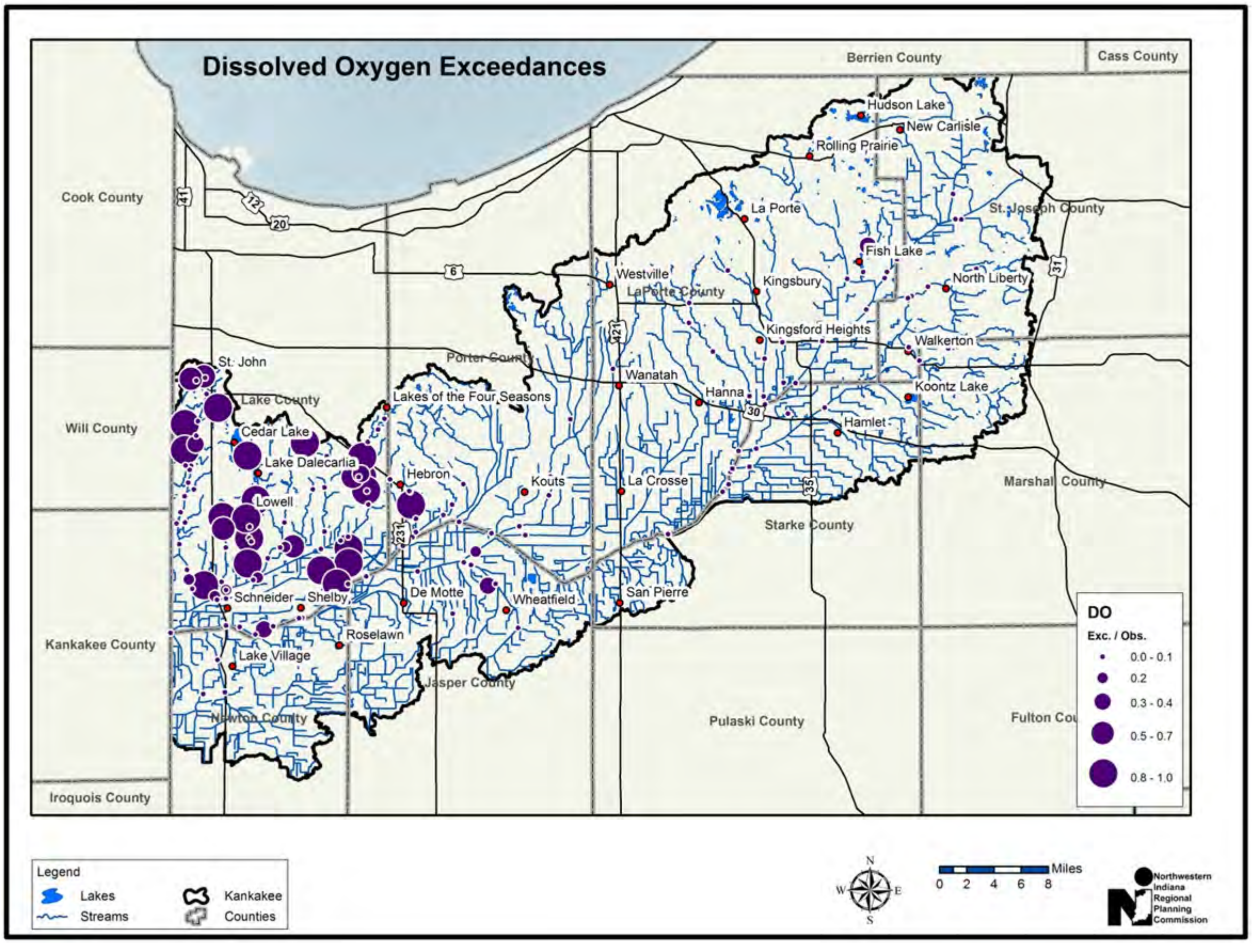

Figure 44. Dissolved Oxygen Exceedances

pH

pH is an important measure of water quality because many organisms are sensitive to low or high levels. Low pH levels can also increase the solubility of some heavy metals such as copper and aluminum allowing them to dissolve into the water column where they become toxic to aquatic life. A number of natural and human activities can affect pH levels. For example, algal blooms can raise pH by removing carbon dioxide (CO_2).

Between 1999 and 2010, IDEM measured pH at 172 different stations in the sub-basin project area. The water quality standard for pH is falls within the range of 6-9 (Table 4). None of the 1021 pH measures taken at the 172 different stations exceeded the water quality standard. Figure 45 shows the sample locations in which water temperature was taken.

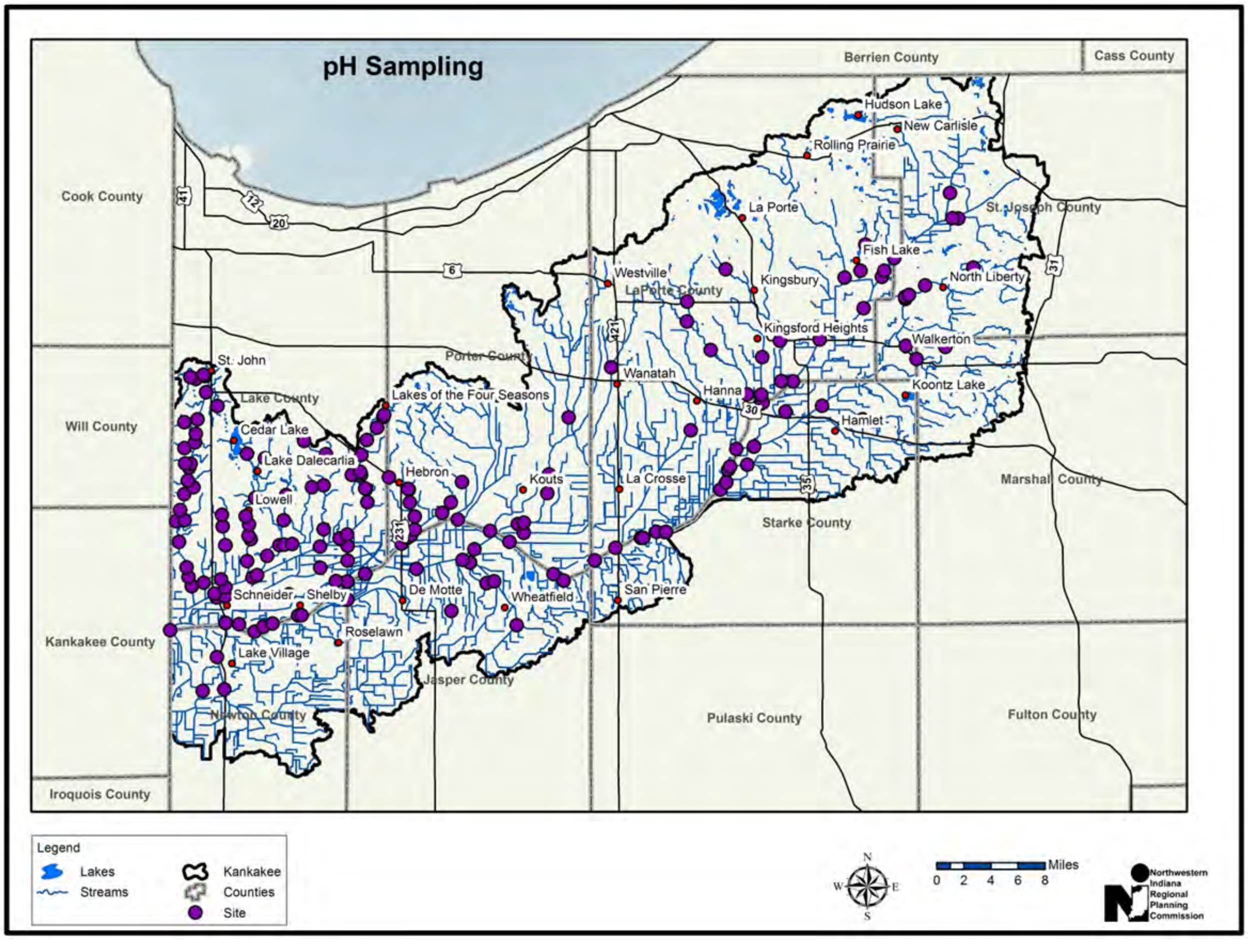

Figure 45. pH Sampling Locations.

Turbidity

Turbidity is a measure of the relative clarity of water and is measured by shining a light through the water column. Suspended materials such as soil particles, algae, plankton, and other substances scatter and absorb light. This can cause increases in water temperature while also reducing the amount of sunlight reaching submerged vegetation. Both of which can lead to declines in dissolved oxygen levels. As stream velocity decreases suspended particles can settle to the bottom where they can smother critical benthic habitat. Sources of turbidity include soil and stream erosion, urban runoff, wastewater discharges, excessive algae growth and large numbers of bottom feeding fish which can stir up sediment.

Between 1999 and 2010, IDEM collected 996 Turbidity samples from 163 different stations in the sub-basin project area. Since Indiana does not currently have a water quality standard for Trubidity, the U.S. EPA's recommendation of 10.4 NTU was used as a target value (Table 5). One Hundred Twenty Eight of the 163 stations (79%) sampled had a target value exceedance and 650 of the 996 total samples (65%) collected exceeded the target value. Figure 46 shows the sample locations and the location in which the target value of 10.4 NTU was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for Turbidity.

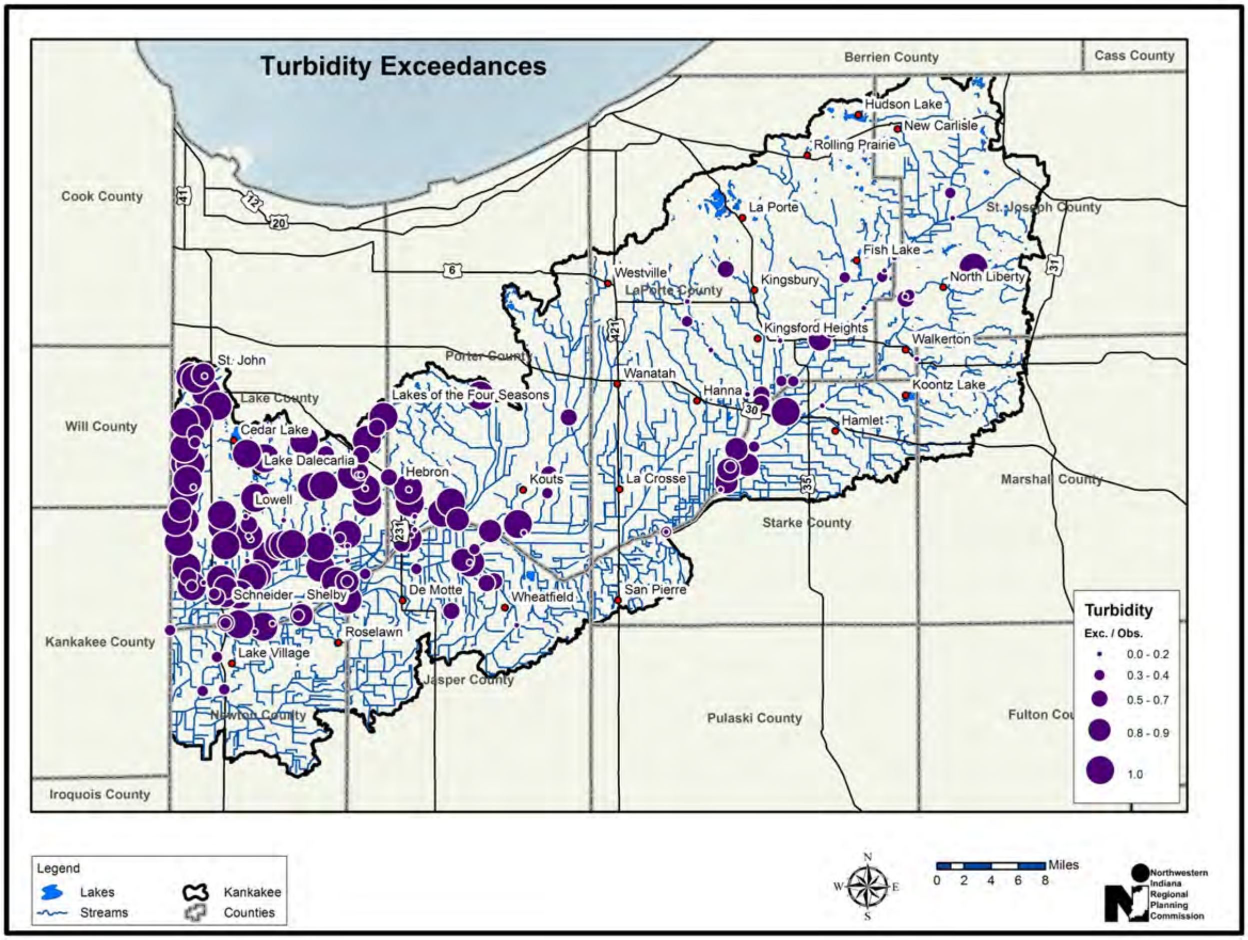

Figure 46. Turbidity Exceedances

NPDES Facilities

The National Pollution Discharge Elimination System (NPDES) facility locations shown in Figure 47 was provided by the IDEM Office of Water Quality as a GIS shapefile on July 20, 2011. The information used to create the shapefile was extracted from the U.S. EPA Integrated Compliance Information System (ICIS) database which includes all available records listed in Indiana associated with "Active" surface water discharges. It consists primarily of state permitted and regulated wastewater facility related information. The figure shows both “effective” and “terminated” permits. In total there are 52 NPDES facilities located in the sub-basin project area based upon this data. Although the database record set depicts all available information on regulated wastewater discharge sites as of the date of extraction, the locational and coordinate information is not complete; therefore queries and other searches are best handled through the attribute tables rather than from visually on maps where not all sites are represented

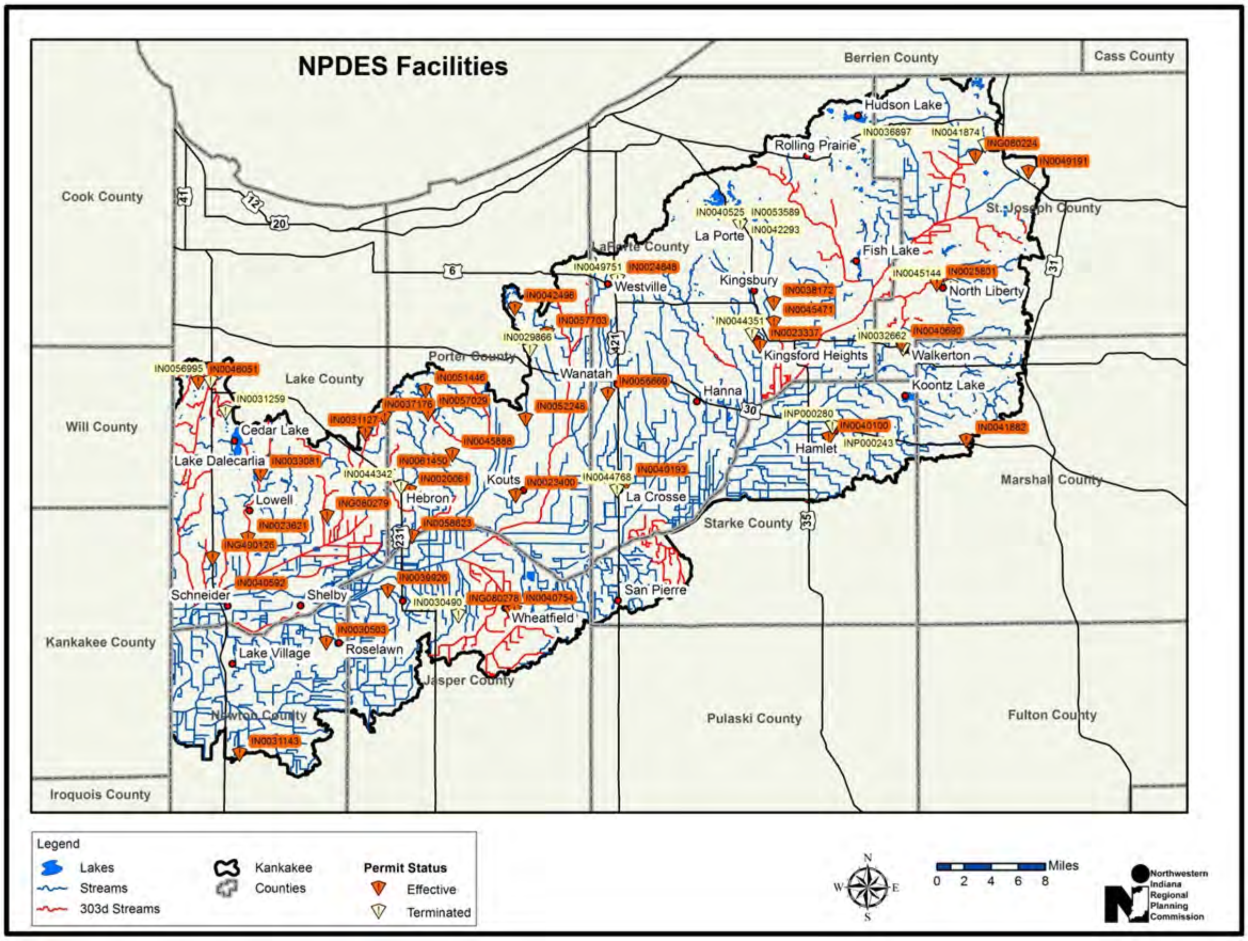

Figure 47. NPDES Facilities

Data presented below in Table 8 provides a summary of NPDES facility effluent exceedances and enforcement actions in the sub-basin project area. The data was generated through a query of the U.S. EPA's Enforcement & Compliance History Online (ECHO) system by NIRPC on July 20, 2011. ECHO provides a fast integrated search of U.S. EPA and state data for regulated facilities. It integrates inspection, violation, and enforcement for the Clean Water Act. Data is generated as tables and can be viewed via the mapping tool. ECHO is available at http://www.epa-echo.gov/echo/index.html. Additional water quality information available but not presented here includes watershed condition, possible facility discharges related to 303(d) water impairment, and along with other relevant factors. Facility names with an asterisk were not included on IDEM's list of facilities.

