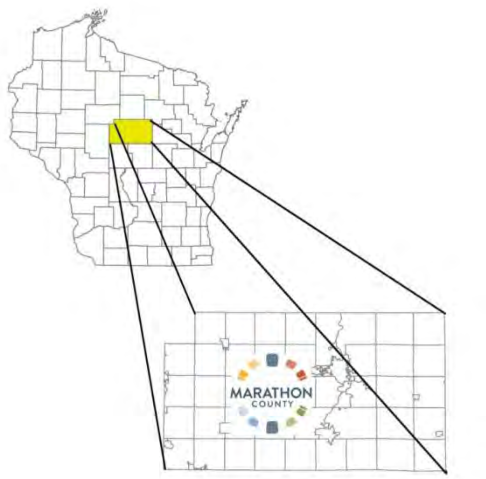
MARATHON
COUNTY

FENWOOD CREEK
WATERSHED MANAGEMENT PLAN

Hydrologic Unit Code (HUC) 070700021602



In Support of the

BIG EAU PLEINE RIVER
WATERSHED AND RESERVOIR PROJECT

ACKNOWLEDGEMENTS

The development of Fenwood Creek Watershed Plan involved a diverse group of individuals with a wide range of expertise. The Fenwood Creek (as well as all the western watersheds of Marathon County) was identified as a priority for programming in the Marathon County Land and Water Resource Management Plan in 2010 to address water quality concerns resulting from the impacts of agricultural runoff. At that time, the Citizen Advisory Group consisting of a diverse group of stakeholders provided key recommendations to address the runoff issues. Their input, as well as the strategic plan developed by the Big Eau Pleine Task Force in 2011 will continue to play an integral role in defining program priorities for Marathon County that respond to water quality issues. Thank you to everyone who helped with this process.

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INTRODUCTION TO THE FENWOOD CREEK WATERSHED

The Fenwood Creek watershed drains approximately 39 square miles (24,958 acres) of land into the Big Eau Pleine (BEP) reservoir. The Fenwood Creek sub-watershed is identified by the following 12 digit hydrologic unit code: (HUC) 070700021602. The Fenwood Creek represents one of three (3) major surface water tributaries that empty into the BEP reservoir which immediately flows into Lake DuBay, both flowages of the Upper Wisconsin River Central Sub Basin. The other two tributaries include the Big Eau Pleine River and Freeman Creek. Figure 1 outlines the location of the Fenwood Creek watershed (yellow) in context to the Big Eau Pleine River watershed (blue).

The Big Eau Pleine (BEP) River Watershed is located mostly in western Marathon County with smaller areas located in Clark and Taylor counties.

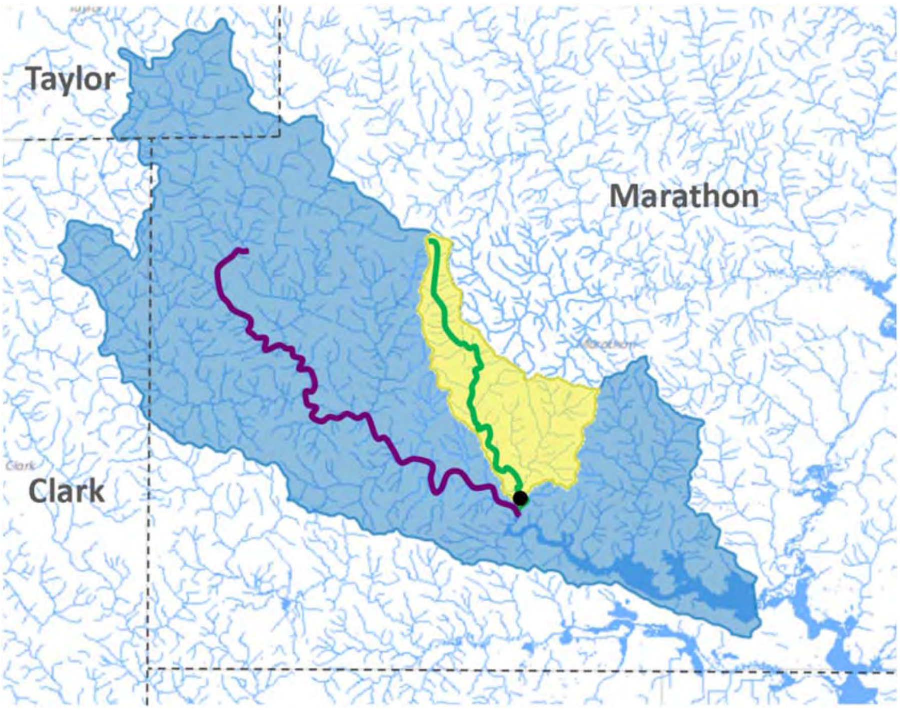


Figure 1 Big Eau Pleine River (HUC 8) and Fenwood Creek (HUC 12) Watersheds

Low dissolved oxygen levels during the spring ice melt period as well as high algae concentrations (during late summer months) have been associated with the reservoir since its construction in 1937. The reservoir acts as the major source of seasonal water that is used to regulate the flow of the Wisconsin River during low flow seasons. Poor water quality and fish kills significantly impact the economic and recreational opportunities associated with the reservoir such as boating, swimming, fishing and businesses that support these activities.

As runoff from agricultural lands increases, sediment and nutrient (phosphorus and nitrogen) loads increase. Although some of the sediment carried from cropland is deposited in the vegetated riparian areas near streams, most of the sediment and dissolved nutrients are transported to the Fenwood Creek and reservoir creating water quality degradation. The

Environmental Protection Agency (EPA) has designated the Big Eau Pleine River watershed as a 303D impaired water body due to the impacts from excessive phosphorus.

The Fenwood Creek is partially located in a farmland preservation area in Marathon County referred to as an “Agricultural Enterprise Area” (AEA). The AEA area is recognized as an important economic “cluster” based upon the competitive advantages of the dairy industry to create jobs and support related business activity. The significance of the AEA designation is that Marathon County will actively support the growth and prosperity of the dairy industry in this area. However, the challenge is to grow the industry while minimizing environmental impacts caused by excessive soil sedimentation and nutrient loading.

The following plan will provide an overview of the physical characteristics of the Fenwood Creek watershed including land use and land management. The plan will also summarize the several environmental studies and programs that increased the understanding of the causes of water quality degradation, past conservation initiatives and investments aimed at reducing agricultural runoff, and program outcomes. The intent of the background information is to provide a historical perspective of water quality and quantity issues for the watershed which will serve as a basis for developing a long range plan for the river system. Success is achieved when the long term use of soil and water resources are balanced with the safety, health and prosperity of the community.

At the time of the Fenwood Creek watershed plan submission, the Total Maximum Daily Load (TMDL) plan for the Wisconsin River basin is not complete. Marathon County acknowledges that the goals and allocation limits developed to address the current resource concerns in both streams and flowages are forthcoming. Marathon County also acknowledges that once the TMDL plan is complete, this plan may need to be modified to be consistent with the TMDL plan.

Appendix A will serve the reader as a glossary and listing of acronyms common the watershed planning in Wisconsin.

A CALL TO ACTION: DEFINING A COMMUNITY PARTNERSHIP

As the ice gave way and spring runoff events began in the Big Eau Pleine Reservoir in the spring of 2009, residents, sportsman and local officials saw the first evidence of a significant fish die-off. In January, the dissolved oxygen (DO) levels throughout the reservoir had dropped to less than 1 part per million (ppm). Without areas of safe harbor for the fish within the reservoir or adequate aeration capacity to provide a limited refuge for fish, the fishery collapsed. Unfortunately, fish kills are not new to the reservoir. Low dissolved oxygen levels during the mid to late winter (during ice cover periods) have been a reality with the reservoir since its construction in 1937.

In response to the fish kill, Marathon County convened a meeting between Wisconsin Department of Natural Resources (DNR), Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), dairy farmers, Clark County, Taylor County, Big Eau Pleine

Citizens Organization (BEPCO) and Wisconsin Valley Improvement Company (WVIC) to develop a strategic plan to assess the vulnerability of the fishery, adequacy of the aeration system, and current water quality conditions. The goal of the strategic plan was to improve the health of the river system and stop fish kills while balancing the needs of community and economic interests. See Appendix B: Strategic Plan for the Big Eau Pleine Watershed and Reservoir.

The key finding of the task force was that the fish kill of 2009 is symptomatic of a serious water quality problem caused by excessive soil sediments, nutrients and organic matter that flow into the Big Eau Pleine Reservoir primarily from cropping and manure management activities. Water quality conditions are made worse for the fishery by low water inflows during drought periods. Until poor water quality is abated in the Big Eau Pleine Reservoir watershed, the potential for fish kills will remain high.

BIG EAU PLEINE TASK FORCE RECOMMENDATIONS: FENWOOD CREEK PILOT PROJECT

The strategic plan was designed to build upon the existing capacities and resources of agencies to effectively and efficiently leverage financial and technical assets. The task force was established so that all watershed stakeholders were represented and local policy is based upon recommendations consistent with community and economic development goals. Farm producers were a critical part of the task force and served to ensure that members understood farming practicalities, as well as the effectiveness of past conservation initiatives.

The recommendations forwarded by the Big Eau Pleine River Task Force represent policies and activities that Marathon County should develop, coordinate and implement to lead a local effort to improve community and economic development opportunities, as well as minimize public health concerns associated with the watershed's water quality.

The Fenwood Creek was selected as a" pilot project" by the Big Eau Pleine task force. The concept of a pilot project is to establish the education, planning, and technical assistance models with agricultural producers during the TMDL development process so that when the allocation plan is complete, the programming, education and incentive models are in place and proven for quick application to a larger Big Eau Pleine River watershed. Criteria for the pilot project identified the Fenwood Creek watershed as:

1. Representing an example of a traditional dairy agricultural watershed where the average herd size is 70 cows and cropping practices are intensifying relative to production models and resource challenges (increasing agricultural runoff).
2. Having an extensive and positive history of farmer involvement with conservation programs. During the 1990's, nearly 30% of landowners implemented BMP's through the Lower Big Eau Pleine River priority watershed project.
3. Having a long history of water quality monitoring to allow Marathon County to evaluate the trends of past farming activities against water quality changes (phosphorus and sediment loading).

4. Having farmers and town leaders who are actively interested in the TMDL and can help share the message with peers.

Marathon County with this plan is seeking funding and program support for the Fenwood Creek Pilot Project, but drawing upon all previous watershed data, studies, assessments and monitoring to describe the resource concerns, the cause of water quality degradation and best management practice application strategies.

CHAPTER 1: CHARACTERIZING THE FENWOOD CREEK WATERSHED

The Fenwood Creek watershed drains 24,958 acres of which 65% (16,222 acres) is utilized as agriculture cropland and 25% as woodland. Of the 16,222 acres of cropland, Marathon County estimates approximately 14,600 acres are tillable. The balance (1,622 acres) is considered marginal, transitional land lying at the downslope edge of cropland and drainage corridors.

There are 64 livestock operations within the Fenwood Creek watershed representing beef, dairy heifer, and dairy cow enterprises. These livestock operations range in scale from 6 to 120 head per site with an estimated total of nearly 5,000 head of cattle. The watershed contains one Wisconsin Pollutant Discharge Elimination System (WPDES) permitted municipality (Village of Fenwood).

The Fenwood Creek watershed is one of several HUC 12 watersheds (070700021602) that comprise the Big Eau Pleine (BEP) River Watershed which drains approximately 238,000 acres of land. The land use in the BEP River watershed is as follows: cropland (60%) – 142,800 acres, pasture (15%) 35,700 acres, woodland (17%) – 40,460 acres; and miscellaneous (8%) – 19,040 acres. See figure 2.

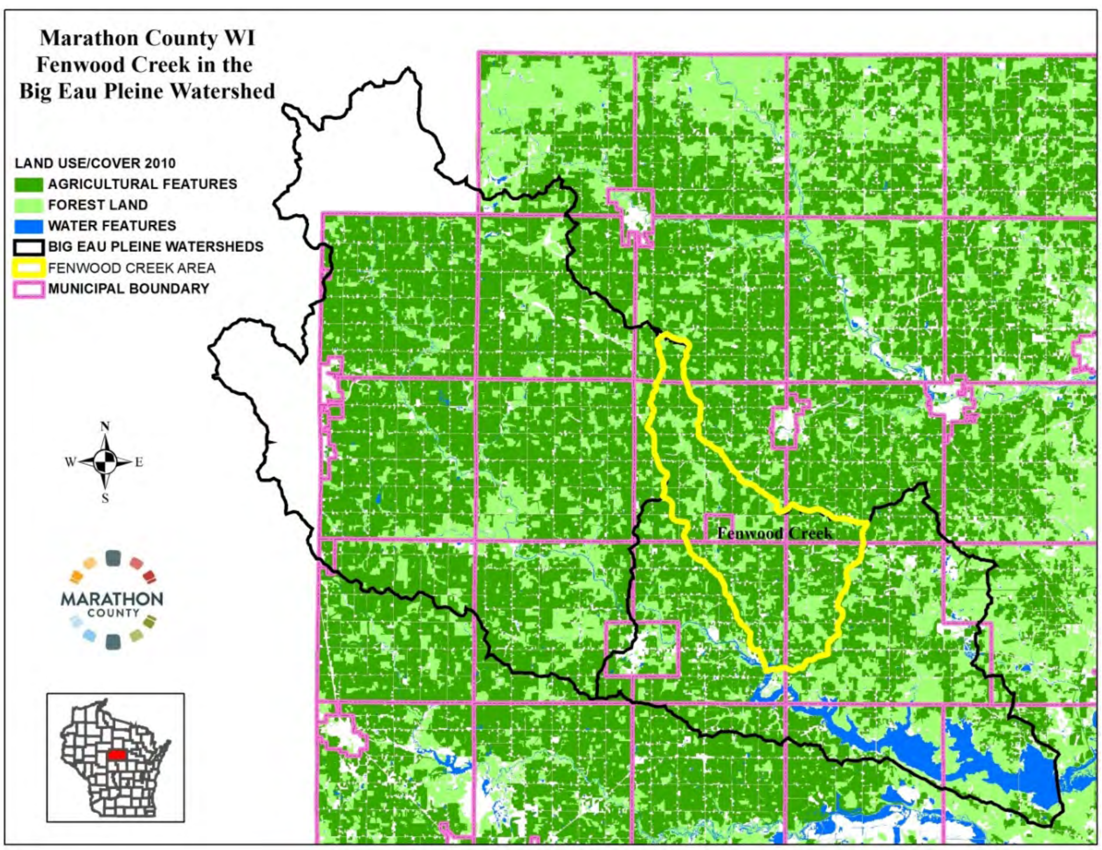


Figure 2 Land Use Map of Fenwood Creek Watershed

The Fenwood Creek watershed lies west of a terminal moraine. The gently rolling landscape is characterized by a well-developed surface drainage system that was developed through nearly four decades of governmental assistance (See Figure 3). Since there are very few undrained depressions, essentially every acre of cropland drains to a surface channel and eventually to the reservoir. The "flashiness" of the watershed's hydrology is the result of a prolonged effort to drain the croplands to accommodate row crop production. For example, in September 2015, a 3 inch rain in the Big Eau Pleine watershed caused the flow rate of the Big Pleine River to increase from approximately 30 cubic feet second (cfs) to nearly 10,000 cfs within 6 hours. Water quality assessments indicate that flashiness of hydrology (the rapid rate of runoff) is a major contributor to degradation of water quality, aquatic habitat, and the fishery of the river system.

The watershed is covered with relatively deep (5-10 feet) fine textured, loamy glacial till over granitic bedrock. The fine textured, highly plastic till has a low permeability, but conducts free water (storm events and groundwater) both vertically and horizontally throughout the soil profile in fractures comparable to fractures in crystalline bedrock. Shallow dug wells are common in this landscape and are responsive to rain and snowmelt events because of the highly developed structural fracturing within the glacial till. Along river and intermittent surface water flows, the glacial till has been eroded to expose Precambrian rock.

Figure 3 Typical surface drainage feature in BEP Watershed

The soils of the watershed provide the basis for a productive agricultural industry; however, the soils of the Fenwood Creek watershed are characterized by low infiltration and permeability rates (Hydrologic Group B and C). The non-erosive removal of surface water through a system of terraces, grassed diversions, waterways, and drainage ditches to create an aerated root zone is the basis of most historical conservation and agricultural initiatives. Without functional surface drainage systems, crop failure was expected 1 out of every 10 years. Soil textures create three agricultural management practices that pose direct negative water quality implications in this watershed:

1. *Seasonal Soil Saturation and Waste Applications.* Manure applications that occur in the fall and spring coincide with saturated surface soil conditions and groundwater recharge.

2. *Waste Application onto Frozen Soils*. Many manure spreading operations (emptying of waste storage facilities) occur after soils freeze (fall) or before they thaw (spring) in order to support the weight of loaded manure equipment.

3. *Fall Tillage*. Fall plowing is beneficial in allowing the producer to distribute the labor needs for nutrient management, tillage and seedbed preparation over two seasons. Nearly 80% of cropland is fall tilled with most utilizing the mowboard plow.

The wetland characteristics of the Fenwood Creek watershed have been drastically altered by the development of agriculture land and associated surface drainage activities. It is estimated that nearly 50% of the BEP watershed was wetland prior to agricultural development.

The Fenwood Creek region has experienced a decline of dairy farms over the past 43 years with the consolidation of the smaller herds into concentrated feedlot animal operations (CAFO's). Since the 1970's, the number of dairy farms has declined to nearly half the previous numbers, yet the number of cattle has remained nearly constant. Although the Fenwood Creek watershed does not house a CAFO site, the watershed has 64 small scale livestock operations as of 2014.

EARLY CONSERVATION INITIATIVES

The following section outlines the many conservation activities that have been initiated and completed in response to the agricultural runoff concerns in the Fenwood Creek and the larger BEP River watershed (See Appendix C). Our understanding of the resource concerns associated with the agricultural industry rest upon the work of previous local and federal conservation staff and researchers. There is a great respect for the resource professionals and farmers who collaborated to install best management practices to improve water quality.

During the 1940-1950's the focus of conservation efforts was to develop and improve the productive potential of agricultural lands within Marathon County. Government assistance provided public financial and technical assistance to farmers through liming, fertility, erosion control, and design of water disposal systems (drainage). The following list identifies key dates, policies, and civic activities that defined early conservation efforts:

- 1941 – Marathon County Soil and Water Conservation District established.
- 1958 – Big Eau Pleine Citizens Organization (BEPCO) established.
- 1965 – Inventory of BEP River Watershed project completed. Sedimentation and pollution from agriculture identified and assessed for the first time.
- 1972 – Clean Water Act establishes federal water quality policy.
- 1982 – Wisconsin Chapter 92 becomes law and farmer led conservation districts are eliminated as the conservation program model in Wisconsin. Local conservation now administered by county and state government.

RESOURCE STUDIES AND ASSESSMENTS

1. 1958 – The Wisconsin Valley Improvement Company (WVIC) begins measuring and tracking dissolved oxygen levels in the Big Eau Pleine Reservoir.
2. 1965 – First Big Eau Pleine River watershed inventory of resource concerns.

3. 1972 – National Eutrophication Study. Annual Phosphorus (P) load to reservoir estimated at approximately 92,500 lbs.
4. 1974 – UW-Stevens Point Study of Reservoir. Predicts that 50% reduction in P loads would be needed to reduce algae concentrations in reservoir by 57%. Studies by EPA and UW-Stevens Point indicate a Phosphorus (P) load of 100,000 lbs. annually. Study identifies that 95% of pollutant load comes from agriculture.
5. 1984-1994 – DNR Upper Big Eau Pleine Priority Watershed Project. Appraisal determined that phosphorus was the primary pollutant of concern and flashy hydrology is a huge concern to the condition and use of the water system.
6. 1993-2003 – DNR Lower Big Eau Pleine Watershed Project. Total phosphorus load delivery to the reservoir is 163,636 lbs. annually with 78,860 lbs. point-sourced (42,161 lbs. controllable) and 84,776 lbs. non-point sourced (29,196 lbs. controllable).
7. *2009 – Big Eau Pleine Flowage Winter Runoff Study*. The dominant land use of dairy farming in the BEP River watershed contributes significantly to increased delivery of bacteria, BOD and P to tributaries.
8. Marathon County Soil Erosion Transect Survey (1999-2016). From 1999-2006, the erosion rates within the Fenwood Creek watershed had averaged approximately 2.4 tons per acre per year. Ninety five (95) percent of the sediment delivery to the streams and reservoir is sourced from this upland soil erosion. Since 2010, the soil erosion rates have steadily increased to a rate of 3.2 tons/acre/year. Note that the transect data does not include ephemeral or snowmelt erosion contributions which are significant in the watershed. See Table 1.

Table 1. Annual Soil Erosion Rates

Year	County Average Soil Erosion Rate (tons/acre/year)	Fenwood Creek Average Soil Erosion Rate (tons/acre/year)
2000	2.0	1.9
2002	2.3	3.2
2004	2.3	2.8
2006	2.1	2.4
2008	1.7	2.1
2010	1.8	2.3
2012	2.3	2.6
2014	2.2	3.0
2016	2.2	3.2

Source: Marathon County Soil Erosion Transect Survey

9. Wisconsin River Basin Clean Waterways Projects. Monitoring for the Upper Wisconsin TMDL provided four years (2010-2013) of regular water data in Fenwood Creek to measure the current nutrient and sediment concentration and loading levels. The average median phosphorus concentration (May-October 2010-13) in the Fenwood Creek during the monitoring period was determined to be 129 µg/L (see Figure 4).

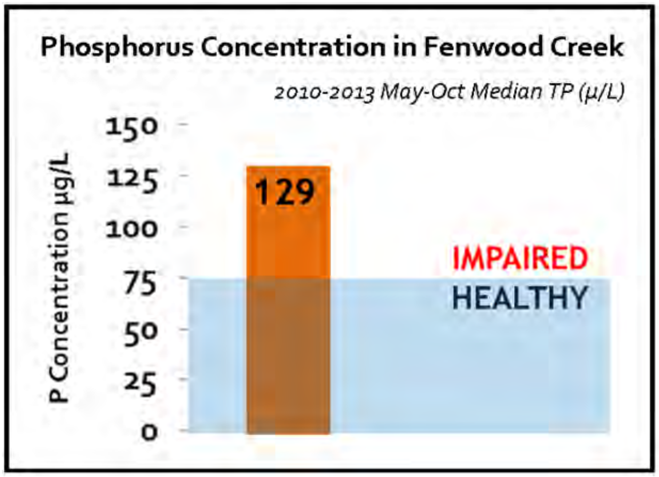


Figure 4 Phosphorus concentrations in Fenwood Creek

Figure 5 and Table 2 show the average amount of phosphorus (pounds) and suspended solids entering Fenwood Creek each year. The amount of phosphorus and sediment varies greatly from year-to-year depending on annual and seasonal variations in rainfall, snowmelt and other climate variables. The average annual phosphorus for this monitoring period was 11,228 pounds.

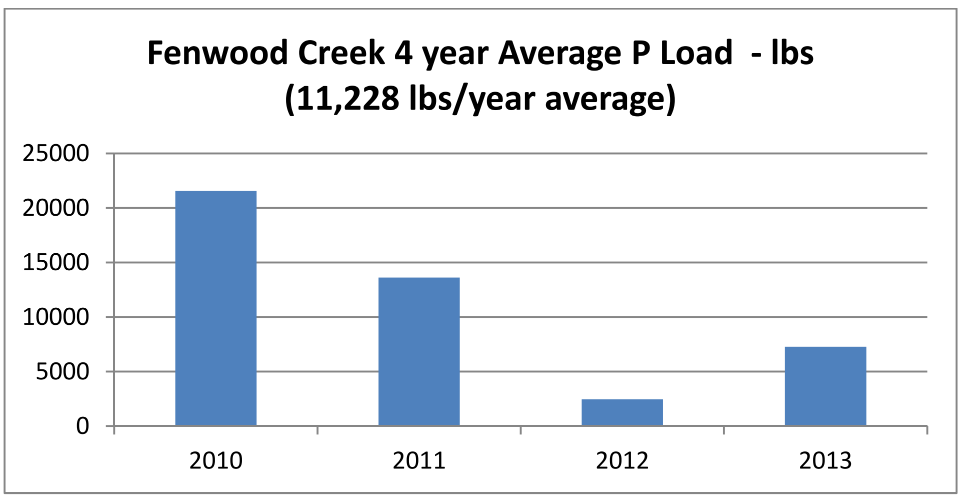


Figure 5 Fenwood Creek Total Annual Phosphorus Load (lbs.)

