# STRATEGIES FOR REDUCING FISH KILLS IN THE BIG EAU PLEINE RESERVOIR

*VISION*

*Water quality and recreation on the Big Eau Pleine Reservoir are enhanced and a flourishing fishery is sustained which is not harmed by manmade events.*

# Strategies for Reducing Fish Kills in the Big Eau Pleine Reservoir

2017

The authors would like to acknowledge the commitment and enthusiasm of the Big Eau Pleine Citizens Organization (BEPCO), land owners in the Big Eau Pleine watershed, and participants in the Community Conversations.

This plan was prepared in 2017 by Nancy Turyk, Center for Watershed Science and Education at the University of Wisconsin – Stevens Point. Along with the Community Conversation participants, the following individuals and organizations contributed to the content of this plan.

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Tim Garrigan and John Kennedy, BEPCO Board

Jim Arch and Matt Zoschke, Clark County Land Conservation Dept.

Keith Foye, Dept. Agriculture, Trade, and Consumer Protection

Tom Meronek, Al Niebur, Buzz Sorge, Dept. of Natural Resources

John Small, Marathon City

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Diane Hanson and Andy Johnson, Marathon County CPZ

Matt Krueger, River Alliance of Wisconsin

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Ben Niffenegger, Wisc. Valley Improvement Company

Lead persons and resources are given under each objective of this plan. These individuals and organizations are able to provide information, suggestions, or services to achieve goals. The following table lists organization names and their common acronyms used in this plan. This list should not be considered all-inclusive – assistance may also be provided by other entities, consultants, and organizations.

| Resource | Acronym or Truncated Name |
|---|---|
| Big Eau Pleine Citizens Organization | BEPCO |
| Clark County Land Conservation Dept. | Clark County LCD |
| Marathon County Board of Supervisors & professional staff | Marathon County CPZ |
| River Alliance of Wisconsin | River Alliance |
| Taylor County Land Conservation Department | Taylor County LCD |
| University of Wisconsin - Extension | UWEX |
| USDA Natural Resources Conservation Service | NRCS |
| Walleyes for Tomorrow | WFT |
| Wisconsin Department of Agriculture, Trade and Consumer Protection | DATCP |
| Wisconsin Department of Natural Resources | WDNR |
| Wisconsin Valley Improvement Company | WVIC |

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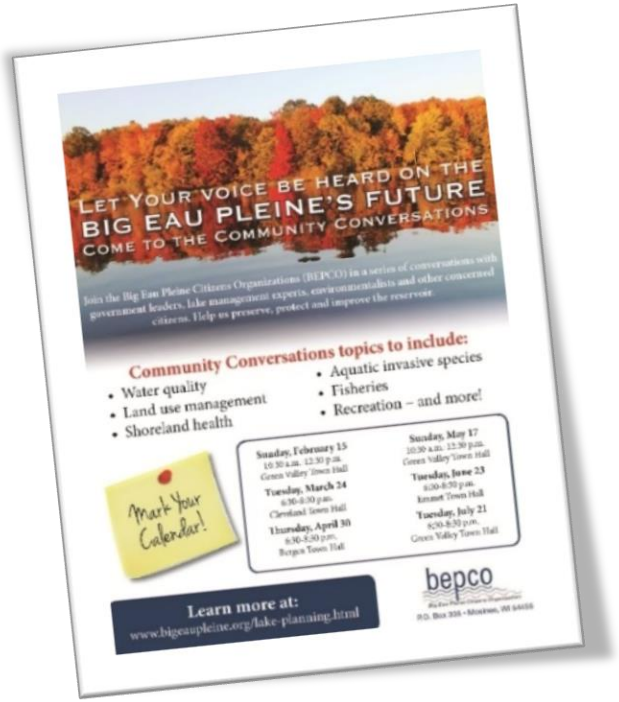
## VISION FOR THE BIG EAU PLEINE RESERVOIR

***Water quality and recreation on the Big Eau Pleine Reservoir are enhanced and a flourishing fishery is sustained which is not harmed by manmade events.***

### Plan Development

**Who created the strategic plan?**

This plan is the result of a stakeholder-driven effort which involved many partners combining insight, knowledge, and expertise throughout the process. More than 112 participants gathered at a series of community conversations which provided opportunities to learn from one another and make suggestions about the fishery, water quality, habitat, and land management in the Big Eau Pleine watershed. The Big Eau Pleine Citizens Organization (BEPCO) hosted the meetings at venues throughout the watershed between February and July, 2015.




An advisory committee provided guidance for the content of the community conversations, the planning process, and plan refinements. Committee members will continue to meet to ensure the goals in this plan are achieved. The committee includes representatives from BEPCO, Clark, Marathon and Taylor counties, USDA Natural Resources Conservation Service, Wisconsin Dept. of Agriculture, Trade and Consumer Protection, Wisconsin Dept. of Natural Resources, and Wisconsin Valley Improvement Company. Plan development was guided by staff from UW-Stevens Point, River Alliance of Wisconsin, and UW-Extension. Descriptions of these organizations can be found in the "Meet the Partners" section in this document. Funding to create this plan was provided to BEPCO from the Wisconsin Dept. of Natural Resources.

**How were the opinions of those not attending the meetings considered?**

A total of 625 households were contacted using a mail survey in early 2015 to understand the priorities of landowners. Two unique surveys were designed to obtain opinions from 375 agricultural producers and 250 waterfront landowners. The return rate was high: 42% (150) of the agricultural surveys and 72.6% (167) of the riparian surveys were received. The results of both surveys are incorporated throughout this plan and can be found in the appendices.

## The Problem

Periodically, winter fish kills occur in the Big Eau Pleine Reservoir. Multiple factors within the BEP reservoir and watershed lead to conditions which result in low oxygen levels in the water, asphyxiating the more sensitive fish species.

### Challenges within the watershed

Too many nutrients (fertilizers, often from agricultural land) move off the landscape during rains and snowmelt, and flow downstream to the BEP reservoir. The nutrients feed algae and aquatic plants. During the winter, microbes that are decomposing algae consume oxygen in the water. This results in less oxygen being available to fish, which can lead to fish kills.

### Weather

The amount and timing of precipitation play significant roles in the problem. Years with heavy rain or snow lead to more nutrients getting into the BEP system. Summers and falls with less than normal amounts of rain lead to low water levels in the BEP reservoir in early winter. Temperature can also play a role, with warmer water leading to nutrient release from sediments.

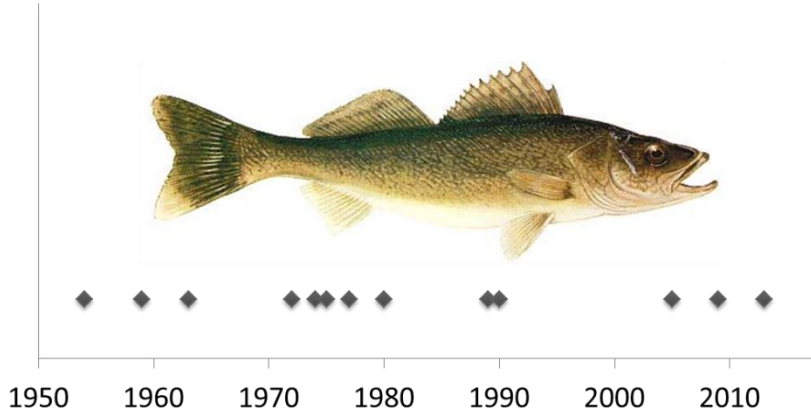
### Water levels

During some years, low water levels can affect the amount of oxygen available during the winter. This is particularly important when the levels are low at the beginning of a long winter. Simply put, more water holds more oxygen.

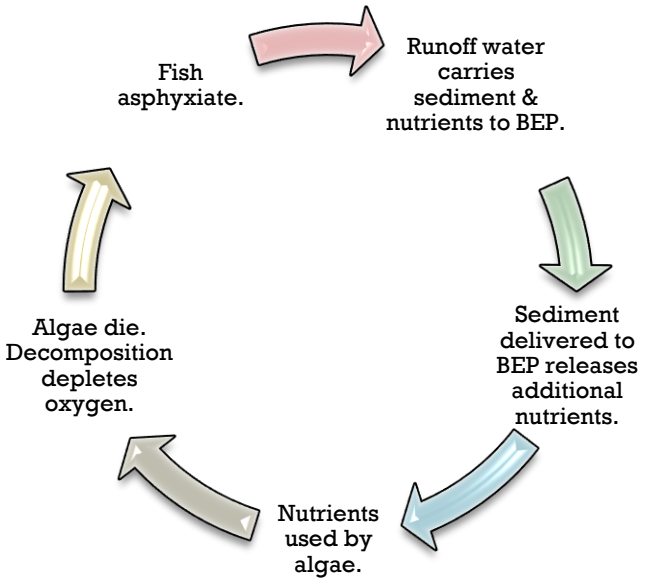
***Survey of Shoreland Owners Revealed …***

Based on their experiences living near the BEP, more than 60% of landowners feel the quality of fishing has declined in recent years. Additionally, nearly 1 in 3 believe property values have decreased as a result of changes to the quality of fishing.

Years with reported winter fish kills.




Note: The fish kills in 1989, 1990, and 2005 were considered small.



## BEP Basics

### River or Lake?

The Big Eau Pleine Reservoir (BEP) comprises a surface area of 6,677 acres with a maximum depth of 46 feet (Brodzeller & McGinley, 2015). The reservoir was created in 1937 by the construction of a dam on the Big Eau Pleine River. The Wisconsin Valley Improvement Company (WVIC) created reservoirs, including the BEP, to help provide uniform flow in the Wisconsin River for the generation of power by storing surplus water in reservoirs for release when water flow is low. This is done to improve the usefulness of the rivers for all public purposes and to reduce flood damage. This is achieved by storing water in the reservoirs and releasing it to the Wisconsin River during periods of lower flow.

### Multiple interests

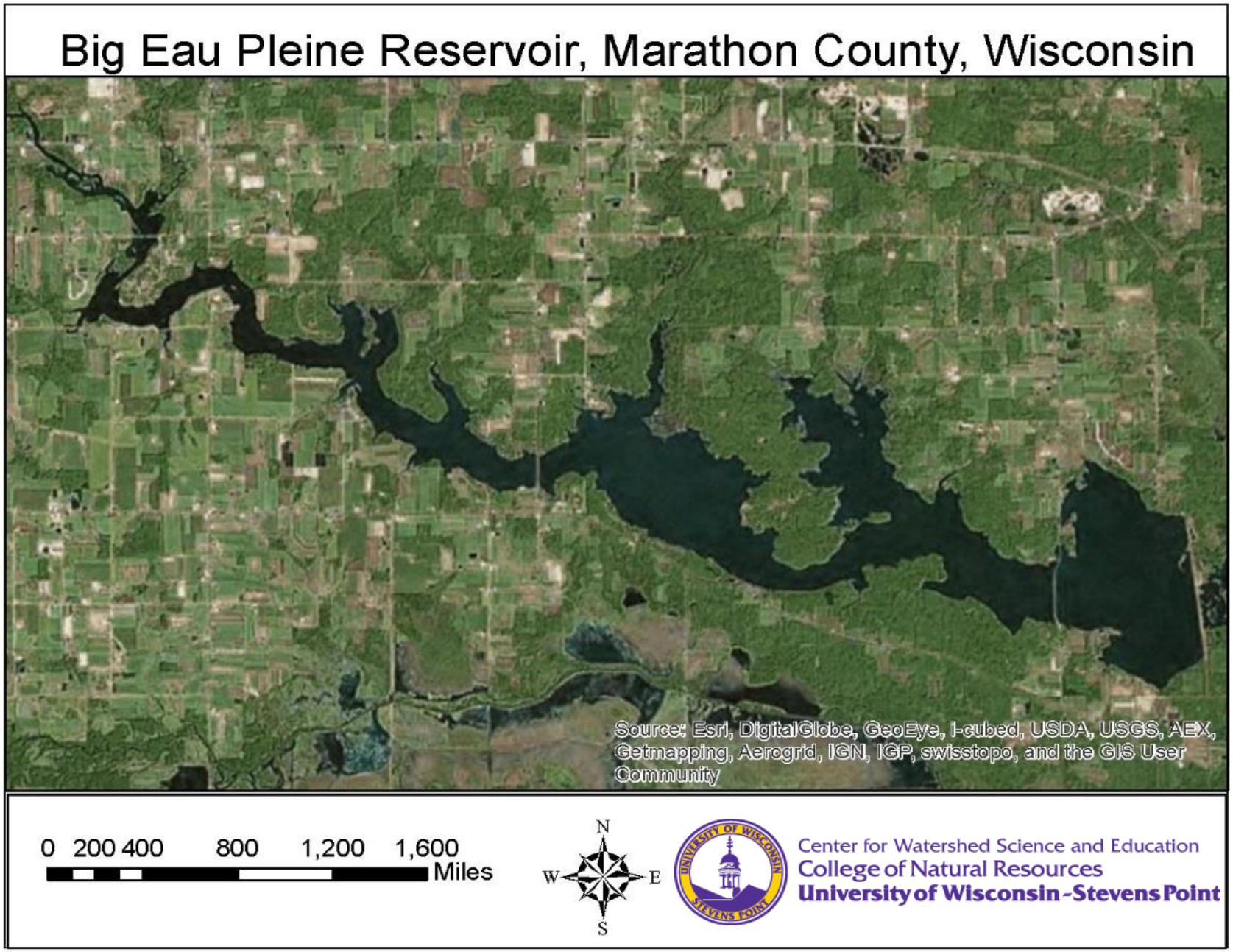
In addition to providing water storage for energy production, the BEP provides a lake-like setting capable of supporting a healthy fishery, habitat for waterfowl and other wildlife, and recreational activities such as boating and snowmobiling. The variety of uses can lead to differing ideas about how the reservoir should be managed, particularly its water levels; therefore, working together and finding common ground is especially important to achieving shared goals for the BEP.

Survey results show the majority of individuals believe the BEP vastly adds to the beauty of the community and its surroundings. Respondents feel strongly that time spent on the BEP is relaxing because the lake is quiet and not overcrowded. Most enjoy the natural, scenic shorelines and are not looking for the suburban backyards found on other lakes. They actively recreate on the BEP, rather than choosing to go to other nearby lakes.

Additionally, they see excellent fishing opportunities on the BEP and feel safe eating fish caught there. Survey responses showed overall agreement that the greatest threat to fish populations in the BEP is the decline in the water level during winter months.


### Challenges with reservoirs

A dam on the river slows the water, allowing sediment to fall out of the water and build up in the reservoir. This sediment, from its agriculturally dominated watershed, is rich in nutrients, which provides food for aquatic plants and algae. Since it is difficult for rooted aquatic plants to thrive in the BEP due to its abundance of carp, light limitations from algal blooms, and fluctuating water levels, algae will use the available nutrients to flourish. While some algal growth is normal, an overabundance of algae can produce poor conditions for recreation and, in some cases, can even be a health hazard for people and wildlife.


Big Eau Pleine Reservoir, Marathon County, Wisconsin
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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Miles
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W
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S
Center for Watershed Science and Education
College of Natural Resources
University of Wisconsin-Stevens Point

# Goal 1.

# Sustain and Improve the Fishery of the BEP Reservoir

Primary Partners:

BEPCO

WDNR Fisheries Biologists

WVIC

# OXYGEN, FISH KILLS, AND THE BEP

## Understanding Oxygen Challenges in the BEP

During some winters, maintaining sufficient oxygen in the water to support the sport fishery (muskellunge, walleye, and northern pike) in the BEP has been a challenge since the reservoir's creation. As described in Goal 2, the agricultural nature of the BEP watershed and its management as a WVIC-owned storage reservoir creates challenges for maintaining a healthy fishery, due to fish kills.

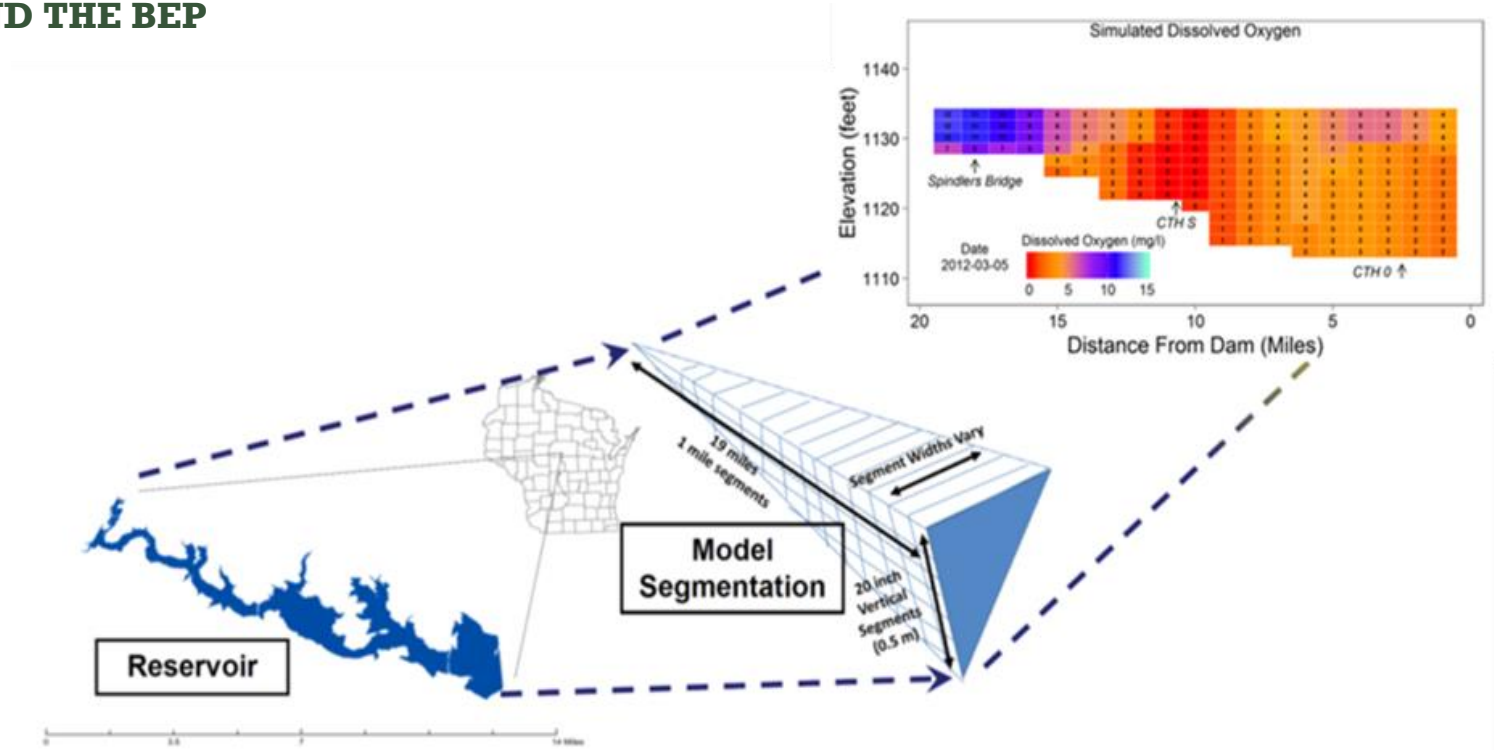



Figure 1. Illustration of how the BEP Dissolved Oxygen Model simulates the shape of the reservoir and calculates a dissolved oxygen concentration in the reservoir profile.

