

# Weyauwega Lake-Waupaca River Watershed Management Plan

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2019



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# Weyauwega Lake-Waupaca River Watershed Management Plan

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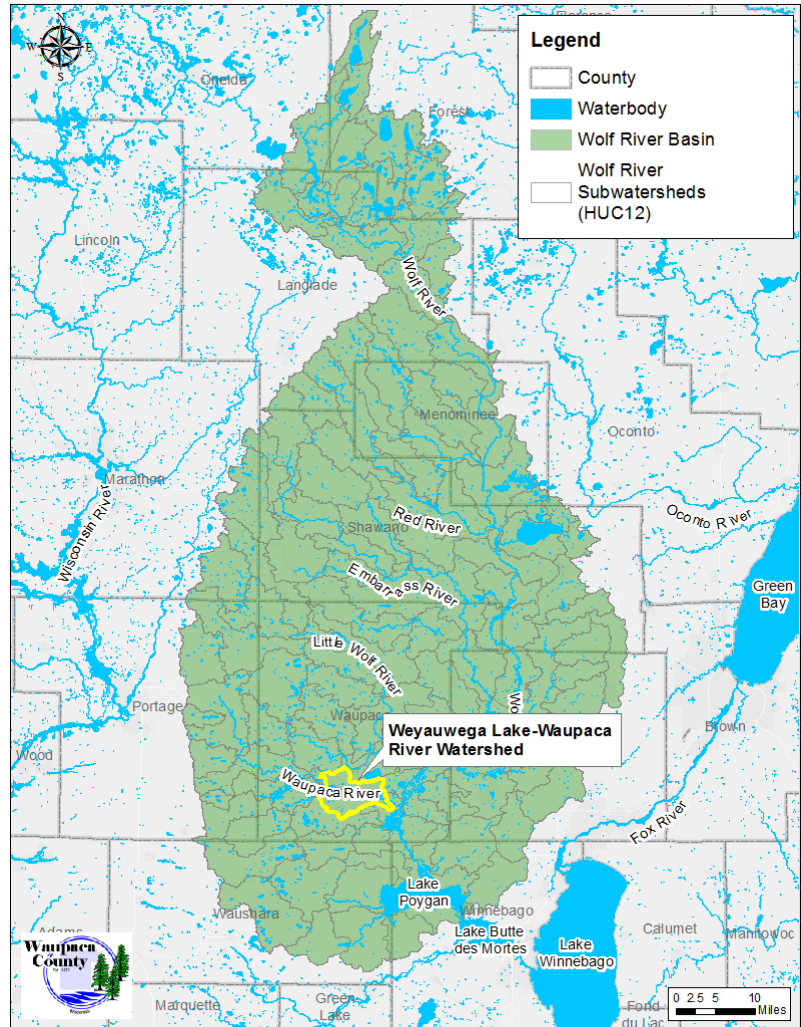
# *Weyauwega Lake-Waupaca River Watershed Management Plan*

## Executive Summary

The Weyauwega Lake-Waupaca River Watershed is a subwatershed of the Wolf River Basin in Wisconsin and is located in southern Waupaca County. The watershed drains a total area of 20,742 acres with City of Waupaca on the west side and City of Weyauwega on the east end.

Historically, the land in the area was covered with forests, prairie and wetlands. Waupaca County was home to the Menominee Indian Tribe before Europeans began to settle in the area in the early 1800's. The farming and forestry industry in the area has led to clearing of forests and natural areas and draining of wetlands in the watershed. Farming, industry, and urban development have led to a decrease in water quality in the watershed.

Waters in the Wolf River Basin are impaired due to excess phosphorus and total suspended solids. The Federal Clean Water Act requires states and authorized tribes to identify and restore impaired water bodies. A draft Total Maximum Daily Load (TMDL) plan has been developed for the Upper Fox and Wolf Basins to identify the sources of pollutants and the reductions necessary to address water quality impairments. The development of implementation plans for the subwatersheds of the Upper Fox and Wolf River Basin are necessary to meet the assigned daily loads of the TMDL.



The Weyauwega Lake-Waupaca River Watershed plan provides a framework to accomplish the following goals:

Goal #1: Improve surface water quality to achieve Wisconsin Department of Natural Resources/Environmental Protection Agency water quality standards.

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

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

Goal #4: Conserve and restore aquatic and terrestrial habitat.

Challenges and sources in the watershed:

The dominant land use in the watershed is agriculture and is responsible for approximately 46% of the phosphorus load and 75% of the sediment load in the watershed. Wetlands and forest land have been cleared and drained to increase agricultural production in this area. 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.

Watershed Implementation Plan:

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 project. The plan includes estimated costs, potential funding sources, agencies responsible for implementation and measures of success.

Recommended Management Practices:

- Conservation Tillage Methods (Strip/Zone till, No till, Mulch till)
- Cover Crops
- Vegetated buffers
- Wetland restoration/creation
- Grassed Waterways
- Nutrient Management
- Low Disturbance Manure Injection
- Water and Sediment Control Basins
- Critical Area Planting
- Tree Plantings/Conservation Cover/Habitat



restoration

- Barnyard Runoff Management
- Waste Storage
- Prescribed Grazing
- Two-stage ditches/channel restoration

#### Information and Education Recommendations:

- Provide educational workshops, field demonstrations and tours on how to implement best management practices.
- Engage landowners in planning and implementing conservation on their land and by providing information on the technical tools and financial support 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 Weyauwega Lake-Waupaca River watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for “noncompliant” 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 as implementation moves forward.

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## **1. Background and Purpose**

This watershed plan was developed by the Waupaca County Land & Water Conservation Department (LWCD) to more effectively implement conservation work on agricultural lands in the Weyauwega Lake-Waupaca River Watershed. The Weyauwega Lake-Waupaca River Watershed is in the Wolf River Basin which is currently in the process of Total Maximum Daily Load<sup>1</sup> (TMDL) development for phosphorus and sediment. As a result of the pending TMDL and available funding, Waupaca County LWCD decided to develop a watershed assessment plan that will identify where conservation implementation will have the greatest impact on improving water quality.

The information in the watershed plan will be used by conservation professionals in the watershed to identify priority farms and fields for further resource assessment and implementation of conservation practices.

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<sup>1</sup> Additional information on TMDL can be found at <http://dnr.wi.gov/topic/tmdls/>.

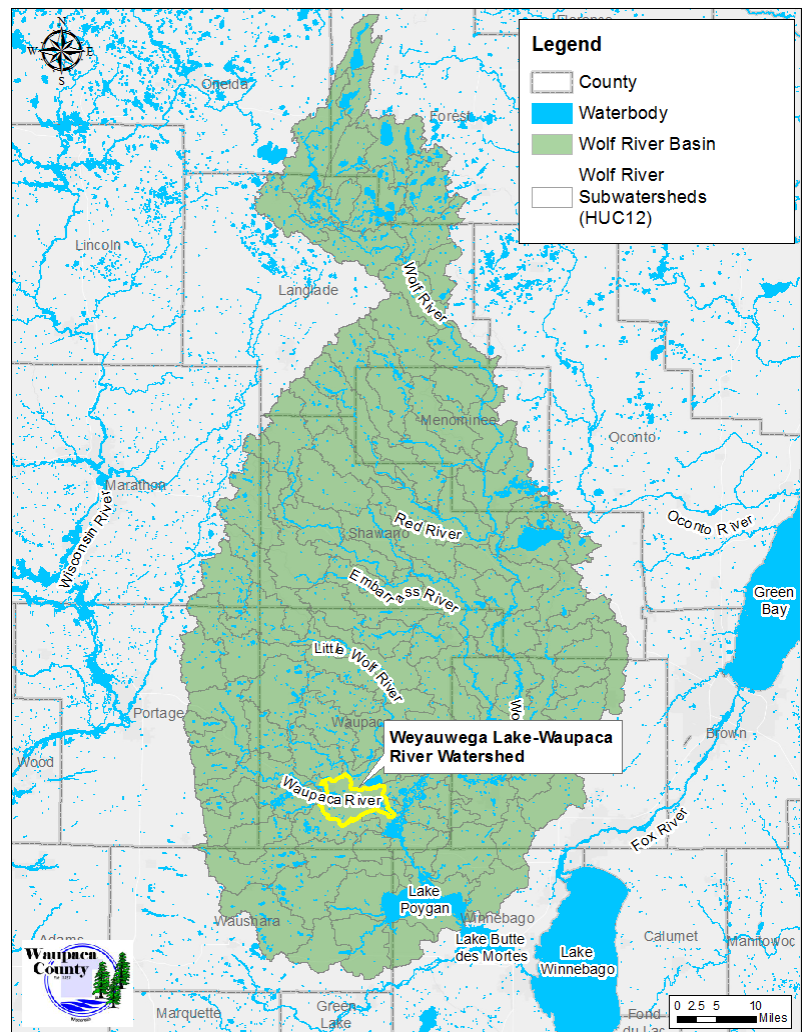
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## 2. Watershed Characterization

### 2.1 Weyauwega Lake-Waupaca River Watershed Setting

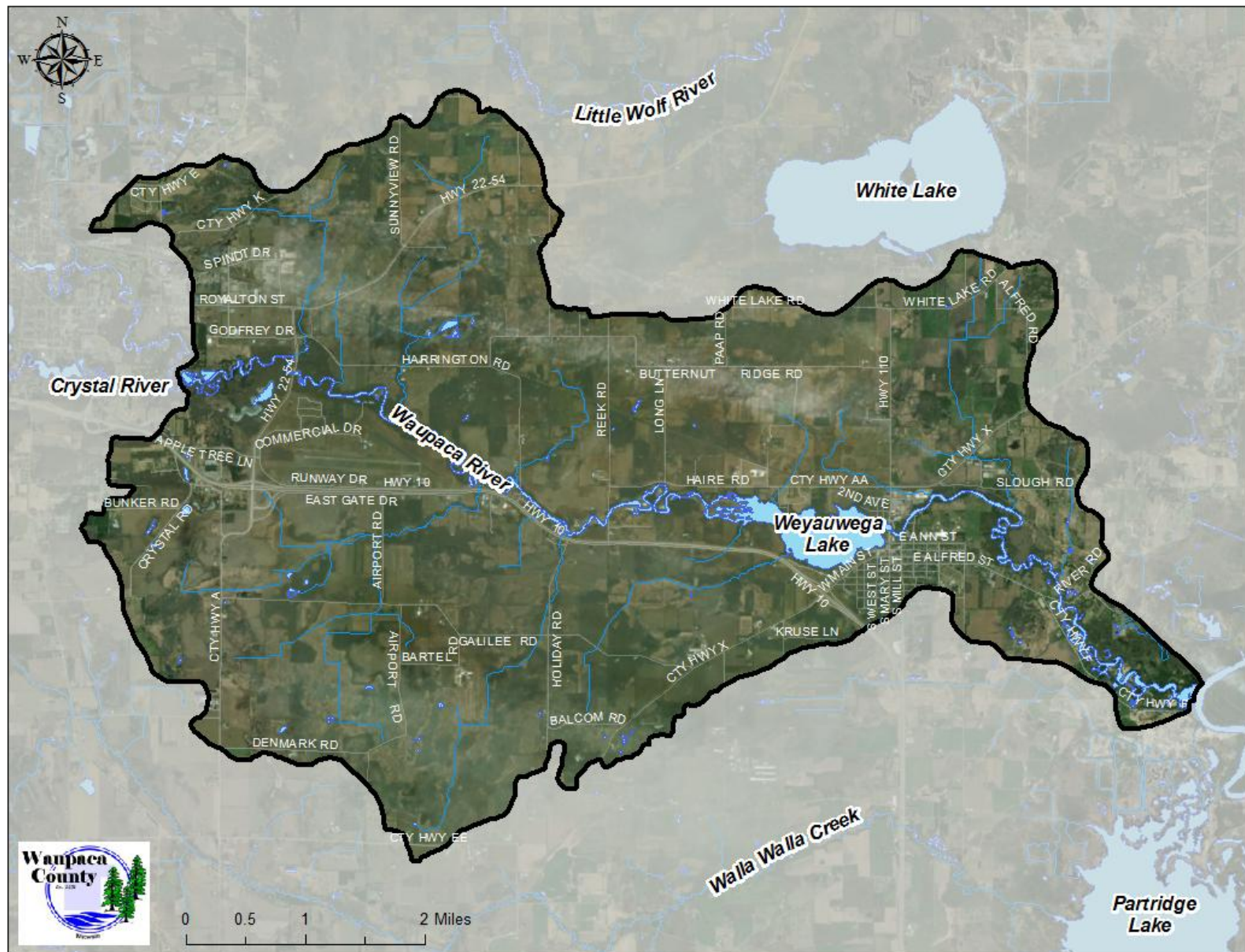
The Weyauwega Lake-Waupaca River Watershed is a subwatershed of the Wolf River Basin.

The Wolf River Basin encompasses 11 counties in Wisconsin starting in the north in Forest and Oneida Counties draining south to Waushara and Winnebago Counties draining into Lake Poygan (Figure 1). The Weyauwega Lake-Waupaca River Watershed is centrally located in southern Waupaca County. There are several unnamed tributaries that flow to the Waupaca River and Lake Weyauwega in the watershed (Figure 2). The watershed drains a total area of 20,742 acres with City of Waupaca on the west end and City of Weyauwega on the west end.



**Figure 1.** Wolf River Basin.





**Figure 2.** Weyauwega Lake-Waupaca River Watershed.



## *2.2 Prior Studies, Projects and Existing Resource Management and Comprehensive Plans.*

Various studies have been completed in the Wolf River Basin and Lake Michigan Basin describing and analyzing conditions in the area. Several management and comprehensive plans as well as monitoring programs have already been developed for the Wolf River Basin and Lake Michigan Basin. A list of known studies, plans and monitoring programs are listed below:

### Nonpoint Source Control Plan for the Tomorrow-Waupaca River Priority Watershed Project-1993

Nonpoint source watershed plan developed for the Tomorrow-Waupaca River Priority Watershed that focused on phosphorus and sediment reduction. The Wisconsin Nonpoint Source Water Pollution Abatement Program provided cost sharing to landowners who voluntarily implemented best management practices in priority watershed areas. Plan implementation began in 1995 and ended in 2008. The BMPs that were implemented during the Priority Watershed Project were nutrient management, residue management, barnyard-runoff management, streambank restoration, and manure storage throughout the watershed.

### Waupaca County Land and Water Resource Management Plan-2012

A 10 year comprehensive plan to work with the citizens of Waupaca County to improve the water quality and natural resources of Waupaca County. The plan has specific goals, objectives and actions to achieve that mission.

### The State of the Wolf Basin-2001

The State of the Wolf Basin Report identified the status of resources in the basin and articulated WDNR and partner goals and objectives to maintain, restore and protect ecosystem health. This plan serves as an update to the Wolf River Basin Water Quality Management Plan. Four priority areas identified in the plan are: water pollution, loss of shoreline habitat, hunting, fishing, trapping and recreational uses, and need for an inventory of basin resources. Other concerns identified include: preservation and protection of wetlands, exotic species, pressures from development, and land use and smart growth.

### Priority Watershed Water Quality Evaluation for the Tomorrow-Waupaca River Watershed, Portage and Waupaca County, Wisconsin- 2017

A WDNR project to evaluate water quality improvement made in the Tomorrow-Waupaca River Watershed from best management practices installed in the watershed from 1995-2008 as part of Tomorrow-Waupaca River Priority watershed project. Water quality samples were collected from over 20 locations in the watershed and were analyzed for nitrogen and phosphorus in 2016. Macroinvertebrate and fish surveys were also done at these locations. The water quality monitoring results showed improvements and declines in surface waters in the watershed since the implementation of the priority watershed project. The upper portions of the Tomorrow River

maintained excellent macroinvertebrate communities, and the fish communities throughout the Tomorrow-Waupaca River mainstem indicated good to excellent water quality. The macroinvertebrate communities in the Waupaca River upstream and downstream of Lake Weyauwega indicated a decrease in water quality from 1994. Water quality monitoring also indicated that two unnamed tributaries to the Waupaca River near Lake Weyauwega are not meeting their potential uses, have high nutrient concentrations, and sedimentation occurring which limits available fish and aquatic macroinvertebrate habitat.

#### Targeted Watershed Assessment of the Lake Weyauwega Sub-watershed of the Waupaca River Watershed, Waupaca County, Wisconsin-2018

The Lake Weyauwega sub-watershed indicated some of the highest nutrient concentrations and poorest water quality in the Tomorrow- Waupaca River Watershed during a watershed assessment in 2016. This project was done to provide baseline water quality data in support of the Natural Resource Conservation Service's and Waupaca County LWCD's efforts to develop a nine key element plan and reduce nutrient and sediment runoff within the watershed. Total phosphorus and total nitrogen samples were collected at 11 sites May-October in 2017. Macroinvertebrate surveys were conducted at 5 sites and fish surveys were conducted at 8 sites.

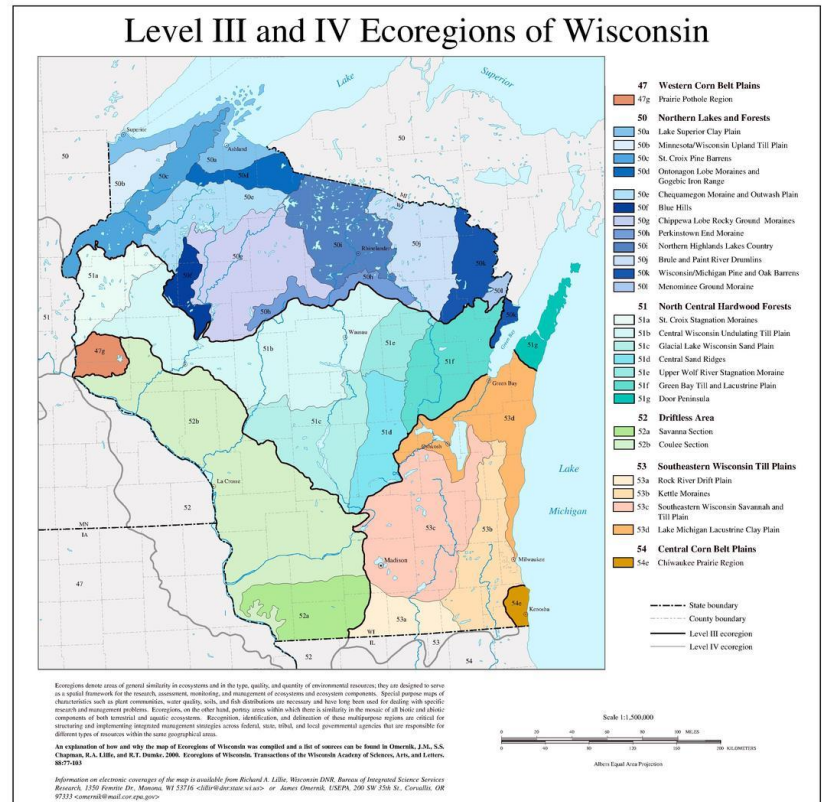
#### Weyauwega Lake-Lake Management Plan-2016

Comprehensive lake management plan developed to address the issue of sediment accumulation and a dense aquatic plant community worsened by the presence and expansion of aquatic invasive species such as curly-leaf pondweed (*Potamogeton crispus*) and flowering rush (*Botumus umbulatus*) in the impoundment lake.

## 2.3 Wisconsin Ecoregions

Ecoregions are based on abiotic and biotic 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. Omernik of the USGS. The Weyauwega Lake-Waupaca River watershed is located in the North Central Hardwood Forest ecoregion and in the Green Bay Till and Lacustrine Plain sub ecoregion. The North Central Hardwood ecoregions is transitional between predominately forested ecoregions to the north and the agricultural ecoregions to the south. The land use/cover in this region consists of a variety of forests, wetlands, lakes, and agriculture.

The Weyauwega Lake-Waupaca River watershed is split by the Central Sand Ridges and Green Bay Till and Lacustrine Plain sub ecoregions. The Central Sand Ridges sub ecoregion is characterized by pitted glacial outwash with eskers and drumlins, ice contact deposits, rolling ground moraines, and steep end moraines. The dry, sandy, and loamy till soils of this region support native vegetation of oak savanna and areas of sedge meadows. The Green Bay Till and Lacustrine Plain sub ecoregion is characterized by outwash and loamy recessional moraines in the northwest and lake plains and ground moraines in the south. The soils of this region are sandy and loamy and support native vegetation of maple/basswood/oak forests and oak savanna. The growing season is favorable to agriculture in this sub ecoregion and much of the natural vegetation has been cleared for agriculture.



**Figure 3.** Map of Ecoregions of Wisconsin. Source: Omernik et al, 2000.

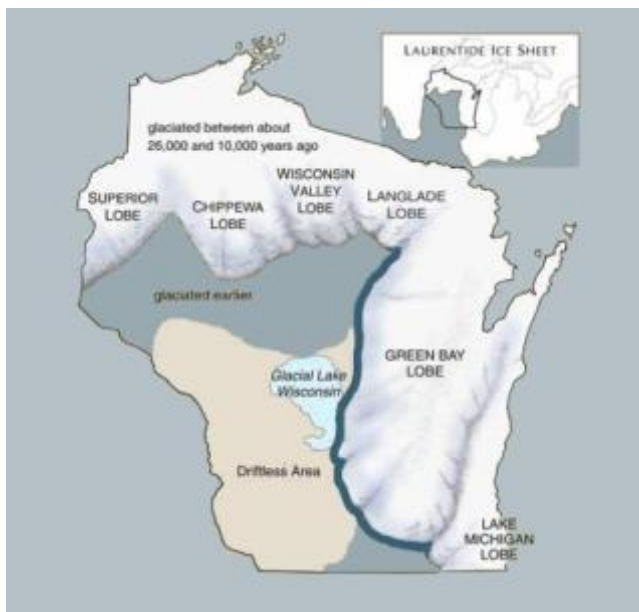
## 2.4 Climate

Wisconsin has a continental climate that is affected by Lake Michigan and Lake 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. Temperatures can reach minus 30°F or colder in the winter and above 90°F in the summer. Average annual precipitation is about 31 inches a year of rain and snow in the watershed area. The majority of precipitation occurs in the form of storm events during the growing season (May-September). Most runoff occurs in February, March, and April when the land surface is frozen and soil moisture is highest. The climate in central and southern Wisconsin is favorable for dairy farming, where corn, small grains, hay, and vegetables are the primary crops.

## 2.5 Topology and geology

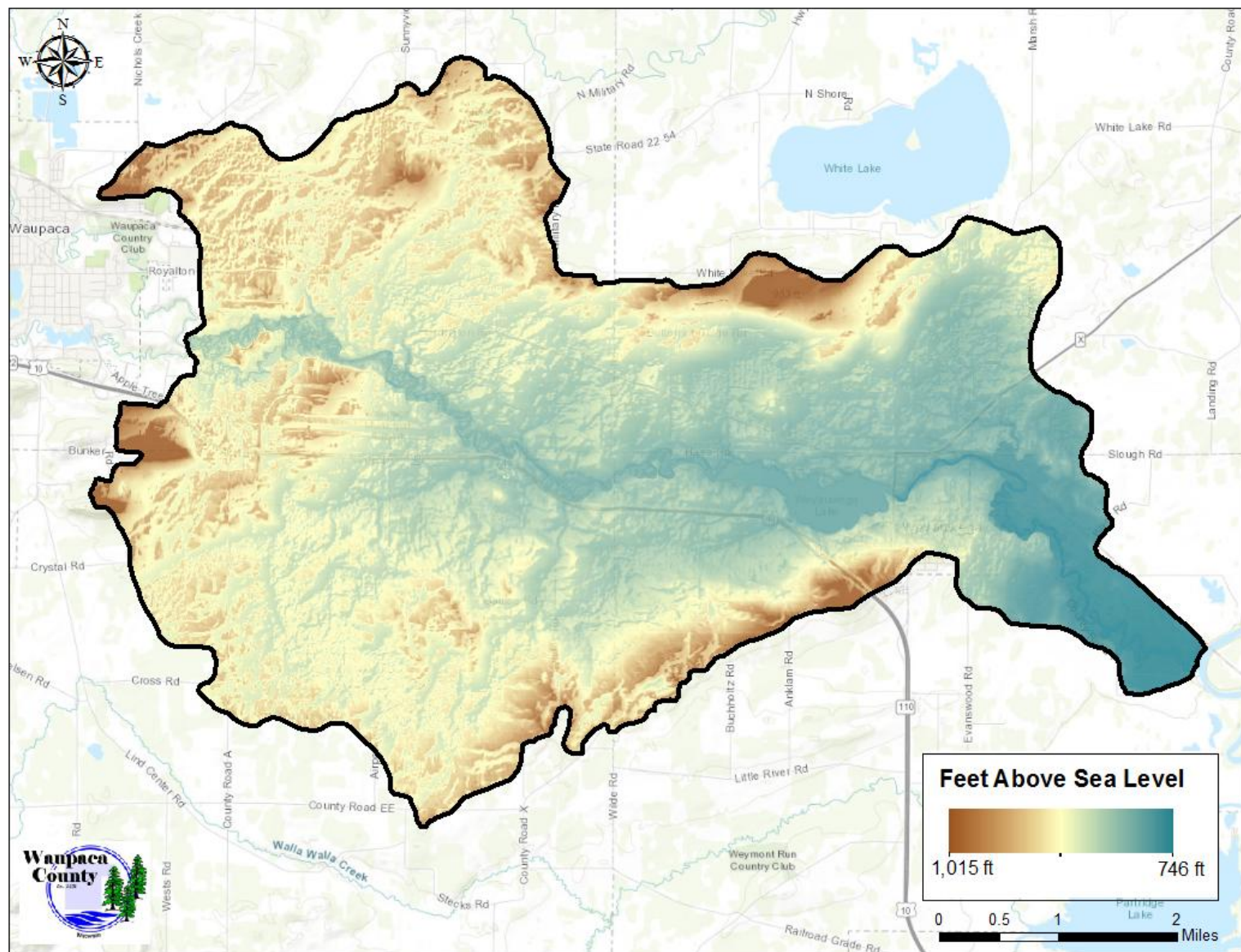
The Weyauwega Lake-Waupaca River watershed lies in the Eastern Ridges and Lowlands geographical province of Wisconsin. The watershed area was part of the glaciated portion of Wisconsin. During the last Ice Age the Laurentide Ice Sheet began to advance into Wisconsin

where it expanded for 10,000 years before it began to melt back after another 6,500 years. Glaciers have greatly impacted the geology of the area. 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, drumlins, and lake plain. The region contains numerous marshes, wetlands, and scattered lakes. The highest point in the watershed area is 1,015 ft above sea level and the lowest point in the watershed is 746 feet above sea level (Figure 5). There is a 269 foot change in elevation from highest and lowest point in the watershed.



**Figure 4.** Ice Age Geology of Wisconsin.  
©Mountain Press, 2004.





**Figure 5.** Digital elevation model.

## 2.6 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.

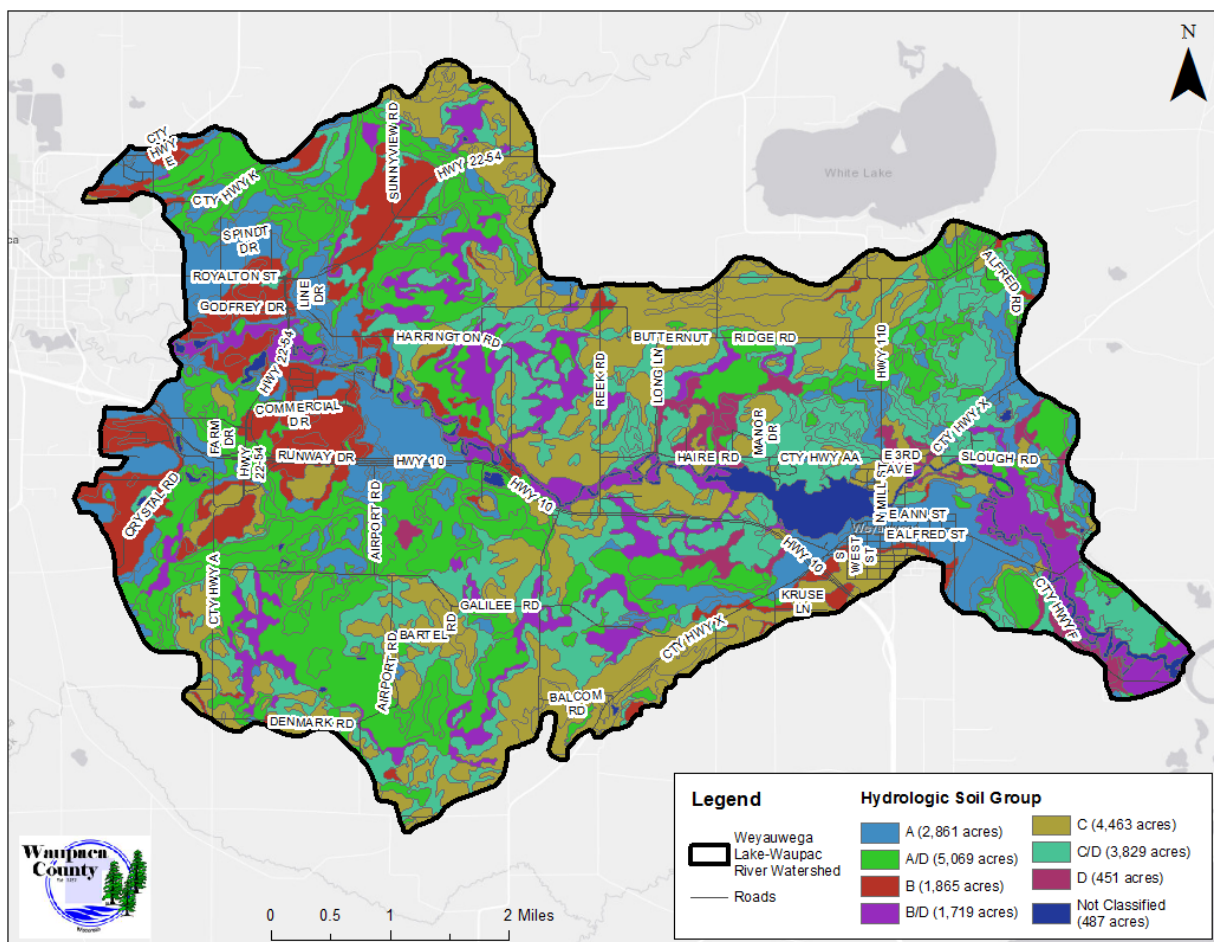
The dominant soil types in the watershed are Hortonville fine sandy loam (16.1%), Plainfield loamy sand (14.6%), Symco loam (11.9%), Meehan loamy sand (10.1%) and Cathro and Markey Mucks (8.5%).

### 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 1. 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. The dominant hydrologic soil group in the watershed is Group C (59%) (Figure 6). Group C soils have moderately high runoff potential and low infiltration and transmission rates.

**Table 1.** Hydrologic soil group description.

| 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 6.** Hydrologic soil groups.

## 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 less susceptible to erosion than fine textured soils such as silt. The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. It is one of the six factors used in the Revised Universal Soil Loss Equation (RUSLE)<sup>2</sup> to predict the average annual rate of soil loss by sheet and rill erosion in tons/acre/year. Values of K range from 0.02 to 0.49. Soil erodibility factors for Weyauwega Lake- Waupaca River Watershed are shown in Figure 7, soils with high erodibility are indicated by orange and red.

<sup>2</sup> USLE refers to the Universal Soil Loss Equation that estimates average annual soil loss caused by sheet and rill erosion base on the following factors: rainfall and runoff (A), soil erodibility factor (K), slope factor (LS), crop and cover management factor (C), and conservation practice factor (P).