Table 2. Total Suspended Solids (TSS) Load (tons) at TMDL Monitoring Sites*

Year	BEP River	Freeman	Fenwood		BEP Outlet
2011	8161	294	436		2637
2012	1982	85	69		1670
2013	7810	287	168		3671

**Draft, USGS Load Calculations*

CONSERVATION PROGRAMMING

Conservation efforts aimed at addressing the sediment and nutrient impacts to water quality in the Fenwood Creek and BEP River watersheds began in the 1930's. In the first four decades, the work focused on developing drainage systems to increase productivity of heavy-textured soils via the installation of terraces and waterways to shorten slope lengths to reduce the energy (erosiveness) of runoff. The following is a short summary of past and current conservation programming in the Fenwood Creek area.

1. *Model Implementation Program* – MIP (United States Department of Agriculture, USDA and Environmental Protection Agency, EPA, 1977). WVIC began measuring dissolved oxygen levels in 1958 and observed oxygen depletion to one part per million or less almost every year with fish kills occurring during most of those years (1958 to 1977). The MIP Pilot Project was designed to show how voluntary landowner cooperation and targeting financial and technical resources can improve the resource problems of the watershed.
2. *Hamann Creek Watershed Project-1978.* (16,000 acre drainage area). The project's funds ($100,000) provided cost-share assistance to landowners for best management practices such as vegetated channels, terracing, soil treatment (liming), permanent vegetated areas, and pond dugouts. The intent of the project was to focus conservation efforts on a relatively small watershed with monitoring to determine if technical assistance and funds could provide measurable water quality benefits.
3. *Upper Big Eau Pleine Priority Watershed Project (UBEP) 1984-1994* with *Final Report by DNR (June 1997)*. The estimated total P load is 161,636 lbs. annually. The project plan projected that if conservation objectives met, overall P delivery would be reduced 16.2%. This would also reduce amount of algae by 16%.
4. *Lower Big Eau Pleine Priority Watershed Project (LBEP) 1993-2003.* LBEP is a continuation of the UBEP effort aimed at reducing polluted runoff from barnyards and feedlots; sediment from cropland; and runoff from winter spread manure.
5. *Marathon County Nutrient Management (NM) Program (March 1993).* Marathon County initiates a Nutrient Management Program in April 1991, as part of the Priority Watershed Project. Project provided technical and planning assistance to farmers on a voluntary basis and initially works with farmers receiving municipal and industrial wastes for cropland applications. The project provides free soil and manure sampling for participants. The NM program finds that landowners are over applying fertilizer by 65% based on soil tests and UW technical recommendations. Since NM is considered a new concept and management skill for landowners, most farmers are hesitant to participate.

   In 2014, Marathon County had nearly 154,000 acres of cropland under certified nutrient management (NM) plans which guide application decisions for livestock manure and commercial fertilizer. This represents nearly 54% of total cropland acres. In the Fenwood Creek approximately 5,614 acres of cropland are under certified NM plans out of the 16,222 acres of total cropland (only 34% participation).

REGULATORY PROGRAMS AND COMPLIANCE

Local Land Management Ordinances:

1. 1984 – Marathon County Board approves Animal Waste Storage Ordinance to regulate the construction and significant alteration of waste storage impoundments (earthen lagoons only). Regulatory compliance is guided by State and federal technical standards, but administered through local ordinances.

   The ordinance is modified in 1990's to extend regulatory reach to the construction or modification of waste storage structures (concrete and steel containment facilities).

2. 2006 – Livestock Facility Siting Ordinance. This ordinance authorizes the County to regulate Concentrated Animal Feedlot Operations (CAFO's) with specific livestock types with 500 or greater animal units. For existing livestock operations at 500 animal units or greater in October 2006, the ordinance will apply at a point they expand livestock numbers over 20% of 2006 cattle population. Regulatory guidelines are provided by State Statute 93 and Administrative Rule ATCP 51.

3. 2009 – Waste Storage Facility and Nutrient Management Ordinance. This revision for the first time provides clear authority to the County to regulate nutrient management planning when associated with waste storage facilities.

4. 2015 – Modifications to animal waste regulatory policies initiated by Marathon County. Initiatives include citation authority to enforce code violations, increased attention to "operation and maintenance" plans, spills reporting, and nutrient management planning. Specific focus on addressing agricultural runoff problems. Citation authority is authorized to increase the efficiency of regulatory compliance efforts.

CHAPTER 2: SPECIFIC RESOURCE CONCERNS

The Fenwood Creek watershed is representative of the larger BEP River watershed relative to the resource concerns. As stated in Chapter 1, the Fenwood Creek is impacted primarily by nonpoint agricultural runoff. All studies, research, and monitoring efforts point to two primary causes of water quality degradation: soil sedimentation and nutrient enrichment.

1. Soil sedimentation. Soil is primarily sourced from upland cropland erosion with most of the delivery to riparian buffers and surface water occurring between March and July. It is important to note that the Revised Universal Soil Loss Equation (RUSLE) does not estimate the erosion associated with snowmelt or ephemeral erosion dynamics (See Figures 6 and 7). More specific causes of the erosion include:

   a. Nearly 80% of cropland is fall tilled with aggressive chisel or mowboard equipment.

   b. Flashiness of hydrology is due to highly developed, surface drainage systems.

   c. Intensification of cropping (corn silage and soybean acres and less grass/legume in rotations) and increased tonnage yields.

   d. Hydrologic group C soils dominate the landscape (low infiltration).

Figure 6 Ephemeral erosion in Fenwood Creek Watershed

Figure 7. Ephemeral erosion in Fenwood Creek Watershed

2. Nutrient enrichment. The source of nutrient runoff is primarily livestock manure and commercial fertilizers with most (80%) contaminants being delivered to the edge of fields between February and June (See Figure 8). More specific causes of the discharge include:
    a. Manure applications coinciding with saturated soil conditions,
    b. Manure applications to frozen and snow-covered cropland in late fall and early spring (See Figure 10),
    c. Over-application of liquid manure to cropland,
    d. Un-treated barnyard and feedlot runoff,
    e. Un-treated feed storage leachate runoff (See Figure 9).

Specific values for delivery of phosphorus and soil sediment can be found in TMDL monitoring results (see Figure 5 and Table 2), priority watershed reports (1983-2002), soil transect surveys (1999-2016), and UW-Stevens Point research and assessments (1970's). See Chapter 1. Based upon the median phosphorus concentration of the Fenwood Creek, the predicted average annual phosphorus load delivered to the reservoir is 11,288 pounds.

The Village of Fenwood is the only WPDES permitted point source in watershed. The village currently has an estimated annual phosphorus load about 44 lbs. over a 5 year average (DNR, 2015). The average phosphorus concentrations for effluent (2010-2015) were 0.95 mg/l with over 28 million gallons of effluent released. In 2017, a new WPDES permit will be issued based upon the 0.075 mg/l water quality based effluent limits. The village has a storage lagoon and therefore, a seasonal discharger. The village is not allowed to discharge January-March and June-September.

Figure 8 Manure applications on saturated soils.

Figure 9 Feed storage leachate runoff.

Figure 10 Manure applications on frozen and snow covered soils.

CHAPTER 3: GOALS AND IMPLEMENTATION STRATEGIES

Marathon County is initiating a pilot project in the Fenwood Creek watershed which is a representative HUC 12 dairy-based watershed within the Big Eau Pleine River watershed. The proposed project has secured funds from the Wisconsin Targeted Resource Management (TRM) grant program. Implementation will commence in 2016 and end in 2018. Although the TRM project is only three (3) years in length, Marathon County will document a 10 year project implementation schedule for the purpose of the 9 Key Element Plan. Initial and Intermediate outcomes for the Fenwood Creek project will focus upon TRM funded activities. Long-term outcomes will be administered through the proposed Wisconsin River Total Maximum Daily Load (TMDL) plan. The intent of the pilot project is to support:

1. Education and Outreach: Develop a communication, education, and community capacity model that includes primary stakeholders in local water quality activities in the community.

2. Technical assistance to landowners/farmers:

    a. Provide landowners and farmers with information about their farms relative to resource concerns, as well as the status of their current conservation activities relative to state agricultural performance standards (WI Administrative Code 151) and local ordinances.

    b. Provide conservation plan, nutrient management plan, and best management practice (BMP) design support to landowners to maintain and improve conservation performance (reduced sediment and nutrient loading) on their respective farms.

The Fenwood Creek pilot project will serve to develop a new conservation delivery model based upon increased community capacity that collaboratively minimizes resource concerns and improves watershed soil health, while targeting staff and financial assets to areas of disproportionate contaminant delivery. The new conservation delivery model with specific education and technical strategies will be proven and transferable to the larger western Marathon County watersheds when the TMDL is completed in 2017.

IN STREAM PHOSPHORUS CONCENTRATION
BASELINE AND REDUCTION GOALS

In 2015, WI Department of Natural Resources staff determined that the current estimated phosphorus concentration (expressed as the flow-weighted mean) for Fenwood Creek is 187 micrograms per liter. Furthermore, the DNR staff estimated that a 45% reduction in the flow-weighted mean concentration is needed to reach median concentration of 75 micrograms per liter, the water quality goal for the Fenwood Creek. A 45% annual reduction of in-stream phosphorus represents nearly 5,080 pounds (based on the 11,200 pound 4 year average) determined by DNR 2010-2013 stream monitoring.

Strategically, Marathon County will pursue the interim in-stream concentration reduction goal of 45% by focusing on education; ordinance and program administration activities; best management practices implementation; and cost-share assistance to agricultural producers. Specifically, county efforts will focus on reducing phosphorus and sediment delivery from farmsteads and cropland by 45%. As noted previously, the 45% reduction goal may be modified when the allocation limits developed for the pending TMDL plan are released in 2017.

The SNAP+ model predicts phosphorus delivered from cropland to stream; however, it cannot be directly compared with the measured in-stream P concentration and loading at mouth of the watershed. Marathon County will utilize the SNAP+ mode (cropland) and BARNY model (animal feedlot delivery) to establish the following:

- “Baseline” values for cropland and farmstead phosphorus contributions that reflect current agricultural practices within the watershed.
- Reductions of phosphorus and soil sediment loading after the implementation of structural best management practices funded with the Targeted Resource Management grant ($805,000). This is phase 1 of the Fenwood Creek project and will be the focus of county field activities in 2016-2019.
- Reductions of phosphorus and soil sediment loading after the implementation of non-structural best management practices funded by segregated funding sources. This is phase 2 of the Fenwood Creek project and will be the focus of county field activities in 2019-2025.

BASELINE CROPLAND PHOSPHORUS CONTRIBUTIONS: BASELINE DELIVERY AND REDUCTION GOALS

The SNAP+ model was used to model Fenwood Creek watershed average cropland phosphorus loss (pounds/acre) and soil erosion rates (tons/acre/year) by incorporating the following variables provided in the WIDNR Wisconsin River Basin SWAT model and Revised Universal Soil Loss Equation (RUSLE):

1. Cropping rotations: the modeling used the following spatial distribution of rotational options based upon Conservation, Planning and Zoning Department staff performing conservation compliance evaluations of agricultural performance standards for various programs:
   a. Dairy forage rotation (60% of cropland acres): corn silage (2 years), soybeans, alfalfa directly seeded, and alfalfa (2 years). Estimates equally reflected both solid and liquid manure application scenarios.
   b. Cash commodity rotation (40% of cropland acres): corn grain and soybeans.
2. Predominant soil types for cropland (See Appendix E)
3. Average soil slope steepness and slope lengths for cropland
4. Current conservation management practices
5. Current tillage management practices

See Table 3 for estimated “baseline” delivery values for phosphorus (expressed as Phosphorus Index – PI value) and soil erosion rates (expressed as tons per acre per year). Baseline calculations found in Appendix F.

Table 3: Baseline Phosphorus Index and Soil Erosion Rates Values for Fenwood Creek

Rotation	Phosphorus Index	Soil Erosion Rate
Dairy (with liquid manure)	6.0	3.7
Dairy (with solid manure)	5.3	2.3
Average Dairy (60%)	5.6	3.0
Commodity Crop (40%)	3.5	3.2
Weighted Watershed Average	**4.8**	**3.1***

*Footnote: The 2016 Marathon County Soil Erosion Transect Survey estimates that the soil erosion rate for the Fenwood Creek watershed is 3.2 tons per acre per year.

For the Fenwood Creek Watershed 9 Key Element Plan, Marathon County will use a phosphorus index of 4.8 and a soil erosion rate of 3.1 to calculated weighted watershed contributions of phosphorus and soil sediment from cropland fields.

A 45% reduction of the baseline weighted watershed phosphorus is the long term goal of the Fenwood Creek project. Therefore, the plan proposes to lower the watershed's average PI from 4.8 (lbs. /acre) to 2.6 over time. Similarly, the average soil erosion rate will be reduced from the current average of 3.1 (tons/acre/year) to 1.7. Table 4 provides a summary of the proposed phosphorus and soil erosion reduction goals.

Table 4. Baseline Phosphorus and Soil Sediment Delivery Estimates for Cropland in Fenwood Creek

Pollutant	Cropland Acres	Current Weighted Watershed Average	Proposed Weighted Watershed Average	Current Total Estimated Loading	Proposed 45% Load reduction
Phosphorus	14,600	4.8 Phosphorus Index	2.6 Phosphorus Index	70,080 pounds/acre/year	31,536 pounds/acre/year
Soil Sediment	14,600	3.1 tons/acre/year	1.7 tons/acre/year	45,260 tons/acre/year	20,367 tons/acre/year

Calculation of potential phosphorus delivery and reductions and soil erosion rates for individual cropland fields will be based upon SNAP+ model. For delivery estimates of phosphorus associated with animal feedlots, the BARNY model will be utilized. SNAP+ modeling will include evaluation of sites before and after BMP implementation to determine the environmental benefits of BMP implementation and investments. The monitoring of phosphorus delivery at the individual cropland field level is impractical, and therefore, must be completed by DNR at the watershed level.

For cropland without existing SNAP+ or conservation planning information available to establish a beginning baseline soil erosion rate and phosphorus delivery value, Marathon County will utilize an average dairy rotation with standardized slope values and conservation practices. These standardized values are consistent with the values utilized by DNR staff for Total Maximum Daily Loading (TMDL) modeling.

When calculating estimated load reductions, the plan will take into account the reality that not all implemented practices will be maintained or function with the same pollutant reduction efficiency over time. Some practices provide diminishing returns/pollutant reductions over time. Therefore, this plan will follow EPA technical memorandum on BMP depreciation to evaluate modeled pollutant reductions and plan implementation. See Appendix D.

Farm assessment information will be gathered by CPZ staff conducting on-farm and cropland field assessments that evaluate the condition and performance of the best management practices. Assessments included verification of rotations, manure applications, waste storage facility condition, feedlot runoff controls, residue management, grassed waterways, roof runoff control systems, gullies, tillage, and conservation practices. It will not include ephemeral or event driven runoff events. Assessment data will be integrated into SNAP+ modeling to demonstrate current sediment and nutrient delivery loading to provide an accurate estimate of reductions.

Phase 1: Structural Practices - Targeted Resource Management Funding

In 2016, Marathon County received an $805,000 grant from the WI Department of Natural Resources through the Targeted Resource Management (TRM) program. The funds will primarily provide cost-share to landowners and agricultural producers for structural practices. The TRM grant phase of the Fenwood Creek project will extend from 2016 -2018 and focus on structural best management practices located in the farmstead, cropland, and edge of field.

For waste storage facilities, the phosphorus reduction estimates were determined with the SNAP+ model comparing the manure applications as a daily haul versus a spring and fall distribution.

For barnyard phosphorus estimates, the BARNY model was utilized to compare before and after practice implementation scenarios along with analysis of previously installed practices during the LBEP priority watershed project. The Fenwood Creek watershed has 42 active barnyard sites of which 26 are considered commercial in nature. The average weighted discharge from the barnyards is 42 pounds of phosphorus annually (or 1,516 total pounds/total). Table 5 provides a listing of primary best management practice categories and estimated load reductions to be implemented in phase 1 (TRM funded) of the project. Note that within the primary categories of practices listed in table 5, there are subsets of specific, site specific practices that landowners may choose to implement (See Table 6).

Table 5: Phase 1: Fenwood Creek Sub-watershed Load Reductions

Practice	No. of BMP's	Estimated P-load reduction Potential/unit	Estimated P-reduction Total (lbs.)	Cost/Unit	Total Cost
Nutrient Management[1]	3,244 acre	0.5 lb./ac.	1,622	$28/acre	$91,000
Cropland Management –factors[2]	850 acre	0.25 lb./ac.	125	$29.11/acre	$24,750
Hydrologic P-factors[3]	1000 acre	0.25 lb./ac.	250	$50/acre	$50,000
Waste Storage Facilities	3	200 lb.	600	$100,000	$300,000
Feed Leachate Treatment[4]	3	200 lb.	600	$50,000	$150,000
Farmstead barnyards[5]	6	40 lb.	240	$40,000	$200,000
			+/-3,437		**$816,000**

[1] Nutrient Management represents the positive impact that planning and improved management decisions have on load reductions. The estimated phosphorus load reduction represents the SNAP+ calculated benefits of improved practices. Source of load reduction estimates is from landowner nutrient management plans.

[2] "Cropland management factors" is a primary BMP category. Within this category are specific BMP's such as high residue management systems (tillage and cover crops), contour cropping, and rotational grazing. The estimated phosphorus load reduction is the average load reduction after BMP implementation per SNAP+ model.

[3] "Hydrologic P-factors" is primary BMP category. Within this category are specific BMP's such as clean water diversions, grassed waterways, and sediment basins. The estimated phosphorus load reduction is the average load reduction after BMP implementation per SNAP+ model.

[4] Feed leachate treatments represent structural practices implemented to collect and treat leachate runoff. Specific best management practices include leachate collection and storage in waste storage facilities, as well as vegetated treatment areas. The estimated phosphorus load reductions are estimates of reductions derived from Discovery Farms research.

[5] "Farmstead barnyards" is a primary BMP category. It represents collection treatment systems such as sediment basins, vegetated treatment areas, clean water runoff controls, and heavy use protection. The estimated phosphorus load reductions are estimates after structural best management practices implementation. Values derived from BARNY model applied to average sized feedlots within the watershed.

Table 6 provides a detailed summary of proposed "hard" practices to be implemented in phase 1 (TRM funded) of the project.

Table 6. Phase 1: Structural Practices: BMP implementation and cost estimate

BMP	No. of BMP's	Cost/BMP	Total Cost
Stream crossing	2	$1500	$3000
Trails and lanes	1000 ft.	$10/ft.	$10,000
Waste storage facility Engineering (12%)	3	$180,000 $21,600	$540,000 $64,800
Waste transfer	3	$12,000	$36,000
Waste storage closure	4	$10,000	$40,000
Milk house/feed storage VTA's	6	$5,000	$30,000
Barnyard	6	$30,000	$180,000
Roof runoff system	6	$1,500	$9,000
Diversion	2000 ft.	$2.25/FT	$4,500
Waterway	1000 ft.	$3.00/FT	$3,000
Sediment basin	2	$5,000	$10,000
WASCOB (edge of field)	3	$10,000	$30,000
Outlets	6	$500	$3,000
Subsurface drains	6	$500	$3,000
Heavy use protection	6	$10,000	$60,000
Waste water treatment	3	$3,000	$9,000
Wetland	1	$12,000	$12,000
Grazing	250 ac	$25/Ac	$6,250
Fencing	1000 ft.	$0.50/ft.	$500
Riparian buffer	3	$1,000	$3,000
			$1,057,050

Phase 2: Cropland Management Practices

After structural practices are initiated utilizing the TRM funds, Marathon County will begin education and technical assistance to address the cropland erosion and nutrient runoff contributions of phosphorus across the watershed.

The remainder of this chapter will outline and describe the estimates of the load reductions expected from proposed "soft" conservation measures (which are non-structural, management practices). In August 2016, Marathon County was notified of approval of a $50,000 grant from Greenheck Foundation that will provide financial support of both types of practices, as well as staff. The project will focus on the reduction of soil sediment and manure runoff contributions by reducing erosion rates through the implementation of conservation cropping practices.

Table 7 describes the plan's Phase 2 - 10 year implementation strategy, beginning in YR 2016 and ending in YR 2025. Estimated interim P and soil erosion reductions resulting from a combination of cropland practices implemented on 64% (9,344 acres) of the total cropland acres (14,600 acres) within the Fenwood Creek watershed are shown.

Table 7. Phase 2 Phosphorus and Soil Erosion Rate Delivery Comparisons

Practice	**Acres**	**% of Land Application**	**Phosphorus Index (PI) Difference**	**Soil Erosion Rate Difference**	**Total Phosphorus Reduction (lbs.)**	**Total Soil Sedimentation Reduced (Tons)**
CREP	146	1%	4.8	3.1	701	453
Rotational Grazing[1]	1314	15%	4.6	3	6044	3942
Cover Crops	730	5%	1.1	1.0	803	730
Contour	1460	10%	1.6	1	2336	1460
No Till	730	5%	3	2.5	2190	1825
Chisel/Reduced Till	1460	10%	0.4	0.6	584	876
Rotation (Increase hay 1 yr.)	1314	15%	0.7	0.4	920	526
Reduced Tillage: Spring Chisel	2190	15%	0.7	0.9	1533	1971
Totals	9,344[2]				**15,111** **(48%)**	**11,783** **(58%)**
Average reduction per acre					1.6 lb.	1.26 ton
Phase 1 reduction (table 5)					3,437 lb.	
Phase 1 + Phase 2 reductions Total % phosphorus reduction of plan reduction goal - 31,536 lbs.					**18,548 lb.** **(60%)**	

[1]Total acres for these are 8760 because only 60% of total acres are dairy
[2]Total acres of cropland implementing a best management practice(s). Note that some acres may benefit from more than one best management practice.

The plan's ten year "interim" reduction goals/practices will not achieve in-stream water quality standards of 75 micrograms/liter, but will be used as plan implementation milestones to determine, in combination with WQ monitoring by DNR or other entities, if substantial progress is being made towards meeting Wisconsin's numeric phosphorus criteria. Implementation of similar or additional cropland practices listed in Table 7 will likely be needed on remaining cropland (5,256 acres) in watershed to meet the plan's overall phosphorus and soil sediment reduction goals and to meet achieve in-stream water quality standards of 75 micrograms/liter phosphorus concentration. Marathon County, along with its partners, will monitor and evaluate the project relative to successfully achieving the proposed **interim** reduction goals in Table 7 both during and after this plan's ten year schedule. After plan evaluation is completed, Marathon County will work with DNR and its other partners to adaptively manage and revise this plan to reflect additional programming and practices within the watershed necessary to achieve the remaining reductions necessary to achieve the plan's **long-term** phosphorus and sediment reduction goals.

The strategies to improve conservation performance in the Fenwood Creek watershed include: 1. regulatory, 2. conservation planning, and 3. technical and financial assistance.

LOCAL REGULATORY POLICY STRATEGIES

In response to significant, documented agricultural runoff events, the Marathon County Board of Supervisors has initiated several regulatory–based policy initiatives to address excessive soil erosion and nutrient runoff activities with specific attention focused upon spill or event discharges. The intent of these regulatory initiatives is to provide local education and enforcement support to landowners. The focus of these efforts will minimize the occurrence of spills and discharge events due to the mismanagement of wastes and to ensure that there is an adequate response by responsible parties in case of discharge events. It is important to note that event discharges of phosphorus sources and soil sediment (such as ephemeral erosion) are not quantified through the SNAP+ model. Therefore, it is important to quantify, qualify and respond to these events in a regulatory manner. The regulatory and policy development strategy and time line is as follows:

Animal Waste Storage Facilities and Nutrient Management Ordinance (AWO) and Livestock Facility Siting License Ordinance (LSO)

Goals

1. Reduce the number of spills or discharge events that contribute direct and significant sediment and nutrient discharges to the state's waters.
2. Structural performance and management expectations of BMP's will be clearly articulated in an "operation and maintenance" plan for waste storage facilities and barnyard systems.
3. The impact of unexpected agricultural runoff events involving soil sediment and nutrients sources will be minimized relative to water quality.

