Chetek Lakes Comprehensive Management Plan

Chetek Lakes Management Planning

Barron County, Wisconsin

City/DNR Project No. LPL-1515-13
SEH No. CHLPA 124347

April 8, 2015

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April 8, 2015

RE: Chetek Lakes Management Planning
Chetek Lakes Comprehensive
Management Plan
Barron County, Wisconsin
DNR Project No. LPL-1515-13
SEH No. CHLPA 124347

Mr. John Plaza, President
Chetek Lakes Protection Association
1056 24 ¾ Street
Cameron, WI 54822

Dear Mr. Plaza:

Short Elliott Hendrickson Inc. (SEH) is pleased to submit the enclosed copy of the Chetek Lakes Comprehensive Management Plan.

Sincerely,

Jacob A. Macholl
CLM

JAM
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Chetek Lakes Comprehensive Management Plan

Chetek Lakes Management Planning
Barron County, Wisconsin

Prepared for:
Chetek Lakes Protection Association
Chetek, Wisconsin

Prepared by:
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Distribution List

No. of Copies	Sent to
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___	Alex Smith WDNR Lakes Coordinator 810 W Maple Street Spooner, WI 54801

Executive Summary

This Comprehensive Lake Management Plan contains lake restoration projects that include in-lake activities intended to increase the recreations and environmental values of the lakes. These projects include aeration, drawdown, habitat restoration, dredging, iron addition, and hypolimnetic withdrawal. The Association will support county- and federal-led watershed management activities for nonpoint source pollution prevention and control practices in the farm dominated landscape surrounding the lakes. The Association will also continue to strive for the establishment of a Lake District to provide secure funding and appropriate accountability for all management activities to be undertaken.

Lake Management Goals and Objectives

- Goal 1: Reduce algal bloom frequency by 25% during the summer months in the chain of lakes.
- Goal 2: Continue to follow the Aquatic Plant Management Plan and incorporate as a companion document to this plan.
- Goal 3: Enhance fishery and wildlife habitat in and around the chain of lakes.
- Goal 4 Track, evaluate and revise the plan as new information and data are acquired.

Implementation Plan and Timeline

	Action	Resources	Measurement/Result	Target Date
	Water Level Management			PROPOSED
1	Implement proposed dam operating plan	•Barron County •CLPA •WDNR	•County follows and evaluates proposed plan	Spring 2015
	Biomanipulation			
2	Support catch and release efforts in the Chetek Lakes	•CLPA •Resort Owners Assoc. •Conservation/Sports groups •WDNR	•Larger predator fish population	On-going
	Monitoring and Evaluation			
3	Continue CLMN and WAV monitoring at existing active sites	•CLPA •WNDR •UW-Extension	•Uninterrupted long-term lake and stream data	On-going
	Dredging			
4	Soft Sediment depth survey (Begin with Aagot Bay trial)	•CLPA •Barron County •UW-Extension •Consultant	•Develop soft-sediment depth maps •Dredging volumes	Spring 2015
5	Coordinate dredging method and disposal of materials	•CLPA •Barron County •Local farmers	•Select method/entity to perform dredging •Identify locations to deposit dredge materials	July 2015
6	Identify funding source for dredging (sale of dredge materials, donations, other)	•CLPA •Barron County	•Secure funding	Winter 2014/2015
7	Complete permitting	•Barron County •Consultant	•Permit to dredge lake bed	Spring 2015
8	Complete dredging	•Barron County •CLPA •WNDR	•Soft-sediments removed from lake bed in Aagot Bay	Summer 2015
9	Continue selective dredging throughout the Lakes	•CLPA •Barron County	•Removal of high-P sediments from lake bed	Long-range (15+ years)
	10			
10	Solicit public comment regarding closure of The Draw (explain benefits)	•CLPA •Chetek Alert	•Determine public acceptance	Summer 2015
11	Solicit bids to design a spillway on the Tenmile Lake levy	•Barron County •CLPA	•Determine cost of design-build of levy	Winter 2015
12	Secure funds for design and construction of Tenmile Lake spillway	•Barron County •CLPA	•Funds to completed design-build allocated	Spring 2015

Implementation Plan and Timeline

	Action	Resources	Measurement/Result	Target Date
		Ordinances		PROPOSED
13	CLPA representative for each unit of local gov't to attend meetings and serve as local contact	•CLPA •Local Gov't (towns, city)	•CLPA presence at all local gov't meetings	2014 and on-going
14	Promote importance of no-wake zones and strive to implement recommended no-wake areas at town level	•CLPA •Local Gov't (towns, city)	•Ordinances adopted	On-going
		Hypolimnetic Withdrawal		
15	County and Local Farmers identify irrigated lands in the vicinity of Chetek Lakes	•Barron County	•Determination of potential irrigation lands	Spring 2015
16	Assemble driving group of interested farmers and regulators	•Barron County •WDNR	•Team assembled to pursue development and implementation of lake-based irrigation	Fall 2015

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Chetek Lakes Comprehensive Management Plan

Chetek Lakes Management Planning

Prepared for Chetek Lakes Protection Association

1.0 Introduction

The Chetek Lakes are located in southwestern Barron County, Wisconsin (**Figure 1)**. The chain of lakes is an impoundment of Pokegama Creek, Moose Ear Creek, and Tenmile Creek. The lakes cover approximately more than 3,700 acres and are comprised of five lakes: Prairie Lake, 1,619 acres; Ojaski (Mud) Lake, 578 acres; Pokegama Lake, 506 acres; Lake Chetek, 770 acres; and Tenmile Lake, 376 acres. The lakes have more than 60 miles of well-developed shoreline with the City of Chetek located along the shores of Lake Chetek.

The mean depth in all five lakes is 8.6 feet ranging from 4 feet in Ojaski Lake to 13 feet in Lake Chetek. The maximum depth averages 16.8 feet and ranges from 12 feet in Tenmile Lake to 22 feet in Lake Chetek. **Table 1** shows the physical characteristics of each lake. The lakes are used for recreational purposes including water-skiing, fishing, and boating. There are more than 30 resorts and other facilities that provide lodging to support seasonal tourism which is of high importance to the community and surrounding area. There is a public beach, and two church camps also associated with the lakes.

Table 1
Physical Characteristics of the Chetek Lakes

Lake	Area[1] (acres)	Volume[2] (acre-feet)	Shoreline[1] (miles)	Maximum Depth[3] (feet)	Average Depth[4] (feet)	Residence Time[5] (days)
Chetek	942.9	11,100.6	11.36	22	11.8	44
Ojaski (Mud)	358.5	1,850.8	10.08	15	5.2	31
Pokegama	520.8	5,307.6	13.41	19	10.2	73
Prairie	1,487.8	12,870.1	31.20	16	8.7	172
Tenmile	252.7	1356.1	7.74	12	5.4	15
Total	**3,562.6**	**32,485.3**	**73.78**	**22**	**9.1**	

[1]Barron County LiDAR (2005) [2]Aquatic Plant Survey Data [3]WDNR Lakes Bulletin
[4]Computed, volume divided by area [5]1999 Lake Management Plan

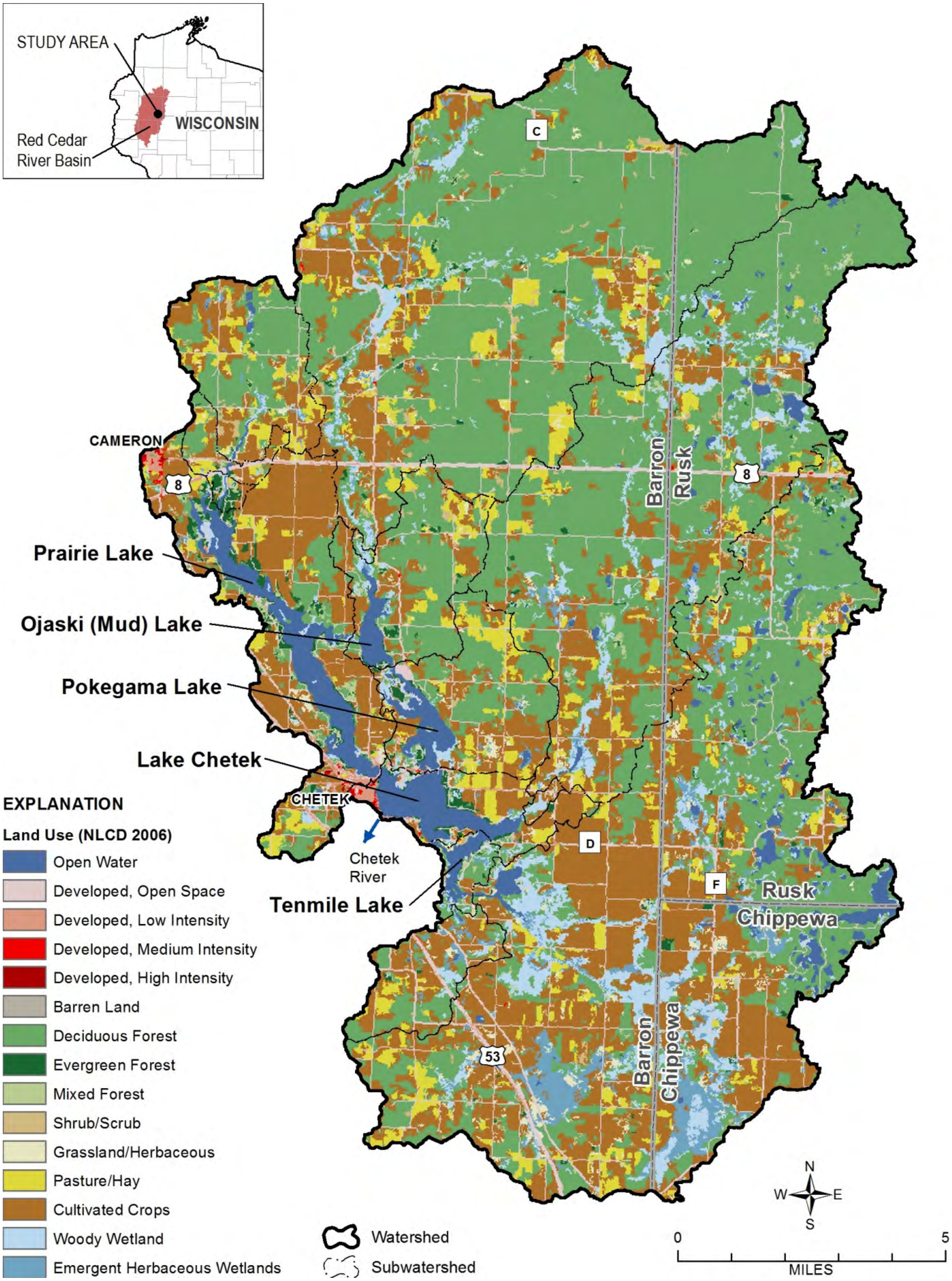


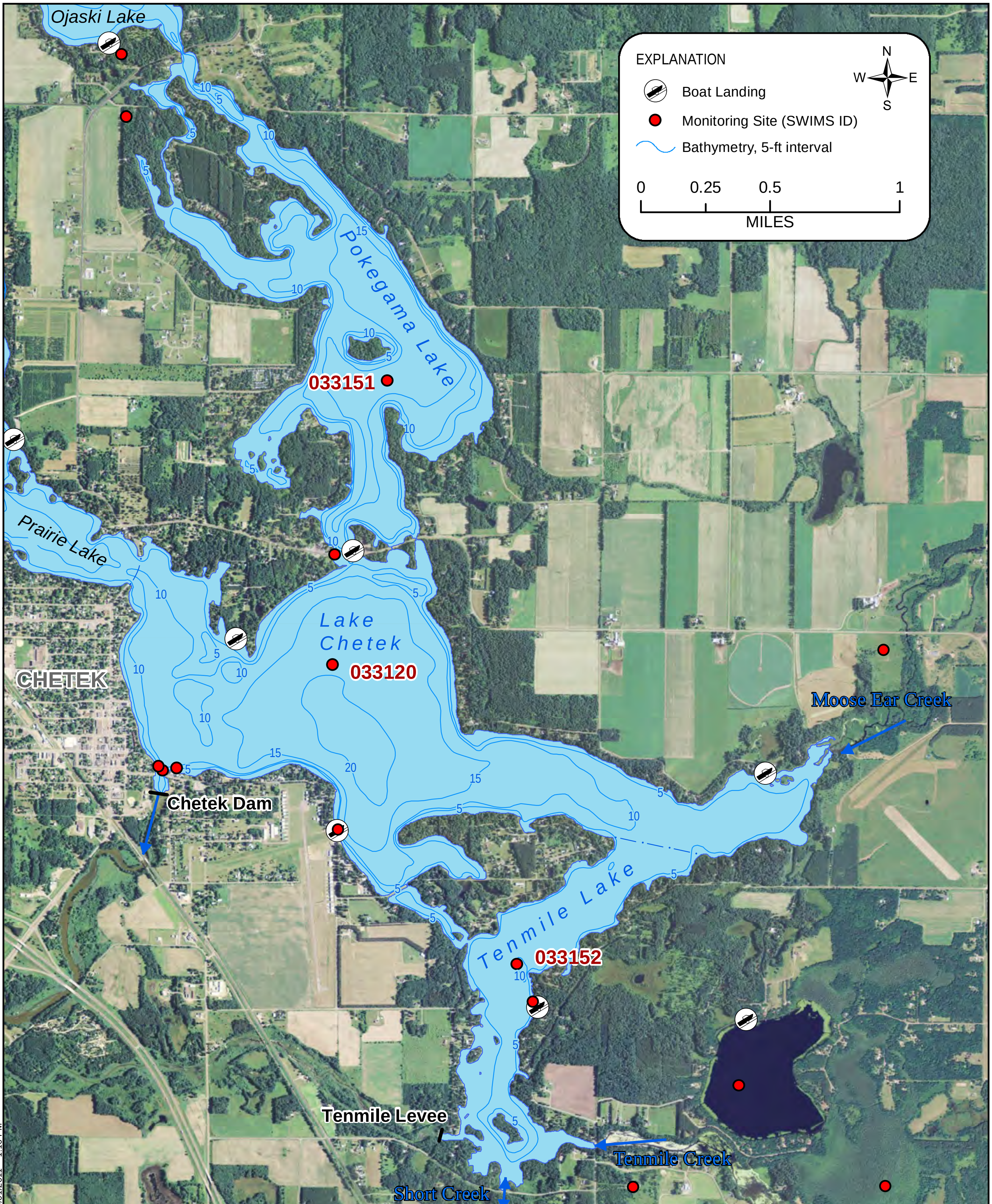
Figure 1 – The Chetek Lakes and Watershed