NPDES ID	Facility Name	# Effluent Exceedances (3yrs)	Informal Enforcement Actions (5yrs)	Formal Enforcement Actions (5yrs)
IN0020061	Hebron Wastewater Treatment Plant	24	5	
IN0023337	Kingsford Heights WWTP	4		
IN0023400	Kouts Municipal WWTP	2	1	

NPDES ID	Facility Name	# Effluent Exceedances (3yrs)	Informal Enforcement Actions (5yrs)	Formal Enforcement Actions (5yrs)
IN0023621	Lowell WWTP	2		
IN0024848	Westville WWTP	24		
IN0025577	La Porte WWTP	1		
IN0025801	North Liberty WWTP	1	2	
IN0030503	Lincoln Elementary School	5		
IN0031127	Winfield Elementary School	8	2	
IN0031143	North Newton Jr. Sr. High School	10	2	
IN0031275	Kankakee Rest Area*	16	1	
IN0033081	Lake Dalecarlia RWD WWTP	63	2	1
IN0037176	Twin Lakes Utilities	3	2	
IN0038172	Roll Coater Inc.	15	1	1
IN0039926	Demotte Municipal WWTP	3	1	
IN0040100	Hamlet Municipal WWTP	5	1	
IN0040193	La Crosse WWTP	3		
IN0040592	Schneider WWTP	Incomp entry	4	
IN0040690	Walkerton Municipal WWTP	5		
IN0040754	Wheatfield Municipal WWTP	2		
IN0041882	Yogi Bears Jellystone Park	13	3	
IN0042498	Valparaiso Flint Lake Pumping Station	0		
IN0042978	Westville Correctional Facility WWTP	2		
IN0043184	Mixsawbah State Fish Hatchery*	2	1	
IN0043397	Apple Valley Mobile Home Park Inc*.	6	1	
IN0045471	Kingsbury Utility Corp	6		
IN0045888	Boone Grove Elem. & Middle School	2		
IN0046051	St John Compressor Station	1		

NPDES ID	Facility Name	# Effluent Exceedances (3yrs)	Informal Enforcement Actions (5yrs)	Formal Enforcement Actions (5yrs)
IN0049191	New Energy Corp	6		
IN0051446	Lake Eliza Area Conservancy District	9	2	
IN0052248	Morgan Township Schools WWTP	0	1	
IN0052272	Potato Creek State Park*	6		
IN0053201	NIPSCO Schahfer Gen Station*	0		
IN0056669	Wanatah WWTP	4		
IN0057029	Boone Grove High School WWTP	1		
IN0057703	Washington Twp. School WWTP	0	1	
IN0058548	Buckhill Estates WWTP*	5	2	
IN0058823	Martis Place Bomars River Ldg.	2		
IN0059862	Bosch Automotive Proving Grounds	0		
IN0061085	Swan Lake Golf Resort*	11	4	
IN0061123	Red D Mart Store 33*	0		
IN0061450	Hebron Water Utility	1		
ING080224	Country Cupboard 7	0		
ING080231	Speedway Store 6075*	2	1	
ING080278	Family Express 6	Incomp entry	1	
ING080279	Superior Environmental Remediation, Inc.	0		
ING250007	Hoosier Tire & Rubber Corp*	0		
ING250071	IP Callison & Sons*	11		
ING490038	Vulcan Construction Materials Lp*	0		
ING490089	VCNA Prairie Aggregates Inc. Lowell Yard 6106*	0		
ING490126	Indiana Group Resources LLC	Incomp entry	2	

Table 8. NPDES Facility Compliance

3.2.3 Habitat & Biological Information

Qualitative Habitat Evaluation Index

The Qualitative Habitat Evaluation Index (QHEI) provides information on a stream's ability to support healthy fish and macroinvertebrates communities by evaluating instream habitat and the land that surrounds it. The QHEI is composed of six separate metrics each designed to evaluate a different portion of a stream site. The metrics include substrate, instream cover, channel morphology, bank erosion and riparian zone, pool/glide and riffle/run quality, and gradient. When the 6 metrics are added together you get a total QHEI score. The higher the total score, the better the habitat. For streams where the macroinvertebrate and/or fish community (mIBI and/or IBI) scores indicate IBC, QHEI scores are evaluated to determine if habitat is the primary stressor on the aquatic communities or if there may be other stressors/pollutants causing the IBC.

Between 1999 and 2010, IDEM evaluated stream and riparian habitat using the QHEI at 76 different stations in the sub-basin project area. IDEM has determined that a QHEI total score of <51 indicates poor habitat so this was used as the target value. Fifty five of the 76 stations (79%) evaluated had a target value exceedance (QHEI <51). Figure 48 shows the sample locations and the location in which the target value of 51 was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken).

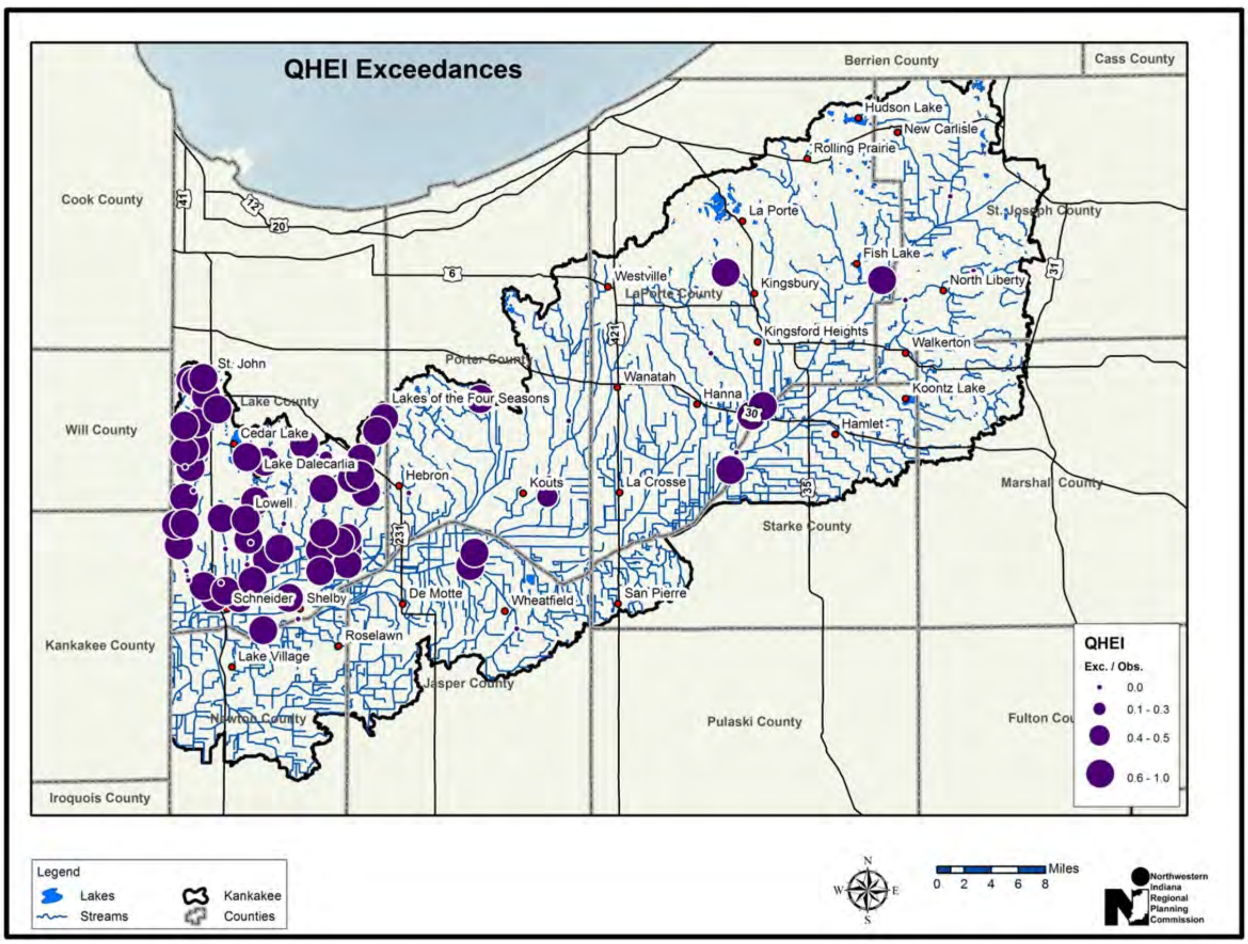

Figure 48. Qualitative Habitat Evaluation Index Exceedances

Index of Biotic Integrity

The Index of Biotic Integrity (IBI) provides a measure of a stream's health based upon the fish species collected from that stream. The IBI is comprised of a series of metrics to evaluate the health of the fish community. The metrics included in the IBI change by ecoregion however they all generally consider species richness and composition, indicator species, trophic function, and reproduction function. When the metrics are added together you get a total IBI score. The higher the total score, the better the stream's health based upon the fishery.

Between 1999 and 2010, IDEM evaluated fish communities at 82 different stations in the sub-basin project area. IDEM has determined that an IBI total score of <36 is considered non-supporting so this was used as the target value. Forty eight of the 82 stations (59%) evaluated had a target value exceedance (IBI <36). Figure 49 shows the sample locations and the location in which the target value of 36 was exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken) for the IBI.

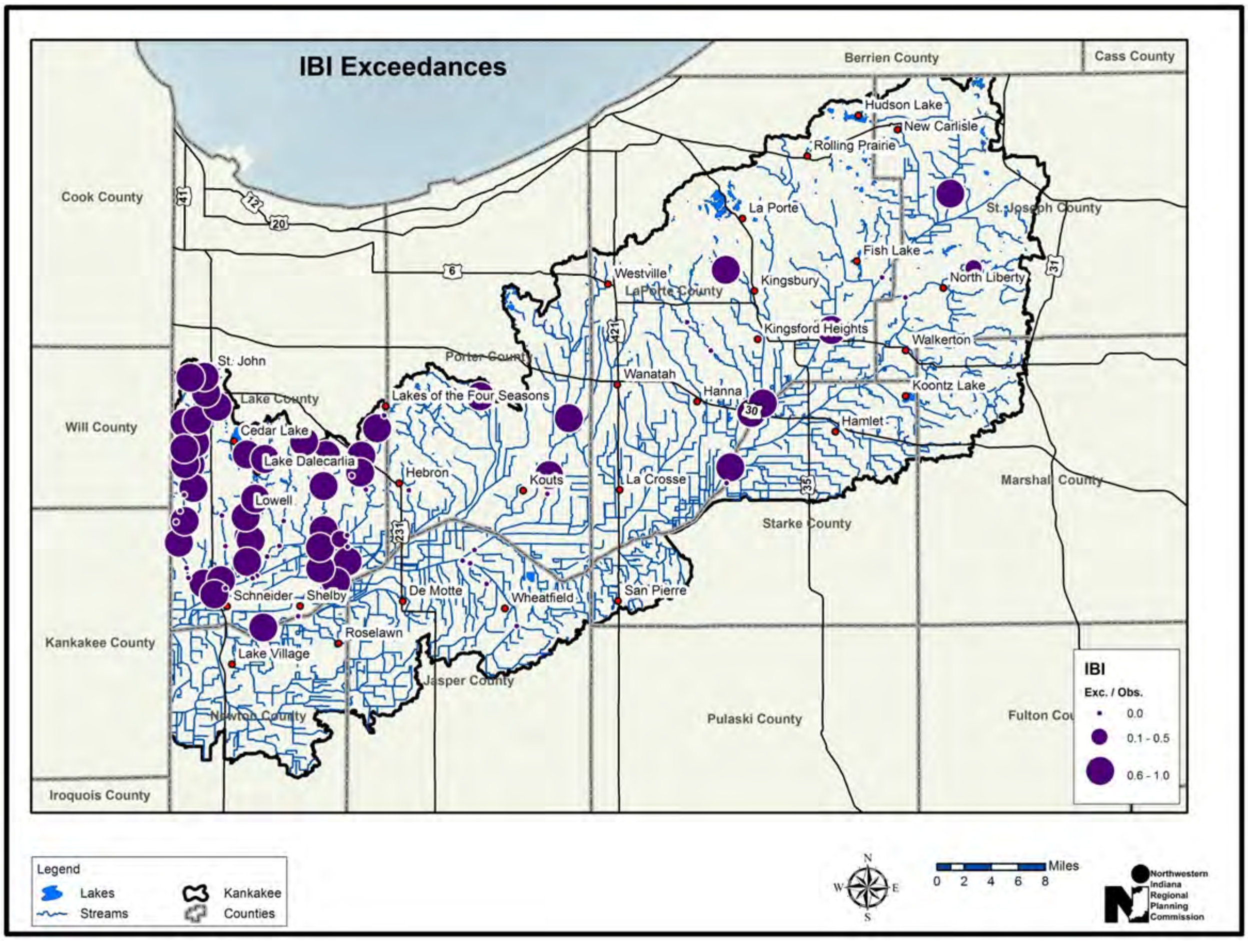

Figure 49. Index of Biotic Integrity Exceedances

Macroinvertebrate Index of Biotic Integrity

The macroinvertebrate Index of Biotic Integrity (mIBI) provides a measure of a stream's health based upon the macroinvertebrate species collected from that stream. Like the IBI, the mIBI is comprised of a series of metrics to evaluate the health of the macroinvertebrate community. When the metrics are added together you get a total IBI score. The higher the total score, the better the stream's health based upon the macroinvertebrate community.

Between 1999 and 2010, IDEM evaluated macroinvertebrate communities at 12 different stations in the sub-basin project area. IDEM has determined that a mIBI total score of <2.2 is considered non-supporting so this was used as the target value. None of the 12 stations (0%) evaluated exceeded the target value (mIBI <2.2). Figure 50 shows the sample locations within the sub-basin project area.