Objectives

1. April 2015: Marathon County Conservation, Planning and Zoning Department (CPZ) given citation authority. Regulated activities include the following:
    A. Construction of new Waste Storage Facilities (WSF's)
    B. Significant modification of existing WSF's
    C. Closure/deconstruction of abandoned WSF's
    D. Development of nutrient management plans by all permitted WSF's
    E. Development of nutrient management plans by unpermitted WSF's (pre-*1985)*

2. Spring 2017: Proposed regulatory administration emphasis of local ordinances (current permittees only) will extend to include:
    A. Direct runoff from manure applications to cropland and pastures
    B. Development and implementation of *Emergency Response Plans*
    C. Development and implementation of *Operation and Maintenance Plans*
3. Spring 2018: Proposed local ordinances will expand service and administrative authority of CPZ to include:
    A. Nutrient Management Plans for all landowners/producers applying commercial and/or organic fertilizers and amendments to cropland and pastures.
    B. Spills Management: Enforcement will include:
        1) Direct runoff of manure and contaminated runoff from farmstead areas
        2) Overflowing WSF's
        3) Unconfined manure storage in Surface Water Management Areas.

Outcomes

1. Initial Outcome (YR 2017)
    A. Landowners will understand state agricultural performance standards and compliance status of their respective farms.
    B. Landowners will understand spill reporting requirements, event minimization, and prevention.
    C. Landowners, agronomists, and farmers will understand value of emergency response plans.
    D. Landowners and consulting engineers will understand value of "operation and maintenance plans.

2. Intermediate Outcome (2017-2019)
    A. All landowners will develop, train staff and contracted workers, and follow an emergency response plan
    B. All landowners will develop, train staff and contracted workers, and follow an “operation and maintenance” plan for structural and management conservation practices.
3. Long term outcome (2019-2025)
    A. All landowners and cropland acres (14,600) will meet 100% compliance with state agricultural performance standards (WI Administrative Code NR 151)
    B. Beyond compliance with state agricultural performance standards, apply cropland BMP’s to achieve a 58% reduction of soil sediment delivery to edge of field.
    C. Beyond compliance with state agricultural performance standards, apply cropland and farmstead practices to achieve a 60% reduction of phosphorus delivery to field edge.
    D. Inform community leaders and producers of progress of plan implementation and assess the adequacy of agricultural performance standards and level of practice implementation to achieve or not achieve the P water quality standard.
    E. Educate local officials and agricultural producers that in order to comply with the water quality standards, a 45% reduction in phosphorus delivery to Fenwood Creek from cropland acres is necessary. The plan contains ten year interim and will then need to be amended to reflect the long term phosphorus reduction goals.
    F. Number of event discharges or spills of soil sedimentation or manure less than 5 annually.

Private Sewage Systems Ordinance

Although the contribution of nutrients from private on-site wastewater treatment systems (POWTS) to the waters of the Fenwood Creek is low (less than 1%), Marathon County will continue to administer standards for the construction, modification and maintenance of POWTS. Figure 11 shows the location of existing permitted POWTS. The proposed Fenwood Creek Pilot Project will provide education, inventory and enforcement activities for unpermitted systems, as well as the maintenance of permitted systems.

<u>Goals</u>

- Complete an inventory of all private on-site waste treatment systems (POWTS) in the Fenwood Creek watershed (permitted and non-permitted)
- Develop a plan to address high risk discharges from POWTS

Outcomes

1. Initial Outcome (2016-2017)
   A. Landowners will understand status of POWTS construction and maintenance compliance.
2. Intermediate Outcome (2017-2018)
   A. All landowners with non-compliant POWTS will be notified of status and solution process.
3. Long term outcome (2019-2021)
   A. All (100%) POWTS will be in compliance with standards.

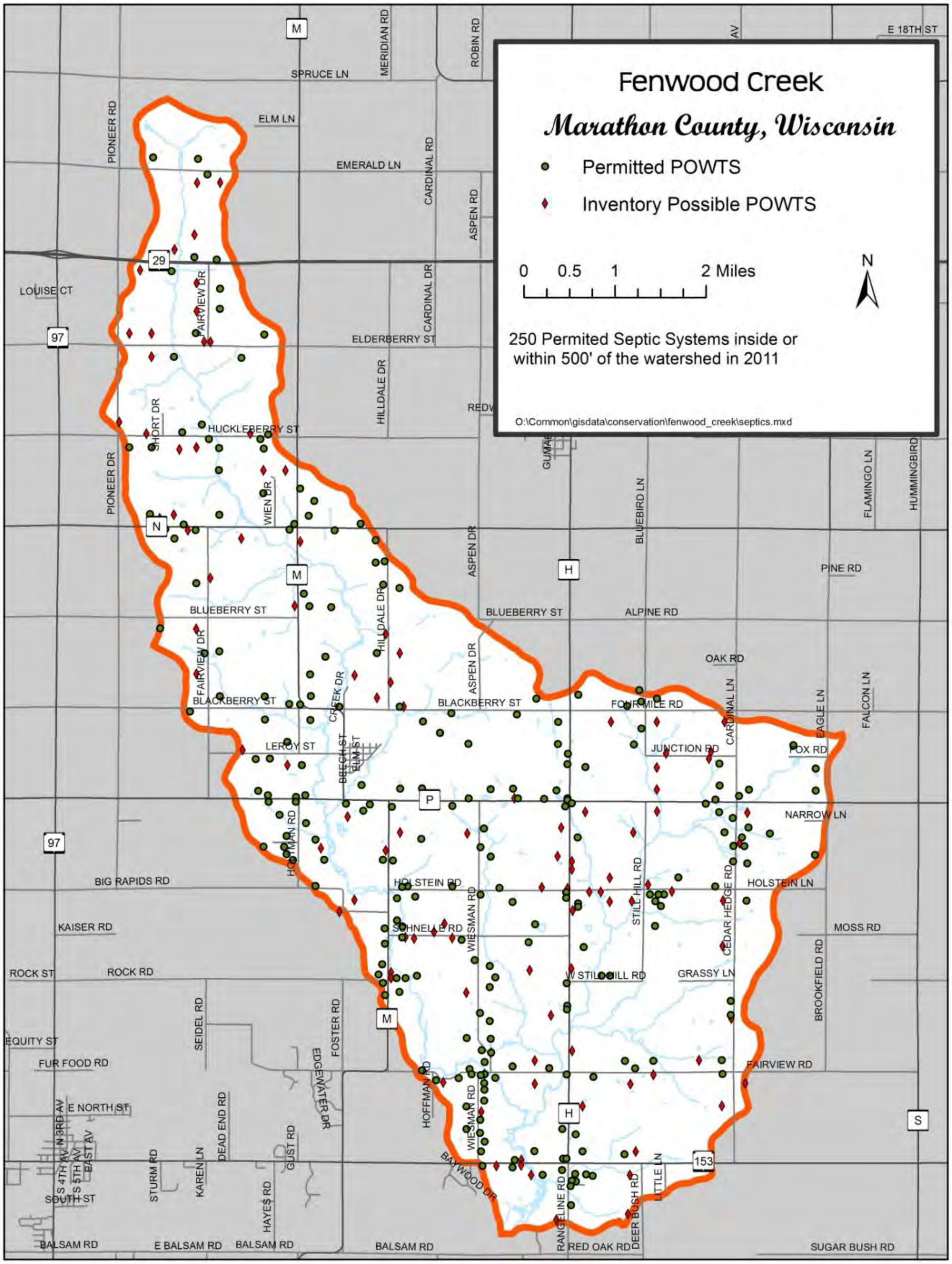


Figure 11 Location of POWTS in Fenwood Creek Watershed

CONSERVATION PLANNING STRATEGIES:
DEFINING DISPROPORTIONALITY

Conservation planning will be an important part of the education and outreach to landowners in the Fenwood Creek watershed. There are two primary points of emphasis that Marathon County will communicate to agricultural landowners:

1. Disproportionality: identifying and targeting the most serious farm field and farmstead contributors of soil sedimentation, organic matter and phosphorus.

2. Current performance of conservation practices installed in prior years through ordinances, federal and state programs, and local conservation efforts.

Disproportionality is a watershed planning concept that simply states that a few cropland acres or facilities produce the largest percentage of the water quality degradation. Historically, this was expressed as the "80-20 rule" where 80% of the problem is caused by 20% of the people/acres. Finding these specific attributes of the Fenwood Creek disproportionality will be important to best target limited staff and financial resources to the landowners where phosphorus and sediment reduction needs are greatest. Farmer input from the BEP task force indicated that farmers would be quite receptive to targeting efforts rather than the traditional whole farm planning approach.

Research that evaluated the application of the universal soil loss equation (USLE) in the Big Eau Pleine River watershed showed the USLE ***significantly underestimates soil loss*** by not accounting for ephemeral and snowmelt erosion. Additionally, research has identified that as slope steepness increases (doubles) the erosion rate increases 250%. Because of long slopes and fine textured soil, Marathon County will initially define disproportionality on cropland as follows:

- Cropland field slopes greater than 3%
- Slope lengths over 200 ft.
- Fenwood, Withee and Marathon soil types

Figure 12 and Figure 13 are useful maps that indicate and target programming priorities based upon soil slope lengths and soil erosion vulnerability within the Fenwood Creek watershed.

Marathon County will utilize BARNY, and SNAP+ models to identify high risk fields and farmsteads.

Conservation planning for most farms in the Fenwood Creek watershed will begin with an evaluation of previously installed best management practices either from the priority watershed era of 1993-2002, or through programming with the waste storage facility and nutrient management ordinance and farmland preservation. Marathon County estimates that approximately 30% of cropland fields and barnyards have best management practices currently in place through previous local conservation programming. The purpose of the planning assessment is to determine if existing BMP's are functioning as designed. The assessment of existing best management practices for the entire watershed will be the basis of either revising or re-committing to the BMP to achieve the planned benefit. Because many BMP's have been installed, the new conservation activities should build upon previous efforts.

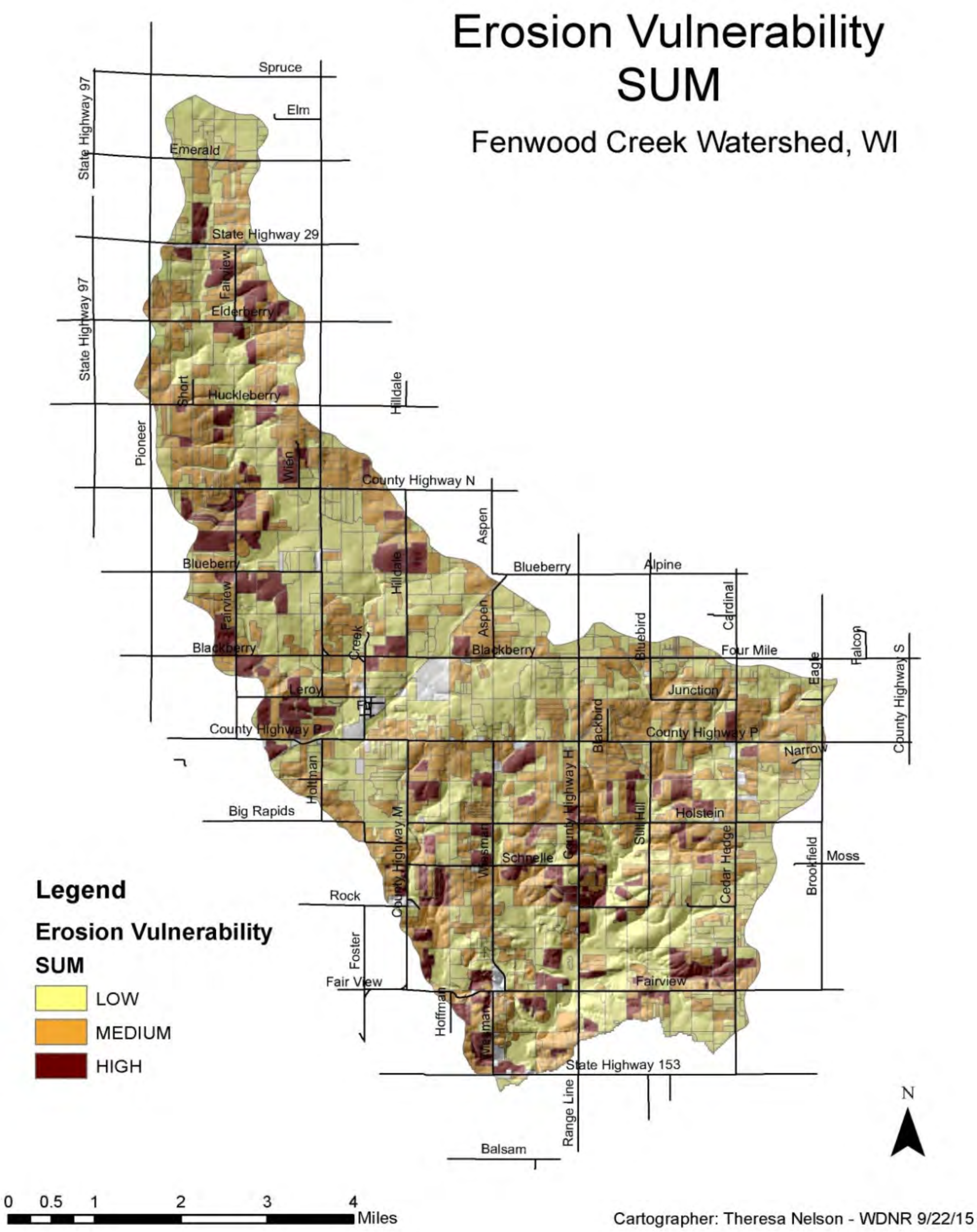


Figure 12 Erosion Vulnerability SUM

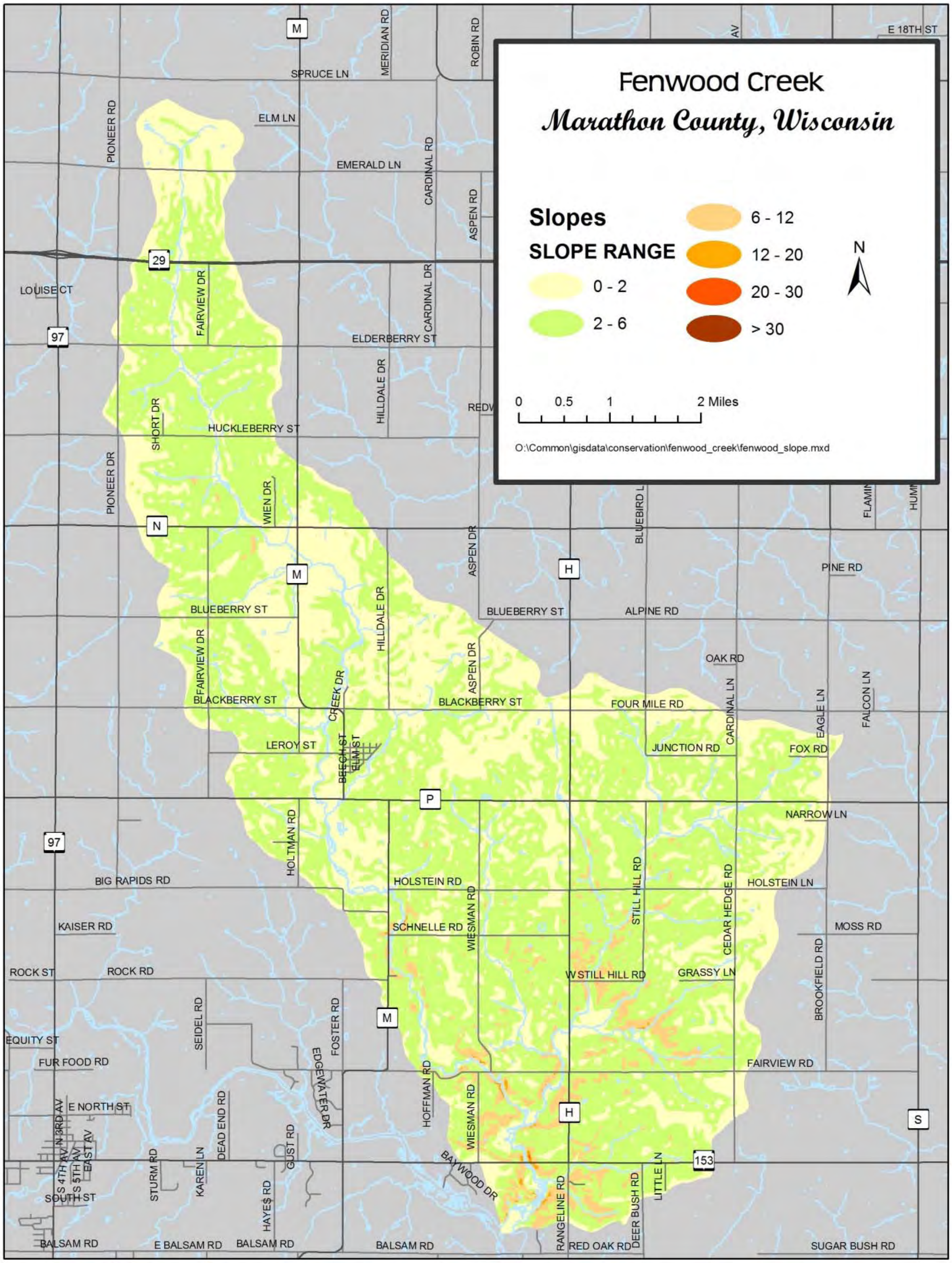


Figure 13 Fenwood Creek cropland slope grades

See Figures 14 for existing inventory of waste storage facilities and animal barnyards and Figure 15 for nutrient management plans in the Fenwood Creek watershed. The maps differentiate between facilities that were cost-shared or not through local conservation programming.

<u>Goals</u>

1. Reduce average soil loss rate in the Fenwood Creek watershed to 1.7 (current soil erosion rate 3.1).
2. Reduce average soil phosphorus index in the Fenwood Creek watershed to 2.6 on cropland (current average phosphorus index 4.8).

<u>Outcomes</u>

1. Initial Outcome (YR 2017)
    A. Landowners will understand compliance requirements of state agricultural performance standards (WI Administrative Code NR 151).
    B. Landowners will understand how the contributions of sediment and nutrients from farms impact water quality in the Fenwood Creek watershed.
    C. Farmer Council will be initiated to provide opportunity for landowners and producers to develop education and program activities and strategies for water quality improvements within the watershed.
2. Intermediate Outcome (2017-2019)
    A. Complete an inventory and assessment of existing waste storage facilities and barnyards to determine compliance with previous contracts and performance standards (WI Administrative Code NR 151).
    B. All landowners with non-compliance systems will be notified of status and solution process.
    C. Lower modeled potential cropland phosphorus delivery in watershed by 3,437 pounds.
    D. Lower modeled soil erosion within cropland fields by 3,000 tons/acre/year.
3. Long term outcome (YR 2019 – 2025)
    A. Lower average or modeled cropland phosphorus delivery in watershed by 18,548 pounds using figures 12 and 13 and practices listed in Table 7.
    B. Lower modeled soil erosion within cropland fields by 11,783 tons/acre/year using figures 12 and 13 and practices listed in Table 7.
    C. All landowners will be 100% in compliance with ordinances and state agricultural performance standards (per WI Administrative Code NR 151).

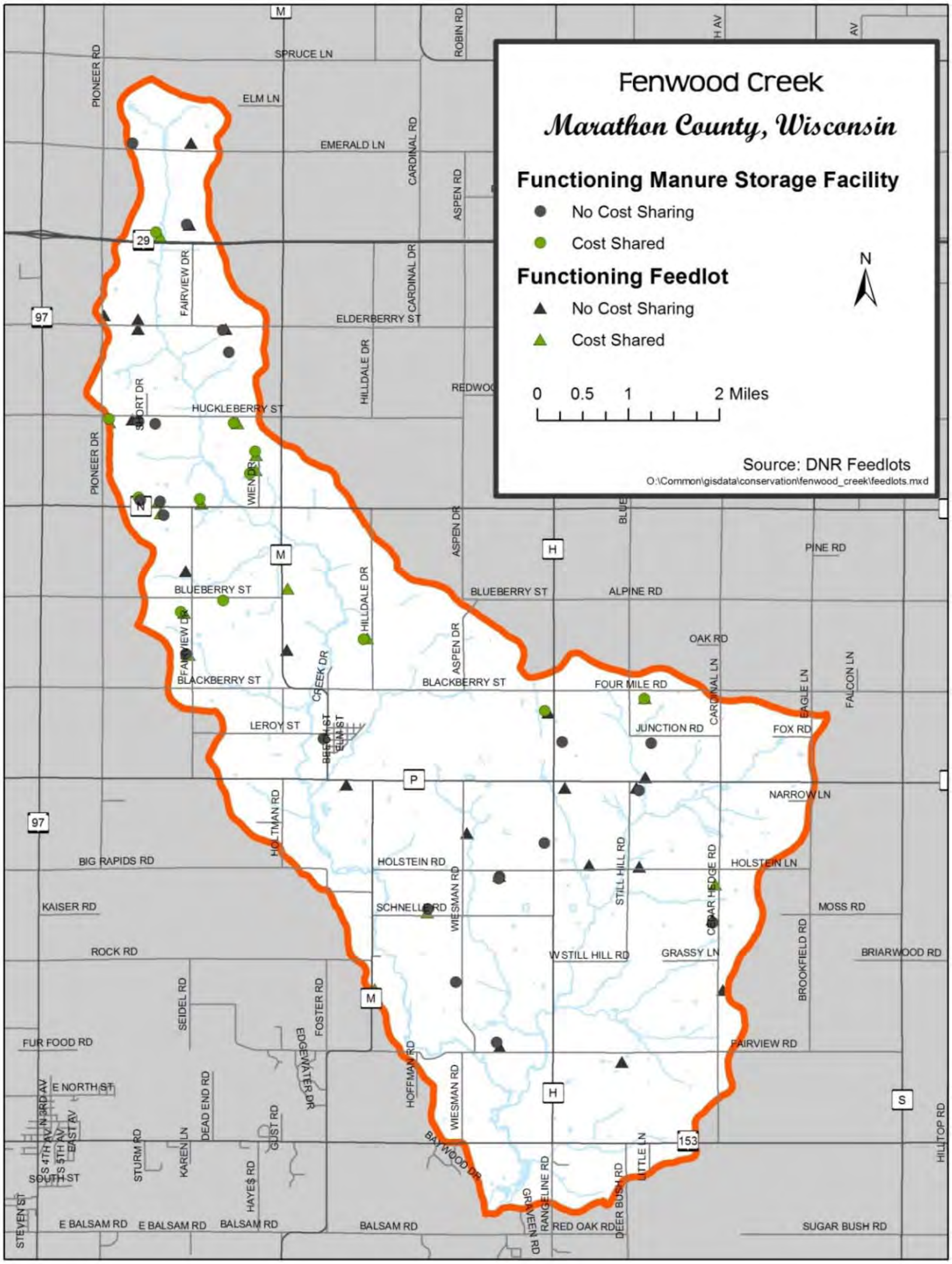


Figure 14 Current waste storage facilities and barnyards in Fenwood Creek

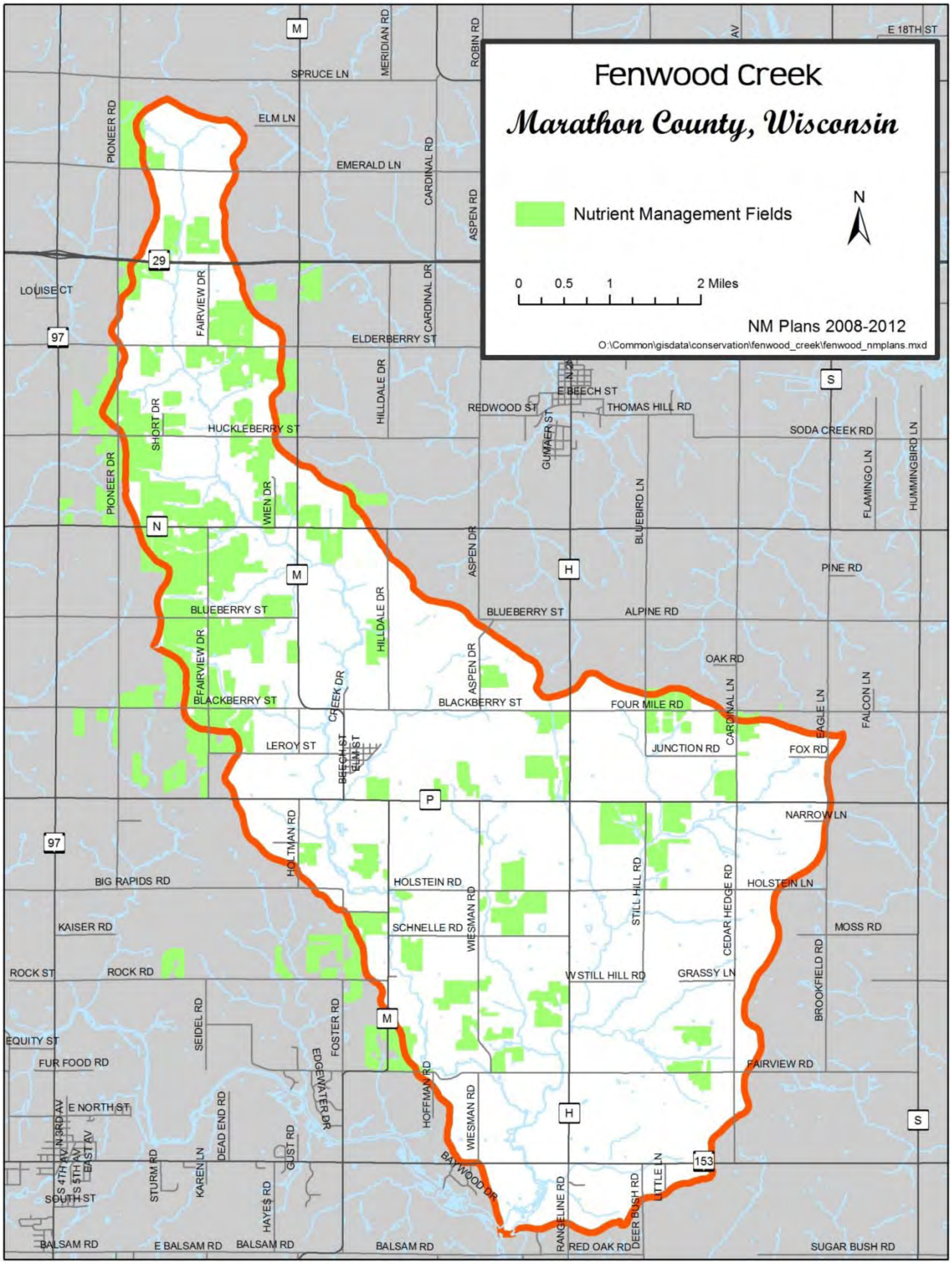


Figure 15 Acres under nutrient management plans in Fenwood Creek

TECHNICAL AND FINANCIAL ASSISTANCE AND ACTIVITIES

The following section identifies the best management practices that Marathon County will plan and implement to resolve resource concerns. Because the Fenwood Creek watershed plan is written prior to the final TMDL plan completion, this plan will be modified, if needed, to reflect the needs of the final TMDL plan.