Maps of the lakes are shown in **Figure 2 and Figure 3.** Ojaski Lake, or Mud Lake, receives water from Pokegama Creek on the northern end of the shore and from an unnamed ephemeral stream on the southeastern shore. There is likely diffuse flow between Mud and Prairie Lake through narrows known as “the Draw” which has not been quantified. Outflow is primarily south to Pokegama Lake, which also receives flow from an unnamed ephemeral tributary draining Jacobson Lake near the southern end of the lake. Outflow from the lake is to the south to Lake Chetek.

Prairie Lake receives water from Rice Creek and an unnamed spring near at the northern end of the lake, and from two ephemeral tributaries along the eastern shore. The majority of the water entering Tenmile Lake the lake is from Tenmile Creek entering from the east. Water also enters from the south via Short Creek, which is primarily wetland drainage. Short Creek at times acts as an outlet, as was noted during the summer of 2012 when water was flowing from Tenmile Lake into Short Creek. The timing and conditions during which backflow into the creek occurs is not known at this time. Water primarily flows out of Tenmile Lake north to Lake Chetek. Water enters Lake Chetek from the north via Moose Ear Creek and from outflow from Prairie Lake, Pokegama Lake and Tenmile Lake. Outflow is over a dam in Chetek, Wis. to the Chetek River, which joins the Red Cedar River 5 miles southwest of the lakes.

The dam creating the Chetek Lakes was first constructed in 1865 and used for logging of the area. Prior to that time, Prairie Lake, Pokegama Lake, and Chetek Lake were distinct separate basins and Ojaski Lake and Tenmile Lake were riverine wetlands. The dam was used for power generation until the 1960s, after which ownership was transferred to Barron County. There is a levee on the southwest side of Tenmile Lake managed by Barron County that is completed to an elevation higher than the Chetek Dam, essentially shutting off the surface water flow to Tenmile Creek.

The fishery of the Chetek Lakes is very important to the local economy with a number of small business and resorts relying on the sport fishery. The lakes experience heavy fishing pressure during both the summer and winter months. It has an outstanding reputation as one of the top panfish producing lakes around the area, and as such the lake is largely fished for panfish species such as bluegill and black crappie. The lake is also a popular bass tournament destination during the summer months due to the strong largemouth bass population.



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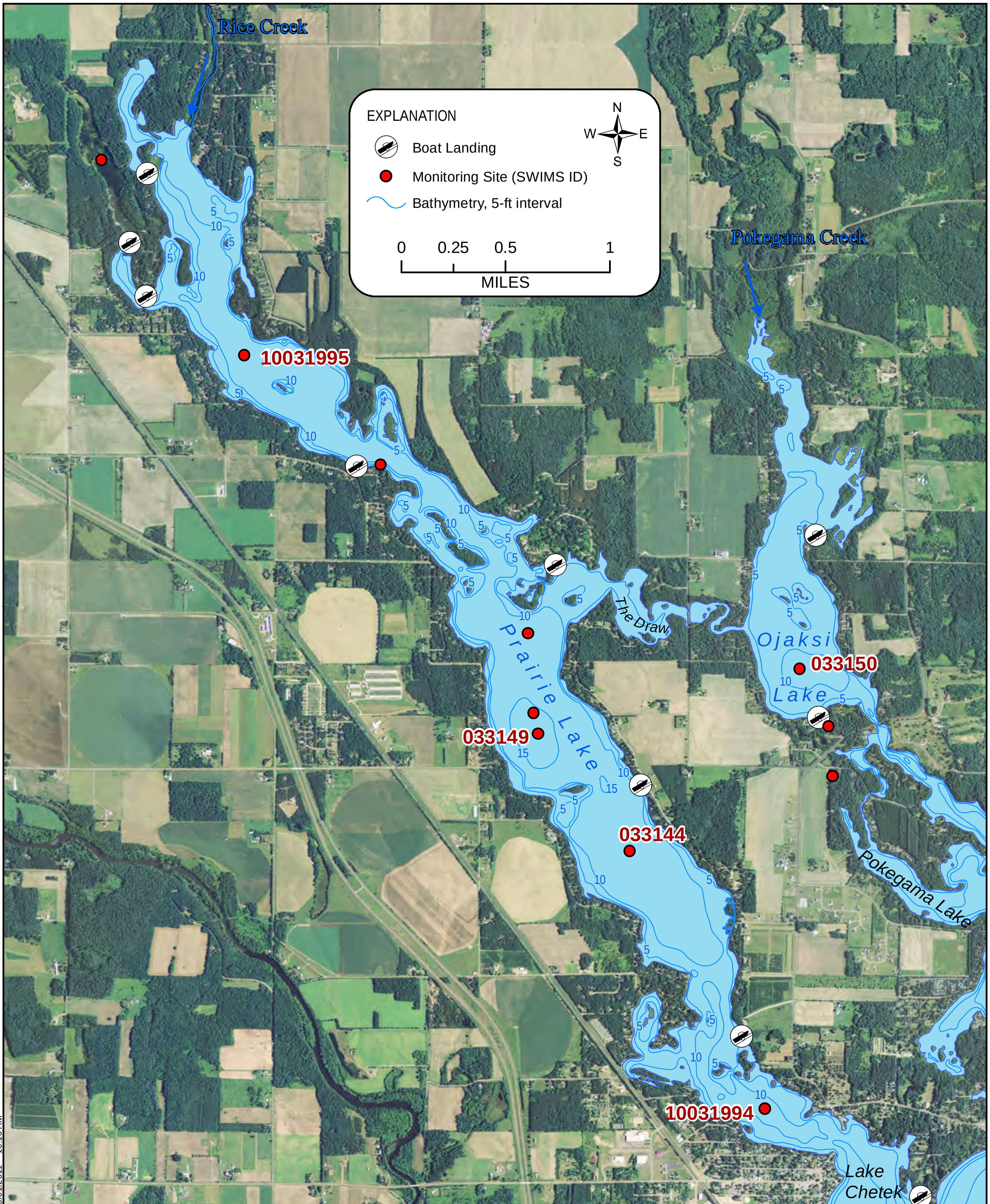
Project: CHLPA 115161
Print Date: 2012-05-02

Map by: JAM
Projection: Barron County (feet)
Source: Barron Co, WDNR
Basemap: NAIP 2013

Lake Chetek, Pokegama Lake and Tenmile Lake

Barron County, Wis.

Figure 2



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SEH	1701 W. KNAPP ST., SUITE B RICE LAKE, WI 54868 PHONE: 715.236.4000 FAX: 715.234.4069 WATTS: 800.903.6970 www.sehinc.com	Project: CHLPA 115161 Print Date: 2012-05-02 Map by: JAM Projection: Barron County (feet) Source: Barron Co, WDNR Basemap: NAIP 2013	***Prairie Lake and Ojaski Lake*** Barron County, Wis.	Figure 3

The Chetek Lakes are a very productive (nutrient rich) system. A long history of excessive nutrients has led to an ongoing problem of nuisance algal blooms, particularly in the many small, shallow bays located throughout the lakes. Cyanobacteria blooms throughout the growing season make many bays nearly unbearable to property owners and lake users and are the source of many concerns. Concerns about the severely degraded water quality are also raised by the businesses that rely on the tourism industry. The Chetek Lakes are listed on the Wisconsin “Impaired” water list for total phosphorous levels and eutrophication caused by non-point sources. This designation means that the lakes are not meeting their expected uses due to impaired water quality.

Historic management activities have treated the symptoms of over-fertilization (excessive algae and excessive plant growth) rather than the cause (non-point sources and in-lake sources of nutrients). The rehabilitation of the Chetek Lakes requires many activities including monitoring and management of aquatic invasive species (AIS), native plant restoration, and the implementation of Best Management Practices (BMPs) and Agricultural Conservation Practices (ACPs) throughout the watershed.

The Chetek Lakes Protection Association (CLPA) is a local non-profit volunteer based organization whose vision is to preserve and protect the Chetek Lakes and their surroundings and to enhance the water quality, fishery, boating, safety, and aesthetic values of the Chetek Lakes as a public recreational facility for today and for future generations. In 2011 the CLPA received a Wisconsin Department of Natural Resources Aquatic Invasive Species Grant to complete an Aquatic Plant Management (APM) Plan for the Chetek Lakes. Through the development of the APM Plan, the need for a Comprehensive Lake Management Plan became evident and was a primary recommendation in the APM Plan. A previous Lake Management Plan completed in 1999 for the Chetek Lakes also recommended the completion of a Comprehensive Lake Management Plan.

This plan is a Comprehensive Lake Management plan for the Chetek Lakes and it addresses the poor water quality currently afflicting the lakes, prioritizes lake management needs set forth in the APM plan, and provides goals and specific objectives for the long-term management of the Chetek Lakes and watershed. Recreational uses, the fishery and other biological uses are considered in the plan. It incorporates and evaluates new findings along with previous data, recommendations, and activities presented in prior investigations.

1.1 Public Comment

The Association provided input and review of draft documents during the development of this plan, primarily through the quarterly stakeholders meetings. The Draft Chetek Lakes Comprehensive Lake Management Plan was released to the public on February 24, 2015 for a one-month public review and comment period. A press release announcing the availability of the pland was distributed to the local newspaper. The draft plan was posted on the Association website for the duration of the public comment period. Individuals could also request digital copies by contacting the Association.

Comments recieved during the public comment period were compiled by the Association. Public comment generally focused on other potential management activities the Association could consider implementing. Where appropriate, editorial comments were taken under consideration. The comprehensive plan and management activities were presented at a public meeting at the Chetek Town Hall in the City of Chetek on April 8, 2015.

2.0 Study Components

The development of the Chetek Lakes Comprehensive Lake Management Plan includes the compilation and incorporation of data from a number of sources including the 1999 Chetek Lakes Management Plan, the 2012 Chetek Lakes Aquatic Plant Management Plan and data collected in conjunction with development of that plan (including the public input survey, watershed-wide stream water quality synoptic surveys, and a watershed land use analysis completed by Barron County). Data that was collected during 2012 and 2013 as part of this project and recent volunteer monitoring data have also been incorporated in this plan.

2.1 In-Lake Water Quality

The water quality of a lake influences the aquatic plant community, which in turn can influence the chemistry of a lake. Water clarity, total phosphorus, and chlorophyll *a* are measures of water quality that can be used to determine the productivity or trophic status of a lake. The Carlson trophic state index (TSI) is a frequently used biomass-related index. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms. Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms.

Water quality data are available online in the WDNR Surface Water Integrated Monitoring System (SWIMS) database. Data are available for Chetek Lake beginning in 1973, Prairie Lake in 1979, and Mud Lake, Pokegama Lake and Tenmile Lake since 1987. Parameters that have been collected include temperature and dissolved oxygen profiles, nutrient concentrations, and Secchi depths.