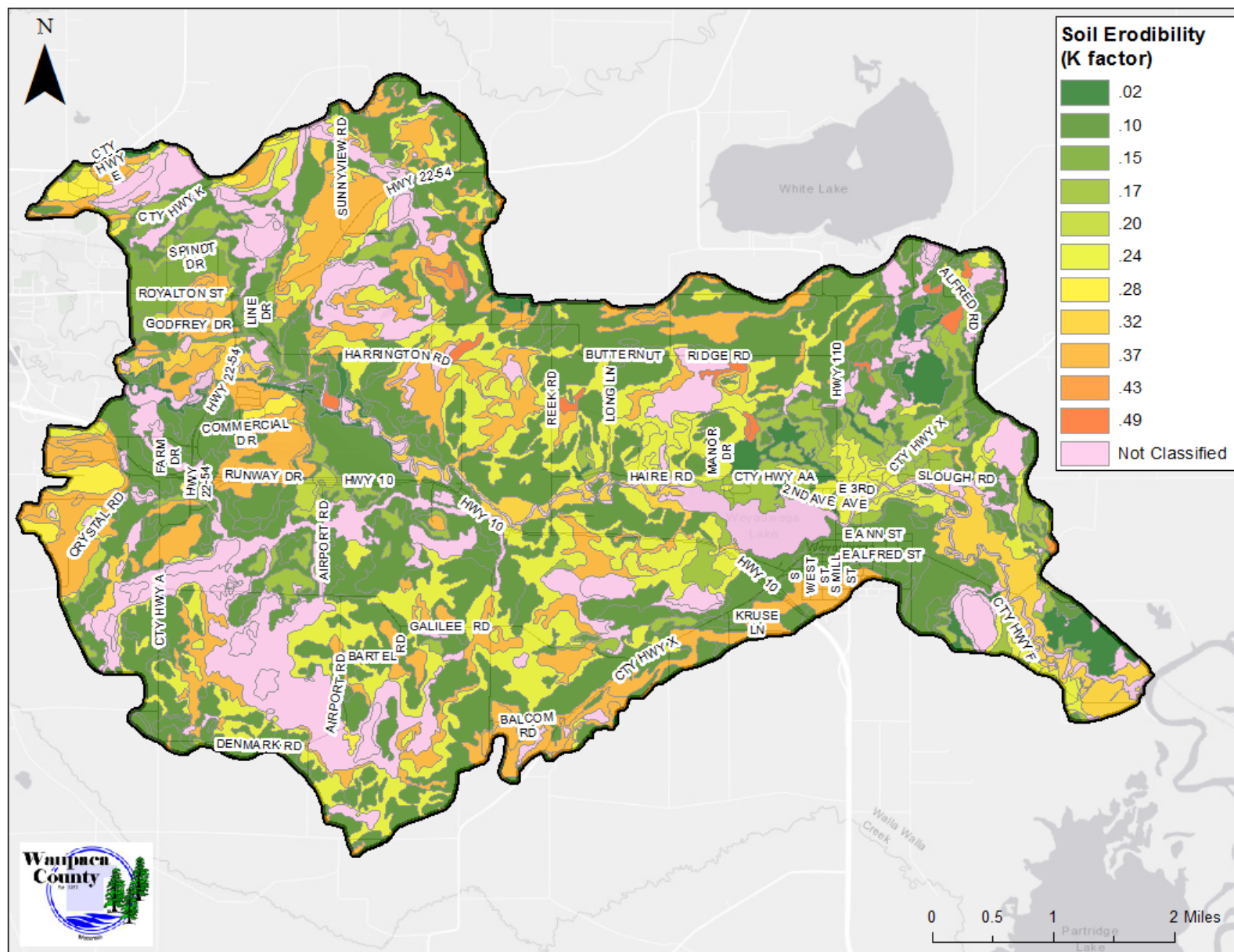


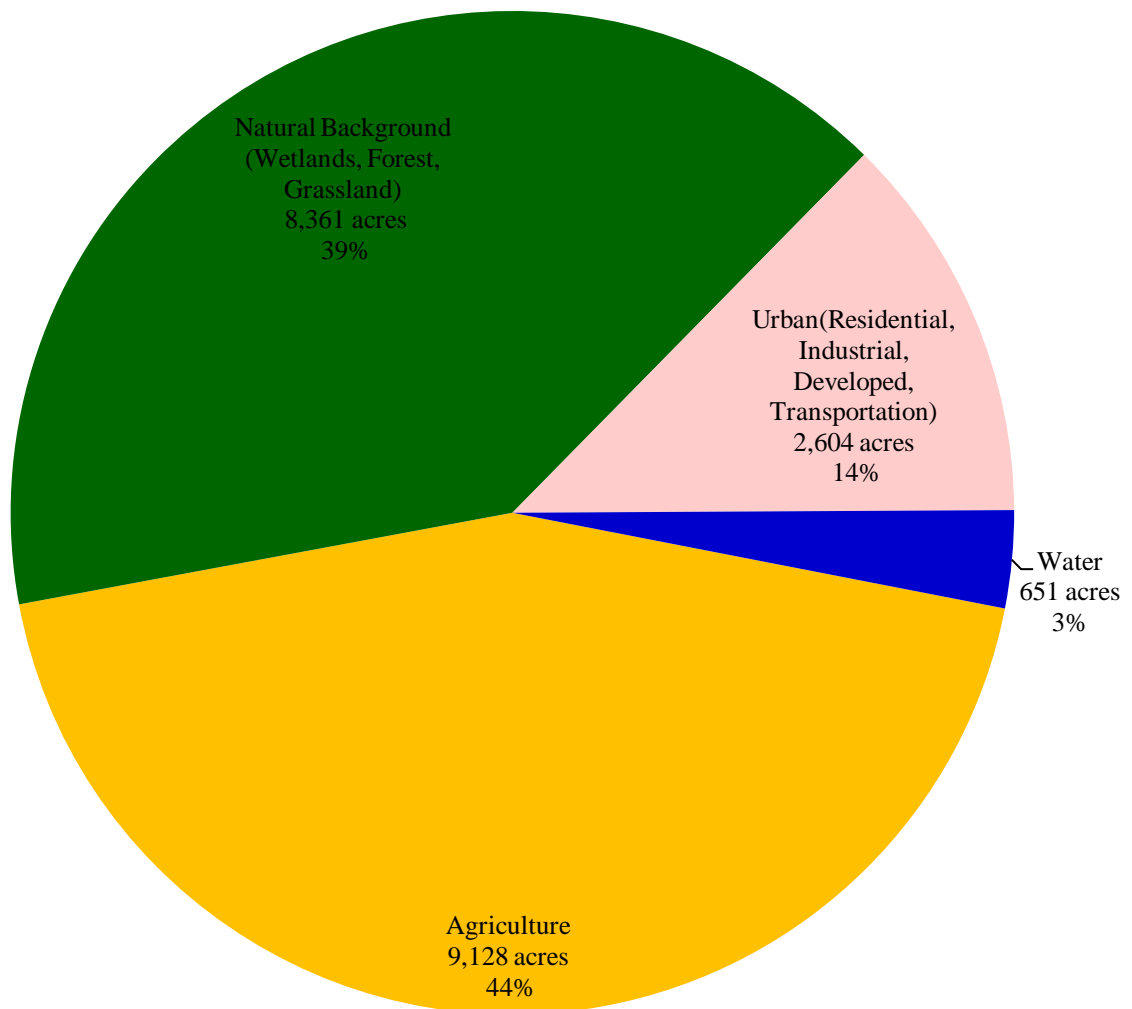
Figure 7. Soil erodibility.



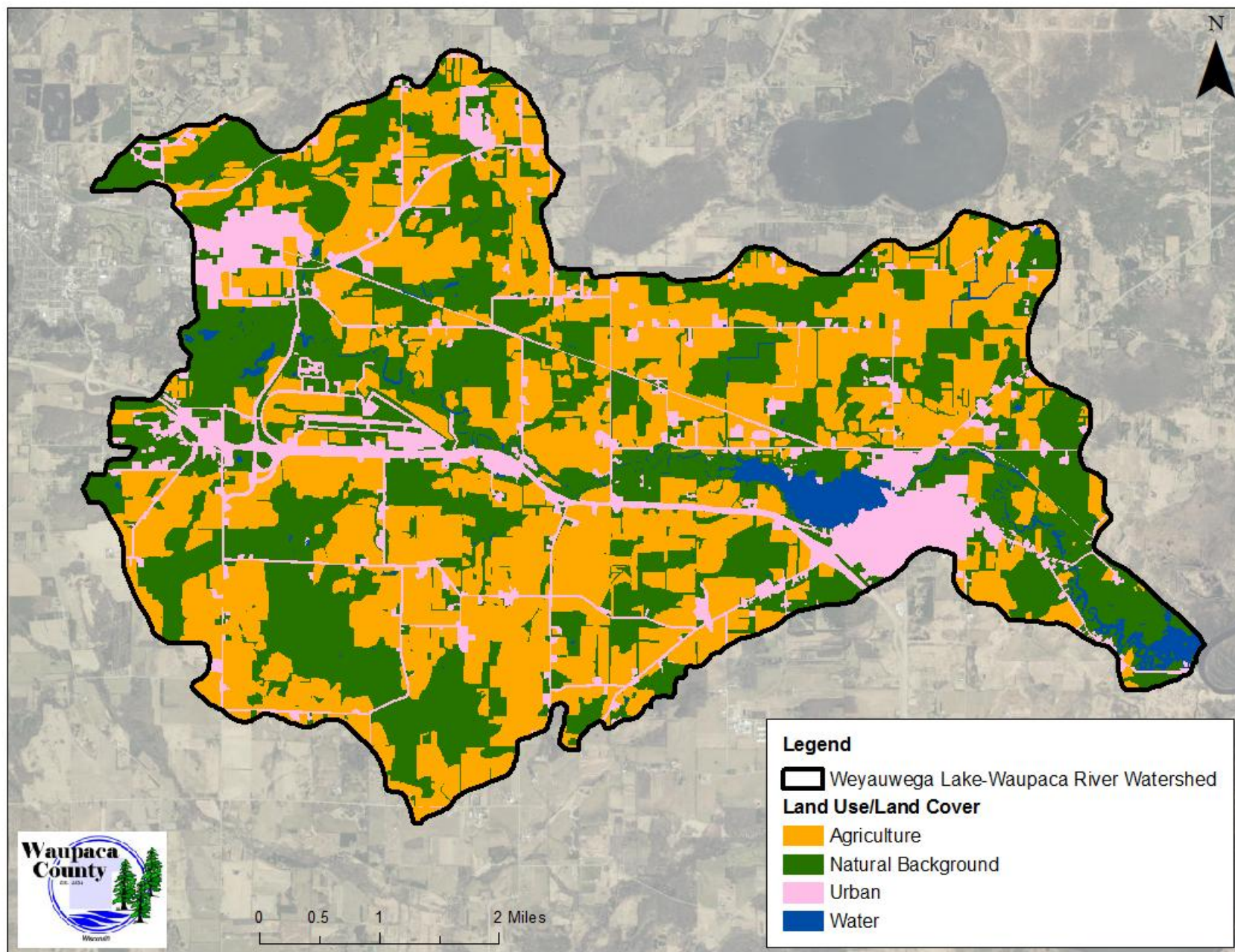
## 2.7 Land Cover/Land Use

### 2.7.1 Land Cover/Land Use

Existing land use data was determined by using the Waupaca County 2015 Land Use data set and aerial imagery. Land use was classified into four categories: natural background (forests, wetlands, and grassland), urban (residential, industrial, developed, and transportation), agriculture, and water. Agriculture is the dominant land use in the watershed at 44% followed by natural background at 39% (Figure 8).



**Figure 8.** Summary of land use in Weyauwega Lake-Waupaca River Watershed.



**Figure 9.** Weyauwega Lake-Waupaca River Watershed land use.

### 2.7.2 Crop Rotation

Cropland data was obtained from the USDA National Agriculture Statistics Service (NASS). NASS produces the Cropland Data Layer using satellite images at 30 meter observations, Resourcesat-1 Advanced Wide Field Sensor, and Landsat Thematic mapper. Data from 2009 to 2016 was analyzed using the WDNR EVAAL<sup>3</sup> tool to obtain a crop rotation. Crop rotations for the watershed are shown in Table 2 and Figure 10.

Cash grain rotation is the dominant rotation in the watershed at 47 % with dairy rotation following at 41%. Different crop rotations can affect the amount of erosion and runoff that is likely to occur on a field. Corn is often grown in dairy rotations and harvested for corn silage; harvesting corn silage leaves very little residue left on the field making the field more susceptible to soil erosion and nutrient loss. 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.

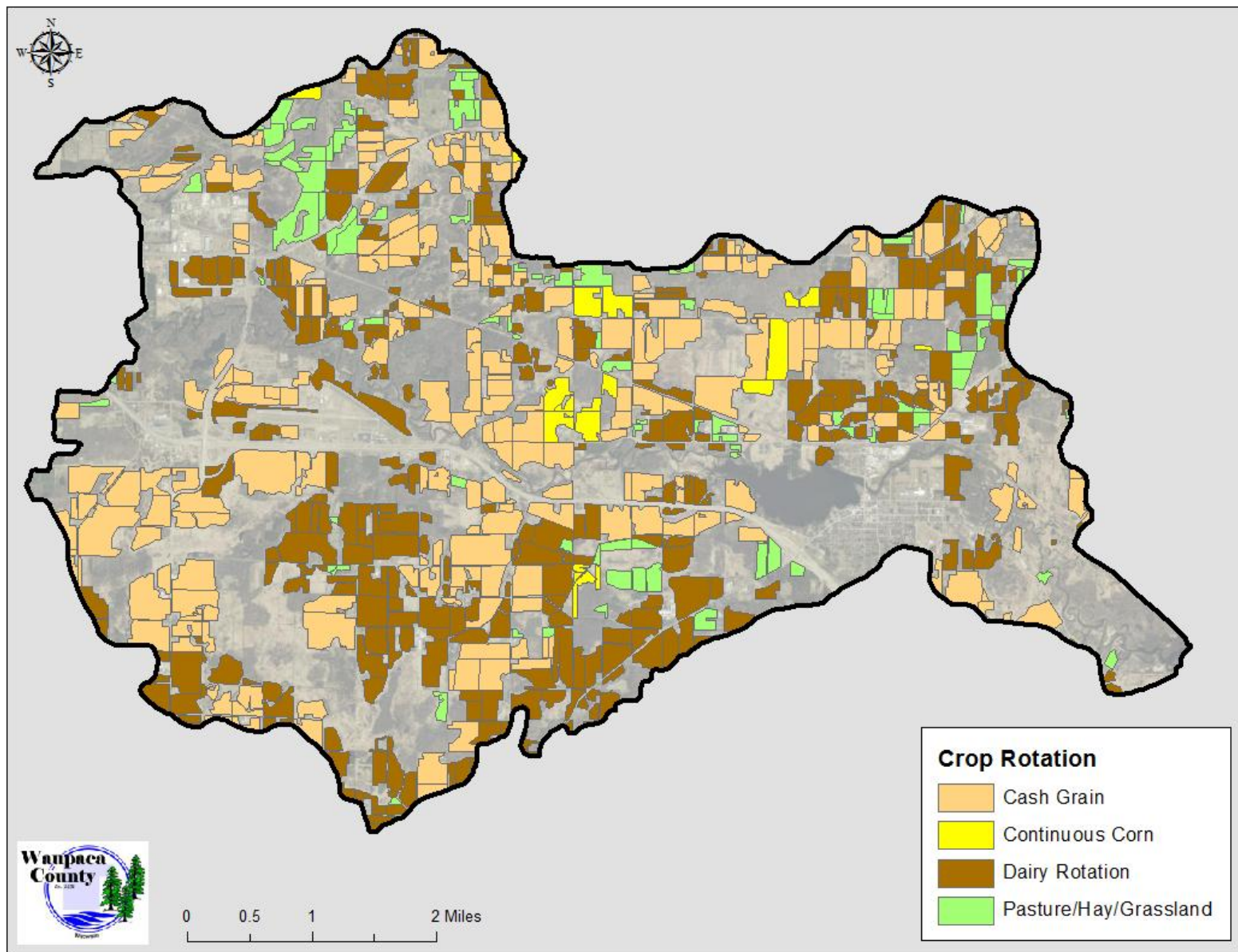
**Table 2.** Crop rotation summary.

| Crop Rotation         | Acres        | Percent    |
|-----------------------|--------------|------------|
| Cash Grain            | 4,192        | 47         |
| Continuous Corn       | 293          | 3          |
| Dairy Rotation        | 3,676        | 41         |
| Pasture/Hay/Grassland | 813          | 9          |
| <b>Total</b>          | <b>8,975</b> | <b>100</b> |

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<sup>3</sup> Additional information on EVAAL can be found at <http://dnr.wi.gov/topic/nonpoint/evaal.html>.





**Figure 10.** EVAAL crop rotation analysis by field.

## 2.8 Watershed Jurisdictions

The Weyauwega Lake-Waupaca River Watershed is located entirely in Waupaca County. The Towns of Royalton, Waupaca, Weyauwega, and Lind as well as the City of Waupaca and Weyauwega are located in the watershed area.

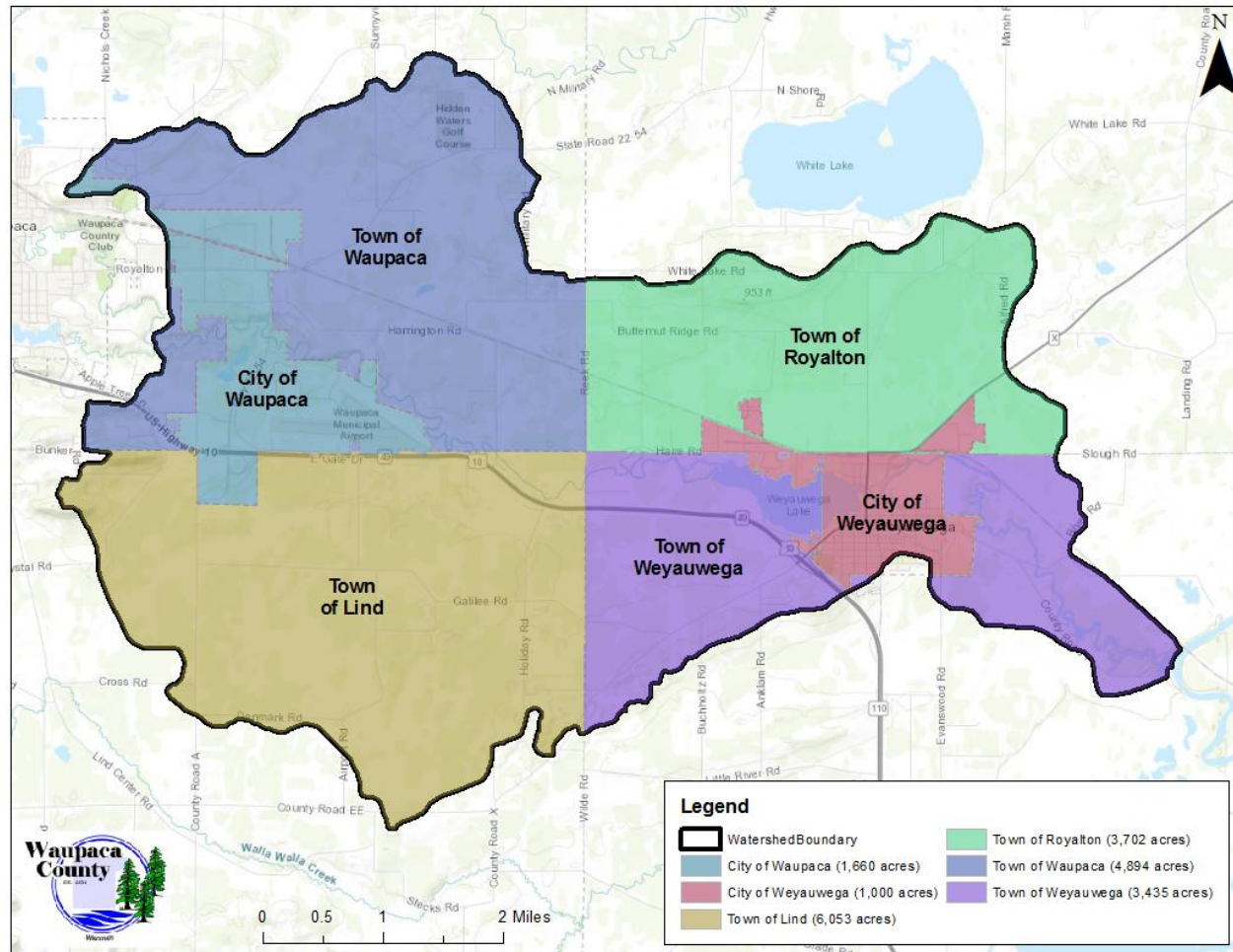


Figure 11. Municipal jurisdictions.

## *2.9 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. Municipalities in the watershed currently have ordinances relating to shore land, wetland, and floodplain zoning. Municipalities have to meet the minimum requirements of County ordinances; however, they have the ability to adopt higher levels of protection. In addition to urbanization-level regulations, Waupaca County has the implementation of the Working Lands Initiative program to provide additional watershed protection above and beyond existing ordinances under local municipal codes.

Other governmental and private entities with watershed jurisdictional or technical advisory roles include: Natural Resources Conservation Service, Department of Agriculture, Trade, and Consumer Protection, East Central Wisconsin Regional Planning Commission, and Department of Transportation.

## *2.10 Population and Economic Demographics*

The Weyauwega Lake-Waupaca River Watershed is rural and has a very low population. The City of Waupaca, located on the western edge of the watershed, is the most populated area in the watershed with an estimated population of 6,069. The majority of the population in the watershed area is employed in agriculture, manufacturing, health services and construction. The median household income of the townships within the watershed ranges from \$41,538 to \$62,552.

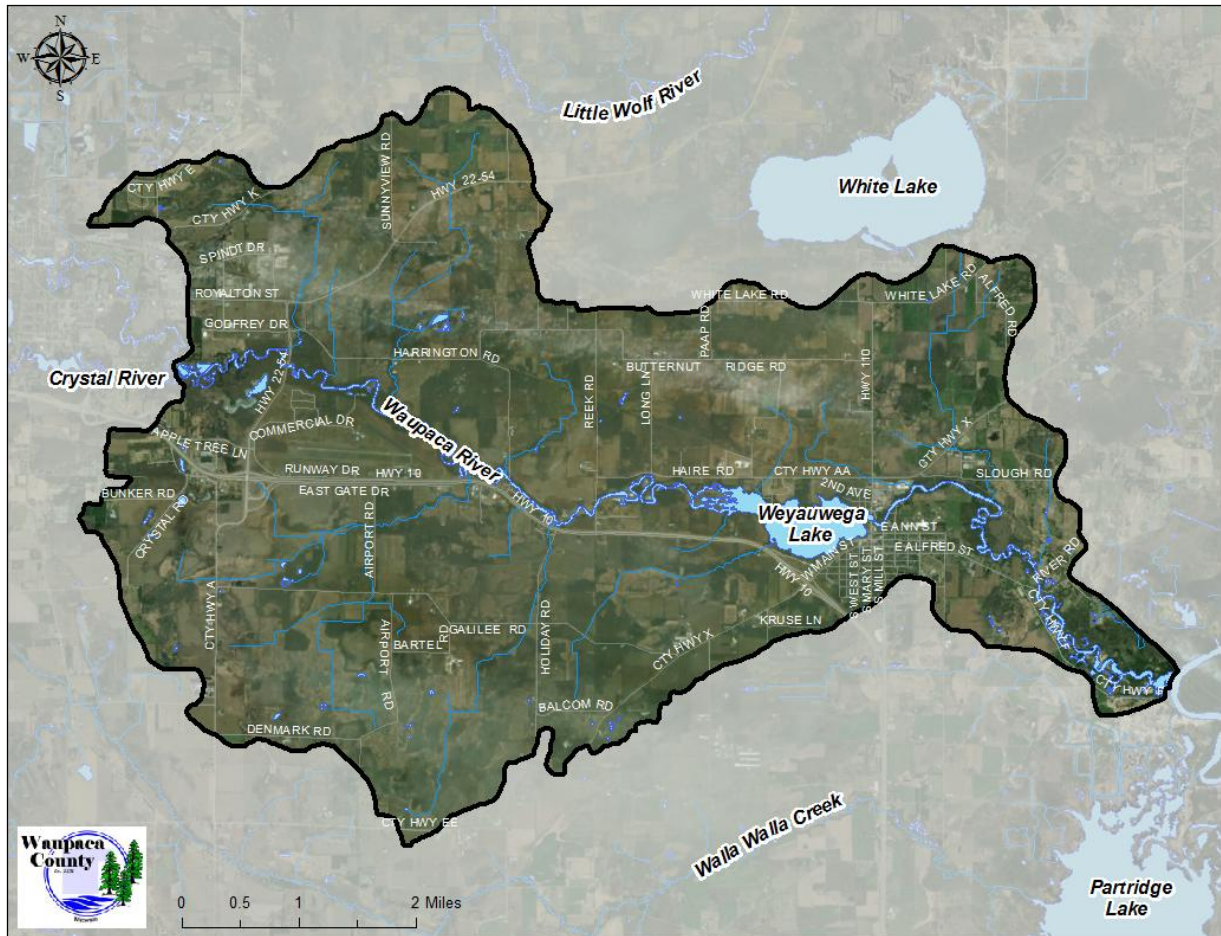
**Table 3.** Population and median household income (US Census Bureau).

| <b>Jurisdiction</b> | <b>Population</b> | <b>Median Household Income</b> |
|---------------------|-------------------|--------------------------------|
| <b>Municipality</b> |                   |                                |
| Town of Waupaca     | 1,228             | \$62,552                       |
| City of Waupaca     | 6,069             | \$45,433                       |
| Town of Royalton    | 1,434             | \$53,214                       |
| Town of Lind        | 1,579             | \$54,821                       |
| Town of Weyauwega   | 583               | \$54,250                       |
| City of Weyauwega   | 1,900             | \$41,538                       |
| <b>County</b>       |                   |                                |
| Waupaca             | 51,974            | \$52,441                       |



### 3.0 Hydrology and Water Quality Characterization

#### 3.1 Hydrology



**Figure 12.** Surface waters in Weyauwega Lake-Waupaca River Watershed (WDNR 24K Hydrology).

#### Surface Waters

##### **Rivers and Streams**

The Waupaca River and Crystal River converge west of Waupaca where the watershed begins; the Waupaca River then flows eastward through Weyauwega and leaves the watershed near County Hwy E where the river empties into the Wolf River. This portion of the Waupaca River contains warm water species and forage fish while the Waupaca River above the City of Waupaca is classified as a Class II trout water. There are several unnamed small tributaries in the watershed.

Many tributaries and streams in the Weyauwega Lake-Waupaca River Watershed have been significantly altered from their natural state. Ditching and straightening of streams is evident throughout the watershed. Straightening of streams increases velocity of water which can lead to increased bed scour and bank erosion. Straightening of streams and ditching also results in loss of habitat, increased flooding downstream and a decrease in water quality.

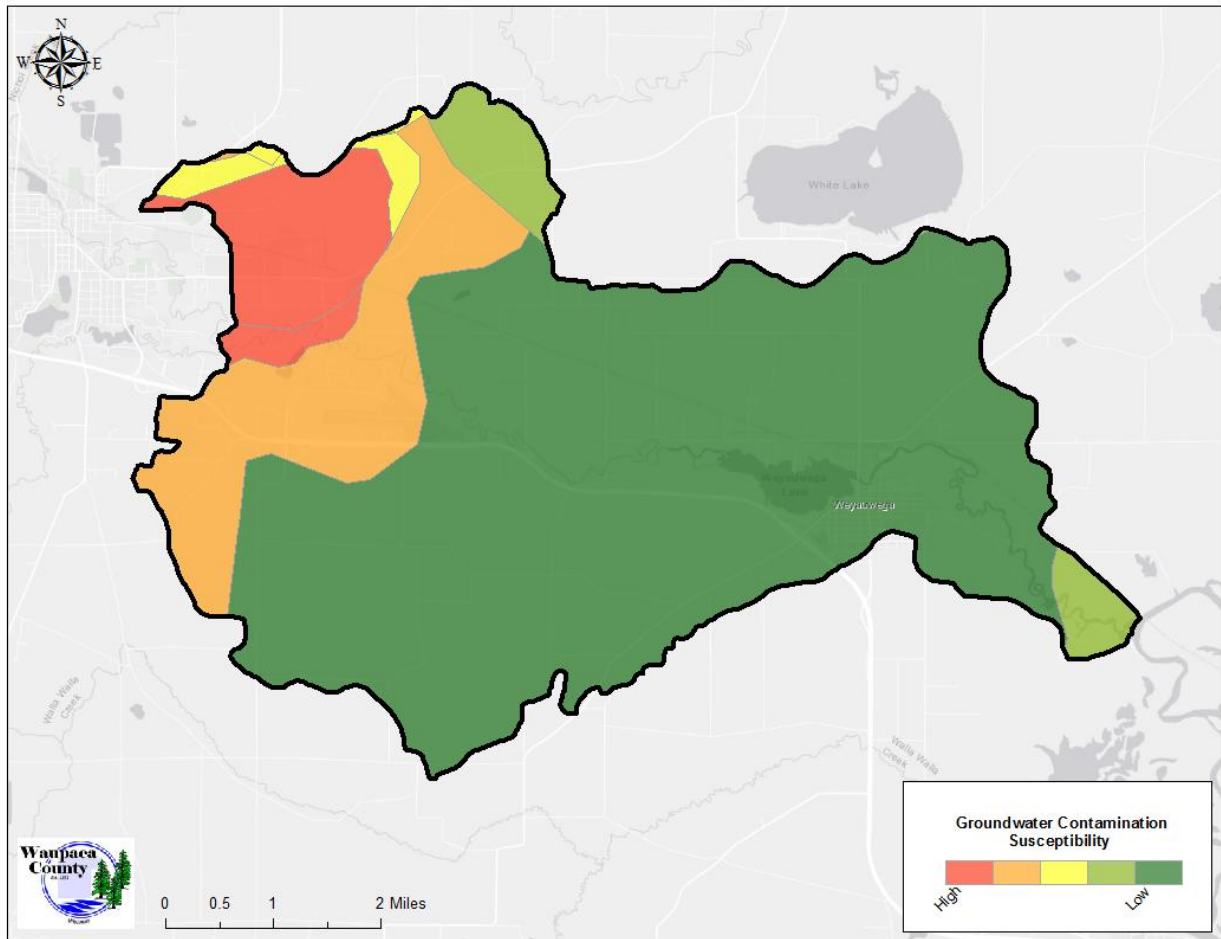
## **Lakes**

Weyauwega Lake is a 253 acre man-made lake with an average depth of 5 feet. The Lake was created by damming the Waupaca River in 1855 to power a grist mill and then was replaced in 1931 to produce hydroelectricity.

## **Groundwater**

Lake levels and base stream flows are directly related to local ground water supplies in the watershed. The average depth to the water table in the watershed is 0-20 feet in the majority of the watershed. The bedrock in the northwest portion of the watershed is categorized as igneous, metamorphic and volcanic and the southeast part of the watershed has sandstone bedrock. Shale bedrock is very close to impermeable while igneous, metamorphic and volcanic rock is less permeable than carbonates and sandstone, the rock tends to be fractured. The depth to bedrock for the majority of the watershed is greater than 100 ft from the land surface. The greater the depth to bedrock, the more likely the water table is located above the bedrock layer. The majority of the soils in the watershed are fine textured and have low permeability, except near the east side of Waupaca where the soils are coarse textured and have high permeability. Surficial deposits in the watershed include sand and gravel on the western third of the watershed and clay covering the rest of the watershed. The Wisconsin DNR's groundwater contamination susceptibility model estimates groundwater susceptibility based on several characteristics such as bedrock type and depth, water table depth, soil characteristics and type of surficial deposits. Figure 13 shows groundwater contamination susceptibility in the watershed. The area of the watershed near the City of Waupaca is the most vulnerable to groundwater contamination, while the majority of the watershed has a low susceptibility.





**Figure 13.** WDNR groundwater contamination susceptibility.

### 3.2 Water Quality

#### 3.2.1 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, Stormwater, and Agricultural permits.

##### Individual

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 three WPDES permit holders in the watershed. Total phosphorus and total suspended solid loads and draft TMDL allocations for WPDES permit holders in the watershed are shown in (Table 4).

**Table 4.** Total phosphorus and total suspended solids loads and draft TMDL allocations for WPDES permit holders (Cadmus Group LLC, 2018).

| Sources                                 | Total Phosphorus Load (lbs/yr) |           |           | Percent Reduction from Baseline | Total Suspended Solids Load (lbs/yr) |           |           | Percent Reduction from Baseline |
|---|--------------------------------|-----------|-----------|---------------------------------|--------------------------------------|-----------|-----------|---------------------------------|
|   | Baseline                       | Allocated | Reduction |                                 | Baseline                             | Allocated | Reduction |                                 |
| Agropur Inc Weyauwega Plant             | 471                            | 80        | 391       | 83.0%                           | 3,819                                | 3,819     | -         | -                               |
| Weyauwega Star Dairy                    | 13                             | 13        | -         | -                               | 183                                  | 183       | -         | -                               |
| Weyauwega Wastewater Treatment Facility | 2,557                          | 439       | 2,118     | 82.8%                           | 77,318                               | 50,083    | 27,235    | 35.2%                           |
| <b>Total</b>                            | 3,041                          | 532       | 2,509     | 82.5%                           | 81,320                               | 54,085    | 27,235    | 33.49%                          |

##### Agricultural

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 no permitted CAFO's in the watershed area. Permits for CAFO's require that the production area has zero discharge.