1. In Field Soil Erosion - sedimentation

   A. Slope length and gradient factor (LS): Research indicates that a doubling of slope steepness on the soil types prevalent in the Fenwood Creek watershed results in 250% increase in erosion. Because we cannot change steepness grades in cropland, conservation practices must be installed to shorten slope lengths.

      BMP choice: Terraces and diversions to shorten slopes along with grass waterways to safely convey water to edge of field.

   B. Conservation management factor (C): The greatest benefit to the water quality and soil health of the watershed would be to add vegetated cover or residue cover to the cropland during spring and fall. The trend in the watershed is to increase the presence of row crops with low residue additions and less grass/hay mixtures.

      BMP choice:

      1. Rotational grazing or increasing the length of hay in crop rotation.
      2. Winter cover crops. Cover crops protect the soil between commodity crops and can improve soil health over time.
      3. No-till: Tillage breaks up soil pores and reduces the amount of residue on the soil surface.
      4. Reduce prevalence of fall tillage (currently 80% of cropland tilled in fall).
      5. Modify crop rotations. Increase grass and hay in dairy rotation. See Figure 16 for current crop rotation in the Fenwood Creek watershed.

   C. Conservation practice factors (P): This factor reflects the effect of practices that will reduce the amount and rate of the water runoff and thus reduce the amount of cropland erosion.

      BMP Choice:

      1. Contour cropping
      2. Field strip cropping

In comparing the practice of straight-row farming up and down the slopes, cropping practices such as cross-slope cultivation, contour farming and strip cropping can reduce the soil erosion by 25% to 75%.

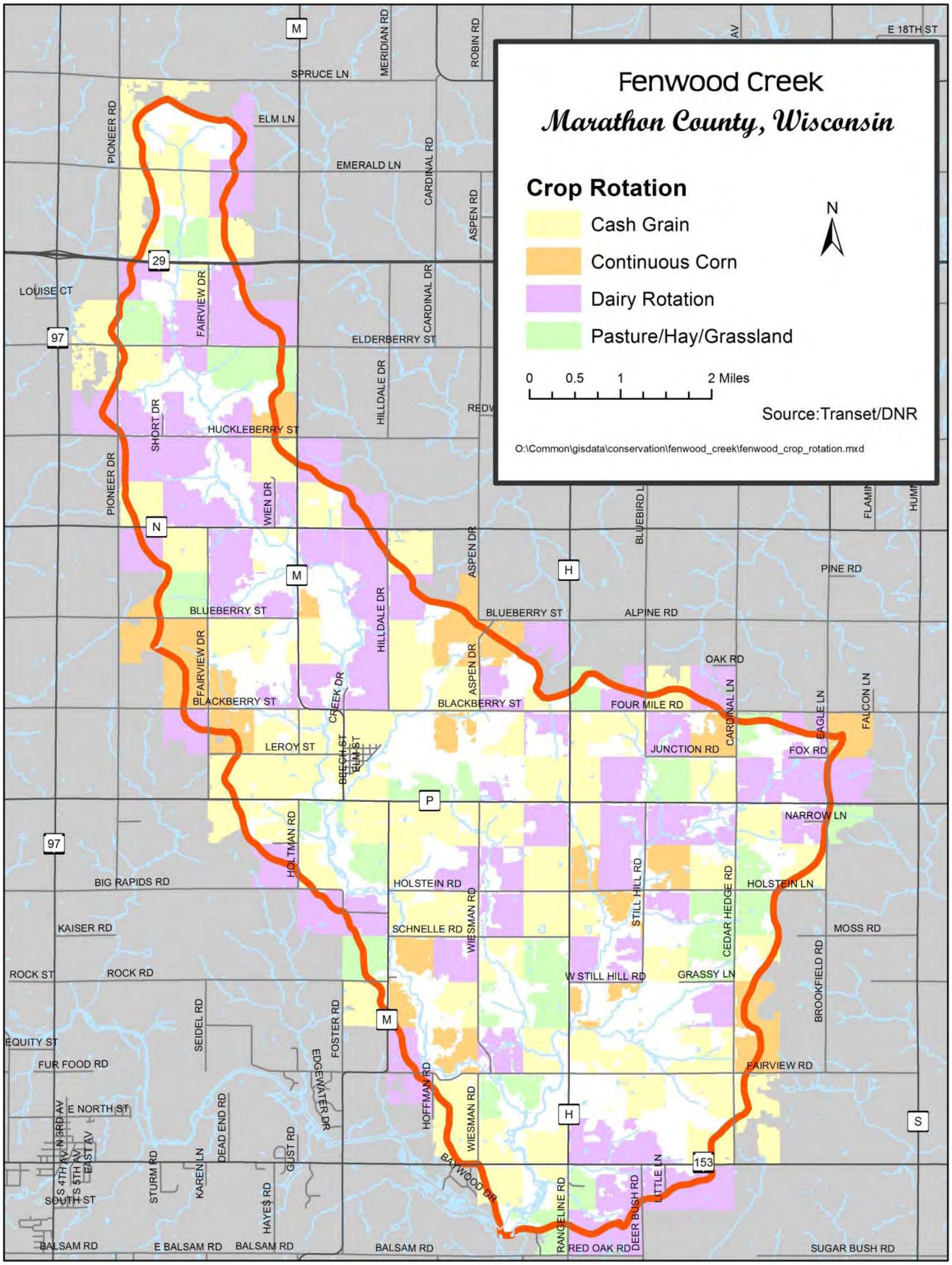


Figure 16 Crop rotations in Fenwood Creek Watershed

2. Animal Waste and Nutrient Management
   A. Nutrient management planning assistance to landowners and agronomists
   B. Improved barnyard runoff controls with sediment basins, heavy use protection and vegetated treatment strips
   C. Technology adoption: Manure injection systems allow producers to inject liquid manure below the soil surface with minimum disturbance. This process improves nitrogen use efficiency, preserves soil structure, retains crop residue and reduces nutrient losses associated with surface application of manure.
   D. Waste storage facilities will be implemented on farms where winter spreading is at a high risk. This will reduce phosphorus, nitrogen, and organic loading during spring runoff periods. Storage facilities constructed will also capture milking center waste that currently discharges to waters of the state. Landowners with long-term storage facilities will not be allowed to spread liquid wastes during frozen, saturated or snow-covered conditions.
   E. Barnyard and feedlot runoff controls will be implemented to reduce phosphorus, nitrogen, and organic loading. Marathon County estimates that the barnyards that are active throughout the year contribute as much as 1,516 lbs. of phosphorus per year.
   F. Milk house discharge controls. Marathon County estimates that there are approximately 8 landowners that directly discharge their milking center waste to waters of the Fenwood Creek. This accounts for an estimated 4,000 lbs. of biological oxygen demand annually. This waste stream also accounts for 520 lbs. of total phosphorus, 280 lbs. of soluble phosphorus, and 900 lbs. of suspended solids per year.
3. Edge of Field Practices: Re-establish riparian corridor wetland.

   Wetland restorations provide many benefits and are appropriate projects for areas where cropland fields are usually too wet to plant or harvest. Wetlands act as natural filtration systems for agricultural chemicals, and nutrients and serve as catchment areas for sediment. Wetlands can help recharge groundwater supplies, and provide habitat for migratory birds and important pollinator species that many crops rely on, such as bees.

   In the Fenwood Creek watershed, Marathon County will implement three Water and Sediment Control Basin practices to minimize sediment collection at the edge of cropland to prevent discharge into streams. Marathon County will rely on the use of LiDAR two foot contour maps to aid in developing edge of field buffers especially where delivery of sediment is adjacent to waters of the state. Marathon County and the BEP task force identified this land use practice as a BMP with great potential in the Fenwood Creek and larger BEP River watershed to reduce sedimentation into the river and reservoir system.

Goals

1. Reduce soil erosion on cropland.
2. Reduce sedimentation delivery from cropland to streams and rivers.
3. Reduce phosphorus delivery from farms.

Outcomes

1. Initial Outcome (YR 2016)
    a. Landowners will understand soil erosion processes and delivery dynamics of sediment from their farm.
    b. Landowners will understand principles of nutrient management and delivery of phosphorus from their farms.
    c. Landowners will understand the purpose and value of riparian wetlands to protect the stream from sediment discharges.
2. Phase 1(TRM) Outcome (2017-2019)
    a. Complete a conservation plan for 3,244 cropland acres in watershed.
    b. Complete a nutrient management plan and other C and P soil erosion practices for 3,244 cropland acres in watershed. Includes winter spreading plans for high risk fields.
3. Long term outcome (2019-2026)
    a. Complete a conservation plan for all tillable cropland acres (14,600 acres) in watershed.
    b. Complete a nutrient management plan and other C and P soil erosion practices for 64% (9,344) tillable cropland acres in watershed. Includes winter spreading plans for high risk fields.
    c. Evaluate if amount and types of practices implemented on 64% cropland acres (9,344 acres) do or do not result in average watershed soil loss (tons/acre/year) of 1.7 and average phosphorus index of 2.6 (lbs./acre/year).

CHAPTER 4: STAFFING AND FINANCIAL RESOURCE NEEDS WITH TIMELINE OF ACTIVITIES

Marathon County believes the Fenwood Creek pilot project will prove to be cost effective. Through previous landowner work with the Environmental Quality Improvement Program, Lower Big Eau Pleine River priority watershed program, farmland preservation program, Livestock Facility Siting Ordinance, Animal Waste and Nutrient Management ordinance, and Concentrated Animal Feedlot Operation permitting (WPDES), there are many conservation practices and compliance elements in place that control runoff that can be used to evaluate effectiveness, and ensure and promote the benefits of installed practices.

The Marathon County Conservation, Planning and Zoning (CPZ) department will address any current situations where performance standards are not being met such as barnyards, overflowing waste storage facilities, manure stacking in late winter and spring, and winter spreading of manure. A full description of the Marathon County implementation strategy for the agricultural performance standards found in WI Administrative Code NR 151 can be found in Marathon County Land and Water Resource Management Plan Chapter 4, section C. The most extensive work **will be to improve agronomic practices with contour farming, cropping practices, residue management, time of tillage, edge of field buffers (ephemeral erosion), and crop rotations**.

CPZ will identify and advance strategies to improve liquid manure application and distribution methods to promote immediate soil incorporation, increase soil organic matter, and reduce soil compaction. Marathon County will also develop strategies (regulatory and voluntarily) to minimize or prevent liquid manure application on snow-covered or frozen soils.

STAFFING RESOURCES

The Conservation Division of the Conservation, Planning and Zoning Department consists of approximately 6.25 Full Time Equivalent (FTE) staff members that are focused on Land and Water Resource Management Plan efforts. To the extent possible, Marathon County will target existing staff to focus their priorities in alignment with the Fenwood Creek project. In addition, staffing grants will be sought to augment the program delivery of the project. The breakdown for staff time and responsibilities is as follows:

1. 0.5 FTE – Education and Outreach. Staff will assist with development of Farmer Councils and education to stakeholders and community partnerships to develop community capacity.
2. 0.25 FTE – Farmland Preservation/Regulatory and program compliance. Staff will be responsible for the administration of ordinances including permit and license application review and approval, and annual monitoring.
3. 0.5 FTE – Technical Assistance. Staff will provide educational and technical assistance to livestock producers, schools and lenders, as well as administering federal and state cost-share funds to landowners to implement best management practices.

4. 0.25FTE – Agronomic and Nutrient Management Support. Staff will provide training to landowners and agronomists on issues concerning, technical standards, spills reporting, plan compliance, and emergency response planning.

Additional staff time within the CPZ Department is available to provide grant administration, Geographical Information System, Comprehensive Planning, and regulatory assistance. See Table 8 for a breakdown of estimated staffing hours and costs.

Along with the county staff, the CPZ Department relies on the following agencies to provide the specialized assistance to local conservation program delivery.

1. Department of Natural Resources – Coordination of WPDES permit monitoring and compliance, site evaluations and administration of Targeted Resource Management projects, enforcement inspections and compliance checks of performance standards.
2. USDA–Natural Resource Conservation Service – Conservation planning, engineering standards review; EQIP grant administration and project selection; CREP administration and education; and Grazing Initiative projects.
3. UW-Extension – Information sharing and development of handouts to keep producers and professional groups aware of program and performance standards requirements.
4. Department of Agriculture, Trade and Consumer Protection – Engineering design, grant allocations for staffing and LWRM Plan implementation activities, soil erosion transect support, and CPZ staff training and education.

Marathon County CPZ proposes that implementing the BMP's will provide for a significant advancement in reduction of sediment and phosphorus from agricultural lands.

Fenwood Creek Pilot Project
Targeted Runoff Management Grant – 2015

Table 8. Staffing estimate

Activity	**Hours/year**	**Total project Hours**
Landowner Contacts	500	1500
Education	250	750
Inventory	250	750
Targeting	333	1000
CSA	250	750
Design/Implementation	500	1500
Project Management	333	1000
Evaluations	250	750
Final Report	-	100
Enforcement	250	750
Total		**8850**

Cost Summary: (8850 hours) x $45/hour= $398,250
Staffing: 1.5 FTE/year

FISCAL RESOURCES

Marathon County CPZ will use the cost control methods as prescribed in the state administrative rules for grants. The two common methods utilized to contain costs are bidding and average costing. Cost estimates for proposed management and structural practices are based upon average costs of implementation tracked by Marathon County annually. Each year, CPZ staff tracks installation of "bid" projects to maintain an average costs per unit of construction. The cost projections always reflect the staff's familiarity with BMP installation in this region where shallow bedrock will influence siting of projects and construction materials.

Cost containment for project implementation will be based on two (2) considerations:

1. Each project will consist of an inventory of past practice implementation to ensure that those BMP's are realizing their full potential. Project funds will not be utilized to maintain or rebuild previously funded practice work.
2. Project bidding. CPZ will utilize competitive bidding to obtain estimated costs of all BMP's. In cases where a landowner prefers to select the contractor without open, competitive bidding, the CPZ will determine costs by utilizing average cost methods.

Please note that if additional federal dollars or local funds are found, cropping practices and barnyard waste storage facility work will be enhanced to focus on spring time to prevent spring runoff of nutrients and sediment when heaviest loads are encountered.

CHAPTER 5: BUILDING COMMUNITY CAPACITY – INFORMATION AND EDUCATION

An information and education component will be used to enhance public understanding of the project and encourage the public's early and continued participation in selecting, designing, and implementing the appropriate non-point source management strategies and conservation practices.

Marathon County will actively lead efforts to build community capacity of both public and private partners to improve the water quality of the Fenwood Creek watershed. To help effectively engage the public and the specific stakeholders, the Big Eau Pleine Citizens Organizations (with a grant from the WI Department of Natural Resources) partnered with Marathon County, University of Wisconsin- Stevens Point, River Alliance of Wisconsin and the DNR to conduct a survey of riparian landowners and farmers. The results of the survey will be incorporated into this plan to guide Marathon County's outreach. Specifically, the survey will provide the following insight and understanding into the Fenwood Creek community:

1. Economic value of clean water to residents and users
2. Economic barriers to BMP implementation
3. Perception and value of regulatory strategies to improve water quality
4. The governance capacity of the towns and village to support water quality activities
5. Community assets available to change behavior and invest in practices
6. Communication preferences of the diverse watershed stakeholders

When the survey results and analysis become available in 2017, Marathon County will utilize this social science information to design a community engagement plan with its partners.

The UW Agriculture Research Station (ARS), located in Town of McMillan, will support the project by providing research based documentation of sedimentation and pollutant runoff from cropland and pastures. The ARS has landscape, drainage systems and farming practices very comparable to the Fenwood Creek. Currently, the ARS has edge of field agricultural runoff monitoring available to help determine the effect of crop residue management on soil and phosphorus delivery to concentrated, surface drainage systems common to western Marathon County. Although research into the role and effectiveness of best management practices such a riparian buffers and edge of field sediment basins to control sediment and phosphorus will be initiated at the ARS, the research will not be available for this initial project.

Specific educational activities for the Fenwood Creek watershed will include:

1. In the first year of the project,(January 2017), Marathon County and the University of Wisconsin Extension will establish a farmer council to provide conservation staff with conservation planning and payment incentive strategies best suited to area farmers. Farm councils provide an opportunity for farmers to interact with peers, agency support staff and

community partners. Education, innovation and community sharing in solutions are the hope of developing these councils. The establishment of the farmer councils will be shaped and designed by a farmer survey conducted by Aaron Thompson. Although the design of the farmer council will emulate similar efforts in western Wisconsin within the St. Croix and Red Cedar watersheds, the specific information about the Fenwood Creek area farmers will be used to customize this project's effort. Develop education material and plan formats with these leaders to improve understanding of management goals and performance of BMP's. Create a website to distribute information to stakeholders, citizens and community members.

2. BEPCO/River Alliance/NRCS/Marathon County will host a social and educational meeting in fall 2016 in the Fenwood Creek watershed and on the reservoir to discuss runoff changes and unique challenges and commitments of the groups
3. Farm assessments in 2016-2017 to determine current farm practice compliance with state agricultural performance standards utilizing SNAP+ and BARNY models. Provide planning to achieve increased performance with enhanced BMP implementation.
4. Provide landowners (10 per year) with conservation planning, financial grant administration, and technical assistance (NRCS/Marathon County).
5. One-on-one landowner education and consulting to provide farm specific assessments and planning.
6. Provide town and village officials with information support for local comprehensive planning, zoning, and resource protection strategies that improve soil and water resource protection.
7. Identification of and contact with key stakeholders in the watershed to solicit their participation in improvements to water quality.
8. Support BEPCO organizational to build the capacity to lead landowners.

BEP TASK FORCE

In 2010, in response to the fish kill, Marathon County convened a meeting between Wisconsin Department of Natural Resources (DNR), Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), farm producers, Clark and Taylor County staffs, Big Eau Pleine Citizens Organization (BEPCO) and Wisconsin Valley Improvement Company (WVIC) to develop a short term plan to assess the impact on the fishery, adequacy of the aeration system, and water quality conditions.

The Big Eau Pleine Task Force prepared a document to identify the role of governmental agencies, sportsman and citizen groups, educational institutions, agricultural groups, and the WVIC to improve the health of the river system while balancing the needs of community and economic interests. It will also provide a foundation of understanding for the policies that may be proposed by local leaders.

The task force was established by Marathon County to ensure that all interested parties were represented and County policy is based upon recommendations consistent with community and economic development goals.

The recommendations forwarded by the Big Eau Pleine River Task Force represent policies and activities that Marathon County should develop, coordinate and implement to lead a local effort to improve community and economic development opportunities, as well as minimize public health concerns associated with the watershed's water quality.

POLICY RECOMMENDATIONS

An effective education and outreach effort will help develop and create local policies that support reasonable strategies and implementation tactics that include a mix of volunteering and enforcement measures. Below are the policy recommendations as well as the commitments made by partners of the Fenwood Creek Pilot Project:

- **Aeration System Operation and Maintenance**. The aeration system will be an ongoing and necessary management tool to the well-being of the reservoir and fishery. Operations and maintenance and capital expenditures for the system will be administered through a Memorandum of Agreement established for 5 year periods.

  WVIC, the FERC licensed operator of the reservoir, and DNR, the owner of the land and aeration equipment, will serve as the primary agents to determine the start-up criteria, safety and operations of the system. These organizations will also serve as the primary water quality monitoring agents for the tributary and reservoir waters.

Participating partners should contribute funds to pay for annual electrical costs and the repair or replacement of capital improvements such as items associated with motors, blowers, and buildings.

- **Resource Management Initiatives**. The local, state and federal agencies serve as the primary vehicle of delivery of local conservation programming to landowners and residents. Local conservation programs include education, resource assessments and planning, technical assistance, grant funding, and administration of regulations. Marathon County will provide leadership through policy, and partnership coordination through the Marathon County Comprehensive Plan. Specifically,

a. Marathon County will:

i. Adopt and implement state agricultural performance standards in local ordinance to address chronic and significant discharges.
ii. Minimize or eliminate winter land surface spreading activities of wastes.
iii. Promote technologies to treat and distribute livestock waste.
iv. Provide Best Management Practice education and training to landowners.
v. Administer the Non-metallic Mining Ordinance.
vi. Eliminate direct surface discharges of sanitary wastes.
vii. Develop a reservoir recreation management plan.
viii. Provide financial support of annual operational costs of the aerator.
ix. Develop and implement a Fenwood Creek pilot project (see description below).

b. WI Department of Natural Resources (DNR) will:

i. Develop a reservoir management plan to protect the natural resources (land, water and fish) of the Big Eau Pleine reservoir and tributary waters. The plan will set goals for the fishery and supporting food system.
ii. Provide lake management grants to local partners.
iii. Complete a water quality assessment of the Upper Wisconsin River Basin and develop a Total Maximum Daily Load (TMDL) plan for the Big Eau Pleine Watershed and Wisconsin River.
iv. Support Taylor, Marathon, and Clark Counties with investigation and enforcement of agricultural performance standards and prohibitions.
v. Provide Best Management Practices cost-share grants to landowners.
vi. Provide water quality monitoring of algae concentrations that threaten public health.
vii. Primary responsible agency role (with WVIC) for the aeration system in an operation and maintenance plan.
viii. Coordinate aeration system operations (with WVIC).

c. WI Department of Agriculture, Trade and Consumer Protection will:

i. Provide BMP grants to landowners for state agricultural performance standard(s) compliance.
ii. Provide administrative support for the Farmland Preservation Program.

iii. Coordinate education with agriculture industry associations and producers on nutrient management and non-point runoff controls.

d. **Wisconsin Valley Improvement Company will:**
   i. Provide water quantity and quality monitoring.
   ii. Coordinate aeration system operations with DNR.
   iii. Lead reservoir operation activities.
   iv. Update reservoir modeling tool(s) and drought management plan at 5-year intervals (next update due 2016).

e. **USDA – Natural Resources Conservation Service will**:
   i. Provide technical assistance, conservation planning, and engineering support to landowners.
   ii. Provide cost-share assistance to landowners.
   iii. Develop and implement manure winter spreading evaluation and planning strategies to minimize runoff risks.

f. **Big Eau Pleine Citizens Organization will**:
   i. Provide a citizen's voice to community needs relative to property, resource management, and public waters.
   ii. Coordinate input from community-based organizations such as recreational and lake groups to provide feedback about program outcomes and outreach needs.
   iii. Pursue grant opportunities. Specifically, grants to support development of lake management plans and studies to better understand the dynamics of sediment, water level management, and nutrient enrichment in the watershed.

g. **Farm industry representatives will**:
   i. Provide landowner education through Farmer Councils.
   ii. Provide feedback on incentives and program initiatives.

h. **Taylor County Land Conservation Department will**:
   i. Implement conservation programs focusing upon conservation compliance, nutrient management, and animal waste management through the Land and Water Resource Management (LWRM) plan.
   ii. Provide education on groundwater protection and Best Management Practices.

i. **Clark County Land Conservation Department will**:
   i. Implement conservation programs focusing upon conservation compliance, nutrient management, and animal waste management through the LWRM plan.
   ii. Implement Heart of America's Dairyland Agricultural Enterprise Area.