2.1.1 Alkalinity

The Chetek Lakes are soft water lakes, that is, the lakes have an alkalinity, also known as hardness, below 50 mg/L $CaCO_3$. Alkalinity buffers lakes from acid rain. Lakes such as the Chetek Chain with an alkalinity greater than 25 mg/L $CaCO_3$ are not sensitive to the effect of acid rain. Iron tends to control internal phosphorus dynamics in soft water lakes. When oxygen is present, iron forms sediment particles that store phosphorus; when the lakes lose oxygen in the winter or in the summer due to decomposition, iron and phosphorus again dissolve in water. Over many years of eutrophication, the mechanisms for chemical removal of phosphorus in the water column weaken due to iron reducing to insoluble ferrous sulfide. When the iron is lost permanently to the sediments during this reaction, it is no longer able to remove phosphorus from the water.

Although data have not been collected to determine if iron is low in the lakes, the hydrogen sulfide smell (rotten eggs) of the sediments throughout the chain of lakes in the summer suggest that redox conditions are sufficient to reach low enough oxidation-reduction potentials that sulfur is used during respiration, releasing hydrogen sulfide and permanently binding iron in the sediment.

2.1.2 Temperature and Dissolved Oxygen

The Chetek Lakes are discontinuous cold polymictic lakes, meaning the lakes are ice-covered part of the year and stratified during the warm season for periods of several days to weeks, but mix (de-stratify) for periods throughout the summer. Low dissolved oxygen concentrations (less than 5 mg/L) are generally found at depths greater than about 10 feet during the summer months. Dissolved oxygen levels below 5 mg/liter stresses many fish species. Hypoxic conditions (less than 2 mg/liter) existed at slightly deeper depths during the summer months.

The minimum oxygen level of 2 mg/L is an important criterion of sediment phosphorus release. When near-bottom dissolved oxygen is at 2 mg/L or less, the sediment-water interface is likely anoxic (no oxygen) and therefore releasing phosphorus. If the phosphorus released from sediments reaches the upper part of the lake (for example, during a mixing event), it can provide a significant internal source of phosphorus to fuel algae blooms. For example, in 2011, Chetek Lake completely mixed twice during the growing season, Mud Lake, Pokegama Lake, and Prairie Lake mixed once, and Tenmile Lake was only stratified during August.

Measurements taken during the summer of 2013 in shallow bays with depths of about 5 feet, notably Aagate Bay near CTH SS and 8½ Avenue, found dissolved oxygen levels below 5 mg/L immediately below the surface throughout the summer and often below 2 mg/L.

Dissolved oxygen levels were measured in Prairie Lake during the winter months of 2012-2013. Dissolved oxygen levels remained above 5 mg/L near the aerator at depths generally shallower than about 5 feet (the total lake depth at the site is 11 feet). Measurements throughout the rest of the lake were below 5 mg/L at depths greater than 2 feet or immediately below the ice, and anoxic at depths greater than about 5 feet.

The low levels of oxygen in the Chetek Lakes are due to bacteria consuming the oxygen when decomposing dead plant—including algae—and animal matter in the water. The many shallow bays of the lake have thick organic muck substrates conducive of oxygen depletion, and have few aquatic plants and are sheltered from the wind and wave action necessary to replenish oxygen levels. Algae blooms initially produce more dissolved oxygen, but the additional plant respiration uses dissolved oxygen, and when the algae die decomposition increases and utilizes much or all of the available dissolved oxygen and fish and other organisms cannot survive (the same process creates the Gulf of Mexico Dead Zone).

2.1.3 Water Clarity

The depth to which light can penetrate a lake is a factor that limits aquatic plant growth. Water clarity is measured by lowering a black and white Secchi disk into the water and the depth of disappearance is recorded. The disk is then lowered further and slowly raised until it reappears. The Secchi depth is the mid-point between the depth of disappearance and the depth of reappearance. Because light penetration is usually associated with algae growth, a lake is considered eutrophic when Secchi depths are less than 6.5 feet. Secchi depths vary throughout the year, with shallower readings in summer when algae become dense and limit light penetration and deeper readings in spring and late fall.

The average Secchi depth measured in the lakes during the summer (July-August) are shown in **Figure 4**. Annual variations in water clarity are about 3 feet in the lakes, with the highest water clarity generally measured in May and the lowest in August.

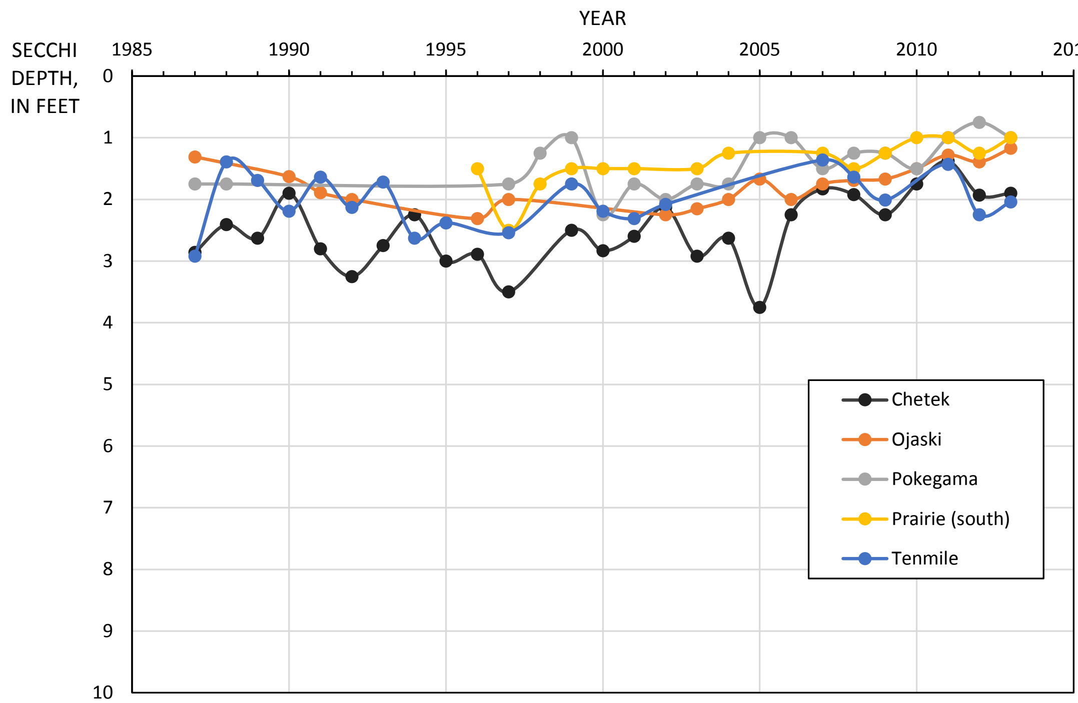

Figure 4 – Average Summer (July-August) Secchi Depths in the Chetek Lakes.

2.1.4 Phosphorus

Phosphorus is an important nutrient for plant growth and is commonly the nutrient limiting plant production in Wisconsin lakes. A total phosphorus concentration below 20 µg/L is necessary to prevent nuisance algal blooms in most lakes. In shallow lake systems such as the Chetek Lakes, aquatic plants and clear water conditions can dominate without threat at total phosphorus concentrations below about 25 to 50µg/L (or total nitrogen below about 250 to 500 mg/L). At total phosphorus levels greater than about 50 µg/L, such as found in the Chetek Lakes, either plant- or algae-dominated systems can exist, but if in the plant-dominant state, there is a high risk of the system switching to algae dominance.

Lake Chetek total phosphorus concentrations ranged from 72 to 198 µg/L in the 2011 growing season. The summer (July-August) average was 68 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], but lower than the 1996 average of 77 µg/L.

Mud Lake total phosphorus concentrations ranged from 73 to 225 µg/L in the 2011 growing season. The summer (July-August) average was 197 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and also much higher than the 1996 average of 114.3 µg/L.

Pokegama Lake total phosphorus concentrations ranged from 84 to 288 µg/L in the 2011 growing season. The summer (July–August) average was 249 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and also much higher than the 1996 average of 86 µg/L.

Prairie Lake total phosphorus concentrations ranged from 77 to 350 µg/L in the 2011 growing season. The summer (July–August) average was 327 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10], and higher than the overall summer mean (1994 to present) of 192 µg/L.

Tenmile Lake total phosphorus concentrations ranged from ranged from 92 to 288 µg/L in the 2011 growing season. The summer (July–August) average was 232.5 µg/L, much higher than the mean for northwest Wisconsin lakes of 28.0 µg/L [10].

2.1.5 Chlorophyll *a*

Chlorophyll *a* is the green pigment found in plants and algae. The chlorophyll *a* concentration is used as a measure of the algal population in a lake. Concentrations greater than about 10 µg/L are considered indicative of eutrophic conditions and concentrations 20 µg/L or higher are associated with algal blooms. For trophic state classification, preference is given to the chlorophyll *a* trophic state index because it is the most accurate at predicting algal biomass.

Lake Chetek chlorophyll *a* concentrations ranged from 48.2 to 76.8 µg/L during the 2011 growing season. The summer (July-August) average was 65.7 µg/L, higher than the summer average in 1996 of 51.1 µg/L.

Ojaski Lake chlorophyll *a* concentrations ranged from 35.1 to 191 µg/L during the 2011 growing season. The summer (July-August) average was 147 µg/L, higher than the summer average in 1996 of 72.1 µg/L.

Pokegama Lake chlorophyll *a* concentrations ranged from 49.7 to 192 µg/L during the 2011 growing season. The summer (July-August) average was 165 µg/L, higher than the summer average in 1996 of 52.6 µg/L.

Prairie Lake chlorophyll *a* concentrations ranged from 38.6 to 147 µg/L during the 2011 growing season. The summer (July-August) average was 143 µg/L, higher than overall (1994 to present) summer average 88.5 µg/L.

Tenmile Lake chlorophyll *a* concentrations ranged from 9.23 to 110 µg/L during the 2011 growing season. The summer (July-August) average was 65.5 µg/L.

The 2011 chlorophyll *a* concentrations classify each of the Chetek Lakes as a hypereutrophic system, where dense algae limit light and therefore lake productivity. Based on the long term continuous data available (Secchi depths for all lakes, phosphorus and chlorophyll *a* for Prairie Lake), 2011 was one of the most productive years in the Chetek Lakes for the period of record (**Figure 5 and Figure 6**).

