Nonpoint Source Implementation Plan for the Plum and Kankapot Creek Watersheds

Mouth of Kankapot Creek near 1000 Islands Nature Preserve in Kaukauna, WI (Spring 2014)

Prepared by:

Outagamie County LCD Land Conservation Department

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Acknowledgements

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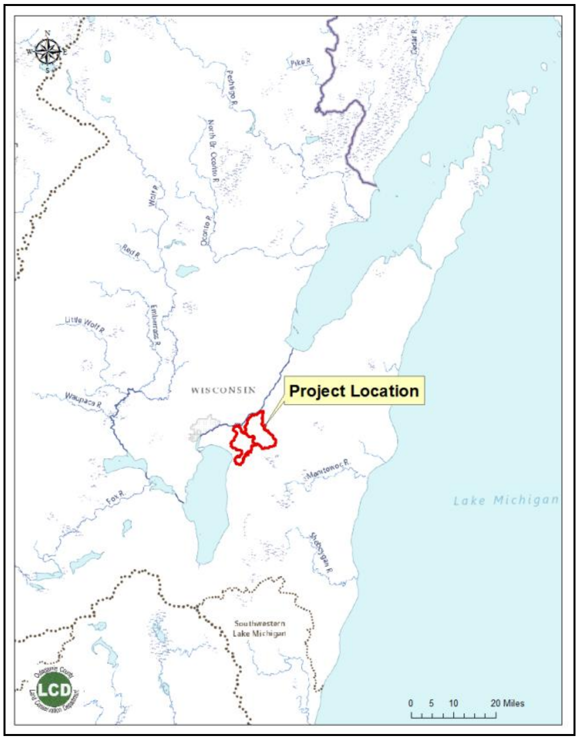
*All photos taken by Outagamie County Land Conservation Department unless otherwise noted.

Executive Summary

The Plum and Kankapot Watershed is a subwatershed of the Lower Fox River Watershed and is located in east central Wisconsin in Brown, Outagamie, and Calumet Counties. The Plum and Kankapot Creeks empty into the Lower Fox River draining approximately 38,712 acres. Historically, the Plum and Kankapot watershed was once forested with wetlands. The Lower Fox River Basin was home to many Native American cultures before Europeans began to settle in the area in the early 1800's. The farming and paper industry in the area has led to clearing of forests and natural areas and draining of wetlands in the Lower Fox River Basin. The extent of farming in the Plum and Kankapot watershed has greatly impacted the water quality of Plum and Kankapot Creeks.



Excessive sediment loads and increased algal blooms in the Lower Fox River and Bay of Green Bay prompted the need for action to be taken in the Lower Fox River Basin. A Total Maximum Daily Load was approved for the Lower Fox River and its tributaries in 2012. The Lower Fox River TMDL plan characterized the Plum and Kankapot Creek watershed as one of the highest contributors of sediment and phosphorus in the Lower Fox River Basin. As a result the Plum and Kankapot watershed implementation plan was developed. The main goal of the implementation plan is to improve the water quality of Plum and Kankapot Creeks to meet the assigned TMDL.

Lower Fox River Basin Total Maximum Daily Load Allowances and Reductions for the Plum and Kankapot Watershed.

Loading Summary Total Phosphorus (lbs/yr)		
Watershed	Plum	Kankapot
Baseline	31,569	20,050
TMDL	7,193	5,548
Reduction	24,376	14,502
% Reduction Needed	77.20	72.30
Loading Summary Total Suspended Solids (tons/yr)		
Watershed	Plum	Kankapot
Baseline	6,019	3,627
TMDL	1,779	1,372
Reduction	4,240	2,254
% Reduction Needed	70.40	62.20

Mouth of Plum Creek emptying into the Lower Fox River- August 2014

The Plum and Kankapot Watershed Implementation plan provides a framework to accomplish the following goals:

Goal #1: Improve surface water quality to meet the TMDL limits for total phosphorus and sediment.

Goal #2: Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.

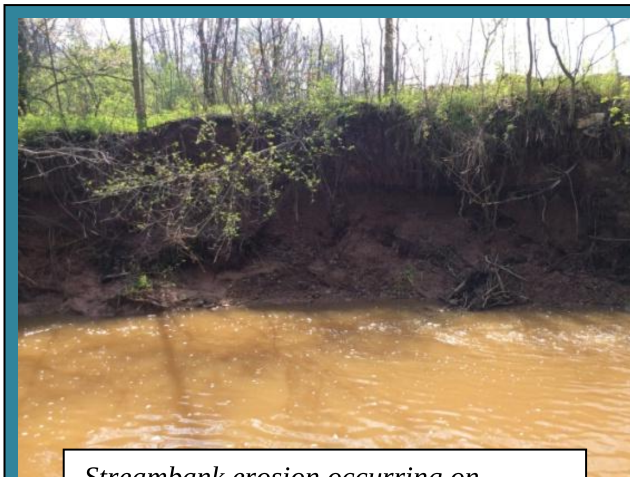
Goal #3: Reduce flood levels during peak storm events.

Goal #4: Improve streambank stability and reduce amount of streambank degradation.

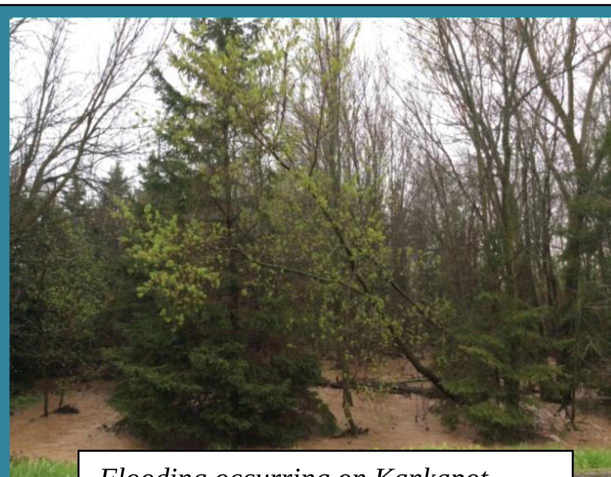
Challenges and sources in the watershed:

Field erosion in Plum and Kankapot watershed.

The dominant land use in the watershed is agriculture and is responsible for over 85% of the sediment and phosphorus loading in the watershed. Wetlands and natural areas have been cleared and drained to increase agricultural production in this area. Recent high land values and rental rates due to competition with urban development and farm expansion in this watershed have exacerbated the amount of natural areas lost. A predominant focus on maximum production of all available acreage combined with a lack of awareness of the need for conservation practices and sustainable management of farmland in this area has led to significant sediment and nutrient loss from agricultural land. Increased drainage and flooding has led to significant erosion of streambanks during high flow periods. Moderate to very severe erosion was found to be occurring along the majority of the main stream channels on both the Plum and Kankapot Creek. Sediment loading from streambank erosion was significantly higher in the watershed than what was predicted by modeling.



Streambank erosion occurring on Kankapot Creek.



Flooding occurring on Kankapot Creek in May 2014.

Another challenge in this watershed is the lack of awareness of water quality issues and conservation practices. A survey of agricultural landowners in the watershed in spring of 2014 showed a low awareness to water quality issues in the area and lack of knowledge of conservation practices and programs. In order to engage citizens to improve water quality they need to be aware that there is a problem in the first place.

<u>Watershed Implementation Plan</u>:

In order to meet the goals for the watershed a 10 year implementation plan was developed. The action plan recommends best management practices, information and education activities, and needed restoration to achieve the goals of the watershed. The plan includes estimated cost, potential funding sources, agencies responsible for implementation, and a measure of success.

Recommended Management Practices:

- Reduced Tillage Methods
- Cover Crops
- Vegetated Buffers
- Wetland Restoration
- Treatment Wetlands
- Nutrient Management Planning
- Prescribed Grazing & Grazing Management Planning
- Grassed Waterways
- Concentrated Flow Area Seeding
- Water and Sediment Control Basins
- Manure Storage
- Barnyard Runoff Management

Agricultural Best Management Practices (Photo Credit: USDA NRCS, Ohio)

Education and Information Recommendations:

Field Demonstration in Outagamie County

- Provide educational workshops and tours on how to implement best management practices
- Engaging the landowners in planning and implementing conservation on their land and ensuring they know what technical tools and financial support is available to them.
- Provide information on water quality and conservation practices to landowners in the watershed area.
- Newsletters and/or webpage with watershed project updates and other pertinent conservation related information.

Conclusion

Meeting the goals for the Plum and Kankapot watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for "non-compliant" sites that will need to be supported by focused technical and financial assistance. It will require widespread cooperation and commitment of the watershed community to improve the water quality and condition of the watershed. This plan needs to be adaptable to the many challenges, changes, and lessons that will be found in this watershed area.

List of Acronyms

AM- Adaptive Management

BMP- Best Management Practice

CAFO- Concentrated Animal Feeding Operation

CLU- Common Land Unit

GBMSD- Green Bay Metropolitan Sewerage District (NEW Water)

GIS- Geographic Information System

HSG-Hydrologic Soil Group

IBI- Index of Biotic Integrity

LWCD/LCD- Land and Water Conservation Department/ Land Conservation Department

MS4- Municipal Separate Storm Sewer System

NRCS-Natural Resource Conservation Service

PI- Phosphorus Index

USEPA- United States Environmental Protection Agency

UWEX- University of Wisconsin Extension

USDA- United States Department of Agriculture

USGS-United States Geologic Service

UWGB-University of Wisconsin-Green Bay

WDNR-Wisconsin Department of Natural Resources

WPDES- Wisconsin Pollutant Discharge Elimination System

WWTF- Waste Water Treatment Facility

TMDL-Total Maximum Daily Load

TP- Total Phosphorus

TSS- Total Suspended Solids

WQT- Water Quality Trading

***Note*: Lower Fox River TMDL plan-** Refers to the report "*Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower*

Fox River Basin and Lower Green Bay" prepared by the Cadmus Group that was approved in 2012 by WDNR and EPA.

1.0 Introduction

1.1 Plum and Kankapot Watershed Setting

The Plum and Kankapot watersheds are a sub watershed of the Lower Fox River watershed. The watersheds are located in Brown, Calumet, and Outagamie County. The watersheds drain a total area of 38,712 acres. The watershed is Northeast of Lake Winnebago and Southwest of the Bay of Green Bay. Kankapot Creek is 9 miles long and Plum Creek is 19 miles long. Both creeks have many small tributaries that flow into them. Plum Creek flows into the Fox River near Wrightstown, WI, and Kankapot Creek empties into the Fox River near Thousand Islands Nature Preserve in Kaukauna, WI. The southwest portion of the watershed borders High Cliff State Park. The watershed includes portions of the Villages of Sherwood, Harrison and Wrightstown; Towns of Wrightstown, Holland, Buchanan, Woodville, Brillion; and City of Kaukauna. The Fox River Trail, about 25 miles long from Green Bay to Hilbert, starts in the southeast portion of the Plum watershed. There are two golf courses located in the watershed, The Countryside Golf Club and the Sherwood Forest Golf Club. A small portion of the Eagle Links Golf Course also lies within the watershed.

Figure 1. Plum and Kankapot watershed project location.

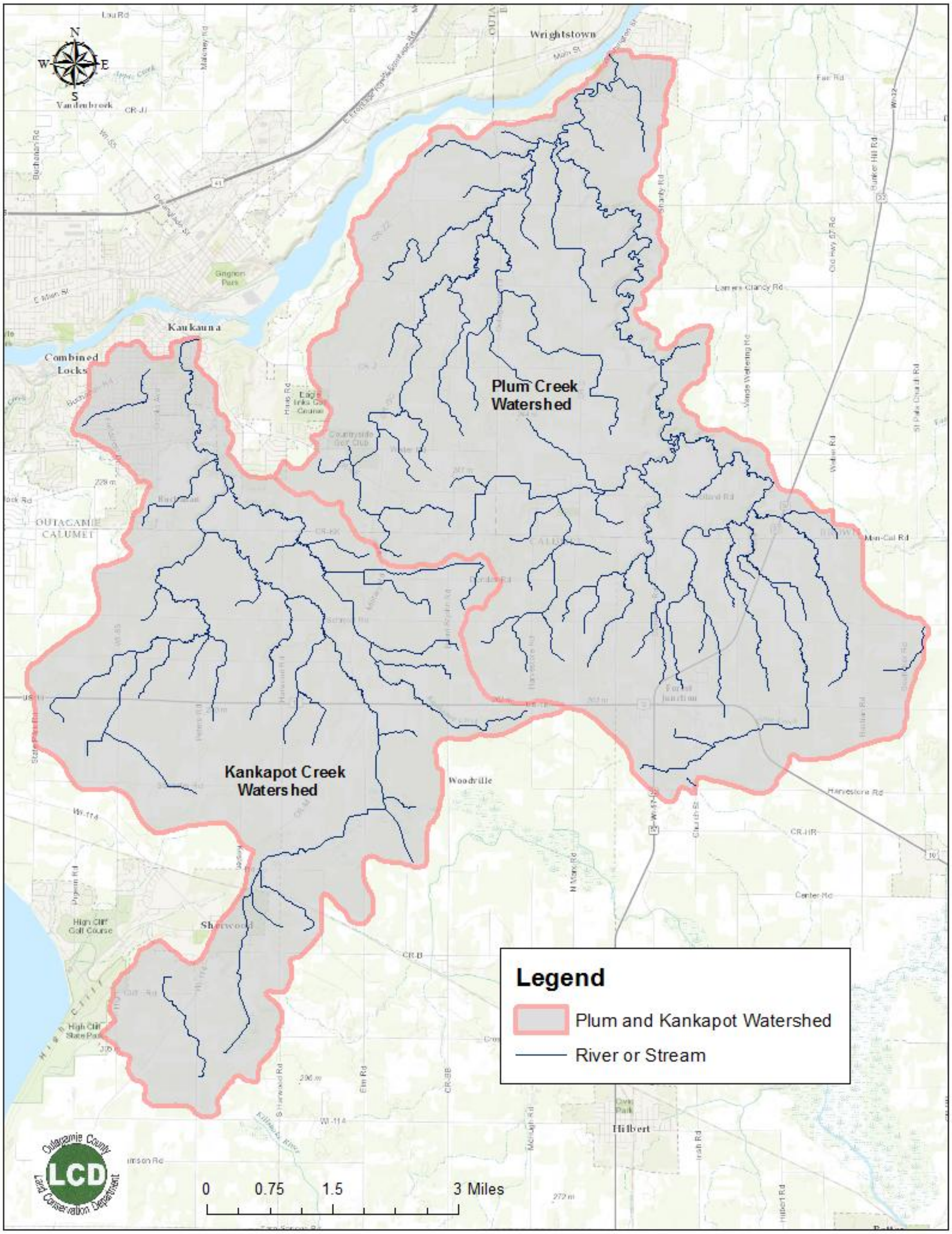


Figure 2. Plum and Kankapot watersheds.

1.2 Purpose

Excessive sediment and nutrient loading to the Lower Fox River and Bay of Green Bay has led to increased algal blooms, oxygen depletion, water clarity issues, and degraded habitat. Algal blooms can be toxic to humans and costly to a local economy. Estimated annual economic losses due to eutrophication in the United States are as follows: recreation ($1 billion), waterfront property value ($0.3-2.8 million), recovery of threatened and endangered species ($44 million) and drinking water ($813 million) (Dodds, et al 2009). The Plum and Kankapot Creeks were listed as impaired waterways by the EPA in 1998. Due to the impairments of the Lower Fox River Basin, a TMDL (Total Maximum Daily Load) was developed for the Lower Fox River basin and its tributaries that was approved in 2012. The Lower Fox River TMDL plan characterized the Plum and Kankapot subwatersheds as the largest contributors of sediment and phosphorus to the Lower Fox River. The purpose of this project is to develop an implementation plan for the Plum and Kankapot subwatersheds to meet the requirements of the TMDL. The Lower Fox River TMDL requires that any tributaries to the Lower Fox River meet a median summer total phosphorus limit of 0.075 mg/l or less and a median summer total suspended solids concentration of 18 mg/l or less. According to the Lower Fox River TMDL plan this calls for 77.2 % and 70.4% reduction in phosphorus and total suspended solids in the Plum Creek and 72.3% and 62.2 % reduction in Kankapot Creek respectively.

Figure 3. Mouth of the Fox River emptying into the Bay of Green Bay, April 2011. Photo Credit: Steve Seilo.

1.3 US EPA Watershed Plan Requirements

In 1987, Congress enacted the Section 319 of the Clean Water Act which established a national program to control nonpoint sources of water pollution. Section 319 grant funding is available to states, tribes, and territories for the restoration of impaired waters and to protect unimpaired/high quality waters. Watershed plans funded by Clean Water Act section 319 funds must address nine key elements that the EPA has identified as critical for achieving improvements in water quality (USEPA 2008). The nine elements from the USEPA Nonpoint Source Program and Grants Guidelines for States and Territories are as follows:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed

2. An estimate of the load reductions expected from management measures.

3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element 2, and a description of the critical areas in which those measures will be needed to implement this plan.

4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

5. An information and education component used to enhance public understanding of the plan and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element 8.

1.4 Prior Studies, Projects, and Existing Resource Management and Comprehensive Plans

Various studies have been completed in the Lower Fox River Basin and Lake Michigan Basin describing and analyzing conditions in the area. Management and Comprehensive plans as well as monitoring programs have already been developed for the Lower Fox River Basin and Lake Michigan Basin. A list of known studies, plans, and monitoring programs is listed below:

<u>Total Maximum Daily Load & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay</u> -2012

The *TMDL & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay* was prepared by the Cadmus Group for the EPA and WDNR and was approved in 2012. This plan set a TMDL for the Lower Fox River and its tributaries as well as estimated current pollutant loading and loading reductions needed to meet the TMDL for each subwatershed in the Lower Fox River Basin. The Lower Fox River TMDL modeling has shown that Plum Creek has the highest phosphorus and sediment loading watershed in the Lower Fox River Basin.

<u>Phosphorus and Sediment Runoff Loss: Management Challenges and Implications in a Northeast Agricultural Watershed.</u> – 2012, Martin D. Jacobson. University of Wisconsin-Green Bay

The Plum Creek watershed was studied in a graduate thesis, *Phosphorus & Sediment Runoff Loss: Management Challenges & Implications in N.E. Wisconsin Agricultural Watershed*, by Martin D. Jacobson through the University of Wisconsin-Green Bay. This study analyzed phosphorus and sediment concentrations from 17 multi-field catchments in Plum Creek from 4 runoff events as well as event flow and low flow suspended solids, total phosphorus, and dissolved phosphorus at an automated monitoring station from October 2010 to April 2012. Phosphorus and sediment loading from Plum Creek was found to be higher than five other sub watersheds in the Lower Fox River Basin. Snap Plus and Wisconsin Phosphorus Index data was analyzed for the multi-field catchments. The study found that even though the majority of the fields were meeting the PI Index of 6, the basin phosphorus yield of 2.54 kg/ha is many times higher than the yield goal of 0.35 kg/ha stated in the TMDL. Thus suggesting a much lower PI Index is needed to meet the TMDL water quality goals and that the current use of SNAP and Wisconsin Phosphorus Index will not improve Plum Creek water quality. The study also concluded that drastic changes in land management and use are needed in order to meet the TMDL.

<u>Lower Fox River Watershed Monitoring Program</u>

The Lower Fox River Watershed Monitoring Program is a watershed education and stream monitoring program that involves coordination from university students and researchers from University of Wisconsin-Green Bay, University of Wisconsin-Milwaukee, Green Bay Metropolitan Sewerage District (GBMSD/New Water), Cofrin Center for Biological Diversity, and the United States Geological Survey. The program also involves area high school teachers and students.

Lake Michigan Lakewide Management Plan-2008

Plan developed by the Lake Michigan Technical Committee with assistance from the Lake Michigan Forum and other agencies and organizations. The plan focuses on improving water quality and habitat in the Lake Michigan basin including reducing pollutant loads from its tributaries.

Lower Green Bay Remedial Action Plan-1993

The Lower Green Bay Remedial Action Plan is a long term strategy for restoring water quality to the Lower Green Bay and Fox River. Two of the top five priorities for the Remedial Action Plan are to reduce suspended sediments and phosphorus.

1.5 Wisconsin Ecoregion

Ecoregions are based on biotic and abiotic factors such as climate, geology, vegetation, wildlife, and hydrology. The mapping of ecoregions is beneficial in the management of ecosystems and has been derived from the work of James M. Omerik of the USGS. The Plum and Kankapot watershed is located in the Southeastern Wisconsin Till Plains ecoregion. The Southeastern Wisconsin Till Plains supports a variety of vegetations types from hardwood forests to tall grass prairies. Land used in this region is mostly used for cropland and has a higher plant hardiness value than in ecoregions to the north and west. The watershed has the most area in the Lake Michigan Lacustrine clay sub ecoregion and small portion in the Southeastern Wisconsin Savanna and till plain sub ecoregion.

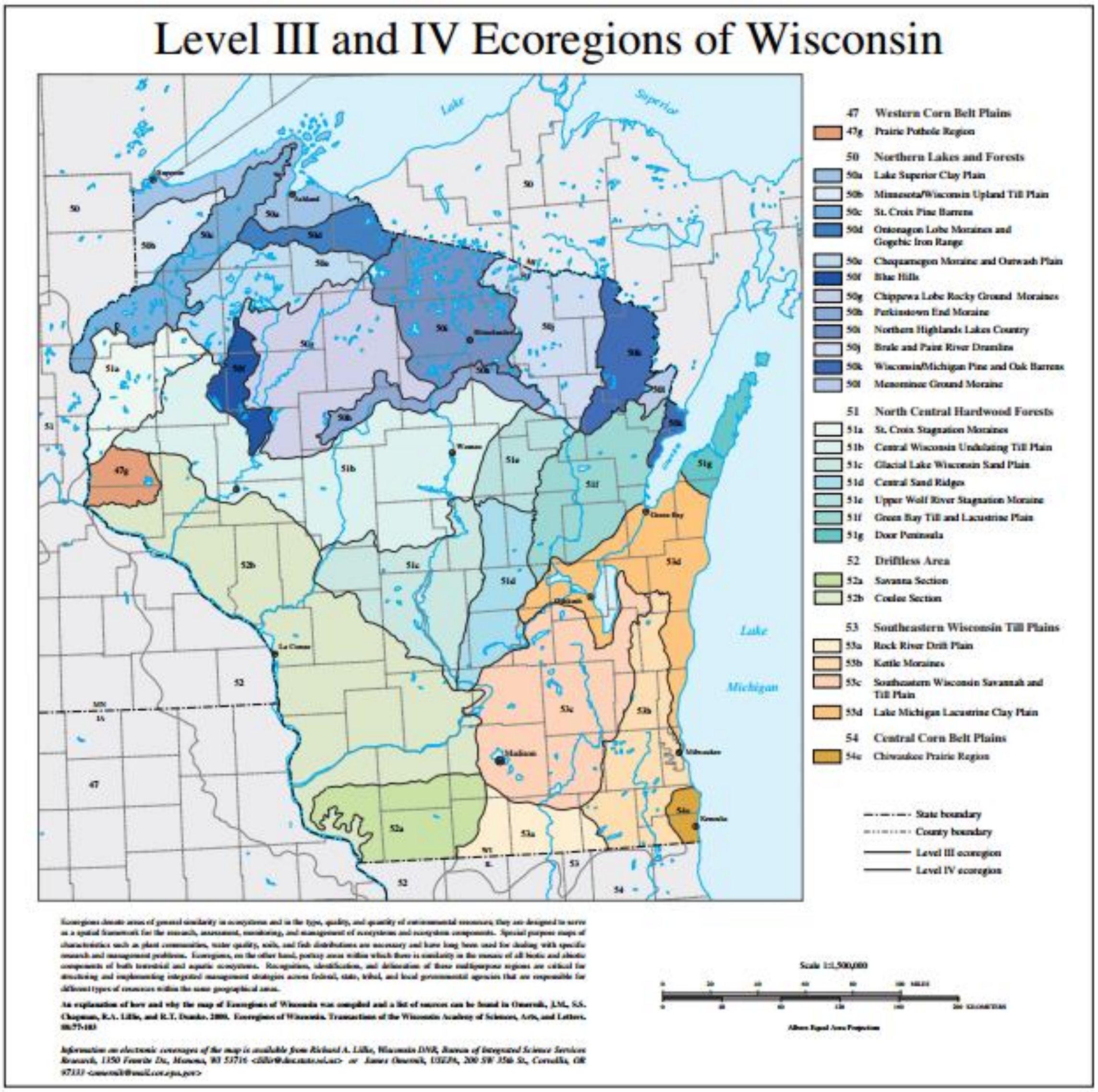


Figure 4. Map of Ecoregions of Wisconsin. Source: Omerik, et al 2000

1.6 Topology and geology

The Plum and Kankapot watershed lies in the Eastern Ridges and Lowlands geographical province of Wisconsin. The Plum and Kankapot watershed area was part of the glaciated portion of Wisconsin. Glaciers have greatly impacted the geology of the area. The dolomite Niagara Escarpment is the major bedrock feature. Plum Creek watershed also contains the Fort Atkinson Formation of the Maquoketa Group. The topography is generally smooth and gently sloping with some slopes steepened by post glacial stream erosion. The main glacial landforms are ground moraine, outwash, and lake plain. The highest point in the watershed area is 1000 ft above sea level and the lowest point in the watershed is 596 feet above sea level. The southern tip of Kankapot watershed and the southeast half of Plum Creek watershed are relatively flat while the remaining northern areas of the watershed contain ridges and rolling slopes.

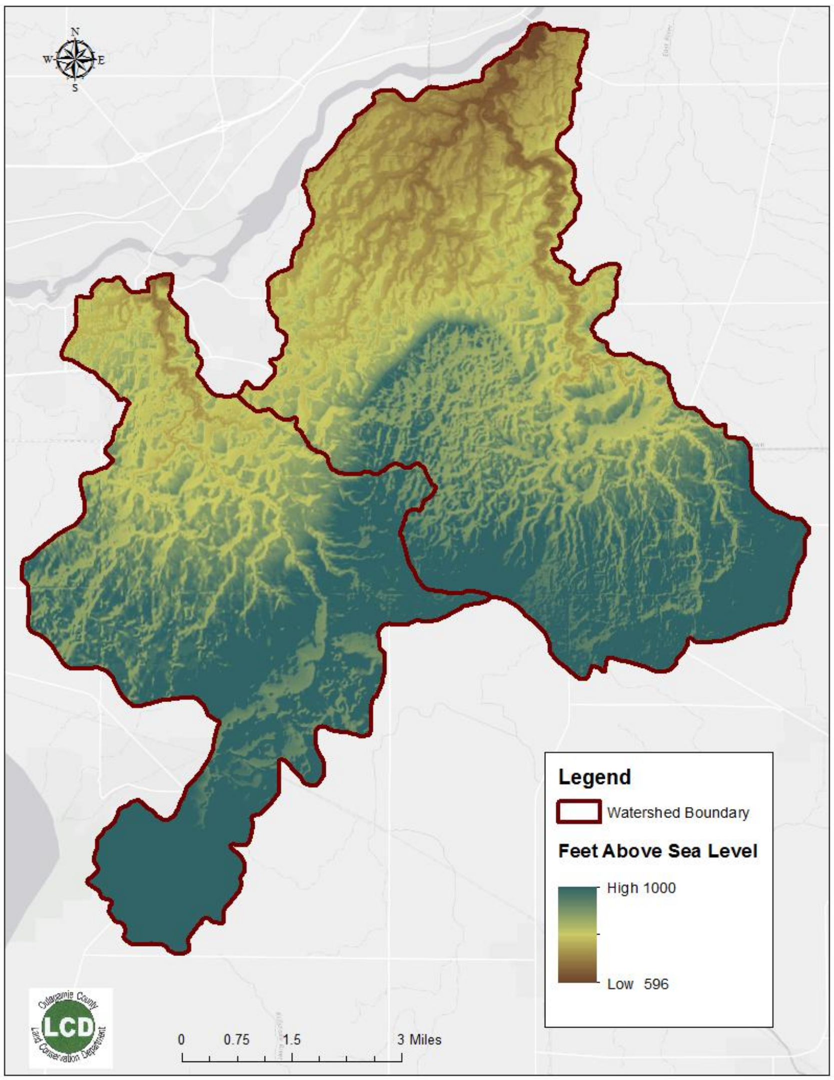


Figure 5. Digital Elevation Model of the Plum and Kankapot Watershed.

1.7 Climate

Wisconsin has a continental climate that is affected by Lake Michigan and Superior. Wisconsin typically has cold, snowy winters and warm summers. The average annual temperature ranges from 39°F in the north to about 50°F in the south. Average annual precipitation is about 30 inches a year in the watershed area.

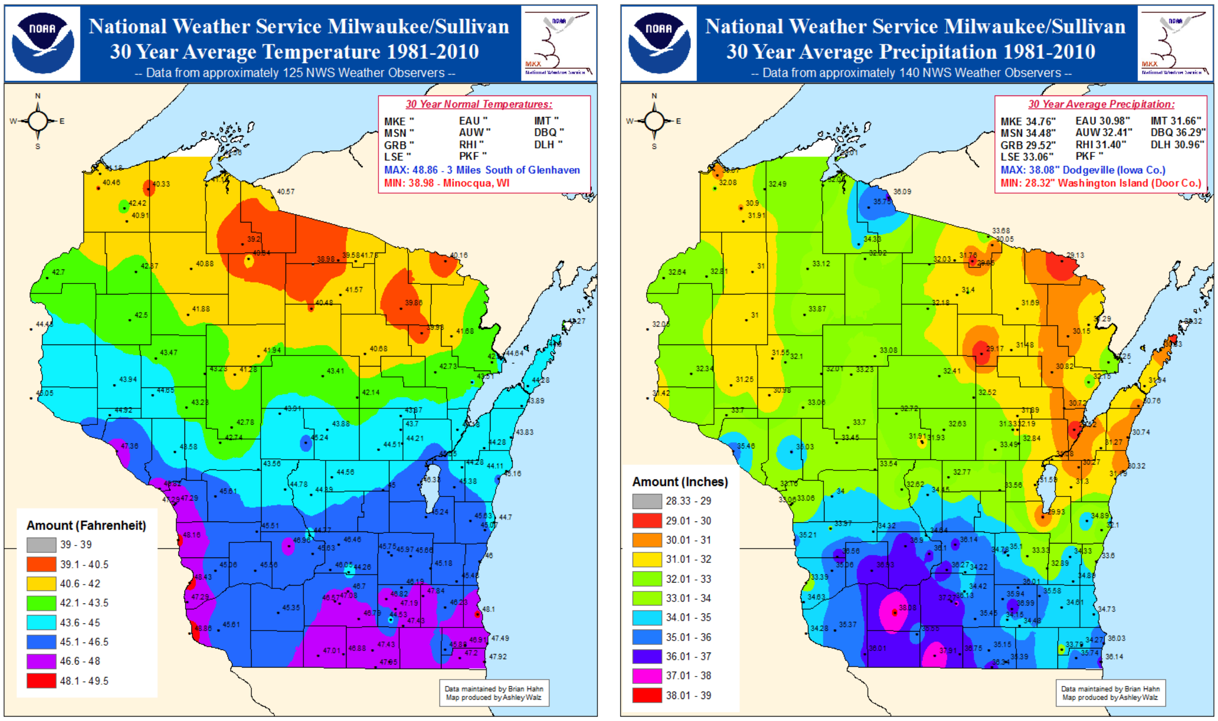


Figure 6. 30 year average precipitation and temperature data for Wisconsin. Source: NOAA National Weather Service Forecast Office Milwaukee/Sullivan 2010 & 2010b.

1.8 Soil Characteristics

Soil data for the watershed was obtained from the Natural Resources Conservation Service (SSURGO) database. The type of soil and its characteristics are important for planning management practices in a watershed. Factors such as erodibility, hydric group, slope, and hydric rating are important in estimating erosion and runoff in a watershed.

The dominant soil types in the Plum and Kankapot watershed are Manawa Silt Loam (26.9%), Kewaunee loam (18.3%), Kewaunee silt loam (17.0%), and Manawa Silty Clay Loam (5.7%).

Hydrologic Soil Group

Soils are classified into hydrologic soil groups based on soil infiltration and transmission rate (permeability). Hydrologic soil group along with land use, management practices, and hydrologic condition determine a soil's runoff curve number. Runoff curve numbers are used to estimate direct runoff from rainfall. There are four hydrologic soil groups: A, B, C, and D. Descriptions of Runoff Potential, Infiltration Rate, and Transmission rate of each group are shown in

Table 2. Some soils fall into a dual hydrologic soil group (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and water table depth when drained. The first letter applies to the drained condition and the second letter applies to the undrained condition. Table 1 summarizes the acreage and percent of each group present in the watershed and Figure 7 shows the location of each hydrologic soil group. The dominant hydrologic soil groups in the watershed are Group D (51.17%) and Group C (38.9%). Group D soils have the highest runoff potential followed by group C. Soils with high runoff potentials account for 90% of the soils in the watershed.

Table 1. Soil Hydrologic Groups of Plum and Kankapot watershed.

Soil Hydrologic Group	Percent of Watershed
D	51.17
C	38.90
B	4.80
C/D	3.64
A/D	1.23
B/D	0.04
Open Water	0.21

Table 2. Description of Hydrologic Soil Groups.

HSG	Runoff Potential	Infiltration Rate	Transmission Rate
A	Low	High	High
B	Moderately Low	Moderate	Moderate
C	Moderately High	Low	Low
D	High	Very Low	Very Low

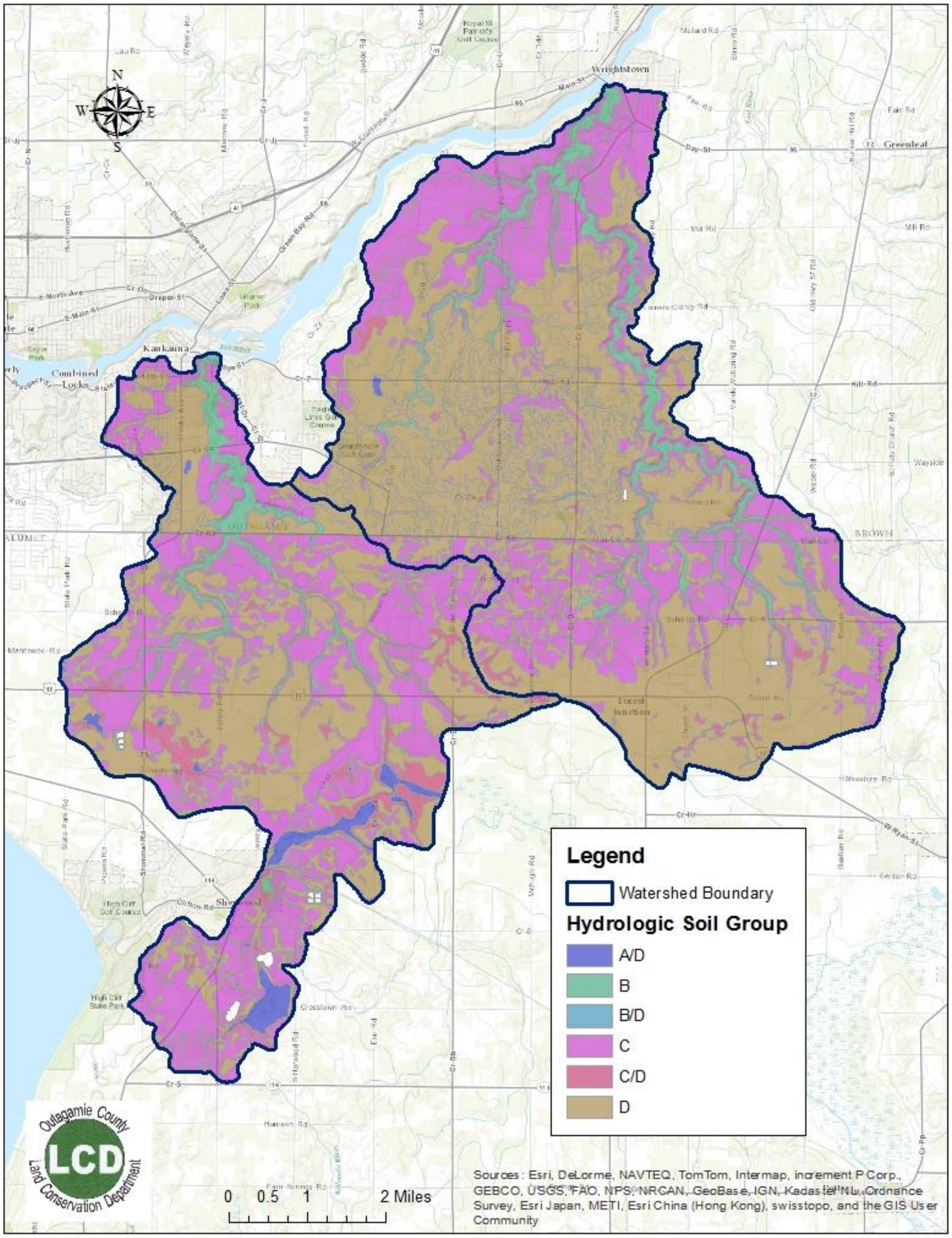


Figure 7. Hydrologic Soil Groups of the Plum and Kankapot Watershed.