- **Fenwood Creek Watershed Project**. Because the water quality assessment activities and the Big Eau Pleine River and Reservoir Total Maximum Daily Load plan will not be completed until 2016-17, the task force recommends that the agencies initiate a small scale watershed project. The purpose of the project is to develop the strategies relative to Best Management Practices, waste treatment and distribution technology implementation, conservation planning, financial incentives, technical assistance, and education needed to achieve water quality outcomes for the watershed. The project would include the following elements:

- Water quality monitoring. Assess the management and environmental performance of BMPs, quantify the pollutant contributions of major event runoff discharges vs. chronic low-level discharges, and document changes in water quality over time.
- Education. Communicate performance expectations and regulatory requirements to landowners, towns, cities and villages.
- Nutrient management planning. Provide technical and financial assistance to landowners to assure all producers have and follow nutrient management plans.
- Manure winter spreading assessments. Develop and implement criteria to assess winter spreading runoff risks and provide planning assistance to landowners to manage risks.
- "Edge of Field" Best Management Practices. Implement BMPs down slope of cropland to treat and reduce sediment and nutrient loading from runoff. In cases where runoff contributions are chronic and cannot be minimized to acceptable levels, permanent land use conversion strategies will be developed.
- Financial and management incentives. Develop financial and management incentives to promote BMP implementation, including long-term maintenance and performance of BMP.
- Waste treatment and distribution technology. Increase understanding and implementation of waste treatment and distribution technologies that reduce runoff risks and maximize nutrient utilization. Provide cost-benefit analysis of new technologies and develop adoption strategies.

CHAPTER 6: MONITORING AND REPORTING

Measuring progress is essential to determine if the goals of the plan are being accomplished. Several methods will be used to measure planning, assessment and BMP implementation progress. Marathon County has developed a parcel based tracking and monitoring system for conservation activities and monitoring. Furthermore, the conservation plan will function as the primary document to record decisions made by landowners and conservation staff for BMP activities and planned compliance. The tracking system will document the following information on a specific land parcel:

1. Landowner/Address
2. Compliance Status relative to NR 151, pertinent local ordinances and codes, and compliance status
3. Program Participation Status: Federal programs as well as Farmland Preservation, Grazing, Priority Watershed, CREP, etc.
4. Existing and Planned Conservation Best Management Practices
5. Maps and Field Delineations
6. Follow-up inspections/Verification of practice implementation

Throughout the Fenwood Creek plan there are number of intermediate goals and outcomes identified such as:

- The number agricultural best management practices implemented and adopted
- Modeled Reduction in phosphorus (pounds) and soil sediment (tons) annually delivered from cropland to the Fenwood Creek
- Modeled Reduction of average annual soil erosion rate on cropland
- Modeled Reduction of average annual potential to deliver phosphorus (watershed phosphorus Index).

These intermediate outcomes will serve to establish short-term and long-term milestones that will allow CPZ staff to track the implementation success of proposed strategies.

Specific tracking of activities include the following:

A. SOIL EROSION

The County will continue its soil erosion transect survey every other year in the spring. The survey shows land use and cropping trends and evaluates the rate of application of conservation practices.

Program status reviews and ordinance monitoring activities are conducted by CPZ and NRCS staff to ensure landowners and operators are in compliance with their conservation plans, permits and licenses.

Reductions in sediment delivery will be calculated for projects in the Fenwood Creek watershed areas utilizing SNAP+ model. Staff will continue to develop a report to assess the trends in organic matter content of topsoil utilizing soil testing data in nutrient management plans.

Acreages of farm plans prepared and revised will continue to be recorded. All conservation plans will be developed to assure that the NR 151 cropland performance standards are met. Once landowners are determined to meet agricultural standards (Wi Administrative Code NR 151), including erosion standards, a certification letter is sent to them.

Once soil erosion risk maps are developed to identify cropland to show areas of disproportionality, Marathon County will track conservation planning, nutrient management planning, and BMP implementation on those fields to ensure that 100% of these fields are below tolerable soil loss rates.

B. WATER QUALITY

The calculated amounts of phosphorus runoff reduction will be totaled for barnyard practices and reductions in winter spread manure due to construction of waste storage structures. All practices installed under the Marathon County Waste Storage Facility and Nutrient Management code will be properly permitted by CPZ and certification letters sent to landowners upon BMP completion verifying satisfaction with performance standards and ordinances.

C. SPOT CHECKS, AUDITS AND ANNUAL REPORTS (includes basic performance standards as well as additional efforts)

The DATCP and NRCS will conduct annual engineering and conservation planning spot checks on work performed by Conservation staff. These checks ensure financial and quality control of landowner cost-share grants, staffing grants, administration responsibilities and technical design work.

DNR performs similar program and financial audits on projects funded by Targeted Runoff Management or Notice of Discharge grants. The county also conducts financial audits each year. Those audits ensure quality control from an administrative perspective.

Items in the Goals section will be reported by the units or numbers as they appear. CPZ will complete and submit an Annual Report of progress to DNR that relates information concerning Best Management Practice installations, status of informational activities initiated, acres of Conservation Plans developed, compliance status of agricultural performance standards (Wi Administrative Code NR 151) within the watershed, and staff hours spent on the various program efforts.

D. OUTCOME MEASUREMENT

Marathon County has developed a scorecard method of evaluating program outcomes. Specifically, the county is utilizing a “Logic Model” approach that identifies resource inputs, such as grants, staff, equipment and partnerships, activities, and both short term and long term outcomes of the county’s efforts relative to conservation programming. The scorecard tracks outcomes and trends toward successful implementation of programs. The scorecard will be developed annually to present to the Marathon County Environmental Resources Committee, BEPCO, DNR and local officials. For purposes of meeting element 8 of EPA’s 9 Key Elements, if less than 20% of the milestones listed within Tables 5 and 7 are achieved by 2021, then this plan’s goals, objectives and milestones will be revised to reflect the lack of plan implementation. See Table 9 – Fenwood creek Project Logic Model.

E. RESOURCE EVALUATION AND MONITORING

In consultation with the Central Wisconsin River Basin and DNR staff, Marathon County will advance efforts to monitor best management practices and water quality improvements and status of the County’s water resources in the Fenwood Creek Watershed and the Big Eau Pleine River Watershed. By utilizing both professional and volunteer monitoring programs, Marathon County hopes to advance the information sharing required to communicate the resource problems that impact communities.

Specific activities for evaluation and monitoring include:

1. Marathon County will survey all landowners pre and post project to assess their understanding and value of the farm runoff dynamics and performance standards.
2. Marathon County will provide a summary report of farmer council feedback relative to BMP adoption barriers, appropriate strategies for incentives, and alternative Best Management Practices strategies and technologies needed to improve water quality.
3. Documentation of educational and implementation activities and progress. CPZ will maintain records of education and conversation with individual landowners as well as decisions related to BMP compliance status and future BMP implementation schedules.
4. CPZ will develop and submit a regular status report of the pilot project to its partners and DNR. Quarterly, the project status will be presented to the authorized local county committees, local Town officials, and BEPCO.
5. CPZ will provide biannual and annual status reports to DNR, BEPCO and Farmer Council to track farmer interaction, financial administration and distribution of funds, implementation of BMP's, water quality monitoring results, and environmental performance of implemented BMP's.

   Because of the pilot nature of the project, landowners and partnerships will be assessing the effectiveness of education and implementation strategies. The status of the project will be reviewed regularly with DNR, farmer councils, and partnership to determine if strategies need to be modified and re-directed.

Lessons learned and changes will be included in monthly and annual reports to document challenges and effectiveness of changes.

6. In-stream water monitoring: Currently, the only sites DNR has committed to routine water chemistry monitoring are its long-term trend monitoring sites. Those are the large river sites at Merrill, Biron, and Wisconsin Dells on the Wisconsin, plus one site on the Baraboo River. DNR has indicated that they will rely on implementation tracking of this plan and other efforts as the trigger to reinstate more intense DNR-led monitoring activities to determine in stream P concentrations and loads.

   CPZ will consult with DNR to conduct water quality sampling at the mouth of the Fenwood Creek watershed and after implementing cropland BMP's to determine if sediment and phosphorus reductions are occurring. Marathon County will request monitoring after Targeted Resource Management (TRM) activities have concluded (2019) and also after modeled reductions from implementation of practices on > 50% of cropland acres in watershed are shown (2025).

   That being said, there certainly are opportunities for volunteer trend monitoring to take place between these two time periods.

   Annual Total Phosphorus (TP) loading is variable. For example, in 2012 (drought year), the TP load was approximately 12,500 lbs. per year and in 2010 (wet year), the TP was 2,500 pounds per year. Marathon County, in consultation with DNR, estimates that the average annual TP load is approximately 11,200 pounds. DNR WQ biologists recommend TP load monitoring be done for a minimum of 2 to 3 years to in a watershed to understand annual TP variability. Marathon County will evaluate progress first by using land use models and if modeled reductions are found, then the in-stream load monitoring will be requested.

Table 9. FENWOOD CREEK PROJECT – LOGIC MODEL

Contact Name: Andy Johnson, Environmental Resources Coordinator
Standing Committee: Environmental. Resources Committee
Working Committees: Land Conservation & Zoning Committee
Program customer: Fenwood Creek: Towns, Village of Fenwood, and landowners

COMMITMENTS	ACTIVITIES		OUTCOMES		
Category	Outputs/Milestones	Current	Initial (YR 2016)	Intermediate (YR 2017-2018)	Long Term (YR 2019-2026)
1. **TRM Project (Phase 1)** Education Improve nutrient management Improve Cropland Management Practices Improve cropland erosion control and runoff practices Improve livestock waste management in farmstead and cropland Improve feed leachate runoff control practices Improve open feedlot runoff practices	Nutrient management planning and education Conservation planning Farmstead runoff evaluations, planning, and design support	Animal Waste and Nutrient Management Ordinance	Landowner and agronomist education about Standard 590 and impacts of phosphorus in water 3,244 acres additional nutrient management planned 1,850 acres of cropping and cropland runoff control practices 3 waste storage facilities 3 feed leachate runoff control systems 6 feedlot runoff control systems	1,622 lbs. phosphorus reduction due to improved nutrient application practices 375 pounds phosphorus reduction due to improved cropping and runoff control practices 600 lbs. of phosphorus reduction due to reduced winter spreading of manure 600 lbs. of phosphorus reduction due to collection and storage of feed leachate 240 lbs. of phosphorus reduction due to collection and treatment of feedlot runoff.	NA

COMMITMENTS	ACTIVITIES		OUTCOMES		
Category	Outputs/Milestones	Current	Initial (YR 2016)	Intermediate (YR 2017-2018)	Long Term (YR 2019-2026)
2. **Local Regulatory Policy**: Reduce the number of spills or event discharge events that contribute direct and significant sediment and nutrient discharges to the state's waters. Structural performance and management expectations of BMP's will be clearly articulated in an "operation and maintenance" plan for waste storage facilities and barnyard systems. The impact of unexpected agricultural runoff events involving soil sediment and nutrients sources will be minimized relative to water quality.	Ordinance Revisions: Administrative Guidelines Policy Guidelines Education and Outreach Plan	Livestock Facility Siting Ordinance Animal Waste and Nutrient Management Ordinance	Landowners will understand state agricultural performance standards and compliance status of their respective farms. Landowners will understand spill reporting requirements, event minimization, and prevention. Landowners and agronomists and farmers will understand value of emergency response plans. Landowners and consulting engineers will understand value of "operation and maintenance plans. CPZ and UW-Extension will organize a Farmer Council	All landowners will develop, train staff and contracted workers, and follow an "emergency response plan" for existing structural BMP's All landowners will develop, train staff and contracted workers, and follow an "operation and maintenance" plan for existing structural and management conservation practices. 3,437 (pounds) reduction in phosphorus delivery to Fenwood Creek (Snap+ based)	All landowners and tillable cropland acres (14,600) will meet 100% compliance with state agricultural performance standard (NR 151) 18,548 (pounds) reduction in phosphorus delivery to Fenwood Creek (Snap+ based) 58% reduction of soil sediment delivery to edge of field Number of event discharges or spills of soil sedimentation or manure less than 5 annually

COMMITMENTS	ACTIVITIES		OUTCOMES		
Category	Outputs/Milestones	Current	Initial (YR 2016)	Intermediate (YR 2017-2018)	Long Term (YR 2019-2026)
3. **Determine Watershed Disproportionality and BMP Inventory/Assessment**: Determine specific cropland attributes of the Fenwood Creek that lead disproportionality to high pollutant delivery loading to best target staff and financial resources to the landowners where needs are greatest. Complete an inventory of previously implemented agricultural BMP's Assess existing agricultural BMP's to determine compliance with contracted "Operation & Maintenance" requirements and environmental performance Improve Community Capacity to address water quality concerns.	Disproportionality Report (Criteria and spatial location) Fenwood Creek Best Management Practice Inventory and Assessment Report (establish baseline)	No data exist for targeting cropland or farmstead best management practices No data exists for current condition or performance of previously implemented best management	Landowners will understand state agricultural performance standards and compliance status of their respective farms. Landowners receive an on-farm assessment of existing BMP. CPZ will develop methodologies and evaluations to define disproportionality in the Fenwood Creek Watershed. Form a Farmer Council of individuals and organizations in the watershed to collectively resolve water quality concerns.	Landowners will receive a farm specific report describing their current cropland and farmstead conservation practices and environmental performance. Producers out of compliance with WI Adm. Code NR 151 will be notified of compliance status and solution alternatives. CPZ will establish a baseline of current BMP's and performance relative to phosphorus and soil sediment delivery. CPZ will establish the criteria to identify high priority cropland and farmstead sites for conservation/nutrient planning in order to target staff and fiscal resources. Reduce average soil phosphorus delivery by 3,437 pounds annually. Lower soil erosion rate from cropland by 3,000 tons annually	All landowners and acres (14,600)(will meet 100% compliance with state agricultural performance standard (NR 151) 18,548 (pounds) reduction in phosphorus delivery to Fenwood Creek from cropland via various practices on 64% of cropland acres (see Table 7) 58% reduction of soil loss from cropland via various cropland practices (see table 7)

COMMITMENTS	ACTIVITIES		OUTCOMES		
Category	Outputs/Milestones	Current	Initial (YR 2016)	Intermediate (YR 2017-2018)	Long Term (YR 2019-2026)
4. **Technical Assistance and BMP Implementation**:	Conservation planning	5,614 acres	5,614 acres	7,114 acres	9,344 acres
	Nutrient Planning	5,614 acres	5,614 acres	7,114 acres	9,344 acres
Provide conservation and nutrient planning support to agricultural producers.	Waste Storage Facilities – Construction	31	32	34	37
	Waste Storage Facility Closure	8	9	11	14
Provide administrative support and guidance to producers for best management practice design and installation	Livestock Barnyards	33	33	34	37
	Feed Leachate Control Systems	0	0	1	2
Provide administrative and reporting support to BMP installation and environmental response reports.	Cropland "C" and "P" BMP's	5,614 acres	5,614 acres	7,114 acres	9,344 acres

APPENDIX A

Land and Water Resource Management Plan

Glossary and List of Acronyms

1. **AFO – Animal Feeding Operation:** feedlot or facility, other than pasture, where animals have been, are or will be fed, confined, maintained or stabled for a total of 45 days or more in any 12 month period. Administrative Code NR 243.

2. **A.U. – Animal Units:** a unit of measure used to determine the total number of single animal types or combination of animal types which are fed, confined, maintained or stabled in an animal feedlot operation. Administrative Code NR 243, local ordinances (Zoning, Livestock Facility License, and Waste Storage Facility/Nutrient Management).

3. **AWO – Waste Storage Facility and Nutrient Management Ordinance:** Chapter 11.02 of General Code of Ordinances.

4. **BMP – Best Management Practices:** means structural and non-structural measures, practices and techniques or devices employed to avoid or minimize soil, sediment, or pollutants carried in runoff to waters of the state.

5. **CAFO – Confined Animal Feeding Operation (>1000 A.U):** means an animal feeding operation which feeds, confines, maintains or stables 1,000 animal units or more.

6. **CNMP – Comprehensive Nutrient Management Program:** conservation plans unique to livestock operations. These plans document practices and strategies adopted by livestock operations to address natural resource concerns related to soil erosion, livestock manure and disposal of organic by-products.

7. **CPZ – Department of Conservation, Planning and Zoning (Marathon County):** the Department mission is to create, advocate and implement strategies to conserve natural and community resources.

8. **CREP – Conservation Reserve Enhancement Program:** a partnership between the USDA Farm Service Agency, Wisconsin Department of Agriculture, Trade and Consumer Protection, USDA, Natural Resources Conservation Service, the Wisconsin Department of Natural Resources, and participating county land conservation departments throughout the state. It is an opportunity for Wisconsin landowners to enroll agricultural lands into various practices such riparian buffers, wetland restoration and establishment of native grassland areas, among others.

9. **CRP – Conservation Reserve Program:** a program that reduces soil erosion protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. The program is administered through the Farm Service Agency (FSA). Natural Resources Conservation Service works with landowners to develop their application, and to plan, design and install the conservation practices on the land. County Land Conservation Departments and the Wisconsin Department of Natural Resources also provide technical support for the Conservation Reserve Program.

10. **CSP – Conservation Security Program:** a voluntary program that provides financial and technical assistance for the conservation, protection, and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private lands. The program provides payments for producers who practice good stewardship on their agricultural lands and incentives for those who want to do more. The program is designed to reward the best conservation stewards of the most environmentally sensitive areas in targeted watersheds.

11. **DATCP – Department of Agriculture, Trade and Consumer Protection:** State agency responsible for food safety, animal and plant health, protecting water and soil and monitoring fair and safe business practices. The Soil and Water Resource Management Grant Program supports locally led conservation efforts. Each year DATCP awards grants primarily to counties to pay for conservation staff and provide landowner cost sharing to implement Land and Water Resource Management plans.

12. **DFP - Discovery Farms Program:** takes a real-world approach to finding the most economical solutions to overcoming the challenges environmental regulations place on farmers. The Discovery Farms Program will develop on-farm and related research to determine the economic and environmental effects of Best Management Practices on a diverse group of Wisconsin farms; and educate and improve communications among the agricultural community, consumers, researchers, and policy-makers to better

identify and implement effective environmental management practices that are compatible with profitable agriculture.

13. **DOC - Dissolved Organic Carbon:** a measure of a wide range of plant and animal-derived organic compounds that have sufficiently broken down to become dissolved in lake water. Some DOC compounds affect lake water pH, while others stain the water a tea-like color. DOC is strongly influenced by the surrounding landscape of the water body.

14. **EQIP – Environmental Quality Incentive Program:** a voluntary conservation program. It supports production agriculture and environmental quality as compatible goals. Through EQIP, farmers may receive financial and technical help with structural and management conservation practices on agricultural land. EQIP offers financial assistance to help off-set the costs of eligible conservation practices. Incentive payments may also be made to encourage a farmer to adopt land management practices, such as nutrient management, manure management, integrated pest management, or wildlife habitat management.

15. **EWR – Exceptional Water Resources:** a lake, stream, or flowage exhibiting the same high quality resource values as outstanding waters, but may be affected by point source pollution or have the potential for future discharge from a small sewer community.

16. **FCL – Forest Crop Law:** was a landowner incentive program that encouraged long-term, sustainable management of private woodlands by reducing and deferring property taxes. The FCL program was enacted in 1927 and enrollment was closed on January 1, 1986.

17. **FEMA – Federal Emergency Management Agency:** On March 1, 2003, FEMA became part of the U.S. Department of Homeland Security (DHS). The primary mission of the Federal Emergency Management Agency is to reduce the loss of life and property and protect the Nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the Nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

18. **FIRM – Flood Insurance Rate Map:** the official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.

19. **FOTG – Field Office Technical Guide:** the primary technical reference tool used in accomplishing the Natural Resources Conservation Service (NRCS) mission. WI-FOTG contains technical reference material to be used when planning, designing, applying, and maintaining conservation practices.

20. **FPP – Farmland Preservation Program:** The Wisconsin Farmland Preservation Program was created in 1977 to preserve agricultural resources by supporting local government efforts to manage growth. Eligible farmland owners receive a state income tax credit. To participate in the program, the county must have an agricultural preservation plan that meets the standards of Chapter 91, Wisconsin Statutes, and has been certified by the state Land and Water Conservation Board (LWCB). The program assists in preserving Wisconsin's valuable farmland by supporting counties in creating county agricultural preservation plans. These lay the groundwork for towns, municipalities and the county to develop exclusive agriculture zoning districts. Farmers also can participate by signing an individual, long-term agreement. The farmland preservation program provides state income tax credits to farmers who meet the program's requirements; to meet soil and water conservation standards; and to use the land for agriculture only.

21. **GIS – Geographical Information System:** captures, stores, analyzes, manages, and presents data that is linked to location. It includes mapping software and its application with remote sensing, land surveying, aerial photography, mathematics, photogrammetry, geography, and tools that can be implemented with GIS software.

22. **GLCI – Grazing Lands Conservation Initiative:** a partnership between USDA Natural Resources Conservation Service, the Wisconsin Department of Agriculture, Trade, and Consumer Protection, and private sector agricultural and conservation groups, working together to promote best management practices on Wisconsin private grazing lands. GLCI focuses on providing technical assistance to help new graziers begin using rotational grazing methods. Trained grazing specialists work one-on-one with farmers, developing grazing plans, including seeding recommendations, fencing and watering plans.

23. **GPR – General Purpose Revenue**

24. **HUC – Hydrologic Unit Code:** Hydrologic unit codes are a way of identifying all of the drainage basins in the United States in a nested arrangement from largest (regions) to smallest (cataloging units).

25. **LWCB – Land and Water Conservation Board:** connects local and state governments on conservation and farmland preservation issues. The board certifies agricultural preservation plans for the farmland preservation program and exclusive agricultural zoning ordinances for counties and towns; reviews and makes recommendations on county land and water plans; and recommends how funds are to be allocated to Wisconsin counties to put conservation plans into action. The LWCB is composed of three members of county land conservation committees, three state agency leaders, one Governor-appointed member that serves a two-year term, and four Governor-appointed members representing urban, rural, river management, and natural resource preservation areas.

26. **LWRM – Land and Water Resource Management Planning Program:** Through 1997 Act 27 and 1999 Act 9, the Wisconsin legislature established the land and water resource management (LWRM) planning program, (Wis. stats. Ch. 92). This program is the primary statewide vehicle for implementing conservation practices as identified in Department of Agriculture, Trade and Consumer Protection Administrative Rules (ATCP 50). Under this program, counties are required to develop land and water resource management plans for the purpose of conserving soil and water resources. Every 5 years, counties must revise these plans and are scheduled to present these revisions to the Wisconsin Land and Water Conservation Board (LWCB). The LWCB is responsible for recommending the plans for approval by the Department of Agriculture, Trade and Consumer Protection (DATCP). Only counties with DATCP-approved land and water resource management plans are eligible to receive annual funding through the soil and water resource management grant program.

27. **MIG – Management Intensive Grazing:** a best management practice for livestock production where permanent pasture is divided into smaller areas or paddocks, often using portable fencing. One paddock is grazed for a short time, while the remaining paddocks rest and recover.

28. **MFL – Managed Forest Law:** a landowner incentive program that encourages sustainable forestry on private woodlands by reducing and deferring property taxes. It was enacted in 1985 and replaced the Woodland Tax Law and the Forest Crop Law. It

is the only forest tax law that is open to enrollment. Land enrolled in the MFL program must be managed according to a plan agreed to by the landowner.