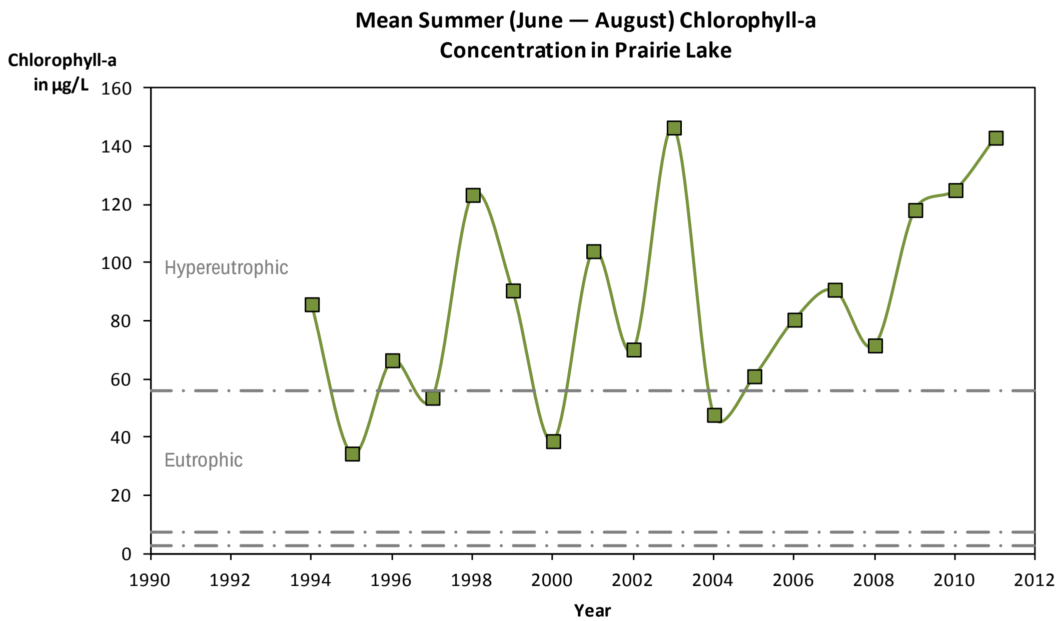

Figure 5 – Mean Summer Chlorophyll-a in Prairie Lake near South End

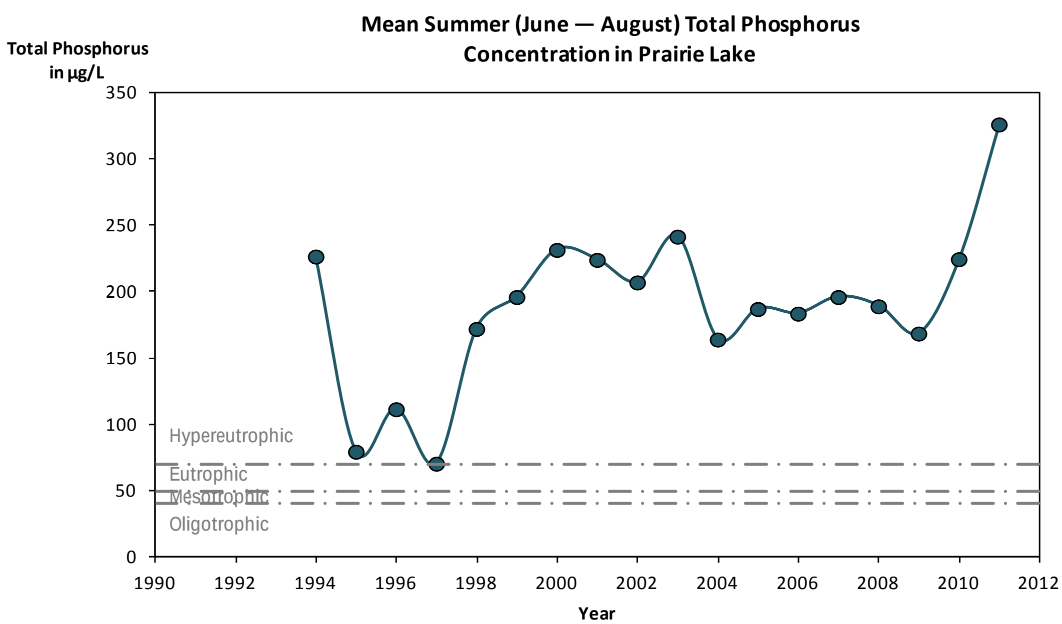

Figure 6 – Mean Summer Total Phosphorus in Prairie Lake Near South End

2.1.6 Limiting Nutrient

When a nutrient is limiting production, small additions of the nutrient to a lake can cause dramatic increases in plant and algae growth and should therefore be the focus of management efforts to improve water quality. The ratio of the total nitrogen to total phosphorus (N:P) is used to determine the nutrient that likely limits aquatic plant growth in a lake. When N:P is greater than 17:1, phosphorus is interpreted as the limiting nutrient and when the ratio is less the 10:1, nitrogen is likely the limiting nutrient.

Water quality data indicate that the nutrient enriched Chetek Lakes appear to experience periods of both phosphorus and nitrogen limitation throughout the growing season. Phosphorus was the limiting nutrient the majority of the time in 1996 but in 2011, the N:P was in a “gray” area (between 10:1 and 17:1) where it is unclear whether nitrogen or phosphorus is limiting the growth of algae When phosphorus is limiting, one pound of phosphorus can grow up to 500 pounds of algae.

2.2 Aquatic Plants

Aquatic plants play an important role in lakes. They anchor sediments, buffer wave action, oxygenate water, and provide valuable habitat for aquatic animals. The amount and type of plants in a lake can greatly affect nutrient cycling, water clarity, and food web interactions. Furthermore, plants are very important for fish reproduction, survival, and growth, and can greatly impact the type and size of fish in a lake.

Surveys of the plant communities in the lakes were completed on three different occasions. The first evaluation was done by the WDNR in August of 1997, the second by the Beaver Creek Reserve (Fall Creek, Wis.) in 2009 during a five-county invasive species study, and the third by Endangered Resources Services, LLC (ERS) (St. Croix Falls, Wis.) in 2011. In each of the surveys, all five lakes in the system were found supporting diverse native aquatic plant communities rated as average or slightly above average for the region; however the plants had a relatively limited distribution.

During the 2011 aquatic plant surveys, wild rice was found in Tenmile Lake, specifically in the narrows of the Tenmile Creek inlet. The non-native invasive species curly-leaf pondweed was found in all lakes during the early season survey. Reed canary grass and narrow-leaved cattail are invasive species found in the shallow margins of the lakes and can form dense stands that displace all other species from wetlands.

The 2011 ERS investigations (the most recent and extensive plant surveys) were used to develop the 2012 Chetek Lakes Aquatic Plant Management Plan, which includes a detailed discussion of the results. The individual reports for each lake are available on the Association website at http://www.cheteklakespa.org/grant2011.htm (last accessed June 2014). The surveys found a total of 51 aquatic plant with 16 species common to all five lakes as shown in **Table 2**.

Table 2
Aquatic Plant Species Found in the Chetek Lakes

Scientific Name	Common Name	Chetek	Ojaski	Pokegama	Prairie	Tenmile
Calla palustris	Wild calla		O	O	X	X
Callitriche hermaphroditica	Autumnal water-starwort		X			
Carex comosa	Bottle brush sedge		O	O	X	
Ceratophyllum demersum	Coontail	X	X	X	X	X
Comarum palustre	Marsh cinquefoil		O			
Decodon verticillatus	Swamp loosestrife				X	
Dulichium arundinaceum	Three-way sedge		O	X		
Eleocharis acicularis	Needle spikerush			X	X	
Eleocharis erythropoda	Bald spikerush		X	X		X
Eleocharis intermedia	Matted spikerush				O	
Elodea canadensis	Common waterweed	X	X	X	X	X
Heteranthera dubia	Water star-grass	X	X		X	X
Juncus effusus	Common rush		O			
Leersia oryzoides	Rice cut-grass				O	
Lemna minor	Small duckweed	X	X	X	X	X
Lemna trisulca	Forked duckweed		X			X
Myriophyllum sibiricum	Northern water milfoil	X	O			
Myriophyllum verticillatum	Whorled water-milfoil					X
Najas flexilis	Slender naiad	X	X			X
Nitella sp.	Nitella	X	X			X
Nuphar variegata	Spatterdock	X	X	X	X	X
Nymphaea odorata	White water lily	X	X	X	X	X
Phalaris arundinacea	Reed canary grass	O	X	O	O	O
Potamogeton amplifolius	Large-leaf pondweed	X	X	O	O	X
Potamogeton crispus	Curly-leaf pondweed	X	X	X	X	X
Potamogeton epihydrus	Ribbon-leaf pondweed		X			X
Potamogeton friesii	Fries' pondweed					X
Potamogeton natans	Floating-leaf pondweed		X			
Potamogeton nodosus	Long-leaf pondweed	X	X		O	X
Potamogeton obtusifolius	Blunt-leaf pondweed					X
Potamogeton pusillus	Small pondweed	X	X	X		X
Potamogeton richardsonii	Clasping-leaf pondweed	X		X	X	X
Potamogeton robbinsii	Fern pondweed	X	X	X	X	X
Potamogeton spirillus	Spiral-fruited pondweed	X				
Potamogeton strictifolius	Stiff pondweed	O	X			X
Potamogeton zosteriformis	Flat-stem pondweed	X	X	X		X
Ranunculus aquatilis	White water crowfoot		O			
Sagittaria cristata	Crested arrowhead			X		
Sagittaria latifolia	Common arrowhead	X	O		O	O
Sagittaria rigida	Sessile-fruited arrowhead	X	X	X	X	X
Schoenoplectus tabernaemontani	Softstem bulrush	O	X		O	O
Sparganium americanum	American bur-reed		X			
Sparganium eurycarpum	Common bur-reed	X	X	X	X	X
Spirodela polyrhiza	Large duckweed	X	X	X	X	X
Typha angustifolia	Narrow-leaved cattail		O			
Typha latifolia	Broad-leaved cattail	O	X	O	O	O
Utricularia vulgaris	Common bladderwort		X	X		X
Vallisneria americana	Wild celery	X	X	O	X	X
Wolffia columbiana	Common watermeal	X	X	X	X	X
Zizania palustris	Northern wild rice					X
	Filamentous algae	X	X	X	X	X
	Aquatic moss					X

X, sample collected; O, visually observed.

Where aquatic plants grow in the lakes varies throughout the year. As shown in **Figure 7** below, the littoral zone (maximum depth of plant growth) decreases in the lakes as the growing season progresses. This is attributed to the increase in algae growth which decreases light penetration and limits plant growth. The average summer littoral zone depth in the lakes of about 7 feet is half that of other nearby impoundments with clearer water. The Association is currently not actively targeting curly-leaf pondweed as it is of little nuisance to lake users and it is one of the few plants in the lake that provides early- to mid-season habitat in the lakes.

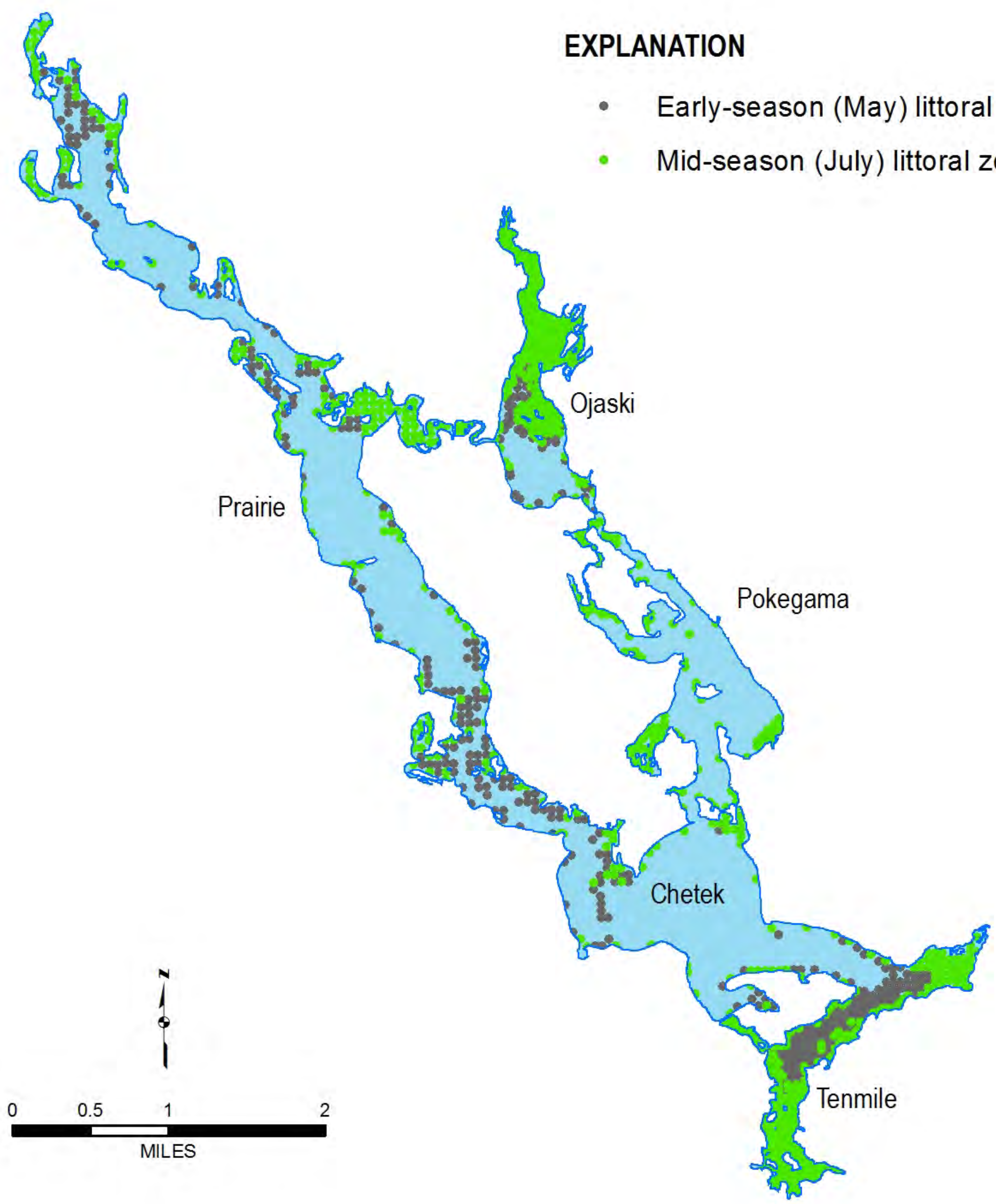

Figure 7 – Seasonal Variation in the Chetek Lakes Littoral Zone

2.3 Fishery

The fishery is very important for lake users and drives much of the local economy. The following fishery management activities and objectives were provided by Aaron Cole, WDNR Fisheries Biologist for the lakes.

The Chetek Chain is a highly-productive fishery that attracts many resident and non-resident anglers. The sport fishery consists of bluegill, black crappie, yellow perch, largemouth bass, smallmouth bass, walleye, northern pike, and bullhead species. The fertile water and shallow depth of the Chetek Chain create a productive environment that is able to support high fish production where the population can withstand high angler effort and harvest. However, the downside of this high fertility is that it also causes heavy summer algae blooms commonly reaching nuisance levels.

The most recent fisheries survey was conducted in 2012. This survey consisted of an adult walleye population estimate through fyke netting and electrofishing, bass and panfish surveys through late spring electrofishing, a fall electrofishing survey to assess walleye recruitment, and a creel survey. The adult (>15 in) walleye population was 0.4 fish per acre. Largemouth bass, bluegill, and black crappie were abundant in all lakes. Size structure of those species was also good, and their growth rates were above average.