(Note: Soil interpretations do not completely agree across soil survey area boundaries because it encompasses more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail)

Soil Erodibility

The susceptibility of a soil to wind and water erosion depends on soil type and slope. Course textured soils such as sand are more susceptible to erosion than fine textured soils such as clay. Highly erodible and potentially highly erodible soils were mapped out based on soil type and slope. Soils with a 2-6 % slope were considered potentially highly erodible soils. Soils with a 6% or higher slope were considered highly erodible. A large proportion of soils in the Plum and Kankapot Watershed are considered potentially highly erodible to highly erodible (Figure 8). There are 2,065 acres considered highly erodible and 14,432 acres considered potentially highly erodible.

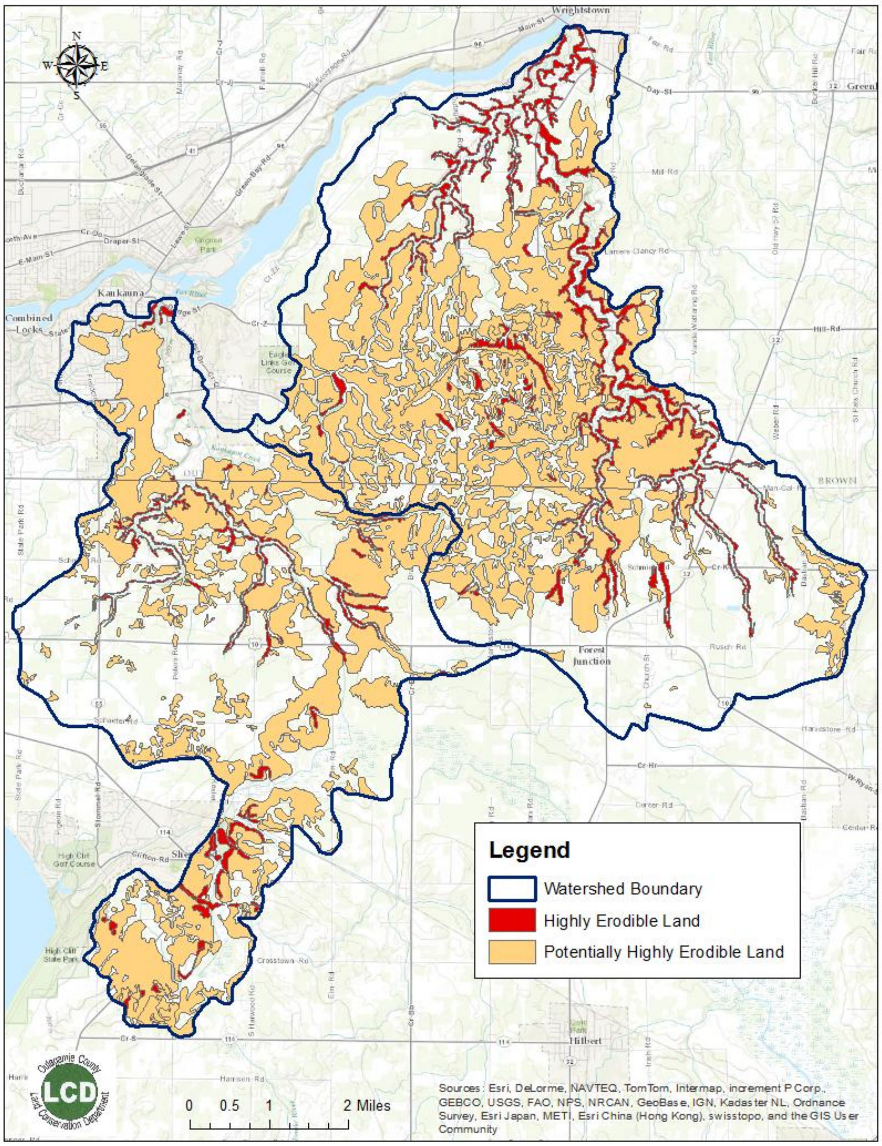


Figure 8. Highly Erodible and Potentially Highly Erodible Land in the Plum and Kankapot Watershed.

2.0 Watershed Jurisdictions, Demographics, and Transportation Network

2.1 Watershed Jurisdictions

The Plum and Kankapot Watershed contains portions of 3 counties and 10 municipalities (Figure 9**,** Table 3). The largest portion of the watershed is in Calumet County (58%). Outagamie and Brown County each have about 21% of the watershed area. There are ten municipalities that lie within the watershed. The Village of Harrison, Town of Woodville, Town of Buchanan, Town of Brillion, and Town of Holland occupy the most area in the watershed.

Table 3. County and municipal jurisdictions.

Jurisdiction	Acres	% of Watershed
County	**38,712**	**100**
Calumet	22,422	57.92
Brown	8,223	21.24
Outagamie	8,067	20.84
Municipality	**38,712**	**100**
Village of Combined Locks	6	0.01
Town of Buchanan	6,739	17.41
City of Kaukauna	1,331	3.44
Town of Woodville	8,298	21.44
Town of Brillion	5,953	15.38
Village of Sherwood	376	0.97
Village of Harrison	7,786	20.11
Town of Holland	6,480	16.74
Village of Wrightstown	650	1.68
Town of Wrightstown	1,093	2.82

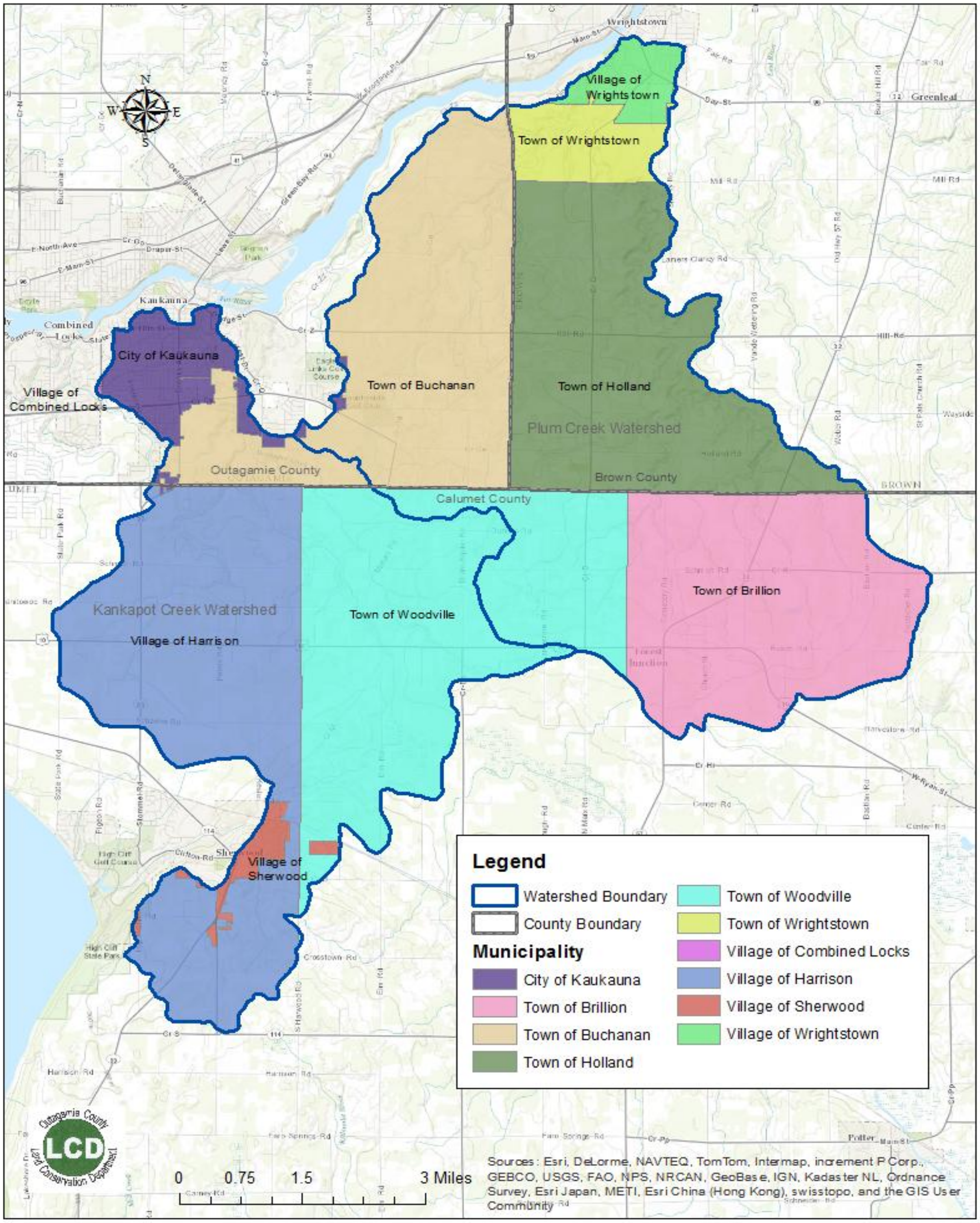


Figure 9. County and municipal jurisdictions of the Plum and Kankapot Watershed.

2.2 Jurisdictional Roles and Responsibilities

Natural resources in the United States are protected to some extent under federal, state, and local law. The Clean Water Act is the strongest regulating tool at the national level. In Wisconsin, the Wisconsin Department of Natural Resources has the authority to administer the provisions of the Clean Water Act. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers work with the WDNR to protect natural areas, wetlands, and threatened and endangered species. The Safe Drinking Water Act also protects surface and groundwater resources.

Counties and other local municipalities in the watershed area have already established ordinances regulating land development and protecting surface waters. Brown, Calumet, and Outagamie County have ordinances relating to Shoreland and Wetland Zoning, Animal Waste Management & Runoff management, Erosion Control, and Illicit Discharge. In addition Brown County has an Agriculture Shoreland Management ordinance requiring the installation of vegetated buffers on all blue lines found on USGS quadrangle maps, and Outagamie County has an Agricultural Performance Standards and Prohibitions Ordinance.

In addition to County-level regulations, each municipality has their own regulations. Municipalities may or may not provide additional watershed protection above and beyond existing watershed ordinances under local municipal codes. The City of Kaukauna has an Illicit Discharge & Connection Ordinance, Construction Site Erosion Control Ordinance, and a Storm Water Utility ordinance. Village of Harrison has a Stormwater Management & Illicit Discharge Ordinance and a Construction Site Erosion Control Ordinance. The Town of Buchanan has an Illicit Discharge & Connection Ordinance and is served by the Garners Creek Stormwater Utility. Village of Wrightstown regulating ordinances include Erosion Control Ordinance, Shoreland and Wetlands Zoning Ordinance, and Sewer Utility Ordinance. Village of Sherwood has an Illicit Discharge & Connection Ordinance, Construction Site Erosion Control Ordinance, and Post Construction Stormwater Management Ordinance.

The Northeast Wisconsin Stormwater Consortium (NEWSC) is a private entity in the watershed area that provides a technical advisory role. In 2002, Fox Wolf Watershed Alliance began exploring the creation of an organization to assist local and county governments in cooperative efforts to address storm water management, which led to the creation of the Northeast Wisconsin Stormwater Consortium. Outagamie County, Brown County, Calumet County, and the City of Kaukauna have representatives in the organization. Northeast Wisconsin Stormwater Consortium facilitates efficient implementation of stormwater programs that meet DNR and EPA regulatory requirements and maximize the benefit of stormwater activities to the watershed by fostering partnerships, and by providing technical, administrative, and financial assistance to its members.

Other governmental and private entities with watershed jurisdictional or technical advisory roles include: Natural Resources Conservation Service, Outagamie County Land Conservation Department and Planning and Zoning Department, Calumet County Resource Management Department, Brown County Land and Water Conservation Department and Planning and Land

Services Department, Department of Agriculture, Trade, and Consumer Protection, East Central Wisconsin Regional Planning Commission, Bay-Lake Regional Planning Commission, Department of Transportation.

2.3 Transportation

The major roads that run through the Plum and Kankapot watershed include State Highways 10, 55, 32, and 114. Hwy 10 runs east-west across the center of the Kankapot watershed. Hwy 32 runs north-south through the southeast corner of the Plum watershed. County roads KK, CE, M, D, GG, and Z are also throughways in the watershed. The Fox River Trail is a 25 mile long trail that can be used for biking and hiking as well as horseback riding in some sections. The trail begins just north of Hilbert in Calumet County passes through Wrightstown and Holland up to Green Bay. There is only one railroad that passes through the southern tip of the Kankapot watershed near Sherwood, WI.

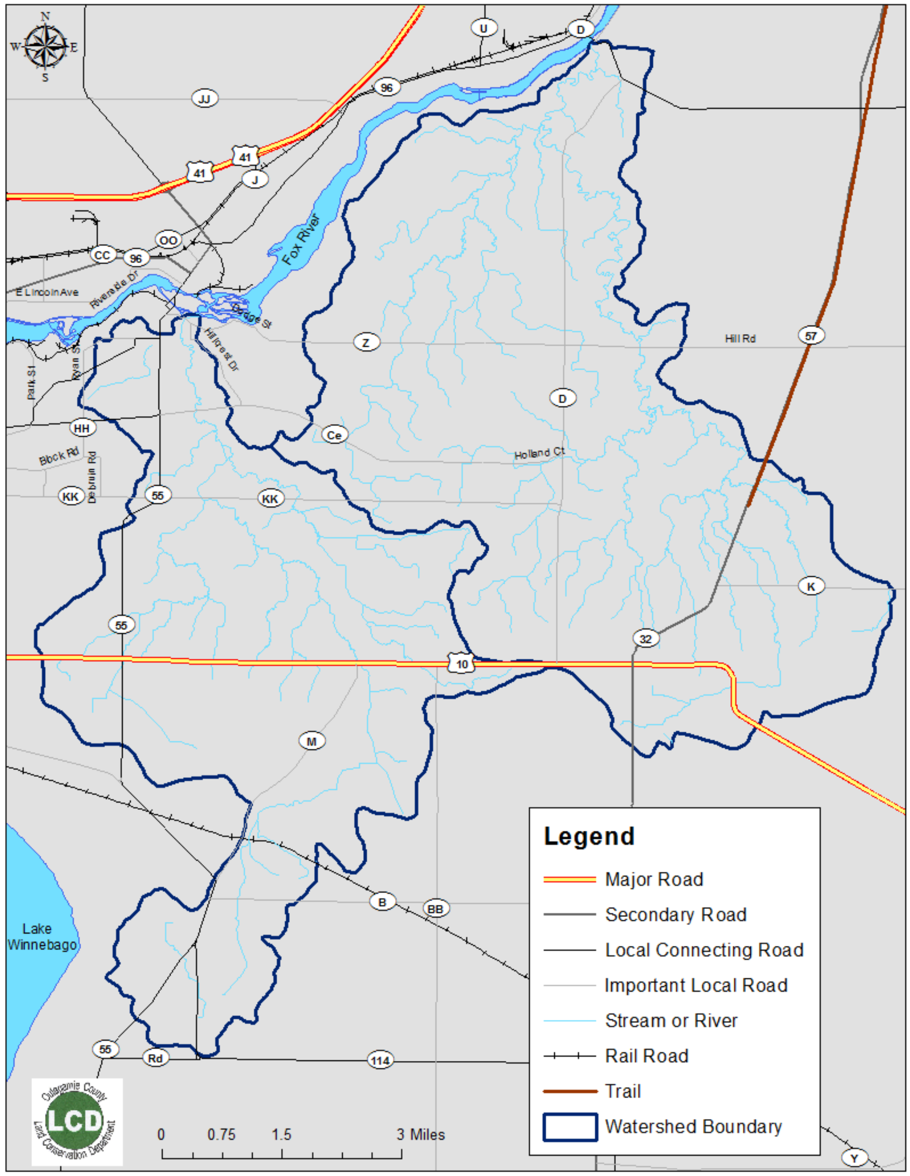


Figure 10. Transportation in the Plum and Kankapot Watershed.

2.4 Population Demographics

In 2013, David Eagan-Robertson-UW Madison developed a population projections report for the Wisconsin Department of Administration Demographic Services Center. Calumet County and Brown County are in the top five projected fastest growing populations in this projections report. The Village of Sherwood and the Village of Harrison in Calumet County are also projected to be some of the fastest growing municipalities in the state. If population growth continues as predicted urban runoff may have more of an impact in the watershed in the future.

Table 4. Population projection data. Source: Wisconsin Department of Administration Demographic Services Center (Eagan-Robertson 2013).

County Name	April 2010 Census	April 2020 Projection	April 2030 Projection	Total Change
Brown	248,007	270,720	299,540	51,533
Calumet	48,971	54,555	61,255	12,284
Outagamie	176,695	191,635	208,730	32,035

Median annual income data was collected from 2008-2012 by the American Community Survey. The median annual income for the municipalities located within the watershed is higher than the median for the counties that they lie in. Population data for municipalities and counties are from 2010 US Census.

Table 5. Median annual income. Source: U.S. Census Bureau (US Census Bureau 2010 & US Census Bureau American Community Survey 2012)

Municipality	Population	Median Income
C. Kaukauna	15,462	53,402
T. Brillion	1,486	68,021
T. Buchanan	6,755	85,299
T. Harrison	10,839	83,442
T. Holland	1,519	65,750
T. Woodville	980	69,583
T. Wrightstown	2,221	74,219
V. Sherwood	2,713	101,000
V. Wrightstown	2,827	71,522
County		
Brown	248,007	53,419
Calumet	48,971	48,971
Outagamie	176,695	57,584

3.0 Land Use/Land Cover

3.1 Existing Land Use/Land Cover

Land Cover and Land Use data for the watershed area was obtained from the National Land Cover Database 2011 (NLCD 2011). The land cover data was created by the Multi-Resolution Land Characteristics (MRLC) Consortium. The NLCD 2011 has 16 land cover classifications and a spatial resolution of 30 meters. The classification of land use is based on 2011 Landsat satellite data. Land cover and land use for the watershed is shown in Figure 11 & Table 6.

Agricultural land use is the dominant land use in the watershed area at 77.66 %. Cultivated Crops consists of 45.20% and Pasture/Hay accounts for 32.46% of the agricultural land use. Developed land accounts for a total of 11% of the watershed area. The medium to high intensity development mainly covers the northwest and northeast corners of the watershed where Plum and Kankapot Creeks empty into the Fox River. Forested land covers 7.45% of the watershed followed by wetlands which cover 3.19%.

Table 6. Existing land use/land cover 2011. Source: NLCD 2011

Land Use	Area (acres)	% of Watershed
Cultivated Crops	17,497.55	45.20
Pasture/Hay	12,567.21	32.46
Deciduous Forest	2,445.24	6.32
Developed, Low Intensity	2,092.39	5.41
Developed, Open Space	1,628.65	4.21
Woody Wetlands	833.26	2.15
Emergent Herbaceous Wetlands	440.91	1.14
Developed, Medium Intensity	375.04	0.97
Evergreen Forest	327.01	0.84
Grassland/Herbaceous	179.23	0.46
Developed, High Intensity	156.43	0.40
Mixed Forest	111.44	0.29
Barren Land (Rock, Sand, Clay)	31.36	0.08
Open Water	25.99	0.07
Total	38,711.70	100.00

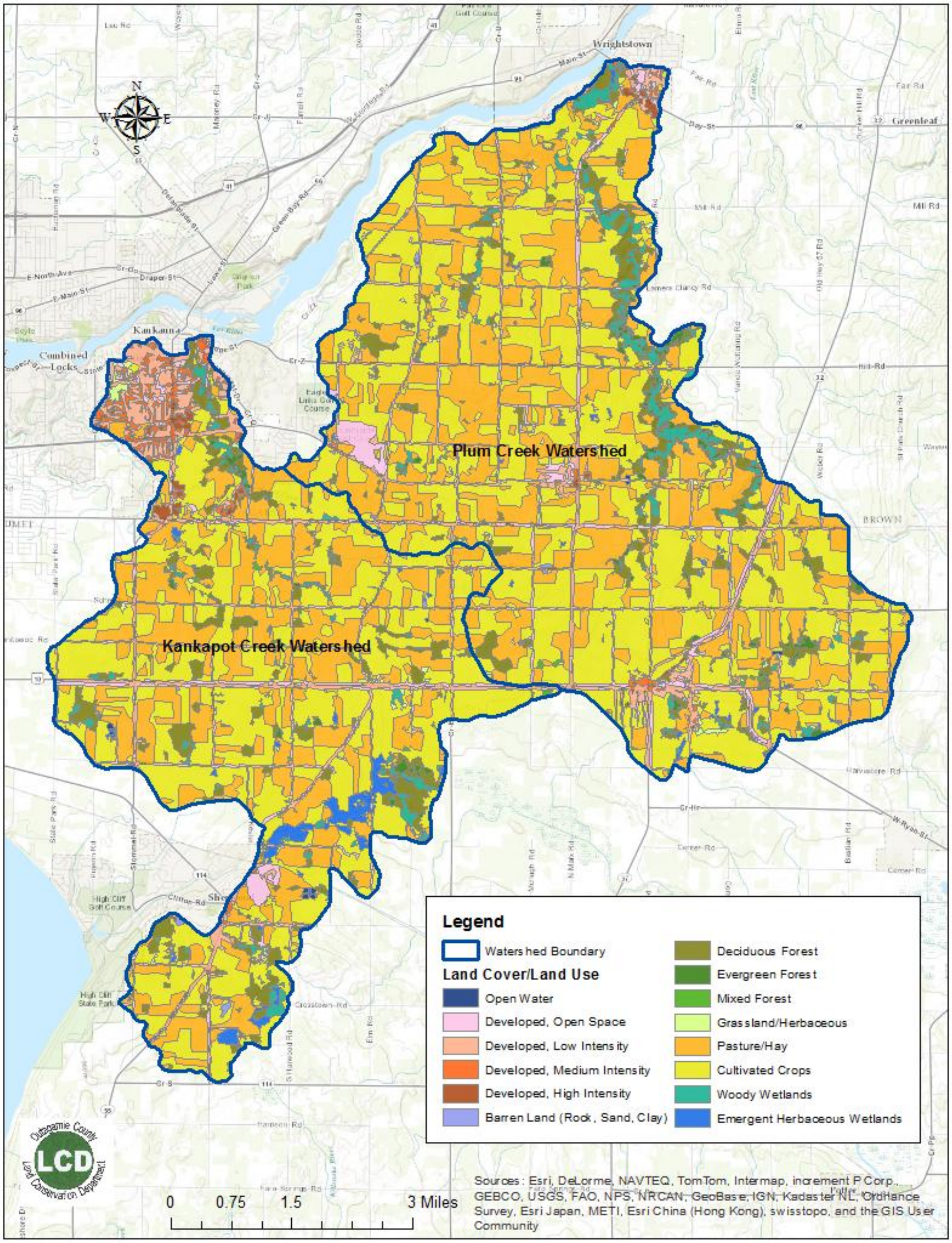


Figure 11. Land cover of the Plum and Kankapot Watershed from National Land Cover Database 2011.

3.2 Exotic/ Invasive Species

Invasive species can have a negative impact on watersheds. They can out compete native species that provide an optimal natural habitat. Species such as Purple Loosestrife and Phragmites tend to populate ditches and edge of water bodies. There are a few exotic species located in the watershed. These species consist of Purple Loosestrife, Cut Leaf Teasel, Phragmites, Garlic Mustard, and Japanese Knotweed. Invasive species are not a significant issue in this watershed. Invasive species can reduce the nutrient removal efficiency of riparian buffers and grassed waterways. Conservation practices implemented should be maintained to prevent establishment and spread of invasives.

3.3 Crop Rotation

Cropland data was obtained from the USDA National Agriculture Statistics Service. NASS produced the Cropland Data Layer using satellite images at 30 meter observations, Resourcesat-1 Advanced Wide Field Sensor, and Landsat Thematic mapper. Data from 2008 to 2012 was analyzed to obtain a crop rotation. Crop rotations for the watershed are shown in Figure 12 and Table 7.

Dairy rotation is dominant in the watershed at 65.2% followed by Pasture/Hay/Grassland at 21.5% and Cash Grain at 12.2%. Different crop rotations can affect the amount of erosion and runoff that is likely to occur on a field. Changing intensive row cropping rotations to a conservation crop rotation can decrease the amount of soil and nutrients lost from a field. Increasing the conservation level of crop rotation can be done by adding years of grass and/or legumes, add diversity of crops grown, or add annual crops with cover crops.

Table 7. Crop rotations in Plum and Kankapot Watershed.

Crop Rotation	Acres	Percent
Pasture/Hay/Grassland	6,192.4	21.5
Dairy Rotation	18,687.8	65.0
Cash Grain	3,520.7	12.2
Potato/Grain/Vegetable	250.3	0.9
Continuous Corn	93.5	0.3
Total	**28,744.8**	**100.0**

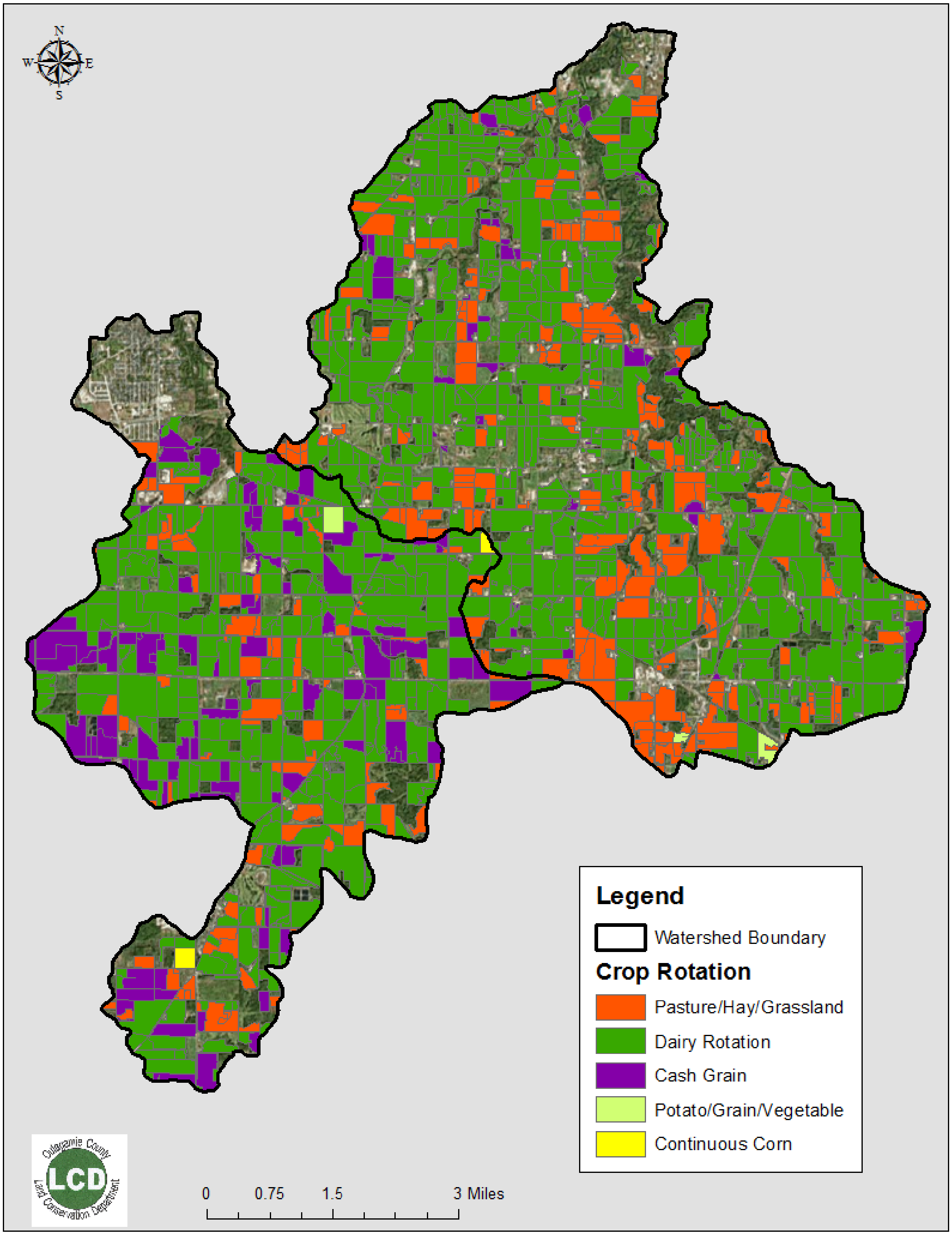


Figure 12. Crop rotations in the Plum and Kankapot Watershed.

4.0 Water Quality

The federal Clean Water Act (CWA) requires states to adopt water quality criteria that the EPA publishes under 304 (a) of the Clean Water Act, modify 304 (a) criteria to reflect site-specific conditions, or adopt criteria based on other scientifically defensible methods. Water quality standards require assigning a designated use to the water body.

4.1. Designated Use and Impairments for the Plum and Kankapot Creeks.

A 303 (d) list is comprised of waters impaired or threatened by a pollutant, and needing a TMDL. States submit a separate 303 (b) report on conditions of all waters. EPA recommends that the states combine the threatened and impaired waters list, 303 (d) report, with the 305 (b) report to create an "integrated report". Plum and Kankapot Creeks were first listed as impaired waterways in 1998. The conditions of streams and rivers in Wisconsin are assessed for the following use designations: Fish and Aquatic Life, Recreational use, Fish Consumption, and General Uses. The designated use for both waterways is for Fish and Aquatic Life. A waterway is considered impaired if it does not meet the minimum threshold requirement for its designated use. Both Plum and Kankapot Creeks are listed as impaired for total phosphorus and total suspended solids (Figure 13). A TMDL (Lower Fox River TMDL) was approved in 2012 for TSS and TP for tributaries to the Lower Fox River. The Plum and Kankapot Creeks are considered a Cool (Warm Transition Headwater) under the State's Natural Communities Determinations.

> Definition: Cool (Warm-Transition) Headwaters are small, sometimes intermittent streams with cool to warm summer temperatures. Coldwater fishes are uncommon to absent, transitional fishes are abundant to common, and warm water fishes are common to uncommon. Headwater species are abundant to common, main stem species are common to absent, and river species are absent.

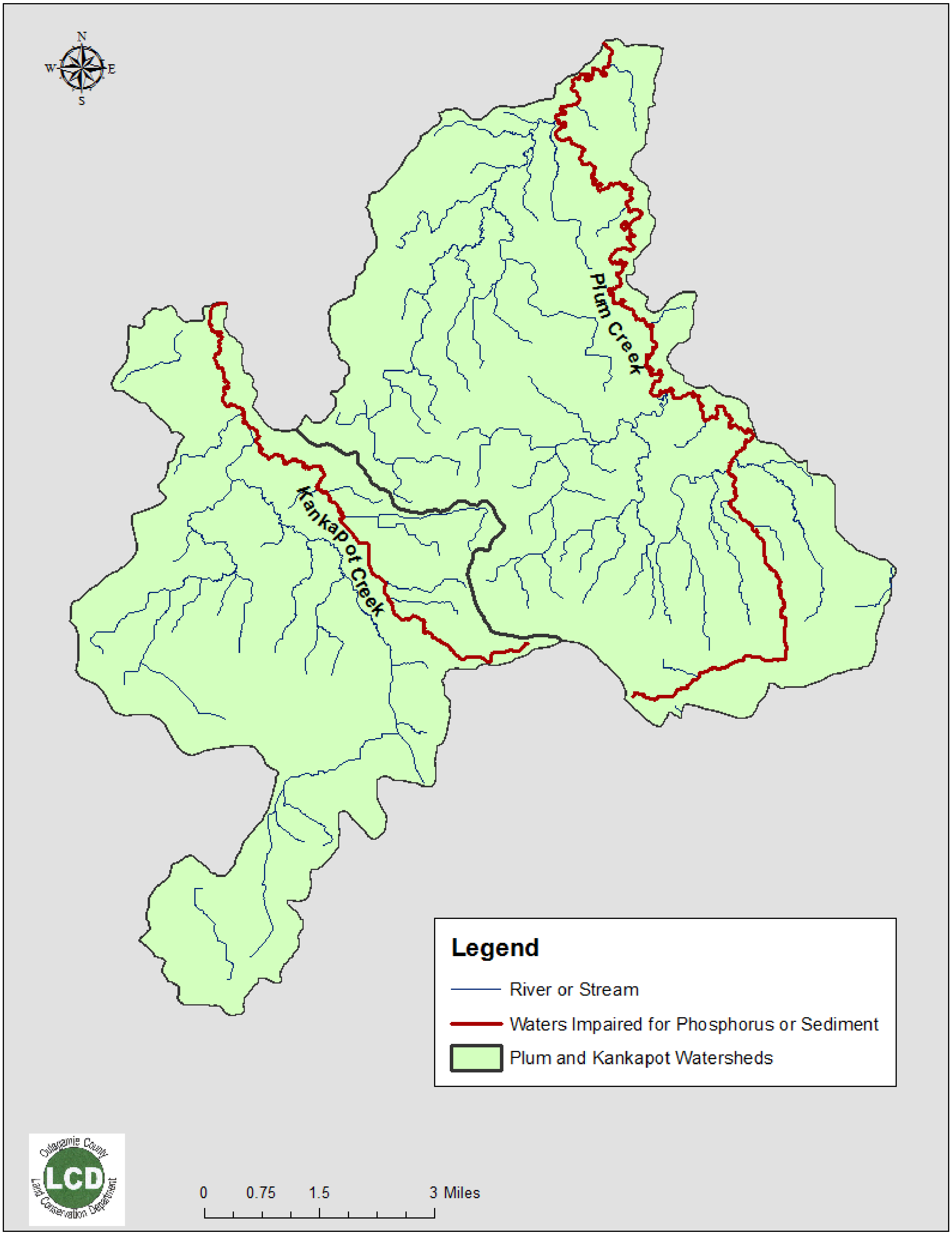


Figure 13. Map of impaired Waters in the Plum and Kankapot Watershed.