29. **NOD – Notice of Discharge:** is issued by the Department of Natural Resources under Chapter NR 243 (Animal Feeding Operations) to small and medium animal feeding operations that pose environmental threats to state water resources.

30. **OWR – Outstanding Water Resources:** means a lake, stream or flowage having excellent water quality, high recreational and aesthetic value and high quality fishing. ORW waters are free from point source or nonpoint source pollution.

31. **"P" – WI Phosphorus Index:** is a runoff phosphorus loss risk assessment tool for cropland management planning. It uses information that is readily available to farmers and agricultural consultants to evaluate the potential for phosphorus in runoff from a specific field entering a nearby stream. The P Index currently has two types of uses: 1. nutrient management planning and 2. water quality improvement planning to identify where the major sources of phosphorus (P) are on the landscape. It also shows why these areas are problems. Field P Index values are calculated using the SNAP+ nutrient management and soil loss assessment software program.

32. **POWTS – Private On-Site Waste Treatment Systems:** a sewage treatment and disposal system serving a single structure with a septic tank and soil absorption field located on the same parcel as the structure. This term also means an alternative sewage system approved by the department including a substitute for the septic tank or soil absorption field, a holding tank, a system serving more than one structure or a system located on a different parcel than the structure. A private sewage system may be owned by the property owner or by a special purpose district.

33. **PS&P – Agricultural Performance Standards and Prohibitions:** All cropland and livestock operations in Wisconsin, regardless of size, must abide by the agricultural performance standards and manure management prohibitions.
    a. Agricultural performance standards include:
        - Control cropland erosion to meet tolerable rates.
        - Build, modify or abandon manure storage facilities to accepted standards.
        - Divert clean runoff away from livestock and manure storage areas located near streams, rivers, lakes or areas susceptible groundwater contamination.

- Apply manure and other fertilizers according to an approved nutrient management plan.

b. Manure management prohibitions include:

- No overflow of manure storage facilities.
- No unconfined manure piles near water bodies.
- No direct runoff from feedlots or stored manure into state waters.
- No trampled stream banks or shorelines from livestock.

34. **RC&D – Resource Conservation and Development:** Wisconsin has seven RC&D areas, covering all Wisconsin counties. RC&D works to stir up new opportunities, link people together, and help promote economic develop while protecting the natural resources. RC&D is a USDA program administered by the Natural Resources Conservation Service.

35. **SEG – Segregated Funding**

36. **SNAP+ - Soil Nutrient Application Program:** is a Microsoft Windows® based Nutrient Management Planning software program designed for the preparation of nutrient management plans in accordance with Wisconsin's Nutrient Management Standard Code 590.

37. **SSA – Sewer Service Area:** The State's Area wide Water Quality Management Planning code (Wisconsin Administrative Code, NR 121) establishes Sewer Service Area (SSA) Planning. The WDNR is responsible for working with regional planning commissions, county governments, municipalities, townships and the public to develop SSA plans that guide publicly sewered growth and which protect water quality.

38. **SWRM – Soil and Water Resource Management:** The Soil and Water Resource Management Grant Program supports locally-led conservation efforts. Each year DATCP awards grants primarily to counties to pay for conservation staff and provide landowner cost-sharing to implement Land and Water Resource Management plans.

39. **"T" – Tolerable annual soil erosion rate:** represents the tolerable soil loss for any specific soil. The term signifies the point at which new soil is naturally produced in greater or equal amounts to that which is lost to erosion. T values range from one to five tons per acre per year, depending on the soil type.

40. **TMDL – Total Maximum Daily Load:** the amount of pollutant that a water body can tolerate before it exceeds water quality standards. A TMDL is required for each state impaired water body to address each pollutant or impairment.

41. **TSS – Total Suspended Solids:** the amount of organic and inorganic particles suspended in the water column. TSS measures the weight of the particles and high values can have implications on light penetration, recreational value, and habitat value.

42. **TRM – Targeted Runoff Management:** A DNR administered program that provide grants to local communities to control polluted runoff from both urban and rural sites. The grants are targeted at high-priority resource problems. Projects funded by TRM grants are site-specific and serve areas generally smaller in size than a sub watershed. The grant period is 2 years, with a possible 1-year extension. The maximum cost-share rate available to TRM grant recipients is 70 percent of eligible costs, with the total of state funding not to exceed $150,000.

43. **USDA-FSA – Farm Services Agency:** administers and manages farm commodity, credit, conservation, disaster, and loan programs as laid out by Congress through a network of federal, state and county offices. These programs are designed to improve the economic stability of the agricultural industry and to help farmers adjust production to meet demand.

44. **USDA-NRCS – Natural Resources and Conservation Services:** The Natural Resources Conservation Service is the federal agency that works with landowners on private lands to conserve natural resources. NRCS is part of the U.S. Department of Agriculture. Three-fourths of the technical assistance provided by the agency goes to helping farmers and ranchers develop conservation systems uniquely suited to their land and individual ways of doing business.

45. **UWEX – University of Wisconsin Extension Service:** offers Wisconsin people access to university resources to engage in lifelong learning, wherever they live and work.

46. **WBI – Wisconsin Buffer Initiative:** was a collaborative effort between a diverse group of Wisconsin citizens and UW-Madison scientists to develop recommendations for the Wisconsin DNR on how riparian buffers can be part of a larger conservation system to address agricultural nonpoint source pollution. Instead of a fixed standard that would be uniformly applied across the diversity of Wisconsin's agricultural landscapes, the

collaboration developed an innovative approach that identified site-specific areas where buffers, as part of a larger conservation system, would have the greatest likelihood of reducing pollution in waters that would benefit the most from this reduction.

47. **WisDNR – Wisconsin Department of Natural Resources:** The State agency dedicated to the preservation, protection, effective management, and maintenance of Wisconsin's natural resources. It is responsible for implementing the laws of the state and, where applicable, the laws of the federal government that protect and enhance the natural resources of our state.

48. **WLI – Working Lands Initiative:** included as part of the 2009 – 2011 state budget signed into law by Governor Doyle on June 29, 2009. Three main components in the budget include updates to the state's current Farmland Preservation Program.

49. **WLWCA – Wisconsin Land and Water Conservation Association:** a 501(c)(3) nonprofit organization representing Wisconsin's County Board Land Conservation Committees and Departments.

50. **WPDES – Wisconsin Pollution Discharge Elimination System:** Through the Wisconsin Pollutant Discharge Elimination System (WPDES) permit program, the DNR regulates municipal, industrial, and animal waste operations discharging water to surface or ground waters. Because of the potential water quality impacts from CAFOs, animal feeding operations with 1,000 animal units or more are required to have a Wisconsin Pollutant Discharge Elimination System (WPDES) Concentrated Animal Feeding Operation permit. These permits are designed to ensure that operations choosing to expand to 1,000 animal units or more use proper planning, construction, and manure management to protect water quality from adverse impacts.

51. **WTA – Wisconsin Towns Association:** a statewide, voluntary, non-profit and non-partisan association of member town and village governments in the State of Wisconsin controlled by its Board of Directors. WTA's twin purposes are to (1) support local control of government and to (2) protect the interest of towns.

52. **WVIC – Wisconsin Valley Improvement Company:** a private corporation that operates 21 water storage reservoirs to regulate a uniform flow in the Wisconsin River. WVIC coordinates the operation of the 25 hydroelectric plants on the Wisconsin River that are owned and operated by ten utilities or paper companies.

53. **303 (d) “impaired” water resources:** identifies surface waters that do not meet water quality standards expressed in Chapters NR 102-105 of the Wisconsin Administrative Code. The Impaired Waters List is submitted every two years to the United States Environmental Protection Agency (USEPA) as required under Section 303(d) of the federal Clean Water Act.

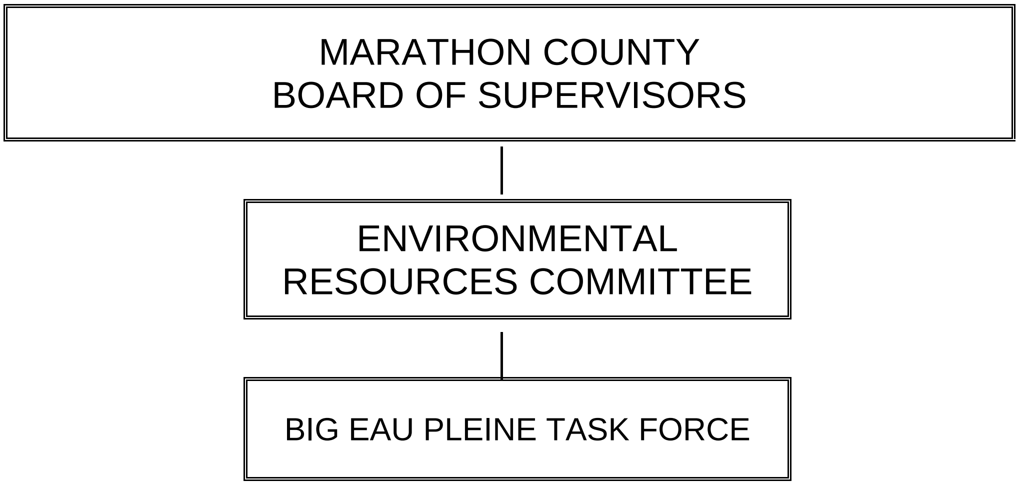
APPENDIX B

STRATEGIC PLAN

FOR THE

BIG EAU PLEINE RIVER WATERSHED AND RESERVOIR

December 2011



BIG EAU PLEINE TASK FORCE

John Small, Task Force Chair	Marathon County Supervisor
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Andy Johnson, Environmental Resources Coordinator	Conservation, Planning & Zoning
William Duncanson, Director	Parks, Recreation and Forestry
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Steve Oberle, County Conservationist	Taylor County
Dave Ruesch	Farm Producer
Ken Hein, Maple Ridge Dairy	Farm Producer
Michael R. Paul, President Ken Dorshorst, Member	Big Eau Pleine Citizen Organization

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Paul Daigle	Conservation Division Manager

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STRATEGIC PLAN
FOR THE
BIG EAU PLEINE RIVER
WATERSHED AND RESERVOIR

List of Acronyms

BEPCO	Big Eau Pleine Citizens Organization
BMP	Best Management Practices
DATCP	Wisconsin Department of Agriculture, Trade and Consumer Protection
DO	Dissolved Oxygen
DNR	Wisconsin Department of Natural Resources
FERC	Federal Energy Regulatory Commission
LWRM	Land and Water Resource Management
MOA	Memorandum of Agreement
NRCS	USDA-Natural Resources Conservation Service
POWTS	Private On-site Waste Treatment Systems
PPM	Part per million
TMDL	Total Maximum Daily Load
WVIC	Wisconsin Valley Improvement Company

INTRODUCTION

As ice melting and spring runoff events began on the Big Eau Pleine Reservoir in the spring of 2009, residents, sportsman and officials saw the first evidence of a significant fish die-off. In January, the dissolved oxygen (DO) levels throughout the reservoir had dropped below 1 part per million (ppm). Without areas of safe harbor for the fish within the reservoir or adequate aeration capacity to provide a limited refuge for fish, the fishery collapsed. Unfortunately, fish kills are not new to this river and reservoir system. Low dissolved oxygen levels during the mid to late winter have been a reality with the reservoir since its construction in 1937.

In response to the fish kill, Marathon County convened a meeting between Wisconsin Department of Natural Resources (DNR), Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), Big Eau Pleine Citizens Organization (BEPCO) and Wisconsin Valley Improvement Company (WVIC) to develop a short term plan to assess the impact on the fishery, adequacy of the aeration system, and water quality conditions. In November 2009, the Big Eau Pleine Task Force completed the short term strategic plan which included the following:

a. Historic Case Study of the Big Eau Pleine Watershed and Reservoir. The case study summarizes nearly 70 years of water quality studies, management plans, conservation projects, and regulatory initiatives aimed at reducing the sediment and nutrient runoff.

b. Action Plan to Upgrade the 1981 Aerator System. The plan described the purpose, condition and performance of the aeration equipment as of 2009. The plan outlined improvements to the aeration equipment to improve performance, as well as a Memorandum of Agreement (MOA) to clarify the roles and contributions of the partners in the aeration equipment's on-going operations and maintenance.

c. Long Range "Plan of Work" to Address the Water Quality and Quantity of the Big Eau Pleine River System. The "plan of work" identified the partners and actions needed to assess best management practice needs.

The Big Eau Pleine Task Force submits this document to identify the role of governmental agencies, sportsman and citizen groups, educational institutions, agricultural groups, and the WVIC to improve the health of the river system while balancing the needs of community and economic interests. It will also provide a foundation of understanding for the policies that may be proposed by local leaders.

FRAMING THE PARTNERSHIP PROCESS

The strategic plan process is designed to build upon the existing capacities and resources of agencies to efficiently leverage financial and technical assets. The task force was established by Marathon County to assure that all interested parties were represented and County policy is based upon recommendations consistent with community and economic development goals.

The task force consisted of representatives of USDA-Natural Resources Conservation Service (NRCS), DNR, WVIC, DATCP, Clark County, Marathon County, Taylor County, BEPCO, and local dairy producers. It was important for farm producers to be part of the task force to assure that members understand farming challenges and the effectiveness of conservation initiatives.

THE ECONOMIC AND LANDSCAPE CONTEXT OF THE BIG EAU PLEINE

Policy recommendations and program activities for the Big Eau Pleine River Watershed and Reservoir need to be established with an understanding of the region’s unique natural resources and economic contributions. Recommendations must realistically capture the scope of financial and technical resources required to improve the water quality and the time required for best management practices to influence change in water quality. The financial limitations of landowners, industries and public agencies require that local partnerships coordinate and leverage multiple-sourced resources to be effective.

The Big Eau Pleine is part of the Upper Wisconsin River basin which comprises nearly 20% of the State’s landscape. The reservoir acts as the major source of water that is used to help regulate the flow of the Wisconsin River during low flow seasons. DNR has identified four (4) municipalities and eight (8) industries within Marathon County along the Upper Wisconsin River with Wisconsin Pollutant Discharge Elimination System permits that base respective discharge limits upon water flow in the river. The operation of the Wisconsin River System, including the Big Eau Pleine reservoir is the responsibility of WVIC with regulatory authority provided by the Federal Energy Regulatory Commission (FERC).

The Big Eau Pleine agricultural producers represent nearly 850 farms. These farms create $100 million annually of direct farm receipts from dairy and commodity crops. Fifteen percent of Marathon County’s jobs are created by the agricultural industry. Profitable farmers with reasonable and achievable performance criteria and incentives are critical to the success of any proposed policy initiatives. Success is achieved when soil and water resources are protected while assuring that landowners meet the challenge of producing food.

The Big Eau Pleine Reservoir is a regional recreation destination. The Marathon County Parks, Recreation and Forestry Department provides recreational opportunities within 3 parks in the Big Eau Pleine watershed. The most notable is the Big Eau Pleine Park which consists of 2,050 acres located on the north shore of the 7,000 acre Big Eau Pleine Flowage. Poor water quality and fish kills significantly impact the economic and recreational opportunities associated with the reservoir such as boating, swimming, fishing and businesses that support these activities. The Big Eau Pleine Park represents a major public investment of land and recreational infrastructure along the reservoir. In 2010, camping in the BEP Park generated nearly $300,000 of revenue for the local economy. According to BEPCO estimates, nearly $2 million of economic activity is generated annually from fishing opportunities in the watershed.

MAKING THE CASE FOR ACTION IN THE BIG EAU PLEINE RIVER WATERSHED

The Big Eau Pleine watershed includes nearly 238,000 acres with 217,000 acres in Marathon County, 8,500 acres in Clark County, and 12,000 acres in Taylor County. It represents the most extensive agricultural area in Marathon County with nearly 60% of the land base under active cropping use and 17,000 cows. The fine textured soils, extensive man-made field drainage system, and loss of wetlands create a “flashy” hydrology where runoff from snowmelt and rain carry soil and manure loads to streams. The runoff contributes excessive loads of nutrients to the reservoir and Wisconsin River. The soil sediment, organic matter and nutrients compromise the water quality necessary to support a sustainable fishery and provide high quality recreational activities. Excessive nutrient loading contributes to algae blooms which occur several times annually. Decomposition of algae and organic matter sediment consumes available dissolved oxygen needed by the fishery in the winter.

Water quantity management and operational activities for the reservoir are a complicated balancing act. The WVIC must strive to meet the water flow needs of the Wisconsin River for municipal discharges, power and paper industries, as well as sustain the natural resources and recreational expectations of the local communities. The waters of the Big Eau Pleine Reservoir are necessary to help sustain the river flows during low flow periods, commonly in summer and winter.

The “60% Solution” is a water quantity management concept proposed by BEPCO to reduce the probability of fish kills. BEPCO has assessed that there is a very strong statistical correlation between fish kills and prescribed water levels over winter. The concept is supported by 40 years of operational data, but the application of the data to reservoir operations is not endorsed by all parties. The DNR recommends a winter storage goal of 60%, using operation criteria from July through November to continue protection of the Wisconsin River target flows and maximize the potential to reach the 60% winter storage goal. WVIC wants to maximize operational flexibility, but recognizes the value of winter storage goals.

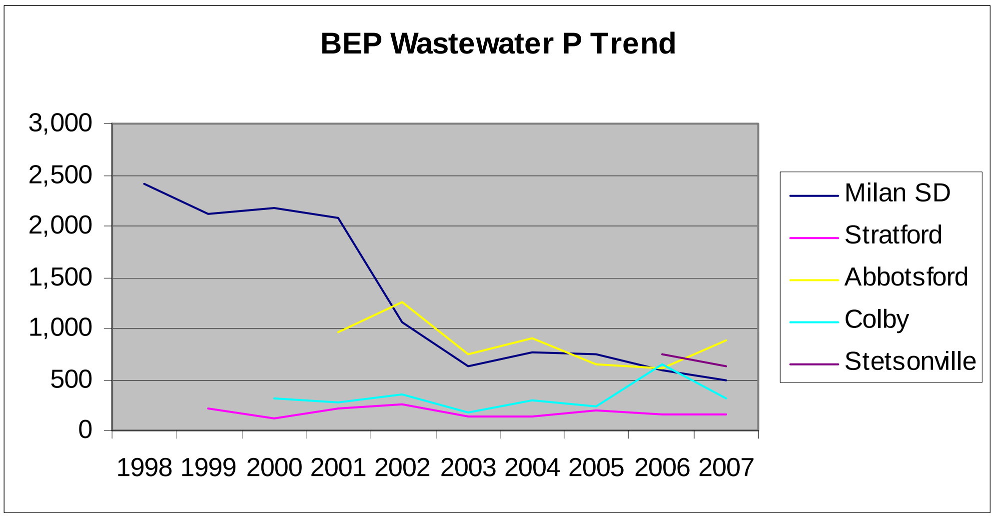
Through modeling conducted at BEPCO's request, the WVIC determined that it is possible to change the summer and winter operating procedures and realize a significant increase in water levels over winter during drought conditions. This can be done while still protecting minimum Wisconsin River flows and without impacting flows or reservoir operations upstream of the Big Eau Pleine. However, WVIC believes that a change in reservoir operations every year is not required to help protect the fishery. Moreover, modifying the operating plan according to the modeling would result in an estimated hydropower generation loss averaging 1.7 million KWh per year whether drought conditions existed or not. Instead, the WVIC believes that its enhanced drought contingency plan is the methodology that should be used to address severe drought conditions and thereby help protect the fishery during these extreme events, not a permanent change in reservoir operations.

Agricultural producers have a long history of implementing conservation in the watershed. Although most farmers are in compliance with state agricultural performance standards and local ordinances, the sediment and nutrient loads remain too high to protect the water quality. In cases where performance standards are not being met or chronic runoff events occur that threaten the water quality and fishery, Marathon County may need to provide an increased regulatory presence. In order to require farmers to reach beyond current performance criteria, additional education, technical and financial assistance will need to be offered. Marathon County with its partners must provide producers with better strategies to minimize runoff through soil saving Best Management Practices (BMPs), nutrient management plans, and manure treatment and distribution technologies such as anaerobic digestion and manure injection equipment.

Farming is not the only contributor to pathogens, nutrients, and sediment to the Big Eau Pleine River system. Sediment from non-metallic mining, once a significant contributor of sediment to the river system, is now regulated and minimized through state codes and local ordinances. Continued support of administrative and technical efforts by local and state agencies in regulation of these mining activities is necessary. Similarly, private sanitary treatment systems contribute less than 1% of the nutrient load to the river but pose serious public health concerns when left to directly discharge into ditches and waterways. Current regulatory oversight has been effective in controlling design and operations of new Private On-site Waste Treatment Systems (POWTS), but more needs to be done to address discharges from old systems and the education of holding tank owners to reduce discharges of human wastes.

Soil erosion from non-agriculture activities has been significantly reduced since storm water permits have established erosion control standards for construction sites, road work, and industrial storage. The mass of phosphorous discharged to the Big Eau Pleine River from point sources has been reduced with the inclusion of phosphorous limits in waste water permits since 1997 (see Table 1).

Table 1. Pounds of Phosphorus Delivered/Year.



CONCLUSION

The Big Eau Pleine River Watershed and Reservoir represent tremendous natural and cultural resource assets to our community. The watershed is home to an agricultural industry producing and processing a variety of dairy and commodity products. The rural character of the region is defined by its land use, beauty and the local businesses. However, runoff from fields and farmsteads threatens the health of its people, soil and water resources, and community. The time to act is now.

For nearly 80 years, conservation agencies have worked with private landowners and shared in their investments to improve the management of the soil and water resources in order to sustain its inherent productivity and to help them prosper. Even though the landowners have done much to meet the expectations of state and local resource management goals, the Big Eau Pleine River and Reservoir remains a polluted water body due to runoff of nutrient, soil sediment, and organic matter. Aeration alone is not enough to protect the fishery through low oxygen periods.

Marathon County needs to lead an effort with many identified partners to efficiently leverage existing and new resources to continue improvements of water quality. Education, technical assistance and financial incentives are needed to help landowners, cities, villages, and towns better manage and protect the resources in ways that are profitable and sustainable.

The recommendations forwarded by the Big Eau Pleine River Task Force represent policies and activities that Marathon County should develop, coordinate and implement to lead a local effort to improve community and economic development opportunities, as well as minimize public health concerns associated with the watershed's water quality.

The fish kill of 2009 is symptomatic of a serious water quality problem caused by excessive soil sediments, nutrients and organic matter that flow into the Big Eau Pleine Reservoir. Conditions are made worse by low flows during drought periods. Until poor water quality is abated in the Big Eau Pleine Reservoir watershed, the potential for fish kills will remain.

POLICY RECOMMENDATIONS

- **Aeration System Operation and Maintenance**. The aeration system will be an ongoing and necessary management tool to the well-being of the reservoir and fishery. It opens 30-60 acres of water surface for aeration during the late winter and early spring. Operations and maintenance and capital expenditures for the system will be administered through a Memorandum of Agreement established for 5 year periods.

  WVIC, the FERC licensed operator of the reservoir, and DNR, the owner of the land and aeration equipment, will serve as the primary agents to determine the start-up criteria, safety and operations of the system. These organizations will also serve as the primary water quality monitoring agents for the tributary and reservoir waters.

  Participating partners should contribute funds to annual electrical costs and the repair or replacement of capital improvements such as items associated with motors, blowers, and buildings.