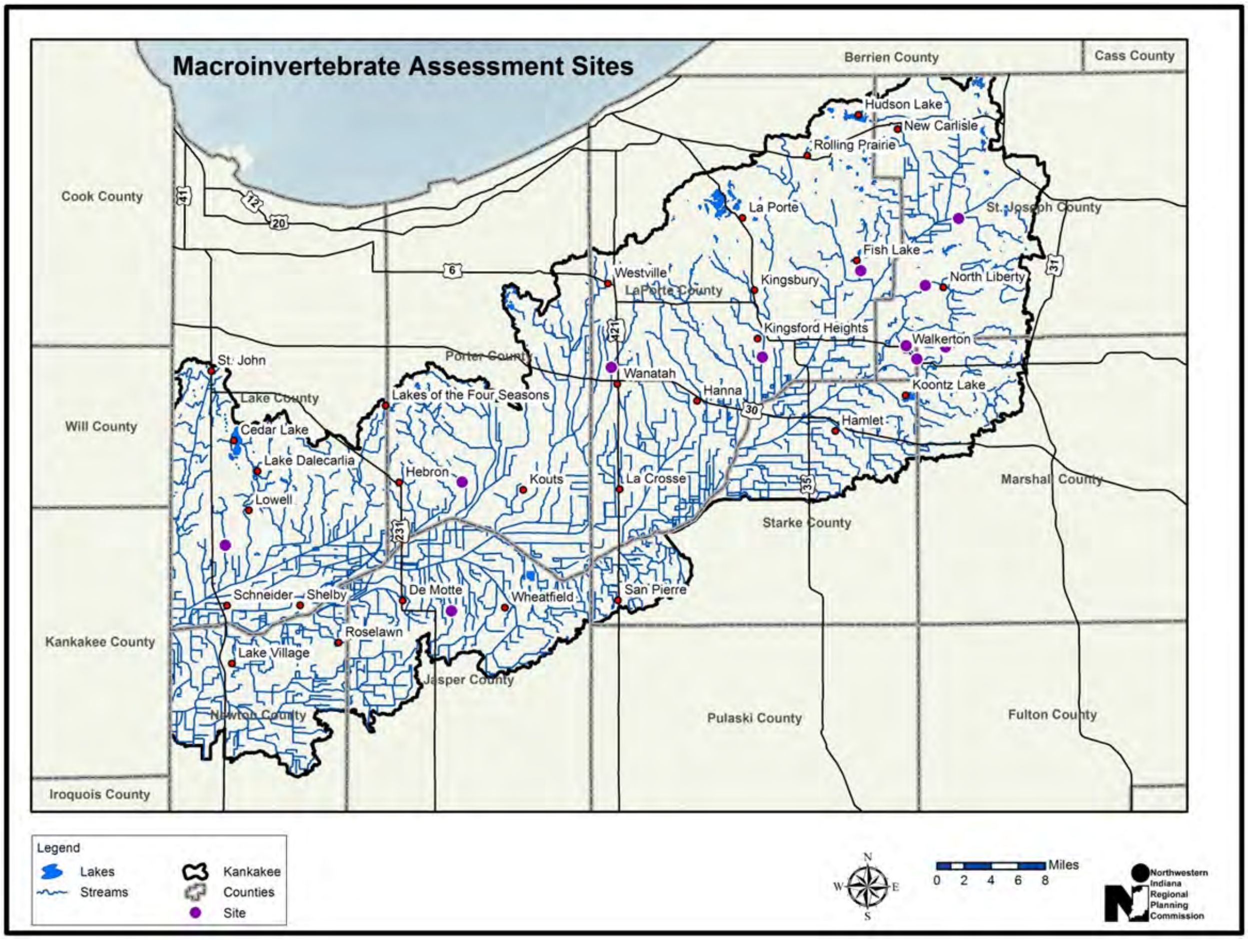

Figure 50. Macroinvertebrate Assessment Sites

The water quality data gathered by IDEM and presented above was used to generate Figure 3-51. This figure is a composite of all the water quality/habitat/biological parameters used by NIRPC for exceedance analysis. In total, 7,616 observations were made by IDEM at 185 stations in the sub-basin project area. One hundred sixty two of the 185 stations (88%) sampled had at least one target value exceeded and 1,568 of the 7,616 observations (21%) exceeded a target value. Figure 51 shows the sample locations and the location in which the target values were exceeded. The number of exceedances by station was normalized by the total number of observations at that station (i.e. samples taken). The most readily visible cluster of exceedances occurs in the area of southern Lake County around Cedar Lake, Lake Dalecarlia, Lowell, St. John, Schneider, and Shelby.

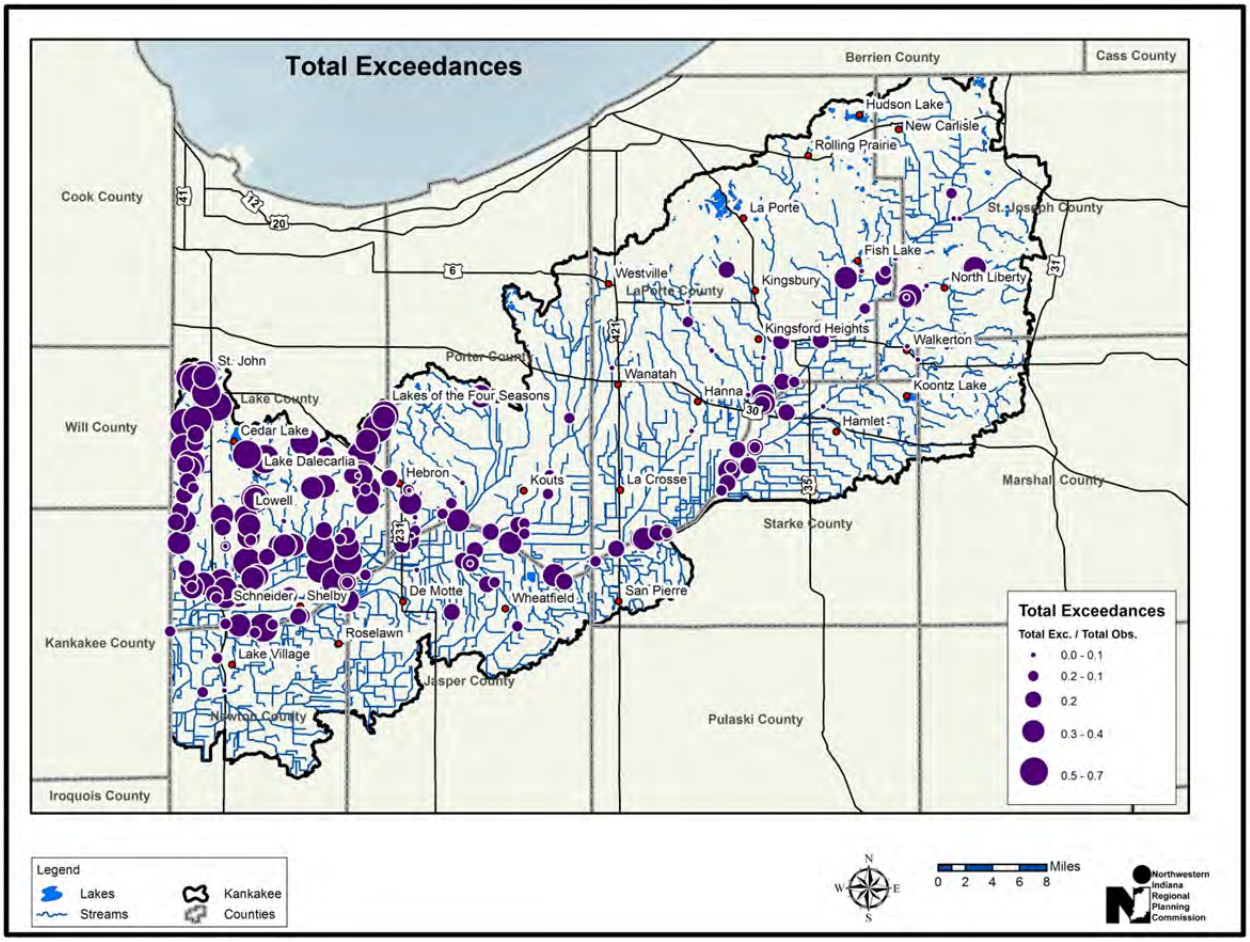

Figure 51. Total Exceedances

To further assist watershed groups in identifying critical subwatersheds and areas where additional data may be needed; an analysis of percent exceedance by subwatershed was done using ArcMap10 (Figure 52). The percent exceedance for all IDEM stations used in the analysis above was calculated for each subwatershed in the sub-basin project area. Subwatersheds without a fill color did not have data available for the analysis. Overall the subwatersheds in the Singleton Ditch watershed had the greatest percentage of exceedances. The most impacted based on this analysis being the Bull Run-West Creek subwatershed (HUC 071200011308) followed by the East Branch Stony Run (HUC 071200011301) and Brown Ditch (HUC 071200011307) subwatersheds.

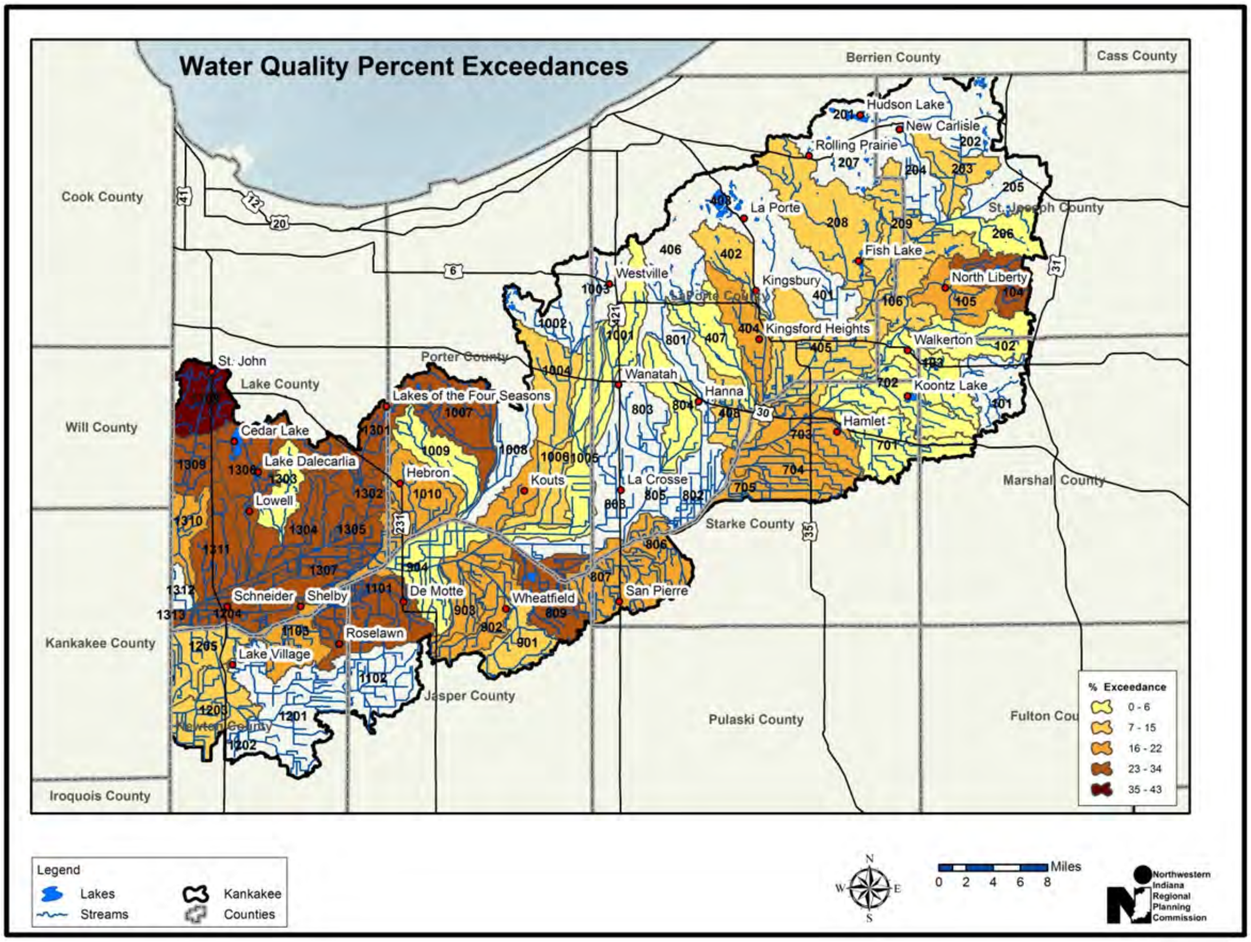

Figure 52. Percent Water Quality Exceedances by Subwatershed

3.3 Problems & Causes

3.3.1 Stakeholder Concerns

The following table (Table 9) is a synopsis of the concerns identified by stakeholder during the development of the 2005 Regional Watershed Management Plan for Lake, Porter and LaPorte Counties.

Concern(s)	Problem
Inconsistent requirements and goals for water quality data collected by agencies (ex. IDEM, USACE, USGS).	Locations have been tested to the point that there is a wealth of information available for some locations and none at all for other areas (subwatersheds).
Fishery condition	A number of area streams are included on IDEM's 303d list for impaired biotic communities.
Contaminated fish	A number of area streams and lakes have fish

Concern(s)	Problem
	consumption advisories in place.
E. coli	A number of area streams and Lake Michigan shoreline are impaired for recreational contact on IDEM's 303d list.
Excessive nutrient levels	A number of area streams have nutrient levels that exceed IDEM target values for draft nutrient TMDLs.
Streambank/shoreline erosion and sedimentation	Streambank/shoreline erosion and sedimentation.
Flooding	Development and/or alteration of floodplains. Lack of upland storage in urbanized areas. Loss of wetlands and natural land cover that promote infiltration and reduce runoff volume (ex. forest and grasslands). Increasing impervious surface area with development.
Loss of open space	Development pattern trending outside of core communities.
Surface and groundwater contamination from failed septic systems	An operation and maintenance program does not currently exist for septic systems. Severe soil limitations for traditional systems.
Disposal of household and commercial wastes	Illegal dumping of household and commercial wastes. Litter in streams and lakes.
Contaminated sites	Remediation efforts lagging to reduce risk to human and wildlife health from contaminated sites and sediments.
Transportation impacts to water quality and habitat	Increased runoff volume and pollutant loads and loss of habitat and/or connectivity from transportation projects.
Combined sewer overflows	CSOs contribute to high E. coli levels and beach closures. Threat to public health, water quality and drinking water supplies.
Water supply/drinking water protection	Development outside the Lake Michigan basin puts stress on ground water supplies for human

Concern(s)	Problem
	consumption and support of aquatic life.
Pesticides	USGS shows increasing trends in pesticide concentrations in urban streams for the US.
Thermal pollution	Increased impervious surface area and lack of forested stream buffers contribute to increases in stream water temperatures.
Loss of species diversity/invasive species	Habitat loss and fragmentation from development coupled with invasive species introduction are threatening biodiversity in the region.
Lack of or reduced funding for WMP development and implementation	Watershed planning and implementation is underfunded.
Public awareness and buy-in	Public is not fully aware of water quality and aquatic habitat issues in their watersheds.
Local government involvement (participation)	Lack of local government involvement in watershed planning and implementation efforts.
Availability of information	Information can be difficult to obtain at times or difficult to understand for the average citizen.
Zoning and development	Existing development patterns have led to growth far outside existing core development areas.
Insufficient stream buffers	A number of area stream lack sufficient riparian buffers. Poor QHEI scores
Insufficient staff to implement watershed program/no watershed coordinator	Insufficient staff to implement watershed program/no watershed coordinator
Hydromodification	A number of area streams that have been modified are included on the 303d List by IDEM
Local coordination	A unified group/program does not exist for some areas.
Public access	Access to streams, lakes, Lake Michigan shoreline and other natural areas is limited in some

Concern(s)	Problem
	communities or areas.
Agricultural impacts to water quality	Use of conservation tillage practices are low compared to some other counties in the state.
Stormwater runoff from industrial/commercial sites	Streams in highly industrial areas listed by IDEM on 303d list.

Table 9. Concerns & Problems

2.3.2 Potential Causes

Table 10below relates problems identified in Table 9 to potential causes.