4.2 Point Sources

Point sources of pollution are discharges that come from a pipe or point of discharge that can be attributed to a specific source. In Wisconsin, the Wisconsin Pollutant Discharge Elimination System (WPDES) regulates and enforces water pollution control measures. The WI DNR Bureau of Water Quality issues the permits with oversight of the US EPA. There are four types of WPDES permits: Individual, General, Storm water, and Agricultural permits.

Individual permits are issued to municipal and industrial waste water treatment facilities that discharge to surface and/or groundwater. WPDES permits include limits that are consistent with the approved TMDL Waste Load Allocations. There are five individual WPDES holders that discharge in the Plum and Kankapot watershed (Table 8). Three of them are municipal and two are industrial facilities. Facilities are required to report phosphorus and sediment loads to the DNR in Discharge Monitoring Reports (DMR).

Table 8. Waste Water Treatment Facilities in the Plum and Kankapot Watershed.

Waste Water Treatment Facilities	Permit #
Arla Foods Production LLC	27197
Belgioso Cheese Inc, Sherwood	27201
Forest Junction Sanitary District	32123
Holland Sanitary District	28207
Sherwood WWTP	31127

To meet the requirements of the federal Clean Water Act, the DNR developed a state Storm Water Permits Program under Wisconsin Administrative Coded NR 216. A Municipal Separate Storm Sewer System (MS4) permit is required for a municipality that is either located within a federally designated urbanized area, has a population of 10,000 or more, or the DNR designates the municipality for permit coverage. Municipal permits require storm water management programs to reduce polluted storm water runoff. There are 6 permitted MS4's in the watershed area (Table 9). NR 216 also requires certain types of industries in the state to obtain storm water discharge permits from the DNR. There is one industrial storm water permit in the watershed issued to Arla Food Production LLC which has a no exposure certification. Outagamie, Brown, and Calumet Counties have a general MS4 permit # WI-S050075-2. The general permit requires an MS4 holder to develop, maintain, and implement storm water management programs to prevent pollutants from the MS4 from entering state waters. Examples of stormwater best management practices used by municipalities to meet permits include: detention basins, street sweeping, filter strips, and rain gardens.

Table 9. MS4 Permit holders in the Plum and Kankapot Watershed.

MS4	FIN
Brown County	33656
Outagamie County	33644
Calumet County	33653
City of Kaukauna	31102
Town of Buchanan	31099
Village of Combined Locks	31100

State and federal laws also require that Concentrated Animal Feeding Operations (CAFO) have water quality protection permits. An animal feeding operation is considered a CAFO if it has 1,000 animal units or more. A smaller animal feeding operation may be designated a CAFO by the DNR if it discharges pollutants to a navigable waters or groundwater. There are currently three permitted CAFO's in the watershed area and one farm in process of obtaining a CAFO permit. Permits for CAFO's require that the production area has zero discharge.

Table 10. Waste Load Allocations for permitted sources in Plum and Kankapot Watershed. Source: WDNR 2012

Source	Total Suspended Solids (lbs/yr)			Total Phosphorus (lbs/yr)		
	Baseline	Allocated	Reduction	Baseline	Allocated	Reduction
Urban (MS4)						
Buchanan	77,335	46,401	30,934	186	130.2	55.8
Combined Locks	2,354	1,412	942	5	3.5	1.5
Kaukauna	666,046	399,632	266,414	1,358	950.3	407.7
WWTF-Industrial						
Belgioso Cheese- Sherwood	2,432	2,432	-	143	143	-
Arla Foods Production	682	682	-	546	341	205
WWTF-Municipal						
Forest Junction	2,471	2,471	-	471	122	349
Town of Holland SD #1	27,786	27,786	-	809	809	-
Sherwood	1,713	1,713	-	295	295	-

4.3 Non Point Sources

The majority of pollutants in the Plum and Kankapot watershed come from non point sources. A non point source cannot be traced back to a point of discharge. Runoff from agricultural and urban areas is an example of non point source. Agriculture is the dominant land use in the Plum and Kankapot watershed and accounts for 86.9% of total phosphorus loading and 89.8 % of total suspended sediment loading. Other non point sources in the watershed include erosion from stream banks and runoff from golf courses, lawns, and impervious surfaces.

In 2010, new state regulations in Wisconsin went into effect that restricts the use, sale, and display of turf fertilizer that is labeled as containing phosphorus or available phosphorus (Wis.Stats.94.643) The law states that turf fertilizer that is labeled containing phosphorus or available phosphate cannot be applied to residential properties, golf courses, or publicly owned land that is planted in closely mowed or managed grass. The exceptions to the rule are as follows:

- Fertilizer that is labeled as containing phosphorus or available phosphate can be used for new lawns during the growing season in which the grass is established.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be used if the soil is deficient in phosphorus, as shown by a soil test performed no more than 36 months before the fertilizer is applied. The soil test must be done by a soil testing laboratory.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be applied to pastures, land used to grow grass for sod or any other land used for agricultural production.

Wisconsin also has state standards pertaining to agricultural runoff. Wisconsin State Standards, Chapter NR 151 subchapter II describes Agricultural Performance Standards and Prohibitions. This chapter describes regulations relating to phosphorus index, manure storage & management, nutrient management, soil erosion, tillage setback as well as implementation and enforcement procedures for the regulations.

4.5 Water Quality Monitoring

Both the Plum and Kankapot Creeks have very high loading of nutrients and suspended solids in the water. A visual assessment of Plum and Kankapot Creek during a peak storm or runoff event clearly shows high amounts of sediment being carried as seen in Figure 14. Algae blooms are also prominent on Plum Creek near Wrightstown in the summer months which can be seen from aerial photographs (Figure 14).

Figure 14. Plum Creek during spring runoff event (left) and algae bloom in Plum Creek near Wrightstown (right).

In 2010, a USGS continuous monitoring station was established on the main branch of Plum Creek by the County Hwy D bridge near Wrightstown, WI (Figure 15). The USGS station collects daily discharge rates and water samples. This station is cooperatively operated by the University of Wisconsin-Green Bay, and chemical analysis of samples is performed by the Green Bay Metropolitan Sewerage District Laboratory. Three years of data is available for the main Plum Creek station for Water Years 2011-2013. Annual surface water statistics for Plum Creek are shown in Table 11. By looking at the trends in suspended solids, total phosphorus, and discharge in Plum Creek, the highest amounts of pollutant loading occurs during the spring and during high precipitation events (Figure 16, Figure 17, Figure 18). This indicates that a significant amount of the pollutants can be attributed to runoff. Another monitoring station was recently installed on West Plum Creek in 2012. Currently only published data from the main branch Plum Creek monitoring station is available.

The allocated mean rate of phosphorus loading for Plum Creek under the TMDL is 19.69 lbs/day and 4.871 tons/day for total suspended solids. As you can see in Table 11, the current annual loading rates are much higher than allocated. The maximum daily suspended solids discharge and total phosphorus discharge for the period of record occurred on July 8, 2013, when 2,110 tons of suspended solids and 5,100 lbs of total phosphorus were discharged. Keeping in mind that the USGS station on Plum Creek in Wrightstown, WI is located upstream of where West Plum enters into the Main Plum Creek, the actual loading numbers are probably much higher for the entire stream.

Figure 15. Location of continuous monitoring stations in the Plum Creek Watershed.

Table 11. Annual Surface Water Statistics. USGS Station 0408491, Plum Creek, Wrightstown, WI.

Water Year	Suspended Solids (tons/day)	Phosphorus (lbs/day)	Discharge (cubic feet/second)
2011	21.07	83.43	20.3
2012	10.57	36.88	8.07
2013	19.62	77.75	17.2

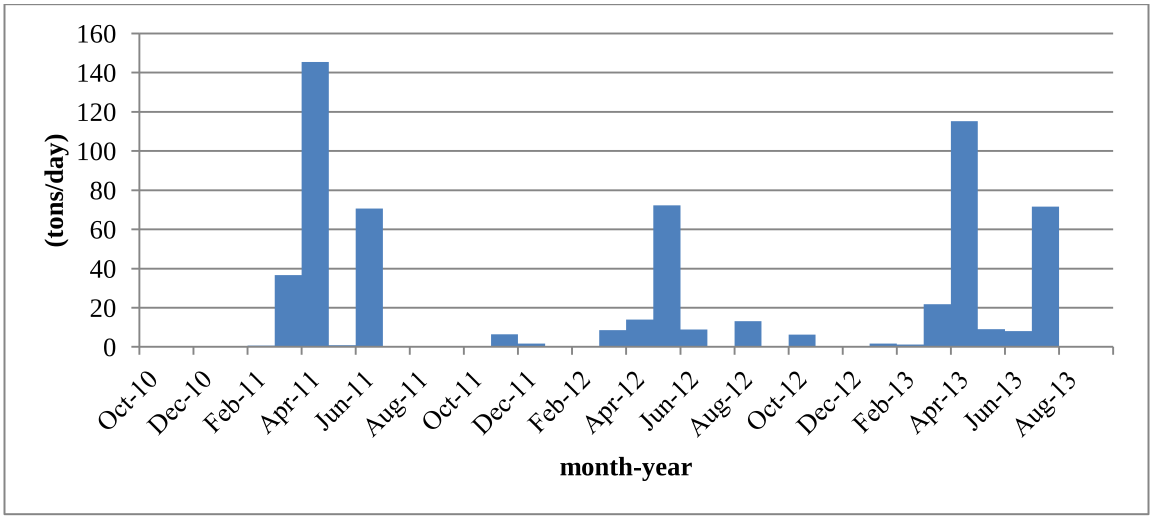


Figure 16. Annual monthly statistics for total suspended solids. USGS Station 040891, Plum Creek, Wrightstown, WI.

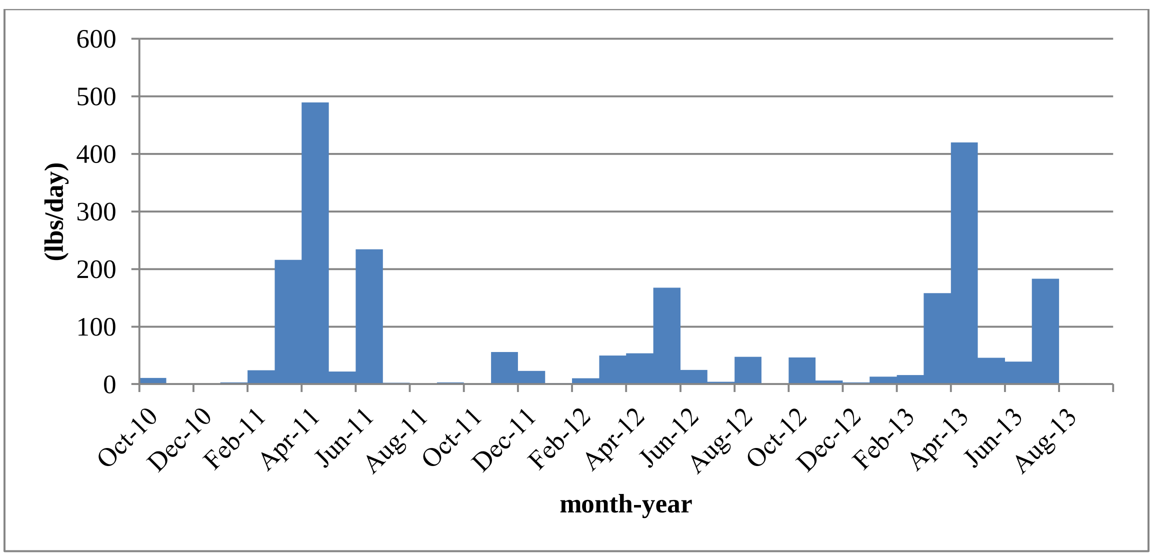


Figure 17. Annual monthly statistics for total phosphorus. USGS Station 0408491, Plum Creek, Wrightstown, WI.

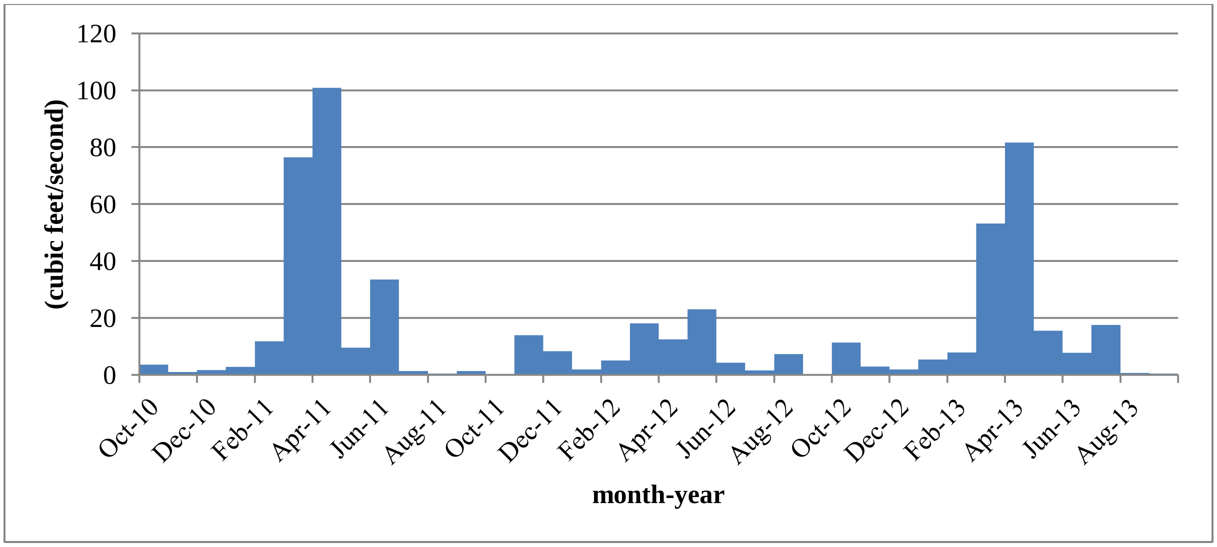


Figure 18. Annual monthly statistics for discharge. USGS Station 0408491, Plum Creek, Wrightstown, WI.

The WDNR monitors water quality of aquatic resources in the state through various monitoring programs. WDNR water quality data is available for Plum and Kankapot Creeks for various years from 1992-2006 from water quality monitoring programs that have occurred since 1992. The most recent total phosphorus and total suspended sediment data available from the WDNR for Plum and Kankapot Creeks is shown in Figure 19 & Figure 20. WDNR water quality data for all years can be viewed at http://dnr.wi.gov/water/waterSearch.aspx.

Macroinvertabrate analyses were conducted at various locations on both Plum and Kankapot Creeks by the University of Wisconsin-Stevens Point from 1992-2001. The macroinvertebrate index of biotic integrity is a biological indicator for impairment classification.Different types of macroinvertabrates are more tolerant of poor water pollution than others. The number and type of macroinvertabrates present in a stream can provide an indicator of water quality The sites that were surveyed on the Plum and Kankapot Creeks were rated fair to poor (Table 13). Table 12 shows the macroinvertabrate IBI rating system.

Figure 19. Total Phosphorus data from 2005-2006 for WDNR NER Watershed Rotation Sites (Non_LTT). (Plum Creek-Cth ZZ Bridge, Wrightstown, ID 53201, Kankapot Creek-Cth Z, 100 ft US of Bridge, ID 453261)

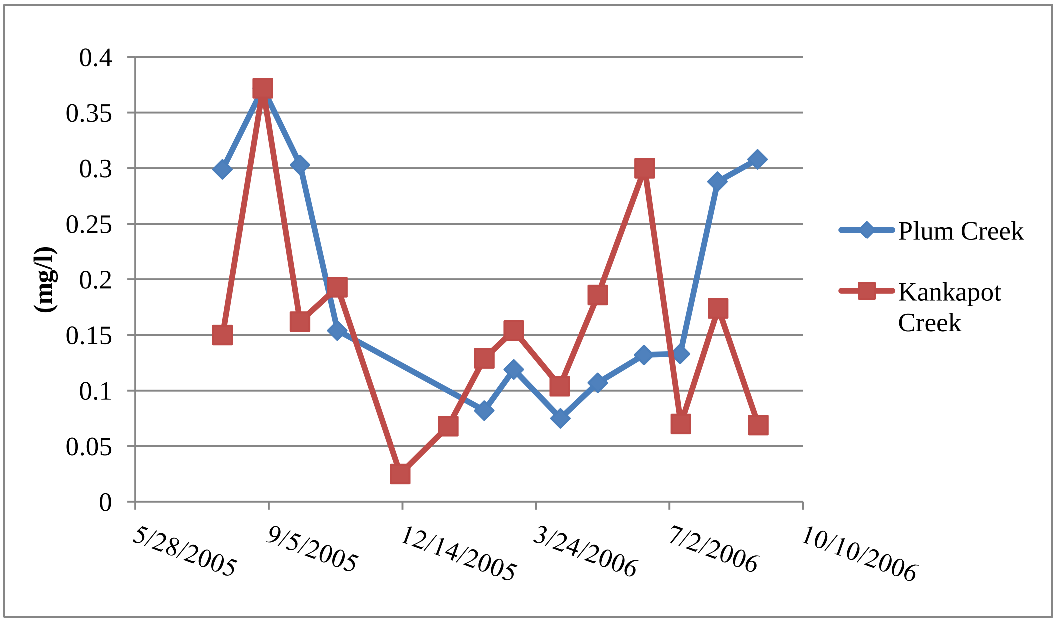


Figure 20. Total Suspended Solids data from 2005-2006 for WDNR NER Watershed Rotation Sites (Non_LTT). (Plum Creek-Cth ZZ Bridge, Wrightstown, ID 53201, Kankapot Creek-Cth Z, 100 ft US of Bridge, ID 453261)

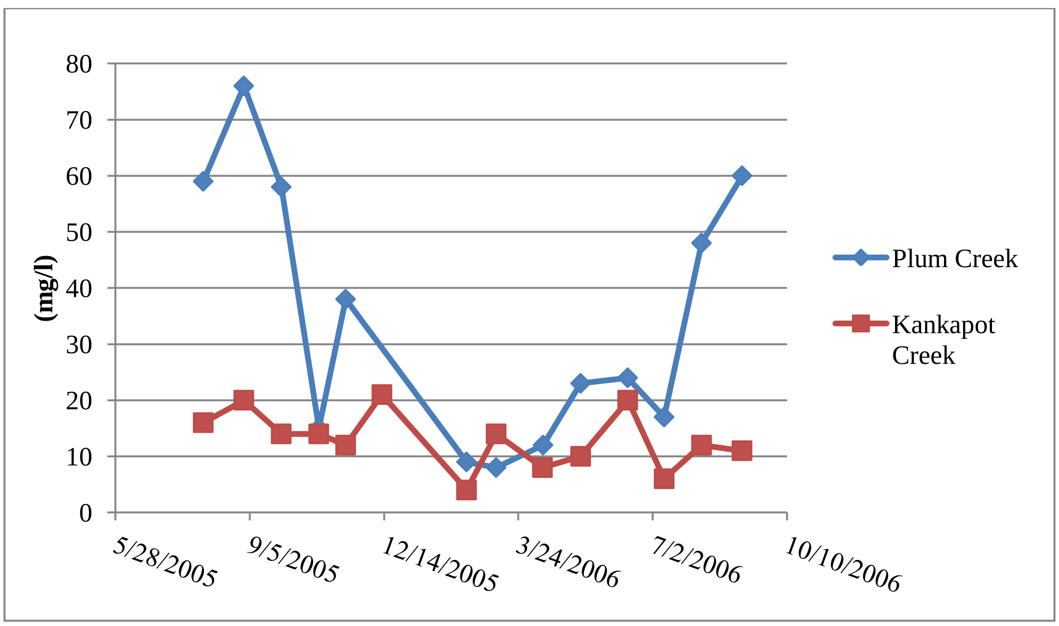


Table 12. Macroinvertebrate Index of Biological Integrity (IBI). Source: WDNR 2012b.

Macroinvertebrate IBI Rating	
7.5-10	Excellent
5.0-7.4	Good
2.6-4.9	Fair
0-2.5	Poor

Table 13. Macroinvertebrate Index of Biological Integrity Survey Scores from 1992- 2001 at WDNR survey sites.

Date	Location	IBI	Rating
10/16/2001	Kankapot Creek - Near Kaukauna, WI, ID 453276	4.30	Fair
10/12/1998	Plum Creek - County D, ID 10015963	2.65	Fair
10/20/1997	Kankapot Creek-Cth CE, ID 453245	2.41	Poor
10/20/1997	Plum Creek - Under Chy D Bridge Station ID 10016000	2.85	Poor
5/22/1997	Plum Creek - Located Right Beneath Bridge Oncth D Station ID 10016001	2.00	Poor
10/13/1992	Plum Creek - Upstream Of Cth D Bridge Station ID 10016044	2.47	Poor
10/13/1992	Plum Creek - Upstream Of Lamers And Clancy Road Station ID 10016874	2.12	Poor
10/13/1992	Plum Creek - Downstream Of Cth Z - Hills Road, ID 10016599	1.67	Fair
4/8/1992	Plum Creek - Pstream Of Holland Road Bridge, ID 10016258	1.44	Poor
4/8/1992	Plum Creek - Downstream Of Cth Z - Hills Road, ID 10016605	3.32	Fair
4/7/1992	Kankapot Creek-Upstream of Cth KK Bridge-10016668	1.68	Poor

5.0 Pollutant Loading Model

The developers of the Lower Fox River TMDL plan ran the Soil and Water Assessment Tool[1] (SWAT) for all the subwatersheds in the Lower Fox River Basin. The SWAT model is able to predict the impact of land use management on the transport of nutrients, water, sediment, and pesticides. Actual cropping, tillage and nutrient management practices typical to Wisconsin were input into the model. Other data inputs into the model include: climate data, hydrography, soil types, elevation, land use, contours, political/municipal boundaries, MS4 boundaries, vegetated buffer strips, wetlands, point source loads, and WDNR-Enhanced USGS 1:24K DRG topographic maps.The model was calibrated with water quality data taken at USGS sites from the East River, Duck Creek, Baird Creek, Ashwaubenon, and Apple Creek in the Lower Fox River Basin.

SWAT model pollutant loading results for the Plum and Kankapot Watershed are shown in Table 14 & 15 and Figure 21 & 22. Breakdown of data per individual watershed and source is available in Appendix J. Agriculture is the main contributing source of sediment and phosphorus in the Plum and Kankapot Watershed. Agriculture accounts for 86.9% of total phosphorus loading and 89.8% of total suspended solids loading (Figure 21 & Figure 22).

Another model that is used to calculate nutrient loading in a watershed is STEPL (Spreadsheet Tool for Estimating Pollutant Load)[2]. The STEPL model calculates nutrient loads based on land use and soil type. The STEPL model was also ran on the watershed as a comparison and to estimate load reductions. STEPL model results for pollutant loading and load reductions are shown in Appendix C-D. The results from the STEPL model were similar to the results obtained from the SWAT model except STEPL had higher estimates for both phosphorus and sediment (Appendix C).

Table 14. Total Phosphorus and total suspended solids loading summary for Plum and Kankapot watersheds. Source: WDNR 2012

Loading Summary	Total Phosphorus (lbs/yr)		Total Suspended Solids (lbs/yr)	
Watershed	Plum	Kankapot	Plum	Kankapot
Baseline	31,569	20,050	12,038,905	7,253,520
TMDL	7,193	5,548	3,558,318	2,744,726
Reduction	24,376	14,502	8,480,587	4,508,794
% Reduction Needed	77.20	72.30	70.40	62.20

[1] Information on the SWAT model can be found on the website http://swat.tamu.edu/.
[2] Information on the STEPL model can be found on the website http://it.tetratech-ffx.com/steplweb/.

Table 15. Combined baseline loading summary by source for Plum and Kankapot watersheds. Source: WDNR 2012.

Sources	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline
	Baseline	Allocated	Reduction	
Agriculture	44,855	6,996	37,859	84.4
Urban (non-regulated)	1,809	1,809	-	-
Natural Background	628	628	-	-
Load Allocation	**47,292**	**9,433**	**37,859**	**80.1**
Urban (MS4)	1,549	1,084	465	30.0
Construction	263	263	-	-
General Permits	251	251	-	-
WWTF-Industrial	689	484	205	29.8
WWTF-Municipal	1,575	1,226	349	22.2
Wasteload Allocation	**4,327**	**3,308**	**1,019**	**23.5**
Total (WLA+LA)	**51,619**	**12,741**	**38,878**	**75.3**
Sources	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline
	Baseline	Allocated	Reduction	
Agriculture	17,316,419	4,837,990	12,478,429	72.1
Urban (non-regulated)	640,336	640,336	-	-
Natural Background	211,492	211,492	-	-
Load Allocation	**18,168,247**	**5,689,818**	**12,478,429**	**68.7**
Urban (MS4)	760,809	456,485	304,324	40.0
Construction	258,285	51,657	206,628	80.0
General Permits	70,000	70,000	-	-
WWTF-Industrial	3,114	3,114	-	-
WWTF-Municipal	31,970	31,970	-	-
Wasteload Allocation	**1,124,178**	**613,226**	**510,952**	**45.5**
Total (WLA+LA)	**19,292,425**	**6,303,044**	**12,989,381**	**67.3**

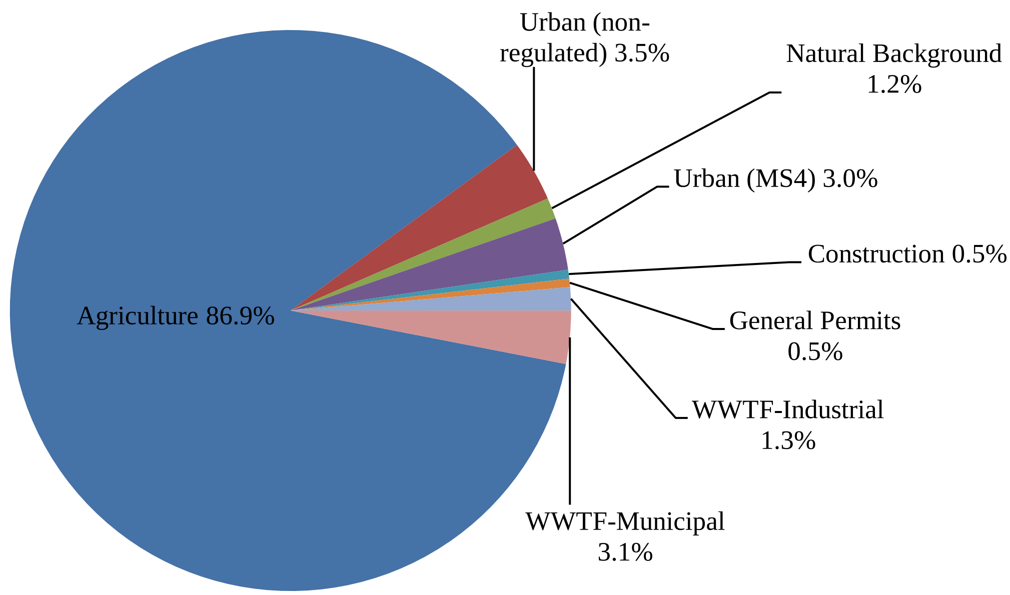


Figure 21. Sources of baseline total phosphorus loading in the Plum and Kankapot watershed. Source: WDNR 2012.

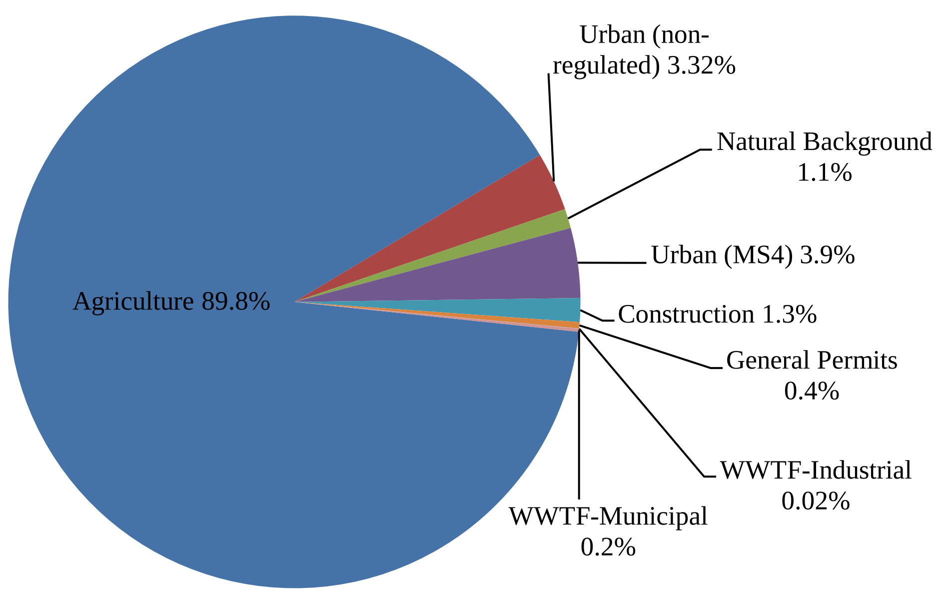


Figure 22. Sources of baseline total suspended solids loading in the Plum and Kankapot watershed. Source: WDNR 2012.

6.0 Watershed Inventory Results

Staff from the Outagamie Land Conservation Department collected field data on livestock operations, stream bank, and uplands during spring and early summer of 2014. The Outagamie County Land Conservation Department also gathered existing data from other county land conservation departments and available federal and state data sets.

6.1 Barnyard Inventory Results

Location on current livestock operations was compiled through existing Land Conservation Department Data, air photo interpretation, and windshield surveys. There are a total of 72 known active livestock operations with an estimated 17,744 animal units in the Plum and Kankapot watersheds. Three of these farm sites are permitted CAFO's with one farm site in the process of obtaining a CAFO permit. All CAFO's were assumed to have zero discharge from their production area. Locations of livestock operations in the watershed are shown in Figure 23. On site barnyard inventories were conducted on 48 of the sites. Barnyard data on the remaining sites was already available or collected by windshield survey.

Barnyard data was entered in to the NRCS BARNY spreadsheet tool to estimate phosphorus loading. According to the BARNY calculations an estimated 1,281 lbs of phosphorus per year can be attributed to barnyard runoff. Barnyard runoff accounts for 2.9% of the total phosphorus loading from agriculture. Barnyard runoff is not a significant source of phosphorus in this watershed. Barnyards that exceed the annual phosphorus discharge limit of 15 lbs/year will be eligible for cost share assistance to obtain necessary reductions in phosphorus loading. There are 23 sites with phosphorus discharges of 15 lbs/year or more (Table 16). Eight of those sites have discharges of over 50 lbs/ year and should be considered high priority. Three of these high priority sites have currently been evaluated by Calumet County Land Conservation Department staff. One site (Farm #9250) in Brown County is currently converting to an all confined operation which should decrease P from 41 lbs/yr to 0 lbs/yr from barnyard lots. Most of these sites can reduce their annual load with low cost, clean water diversions and roof gutters. Barnyard runoff management systems, waste storage, filter strips, and/or a settling basin may also be needed to get the necessary reduction in P from the more critical sites.

Table 16. Priority barnyard sites with estimated phosphorus discharge over 15 lbs of P/year.

Farm #	lbs of P/yr (all lots combined)	Watershed	County
9472	103.00	Kankapot	Calumet
9284	84.90	Plum	Brown
9595	78.80	Kankapot	Calumet
9455	75.80	Plum	Calumet
9454	63.40	Plum	Calumet
9485	62.10	Plum	Calumet
9496	59.80	Plum	Calumet
9512	54.60	Kankapot	Calumet
9006	48.90	Plum	Outagamie
9509	47.10	Kankapot	Calumet
9616	44.30	Kankapot	Calumet
9250	41.10	Plum	Brown
9435	37.70	Kankapot	Calumet
9251	36.30	Plum	Brown
9403	35.80	Kankapot	Calumet
9494	31.90	Plum	Calumet
9507	28.00	Plum	Calumet
9432	27.90	Kankapot	Calumet
9506	20.90	Kankapot	Calumet
9481	20.70	Plum	Calumet
9296	18.70	Plum	Brown
9502	18.00	Plum	Calumet
9481	17.80	Plum	Calumet

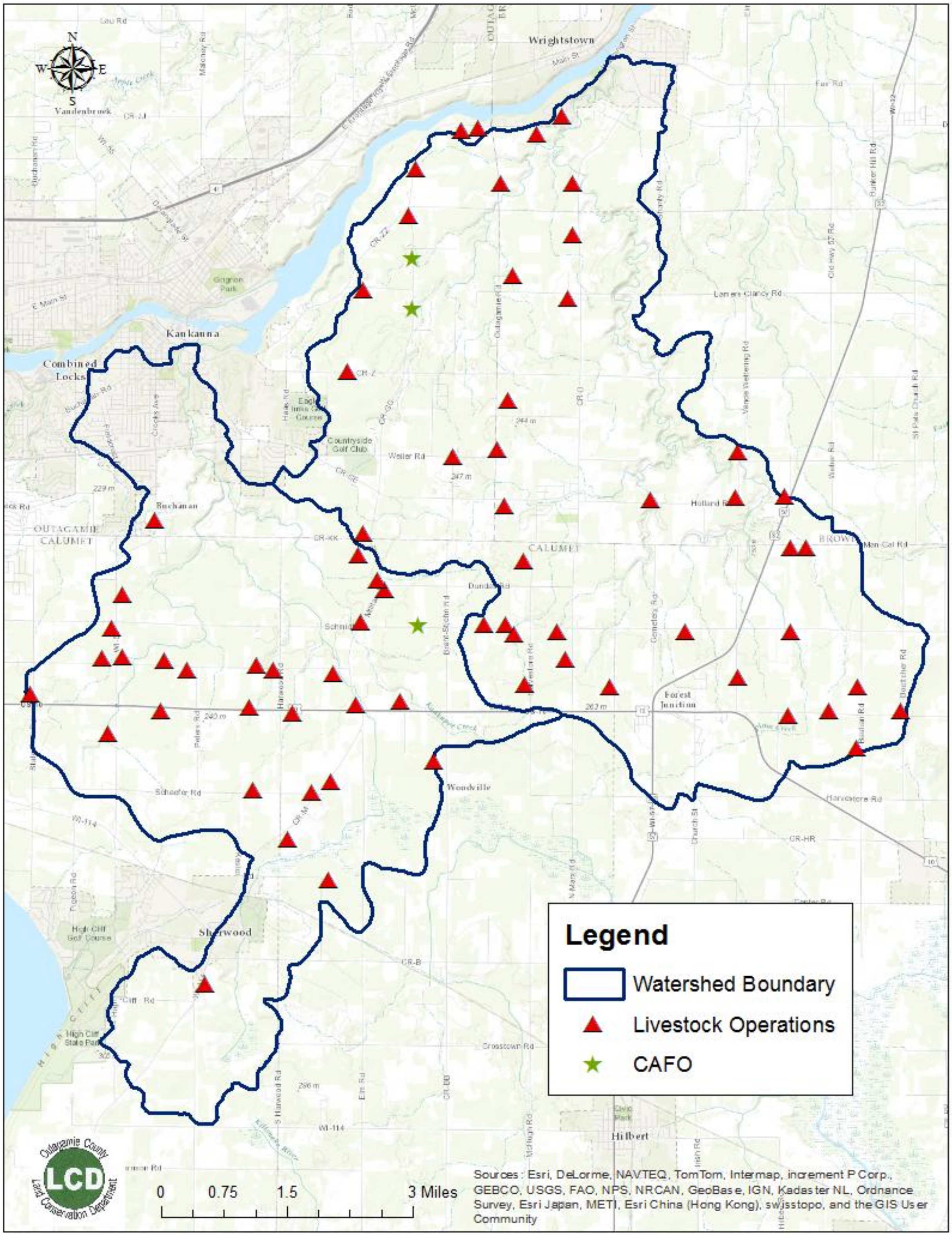


Figure 23. Livestock operations in the Plum and Kankapot Watershed.