The Chetek Chain experiences high fishing pressure year-round. The lakes have long had a reputation as a strong panfish producer. During the 2012 creel survey, the average angling pressure for the entire chain of lakes was 82.0 hours per acre during the open water season. In comparison, the average fishing pressure over that same time period is 25.6 hours per acre in Barron County, and 29.1 hours per acre statewide. Most (77%) of the angling effort on the Chetek Chain is directed at panfish species (e.g., bluegill, black crappie, pumpkinseed, and yellow perch).

Walleye have been the most stocked species into the Chetek Chain. The walleye population is dependent upon stocking. In recent history the WDNR has stocked small fingerling walleye into the Chetek Chain; however, those stockings have not produced measureable year classes. In 2012, the WDNR began stocking large fingerling walleye at rate of 10 fish per acre on an alternate year basis. Stocking large fingerling walleyes into the Chetek Chain should improve stocking success and ultimately improve the adult density.

The Chetek Chain is managed as a bass-panfish fishery with a stocked walleye population. There is currently a desirable fishery present with abundant panfish populations with good growth rates. The walleye population is currently less than desired, but stocking large fingerling walleye should improve the walleye population in the future.

The Chetek Chain is an important resource in terms of recreational value and value to the local economy. Improving shoreline habitat and water quality is a high priority for stakeholders.

2.4 Shoreland Assessment

A study of the Barron County lakes completed in 1997 by the Soil and Water Conservation Department (then the Land Conservation Department) provides information on the development of the shoreland area of the lakes. Each of the five lakes in the chain is in the top 10 most developed lakes (dwellings on the lake), and all but Tenmile are in the top ten of densest development (dwellings per mile of shoreline); Tenmile lake ranks number 11. **Table 3** below shows the development of the shoreland as measured in 1996.

Table 3
Number of Dwellings on the Chetek Chain of Lakes, 1996

Lake	No. of Dwellings	Miles of Shoreline	Dwellings per Mile
Chetek	286	7.05	40.6
Ojaski (Mud)	186	5.22	35.6
Prairie	598	21.44	29.7
Pokegama	257	10.04	25.6
Tenmile	159	6.36	25.0

Source: The Lakes of Barron County, D. Thorson (1997).

The 1997 study identified 499 shoreland structures (rip rap and retaining walls) along the shores of the Chetek Lakes, with the most (193) found on Prairie Lake. The report noted that many old, weathered and dilapidated wooden retaining walls are in very poor shape and will likely disintegrate and cause failure of the shoreline. The report also noted that rip rap structures often do not function as intended and some are over built causing a change in shoreline character and visual quality. Both of these structures result in a loss of wildlife habitat and a disruption of wildlife travel corridors.

Phosphorus loading from the near-shore area (within 300 feet of the lakes) was evaluated as part of the APM Plan. Land uses and land cover including mowed lawn, impervious surfaces, agricultural lands, forests, wetlands, and open water were mapped using ArcGIS and high-resolution air photos. Phosphorus loading to the lakes from this area was calculated using the "most likely" export coefficients in the Wisconsin Lake Modeling Suite. Results are shown in **Table 4** below, sorted by largest phosphorus source first.

Table 4
Near-shore Land Use and Land Cover around the Chetek Lakes

Land Use (Level 1)	Land Use (Level 2)	Acres	Percent	Annual Phosphorus Load (pounds)
Developed	Impervious	256.99	12.5	343.9
Developed	Lawn	495.46	24.2	220.5
Natural	Forest	1166.37	56.9	92.6
Ag	Ag	38.90	1.9	28.7
Natural	Wetland	74.99	3.7	6.6
Natural	Open Water	17.19	.8	2.2
TOTAL		**2049.90**	**100.0**	**694.5**

Land cover and land use management practices within a watershed have a strong influence on water quality and water quantity. Increases in impervious surfaces, such as roads, rooftops and compacted soils associated with residential and agricultural land uses, can reduce or prevent the infiltration of runoff. This leads to an increase in the volume and rate of stormwater runoff and pollutant loading to the lakes and their tributary streams. The removal of riparian (near-shore) vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to a waterbody during rain events.

2.5 Watershed Assessment

A watershed is an area of land from which water drains to a common surface water feature, such as a stream, lake, or wetland. The watershed boundary for the Chetek Lakes was delineated using the Soil and Water Assessment Tool and 10-meter USGS digital elevation model. The total watershed area for all the lakes is about 200 mi^2 with the majority of the land use comprised of forests (47%), followed by agriculture (32.8%). Although urban areas are only identified near the outlet (the City of Chetek) and northwest of Prairie Lake (the Village of Cameron), areas of relatively high-density residential development are present around portions of the Chetek Lakes. The land use and land cover in the watershed is shown in **Table 5** below and displayed on **Figure 1** above.

Table 5
Land Use in the Chetek Lakes Watershed

Land Use	Square Miles	Percent of Total
Urban	10.53	5.3
Agriculture	65.77	32.8
Forest	94.16	47.0
Grassland/shrubland	5.07	2.5
Barren	.01	< 0.1
Wetland	16.05	8.0
Water	8.77	4.4
Total	**200.35**	**100.0**

Source: 2006 National Land Cover Database

The sources of phosphorus to the Chetek Lakes were investigated as part of the 1999 management plan and updated with new information (septic systems, atmospheric deposition, curly-leaf senescence, and internal loading) collected as part of 2012 APM Plan. Tributaries account for the majority of the phosphorus load to the system, followed by the direct drainage area to the lake (22%) followed closely by internal loading (18%). Direct drainage areas are portions of the watershed that drain directly to the lake without first draining to a stream and includes intermittent streams and areas downstream of monitoring points near the shoreline of lakes. The 2012 nutrient budget for the entire chain of lakes is shown in **Figure 8** with the direct drainage area separated by the various land use/cover classes. The direct drainage area to the lakes is shown in **Figure 9.**

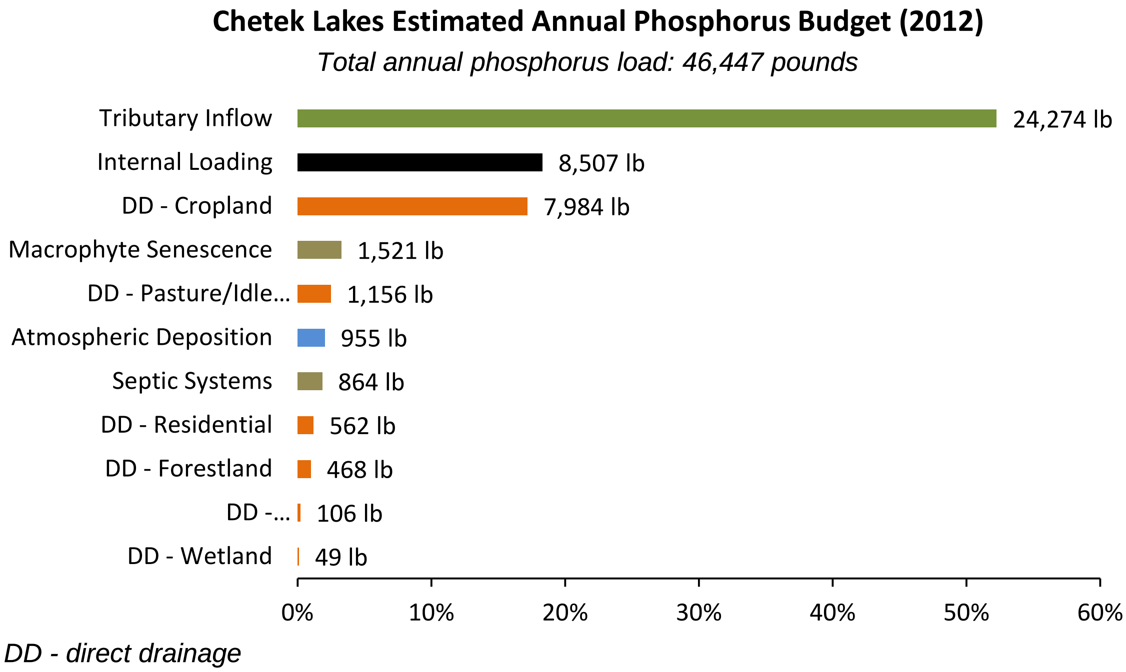

Figure 8 – Chetek Lakes Phosphorus Budget (2012)

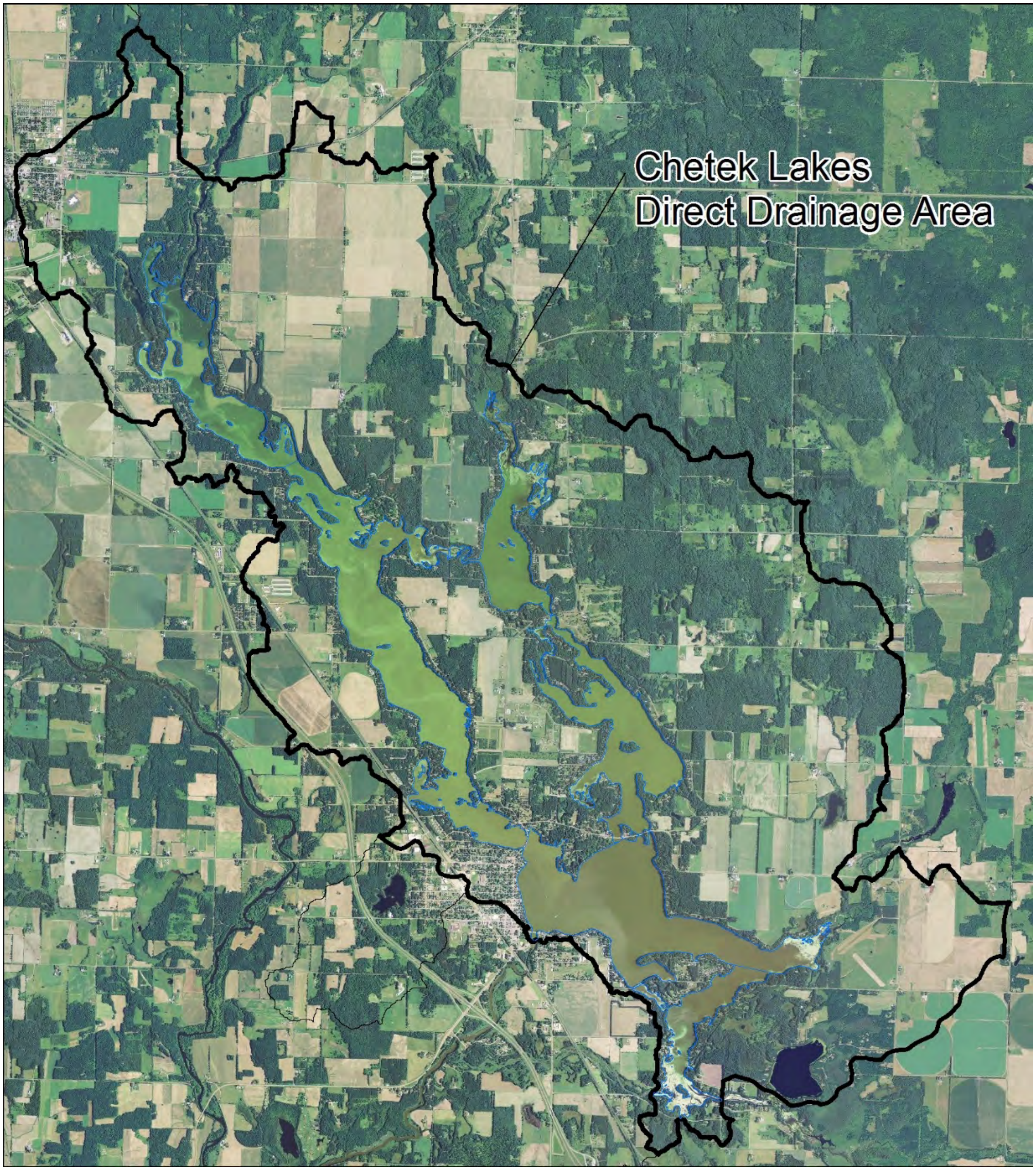

Figure 9 – Chetek Lakes Direct Drainage Area

Due to the large size of the watershed (over 200 square miles), large-scale management efforts will be very difficult for the Association to administer and complete. The Advisory Committee deemed the direct drainage area (22,100 acres or 34.5 square miles including the lakes) and in-lake management activities as a first priority for management by the Association. Although it is still a large area, it is the portion of the landscape with the most immediate and direct impact to the lakes as the water from the landscape does not first enter a stream where nutrients of pollutants can be attenuated.