To better understand the dynamics and availability of dissolved oxygen for gamefish during the winter, in 2014 BEPCO obtained WDNR funding to support Dr. Paul McGinley's staff at the UW-Stevens Point to develop a model to understand the dynamics associated with oxygen depletion in the BEP. The Dissolved Oxygen Technical Committee reviewed and commented on their modeling efforts, meeting monthly from Jan 2014 to Aug 2016.

Excerpts from the work of both Dr. McGinley, and the Committee that supported his work are featured throughout this chapter.

**What was considered in the model?**

The BEP Dissolved Oxygen Model uses size and shape of the reservoir, weather, river flow, and water level in a computer simulation to project how oxygen concentrations vary under the ice in the BEP. Eighteen years of monitoring in the BEP was incorporated into the Model. Figure 1 shows how the model segments the reservoir and calculates the dissolved oxygen concentration throughout the reservoir.

**Why was the model developed?**

The ***Model*** was used to understand oxygen concentrations under the ice during the winter because the BEP has had problems with winter fish kills since it was created in the 1930s. The model allows for analysis of the importance of individual factors on winter oxygen concentrations. It is important to note that while the model uses a state-of-the-art computer simulation tool, it simplifies the many and complex processes that occur in the reservoir.

Figure 2 shows a typical yearly pattern of water ice formation, water level lowering, and dissolved oxygen depletion. The study showed the importance of ***winter length*** or the time between ice formation and the spring flush that replaces much of the water in the reservoir on oxygen concentration. In many years, the spring flush occurred by early March. In a few years, the spring flush occurs much later. In 2013, that flush did not occur until March 30.

**What was learned from the model?**

Oxygen is used under the ice by bacteria decomposing organic material that has accumulated in the sediments. This ***sediment oxygen demand*** is very high in the BEP. This is consistent with the large quantity of nutrients that flow in from the watershed, the resulting high concentration of phosphorus in the reservoir, and the conversion of that phosphorus to algae in the reservoir.

***Oxygen depletion*** during the winter follows warming of the water in the reservoir. During the winter, heat stored in the sediment during the summer warms the water from the bottom. This accelerates the upward propagation of low oxygen water during the winter. In reservoirs like the BEP, the high sediment area and the high sediment oxygen demand can rapidly deplete oxygen in the water under the ice.

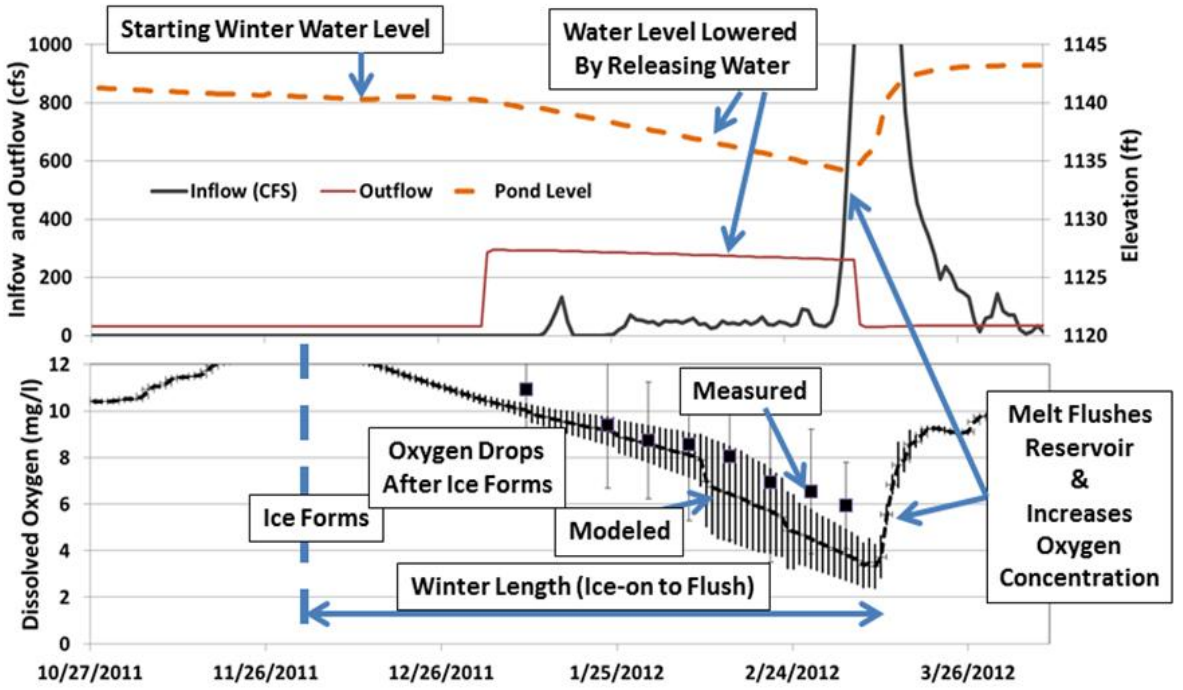



**Figure 2. Comparison of water level operation (above) and dissolved oxygen concentrations (below) during a typical winter in the BEP.**

The ***water level in the reservoir*** is important to how the oxygen concentrations drops during the winter. The model can be used to estimate how different water levels would have affected the oxygen concentrations. For example, the graph to the right shows how, using characteristics of the 2013 winter, higher water levels at the start of winter decreases the number of days that the oxygen concentrations are low. As an illustration, starting the winter at 60% full (approx. 15 days), would result in 15 days with oxygen less than 2 mg/L or almost 10 more days where the dissolved oxygen would be less than 2 mg/L than starting at 45% full, which would have approximately 25 days of low oxygen.

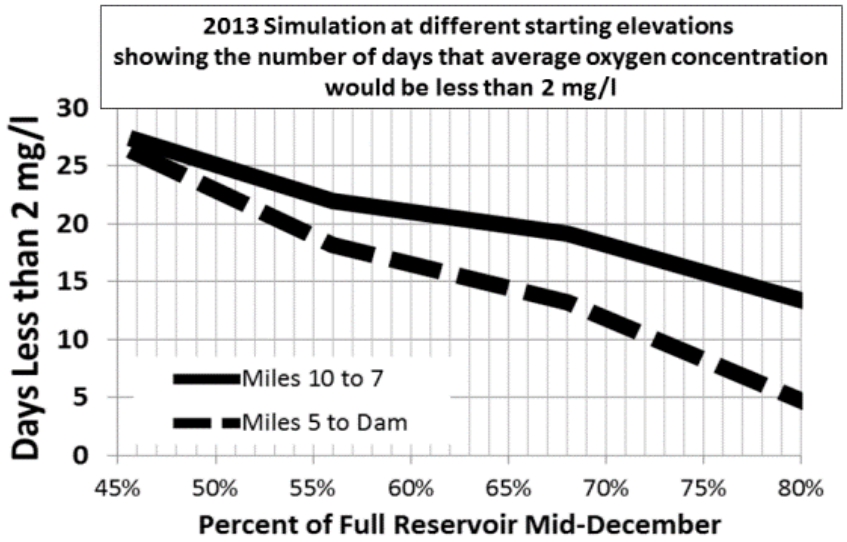
The model can be used to examine the combined effect of water level and winter length. As the graph to the right shows, for the very long winter length in 2013, although the duration of lower oxygen levels was shorter as the starting elevation increased, the model projected some days of low oxygen under all the starting water elevations shown.

The study shows how reductions in sediment oxygen demand (SOD) will benefit the reservoir. Options for reductions are discussed in the Goal 2 section of this plan. Similar to higher starting elevations, a reduction in SOD leads to more days during the winter that the oxygen concentration is higher. The model projects that a 10% reduction in SOD would add another week where the average oxygen would be above 2 mg/L near the dam.

The ***aerator*** was also examined in the model. It uses mixing to create an opening in the ice that allows oxygen to transfer from the atmosphere to the water. The result is that the aerator can provide a zone of higher oxygen concentrations. The model suggests this zone will not travel far in low-flow winters but that it should be able to overcome the oxygen demand in the vicinity of the aerator.

The full report *CE-QUAL-W2 Model for Dissolved Oxygen in the Big Eau Pleine Reservoir, Wisconsin to Understand and Manage Winter Anoxia* J. Brodzeller & P. McGinley, 2016 is available at

http://www.uwsp.edu/cnr-ap/watershed/Documents/BEP_FinalReport_Draft_July11_2016.pdf



**Reviewing the scientific understanding over time**

Over the last 40 years, several recommendations have been made to reduce the likelihood of winter oxygen depletion and fish kills in the BEP.

Shaw (1979) and Sullivan (1982) suggested that higher water levels in the BEP in early winter would reduce the impact of SOD on oxygen concentrations. Shaw also recommended a minimum pool of 25 to 30% of full volume at the end of the winter. Coon (1998) described how water levels in the BEP, streamflow and drawdown timing were all important to the movement of upstream oxygen depleted water into the BEP. He suggested a flexible management strategy using the three factors to control the development and movement of the oxygen depleted zone.

BEPCO (2011) analyzed 40 years of reservoir data and observed there were **no fish kill**s when the reservoir was both 60% full at the start of winter and 20% full at the end of winter. In the years where fish kills were reported, one or both of those criteria were not met, primarily the former.

While all these studies suggested a relationship between water levels and oxygen depletion in the BEP, the extent to which streamflow, weather, runoff and other factors combine with water level to contribute to the depletion of oxygen was not fully understood.

The purpose of Dr. McGinley's study was to develop a computer simulation model to improve the understanding of winter oxygen concentrations in the BEP and evaluate management actions to prevent oxygen depletion. While the sources of winter oxygen depletion were understood, the extents to which site-specific conditions and year-to-year variations in runoff, water level, air temperature, and ice cover determine oxygen concentrations were not well understood.

## Aeration

**The role of aeration**

Oxygen in the water can be limited during the winter. Ice cover restricts contact with the atmosphere and oxygen production from algae and aquatic plants is minimal. In addition, oxygen in the water is consumed by microbes and other organisms.

In the BEP, aeration can help to guard against massive fish kills by maintaining sufficient oxygen in the water to support the nearby fishery, creating a zone of refuge. The **zone of refuge** is the area located between BEP Reservoir Miles 5-6. This area was chosen because of the narrowing of the reservoir which allows for nearly shore to shore coverage as well as excellent access through the BEP county park and proximity to WDNR owned property.

**Why is aeration important to the BEP?**

Currently, all of the factors leading to oxygen problems in the BEP cannot be controlled, so there are years when oxygen levels in the BEP are insufficient to support the fishery. It will take time for improvements on the landscape to result in better water quality in the BEP (see Chapter 2), and during some years, there will not be enough precipitation in the fall and winter to replenish the water released from the BEP to the Wisconsin River.

**Who is involved in the operation of the BEP aeration system?**

Following a large fish kill, in 2009, the BEP Task Force was organized as a result of a resolution by the Marathon Co Board of Supervisors. It includes representation by WDNR, WVIC, Marathon County, and BEPCO. This group entered into a memorandum of agreement (MOA) for the operation of the BEP aeration system. The MOA specifies responsibilities associated with monitoring to determine the need for an aeration system, and

the safety, maintenance, operation, and expenses of running the aeration system. A copy of the agreement can be found in the appendices.

**The Challenges**

Studies indicate aeration should be operated over a longer period of time during some years. A strategy needs to be developed for safe deployment of the aeration prior to ice-on, as well as how to inform the public where ice will be unsafe and/or open water will exist.

- A longer period of operation will increase operational costs, particularly related to power.
- In addition to operational costs, there will be maintenance and replacement costs for the aeration system.

## Managing Flow and Water Levels in the BEP

**Who manages flow and water levels in the BEP?**

WVIC is responsible for outflow and water levels in the BEP, which is one of the reservoirs created on Wisconsin River tributaries to provide more uniform flow in the Wisconsin River. Privately owned by dam owners and member companies along the Wisconsin River and its tributaries, WVIC was founded in 1907 by the State Legislature. According to its charter, WVIC is to provide "*nearly a uniform flow of water as practicable in the Wisconsin and Tomahawk rivers by storing in reservoirs surplus water for discharge when the water supply is low to improve the usefulness of the rivers for all public purposes and to reduce flood damage*." In total, 21 reservoirs make up the WVIC system. As part of licensing requirements, WVIC has many management plans related to the BEP including Operations, Land Resource Management, Recreation, Fish and Wildlife Management, and Historic Resource Management. More information about WVIC may be found on its website: http://www.wvic.com/

**What guides WVIC management decisions?**

The Federal Energy Regulatory Commission (FERC) is the agency responsible for licensing hydropower dams and storage reservoirs such as the BEP. A FERC license provides the structure needed to guide the operation of a reservoir or system of reservoirs. The most recent FERC license for the Wisconsin River reservoir system, which included the BEP, was issued to WVIC in 1996. The license has a 30-year term.

**Can the FERC license for the BEP be changed?**

A process involving many studies and public input is laid out by FERC for licensing, relicensing, and periodic review of elements of the license. The license period for the BEP is currently 30 years and was last renewed in 1996. It is scheduled to be renewed in 2026. The FERC license and periodic review processes are designed to create a balance between the generation of power and the public interest. There are opportunities for input from the public and agencies during review periods, which occur every 5 years.

**Be Informed**
**Share Your Opinions**
**Do Your Part**
**Support Improvements**

# Share Your Ideas

***Informed community members, agency staff, and elected officials can provide suggestions about improvements to the license for the BEP.***

**Learn the basics of the FERC license for the BEP held by WVIC.**

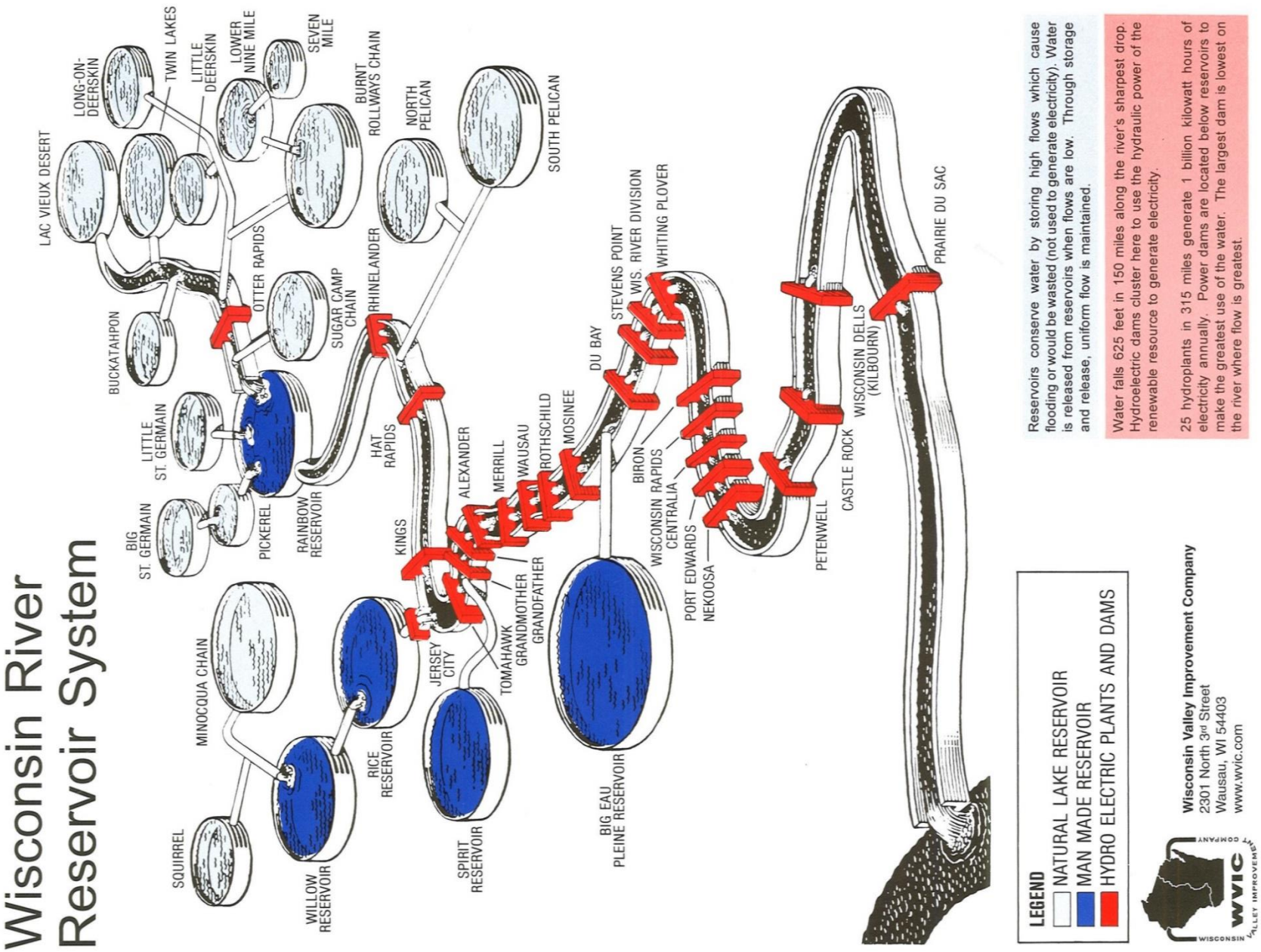
Timeline: Ongoing.

**Sign up for a FERC e-subscription to learn details related to license P-2113.** https://www.ferc.gov/docs-filing/esubscription.asp

**Know the schedule for comment-periods related to the BEP FERC license.**

Timeline: 2021 and every 5 years.

**When there are comment periods - share your opinions about strategies for the management of the BEP that are identified in the FERC license.**


Wisconsin River
Reservoir System
LAC VIEUX DESERT
LONG-ON-DEERSKIN
TWIN LAKES
LITTLE DEERSKIN
LOWER NINE MILE
SEVEN MILE
BURNT ROLLWAYS CHAIN
NORTH PELICAN
SOUTH PELICAN
BUCKATAHPON
OTTER RAPIDS
SUGAR CAMP CHAIN
RHINELANDER
LITTLE ST. GERMAIN
BIG ST. GERMAIN
PICKEREL
RAINBOW RESERVOIR
HAT RAPIDS
KINGS
ALEXANDER
MERRILL
WAUSAU
ROTHSCHILD
MOSINEE
DU BAY
STEVENS POINT
WIS. RIVER DIVISION
WHITING PLOVER
BIRON
WISCONSIN RAPIDS
CENTRALIA
PORT EDWARDS
NEKOOSA
PETENWELL
CASTLE ROCK
WISCONSIN DELLS (KILBOURN)
PRAIRIE DU SAC
MINOCQUA CHAIN
SQUIRREL
WILLOW RESERVOIR
RICE RESERVOIR
JERSEY CITY
TOMAHAWK
GRANDMOTHER
GRANDFATHER
SPIRIT RESERVOIR
BIG EAU PLEINE RESERVOIR
LEGEND
NATURAL LAKE RESERVOIR
MAN MADE RESERVOIR
HYDRO ELECTRIC PLANTS AND DAMS
Reservoirs conserve water by storing high flows which cause flooding or would be wasted (not used to generate electricity). Water is released from reservoirs when flows are low. Through storage and release, uniform flow is maintained.
Water falls 625 feet in 150 miles along the river's sharpest drop. Hydroelectric dams cluster here to use the hydraulic power of the renewable resource to generate electricity.
25 hydroplants in 315 miles generate 1 billion kilowatt hours of electricity annually. Power dams are located below reservoirs to make the greatest use of the water. The largest dam is lowest on the river where flow is greatest.
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2301 North 3rd Street
Wausau, WI 54403
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WVIC
WISCONSIN VALLEY IMPROVEMENT COMPANY

## Drought Contingency Plan

**What is WVIC's drought contingency plan (DCP)?**

In 2011, WVIC updated the DCP, as required by their license. The strategies in the DCP are complex and require balancing the needs in the BEP while allowing for sufficient flow in the Wisconsin River.