##### General/Storm Water

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. A MS4 permit is also required for certain counties if they have a population greater than 100,000. Municipal permits require storm water management programs to reduce polluted storm water runoff. 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. Waupaca County is under the population limit for a general permit and has no municipal MS4's either.

### 3.2.2 Nonpoint Sources

The majority of pollutants in the Weyauwega Lake-Waupaca River watershed come from nonpoint sources. A nonpoint source cannot be traced back to a point of discharge. Runoff from agricultural and urban areas is an example of nonpoint source. Agriculture is the dominant land use in the watershed and accounts for approximately 46% of the total phosphorus loading and 75% of the total suspended sediment loading. Nonpoint sources in the watershed include:

- Erosion/Runoff from agricultural lands
- Tile drainage
- Fertilizer/Manure Application
- Erosion from stream banks and construction sites
- Runoff from lawns and impervious surfaces
- Failing Septic Systems
- Pet/animal waste

#### **Relevant Nonpoint Source Regulations**

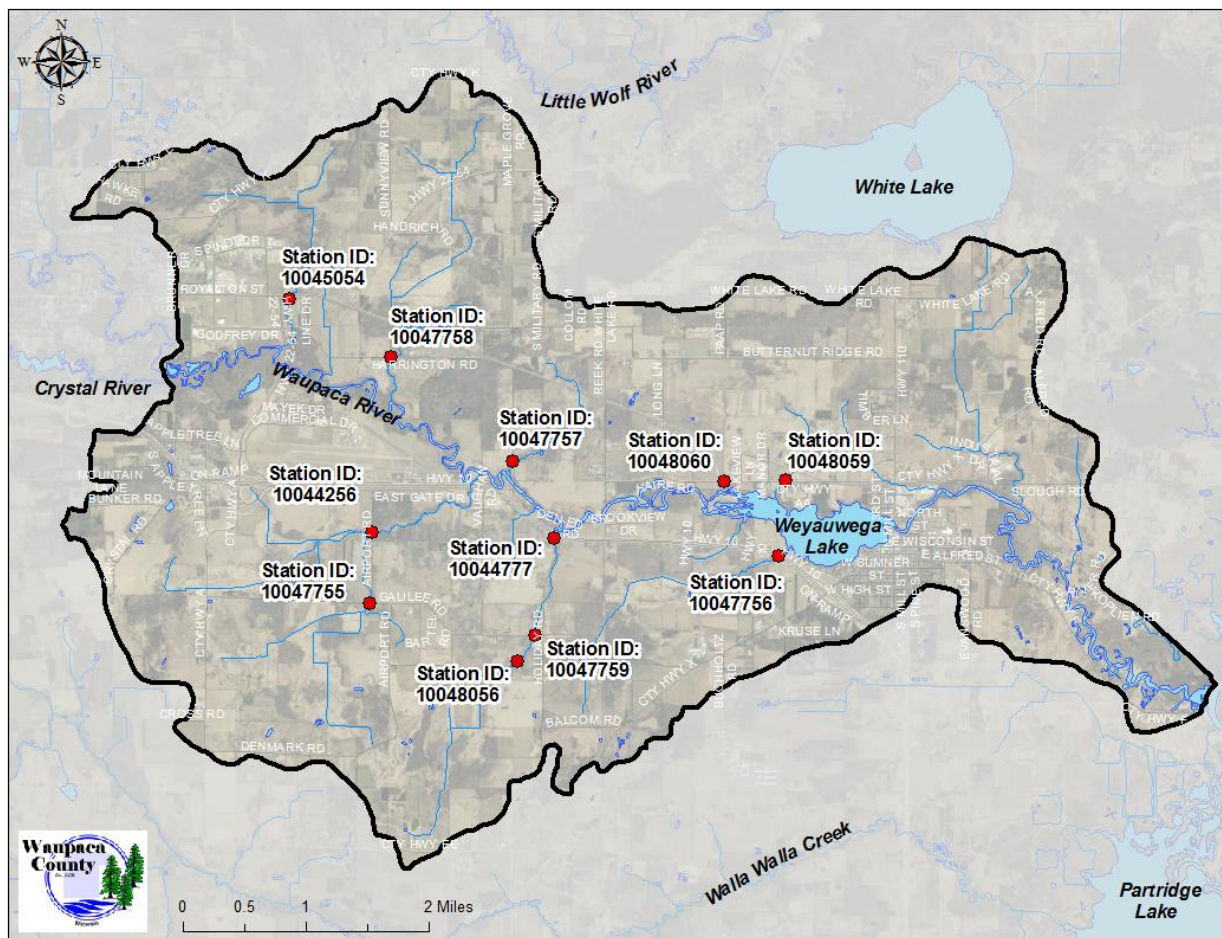
Wisconsin Administrative Code Chapter NR 151 regulates runoff management in the state.

Agricultural runoff is regulated under subchapter 2. This chapter describes regulations relating to phosphorus index, manure storage & management, nutrient management, soil erosion and tillage setback. Implementation and enforcement procedures are also described in this chapter.

Conservation practices used to meet performance standards in Ch. NR 151.2 are identified in Chapter ATCP 50 of the Wisconsin Administrative Code. Subchapter 3 of NR 151 describes non-agricultural performance standards relating to construction sites, developed urban areas, turf and garden nutrient management, total suspended solids, peak discharge, infiltration, and fueling and vehicle maintenance. Subchapter 4 describes similar performance standards as subchapter 3 but applies to transportation facilities.

### 3.4 Water Quality Monitoring

The Weyauwega Lake-Waupaca River Watershed was recently evaluated for water quality conditions by the DNR in 2016 to determine if there were improvements in water quality from the Tomorrow-Waupaca River Priority Watershed project that ran from 1995-2008. The sites in the watershed were sampled for macroinvertebrate and fish biotic integrity indices, nitrogen, and phosphorus. The Lake Weyauwega sub-watershed indicated some of the highest nutrient concentrations and poorest water quality in the Tomorrow-Waupaca River watershed. The DNR sampled locations in the Waupaca River-Weyauwega Lake subwatershed again in 2017 to provide baseline data for this management plan. Locations of sample sites are shown in Figure 14. A summary of the data collected at each sample location is shown in Table 5.

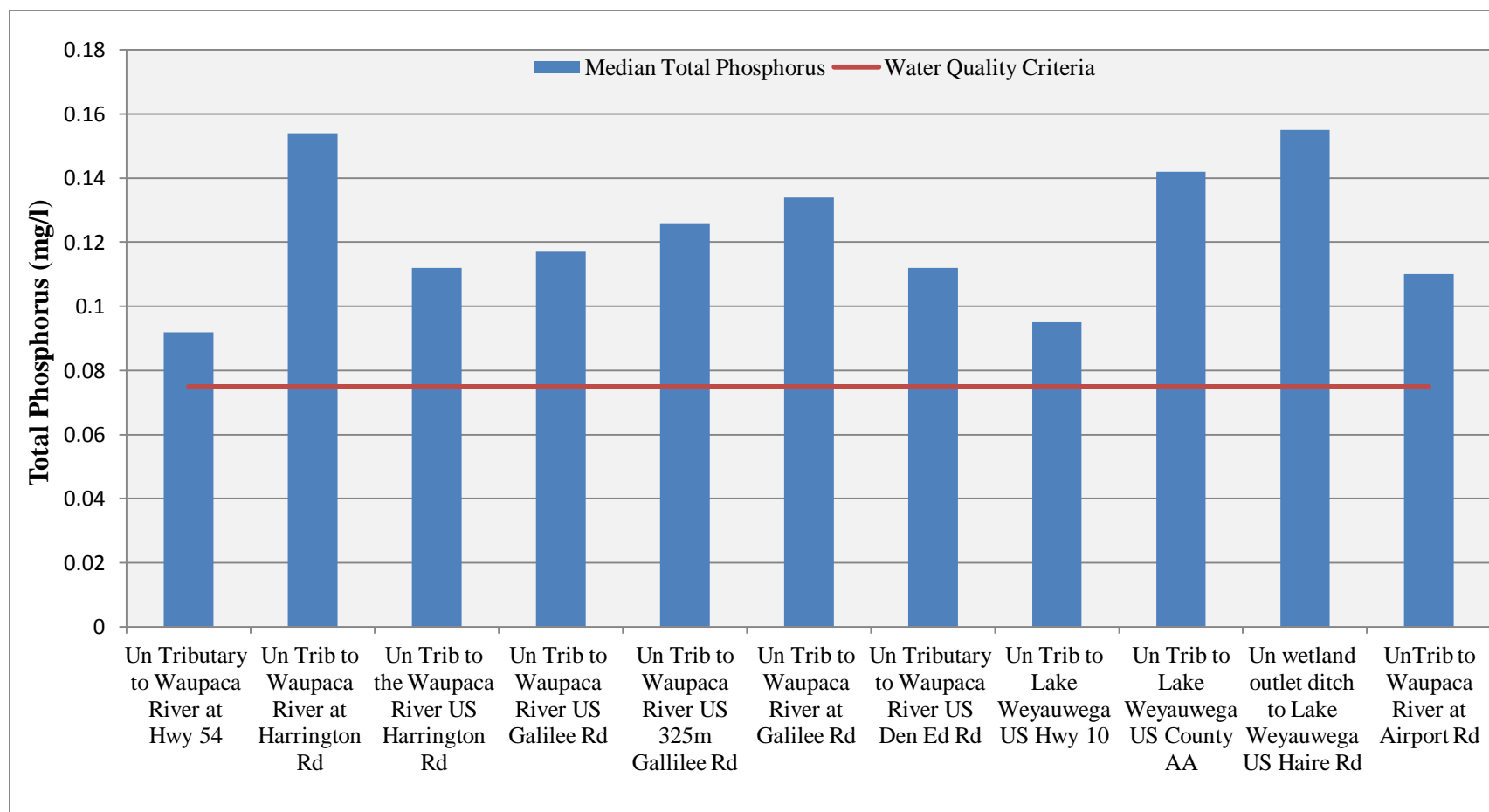


**Figure 14.** WDNR water quality sampling locations in Weyauwega Lake-Waupaca River Watershed (2017).

**Table 5.** Summary of water quality data for WDNR sample locations (2017).

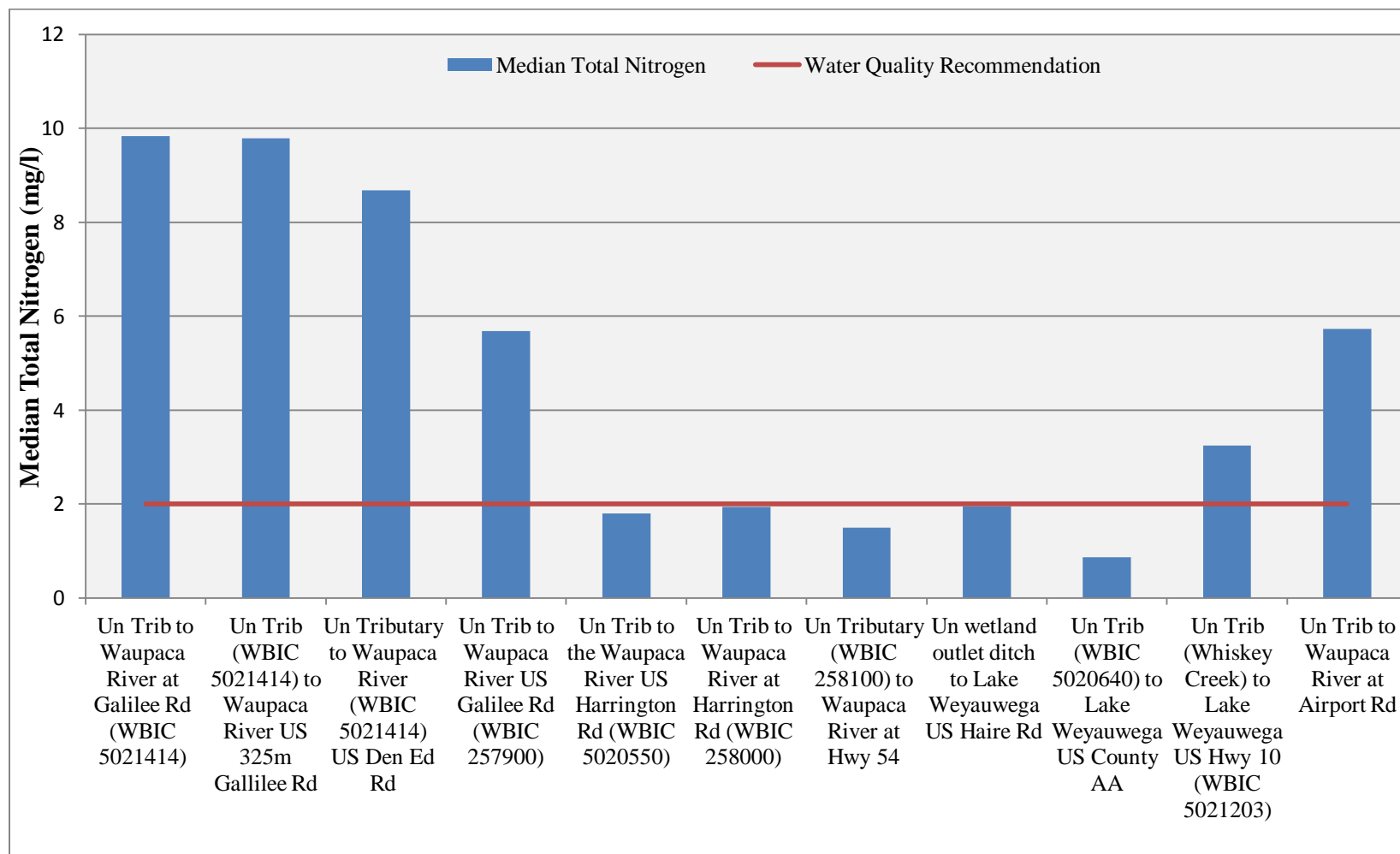
| <b>Station ID</b> | <b>Station Name</b>   | <b>Total Phosphorus</b> | <b>Total Nitrogen</b> | <b>Fish IBI</b> | <b>Macroinvertebrate IBI</b> |
|-------------------|---|-------------------------|-----------------------|-----------------|------------------------------|
| 10047759          | Unnamed Trib to Waupaca River at Galilee Rd (WBIC 5021414)        | x                       | x                     | x               | x                            |
| 10048056          | Unnamed Trib (WBIC 5021414) to Waupaca River US 325m Gallilee Rd  | x                       | x                     |                 |                              |
| 10044777          | Unnamed Tributary to Waupaca River (WBIC 5021414) US Den Ed Rd    | x                       | x                     | x               |                              |
| 10047755          | Unnamed Trib to Waupaca River US Galilee Rd (WBIC 257900)         | x                       | x                     | x               |                              |
| 10047757          | Unnamed Trib to the Waupaca River US Harrington Rd (WBIC 5020550) | x                       | x                     | x               | x                            |
| 10047758          | Unnamed Trib to Waupaca River at Harrington Rd (WBIC 258000)      | x                       | x                     | x               | x                            |
| 10045054          | Unnamed Tributary (WBIC 258100) to Waupaca River at Hwy 54        | x                       | x                     | x               |                              |
| 10048060          | Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd        | x                       | x                     |                 |                              |
| 10048059          | Unnamed Trib (WBIC 5020640) to Lake Weyauwega US County AA        | x                       | x                     |                 |                              |
| 10047756          | Unnamed Trib to Lake Weyauwega US Hwy 10 (WBIC 5021203)           | x                       | x                     |                 | x                            |
| 10044256          | Unnamed Trib (WBIC 257800) to Waupaca River at Airport Rd         | x                       | x                     | x               | x                            |

In 2017, summer median total phosphorus concentrations ranged from 0.021 mg/l to 0.155 mg/l at the sample locations in the watershed (Figure 15). The state total phosphorus water quality criteria for streams is a summer median of 0.075 mg/l during the growing season (May-October). All of the tributaries to the Waupaca River sampled in the watershed had summer median total phosphorus concentrations that were above the water quality criteria of 0.075 mg/l in the summer of 2017.



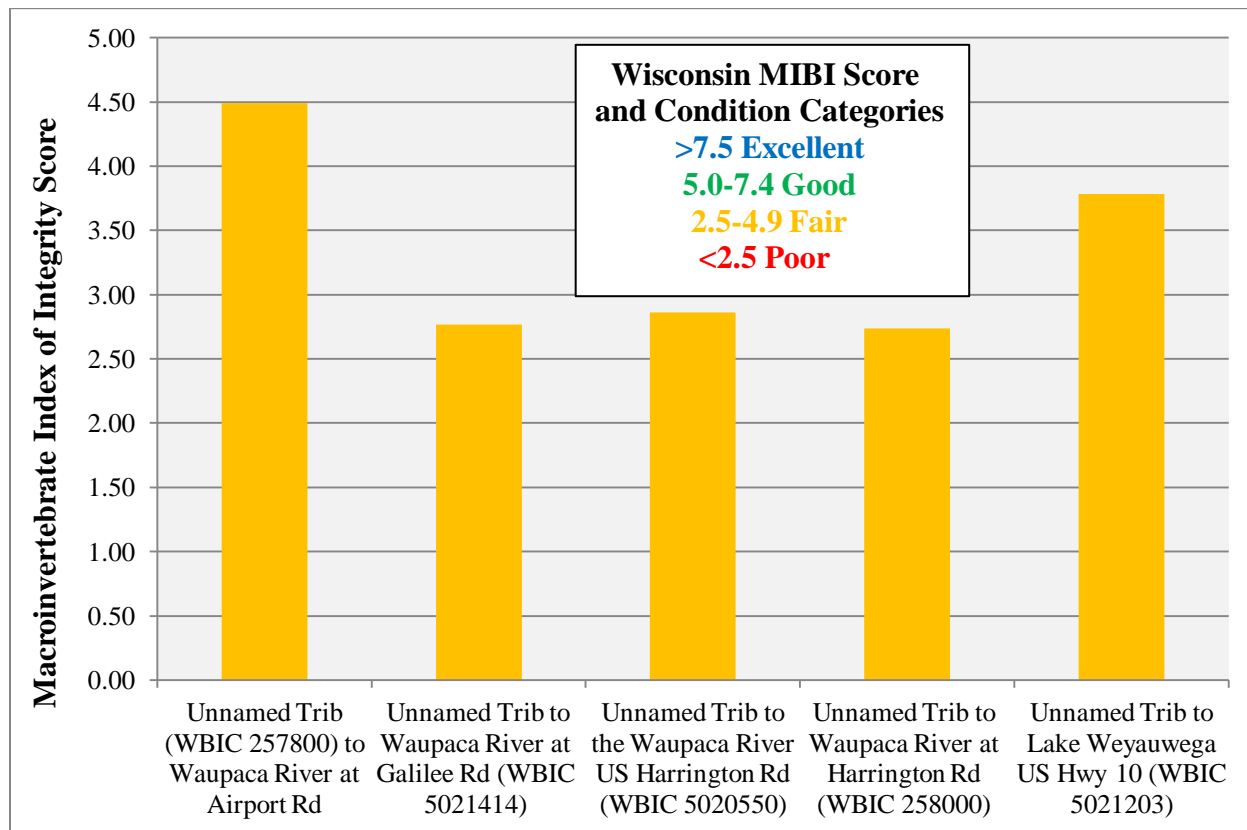
**Figure 15.** Summer median phosphorus (mg/l) concentrations at sample locations in Weyauwega Lake-Waupaca River Watershed (2017).

Currently the state of Wisconsin does not have water quality criteria for total nitrogen but considers levels above 2 mg/l high. The median total nitrogen concentrations for 2017 at the sites sampled ranged from 0.87 mg/l to 9.8 mg/l (Figure 16). Streams on the south side of the Waupaca River had the highest concentrations of total nitrogen in the watershed.



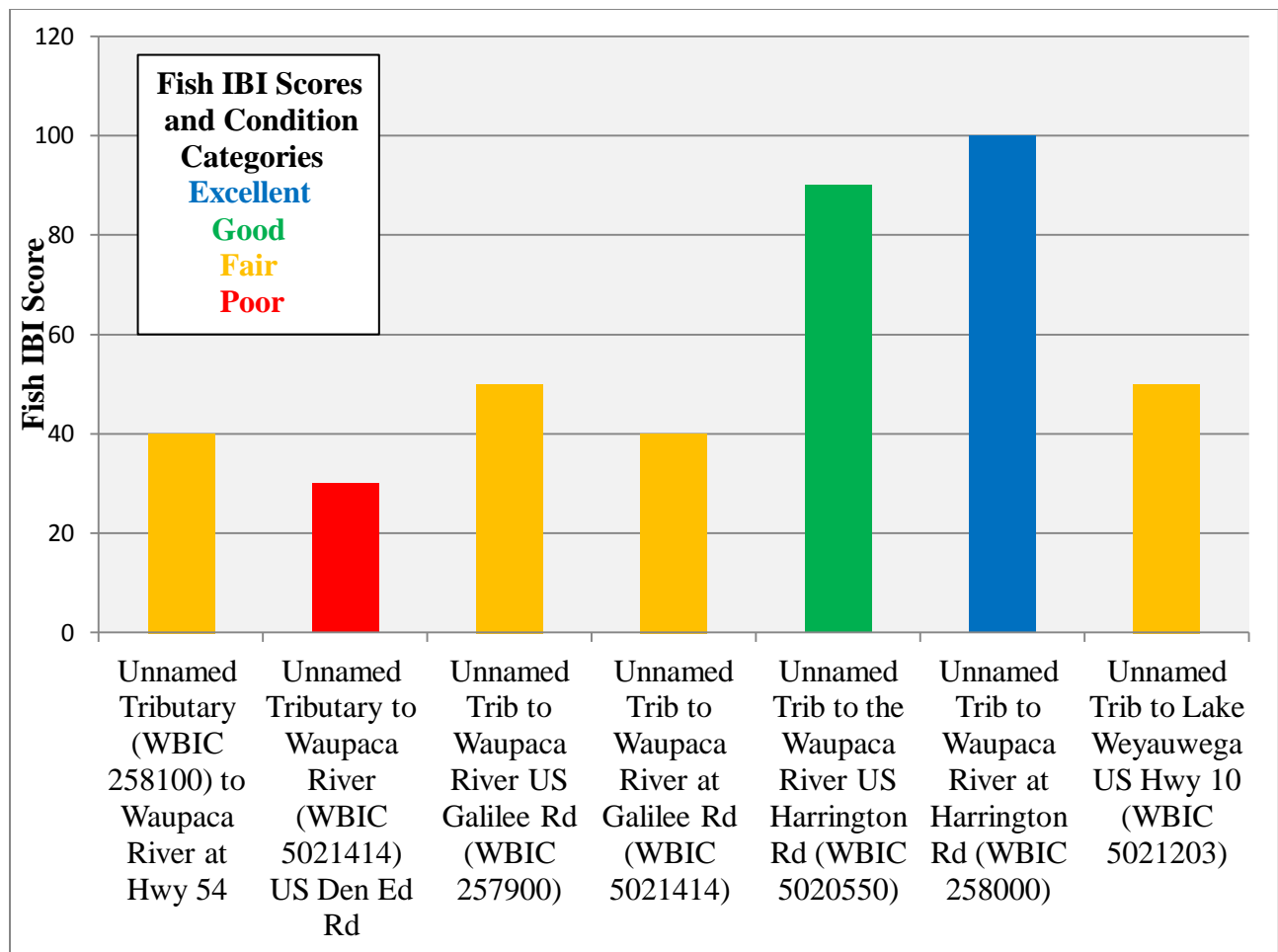
**Figure 16.** Summer median total nitrogen concentrations (mg/l) in Weyauwega Lake-Waupaca River Watershed in 2017.

The WDNR identifies the attainment of fish and aquatic life uses for a given stream by reviewing the type, number, and presence of aquatic macroinvertebrate species and fish species. Certain types of fish and aquatic macroinvertebrate species are more tolerant to environmental degradation and pollution than others. An index of biotic integrity (IBI) can be calculated for fish and macroinvertebrate species to indicate the water quality condition. Macroinvertebrate IBI data for sites sampled in the watershed in 2017 is shown in Figure 17. All of the sample sites sampled for macroinvertebrate IBI were ranked fair. Fish IBI data for sites sampled in 2017 is shown in Figure 18.



**Figure 17.** Macroinvertebrate Index of Biotic Integrity at sample sites in Weyauwega Lake-Waupaca River Watershed (2017).

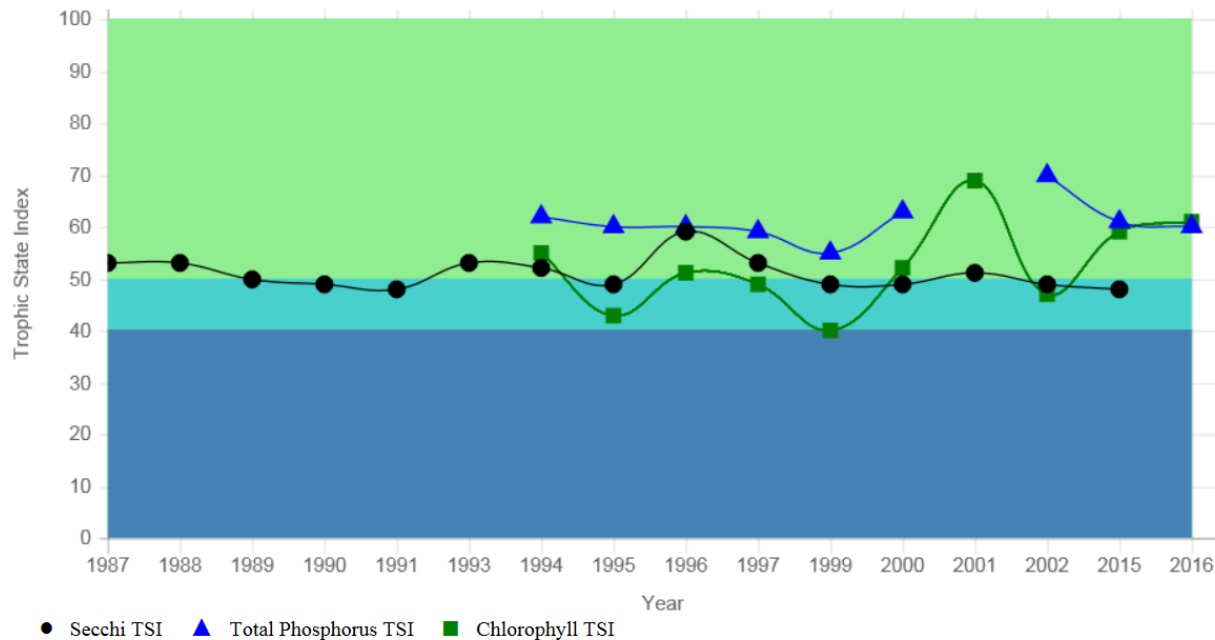




**Figure 18.** Fish Index of Biotic Integrity Scores at sample sites in Weyauwega Lake-Waupaca River Watershed (2017).

## Lake Water Quality

Weyauwega Lake water quality is monitored by the WDNR through their volunteer monitoring program. Volunteers monitor water clarity, total phosphorus, and chlorophyll levels of the lake. In 2016 the average summer Chlorophyll was 32.4 µg/l and the summer Total Phosphorus average was 62.2 µg/l. In 2016, overall Trophic State Index (based on chlorophyll) for Weyauwega lake was 61, indicating that the lake is eutrophic.



**Figure 19.** Trophic State Index of Weyauwega Lake from 1987 to 2016.

A lake management plan was prepared for Weyauwega Lake in 2016 by Wisconsin Lake and Pond Resource through a DNR grant received by Weyauwega Lake Restoration, Inc. The comprehensive management plan was developed to improve management of the lake and to address the issue of increased aquatic invasive species, sedimentation, and decreased water depth. Additional information on Weyauwega Lake water quality and proposed management measures for Weyauwega Lake can be found at

<https://dnr.wi.gov/lakes/grants/project.aspx?project=114452851> .

### *3.5 Impaired Waters*

The federal Clean Water Act 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. 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 303(b) report to create an “integrated report”. Currently none of the waters in the watershed are listed as impaired in the watershed. Waupaca River and Crystal River upstream of Waupaca are both listed as impaired due to elevated water temperature.

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## 4.0 Resource Analysis/Source Assessment

### 4.1 Pollutant Load Model

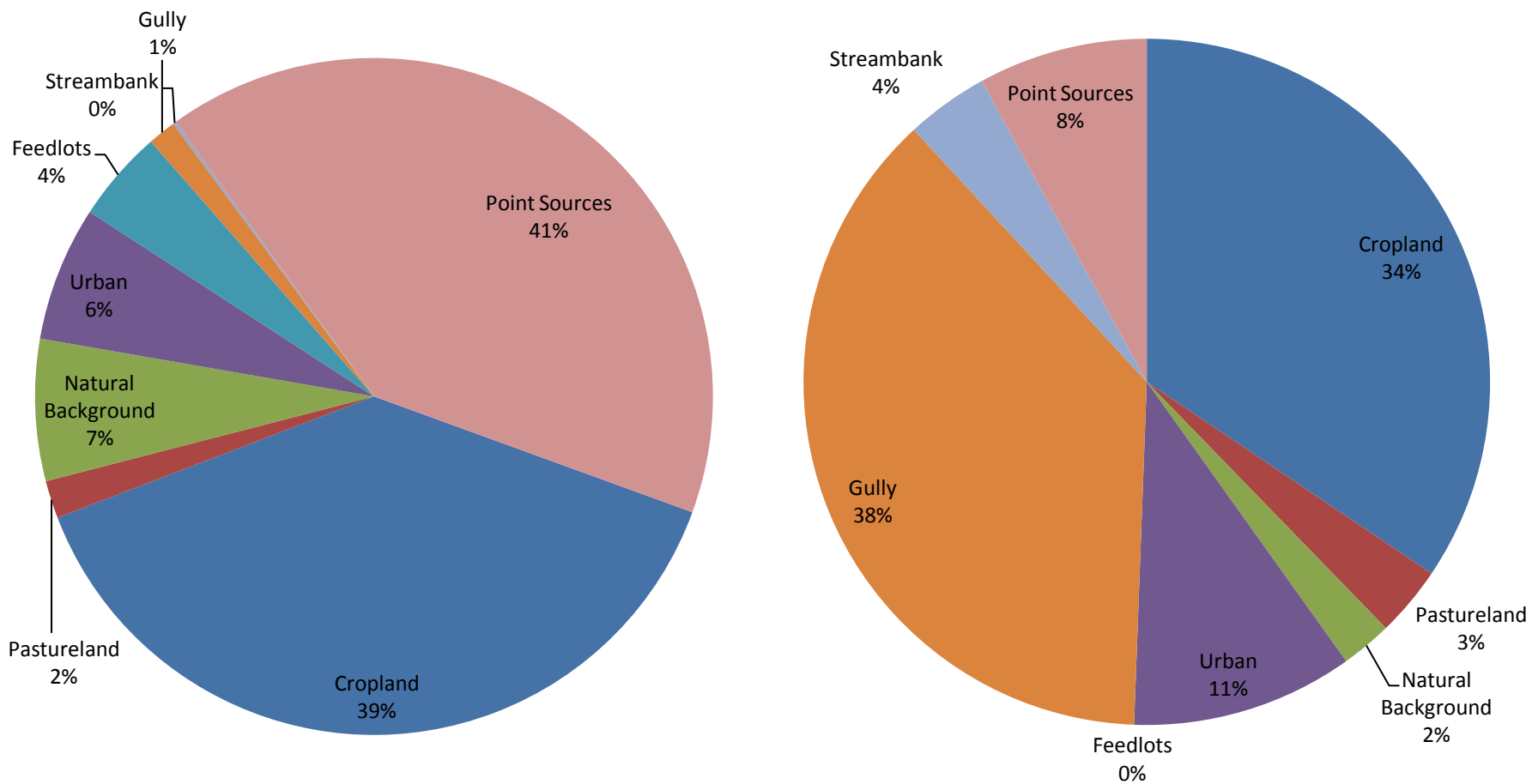
The developers of the Upper Fox and Wolf River Basin TMDL draft plan ran the Soil and Water Assessment Tool (SWAT) for all sub-basins in the Upper Fox and Wolf River Basin. The SWAT model is able to predict the impact of land use management on the transport of nutrients, water, sediment, and pesticides. 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 and stream flow data from USGS gage stations located in the Upper Fox and Wolf River Basin. The TMDL SWAT model characterized loading based on 89 sub-basins. The Weyauwega Lake-Waupaca River watershed is subwatershed of the Waupaca River sub-basin modeled by SWAT. The SWAT model load analysis for the entire Waupaca River Watershed can be seen in Table 8 in Section 5.1.