- **Resource Management Initiatives**. The local, state and federal agencies serve as the primary vehicle of delivery of local conservation programming to landowners and residents. Local conservation programs include education, resource assessments and planning, technical assistance, grant funding, and administration of regulations. Marathon County will provide leadership through policy, and partnership coordination through the Marathon County Comprehensive Plan. Specifically,

  j. Marathon County will:

  i. Adopt and implement state agricultural performance standards in local ordinance to address chronic and significant discharges.
  ii. Minimize or eliminate winter land surface spreading activities of wastes.
  iii. Promote technologies to treat and distribute livestock waste.
  iv. Provide Best Management Practice education and training to landowners.
  v. Administer the Non-metallic Mining Ordinance.
  vi. Eliminate direct surface discharges of sanitary wastes.
  vii. Develop a reservoir recreation management plan.
  viii. Provide financial support of annual operational costs of the aerator.
  ix. Develop and implement a Fenwood Creek pilot project (see description below).

  k. WI Department of Natural Resources (DNR) will:

  i. Develop a reservoir management plan to protect the natural resources (land, water and fish) of the Big Eau Pleine reservoir and tributary waters. The plan will set goals for the fishery and supporting food system.
  ii. Provide lake management grants to local partners.
  iii. Complete a water quality assessment of the Upper Wisconsin River Basin and develop a Total Maximum Daily Load (TMDL) plan for the Big Eau Pleine Watershed and Wisconsin River.
  iv. Support Taylor, Marathon, and Clark Counties with investigation and enforcement of agricultural performance standards and prohibitions.
  v. Provide Best Management Practices cost-share grants to landowners.
  vi. Provide water quality monitoring of algae concentrations that threaten public health.
  vii. Primary responsibility role (with WVIC) for the aeration system in an operation and maintenance plan.
  viii. Coordinate aeration system operations (with WVIC).

  l. WI Department of Agriculture, Trade and Consumer Protection will:

i. Provide BMP grants to landowners for state agricultural performance standard(s) compliance.
ii. Provide administrative support for the Farmland Preservation Program.
iii. Coordinate education with agriculture industry associations to producers on nutrient management and non-point runoff controls.

m. Wisconsin Valley Improvement Company will:

i. Provide water quantity and quality monitoring.
ii. Coordinate aeration system operations with DNR.
iii. Lead reservoir operation activities.
iv. Update reservoir modeling tool(s) and drought management plan at 5-year intervals (next update due 2016).

n. USDA – Natural Resources Conservation Service will:

i. Provide technical assistance, conservation planning, and engineering support to landowners.
ii. Provide cost-share assistance to landowners.
iii. Develop and implement manure winter spreading evaluation and planning strategies to minimize runoff risks.

o. Big Eau Pleine Citizens Organization will:

i. Provide a citizen’s voice to community needs relative to property, resource management, and public waters.
ii. Coordinate input from community-based organizations such as recreational and lake groups to provide feedback about program outcomes and outreach needs.
iii. Pursue grant opportunities.

p. Farm industry representatives will:

i. Provide landowner education.
ii. Provide feedback on incentives and program initiatives.

q. Taylor County Land Conservation Department will:

i. Implement conservation programs focusing upon conservation compliance, nutrient management, and animal waste management through the Land and Water Resource Management (LWRM) plan.
ii. Provide education on groundwater protection and Best Management Practices.

r. Clark County Land Conservation Department will:

i. Implement conservation programs focusing upon conservation compliance, nutrient management, and animal waste management through the LWRM plan.

ii. Implement Heart of America's Dairyland Agricultural Enterprise Area.

- **Fenwood Creek Watershed Project**. Because the water quality assessment activities and the Big Eau Pleine River and Reservoir Total Maximum Daily Load plan will not be completed until 2015-16, the task force recommends that the agencies initiate a small scale watershed project. The purpose of the project is to develop the strategies relative to Best Management Practices, waste treatment and distribution technology implementation, conservation planning, financial incentives, technical assistance, and education needed to achieve water quality outcomes for the watershed. The project would include the following elements:

  - <u>Water quality monitoring</u>. Assess the management and environmental performance of BMPs, quantify the pollutant contributions of major event runoff discharges vs. chronic low-level discharges, and document changes in water quality over time.
  - <u>Education</u>. Communicate performance expectations and regulatory requirements to landowners, towns, cities and villages.
  - <u>Nutrient management planning</u>. Provide technical and financial assistance to landowners to assure all producers have and follow nutrient management plans.
  - <u>Manure winter spreading assessments</u>. Develop and implement criteria to assess winter spreading runoff risks and provide planning assistance to landowners to manage risks.
  - <u>"Edge of Field" Best Management Practices</u>. Implement BMPs down slope of cropland to treat and reduce sediment and nutrient loading from runoff. In cases where runoff contributions are chronic and cannot be minimized to acceptable levels, permanent land use conversion strategies will be developed.
  - <u>Financial and management incentives.</u> Develop financial and management incentives to promote BMP implementation, including long-term maintenance and performance of BMP.

<u>Waste treatment and distribution technology</u>. Increase understanding and implementation of waste treatment and distribution technologies that reduce runoff risks and maximize nutrient utilization. Provide cost-benefit analysis of new technologies and develop adoption strategies.

APPENDIX C

CASE STUDY

FOR

BIG EAU PLEINE WATERSHED

December 2009

BIG EAU PLEINE TASK FORCE

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Jim Burgener, Assistant Director	Conservation, Planning & Zoning
Andy Johnson, Environmental Resources Coordinator	Conservation, Planning & Zoning
Bill Duncanson, Director	Parks, Recreation and Forestry
Scott Watson, Basin Supervisor	Wisconsin Dept. Natural Resources
David Coon, Director Environmental Affairs	Wisconsin Valley Improvement Company
Michael R. Paul, Vice President	Big Eau Pleine Citizen Organization

INTRODUCTION

In the spring of 2009, during the seasonal runoff and ice melting period, the Big Eau Pleine Reservoir experienced a significant fish kill. Low dissolved oxygen levels during the spring, as well as high algae concentrations have been associated with the reservoir since its construction in 1937. This case study will provide an overview of the physical characteristics of the watershed, land use, land management, environmental studies, and a history of the conservation initiatives that define the story of the watershed. The intent of the case study is to provide a historical perspective of water quality and quantity issues for the watershed to serve as a basis for developing a long range plan for the river system.

PHYSICAL OVERVIEW

Geography. The watershed includes 363 square miles. The Big Eau Pleine River flows into the reservoir (which swells to 6,677 acres when full) and then to Lake DuBay, both flowages of the Upper Wisconsin River Central Sub Basin. The BEP River Watershed drains approximately 238,000 of the following land use distribution: cropland (60%) – 142,800 acres, pasture (15%) 35,700 acres; 3. Woodland (17%) – 40,460 acres; and 4. Miscellaneous (8%) – 19,040.

The BEP watershed includes the following Villages and Cities: Stratford, Colby, Abbotsford, Dorchester, Stetsonville, Fenwood, and Milan.

Soil Resources. The soils of the watershed provide the basis for a productive agricultural industry. The soils of the Upper BEP Watershed are poorly drained with low infiltration and permeable rates. The non-erosive removal of surface water through a system of terraces, grassed diversions, waterways, and drainage ditches to create an aerated root zone is the basis of most historical conservation and agricultural initiatives. Soil textures create three agricultural management practices that pose direct water quality implications in this watershed:

1. *Seasonal Soil Saturation and Waste Applications.* Manure applications occur in the fall and spring and coincide with saturated surface soil conditions and groundwater recharge.
2. *Waste Application onto Frozen Soils*. Many manure spreading operations (emptying of waste storage facilities) occur after soils freeze (fall) or before they thaw (spring) in order to accommodate and support the weight of loaded equipment.
3. *Fall Tillage*. Fall plowing is beneficial in allowing the producer to distribute the labor for nutrient management, tillage and seedbed preparation over two seasons. Hauling waste in the late fall and early winter also minimizes road loading stress and conflicts during the spring when weights limits are necessary to protect roads as the frost and water are leaving the roadbed.

Water Resources. The BEP River Watershed consists of nearly 210 miles (116 in UBEP and 94 LBEP) of rivers and streams. Much of the early agricultural development was supported by relatively shallow dug wells. Because of the extensive surface drainage system, the recharge of the aquifer has been compromised. Water quality assessments indicate that flashiness of hydrology (the rapid rate of runoff) is a major contributor to degradation of water quality, aquatic habitat, and the fishery of the river system. In recent years, due to increase water consumption of industry, agriculture, residential, and municipal interests, the quantity of groundwater is becoming a concern. See Map 4 for surface water delineations, including Outstanding and Exceptional Waters.

Farms. In 1972, the BEP watershed consisted of 1,050 dairy farms with an average size of 180-200 acres. These farms managed on average a dairy herd of 70 cows with calves. 900 dairy farms during the 1980's.

CONSERVATION INITIATIVES

During the 1940-1950's the focus on conservation was to develop the productive agricultural potential of Marathon County. Government assistance provided public financial and technical assistance to farmers through liming, fertility, erosion control, and design of water disposal systems. The following list key dates and activities of early conservation efforts:

- 1941 - Marathon County Soil and Water Conservation District established
- 1958 – BEPCO and Rib River Watershed Association.
- 1965- Inventory of BEP Watershed project completed. Sedimentation and pollution from agriculture identified and assessed for first time.
- 1972 – Clean Water Act establishes federal policy.

STUDIES AND ASSESSMENTS

10. 1958 – The Wisconsin Valley Improvement Company (WVIC) began measuring dissolved oxygen levels in the BEP Reservoir.
11. 1965 – First BEP watershed inventory.
12. 1972 National Eutrophication Study. A predicted annual P load of 92,500 lbs.
13. 1974 UW- Stevens Point Study of Reservoir. Predicts that 50% reduction in P loads would reduce algae concentrations in reservoir by 57%. Independent studies by EPA and UW-Stevens Point indicate that Phosphorus (P) is the limiting or controlling nutrient levels in the BEP. A similar loading of 100,000 lbs. was calculated, a 58% P reduction would need to be realized to achieve a perceivable improvement of water quality. The UWSP study indicated that 75% of P load was delivered during November and April. About 95% of load came from agriculture (3% from municipal and industrial sources). Septic tanks are contributing approximately 1%. Manure is major source of the organic pollutant and Phosphorus load. The UWSP study indicated that 87% of farm operations spread manure in winter.
14. 1982 – 1992 Non-point Priority Watershed (Upper and Lower Sections). The appraisal determined that phosphorus was the primary pollutant of concern. The report indicated that the flashy hydrology is a huge concern to the condition and use of the water system. Headwaters streams are often fed by wetland drainage. It is estimated that 54% of nutrient enrichment occurs during the spring season with runoff and snowmelt.
15. 1992 - DNR LBEP River Resource Appraisal Final Report (Jim Krietlow). This reports states that the total P load delivery to the reservoir is 163,636 lbs. annually from the BEP watershed of which 78,860 lbs. is point-sourced (42,161 lbs. controllable) and 84,776 lbs. non-point sourced (29,196 lbs. controllable).

16. *2009 - Big Eau Pleine Flowage Winter Runoff Study* (Mark Hazaga). The dominant land use of dairy farming in the BEP contributes significantly to increased delivery of bacteria, BOD and P to tributaries. The average BOD load of the BEP during three days of runoff was compared to Wausau's average 3 day influent of BOD. The BOD load in BEP was 14 times greater than the influent (raw sewage) BOD load to Wausau Wastewater Treatment Plant.
17. Soil Erosion Transect Survey (1999-2008). Over the period of tracking, the erosion rates within the BEP watershed have averaged approximately 2.3 tons per acre per year. Ninety five percent of the sediment delivery to the streams and reservoir is sourced from this upland soil erosion.

CONSERVATION PROGRAMMING

6. *Model Implementation Program* – MIP (United States Department of Agriculture, USDA and Environmental Protection Agency, EPA, 1977). Robert Gall indicates that WVIC began measuring dissolved oxygen levels in 1958 and has observed oxygen depletion to one part per million or less almost every year with fish kills occurring during most of those years (1958 to 1977). The MIP Pilot Project was designed to show how agency cooperation and the positive benefits/efficiencies of targeting financial and technical resources can improve the resource problems of the watershed. Landowners have access to ASCS funds, but are expected to shoulder some costs and to maintain best management practices. The program's structural policy is based upon voluntary participation in programs with financial and technical support provided by public agencies.

   A rapid improvement of water quality was expected because of the program efforts. The improvement (outcome) would be seen as a reduction in the intensity of algae bloom.

7. *Hamann Creek Watershed Project-1978.* (16,000 acre drainage area).

This voluntary project was established in March 1978 in response to the failure of Model Implementation Program bid. The project's funds ($100,000) were administered through the Marathon County Agricultural Stabilization and Conservation Service (ASCS). Conservation best management practices focused on vegetated channels, terracing, soil treatment (liming), permanent vegetated areas, and pond dugouts. The intent of the project was to focus conservation efforts on a relatively small watershed (third order) with monitoring to determine if technical assistance and funds could provide measurable water quality benefits.

3. *Upper Big Eau Pleine (UBEP).* Implementation began July 1987 and was completed in August 1995.

Of the approximately 900 farms inventoried for the UBEP project, Table 2 identifies the breakdown of landowners/resource concerns that were determined to be eligible for program funds and technical assistance.

Table 2. Rankings of Evaluated UBEP farms:

	Manure Spreading	Cropland Erosion	Animal Lot Runoff
No. Eligible Operations	212	244	121
Pollutant Reduction if all eligible operations participate	70%	90%	70%

According to this report, the estimated total P load is 161,636 lbs. annually (1987). With 1989 point source sampling results, the estimated P load was reduced to 128,613 lbs. annually. The nonpoint contribution is 106,500 lbs. Point sources represent overall 17% of P load. resource objectives.

Final Report by DNR (June 1997). The project plan estimated that if objectives met, overall P delivery would be reduced 16.2%. This would also reduce amount of algae by 16%.

During the 10-year period of the Upper and Lower Big Eau Pleine non-point source pollutant reduction programs, total phosphorus concentrations within the reservoir showed no improvement (no decline) from 1985 through 1994 based on WVIC water chemistry data. WVIC Trophic State Index (TSI) water quality studies conducted from 2000 through 2002 showed a slight increase in total phosphorus and chlorophyll 'a' throughout the reservoir. Secchi depth (water transparency) declined during this same period. The reasons cited by landowners for non-participation in the watershed program were: 1. avoidance of government, 2. too costly for BMP's, 3. cost-share offer not high enough, 4. poorly understood the eligibility criteria, 5. close to retirement age, and 6. left farming or uncertain of future.

In 1989, 17% of total P load to reservoir was from discharges of wastewater treatment plants. In 1995, it was determined that the point source loadings were close to 1985 levels. Regulatory rules are in place to improve this point source contribution by 2000 (See Table 3).

Land Management Evaluations:

1. Barnyard Runoff – thirty three (33) practices installed. UBEP project funded 31 projects and 2 were completed without cost-share money. Approximately 1000 lbs. Total P/ yr. in a 10 year storm event have been reduced or 42% of project goal. (42% of 70% = 29% reduction).
2. Manure Storage – realized 74% of project goal in eliminating winter spread manure. Sixty-seven (67) waste storage facilities were funded by project and 13 installed without cost-share funds. Note that Marathon County developed and adopted the first county-wide Animal Waste Storage Ordinance via leverage of the Priority Watershed Project.

3. Cropland Erosion – goal to reduce 25% of sediment delivery from cropland. Cropland is 95% of sediment source to reservoir. Only 10% of goal achieved (3% reduction in total erosion). Targeted rate of 2 Tons/acre/year. This was a difficult sell because most program compliance requirements are 4 tons/acre/year.
8. Milking center wastes – project did not address this waste source of P. This waste stream was addressed at 67 farms where the dilute waste was incorporated into designs for waste storage facility systems.

Financial evaluation:

1. State expended $1,786,429 for UBEP project.
   - $685,687 for local assistance (includes Taylor and Clark Counties) and
   - $1,100,742 for practice implementation, could have been much greater if all agreements were implemented (nearly 36% of agreements expired without action).

Summary – The BEP Reservoir will likely always be eutrophic, hampered by nutrients originating from agricultural lands. Sedimentation continues to be the major concern with phosphorus contributions.

Tracking progress hindered by lack of updated farm information (before vs. after).

Note that "critical sites" became a planning concept in 1993 but not incorporated into the UBEP project.

See Appendix B for list of participating landowners, cost-share agreements, and BMP implementation.

4. Lower Big Eau Pleine Watershed – LBEP (1991-2003). (139 sq. mi)

Inventory begins in 1991. Implementation begins in 1993 and ended in 2003. LBEP is a continuation of the UBEP effort aimed at reducing: polluted runoff from barnyards and feedlots, sediment from cropland, and runoff from winter spread manure.

Ground Water Assessment: A groundwater assessment involved well sampling; also a feature of this watershed: 23 % of wells collected had nitrates exceeding 10 mg/l (enforcement standard -ES) and 65% of wells had nitrates between 2-10 mg/l (preventative advisory level-PAL). The area wells were considered to have a significant nitrate concern. Triazine is found in 1% wells at ES levels while 19% of wells above PAL.

Surface Water Resource Assessments:

- 95% of the inventoried sediment source from cropland and 3% from streambanks
- Barnyards – 208 yards assessed contributing 9,873 lbs. P annually to waters.
- Streambanks – 99 miles assessed contributing 830 tons of sediment annually (3% of total).
- 12 miles of reservoir shoreline found to have eroding concerns contributing 513 tons annually. Affects 55 landowners.
- Upland sediment – 91,526 acres inventoried. Streams receive 23,755 tons annually (95% of total). 80% cropland, 8 grazed woods, and 3% pasture.

Pollution reduction Goals:

- sediment reduction by 35% (33% reduction of agricultural uplands, 45% reduction of streambank sediment, and 60% reduction of shoreland reduction)
- P reduction by 50%. To accomplish this goal 70% reduction from barnyard sources; 50% of winter spread organic pollutant sources on "unsuitable" acres; and sediment sourced P must be achieved. Unsuitable acres for winter spreading include acres located within 200 feet of surface water that have a significant surface drainage development, slopes greater than 4%, and flood prone.
- Algae controls reduction of 57%. A combined 50% reduction in P load from both UBEP and LBEP will reduce algae in reservoir by 57%.

Landowner participation: Voluntary:

- Agricultural lands: Category I eligible if eroding > 4.0 tons/ac/y. (16,379 ac or 31% of total sediment load), Category II eligible if erosion 2.0-4.0 tons/ac/y (9% of sediment load)
- Animal Lots (115 of 208 sites need control of runoff): Category I if > 40 lbs. P/year; Category II is 20-24 lb. P/year. The target delivery rate is 20 lbs. P/yr. (today's performance standard is 15 lbs. P/yr. or 5 lbs. P/yr. in a Surface Water Management Area).
- Manure Spreading: Category I if winter spread of 16 or more acres of unsuitable acres. Category II if spreading on 11-15 critical acres. Critical acres are those with slopes of 4% or if flood prone.

Funding projections:

- $5,902,043 ($4,738,750 for BMP installation w/ $2,391,865 cost-share portion, $50,000 for easements w/ 437,500 c/s, $1,099,733 staffing w/ $824,800 state local assistance, $13,560 for educational activities w/ $10,170 state allocation).

See Appendix C for list of participating landowners, cost-share agreements, and BMP implementation.

LBEP Close-out Report (compiled by CPZ staff):

Barnyard Runoff. There were 53 barnyard runoff projects installed through the priority watershed project. These projects reduced phosphorus loadings an estimated 6,142 pounds/annually (during a 10 year storm event) which is 62% reduction. The reduction goal was 70% reduction of P from this source. The cost for barnyards was $816,900.

Waste Storage Facilities. There were 28 waste storage facilities installed to reduce winter spreading applications of manure. These projects addressed 930 "critical acres." The project goal was to reduce manure applications to critical acres by 50% or 374 acres. The subset inventory may have underestimated the total critical acres in the watershed. The total cost for waste storage facilities was $681,213.

Cropland Erosion. The goal for cropland erosion was a 33% reduction. The project achieved 23% of its goal or a total reduction of 7.5% overall.

Streambank Erosion. The watershed goal was to reduce streambank erosion by 50%. The project installed 13,500 lineal feet of streambank fencing to limit cattle access and trampling of the stream banks. As a result, the project achieved 75% of its goal for an overall sedimentation reduction of 37.5%.

Other Practices. The watershed project also funded 4,482 acres of nutrient management plans, 977 acres of managed intensive grazing, 34 acres of wetland restoration, 12 acres of waterways, 30 milking center waste control systems, and 4 well abandonments. In all, 88 cost-share agreements were developed and implemented with $1,701,872.82 allocated to landowners.

9. *Marathon County Nutrient Management (NM) Program (March 1993).*

Marathon County initiates a Nutrient Management Program in April 1991, as part of the Priority Watershed Project. Project provided technical and planning assistance to farmers on a voluntary basis and initially works with farmers receiving municipal and industrial wastes for cropland applications. The project provides free soil and manure sampling for participants. The NM program finds that landowners are over applying fertilizer by 65% based upon soil tests and UW technical recommendations. Since NM is considered a new concept and management skill for landowners, most farmers are hesitant to participate. Most participation is limited to a small percentage of cropland in order to assure that reduced nutrient application does not lower yield production. The lack of whole farm participation makes it difficult to determine the environmental and economic implication of current fertilizer programs.

REGULATORY PROGRAMS AND COMPLIANCE

Local Land Management Ordinances:

- 1984 – Marathon County Board approves Animal Waste Storage Ordinance to regulate the construction and significant alteration of waste storage impoundments (earthen lagoons only). Incidental non-regulatory mention of STD 633-nutrient management. See Appendix D – history of AWO or Waste Storage Facility and Nutrient Management Ordinance.
- 2002 – State Agricultural Performance Standards and Prohibitions (NR 150's). This effort fully develops a statewide regulatory direction to conservation compliance and long term maintenance of public conservation investments. Regulatory compliance is guided by State agencies, but implemented through local ordinances and administration. See Appendix E – State Agricultural Performance Standards and Prohibitions (PS&P's). Note that administrative rules that implement the PS&P's are found in NR 151, 152, and 153, as well as ATCP 50. Chapter 92 of State Statutes provides County Land Conservation Committees authority to regulate these activities, conduct resource studies, and administer cost-share funding to implement rules.
- 2008 – Livestock Facility Siting Ordinance. This ordinance authorizes the County to regulate Concentrated Animal Feedlot Operations (CAFO's) with specific livestock types when over 500 animal units and they expand by over 20% of 2006 cattle population. Regulatory guidelines are provided by State Statute 93 and Administrative Rule ATCP 51. Marathon County CPZ Department works closely with regional DNR staff to coordinate the regulatory administration of this ordinance with NR 243 regulatory activities administered by DNR for CAFO's over 1000 animal units.
- 2009 – Waste Storage Facility and Nutrient Management Ordinance. This revision for the first time provides clear authority to the County to regulate nutrient management planning when associated with waste storage facilities. As of 2008, there are approximately 60,103 acres (40%) of cropland under Nutrient Management (NM) planning compliance in the BEP watershed. This represents 230 individual landowner/operator NM plans of which 104 are associated with Waste Storage Facilities (WSF's) constructed prior to 1985; 115 NM plans are associated with WSF's constructed after 1985 construction; and 11 NM plans are associated with program compliance requirement (not ordinance). There remain 19 total WSF systems currently without a NM plan (no cost-share to impose compliance). See Map 6 for farms with a NM plan. According to the 2007 CPZ Inventory of Waste Storage Facilities, there are a total of 313 waste storage facilities in the BEP watershed of which 252 are currently utilized (See Map 7 for location of waste storage facilities). Since 1997, when the closure of abandoned waste storage facilities became regulated by Marathon County through ordinance, the CPZ has closed 51 facilities in the BEP watershed.

Land Use Ordinances and Initiatives:

1. Zoning ordinances
2. Non-metallic Mining Ordinance.
3. Sanitary ordinances. See Map 8.
4. Farmland Preservation Program (41,344 acres enrolled). See Map 6.

    i. Contract Agreement – Compliance per Soil and Water Standards.
    ii. Zoning Certificates- PS&P's compliance

5. Managed Intensive Grazing Project

6. *Regulatory Compliance:*

Table 3. BEP Wastewater Permits: WPDES P loadings for municipalities (Lbs./year).

Municipality	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Milan SD	2404	2109	2183	2073	1058	620	769	738	597	492
Stratford		222	125	219	256	141	144	192	150	165
Colby			311	277	352	173	290	229	642	314
Abbotsford				958	1259	736	908	641	604	884
Stetsonville									747	629

Source NC – DNR (Jim Schmidt, 2007).

Table 4. BEP WPDES – DNR Concentrated Animal Feedlot Operation (CAFO) permits

Permit No	Facility	Animal Units	Dairy	Heifers	Calves
WI-0061841-02-0	Heeg Bros	1385	950	55	
WI-0061832-02-0	Maple Ridge	1465	975	70	150
WI-0062413-01-0	Lynn Bros	3623			
	Miltrim Farms (land)	2520	1800	0	0
	Bach Dairy (land)	>1000			
	Dic-Wisco Farms (land)	>1000			

Table 5. Marathon County Regulatory Programming Compliance

Program	Animal Units	Acres	No.	
Waste Storage Facility Ordinance			252	
NM Planning		60,103	230	
Farmland Preservation		41,344		
WSF abandonments			51	
SWRM compliance				
TRM compliance			24	
Livestock Siting Ordinance • DeJong Dairy • Hein Homestead Farms	 710 700			
Managed Intensive Grazing Project				

USDA programming to be determined.