Since the conditions leading to a drought can vary, there is no single approach that will serve to meet the needs of the BEP and the Wisconsin River. Some of the variability depends upon how widespread the drought is in the upper Wisconsin River basin, the predicted duration of the drought, the time of year, and other measures of severity.

**When is the drought contingency plan activated?**

The following circumstances serve as triggers to enact the DCP.

1) If the 24-month running average cumulative precipitation deficit reaches 6 inches.

2) If after two consecutive weeks, the natural river flow in the Wisconsin River is less than 900 cubic feet per second at Merrill or 1,300 cubic feet per second at Wisconsin Rapids.

3) If the index level in any of the five large reservoirs (Rainbow, Willow, Rice, Spirit, or Eau Pleine) falls below "level 3" during the period of June through November. In the BEP, level 3 elevations are set by month; 3,182 June – August, and 1,854 September to November. See DCP in the appendix for more details.

**Summary of the drought contingency plan**

Once the need to enact the DCP has been demonstrated, WVIC will begin consultation with staff from the WDNR, U.S. Fish and Wildlife Service, and FERC. Although not required, a representative from BEPCO may also be included in the consultation.

- The consultation is intended to develop a response to the specified drought.
- A minimum release of water from the BEP is required; however, when water levels in the BEP drop below the specified minimum water elevation, resource agencies may require WVIC to release less water than the minimum-required release. The minimum-water release and water elevations are defined in the FERC license.
- The minimum flows were set using criteria that included protecting water quality, vegetation and cover for fish and wildlife, areas for spawning, feeding, and nursery, aquatic invertebrates (insects), recreation (esp. fishing and canoeing), and aesthetics.

Additional details associated with the DCP can be found in the appendices.

### Strategies

***Avoid or reduce fish kills in the BEP during drought by enacting the drought contingency plan (DCP).***

**Enact the DCP and initiate consultation with WDNR and USFWS when trigger levels for defining drought in the BEP watershed are met.**

Timeline: As needed.

## Reducing Oxygen Problems in the BEP to Protect the Fishery

The Dissolved Oxygen Technical Committee developed and unanimously agreed upon the following set of management recommendations to protect the fishery of the BEP, particularly during winter when the fishery is most susceptible to fish kills.

The Committee acknowledges that focusing on enhancing dissolved oxygen in the zone of refuge is part of the best short-term approach to protecting the fishery of the BEP. However, due to the size of the reservoir, it is important to note that this approach will not protect all fish in the reservoir.


### Risk Factors that Influence the Possibility of a Fish kill

Factors of significance that influence fish kills were identified during the development of Model. These factors provided sound basis for the management recommendations and are presented in a matrix of options in this plan.

- **Air temperatures** during the preceding summer (June-Aug) which can increase water and soft sediment temperatures prior to wintertime.
- **Severity of winter**, specifically duration of ice cover.
- **Seasonal distribution of precipitation**. Heavy rainfall events in the spring and fall can negatively impact winter fish survival through increased nutrient loadings, while increased summer precipitation can be protective by increasing the volume of water available for winter storage.
- **Reservoir elevation/water level** prior to the formation of ice cover.
- **Timing and duration of mechanical aeration**.

**Understanding the matrix risk factors and critical indicators**

***Predicted Winter Severity*** – Of the risk factors identified in the Matrix, predicted winter severity as measured by ice cover duration is of significant importance for winter oxygen depletion. The Committee did not apply a particular weight to this factor in the Matrix, but it appears to be a significant driver of winter oxygen depletion, and should be treated as such.

The Model indicates winters with ice cover longer than 90 days have a greater likelihood of fish kills. Therefore, if a severe winter is predicted (with increased likelihood of ice cover lasting over 90 days), a high risk for low oxygen conditions is indicated in the Matrix. Dec 1 is the average date that ice covers the BEP. An increasingly high risk for winter oxygen problems exists for every day that ice cover is present prior to Dec 1.

***Water Level*** – Water levels at the start of winter are important to the time it takes for oxygen depletion and are of significant importance. Based on the 2013 simulation, the Model suggests a winter starting volume of 60% of full pool would provide 10 additional days of oxygen above 2 mg/L, compared to a starting winter volume of 45% of full pool. This is supported by a statistical analysis of historical records (1981 to present) performed by BEPCO which showed that during this period there had never been a fish kill when the water level in the BEP was above 60% at ice over. This study showed that in 6 of the 13 years (46%) that winter started with levels in BEP below 60%, a reported fish kill occurred.

***Preceding Summer Temperatures*** – Warmer-than-average summer (June-Aug) temperatures increase the bottom sediment temperatures in the BEP. During winter, oxygen depletion of the water occurs at the sediment-water interface. Warmer sediment temperatures warm the oxygen-depleted bottom water, causing it to rise thus increasing the rate of oxygen depletion in the water column above. Therefore, if preceding summer temperatures are warmer than the mean, an increased risk of low oxygen in the BEP exists.

The best weather station to utilize for the BEP is the National Weather Service—Wausau ASOS (Wausau Airport) as it closely matches precipitation data at Stratford, and provides a historical record for comparison and prediction. To retrieve recent data, visit http://w2.weather.gov/climate/index.php?wfo=grb then select *1. Product* and then *Preliminary Monthly Climate Data (CF6)*. Next, select *2. Location* and *Wausau*, and finally, select *3. Timeframe*, followed by *Archived Data* and the appropriate dates.

***Preceding Spring Rainfall*** – Above-average precipitation in the months of the preceding spring (March - May) can negatively influence winter oxygen in the BEP. Excess rainfall and storm events can wash nutrients and sediment from farm fields at a vulnerable time, when the root systems of crops (which can hold soil in place) are not fully established. Most of the nutrients and sediment that wash into the BEP will remain, and can contribute to oxygen depletion the following winter. Preceding spring rainfall amounts greater than the mean creates a risk for oxygen depletion.

***Preceding Fall Rainfall*** – Similar to spring precipitation, above-average rainfall in the preceding fall (Sept - Nov) can influence oxygen in the BEP by washing nutrients and sediment from farm fields at a vulnerable time, when crops have been harvested from farm fields and bare soil is exposed. Most of the nutrients and sediment that wash into the BEP will remain, and can contribute to oxygen depletion the next winter. Preceding fall rainfall greater than the mean creates a risk for low oxygen in the winter.

## Aeration Decision Matrix

| | Risk factor | Low Risk | High Risk | Critical Indicator | Resource for assessing risk |
|---|---|---|---|---|---|
| **Predicted winter severity** | The predicted duration of winter is… | Less than 90 days | Greater than 90 days | 90 days | http://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml |
| | The date that ice covers the BEP is… | Later than Dec. 1 | Earlier than Dec. 1 | Dec. 1 | Ice-cover data is collected by Wisconsin Valley Improvement Company |
| **Water level** | The Dec. 1 BEP water level/elevation is… | Above 1139.3 ft. | Below 1139.3 ft. | 61.7% full pool (1139.3 feet elev.) | Wisconsin Valley Improvement Company water level reports http://www.wvic.com/WaterReports/Water_Level_Report.cfm |
| **Preceding summer temperatures** | Recorded air temperatures for the preceding June-Aug were… | Cooler than the mean | Warmer than the mean | Mean temp. of 67.2 degrees F | National Weather Service - Wausau Airport station 1. Preliminary Monthly Climate Data (CF6) 2. Location – Wausau 3. Archived Data http://w2.weather.gov/climate/index.php?wfo=grb |
| **Preceding spring and fall rainfall** | Precipitation for the preceding March-May was… | Less than the mean | Greater than the mean | Mean precip. of 7.97 inches | National Weather Service - Wausau Airport station 1. Preliminary Monthly Climate Data (CF6) 2. Location – Wausau 3. Archived Data http://w2.weather.gov/climate/index.php?wfo=grb |
| | Precipitation for the preceding Sept-Nov was… | Less than the mean | Greater than the mean | Mean precip. of 8.84 inches | National Weather Service - Wausau Airport station 1. Preliminary Monthly Climate Data (CF6) 2. Location – Wausau 3. Archived Data http://w2.weather.gov/climate/index.php?wfo=grb |

**Example of Matrix application**

If a severe winter is predicted and ice cover is established on the BEP at or near Dec 1, managers should consider initiating aeration earlier in the winter. Note: Both of these situations are High Risk factors.

If multiple risk factors are present but a severe winter is not predicted, early winter oxygen monitoring should be closely watched, and if depletion of oxygen is indicated, the aeration system should be turned on. This decision should factor in the two-week "lag time" before an increase in oxygen occurs as a result of aeration.

This is a dynamic process and adaptions should be made upon annual review of monitoring data and aeration operation schedule of the preceding year or years.

**Dissolved Oxygen Committee Management Recommendations**

1) Convene the parties named in the BEP Aerator System Memorandum of Agreement (MOA) and any other relevant parties to discuss the framework and commitments of a new MOA.

BEPCO, Marathon County, WDNR, and WVIC are the parties named in the current MOA, set to expire in 2017. These parties should convene to consider, and come to consensus on, actions related to the following:

a. Update the Reservoir Monitoring and Operation section to include the use of an Aeration Decision Matrix to evaluate the need and timing of aerator operations (see Recommendation #3).

b. Identify strategies to adaptively manage aeration operations to maximize the wintertime zone of refuge downstream of the aerator, while addressing recreational safety concerns (see Recommendation #4).

c. Develop a comprehensive, year-round monitoring strategy that complements existing monitoring conducted by WVIC (see Recommendation #7).

d. Identify and expand funding sources to allow for earlier startup of the aeration system.

e. Identify new partners to be added to the MOA (i.e. Greater Wausau Area representation from the tourism sector).

2) Maintain BEP water levels as high as is practical and for as long as possible in advance of the winter drawdown, within the constraints of WVIC's FERC license, particularly as it relates to maintaining flows in the Wisconsin River.

According to the Model, starting the winter at a higher water level leads to higher average oxygen concentrations at the surface near the dam late in the winter which decreases the likelihood of oxygen depletion near the surface before spring runoff but does not guarantee adequate oxygen near the surface during a very long winter. At the onset of most winters (Dec 1), greater volume equates to more oxygen to support the fishery throughout the winter, prolonging the onset of oxygen depletion.

Also, holding the starting elevation longer into the winter could delay reaching low oxygen concentrations in the *metric regions*. The intended outcome behind recommending a higher Dec 1 water level is to limit the number of days dissolved oxygen concentrations in the metric regions fall under the threshold of 2 mg/L, below which gamefish populations are stressed and the likelihood of fish kills increases. Metric regions are two focal areas—BEP Miles 10-7, and 5-0 which the model used as reference points for dissolved oxygen concentrations.

3) Develop an Aeration Decision Matrix that identifies and weights the risk factors that contribute to wintertime dissolved oxygen depletion in the Big Eau Pleine, to serve as a guide for managers to initiate mechanical aeration.

According to the modeling results, increased and earlier mechanical aeration (before Feb 15, the average aeration start date in the years that aeration has been necessary) could result in a greater chance of providing a greater the zone of refuge and protecting the fishery through the winter. However, earlier and longer operation of the aerator leads to increased operational expenses and potential safety concerns due to thin or non-existent ice. These and other concerns mentioned in Recommendation #1 should be considered prior to altering aeration regimes.

The Committee identified several risk factors that are potential predictors of winter oxygen depletion—predicted winter severity, water levels on Dec 1, and air temperature and rainfall amounts that occurred from the preceding March through November. If any of these factors fall under a critical indicator of risk (identified in the Matrix), there is increased chance of oxygen depletion, at which point the Committee recommends aeration should be considered. The Matrix is the Committee's best attempt to identify key risk factors and associated indicators of risk; however, the Committee acknowledges that more data is necessary to further refine these indicators and make the Matrix more operational as a predictive tool for anoxic conditions on the BEP.

Considerations for aeration start up after ice fully covers the BEP:

- depending on thickness of ice cover, there can be a two-week or more delay between when the aeration system is turned on, and when full benefits of aeration are realized.
- the initial process of starting the aerator re-suspends bottom sediments full of oxygen-consuming material, which, if occurring during ice-covered conditions, likely actually consumes rather than generates oxygen.

4) Adaptively manage aerator operations to determine and optimize which operational practices maximize the zone of refuge for fish within and downstream of the aeration system.

a. The Model shows that turning on the aerator earlier can increase the winter oxygen in the zone of refuge downstream of the aerator by preventing ice formation, which in turn can increase the chances of fish survival. To the extent possible, the Committee recommends evaluating the economics, safety, and environmental benefit of an earlier start date for the aeration system, consistent with Wis. Stat. § 167.26.

b. Determine if additional holes could be drilled in the aerator blower lines, without impacting the efficacy of the aeration system. This may expedite connection of the holes in the ice (created by the aerator) which could lead to a larger open water area, which would provide oxygen to the zone of refuge.

c. Evaluate a staggered aerator blower operation rather than operating both blowers at the same time. One blower could be turned on a few weeks in advance of the other, to begin opening up holes in the ice sooner. This could provide oxygen to the zone of refuge earlier and without increased electrical operation expenses.

d. Develop a monitoring plan related to aeration, to determine and quantify the net effect of the aerator's influence within and immediately downstream of the aeration zone.

5) Conduct a fish movement study in the BEP using acoustic technology.

Improve the understanding of how, where, and when fish move within the reservoir and river during the winter. WDNR fish survey data have shown that even in major fish kill years, some fish survive. For instance, many of the first-year walleye survived the extreme 2009 fish kill, the largest fish kill recorded since 1980. Conversely, in some winters not characterized as extreme fish kills, a percentage of fish die, presumably due to low oxygen.

The results of a 1988-89 WVIC-sponsored radio telemetry study showed extensive movement of walleye over the winter period; however, questions remain on how they survive periods of winter where conditions aren't favorable for survival. These questions include: Where do fish find oxygen during the winter outside the zone of refuge created by the aerator? Will fish move, and how far

will they move to seek out the zone of refuge? Why were young walleye less susceptible than adult fish to the 2009 fish kill?

6) Develop a BEP Watershed Manure Advisory System to warn agricultural producers of the threat for winter oxygen problems in the BEP, as described in the Aeration Decision Matrix and by monitoring dissolved oxygen.

The Model clearly describes sediment-oxygen demand (SOD) as a driver of oxygen in the BEP. SOD results from nutrient-rich runoff entering the BEP from watershed sources during melt and storms. The runoff can contain manure, fertilizer, and phosphorus-rich soil.

The Model shows that if SOD is reduced, there is a direct benefit on winter availability of oxygen in the BEP. When conditions are present that threaten of the onset of winter oxygen problems and/or fish kills, agricultural producers should be notified along with guidance on winter spreading of manure and other discharge practices. The advisory could use a similar model as the Wisconsin Manure Advisory System.

7) Develop and implement a summer and fall monitoring strategy incorporating phosphorus, algal blooms, and water temperature, to better predict how and when oxygen will be depleted in the winter.

The Model suggests that processes occurring in the watershed and BEP in the summer influence the availability of oxygen the following winter. Monitoring phosphorus and algal blooms in the summer will provide data that could be used as a predictor of winter oxygen depletion, and an indicator of the need for earlier and prolonged aeration. Summer water temperatures are an indicator of winter sediment temperatures.

8) Continue the winter monitoring efforts for dissolved oxygen and ice cover currently being conducted by WVIC.

The monitoring data provided by WVIC used in the Model was critical. To continue to have the best available science to guide management decisions on the BEP, WVIC's data collection should continue.

9) Support development and implementation of measures that reduce nutrient and organic matter loading to the BEP.

Until nutrient runoff from the surrounding lands is reduced, the BEP will continue to be challenged by winter oxygen problems and fish kills. Ongoing efforts by the WDNR (Wisconsin River TMDL), Marathon County, DATCP, and NRCS (non-point source pollution reduction programs), and municipalities (phosphorus compliance efforts such as watershed adaptive management and water quality trading) will all contribute toward reducing nutrient loading to the BEP. These, and other similar efforts, should be supported, and implemented where possible, by all affected parties.

# ENHANCING FISH HABITAT

## Spawning Habitat

Different species of fish prefer different types of spawning habitat. Walleyes favor gravel beds. Walleyes for Tomorrow, BEPCO, WDNR, and WVIC have partnered on projects to improve spawning habitat in the BEP by constructing several extensive gravel beds similar to the one displayed right.

## Shelter and Other Habitat

Due to lack of aquatic plants, the BEP does not provide as much habitat as other water bodies in central Wisconsin. Typically, aquatic plants support fish and other species by providing habitat and shelter, especially for young fish and their food. With the absence of plants, woody structure in shallow water can offer shelter for fish, opportunities for turtles to warm themselves, and places for birds to perch and fish.

***Survey of Shoreland Owners Revealed ...***

*Where do 'riparian' stakeholders agree?*

Agree

Providing better habitat for fish and wildlife on the lake motivates me to support efforts to improve the BEP.

**"Let it Fall" or Add Fish Sticks**

Adding fish sticks to the BEP can be beneficial; however, the locations should be carefully identified so logs don't float downstream and block the dam. Back bays provide shelter from the primary flow of the river and therefore are good sites for the addition of fish sticks. Consultation with the WDNR Fisheries Biologist is recommended during project development to ensure chosen sites will be beneficial to fish, and the techniques proposed to secure the wood in place are sufficient. For more information visit the WDNR website:

http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html

Enhancement of fishery habitat using fish sticks and other woody structure is recommended.
Projects will be most successful in back bays such as those indicated by pink circles on the map.

## GOAL 1. SUSTAIN AND IMPROVE THE FISHERY OF THE BEP RESERVOIR

**Outcome 1.1 – Operate the aeration system in the BEP to reduce the likelihood of winter fish kills while ensuring safety.**

**Who**: BEPCO, Marathon County, WDNR and WVIC (BEP Task Force)

**What**: The BEP Aeration operation group will review and update the aeration system plan and memorandum of agreement (MOA). For purposes of broader ownership, the aeration operation group should consider adding new representatives to the group.

- In winter 2016-17, the BEP Aeration operation group will review and update plans for the aeration system in the BEP Aerator System Operation Memorandum of Agreement (MOA).
- Updates to aeration operations should consider recommendations from the DO Technical Modeling Committee, timing and duration of operation, safety of deployment, and public safety during operation.
- The BEP Aeration operation group should develop a governance structure for inclusion in the MOA which addresses leadership roles and responsibilities related to financial contributions, maintenance and operation, monitoring, safety considerations, points of contact, and processes for calling meetings, distributing information, decision-making, and changes to the MOA.

**When**: 2017 and every 5 years thereafter.

**Indicators of success**: An updated MOA by October 1, 2017 for operations in 2018.

**What**: Sustainable funding is identified to assure the maintenance and operation of the aeration system.

- In 2017, BEPCO and WDNR will convene a meeting of the BEP Task Force, towns, local businesses, sports, conservation and agricultural groups, Wausau Area Visitor's Bureau, and others to identify cost estimates and sustainable funding sources for the operation of the aerator.
- BEPCO should engage with UWEX Lakes to explore options for the formation of a Lake District to help with funding for the aeration system.

**Indicators of success**: A sustainable funding strategy is identified that will cover maintenance and operational costs for the aeration system. The funding strategy is initiated by Jan 1, 2018.