To characterize the loading from agriculture, natural background, and urban land use based on current conditions in the Weyauwega Lake-Waupaca River Watershed, the STEPLV4.4 model was used. STEPL (Spreadsheet Tool for Estimating Pollutant Load) is a watershed model that calculates nutrient loads based on land use, soil type, and agricultural animal concentrations. Baseline conditions used for STEPL modeling are shown in Appendix A. The NRCS BARNY model was also used to estimate phosphorus loading from barnyards in the watershed.

The Weyauwega Lake-Waupaca River Watershed contributes an estimated 7,507 lbs of phosphorus and 514 tons of sediment to the Wolf River per year (Table 6). Agriculture including pasture land, gully erosion, and barnyards contributes 46% of the phosphorus loading and 75% of the sediment loading in the Weyauwega Lake-Waupaca River Watershed.

**Table 6.** Weyauwega Lake-Waupaca River Watershed pollutant load estimates.

| Sources                                   | Phosphorus Load (lbs/yr) | Sediment Load (tons/yr) |
|---|--------------------------|-------------------------|
| Cropland                                  | 2,899                    | 177                     |
| Pastureland                               | 135                      | 17                      |
| Natural Background (Including streambank) | 518                      | 32                      |
| Urban                                     | 483                      | 54                      |
| Feedlots                                  | 330                      | NA                      |
| Gully                                     | 101                      | 193                     |
| Point Sources                             | 3,041                    | 41                      |
| <b>Total</b>                              | <b>7,507</b>             | <b>514</b>              |



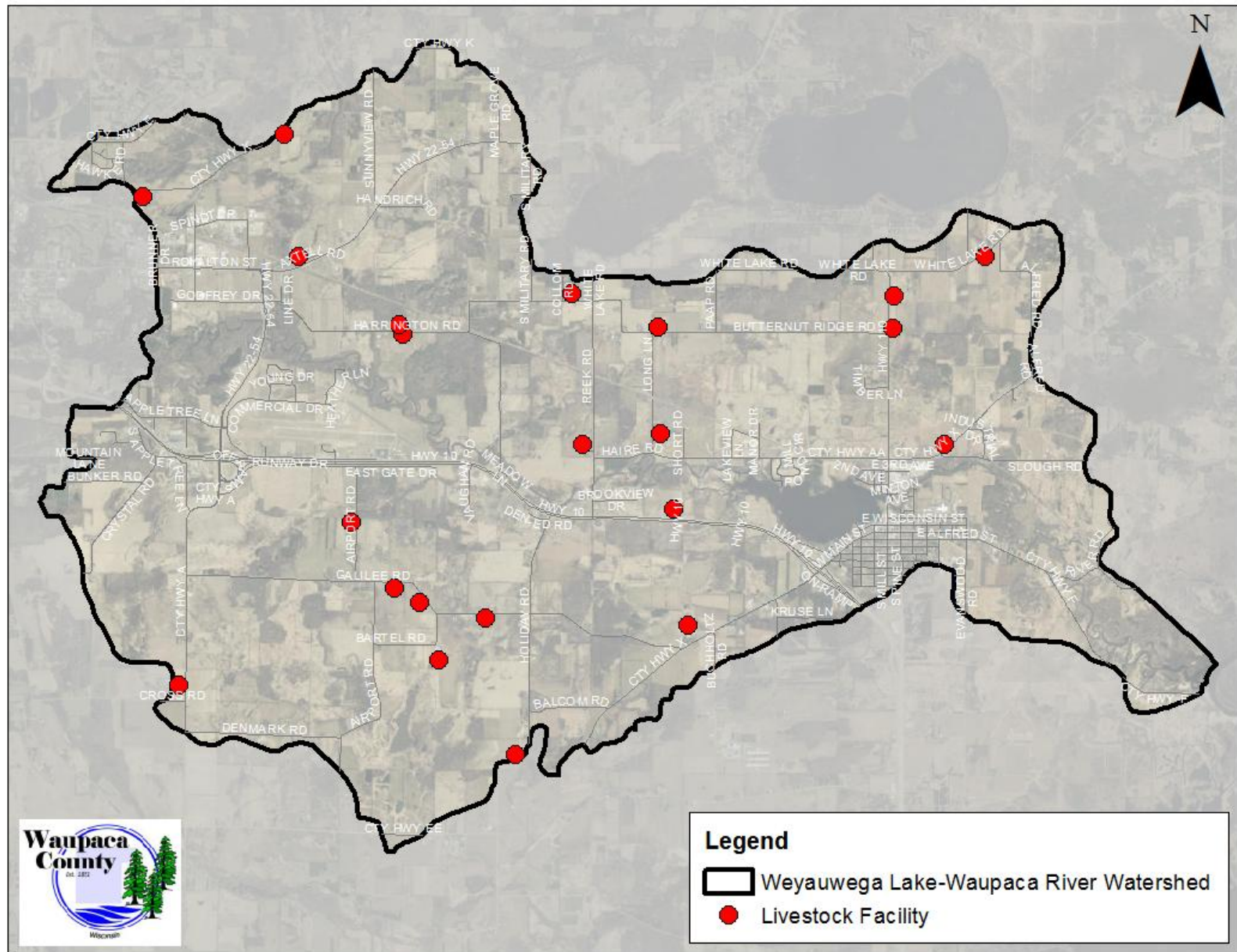
**Figure 20.** Summary of total phosphorus (left) and total sediment load (right) to Wolf River.



## *4.2 Watershed Inventory/Source Assessment*

### **4.2.1 Barnyard Inventory**

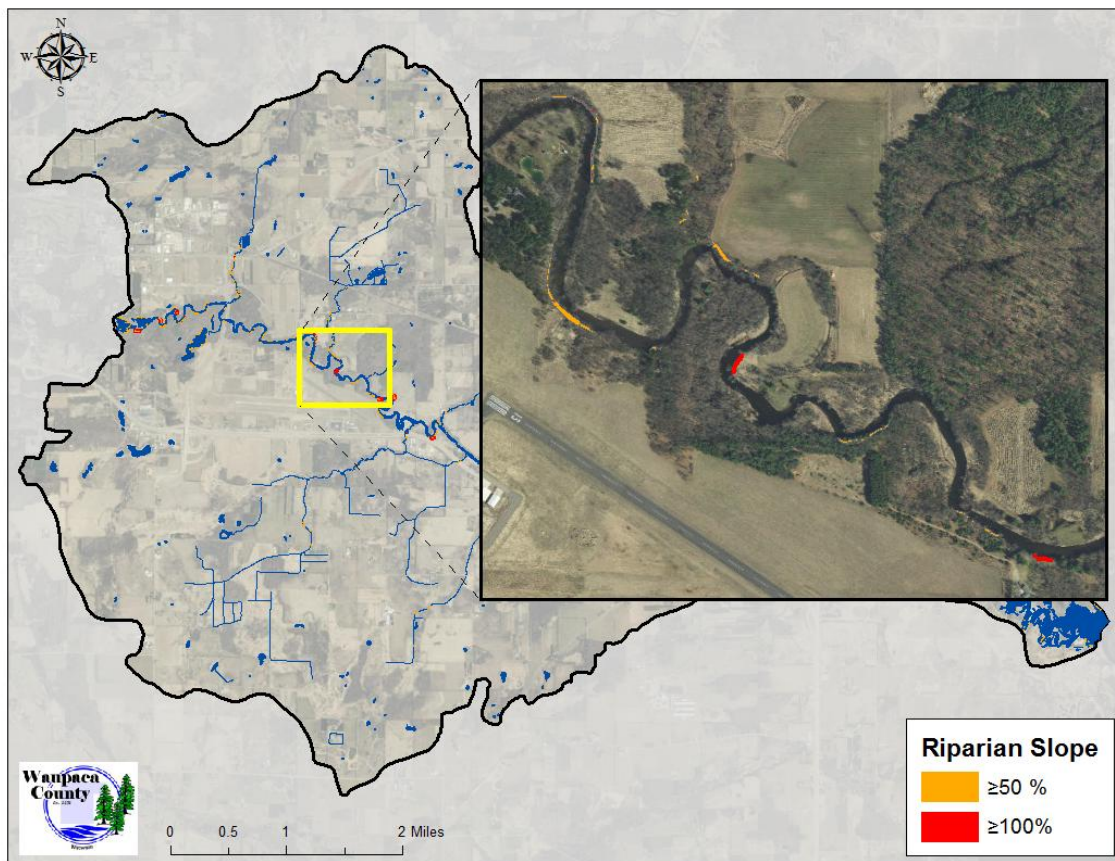
Location and data on current livestock operations was compiled through existing NRCS and Waupaca County LWCD data, air photo interpretation, and windshield surveys. There are a total of 22 active livestock operations with an estimated 3,650 animal units (AU) including dairy and beef farms. Locations of livestock operations in the watershed are shown in Figure 21. There were 2 farms identified as high priority and 4 farms identified as medium priority for needing conservation practices such as barnyard runoff management or waste management practices. The NRCS BARNY model was used to estimate phosphorus loading from livestock facilities in the watershed area. It is estimated that livestock facilities contribute 330 lbs P/year to the Lower Wolf River which is about 4.3% of the total phosphorus load. Many of these sites can reduce their load with low cost practices such as fencing, vegetative filter strips, and critical area plantings. Some of the priority sites will require more expensive barnyard runoff management systems and waste storage to reduce their phosphorus load.



**Figure 21.** Livestock facilities in Weyauwega Lake-Waupaca River Watershed.

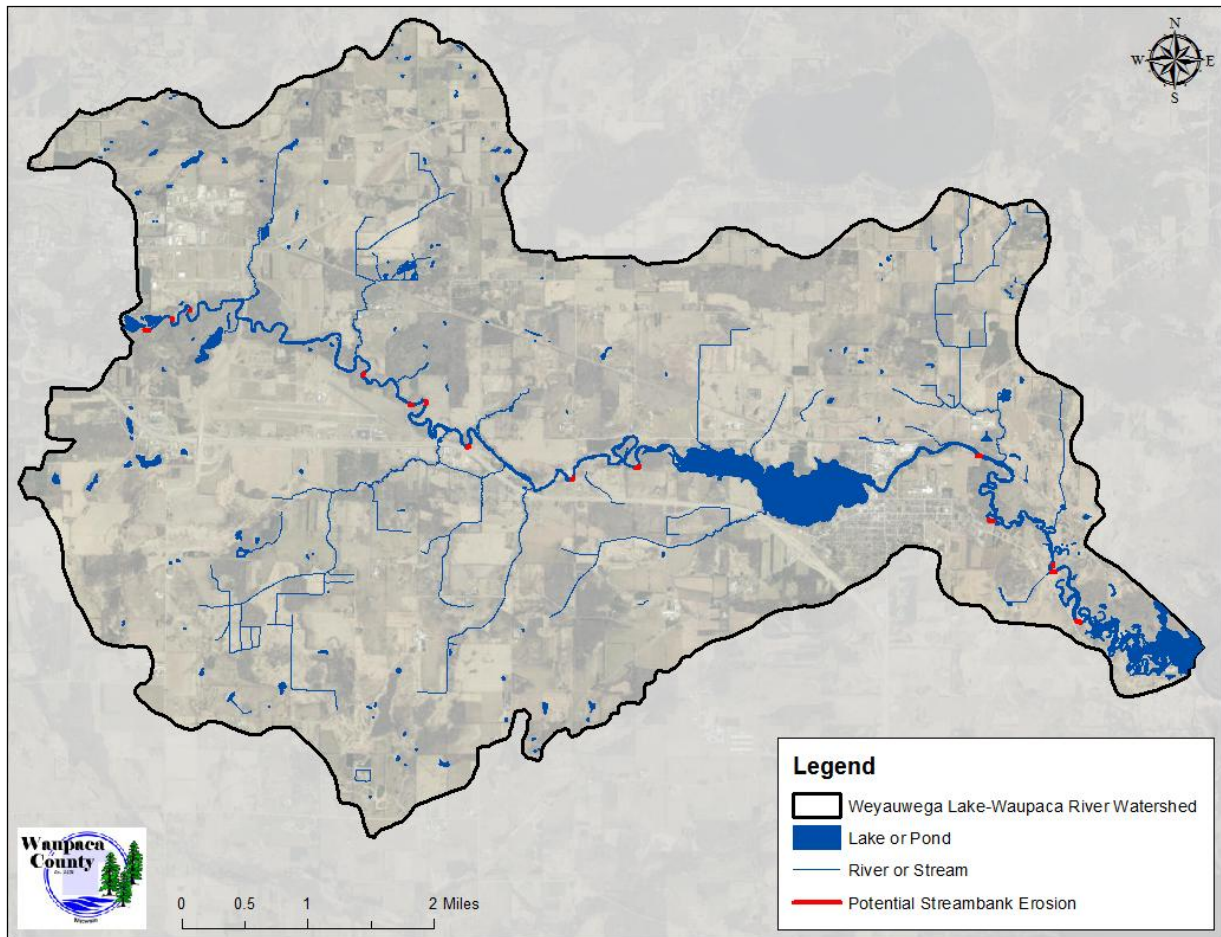
#### 4.2.2 Streambank Erosion

A GIS analysis of streambank slopes was performed on the watershed to identify areas of potential streambank erosion. Riparian bank areas with slopes greater than 50% were considered to have the highest potential for bank erosion (Figure 22). The resulting riparian slope layer was overlain on aerial imagery to identify sites that were actively eroding. Potential areas of bank erosion identified are shown in Figure 23. Several locations at road crossings of the tributary streams in the watershed were also visited to see if there was significant streambank erosion occurring. Sediment loss was estimated for each site identified based on the NRCS method. The sites identified by GIS were estimated to be contributing 20 tons of sediment and 10 lbs of phosphorus to the Waupaca River. Based on site visits and GIS analysis streambank erosion is not a significant source of sediment and nutrients in this watershed.



**Figure 22.** Riparian slope analysis.



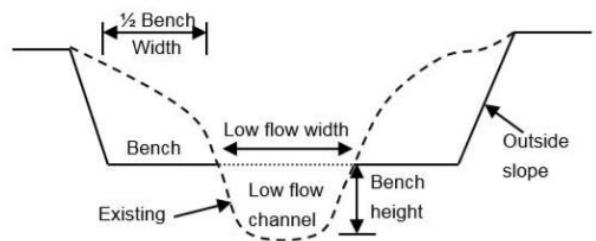


**Figure 23.** Potential streambank erosion sites.

### Channel/Ditch Erosion

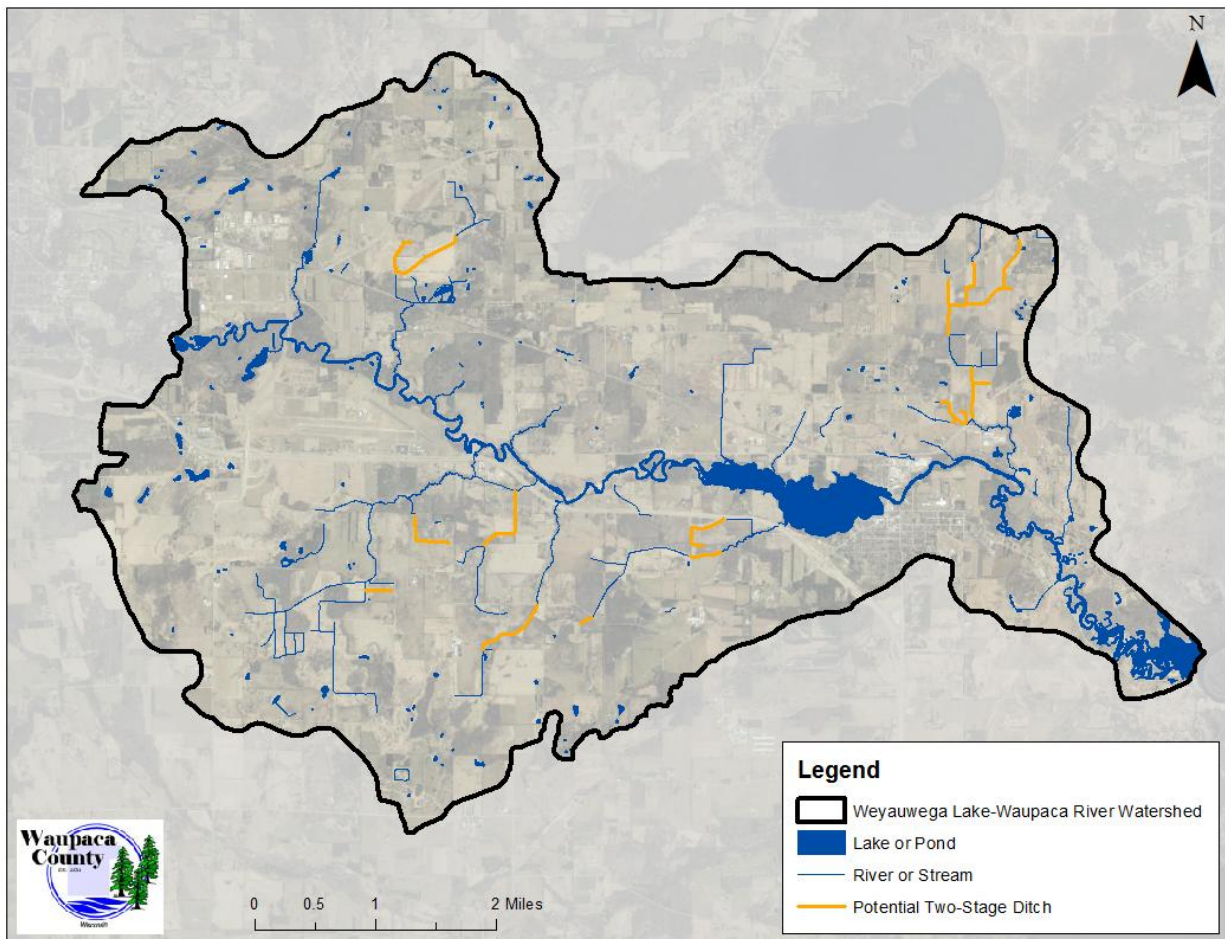
There are several miles of agricultural drainage ditches and unnamed tributaries that have been significantly altered from their natural state in the Weyauwega Lake-Waupaca River watershed.

Traditional drainage ditches are prone to erosion, channelization, and bank failure due to high volumes of water they must handle during peak flows. These ditches do nothing to prevent the flow of nutrients and other contaminants from farm fields downstream. Recent research into two-stage ditches (Figure 24) has shown that they can be an effective way to stabilize ditch and stream channels and reduce nutrient loads. A two-stage ditch is a drainage ditch that has been modified by adding benches that serve as floodplain for the channel. The vegetated benches reduce the velocity of high flows and retain



**Figure 24.** Typical two-sided, two-stage ditch. (NRCS, 2018)

nutrients and sediment. Two-stage ditches can also be designed to improve habitat for wildlife. Agriculture drainage ditches and channels in the watershed that could potentially be modified with the two-stage ditch design are shown in Figure 25.



**Figure 25.** Potential locations for two-stage ditch channel modification.



#### 4.2.3 Upland Inventory

Agricultural land was inventoried and analyzed to determine current tillage practices, identify priority locations for best management practice, and to identify the extent of current BMP implementation in the watershed. Agricultural uplands were inventoried by windshield survey, use of GIS data and tools and with aerial photography. The use of the WDNR EVAAL (Erosion Vulnerability Assessment for Agricultural Lands) and USDA-ARS ACPF <sup>4</sup>(Agricultural Conservation Planning Framework) toolsets were used to determine priority areas for best management practices in the watershed.

#### **Erosion Vulnerability**

The EVAAL (Erosion Vulnerability Analysis for Agricultural Lands) tool was used to determine areas in the watershed that are more prone to sheet, rill, and gully erosion. The tool analyzes the watershed based on precipitation, land cover, crop rotation, soils and elevation data. The resulting outputs of the tool are an Erosion Score, Stream Power Index, and Soil Loss Index. Figure 26 shows the EVAAL erosion score indicating which fields are more susceptible to erosion based on USLE, SPI, and internally draining areas. By running the EVAAL tool twice for the USLE and using the high C-factor for “worst case” and low C-factor for “best case” scenarios, the worst case can be subtracted from the best case which indicates areas with the greatest potential for improvement (Figure 27). The ACPF (Agricultural Conservation Planning Framework) tool also provides a similar output that identifies fields with the highest runoff risk (Appendix B). These maps are an important tool in indicating which fields are contributing the most sediment and phosphorus in comparison to other fields in the watershed, therefore indicating where best management practices are going to benefit the most in the watershed.

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<sup>4</sup> Additional information on ACPF can be found at <http://northcentralwater.org/acpf/>

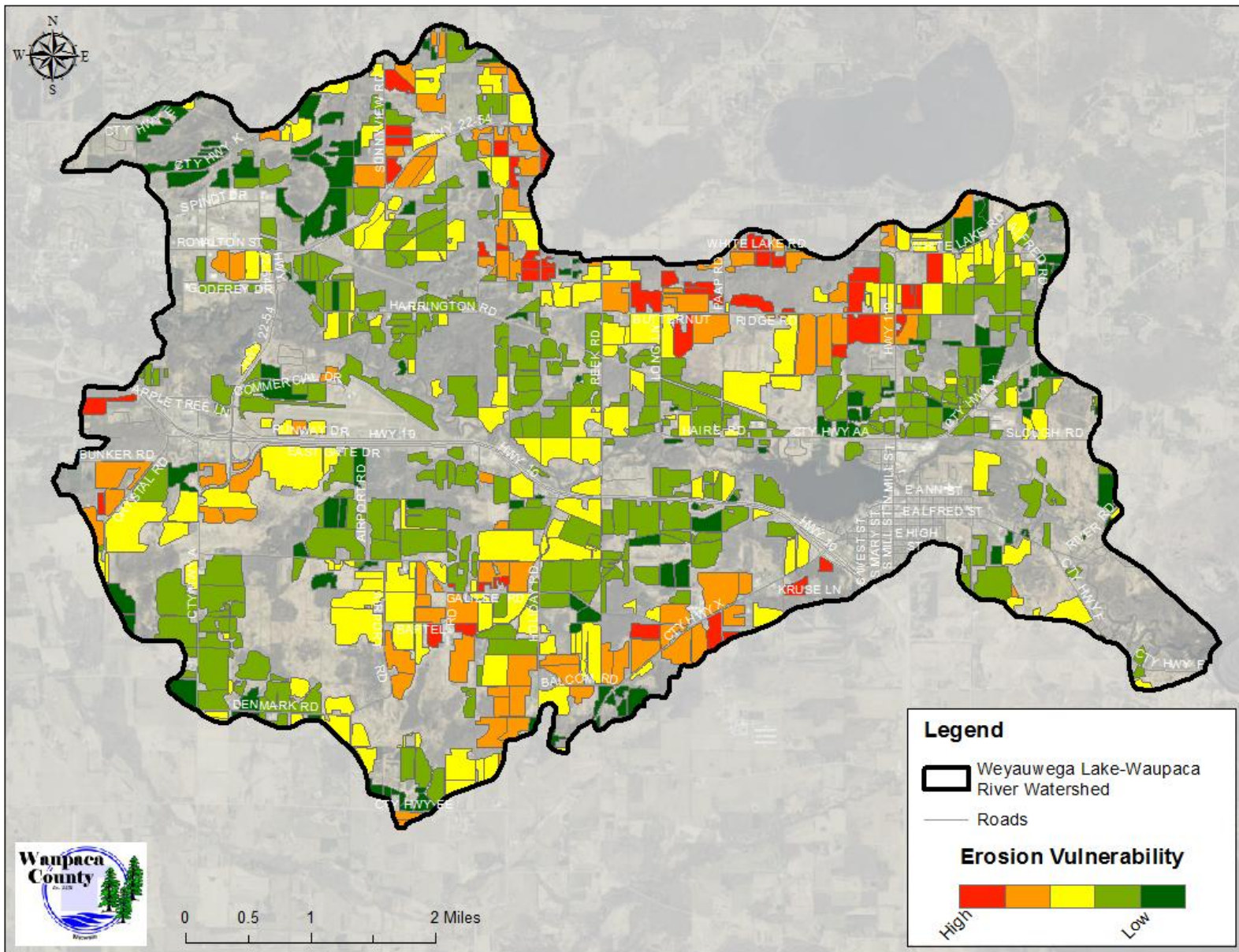


Figure 26. EVAAL erosion score by field.



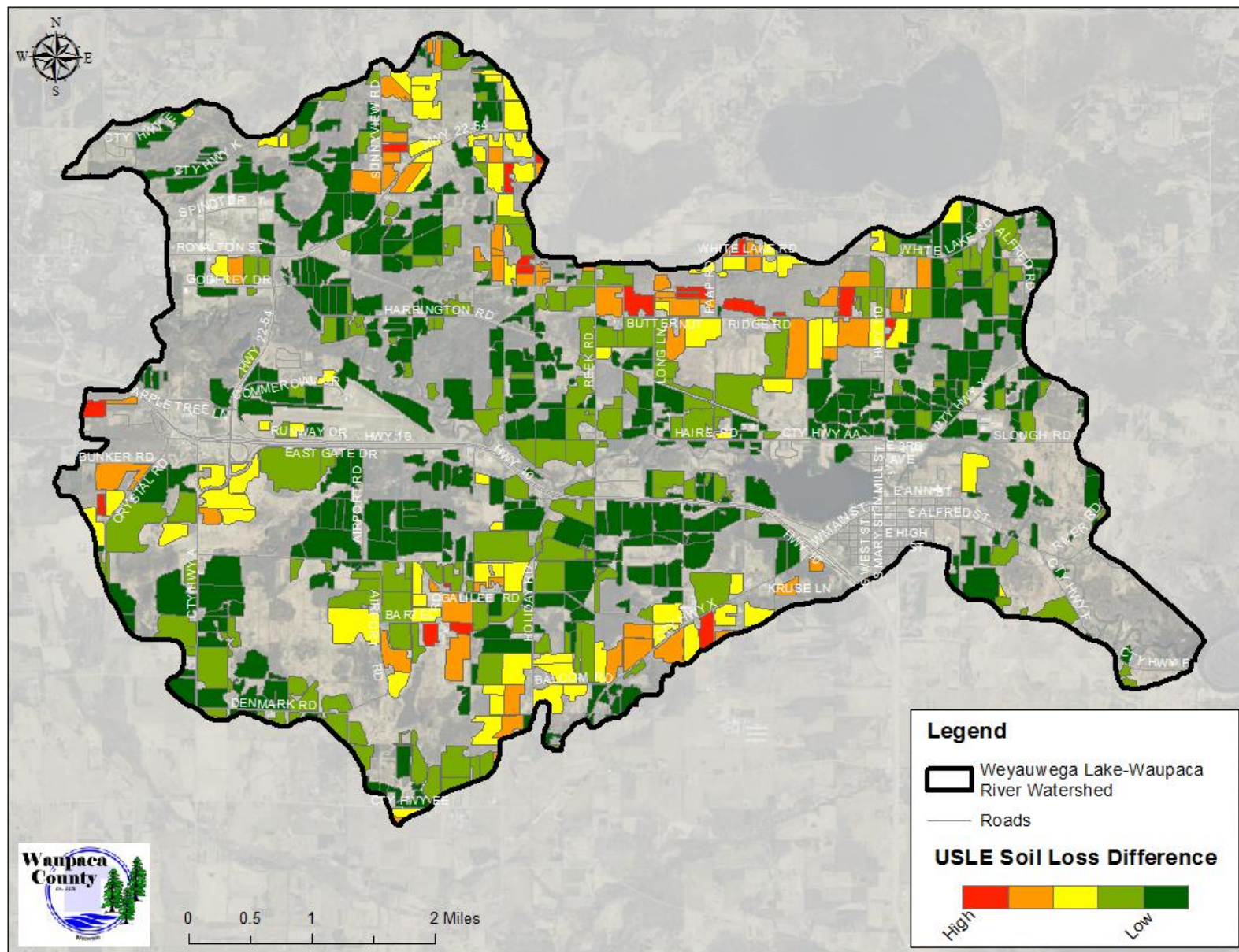


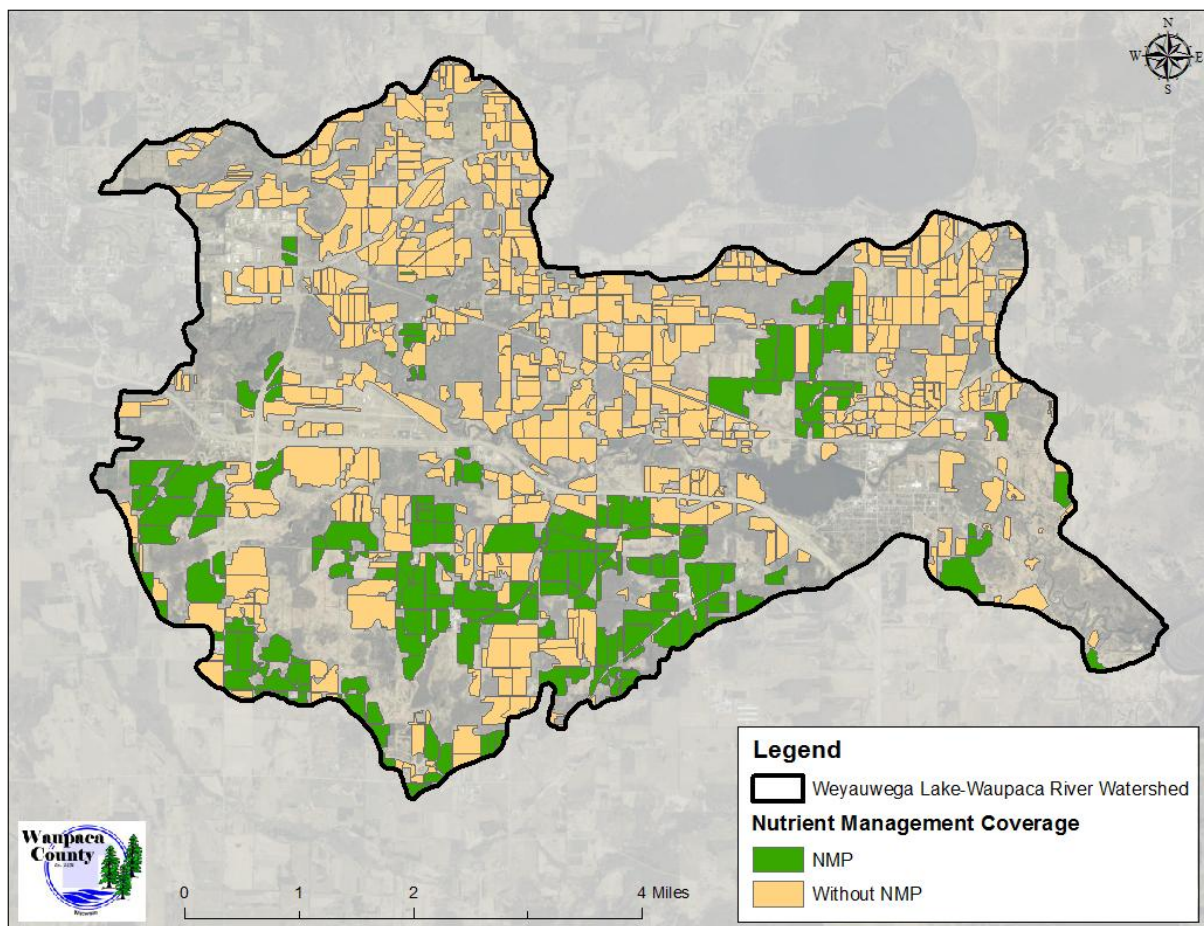
Figure 27. Soil loss difference.

## Nutrient Management Planning

Nutrient management plans are conservation plans specific to anyone applying manure or commercial fertilizer. 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.

Landowners are required to turn in a copy of their nutrient management plans to County Land & Water Conservation departments if they have a manure storage permit, received cost sharing for nutrient management, or if they participate in the Working Lands Initiative program.

Waupaca County tracks nutrient management plans by field using GIS. Nutrient Management Coverage for the watershed is shown in Figure 28. Tracking nutrient management plan coverage by GIS is beneficial in identifying landowners in the watershed that still need nutrient management. Approximately 3,037 acres in the watershed are covered by a nutrient management plan, which is 37% of the total cropland in the watershed area.