Problem	Potential Cause(s)
Locations have been tested to the point that there is a wealth of information available for some locations and none at all for other areas (subwatersheds).	• State and federal agencies not coordinating to extent possible • Different sampling program design and priorities
A number of area streams are included on IDEM's 303d list for impaired biotic communities.	• Cumulative effects of activities that affect water quality and habit conditions over time
A number of area streams and lakes have fish consumption advisories in place.	• Mercury and PCBs in fish tissue exceed levels safe for human consumption
A number of area streams and Lake Michigan shoreline are impaired for recreational contact on IDEM's 303d list.	• *E. coli* levels exceed the water quality standard
A number of area streams have nutrient levels that exceed IDEM target values for draft nutrient TMDLs.	• Nutrient levels exceed IDEM's draft nutrient TMDL target values set by this project
Streambank/shoreline erosion and sedimentation.	• Stream alterations • Increased peak flow and volumes • Destruction or encroachment on riparian areas
Development and/or alteration of floodplains. Lack of upland storage in urbanized areas. Loss of wetlands and natural land cover that promote infiltration and reduce runoff volume (ex. forest and grasslands). Increasing impervious surface	• Encroachment of development into floodplains • Destruction of wetlands and loss of open space from development and agriculture • Increased impervious surface area with

Problem	Potential Cause(s)
area with development.	development
Development pattern trending outside of core communities.	
An operation and maintenance program does not currently exist for septic systems. Severe soil limitations for traditional systems.	• Lack of rules/regulations requiring maintenance • Public and elected official awareness of issue • Lack of buy-in from public and elected officials
Illegal dumping of household and commercial wastes. Litter in streams and lakes.	• Lack of awareness of existing Hazardous Household Waste Disposal programs • Ease of public and commercial businesses to dispose of waste in an appropriate manner • Lack of funding for HHWD program expansion and outreach
Remediation efforts lagging to reduce risk to human and wildlife health from contaminated sites and sediments.	• Population loss and growth shifting outside of urban core communities • Lack of funding for remediation • Unknown risk for developers
Increased runoff volume and pollutant loads and loss of habitat and/or connectivity from transportation projects.	• Inadequate use or selection of BMPs to mitigate NPS impacts from transportation • Lack of funding to mitigate impacts • Transportation agencies, communities and "environmental" organizations not coordinating to the extent possible
CSOs contribute to high E. coli levels and beach closures. Threat to public health, water quality and drinking water supplies.	• Stormwater and sewer infrastructure in CSO communities • Aging infrastructure • Lack of funding for separation • Increased impervious surface area
Development outside the Lake Michigan basin puts stress on ground water supplies for human consumption and support of aquatic life.	• Population shift outside of core communities with water supply infrastructure
USGS shows increasing trends in pesticide concentrations in urban streams for the US.	• Pesticide application by homeowners and businesses • Insufficient outreach on proper pesticide use and disposal

Problem	Potential Cause(s)
	• Proliferation of weed-and-feed products available to general public
Increased impervious surface area and lack of forested stream buffers contribute to increases in stream water temperatures.	• Urban and rural growth • Insufficient use of infiltration BMPs • Destruction of forested riparian habitat
Habitat loss and fragmentation from development coupled with invasive species introduction are threatening biodiversity in the region.	• Conversion of natural areas for development • Insufficient planning and effort to maintain or restore wildlife corridors
Watershed planning and implementation is underfunded.	• Federal and state funding mechanisms being cut back • Local match for grant funds • Not a priority for some communities or areas with shrinking budgets
Public is not fully aware of water quality and aquatic habitat issues in their watersheds.	• Insufficient coordination amongst groups and communities • No active group/organization or local champion to convey information • Existing outreach programs need bolstering • Sources of information are hard to find or understand for the average citizen • Water quality in not a concern or priority in the day-to-day lives for some members of the public
Lack of local government involvement in watershed planning and implementation efforts.	• Not a priority issue for community • Determining appropriate/key staff to participate • Lack of leadership support to participate
Existing development patterns have led to growth far outside existing core development areas.	• Zoning and ordinance • Declining quality of life
A number of area stream lack sufficient riparian buffers. Poor QHEI scores	• Destruction or encroachment of development or agricultural production into riparian zone • Drainage improvement • Lack of restoration funding • Insufficiently protective ordinances • Lack of incentives to maintain or restore riparian habitat

Problem	Potential Cause(s)
	• Removal of land in agricultural production (financial loss) • Insufficient education and outreach on riparian habitat benefits and programs • No interest in participating in federal or state funding programs • Lack of technical staff to support program • General lack of interest
Insufficient staff to implement watershed program/no watershed coordinator	• Insufficient funding for dedicated watershed coordinator • Workload and responsibilities of existing staff
A number of area streams that have been modified are included on the 303d List by IDEM	• Design and maintenance practices
A unified group/program does not exist for some areas.	• Lack of awareness on watershed issues • Insufficient collaboration between local communities, organizations, and groups
Access to streams, lakes, Lake Michigan shoreline and other natural areas is limited in some communities or areas.	• Lack of funding to acquire or improve access • Availability of land for purchase
Use of conservation tillage practices are low compared to some other counties in the state.	• Lack of interest in conservation programs • Insufficient understanding of practice benefits • Insufficient technical staff available locally • Insufficient funding for outreach
Streams in highly industrial areas listed by IDEM on 303d list.	• Legacy contaminants • Point source discharges • Storm water runoff

Table 10. Problems & Potential Causes

3.4 Potential Sources & Pollutant Loads

3.4.1 Potential Sources for Each Pollution Problem

Table 10 below relates potential causes identified in Table 10 to potential sources. Potential sources in the table are presented at a somewhat course scale. Further refinement of potential sources is possible through specific watershed management plan development with more detailed input from stakeholders.

Problem	Potential Cause(s)	Potential Source(s)
Locations have been tested to the point that there is a wealth of information available for some locations and none at all for other areas (subwatersheds).	• State and federal agencies not coordinating to extent possible • Different sampling program design and priorities	N/A
A number of area streams are included on IDEM's 303d list for impaired biotic communities.	• Cumulative effects of activities that affect water quality and habit conditions over time	• Poor habitat quality (QHEI <51) • High ISC (>11%) in urban areas • Conversion of critical wetland habitat adjacent to streams • Row crop production on HEL not utilizing conservation practices (ex. conservation tillage) • Lack of stream buffers in developed or agricultural areas • Urban and agricultural runoff, industrial discharges
A number of area streams and lakes have fish consumption advisories in place.	• Mercury and PCBs in fish tissue exceed levels safe for human consumption	• Air deposition • NPDES point source discharges • Contaminated sediments
A number of area streams and Lake Michigan shoreline are impaired for recreational contact on IDEM's 303d list.	• *E. coli* levels exceed the water quality standard	• Failed septic systems • Non-systems • CSOs • Livestock access to streams • Runoff from

Problem	Potential Cause(s)	Potential Source(s)
		livestock operations • Wildlife (including ducks and geese) • Pet waste
A number of area streams have nutrient levels that exceed IDEM target values for draft nutrient TMDLs.	• Nutrient levels exceed IDEM's draft nutrient TMDL target values set by this project	• Urban and agricultural fertilizer runoff • CSOs • Livestock access to streams
Streambank/shoreline erosion and sedimentation.	• Stream alterations • Increased peak flow and volumes • Destruction or encroachment on riparian areas	• High ISC (>11%) in developed areas • Conversion of critical wetland habitat adjacent to streams and headwater areas in developed or agricultural areas • Lack of stream buffers in developed or agricultural areas • Poorly designed drainage improvement projects • Loss of forest and grasslands in developed areas
Development and/or alteration of floodplains. Lack of upland storage in urbanized areas. Loss of wetlands and natural land cover that promote infiltration and reduce runoff volume (ex. forest and grasslands). Increasing impervious surface	• Encroachment of development into floodplains • Destruction of wetlands and loss of open space from development and agriculture • Increased impervious surface area with development	• Floodplain encroachment in developed areas • Conversion of wetlands, forest, and grasslands in developed and agricultural areas • High ISC in developed areas

Problem	Potential Cause(s)	Potential Source(s)
area with development.		• Conveyance constriction
Development pattern trending outside of core communities.		N/A
An operation and maintenance program does not currently exist for septic systems. Severe soil limitations for traditional systems.	• Lack of rules/regulations requiring maintenance • Public and elected official awareness of issue • Lack of buy-in from public and elected officials	N/A
Illegal dumping of household and commercial wastes. Litter in streams and lakes.	• Lack of awareness of existing Hazardous Household Waste Disposal programs • Ease of public and commercial businesses to dispose of waste in an appropriate manner • Lack of funding for HHWD program expansion and outreach	• Developed areas
Remediation efforts lagging to reduce risk to human and wildlife health from contaminated sites and sediments.	• Population loss and growth shifting outside of urban core communities • Lack of funding for remediation • Unknown risk for developers	• Primarily urban areas
Increased runoff volume and pollutant loads and loss of habitat and/or connectivity from transportation projects.	• Inadequate use or selection of BMPs to mitigate NPS impacts from transportation • Lack of funding to mitigate impacts • Transportation agencies, communities and “environmental” organizations not coordinating to the extent possible	• Roads, highways and bridges in developed areas
CSOs contribute to high E. coli levels and beach closures. Threat	• Stormwater and sewer infrastructure in CSO communities	• CSO communities

Problem	Potential Cause(s)	Potential Source(s)
to public health, water quality and drinking water supplies.	• Aging infrastructure • Lack of funding for separation • Increased impervious surface area	
Development outside the Lake Michigan basin puts stress on ground water supplies for human consumption and support of aquatic life.	• Population shift outside of core communities with water supply infrastructure	N/A
USGS shows increasing trends in pesticide concentrations in urban streams for the US.	• Pesticide application by homeowners and businesses • Insufficient outreach on proper pesticide use and disposal • Proliferation of weed-and-feed products available to general public	• Developed and agricultural areas
Increased impervious surface area and lack of forested stream buffers contribute to increases in stream water temperatures.	• Urban and rural growth • Insufficient use of infiltration BMPs • Destruction of forested riparian habitat	• Developed areas
Habitat loss and fragmentation from development coupled with invasive species introduction are threatening biodiversity in the region.	• Conversion of natural areas for development or agricultural production • Insufficient planning and effort to maintain or restore wildlife corridors	• Developed and developing areas • Agricultural areas
Watershed planning and implementation is underfunded.	• Federal and state funding mechanisms being cut back • Local match for grant funds • Not a priority for some communities or areas with shrinking budgets	N/A
Public is not fully aware of water quality and aquatic habitat issues in their watersheds.	• Insufficient coordination amongst groups and communities • No active group/organization or local champion to convey	N/A

Problem	Potential Cause(s)	Potential Source(s)
	information • Existing outreach programs need bolstering • Sources of information are hard to find or understand for the average citizen • Water quality in not a concern or priority in the day-to-day lives for some members of the public	
Lack of local government involvement in watershed planning and implementation efforts.	• Not a priority issue for community • Determining appropriate/key staff to participate • Lack of leadership support to participate • Multijurisdictional	N/A
Existing development patterns have led to growth far outside existing core development areas.	• Zoning and ordinance • Declining quality of life	N/A
A number of area streams lack sufficient riparian buffers. Poor QHEI scores.	• Destruction or encroachment of development or agricultural production into riparian zone • Drainage improvement • Lack of restoration funding • Insufficiently protective ordinances • Lack of incentives to maintain or restore riparian habitat • Removal of land in agricultural production (financial loss) • Insufficient education and outreach on riparian habitat benefits and programs • No interest in participating in federal or state funding programs	• Developed and agricultural areas

Problem	Potential Cause(s)	Potential Source(s)
	• Lack of technical staff to support program • General lack of interest	
Insufficient staff to implement watershed program/no watershed coordinator	• Insufficient funding for dedicated watershed coordinator • Workload and responsibilities of existing staff	N/A
A number of area streams that have been modified are included on the 303d List by IDEM	• Design and maintenance practices	• Urban drains • Regulated drains
A unified group/program does not exist for some areas.	• Lack of awareness on watershed issues • Insufficient collaboration between local communities, organizations, and groups	N/A
Access to streams, lakes, Lake Michigan shoreline and other natural areas is limited in some communities or areas.	• Lack of funding to acquire or improve access • Availability of land for purchase	• Developed areas
Use of conservation tillage practices are low compared to some other counties in the state.	• Lack of interest in conservation programs • Insufficient understanding of practice benefits • Insufficient technical staff available locally • Insufficient funding for outreach	• Agricultural areas adjacent to streams • Row crop production on HEL
Streams in highly industrial areas listed by IDEM on 303d list.	• Legacy contaminants • Point source discharges • Storm water runoff	• Developed areas

Table 11. Potential Sources for Each Problem

In an effort to help identify conditions in which exceedances occur and potential sources in the sub-basin, NIRPC used Purdue University's web-based Load Duration Curve Analysis System[1]. The duration curve approach allows for characterizing water quality concentrations at different flow regimes. Using the duration curve framework, the frequency and magnitude of water quality standard exceedances,

[1] Purdue University Web-Based Load Duration Curve Analysis System https://engineering.purdue.edu/~ldc/JG/duration/main.cgi

allowable loadings, and size of load reductions are easily presented and can be better understood[2]. Loads that plot above the curve indicate and exceedance of the water quality standard or target, while those below the curve show compliance. Table 12 shows the general relationship between duration curve zone and potential contributing sources.

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
On-site wastewater systems/Unsewered areas	M	M-H	H	H	H
Urban stormwater/CSOs	H	H	H		
Agricultural runoff	H	H	M		
Bacterial re-suspension from stream sediments	H	M			
Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)					

Table 12. General Relationship between Duration Curve Zone and Contributing Sources[3]

Within the sub-basin study area there are three IDEM sampling sites that are located in near proximity to a USGS stream gage. IDEM site number UMK110-0002 corresponds with USGS gage number 05518000 located at Shelby on the Kankakee River. IDEM site number UMK080-0001 corresponds with USGS gage number 05517500 which is located at Dunns Bridge on the Kankakee River. IDEM site number UMK030-0033 is located slightly upstream of USGS gage number 05515500 at Davis on the Kankakee River. However, only three sampling events occurred at this station during the 1999-2010 time periods. In addition to these sites in the project area, water quality data for IDEM site number UMK060-0018 was analyzed to determine the contributions of the Yellow River at the USGS gage station (05517000) at Knox.

Kankakee River at Shelby, UMK110-0002

Nearly 1,779 square miles of the Kankakee sub-basin drain through the USGS gaging station located in Shelby, Indiana. While limited to nine sampling dates during the 1999-2010 time periods, the load duration curve for *E. coli* (Figure 53) does show that the water quality standard of 235 CFU/100ml is

[2] An Approach for Using Load Duration Curves in the Development of TMDLs (EPA 841-B-07-006) https://engineering.purdue.edu/~ldc/JG/duration/PDF/duration_curve_guide_aug2007.pdf
[3] Kankakee/Iroquois Watershed TMDL Report http://www.in.gov/idem/nps/files/tmdl_kankakee_iroquois_part3.pdf

exceeded during mid-range flow conditions. Under these conditions septic systems and urban stormwater runoff/CSOs are high potential contributors. Runoff from agricultural lands is a moderate contributor. Septic system location information does not currently exist for the region however Figure 9 shows that most soils in the station's drainage area are classified as "very limited" for absorption fields. Over 20 communities in the study area are located upstream of the station. LaPorte has the only CSO located within in the Kankakee sub-basin study area (Travis Ditch subwatershed, HUC 071200010403), however over two dozen exist in the upper reaches of the sub-basin within St. Joseph and Marshall County. There are over 80 CFOs located in the sub-basin study area and roughly 90% of these are located upstream of the Shelby station (Figure 22).

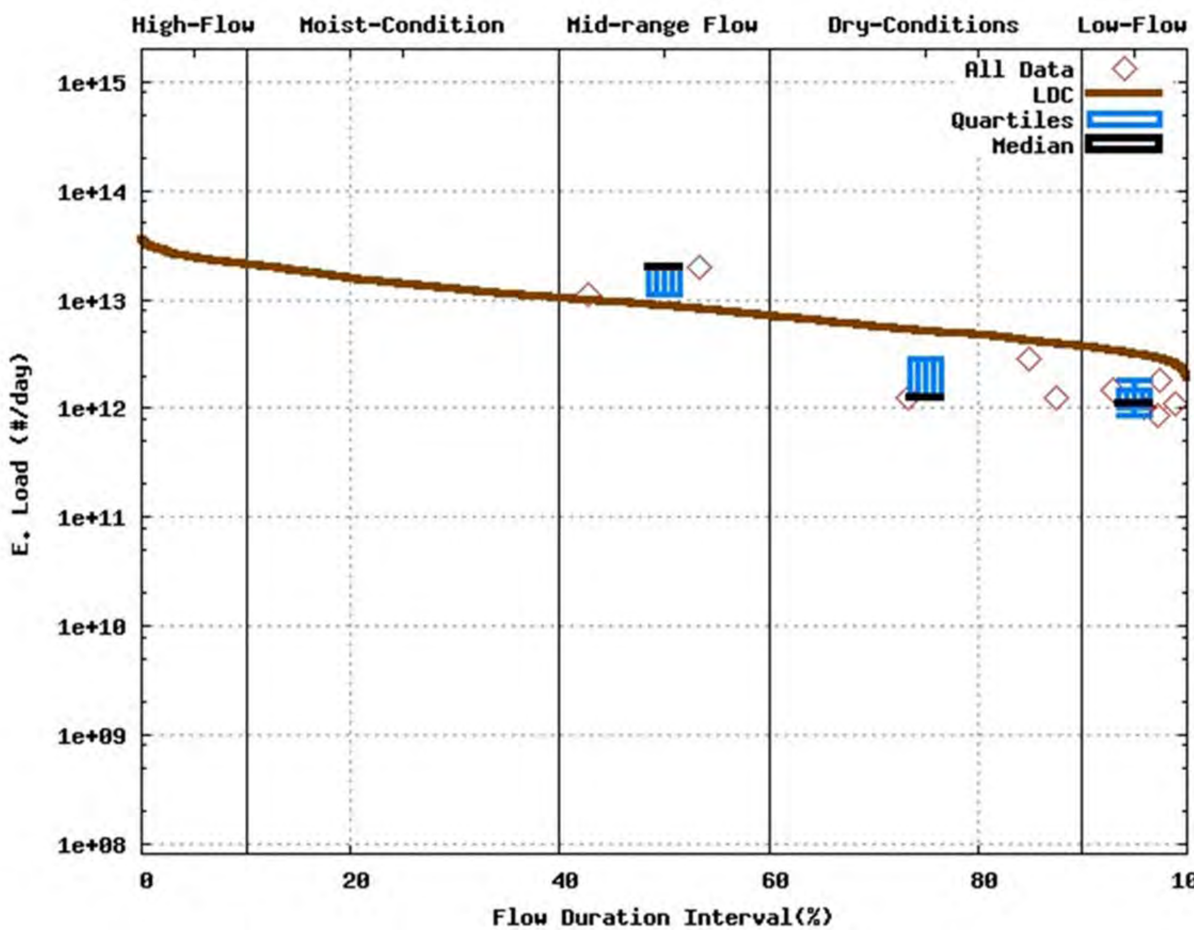

Figure 53. E. coli Load Duration Curve (IDEM Site UMK110-0002)

The load duration curve for TKN (Figure 54) shows that the water quality target of 0.591 mg/l is exceeded across all flow regimes. However the greatest percentage of exceedances, based on the box-whisker plots, occur during mid-range, moist, and high-flow conditions where nonpoint sources are the primary contributor. Urban runoff is a high probable contributor under each of these flow conditions along with failing septic systems under the mid-range to moist conditions and agricultural runoff under moist and high flow conditions. Sources of TKN include the decay of organic material such as plant material and animal wastes, urban and industrial disposal of sewage and organic waste, and ammonia and organic nitrogen applied as fertilizer to cropland. Both ammonia and organic nitrogen are relatively immobile in soils and ground water because of adsorption on soil surfaces and particulate filtering, but are susceptible to nitrification under aerobic conditions[4].