## GOAL 1. SUSTAIN AND IMPROVE THE FISHERY OF THE BEP RESERVOIR

**Outcome 1.2. - Enact the Drought Contingency Plan (DCP) and initiate consultation with WDNR and the U.S. Fish and Wildlife Service when trigger levels for defining drought are met.**

**Who will take the lead**: WVIC

**What:** See DCP in Appendix for details.

**When**: As needed, when triggers of the DCP are met.

**Indicators of success**: The DCP is enacted when trigger levels defining drought conditions are met.

MOA participants understand the DCP prescribed activities and know the definitions of drought conditions/indicators that trigger implementation of the DCP.

The actions taken and plans enacted as a result of the required consultation prevents a fish kill during the following winter.

**Outcome 1.3 – Obtain information related to gamefish movement that can assist with maximizing habitat improvements, aeration operation, and overall management of the fishery.**

**Who:** WDNR, WVIC, Marathon County, UWSP Fisheries Faculty and Students

**What**: Conduct a gamefish movement study on the BEP using acoustic technology.

- Design a gamefish movement study using acoustic technology that outlines materials, tasks, methods, performance measures reporting etc. Identify study duration.
- Apply for Marathon County Environmental Impact Grant Funds to purchase the necessary materials and equipment, and hire the staff needed to implement the study.
- Continue collecting dissolved oxygen and temperature profiles during the winter months which can be analyzed relative to gamefish movement/distribution and aerator operation.

**When:** Submit application for funding to the Marathon County Environmental Impact Fund by June 1, 2017. Funding would be available in 2018.

**Indicators of success:** A study is designed and implemented that provides a better understanding of how, where, and when gamefish move within the reservoir throughout the year and particularly during the winter when dissolved oxygen

## GOAL 1. SUSTAIN AND IMPROVE THE FISHERY OF THE BEP RESERVOIR

**Outcome 1.4 – The fishery will be improved by increasing fish habitat in the BEP reservoir.**

**Who:** Shoreland property owners

**What:** Improve fish habitat in the BEP.

- Learn about the importance of the addition of fish habitat to the BEP reservoir and which permits are necessary to ensure it is safely deployed. WDNR Fishery Biologists can provide technical assistance.
- WDNR Fishery Biologist will work with stakeholders to develop a habitat development plan to identify and prioritize important habitat needs for major gamefish and panfish in the BEP.
- Over the next 3 years, shoreland property owners and fishing clubs will work together to improve fish habitat in the BEP. WDNR Fishery Biologists can provide technical assistance.
- BEPCO or Walleyes for Tomorrow can apply for Healthy Lakes Grants (WDNR) to offset funding for "Fish Sticks" projects.

**When:** 2017

**Indicators of success**: WDNR fish surveys show improvement in fish reproduction and size structure.

**Outcome 1.5 – The status of the fishery, including community and population, will be known. This information can be used as a measure of this plan's success and to adjust approaches in this plan.**

**Who:** WDNR, WVIC (as needed), community members (as needed)

**What**:

- Monitor the fishery. Monitoring will be conducted by the WDNR Fishery Biologists following WDNR standardized lake assessment protocol to determine the survival and health of the fish community in the BEP.
  - An annual spring electrofishing transect will be completed to assess the spawning adult walleye population along with a fall electrofishing transect to monitor walleye recruitment.
  - A comprehensive survey will be conducted on a 7-year rotational basis, which will include spring fyke netting, spring electrofishing and fall electrofishing to assess the status of the entire fishery.
  - Primary fish metrics to monitor the fishery would include catch per unit effort (CPUE) and proportional and relative stock density indexes.
- If needed, WVIC staff can assist with surveys.
- Make survey results with interpretation and comparison to prior surveys available to BEPCO and other interested stakeholders.

## GOAL 1. SUSTAIN AND IMPROVE THE FISHERY OF THE BEP RESERVOIR

**Outcome 1.6 – Understand the economic benefits from a healthy fishery and the negative impacts to the economy from fish kills in the BEP. Maintain the BEP's reputation for a healthy fishery, which is especially important following fish kills, when it is assumed the whole fishery was harmed.**

**Who:** BEPCO, Marathon County, WDNR, Walleyes for Tomorrow, other fishing clubs

**What**:

- Hire an economist to conduct an economic assessment to determine the benefits of the BEP including property values, business, municipal, and industrial benefits, and a healthy fishery. Request recommendations about the economic issues that should be addressed.
- Obtain economic information related to the International Ice Fishing Championships from the Wausau/Central Wisconsin Convention and Visitors Bureau.

**When**: 2019

**Indicators of success**: The economic impacts of the BEP to the economy in central Wisconsin and the extent of negative impacts of fish kills will be understood.

**Who**: BEPCO, Walleyes for Tomorrow, other fishing clubs

**What**:

- Following a fish kill, once the health of the fishery has been established, make a splash about the fishery by submitting news articles, contacting the local media, and posting on Lake_Link.com and other fishing sites.
- Following a fish kill, host an event that brings fishers back to the BEP.

**When**: As needed.

**Indicators of success:** The reputation for the BEP is that it has an excellent fishery.

# Goal 2.

# Improve Water Quality in the BEP Reservoir and Watershed

**Primary Partners**

Shoreland and Watershed Property Owners

Conservation and Farmers Groups

Clark, Marathon, and Taylor Counties

Wisconsin Dept. of Agriculture, Trade and Consumer Protection

United States Dept. of Agriculture – NRCS

United States Environmental Protection Agency

# WATER QUALITY IN THE BEP

## Improving the Water helps the Fishery

The water quality goal for the BEP to decrease nutrient levels (phosphorus) which would decrease the frequency of algal blooms, improve water clarity and reduce fish kills related to oxygen depletion. To achieve these goals, the water quality standard for phosphorus in the BEP is 30 ppb (parts per billion) during the summer. Reducing the current levels in the BEP is essential for the long- term reduction of winter fish kills and reducing summer algae blooms.

Achieving the water quality goals for the BEP will be accomplished by the BEP community working together to place a high community value on sustaining the fishery and improving the water quality in the BEP and its watershed. Monitoring and modeling has been conducted in the BEP and its watershed which identified the amount of phosphorus coming into the BEP that must be controlled to improve water quality. This process, a TMDL, is described later in this chapter. Based on monitoring results and modeling, the majority of phosphorus entering the BEP is from agricultural land. Achieving the needed phosphorus reductions from agricultural lands will require the greater BEP community to support the agricultural community in a meaningful way in order to reduce the amount of nutrients and runoff from agricultural lands.

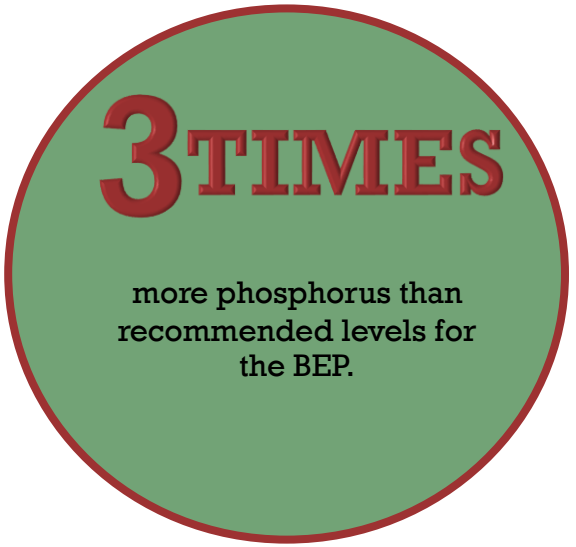
## What We Know about Water Quality in the BEP

Water quality in the BEP is the result of natural characteristics such as geology, slope, soil type, native vegetation, wetlands, the amount of land that drains to the reservoir, and climatic factors. The water quality is heavily impacted by human activity including land management in the watershed, and the dam slowing the flow and allowing sediment and nutrients to settle out in the BEP.

Changes in the land use, and intensive land management practices, such as fertilizing, draining and ditching wetlands, discharge of municipal and industrial wastewater, spreading livestock manure and solids from human waste treatment on land, and soil erosion can have negative effects on water quality.

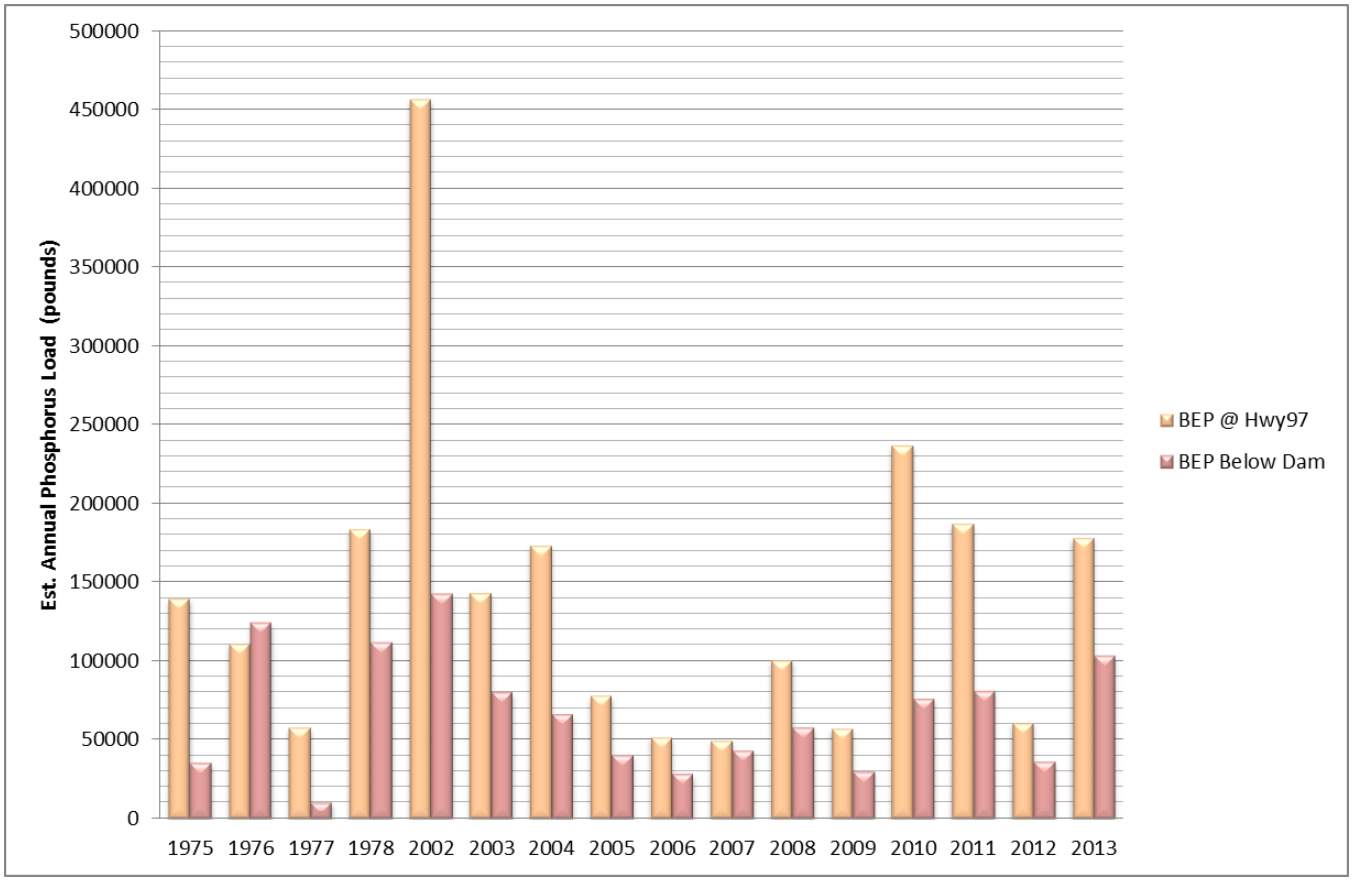
Water quality has been monitored in the BEP for over 40 years. Many studies have been conducted in the water and in the watershed to help the community understand the conditions leading to algal growth and oxygen depletion that leads to fish kills in the BEP.

Water samples collected 2010-2013 indicated median phosphorus concentrations in the BEP were **above 100 ppb.** While this sounds like a small amount, this is more than three times the acceptable level of phosphorus for good water in the BEP. Most of the phosphorus enters the BEP from the BEP River, Fenwood Creek, and Freeman Creek, which all have water with high levels of phosphorus.



**Some of the phosphorus entering the BEP remains in the BEP**

During most years, more phosphorus enters the BEP than exits. This means phosphorus has been accumulating in the sediments since the BEP River was dammed in 1937. This "internal" phosphorus load will continue to fuel algal growth for many years. Therefore, changes on the landscape are not likely to result in immediate improvements in the BEP. Regardless, making changes now is critical to ensure that improvements in the BEP occur, including reductions in the frequency and intensity of algal blooms and fish kills.



## Societal Guidance and Rules Related to Water Quality

Wisconsin and the United States have developed guidance to identify the levels of phosphorus and other pollutants that are allowable in our groundwater, lakes, and streams. When a waterbody exceeds these thresholds, specific steps are required to address the problem. For the phosphorus problem in the BEP, the Clean Water Act (CWA), signed into law in 1972 by President Nixon, directs the state to address the problem.

### The Clean Water Act, TMDL, and the BEP

Because of its high phosphorus concentrations, the BEP was identified by the WDNR and the U.S. Environmental Protection Agency (EPA) as a water body that is degraded and does not meet the phosphorus water quality standards. The CWA requires that a Total Maximum Daily Load (TMDL) be determined for the BEP.

According to the EPA's website, *A TMDL is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody and allocates the necessary reductions to one or more pollutant sources. A TMDL serves as a planning tool and potential starting point for restoration or protection activities with the ultimate goal of attaining or maintaining water quality standards.*

The WDNR monitored water quality and used WVIC, citizen acquired, and other water quality data to develop a phosphorus budget for the BEP. The TMDL is being prepared by staff from the WDNR working with experts from the U.S. Army Corps of Engineers, U.S. Geologic Survey, and UW-Stout.

### How will the phosphorus reductions be achieved?

Once the BEP phosphorus budget and allocations to reduce phosphorus are known, the next step is for community members to work together to develop a specific strategy to the reduce phosphorus from the landscape of the BEP. This strategy is called a 9 key element plan. The first element of the BEP 9 key element plan has been accomplished and the second element is underway.

The 9 elements are:

1. Identify the causes and sources
2. Estimate pollutant loading into the watershed and the expected load reductions
3. Describe management measures that will achieve load reductions and targeted critical areas
4. Estimate the amounts of technical and financial assistance and the relevant authorities needed to implement the plan
5. Develop an information/education component
6. Develop a project schedule
7. Develop the interim, measurable milestones
8. Identify indicators to measure progress and make adjustments
9. Develop a monitoring component

## Get Involved!

***9 Key Element Plan***

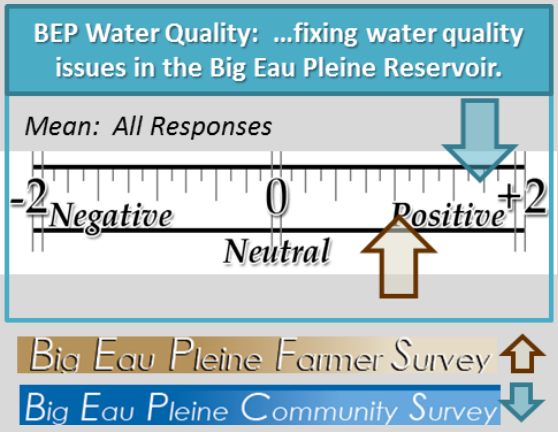
The community will work together to develop strategies for clean water in the BEP. Participate in the events and public input sessions for the development of the BEP 9 Key Element Plan. Discussions about how to achieve the pollutant budget in the BEP watershed will be coordinated by Marathon County CPZ and is anticipated to begin in 2017.

## Water Quality: Working Together to Achieve Goals

Achieving water quality improvements will require commitment by the community to make good water quality a focus and priority. Community partnerships and relationships are imperative; partnerships have occurred for many years. In addition, the conversations that have taken place over the past 3 years have helped to expand and solidify relationships. The conversations must continue, partnerships and commitments need to be affirmed, leaders (and their replacements) must be identified, and additional community members should be sought and welcomed.

### Agreement among land owners

In the survey, improving the BEP's water quality was supported by the shoreland and agricultural landowners. Survey results indicated that **the average shoreland owner 'strongly agrees' with the goal of improving water quality in the BEP**. On average, agricultural landowners also 'agree' with this priority, but to a lesser degree than the shoreland owners.




Scale: Strongly Disagree (-2) to Strongly Agree (+2)

### Disagreement among shoreland owners

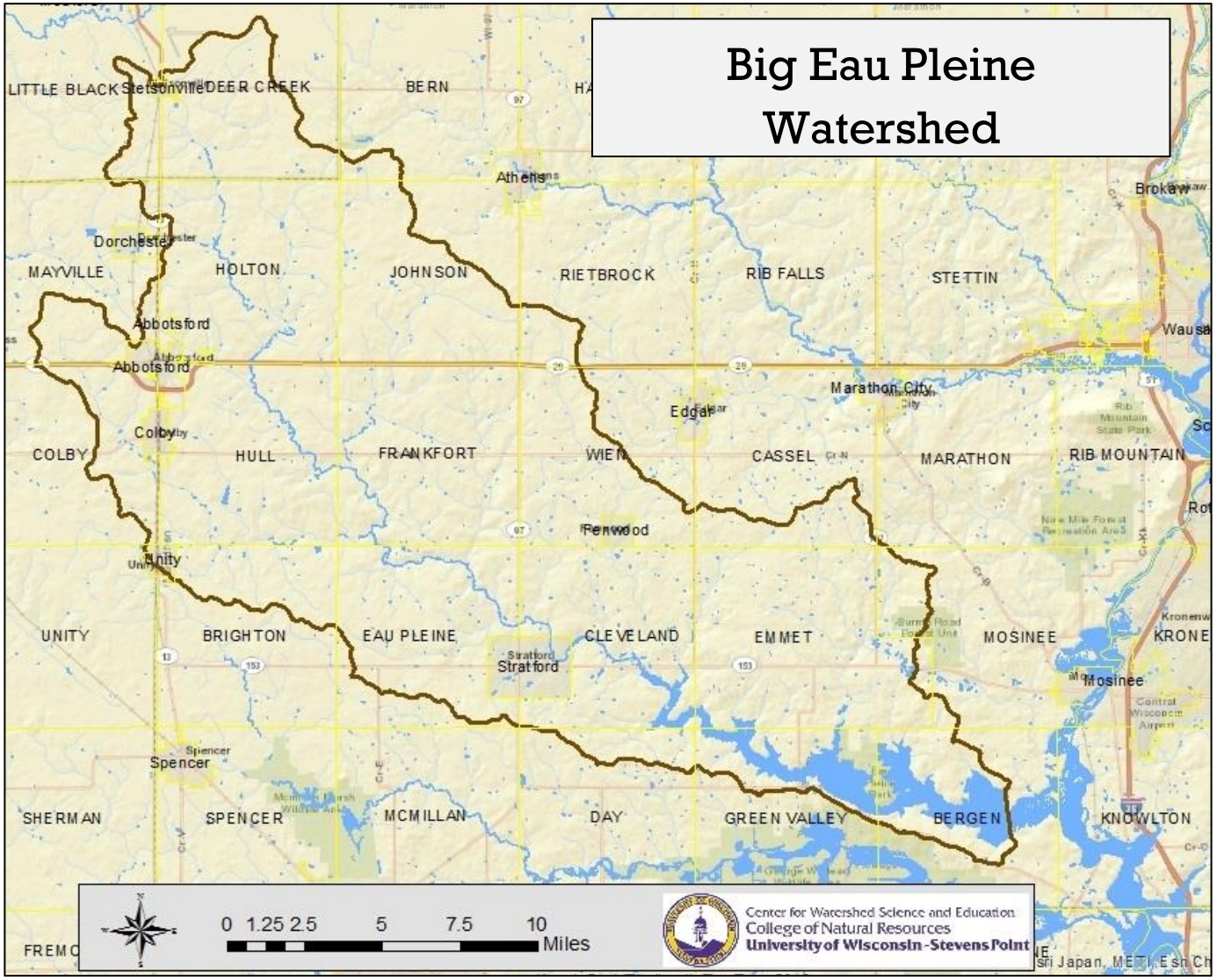
When asked if *spending time on the reservoir was less enjoyable due to unclear water*, many respondents disagreed; however, nearly 1 in 5 survey respondents indicated they see the BEP as a water body in decline, and indicated 'strong agreement' that *algae blooms have made the BEP unsafe for the types of lake activities they enjoy most*. For a subset of shoreland owners, this was less important - it was clear their recreational enjoyment is tied more to the relative solitude and lack of overcrowding.