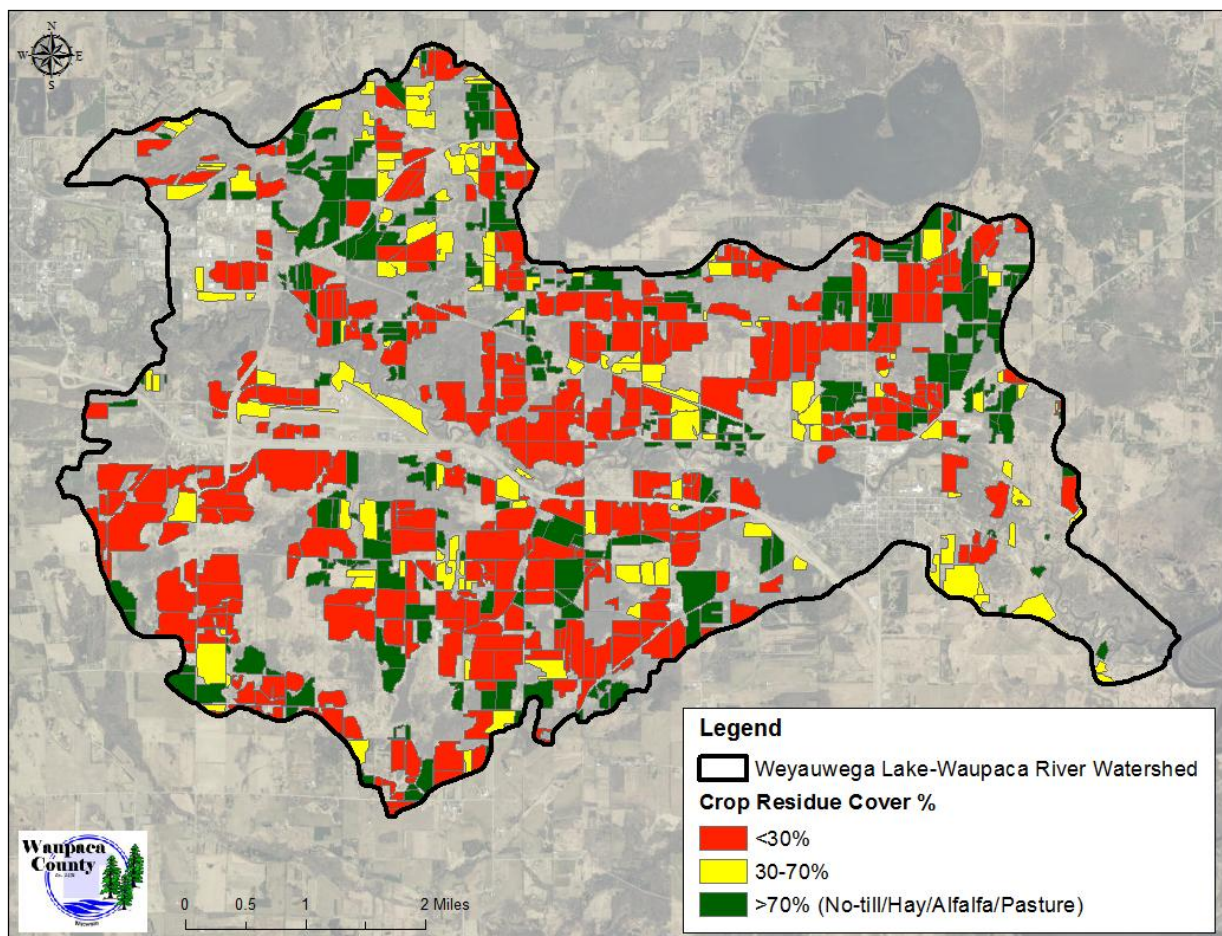


**Figure 28.** Nutrient management coverage.



## Tillage Practices and Residue Management

Crop residue levels and tillage intensity can be analyzed from readily available satellite imagery. Since tillage takes place at different times a series of satellite images were chosen for analysis. Landsat 8 satellite photos from June, October, and November 2017 were used to calculate a minimum Normalized Difference Tillage Index (minNDTI). The NDTI estimates crop residue levels based on shortwave infrared wavelengths. The mean minNDTI values per agricultural field for 2017 are shown in Figure 29. The mean minNDTI can help easily identify fields that would be good candidates for implementation of reduced tillage practices and cover crops. This analysis of imagery can also be used as a way to track implementation of cropping practices as more years of imagery is collected, since satellites regularly circle the earth. Field verification of crop residue levels can be compared to NDTI to more accurately correlate NDTI values to tillage intensity in the watershed.

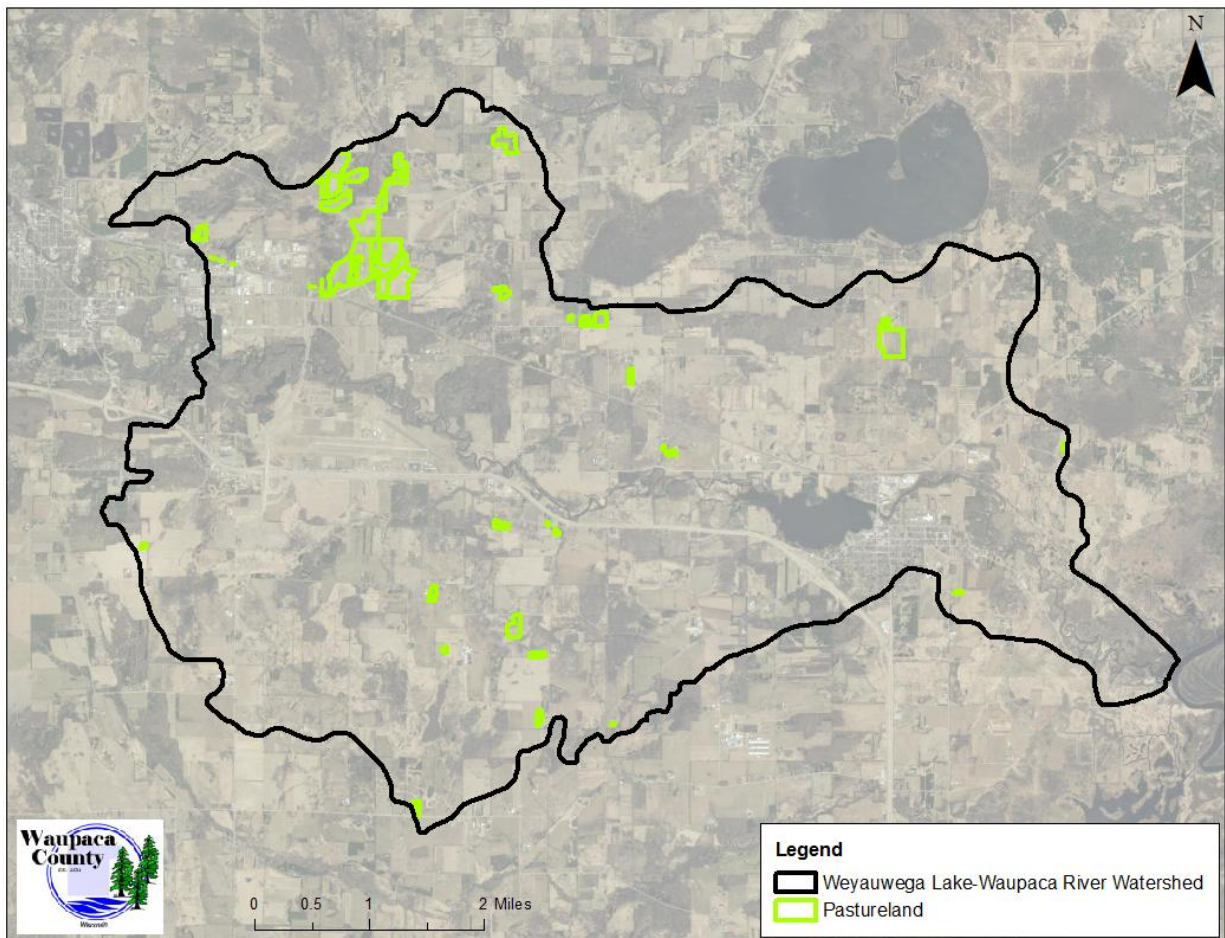


**Figure 29.** Crop residue cover estimates based on Normalized Difference Tillage Index (June, October, and November 2017).



## Grazing/Pastureland Management

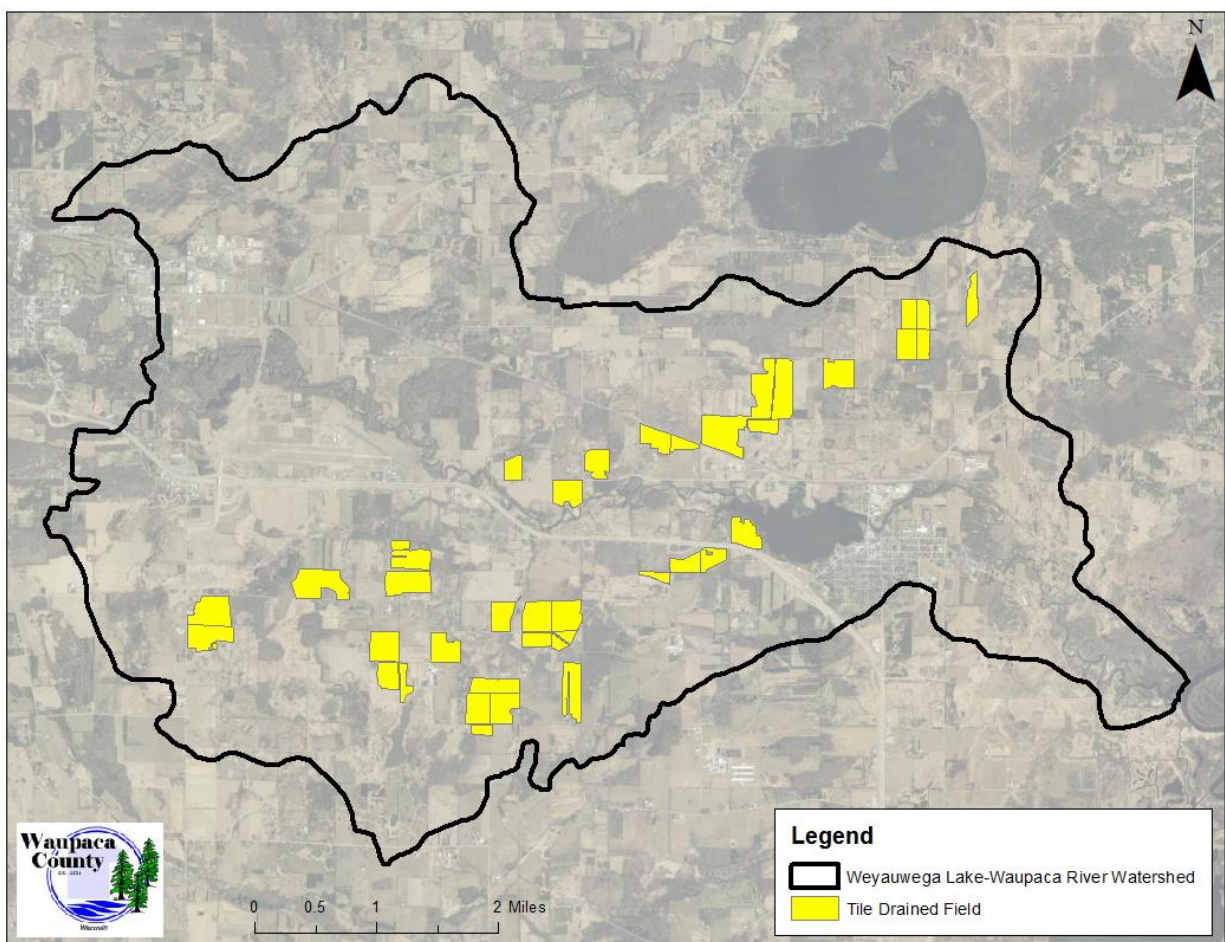
Land used for pasture was analyzed using recent aerial imagery of the watershed area and using the NASS cropland data layer. Approximately 370 acres in the watershed are currently being used as pasture for livestock. Most of the farmers that do pasture their livestock in the watershed do it for exercise and not as a means of forage with the exception of a few smaller hobby farms with horses and beef cattle. The STEPL model estimated 135 lbs of phosphorus/year and 17 tons of sediment per year can be attributed to the pasture/hay land use category. Encouraging farms to convert cropland or land used for hay to managed grazing land will help in reducing pollutant loads from cropland. Grazing can also benefit farmers financially by saving them money on fuel costs associated with harvesting, planting, and transportation. Better management of current pastureland can reduce pollutant loading as well.



**Figure 30.** Land used for pasture/grazing.

## Tile Drainage

Fields with tile drainage were inventoried by using aerial imagery and then mapped using ArcGIS®. There were 1,116 acres of fields that had visible signs of tile drainage in the watershed area (Figure 31), which is approximately 13% of the cropland in the watershed. Tile drains in fields can act as a conduit for nutrient transport to streams if not managed properly. Fields that are drained by tile may need to be further evaluated in this watershed as potential sources of phosphorus and nitrogen loading that might need tile drainage management practices. Some options for treating tile drainage at the outlet include constructing a treatment wetland, saturated buffers, two-stage ditches, and installation of water control structures to stop the flow of drainage water during poor conditions.

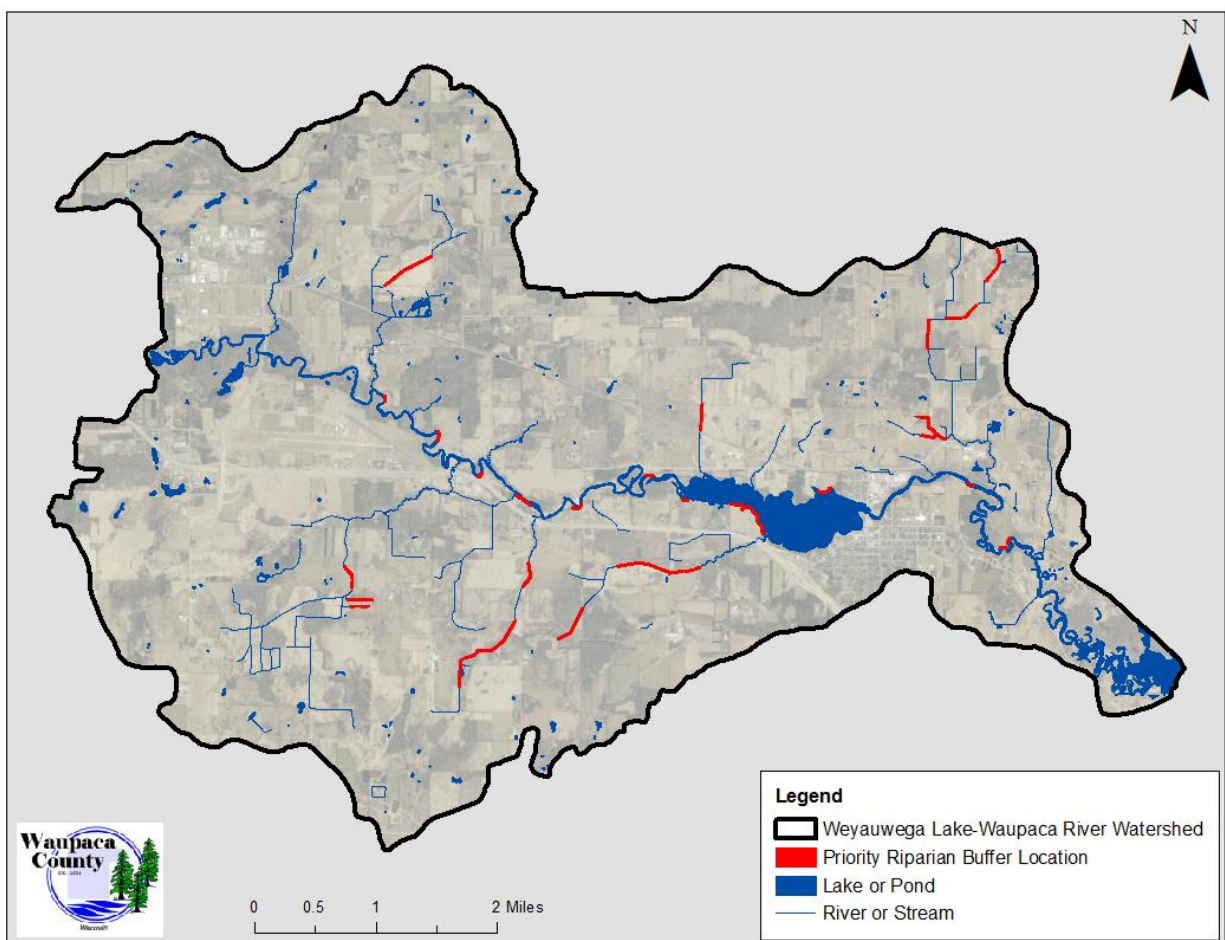


**Figure 31.** Tile drained fields.



## Riparian Buffers

Riparian buffers improve water quality by filtering out sediment and nutrients from water before reaching surface waters and by providing herbaceous cover in floodplain areas subject to out-of-bank flow and/or scour erosion. Buffers also reduce the amount of runoff volume, provide wildlife habitat, and help regulate stream temperature. A minimum 35 ft buffer for streams is generally recommended for water quality protection. In addition to meeting the standard 35 ft. width some priority buffer areas may need to be extended up to a maximum of 120 ft to provide necessary reductions in pollutant loads based on the WI NRCS Technical Standard 393 for filter strips. Priority buffer areas were determined using aerial photography, the DNR 24K Hydrography data set, and USGS topography maps (Figure 32).



**Figure 32.** Priority buffer locations.

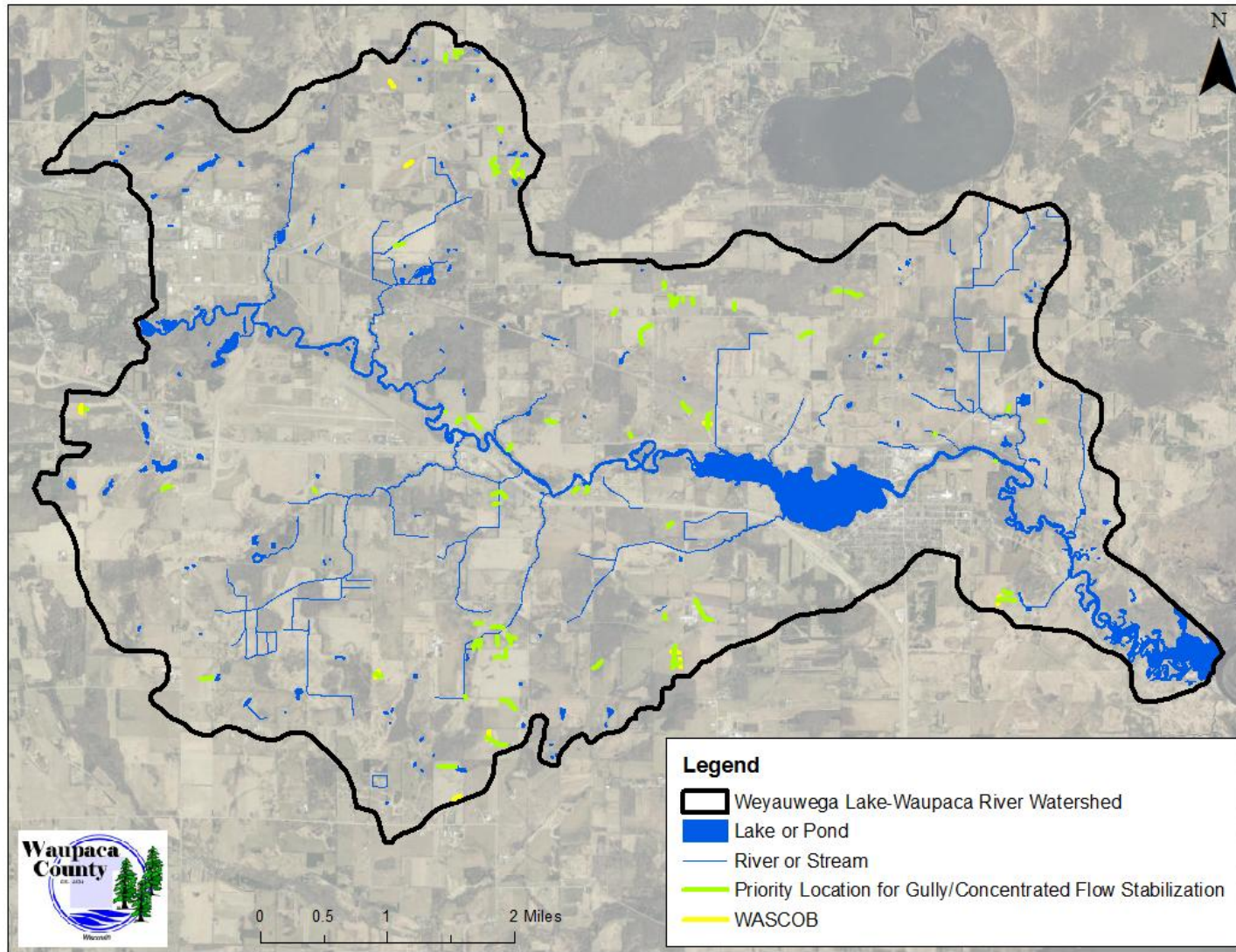
## Gully and Concentrated Flow Stabilization

Gullies and concentrated flow areas were determined by GIS analysis and by windshield survey. Elevation and flow direction data is used to develop a stream power index (SPI) that can indicate areas of concentrated flows that might be gullies. High stream power values are shown in Figure 33. A high stream power index along with air photo interpretation was used to determine where gully and concentrated flow stabilization practices may be necessary in the watershed.

Recommended gully and concentrated flow stabilization practices include grassed waterways, water and sediment control basins (WASCOB), and critical area plantings. Other practices that may also be used to stabilize gully erosion include lined waterways, grade stabilization, and terraces. A grassed waterway is a shaped or graded channel that is established with vegetation to convey surface water to prevent erosion. 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. The Agricultural Conservation Planning Framework WASCOB tool was used to site areas for Water and Sediment Control Basins. The tool evaluates potential WASCOB locations approximately every 200 ft along flow paths within a drainage range of 2-50 acres (Porter et al., 2015). Concentrated flow areas that have less severe erosion should also be stabilized may not necessarily require a grassed waterway or WASCOB. To stabilize these less severe 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. Priority areas for gully and concentrated flow stabilization determined by GIS methods and windshield survey are shown in Figure 34.



**Figure 33.** High stream power index indicating potential gully erosion.



**Figure 34.** Priority locations for gully and concentrated flow stabilization practices (Water and Sediment Control Basin, Critical Area Planting, Grassed Waterway, etc).



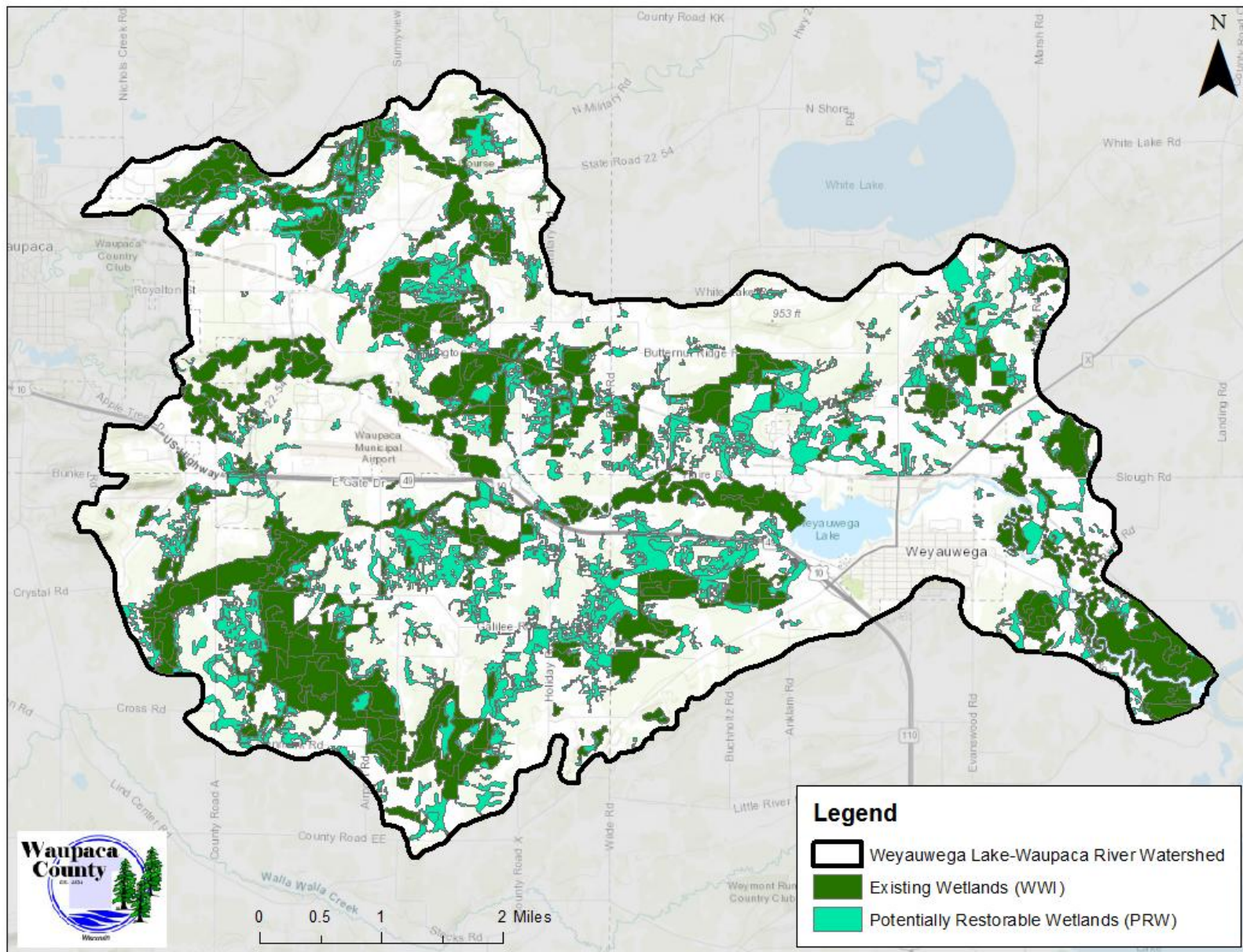
#### 4.2.4 Wetland Inventory

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 in the watershed area will provide water storage and reduce sediment and phosphorus loading.

Existing wetland and potentially restorable wetland GIS spatial data was obtained from the Wisconsin Department of Natural Resources (WDNR). 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. The WDNR considers an area a potentially restorable wetland (PRW) if it meets hydric soil criteria and is not in an urban area. There are 1,165 acres of existing wetlands and 2,428 acres of potentially restorable wetlands in the Weyauwega Lake-Waupaca River watershed according to the WDNR wetland and potentially restorable wetland layers (Figure 35).

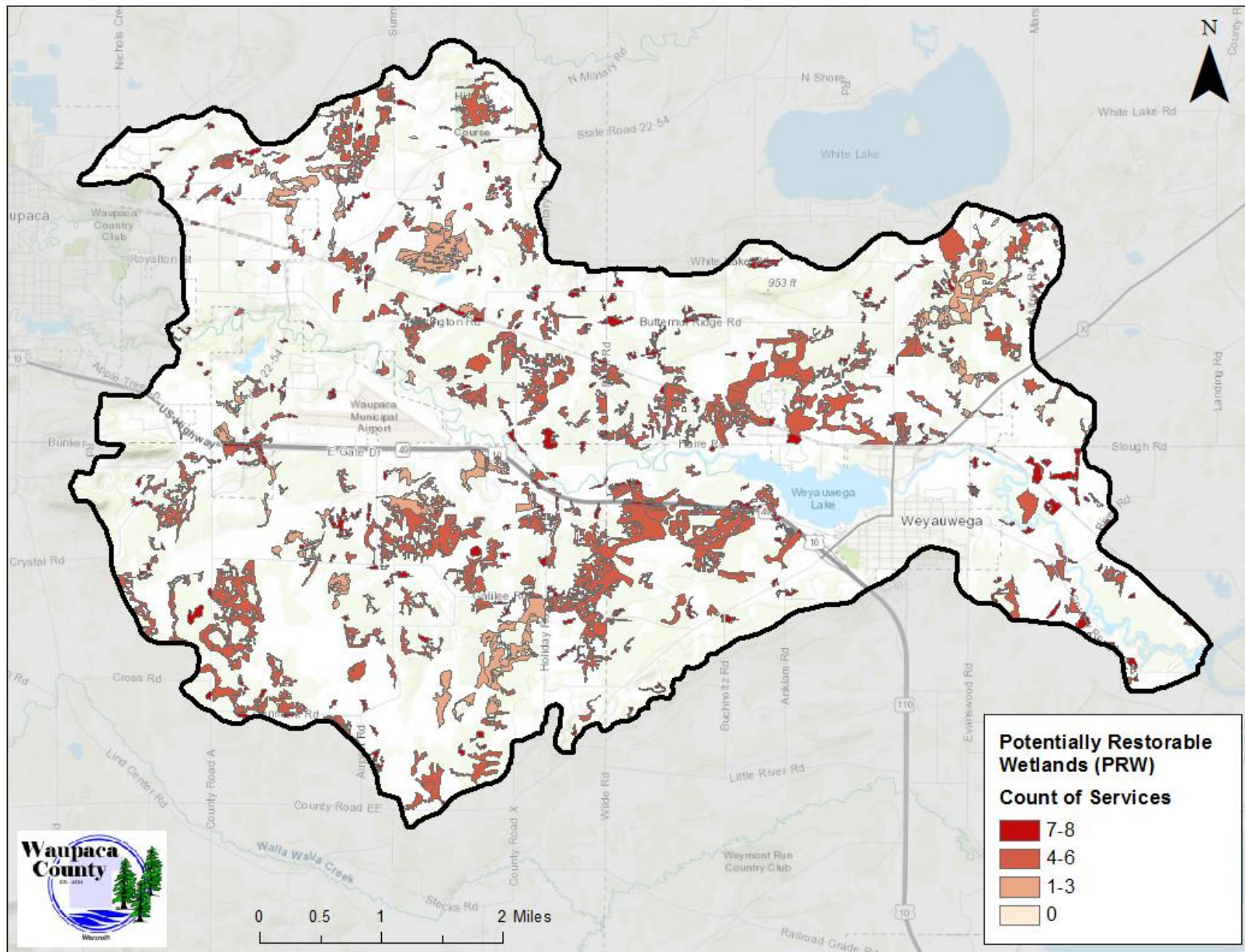
In December of 2017, The Nature Conservancy, Wisconsin Department of Natural Resources, and Conservation Strategies Group finished the *Wetlands by Design: A Watershed Approach for Wisconsin* project. *Wetlands by Design* was developed to support a watershed approach to wetland mitigation and to support voluntary wetland conservation efforts. *Wetlands by Design* ranks watersheds, existing wetlands and potentially restorable wetlands based on landscape position and the amount of services or potential services provided. At a watershed level the following services were evaluated: flood abatement, fish and aquatic habitat, sediment reduction, nutrient transformation, and surface water supply. Additional services were evaluated at the site level: carbon storage, floristic integrity, and shoreline protection. Rankings can be viewed through a web-based tool [Wetlands and Watersheds Explorer](#).

The *Wetlands by Design* data for the Weyauwega Lake-Waupaca River watershed was overlain on aerial imagery from 2017 to identify any potentially restorable wetlands that were now urbanized. Any PRW that was urbanized was removed from the data set. This dataset will be useful in prioritizing sites for wetland restoration based on each sites potential for the services mentioned above. Figure 36 shows PRWs in the watershed ranked by the number of potential services provided at a high or very high level in the watershed.



**Figure 35.** Existing and potentially restorable wetlands.





**Figure 36.** Potentially restorable wetlands rank base on count of services (*Wetlands by Design*).

#### 4.2.5 Current Management Practices/Projects

Waupaca County LWCD and the NRCS have been working with farmers in Weyauwega Lake-Waupaca River Watershed for an extended period of time. The watershed was previously part of the Tomorrow-Waupaca River Priority Watershed Project which ran from 1995-2008. Over time many contracts have expired and some of the practices have either been discontinued or not maintained. A summary of practices implemented through the Waupaca County NRCS and LWCD in the last 10 years is shown in Table 7.