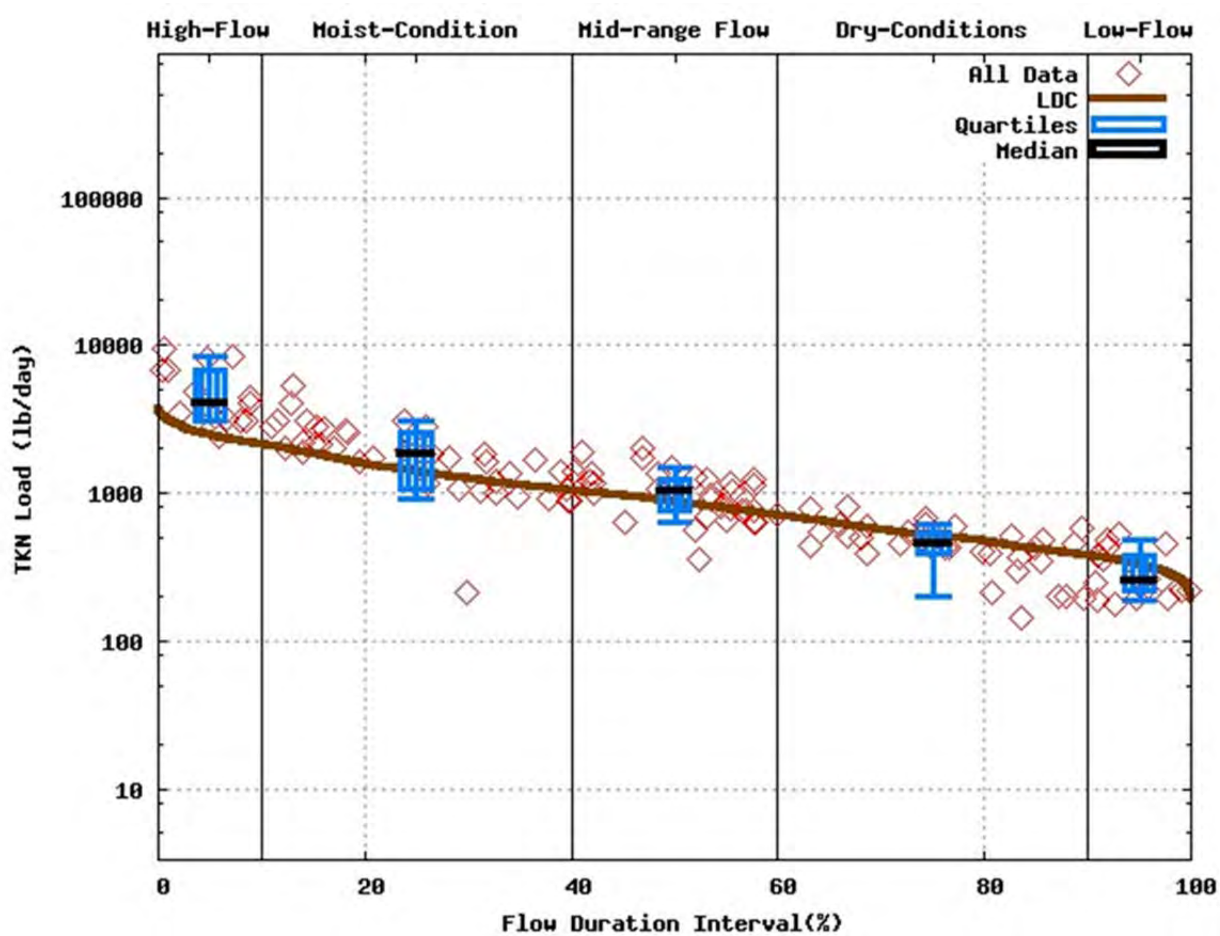

Figure 54. TKN Load Duration Curve (IDEM UMK110-0002)

The TSS load duration curve for this station (Figure 55) shows that the water quality target of 30 mg/l is exceeded occasionally (25% or less) during dry to high flow conditions. Across these conditions runoff from urban and agricultural are the primary contributors. During high-flow events streambank erosion is also a primary contributor to high TSS loading. The high percentage Group A and Group B soils, 48% and 33% respectively, on which much of the sub-basins' agricultural land exists likely attenuates runoff to some extent even during high flow conditions. Mid-range exceedances occur more frequently than at the Dunns Bridge station indicating increased loading during mid-range flow conditions from the Crooked Creek watershed (HUC 0712000110) and/or Hodge Ditch watershed (HUC 0712000109). The

[4] USGS Chesapeake Bay River Input Monitoring Program http://va.water.usgs.gov/chesbay/RIMP/waterchem.html

Crooked Creek watershed does have significant inclusions of soils classified as HEL in agricultural production (Figure 33) and group "C" soils (Figure 8) based on NIRPC analysis.

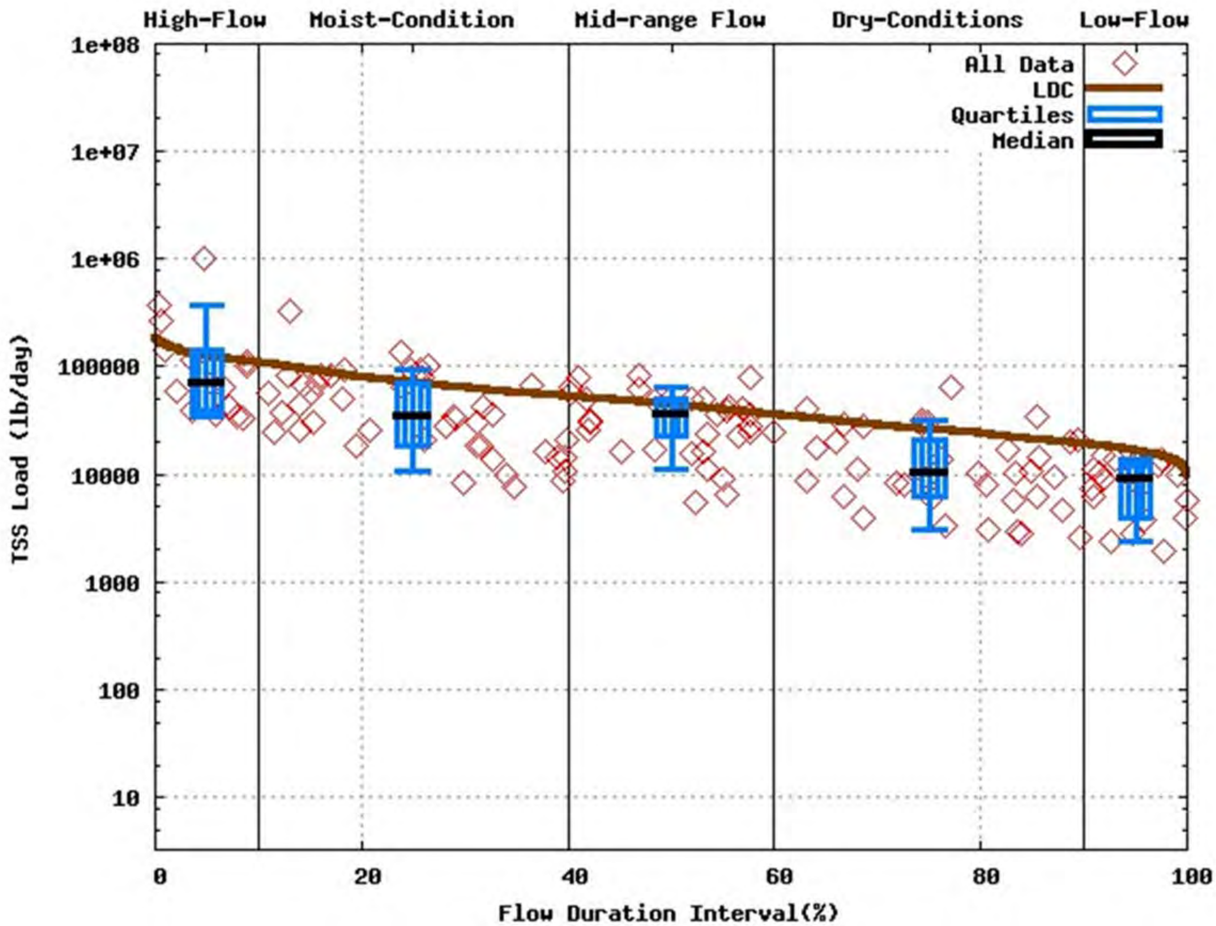

Figure 55. TSS Load Duration Curve (IDEM Site UMK110-0002)

Kankakee River at Dunns Bridge, UMK080-0001

Approximately 1,352 square miles of the sub-basin's land area drains through the USGS gaging station located at Dunns Bridge on the Kankakee River. The load duration curve for TKN (Figure 56) at this station is very similar to the one for Shelby (Figure 54). The greatest percentage of exceedances occurs from mid-range to high-flow conditions. Urban runoff is a high probable contributor under each of these flow conditions along with failing septic systems under the mid-range to moist conditions and agricultural runoff under moist and high flow conditions.

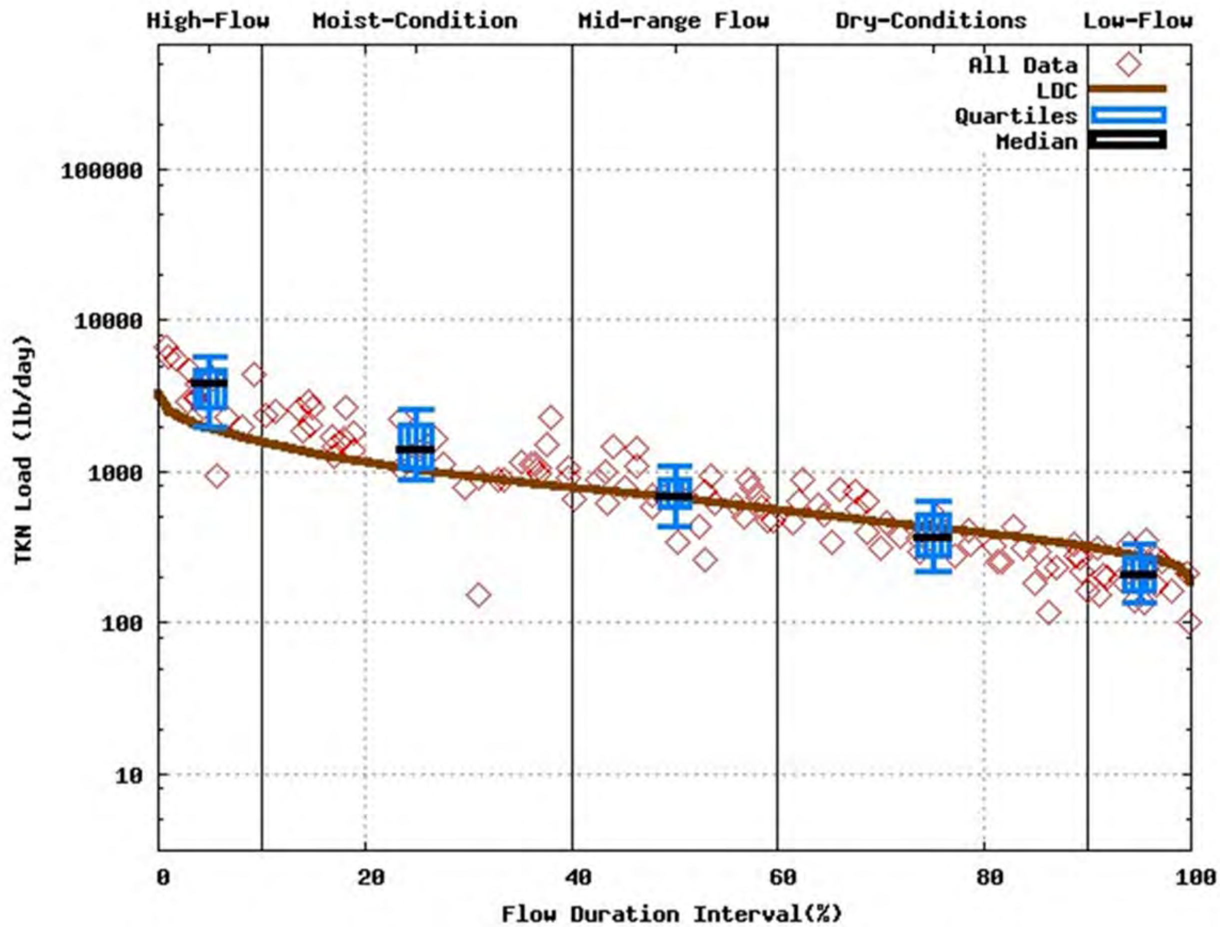

Figure 56. TKN Load Duration Curve (IDEM Site UMK080-0001)

The TSS load duration curve for this station (Figure 57) shows that the water quality target of 30 mg/l is exceeded occasionally (25% or less) during moist to high flow conditions. Across these conditions runoff from urban and agricultural are the primary contributors. During high-flow events streambank erosion is also a primary contributor to high TSS loading. Mid-range exceedances occur less frequently than at the Shelby station.