Clearly, the BEP community can find common ground, and the survey results are a way to identify where community members can agree and come together to make water quality improvements in the BEP a community priority. Additional details about community perception and partnerships can be found in the Goal 3 chapter.

## THE BEP WATERSHED AND LAND USE

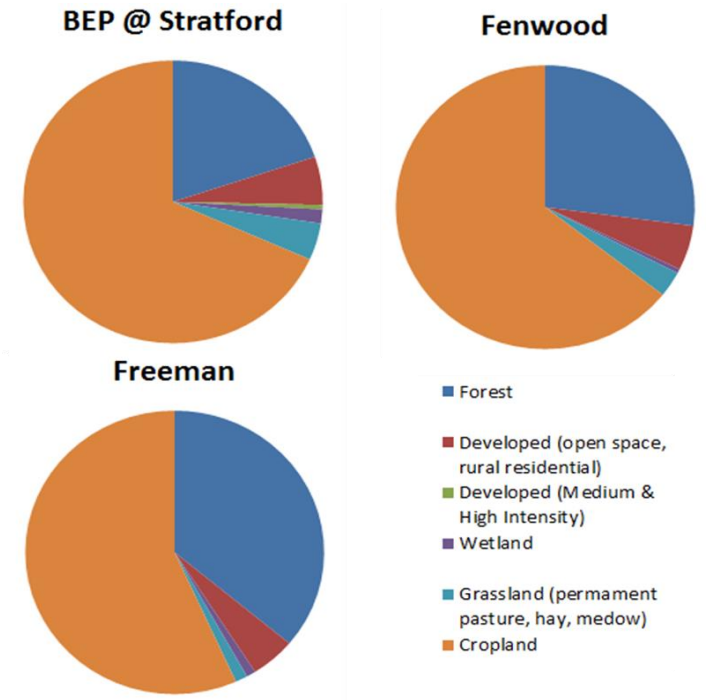
Water quality and land use management are intimately tied to one another. Therefore, developing strategies to improve land management practices is an essential part of addressing water quality problems in the BEP.

*Approximately 238,000 acres of land in Marathon, Taylor, and Clark counties are included in the BEP watershed.*



## Land Use in the BEP Watershed

A large proportion of the land in the BEP watershed is agricultural cropland (60%). In the sub-watersheds that drain to the Big Eau Pleine River at Highway 97 in Stratford, Fenwood Creek, and Freeman Creek, nearly two-thirds of the land use is agricultural. Agricultural lands contribute the largest source of phosphorus to the BEP; therefore, it is critical to look for changes that can be made on these lands to reduce the movement of phosphorus and soil from the landscape to the water.



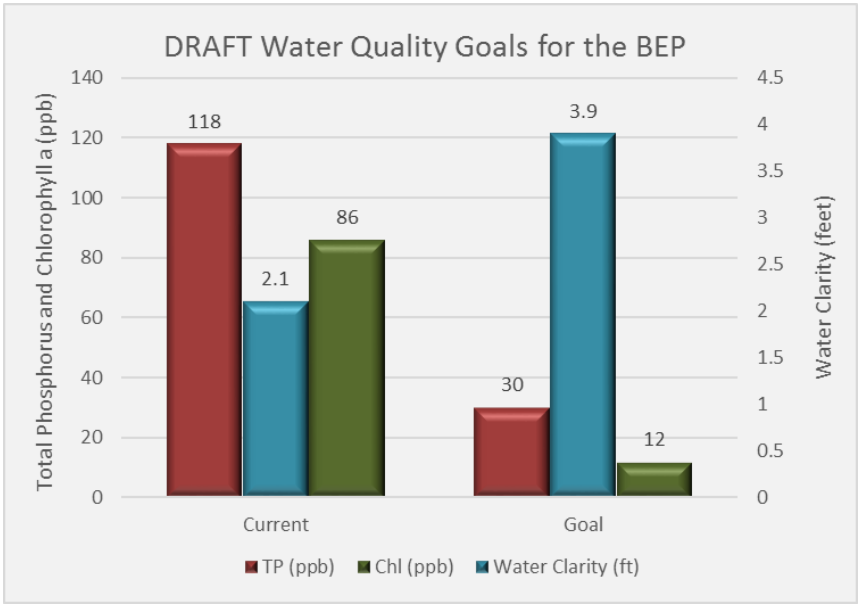

Graphic: Pat Oldenburg

**Land use categories in three BEP sub-watersheds.**

**How good can the water quality get in the BEP?**

Water quality goals for the BEP are being developed as a part of the BEP TMDL. The goal will be identified for total phosphorus. Reductions in phosphorus lead to reductions in chlorophyll *a*, a measure of algae, and increases in water clarity. Preliminary models estimate that if phosphorus can be reduced from an average of 118 ppb to 30 ppb, algae will be reduced by about 74 ppb, which would equate to a two-foot increase in water clarity in the BEP.

To achieve these water quality goals, it will be necessary to reduce the phosphorus contributions from the landscape.



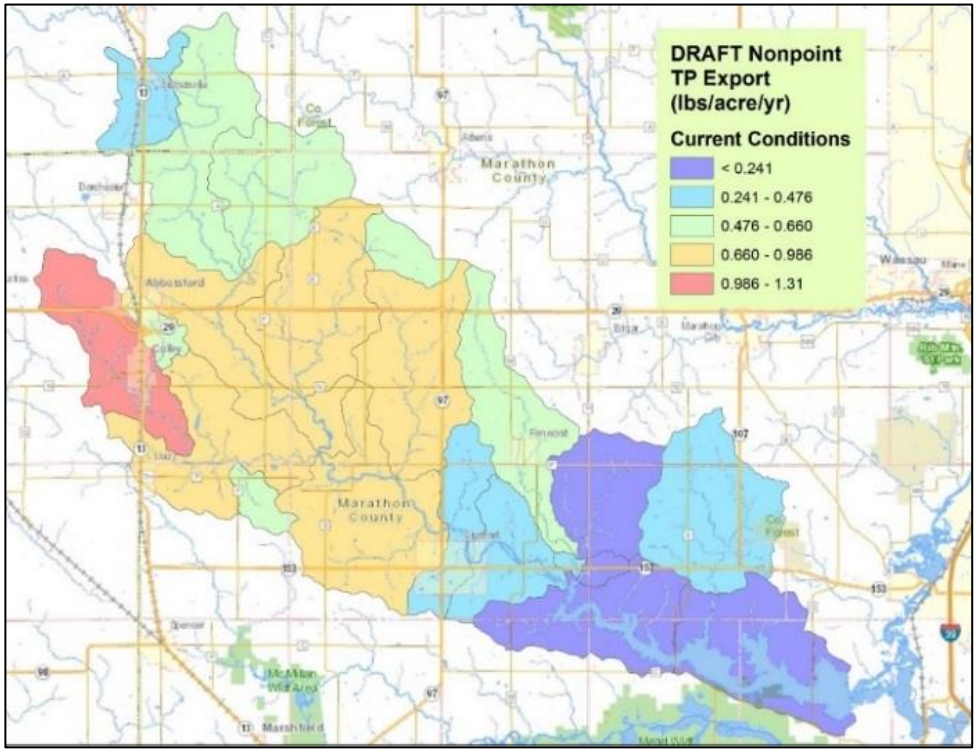
**Phosphorus in the BEP watershed**

To evaluate the amount of phosphorus coming off the landscape from different parts of the BEP watershed, a model called SWAT was developed. The SWAT model used soil type, land use, crop types, and slope to replicate estimates for the current conditions in the watershed, below left. The model was adjusted for a goal of obtaining phosphorus reductions needed to meet water quality goals. The resulting map displays the **draft** phosphorus contributions, below right. Most of the improvements would need to occur in the parts of the watershed nearest the BEP. The map showing the percent of the phosphorus reduction used in the draft phosphorus reduction exercise is shown in the Appendix. **It is important to note that these results are not the final TMDL results.** It is anticipated the final results will become available in 2017.

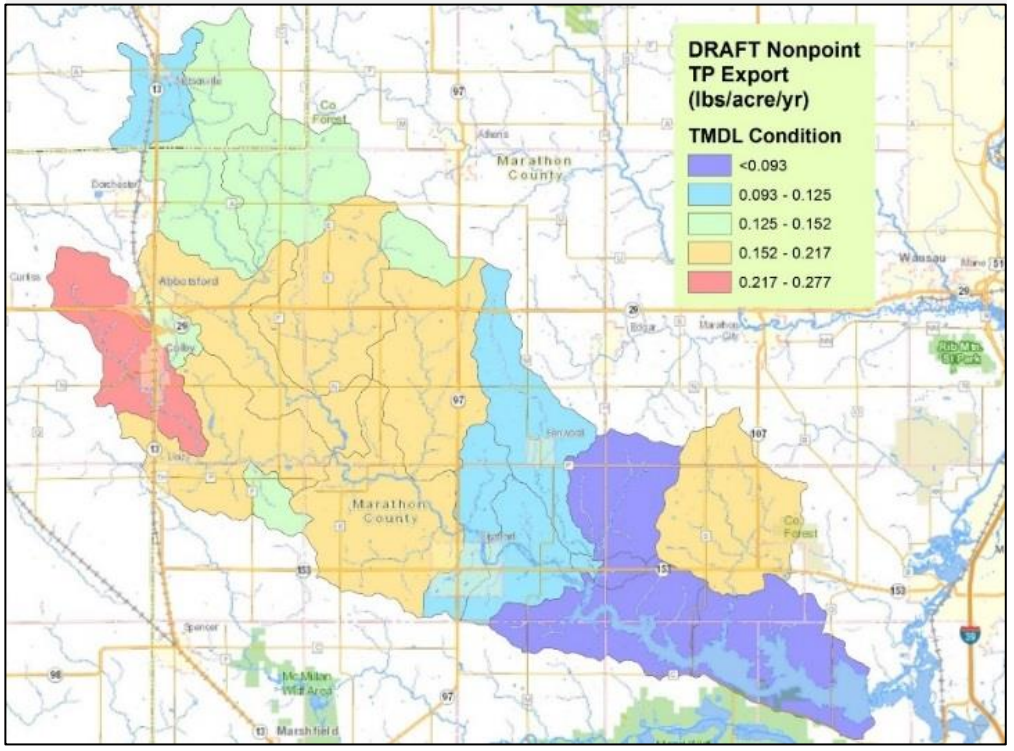
**Options for phosphorus reduction**

The next section of the plan will describe some of the options that could be applied to reduce the movement of phosphorus from the landscape to the water.

Estimated phosphorus contributions from the BEP watershed.
CURRENT SCENARIO




Estimated phosphorus contributions from the BEP watershed.
MEETING WATER QUALITY GOALS SCENARIO



## How the Land is Managed Matters!

Wastewater, animal waste, and fertilizers used on lawns, gardens and crops can contribute nutrients, especially phosphorus, to the BEP that increases the growth of algae.

**Where is the agricultural phosphorus coming from?**

In the BEP watershed, the primary sources of phosphorus from agricultural land include manure, phosphorus-containing fertilizers, and soil erosion. Phosphorus reaching the BEP was not used by the crops for which it was intended, resulting in problems within the BEP and economic waste.

**Strategies to reduce excessive phosphorus**

There are many management practices that can be used to reduce phosphorus loads to the BEP. Selecting phosphorus reduction strategies depends on the setting and can vary with the type and size of the farm, slope of the landscape, proximity to water, available equipment, economics, and the capabilities of the manager. However, the basics are the same for all farms: 1) keep the soil covered, 2) apply only the amount of nutrients a crop needs, 3) improve soil health, and 4) limit the amount of runoff coming off the landscape.

**1. Keep soil in place - where it is useful!**

Retaining soil on the landscape and not in the water is beneficial from a number of perspectives. Healthy soil grows crops requiring less fertilizer, pesticides, and irrigation compared to crops grown in poor quality soil. It can also increase the amount of water that soaks into the ground.

A number of practices can be employed to prevent soil erosion. Vegetation helps to keep soil in place. Permanently covering soil with hay, alfalfa, pasture, or other perennial vegetation is one of the best ways to minimize soil erosion. On fields with annual crops, cover crops can be planted to retain vegetative cover while a crop is not being grown. Depending upon the crop, beneficial cover crops may be interspersed among row crops.

Reduced tilling, using no-till cropping, and leaving crop residuals on the landscape are commonly used practices. Reduced tilling can increase soil health and limit soil erosion by allowing the soil to form clods instead of individual particles that are easily carried by wind or water. No-till cropping allows the field to remain covered by crops and cover crop residuals at all times. Crop residuals (leftovers after harvest) remaining on the field help reduce soil erosion and provide organic materials to the soil.

Vegetation can be intentionally managed on a farm near wetlands and waterways to slow runoff and remove pollutants before they enter the water.

**2. Nutrient management planning: Budget nutrients and reduce costs!**

Nutrient budgets should be developed for the farmland. This concept is similar to calculating and managing a household budget. A phosphorus budget includes an inventory of all of the sources of phosphorus added to the soil, as well as amounts already existing in the soil. To achieve a balance and avoid accumulating excess phosphorus in the soil, the amount of available phosphorus should balance with and not exceed the needs of the crop. Understanding how much phosphorus already exists in the soil, a first step to understanding the true application/crop needs, can be assessed by a routine series of soil tests across a field.

Alterations in the amount, timing, and type of application of fertilizers, manure, and crop residue can help to reduce the amount of phosphorus reaching the waterways in the BEP watershed.

**3. Improve Soil Health**

Contributed by NRCS (Smith et. al, 2016)

Only "living" things can have health, so viewing soil as a living ecosystem reflects a fundamental shift in the way we care for our nation's soils. Soil is not an inert growing medium; it is teaming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem. Soil is an ecosystem that can be managed to provide nutrients for plant growth, absorb and hold rainwater for use during dryer periods, filter and buffer potential pollutants from leaving our fields, serve as a firm foundation for agricultural activities, and provide habitat for soil microbes to flourish and diversify to keep the ecosystem running smoothly.

"Soil health management systems" are one way to try to offset the effects of projected climate changes on crops and cropland and to improve short-term drought tolerance and, potentially, ground-water recharge. These systems can increase infiltration, reduce evaporation, moderate soil temperature changes, increase rooting depth, increase nutrient uptake, and improve the water-holding capacity for most soils. These improvements lead to better crop resilience during drought. In some circumstances, they also provide for ground-water recharge. Additionally, increased infiltration rates decrease runoff, thereby reducing sediment and nutrient loading to streams as well as reducing flood volumes.

**More runoff carries more pollutants**

Land use and land management practices within the BEP watershed can affect the water quality in streams and the BEP. Forests, grasslands, wetlands, and some land with healthy farmland soils allow a fair amount of rainfall to soak into the ground. These land uses can help to recharge groundwater, filter nutrients, and improve water quality.

In contrast, agricultural, industrial, municipal, and residential land uses may result in more runoff and less groundwater recharge. Increased runoff promotes the delivery of nutrients and sediment into surface water. Specifically, conventional soil tillage, as well as manmade drainage systems (ditches, tiles, and "waterways") and alterations to vegetation on the landscape may increase the amount of pollutants leaving the landscape. Impervious (hard) surfaces such as roads, rooftops, and compacted soil prevent rainfall from soaking into the ground, which may result in more runoff carrying more pollutants, including phosphorus to the BEP.

*Best management practices* can be utilized to reduce the amount of runoff from the landscape. Depending upon the setting, practices may include routing runoff to depressions, "buffering" areas with vegetation, collecting and storing wastewater and manures for improved application timing, and routing runoff through areas with permanent groundcover vegetation before it enters a stream.

**Eroding soil can carry nutrients to streams and the BEP**

Areas of land with exposed soil can produce soil erosion. Soil entering the BEP or its streams can make the water cloudy and cover fish spawning beds. Soil also contains nutrients that increase the growth of algae in the BEP and its tributaries.

## Land Use Management: How Do We Get There?

***Approach 1: Create opportunities for cooperation and emphasize co-learning and communication with partners.***

*Recommendation:* Experts working collaboratively with landowners is central to the success of this preferred approach. Efforts need to build on presenting stakeholders with options for inviting in different experts for discussions that provide opportunities for small group interaction.

*Recommendation:* Create forums for clarifying rules and regulations about what is expected of rural landowners AND demonstrate what these practices (such as reservoir-friendly farming) look like when correctly installed and maintained. This is intended to address a perception that not everyone is equally treated by existing rules, and to prepare non-farm stakeholders (such as shoreland owners) to appreciate when actions are being taken by producers that will have a direct benefit on water quality.

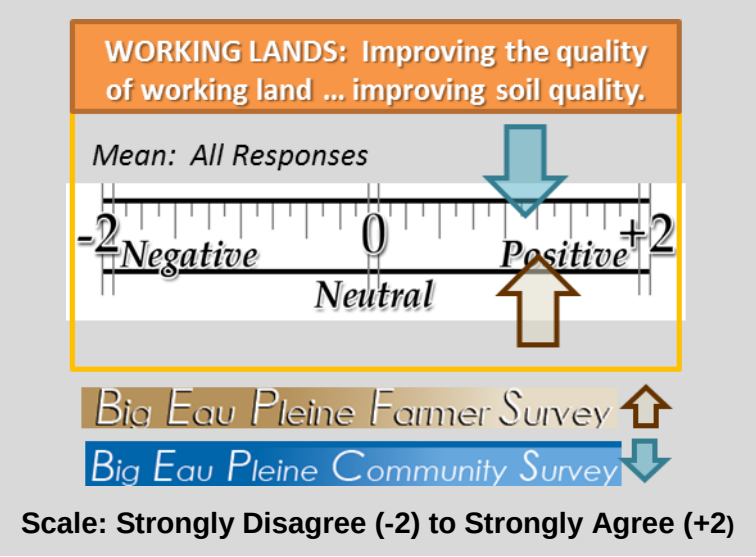
***Approach 2: Focus on improving working lands and identify strategies that protect priority areas*.**

*Recommendation:* Soil health and farm profitability have become part of the message for conservation practice adoption in Wisconsin. The survey revealed a top goal of farmers in the BEP watershed is improving the quality of working lands, which suggests that approaches emphasizing soil health benefits and/or outreach that provide cost and benefit information (such as yield impact) would be appropriate in the BEP watershed.