6.2 Streambank Inventory Results

The Wisconsin DNR 24K Hydrography data set was used to determine the location of perennial streams in the watershed area. There are approximately 142 miles of perennial and intermittent streams in the Plum and Kankapot watershed including their tributaries. Stream bank erosion was inventoried by walking the streams with an Ipad using the ArcCollector application. Information on lateral recession, soil type, height, and length were collected with the app as well as GPS located photos. Forty three miles of stream were inventoried. Of the 43 miles inventoried 24.7 miles of stream were actively eroding. Inventoried streambank erosion is shown in Figure 24.

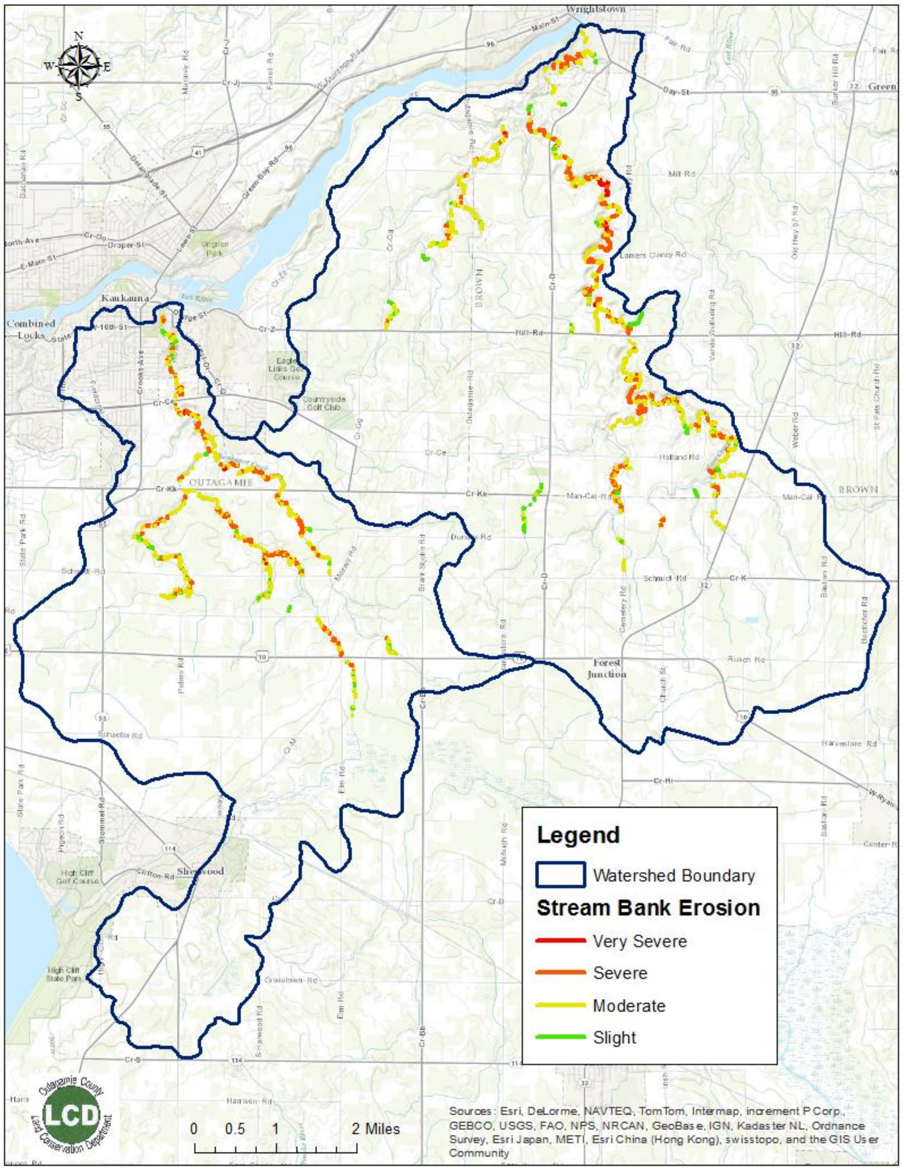


Figure 24. Inventoried streambank sites on Plum and Kankapot Creeks.

Sediment loss was calculated for the 43 miles of blue line using the NRCS Direct Volume Method:

$$[(eroding\ area)(lateral\ recession\ rate)(density)] \div \left(2000\,\frac{lbs}{ton}\right) = erosion\ in\ tons/year$$

Lateral recession rate was determined by Table 17 and density was determined by soil type using

Table 18. The lowest density value for the soil types and the lowest value for lateral recession were used for all calculations. Sediment loss calculations for inventoried sites are shown in Table 20. The amount of sediment loss for the remaining 99 miles of intermittent and perennial stream that was not inventoried was extrapolated. The estimated amount of annual gross sediment loss due to stream bank erosion in Plum and Kankapot Creeks is approximately 4,920 tons/year. Adjacent gullies and eroding ravines entering into the stream were also inventoried. The same NRCS equation was used to estimate sediment coming from the adjacent gullies and eroding ravines. The adjacent gullies/ravines inventoried had an estimated 200 tons/year sediment loss. The amount of sediment actually delivered depends on factors such as channelization, straightening, modification, and amount of disturbed channels. By using the NRCS Field Office Technical Guide for Erosion and Sediment Delivery, a sediment delivery ratio of 80% was assumed for both Plum and Kankapot (Table 19).

Table 17. Stream erosion lateral recession rate descriptions. Source : NRCS 2003

Lateral Recession Rate (ft/yr)	Category	Description
0.01-0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06-0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang. Some exposed tree roots but no slumps or slips.
0.3-0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross section becomes U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross section is U-shaped and stream course may be meandering.

Table 18. Soil densities. Source: NRCS 2003

Soil Texture	Volume-Weight (pcf)
Clay	60-70 pcf
Silt	75-90
Sand	90-110
Gravel	110-120
Loam	80-100
Sandy loam	90-110
Gravelly loam	110-120

Table 19. Typical delivery rates for concentrate flow erosion (watershed < 20,000 acres). Source: NRCS 1998

Erosion Type	Integrated drainage, Incised Channel (%)	Nonintegrated drainage, Nonincised channel (%)
Ephemeral Gully	50-90	20-50
Classic Gully	80-100	60-80
Streambank	80-100	60-80

Table 20. Estimated sediment loss from inventoried stream sites**.**

Watershed	Lateral Recession			
	Very Severe	Severe	Moderate	Slight
Plum	-	-	-	-
length (ft)	2,922	30,552	61,160	7,009
sediment (tons/yr)	420	1,944	578	9.5
Kankapot	-	-	-	-
length (ft)	838	20,705	41,899	3,051
sediment (tons/yr)	148	1,148	328	3.3

The SWAT modeled lumped pollutant loading from streambank into the agricultural contribution. Using the 80% sediment delivery ratio, the amount of sediment that is actually delivered to the Fox River from streambank erosion is estimated to be about 3,936 tons/year which is 45.5% of the modeled baseline sediment load allocated to agricultural sources in the TMDL. There is an estimated 2,047 lbs of P loading attributed to stream bank erosion which is 4.6% of the total phosphorus loading from agriculture. Adjacent gullies and ravines add another

160 tons sediment/year and approximately 83 lbs of phosphorus/year. Inventory data indicates that stream bank erosion is a significant source of sediment in these subwatersheds.

Our streambank inventory results show that sediment loading from streambank erosion was underestimated by the SWAT model for the Plum and Kankapot watershed. The SWAT model that was run for the Lower Fox River TMDL lumped stream bank erosion into the agricultural contributions of phosphorus and sediment. The stream bank erosion component of the model was essentially turned off. This was due to lack of data on stream bank erosion in some watersheds, and in other watersheds data suggested that stream bank contributions were not a major source compared to upland sources.

Severe erosion, slumping, sediment deltas, fallen trees, and meandering were common features on both Plum and Kankapot Creeks. The stream appeared to be very unstable in many areas. An increased amount of runoff during storm periods is likely the cause to erosion and degradation of the stream. There were multiple sites on both streams were tree and shrub debris was blocking the flow of water and in some instances redirecting the flow path and causing erosion.

(a) (b)

Figure 25. Inventoried sites on Kankapot Creek. (a) Example of large amount of debris blocking flow. (b) Example of crossing that needs to be stabilized.

Many of the areas of severe erosion along both the streams are not easily accessible by equipment due to steep slopes and dense forest and vegetation. Sites that were easily accessible by equipment were considered potentially feasible and sites that may be difficult to access were considered limited feasibility. There are 52 sites that have been identified as potentially feasible (Table 21). Sites with severe to very severe erosion and easy access will be priority sites for restoration. Due to many unmarked paths on private property, additional severe areas of stream bank erosion may be determined to be feasible after further evaluation and contact with landowners. In order to achieve necessary load reductions, additional stream bank sites with high sediment contributions with limited feasibility will also need to be addressed. There are 7 sites where a stabilized crossing is needed in the watershed area and 5 sites where removal of debris is needed. There are 18 gullies/ravines adjacent to the stream that were identified as feasible for stabilization. Increased tile and ditch drainage as well as urbanization have caused excess runoff to the streams. Best management practices that involve slowing the flow of water to the stream will be needed such as wetland restorations, grassed waterways, and water and sediment control basins.

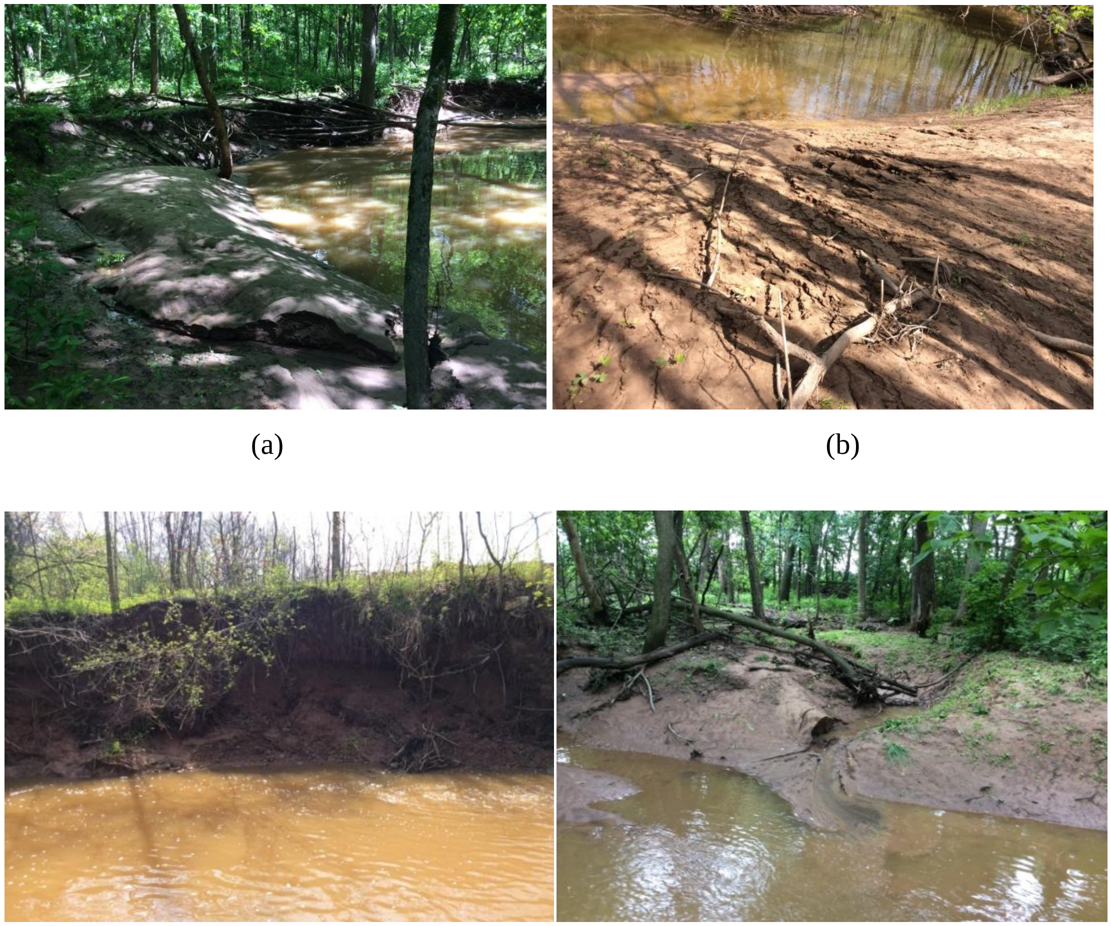
Livestock have free access to about 2 miles of stream bank in the watershed area. Most of the stream banks in these areas are in fair to good condition. There are 2 sites where there is stream degradation due to livestock access. Limiting livestock access to the streams by means of fencing and better management will help prevent further degradation of the stream in these areas.

Figure 26. Flooding of Kankapot Creek during rain event in May 2014.

Table 21. Potentially feasible streambank restoration sites.

Number	Site ID	Length	Lateral Recession	Erosion (tons/year)	Feasibility
1	10414	549.41	Severe	74.17	Potentially Feasible
2	14420	676.27	Severe	45.65	Potentially Feasible
3	10022	123.25	Very Severe	39.44	Potentially Feasible
4	8422	167.42	Severe	30.14	Potentially Feasible
5	14012	139.36	Very Severe	25.08	Potentially Feasible
6	23751	301.19	Severe	24.40	Potentially Feasible
7	10017	222.84	Severe	24.07	Potentially Feasible
8	10027	374.58	Severe	22.47	Potentially Feasible
9	10432	391.92	Severe	18.81	Potentially Feasible

Number	Site ID	Length	Lateral Recession	Erosion (tons/year)	Feasibility
10	18813	253.33	Severe	18.24	Potentially Feasible
11	10812	239.84	Severe	14.39	Potentially Feasible
12	11210	298.94	Severe	14.35	Potentially Feasible
13	1201	586.88	Moderate	14.09	Potentially Feasible
14	13205	155.61	Severe	13.07	Potentially Feasible
15	14408	85.41	Severe	10.25	Potentially Feasible
16	23788	94.10	Severe	10.16	Potentially Feasible
17	13605	89.63	Severe	8.60	Potentially Feasible
18	14029	397.95	Moderate	7.64	Potentially Feasible
19	10816	176.97	Severe	7.43	Potentially Feasible
20	26381	134.83	Severe	7.28	Potentially Feasible
21	5602	141.21	Severe	6.78	Potentially Feasible
22	34167	186.04	Severe	6.70	Potentially Feasible
23	8015	138.37	Severe	6.64	Potentially Feasible
24	38280	126.74	Severe	5.70	Potentially Feasible
25	23804	105.28	Severe	5.69	Potentially Feasible
26	22466	65.69	Severe	5.32	Potentially Feasible
27	23817	128.65	Severe	5.21	Potentially Feasible
28	26434	90.62	Severe	4.89	Potentially Feasible
29	4401	168.98	Moderate	4.87	Potentially Feasible
30	12438	128.76	Severe	4.64	Potentially Feasible
31	23744	105.34	Severe	4.27	Potentially Feasible
32	29251	75.32	Severe	4.07	Potentially Feasible
33	12826	102.06	Severe	3.67	Potentially Feasible
34	23757	173.79	Moderate	3.28	Potentially Feasible
35	23752	200.32	Moderate	3.25	Potentially Feasible
36	37871	36.18	Severe	2.17	Potentially Feasible
37	16434	51.58	Severe	2.17	Potentially Feasible
38	6002	58.59	Severe	2.11	Potentially Feasible
39	12820	73.86	Severe	1.99	Potentially Feasible
40	29724	28.92	Severe	1.56	Potentially Feasible
41	26427	26.92	Severe	1.45	Potentially Feasible
42	14407	138.25	Moderate	1.33	Potentially Feasible
43	27754	17.67	Severe	1.27	Potentially Feasible
44	29307	46.92	Severe	1.27	Potentially Feasible
45	26866	132.79	Moderate	1.08	Potentially Feasible
46	12406	17.60	Severe	1.06	Potentially Feasible
47	27767	79.59	Moderate	0.57	Potentially Feasible
48	23856	50.51	Moderate	0.55	Potentially Feasible
49	8014	71.47	Moderate	0.51	Potentially Feasible
50	27766	33.56	Moderate	0.16	Potentially Feasible



(a) (b) (c) (d)

Figure 27. Common features found on Plum and Kankapot Creeks. (a) Sediment deposit on Plum Creek near Holland Rd. (b) Rills forming on bank on Plum Creek North of Lamers Clancy Rd. (c) Severe erosion on Kankapot Creek (d) Gully inlet on Kankapot Creek with visible sediment discharge south of County Rd. KK.

6.3 Upland Inventory

Agricultural uplands were inventoried by windshield survey, use of GIS data and tools, and with aerial photography. The use of a tool developed by the WDNR called EVAAL[3](Erosion Vulnerability Assessment for Agricultural Lands) and its data sets were used to determine priority areas for best management practices in the watershed. The tool estimates the vulnerability of a field to erosion and can be used to determine internally draining areas, potential for gully erosion, and potential for sheet and rill erosion.

Tillage Practices and Residue Management

A total of 8,621 acres of agricultural fields were inventoried for crop type, tillage, and residue level by windshield survey using the ArcGIS collector application in early spring of 2014. Residue estimates from the windshield survey are very rough estimates due to proximity to fields and time. There were 5,107 acres of fields inventoried that were not currently in hay/alfalfa, of those fields, 3,739 acres (73%) had low residue, 561 acres (11%) had medium residue levels, and 807 acres had high residue (15.8%). These results of the windshield survey are very similar to tillage conditions used in the Lower Fox River TMDL SWAT model. Data was analyzed from the Conservation Technology Information Center (CTIC) Conservation Tillage Reports (Transect Surveys) from Brown, Outagamie, Calumet, and Winnebago Counties to determine primary tillage practices for the SWAT model input for the Lower Fox River TMDL. The baseline tillage conditions for a dairy rotation were determined to be 83.1% Conventional Tillage, 15.2 % Mulch Till, and 1.7% No till and 75.9% Conventional Tillage, 20.2 % Mulch Till, and 3.9% No till for Cash Crop Rotation (WDNR 2012). During the upland inventory visible signs of erosion were prominent throughout the watershed area. Gullies and rills were visible on many fields as well as sedimentation in drainage ditches.

Figure 28. Examples of fields with low residue with erosion occurring in the Plum and Kankapot Watershed.

[3] Information on EVAAL can be found on the website http://dnr.wi.gov/topic/nonpoint/evaal.html.

Nutrient Management

Nutrient management plans are conservation plans specific to livestock operations. Nutrient management plans address concerns related to soil erosion, manure management, and nutrient applications. Nutrient management plans must meet the standards of the Wisconsin NRCS 590 Standard.

Agricultural land with nutrient management plans was mapped by parcel in Figure 29. There are currently 16,023 acres under a nutrient management plan and 15,175 acres not covered under a nutrient management plan. The majority of land in the Kankapot watershed is not covered under nutrient management in comparison to land in Plum Watershed. All agricultural operators in the watershed should have nutrient management plans. Enforcement of nutrient management plans will also be necessary since many farmers do not always follow their nutrient management plans.

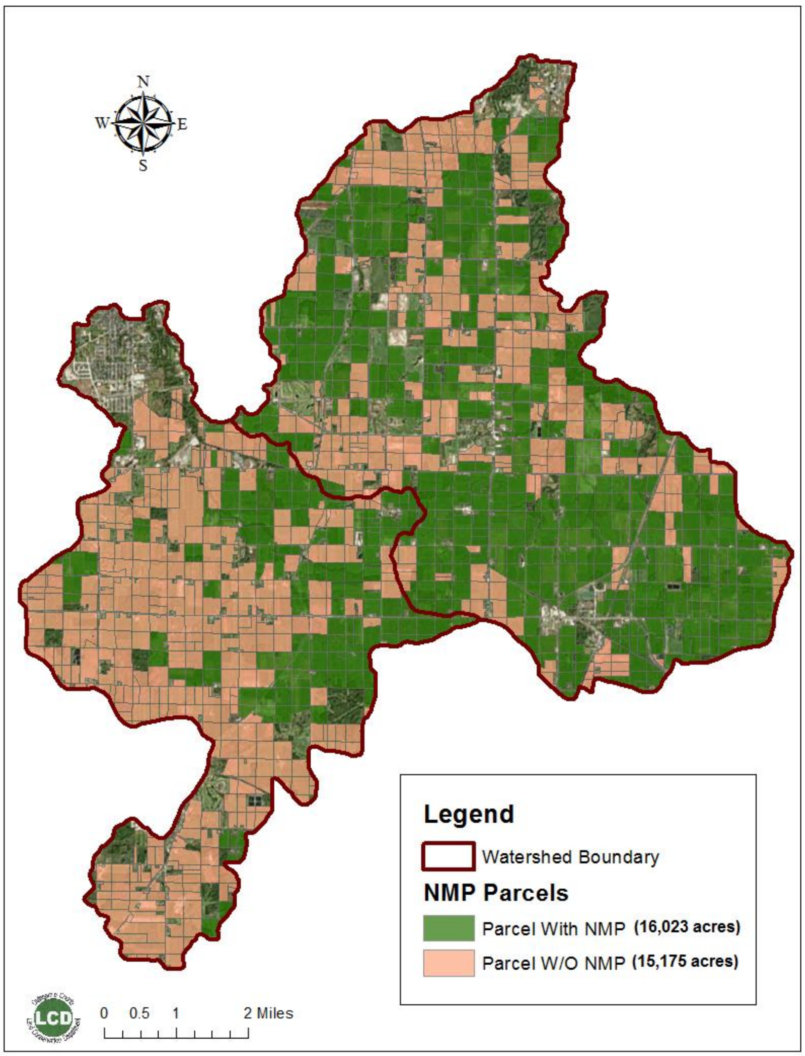


Figure 29. Parcels with Nutrient Management Plans in the Plum and Kankapot Watershed.

Table 22. Nutrient Management Plan coverage by county in watershed area.

County	With NMP (acres)	Without NMP (acres)
Brown	3,434	3,100
Calumet	9,834	9,563
Outagamie	2,755	2,512
Total	16,023	15,175

Erosion Vulnerability

Priority fields for conservation practices were evaluated using slope data and the EVAAL tool erosion score. Cropland with a high percent slope is more likely to have runoff and erosion problems. Mean cropland slope was determined for each CLU (Common Land Unit) in the watershed and is shown in Figure 31. Any cropland with a mean cropland slope of 3 percent or greater will be considered priority fields for conservation practices. There are 6,802 acres of fields with a 3% slope or greater in the watershed. Cropland with a mean slope greater than 6% will be considered critical fields (462 acres). Critical fields should be kept in continuous cover and/or use a no till system. In addition, the mean erosion score calculated using EVAAL will also facilitate prioritization of the implementation of BMPs (Figure 32). The erosion score is based on stream power index, curve number, precipitation data, elevation, and USLE[4] factors C & K. This tool does not predict erosion rates, but estimates the probability of a field to have more erosion problems than its neighboring fields. The use of best management practices such as cover crops, conservation tillage, no tillage, contour farming, or strip cropping practices on all priority fields will be necessary to achieve phosphorus and sediment reductions.

Figure 30. Multiple gullies down slope in field in the Plum Creek Watershed.

[4] USLE refers to the Universal Soil Loss Equation that estimates average annual soil loss caused by sheet and rill erosion based on the following factors : rainfall and runoff (A), soil erodibility factor (K), slope factor (LS), crop and cover management factor (C), conservation practice factor (P).

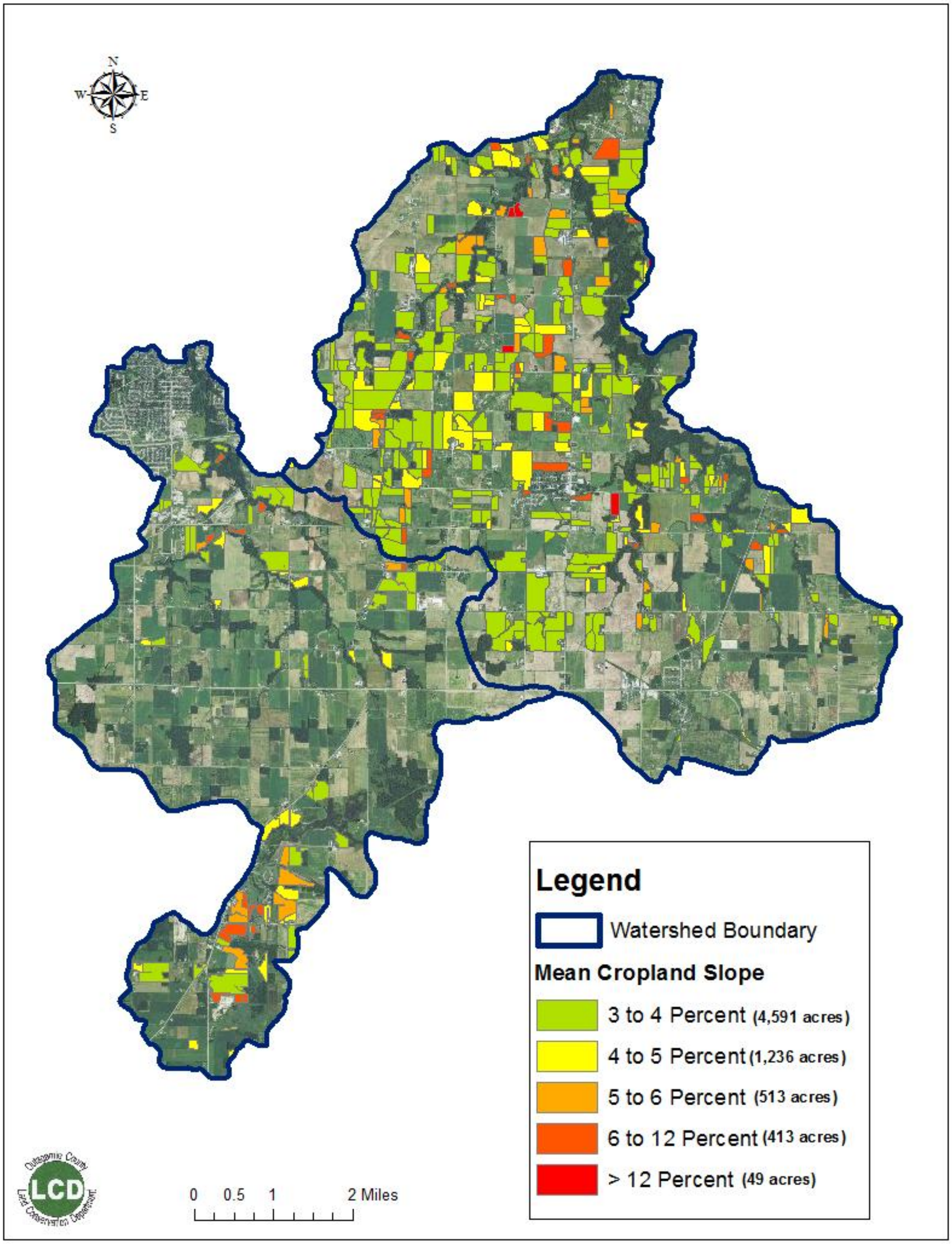


Figure 31. Mean cropland slope in the Plum and Kankapot Watershed indicating priority fields.

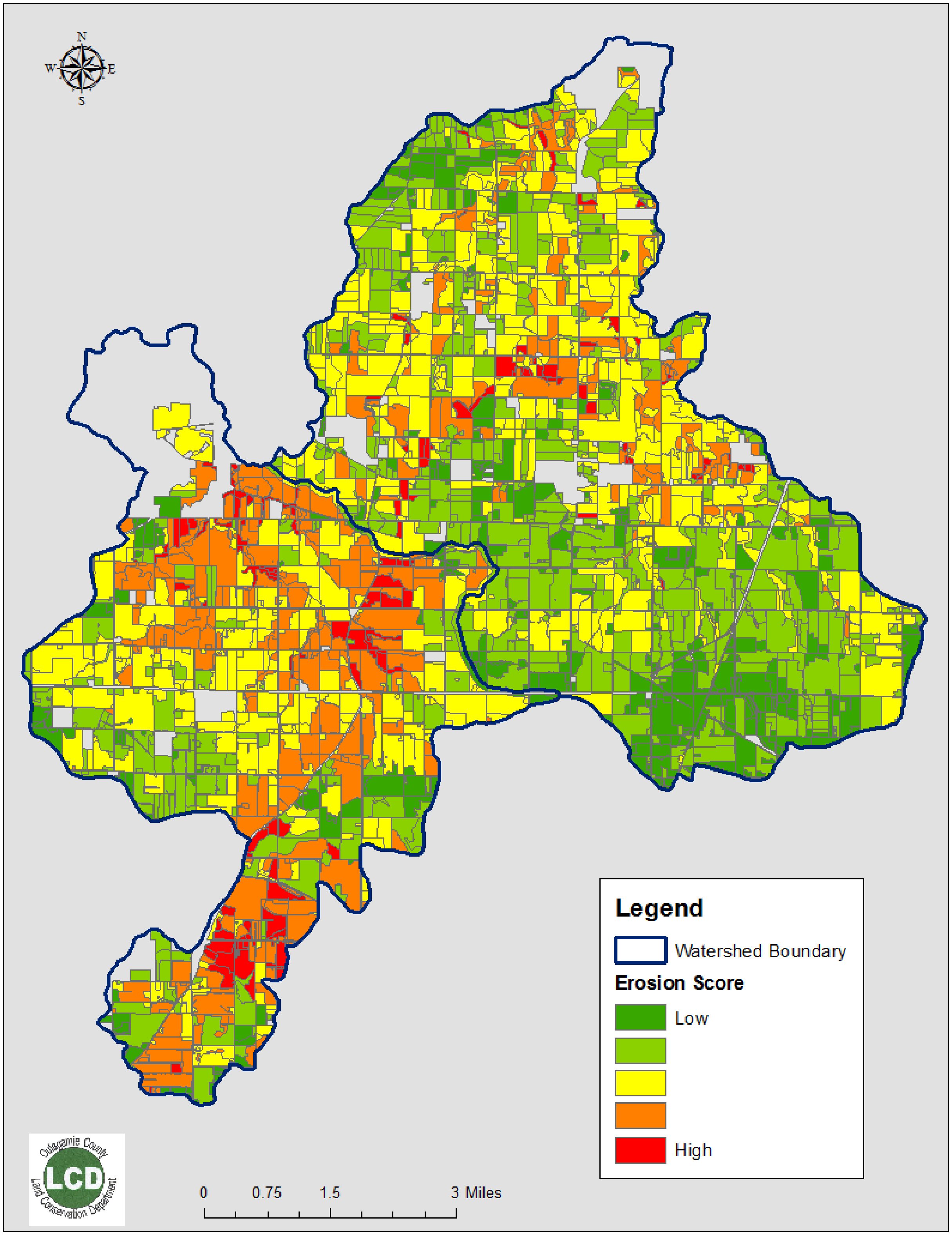


Figure 32. EVAAL tool erosion score indicating priority fields in the Plum and Kankapot Watershed.

Phosphorus Index and Soil Test Phosphorus

Phosphorus Index and phosphorus concentrations for fields under Nutrient Management plans have been tracked by Brown and Outagamie County on a limited basis. Calumet County is in the process of starting to track phosphorus index and concentrations per field. Soil test phosphorus values are shown in Figure 34. Better tracking of soil test phosphorus concentration and P index in the watershed will be useful in prioritizing fields for improved management practices. As you can see in Figure 33 the majority of the fields that have been tracked in the Plum Creek watershed are below the PI Index of 6. As concluded in Martin Jacobson's study a lower target PI, less than the state standard of 6, for this watershed may be necessary to achieve water quality goals in this watershed (Jacobson 2012). As more landowners in the watershed area sign up for nutrient management plans, more soil test phosphorus and phosphorus index data will become available. Further analysis of this data will be needed before any conclusions can be drawn to a specific target PI or soil test phosphorus concentration needed for this watershed.

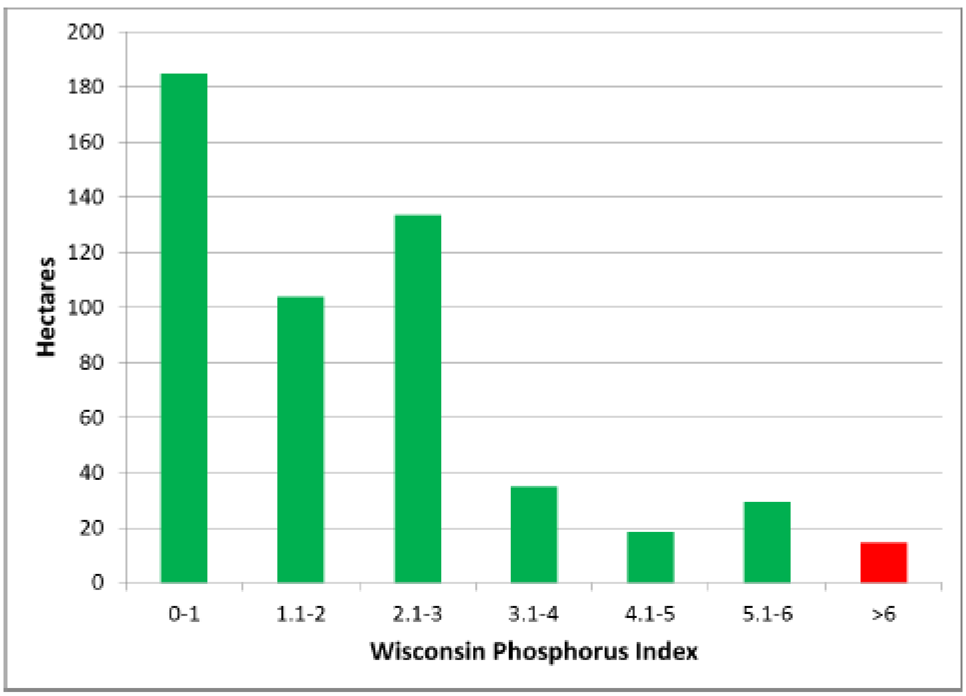


Figure 33. Distribution of Wisconsin Phosphorus Index values within multi-field catchment areas in Plum Creek studied by Martin Jacobson during crop year 2012 (Jacobson 2012).