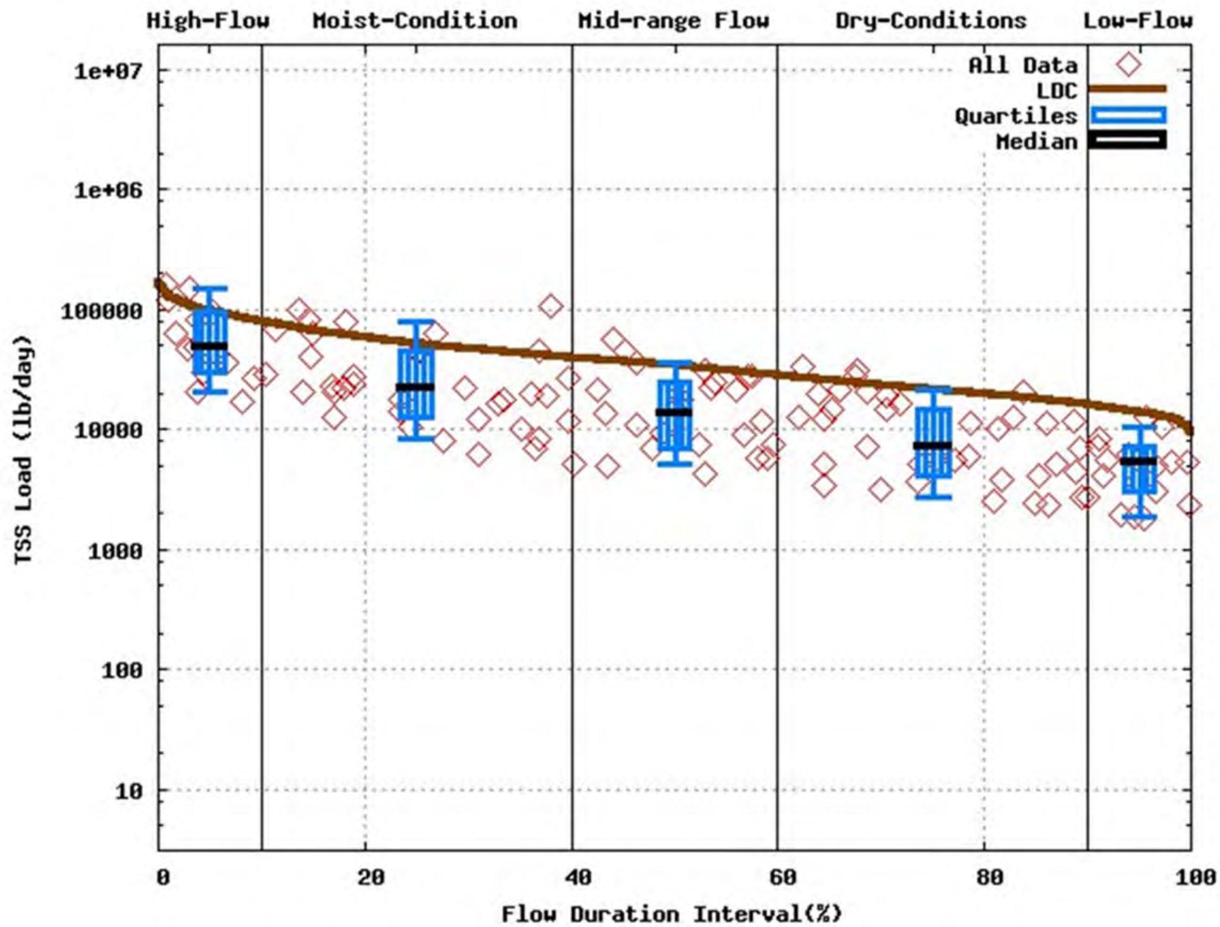

Figure 57. TSS Load Duration Curve (IDEM Site UMK080-0001)

Yellow River at Knox, UMK060-0001

The load duration curve for *E. coli* (Figure 58), while limited to six samples shows that the water quality standard of 235 CFU/100ml is exceeded during dry and moist conditions. This indicates that both point and nonpoint sources contribute to the impairment. Under dry conditions, failing septic systems are the highest probable contribution source, with wastewater treatment plants, wildlife and livestock direct access being moderate contribution sources. Under moist conditions failing septic systems, urban runoff/CSOs, and runoff from agricultural land are high probability sources with re-suspension of bacteria laden sediment being moderate probability. A review EPA data shows that over two dozen CSOs exist within the upper reaches of the sub-basin in St. Joseph and Marshall County.[5]

[5] EPA Watershed Assessment, Tracking & Environmental Results (WATERS) EnviroMapper for Water http://www.epa.gov/waters/index.html

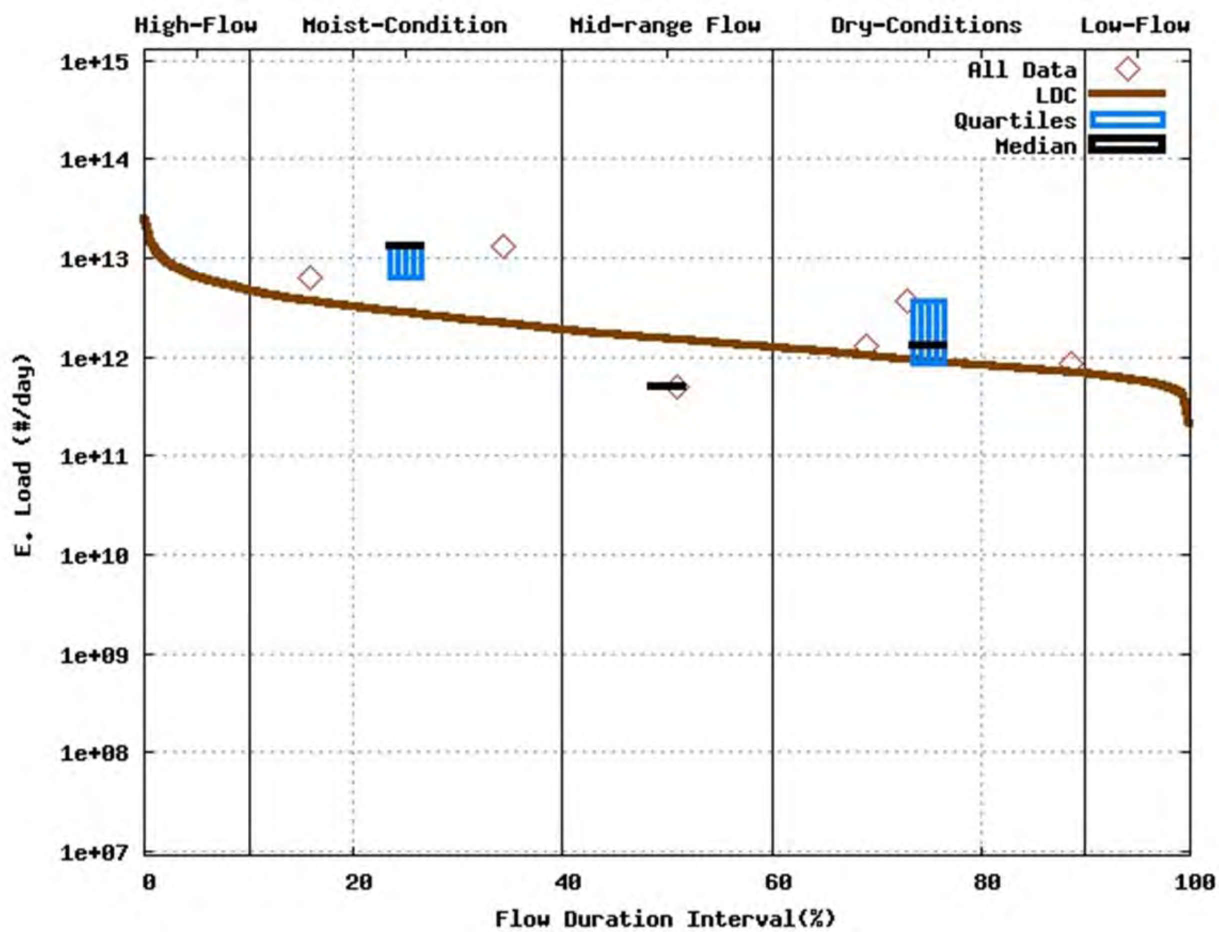

Figure 58. E. coli Load Duration Curve (IDEM Site UMK060-0001)

The load duration curve for Nitrate-Nitrite (Figure 59) shows that the water quality standard of 10mg/l is occasionally exceeded during moist conditions. Under these conditions nonpoint sources are the primary contributor. This includes failing septic systems, urban runoff/CSOs, and agricultural runoff. Land use was not analyzed for this area however, as noted above a number of CSOs exist in the upper reaches of the drainage area.

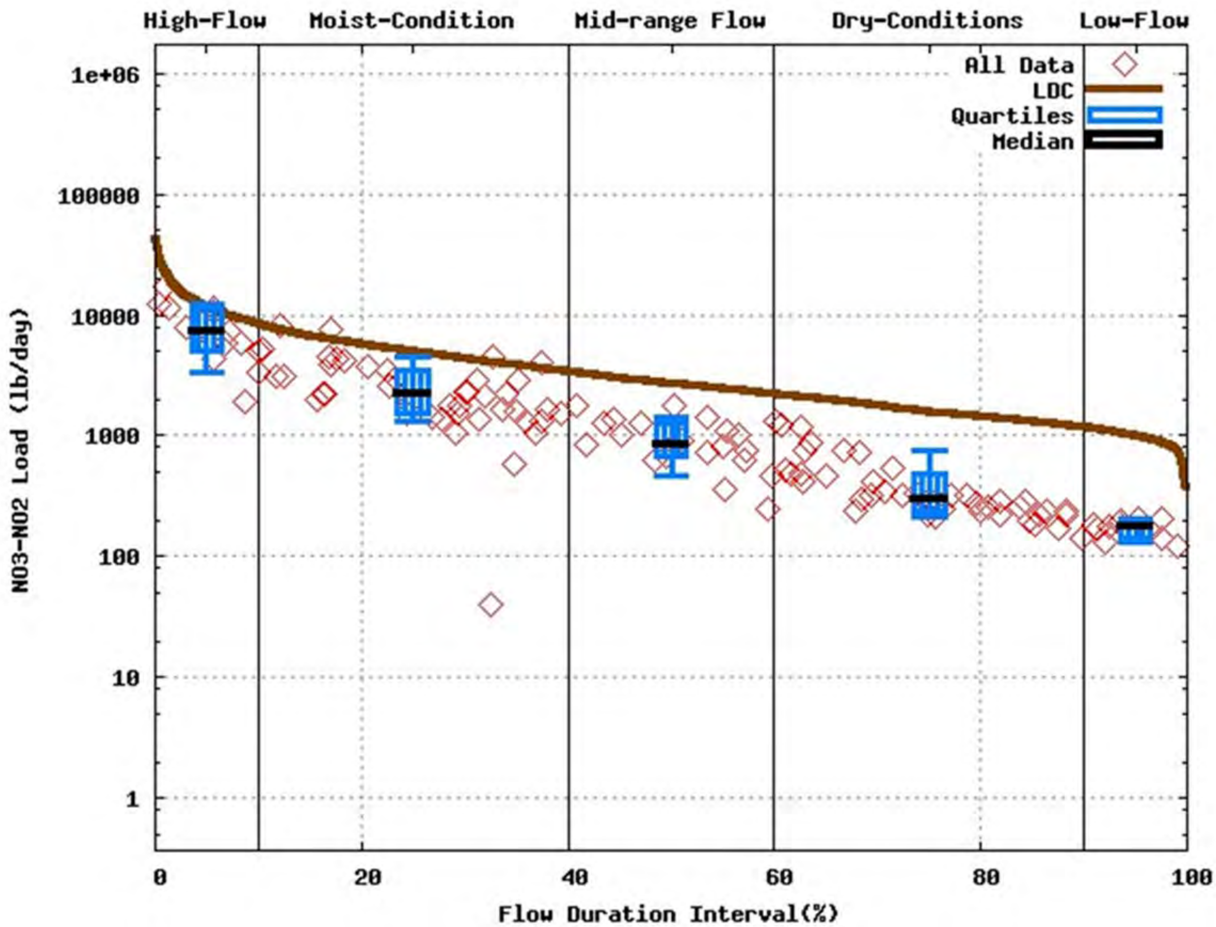

Figure 59. NO3-NO2 Load Duration Curve (IDEM Site UMK060-0001)

The load duration curve for total phosphorous shows the target value of 0.30 mg/l is rarely exceeded. Only one point is apparent above the target value curve during high flow conditions. Under these conditions high probability contributing factors include urban runoff/CSOs and runoff from agricultural lands.

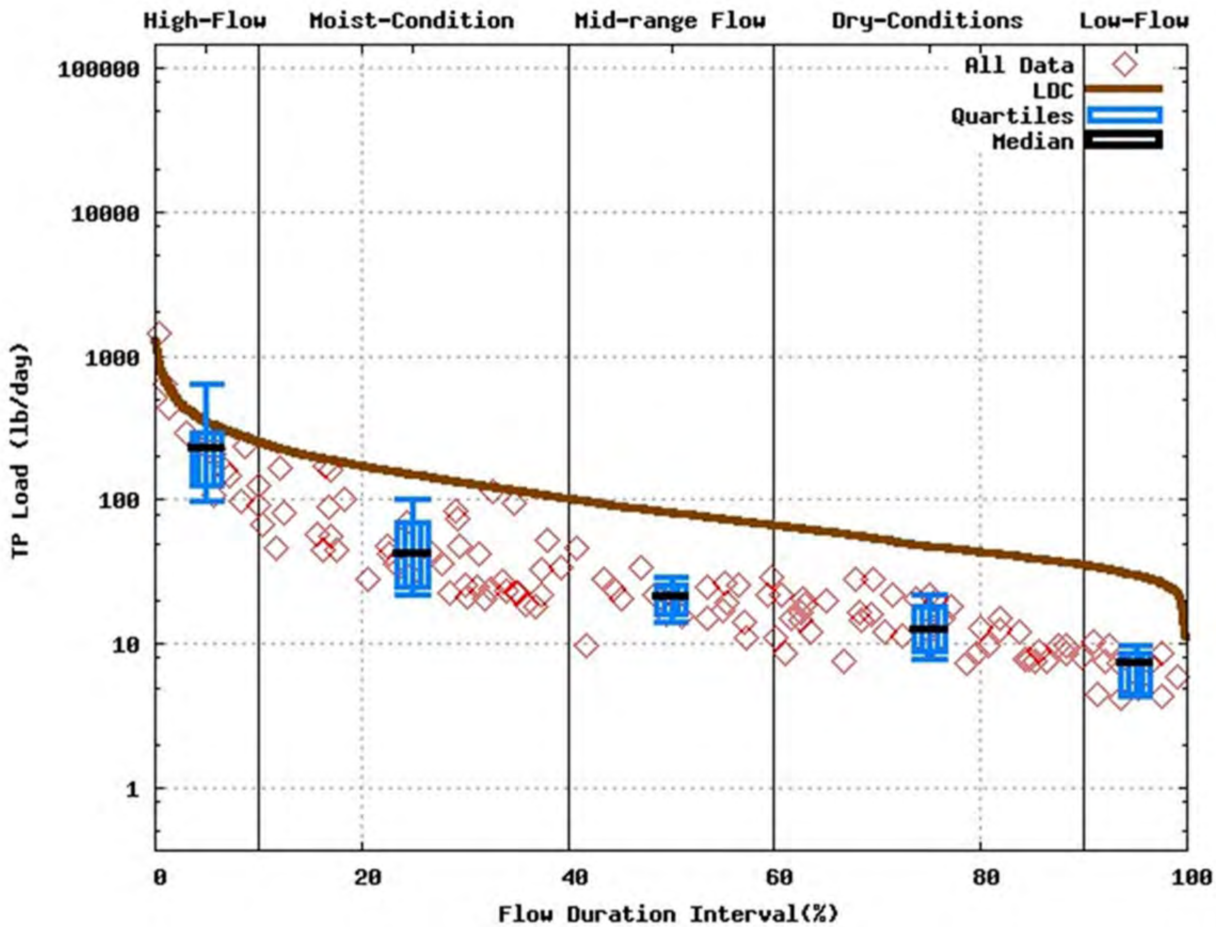

Figure 60. TP Load Duration Curve (IDEM Site UKM060-0001)

The load duration curve for Total Kjeldahl Nitrogen displayed in Figure 61 shows the target value of 0.591 mg/l is frequently exceeded during dry to high flow conditions. This indicates that both point and nonpoint sources contribute to water quality target exceedances. During dry conditions failing septic systems are a high potential contributor followed by moderate contributors which include waste water treatment plants and livestock access to streams. This pattern in conditions of occurrence is repeated throughout the Kankakee sub-basin based on the TKN load duration curve data presented here.

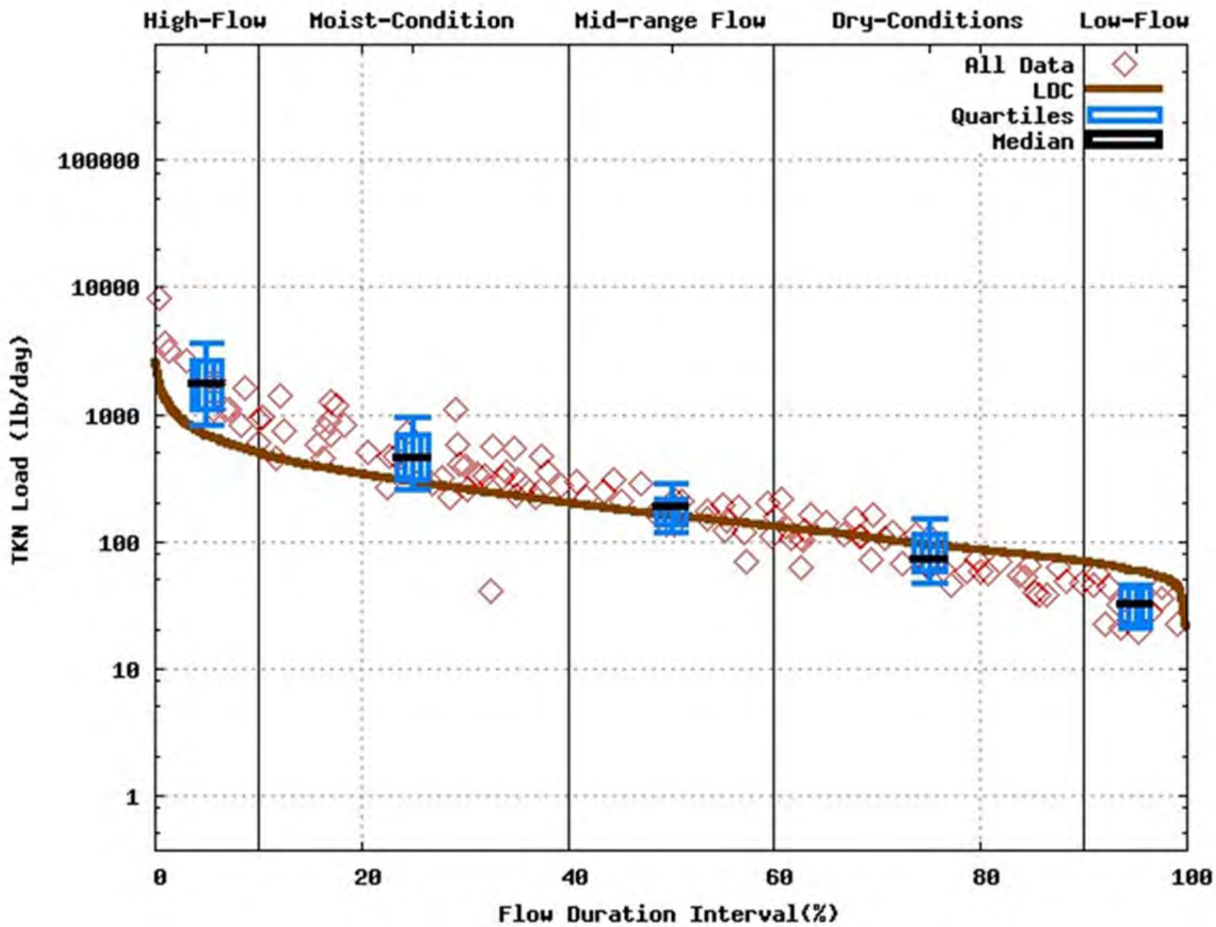

Figure 61. TKN Load Duration Curve (IDEM Site UKM060-0001)

The load duration curve for total suspended solids (Figure 62) shows that the target value of 30mg/l is most often exceeded during moist and high flow conditions. However exceedances are also noted to occasionally occur during dry conditions. Under dry conditions direct livestock access to streams can be a potential source as can waste water treatment plants and wildlife access to streams. During moist and high flow condition high potential contributing sources include urban runoff/CSOs, runoff from agricultural land and streambank erosion.