*Recommendation:* Working with multiple partners (county, agricultural producers, and BEPCO), identify high priority project areas within the BEP watershed. This is a large watershed and there is support from shoreland and agricultural landowners for focusing efforts on priority areas (such as lands near existing streams, wetlands, and the BEP).

***Approach 3: Focus efforts on willing partners first. The path to success begins with mobilizing supporters in the agriculture community to show what can be done.***

*Recommendation:* Focus in the lower portion of the BEP watershed. This group of property owners clearly separated itself from other respondents with positive environmental attitudes characterized by strong support for statements such as *good farming results from placing equal importance in managing both the agricultural and natural areas of my farm*.




**Scale: Strongly Disagree (-2) to Strongly Agree (+2)**

# BEP SHORELANDS

## The Importance of Shoreland Vegetation

**Land closest to the streams and the BEP has the most direct effect on water quality and habitat**

Healthy shoreland vegetation can help improve the quality of the runoff flowing across the landscape towards a stream or the BEP. It also provides habitat for many aquatic and terrestrial animals including birds, frogs, turtles, and many small and large mammals.

Shorelands include adjacent wetlands, which also serve the BEP by allowing contaminants to settle out, providing shelter and food for fish and wildlife, and decreasing the hazard of shoreline erosion by providing a barrier from waves and wind.

Shoreland vegetation prevents erosion

The deep roots of native flowers, grasses, shrubs and trees create a network of plant material that helps to keep soil in place. This is particularly beneficial during periods of low water in the BEP.

When the water is low, shorelands lacking vegetation or comprised of shallowly-rooted plants (such as bluegrass) can be prone to erosion. Soil delivered to the BEP can eventually blanket gravel and rocks needed for fish spawning and aquatic insect habitat. Eroded soil also carries nutrients into the BEP, adding to the already high nutrient load.

***Survey of Shoreland Owners Revealed …***

Most shoreland owners enjoy the natural, scenic shorelines and are not looking for the suburban backyards found on other lakes.

**Making good management choices**

Water quality is altered by the cumulative effect of management choices. Even if the size of a property is small compared to the overall BEP watershed, changes made by one property owner can serve as an example to others. When neighbors see improvements being made, they are more likely to make better management choices themselves.

## What You Can Do

***Shoreland property owners can make informed decisions about the management of their land.***

**Shoreland property owners can lead the way by:**

- **understanding what a healthy shoreland means**
- **maintaining shorelands that are already healthy**
- **making strides to improve disturbed shorelands**

**Learn from each other through demonstration sites on public land, shoreland open houses, and talking with neighbors and others in the watershed.**

**Identify incentives and funds to help people with their efforts (WDNR Lake Protection Grant, WDNR Healthy Lakes Grant, contests, reduced taxes/dues, other incentives)**

**If you are a shoreland property owner, do not disturb exposed habitat when water levels are low.**

## Healthy Shorelands: How Do We Get There?

***Approach 1: Set an example.***

*Recommendation:* Use public spaces, such as boat launches and parks, to provide settings for examples of healthy shoreland practices and give a municipality a way to show it shares a stake in the health of the BEP. Practices may include the diversion of runoff from boat ramps, access roads, and parking lots; rain gardens to capture water from buildings; and, shoreland vegetation restorations.

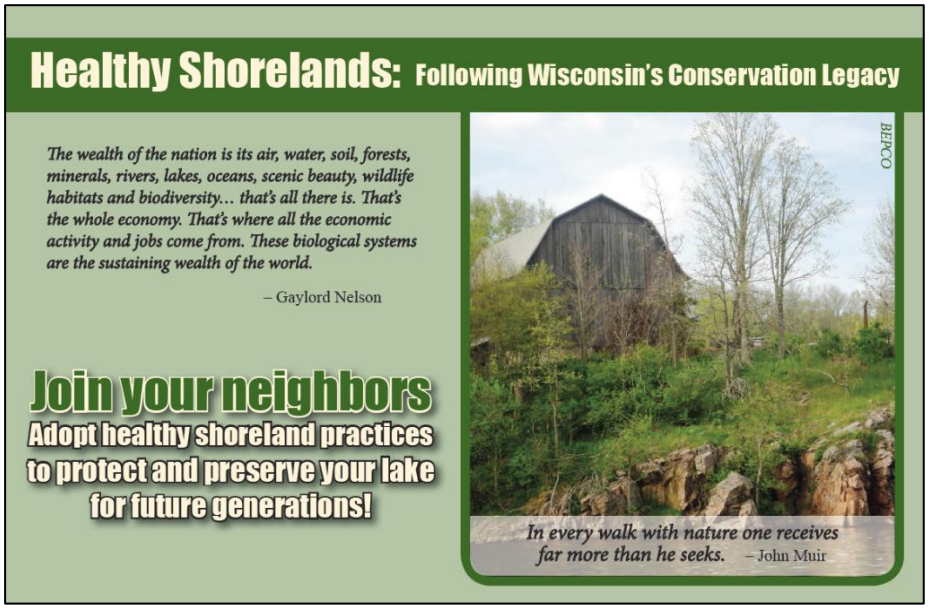
Acknowledging that public spaces are intended to provide access to the BEP, shoreland restorations can be designed in ways that don't impede access but still provide benefits and examples for others to view and learn from. Signage describing the benefits of the restoration is another way to disseminate information.

***Approach 2: Spread the word.***

*Recommendation:* There are a variety of written materials and websites that provide information about healthy shorelands. Many creative ways can also be used to get the word out and have some fun.

Example: During summer 2015, neighbor-to-neighbor conversations were initiated at 28 out of 76 BEP properties visited by volunteers. During these conversations, volunteers gathered information about their community's lake-related interests. Overall, a majority of property owners expressed interest in healthy shorelands, and no residents conveyed disinterest.

The volunteers participating in this project reported they were well-received by neighbors in subdivisions along a portion of the western side of the BEP. This approach allowed them to have conversations with people who may not attend meetings or other gatherings or read newsletters. Conversations can create a less intimidating first step in talking about the importance of shorelands and can also strengthen the BEP community. A successful informational campaign should include plans for follow-up by offering assistance to interested landowners. This could be accomplished by the county or BEPCO. Future efforts should include a handbill/brochure describing the benefits of maintaining the shoreland vegetation and good habits (not cleaning up woody habitat, not driving on the exposed lake bed during periods of low water levels, etc.).



## GOAL 2. IMPROVE WATER QUALITY IN THE BEP RESERVOIR AND WATERSHED: OUTCOMES AND ACTIONS

**Outcome 2.1 -- BEP community members will develop and host educational and celebration events, as well as take actions that lead to elevating clean water to a community value.**

Desired outcomes could include advocacy for local policies to improve clean water, clean water conservation demonstrations on working farmlands and shorelands, collaboration between agricultural and conservation organizations, and participating in local agency and governmental meetings and workgroups that develop policies and strategies to improve water quality in the BEP watershed.

**Who**: Waterfront property owners, landowners and agricultural producers in the BEP watershed, including BEPCO, Marathon County Chapter of Farm Bureau. Farmers Union, and Grazing Groups.

**What:**

- School-based events
- Results of water quality and fishery monitoring
- BMP demonstrations
- Community gatherings

**When:** Ongoing

**Indicators of success**: The community values clean water by providing support for clean water initiatives and property owners manage their land in ways that lead to clean water.

- The community will understand how they can individually and collectively support clean water initiatives.
- Property owners and agricultural producers will actively manage their land in ways that lead to clean water.
- Additional resources for individuals, organizations and institutions to improve water quality.

## GOAL 2. IMPROVE WATER QUALITY IN THE BEP RESERVOIR AND WATERSHED: OUTCOMES AND ACTIONS

**Outcome 2.2 – Conservation and agricultural organizations, property owners, and agencies will seek opportunities to increase and maintain conservation efforts on shoreland and rural lands that contribute runoff to the BEP.**

This could include demonstration projects which improve habitat and reduce phosphorus runoff, as well as implementing conservation provisions into leases for rented agricultural land.

**A. Who**: Clark, Marathon, and Taylor Counties, NRCS, Marathon County Chapter of Farm Bureau. Farmers Union, and Grazing Groups.

**What**:

- Apply for and utilize DATCP funding through the Soil and Water Resource Management Program and Nutrient Management Farmer Education Program to promote proper timing, rates, and methods to apply manure and other nutrients. The grant applications for calendar year 2018 are due in April 2017. Identify funding opportunities. Apply for WDNR Targeted Runoff Management and SWRM Bond funds for the watershed for engineered practices.
- By 2018, Marathon County, DATCP and National Weather Service will generate manure spreading advisory strategies to alert farmers to risky spreading situations (scale of 1.5 square miles).
- Marathon County and WDNR will prepare a report on any "significant" cropland runoff events to quantify the impacts of erosion and nutrient loading to water quality in the BEP watershed. The information can be used to inform the community of resource concerns and to provide information for the aeration implementation decision matrix.
- Marathon County, NRCS, and WDNR will collaborate to maximize funding for farmers to improve conservation practices.
- The installation of 2 learning, or demonstration, sites will be established by UWEX, Marathon County, BEPCO, NRCS, Marathon County Farm Bureau, and Farmers Union working in conjunction with willing landowners within 3 years for the purpose of informing landowners about best practices to protect water quality within the BEP.

**When**: Ongoing or as noted.

**Indicators of success**: Property owners will install the demonstrated conservation practices on their farmland.

- By Dec 31, 2028, phosphorus loading from agricultural lands will be reduced by 50%.
- By Dec 31, 2022, shoreland and storm water BMP's will be installed on all public lands along the BEP.

## GOAL 2. IMPROVE WATER QUALITY IN THE BEP RESERVOIR AND WATERSHED: OUTCOMES AND ACTIONS

**Outcome 2.2 – Conservation and agricultural organizations, property owners, and agencies will seek opportunities to increase and maintain conservation efforts on shoreland and rural lands that contribute runoff to the BEP.**

**B. Who**: BEPCO

**What:** Create a watershed-wide culture of conservation by supporting and recognizing farmers that successfully implement conservation measures.

**When**: Ongoing

**Indicators of success**:

- Boat tours of the BEP, hosted by BEPCO and attended by "upstream" farmers
- Participation in any efforts to organize a watershed council in Fenwood Creek
- Recognition of BEP "conservation farmers" in BEPCO communications and at meetings

**C. Who**: BEPCO

**What:** Create a watershed-wide culture of conservation by engaging waterfront property owners on best landscape management practices to protect the BEP

**When**: Summer 2017

**Indicators of success**:

- Advocating for/working with Marathon County to construct a demonstration "healthy shorelands" rain garden at Big Eau Pleine County Park.
- Sharing via BEPCO communications and at meetings what was learned about healthy shorelands and their relationship to a healthy fishery by BEPCO members who participated in neighbor-to-neighbor shoreland outreach.
- Developing a section on the BEPCO website with resources for members about healthy shorelands.

## GOAL 2. IMPROVE WATER QUALITY IN THE BEP RESERVOIR AND WATERSHED: OUTCOMES AND ACTIONS

**Outcome 2.3 – Within Marathon County, the Marathon County CPZ Staff and Committee will have the governmental leadership role in developing projects, programs and policies in collaboration with the BEP community and agricultural groups that reduce polluted runoff, improve soil health, and improve water quality.**

**Who**: Agricultural groups such as Marathon County Farm Bureau and Farmers Union, municipalities, property owners, local businesses, BEPCO, and conservation groups.

**What**: Develop strategies to address clean water improvements in the BEP.

- The series of discussions about how to achieve the pollutant goals in the BEP watershed will be coordinated by the Marathon County CPZ and is anticipated to begin in 2017. The community will work together to develop strategies for clean water in the BEP by participating in the events and requests for public input related to the development of the 9-Key Element Plan for the BEP watershed.
- Taylor and Clark Counties will assist with the development of the 9-Key Element Plan for the BEP watershed.
- Marathon County will provide support to a producer-led watershed council. BEPCO representatives will be invited to participate on this council. The next round of applications for Producer Led Watershed Protection Grants for 2018 will be available from DATCP in August/September 2017.

**When**: Ongoing

**Indicators of success:**

- Community supported guidance for the improvement of water quality in the BEP will be laid out in the 9-Key Element plan.
- Marathon County internal collaboration between UWEX, NRCS, and CPZ will be strong, demonstrated by coordination of education and technical program integration.

## GOAL 2. IMPROVE WATER QUALITY IN THE BEP RESERVOIR AND WATERSHED: OUTCOMES AND ACTIONS

**Outcome 2.4 – Continue to monitor water quality to evaluate the success of the efforts and identify changes. Phosphorus goals identified for the BEP in the TMDL should be met or exceeded.**

**Who:** WDNR, WVIC, Taylor County, Volunteer monitors

**What**:

- WDNR will lead the water quality monitoring effort in the BEP. At a minimum, measurements of water quality should include dissolved oxygen, phosphorus, nitrogen, chlorophyll a, pH, specific conductance, and temperature. Some agricultural pesticides have also been shown to effect algal growth.
- WVIC will continue to collect water quality data in accordance with its Water Quality Monitoring Plan including collecting bi-monthly D.O. and temperature profiles at the Eau Pleine Dam throughout the year; Trophic State Index data in June, July, August and during fall overturn for 3 consecutive years out of every 10 years. Additional sampling parameters (alkalinity, BOD, color, conductivity, D.O. pH, phosphorus, Secchi depth, temperature and turbidity) collected seasonally as part of WVIC's *Man-Made Quarterly Monito*ring during the same years. Winter D.O. and temperature profiles will be collected at each reservoir mile.
- Over the next 3-10 years, Taylor County Land Conservation staff will continue to monitor four sites in the BEP River from May to October for total phosphorus, conductivity, dissolved oxygen, and temperature.
- Volunteer citizen monitoring near demonstration sites in the BEP and/or tributaries could be beneficial. Monitoring strategies and protocol will be developed based on the site and purpose. Grants may be needed to purchase equipment or analyses.

**When**: Ongoing

**Indicators of success**:

- A robust dataset is available to describe conditions in the BEP, identify problems, and determine if goals are being met.
- Resource management plan(s) outcomes are monitored and reported to community groups to demonstrate success of education and BMP activities.
- Farmers and landowners are recognized for positive improvements to water quality.
- Farmers and landowners understand the connection between land use activities and water quality.

# Goal 3.

# Develop, Engage & Sustain Partnerships Necessary to Implement this Plan for Reducing Fish Kills in the BEP

## ACHIEVING GOALS THROUGH PARTNERSHIPS

The actions outlined in this plan will have the greatest chance of being implemented if the partnership of those involved remains strong. Understanding who the partners are and what their roles may be can help to clarify expectations and responsibilities.

### Meet the Partners

Many individuals, agencies, and municipalities manage or play a role in the management of the BEP reservoir. Active participants have included:

Agricultural Producers and Landowners in the Watershed

Big Eau Pleine Citizens Organization (BEPCO) Local residents and businesses formed this 501(c)(3) organization. Their mission is to preserve, protect, and improve the Big Eau Pleine Reservoir.

Clark County Land Conservation Dept. (LCD) It is the mission of the LCD to promote and assist in wise land use decisions that preserve, protect, and enhance the natural resources of Clark County.

Marathon County Board of Supervisors and professional staff The mission for the Conservation, Planning, and Zoning Dept. (CPZ) is to "Protect our community's land and environment". The county board is the governing body of the county and functions as the policymaking and legislative branch of county government. Through its decisions, the Marathon County Board of Supervisors directs the work and funding for the CPZ.

River Alliance of Wisconsin Advocates for the protection, enhancement and restoration of Wisconsin's rivers and watersheds, and helps citizen advocacy groups work toward clean and plentiful water.

Shoreland Property Owners Property owners adjacent to the BEP and its streams can have some of the greatest impacts (positive or negative) to the BEP from the land management choices that they make. They have the ability to set examples for other property owners in the BEP watershed.

Taylor County Land Conservation Department (LCD) Their mission is to work with Taylor County citizens and local, state, and federal agencies and organizations to provide information, technical assistance, and financial aid for the conservation and protection of natural resources throughout Taylor County.

University of Wisconsin - Extension (UWEX) provides statewide access to university resources and research so the people of Wisconsin can learn, grow and succeed at all stages of life.

USDA Natural Resources Conservation Service (NRCS) NRCS is an agency committed to "helping people help the land". Their mission is to provide resources to farmers and landowners to aid them with conservation. Ensuring productive lands in harmony with a healthy environment is their priority.

Walleyes for Tomorrow (WFT) The mission of WFT is to work with other clubs, agencies, and the WDNR to improve the quality of walleye and sauger fishing. WFT is a project-oriented organization with the goal of increasing the population of walleye in the waters where habitat projects are undertaken.

Wisconsin Department of Agriculture, Trade and Consumer Protection (WI DATCP) Their mission is to partner with all the citizens of Wisconsin to grow the economy by promoting quality food, healthy plants and animals, sound use of land and water resources, and a fair marketplace.

Wisconsin Department of Natural Resources (WDNR) The WDNR is dedicated to working with the citizens and businesses of Wisconsin while preserving and enhancing the natural resources of Wisconsin. In partnership with individuals and organizations, WDNR staff manage fish, wildlife, forests, parks, air and water resources while promoting a healthy, sustainable environment and a full range of outdoor opportunities.

Wisconsin Valley Improvement Company (WVIC) WVIC's mission is to operate the Big Eau Pleine Reservoir as part of the Wisconsin River Reservoir System to maintain as uniform a flow as practicable in the Wisconsin River and a reasonable balance among the benefits the water resource provides including water conservation, flood control, low flow augmentation, hydroelectric generation, water quality, wildlife and recreation.

## Working Together: How Do We Get There?

**Audience 1: BEP supporters**

Survey results demonstrate shoreland owners have both a high level of awareness about BEPCO and strong support for its mission; however, there is a gap between awareness/support and membership in the organization. Responding to the short and long term needs identified in the watershed planning process will require a volunteer management strategy.

*Recommendation:* Trusted facilitators such as County Extension, River Alliance of Wisconsin, and others should assist BEPCO in developing implementation capacity that emphasizes expanding outreach to shoreland owners and lake users who support this work, but aren't involved. Understand why these individuals aren't joining or participating and identify new pathways to gain their involvement.

**Audience 2: Stewardship-focused agricultural producers**
There is an overall lack of awareness by the agricultural community about BEPCO's presence and objectives in the landscape.

*Recommendation:* For BEPCO, it may be possible to create an informational campaign about the BEP watershed management plan that emphasizes positive messaging about the link between good land stewardship and productive agricultural landscapes. Emphasis should be on recognizing the efforts of farmers and sharing conservation success stories within the watershed.

*Recommendation:* Work with Marathon County staff with support from other organizations (such as UWEX) to develop programming to support awareness of options for achieving conservation on rented agricultural land. This could be in the form of workshops that introduce non-farming households to available conservation programs or more advanced sessions that discuss changing lease agreements to ensure conservation goals are achieved.

## ECONOMIC IMPORTANCE OF THE BEP

The BEP has economic value to property owners, business owners, Marathon County, WVIC, and others in the region who benefit from tourism.

During the planning process, participants expressed concerns about reduced property values, loss of revenue to local businesses, and diminished willingness to invest in new businesses such as bait shops, boat rental facilities, fishing tours, restaurants and taverns. Most people linked these concerns to low water levels during the summer that limit boating and other recreational activities. In addition, the reputation of the BEP fishery is perceived to be damaged when fish kills occur, with the bad reputation lingering for years. Some of the concerns about economic impacts may be genuine, while other concerns may not be as damaging as they are perceived.