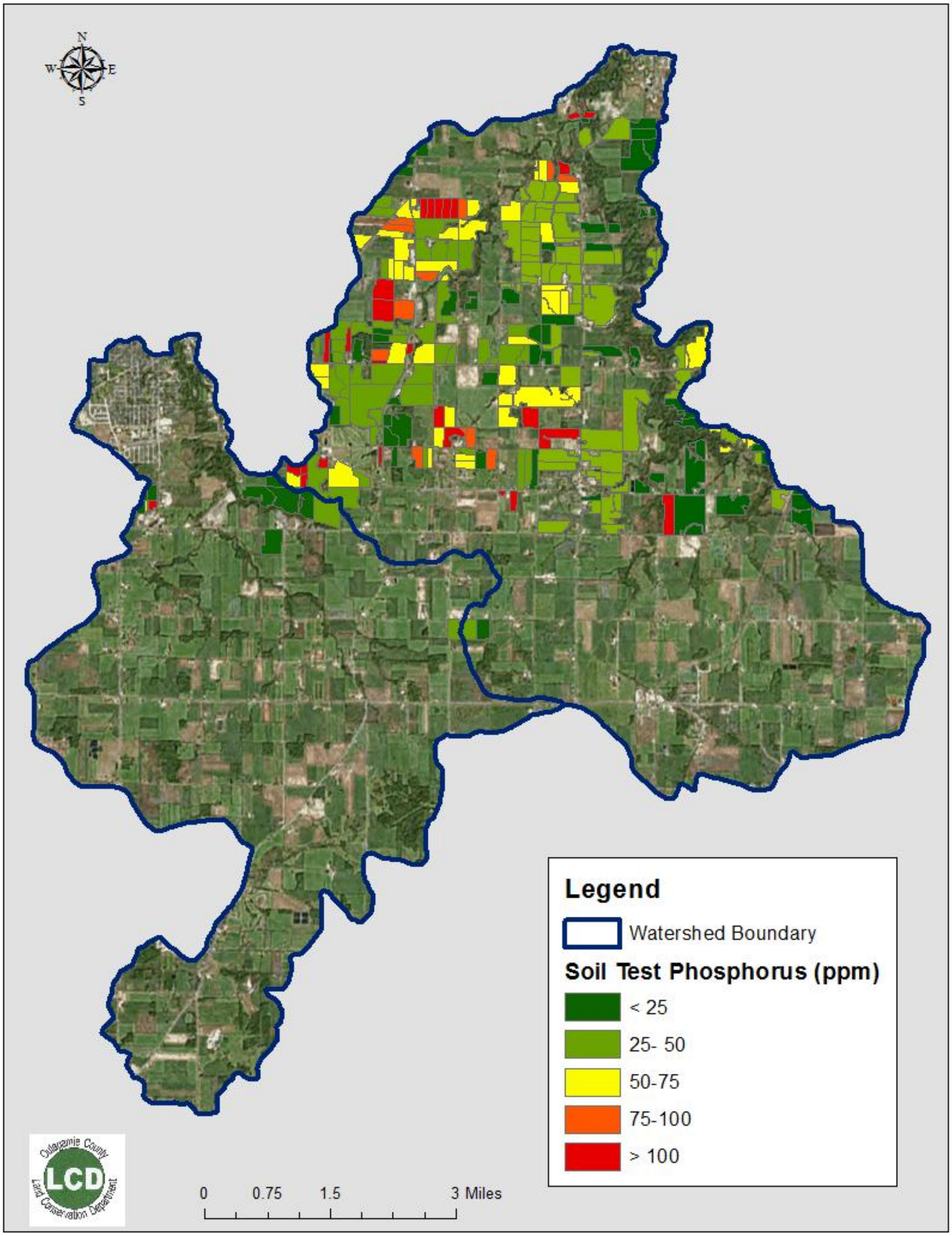


Figure 34. Soil test phosphorus concentrations of fields in the Plum and Kankapot Watershed.

Grazing/Pastureland Management

By doing one on one inventory with farms in the area we were also able to determine how many farms grazed or pastured their livestock. Very few farmers graze their livestock in either watershed. Farmers that do pasture their livestock in the watershed do it for exercise and not as a means of forage with the exception of 2-3 farmers. The STEPL model estimated 4,063 lbs of phosphorus/year and 287 tons of sediment per year can be attributed to pasture/hay land. Encouraging smaller farms to convert cropland or land used for hay to managed grazing land could result in significant pollutant reductions. Grazing can also benefit farmers financially by saving them money on fuel costs associated with harvesting, planting, and transportation. In addition better management of current pastureland can reduce pollutant loading as well.

Constructed and Restorable Wetlands

Wetlands are an important feature of a watershed. Wetlands provide a number of benefits such as water quality improvement, wildlife habitat, and flood control. According to the USEPA a typical one acre wetland can store about 1 million gallons of water (USEPA 2006). Restoring wetlands and constructing designed wetlands in the watershed area will provide water storage and reduce sediment and phosphorus loading. Constructed treatment wetlands can be used to treat water from tile drains, barnyards, upland runoff, and waste water.

The Cadmus Group (developers of the Lower Fox TMDL plan) analyzed each subwatershed for potentially restorable wetlands using the Wisconsin Wetlands Inventory, hydric soils, and land cover data. A restorable wetland is any wetland that was historically a wetland but has since been drained due to tiling and ditching or has been filled in. A wetland was considered potentially restorable if it met hydric soil criteria and was not in an urban area. Any wetland less than 0.5 acres was considered economically infeasible. This analysis estimated that there are 352 acres of potentially restorable wetlands in Plum Creek and 619 acres in Kankapot Creek (Table 23). Table 24 shows the percent reduction in phosphorus and sediment by subwatershed if 100% of the potentially restorable wetlands are restored. According to the analysis done for the Lower Fox River TMDL, restoring wetlands in the Kankapot watershed would result in a significant reduction in pollutant loading. Potentially restorable wetlands and existing wetlands are shown in Figure 35.

Table 23. Summary of original, lost, remaining, and potentially restorable wetlands (PRW) in acres for each sub-basin in the Lower Fox River Basin. Source: WDNR 2012

Sub-Basins	Original	Lost	Remaining	PRWs
East River	4,479	2,052	2,427	1,558
Baird Creek	3,584	1,831	1,753	1,498
Bower Creek	2,221	1,541	680	1,193
Apple Creek	2,270	1,458	811	1,002
Ashwaubenon Creek	1,075	625	450	439
Dutchman Creek	2,168	949	1,219	561
Plum Creek	667	389	277	352
Kankapot Creek	1,993	704	1,289	619
Garners Creek	254	91	163	34
Mud Creek	753	394	359	103
Duck Creek	16,403	5,166	11,238	3,715
Trout Creek	2,753	838	1,915	662
Neenah Slough	1,734	998	735	696
Lower Fox (main stem)	3,974	2,163	1,811	494
Lower Green Bay	6,572	2,045	4,527	1,438
Total	**50,900**	**21,244**	**29,654**	**14,364**
Percent	**13% of Basin**	**42% of Original**	**58% of Original**	**68% of Lost**

Table 24. Summary of relative yield reductions for particulate phosphorus (sed-P) and sediment (as TSS) for each sub-basin in the Lower Fox River Basin. Source: WDNR 2012

Sub-Basins	Baseline Sed-P Yield (lbs/ac/yr)	Relative Sed-P Yield Reduction (lbs/ac/yr)	Sed-P Reduction (%)	Baseline TSS Yield (lbs/ac/yr)	Relative TSS Yield Reduction (lbs/ac/yr)	TSS Reduction (%)
East River	0.66	0.28	42%	405.1	168.1	42%
Baird Creek	0.45	0.28	62%	231.6	131.7	57%
Bower Creek	0.68	0.34	51%	383.0	194.0	51%
Apple Creek	0.63	0.23	37%	372.1	133.4	36%
Ashwaubenon Creek	0.49	0.17	35%	262.9	87.7	33%
Dutchman Creek	0.45	0.18	41%	262.4	107.8	41%
Plum Creek	0.90	0.24	27%	526.6	138.0	26%
Kankapot Creek	0.79	0.38	49%	442.0	212.8	48%
Garners Creek	0.58	0.05	9%	406.9	37.7	9%
Mud Creek	0.38	0.08	20%	305.1	62.2	20%
Duck Creek	0.43	0.21	49%	290.9	141.7	49%
Trout Creek	0.23	0.15	64%	150.8	97.0	64%
Neenah Slough	0.47	0.24	51%	335.1	147.7	44%
Lower Fox (main stem)	0.43	0.08	18%	379.9	64.4	17%
Lower Green Bay	0.41	0.24	59%	231.2	127.8	55%

Using the Wisconsin Department of Natural Resources' potential restorable wetlands GIS layer, potential wetland restoration sites were evaluated by air photo for their feasibility for restoration based on location, size, and the number of landowners. Large sites with multiple landowners were considered limited feasibility due to difficulties that would be involved in cooperation agreements. Any site that was located where existing development existed or was occurring was eliminated. Of the 971 acres of potentially restorable wetland only 757 acres was determined to be potentially feasible or limited feasibility with 519 acres considered limited and 238 acres considered potentially feasible (

Table 25, Figure 36). Implementing restoration of wetlands will be difficult since it involves taking agriculture land out of production. Of the 238 acres of potentially feasible restoration sites it is estimated that approximately 50 acres could be restored. The load reductions for 50 acres of wetlands are shown in Table 28 in Section 9.0 Load Reductions. Restoring wetlands for the purpose of water storage in this watershed is also necessary to prevent flooding and streambank erosion. These potentially restorable wetland sites are also potential sites for constructed wetlands designed for treating agricultural runoff or tile drainage. Any potential wetland restoration and constructed wetland site will have to be further evaluated prior to any planning and implementation.

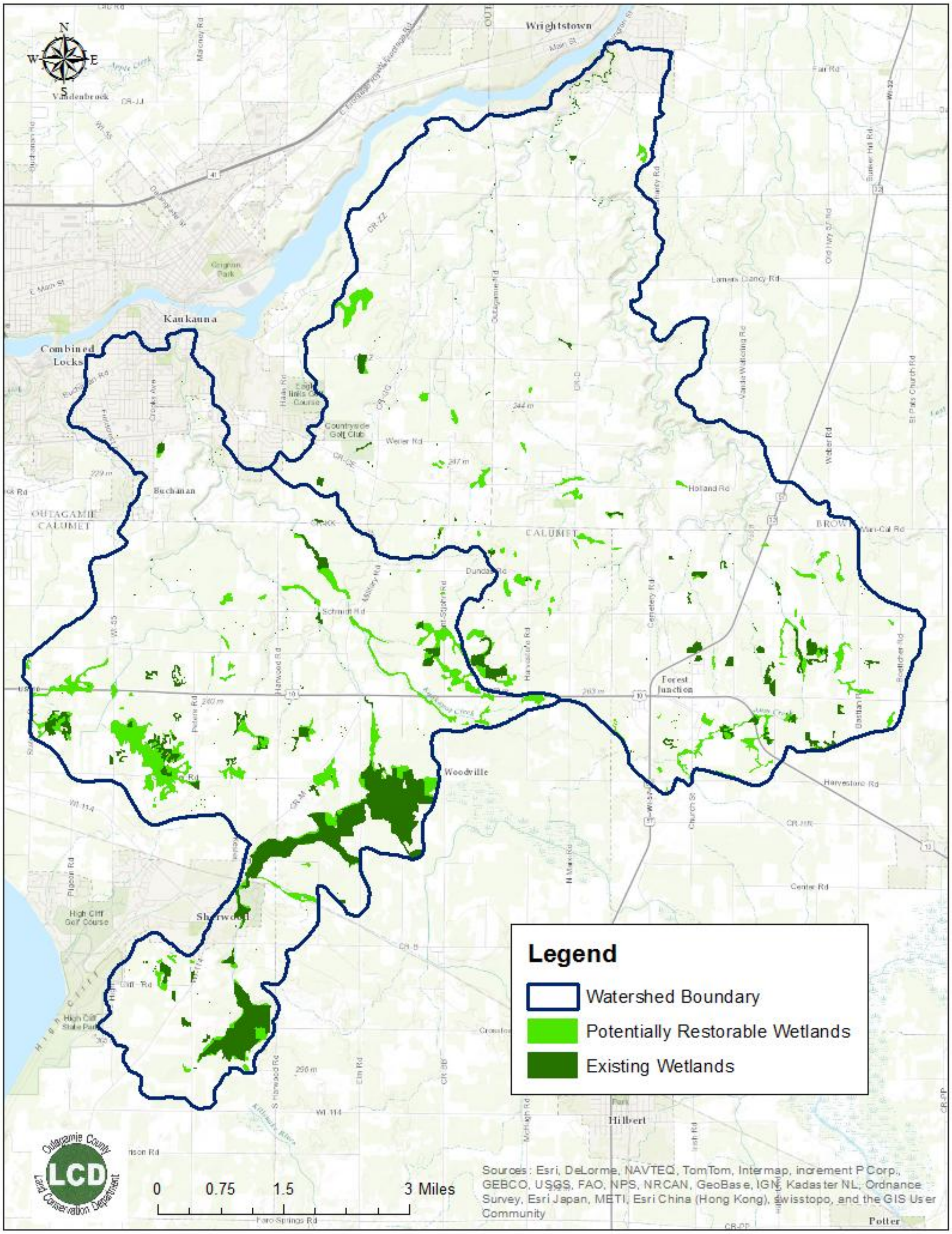


Figure 35. Existing wetlands and potentially restorable wetlands in the Plum and Kankapot Watershed.

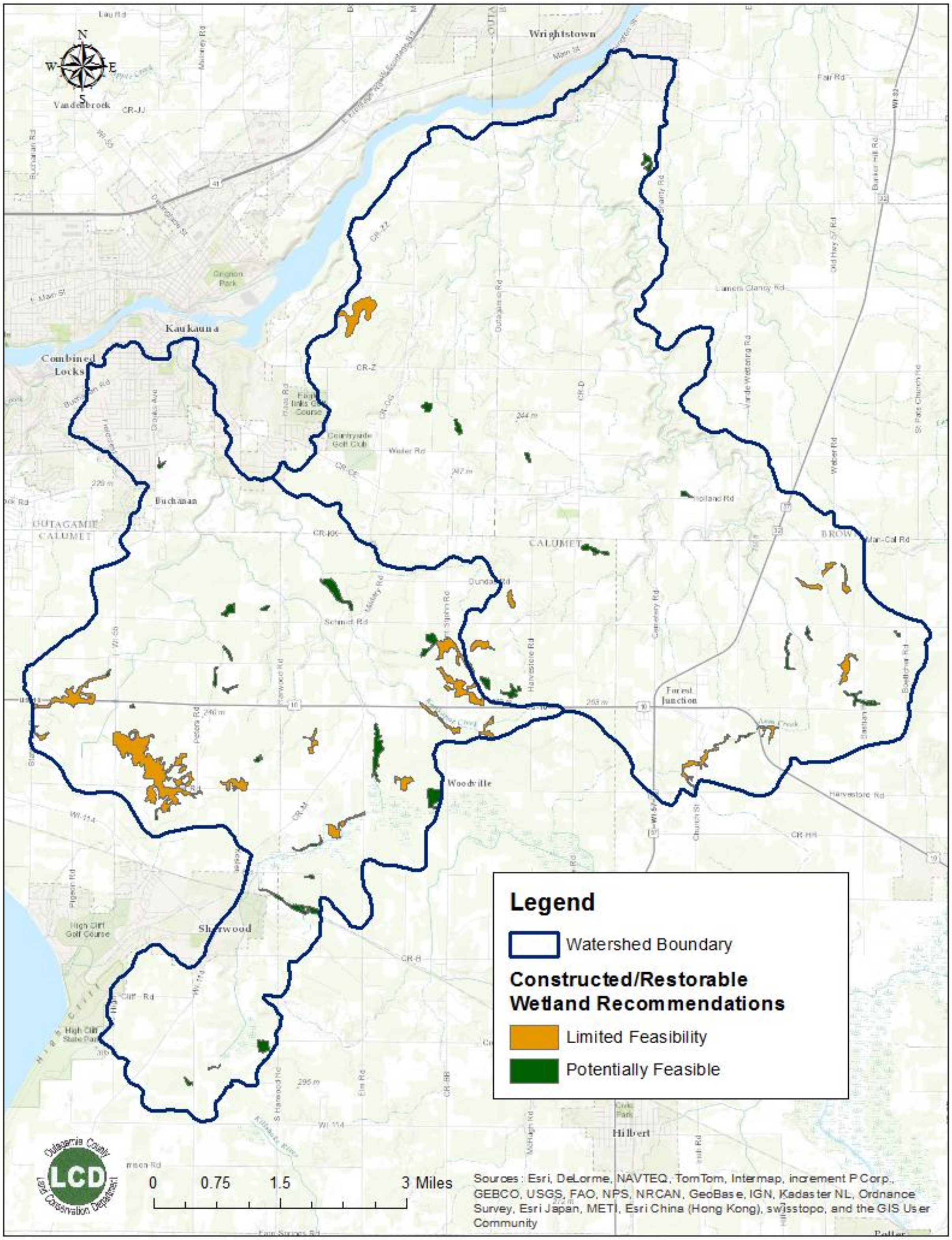


Figure 36. Constructed/Restorable Wetland recommendations in the Plum and Kankapot Watershed.

Table 25. Potential wetland restoration sites.

Site ID	Acres	Feasibility
1	7.76	Potentially Feasible
2	1.18	Potentially Feasible
3	3.35	Potentially Feasible
4	2.34	Potentially Feasible
5	3.44	Potentially Feasible
6	2.83	Potentially Feasible
7	12.30	Potentially Feasible
8	16.28	Limited Feasibility
9	11.67	Limited Feasibility
10	2.54	Potentially Feasible
11	172.21	Limited Feasibility
12	25.02	Potentially Feasible
13	1.70	Potentially Feasible
14	3.21	Potentially Feasible
15	1.27	Potentially Feasible
16	1.84	Potentially Feasible
17	1.50	Potentially Feasible
18	3.71	Potentially Feasible
19	8.16	Limited Feasibility
20	9.29	Potentially Feasible
21	50.62	Limited Feasibility
22	4.98	Potentially Feasible
23	9.82	Limited Feasibility
24	1.83	Potentially Feasible
25	3.98	Potentially Feasible
26	5.83	Limited Feasibility
27	12.13	Potentially Feasible
28	20.06	Limited Feasibility
29	2.70	Potentially Feasible
30	6.06	Potentially Feasible
31	9.65	Potentially Feasible
32	6.91	Potentially Feasible
33	10.27	Potentially Feasible
34	7.35	Limited Feasibility
35	7.01	Limited Feasibility
36	31.49	Limited Feasibility
37	52.30	Limited Feasibility
38	10.94	Potentially Feasible
39	2.77	Potentially Feasible

Site ID	Acres	Feasibility
40	16.42	Limited Feasibility
41	11.22	Limited Feasibility
42	5.93	Potentially Feasible
43	7.68	Limited Feasibility
44	2.60	Potentially Feasible
45	22.38	Potentially Feasible
46	7.38	Limited Feasibility
47	2.12	Limited Feasibility
48	1.91	Potentially Feasible
49	39.26	Limited Feasibility
50	16.14	Limited Feasibility
51	8.44	Potentially Feasible
52	8.94	Limited Feasibility
53	2.57	Potentially Feasible
54	19.78	Potentially Feasible
55	12.67	Limited Feasibility
56	6.51	Potentially Feasible
57	12.80	Potentially Feasible

Tile Drainage

Fields with tile drainage were inventoried by using aerial photographs and then mapped using ArcGIS. There were 12,773 acres of fields that had visible signs of tile drainage in the watershed area (Figure 37). Tile drains in fields can act as a conduit for nutrient transport to streams if not managed properly. Treating tile drainage at the outlet and better management of nutrient/manure applications on fields can reduce the amount of phosphorus reaching Plum and Kankapot Creek. Some options for treating tile drainage at the outlet include constructing a treatment wetland, biofilters at the outlets, and installation of water control structures to stop the flow of drainage water during poor conditions.

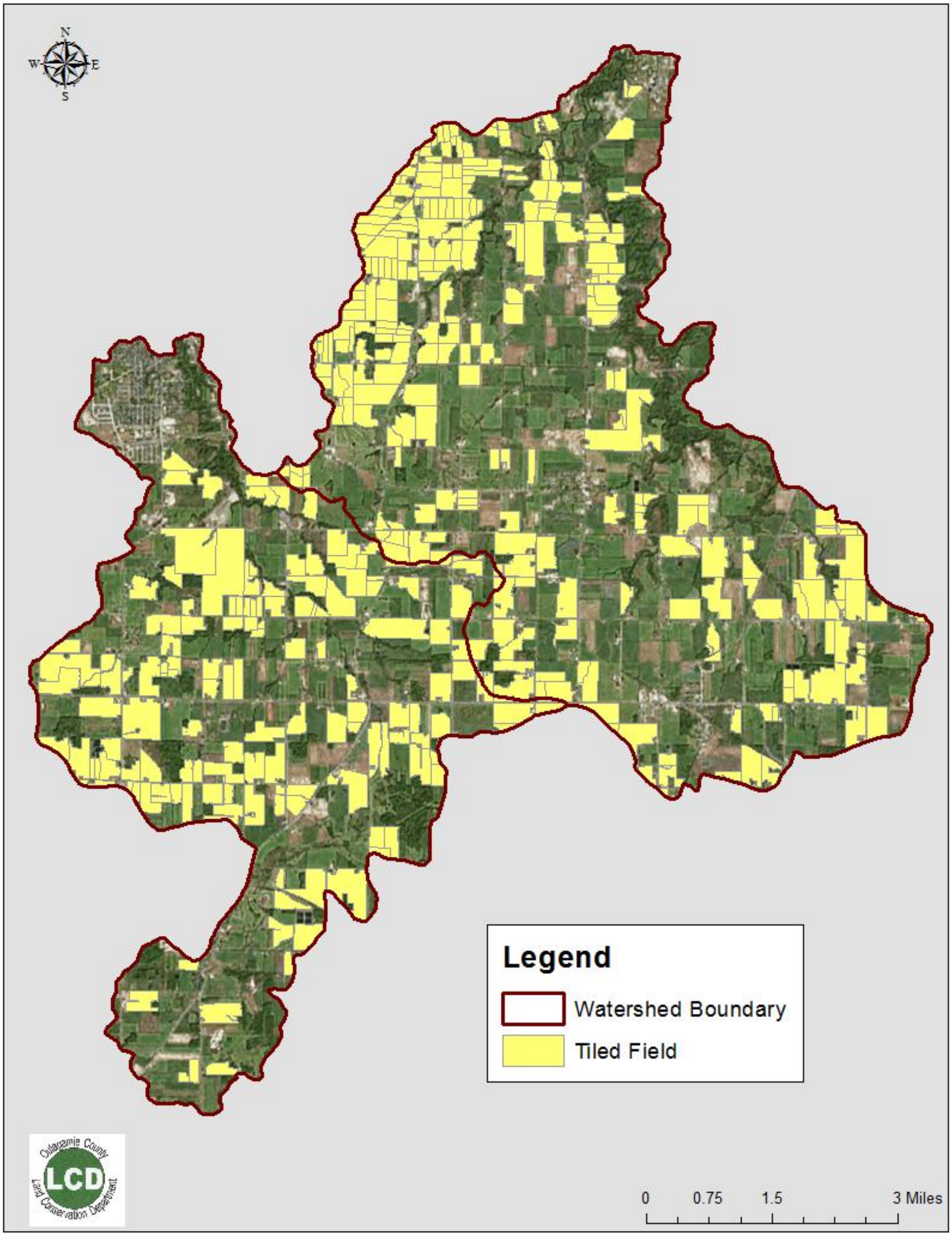


Figure 37. Tiled fields in the Plum and Kankapot Watershed.

Vegetative Buffer Strips

Riparian Buffers

Riparian buffers filter out sediment and nutrients from water before reaching a stream channel. Buffers also reduce amount of runoff volume, provide wildlife habitat, and help regulate stream temperature. Wisconsin state standards (NR 115) require a minimum 35 ft buffer running parallel to the ordinary high water mark of navigable lakes, streams, and rivers. Any stream without the minimum 35 ft buffer will be considered a priority buffer area. In addition to meeting the standard 35 ft buffer some priority area buffers may need to be extended to 50 ft to provide necessary reductions in pollutant loads. Priority riparian buffer areas were determined using aerial photography, the DNR 24K Hydrography data set, and USGS topography maps (Figure 40). There may be additional streams, drainage ditches, and channels not delineated that could also have vegetated buffer strips installed to improve water quality and riparian habitat

Chapter NR115, Wis. Amin. Code : MINIMUM STATEWIDE STANDARDS

Chapter NR 115, Wis. Admin. Code, requires a 35 foot deep shoreline buffer running parallel to the ordinary high-water mark of navigable lakes, rivers and streams. In this buffer area, activities are limited. No more than 30 feet in any 100 feet may be clear-cut; however cutting regulations do not apply to dead, diseased or dying trees and shrubbery. Beyond 35 feet inland, tree and shrubbery cutting shall be governed by the use of sound forestry and soil conservation practices to protect water quality.

Tillage Setback and Field Borders

During windshield surveys of the watershed area there were many fields noted that did not have any tillage setback from drainage ditches. As seen in Figure 38, not having an adequate buffer between a field and a ditch can contribute to significant sediment and phosphorus loading in a watershed. Enforcement of NR 151.03 tillage setback standards of 5 ft from the top of the channel of surface waters will be necessary in the watershed. In addition to the mandated tillage setback requirements, some fields may need additional buffer area to protect surface water in road and other drainage ditches. An additional 20 ft field border may be necessary in fields where there are resource protection concerns. Field borders should also be applied on fields bordering forested riparian areas with high slopes to achieve additional phosphorus and sediment reduction. Field borders along wooded areas also provide necessary habitat for wildlife. Crop yield losses have been found to be greatest along the edges of fields that are surrounded by woody vegetation due to competition for sunlight and nutrients (Pierce et al, 2008). Therefore adding a buffer to these areas would not be taking prime production areas out of a field. Fields with high slopes and high erosion scores (Figure 31 & 32), fields bordered by forested riparian area, and fields where the minimum set back is not sufficient will be considered priority fields for installation of field borders.

Figure 38. Example of inadequate tillage setback in Plum Creek Watershed.

Figure 39. Example of inadequate riparian buffer on Kankapot Creek.

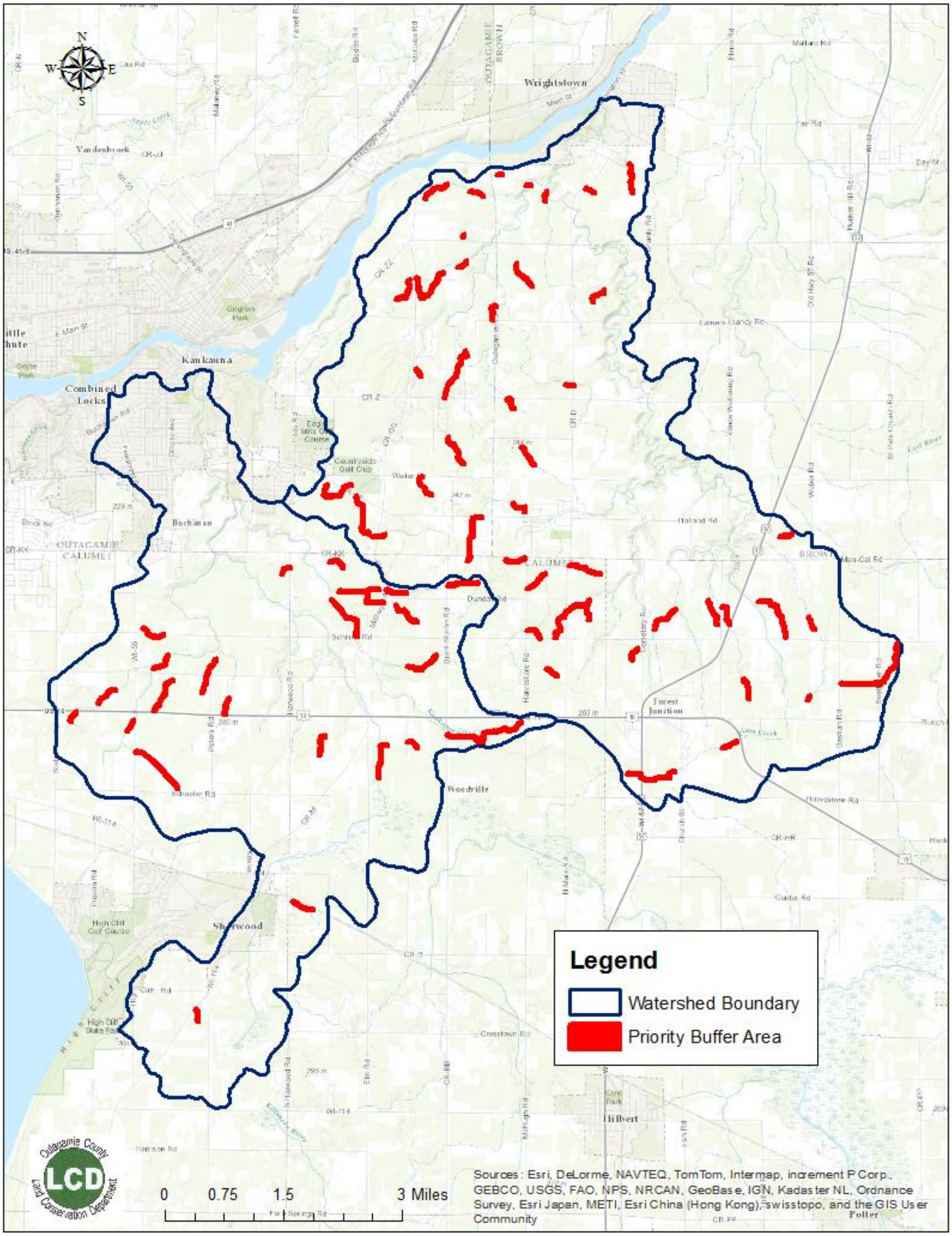


Figure 40. Priority riparian buffer restoration sites.

Gully and Concentrated Flow Stabilization

GIS data along with aerial photographs were used estimate the location of possible gullies and concentrated flow in fields. Elevations and flow direction data was used to develop a stream power index (SPI) for the EVAAL tool that indicates areas of concentrated flows that might be gullies. Stream power index data for the watershed can be found in Appendix E. Five acre and 10 acre drainage lines were also developed using ArcGIS. A high stream power index and 10 acre drainage lines were used to determine where grassed waterways may be necessary in the watershed. Priority areas for grassed waterways determined by GIS methods are shown in Figure 42. The same method was applied for concentrated flow area seedings except the 5 acre drainage line was used with a lower stream power index value than used for grassed waterways. Five acre drainage lines for the watersheds can be found in Appendix F. To stabilize concentrated flow areas while still promoting productive agricultural practices, these areas should be seeded with permanent cover. Unlike a grassed waterway, crops can still be planted in the concentrated flow area seeding but the area cannot be tilled. In addition to using grassed waterways and concentrated flow area planting, water and sediment control basins will also be necessary with these practices in some locations. Water and sediment control basins usually consist of an earth embankment or a combination ridge and channel generally constructed across the slope and minor water courses to form a sediment trap and water detention basin.

Figure 41. Example of concentrated flow area in Kankapot Creek Watershed (left) and example of gullies in a field in Plum Creek Watershed (right).

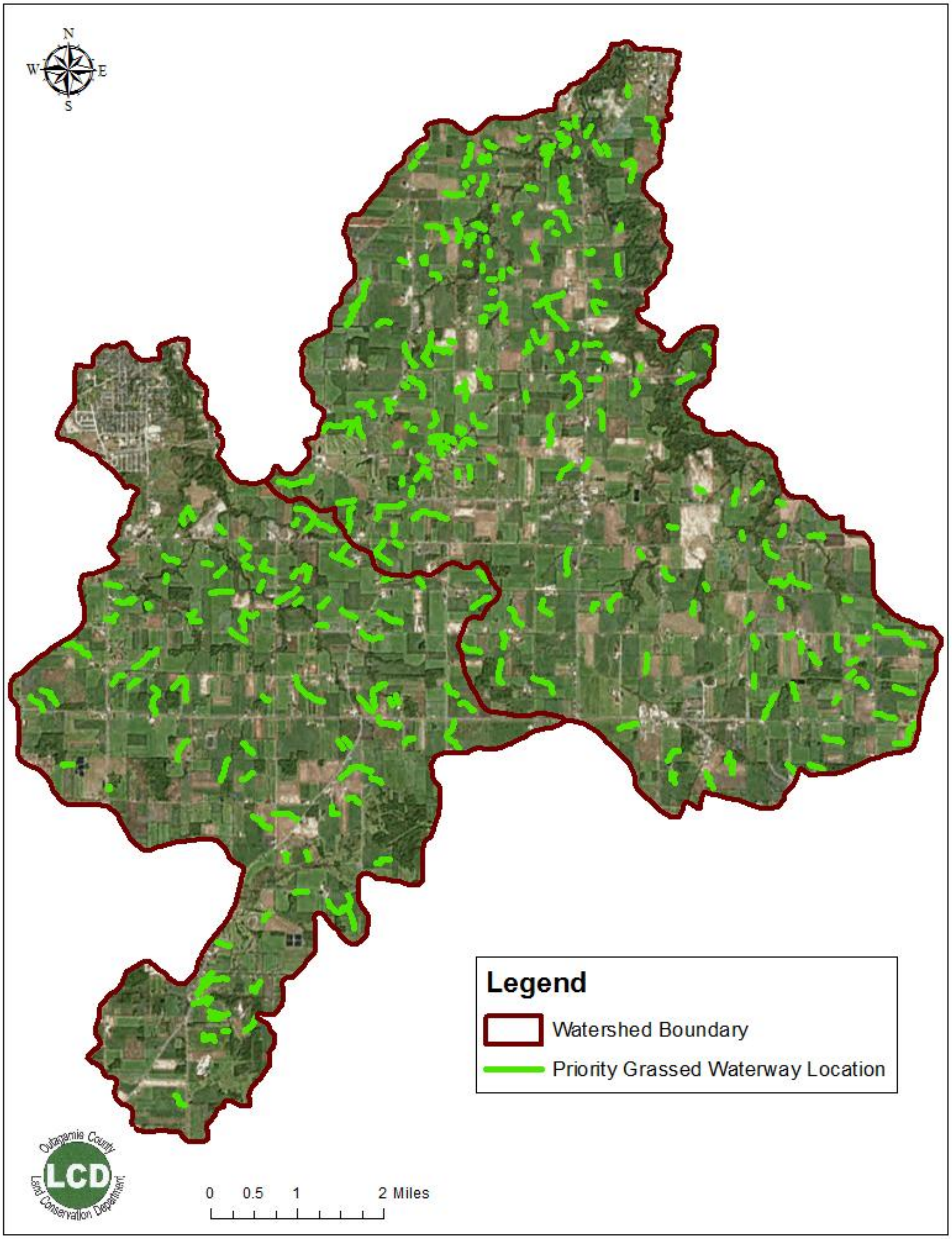


Figure 42. Priority areas for grassed waterways.

Current Management Practices/Projects

There have been a number of conservation projects installed within the Plum and Kankapot Watersheds over the last several years. These projects include barnyard runoff control systems, grade stabilization, waste storage facilities, buffers, and nutrient management planning. Most of the current conservation practices have been installed in the West Plum Creek subwatershed. Manure storage facilities have already been installed at 41 of the production sites in the watershed area. Nutrient management coverage in the watershed is shown in Figure 29 in Chapter 6.3.