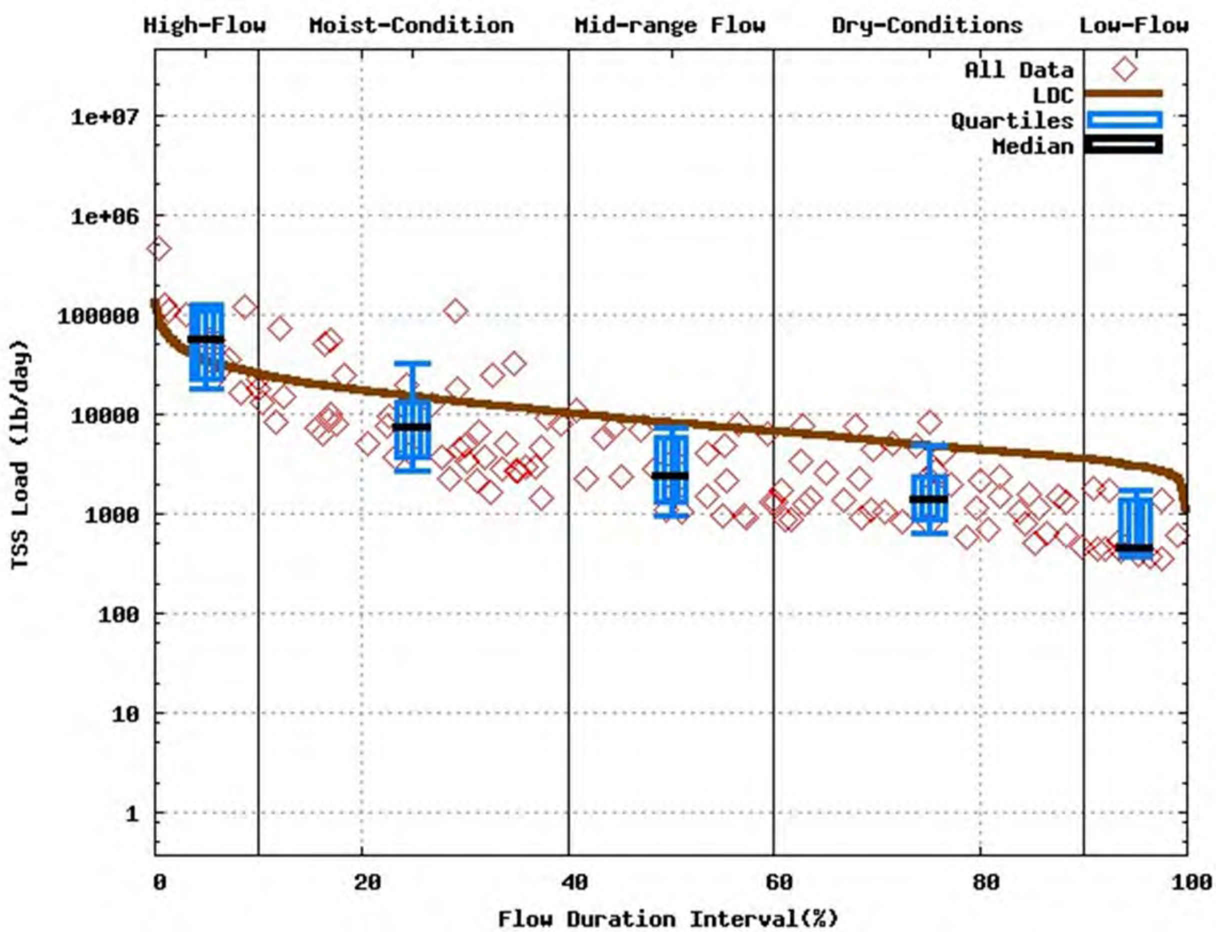

Figure 62. TSS Load Duration Curve (IDEM Site UKM060-0001)

3.4.2 Current Loads

Subwatershed loading of pollutants was done by NIRPC using the EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL). STEPL uses simple algorithms to calculate nutrient and sediment loads from different land uses. The results are presented as total load (nitrogen, phosphorous, biochemical oxygen demand (BOD), and sediment) by subwatershed and land use. The user inputs land use area (acres), agricultural animals (number), septic system data, and has the option to modify the Universal Soil Loss Equation (USLE) parameters for each land use. Data to help fill in these fields is available from the STEPL Data Server. Additionally the user can provide optional/modify input data including average soil hydrologic group (Figure 8), reference runoff curve number, nutrient concentration, urban land use distribution, and irrigation data. STEPL is available for download at http://it.tetratech-ffx.com/steplweb/default.htm as is access to the STEPL data server.

NIRPC used the 2006 NOAA CCAP data presented in **3.1.5 Land Use & Land Cover** as input to STEPL for each subwatershed in the sub-basin. The CCAP developed land cover classes (high, medium and low density) were grouped for the urban input. The CCAP cultivated and pasture/hay land cover classes were used for cropland and pastureland inputs respectively. The CCAP deciduous, mixed and evergreen land cover classes were grouped for the forest input. The CCAP developed open space land cover class was used for the user defined land use input. Input values for agricultural animals and septic systems were obtained from the STEPL data server. The USLE parameters were modified for each land cover type with data provided with the STEPL download for the region. Average soil hydrologic group for each subwatershed was determined from the soils data presented in **3.1.4 Soils**. Soil nitrogen and phosphorous concentration percentage was modified with data provided with the STEPL download for the region. The open space runoff curve number was used as the reference curve number for the user defined land cover input. The urban land use distribution was modified to zero to account for the inclusion of open space as a user defined input. The 5% that was used for percent open space was added to percent single family. All other parameter for the analysis was left as the default value provided.

The results of the analysis are presented in the following table and figures of this section. Table 13 presents the total annual pollutant load for each subwatershed in the Kankakee sub-basin. Each subwatershed's annual pollutant load has been ranked against all subwatersheds in the sub-basin study area and then a cumulative value presented in the last column based on the sum of ranks. In this manner an overall ranking has been assigned to help prioritize subwatershed pollutant loading contributions based upon STEPL analysis. Pollutant loading information for each subwatershed is also presented in a bar graph format in Figure 63, Figure 64, Figure 65, and Figure 66.

Overall, the Johanni Ditch-Kankakee River subwatershed (HUC 071200010405), which part of the Mill-Creek – Kankakee River watershed, had the highest pollutant loading contribution. It had the highest phosphorous and sediment load and second highest nitrogen and BOD load observed during the analysis. The Cobb Creek-Kankakee River subwatershed (HUC 071200011010), part of the Crooked Creek watershed (HUC 0712000110), had the second lowest cumulative value. It had the highest annual nitrogen and BOD load and third highest phosphorous and sediment load. The West Branch Crooked Creek subwatershed (071200011102), also part of the Crooked Creek watershed, had the third lowest cumulative score. It had the second highest phosphorous and sediment loads observed and third highest nitrogen and BOD loads.

Subwatershed		**N Load**		**P Load**		**BOD Load**		**Sediment Load**		**Cumulative**
HUC-12	STEPL #	lb/year	Rank	lb/year	Rank	lb/year	Rank	t/year	Rank	
0405	W20	104,396.9	2	48,615.4	1	229,019.4	2	5,067.4	1	6
1010	W51	109,910.3	1	41,497.3	3	259,991.8	1	4,050.2	3	8
1102	W53	98,232.2	3	45,140.5	2	216,313.8	3	4,739.3	2	10
0808	W36	84,896.0	4	36,468.9	4	184,450.2	4	3,643.0	6	18

Subwatershed		N Load		P Load		BOD Load		Sediment Load		Cumulative
HUC-12	STEPL #	lb/year	Rank	lb/year	Rank	lb/year	Rank	t/year	Rank	
0208	W14	68,184.8	9	34,946.4	5	158,060.9	10	3,873.5	5	29
0703	W26	77,309.5	7	33,438.1	7	166,575.6	7	3,386.3	9	30
1311	W70	80,350.6	5	32,876.8	8	184,426.2	5	3,302.7	12	30
0702	W25	79,669.0	6	32,794.9	9	177,932.4	6	3,218.8	14	35
1001	W42	67,345.9	10	32,722.8	10	148,686.3	13	3,512.4	8	41
1005	W46	59,098.1	14	34,493.0	6	127,246.1	18	3,934.4	4	42
1305	W64	62,404.4	12	30,467.4	12	138,586.8	14	3,278.4	13	51
1008	W49	69,463.1	8	28,856.8	14	156,848.4	11	2,890.8	23	56
1203	W57	59,356.4	13	29,108.9	13	130,112.2	16	3,151.2	17	59
1007	W48	66,011.9	11	27,478.9	20	159,305.2	8	2,837.8	24	63
0209	W15	54,813.2	22	31,486.1	11	120,064.9	25	3,550.8	7	65
1101	W52	54,604.4	23	28,740.5	16	128,893.6	17	3,333.0	11	67
0804	W32	57,132.0	17	28,303.8	17	125,416.3	20	3,053.7	20	74
0803	W31	56,315.7	19	28,001.4	18	122,956.0	23	3,071.5	19	79
0201	W7	57,176.1	16	25,825.9	23	134,330.2	15	2,708.0	27	81
0904	W41	49,403.8	30	28,813.9	15	107,244.3	32	3,341.0	10	87
1004	W45	50,556.2	28	27,449.5	21	118,647.0	26	3,174.2	16	91
0805	W33	57,767.7	15	25,730.4	25	124,729.7	22	2,657.9	30	92
0403	W18	54,363.4	24	23,312.1	34	148,721.1	12	2,698.5	28	98
0807	W35	48,117.5	33	27,758.7	19	105,290.3	33	3,180.4	15	100
1304	W63	56,465.8	18	24,656.4	29	125,351.4	21	2,515.4	36	104
0404	W19	51,540.6	27	25,568.4	26	114,511.9	29	2,779.8	25	107

Subwatershed		N Load		P Load		BOD Load		Sediment Load		Cumulative
HUC-12	STEPL #	lb/year	Rank	lb/year	Rank	lb/year	Rank	t/year	Rank	
0406	W21	52,418.6	25	25,100.2	28	117,281.9	27	2,673.4	29	109
0903	W40	55,532.7	21	23,672.1	32	125,855.9	19	2,426.4	39	111
1307	W66	45,915.0	35	27,343.9	22	99,407.6	36	3,149.3	18	111
0102	W2	51,551.4	26	24,631.8	30	115,516.3	28	2,600.9	32	116
1306	W65	56,075.8	20	20,600.7	43	158,223.2	9	2,273.7	46	118
0701	W24	44,231.1	36	25,741.5	24	95,408.0	39	2,983.3	21	120
0802	W30	42,098.4	39	25,513.8	27	90,169.0	41	2,953.6	22	129
1003	W44	50,261.3	29	22,438.6	36	120,218.1	24	2,408.4	40	129
0801	W29	47,446.1	34	23,498.0	33	104,967.1	34	2,536.0	35	136
0408	W23	48,852.8	32	21,956.7	39	107,566.9	31	2,268.5	47	149
0704	W27	38,836.2	41	23,941.2	31	81,672.7	51	2,772.4	26	149
0407	W22	38,547.5	42	22,661.3	35	84,827.9	47	2,617.7	31	155
1204	W58	49,025.3	31	20,910.7	42	112,059.7	30	2,134.1	52	155
1009	W50	38,360.3	43	22,164.4	38	85,501.3	46	2,551.0	34	161
1103	W54	38,317.7	44	21,663.6	40	87,034.7	45	2,504.5	37	166
0902	W39	37,533.1	46	22,271.4	37	81,461.9	52	2,596.2	33	168
0202	W8	40,018.1	40	19,441.4	50	97,503.0	38	2,125.7	53	181
0901	W38	43,884.5	37	19,075.4	52	98,607.9	37	1,950.3	57	183
1006	W47	35,108.8	52	21,276.9	41	76,003.8	55	2,468.4	38	186
0103	W3	35,834.9	49	20,205.6	45	81,802.4	49	2,320.1	44	187
0204	W10	35,467.5	51	20,326.4	44	81,681.6	50	2,327.8	42	187
0207	W13	42,491.6	38	18,364.0	56	103,207.3	35	1,933.0	59	188

Subwatershed		N Load		P Load		BOD Load		Sediment Load		Cumulative
HUC-12	STEPL #	lb/year	Rank	lb/year	Rank	lb/year	Rank	t/year	Rank	
0106	W6	37,735.8	45	19,970.2	49	82,003.8	48	2,171.1	51	193
0205	W11	35,760.9	50	18,657.1	54	91,509.6	40	2,178.1	50	194
0809	W37	35,050.4	53	20,018.5	48	79,033.6	53	2,325.2	43	197
1201	W55	33,831.6	55	20,125.2	46	73,849.9	58	2,354.6	41	200
1302	W61	34,658.0	54	20,065.4	47	77,369.1	54	2,306.6	45	200
0203	W9	36,298.3	47	17,953.6	57	87,389.2	44	1,986.6	55	203
0101	W1	33,523.3	56	19,347.9	51	73,925.8	57	2,223.2	48	212
0402	W17	35,977.8	48	16,476.9	60	88,138.6	43	1,823.7	61	212
1202	W56	31,143.7	60	18,806.2	53	66,954.2	61	2,209.1	49	223
0105	W5	31,539.2	58	18,417.5	55	71,523.3	59	2,102.1	54	226
1308	W67	31,455.9	59	13,648.1	66	88,498.9	42	1,617.1	63	230
0401	W16	29,287.7	62	17,176.4	58	64,920.6	63	1,964.5	56	239
0206	W12	31,866.8	57	15,212.7	62	74,695.3	56	1,606.6	65	240
1205	W59	28,707.5	63	16,564.3	59	65,373.9	62	1,945.1	58	242
1310	W69	30,138.7	61	14,747.2	63	68,874.3	60	1,597.7	66	250
0806	W34	25,548.5	64	15,749.6	61	55,263.8	67	1,837.7	60	252
1303	W62	24,523.5	66	13,826.0	65	57,553.0	66	1,614.3	64	261
0705	W28	22,943.0	69	14,328.0	64	49,663.4	69	1,682.3	62	264
1301	W60	24,795.7	65	12,599.9	68	62,890.2	64	1,468.2	68	265
1002	W43	24,498.8	67	12,933.0	67	60,379.3	65	1,505.4	67	266
1309	W68	23,005.9	68	12,530.3	69	54,914.7	68	1,446.6	69	274
0104	W4	19,767.8	70	11,473.8	70	45,619.8	70	1,276.1	70	280

Subwatershed		N Load		P Load		BOD Load		Sediment Load		Cumulative
HUC-12	STEPL #	lb/year	Rank	lb/year	Rank	lb/year	Rank	t/year	Rank	
1312	W71	11,613.4	71	7,848.4	71	24,579.0	71	938.9	71	284
1313	W72	94.3	72	67.7	72	217.1	72	8.6	72	288
	Total	337,6460.9		1,675,896.4		7,684,830.8		183,714.3		