***Survey of Shoreland Owners Revealed ...***

*Where do 'riparian' stakeholders agree?*

Agree

Local funding to revitalize the lake is a great investment in our future.

## Strategies

***Understand the economic impacts of the BEP to the economy in central Wisconsin and the extent of negative impacts of fish kills.***

Hire an economist to conduct an economic assessment to determine the benefits of the BEP and make recommendations about the economic issues that should be addressed.

***Reduce the negative impacts to the economy from fish kills in the BEP.***

The reputation of the BEP as a healthy fishery may be diminished following fish kills; however, much of the fishery may still remain even after bigger fish kills.

After a fish kill, once the health of the fishery has been established, make a splash about the fishery by submitting news articles, contacting the local media, and posting on Lake_Link.com and other fishing sites.

Host an event that brings fishers back to the BEP.

## Economics: What Do People Think?

### Economic and recreational characteristics

One of the reasons for undertaking the shoreland owner survey was to determine current levels of recreational use on the BEP reservoir. Respondents were asked whether or not they participate in seven recreational activities on or around the BEP, including: canoeing or kayaking, motor boating, fishing (spring-fall), ice fishing, hunting, wildlife viewing, and biking or walking. The key findings (listed below and to the right) for the economic and recreational characteristics include:

**The average respondent reported:**

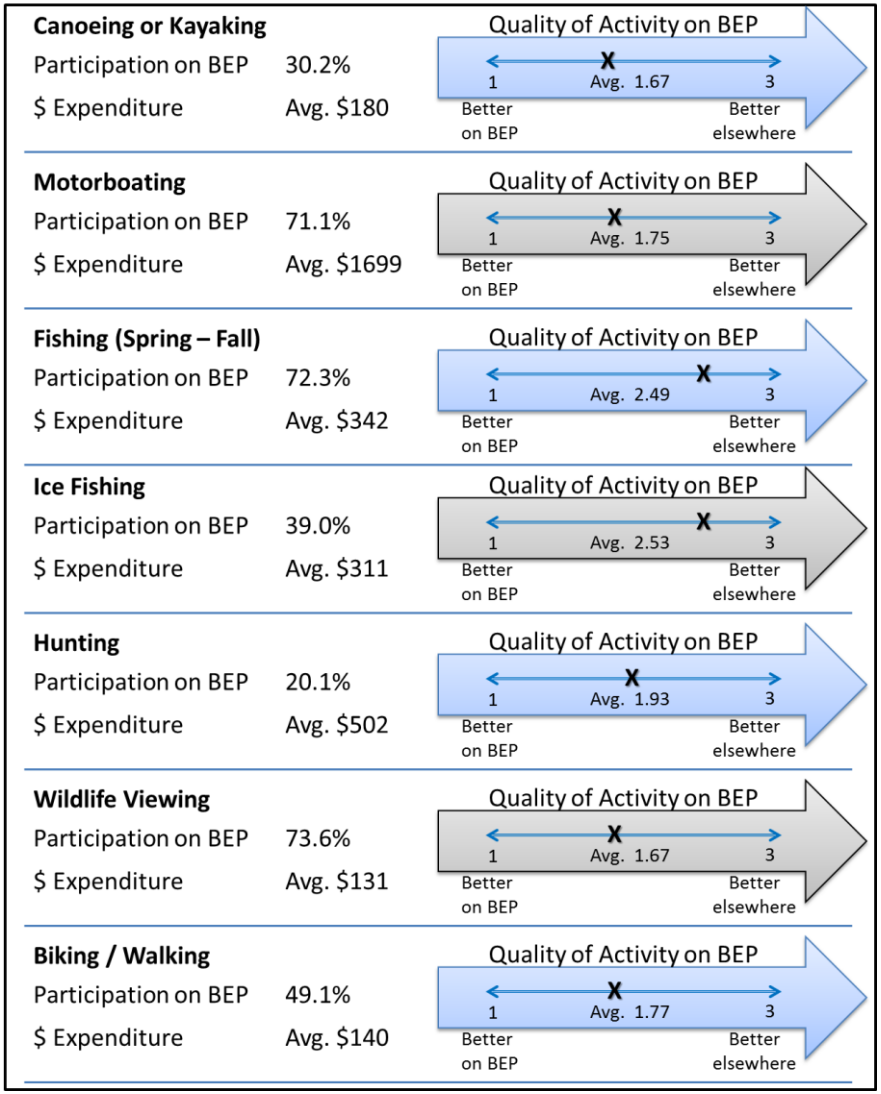
- Participation in 3-4 different activities out of the 7, with the highest participation rates for motor boating, fishing (spring-fall), and wildlife viewing.
- An average annual expenditure of $1,850 per household for all recreational activities.

Total recreational expenditures for these 7 recreational activities exceeded $225,000 per year based on reports from 123 survey respondents. As shown in the figure to the right, the cost and perceived quality varied significantly among activities.

***Survey of Shoreland Owners Revealed …***

As a result of changes to the quality of fishing, nearly 1 in 3 believe property values have decreased.

Recreational Activities: Riparian Users



## GOAL 3. DEVELOP, ENGAGE & SUSTAIN PARTNERSHIPS NECESSARY TO IMPLEMENT THIS PLAN FOR REDUCING FISH KILLS IN THE BEP: OUTCOMES AND ACTIONS

**Outcome 3.1 – Improved coordination of water quality enhancement activities within the BEP watershed.**

**Who**: BEPCO, representatives of Clark, Marathon, and Taylor counties, NRCS, River Alliance of Wisconsin, UW-Extension (UWEX), DATCP, WVIC, WDNR and agricultural groups such as Marathon County Farm Bureau and Farmers Union.

**What**:

- Marathon County and UWEX, with support from other partners, will host at least 2 community listening sessions annually (one with an agricultural focus and one with a shoreland focus) to solicit input about current conditions and to collect suggestions for strategies to engage the community in efforts to improve water quality in the BEP watershed.
- Ensure informed community outreach occurs between all partners.
  - A meeting soliciting the participation of all BEP watershed partners will be convened by Marathon County and BEPCO, with support from other partners, at least biannually to provide an update from all partners on efforts occurring to improve water quality in the BEP watershed.
  - WDNR, with support from other partners, will provide a discussion and training for response to water quality or fish related problematic events such as fish kills, algal blooms, etc. Training topics may include: working with local media, preparing a narrative to describe your current efforts, and the basic science of fish kills / water quality /dissolved oxygen to ensure that all organizations are providing a response based on a common understanding of the BEP facts.
- Within 2 years, WDNR, River Alliance, and UW-Extension convene a leadership team consisting of equal representation of appropriate community and agency partners, who will initially be tasked with developing a civic governance strategy for the BEP watershed.
- At least twice per year, Clark, Marathon, Taylor County Land Conservation Staff and NRCS will meet to discuss current projects and future plans and coordinate efforts, as appropriate.

**Indicators of success**:

- Increased transparency and coordination between all partners regarding implementation of elements of BEP Lake Management Plan.
- Increased participation (numbers and diversity) by community members.

## GOAL 3. DEVELOP, ENGAGE & SUSTAIN PARTNERSHIPS NECESSARY TO IMPLEMENT THIS PLAN FOR REDUCING FISH KILLS IN THE BEP: OUTCOMES AND ACTIONS

**Outcome 3.2 –Increase the capacity for BEPCO to respond to the challenge of enhancing water quality in the watershed.**

**A. Who**: BEPCO

**What**:

- Conduct a two-year outreach campaign designed to increase overall membership and effectiveness of BEPCO. Should focus on non-member waterfront property owners. Could feature house parties; door-to-door recruitment efforts; solicitation for participation on BEPCO work groups/committees; events that members can participate in.
- When: beginning 2017
- Indicators of success: membership increase of 25%, 1-2 new volunteers to support BEPCO leadership or take a leadership role.

**B. Who**: BEPCO

**What**: Expand communications efforts to let the BEP community (members and non-members alike) know what progress is being made to improve water quality and enhance BEPCO as an organization. Could be an update linked to the BEPCO annual meeting, and shared with every property owner on the BEP, each town board within the watershed, appropriate county committees, and state legislators.

**When**: Summer 2018

**C. Who**: BEPCO

**What**: Create opportunities to build watershed-wide support for the BEP, by engaging new partners in the community. Could include hosting an annual event co-sponsored by at least one other community organization (not a county, state, or local agency) to promote awareness of water quality issues in the BEP; or providing opportunities for community organizations to speak about their goals and priorities for the BEP at BEPCO's membership meetings.

**When**: 2017

**Indicators of success**:

- At least one community event is co-hosted with a partner organization
- At least one partner organization presents at a BEPCO membership meeting each year.
- Identification of and a shared dialogue with other community organizations that may be potential partners in the protection of the BEP.
- BEPCO board members will pledge to participate in a minimum of 8 hours of leadership training annually.

## GOAL 3. DEVELOP, ENGAGE & SUSTAIN PARTNERSHIPS NECESSARY TO IMPLEMENT THIS PLAN FOR REDUCING FISH KILLS IN THE BEP: OUTCOMES AND ACTIONS

**Outcome 3.3 – Improve communication between the organizations in the BEP which have common interest in improving water quality.**

**Who**: BEPCO, Marathon County Farm Bureau, etc. Marathon County CPZ staff and Committee Members, Marathon City, UWEX.

**What**:

- Share meeting agendas, define opportunities to collaborate on water quality improvement projects, pool resources to improve water quality, conduct learning events collaboratively.

- Engage the UWEX Center for Land Use Education to complete a comprehensive community capacity assessment to identify community stakeholders, formal and informal communication networks, assess the current capacity of existing and potential partners, and develop a community capacity building strategy for supporting efforts to improve water quality within the basin.

**When**: Ongoing

**Indicators of success**: Examples of collaborations that have led to improved water quality

## GOAL 3. DEVELOP, ENGAGE & SUSTAIN PARTNERSHIPS NECESSARY TO IMPLEMENT THIS PLAN FOR REDUCING FISH KILLS IN THE BEP: OUTCOMES AND ACTIONS

**Outcome 3.4: Informed community members will participate in public processes that are associated with the BEP.**

**Who**: BEPCO, community members, agency staff

**What**:

- Informed community members and agency staff will provide suggestions about improvements to the FERC license for the BEP to ensure a healthy fishery is maintained. Learn the basics of the FERC license for the BEP, including time periods for public comment.
- Community members will share ideas related to the development of the 9-key element plan and natural resource management plans.

**When**: Ongoing

**Indicators of success**:

- FERC licensing processes receive and respond to informed comments about the BEP during public comment periods.
- BEPCO and community partners contribute constructively to resource plans, FERC licensing activities, recreational improvement of the reservoir, and water quality.

**Outcome 3.5: This plan will be implemented and updated by partners in the BEP.**

**Who**: Partners listed in this plan.

**What**:

- By Feb 2017, develop a BEP implementation team and governance structure including the lead and meeting frequency.
- Implementation team will develop annual goals and strategies. Share accomplishments and keep records of the accomplishments. The first meeting will be organized by Marathon County.
- The BEP Implementation Team will update this plan every 2 years. Append the list of accomplishments and track changes made to each revision.

**Indicators of success**: The BEP Implementation Team will coordinate to ensure implementation occurs efficiently and on time. This plan will be kept current so partners are working on the most relevant actions.

## REFERENCES

Barko, J.W., Gunnison, D. 1988. "Investigation of Environmental Problems in the Big Eau Pleine Reservoir, Wisconsin". US Army Corps of Engineers Miscellaneous Paper EL-88-18. St. Paul, Minnesota.

BEPCO, 2011. Big Eau Pleine Reservoir fish kill data analysis and report. Report compiled by the Big Eau Pleine Citizens Organization.

Big Eau Pleine Task Force. 2009. "Case Study for Big Eau Pleine Watershed". Wisconsin Department of Natural Resources Technical Report. Marathon County, Wisconsin.

Brodzeller, J. and P. McGinley. 2016. A CE-QUAL-W2 Model for Dissolved Oxygen in the Big Eau Pleine Reservoir, Wisconsin to Understand and Manage Winter Anoxia. Univ. Wisconsin–Stevens Point, Center for Watershed Science and Education. Report to the Wisc. Dept. Natural Resources.

http://www.uwsp.edu/cnr-ap/watershed/Documents/BEP_FinalReport_Draft_July11_2016.pdf

Coon, D.M. 1999. Assessment of Historical Eau Pleine Reservoir Operations, Winter Dissolved Oxygen, and Periodic Fishkills: Strategies for Future Reservoir Management. Journal of Lake and Reservoir Management 14:77-85.

James, W.F., H.L Eakin, D. Gunnison and J.W. Barko. 1992. Sediment-Overlying Water Relationships Affecting Wintertime Dissolved Oxygen Conditions in the Big Eau Pleine Reservoir, Wisconsin. U.S. Army Corps of Engineers Water Quality Research Program Technical Report W-92-2.

Johnson, A. 2009. Case Study for Big Eau Pleine Watershed. Marathon County Conservation, Planning, and Zoning Dept. http://www.co.marathon.wi.us/Portals/0/Departments/CPZ/Documents/Exec_121009_final_v1.pdf

Marathon County, Big Eau Pleine Task Force. 2011. Strategic Plan for the Big Eau Pleine Watershed and Reservoir.

Shaw, B.H., J.F. Sullivan and J.G. Vennie. The impact of agricultural runoff and reservoir drawdown on the Big Eau Pleine Reservoir, Wisconsin. Paper 4-18, pp 345-359.

Smith, C.W., D. Lamm, M. Kucera. 2016. Effects of Implementation of Soil Health Management Practices on Infiltration, Saturated Hydraulic Conductivity (K sat), and Runoff. USDA, Natural Resources Conservation Service, National Soil Survey Center. 9/7/2016.

https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=stelprdb1257753

Sullivan, J. 1982. Analysis of mechanical aeration in the Big Eau Pleine Reservoir. Unpublished.

Swalby, L.J. 1979. "Long-Term Analysis of the Big Eau Pleine Reservoir, as Related to BOD Source". M.S. Thesis, College of Natural Resources, University of Wisconsin-Stevens Point. Stevens Point, Wisconsin.

Vennie, J.G. 1982. "Water and Nutrient Budgets and Phosphorus Models for the Big Eau Pleine Reservoir, Wisconsin. M.S. Thesis, College of Natural Resources, University of Wisconsin-Stevens Point. Stevens Point, Wisconsin.

WVIC, 2015. "Wisconsin River Reservoir System Summary." Wisconsin Valley Improvement Company. Web. Feb. 2015.

WVIC, 2016. Operating Plan Status Report and Review, FERC Project No. 2113

## APPENDICES

**BIG EAU PLEINE AERATOR SYSTEM**
**MEMORANDUM OF AGREEMENT**

**THIS MEMORANDUM OF AGREEMENT, ("MOA")** is entered into as of the date and year below and in consideration of the mutual promises, obligations and benefits provided herein, the receipt and adequacy of which is hereby acknowledged, the parties hereto agree as follows:

## I. PARTIES

The parties to this MOA are the State of Wisconsin Department of Natural Resources ("DNR" or "Department"), Wisconsin Valley Improvement Company ("WVIC"), Marathon County, and the Big Eau Pleine Citizens Organization ("BEPCO").

## II. PURPOSE

First installed in 1981, the aerator system on the Big Eau Pleine Reservoir had an estimated 10-year life span but continued operation into 2009 when it began failing. The efficiency of the system declined as equipment and aerator lines aged. The original 1981 aeration system on the Big Eau Pleine Reservoir was re-designed and upgraded in 2009 by WVIC, DNR and the Army Corps of Engineers ("ACOE") to improve performance and reliability over the original aeration system. The ACOE provided valuable assistance with design specifications and the evaluation of various operating/engineering scenarios. The new aeration system was funded by Marathon County, BEPCO, WVIC, and DNR and installed in January, 2010. The new aeration system began operation in February, 2010.

When nutrient laden water from the Big Eau Pleine watershed is impounded, the decomposition of the organic material depletes dissolved oxygen in the Big Eau Pleine Reservoir. The Big Eau Pleine Reservoir is susceptible to winter fish kills during periods of extreme low dissolved oxygen conditions. The aerator system helps to mitigate fish kills by creating 30-60 acres of open water and oxygen exchange.

This MOA is intended to describe the tasks and responsibilities of the parties hereto to operate and maintain ("O&M") the new aerator system. The O&M cost estimates include routine maintenance and potential capital replacement costs. The maintenance history and hours of operation of the two 40 hp electric motors and associated blowers are set forth on Attachment A.

## III. RESERVOIR MONITORING & OPERATION

A. WVIC will monitor dissolved oxygen ("DO"), biological oxygen demand ("BOD"), and temperature in the Big Eau Pleine Reservoir during the winter period (January 1st of each year to ice out on the Big Eau Pleine Reservoir) to characterize oxygen conditions, identify DO sags and coordinate operation of the aeration system with the DNR, pursuant to and in strict conformance with the requirements of its 1996 FERC license in Articles 411 and 413.

B. WVIC has the primary responsibility to operate the Big Eau Pleine Reservoir pursuant to and in conformance with the requirements of its 1996 FERC license including the requirements set forth in Article 421.

## IV. WINTER SAFETY FENCE

A. The DNR will coordinate installation of the on-ice winter safety fence and warning signs with assistance from local volunteers. The installation date will be determined at the discretion of the DNR taking into consideration safe ice conditions in the channel.

B. The DNR will coordinate removal of the winter safety fence and warning signs after ice-out.

C. The DNR will store and maintain the winter safety fence.

## V. AERATOR OPERATION

A. WVIC in consultation with the DNR shall review reservoir monitoring data, (Section III) to determine if the aeration system needs to be operated to help mitigate low dissolved oxygen conditions.

B. DNR owns the aerator system and will have primary responsibility for operation of the aerator system including winter season start up, equipment monitoring, routine maintenance, record keeping, and seasonal shut down.

C. DNR shall have the responsibility to identify any major repairs or preventive maintenance needs of the mechanical aeration system. DNR will bring major repair needs to the attention of the parties hereto.

D. DNR shall prepare aerator lines to prevent winter freezing. This includes operating the shallow "bubbler line" to keep the shoreline area ice-free where the aerator lines enter the water and to de-ice the aerator lines early in the winter and just prior to aerator start-up.

E. WVIC shall have the primary responsibility for other off-season routine maintenance of aerator lines including raising line sections for repair and moving lines if displaced. WVIC

will bring major repair needs to the attention of the parties hereto.

F. DNR shall identify a person to appoint as back up operator for the aeration system. The lead operator will train the backup operator on routine operation of the aerator system.

## VI. O&M EXPENSES

A. DNR and WVIC shall share equally annual routine maintenance expenses. These expenses are estimated at $400 annually and include maintenance such as drive belts, air filters, grease, oil and de-icing line compounds.

B. WVIC, DNR, Marathon County, and BEPCO, agree that all future capital expenses related to the 40 hp. electric motors and blowers shall be paid for by each party hereto in proportion to those sums as the parties shall agree. WVIC, DNR, Marathon County, and BEPCO shall collectively decide whether to invest in any other capital expenses and if so how to fund such expenses. Potential future capital expenses are outlined in Attachment B.

C. Nothwithstanding anything to the contrary herein, Marathon County shall contribute the sum of $500 per calendar year for the term of this MOA.