There has also been a significant amount of buffers installed in the Northern portion of the Plum Creek Watershed (Figure 43). In 2011, the Outagamie County Land Conservation Department received a grant from the Great Lakes Restoration Initiative for the Plum and Kankapot Buffer Initiative. The buffer project concluded in September of 2014. The project successfully signed up 90 acres for buffers in the Plum Creek region of Outagamie County. In addition, the Brown County Land Conservation Department has installed 60 acres of buffers in Plum Creek since the adoption of their ordinance requiring the implementation of vegetated buffer strips on all blue lines found in a USGS quadrangle map.

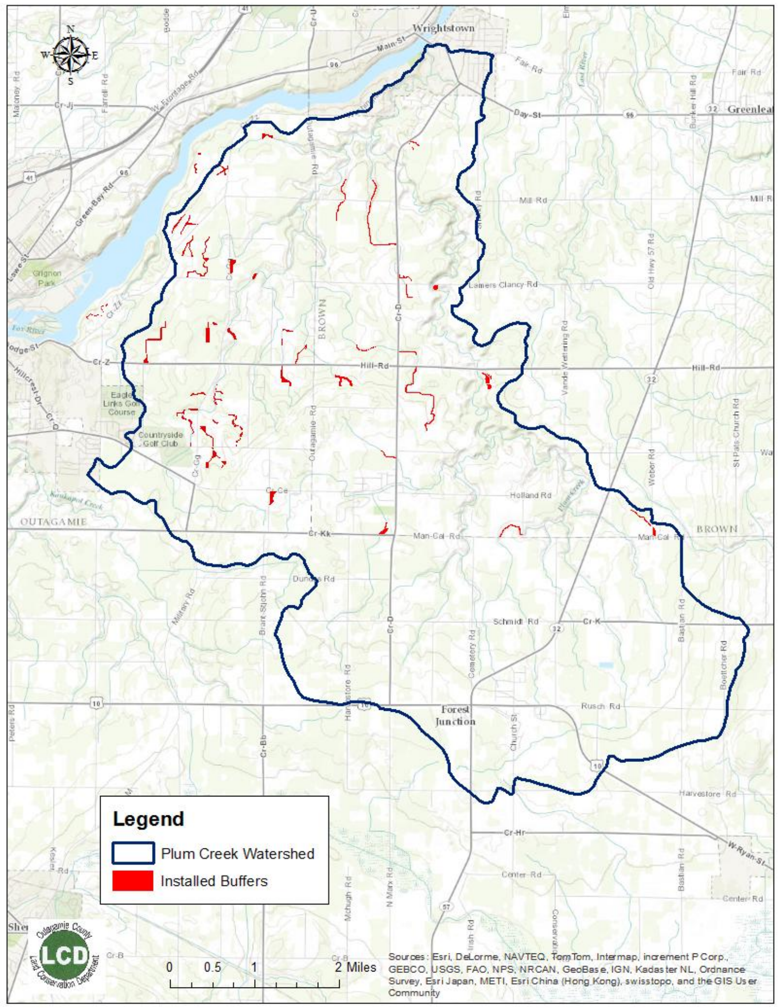


Figure 43. Installed buffers in Plum Creek Watershed.

7.0 Watershed Goals and Management Objectives

The main focus of the watershed project is to meet the limits set by the Lower Fox River TMDL. Additional goals were set that address critical issues in the watershed area based on watershed inventory results. Management objectives address the sources that need to be addressed in order to meet the watershed goals.

Table 26. Watershed Goals and Management Objectives.

Goal	Indicators	Cause or Source of Impact	Management Objective
Improve surface water quality to achieve DNR/EPA water quality standards.	Total Phosphorus , Total Suspended Sediment	High phosphorus levels causing algal growth and decreased dissolved oxygen. Cropland and barnyard runoff.	Reduce the amount of sediment and phosphorus loads from upland sources. Reduce the amount of phosphorus runoff from livestock facilities.
Citizens of the watershed area are aware of water quality issues and are involved in the stewardship of the watersheds.	Interview/Questionnaire results	Low level of focused attention from NRCS & LWCD. Lack of awareness of environmental issues and their impact.	Increase public awareness of water quality issues and increase participation in watershed conservation activities.
Reduce the flood levels during peak storm events.	Peak flow discharges and flash flooding of the creeks and their tributaries occurring during heavy precipitation events.	Increased impervious area, tile drainage, and ditching. Inadequate storm water practices. Poor soil health.	Reduce the flow of runoff from upland areas to streams. Increase soil infiltration.
Improve streambank stability and reduce amount of streambank degradation.	Severe erosion characterized by undercutting, vertical banks, and slumping. Meandering and redirection of flow.	High peak flows to stream, inadequate crossings, and inadequate riparian vegetation.	Restore and stabilize degraded streambanks.

8.0 Management Measures Implementation

The Plum and Kankapot Watershed plan presents the following recommended plan of actions needed over the next 10 years in order to achieve water quality targets and watershed goals. The plan implementation matrix provides a guideline to what kinds of practices are needed in the watershed and to what extent they are needed to achieve the watershed goals. The plan provides a timeline for which practices should be completed, possible funding sources, and agencies responsible for implementation.

Existing runoff management standards have been established by the State of Wisconsin. Chapter NR 151 provides runoff management standards and prohibitions for agriculture. There has been a lack of enforcement of the state standards due to lack of funding and staff in this watershed area. This plan recommends enforcement of the state runoff standards when implementing the plan. NR 151.005 (Performance standard for total maximum daily loads) states that a crop producer or livestock producer subject to this chapter shall reduce discharges of pollutants from a livestock facility or cropland to surface waters if necessary to meet a load allocation in a US EPA and state approved TMDL. Local ordinances and regulations will also be used to implement conservation practices and compliance. County Land Conservation and NRCS departments will work with landowners to implement conservation practices. Landowners will be educated on programs and funding available to them as well as current state and local agricultural regulations.

Many alternative and new conservation technologies and methods are currently being developed and evaluated. Incorporation of new and alternative technologies and management methods into the implementation plan may be necessary to achieve desired water quality targets. Examples of new technologies and methods include:

- Gypsum application to fields: Studies show that gypsum application can improve soil health properties that promote nutrient uptake, increase infiltration, and decrease surface runoff.
- Biofilters at outlets of drain tiles: Installing biofilters at outlets of drain tiles can reduce nutrient loading.
- ROWBOT: Small robot that can travel between corn rows that can apply fertilizer in sync with corn needs, inter-seed cover crops into tall corn, and collect data.

Table 27. 10 Year Management Measures Plan Matrix.

Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
1) Management Objective: Reduce the amount of sediment and phosphorus loading from agricultural fields and uplands.							
a**) Application of conservation practices to cropland. These practices include:*** • Encourage adaptation of less erosive crop rotations. • Utilization of strip cropping and/or contour cropping practices on fields. • Increase acreage of conservation tillage in watershed area. Fields must meet 30% residue. • Implement use of cover crops. • Installation of field borders. • Enforcement of NR151.03 standard for tillage setback from surface waters where necessary. • Use of vertical tillage injector for manure applications on fields with cover crops.	# acres cropland with conservation practices applied	5,400	6,500	5,800	0-10 years	EQIP, TRM, GLRI, CSP, AM, WQT	NRCS, LWCD

Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
b) Installation of grassed waterways in priority areas.	# of linear feet of grassed waterways installed	64,075	85,434	42,724	0-10 years	EQIP, CREP, AM, WQT	NRCS, LWCD
c) Concentrated flow path seedings of cover that can be planted through.	# acres of concentrated flow area seedings	160	190	85	0-10 years	GLRI	NRCS, LWCD
d) Installation of riparian buffers	# acres of riparian buffers installed	100	100	75	0-10 years	CREP/CRP, EQIP, GLRI, AM, WQT	NRCS, LWCD
e) Increase the amount of agricultural land under nutrient management	# of landowners signed up for nutrient management plans	15	15	5	0-10 years	EQIP, TRM, SEG, AM, WQT	NRCS, LWCD
f) Checks to make sure installed practices and management plans are being maintained and properly followed.	# of farms/agricultural landowners checked	20	25	15	0-10 years	N/A	LWCD, NRCS
j) Construct treatment wetlands to treat and store water from agriculture runoff and tile drainage	# of treatment wetlands installed	3	4	3	0-10 years	GLRI, AM, WQT	Nature Conservancy, NRCS, LWCD
k) Convert cropland to grazing/Implement grazing management	# of farms prescribed grazing/grazing management	2	2	2	0-10 years	EQIP, AM, GRP	LWCD, NRCS
i) Use of new technologies such as biofilters, water control structures for tile outlets, gypsum applications, ROWBOT	# sites where new technologies have been used and assessed for effectiveness	4	3	2	0-10 years	GLRI, Other Federal/State/Private funding	LWCD,NRCS
2) Management Objective: Slow the flow of runoff from upland areas to watershed streams							

Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
a) Increase water storage by restoring wetlands.	# of acres of wetlands restored	15	20	15	0-10 years	EQIP, CREP/CRP, WQT, AM	NRCS, LWCD
b) Install Water and Sediment Control basins to store and slow flow of runoff.	# of WASCOBS installed	8	10	7	0-10 years	EQIP, AM, WQT	NRCS, LWCD
c) Increase soil infiltration by implementing practices (a-i) under Management Objective 1.	–	–	–	–	–	–	–
3) Management Objective: Reduce phosphorus runoff from barnyards							
a) Retrofit barnyard sites with necessary runoff control structures (gutters, filter strips, settling basins, clean water diversions)	# of barnyard sites addressed and retrofitted with necessary runoff control measures	6	8	4	0-7 years	EQIP, AM, WQT	NRCS, LWCD
b) Manure management on livestock operation sites.	# of new or updated manure storage facilities	5	5	–	0-7 years	EQIP, AM, WQT	NRCS, LWCD
4) Management Objective: Restore and stabilize degraded streambanks.							
a) Restore eroded stream banks by use of rip rap and/or biostabilization	# of linear feet of streambank stabilized	11,000	12,000	12,000	0-10 years	EQIP, GLRI, WQT	NRCS, LWCD, WDNR
b) Install streambank crossings to prevent further degradation	# of stream crossings installed	3	2	–	0-7 years	EQIP	NRCS, LWCD, WDNR
c) Removal of debris that is deflecting water and causing erosion issues	# of stream sites where debris is removed	2	3	–	0-7 years	EQIP	NRCS, LWCD

Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
d) Stabilization of critical gullies/ravines that are located adjacent to the stream	# of gullies and ravines stabilized	5	5	5	0-10 years	EQIP	NRCS, LWCD
e) Limit livestock access where stream degradation is occurring.	# of sites where fencing is installed	1	1	_	0-5 yeas	EQIP	NRCS, LWCD

* A combination of the listed practices will be applied to agricultural fields to get the desired 70-80% reductions required by the TMDL. Not all practices listed will be applied to each field. The combinations of practices applied will vary by field. In most cases just applying one practice to a field will not get desired reductions and a combination of 2-3 practices will be necessary to get desired reductions. See Appendix D.

9.0 Estimated Load Reductions

Load reductions for upland best management practices were estimated using STEPL (Spreadsheet Tool for Estimating Pollutant Loading), Region 5 Model, and baseline loads from the TMDL. Load reductions from barnyards were estimated using the BARNY model. Percent reduction was based on the SWAT model agricultural baseline loading of 44,855 lbs TP/yr and 8,659 tons TSS/year (Table 28).

Current modeling shows that the needed reduction in suspended sediment from agriculture in the watershed area can be reasonably met with current available conservation practices and cost effectiveness. The percent reduction in sediment is near 100% due to the underestimated amount of sediment loading from stream bank erosion that was not accounted for in the TMDL SWAT model (Table 28). If we were to not include the reduction from streambank stabilization the sediment reduction would be 63% from agricultural land. Current load reduction modeling used for this plan shows that we can achieve a 68 % reduction in phosphorus from agriculture with 100 % of the practices installed and followed in the plan recommendations (Table 28).

It is important to note the discrepancies in loading contributions between the STEPL and SWAT model. The STEPL model had higher loading estimates for both phosphorus (62,717 lbs/yr) and sediment (10,850 tons/yr) compared to the 51,619 lbs TP/yr and 9,646 tons TSS/yr from SWAT modeling. Since the STEPL model gives a higher estimate, a factor of 0.8 for total phosphorus and 0.89 for total suspended solids was applied to estimated reductions from upland practices, treatment wetlands, and riparian buffers calculated using this model to more closely match the SWAT model. Additional evaluation of water quality monitoring data as plan implementation begins will help provide a more accurate prediction of load reductions and current loading rates. STEPL and Region 5 model calculations are shown in Appendix B-D.

Watershed inventory data, modeling, and previous study indicate that reaching the necessary 84.4% reduction for phosphorus from agriculture will be very difficult to achieve in this watershed due to the high amount of land used for agriculture in the watersheds. The allocated phosphorus yield per acre for Plum Creek from the TMDL is 0.22 lb/ac/yr. In the study done by Martin D. Jacobson (2012) only 36 ha (7% of NMP area) in Plum Creek in 2012 had total phosphorus values of 0.2 or less. In this study, hypothetical SnapPlus Scenarios were run on a typical Plum Creek field. One scenario of a three year alfalfa rotation with no nutrient application yields total phosphorus values from 0.2-0.4 lbs/ac/yr, while another scenario showed that unharvested, permanent grassland with no nutrient application yields a total phosphorus value of 0.2 lbs/ac/yr (Jacobson 2012). This indicates that if nearly all agricultural land was in a three year alfalfa rotation or converted to all grassland that phosphorus reductions could be met. Significant reduction in phosphorus loading can be achieved in this watershed, but meeting the phosphorus limit set by the TMDL with current technologies, funding sources, land prices, and attitudes in the watershed area will be unlikely.

Table 28. Estimated Load Reductions for watershed wide management measures (Percent reduction calculated from SWAT agriculture baseline loading)**.**

Management Measure Category	Total Units (size/length)	Total Cost	Estimated Load Reduction			
			TP (lbs/yr)	Percent	TSS (t/yr)	Percent
Streambank Restoration		2,877,577.50				
Bank Stabilization (Feasible)	11,260 ft		219.00	0.49	418.00	4.83
Bank Stabilization (Limited Feasibility)	47,278 ft		1,365.00	3.04	2,607.00	30.11
Adjacent Gully/Ravine Stabilization	3,627 ft		57.00	0.13	110.00	1.27
Riparian Buffers	275 ac	1,031,250.00	3,869.00	8.63	330.00	3.81
Agricultural BMP's						
Barnyard Retrofits (filter strips, manure storage, clean water diversions)	18 sites	1,622,500.00	488.00	1.09	n/a	n/a
Conservation Practices applied to Cropland (Conservation Tillage, Field Borders, Cover Crops, Tillage Setback, Nutrient Management, Contour Cropping, Strip Cropping, Vertical Tillage Injector, Conservation Crop Rotation)[1]	17,700 ac	4,398,055.00	21,568.00	48.08	2,871.00	33.16
Prescribed Grazing/Grazing Management applied to Hay/Pastureland and/or to Cropland.[2]	300 ac	76,500.00	N/A	N/A	N/A	N/A
Use of new technologies/management measures (gypsum applications, biofilters and water control structures at outlets of tiles, etc)[3]	N/A	N/A	N/A	N/A	N/A	N/A
Gully Stabilization						
Grassed Waterways and Water & Sediment Control Basin	192,233 ft 25 WASCOBs	1,080,000.93	762.30	1.70	762.30	8.80
Critical Area Seeding	37,9738 ft		1,286.70	2.87	1,286.70	14.86

Management Measure Category	Total Units (size/length)	Total Cost	Estimated Load Reduction			
			TP (lbs/yr)	Percent	TSS (t/yr)	Percent
Wetlands		465,000.00				
Treatment wetlands for tile drainage and agriculture runoff	10 sites		440.00	0.98	147.00	1.70
Wetland Restoration	50 acres		480.00	1.07	52.00	0.60
Totals		**11,550,883.43**	**30,535.00**	**68.07**	**8,584.00**	**99.13**

1. This category <u>does not</u> indicate that all these practices will be applied to all 17,700 acres of cropland. A combination of conservation practices applied to a majority of the cropland in the watershed is necessary to get the desired pollutant load reductions suggested by the TMDL. It is also important to note that not all fields will need to apply more than one practice to meet desired reduction goals. The BMP Efficiency Calculator was used to determined efficiencies of different combinations of practices such as Reduced Tillage & Cover Crops or the use of a Field Border and Reduced Tillage. An average pollutant reduction efficiency was determined for this category. See Appendix D.

2. Load reductions for the prescribed grazing practice/grazing management was not included in the table since it can be applied to land currently used for hay (which is categorized with pastureland in the STEPL model) or it can be applied to cropland. The reduction efficiency varies greatly depending on if it is applied to cropland or current hay/pasture land. According to the BMP Pollution Reduction Guidance Document, pastureland management has a pollutant reduction efficiency of 34% for phosphorus and 13% for sediment (Evans and Corradini 2001). The pollution reduction efficiency of converting row crop land to pastureland was estimated using STEPL. The estimated pollution reduction efficiency for converting row crop land to pastureland is 68% for phosphorus and 76% for sediment. Further analysis of individual farms sites will need to be done with plan implementation to get a more accurate load reduction from implementing this practice. Load reductions were run for both scenarios and are shown below:

   Scenario 1: 300 acres of cropland converted to managed grazing would result in 353 lbs of P reduced and 45 tons of sediment reduced.

   Scenario 2: 300 acres of hay/pasture land with managed grazing would result in 49 lbs of P reduced and about 2 tons of sediment reduced.

3. The amount of new technologies and management measures has not been determined as well as expected load reductions and cost. In order to meet reductions required by the TMDL use of new technologies may be needed and are included in the plan as alternative options. The effectiveness of these technologies can widely vary and need to be tested before watershed wide implementation. If new management measures/technologies prove effective they will be incorporated into the plan with more accurate load reductions, cost, and amount needed.

10.0 Information and Education

This information and education plan is designed to increase participation in conservation programs and implementation of conservation practices by informing the landowners of assistance and tools available to them and providing information on linkages between land management and downstream effects on water quality.

10.1 Alliance for the Great Lakes Survey

The Alliance for the Great Lakes developed an interview and questionnaire that was given to landowners in the Lower Fox River Watershed area by County Land and Water Conservation Departments and local agronomists. Data from the questionnaires and interviews was analyzed by subwatershed. The survey and questionnaire gathered information on the knowledge of conservation and water quality issues, willingness to participate in conservation programs, and where landowners obtain their information. Thus, particular barriers such as unfamiliarity with available conservation programs and financial assistance were identified as prevalent among respondents in the Plum and Kankapot subwatersheds. As a result, many of them didn’t have nutrient management plans for their land.

The survey results reflect some of the challenges in managing a watershed split among three different counties with different approaches and conservation priorities. Thus many of the operators of smaller farms in this watershed area have not had extensive contact with land conservation departments. Moreover, many landowners of all farm sizes did not recognize the severity of water quality issues impacting the Lower Fox River Basin and the extent to which agricultural sources contribute to nutrient and sediment loadings to the River and the Bay of Green Bay. Providing information on available conservation programs, technical assistance, and education will be a very critical component of implementing the management plan.

Selected Results from Survey

Knowledge and Thoughts on Current Conservation Programs:

One of the interview questions asked respondents to reflect on the conservation programs currently being offered. The responses were organized by themes and further by subwatersheds to gain a better understanding of what landowners think about conservation programs and whether responses differ across different areas of the Lower Fox River watershed. A total of 28 themes were identified (ranging from “Willing to try them” to “More exist than necessary”) with the most frequently mentioned theme being “Not familiar with programs” as shown in Figure 44 below. When comparing responses from different subwatersheds, it is apparent that the Plum and Kankapot subwatershed, in particular, have low familiarity with programs, with that being the most frequently mentioned theme. This is in contrast to the most frequently mentioned themes by the other subwatersheds. For comparison, among respondents in Duck/Trout Creeks subwatershed most frequently mentioned theme was "involved in them", in Apple/Ashwaubenon/Dutchman Creeks, it was "going well-good programs", and in East River/Baird/Bower Creeks, both "involved in them" and going well-good programs" were both at the top of the list.

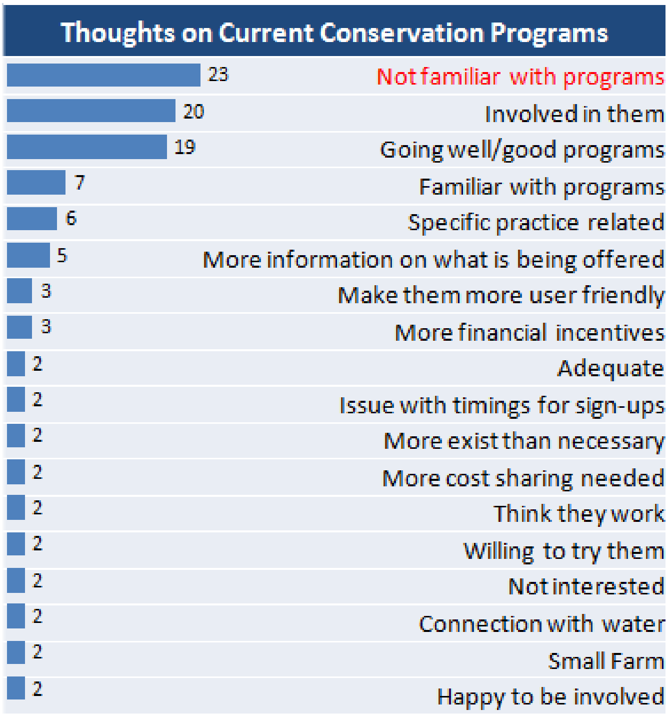


Figure 44. Survey results on Thoughts on Current Conservation Programs in all subwatersheds.

Nutrient Management Planning:

The interview also contained a series of questions about nutrient management plans implemented by the landowners. They were asked if they have nutrient management plan to begin with and if yes, whether it was working well, what could be improved, and whether it was a useful tool. For those who had NMPs, responses revealed that many perceived that the plans were working well, many work closely or rely on their agronomists to advise them, and there is a mix between those who have NMPs because they are required and those who find it a useful tool that benefits their operation. For those who had NMPs, there weren't significant differences in responses between small, medium, and large farms, or between different subwatersheds. However, among respondents who did not have a NMP, the majority of those were in the Plum and Kankapot Creek subwatersheds. This is consistent with the finding that many respondents in the Plum and Kankapot Creek subwatersheds weren't familiar with existing conservation programs and thus weren't aware of cost sharing available that would trigger the need to develop and implement a nutrient management plan on their land.

Information/Communication:

A number of the questions in the interview and questionnaire were designed to get a better understanding regarding what organizations or entities landowners go to for information and how they prefer to receive/exchange information. The results listed below reflect some of the responses most relevant to this plan:

1. Many respondents want to see the County Land and Water Conservation Departments conduct more education and provide information on practices.
2. 44% Moderately to very interested in demonstration farms as information sources in Plum and Kankapot subwatersheds.
3. 44% Moderately to very interested in attending a conference focused on agricultural conservation in Plum and Kankapot subwatersheds.
4. 50% Moderately to very interested in sharing information in a group setting in Plum and Kankapot subwatersheds.
5. The preferred methods of communication were: newsletters, on farm demonstrations/field days, one on one hands on demonstrations, and magazines (based on responses from the entire Lower Fox River watershed).
6. Landowners go to similar organizations for both farming advice and water quality information (% indicates the percentage of respondents who named this organization as important).
    a. For agronomic information in Plum and Kankapot Creeks, these include: Local Farm Cooperatives/Crop Consultants (92%); Farm Service Agency (58%) & County Land and Water Conservation Department (58%); Other Farmers (50%) & Fox Valley Tech Ag Program (50%)
    b. For water quality information in Plum and Kankapot Creeks, these include; Local Farm Cooperatives/Crop Consultants (73%); County Land and Water Conservation Department (73%); Farm Service Agency (55%); NRCS (45%)

Severity of sources of pollution in your area:

The survey asked several questions related to water quality in the Lower Fox River watershed and Green Bay, specifically on impacts, particular pollutants, and sources of the pollutants. Overall, consequences of poor water quality in the area were mostly rated as slight to moderate problems. Similarly, among the sources listed, most were perceived to be slightly or moderately problematic. Notably:

- Respondents perceived the most serious source of water pollution coming from non-agricultural sources.
    - 65 % identified “excessive use of lawn fertilizers and pesticides” as a moderate to severe problem

- Next three most problematic pollutant sources were stormwater runoff from urban areas, discharges from sewage treatment plants, and discharges from industry.

- Of the six agricultural pollution sources, the one perceived as most severe was “soil erosion from fields” with 37% followed by “land application of animal waste” with 19%. By comparison, 31% identified waterfowl droppings as a moderate to severe problem.

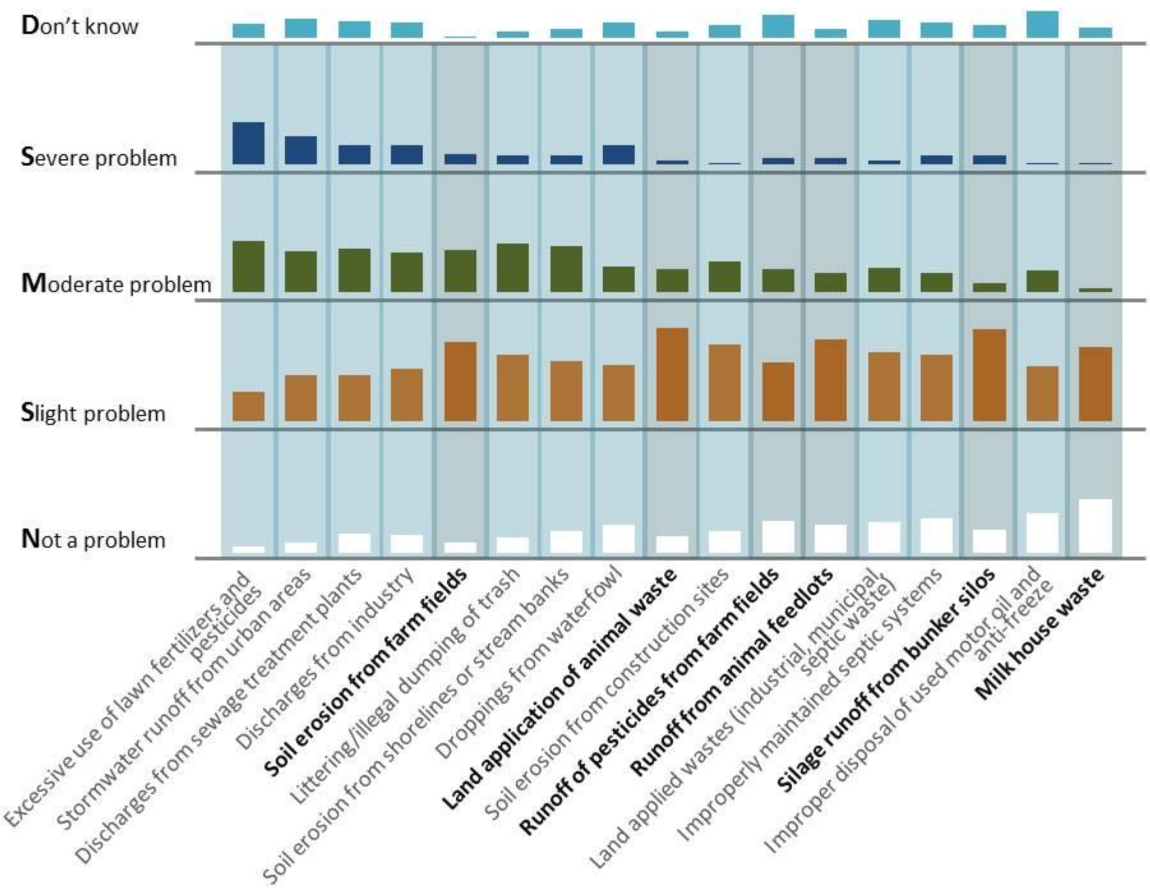


Figure 45. Landowners’ perceptions of sources of water pollution to the Lower Fox River.

10.2 Recommended Information and Education Campaigns

Goals for the Information and education plan and recommended actions were based on the results from the survey. An effective Information and Education Plan includes the following components as referenced in USEPA's "*Handbook for Developing Watershed Plans to Restore and Protect our Waters*" (USEPA 2008):

- Define I&E goals and objectives
- Identify and analyze the target audiences
- Create the messages for each audience
- Package the message to various audiences
- Distribute the message
- Evaluate the I&E program

<u>Goals of the information and education plan</u>: Create public awareness of water quality issues in the watershed, increase public involvement in watershed stewardship, and increase communication and coordination among municipal officials, businesses, and agricultural community.

<u>Objectives</u>

- Educate local officials about the watershed plan. Encourage amendments to municipal comprehensive plans, codes, and ordinances.
- Develop targeted educational materials to appropriate audience in the watershed.
- Host workshops, meetings, and events that landowners can attend to learn about conservation practices.
- Increase landowners' adoption of conservation practices.
- Inform public of current water quality issues in the Lower Fox River Watershed basin and how the Plum and Kankapot watersheds contribute.
- Get local high schools and colleges involved in watershed activities.

Target Audience

There are multiple target audiences that will need to be addressed in this watershed. Target audiences in this watershed will be agricultural land owners and operators, local government officials, private land owners along stream channels, urban home owners, and schools. Focused attention will be on agricultural land owners and operators since the main source of pollutant loading in the watershed is from agricultural land. Non-operator agricultural landowners are an important subset of this group as they are usually not focused on and are less likely to participate in conservation programs. The 1999 Agricultural Economics and Land Ownership survey showed that 34 % of farmland in Wisconsin was owned by non-operator landlords (USDA 1999). Studies have shown that non-operators tend to be older, less likely to live on the farm, and less likely to participate in conservation programs (Nickerson, et al 2012). Non-operator land owners in the watershed area need to be addressed as they control a significant amount of agricultural land but tend to leave the management of the land up to the tenant. In addition women that fall into the category of non-operator agricultural landowners will also be addressed. In a new program called Women Caring for the Land developed by the Project of Women, Food, and Agriculture Network, half of the women that participated in the pilot project in eastern Iowa in 2009, took at least one conservation action within the following year (WFAN 2012).

Existing Education Campaigns:

Fox- Wolf Watershed Alliance: A nonprofit organization that identifies issues and advocates effective policies and actions to protect and restore the water resources of Wisconsin's Fox-Wolf River watershed. They hold events such as river clean-ups, workshops, presentations at Annual Watershed Conferences, and meetings with other organizations to outreach to the public.

Northeast Wisconsin Stormwater Consortium: A subsidiary of the Fox-Wolf Watershed Alliance composed of municipal members and business partners working to address stormwater issues and to educate residents on best management practices, ordinances and other stormwater concerns and programs.

Table 29. Information and Education Plan Implementation Matrix.

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Install Plum and Kankapot Creek "Watershed Project Signs" along major roads in watershed.	General Public	Install signs at key points along major roads in watershed that inform drivers and passenger that they are entering the watershed area.	0-1 years	Drivers see watershed signs when entering watershed. Signs create interest to see what watershed project is about.	$6,000	LWCD
Inform the public on watershed project.	General Public	• Public notice in local newspaper upon completion of watershed plan. • Present plan to public at a public meeting. • Create a web page (Facebook, page on County website) for watershed project. • Develop exhibits for use at libraries, government offices, and local events (County Fairs and Farm Shows).	Present plan to public, creation of web page, and notice in local newspaper following plan completion. Exhibits created and displayed within 2 years of completion.	General public is aware of watershed implementation plan, effects of poor water quality, and has better understanding of how they can impact water quality.	$1,200	LWCD
Educate landowners on watershed project and progress.	Private landowners, agricultural landowners/operators	Bi-annual/annual newsletter including watershed updates as well as information on new practices and programs.	0-10 years	Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available.	$10,000	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance and funding available.	Agricultural landowners/operators	• Distribute educational materials on conservation practices and programs. • One on one contact with individual landowners to provide tools and resources. • Orchestrate group meetings with agricultural landowners in watershed to share knowledge and foster community connections for long term solutions. • Offer workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources. • Tour local demonstration farm and other sites that have implemented conservation practices.	0-10 years Hold workshops every year for 0-5 years.	• Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them. • Increase in interest in utilizing and installing conservation practices. • Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners. • Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality. • Agricultural landowners see success of conservation practices as well as problems that can be expected.	$15,000	LWCD,NRCS,UWEX, Local Agronomists/Crop Consultants

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Reach out to non-operator land owners.	Non-operator agricultural landowners	• Distribute educational materials targeted to non-operator agricultural landowners. • One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions. • Hold workshop for non-operator female land owners based on Women Caring for the Land Handbook (WFAN 2012).	0-5 years 2 workshops held in first 3 years.	Non-operator landowners are informed on conservation practices. Increased participation rates in conservation activities from non-operator land owners.	$3,500	LWCD, NRCS, UWEX
Educate local officials about the completed plan. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives.	Elected officials in Calumet County, Outagamie County, Brown County, Town of Woodville, Town of Brillion, Village of Harrison, Town of Wrightstown, Town of Holland, Village of Sherwood, Town of Buchanan.	Present project plan to officials and conduct meetings with government officials.	1-2 years	Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives.	No cost using existing resources.	LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Provide local schools information about the watershed project to use as a tool in environmental education.	Teachers/Students at local schools	• Provide local schools with watershed project information. • Offer presentations to teachers and student groups. • Get local schools involved in water quality monitoring.	0-5 years	• Schools will use watershed project in environmental/water education programs. • Use watershed area as a site for field trips. • Student participation in watershed monitoring.	$3,000	Wrightstown High School, Kaukauna High School, Fox Valley Technical College, LWCD
Educate riparian landowners on best management practices for stream banks.	Private riparian landowners	• One on one contact with landowners with priority streambank restoration sites on their land. • Distribute educational materials on riparian buffers, bank stabilization techniques, fencing of livestock, and proper stream crossings.	0-5 years	Increased interest and participation in restoring degraded streambanks and riparian habitat.	$1,500	LWCD, UWEX
Educate homeowners on actions they can take to reduce polluted runoff from their yards.	Homeowners	Distribute educational materials to homeowners on how to reduce polluted stormwater runoff from their yards.	0-5 years	Homeowners are aware of the impact they can have on water quality and actions they can take to reduce pollutions from their yards.	$1,000	UWEX, LWCD

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Outcome of information and education plan.	Agricultural landowners/operators	Survey agricultural landowners on water quality awareness, knowledge of conservation practices, and participation on conservation practices.	5-7 years	Increased awareness of water quality and conservation practices in the watershed area in comparison to 2014 survey.	$4,000	LWCD, UWEX

11.0 Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Current conservation project installation rates were obtained through conversations with county conservation technicians. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be $14,083,564.43.

Summary of Cost Analysis

- $11,550,883.43 to implement best management practices.
- $1,635,750 needed for technical assistance
- $136,449 needed for Information and Education
- $760,482 needed for Water Quality Monitoring

Table 30. Estimated cost for management measures and technical assistance.