Partnerships between the Association, County, WDNR, and other institutions (for example, the USDA Natural Resources Conservation Service) will focus on efforts in the larger watershed. These partners are also important for management of the area directly tributary to the lakes as agricultural lands are the primary source of phosphorus to the lakes (Figure 8). A synoptic water quality survey was completed in 2012 for analysis of nutrients and other substances to characterize background nutrient, sediment, and pollutant loading in the Chetek Lakes Watershed. The objective of the synoptic sampling was to determine the total amount or load of various nutrients, sediment and pollutants that move past a monitoring station during a particular period of time. To approximate growing season baseflow loads of these constituents, water quality samples were collected during in the early and late part of the growing season and averaged. The synoptic sampling program identified priority areas for evaluation and implementation of agricultural conservation practices and is being used as a roadmap for identifying and mitigating phosphorus sources in the watershed (**Figure 10**).

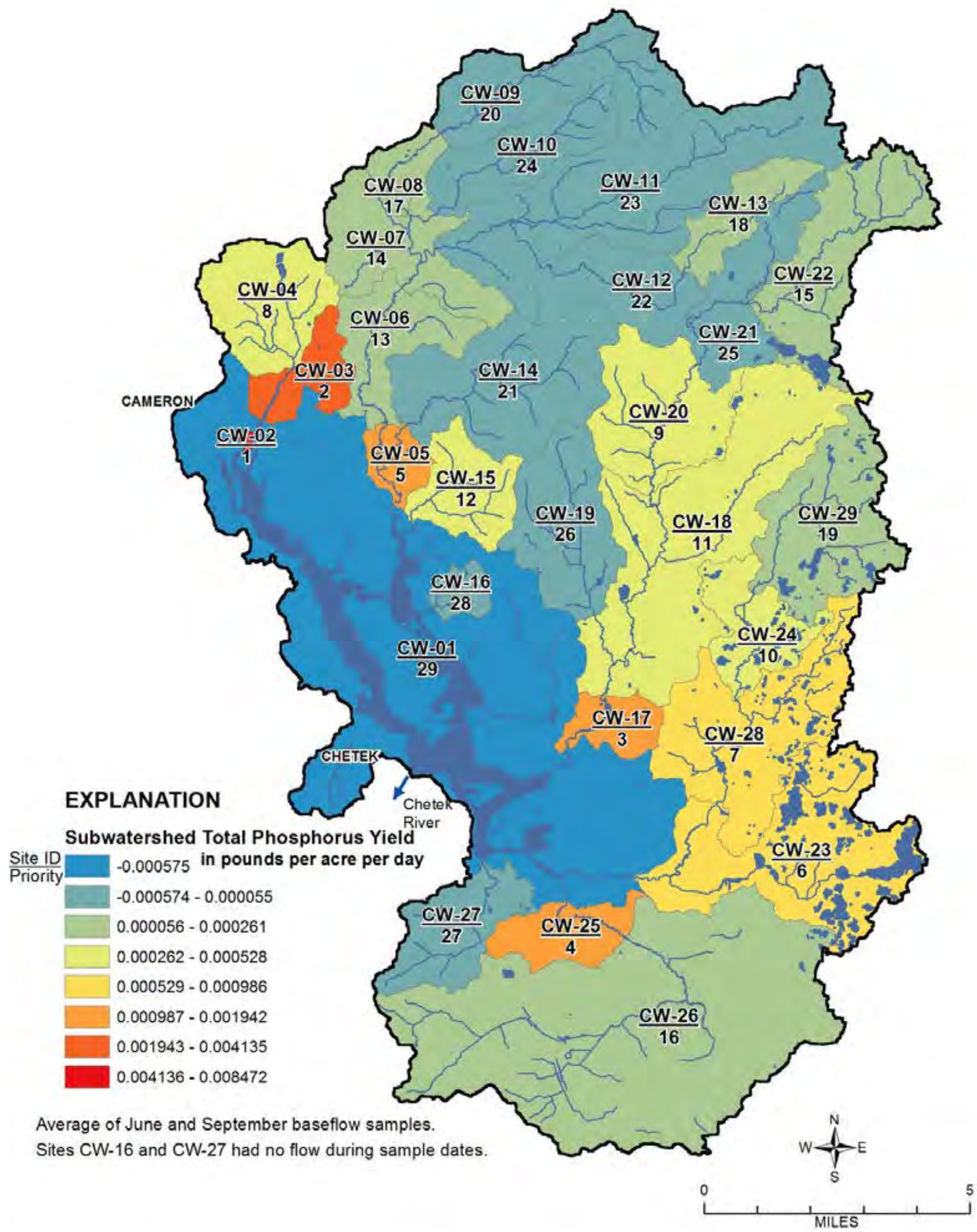

Figure 10 – Daily Total Phosphorus Yields in Subwatersheds of the Chetek Lakes Watershed

2.5.1 Point Sources of Nutrients and Pollutants

The U.S. Environmental Protection Agency (EPA) defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack." There are no major industrial point source permits in the watershed administered by the WDNR under the Wisconsin Pollutant Discharge Elimination System (WPDES). The City of Chetek discharges treated municipal wastewater downstream of the lakes into the Chetek River. The City of Chetek Stormwater Master Plan (dated December 2007) identifies 9 outfalls to the lakes from the City and drainage from local roads, but these have not been evaluated in detail for this project.

There are a number of individual/industrial minor permits for dairy and turkey operations throughout the watershed. The state regulates waste storage structures and manure application at large farms classified as CAFOs (Concentrated Animal Feeding Operations). CAFOs are considered potential point sources of pollution because untreated animal waste may enter nearby waterbodies ad untreated sewage. The Barron County Land and Water Conservation Department maintains a good relationship with these producers and strives to implement the most up to date best management practices.

2.5.2 Ecologic Considerations

2.5.2.1 Wetlands

According to the National Wetland Inventory, emergent, forested/shrub and aquatic bed (lake and freshwater pond) wetlands are present in the Chetek Lakes watershed. A number of these wetlands border the lakes and tributary streams or have a direct hydrologic connection to the lakes (Figure 1). Emergent wetlands are wetlands with saturated soil and are dominated by grasses such as redtop and reed canary grass, and by forbs such as giant goldenrod. Forested/shrub wetlands are wetlands dominated by mature conifers and lowland hardwood trees. Forested/shrub wetlands are the dominant form of wetlands in the watershed and are important for stormwater and floodwater retention and provide habitat for various wildlife. Aquatic bed wetlands are wetlands characterized by plants growing entirely on or within a water body that is no more than six feet deep, which characterizes much of the Chetek Lakes.

Many wetlands have been lost to development pressures—civil, agricultural, and industrial—via ditching, draining, and filling as is evident by reviewing original land survey maps (available at http://digicoll.library.wisc.edu/SurveyNotes/Search.html) and the WDNR potentially restorable wetlands layer on the Surface Water Data Viewer web application. Wetlands provide flood protection within the landscape by retaining stormwater from rain and melting snow and capturing floodwater from rising streams. This flood protection minimizes impacts to downstream areas. Wetlands provide groundwater recharge and discharge by allowing the surface water to move into and out of the groundwater system. The filtering capacity of wetland plants and substrates help protect groundwater quality. Wetlands can also stabilize and maintain stream flows, especially during dry months.

2.5.2.2 Species and Habitats of Concern

The WDNR completed critical habitat data collection on the Chetek Lakes in the mid-2000s but have not determined critical habitat areas. Proposed critical aquatic plant, coarse woody debris, and coarse rock/rubble spawning habitat are included in Appendix C. Management restrictions to protect these areas during plant management operations are included in this plan. In some cases, short-term disruptions to habitat during the removal of monotypic stands of aquatic invasive species such as curly-leaf pondweed may lead to positive long-term improvements to the habitat of the lake. Disruptions to the areas of critical habitat may also be warranted when responding to the discovery of a new invasive species.

The Wisconsin Natural Heritage Inventory (NHI) program is part of an international network of programs that focus on rare plants and animals, natural communities, and other rare elements of nature. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). Species are listed by township: Prairie Lake is in the Townships of Stanley (T34N, R11W), Prairie Lake (T33N, R11W), and Chetek (T33N, R10W); Ojaski, Pokegama, Chetek and Tenmile Lakes are in the Township of Chetek (T33N, R10W) with Tenmile Lake extending to the Township of Dovre (T32N, R10W).

The Natural Heritage Inventory Program tracks examples of all types of Wisconsin's natural communities that are deemed significant because of their undisturbed condition, size, what occurs around them, or for other reasons. Natural communities listed for the Townships include: alder thicket, emergent marsh, northern sedge meadow, lake—shallow soft drainage, northern wet forest, dry mesic prairie, and open bog. Full descriptions of these communities including current threats can be found on the WDNR website at: http://dnr.wi.gov/topic/endangeredresources/communities.asp (last accessed 2014-07-21).

No endangered species are listed for these Townships, but a number threatened and special concern species are present (Table 3). Descriptions of these species can be found at http://dnr.wi.gov/topic/EndangeredResources/biodiversity.html/ (last accessed 2014-07-21). The 2011 aquatic plant survey of the lakes found no additional federally listed plant species. It is important for lake management to consider impacts to these valuable species, nearly all of which can be directly affected by aquatic plant management. Choosing the proper management techniques and the proper timing of management activities can greatly reduce or prevent negative impacts.

Table 6
Natural Heritage Inventory Listing for the Chetek Lakes

				Stanley	Prairie Lake	Chetek	Dovre
Scientific Name	**Common Name**	**State Status**	**Group Name**	**T34N R11W**	**T33N R11W**	**T33N R10W**	**T32N R10W**
Ehteostoma microperca	Least darter	SC/N	Fish				X
Haliaeetus leucocephalus	Bald eagle	SC/P	Bird	X	X	X	X
Canis lupis	Gray Wolf	SC/FL	Mammal	X		X	
Alasmidonta marginata	Elktoe	SC/P	Mussel	X	X		
Artemisia dracunculus	Dragon wormwood	SC	Plant		X		
Asclepias ovalifolia	Dwarf milkweed	THR	Plant		X		
Moxostoma valenciennesi	Greater redhorse	THR	Fish	X	X		
Pleurobema sintoxia	Round pigtoe	SC/P	Mussel	X	X		
Ophiogomphus howei	Pygmy snaketail	THR	Dragonfly	X			

THR, threatened; SC, special concern; FL, federally protected as endangered or threatened; P, fully protected; N, no laws regulating use, possession or harvest.
Data current as of 2009-10-06

2.5.2.3 Stream Connectivity

Volunteers identified stream crossings and evaluated culverts and bridged throughout the watershed in the fall of 2013. Due to time restrictions (volunteers were of students), the entire watershed was not surveyed and not all culverts in surveyed areas were evaluated. A total of 148 crossings were evaluated and site locations were recorded using a handheld recreational grade GPS (**Figure 4**). Variables recorded included the culvert or bridge shape and diameter, flow direction, and a basic determination of ecological barrier status. The data were used to generate a GIS layer for analysis and storage.

Stream crossing and culvert survey data was used to identify areas of the watershed that may be disconnected for certain fish and wildlife. Many culverts that may act as a barrier to fish and wildlife are located in headwater streams, areas that act as important refugia during floods and provide spawning habitat for many species.

These data also provide a starting point for developing a hydrologically conditioned high-resolution digital elevation model (DEM) for the Chetek Lakes watershed. Barron County currently has LiDAR elevation data. To correctly represent flow across the landscape with a DEM, culverts must be identified to remove digital dams created by roadways. A complete survey that includes all culverts and bridges (that is, not just those located on known waterways) can be used to correct the LiDAR DEM.

High-resolution hydrologically condition DEMs have many applications, including predicting locations of concentrated water flows and of field gully erosion; finding depressional areas for potential water storage to reduce runoff, flooding, and sediment loads; targeting best management practices; and prioritizing restoration and protection projects. The WDNR developed GIS-based tool called EVALL to assess the vulnerability of agricultural lands to erosion and nutrient export. Barron County has expressed interest in utilizing this tool and should do so in the Chetek Lakes watershed.