## VII. POINTS OF CONTACT

All notices, certificates or other communications hereunder shall be sufficiently given and be deemed given when hand delivered or when mailed to the official addresses of each of the parties hereto as follows:

DNR: Bob Hujik
NR Region Program Manager
P.O. Box 4001
Eau Claire, WI 54702
Telephone (715) 839-3731
Email Robert.Hujik@wi.gov.

Marathon County:
Bill Duncanson
Director of Parks, Recreation & Forestry
212 River Drive, Ste. 2
Wausau, WI 54403
Telephone (715) 261-1554

WVIC: Cathy Wendt
Director Of Environmental Affairs
2301 North 3rd Street
Wausau, WI 54403
Telephone (715) 848-2976 Ext. 310;
Email wendt@wvic.com.

BEPCO: Tim Garrigan
President, BEPCO
P.O. Box 335
Mosinee, WI 54455
Telephone (715) 687-4773

The parties shall notify each other as soon as practical of any changes to the contact information in this Section.

## VIII. APPLICABLILITY

A. Nothing in this MOA creates any right or obligation, either substantive or procedural, enforceable by any third party.

B. All parties reserve any rights each may have to commence an action against the other for failing to carry out the duties or obligations under this MOA.

C. The invalidity of any one or more phrases, sentences, clauses or sections in this MOA shall not affect the remaining portions of this MOA or portions thereof.

## IX. FUNDING

All obligations on the part of the parties hereto shall be subject to and dependent on the appropriation, allocation, and allotment of sufficient funds for such purposes by the parties hereto.

## X. LIABILITY

To the extent allowed by law, the parties hereby mutually agree to hold each other harmless and indemnify the other from and against all claims, costs and liability of every kind and nature, for injury or damage received or sustained by any person or entity in connection with, or on account of the performance of obligations under this MOA caused by the other or their agents, employees or any third party from whom said party is responsible.

## XI. EFFECTIVE DATE, DURATION, MODIFICATION, AND REVOCATION

A. This MOA shall take effect on the date the last party signs the same.

B. This MOA shall remain in effect for a period of five years from the date of execution by all the parties hereto unless modified, renewed, or revoked as provided in this Section.

C. This MOA may only be modified by the written agreement of all parties hereto.

D. This MOA contains the entire understanding of the parties as set forth herein and supersedes all prior written and/or verbal agreements of the parties hereto.

## XII. AGREED TO BY

The parties, by their signatures, certify that they have been duly and properly authorized by their respective entities to make the commitments contained herein, intending them to be binding upon their respective entities and to execute this MOA on their behalf.

Dated at Wausau, Wisconsin, this 19th day of Dec., 2012.

WISCONSIN VALLEY IMPROVEMENT COMPANY

By: Thomas Kipp, President

Dated at Madison, Wisconsin, this 13th day of August 2012.

STATE OF WISCONSIN,
DEPARTMENT OF NATURAL RESOURCES

for By: Cathy Stepp, Secretary

Dated at Wausau, Wisconsin, this 10th day of Dec., 2012.

MARATHON COUNTY

By: Brad Karger, Administrator

Dated at Mosinee, Wisconsin this 12th day of Dec, 2012.

BEPCO

By: Tim Garrigan

**Attachment A**

**Eau Pleine Reservoir Winter Aerator Hours Of Operation**
**1981 - 2011**

| Year | Date Aerator Turned On | Date Aerator Turned Off | Total No. Days | Total Hours for Each Motor & Blower |
|---|---|---|---|---|
| 1981 | Feb. 7 | Mar. 17 | 38 | 912 |
| 1982 | Feb. 11 | Mar. 26 | 43 | 1,032 |
| 1983 | Mar. 1 | Mar. 6 | 5 | 120 |
| 1984 | Feb 27 | Mar. 23 | 25 | 600 |
| 1985 | Feb. 13 | Mar. 21 | 36 | 864 |
| 1986 | Mar. 5 | Mar. 26 | 21 | 504 |
| 1987 | Feb. 10 | Mar. 30 | 48 | 1,152 |
| 1988 | Mar. 7 | Mar. 26 | 19 | 456 |
| 1989 | Feb. 13 | Mar. 27 | 42 | 1,008 |
| 1990 | Jan. 29 | Mar. 16 | 46 | 1,104 |
| 1991 | Mar. 18 | Mar. 27 | 9 | 216 |
| 1992 | Jan. 28 | Apr. 10 | 73 | 1,752 |
| 1993 | Feb. 22 | Apr. 8 | 45 | 1,080 |
| 1994 | Feb. 23 | Mar. 24 | 29 | 696 |
| 1995 | Mar. 6 | Apr. 7 | 32 | 768 |
| 1996 | Feb. 26 | Apr. 10 | 44 | 1,056 |
| 1997 | Feb. 10 | Mar. 31 | 49 | 1,176 |
| 1998 | Feb. 12 | Mar. 27 | 43 | 1,032 |
| 1999 | Not Operated | | 0 | 0 |
| 2000 * | Jan. 19 | Mar. 3 | 44 | 1,056 |
| 2001 | Mar. 12 | Apr. 6 | 25 | 600 |
| 2002 * | Not Operated | | 0 | 0 |
| 2003 | Not Operated | | 0 | 0 |
| 2004 | Feb. 25 | Mar. 11 | 15 | 360 |
| 2005 | Feb. 21 | Mar. 29 | 36 | 864 |
| 2006 | Not Operated | | 0 | 0 |
| 2007 | Feb. 23 | Mar. 20 | 25 | 600 |
| 2008 | Feb. 20 | Apr. 8 | 48 | 1,152 |
| 2009 | Jan. 14 | Mar. 20 | 65 | 1,560 |
| 2010 | Feb. 17 | Mar. 26 | 37 | 888 |
| 2011 | Mar. 7 | Apr. 11 | 35 | 840 |
| | | TOTAL = | 977 | 23,448 hrs |

*** Note: The East 40 hp motor was rebuilt by Linder Electric, Wausau in 2000 and had 16,464 hrs and since has 6,864 hrs.**
**The West 40 hp motor rebuilt by Linder Electric, Wausau in 2002 and had 17,064 hrs and since has 6,264 hrs.**
**The rebuild for both mortors included rewinding, new seals and bearings.**
**The blowers have not required any other non-routine maintenance to date.**

File: ENV/Water quality: EP3 Ops Aerator hrs 1981-2011.xls

**Attachment B**

**Eau Pleine Reservoir Aerator: Potential Capital Expenses**

The aerator system is composed of two electric motors that drive one blower each to deliver surface air through the fourteen 2-inch aerator lines located on the bottom of the reservoir. Each blower delivers air into a manifold which contains seven 2-inch ports to which the aerator lines are connected. Each 2-inch aerator line has two drilled orifices 3/8 inch in diameter (orifices drilled through both sides of the 2 inch line). On each aerator line, one orifice is located approximately 6 ft from the outer end of the line and the second orifice is located at a mid-point area that coincides with maximum reservoir depth in the area of each specific line. The electric motors and blowers are housed in a cement block building owned by the DNR.

The specifications for the electric motors and blowers and associated capital replacement costs are given below:

**Electric Motors**

40 hp electric 3-phase, 1800 rpm, 240 volt, 326T-Frame

Option 1. Purchase new motor = $1,800/motor per Linder Electric, Wausau, WI (New motor can be delivered w/in 24 hrs) (Hyundai motor w/ 2 yr warranty; Worldwide Electric motor w/ 3 yr warranty – both are highly rated motors)

Option 2. Rewind and replace bearings and seals = $1,800 per motor Linder Electric, Wausau, WI

**Gardner Denver Blowers**

Model: 5CDL13F GD Cycloblower (serial #'s 35031 & 35032)

Overhaul kit (GD P/N: 8508096) = $2,400 (2011 costs) + labor install = $2,600 = Total $5,000/blower. Factory lead time is 4-6 weeks ARO.

New replacement blower (GD Model # 5CDL13P drop in replacement for F version) = $11,727/blower (2011 cost). Factory lead time is 6-8 weeks ARO.

The above blower cost estimates are from:

Air Process Systems Co.
%Dan Geoghegan
774 Burr Oak Drive
Westmont, IL 60659

Ph: 630-887-0700 Fax: 630-887-0771
Email: dang@airprocesssystems.com

## APPENDIX B: WVIC DROUGHT CONTINGENCY PLAN

WVIC 2016 - Article 409

Summary

Requires that a Drought Contingency Plan (DCP) be developed in consultation with the resource agencies within one year of license issuance. Plan is to include procedures to define drought conditions and modify minimum reservoir releases and downstream target flows during a drought.

Status

The original DCP was developed in cooperation with the resource agencies and submitted to FERC on July 17, 1997. FERC approved the plan on August 5, 1997. A revised plan was submitted to FERC in July 2011. FERC approved the revised DCP on August 1, 2014.

The revised plan set trigger levels for defining drought conditions and set up a consultation process with the resource agencies when drought conditions are expected. The revised plan also outlines possible actions to be taken during drought conditions, but specifies that the final decision for implementing these actions will be made on a case-by-case basis.

Based on the requirements of the DCP, the following consultations occurred during the 2011-2015 period.

Wisconsin River Low Flow Triggers

During August and September 2012, the Wisconsin River experienced low flows because of a hot, dry summer and low groundwater levels (hence low base flows) that was a carry-over from the 2003-2012 drought. Prior to the consultation meeting, in late August, WVIC reduced target river flows to the allowable minimums prescribed in its FERC license. Despite lowering flows to these Q(7,10) levels, there was not sufficient reservoir storage to maintain these flows through the winter. WVIC proposed to lower the target flows from 900 to 750 cfs at Merrill and from 1,300 to 950 cfs at Wisconsin Rapids in order to conserve reservoir storage for the winter.

During a consultation meeting on October 5, 2012, previous reductions in target flows were discussed. Similar consultations resulted in lowered target flows in 2009 and similar flow reductions had also occurred in 1976 and 1988-89. Under WVIC's old license, consultation with the agencies was not required at that time.

The resource agencies expressed concerns that further lowering of the target flows may adversely affect Wisconsin River water quality and may be harmful to mussel populations. Minimum flow reductions at WVIC's Rainbow and Spirit Reservoirs at the same ratios as the main Wisconsin River cuts were also discussed to conserve storage in those reservoirs due to their Index Levels being the lowest of the five reservoirs.

No final decisions were made during the meeting as not all parties were able to attend. However, soon after, runoff events occurred and consultation was no longer required.

Decreasing Minimum Releases

Consultations were completed relating to reducing minimum releases out of the Long-on-Deerskin project numerous times during the reporting period and the results of those consultations were discussed under Article 404. Consultation also occurred in September 2013 as the water level at South Pelican was approaching minimum resulting in no changes in operations being requested. Soon after, runoff occurred and the water level rose.

Trigger for consultation on index levels of the five large reservoirs

In August 2013 a consultation meeting was held because 4 of the 5 large reservoirs (Rainbow, Willow, Rice and Spirit) had index levels below level 3. Because the index levels would change dramatically on September 1st based on the formulas in the license, it was determined that there was no need to start discussions on reducing flow goals on the Wisconsin River earlier than normal. In addition, WVIC felt that there was enough water in the reservoirs to handle another month or so of no rainfall. The outcome of the meeting was that if by the end of September no rains had occurred, discussions on reducing flows would be required. No further review was necessary as runoff producing rainfalls occurred.

During the summer of 2015, both the Willow and Spirit reservoirs were below index level 3 as both projects had water levels being held significantly below the maximum to relieve pressures on the dam structures. All agencies were notified of the reasons for low water levels and no concerns were identified.

Index levels improved in the fall based on the formulas in the license.

Review

WVIC has reviewed the three triggers added to the Drought Contingency Plan that were approved on August 1, 2014 and recommend that they be revised as follows:

From:

• WVIC will track the cumulative precipitation departure from normal. If the cumulative precipitation deficit reaches 15 inches, WVIC will consult with WDNR and USFWS to consider reducing flow goals to Q(7,10) earlier than specified. During this consultation process, WVIC and the resource agencies will also consider limiting winter drawdowns in all WVIC reservoirs to facilitate a more complete spring refill. Any changes in flow goals or reservoir drawdowns will remain in effect until all parties agree they can be lifted. It is estimated that consultation for this trigger event will occur approximately once every 25 years.

• WVIC will track the natural flows of the Wisconsin River at Merrill and Wisconsin Rapids. Natural flow is defined as the river flow that would occur without reservoir storage or release. If the natural river flow falls below 900 cfs at Merrill or 1,300 cfs at Wisconsin Rapids, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

• If the index level in any of the five large reservoirs (Rainbow, Willow, Rice, Spirit, or Eau Pleine) falls below level 3 during the period June through November, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

To:

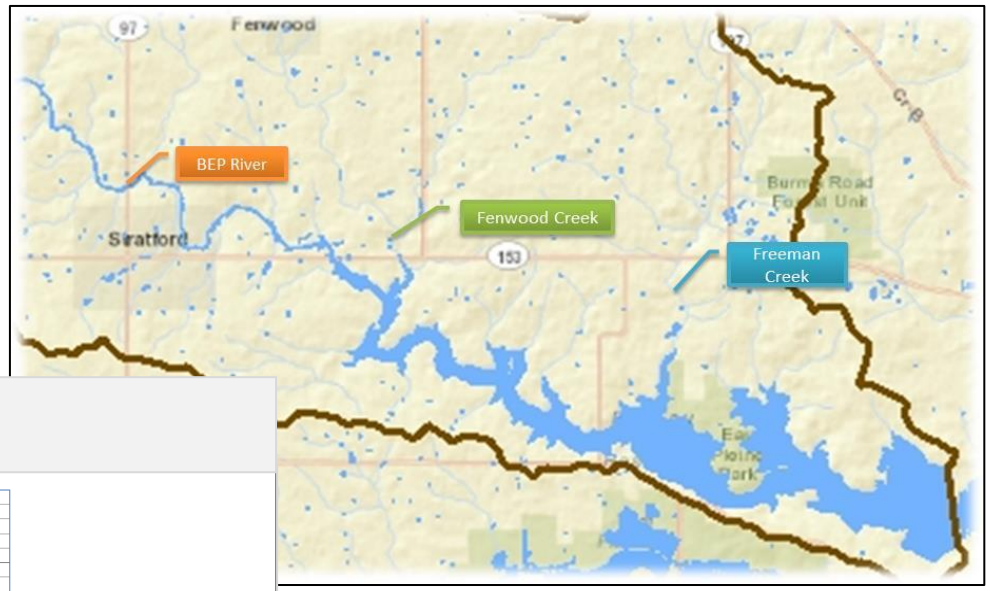
• WVIC will track the cumulative precipitation departure from normal. If the 24-month running average cumulative precipitation deficit reaches 6 inches, WVIC will consult with WDNR and USFWS to consider reducing flow goals to Q(7,10) earlier than specified. During this consultation process, WVIC and the resource agencies will also consider limiting winter drawdowns in all WVIC reservoirs to facilitate a more complete spring refill. Any changes in flow goals or reservoir drawdowns will remain in effect until all parties agree they can be lifted.

• WVIC will track the natural flows of the Wisconsin River at Merrill and Wisconsin Rapids. Natural flow is defined as the river flow that would occur without reservoir storage or release. If after two consecutive weeks the natural river flow falls below 900 cfs at Merrill or 1,300 cfs at Wisconsin Rapids, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

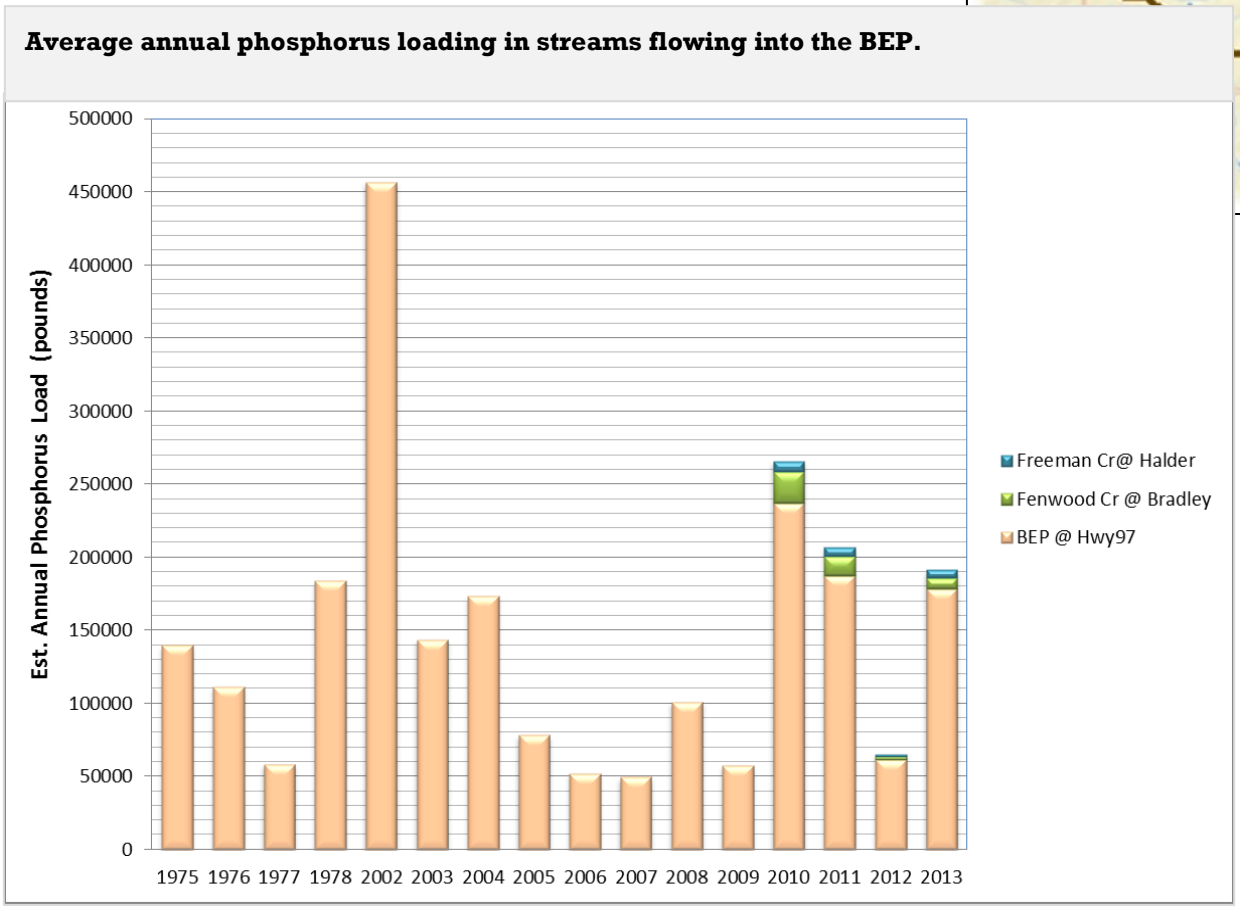
• If the index level in any of the five large reservoirs (Rainbow, Willow, Rice, Spirit, or Eau Pleine) falls below level 3 during the period June through November, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

## APPENDIX C: WATER QUALITY OVER TIME

Since the BEP River is the greatest source of water to the BEP, monitoring the water quality in the Big Eau Pleine River has occurred periodically since the mid-1970s. To estimate the pounds of phosphorus in the BEP River, Fenwood Creek, and Freeman Creek, phosphorus concentrations and flow measurements were combined for each year. Results are shown in the chart below.




**Average annual phosphorus loading in streams flowing into the BEP.**



## APPENDIX D: PERCENT PHOSPHORUS REDUCTION NEEDED TO ACHIEVE THE TMDL IN THE BEP.