**Table 7.** Summary of conservation practices implemented by NRCS and Waupaca County LWCD from 2008-2017.

| Practice Group       | Practice Code | Practice Name                          | Units | Quantity |
|----------------------|---------------|--|-------|----------|
| Farmstead            | 313           | Waste Storage Facility                 | no    | 8        |
|                      | 634           | Waste Transfer                         | no    | 6        |
|                      | CAP102        | Comprehensive Nutrient Management Plan | no    | 2        |
|                      | 561           | Heavy Use Area Protection              | ac    | 0.4      |
|                      | 558           | Roof Runoff Structure                  | no    | 1        |
|                      | 635           | Vegetated Treatment Area               | ac    | 1        |
|                      | 533           | Pumping Plant                          | no    | 2        |
|                      | 500           | Obstruction Removal                    | ac    | 0.1      |
|                      | 620           | Underground Outlet                     | ft    | 267      |
|                      | 342           | Critical Area Planting                 | no    | 1        |
| Pasture              | 382           | Fence                                  | ft    | 8,018    |
|                      | 512           | Forage and Biomass Planting            | ac    | 15.9     |
|                      | 516           | Livestock Pipeline                     | ft    | 2,374    |
|                      | 620           | Underground Outlet                     | ft    | 1,170    |
|                      | 614           | Watering Facility                      | no    | 1        |
|                      | 528           | Prescribed Grazing                     | ac    | 61.4     |
| Agronomic (Cropland) | 340           | Cover Crop                             | ac    | 148.7    |
|                      | 590           | Nutrient Management                    | ac    | 2,017    |
| Forest               | 314           | Brush Management                       | ac    | 14       |
|                      | 106           | Forest Management Plan                 | no    | 1        |

#### 4.2.6 Non-Regulated Urban

The draft Upper Fox and Wolf Basin TMDL identifies 10,646 acres of Urban Non-Regulated area in the Waupaca River sub-basin. According to the SWAT modeling done to develop the TMDL, this land contributes 1,450 lbs per year of phosphorus and 88 tons per year of total suspended solids. Based on STEPL modeling, the Weyauwega Lake-Waupaca River subwatershed is estimated to contribute about 33% of the non-regulated urban total phosphorus load and 62% of the total suspended solids load in the Waupaca River sub-basin.

The draft TMDL recommends an 83% reduction from baseline for phosphorus and 35.2% reduction from baseline for total suspended solids for urban non-regulated areas in the Waupaca River sub-basin (Table 8).

The City of Waupaca and the City of Weyauwega are the most densely populated urban areas in the watershed. To ensure TMDL goals are realized, it is recommended that the City of Waupaca and City of Weyauwega assess their stormwater contribution and develop plans for stormwater control. This plan also recommends that the City of Waupaca and Waupaca County develop ordinances for stormwater and erosion control based on WDNR guidance<sup>5</sup>.

Solutions that may be identified in Urban Non-Regulated stormwater management plans include but are not limited to: detention basins, bio-filters, street sweeping, filter strips, green roofs, porous pavement, rain barrels, and rain gardens.

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<sup>5</sup> Wisconsin Department of Natural Resources guidance document of development of stormwater and erosion control and model ordinances document available at <https://dnr.wi.gov/topic/stormwater/documents/ModelOrdinances.pdf>.

## 5. Phosphorus and Sediment Reduction and Practice Implementation Goals

### 5.1 Watershed Goals and Management Objectives

Waters in the Upper Fox and Wolf Basin are currently impaired due to excess phosphorus and sediment. To restore the waters in the basin a draft TMDL has been developed for phosphorus and sediment. A TMDL identifies the sources of pollutants and reductions necessary to address water quality impairments. Currently impaired waters in the Upper Fox and Wolf Basin are shown in Appendix C. The draft TMDL is expected to be finalized in 2019. Draft TMDL total phosphorus and total sediment yields and reductions for the Waupaca River sub-basin are shown in Table 8. Reduction goals for this plan are 83% reduction in phosphorus and 35% reduction in sediment loads from agricultural nonpoint sources.

**Table 8.** Draft Upper Fox and Wolf Basins TMDL total phosphorus and total suspended solids loads and reductions for Waupaca River sub-basin (Cadmus Group LLC, 2018).

| Sources               | Total Phosphorus Load (lbs/yr) |               |               | Percent Reduction from Baseline | Total Suspended Solids Load (lbs/yr) |                  |                  | Percent Reduction from Baseline |
|-----------------------|--------------------------------|---------------|---------------|---------------------------------|--------------------------------------|------------------|------------------|---------------------------------|
|                       | Baseline                       | Allocated     | Reduction     |                                 | Baseline                             | Allocated        | Reduction        |                                 |
| Background            | 3,778                          | 3,778         | -             | -                               | 261,137                              | 261,137          | -                | -                               |
| Agricultural Nonpoint | 26,648                         | 4,540         | 22,108        | 83.0%                           | 6,757,291                            | 4,377,103        | 2,380,188        | 35.2%                           |
| Non-Regulated Urban   | 1,450                          | 247           | 1,203         | 83.0%                           | 175,068                              | 113,402          | 61,666           | 35.2%                           |
| General Permits       | 145                            | 145           | -             | -                               | 17,507                               | 17,507           | -                | -                               |
| Regulated MS4 Urban   | -                              | -             | -             | -                               | -                                    | -                | -                | -                               |
| Individual Permits    | 8,216                          | 1,441         | 6,775         | 82.5%                           | 240,920                              | 159,603          | 81,317           | 33.8%                           |
| Reserve Capacity      | NA                             | 328           | NA            | NA                              | NA                                   | 244,743          | NA               | NA                              |
| <b>Total</b>          | <b>40,237</b>                  | <b>10,479</b> | <b>29,758</b> | <b>74.0%</b>                    | <b>7,451,923</b>                     | <b>5,173,495</b> | <b>2,278,428</b> | <b>30.6%</b>                    |



The main focus of the watershed plan is to improve and protect water quality and to meet the limits set by the Wolf River and Upper Fox Basin TMDL. Additional goals were set that address critical issues in the watershed area based on watershed inventory results (Table 9). Management objectives address the sources that need to be addressed in order to meet the watershed goals.

**Table 9.** Watershed goals and management objectives.

| Goal  | Indicators   | Cause or Source of Impact   | Management Objective  |
|---|--|---|---|
| Improve water quality to achieve DNR/EPA water quality standards.   | Total Phosphorus, Total Suspended Sediment   | High phosphorus levels causing algal growth and decreased dissolved oxygen. Runoff from cropland, barnyards, and urban areas. Cropland erosion. | Reduce the sediment and phosphorus loads from cropland, barnyards, and urban areas.   |
| Citizens of the watershed area are aware of water quality issues and are involved in the stewardship of the watersheds. | Current agricultural and urban land management practices.  | 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 watershed streams and lakes. Improve soil health and increase soil infiltration. |
| Conserve and restore aquatic and terrestrial habitat.   | Populations of plant and animal species. Connectivity, aerial extent, patch size.  | Wetland and natural area degradation due to development and agriculture.  | Restore wetlands and natural areas to improve habitat.  |

### *5.2 Individual practice and practice system efficiencies*

The EPA's STEPL (Spreadsheet Tool for Estimating Pollutant Loads) tool was used to determine practice system efficiencies for best management practices. STEPL comes with BMP efficiencies for many practices; a literature review was done to determine estimated efficiencies for practices not included in the tool. The tool comes with a BMP Calculator that estimates the combined efficiency of two or more practices when used together. This tool was run to get several practice system efficiencies such as using cover crops and reduced tillage together as a system. Individual practice and practice system efficiencies used are shown in Appendix D.

### *5.3 Planned Practice Implementation*

The Weyauwega Lake-Waupaca River 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 (Table 10). 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. This plan recommends enforcement of the state runoff standards when implementing the plan. Chapter 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. Waupaca County LWCD and NRCS 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.

**Table 10.** 10 Year Management Measures Implementation Matrix.

| 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 sediment and phosphorus loads from cropland, barnyards, and urban areas.  |  |            |           |            |            |  |                |
| a) Application of conservation practices to cropland. These practices include <sup>1</sup> :<br><br>• Increase acreage of conservation tillage (No till, Strip till, Mulch Till) in watershed area. Fields must meet 30% residue.<br>• Implement use of cover crops.<br>• Use of low disturbance manure injection on fields.<br>• Prescribed grazing<br>• Nutrient Management | # of acres of cropland with conservation practices applied | 2,040      | 2,720     | 2,040      | 0-10 years | EQIP, TRM, GLRI, CSP, AM, WQT, MDV, LWRM | NRCS, LWCD     |
| b) Stabilization of gullies and concentrated flow paths (Critical Area Planting, Grassed/Lined Waterway, WASCOB, etc).  | # of linear feet stabilized                                | 5,440      | 13,600    | 8,160      | 0-10 years | EQIP, CREP, AM, WQT, MDV, LWRM           | NRCS, LWCD     |
| c) Installation of vegetative buffers along perennial and intermittent streams.   | # acres of buffers installed                               | 7          | 18        | 11         | 0-10 years | CREP/CRP, EQIP, GLRI, AM, WQT, MDV, LWRM | NRCS, LWCD     |

| 10 Year Management Measures Plan Matrix   |  |            |           |            |            |                                     |                                    |
|---|--|------------|-----------|------------|------------|-------------------------------------|------------------------------------|
| Recommendations   | Indicators   | Milestones |           |            | Timeline   | Funding Sources                     | Implementation                     |
|   |  | 0-3 years  | 3-7 years | 7-10 years |            |                                     |                                    |
| d) Nutrient Management: Sign up remaining landowners for nutrient management.   | # of landowners signed up for nutrient management plans                              | 6          | 10        | 4          | 0-10 years | EQUIP, TRM, SEG, AM, WQT, MDV, LWRM | NRCS, LWCD                         |
| e) Checks to make sure installed practices and management plans are being maintained and properly followed.   | # of farms checked   | 10         | 10        | 10         | 0-10 years | N/A                                 | LWCD                               |
| f) Modify drainage ditches to two-stage ditch design.   | # linear feet of drainage ditches converted to two stage ditch                       | 2,580      | 3,440     | 2,580      | 0-10 years | EQUIP, GLRI                         | NRCS, LWCD                         |
| g) Retrofit barnyard sites with necessary runoff control structures (roof runoff management, vegetated treatment area, clean water diversions, heavy use area protection, fencing, waste treatment, maintenance/repair of existing practices, etc). | # of barnyard sites addressed and retrofitted with necessary runoff control measures | 2          | 3         | -          | 0-7 years  | EQUIP, AM, WQT, TRM, MDV, LWRM      | NRCS, LWCD                         |
| h) Manure management on livestock operation sites.  | # of new or updated manure storage facilities  | 1          | 1         | -          | 0-7 years  | EQUIP, AM, WQT, TRM, MDV, LWRM      | NRCS, LWCD                         |
| i) Assess stormwater contributions from urban areas and development stormwater management plan (City of Waupaca and City of Weyauwega).   | # urban stormwater management plans developed  | 2          | -         | -          | 0-3 years  | UNPS & SW                           | City of Waupaca, City of Weyauwega |



| 10 Year Management Measures Plan Matrix  |   |            |           |            |            |   |                    |
|--|---|------------|-----------|------------|------------|---|--------------------|
| Recommendations  | Indicators                              | Milestones |           |            | Timeline   | Funding Sources                               | Implementation     |
|  |   | 0-3 years  | 3-7 years | 7-10 years |            |   |                    |
| 2) Management Objective: Reduce the flow of runoff from upland areas to watershed streams and lakes. Improve soil health and increase soil infiltration. |   |            |           |            |            |   |                    |
| a) Increase water storage by restoring/creating wetlands.  | # of acres of wetlands restored/created | 5          | 5         | 5          | 0-10 years | EQUIP, CREP/CRP, WQT, AM, MDV, GLRI, DU, NRDA | NRCS,LWCD, FWS, DU |
| b) Install Water and Sediment Control basins to store and slow flow of runoff.   | # of WASCOPS installed                  | 3          | 7         | 5          | 0-10 years | EQUIP, AM, WQT, GLRI,TRM, MDV                 | NRCS, LWCD         |
| c) Increase soil infiltration by implementing practices (a-e) under Management Objective 1.  | —                                       | —          | —         | —          | —          | —   | —                  |
| 3) Management Objective: Restore wetlands and natural areas to improve habitat.  |   |            |           |            |            |   |                    |
| a) Restore wetlands to improve habitat.  | # of acres of wetlands restored         | See 2) (a) | See 2 (a) | See 2 (a)  | 0-10 years | EQUIP, CREP/CRP, WQT, AM, MDV, GLRI, DU, NRDA | NRCS,LWCD, FWS, DU |

| 10 Year Management Measures Plan Matrix   |   |                   |                  |                   |                 |  |                       |
|---|---|-------------------|------------------|-------------------|-----------------|--|-----------------------|
| <i>Recommendations</i>  | <i>Indicators</i>                         | <i>Milestones</i> |                  |                   | <i>Timeline</i> | <i>Funding Sources</i>                   | <i>Implementation</i> |
|   |   | <i>0-3 years</i>  | <i>3-7 years</i> | <i>7-10 years</i> |                 |  |                       |
| b) Create or improve habitat for wildlife and restore or maintain native plant communities. | # of acres of habitat created or improved | 10                | 15               | 5                 | 0-10 years      | EQIP, CREP/CRP, CPP                      | NRCS, LWCD, FWS, NRDA |
| c) Installation of vegetative buffers along intermittent and perennial streams              | # of acres of buffers installed           | See 1 (c)         | See 1 (c)        | See 1 (c)         | 0-10 years      | CREP/CRP, EQIP, GLRI, AM, WQT, MDV, LWRM | NRCS, LWCD            |

1. A combination of the listed practices will be applied to agricultural fields to get the desired reductions. 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 E.

#### 5.4 Estimated Load Reduction

Load reductions for agricultural best management practices were estimated using STEPL (Spreadsheet Tool for Estimating Pollutant Loading) and the NRCS BARNY model. Percent reduction was based on the STEPL model agricultural baseline loading of 3,465 lbs TP/yr and 387 tons TSS/year. An estimated 83.3% reduction in TP and 73.1% reduction in TSS from agricultural sources are expected for planned management measures in the Weyauwega Lake-Waupaca River watershed. Expected load reductions from planned activities are shown in Table 11.

**Table 11.** Estimated load reductions.

| Management Measure Category  | Total Units<br>(size/length) | Total Cost            | Estimated Load Reduction |             |               |             |
|--|------------------------------|-----------------------|--------------------------|-------------|---------------|-------------|
|  |                              |                       | TP (lbs/yr)              | Percent     | TSS<br>(t/yr) | Percent     |
| <b>Farmstead Practices</b> (vegetated treatment area, waste storage including transfer, clean water diversions, fencing, waste treatment, roof runoff management, critical area plantings maintenance/repair of existing practices, etc) | 6 Sites                      | \$840,000.00          | 240.0                    | 6.9         | NA            | NA          |
| <b>Practices applied to Cropland</b> (Conservation Tillage/Residue Management, Cover Crops, Nutrient Management, Low Disturbance Manure Injection, Prescribed Grazing, Riparian Buffers, Two Stage Ditch) <sub>1</sub>                   | 7,340 acres                  | \$1,697,800.00        | 2,403.0                  | 69.4        | 89.0          | 23.0        |
| <b>Gully/Concentrated Flow Stabilization</b> (Grassed Waterways, Critical Area Planting, Lined Waterway, WASCObS, etc)   | 27,200 ft/ 15 WASCObS        | \$135,500.00          | 138.0                    | 4.0         | 185.0         | 47.8        |
| <b>Wetland Restoration/Creation</b>  | 15 acres                     | \$225,000.00          | 93.0                     | 2.7         | 8.0           | 2.1         |
| <b>Upland Habitat Restoration</b> (Conservation cover and tree plantings)  | 30 acres                     | \$18,600.00           | 14.0                     | 0.4         | 1.0           | 0.3         |
| <b>Total</b>   |                              | <b>\$2,916,900.00</b> | <b>2,888.0</b>           | <b>83.3</b> | <b>283.0</b>  | <b>73.1</b> |

1. *This category does not indicate that all these practices will be applied to all 7,340 acres of cropland. A combination of conservation practices applied to a majority of the cropland most vulnerable to erosion and runoff in the watershed is necessary to get the desired pollutant load reductions. 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 determine efficiencies of different combinations of practices such as Reduced Tillage & Cover Crops or the use of a Nutrient Management and Reduced Tillage. A weighted average pollutant reduction efficiency was determined for this category based on expected implementation rates of combinations of practices. See Appendix E.*



## **Legacy Phosphorus and Sediment**

A challenge that presents itself in achieving phosphorus reductions is legacy phosphorus in the soil and in stream. In recent years scientists and watershed managers are finding that water quality is not responding as well as expected to implemented conservation practices (Sharpley et al., 2013). They are attributing this slower and smaller response to legacy phosphorus. Legacy phosphorus is used to describe the accumulated phosphorus that can serve as a long- term source of P to surface waters. Legacy phosphorus in a soil occurs when phosphorus in soils builds up much more rapidly than the decline due to crop uptake. In stream channels, legacy phosphorus can result from sediment deposition of particulate phosphorus, sorption of dissolved phosphorus onto riverbed sediments or suspended sediments, or by incorporation into the water column (Sharpley et al., 2013). Therefore, water quality may not respond to implementation of conservation practices in a watershed as quickly as expected due to remobilization of legacy phosphorus hot spots.

## **6. Information and Education**

This information and education (I&E) 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.

Goals of the information and education plan: 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.

### Objectives

- 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 Upper Fox and Wolf River Basin and how the Weyauwega Lake- Waupaca watershed contributes.
- Get local schools 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, agricultural businesses and organizations, urban home owners, and schools. Focused attention will be on agricultural land owners and operators since the main source of nonpoint pollutant loading in the watershed is from agricultural land. Non-operator agricultural landowners are also an important subset of this group as they are usually not focused on and are less likely to participate in conservation programs.

### **I&E Plan Recommended Actions**

An Information and Education Plan matrix (Table 12) was developed as a tool to help implement the I&E plan. The matrix includes recommended action campaigns, target audience, package for delivery of message, schedule, outcomes, estimated costs, and supporting organizations.

## **Evaluation**

The I&E plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Section 9.3 describes milestones related to watershed education activities that can be used to evaluate I&E plan implementation efforts.

**Table 12.** Information and Education Plan Implementation Matrix.

| Information and Education Plan Implementation Matrix  |   |  |            |  |          |   |
|---|---|--|------------|--|----------|---|
| Information and Education Action  | Target Audience                                       | Recommendations  | Schedule   | Outcomes   | Cost     | Implementation                          |
| Inform the public on watershed project.   | General Public  | <ul style="list-style-type: none"> <li>• Completed plan posted on county website.</li> <li>• Present plan to public at a public meeting.</li> <li>• Create a web/social media page (Facebook, Twitter, page on County website) for watershed project.</li> <li>• Develop exhibits for use at libraries, government offices, and local events (County Fairs and Farm Shows).</li> </ul> | 0-3 years  | General public is aware of watershed implementation plan and has better understanding of how they can impact water quality.  | \$1,200  | LWCD, NRCS, Fox-Wolf Watershed Alliance |
| 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. (Expansion of Basin Buzz or development of similar newsletter) Issues of Basin Buzz newsletter can be viewed at <a href="http://fwwa.org/buzz/">http://fwwa.org/buzz/</a>  | 0-10 years | Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available.   | \$7,000  | LWCD, NRCS, Fox-Wolf Watershed Alliance |
| Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance and funding available. | Agricultural landowners/operators                     | <ul style="list-style-type: none"> <li>• Distribute educational materials on conservation practices and programs.</li> <li>• One on one contact with individual landowners to provide tools and resources.</li> <li>• Orchestrate group meetings with agricultural landowners in watershed to share knowledge and</li> </ul>   | 0-10 years | <ul style="list-style-type: none"> <li>• Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them.</li> <li>• Increase in interest in</li> </ul> | \$20,000 | LWCD, NRCS, UWEX                        |



| Information and Education Plan Implementation Matrix |                 |  |          |  |      |                |
|--|-----------------|--|----------|--|------|----------------|
| Information and Education Action                     | Target Audience | Recommendations  | Schedule | Outcomes   | Cost | Implementation |
|  |                 | foster community connections for long term solutions.<br>• Offer workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources.<br>• Establish & tour local demonstration farms and other sites that have implemented conservation practices. Hold field days at demonstration sites to demonstrate new equipment and practices. |          | utilizing and installing conservation practices.<br>• Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners.<br>• Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality.<br>• Agricultural landowners see success of conservation practices as well as problems that can be expected. |      |                |

| 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        | <ul style="list-style-type: none"> <li>• Distribute educational materials targeted to non-operator agricultural landowners.</li> <li>• One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions.</li> <li>• Hold workshop for non-operator land owners.</li> </ul> | 0-5 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 homeowners on actions they can take to reduce polluted runoff from their yards.     | Non-agricultural landowners/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, Fox Wolf Watershed Alliance, Local Municipalities |
| Educate local agricultural businesses and organizations on objectives of watershed project. | Agronomists, Co-ops, Seed/Equipment dealers | Meetings with local agricultural organizations to share goals of project and planned conservation practices and outreach needed.   | 0-3 years | Local agricultural organizations are aware of watershed project and can assist landowners with conservation needs as well as help deliver common message to protect water quality in watershed area. | \$1,500 | UWEX, LWCD  |

| Information and Education Plan Implementation Matrix   |  |  |            |  |                                   |                |
|--|--|--|------------|--|-----------------------------------|----------------|
| Information and Education Action   | Target Audience  | Recommendations  | Schedule   | Outcomes   | Cost                              | Implementation |
| 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 Waupaca County, City of Waupaca, Town of Waupaca, Town of Lind, Town of Weyauwega, City of Weyauwega, and Town of Royalton. | Present project plan to officials and conduct meetings with government officials.  | 0-3 years  | Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives. | No cost using existing resources. | LWCD           |
| 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. | 7-10 years | Survey will measure landowner awareness of water quality issues and participation in watershed stewardship activities. | \$3,000                           | LWCD, UWEX     |

## 7. Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Cost share rates for conservation practices vary depending on state, local, or federal funding programs. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be \$5,520,789.

Summary of Cost Analysis:

- \$2,916,900 to implement best management practices.
- \$2,201,064 needed for technical assistance.
- \$82,825 needed for information and education.
- \$70,000 for water quality monitoring.
- \$250,000 for new innovative farming equipment.

**Table 13.** Estimated costs for best management practice implementation.

| Best Management Practice   | Unit  | Quantity | Cost/Unit    | Total Estimated Cost  |
|--|-------|----------|--------------|-----------------------|
| No-till/Reduced Tillage <sup>1</sup>   | ac    | 3,500    | \$20.00      | \$210,000             |
| Cover Crops <sup>1</sup>   | ac    | 3,500    | \$70.00      | \$735,000             |
| Grassed Waterway   | ln ft | 5,500    | \$5.00       | \$27,500              |
| Riparian Buffer  | ac    | 36       | \$4,000.00   | \$144,000             |
| Water and Sediment Control Basin ( <i>System including underground outlet</i> )  | each  | 15       | \$7,000.00   | \$105,000             |
| Critical Area Planting ( <i>gully and concentrated flow stabilization</i> )  | ac    | 15       | \$200.00     | \$3,000               |
| Prescribed Grazing <sup>2</sup>  | ac    | 300      | \$270.00     | \$243,000             |
| Nutrient Management <sup>3</sup>   | ac    | 4,900    | \$10.00      | \$196,000             |
| Wetland Restoration/Creation   | ac    | 15       | \$15,000.00  | \$225,000             |
| Low Disturbance Manure Injection   | ac    | 1,000    | \$58.00      | \$58,000              |
| Two-Stage Ditch  | ln ft | 8,600    | \$13.00      | \$111,800             |
| Barnyard Runoff Management ( <i>roof runoff, diversion, vegetative treatment area, heavy use area protection, fencing, critical area planting, waste treatment, etc</i> ) <sup>4</sup> | each  | 5        | \$40,000.00  | \$200,000             |
| Waste Storage Systems( <i>Waste Storage Facility including Waste Transfer</i> ) <sup>4</sup>   | each  | 2        | \$320,000.00 | \$640,000             |
| Conservation Cover   | ac    | 15       | \$680.00     | \$10,200              |
| Tree/Shrub Establishment   | ac    | 15       | \$560.00     | \$8,400               |
|  |       |          | <b>Total</b> | <b>\$2,916,900.00</b> |

1. *Cost based on cost sharing for 3 year time period. These practices become an option during the corn silage years of a typical dairy rotation as well as anytime in a cash grain rotation. Within the 10-years of this plan implementation, it is assumed that all dairy rotation land will have a 3-yr window to implement these soil health strategies.*
2. *Cost based on up to 3 years of cost sharing of approved grazing management plan and includes cost of forage and biomass planting, fencing, and watering facilities.*
3. *Cost based on cost sharing for 4 years*
4. *Many of these practices (Waste Storage/Transfer, Heavy Use Protection, Vegetated Treatment Area, Waste Treatment) require an accepted Comprehensive Nutrient Management Plan in order to receive NRCS EQIP funding.*

**Table 14.** Estimated costs for technical assistance.

| Technical Assistance             | Quantity | Cost/Unit (\$) | Total Cost (\$) |
|----------------------------------|----------|----------------|-----------------|
| Conservation/Project Technician* | 1        | 96,000         | 1,100,532       |
| Agronomist*                      | 1        | 96,000         | 1,100,532       |

*\*Costs based on employment for 10 years including benefits and 3 % increase per year for salary and fringe costs.*

**Table 15.** Information and education costs.

| Information and Education   | Cost (\$) |
|---|-----------|
| Staff hours (1,300 hours of staff time for 10 years)  | 45,625    |
| Materials and Equipment (Postage, printing costs, paper costs, presentation materials/equipment, meeting space and equipment) | 37,200    |

## 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, wetland restoration/creation, barnyard runoff control, manure storage and fencing. For annual practices that require re-installation of management each year such as conservation tillage, cover crops, and nutrient management, landowners are required to maintain the practice for each period that cost sharing is available. Therefore annual assistance may be required for certain practices. 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).



## **Innovative Equipment**

One of the major hurdles for farmers to be able to adopt new cropping management practices is the cost of new farming equipment and lack of access to new farming equipment. This plan recommends finding ways to make innovative equipment such as low disturbance manure injectors, no-till drills and interseeders available for use and demonstration in the subwatershed. Options to achieve this include purchasing equipment if funds can be acquired, working with local co-ops and agricultural equipment dealers to acquire equipment and working with neighboring counties on borrowing equipment.

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## 8. Funding Sources

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

### *8.1 Federal and State Funding Programs*

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 Partners Program (CPP)** – A collaborative effort between U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS) and the National Fish and Wildlife Foundation (NFWF) to provide grants on a competitive basis to increase technical assistance capacity to advance the implementation of NRCS/NFWF initiatives and Farm Bill conservation programs.

**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, riparian buffers, wetland restoration, and grassed waterways.

**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.

**Land and Water Resource Management (LWRM) Grants**- The Wisconsin Department of Agriculture, Trade and Consumer Protection awards annual Land and Water Resource Management grants to county land and water conservation committees and cooperators to help pay for county staff and finance cost-sharing for landowners who install conservation practices with county assistance.

**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. Under the initiative nonfederal governmental entities (state agencies, interstate agencies, local governments, non- profits, universities, and federally recognized Indian tribes) can apply for funding for projects related to restoring the Great Lakes.

**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.

**Producer -Led Watershed Protection Grants-** Grant program administered by DATCP. The grants go to projects that focus on ways to prevent and reduce runoff from farm fields and that work to increase farm participation in these voluntary efforts.

**Urban Nonpoint Source & Stormwater Management Grant Program (UNPS&SW)** - Program offers competitive grants to local governments for the control of pollution from urban sources that is carried by storm water runoff. Grants from the UNPS&SW Program reimburse costs of planning or construction projects controlling urban nonpoint source and storm water runoff pollution.

### *8.2 Adaptive Management and Water Quality Trading*

Adaptive management and water quality trading 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. Adaptive management focuses on compliance with phosphorus criteria while water quality trading focuses on compliance with a discharge limit.

**Table 16.** 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.  |
| Wetland restoration, bank stabilization, and other similar practices can count towards compliance.   | Wetland restoration, bank stabilization, and other similar practices can count towards compliance if reductions are quantifiable. |

### *8.3 Phosphorus Multi- Discharger Variance (MDV) (Wisconsin Act 378)*

In April of 2014, Act 378 was enacted; this act required the Wisconsin Department of Administration in consultation with the Department of Natural Resources to determine if complying with phosphorus limits causes Wisconsin substantial and economic hardship. It was determined that costs associated with waste water treatment to remove phosphorus would cause a substantial and widespread economic impact on the state.

The DNR is working with the EPA to implement a Multi-discharger Phosphorus Variance to help point sources comply with phosphorus standards in a more economically viable way. A multi- discharger variance extends the timeline for complying with low level phosphorus limits. In exchange, point sources agree to step wise reduction of phosphorus within their effluent as well as helping to address nonpoint source of phosphorus from farm fields, cities or natural areas by paying \$50 per pound plus inflation that has occurred since 2015 to implement projects designed to improve water quality. A permittee that chooses to make payments for phosphorus reduction will make payments to each county that is participating in the program and has territory within the basin in which the point source is located in proportion to the amount of territory each county has within the basin. A county will then use the payments to provide cost sharing for projects to reduce the amount of phosphorus entering the waters of the state, for staff to implement phosphorus reduction projects, and/or for modeling or monitoring to evaluate the amount of phosphorus in the waters of the state for planning purposes. The final Multi-Discharger Variance package was submitted to the EPA on March 30, 2016 and approved by the EPA on February 6, 2017.



#### *8.4 Other Funding Sources*

In addition to state and federal funding sources, there are also several non-profit entities that partner with government agencies and provide funding for conservation work. Examples of additional potential project partners and sources of funding listed below:

**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.

**Fox River/Green Bay Natural Resource Trustee Council (NRDA)-** Council provides funding for projects that restore, rehabilitate, replace and/or acquire the equivalent of the natural resources that have been injured by the release of PCB's in Wisconsin and Upper Michigan.

**Ducks Unlimited (DU) -** A non-profit organization that works to conserve, restore, and manage wetlands and associated habitats for North America's waterfowl.

**The Nature Conservancy (TNC) -** A non-profit organization that works around the world to protect ecologically important lands and waters.

## 9. 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.

### *9.1 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.

#### Stream Water Quality Monitoring

This plan recommends the continued monitoring of the same site locations sampled by the WDNR for the Targeted Watershed Assessment of the Lake Weyauwega Sub-watershed of the Waupaca River Watershed done in 2017. Water quality monitoring sampling for nutrients should be conducted on an annual basis with samples collected from May- October. Samples will be analyzed for Total Suspended Sediment, Total Phosphorus, and Nitrates at a state certified lab. These sites should also be evaluated for macroinvertebrate and fish biotic integrity after 7 years of implementation and at the end of plan schedule (10 years). Water quality sampling will be done either by Waupaca County LWCD, WDNR, and/or volunteers depending on funding and staff availability.

### *9.2 Tracking Plan Progress and Success*

Progress and success of the Weyauwega Lake-Waupaca River Watershed Plan 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

Waupaca County LWCD and NRCS will be responsible for tracking progress of the plan. Waupaca County LWCD will need to work with NRCS staff to track progress and implement projects. 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 led 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.
  - i) Percent change in attendance at information and education activities held.
- 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 SnapPlus for upland practices and the BARNY model for barnyard practices.

The methods outlined in the US EPA technical memo, “Adjusting for Depreciation of Land Treatment When Planning Watershed Projects” will be used when evaluating BMP effectiveness and identifying factors that may affect BMP performance levels and implementation. For additional information on BMP deprecation see Appendix H.

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) Changes in land use or land management in watershed that may impact BMP effectiveness.
  - h) Variations in weather that may have influenced implementation of BMPs or effectiveness of installed BMPs.
- 3) Water quality monitoring reporting parameters:
- a) Phosphorus, nitrogen, and sediment concentrations from WDNR/County sampling.
  - b) Fish IBI and Macroinvertebrate IBI from WDNR/County sampling.

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

#### Water Quality Indicators

Plan progress will also be measured by water quality data. Median summer phosphorus concentrations, macroinvertebrate index of biotic integrity and fish index of biotic integrity will be used to determine improvement in water quality. Water quality monitoring indicators for success based on implementation timeline are shown in Table 17. Estimated load reductions from implemented best management practices on agricultural land will also be used to determine if interim water quality goals are being met (Table 18).