List of Information or Inventory Needs

1. How much winter manure is spread? See Shaw's study for primary cause. Utilize SNAP+ modeling and landowner report capabilities to track fields and actual applications. Compare applications to weather and field conditions (saturation and frozen soil conditions).
2. Project monitoring should include stream sampling and soil conditions during fall, winter, and spring distribution periods.
3. How many cheese factories (1974 fish kill thought to be whey) still processing and disposing waste in watershed? Contribution to pollutant load? What are their respective treatment systems?
4. No distinction made relative to dynamics of delivery between liquid or solid manures. Is the increase in the presence of liquid waste (a function of feeding and waste water generation) creating a different pollutant loading and water chemistry dynamic?
5. How about the waste water contributions for farmers? Is the increasingly wet nature of the waste stream recognized? How about feed leachate contributions?
6. Determine the number of BMP's still in-place? No current inventory exists to determine how many BMP's still performing as designed.
7. How many farm facilities abandoned?
8. Determine condition of BMP's?
9. Find and evaluate the sub watershed monitoring of water parameters and habitat (if they exist).
10. Find annual and close-out summary of pollutant reductions as a result of BMP installation for all conservation initiatives.
11. Note the history of BEP Watershed Organization: 1956 (landowners and farmers).
12. Is proposed North Breeze Dairy located in BEP watershed?
13. Operational Plan – Does plan provide guidance to WVIC for drought conditions? In 2/26/1995 news article by *Wausau Daily Herald,* the following condition combinations assessed and identified over previous 16 years that would minimize fish kills:
    a. Reservoir volume at start of winter drawdown > 60%
    b. Base flow on BEP River = or > 6 fps
    c. Drawdown to a level below 10 ft. below capacity (which triggers scouring and promotes oxygen sag) did not occur until Feb 1.

14. The aeration system in BEP reservoir was first in state for a reservoir. Do we have experiences today of other similar attempts to aerate a reservoir where water levels fluctuate?
15. How does FERC license provide balance between hydropower and other public benefits such as fisheries, recreation, flood control and wastewater permitting?
16. Before Natzke project, how many practices (Waste Storage Facilities, barnyards, filter strips installed)?
17. Can we reduce flashiness through wetland developments and vegetated corridor work? Do we need to know the resuspension impact to water quality upstream? Is this load comparable to the reservoir loading due to re-suspension?
18. Using Appendix B & C can we do an assessment of BMP condition, utilization, and effectiveness of investments?
19. Do not know which landowners/sites were distinguished as eligible or eligible nonessential. Did the critical sites get the funding assistance?
20. Summary of livestock concentration trends, waste volume trends, and waste characteristics (liquid and solid).

APPENDIX D

Technical Memorandum #1

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.

October 2015

Fields near Seneca Lake, New York.

Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

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 www.epa.gov/xxx/tech_memos.htm

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.

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 detectable 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).


Abandoned waste storage structure.

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 bio retention 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 bio retention 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 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

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.

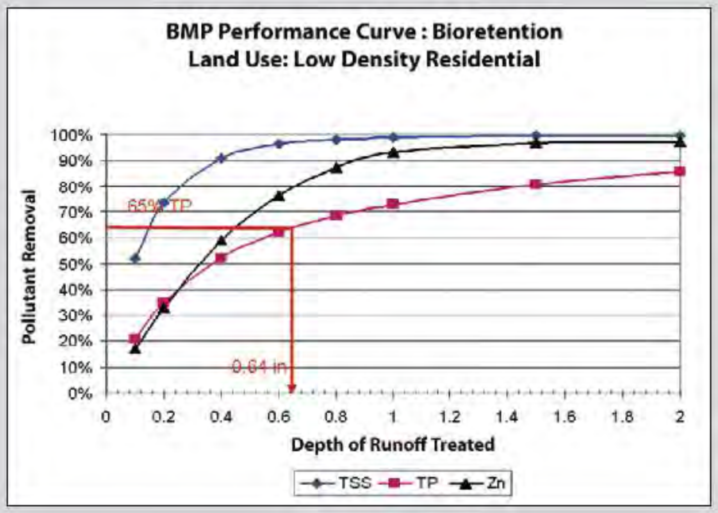


Figure 1. BMP Performance Curve for Bioretention BMP (Tetra Tech 2010).

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.

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 NO_3–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 disproportionally 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.

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

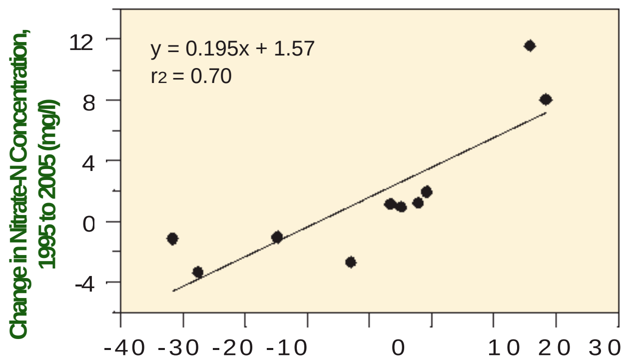
Although short-term (3–5 year) NPS watershed projects will not usually have a sufficiently long data record to evaluate incremental project effects, data on BMP depreciation might still improve interpretation of collected water quality data. Even in the short term, water quality monitoring data might 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[1]) 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 NO_3-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 NO_3-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

[1] "Total maximum daily loads" as defined in §303(d) of the Clean Water Act.



Change in Row Crop Land Cover
in Watershed Area (%), 1990 to 2005

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

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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APPENDIX E

APPENDIX E
Predominate Soil Types for Cropland in Fenwood Creek

Ranking	MUSYM	Soil Name	Slope % Range	Average slope	Acres
1	LoB	Loyal silt loam	1 to 6	3.5	5561
2	WtA	Withee silt loam	0 to 3	1.5	5510
3	FgB	Fewwood-Rozellville silt loam	2 to 6	4	4834
4	MfA	Marshfield silt loam	0 to 3	1.5	2500
5	RcB	Rietbrock silt loam	1 to 8	4.5	1872
6	ShA	Sherry silt loam	0 to 3	1.5	1756
7	ReB	Rietbrock silt loam, stony	1 to 8	4.5	1042
8	Fh	Fordum silt loam	0 to 1	0.5	555
9	MdB	Marathon silt loam	2 to 6	4	449
10	FeC	Fenwood silt loam	6 to 12	9	236
11	Ch	Cathro muck	0 to 1	0.5	175
12	FfC	Fewood silt loam, stony	2 to 15	8.5	156
13	MzB	Mylrea silt loam, stony	1 to 6	3.5	145
14	MdC	Marathon silt loam	6 to 12	9	74
15	Oe	Oesterle loam	0 to 2	1	71
16	MeC	Marathon silt loam, stony	2 to 15	8.5	41
17	MyB	Mylrea silt loam	1 to 6	3.5	35
18	LoC	Loyal silt loam	6 to 12	9	34
19	AmC	Amery silt loam	5 to 15	10	20
20	Mn	Minocqua sandy loam	0 to 2	1	12
21	McA	Mahtomedi loamy sand	0 to 3	1.5	7
22	FnC	Freeon silt loam	6 to 12	9	6
23	FnB	Freeon silt loam	2 to 6	4	6
24	SdA	Scott Lake silt loam	0 to 3	1.5	6
				Total	**25107**

Type	# of farmers	Acres	Soil Test P
Crop Farmer	2	656	20
Dairy Farmer	4	798	34

APPENDIX F

APPENDIX F
BASELINE CALCULATIONS

PI and T from SNAP+

MUSYM	Soil Name	Type	Baseline PI	Baseline T	Cover Crops PI	Cover Crops T	Difference vs Baseline PI	Difference vs Baseline T	Increase Hay by 1 yr. PI	Increase Hay by 1 yr. T	Difference vs Baseline PI	Difference vs Baseline T	No-Till PI	No-Till T	Difference vs Baseline PI	Difference vs Baseline T	Chisel/reduced tillage PI	Chisel/reduced tillage T	Difference vs Baseline PI	Difference vs Baseline T	Spring chisel/ recduced tillage PI	Spring chisel/ recduced tillage T	Difference vs Baseline PI	Difference vs Baseline T	Tillage on Contour PI	Tillage on Contour T	Difference vs Baseline PI	Difference vs Baseline T	Grazing PI	Grazing T	Difference vs Baseline PI	Difference vs Baseline T	Cover Crops 2 PI	Cover Crops 2 T	Difference vs Baseline PI	Difference vs Baseline T
LoB	Loyal silt loam	Dairy-307 (liquid manure)	10	6.3	8	4.7	2	1.6	9	5.4	1	0.9	3	1.5	7	4.8	8	5	2	1.3	7	4	3	2.3	7	4.4	3	1.9	1	0			6	3.6	4	2.7
WtA	Withee silt loam	Dairy-307 (liquid manure)	4	2.4	4	1.9	0	0.5	4	2.1	0	0.3	2	0.7	2	1.7	4	2	0	0.4	3	1.6	1	0.8	3	1.9	1	0.5	1	0			3	1.5	1	0.9
FgB	Fenwood-Rozellville silt loam	Dairy-307 (liquid manure)	7	4.5	5	3.4	2	1.1	6	3.9	1	0.6	2	1.2	5	3.3	6	3.7	1	0.8	5	3	2	1.5	5	3.1	2	1.4	1	0			4	2.8	3	1.7
MfA	Marshfield silt loam	Dairy-307 (liquid manure)	3	1.3	2	1	1	0.3	2	1.1	1	0.2	1	0.4	2	0.9	2	1	1	0.3	2	0.9	1	0.4	2	1.1	1	0.2	1	0			5	0.8	-2	0.5
RcB	Rietbrock silt loam	Dairy-307 (liquid manure)	9	5.7	7	4.3	2	1.4	7	5	2	0.7	3	1.5	6	4.2	7	4.6	2	1.1	6	3.8	3	1.9	6	3.9	3	1.8	1	0			5	3.4	4	2.3
ShA	Sherry silt loam	Dairy-307 (liquid manure)	4	2	3	1.5	1	0.5	3	1.7	1	0.3	2	0.6	2	1.4	3	1.6	1	0.4	3	1.3	1	0.7	3	1.5	1	0.5	1	0			3	1.3	1	0.7
ReB	Rietbrock silt loam, stony	Dairy-307 (liquid manure)	7	4.9	6	3.7	1	1.2	6	4.3	1	0.6	2	1.3	5	3.6	6	4	1	0.9	5	3.2	2	1.7	5	3.4	2	1.5	1	0			5	3	2	1.9
LoB	Loyal silt loam	Dairy-308 (solid manure)	8	3.9	10	3.7	-2	0.2	7	3.4	1	0.5	4	0.8	4	3.1	9	3.6	-1	0.3	8	2.9	0	1	6	2.8	2	1.1					8	2.8	0	1.1
WtA	Withee silt loam	Dairy-308 (solid manure)	4	1.5	6	1.4	-2	0.1	4	1.4	0	0.1	4	0.4	0	1.1	5	1.3	-1	0.2	5	1.1	-1	0.4	3	1.1	1	0.4					5	1.1	-1	0.4
FgB	Fenwood-Rozellville silt loam	Dairy-308 (solid manure)	6	2.9	7	2.8	-1	0.1	5	2.5	1	0.4	4	0.7	2	2.2	7	2.7	-1	0.2	7	2.2	-1	0.7	4	2	2	0.9					7	2.2	-1	0.7
MfA	Marshfield silt loam	Dairy-308 (solid manure)	3	0.8	5	0.8	-2	0	3	0.7	0	0.1	3	0.2	0	0.6	4	0.8	-1	0	4	0.7	-1	0.1	2	0.7	1	0.1					5	0.7	-2	0.1
RcB	Rietbrock silt loam	Dairy-308 (solid manure)	8	3.6	9	3.5	1.5	0.9	7	3.2	1	0.4	4	0.9	4	2.7	8	3.4	0	0.2	8	2.8	0	0.8	5	2.6	3	1					8	2.8	0	0.8
ShA	Sherry silt loam	Dairy-308 (solid manure)	4	1.3	5	1.3	-1	0	3	1.1	1	0.2	4	0.4	0	0.9	5	1.2	-1	0.1	5	1	-1	0.3	3	1	1	0.3					5	1	-1	0.3
ReB	Rietbrock silt loam, stony	Dairy-308 (solid manure)	7	3.1	8	3	-1	0.1	6	2.7	1	0.4	4	0.7	3	2.4	7	2.9	0	0.2	7	2.4	0	0.7	5	2.2	2	0.9					7	2.4	0	0.7
LoB	Loyal silt loam	Crop-400	6	5.3	6	5	0	0.3	n/a	n/a	-	-	1	0.4	5	4.9	4	3.7	2	1.6	4	3.6	2	1.7	3	3	3	2.3					4	3.4	2	1.9
WtA	Withee silt loam	Crop-400	3	2.1	2	2	1	0.1	n/a	n/a	-	-	0	0.2	3	1.9	2	1.5	1	0.6	2	1.5	1	0.6	2	1.4	1	0.7					2	1.2	1	0.9
FgB	Fenwood-Rozellville silt loam	Crop-400	4	3.9	4	3.7	0	0.2	n/a	n/a	-	-	0	0.3	4	3.6	3	2.8	1	1.1	3	2.7	1	1.2	2	2.2	2	1.7					3	2.6	1	1.3
MfA	Marshfield silt loam	Crop-400	1	1.1	1	1	0	0.1	n/a	n/a	-	-	0	0.1	1	1	1	0.8	0	0.3	1	0.8	0	0.3	1	0.9	0	0.2					1	0.7	0	0.4
RcB	Rietbrock silt loam	Crop-400	5	4.9	5	4.7	0	0.2	n/a	n/a	-	-	1	0.4	4	4.5	4	3.5	1	1.4	4	3.4	1	1.5	3	2.8	2	2.1					4	3.2	1	1.7
ShA	Sherry silt loam	Crop-400	2	1.7	2	1.6	0	0.1	n/a	n/a	-	-	0	0.2	2	1.5	2	1.3	0	0.4	2	1.2	0	0.5	1	1.1	1	0.6					1	1.2	1	0.5
ReB	Rietbrock silt loam, stony	Crop-400	4	4.2	4	4	0	0.2	n/a	n/a	-	-	1	0.3	3	3.9	3	3	1	1.2	3	3	1	1.2	3	2.4	1	1.8					3	2.8	1	1.4

Weighed average based on area of soil in Fenwood Creek Watershed

MUSYM	Soil Name	Type	% of Land	Baseline PI	Baseline T	Cover Crops PI	Cover Crops T	Difference vs Baseline PI	Difference vs Baseline T	Increase Hay by 1 yr. PI	Increase Hay by 1 yr. T	Difference vs Baseline PI	Difference vs Baseline T	No-Till PI	No-Till T	Difference vs Baseline PI	Difference vs Baseline T	Chisel/reduced tillage PI	Chisel/reduced tillage T	Difference vs Baseline PI	Difference vs Baseline T	Spring chisel/ recduced tillage PI	Spring chisel/ recduced tillage T	Difference vs Baseline PI	Difference vs Baseline T	Tillage on Contour PI	Tillage on Contour T	Difference vs Baseline PI	Difference vs Baseline T	Cover Crops 2 PI	Cover Crops 2 T	Difference vs Baseline PI	Difference vs Baseline T
LoB	Loyal silt loam	Dairy-307 (liquid manure)	0.222	2.22	1.4	1.776	1.0434	0.444	0.3552	2.00	1.20	0.22	0.20	0.666	0.333	1.554	1.0656	1.776	1.11	0.444	0.2886	1.554	0.888	0.666	0.5106	1.554	0.9768	0.666	0.4218	1.332	0.7992	0.888	0.5994
WtA	Withee silt loam	Dairy-307 (liquid manure)	0.219	0.876	0.5	0.876	0.4161	0	0.1095	0.88	0.46	0.00	0.07	0.438	0.1533	0.438	0.3723	0.876	0.438	0	0.0876	0.657	0.3504	0.219	0.1752	0.657	0.4161	0.219	0.1095	0.657	0.3285	0.219	0.1971
FgB	Fenwood-Rozellville silt loam	Dairy-307 (liquid manure)	0.193	1.351	0.9	0.965	0.6562	0.386	0.2123	1.16	0.75	0.19	0.12	0.386	0.2316	0.965	0.6369	1.158	0.7141	0.193	0.1544	0.965	0.579	0.386	0.2895	0.965	0.5983	0.386	0.2702	0.772	0.5404	0.579	0.3281
MfA	Marshfield silt loam	Dairy-307 (liquid manure)	0.1	0.3	0.1	0.2	0.1	0.1	0.03	0.20	0.11	0.10	0.02	0.1	0.04	0.2	0.09	0.2	0.1	0.1	0.03	0.2	0.09	0.1	0.04	0.2	0.11	0.1	0.02	0.5	0.08	-0.2	0.05
RcB	Rietbrock silt loam	Dairy-307 (liquid manure)	0.075	0.675	0.4	0.525	0.3225	0.15	0.105	0.53	0.38	0.15	0.05	0.225	0.1125	0.45	0.315	0.525	0.345	0.15	0.0825	0.45	0.285	0.225	0.1425	0.45	0.2925	0.225	0.135	0.375	0.255	0.3	0.1725
ShA	Sherry silt loam	Dairy-307 (liquid manure)	0.07	0.28	0.1	0.21	0.105	0.07	0.035	0.21	0.12	0.07	0.02	0.14	0.042	0.14	0.098	0.21	0.112	0.07	0.028	0.21	0.091	0.07	0.049	0.21	0.105	0.07	0.035	0.21	0.091	0.07	0.049
ReB	Rietbrock silt loam, stony	Dairy-307 (liquid manure)	0.042	0.294	0.2	0.252	0.1554	0.042	0.0504	0.25	0.18	0.04	0.03	0.084	0.0546	0.21	0.1512	0.252	0.168	0.042	0.0378	0.21	0.1344	0.084	0.0714	0.21	0.1428	0.084	0.063	0.21	0.126	0.084	0.0798
		Weighted Average		**6.0**	**3.7**	**4.8**	**2.8**	**1.2**	**0.9**	**5.2**	**3.2**	**0.8**	**0.5**	**2.0**	**1.0**	**4.0**	**2.7**	**5.0**	**3.0**	**1.0**	**0.7**	**4.2**	**2.4**	**1.8**	**1.3**	**4.2**	**2.6**	**1.8**	**1.1**	**4.1**	**2.2**	**1.9**	**1.5**
LoB	Loyal silt loam	Dairy-308 (solid manure)	0.222	1.776	0.9	2.22	0.8214	-0.444	0.0444	1.554	0.755	0.222	0.111	0.888	0.1776	0.888	0.6882	1.998	0.7992	-0.222	0.0666	1.776	0.6438	0	0.222	1.332	0.6216	0.444	0.2442	1.776	0.6216	0	0.2442
WtA	Withee silt loam	Dairy-308 (solid manure)	0.219	0.876	0.3	1.314	0.3066	-0.438	0.0219	0.876	0.307	0.000	0.022	0.876	0.0876	0	0.2409	1.095	0.2847	-0.219	0.0438	1.095	0.2409	-0.219	0.0876	0.657	0.2409	0.219	0.0876	1.095	0.2409	-0.219	0.0876
FgB	Fenwood-Rozellville silt loam	Dairy-308 (solid manure)	0.193	1.158	0.6	1.351	0.5404	-0.193	0.0193	0.965	0.483	0.193	0.077	0.772	0.1351	0.386	0.4246	1.351	0.5211	-0.193	0.0386	1.351	0.4246	-0.193	0.1351	0.772	0.386	0.386	0.1737	1.351	0.4246	-0.193	0.1351
MfA	Marshfield silt loam	Dairy-308 (solid manure)	0.1	0.3	0.1	0.5	0.08	-0.2	0	0.300	0.070	0.000	0.010	0.3	0.02	0	0.06	0.4	0.08	-0.1	0	0.4	0.07	-0.1	0.01	0.2	0.07	0.1	0.01	0.5	0.07	-0.2	0.01
RcB	Rietbrock silt loam	Dairy-308 (solid manure)	0.075	0.6	0.3	0.675	0.2625	-0.075	0.9	0.525	0.240	0.075	0.030	0.3	0.0675	0.3	0.2025	0.6	0.255	0	0.015	0.6	0.21	0	0.06	0.375	0.195	0.225	0.075	0.6	0.21	0	0.06
ShA	Sherry silt loam	Dairy-308 (solid manure)	0.07	0.28	0.1	0.35	0.091	-0.07	0	0.210	0.077	0.070	0.014	0.28	0.028	0	0.063	0.35	0.084	-0.07	0.007	0.35	0.07	-0.07	0.021	0.21	0.07	0.07	0.021	0.35	0.07	-0.07	0.021
ReB	Rietbrock silt loam, stony	Dairy-308 (solid manure)	0.042	0.294	0.1	0.336	0.126	-0.042	0.0042	0.252	0.113	0.042	0.017	0.168	0.0294	0.126	0.1008	0.294	0.1218	0	0.0084	0.294	0.1008	0	0.0294	0.21	0.0924	0.084	0.0378	0.294	0.1008	0	0.0294
		Weighted Average		**5.3**	**2.3**	**6.7**	**2.2**	**-1.5**	**0.1**	**4.7**	**2.0**	**0.6**	**0.3**	**3.6**	**0.5**	**1.7**	**1.8**	**6.1**	**2.1**	**-0.8**	**0.2**	**5.9**	**1.8**	**-0.6**	**0.6**	**3.8**	**1.7**	**1.5**	**0.6**	**6.0**	**1.7**	**-0.7**	**0.6**
LoB	Loyal silt loam	Crop-400	0.222	1.332	1.2	1.332	1.11	0	0.0666	-	-	-	-	0.222	0.0888	1.11	1.0878	0.888	0.8214	0.444	0.3552	0.888	0.7992	0.444	0.3774	0.666	0.666	0.666	0.5106	0.888	0.7548	0.444	0.4218
WtA	Withee silt loam	Crop-400	0.219	0.657	0.5	0.438	0.438	0.219	0.0219	-	-	-	-	0	0.0438	0.657	0.4161	0.438	0.3285	0.219	0.1314	0.438	0.3285	0.219	0.1314	0.438	0.3066	0.219	0.1533	0.438	0.2628	0.219	0.1971
FgB	Fenwood-Rozellville silt loam	Crop-400	0.193	0.772	0.8	0.772	0.7141	0	0.0386	-	-	-	-	0	0.0579	0.772	0.6948	0.579	0.5404	0.193	0.2123	0.579	0.5211	0.193	0.2316	0.386	0.4246	0.386	0.3281	0.579	0.5018	0.193	0.2509
MfA	Marshfield silt loam	Crop-400	0.1	0.1	0.1	0.1	0.1	0	0.01	-	-	-	-	0	0.01	0.1	0.1	0.1	0.08	0	0.03	0.1	0.08	0	0.03	0.1	0.09	0	0.02	0.1	0.07	0	0.04
RcB	Rietbrock silt loam	Crop-400	0.075	0.375	0.4	0.375	0.3525	0	0.015	-	-	-	-	0.075	0.03	0.3	0.3375	0.3	0.2625	0.075	0.105	0.3	0.255	0.075	0.1125	0.225	0.21	0.15	0.1575	0.3	0.24	0.075	0.1275
ShA	Sherry silt loam	Crop-400	0.07	0.14	0.1	0.14	0.112	0	0.007	-	-	-	-	0	0.014	0.14	0.105	0.14	0.091	0	0.028	0.14	0.084	0	0.035	0.07	0.077	0.07	0.042	0.07	0.084	0.07	0.035
ReB	Rietbrock silt loam, stony	Crop-400	0.042	0.168	0.2	0.168	0.168	0	0.0084	-	-	-	-	0.042	0.0126	0.126	0.1638	0.126	0.126	0.042	0.0504	0.126	0.126	0.042	0.0504	0.126	0.1008	0.042	0.0756	0.126	0.1176	0.042	0.0588
		Weighted Average		**3.5**	**3.2**	**3.3**	**3.0**	**0.2**	**0.2**					**0.3**	**0.3**	**3.2**	**2.9**	**2.6**	**2.2**	**1.0**	**0.9**	**2.6**	**2.2**	**1.0**	**1.0**	**2.0**	**1.9**	**1.5**	**1.3**	**2.5**	**2.0**	**1.0**	**1.1**