Table 13. Total Annual Load by Subwatershed

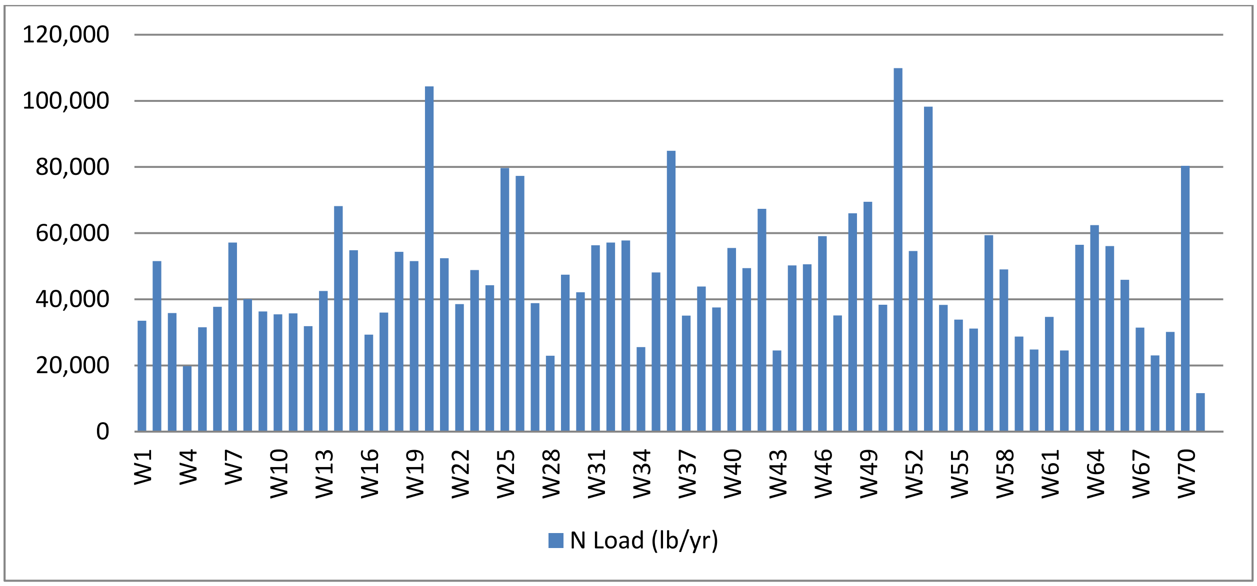

Figure 63. Nitrogen Load by Subwatershed

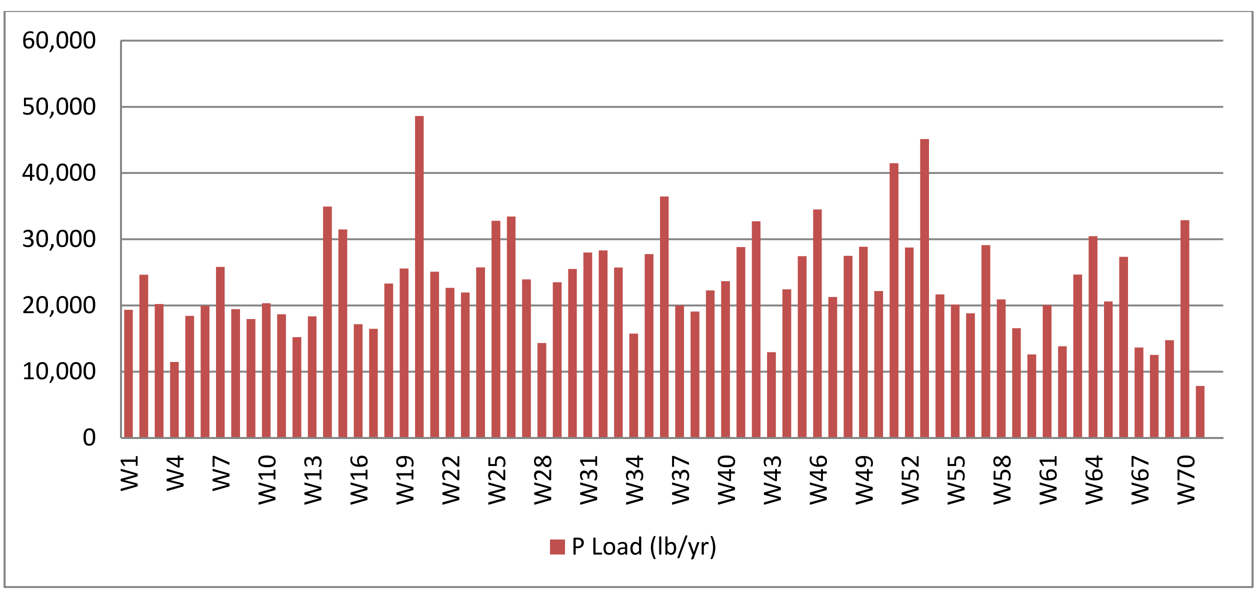

Figure 64. Phosphorous Load by Subwatershed

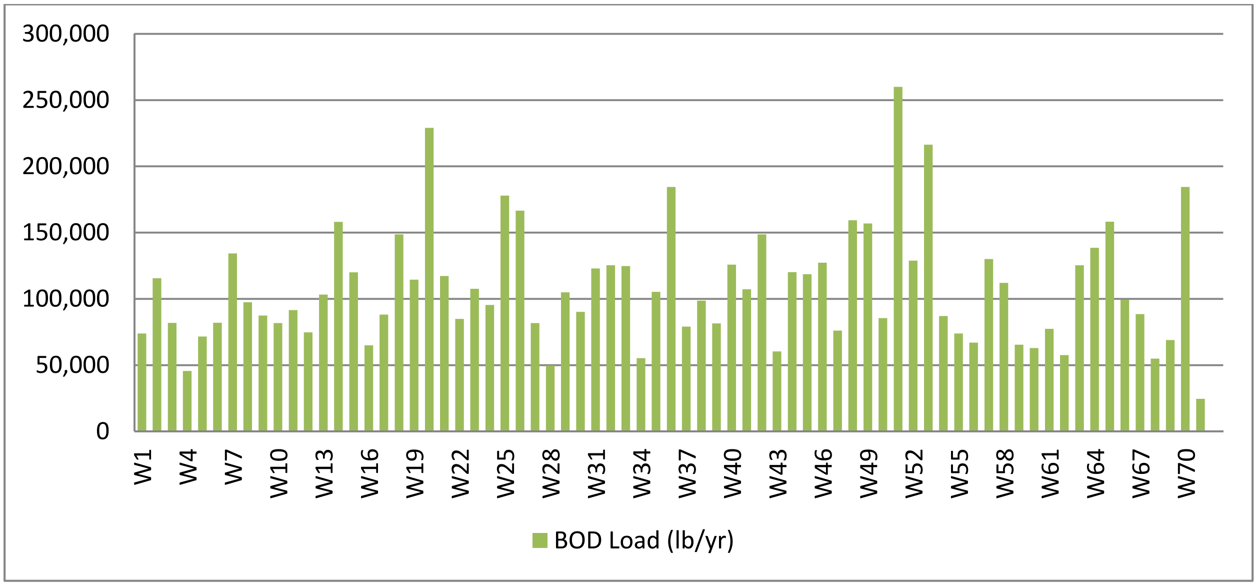

Figure 65. BOD Load by Subwatershed

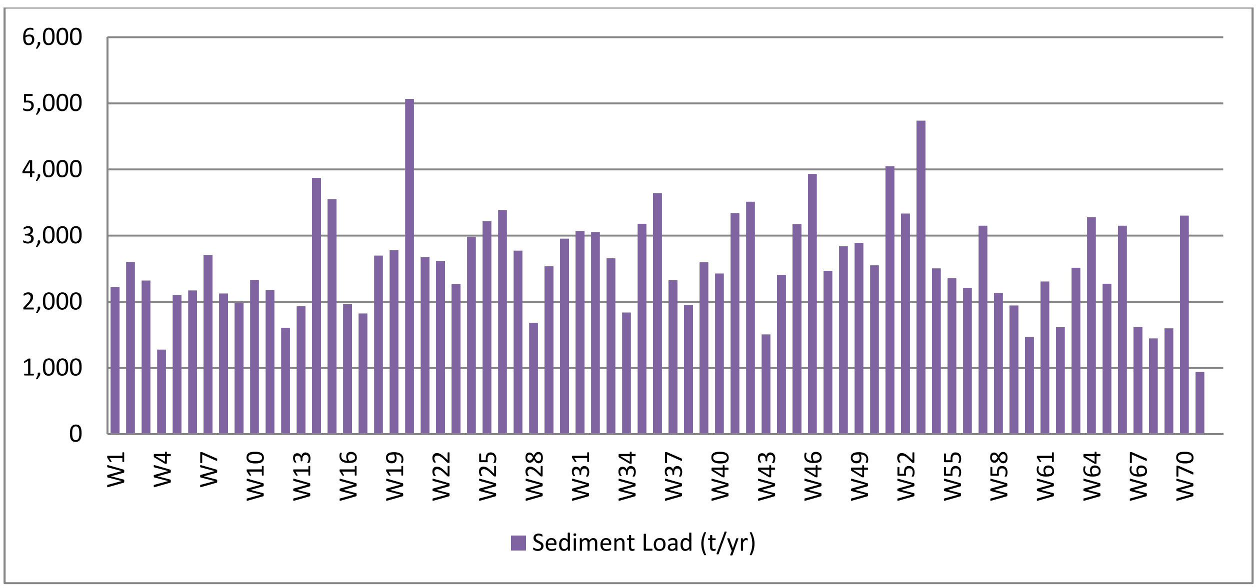

Figure 66. Sediment Load by Subwatershed

The following figures display loading data by land use for the Kankakee sub-basin study area. Given the dominance of agricultural land use within the sub-basin its high percent contribution of each pollutant is not surprising. Cropland accounts for the highest pollutant loading for nitrogen (86%), phosphorous (94%), BOD (77%), and sediment (95%).

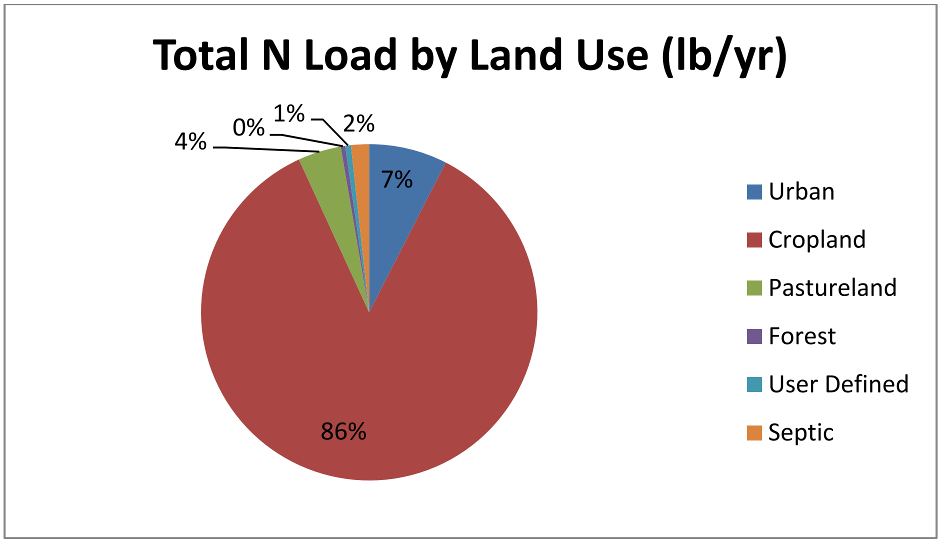

Figure 67. Total N Load by Land Use

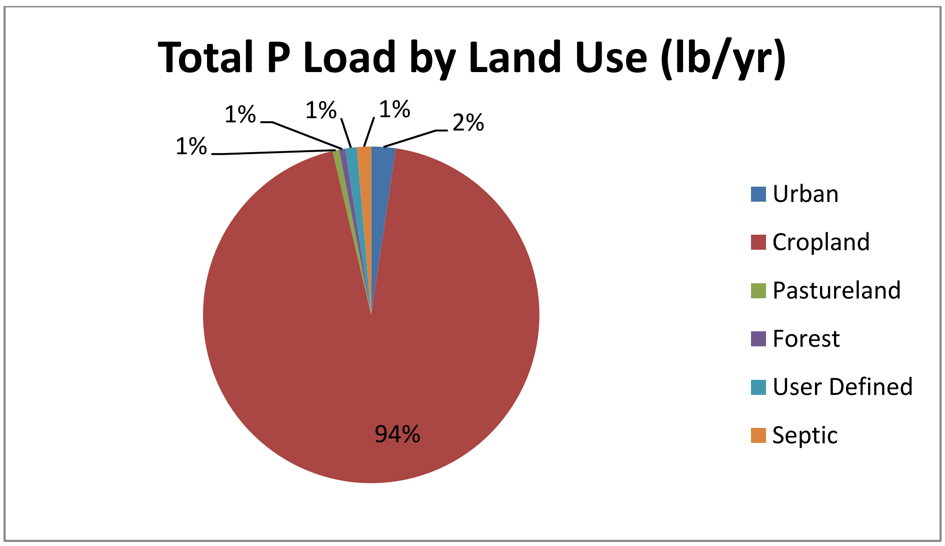

Figure 68. Total P Load by Land Use

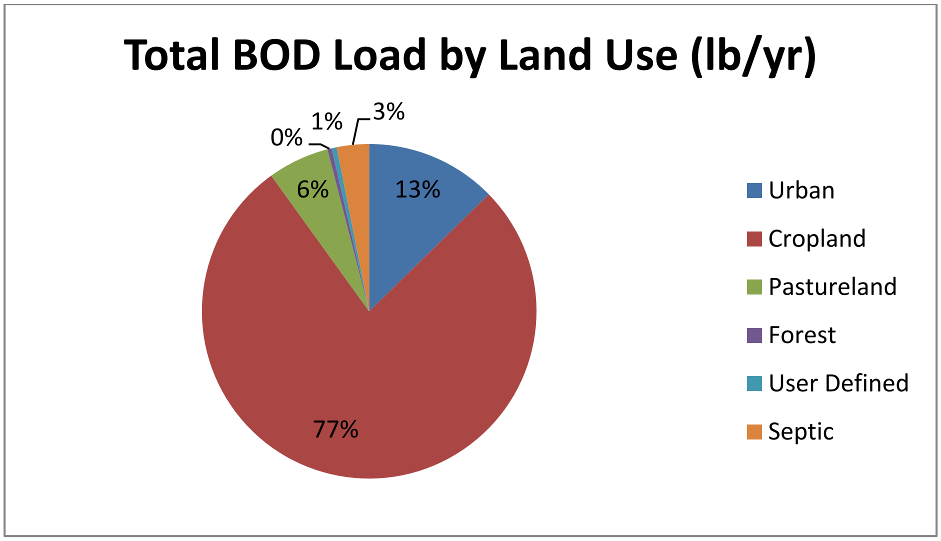

Figure 69. Total BOD by Land Use

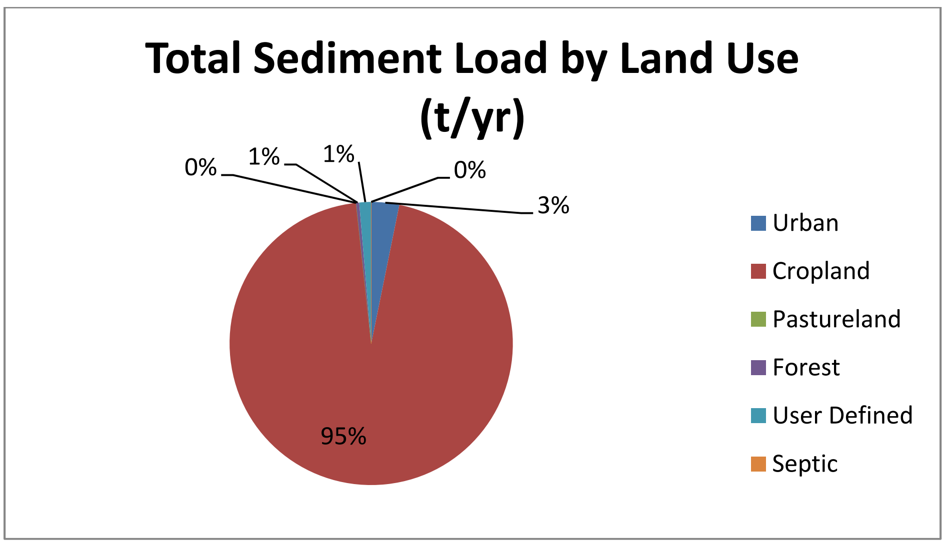

Figure 70. Total Sediment Load by Land Use