**Table 17.** Water quality monitoring indicators for success.

| Monitoring Recommendation   | Indicators                            | Current Value | Target Value | Short Term (3 yrs) | Mid Term (7 yrs) | Long Term (10 yrs) | Implementation | Funding   |
|---|---------------------------------------|---------------|--------------|--------------------|------------------|--------------------|----------------|-----------|
| Unnamed Trib to Waupaca River at Galilee Rd (WBIC 5021414)        | summer median total phosphorus (mg/l) | 0.134         | 0.075        | 0.116              | 0.093            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Fair          | Good         | N/A                | Good             | Good               |                |           |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |           |
| Unnamed Trib to Waupaca River US 325m Gallilee Rd(WBIC 5021414)   | summer median total phosphorus (mg/l) | 0.126         | 0.075        | 0.111              | 0.090            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
| Unnamed Tributary to Waupaca River (WBIC 5021414) US Den Ed Rd    | summer median total phosphorus (mg/l) | 0.112         | 0.075        | 0.101              | 0.086            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Poor          | Good         | N/A                | Fair             | Good               |                |           |
| Unnamed Trib to Waupaca River US Galilee Rd (WBIC 257900)         | summer median total phosphorus (mg/l) | 0.117         | 0.075        | 0.104              | 0.088            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Fair          | Good         | N/A                | Good             | Good               |                |           |
| Unnamed Trib to the Waupaca River US Harrington Rd (WBIC 5020550) | summer median total phosphorus (mg/l) | 0.112         | 0.075        | 0.101              | 0.086            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Good          | Good         | N/A                | Good             | Good               |                |           |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |           |
| Unnamed Trib to Waupaca River at Harrington Rd (WBIC 258000)      | summer median total phosphorus (mg/l) | 0.154         | 0.075        | 0.130              | 0.099            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Excellent     | Excellent    | N/A                | Excellent        | Excellent          |                |           |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |           |
| Unnamed Tributary (WBIC 258100) to Waupaca River at Hwy 54        | summer median total phosphorus (mg/l) | 0.092         | 0.075        | 0.087              | 0.080            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
|   | Fish IBI                              | Fair          | Good         | N/A                | Good             | Good               |                |           |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |           |
| Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd        | summer median total phosphorus (mg/l) | 0.155         | 0.075        | 0.131              | 0.099            | 0.075              | WDNR/LWCD      | WDNR/GLRI |
| Unnamed Trib (WBIC  | summer median total                   | 0.142         | 0.075        | 0.122              | 0.095            | 0.075              | WDNR/LWCD      | WDNR/     |



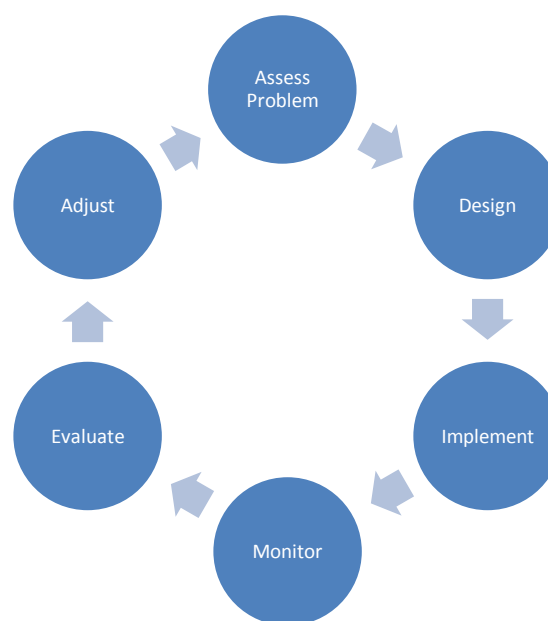
| Monitoring Recommendation                                 | Indicators                            | Current Value | Target Value | Short Term (3 yrs) | Mid Term (7 yrs) | Long Term (10 yrs) | Implementation | Funding    |
|---|---------------------------------------|---------------|--------------|--------------------|------------------|--------------------|----------------|------------|
| 5020640) to Lake Weyauwega US County AA                   | phosphorus (mg/l)                     |               |              |                    |                  |                    |                | GLRI       |
| Unnamed Trib to Lake Weyauwega US Hwy 10 (WBIC 5021203)   | summer median total phosphorus (mg/l) | 0.095         | 0.075        | 0.089              | 0.081            | 0.075              | WDNR/LWCD      | WDNR/ GLRI |
|   | Fish IBI                              | Fair          | Good         | N/A                | Good             | Good               |                |            |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |            |
| Unnamed Trib (WBIC 257800) to Waupaca River at Airport Rd | summer median total phosphorus (mg/l) | 0.108         | 0.075        | 0.098              | 0.085            | 0.075              | WDNR/LWCD      | WDNR/ GLRI |
|   | Macroinvertebrate IBI                 | Fair          | Good         | N/A                | Good             | Good               |                |            |

**Table 18.** Interim phosphorus and sediment reduction goals for Weyauwega Lake-Waupaca River Watershed.

| Indicators                    | Target Value | Short Term (3 yrs) | Mid Term (7 yrs) | Long Term (10 yrs) |
|-------------------------------|--------------|--------------------|------------------|--------------------|
| Phosphorus Reduction (lbs/yr) | 2,888        | 866                | 2,022            | 2,888              |
| Sediment Reduction (tons/yr)  | 283          | 85                 | 198              | 283                |

### 9.3 Progress Evaluation

Due to the uncertainty of models and the efficiency of best management practices, an adaptive management approach should be taken with this subwatershed (Figure 37). Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Plan milestones are based on the implementation schedule with short term (0-3 years), medium term (3-7 years) and long term (7-10 years) milestones. After the implementation of practices and monitoring of water quality, plan progress and success should be evaluated after each milestone period. In addition to the annual report an additional progress report should be completed at the end of each milestone period. The progress report will be used to identify and track plan implementation to ensure that progress is being made and to make corrections as necessary. Plan progress will be determined by minimum progress criteria for management practices, water quality monitoring, and information and education activities held. If lack of progress is demonstrated, factors resulting in milestones not being met should be included in the report. Adjustments should be made to the plan based on plan progress and any additional new data and/or watershed tools.



**Figure 37.** Adaptive management process.

## Water Quality Monitoring Progress Evaluation

This implementation plan recognizes that estimated pollutant load reductions and expected improvement in water quality or aquatic habitat may not occur immediately following implementation of practices due to several factors (described below) that will need to be taken into consideration when evaluating water quality data. These factors can affect or mask progress that plan implementation has made elsewhere. Consultation with the DNR and Water Quality biologists will be critical when evaluating water quality or aquatic habitat monitoring results. Milestones for pollutant load reductions are shown in Table 17 and 18. If the target values/goals for water quality improvement for the milestone period are not being achieved, the water quality targets or timetable for pollutant reduction will need to be evaluated and adjusted as necessary.

The following criteria will be evaluated when water quality and aquatic habitat monitoring is completed after implementation of practices:

- Changes in land use or crop rotations within the same watershed where practices are implemented. (Increase in cattle numbers, corn silage acres, and/or urban areas can negatively impact stream quality and water quality efforts)
- Location in watershed where land use changes or crop rotations occur. (Where are these changes occurring in relation to implemented practices?)
- Watershed size, location where practices are implemented and location of monitoring sites.
- Climate, precipitation and soil conditions that occurred before and during monitoring periods. (Climate and weather patterns can significantly affect growing season, soil conditions, and water quality)
- Frequency and timing of monitoring.
- Percent of watershed area (acres) or facilities (number) meeting NR 151 performance standards and prohibitions.
- Percent of watershed area (acres) or facilities (number) that maintain implemented practices over time.
- Extent of gully erosion on crop fields within watershed over time. How many are maintained in perennial vegetation vs. plowed under each year?
- How “Legacy” sediments already within the stream and watershed may be contributing P and sediment loads to stream?
- Presence and extent of drain tiles in watershed area in relation to monitoring locations. Do these drainage systems contribute significant P and sediment loads to receiving streams?
- Does monitored stream meet IBI and habitat criteria but does not meet TMDL water quality criteria?
- Are targets reasonable? Load reductions predicted by models could be overly optimistic.

## Management Measures/Information and Education Implementation Progress Evaluation

Implementation milestones for management measures are shown in the 10 Year Management Measures Plan Matrix (Table 10) and milestones for Information and Education Plan implementation are shown in Table 19. If less than 70% of the implementation milestones are being met for each milestone period, the plan will need to be evaluated and revised to either change the milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

**Table 19.** Information and education implementation goal milestones.

| <b>Information and Education Plan Implementation Goal Milestones</b> |   |
|--|---|
| <i>Short Term (0-3 years)</i>  |   |
| a)   | Completed watershed plan posted on county website.  |
| b)   | Facebook/Website/or Page on county website developed for watershed information and updates.   |
| c)   | 1 exhibit displayed or used at local library, government office, and/or local event.  |
| d)   | Direct mailing of informational materials on watershed project and conservation practices to all eligible land owners.  |
| e)   | At least 30 one on one contacts made with agricultural landowners.  |
| f)   | At least 2 meetings held with agricultural landowners.  |
| g)   | At least 2 educational workshops/demonstrations held at a demonstration farm.   |
| h)   | At least three issues of "Basin Buzz" newsletter or similar newsletter distributed.   |
| i)   | At least 2 meetings to share goals of watershed project have been held with local agricultural businesses and organizations.  |
| j)   | At least one workshop held for non-operator landowners.   |
| <i>Medium Term (3-7 years)</i>                                       |   |
| a)   | Direct mailing to all eligible landowners notifying them of watershed project progress and available funding and programs for conservation practices.   |
| b)   | At least 4 educational workshops/demonstrations held.   |
| c)   | At least 3 meetings held with agricultural landowners.  |
| d)   | At least 2 municipalities/governing bodies in watershed adopt/amend current code or ordinance to match goals of watershed plan.   |
| e)   | At least 10 people attend each educational workshop and meeting.  |
| f)   | At least 4 issues of "Basin Buzz" newsletter or similar newsletter distributed.   |
| <i>Long Term (7-10 years)</i>  |   |
| a)   | At least 2 educational workshops/demonstrations held.   |
| b)   | At least three issues of "Basin Buzz" newsletter or similar newsletter distributed.   |
| c)   | 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). |

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## **Appendix A. STEPL baseline condition inputs.**

### **Weather Data:**

Weather Station: Waupaca, ID WI 478951

Annual Rainfall: 32.37 in

Rain Days: 108.83

Avg. Rain/Event: 0.588

Rain Correction Factors:

Percent of events that exceed 5mm/year-0.85

Percent of rain day (event) that generates runoff-0.43

### **Land Use:**

Urban: 2,604 acres

Cropland: 8,161 acres

Pastureland/Hay: 846 acres

Natural Background: 8,361 acres

### **Agriculture Animals:**

Beef Cattle: 413

Dairy Cattle: 3,248

Horse: 10

# of months manure applied: 1

### **USLE Parameters:**

Cropland: R 110, K 0.22, LS 0.244, C 0.16, P 0.25

Pastureland/Hay: R 110, K 0.22, LS 0.244, C 0.06, P 0.50

Forest/Natural Background: R 110, K 0.22, LS 0.18, C 0.005, P 0.50

### **Average Soil Hydrologic Group: C**

## Baseline Agriculture Conditions Assumptions:

### Cropland

Nutrient Management (2,540 acres)

Conservation Tillage (2,130 acres)

Cropland with Forest Buffer (3,000 acres)

| Acres        | % Implementation on Cropland | Baseline BMP Conditions                   | % Reduction phosphorus | Weighted % reduction phosphorus | % Reduction sediment | Weighted % reduction sediment |
|--------------|------------------------------|---|------------------------|---------------------------------|----------------------|-------------------------------|
| 1,000        | 12.3%                        | Conservation Tillage & NMP                | 73.70%                 | 14.6%                           | 58.60%               | 11.6%                         |
| 500          | 6.1%                         | NMP & Forest Buffer                       | 70.60%                 | 7.0%                            | 58.60%               | 5.8%                          |
| 632          | 7.7%                         | Conservation Tillage & Forest Buffer      | 74.40%                 | 9.3%                            | 82.90%               | 10.4%                         |
| 1,368        | 16.8%                        | Forest Buffer                             | 46.50%                 | 12.6%                           | 58.60%               | 15.9%                         |
| 500          | 6.1%                         | Conservation Tillage, NMP & Forest Buffer | 85.90%                 | 8.5%                            | 82.90%               | 8.2%                          |
| 1,037        | 12.7%                        | NMP                                       | 45.00%                 | 9.3%                            | NA                   | NA                            |
| <b>5,037</b> | <b>61.7%</b>                 | <b>Combined BMP Efficiency</b>            | <b>NA</b>              | <b>61.4%</b>                    | <b>NA</b>            | <b>52.0%</b>                  |

Baseline BMP Efficiency applied to 61.7% (5,037 acres) of Cropland:

Phosphorus: 0.614

Sediment: 0.52

### Pastureland

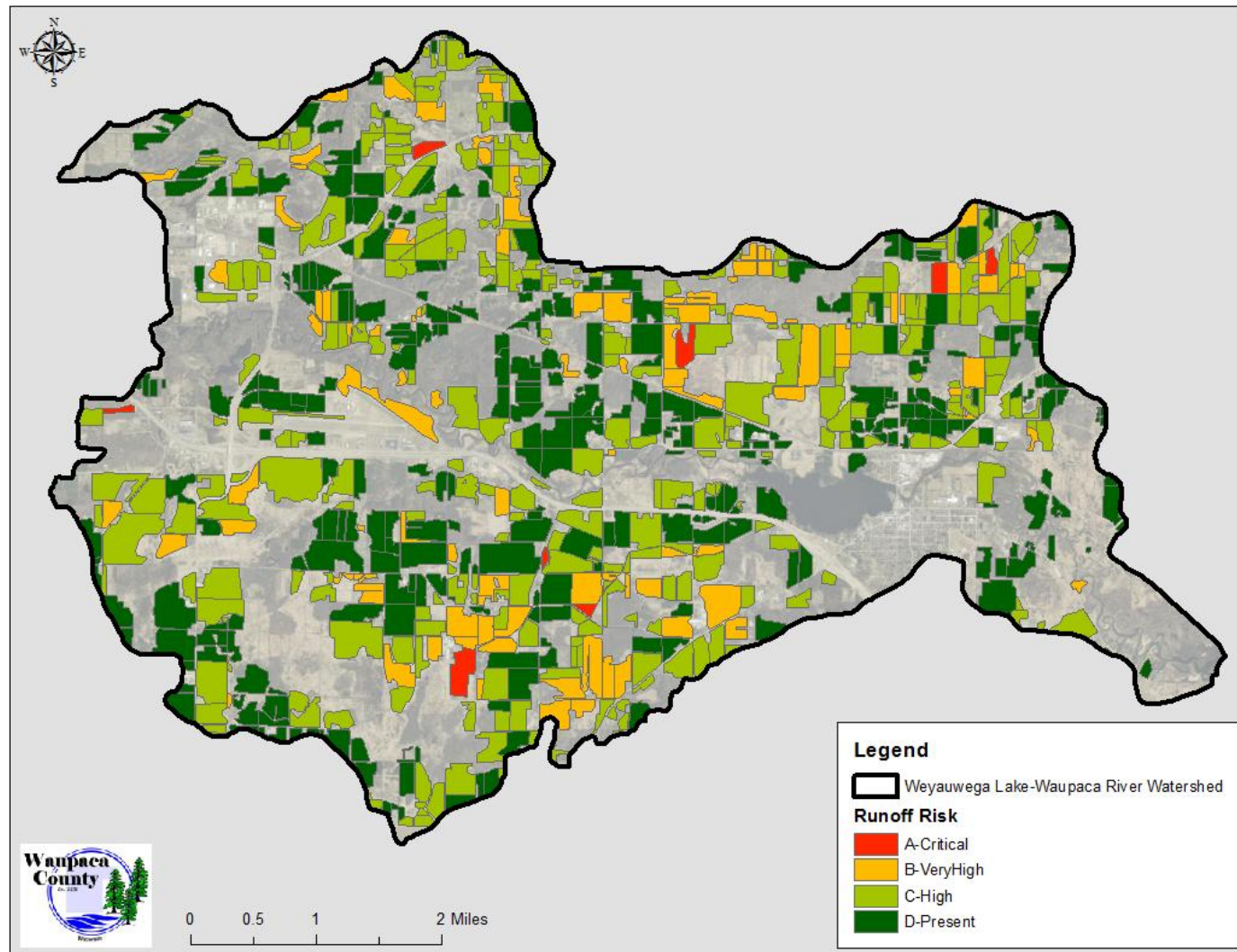
Pastureland with Forest Buffer (260 acres)

Baseline BMP Efficiency applied to 31% of pastureland:

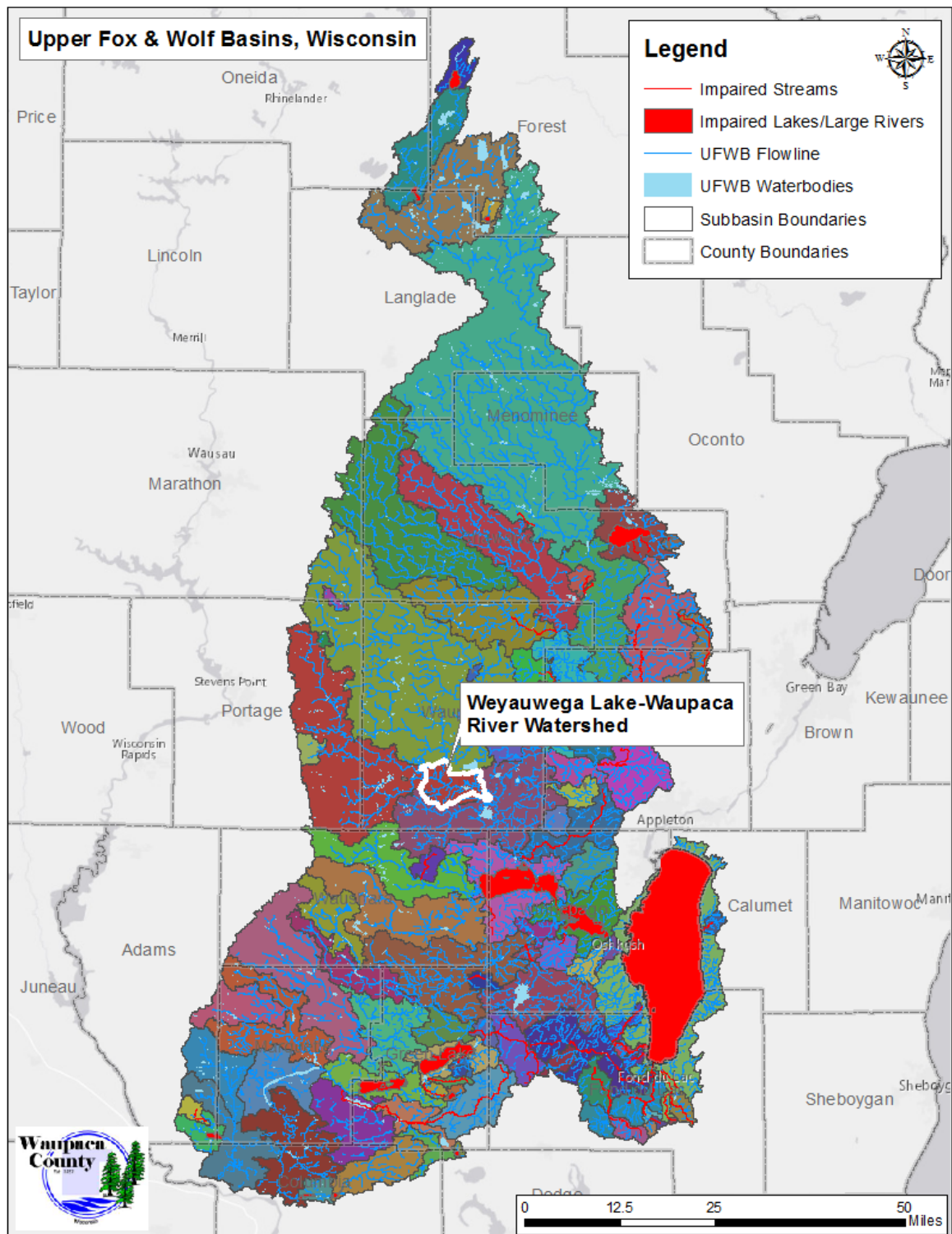
Phosphorus: 0.40

Sediment: 0.533

**Appendix B. ACPF runoff risk.**



**Appendix C. Draft TMDL Upper Fox & Wolf Basins and impaired waters.**



## Appendix D. BMP efficiencies.

| Practice   | Practice Efficiency |              | Source   |
|--|---------------------|--------------|--|
|  | Phosphorus (%)      | Sediment (%) |  |
| <b>Individual Practices</b>                                |                     |              |  |
| <i>Cropland</i>  |                     |              |  |
| Cover Crops  | 15                  | 20           | STEPL V4.4                                       |
| Conservation Tillage (30-59% Residue)                      | 35.6                | 40.3         | STEPL V4.4                                       |
| Conservation Tillage ( $\geq 60$ % Residue)                | 68.7                | 77           | STEPL V4.4                                       |
| Buffer-Grass (35 ft wide)                                  | 43.5                | 53.3         | STEPL V4.4                                       |
| Manure Injection   | 20                  | N/A          | Kansas State Research and Extension <sup>1</sup> |
| Nutrient Management  | 45                  | N/A          | STEPL V4.4                                       |
| Prescribed Grazing   | 56.7                | 50           | STEPL V4.4 (Converting cropland to grazing)      |
| Wetland Detention  | 44                  | 75           | STEPL V4.3/4.4                                   |
| Two-Stage Ditch  | 28                  | N/A          |  |
| <i>Farmstead Practices</i>                                 |                     |              |  |
| Waste Storage Facility                                     | 60                  | N/A          | STEPL V4.3/4.4                                   |
| Diversion  | 70                  | N/A          | STEPL V4.3/4.4                                   |
| Filter Strip   | 85                  | N/A          | STEPL V4.3/4.4                                   |
| <b>Practice Systems</b>                                    |                     |              |  |
| <i>Cropland</i>  |                     |              |  |
| Cover Crops & Conservation Tillage*                        | 59.3                | 66.9         | STEPL BMP Calculator                             |
| Cover Crop & Manure Injection                              | 45.6                | 15           | STEPL BMP Calculator                             |
| Cover Crop, Conservation Tillage*, & Manure Injection      | 67.5                | 66.9         | STEPL BMP Calculator                             |
| Nutrient Management & Cover Crops                          | 53.3                | 20           | STEPL BMP Calculator                             |
| Nutrient Management, Cover Crop, Conservation Tillage*     | 77.6                | 66.9         | STEPL BMP Calculator                             |
| Nutrient Management & Conservation Tillage*                | 73.7                | 58.6         | STEPL BMP Calculator                             |
| Two Stage Ditch, Cover Crops, Conservation Tillage*        | 70.7                | 66.9         | STEPL BMP Calculator                             |
| Two Stage Ditch & Nutrient Management                      | 60.4                | N/A          | STEPL BMP Calculator                             |
| Two Stage Ditch, Buffer-Grass (35 ft), Nutrient Management | 77.6                | 53.3         | STEPL BMP Calculator                             |
| <i>Farmstead Practices</i>                                 |                     |              |  |
| Runoff Management System                                   | 82.5                | N/A          | STEPL V4.3/4.4                                   |
| Waste Management System                                    | 90                  | N/A          | STEPL V4.3/4.4                                   |

1. Tomlinson et al. 2015. Water Quality Best Management Practices, Effectiveness, and Cost for Reducing Contaminant Losses from Cropland. Kansas State University.

\*An average of the two efficiencies for conservation tillage was used for these calculations.



## Appendix E. STEPL inputs and results for best management practices.

### Conservation practices applied to cropland:

A weighted combined best management practice efficiency of 59.05 % for total phosphorus and 37.83% for total sediment was used for conservation practices applied to cropland. This assumes that a combination of practices will be applied to and/or be providing treatment to 90% of the cropland in the watershed. Estimated implementation rates of each practice combination needed to achieve TMDL reductions are shown in Table 20.

**Table 20.** Cropland best management practices scenario and efficiencies.

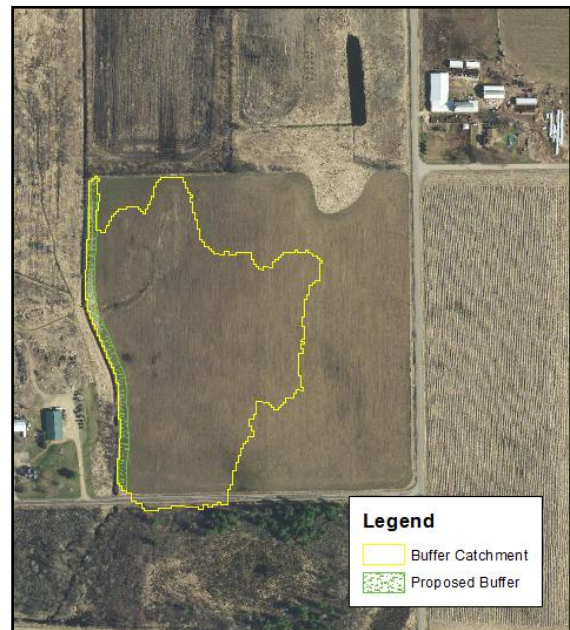
| Acres                          | Percent Implementation of Cropland | Practice Combination   | % reduction (phosphorus) | Weighted % reduction phosphorus | % reduction (sediment) | Weighted % reduction sediment |
|--------------------------------|------------------------------------|--|--------------------------|---------------------------------|------------------------|-------------------------------|
| 500                            | 6.1                                | Cover Crop & Conservation Tillage  | 59.30                    | 4.04                            | 66.90                  | 4.56                          |
| 800                            | 9.8                                | NMP & Conservation Tillage   | 73.70                    | 8.04                            | 58.60                  | 6.39                          |
| 1,300                          | 15.9                               | NMP, Conservation Tillage, & Cover Crops   | 77.60                    | 13.75                           | 66.90                  | 11.86                         |
| 800                            | 9.8                                | NMP & Cover Crops  | 53.30                    | 5.81                            | 20.00                  | 2.18                          |
| 500                            | 6.1                                | Cover Crop, Low Disturbance Manure Injection/Enhanced NM, & Conservation Tillage | 67.50                    | 4.60                            | 66.90                  | 4.56                          |
| 200                            | 2.5                                | Conservation Tillage   | 52.15                    | 1.42                            | 58.65                  | 1.60                          |
| 1,500                          | 18.4                               | Nutrient Management  | 45.00                    | 9.20                            | NA                     | NA                            |
| 200                            | 2.5                                | Cover Crop   | 15.00                    | 0.41                            | 20.00                  | 0.55                          |
| 300                            | 3.7                                | Riparian Buffer (35ft)   | 43.50                    | 1.78                            | 53.30                  | 2.18                          |
| 200                            | 2.5                                | Riparian Buffer (35ft), Two Stage Ditch, & NMP                                   | 77.60                    | 2.12                            | 53.30                  | 1.45                          |
| 300                            | 3.7                                | Prescribed Grazing   | 56.70                    | 2.32                            | 50.00                  | 2.04                          |
| 200                            | 2.5                                | Two Stage Ditch  | 28.00                    | 0.76                            | NA                     | NA                            |
| 300                            | 3.7                                | Two Stage Ditch & NMP  | 60.40                    | 2.47                            | NA                     | NA                            |
| 200                            | 2.5                                | Two Stage Ditch & Cover Crop & Conservation Tillage                              | 70.70                    | 1.93                            | 66.90                  | NA                            |
| 36                             | 0.4                                | Riparian Buffer (35 ft) (Land out of production)                                 | 80.80                    | 0.40                            | 95.00                  | 0.47                          |
| <b>Combined BMP Efficiency</b> |                                    |  | <b>NA</b>                | <b>59.05</b>                    | <b>NA</b>              | <b>37.83</b>                  |

**Table 21.** STEPL inputs for combined cropland practices and load reductions.

| 1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data |          |          |                          |                    | Load Reductions |                    |
|---|----------|----------|--------------------------|--------------------|-----------------|--------------------|
| Watershed   | Cropland |          |                          |                    | P Reduction     | Sediment Reduction |
|   | P        | Sediment | BMPs                     | % Area BMP Applied | lb/year         | t/year             |
| W1  | 0.53     | 0.34     | Combined BMPs-Calculated | 90                 | 2,403           | 89                 |

### **Riparian Buffers:**

In order to determine load reductions from riparian buffers in the STEPL model, the amount of land the buffers will be treating is needed. A GIS hydrology analysis tool was used to determine the catchment area of each proposed riparian buffer needed (Figure 38). An estimated 500 acres would be treated by the proposed priority riparian buffers which is 6% of cropland and 36 acres of cropland would be taken out of production.



**Figure 38.** Riparian buffer catchment.

### Wetland Restoration/Creation:

Reductions from wetland creations/restorations were determined assuming that 1 acre of restored wetland would be treating 20 acres of cropland. Therefore, fifteen acres of restored wetland would be treating approximately 300 acres of cropland. Additional load reduction was also calculated for the conversion of cropland to wetland.

**Table 22.** STEPL inputs for wetland creation/restoration and load reductions.

| 1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data |          |          |                   |                    | Load Reductions |                    |
|---|----------|----------|-------------------|--------------------|-----------------|--------------------|
| Watershed   | Cropland |          |                   |                    | P Reduction     | Sediment Reduction |
|   | P        | Sediment | BMPs              | % Area BMP Applied | lb/year         | t/year             |
| W1  | 0.02     | 0.03     | Wetland Detention | 3.9                | 86              | 8                  |

### Gully/Concentrated Flow Stabilization:

Load reductions for gully and concentrated flow stabilization practices (grassed waterway, WASCOB, critical area planting, etc) were estimated by assuming an average height and width for gullies and concentrated flows identified by the stream power index and air photo interpretation. A total 27,201 feet of gullies and concentrated flow paths were identified in this analysis. A 70% sediment delivery ratio was applied to the load reduction with the assumption that not all sediment from eroding gullies will reach the Waupaca River.

**Table 23.** STEPL inputs for gully/concentrated flow stabilization and load reductions.

| 1. Gully dimensions in the different watersheds |        |                |                   |            |             |               |                      |                     |  |                            |                   |                      |
|---|--------|----------------|-------------------|------------|-------------|---------------|----------------------|---------------------|--|----------------------------|-------------------|----------------------|
| Watershed                                       | Gully  | Top Width (ft) | Bottom Width (ft) | Depth (ft) | Length (ft) | Years to Form | BMP Efficiency (0-1) | Soil Textural Class | Soil Dry Weight (ton/ft <sup>3</sup> ) | Nutrient Correction Factor | Annual Load (ton) | Load Reduction (ton) |
| W1  | Gully1 | 0.75           | 0.75              | 0.5        | 10,835      | 1             | 0.95                 | Sandy loam          | 0.0525                                 | 0.85                       | 213               | 203                  |
| W1  | Gully2 | 0.5            | 0.1               | 0.25       | 16,366      | 1             | 0.95                 | Sandy loam          | 0.0525                                 | 0.85                       | 64                | 61                   |

## Appendix F. GIS data sources.

| GIS/Data Type                               | Source Agency                                      | Source Location/Metadata Link  |
|---|--|--|
| Land Use, Land Cover, and ortho-photos      | Waupaca County Land Information                    | <a href="https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/">https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/</a>  |
|   | US Dept of Agriculture (USDA)-FSA                  | NASS 2015 Cropland. 2015 NAIP:<br><a href="https://nassgeodata.gmu.edu/CropScape/">https://nassgeodata.gmu.edu/CropScape/</a><br><a href="https://gdg.sc.egov.usda.gov/">https://gdg.sc.egov.usda.gov/</a> |
| Soil Types (SSURGO)                         | USDA-NRCS  | <a href="http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx">http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx</a>  |
| Elevation (LIDAR)                           | Waupaca County Land Information                    | <a href="https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/">https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/</a>  |
| Hydrography- 303(d) Impaired surface waters | WI Dept. of Natural Resources                      | <a href="ftp://dnrftp01.wi.gov/geodata/Impaired_Waters/">ftp://dnrftp01.wi.gov/geodata/Impaired_Waters/</a>  |
| Hydrography                                 | WI Dept. of Natural Resources (watershed boundary) | <a href="ftp://dnrftp01.wi.gov/geodata/watersheds/">ftp://dnrftp01.wi.gov/geodata/watersheds/</a>  |
|   | WI Dept. of Natural Resources (surface waters)     | <a href="ftp://dnrftp01.wi.gov/geodata/hydro_24k/">ftp://dnrftp01.wi.gov/geodata/hydro_24k/</a>  |
|   | Waupaca County Land Information                    | <a href="https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/">https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/</a>  |
| Political/municipal boundaries              | Waupaca County Land Information                    | <a href="https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/">https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/</a>  |
| Wetlands                                    | WI Department of Natural Resources                 | <a href="https://data-wi-dnr.opendata.arcgis.com/">https://data-wi-dnr.opendata.arcgis.com/</a>  |
|   | Environmental Protection Agency                    | Potentially Restorable Wetlands:<br><a href="https://www.epa.gov/enviroatlas/enviroatlas-data-download-step-2">https://www.epa.gov/enviroatlas/enviroatlas-data-download-step-2</a>                        |
|   | US Fish and Wildlife Service                       | <a href="https://www.fws.gov/wetlands/Data/Data-">https://www.fws.gov/wetlands/Data/Data-</a>  |
| Groundwater                                 | WI Department of Natural Resources                 | <a href="https://data-wi-dnr.opendata.arcgis.com/">https://data-wi-dnr.opendata.arcgis.com/</a>  |
| Satellite Imagery                           | United States Geological Survey                    | <a href="https://earthexplorer.usgs.gov/">https://earthexplorer.usgs.gov/</a>  |

## **Appendix G. Glossary of terms and acronyms.**

**Animal Unit (AU)** - a standard unit used in calculation of the relative grazing impact of different kinds and classes of livestock. One animal unit is defined as a 1,000 lb beef cow.