BMP	Quantity	Cost /Unit $	Total Cost
Upland Control			
Conservation Crop Rotation[1] (ac)	1,000	1.54	4,620.00
Conservation Tillage[1] (ac)	15,470	18.50	858,585.00
Cover Crops[1] (ac)	6,802	70.00	1,428,420.00
Grass Waterways (ln ft)	192,233	4.21	809,300.93
Concentrated Flow Area Seeding (ac)	435	220.00	95,700.00
Veg. Riparian Buffers (ac)	275	4,000.00	1,031,250.00
Nutrient Management[1] (ac)	12,000	28.00	1,008,000.00
Wetland Restoration (ac)	50	7,500.00	375,000.00
Treatment Wetlands (sites)	10	15,000.00	90,000.00
Water and Sediment Control Basin (ea)	25	7,000.00	175,000.00
Field Borders (ac)	220	4,000.00	880,000.00
Contour Farming (ac)	2,500	7.76	19,400.00

BMP	Quantity	Cost /Unit $	Total Cost
Prescribed Grazing[1] (ac)	300	85.00	76,500.00
Strip Cropping (ac)	1,000	9.03	9,030.00
Vertical Manure Injector (ea)	2	95,000.00	190,000.00
Barnyard Runoff Control			
Filter Strip/ Wall (ea)	11	25,000.00	275,000.00
Roof Gutters (ln ft)	5,350	10.00	53,500.00
Clean Water Diversion (ea)	3	3,000.00	9,000.00
Roofs (ea)	1	50,000.00	50,000.00
Waste Storage (ea)	10	120,000.00	1,200,000.00
Runoff Management System (ea)	1	35,000.00	35,000.00
Streambank Erosion Control			
Fencing (ln ft)	2,822	1.25	3,527.50
Bank Stabilization (ln ft)	55,017	50.00	2,750,850.00
Crossing (ea)	7	5,000.00	35,000.00
Obstruction Removal (ea)	5	1,200.00	6,000.00
Adjacent gully/ravine stabilization (ln ft)	3,627	22.00	82,200.00
Technical Assistance			
Conservation/Project Technician[2]	2	54,525.00	1,090,500.00
Agronomist[2]	1	54,525.00	545,250.00

[1] Estimated costs based on cost sharing for 3 years
[2] Estimated costs based on full time employment for 10 years.

Table 31. Estimated costs for water quality monitoring recommendations.

Water Quality Monitoring	Cost
USGS Subcontract (Plum , W. Plum, Kankapot) (10 years)	238,439.00
USGS Subcontract (treatment wetlands)(5 years)	265,000.00
Analytical Lab Costs (10 years)	226,482.00
Supplies (lab, bottles, chemicals, nets)	8,225.00
Turbidity probe, loggers, auto samplers, flumes (2 sets)	22,000.00

Table 32. Estimated costs for information and education recommendations.

Information and Education	Cost ($)
Staff hours (2,600 hours of staff time for 5 years)	91,249
Signage	6,000
Materials (Postage, printing costs, paper costs, and other presentation materials)	39,200

Cost of new technologies was not included in this estimate since the quantity of these technologies that may be needed is not yet known. Approximate costs for new technologies are as follows:

- $10-15/acre for ROWBOT when used as a service.
- $25-45/ton gypsum
- $4,000- 12,000 for various types of biofilters for treating tile drainage

Operation & Maintenance

This plan will require a land owner to agree to a 10 year maintenance period for practices such as vegetated buffers, grassed waterways, water and sediment control basins, treatment wetlands, wetland restoration, barnyard runoff control, manure storage, streambank stabilization including crossings and fencing, and concentrated flow area seedings. A 10 year maintenance period is also required for implementation of strip cropping and prescribed grazing. For practices such as conservation tillage, cover crops, nutrient management, and prescribed grazing landowners are required to maintain the practice for each period that cost sharing is available. Upon completion of the operation and maintenance period, point sources may be able to work with operators and landowners to continue implementation of the BMP's under a pollutant trading agreement (non EPA 319 monies).

12.0 Funding Sources

There are many state and federal programs that currently provide funding sources for conservation practices. Recently the option of adaptive management and water quality trading has become another option for funding of practices.

12.1 Federal and State Funding Sources

A brief description of current funding programs available and their acronyms are listed below:

Environmental Quality Incentives Program (EQIP) - Program provides financial and technical assistance to implement conservation practices that address resource concerns. Farmers receive flat rate payments for installing and implementing runoff management practices.

Conservation Reserve Program (CRP) - A land conservation program administered by the Farm Service Agency. Farmers enrolled in the program receive a yearly rental payment for environmentally sensitive land that they agree to remove from production. Contracts are 10-15 years in length. Eligible practices include buffers for wildlife habitat, wetlands buffer, riparian buffer, wetland restoration, filter strips, grass waterways, shelter belts, living snow fences, contour grass strips, and shallow water areas for wildlife.

Conservation Reserve Enhancement Program (CREP) - Program provides funding for the installation, rental payments, and an installation incentive. A 15 year contract or perpetual contract conservation easement can be entered into. Eligible practices include filter strips, buffer strips, wetland restoration, tall grass prairie and oak savanna restoration, grassed waterway, and permanent native grasses.

ACEP- Agricultural Conservation Easement Program - New program that consolidates three former programs (Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranchlands Protection Program). Under this program NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agriculture use and conservation values of eligible land.

Targeted Runoff Management Grant Program (TRM) - Program offers competitive grants for local governments for controlling nonpoint source pollution. Grants reimburse costs for agriculture or urban runoff management practices in critical areas with surface or groundwater quality concerns. The cost-share rate for TRM projects is up to 70% of eligible costs.

Conservation Stewardship Program (CSP) – Program offers funding for participants that take additional steps to improve resource condition. Program provides two types of funding through 5 year contracts; annual payments for installing new practices and maintaining existing practices as well as supplemental payments for adopting a resource conserving crop rotation.

Great Lakes Restoration Initiative (GLRI) - Program is the largest funding program investing in the Great Lakes. There is currently 2.6 million in funding available for the Lower Fox Watershed Phosphorus Reduction Priority Watershed.

Farmable Wetlands Program (FWP) - Program designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. The Farm Service Agency runs the program through the Conservation Reserve Program with assistance from other government agencies and local conservation groups.

Land Trusts

Landowners also have the option of working with a land trust to preserve land. Land trusts preserve private land through conservation easements, purchase land from owners, and accept donated land.

12.2 Adaptive Management and Water Quality Trading

Adaptive management (AM) and water quality trading (WQT) are potential sources of funding in this watershed if there are interested point sources. Adaptive management and water quality trading can be easily confused. Adaptive management and water quality trading can provide a more economically feasible option for point source dischargers to meet their waste load allocation limits. Point sources provide funding for best management practices to be applied in a watershed and receive credit for the reduction from that practice. Section 319 nonpoint source funds cannot be used implement practices that are part of a point source permit compliance strategy. Adaptive management focuses on compliance with phosphorus criteria while water quality trading focuses on compliance with a discharge limit.

Table 33. Comparison of Adaptive Management and Water Quality Trading.

Adaptive Management	Water Quality Trading
Receiving water is exceeding phosphorous loading criteria.	The end of pipe discharge is exceeding the allowable limit.
More flexible and adaptive to allow cropland practices to show reductions over extended time period.	Not as flexible, needs to show stable reductions year to year.
Does not use "trade ratios" as modeling factor.	Uses "trade ratios" as margin of error factor.
Uses stream monitoring to show compliance.	Uses models such as SNAP+ or BARNY to show compliance with reduction in loading.
Typically used for phosphorus compliance only.	Can be used for a variety of pollutants, not just phosphorus.
Can be used to quantify phosphorus reductions for up to 15 years.	Can be used to demonstrate compliance indefinitely as long as credits are generated.

13.0 Measuring Plan Progress and Success

Monitoring of plan progress will be an essential component of achieving the desired water quality goals. Plan progress and success will be tracked by water quality improvement, progress of best management practice implementation, and by participation rates in public awareness and education efforts.

Due to the uncertainty of models and the efficiency of the best management practices, an adaptive management approach should be taken with these two subwatersheds (Figure 46). After the implementation of practices and monitoring of water quality, the effectiveness of the plan should be evaluated every 3 years. If progress is not being made the plan will be reevaluated. Adjustments should be made to the plan based on plan progress and any additional new data and/or watershed tools. Implementation of practices in the Plum Creek Watershed will be focused in the West Plum subwatershed first so that the main Plum subwatershed can be used as a comparison of the effectiveness of management practices.

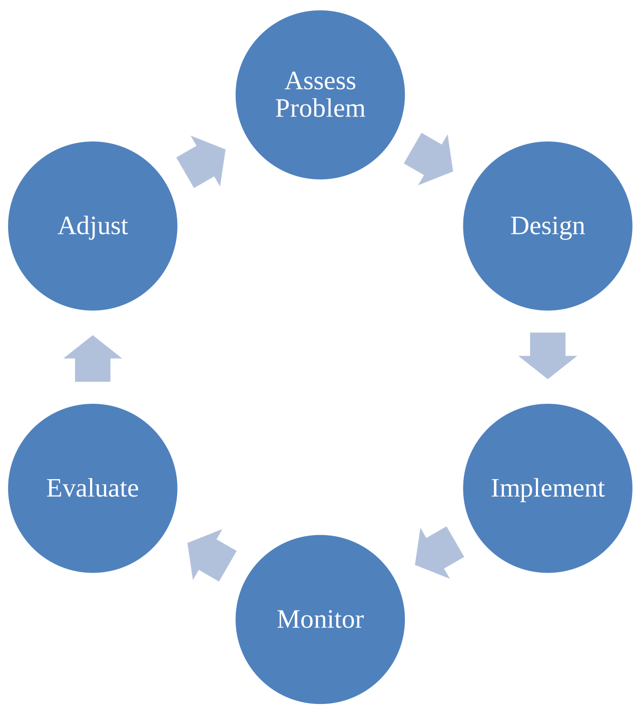


Figure 46. Adaptive management process.

13.1 Water Quality Monitoring

In order to measure the progress and effectiveness of the watershed plan, water quality monitoring will need to be conducted throughout the plan term. Physical, chemical, and biological data will need to be collected to see if the water quality is meeting TMDL standards and designated use standards. This plan calls for the continuation of current monitoring programs with additional monitoring recommendations.

<u>Stream Water Quality Monitoring</u>

The Lower Fox River Watershed Monitoring Program[5] at UWGB, along with the USGS has been cooperatively monitoring water quality with a continuous monitoring station on Plum Creek since October 2010 and the West branch of Plum Creek since 2012. For this watershed plan, the contract with USGS to continue flow, concentration, and load monitoring will need to be extended for both the West Plum and Plum stations for Water Years 2015-2025. An additional USGS continuous monitoring station is also needed on Kankapot Creek.

These monitoring stations record precipitation, gage height, and discharge. Automated samplers installed at the stations take water samples. This plan calls for low flow samples and event samples to be collected from each site. As streamflow increases due to runoff events, automated samplers installed at the stations take water samples. Approximately 39 low flow samples will be collected from each site and 75 event samples from each site per year. Samples from monitoring stations will be collected weekly May- October and monthly for the remaining months. Samples will be analyzed for total phosphorus and total suspended solids. One- half of the low flow samples will be analyzed for dissolved phosphorus in addition to TP and TSS and approximately 25 event samples per site will be analyzed for dissolved phosphorus. All samples will be analyzed at the NEW Water (Green Bay Metropolitan Sewerage District) certified lab. All data from the sites will be

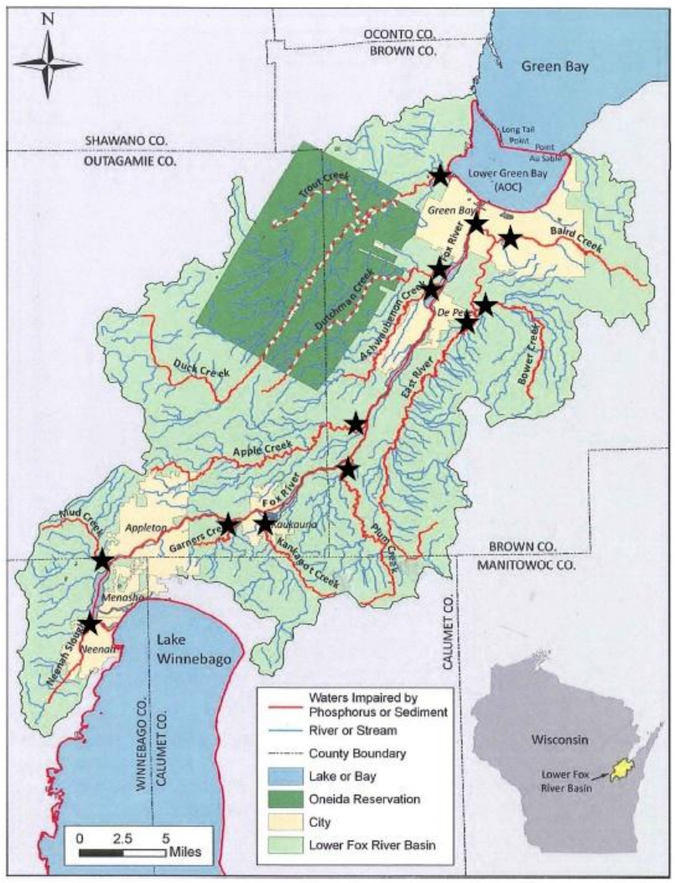


Figure 47. Approximate sample locations for the Lower Fox River Volunteer Monitoring.

[5] Website for the Lower Fox River Watershed Monitoring Program: https://www.uwgb.edu/watershed/.

stored in the USGS National Information System (NWIS) data base. The 2014 water year low flow monitoring schedule for Plum Creek is shown in Appendix L. Currently the stations on Plum Creek are being funded by UWGB and USGS. Additional funding for continued operation and installation of another station on Kankapot will be sought out by applying for grants/funding from federal, state, or private entities.

In addition surface water samples will be collected on a monthly basis from the Plum and Kankapot Creeks from May through October starting in 2015 as part of the Lower Fox River Monitoring program. On each sampling date, volunteers will collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). Volunteers will also utilize transparency tubes to assess and document the transparency of each stream on each date. Macroinvertebrate sampling will also be performed by volunteers on the Plum and Kankapot Creeks during September or October and will be delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3-5 years. All sampling will be conducted in accordance with WDNR protocol. See Appendix K for more information on Lower Fox River Surface Water Sampling.

Agricultural Runoff Treatment Wetland Monitoring

Water quality monitoring and flow measurements will also be conducted at two of the agricultural treatment wetland sites. Discharge and water quality will be monitored at inlets and outlets of the treatment wetland watersheds by the U.S. Geological Survey. The water quality and flow data will be used to compute daily phosphorus and suspended sediment loads and to evaluate the treatment effectiveness of the wetlands. All samples will be analyzed at NEW Water (Green Bay Metropolitan Sewerage District) certified lab. Treatment wetland monitoring will begin once two treatment wetland sites are identified and constructed, which shall occur within the first 2 years of implementation.

Field Catchment Monitoring

University of Wisconsin Green Bay will assist the Outagamie Land Conservation Department in conducting edge-of-field runoff monitoring to compare and demonstrate the effectiveness of sediment and nutrient reduction practices within field catchments. Sample collection will follow standard collection and handling procedures for each parameter. Photographic documentation of catchment conditions, treatment practices, and runoff characteristics will also be conducted and used for outreach and education purposes. Edge of field monitoring will implemented at selected sites within 2 years of plan approval.

Streambank Erosion Monitoring

Land Conservation Department staff will track rates of lateral recession in Plum and Kankapot Creeks. Lateral recession rates will be tracked by using erosion pins. Erosion pins are metal rods that are inserted into the bank perpendicular (Figure 48). Pins will be measured at least 3 times a year to determine trends in erosion. An initial survey of the streambank of selected sites will also be conducted to serve as benchmark. A minimum of 3 sites should be surveyed. At least one site should be located on Plum, West Plum, and Kankapot Creek. Streambank erosion monitoring will be begin following approval of the plan. A decrease in observed lateral recession rate over the 10 year time period will demonstrate plan progress. If lateral recession rates are observed to be increasing or remaining the same after several years of implementation of plan and practices it may indicate that the plan may need to be reevaluated for effectiveness.

Figure 48. Erosion pin inserted into a streambank in Iowa. Photo Credit: Allamakee Soil and Water Conservation District, Iowa.

Table 34. Monitoring schedule for Treatment Wetland, Field Catchment, and Streambank Erosion Monitoring.

Monitoring Recommendation	Schedule for Implementation			Implementation	Funding
	0-2 years	2-5 years	5-10 years		
Treatment Wetland Monitoring	Determine sites for 2 treatment wetlands and installation of treatment wetlands.	Beginning monitoring of inlet and outlet of treatment wetland sites.	N/A	USGS, UWGB, Nature Conservancy	GLRI, Other Federal/State/Private Funding
Field Catchment Monitoring	Determine sites for field catchment monitoring and begin monitoring of sites.	Implementation of practices on monitored field catchments and continued monitoring.	N/A	UWGB, LWCD	GLRI, Other Federal/State/Private Funding
Streambank Erosion Monitoring	Identification of erosion monitoring sites and begin implementation of monitoring	Continued monitoring of sites.	Continued monitoring of sites.	LWCD	LWCD

13.2 Tracking of Progress and Success of Plan

Progress and success of the Plum and Kankapot Watershed Project will be tracked by the following components:

1) Information and education activities and participation
2) Pollution reduction evaluation based on BMP's installed
3) Water quality monitoring
4) Administrative review

Brown, Outagamie, and Calumet County Land Conservation Departments will be responsible for tracking progress of the plan. Land Conservation department will need to work with NRCS staff to track progress and implement practices. Reports will be completed annually, and a final report will be prepared at the end of the project.

1) Information and education reports will include:
   a) Number of landowners/operators in the watershed plan area.
   b) Number of eligible landowners/operators in the watershed plan area.
   c) Number of landowners/operators contacted.
   d) Number of cost-share agreements signed.

e) Number and Type of Information and education activities held, who lead the activity, how many invited, how many attended, and any measurable results of I& E activities.
f) Number of informational flyers/brochures distributed per given time period.
g) Number of one on one contacts made with landowners in the watershed.
h) Comments or suggestions for future activities.

2) Installed best management practices will be mapped using GIS. Pollution reductions from completed projects will be evaluated using models and spreadsheet tools such as STEPL and SNAP Plus[6] for upland practices and the BARNY model for barnyard practices. The annual report will include:
   a) Planned and completed BMP's.
   b) Pollutant load reductions and percent of goal planned and achieved.
   c) Cost-share funding source of planned and installed BMP's.
   d) Numbers of checks to make sure management plans (nutrient management, grazing management) are being followed by landowners.
   e) Number of checks to make sure practices are being operated and maintained properly.
   f) The fields and practices selected and funded by a point source (adaptive management or water quality trading) compliance options will be carefully tracked to assure that Section 319 funds are not being used to implement practices that are part of a point source permit compliance strategy.
   g) Number of new and alternative technologies and management measures used and incorporated into plan.

3) Water Quality Monitoring Reporting Parameters:
   a) Annual summer mean total phosphorus and total suspended solids concentrations and loading values from USGS Stream monitoring stations.
   b) Annual mean discharge and peak flow discharge from USGS stream monitoring stations.
   c) Total phosphorus, dissolved reactive phosphorus, total suspended solids, and clarity data from volunteer grab sampling (Lower Fox River Monitoring Program).
   d) Edge of field monitoring results.
   e) Treatment wetland monitoring results.
   f) Macroinvertebrate Index of Biotic Integrity (Lower Fox River Monitoring Program).

4) Administrative Review tracking and reporting will include:
   a) Status of grants relating to project.

[6] SNAP (Soil Nutrient Application Planner) Plus is Wisconsin's nutrient management software that calculates potential soil and phosphorus runoff losses on field basis while assisting in the economic planning of manure and fertilizer applications. Additional information can be found on the website http://snapplus.wisc.edu/.

b) Status of project administration including data management, staff training and BMP monitoring.
c) Status of nutrient management planning, and easement acquisition and development.
d) Number of cost-share agreements.
e) Total amount of money on cost-share agreements.
f) Total amount of landowner reimbursements made.
g) Staff salary and fringe benefits expenditures.
h) Staff travel expenditures.
i) Information and education expenditures.
j) Equipment, materials, and supply expenses.
k) Professional services and staff support costs.
l) Total expenditures for the county.
m) Total amount paid for installation of BMP's and amount encumbered for cost-share agreements.
n) Number of Water Quality Trading/Adaptive Management contracts.

Information and Education Indicators of Success:

<u>0-2 years</u>

a) Notice in local newspaper on completion of watershed plan.
b) Facebook/Website/or Page on county website developed for watershed information and updates.
c) Watershed boundary signs installed.
d) 3 exhibits displayed or used at local library, government office, and/or local event
e) Distribution of informational materials on watershed project and conservation practices to all eligible land owners.
f) At least 50 one on one contacts made with agricultural landowners.
g) At least 2 meetings held with agricultural landowners.
h) At least 2 educational workshops held.
i) Annual newsletter developed and at least one issue distributed.

<u>2-5 years</u>

a) At least 2 workshops/tours held at a demonstration farm.
b) At least 4 educational workshops held.
c) At least 3 meetings held with agricultural landowners.
d) At least one workshop held for non-operator women landowners.
e) At least 2 municipalities adopt/amend current code or ordinance to match goals of watershed plan.

5-10 years

a) Conduct survey of agricultural landowners on watershed issues (At least 75% surveyed can identify the major source of water pollution in the watershed and methods to protect water quality).

Water Quality Monitoring Indicators of Success:

Table 35. Water quality monitoring indicators of success.

Monitoring Recommendation	Indicators	Current Values	Target Value or Goal	Milestones			Implementation	Funding
				Short Term (4 yrs)	Medium Term (7 yrs)	Long Term (10 yrs)		
Plum								
Lower Fox River Surface Water Monitoring/ Monitoring Stations on W. Plum and Main Plum	# lbs phosphorus/yr	31,569	7,193	25,256	15,785	7,193	UWGB, USGS, WDNR	GLRI, WDNR, USGS, UWGB
	# tons total suspended sediment/yr	6,019	1,779	4,815	3,009	1,779		
Lower Fox River Surface Water Monitoring	% of sites with a Fair to Good IBI rating	Poor-Fair	Fair-Good	50%	75%	100%	WDNR	WDNR
Kankapot								
Lower Fox River Surface Water Monitoring/Monitoring Station on Kankapot	# lbs phosphorus/yr	20,050	5,548	16,040	10,025	5,548	USGS, UWGB, WDNR	WDNR, GLRI, USGS
	# tons total suspended sediment/yr	3,627	1,372	2,902	1,813	1,372		
Lower Fox River Surface Water Monitoring	% of sites with a Fair to Good IBI rating	Poor-Fair	Fair-Good	50%	75%	100%	WDNR	WDNR

Management Measures Indicators of Success:

See Chapter 8, Table 27.

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Appendix A. Glossary of Terms and Acronyms.

BARNY- Wisconsin adapted version of the ARS feedlot runoff model that estimates amount of phosphorus runoff from feedlots.

Baseline –An initial set of observations or data used for comparison or as a control.

Best Management Practice (BMP) – A method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Cost-Sharing- Financial assistance provided to a landowner to install and/or use applicable best management practices.

Ephemeral gully- Voided areas that occur in the same location every year that are crossable with farm equipment and are often partially filled in by tillage.

Geographic Information System (GIS) – A tool that links spatial features commonly seen on maps with information from various sources ranging from demographics to pollutant sources.

Index of Biotic Integrity – An indexing procedure commonly used by academia, agencies, and groups to assess watershed condition based on the composition of a biological community in a water body.

Lateral Recession Rate- the thickness of soil eroded from a bank surface (perpendicular to the face) in an average year, given in feet per year.

Natural Resources Conservation Service (NRCS) - Provides technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land.

Phosphorus Index (PI) – The phosphorus index is used in nutrient management planning. It is calculated by estimating average runoff phosphorus delivery from each field to the nearest surface water in a year given the field's soil conditions, crops, tillage, manure and fertilizer applications, and long term weather patterns. The higher the number the greater the likely hood that the field is contributing phosphorus to local water bodies.

Region 5 Model- Excel spreadsheet tool that provides a gross estimate of sediment and nutrient load reductions from agricultural and urban best management practices.

Riparian – Relating to or located on the bank of a natural watercourse such as a river or sometimes of a lake or tidewater

Soil Nutrient Application Manager (SNAP) – Wisconsin's nutrient management planning software.

Spreadsheet Tool for Estimating Pollutant Load (STEPL) - Model that calculates nutrient loads (Phosphorus, Nitrogen, and Biological Oxygen Demand) by land use type and aggregated by watershed.

Soil and Water Assessment Tool (SWAT) – A small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. Model is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds.

Stream Power Index (SPI) – Measures the erosive power of overland flow as a function of local slope and upstream drainage area.

Total Suspended Sediment (TSS) - The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Total Maximum Daily Load (TMDL) - A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

United States Geological Survey (USGS) – Science organization that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

United States Environmental Protection Agency (USEPA) – Government agency to protect human health and the environment.

University of Wisconsin Extension (UWEX) – UW-Extension works with UW- System campuses, Wisconsin counties, tribal governments, and other public and private organizations to help address economic, social, and environmental issues.

Wisconsin Department of Natural Resources (WDNR) – State organization that works with citizens and businesses to preserve and enhance the natural resources of Wisconsin.

Appendix B. Region 5 Model inputs for gully stabilization.

Load Reductions from Concentrated Flow Area Plantings, Grassed Waterways, and Water and Sediment Control Basins were calculated with the Region 5 Model Spreadsheet. BMP efficiency was assumed to be 90% for both with the use of Water and Sediment Control basins in necessary areas. The Region 5 model estimates the annual tons of gross erosion as sediment delivered at the edge of field. Since the plan is looking at load reductions to the stream system a delivery ratio needs to be applied. Ephemeral gully delivery rates for an integrated (connected) system are typically 50-90% (NRCS, 1998). A delivery ratio of 70 % was assumed for gully erosion. An average gully size was estimated for the length of flow path determined by GIS methods mentioned in Section 6.3.

Concentrated Flow Area Planting:

Gully Stabilization

These may include:

- Grade Stabilization Structure
- Grassed Waterway
- Critical Area Planting in areas with gullies
- Water and Sediment Control Basins

Please select a soil textural class:

- ○ Sands, loamy sands
- ○ Sandy loam
- ○ Fine sandy loam
- ○ Loams, sandy clay loams, sandy clay
- ◉ Silt loam
- ○ Silty clay loam, silty clay
- ○ Clay loam
- ○ Clay
- ○ Organic

Please fill in the gray areas below:

Parameter		Gully	Example	
Top Width (ft)		0.5	**15**	
Bottom Width (ft)		0.1	**4**	
Depth (ft)		0.25	**5**	
Length (ft)		379,739	**20**	
Number of Years		1	**5**	
Soil Weight (tons/ft3)		0.0425	**0.05**	
Soil P Conc (lb/lb soil)*	DEFAULT	0.0005	**0.0005**	*
Soil N Conc (lb/lb soil)*	USER	0.001	**0.001**	*

* If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

Estimated Load Reductions

	BMP Efficiency*	Gully	Example
Sediment Load Reduction (ton/year)	0.9	1089.4	**9**
Phosphorus Load Reduction (lb/year)		1089.4	**7**
Nitrogen Load Reduction (lb/yr)		2178.8	**15**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

Grassed Waterways:

Gully Stabilization

These may include:

- Grade Stabilization Structure
- Grassed Waterway
- Critical Area Planting in areas with gullies
- Water and Sediment Control Basins

Please select a soil textural class:

- ○ Sands, loamy sands
- ○ Sandy loam
- ○ Fine sandy loam
- ○ Loams, sandy clay loams, sandy clay
- ◉ Silt loam
- ○ Silty clay loam, silty clay
- ○ Clay loam
- ○ Clay
- ○ Organic

Please fill in the gray areas below:

Parameter		Gully	Example	
Top Width (ft)		0.75	**15**	
Bottom Width (ft)		0.25	**4**	
Depth (ft)		0.5	**5**	
Length (ft)		192,233	**20**	
Number of Years		1	**5**	
Soil Weight (tons/ft3)		0.0425	**0.05**	
Soil P Conc (lb/lb soil)*	DEFAULT	0.0005	**0.0005**	*
Soil N Conc (lb/lb soil)*	USER	0.001	**0.001**	*

* If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

Estimated Load Reductions

	BMP Efficiency*	Gully	Example
Sediment Load Reduction (ton/year)	0.9	1838.2	**9**
Phosphorus Load Reduction (lb/year)		1838.2	**7**
Nitrogen Load Reduction (lb/yr)		3676.5	**15**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

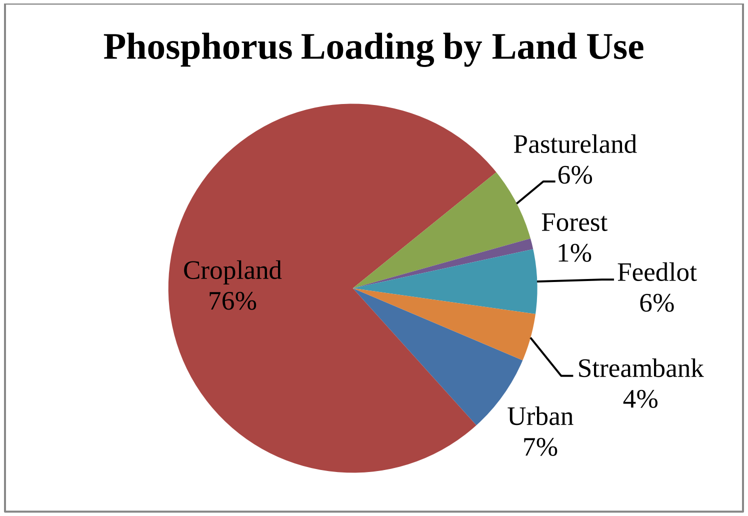
Appendix C. STEPL loading results for the Plum and Kankapot Watershed.

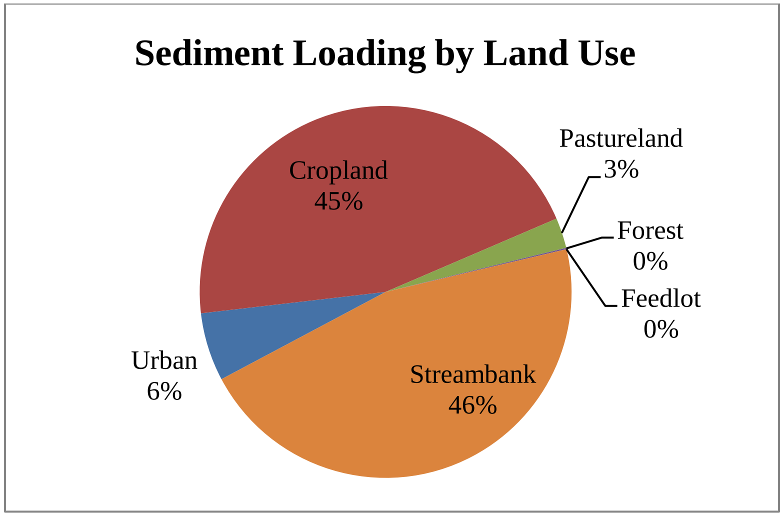
1. Total load by subwatershed(s)

Watershed	P Load (no BMP)	Sediment Load (no BMP)
	lb/year	t/year
W1 (Plum)	35887.4	6244.5
W2(Kankapot)	26829.7	4605.7
Total	62717.2	10850.2

2. Total load by land uses

Sources	P Load (lb/yr)	Sediment Load (t/yr)
Urban	4350.14	644.53
Cropland	47571.54	4924.73
Pastureland	4063.06	286.27
Forest	594.55	12.91
Feedlots	3529.41	0.00
Streambank	2608.47	4981.81
Total	62717.17	10850.24





Appendix D. STEPL load reduction results for combined BMP's for cropland & pastureland practices, streambank restoration, riparian buffers, and wetland restoration.

Upland Practices applied to Cropland:

A combined Best Management Practice efficiency of 71% for total phosphorus and 84% for total sediment was used for conservation practices applied to cropland. This assumes that a combination of practices will be applied to the majority (≈78%) of the crop fields in the watershed. Combined BMP scenarios were calculated using the program's BMP Efficiency Calculator to get a general combined practice efficiency. The scenarios run and their combined efficiencies are shown below. There are two different reduction efficiencies that were run for NMP. If a nutrient management plan is phosphorus based it has a 75% reduction of P, if a NMP is nitrogen and phosphorus balanced the reduction efficiency is 19% for nitrogen and 28% for phosphorus (Evans and Corradini 2001).

Results from STEPL BMP Efficiency Calculator:

Practice Combination	% reduction (phosphorus)	% reduction (sediment)
Contour Farming & Reduced Tillage	75.20	85.10
NMP (P based) & Reduced Tillage	86.30	75.00
Cover Crop & Reduced Tillage	58.70	83.70
NMP (P based), Reduced Tillage, & Cover Crops	89.70	83.70
Field Border & Reduced Tillage	86.30	91.30
Field Border & Reduced Tillage & Cover Crops	90.60	92.60
Conservation Rotation & Reduced Tillage	67.00	88.70
Conservation Rotation & Reduced Tillage & NMP (P based)	91.80	88.70
NMP (N&P balanced) & Reduced Tillage	60.40	75.00
NMP (N&P balanced), Reduced Tillage, & Cover Crops	70.30	83.70
Conservation Rotation & Reduced Tillage & NMP (N & P balanced)	76.20	88.70
Average Practice Efficiency	71.04	84.35

STEPL results for combined management practice efficiency applied to cropland:

1. Total load by subwatershed(s)

Watershed	P Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)
	lb/year	t/year	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1 (Plum)	35887.4	6244.5	5257.0	15152.6	10514.1	1642.8	179563.2	20734.9	394625.0	4601.7
W2 (Kankapot)	26829.7	4605.7	5068.3	11807.8	10136.7	1583.9	127446.4	15022.0	276580.5	3021.9
Total	62717.2	10850.2	10325.4	26960.3	20650.8	3226.7	307009.6	35756.8	671205.5	7623.6

STEPL results for prescribed grazing applied to cropland:

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1 (Plum)	184820.3	35887.4	405139.0	6244.5	79.3	240.1	158.5	24.8
W2 (Kankapot)	132514.7	26829.7	286717.2	4605.7	82.3	201.1	164.6	25.7
Total	317335.0	62717.2	691856.3	10850.2	161.6	441.2	323.2	50.5

STEPL results for managed grazing applied to pastureland:

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1 (Plum)	184820.3	35887.4	405139.0	6244.5	555.4	33.9	5.6	0.9
W2 (Kankapot)	132514.7	26829.7	286717.2	4605.7	447.2	27.5	5.9	0.9
Total	317335.0	62717.2	691856.3	10850.2	1002.6	61.3	11.6	1.8

Feasible Streambank restoration sites load reductions and inputs:

Total lengths of each type of lateral recession were used for inputs into the STEPL model. An average height was used for each type of lateral recession occurring as well. W1 indicates Plum Creek watershed and W2 indicates Kankapot Creek watershed.