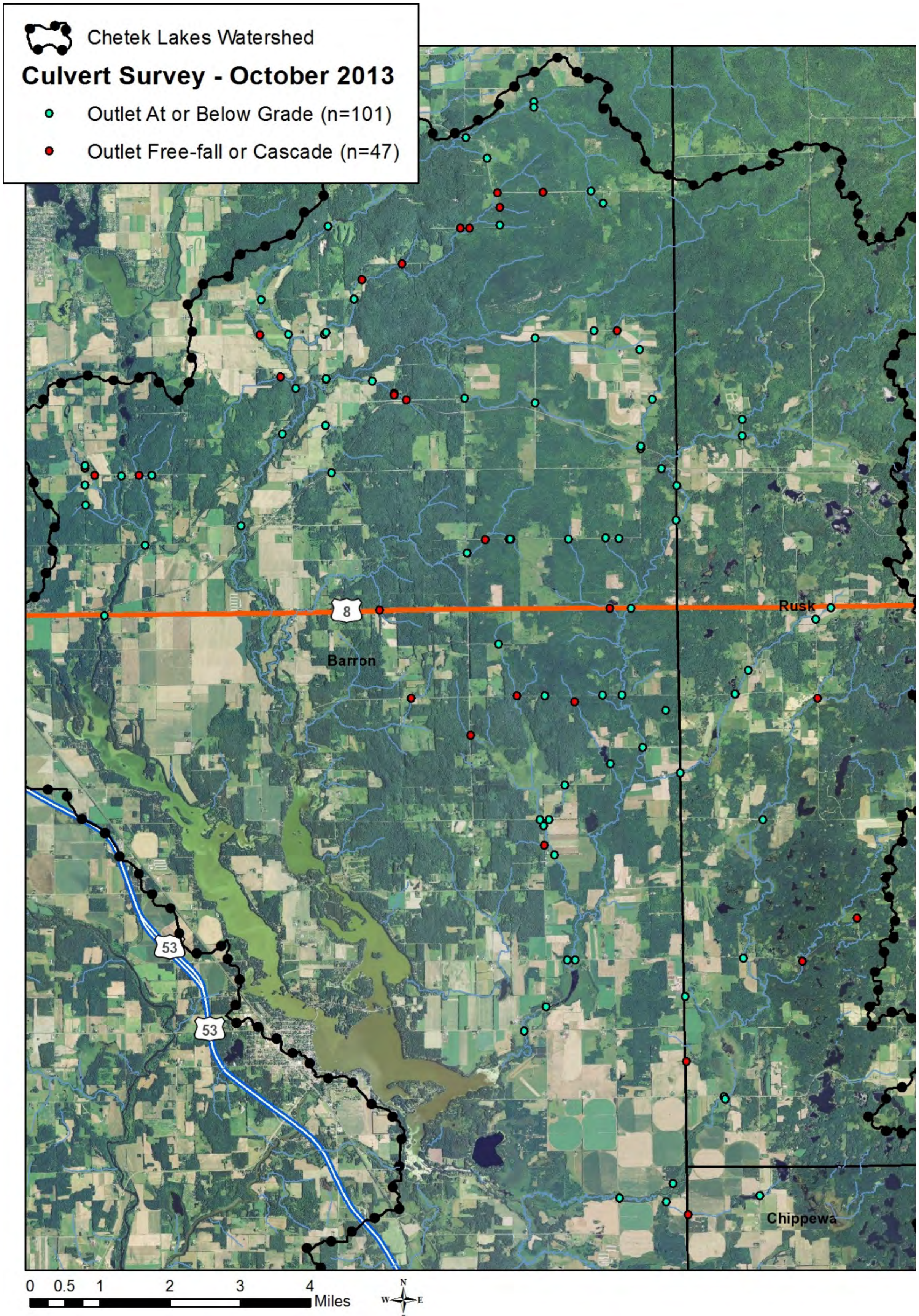

Figure 11 – Stream Crossings Documented during the 2013 Watershed Culvert Survey

2.5.3 Local Governments

The Chetek Lakes themselves are located in the Townships of Stanley, Prairie Lake, and Chetek, with small portions located in Sumner and Dovre (**Figure 10**). The City of Chetek is also directly adjacent to the lakes and Cameron is adjacent to the northern most portion of a backwater to Prairie Lake. Each of these local governments has the ability to enact ordinances (such as no-wake rules) to protect and enhance the Chetek Lakes. The watershed is in portions of three counties (Barron, Rusk, and Chippewa) and a number of other townships are located in the Chetek Lakes Watershed. Each of these serves as an important partner for the rehabilitation of the Chetek Lakes and as a potential avenue for dissemination of information to the general public. Although not directly connected to the lakes, these outlying units of government can also enact ordinances to protect water quality which in turn will benefit the Chetek Lakes.

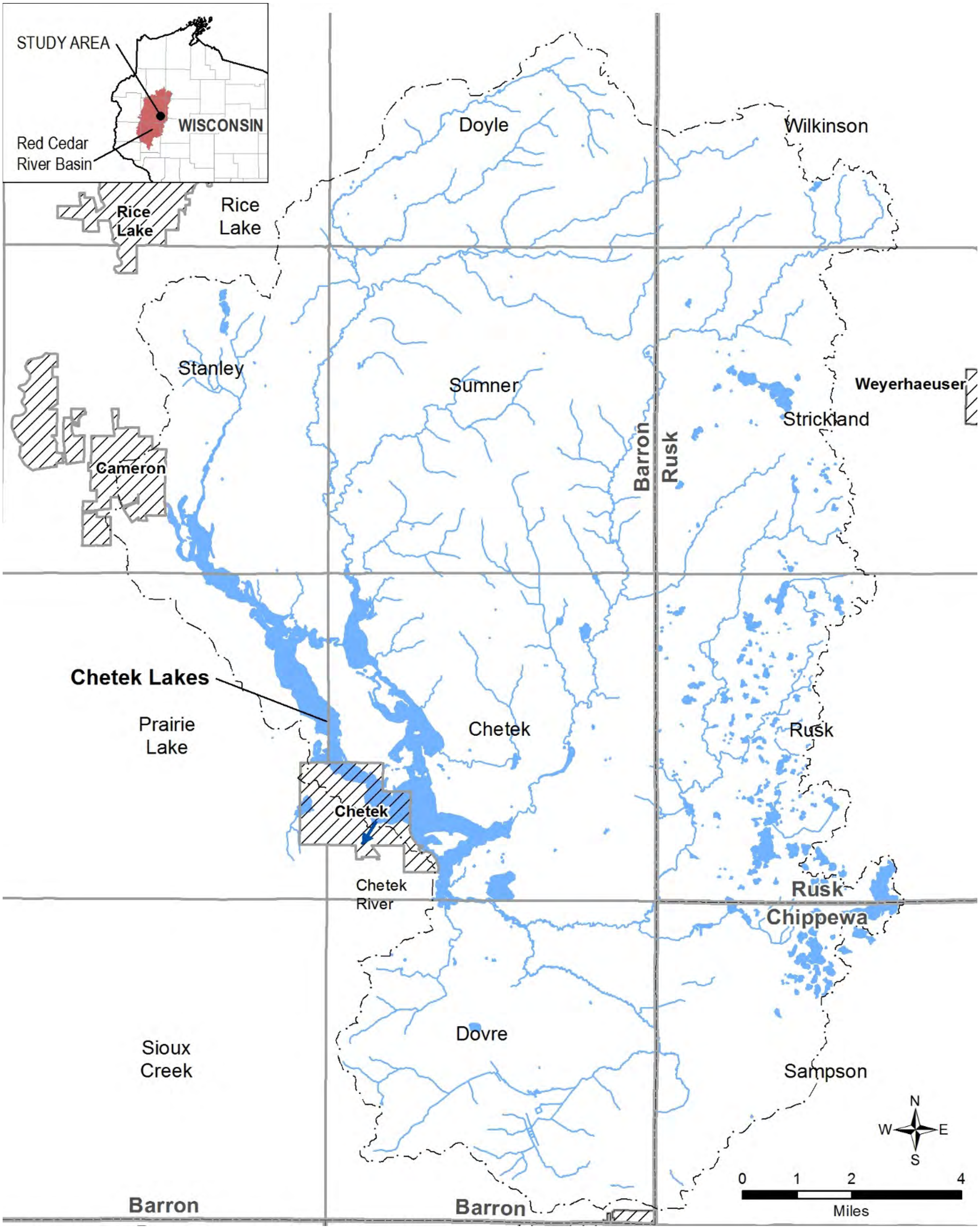

Figure 12 – Management Units in the Chetek Lakes Watershed

2.6 Historic and Current Management Activities

Historic control efforts were often short-term fixes focused on annual control of aquatic plants or algae. With little understanding of shallow lake ecology at the time, the control activities undertaken were often competing against each other to achieve opposite ends of the shallow lake spectrum (that is, clear-water plant dominated versus turbid-water algae dominated).

There is a long history of chemical plant and algae control in the Chetek Lakes with records dating back to the 1940s. Up to the early 2000s, thousands of pounds of copper sulfate were used for algae control in the lakes (**Table 5**). Copper sulfate treatments were popular due to its ability to kill and remove algae almost instantaneously. CLPA volunteers researched WDNR Aquatic Nuisance Control files for the Chetek Lakes and determined the locations and amounts of copper sulfate used throughout the lakes to identify potential copper hot spots.

Table 7
Copper Sulfate Usage in the Chetek Chain of Lakes

Lake	Number of Copper Sulfate Applications ($CuSO_4$)	Total $CuSO_4$ Applied, in pounds
Chetek Chain*	24	37,000.0
Chetek	75	24,784.0
Moose Ear Lake†	24	7,099.0
Ojaski	1	1,500.0
Pokegama	71	29,211.0
Prairie	88	20,811.8
Tenmile	41	7,531.0
TOTAL	**324**	**127,936.8**

* No specific waterbody name given in records.

† Moose Ear Bay historically recorded separately from Lake Chetek.

Many of the historic records lack sufficient detail to precisely map the application areas of copper sulfate; however, the vast majority of applications were along the shore, within about 80 feet of the shoreline. There were also a number of control records that did not indicate the chemical used or the amount applied. A WDNR summary sheet of total copper sulfate applications by year from 1957 through 1977 totals **171,525** pounds, a substantially larger amount than identified through this recent records search which also covered a longer period of time (1940s-Present) than the WDNR summary.

Prior to the 1990s, copper sulfate was applied at an average rate of about 5.2 pounds per acre. In the early 2000s, copper sulfate usage was substantially reduced and when it was used it was in conjunction with other herbicides (although less was used, it was applied at higher rates averaging nearly 13 pounds per acre).

Long term and short term effects of copper accumulation from copper sulfate usage were not realized until the 1980s. Short term effects include: a) the intended temporary killing of algae, b) dissolved oxygen depletion by decomposition of dead algae, c) accelerated phosphorus recycling from the lake bed and recovery of the algal population within 7 to 21 days, and d) occasional fish kills due to oxygen depletion or copper toxicity or both. Long-term effects are shown to include: a) copper accumulation in the sediments, b) tolerance adjustments of certain species of algae to higher copper sulfate dosages, c) shift of species from green to blue-green algae and from game fish to rough fish, d) disappearance of macrophytes (aquatic plants), and e) reductions in benthic macro-invertebrates.

Due to the high usage of copper for historic plant control and its tendency to accumulate in lake sediments, its suggested that sediment samples be taken and analyzed for copper concentrations to determine the appropriate disposal method should dredging be undertaken in the Chetek Lakes.

Currently, the Chetek Lakes are listed on the 303(d) list as a low priority impaired water; there has yet to be any substantial state action on this listing.

A large patch of Japanese knotweed is present on the east shore immediately upstream of the Chetek dam. Japanese knotweed may be present in other areas of the lake, but it has not been officially identified. The Barron County Soil and Water Conservation Department has been working to control and eradicate this patch for many years. Japanese knotweed management includes close monitoring, physical removal, and application of herbicides.

The current 2012-2017 Chetek Lakes aquatic plant management plan has six goals. While the goals are inclusive of all of the Chetek Lakes, some of the objectives and actions vary between lakes. The six goals for the plan are as follows:

- Increase native aquatic plant diversity, distribution, and density in the Chetek Lakes.
- Complete aquatic invasive species management that: encourages greater native plant growth; reduces phosphorus inputs caused by decaying vegetation; does not negatively impact the fishery; and provides nuisance and navigation relief for lake users.
- Provide late season (native aquatic plant) nuisance and navigation relief for lake users and riparian owners.
- Sponsor and support education, fundraising, monitoring, and prevention activities.
- Increase appreciation for aquatic ecosystems and habitat in the Lake Community.
- Reduce total nutrient inputs from non-point sources to the Chetek Lakes

The Aquatic Plant Management Plan goals, objectives and actions are included Appendix A of this plan.

3.0 Lake Management Goals and Objectives

Lake management goals were developed by stakeholders in the Advisory Committee with guidance and input from the WDNR. The overarching goal is to work towards the rehabilitation of the Chetek Lakes—to improve water quality and ecosystem health—with the understanding that the Chetek Lakes exist as a recreational impoundment for anglers, boaters, and those seeking rest and relaxation.

3.1 Goal 1: Reduce algal bloom frequency by 25% during the summer months in the chain of lakes.

Discussion: A reduction in the algal bloom frequency by 25% was a goal developed by the Advisory Committee as a change to the water quality that would be noticeable and favorable. A water quality gradient does not exist in shallow eutrophic lake systems; shallow lakes exists in either a plant-dominated clear water state or an algae-dominated turbid water state, which is discussed in further detail in *Section 4.1* below. Because such systems transition between two alternative states, the predictive capacity of water quality models such as BATHTUB or WiLMS are limited and model results are highly uncertain. It is therefore inappropriate to use a model to identify specific nutrient reduction strategies to estimate improvements to water quality (that is, project future conditions); however models can be useful for estimating the nutrient budget and for guiding adaptive management activities.