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

**Barnyard Evaluation Rating Tool (BERT)**- Rating tool for concentrated livestock areas to determine if the area is resource concern.

**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.

**Concentrated Animal Feeding Operation (CAFO)**-

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

**Clean Water Act (CWA)** - The primary federal law in the United States governing water pollution enacted in 1972.

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

**Eutrophic**- A body of water, lake or pond, which has high biological productivity due to excessive nutrients. These water bodies are able to support an abundance of aquatic plants or algae, resulting in a reduction of dissolved oxygen.

**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 (IBI)** – 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.

**Mesotrophic**- Lakes with an intermediate level of productivity that have medium-level nutrients and are usually clear water with submerged aquatic plants.

**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.



**Riparian** – Relating to or located on the bank of a natural watercourse such as a river, stream, 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.

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

**Total Phosphorus (TP)** - A measure of all the forms of phosphorus, dissolved or particulate, that are found in a sample.

**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.

**Waste Load Allocation (WLA)** - a portion of a receiving water’s assimilative capacity that is allocated to one of its existing or future point sources of pollution. WLAs establish water quality based effluent limits for point source discharge facilities.

**Waste Water Treatment Facility (WWTF)** - A facility where wastewater is processed to remove or breakdown pollutants and treated water is returned back to the water cycle.

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



## Appendix H. EPA Technical Memorandum #1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects.



### Technical Memorandum #1

## Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

### Introduction

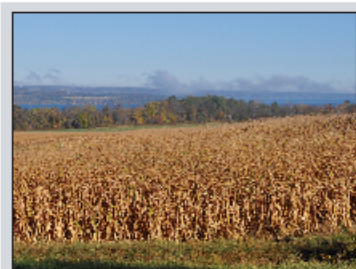
Watershed-based planning helps address water quality problems in a holistic manner by fully assessing the potential contributing causes and sources of pollution, then prioritizing restoration and protection strategies to address the problems (USEPA 2013). The U.S. Environmental Protection Agency (EPA) requires that watershed projects funded directly under section 319 of the Clean Water Act implement a watershed-based plan (WBP) addressing the nine key elements identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters* (USEPA 2008). EPA further recommends that all other watershed plans intended to address water quality impairments also include the nine elements. The first element calls for the identification of causes and sources of impairment that must be controlled to achieve needed load reductions. Related elements include a description of the nonpoint source (NPS) management measures—or best management practices (BMPs)—needed to achieve required pollutant load reductions, a description of the critical areas in which the BMPs should be implemented, and an estimate of the load reductions expected from the BMPs.

Once the causes and sources of water resource impairment are assessed, identifying the appropriate BMPs to address the identified problems, the best locations for additional BMPs, and the pollutant load reductions likely to be achieved with the BMPs depends on accurate information on the performance levels of both BMPs already in place and BMPs to be implemented as part of the watershed project. All too often, watershed managers and Agency staff have assumed that, once certified as installed or adopted according to specifications, a BMP continues to perform its pollutant reduction function at the same efficiency (percent pollutant reduction) throughout its design or contract life, sometimes longer. An important corollary to this assumption is that BMPs in place during project planning are performing as originally intended. Experience in NPS watershed projects across the nation, however, shows that, without diligent operation and maintenance, BMPs and their effects probably will depreciate over time, resulting in less efficient pollution reduction. Recognition of this fact is important at the project planning phase, for both existing and planned BMPs.

This Technical Memorandum is one of a series of publications designed to assist watershed projects, particularly those addressing nonpoint sources of pollution. Many of the lessons learned from the Clean Water Act Section 319 National Nonpoint Source Monitoring Program are incorporated in these publications.

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Donald W. Meals and Steven A. Dressing. 2015. Technical Memorandum #1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects, October 2015. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 16 p. Available online at <https://www.epa.gov/polluted-runoff-nonpoint-source/pollution/watershed-approach-technical-resources>.



Fields near Seneca Lake, New York.

Technical Memorandum #1 | Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

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Knowledge of land treatment depreciation is important to ensure project success through the adaptive management process (USEPA 2008). BMPs credited during the planning phase of a watershed project will be expected to achieve specific load reductions or other water quality benefits as part of the overall plan to protect or restore a water body. Verification that BMPs are still performing their functions at anticipated levels is essential to keeping a project on track to achieve its overall goals. Through adaptive management, verification results can be used to inform decisions about needs for additional BMPs or maintenance or repair of existing BMPs. In a watershed project that includes short-term (3–5 years) monitoring, subtle changes in BMP performance level might not be detect-

able or critical, but planners must account for catastrophic failures, BMP removal or discontinuation, and major maintenance shortcomings. Over the longer term, however, gradual changes in BMP performance level can be significant in terms of BMP-specific pollutant control or the role of single BMPs within a BMP system or train. The weakest link in a BMP train can be the driving force in overall BMP performance.

Application of and methods for BMP tracking in NPS watershed projects are described in detail in [Tech Notes 11](#) (Meals et al. 2014).

This technical memorandum addresses the major causes of land treatment depreciation, ways to assess the extent of depreciation, and options for adjusting for depreciation. While depreciation occurs throughout the life of a watershed project, the emphasis is on the planning phase and the short term (i.e., 3–5 years).

### Causes of Depreciation

Depreciation of land treatment function occurs as a result of many factors and processes.

Three of the primary causes are natural variability, lack of proper maintenance, and unforeseen consequences.

#### Natural Variability

Climate and soil variations across the nation influence how BMPs perform. Tiessen et al. (2010), for example, reported that management practices designed to improve water quality by reducing sediment and sediment-bound nutrient export from agricultural fields can be less effective in cold, dry regions where nutrient export is primarily snowmelt driven and in the dissolved form, compared to similar practices in warm, humid regions. Performance levels of vegetation-based BMPs in both agricultural and urban settings can vary significantly through the year due to seasonal dormancy. In a single locale, year-to-year variation in precipitation affects both agricultural management and BMP performance levels. Drought, for example, can suppress crop yields, reduce nutrient uptake, and result in nutrient surpluses left in the soil after harvest where they are vulnerable to runoff or leaching loss despite careful nutrient management. Increasing incidence of extreme weather and intense storms can overwhelm otherwise well-designed stormwater management facilities in urban areas.

#### Lack of Proper Maintenance

Most BMPs—both structural and management—must be operated and maintained properly to continue to function as designed. Otherwise, treatment effectiveness can depreciate over time. For example, in a properly functioning detention pond, sediment typically accumulates in the forebay. Without proper maintenance to remove accumulated sediment, the capacity of the BMP to contain

and treat stormwater is diminished. Similarly, a nutrient management plan is only as effective as its implementation. Failure to adhere to phosphorus (P) application limits, for example, can result in soil P buildup and increased surface and subsurface losses of P rather than the loss reductions anticipated.

Jackson-Smith et al. (2010) reported that over 20 percent of implemented BMPs in a Utah watershed project appeared to be no longer maintained or in use when evaluated just 5 years after project completion. BMPs related to crop production enterprises and irrigation systems had the lowest rate of continued use and maintenance (~75 percent of implemented BMPs were still in use), followed by pasture and grazing planting and management BMPs (81 percent of implemented BMPs were still in use). Management practices (e.g., nutrient management) were found to be particularly susceptible to failure.

Practices are sometimes simply abandoned as a result of changes in landowner circumstances or attitudes. In a Kansas watershed project, farmers abandoned a nutrient management program because of perceived restrictive reporting requirements (Osmond et al. 2012).

In the urban arena, a study of more than 250 stormwater facilities in Maryland found that nearly one-third of stormwater BMPs were not functioning as designed and that most needed maintenance (Lindsey et al. 1992). Sedimentation was a major problem and had occurred at nearly half of the facilities; those problems could have been prevented with timely maintenance.

Hunt and Lord (2006) describe basic maintenance requirements for bioretention practices and the consequences of failing to perform those tasks. For example, they indicate that mulch should be removed every 1–2 years to both maintain available water storage volume and increase the surface infiltration rate of fill soil. In addition, biological films might need to be removed every 2–3 years because they can cause the bioretention cell to clog.

In plot studies, Dillaha et al. (1986) observed that vegetative filter strip-effectiveness for sediment removal appeared to decrease with time as sediment accumulated within the filter strips. One set of the filters was almost totally inundated with sediment during the cropland experiments and filter effectiveness dropped 30–60 percent between the first and second experiments. Dosskey et al. (2002) reported that up to 99 percent of sediment was removed from cropland runoff when uniformly distributed over a buffer area, but as concentrated flow paths developed over time (due to lack of maintenance), sediment removal dropped to 15–45 percent. In the end, most structural BMPs have a design life (i.e., the length of time the item is expected to work within its specified parameters). This period is measured from when the BMP is placed into service until the end of its full pollutant reduction function.

### Unforeseen Consequences

The effects of a BMP can change directly or indirectly due to unexpected interactions with site conditions or other activities. Incorporating manure into cropland soils to reduce nutrient runoff, for example, can increase erosion and soil loss due to soil disturbance, especially in comparison



Abandoned waste storage structure.

to reduced tillage. On the other hand, conservation tillage can result in accumulation of fertilizer nutrients at the soil surface, increasing their availability for loss in runoff (Rhoton et al. 1993). Long-term reduction in tillage also can promote the formation of soil macropores, enhancing leaching of soluble nutrients and agrichemicals into ground water (Shipitalo et al. 2000). Stutter et al. (2009) reported that establishment of vegetated buffers between cropland and a watercourse led to enhanced rates of soil P cycling within the buffer, increasing soil P solubility and the potential for leaching to watercourses.

Despite widespread adoption of conservation tillage and observed reductions in particulate P loads, a marked increase in loads of dissolved bioavailable P in agricultural tributaries to Lake Erie has been documented since the mid-1990s. This shift has been attributed to changes in application rates, methods, and timing of P fertilizers on cropland in conservation tillage not subject to annual tillage (Baker 2010; Joosse and Baker 2011). Further complicating matters, recent research on fields in the St. Joseph River watershed in northeast Indiana has demonstrated that about half of both soluble P and total P losses from research fields occurred via tile discharge, indicating a need to address both surface and subsurface loads to reach the goal of 41 percent reduction in P loading for the Lake Erie Basin (Smith et al. 2015).

Several important project planning lessons were learned from the White Clay Lake, Wisconsin, demonstration projects in the 1970s, including the need to accurately assess pollutant inputs and the performance levels of BMPs (NRC 1999). Regarding unforeseen consequences, the project learned through monitoring that a manure storage pit built according to prevailing specifications actually caused ground water contamination that threatened a farmer's well water. This illustrates the importance of monitoring implemented practices over time to ensure that they function properly and provide the intended benefits.

Control of urban stormwater runoff (e.g., through detention) has been widely implemented to reduce peak flows from large storms in order to prevent stream channel erosion. Research has shown, however, that although large peak flows might be controlled effectively by detention storage, stormflow conditions are extended over a longer period of time. Duration of erosive and bankfull flows are increased, constituting channel-forming events. Urbonas and Wulliman (2007) reported that, when captured runoff from a number of individual detention basins in a stream system is released over time, the flows accumulate as they travel downstream, actually increasing peak flows along the receiving waters. This situation can diminish the collective effectiveness of detention basins as a watershed management strategy.

## Assessment of Depreciation

The first—and possibly most important—step in adjusting for depreciation of implemented BMPs is to determine its extent and magnitude through BMP verification.

### BMP Verification

At its core, BMP verification confirms that a BMP is in place and functioning properly as expected based on contract, permit, or other implementation evidence. A BMP verification process that documents the presence and function of BMPs over time should be included in all NPS watershed projects.



At the project planning phase, verification is important both to ensure accurate assessment of existing BMP performance levels and to determine additional BMP and maintenance needs. Verification over time is necessary to determine if BMPs are maintained and operated during the period of interest.

Documenting the presence of a BMP is generally simpler than determining how well it functions, but both elements of verification must be considered to determine if land treatment goals are being met and whether BMP performance is depreciating. Although land treatment goals might not be highly specific in many watershed projects, it is important to document what treatment is implemented. Verification is described in detail in [Tech Notes 11](#) (Meals et al. 2014). This technical memorandum focuses on specific approaches to assessing depreciation within the context of an overall verification process.

### Methods for Assessing BMP Presence and Performance Level

Whether a complete enumeration or a statistical sampling approach is used, methods for tracking BMPs generally include direct measurements (e.g., soil tests, onsite inspections, remote sensing) and indirect methods (e.g., landowner self-reporting or third-party surveys). Several of these methods are discussed in [Tech Notes 11](#) (Meals et al. 2014). Two general factors must be considered when verifying a BMP: the presence of the BMP and its pollutant removal efficiency. Different types of BMPs require different verification methods, and no single approach is likely to provide all the information needed in planning a watershed project.

### Certification

The first step in the process is to determine whether BMPs have been designed and installed/adopted according to appropriate standards and specifications. Certification can either be the final step in a contract between a landowner and a funding agency or be a component of a permit requirement.

Certification provides assurance that a BMP is fully functional for its setting at a particular time. For example, a stormwater detention pond or water and sediment control basin must be properly sized for its contributing area and designed for a specific retention-and-release performance level. A nutrient management plan must account for all sources of nutrients, consider current soil nutrient levels, and support a reasonable yield goal. A cover crop must be planted in a particular time window to provide erosion control and/or nutrient uptake during a critical time of year. Some jurisdictions might apply different nutrient reduction efficiency credits for cover crops based on planting date. Some structural BMPs like parallel tile outlet terraces require up to 2 years to fully settle and achieve full efficiency; in those cases, certification is delayed until full stability is reached. Knowledge that a BMP has been applied according to a specific standard supports an assumption that the BMP will perform at a certain level of pollutant reduction efficiency, providing a baseline against which future depreciation can be compared. Practices voluntarily implemented by landowners without any technical or financial assistance could require special efforts to determine compliance with applicable specifications (or functional equivalence). Pollution reduction by practices not meeting specifications might need to be discounted or not counted at all even when first installed.

### Depreciation assessment indicators

Ideally, assessment of BMP depreciation would be based on actual measurement of each BMP's performance level (e.g., monitoring of input and output pollutant loads for each practice). Except in very rare circumstances, this type of monitoring is impractical. Rather, a watershed project generally must depend on the use of indicators to assess BMP performance level.

The most useful indicators for assessing depreciation are determined primarily by the type of BMP and pollutants controlled, but indicators might be limited by the general verification approach used. For example, inflow and outflow measurements of pollutant load can be used to determine the effectiveness of constructed wetlands, but a verification effort that uses only visual observations will not provide that data or other information about wetland functionality. A central challenge, therefore, is to identify meaningful indicators of BMP performance level that can be tracked under different verification schemes. This technical memorandum provides examples of how to accomplish that end.

### Nonvegetative structural practices

Performance levels of nonvegetative structural practices—such as animal waste lagoons, digesters, terraces, irrigation tailwater management, stormwater detention ponds, and pervious pavement—can be assessed using the following types of indicators:

- Measured on-site performance data (e.g., infiltration capacity of pervious pavement),
- Structural integrity (e.g., condition of berms or other containment structures), and
- Water volume capacity (e.g., existing pond volume vs. design) and mass or volume of captured material removed (e.g., sediment removed from stormwater pond forebay at cleanout).

In some cases, useful indicators can be identified directly from practice standards. For example, the Natural Resources Conservation Service lists operation and maintenance elements for a water and sediment control basin (WASCoB) ([USDA-NRCS 2008](#)) that include:

- Maintenance of basin ridge height and outlet elevations,
- Removal of sediment that has accumulated in the basin to maintain capacity and grade,
- Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin, and
- Regular mowing and control of trees and brush.

These elements suggest that ridge and outlet elevations, sediment accumulation, inlet integrity, and vegetation control would be important indicators of WASCoB performance level.

Required maintenance checklists contained in stormwater permits also can suggest useful indicators. For example, the [Virginia Stormwater Management Handbook](#) (VA DCR 1999) provides an extensive checklist for annual operation and maintenance inspection of wet ponds. The list includes many elements that could serve as BMP performance level indicators:

- Excessive sediment, debris, or trash accumulated at inlet,
- Clogging of outlet structures,

- Cracking, erosion, or animal burrows in berms, and
- More than 1 foot of sediment accumulated in permanent pool.

Assessment of these and other indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

#### Vegetative structural practices

Performance levels of vegetative structural practices—such as constructed wetlands, swales, rain gardens, riparian buffers, and filter strips—can be assessed using the following types of indicators:

- Extent and health of vegetation (e.g., measurements of soil cover or plant density),
- Quality of overland flow filtering (e.g., evidence of short-circuiting by concentrated flow or gullies through buffers or filter strips),
- On-site capacity testing of rain gardens using infiltrometers or similar devices, and
- Visual observations (e.g., presence of water in swales and rain gardens).



Parking lot rain garden.

As for non-vegetative structural practices, assessment of these indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

#### Nonstructural vegetative practices

Performance levels of nonstructural vegetative practices—such as cover crops, reforestation of logged tracts, and construction site seeding—can be assessed using the following types of indicators:

- Density of cover crop planting (e.g., plant count),
- Percent of area covered by cover crop, and
- Extent and vitality of tree seedlings.

These indicators could be assessed by on-site inspection or, in some cases, by remote sensing, either from satellite imagery or aerial photography.

#### Management practices

Performance levels of management practices—such as nutrient management, conservation tillage, pesticide management, and street sweeping—can be assessed using the following types of indicators:

- Records of street sweeping frequency and mass of material collected,
- Area or percent of cropland under conservation tillage,

- Extent of crop residue coverage on conservation tillage cropland, and
- Fertilizer and/or manure application rates and schedules, crop yields, soil test data, plant tissue test results, and fall residual nitrate tests.



Illustration of line-transect method for residue.

Assessment of these indicators would generally require reporting by private landowners or municipalities, reporting that is required under some regulatory programs. Visual observation of indicators such as residue cover, however, can also be made by on-site inspection or windshield survey.

#### Data analysis

Data on indicators can be expressed and analyzed in several ways, depending on the nature of the indicators used. Indicators reporting continuous numerical data—such as acres of cover crop or conservation tillage, manure application rates, miles of street sweeping, mass of material removed from

catch basins or detention ponds, or acres of logging roads/landings revegetated—can be expressed either in the raw form (e.g., acres with 30 percent or more residue cover) or as a percentage of the design or target quantity (e.g., percent of contracted acres achieving 30 percent or more of residue cover). These metrics can be tracked year to year as a measure of BMP depreciation (or achievement). During the planning phase of a watershed project, it might be appropriate to collect indicator data for multiple years prior to project startup to enable calculation of averages or ranges to better estimate BMP performance levels over crop rotation cycles or variable weather conditions.

Indicators reporting categorical data—such as maintenance of detention basin ridge height and outlet elevations, condition of berms or terraces, or observations of water accumulation and flow—are more difficult to express quantitatively. It might be necessary to establish an ordinal scale (e.g., condition rated on a scale of 1–10) or a binary yes/no condition, then use best professional judgment to assess influence on BMP performance.

In some cases, it might be possible to use modeling or other quantitative analysis to estimate individual or watershed-level BMP performance levels based on verification data. In an analysis of stormwater BMP performance levels, Tetra Tech (2010) presented a series of BMP performance curves based on monitoring and modeling data that relate pollutant removal efficiency to depth of runoff treated (Figure 1). Where depreciation indicators track changes in depth of runoff treated as the capacity of a BMP decreases (e.g., from sedimentation), resulting changes in pollutant removal could be determined from a performance curve. This type of information can be particularly useful during the planning phase of a watershed project to estimate realistic performance levels for existing BMPs that have been in place for a substantial portion of their expected lifespans.

The performance levels of structural agricultural BMPs in varying condition can be estimated by altering input parameters in the [Soil and Water Assessment Tool](#) (SWAT) model (Texas A&M University 2015a); other models such as the [Agricultural Policy/Environmental eXtender](#) (APEX) model (Texas A&M



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University 2015b) also can be used in this way (including application to some urban BMPs). For urban stormwater, engineering models like [HydroCAD](#) (HydroCAD Software Solutions 2011) can be used to simulate hydrologic response to stormwater BMPs with different physical characteristics (e.g., to compare performance levels under actual vs. design conditions). Even simple spreadsheet models such as the Spreadsheet Tool for Estimating Pollutant Load ([STEPL](#)) (USEPA 2015) can be used to quantify the effects of BMP depreciation by varying the effectiveness coefficients in the model.

Data from verification efforts and analysis of the effects of depreciation on BMP performance levels must be qualified based on data confidence. “Confidence” refers mainly to a quantitative assessment of the accuracy of a verification result. For example, the number of acres of cover crops or the continuity of streamside buffers on logging sites determined from aerial photography could be determined by ground-truthing to be within +10 percent of the true value at the 95 percent confidence level. Confidence also can refer to the level of trust that BMPs previously implemented continue to function (e.g., the proportion of BMPs still in place and meeting performance standards). For example, reporting that 75 percent of planned BMPs have been verified is a measure of confidence that the desired level of treatment has been applied.

While specific methods to evaluate data confidence are beyond the scope of this memo, it is essential to be able to express some degree of confidence in verification results—both during the planning phase and over time as the project is implemented. For example, an assessment of relative uncertainty of BMP performance during the planning phase can be used as direct follow-up to verification efforts to those practices for which greater quantification of performance level is needed. In addition, plans to implement new BMPs also can be developed with full consideration of the reliability of BMPs already in place.

## Adjusting for Depreciation

Information on BMP depreciation can be used to improve both project management and project evaluation.

### Project Planning and Management

#### Establishing baseline conditions

Baseline conditions of pollutant loading include not only pollutant source activity but also the influence of BMPs already in place at the start of the project. Adjustments based on knowledge of BMP depreciation can provide a more realistic estimate of baseline pollutant loads than assuming that existing land treatment has reduced NPS pollutant loads by some standard efficiency value.

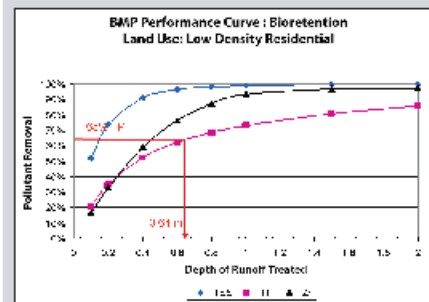


Figure 1. BMP Performance Curve for Bioretention BMP (Tetra Tech 2010).

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Establishing an accurate starting point will make load reduction targets—and, therefore, land treatment design—more accurate. Selecting appropriate BMPs, identifying critical source areas, and prioritizing land treatment sites will all benefit from an accurate assessment of baseline conditions. Knowledge of depreciation of existing BMPs can be factored into models used for project planning (e.g., by adjusting pollutant removal efficiencies), resulting in improved understanding of overall baseline NPS loads and their sources.

While not a depreciation issue per se, when a BMP is first installed—especially a vegetative BMP like a buffer or filter strip—it usually takes a certain amount of time before its pollutant reduction capacity is fully realized. For example, Dosskey et al. (2007) reported that the nutrient reduction performance of newly established vegetated filter strips increased over the first 3 years as dense stands of vegetation grew in and soil infiltration improved; thereafter, performance level was stable over a decade. When planning a watershed project, vegetative practices should be examined to determine the proper level of effectiveness to assume based on growth stage. Also, because of weather or management conditions, some practices (e.g., trees) might take longer to reach their full effectiveness or might never reach it. The Stroud Preserve, Pennsylvania, section 319 National Nonpoint Source Monitoring Program (NNPSMP) project (1992–2007) found that slow tree growth in a newly established riparian forest buffer delayed significant  $\text{NO}_3\text{-N}$  (nitrate) removal from ground water until about 10 years after the trees were planted (Newbold et al. 2008).

The performance of practices can change in multiple ways over time. For example, excessive deposition in a detention pond that is not properly maintained could reduce overall percent removal of sediment because of reduced capacity as illustrated in Figure 1. The relative and absolute removal efficiencies for various particle size fractions (and associated pollutants) also can change due to reduced hydraulic retention time. Fine particles generally require longer settling times than larger particles, so removal efficiency of fine particles (e.g., silt, clay) can be disproportionately reduced as a detention pond or similar BMP fills with sediment and retention time deteriorates. Expert assessment of the condition and likely current performance level of existing BMPs, particularly those for which a significant amount of pollutant removal is assumed, is essential to establishing an accurate baseline for project planning.

### Adaptive watershed management

Watershed planning and management is an iterative process; project goals might not all be fully met during the first project cycle and management efforts usually need to be adjusted in light of ongoing changes. In many cases, several cycles—including mid-course corrections—might be needed for a project to achieve its goals. Consequently, EPA recommends that watershed projects pursue a dynamic and adaptive approach so that implementation of a watershed plan can proceed and be modified as new information becomes available (USEPA 2008). Measures of BMP implementation commonly used as part of progress assessment should be augmented with indicators of BMP depreciation. Combining this information with other relevant project data can provide reliable progress assessments that will indicate gaps and weaknesses that need to be addressed to achieve project goals.

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### BMP design and delivery system

Patterns in BMP depreciation might yield information on systematic failures in BMP design or management that can be addressed through changes to standards and specifications, contract terms, or permit requirements. This information could be particularly helpful during the project planning phase when both the BMPs and their implementation mechanisms are being considered. For example, a cost-sharing schedule that has traditionally provided all or most funding upon initial installation of a BMP could be adjusted to distribute a portion of the funds over time if operation and maintenance are determined to be a significant issue based on pre-project information. Some BMP components, on the other hand, might need to be dropped or changed to make them more appealing to or easier to manage by landowners. Within the context of a permit program, for example, corrective actions reports might indicate specific changes that should be made to BMPs to ensure their proper performance.

## Project Evaluation

### Monitoring

Although short-term (3–5 year) NPS watershed projects will not usually have a sufficiently long data record to evaluate incremental project effects, data on BMP depreciation might still improve interpretation of collected water quality data. Even in the short term, water quality monitoring data might reflect cases in which BMPs have suffered catastrophic failures (e.g., an animal waste lagoon breach), been abandoned, or been maintained poorly. Meals (2001), for example, was able to interpret unexpected spikes in stream P and suspended sediment concentrations by walking the watershed and discovering that a landowner had over-applied manure and plowed soil directly into the stream.

Longer-term efforts (e.g., total maximum daily loads<sup>1</sup>) might engage in sustained monitoring beyond individual watershed project lifetime(s). The extended monitoring period will generally allow detection of more subtle water quality impacts for which interpretation could be enhanced with information on BMP depreciation. While not designed as BMP depreciation studies, the following two examples illustrate how changes in BMP performance can be related to water quality.

In a New York dairy watershed treated with multiple BMPs, Lewis and Makarewicz (2009) reported that the suspension of a ban on winter manure application 3 years into the monitoring study led to dramatic increases in stream nitrogen and phosphorus concentrations. First and foremost, knowledge of that suspension provided a reasonable explanation for the observed increase in nutrient levels. Secondly, the study was able to use data from the documented depreciation of land treatment to determine that the winter spreading ban had yielded 60–75 percent reductions in average stream nutrient concentrations.

The Walnut Creek, Iowa, Section 319 NNPSMP project promoted conversion of row crop land to native prairie to reduce stream  $\text{NO}_3\text{-N}$  levels and used simple linear regression to show association of two monitored variables: tracked conversion of row crop land to restored prairie vegetation and stream  $\text{NO}_3\text{-N}$  concentrations (Schilling and Spooner 2006). Because some of the restored prairie was plowed back into cropland during the project period—and because that change was

<sup>1</sup> "Total maximum daily loads" as defined in §303(d) of the Clean Water Act.

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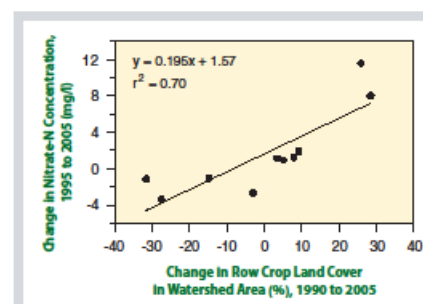


Figure 2. Relating Changes in Stream Nitrate Concentrations to Changes in Row Crop Land Cover in Walnut Creek, Iowa (Schilling and Spooner 2006).

documented—the project was able to show not only that converting crop land to prairie reduced stream  $\text{NO}_3\text{-N}$  concentrations but also that increasing row crop land led to increased  $\text{NO}_3\text{-N}$  levels (Figure 2).

### Modeling

When watershed management projects are guided or supported by modeling, knowledge of BMP depreciation should be part of model inputs and parameterization.

The magnitude of implementation (e.g., acres of treatment) and the spatial distribution of both annual and structural BMPs should be part of model input and should not be static parameters. Where BMPs are represented by

pollutant reduction efficiencies, those percentages can be adjusted based on verification of land treatment performance levels in the watershed. Incorporating BMP depreciation factors into models might require setting up a tiered approach for BMP efficiencies (e.g., different efficiency values for BMPs determined to be in fair, good, or excellent condition) rather than the currently common practice of setting a single efficiency value for a practice assumed to exist. This approach could be particularly important for management practices such as agricultural nutrient management or street sweeping, in which degree of treatment is highly variable. For structural practices, a depreciation schedule could be incorporated into the project, similar to depreciating business assets. In the planning phase of a watershed project, multiple scenarios could be modeled to reflect the potential range of performance levels for BMPs already in place.

## Recommendations

The importance of having accurate information on BMP depreciation varies across projects and during the timeline of a single project. During the project planning phase, when plans for the achievement of pollutant reduction targets rely heavily on existing BMPs, it is essential to obtain good information on the level of performance of the BMPs to ensure that plan development is properly informed. If existing BMPs are a trivial part of the overall watershed plan, knowledge of BMP depreciation might not be critical during planning. As projects move forward, however, the types of BMPs implemented, their relative costs and contributions to achievement of project pollutant reduction goals, and the likelihood that BMP depreciation will occur during the period of interest will largely determine the type and extent of BMP verification required over time. The following recommendations should be considered within this context:

- For improved characterization of overall baseline NPS loads, better identification of critical source areas, and more effective prioritization of new land treatment during project planning, collect accurate and complete information about:
  - Land use,

- Land management, and
- The implementation and operation of existing BMPs. This information should include:
  - Original BMP installation dates,
  - Design specifications of individual BMPs,
  - Data on BMP performance levels if available, and
  - The spatial distribution of BMPs across the watershed.
- Track the factors that influence BMP depreciation in the watershed, including:
  - Variations in weather that influence BMP performance levels,
  - Changes in land use, land ownership, and land management,
  - Inspection and enforcement activities on permitted practices, and
  - Operation, maintenance, and management of implemented practices.
- Develop and use observable indicators of BMP status/performance that:
  - Are tailored to the set of BMPs implemented in the watershed and practical within the scope of the watershed project's resources,
  - Can be quantified or scaled to document the extent and magnitude of treatment depreciation, and
  - Are able to be paired with water quality monitoring data.
- After the implementation phase of the NPS project, conduct verification activities to document the continued existence and function of implemented practices to assess the magnitude of depreciation and provide a basis for corrective action. The verification program should:
  - Identify and locate all BMPs of interest, including cost-shared, non-cost-shared, required, and voluntary practices;
  - Capture information on structural, annual, and management BMPs;
  - Obtain data on BMP operation and maintenance activities; and
  - Include assessment of data accuracy and confidence.
- To adjust for depreciation of land treatment, apply verification data to watershed project management and evaluation by:
  - Applying results directly to permit compliance programs,
  - Relating documented changes in land treatment performance levels to observed water quality,
  - Incorporating measures of depreciated BMP effectiveness into modeling efforts, and
  - Using knowledge of treatment depreciation to correct problems and target additional practices as necessary to meet project goals in an adaptive watershed management approach.

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