2. Impaired streambank dimensions in the different watersheds

Watershed	Strm Bank	Length (ft)	Height (ft)	Lateral Recession	Rate Range (ft/yr)	Rate (ft/yr)	BMP Efficiency (0-1)	Soil Textural Class	Soil Dry Weight (ton/ft3)	Nutrient Correction Factor	Annual Load (ton)	Load Reduction (ton)
W1	Bank1	385	8	4. Very Severe	0.5+	0.5	0.75	Loams, sandy clay loams	0.045	0.85	69.3000	51.9750
W1	Bank2	4274	4.6	3. Severe	0.3 - 0.5	0.3	0.75	Loams, sandy clay loams	0.045	0.85	265.4154	199.0616
W1	Bank3	2325	5.8	2. Moderate	0.06 - 0.2	0.06	0.75	Loams, sandy clay loams	0.045	0.85	36.4095	27.3071
W2	Bank7	3080	4.3	3. Severe	0.3 - 0.5	0.3	0.75	Loams, sandy clay loams	0.045	0.85	178.7940	134.0955
W2	Bank8	1195	2.4	2. Moderate	0.06 - 0.2	0.06	0.75	Loams, sandy clay loams	0.045	0.85	7.7436	5.8077

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1	458837.0	131462.2	963405.6	75208.2	378.5	145.7	757.1	278.3
W2	380391.5	115529.2	788791.1	70647.3	190.3	73.3	380.5	139.9
Total	839228.5	246991.4	1752196.7	145855.5	568.8	219.0	1137.6	418.2

Streambank restoration reductions and inputs for all severe to very severe sites:

Total lengths of each type of lateral recession were used for inputs into the STEPL model. An average height was used for each type of lateral recession occurring as well. W1 indicates Plum Creek watershed and W2 indicates Kankapot Creek watershed.

2. Impaired streambank dimensions in the different watersheds

Watershed	Strm Bank	Length (ft)	Height (ft)	Lateral Recession	Rate Range (ft/yr)	Rate (ft/yr)	BMP Efficiency (0-1)	Soil Textural Class	Soil Dry Weight (ton/ft3)	Nutrient Correction Factor	Annual Load (ton)	Load Reduction (ton)
W1	Bank1	2922	6.5	4. Very Severe	0.5+	0.5	0.75	Loams, sandy clay loams	0.045	0.85	427.3425	320.5069
W1	Bank2	30552	5.3	3. Severe	0.3 - 0.5	0.3	0.75	Loams, sandy clay loams	0.045	0.85	2185.9956	1639.4967
W2	Bank6	838	8.6	4. Very Severe	0.5+	0.5	0.75	Loams, sandy clay loams	0.045	0.85	162.1530	121.6148
W2	Bank7	20705	4.5	3. Severe	0.3 - 0.5	0.3	0.75	Loams, sandy clay loams	0.045	0.85	1257.8288	943.3716

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1	184820.3	35887.4	405139.0	6244.5	2665.6	1026.3	5331.2	1960.0
W2	132514.7	26829.7	286717.2	4605.7	1448.4	557.6	2896.8	1065.0
Total	317335.0	62717.2	691856.3	10850.2	4114.0	1583.9	8228.0	3025.0

Riparian Buffers:

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data						
Watershed	**Cropland**					
	N	P	BOD	Sediment	BMPs	% Area BMP Applied
W1 (Plum)	0.1253	0.13425	ND	0.11635	Filter strip	17.9
W2 (Kankapot)	0.0539	0.05775	ND	0.05005	Filter strip	7.7

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1 (Plum)	184820.3	35887.4	405139.0	6244.5	15068.6	3542.0	1867.1	291.7
W2 (Kankapot)	132514.7	26829.7	286717.2	4605.7	4952.1	1176.9	774.3	121.0
Total	317335.0	62717.2	691856.3	10850.2	20020.7	4718.9	2641.4	412.7

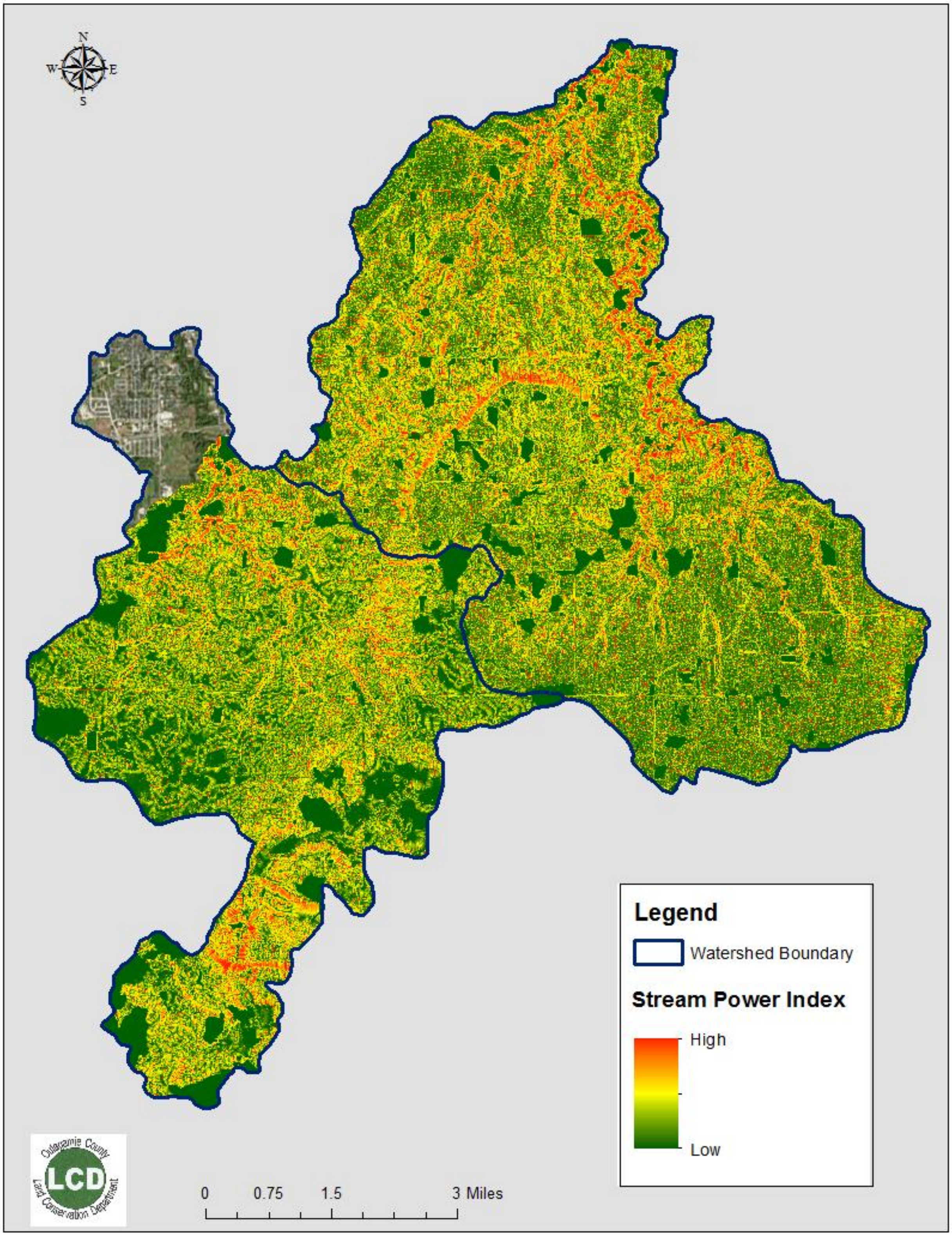
Wetland Restoration:

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data						
Watershed	**Cropland**					
	N	P	BOD	Sediment	BMPs	% Area BMP Applied
W1 (Plum)	ND	0.006	ND	0.006	Wetland Restoration	1.2
W2 (Kankapot)	ND	0.0205	ND	0.0205	Wetland Restoration	4.1

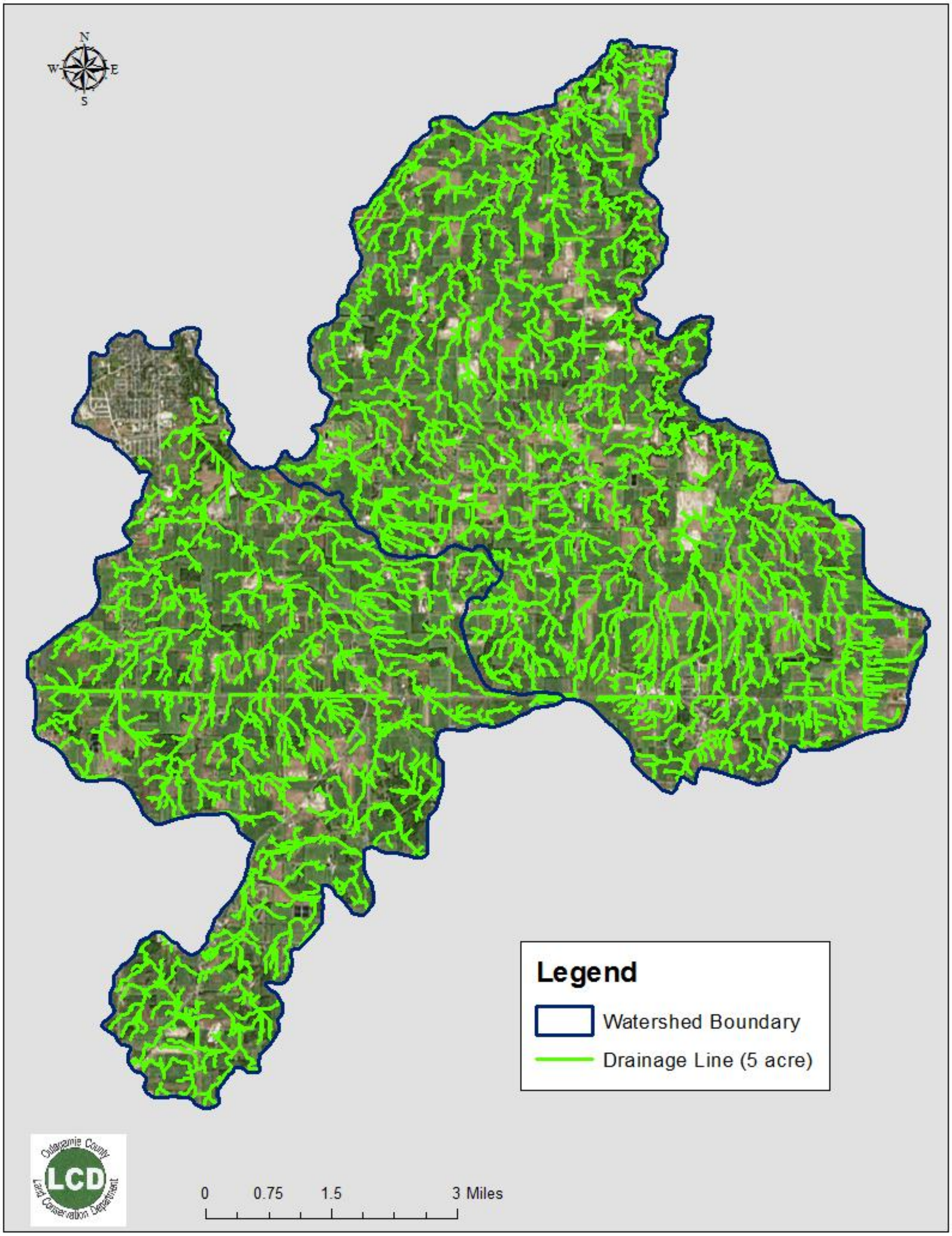
1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1 (Plum)	184820.3	35887.4	405139.0	6244.5	48.1	160.8	96.3	15.0
W2 (Kankapot)	132514.7	26829.7	286717.2	4605.7	158.6	425.9	317.2	49.6
Total	317335.0	62717.2	691856.3	10850.2	206.7	586.7	413.4	64.6

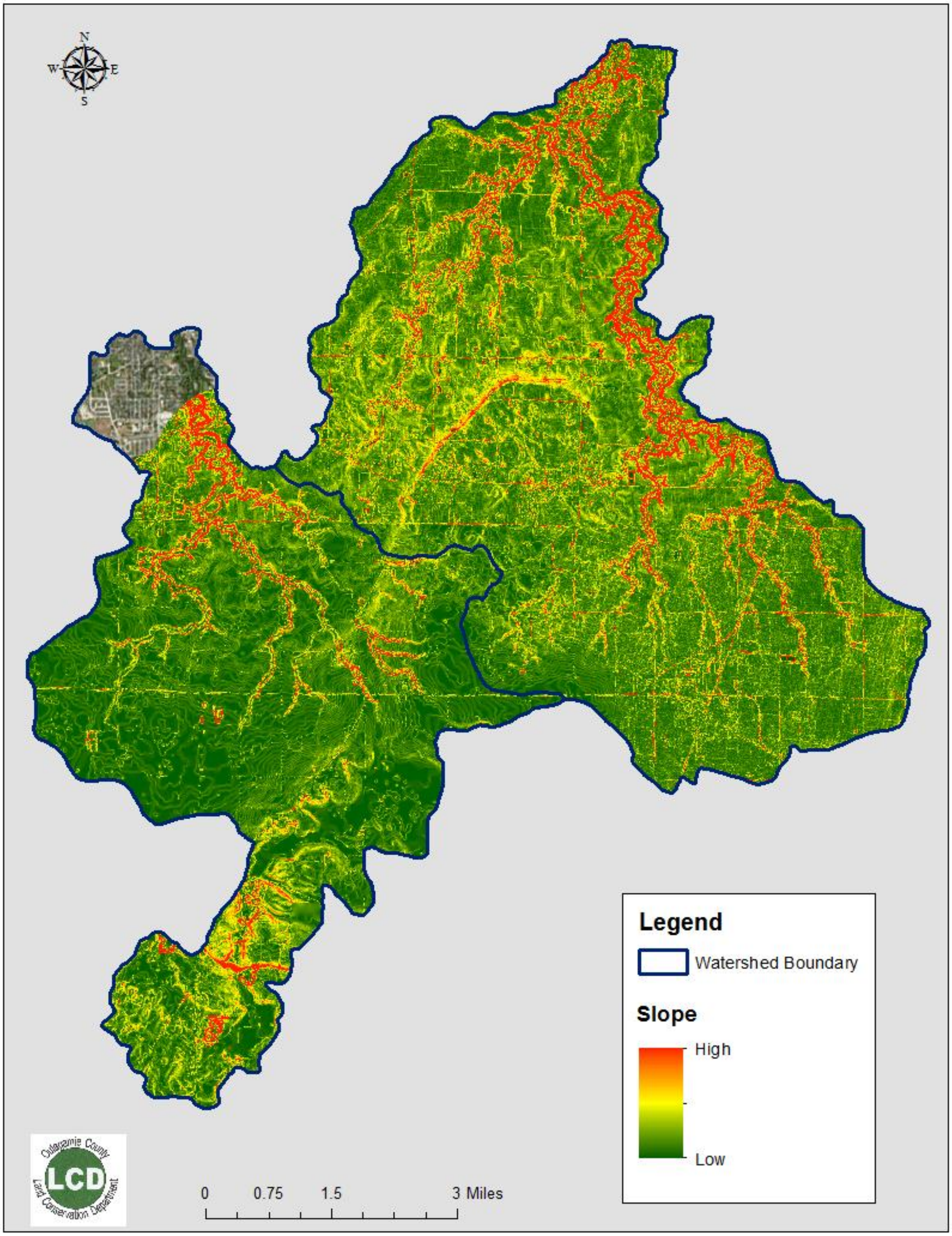
Appendix E. Stream Power Index for the Plum and Kankapot Watershed.



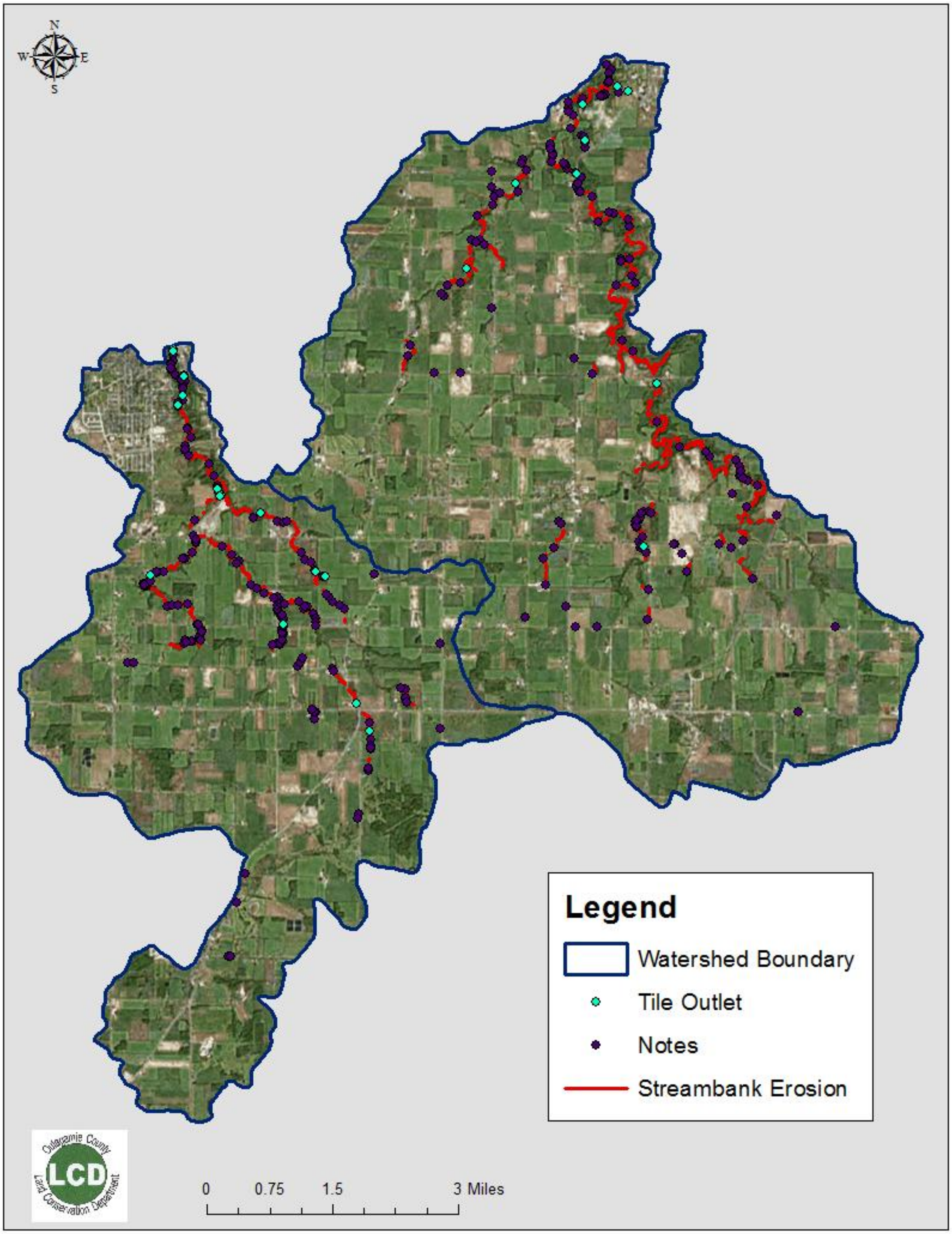
Appendix F. Drainage lines (5 acre) for the Plum and Kankapot Watershed.



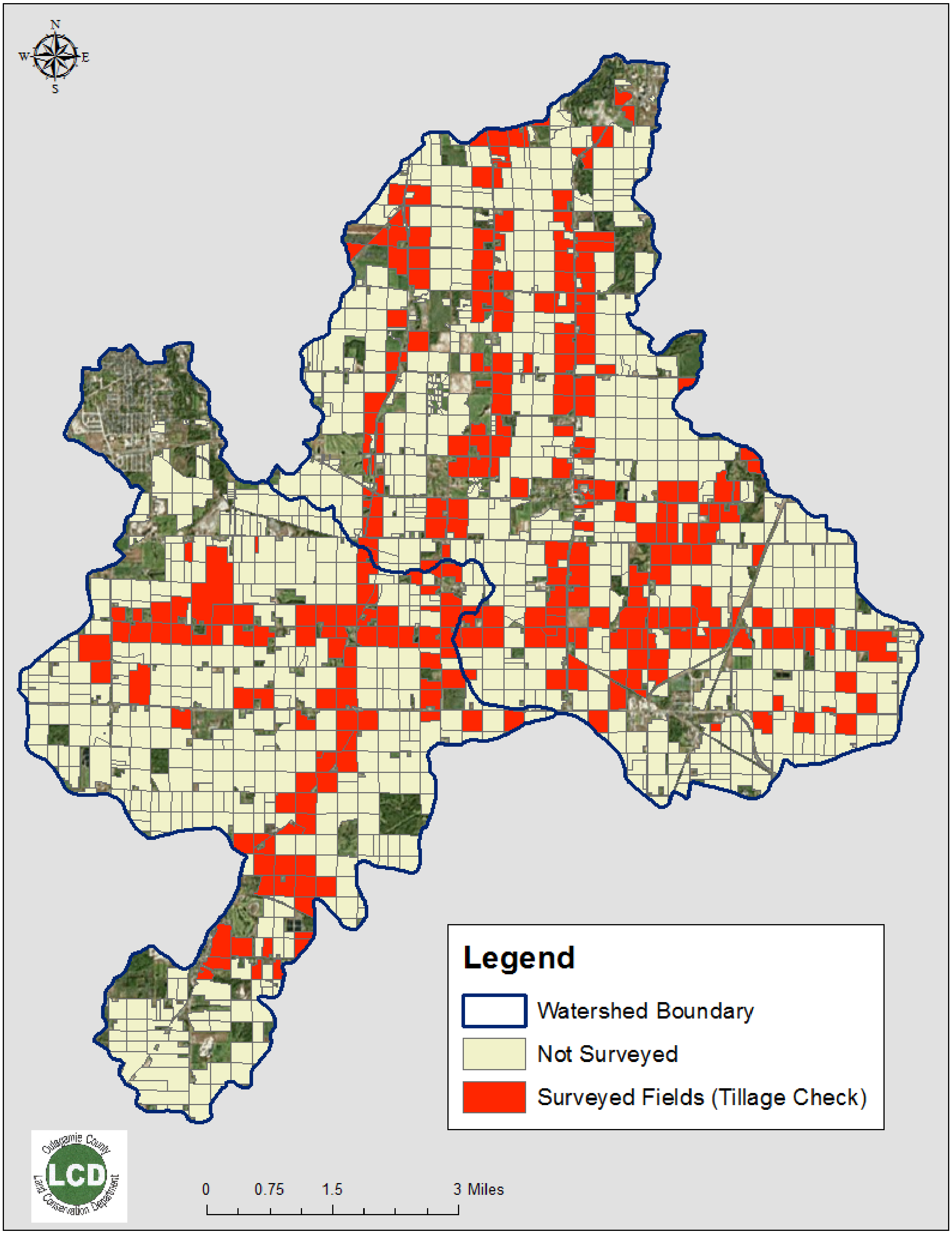
Appendix G. Plum and Kankapot Watershed slope.



Appendix H. Streambank inventory sites in the Plum and Kankapot Watershed.



Appendix I. Fields checked during windshield tillage survey.



Appendix J. SWAT Model analysis results per watershed from Lower Fox River TMDL plan.

KANKAPOT CREEK
TOTAL PHOSPHORUS

Sub-basin Loading Summary (lbs/yr)	
Baseline	20,050
TMDL	5,548
Reduction	14,502
% Reduction Needed	72.3%

Daily TMDL (lbs/day)	15.19

Land Use	Acres	% of Total
Agriculture	11,367	69.3%
Urban (non-regulated)	1,120	6.8%
Urban (MS4)	1,711	10.4%
Construction	31	0.2%
Natural Background	2,172	13.2%
TOTAL	**16,401**	**100.0%**

Sources	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Agriculture	17,195	3,135	14,060	81.8%	8.58
Urban (non-regulated)	493	493	-	-	1.35
Natural Background	269	269	-	-	0.74
LOAD ALLOCATION	**17,957**	**3,897**	**14,060**	**78.3%**	**10.67**
Urban (MS4)	1,473	1,031	442	30.0%	2.82
Construction	99	99	-	-	0.27
General Permits	83	83	-	-	0.23
WWTF-Industrial	143	143	-	-	0.39
WWTF-Municipal	295	295	-	-	0.81
WASTELOAD ALLOCATION	**2,093**	**1,651**	**442**	**21.1%**	**4.52**
TOTAL (WLA + LA)	**20,050**	**5,548**	**14,502**	**72.3%**	**15.19**

Urban (MS4)	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Buchanan	156	109.2	46.8	30.0%	0.30
CombLocks	5	3.5	1.5	30.0%	0.01
Kaukauna	1,312	918.3	393.7	30.0%	2.51

WWTF-Industrial	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Belgioso Cheese - Sherwood	143	143	-	-	0.39

WWTF-Municipal	Total Phosphorus Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Sherwood	295	295	-	-	0.81

KANKAPOT CREEK
TOTAL SUSPENDED SOLIDS

Sub-basin Loading Summary (lbs/yr)	
Baseline	7,253,520
TMDL	2,744,726
Reduction	4,508,794
% Reduction Needed	62.2%

Daily TMDL (lbs/day)	7,515

Land Use	Acres	% of Total
Agriculture	11,367	69.3%
Urban	1,120	6.8%
Urban-MS4	1,711	10.4%
Construction	31	0.2%
Natural Background	2,172	13.2%
TOTAL	**16,401**	**100.0%**

Sources	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Agriculture	6,144,676	2,002,512	4,142,164	67.4%	5,483
Urban (non-regulated)	192,526	192,526	-	-	527
Natural Background	62,915	62,915	-	-	172
LOAD ALLOCATION	**6,400,117**	**2,257,953**	**4,142,164**	**64.7%**	**6,182**
Urban (MS4)	736,480	441,888	294,592	40.0%	1,210
Construction	90,047	18,009	72,038	80.0%	49
General Permits	22,731	22,731	-	-	62
WWTF-Industrial	2,432	2,432	-	-	7
WWTF-Municipal	1,713	1,713	-	-	5
WASTELOAD ALLOCATION	**853,403**	**486,773**	**366,630**	**43.0%**	**1,333**
TOTAL (WLA + LA)	**7,253,520**	**2,744,726**	**4,508,794**	**62.2%**	**7,515**

Urban (MS4)	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Buchanan	68,126	40,876	27,250	40.0%	112
CombLocks	2,354	1,412	942	40.0%	4
Kaukauna	666,000	399,600	266,400	40.0%	1,094

WWTF-Industrial	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Belgioso Cheese - Sherwood	2,432	2,432	-	-	7

WWTF-Municipal	Total Suspended Solids Load (lbs/yr)			% Reduction from Baseline	Allocated (lbs/day)
	Baseline	Allocated	Reduction		
Sherwood	1,713	1,713	-	-	5

PLUM CREEK

TOTAL PHOSPHORUS

Sub-basin Loading Summary (lbs/yr)	
Baseline	31,569
TMDL	7,193
Reduction	24,376
% Reduction Needed	77.2%
Daily TMDL (lbs/day)	19.69

Land Use	Acres	% of Total
Agriculture	17,382	76.2%
Urban (non-regulated)	2,465	10.8%
Urban (MS4)	79	0.3%
Construction	45	0.2%
Natural Background	2,833	12.4%
TOTAL	22,804	100.0%

Sources	Total Phosphorus Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Agriculture	27,660	3,861	23,799	86.0%	10.57
Urban (non-regulated)	1,316	1,316	-	-	3.60
Natural Background	359	359	-	-	0.98
LOAD ALLOCATION	**29,335**	**5,536**	**23,799**	**81.1%**	**15.15**
Urban (MS4)	76	53	23	30.0%	0.15
Construction	164	164	-	-	0.45
General Permits	168	168	-	-	0.46
WWTF-Industrial	546	341	205	37.5%	0.93
WWTF-Municipal	1,280	931	349	27.3%	2.55
WASTELOAD ALLOCATION	**2,234**	**1,657**	**577**	**25.8%**	**4.54**
TOTAL (WLA + LA)	**31,569**	**7,193**	**24,376**	**77.2%**	**19.69**

Urban (MS4)	Total Phosphorus Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Buchanan	30	21	9	30.0%	0.06
Kaukauna	46	32	14	30.0%	0.09

WWTF-Industrial	Total Phosphorus Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Arla Foods Production LLC - Holland	546	341	205	37.5%	0.93

WWTF-Municipal	Total Phosphorus Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Forest Junction	471	122	349	74.1%	0.33
Town of Holland SD #1	809	809	-	-	2.21

PLUM CREEK
TOTAL SUSPENDED SOLIDS

Sub-basin Loading Summary (lbs/yr)	
Baseline	12,038,905
TMDL	3,558,318
Reduction	8,480,587
% Reduction Needed	70.4%
Daily TMDL (lbs/day)	9,742

Land Use	Acres	% of Total
Agriculture	17,382	76.2%
Urban	2,465	10.8%
Urban-MS4	79	0.3%
Construction	45	0.2%
Natural Background	2,833	12.4%
TOTAL	**22,804**	**100.0%**

Sources	Total Suspended Solids Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Agriculture	11,171,743	2,835,478	8,336,265	74.6%	7,763
Urban (non-regulated)	447,810	447,810	-	-	1,226
Natural Background	148,577	148,577	-	-	407
LOAD ALLOCATION	**11,768,130**	**3,431,865**	**8,336,265**	**70.8%**	**9,396**
Urban (MS4)	24,329	14,597	9,732	40.0%	40
Construction	168,238	33,648	134,590	80.0%	92
General Permits	47,269	47,269	-	-	129
WWTF-Industrial	682	682	-	-	2
WWTF-Municipal	30,257	30,257	-	-	83
WASTELOAD ALLOCATION	**270,775**	**126,453**	**144,322**	**53.3%**	**346**
TOTAL (WLA + LA)	**12,038,905**	**3,558,318**	**8,480,587**	**70.4%**	**9,742**

Urban (MS4)	Total Suspended Solids Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Buchanan	9,209.00	5,525	3,684	40.0%	15
Kaukauna	15,120.00	9,072	6,048	40.0%	25

WWTF-Industrial	Total Suspended Solids Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Arla Foods Production LLC - Holland	682	682	-	-	2

WWTF-Municipal	Total Suspended Solids Load (lbs/yr)			% Reduction	Allocated
	Baseline	Allocated	Reduction	from Baseline	(lbs/day)
Forest Junction	2,471	2,471	-	-	7
Town of Holland SD #1	27,786	27,786	-	-	76

Appendix K. Lower Fox River Surface Water Monitoring Summary

A summary of the WDNR Lower Fox River Surface Water Monitoring Strategy provided by Keith Marquardt (WDNR) on September 25, 2014:

Surface Water Monitoring for the Lower Fox TMDL

The primary objective for the Lower Fox River Basin monitoring project is to identify long term trends for phosphorus and suspended solids loading to the Fox River and Green Bay from major tributaries. This will provide an early warning of rising trends, and information for management issues that may arise. The principal water quality parameter of interest is total phosphorus, which is typically the limiting nutrient that affects aquatic plant growth and recreational water uses.
Data collected for this project may also be used in the future to support the following objectives:

- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

To this end, in 2013, the Wisconsin Department of Natural Resources (WDNR) convened a Lower Fox Monitoring Committee to develop and subsequently implement a surface water monitoring plan to evaluate the effectiveness of TMDL implementation in the Lower Fox River Basin. The Lower Fox River Basin comprises approximately 640 sq. miles, and, in general, extends from the outlet of Lake Winnebago to Green Bay. In general, the Basin contains 39 miles of the Fox River (referred to as the main stem) and 13 streams (referred to as tributaries) flowing into the Fox River.

The Lower Fox TMDL Monitoring Committee included representation from the University of Wisconsin Green Bay, (UWGB), the United States Geological Survey (USGS), the Oneida Nation, the WDNR, and municipal wastewater representatives.

The Committee noted that due to the size of the basin and complexity of source inputs (both point and nonpoint source pollution including urban runoff, rural runoff, and discharges) and the lack of currently available funding for surface water monitoring, that the scope of monitoring may be limited at the start. However, the current and proposed monitoring is sufficient to provide a baseline network (framework) that can be expanded upon in the future to accommodate implementation efforts occurring in the basin [for example, if conservation practices are focused in a particular sub-watershed, additional monitoring activities should accompany the implementation efforts].

Surface water monitoring in the Lower Fox was divided into two (2) components: the **Main Stem** (the Fox River itself) and the **Tributaries** (13 total).

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Main Stem

The Lower Fox River Main Stem monitoring includes the weekly collection of water samples from 3 or 4 monitoring locations from roughly March through October for a total of 35 weeks. Water samples will be analyzed at the Wisconsin State Laboratory of Hygiene (or a state certified laboratory) for analysis of total suspended solids (TSS), total phosphorus (TP), dissolved P, volatile organic solids, chlorophyll A, and dissolved oxygen (D.O.) . In addition, flow data will be collected at each of the four (4) main stem locations. The four (4) monitoring locations on the Main Stem include: the Lake Winnebago outlet (Neenah – Menasha dam), the De Pere dam, the mouth of the Fox River, and a proposed location near Wrightstown bridge.

Tributaries

For the 13 streams flowing into the Fox River, surface water quality monitoring will be conducted at one location at each of the 13 tributary sites on a monthly basis from May through October 2015 (for a total of 6 monthly monitoring events at 13 locations).

On each sampling date, volunteers will collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). In addition, volunteers will utilize transparency tubes to assess and document the transparency of each stream on each date.

See location map.

BIOLOGICAL ASSESSMENT and Secchi

Currently, volunteers are anticipated to perform Secchi depth and conduct submergent aquatic vegetation surveys in Lower Green Bay on a periodic basis.

To assess the biological health of the streams, macroinvertebrate samples will be collected during September or October and delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3 to 5 years.

Other

When warranted, based on water quality results, additional monitoring may be required. The WDNR will perform monitoring for confirmation prior to delisting the impaired water segments.

All sampling will be conducted in accordance with WDNR protocol.

Appendix L. Low flow monitoring schedule for Plum and Baird Creek WY 2014.

Sampling schedule Fixed Interval Sampling: Water Year 2014 available from https://www.uwgb.edu/watershed/data/USGSdata.htm

Baird Creek and Plum Creek: Samples collected monthly November-February: biweekly March through October

Week/Month	Baird Creek	Plum Creek	Collector	Constitute
Oct 7-11	X	X	USGS	SS, TP
Oct 21-25	X	X	UWGB	SS,TP,DP
November	X	X	USGS	SS,TP,DP
December	X	X	USGS	SS,TP,DP
January	X	X	USGS	SS,TP,DP
February	X	X	USGS	SS,TP,DP
March 10-14	X	X	UWGB	SS,TP,DP
March 24-28	X	X	USGS	SS,TP
April 7-11	X	X	UWGB	SS,TP,DP
April 21-25	X	X	USGS	SS,TP
May 5-9	X	X	UWGB	SS,TP,DP
May 19-23	X	X	USGS	SS,TP
June 2-6	X	X	UWGB	SS,TP,DP
June 16-20	X	X	USGS	SS,TP
June 30-July 4	X	X	UWGB	SS,TP,DP
July 14-18	X	X	USGS	SS,TP
July 28-Aug 1	X	X	UWGB	SS,TP,DP
August 11-15	X	X	USGS	SS,TP
August 25-29	X	X	UWGB	SS,TP,DP
Sept 8-12	X	X	USGS	SS,TP
Sept 22-26	X	X	UWGB	SS,TP,DP