Although important for sustaining a plant-dominated clear water state, external nutrient load reduction cannot by itself be used to attain the state—the control of in-lake factors is also required and are likely of more importance. As discussed in *Section 2.5* above, internal loading from sediments is the largest contributor of phosphorus to the lakes within the direct drainage area.

Lakes with watersheds greater than 10-times the lake surface area have watershed areas too large to economically (realistically) accomplish the required phosphorus loading reductions. The Chetek Lakes watershed is approximately 30-times the lake surface. In situations such as this, substantial loading reductions of more than 75% must occur and must be sustained. An example of the extreme costs of watershed-wide management strategies is the Yahara River Watershed CLEAN Action Plan. The plan describes a 50% reduction of external loading from agricultural and urban sources over a 20 year period at a cost of $78.6 million dollars.

In-lake management strategies, however, can provide substantial and noticeable changes in shorter time frames and for less money. *Section 4* below discusses the in-lake factors and how they affect the water quality of the chain of lakes. Many of the in-lake methods evaluated requite ongoing inputs of energy money and continuous monitoring and evaluation to remain effective and to determine when the best attainable state is achieved. The best results will be from a strategy that incorporates watershed and in-lake activities. Nutrient reduction practices throughout the watershed are not only important for the Chetek Lakes, but for other stakeholders in the Red Cedar River Watershed, which has a Total Maximum Daily Load (TMDL) and beyond.

3.2 Goal 2: Continue to follow the Aquatic Plant Management Plan and incorporate as a companion document to this plan.

Discussion: The Chetek Lakes Aquatic Plant Management (APM) Plan supports sustainable practices to protect, maintain and improve the native aquatic plant community, the fishery, and the recreational and aesthetic values of the lakes. The APM Plan also lays out a strategy to prevent the introduction of new aquatic invasive species like Eurasian watermilfoil not currently found in the lakes, and lays out a monitoring program to aid in early detection of any new aquatic invasive species. The APM Plan goals are shown in *Section 2.6* above and the goals, objectives, and management actions for the APM Plan are included in Appendix A of this plan.

3.3 Goal 3: Enhance fishery and wildlife habitat in and around the chain of lakes.

Discussion: The importance of a wetland fringe and shoreland buffers to the fishery and wildlife is discussed in the Aquatic Plant Management Plan. The Advisory Committee felt that it is very important that management activities do not further degrade the lake habitat but recognize that short term disruptions may be necessary during rehabilitation activities. Disruptions will be countered by the end result of the activities and by the implementation of shoreland and nearshore projects described in the APM Plan such as buffer installation and coarse woody structure (FishSticks) projects.

Best practices detailed in Wisconsin's Health Lakes Implementation Plan are included in *Section 5* below. These include practices that divert and infiltrate runoff that can be part of a shoreland restoration project or completed as stand-alone projects.

3.4 Goal 4 Track, evaluate and revise the plan as new information and data are acquired.

Discussion: This plan is a working document for guiding management actions on the Chetek Lakes. Annual and end of project assessment reports are necessary to monitor progress and justify changes to the management strategy. Tributary monitoring, CLMN lake monitoring, and future surveys and studies will provide the information needed to monitor project efficacy and ensure the proper maintenance of restoration and best management practice projects. As required by the WDNR, the operation and maintenance period for any grant-funded management practices (for example, grant-funded shoreland restoration projects) will be 10 years.

4.0 Analysis of Alternative Management Actions

As part of this plan, a feasibility analysis of management measures to reduce nutrient loading and improve water quality and habitat in the lakes and watershed was completed. The analysis considered alternatives which are applicable to the Chetek Lakes and its watershed. Watershed and in-lake alternatives evaluated include maintain the status quo, land use and land cover management (for example, BMPs and ordinances), water-level management, fishery management, institutional development, and other alternatives. Cost estimates for specific alternatives have been determined to aid in assessing applicability and funding sources.

The Chetek Lakes system has a number of parties interested in improving the water quality of the lakes. An Advisory Committee consisting of members from the CLPA, the Barron County SWCD, local farmers, the Chetek Area Chamber of Commerce, the Chetek Resort Owners Association, the City of Chetek, and the WDNR met on a quarterly basis to discuss objectives, outcomes, and plan direction. Meeting agendas, minutes and handouts are included in Appendix C.

4.1 Shallow Lake Management Considerations

Lake management requires consideration of the differences between deep and shallow lakes. Shallow lakes are those lakes with a maximum depth of less than 20 feet or with an average depth of less than 10 feet. Only Chetek Lake is considered a deep lake and the others can be classified as shallow lakes. Shallow lakes generally exist in one of two alternative states: the algae-dominated turbid water state and the plant-dominated clear water state as shown in **Figure 12**. The turbid water state is characterized by dense algae (phytoplankton) populations, an undesirable bottom feeding fish community, and few aquatic plants whereas the clear water state is characterized by abundant aquatic plant growth, a greater number of zooplankton, and a diverse and productive gamefish community. The majority of respondents of the 2011 survey indicated they prefer a plant-dominated system over an algae-dominated system.

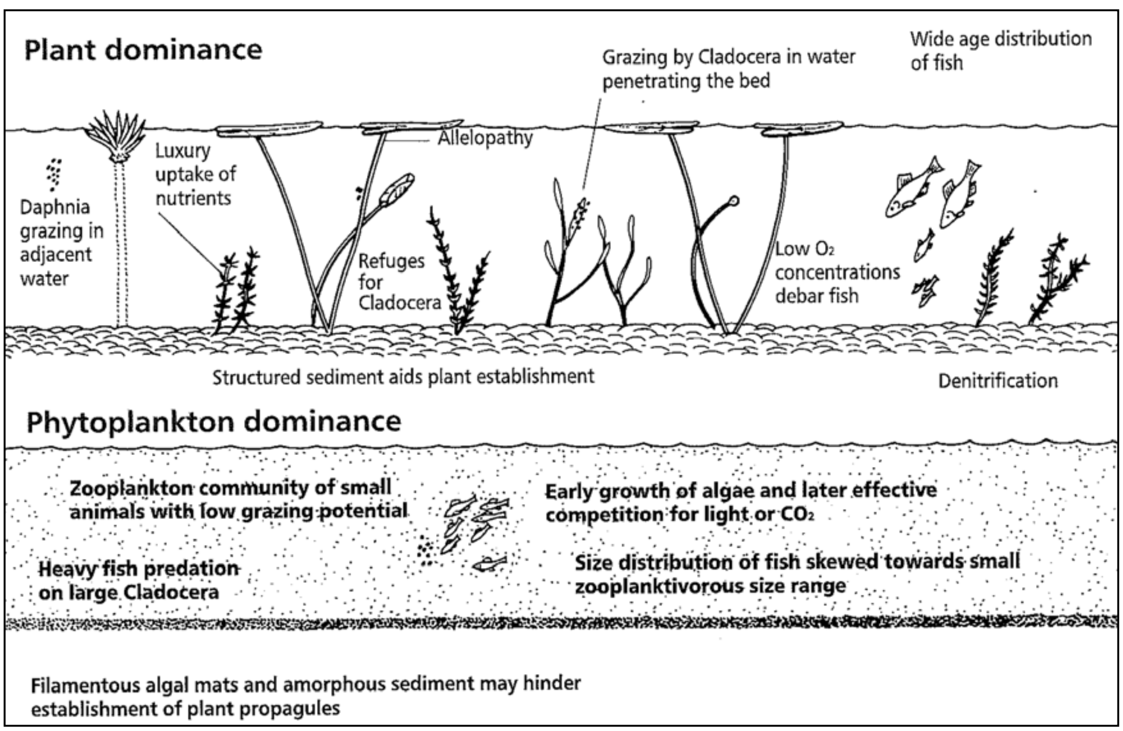

Figure 13 – Shallow Lake Alternative States and Stabilizing Mechanisms

Aquatic plants are the key to clear water in shallow lakes. A shallow lake that is free of both aquatic plants and algae is uncommon and it is unrealistic to expect such a lake to occur without a large investment in money and energy. The chance of plant-free clear water is much higher with deep lakes. Shallow lakes are more responsive to changes in the internal nutrient loading (for example, lake sediment phosphorus release) and biomanipulation (additions or removals of fish that affect the entire aquatic food web) than deep lakes, which are more responsive to changes in the external nutrient load from the watershed.

The mechanism that displaces the plants and allows for algae to take over is called a forward switch. The addition or removal of nutrients can change the composition of an aquatic plant community, but can't displace aquatic plants altogether. Forward switches include the direct loss of plants through harvesting or herbicide use, repeated boat passage damaging the plants beyond recovery, runoff of herbicides from the surrounding watershed, static water levels, the introduction of carp, and a fish community that favors zooplanktivorous (fish that eat the Daphnia that would otherwise eat the algae).

A reverse switch is a process or management option that restores and stabilizes the plant community by overcoming the buffers stabilizing the algae. The most common techniques are biomanipulation, which is a manipulation of the fish community to reduce the number of zooplanktivores (often by adding piscivorous fish), and by re-establishing plants under conditions in which they can thrive. An important aspect of plant restoration is the re-establishment of wetland fringes (cattails, rushes, water lilies) that utilize nutrients, buffer wave action, provide refuge for Daphnia and other algae grazers, and add to the lake's aesthetic appeal.

Each alternative state can persist over a wide range of nutrient concentrations. Aquatic plants can dominate without threat at total phosphorus concentrations below about 25 to 50µg/L (or total nitrogen below about 250 to 500 mg/L). At total phosphorus levels greater than about 50 µg/L, such as found in the Chetek Lakes, either plant- or algae-dominated systems can exist, though at these higher nutrient levels there is a greater risk of the system switching from plant to algae dominance. Plant diversity also decreases at higher nutrient levels and filamentous algae can be common. Native plants can become a nuisance at high nutrient concentrations as highly competitive species such as coontail and water lilies become dominant.

Shallow lake rehabilitation follows a series of graded steps:

1. Forward switch detection and removal
2. External and internal nutrient control
3. Restructuring the ecosystem by a reverse switch (biomanipulation)
4. Plant establishment, including wetland fringe
5. Stabilizing and managing the restored system

The causative factors for shallow lake degradation are commonly in-lake activities and phenomena rather than external sources. Identifying the historic forward switch that moved a lake from the plant-dominated to algae-dominated state can be difficult. It is more important to identify the switch mechanisms currently in operation. Once forward switches have been identified and removed, over-fertilization from the watershed and internal cycling can be addressed through nutrient management strategies. External and internal nutrient sources should be reduced as much as possible (preferably to < 50 µg/L) to buffer against a forward switch and establish conditions favorable for the next steps: biomanipulation and plant reestablishmen. A well-established submerged aquatic plant community is imperative to shallow lake restoration and can withstand moderate impacts without further active management. The lakes and watershed should be monitored for changes and activities that might destabilize the system.

4.2 Management Alternatives Evaluation

4.2.1 Water Level Management

Water level fluctuations are major driving forces for shallow lake ecosystems. Static water levels act as a forward switch in shallow lake systems. The Rock Koshkonong Lake District has assembled a list of 40 studies and publications related to water level management in shallow lakes. This list of abstracts was distributed to stakeholders for review and discussion. By lowering the water level sufficiently in fall, a plant-dominated state can be maintained or even a reverse switch from algal-dominance to a plant-dominated state induced, thereby enhancing water quality and biodiversity. A more natural water level regime in the Chetek Lakes can be achieved by lowering the limits of drawdown at the dam. Currently, the target summer water level at the dam staff gauge is 96.0 feet and the winter draw down level is 95.7 feet for a total drawdown of 0.3 feet (about 3.5 inches).

Stage data collected by the City of Chetek shows operation of the Chetek Dam is currently done such that these goals are met and fluctuations of only a few inches over the course of the year are typical leading to static water levels. To determine an appropriate target for drawdown levels, the seasonal fluctuations of Yellow Lake in Burnett County were evaluated. Yellow Lake was selected as it has similar morphology and a similar sized watershed—with less influence by human development—as the Chetek Lakes, it is located in a similar climate region, and 23 years of lake level data are available from the USGS. Further details of the data analysis can be found in the 2012 Aquatic Plant Management Plan.

The proposed water level plan is shown in **Figure 12** (and again in *Section 5.2*) and is not largely different from the current plan other than the maximum drawdown is increased to from 0.3 to 1.0 feet. The Barron County Fishery Biologist supports a 1.0-foot drawdown as a good level to start with and evaluate. According to public input survey results, the primary lake use times are from April through October with the majority of resort visitors on the lakes during the traditional holiday season of Memorial Day through Labor Day. The reference natural lake level fluctuations accommodated these time periods (somewhat surprisingly) with the historically higher levels occurring from mid-March to mid-September. The proposed drawdown strategy is discussed further in *Section 5.2* below.

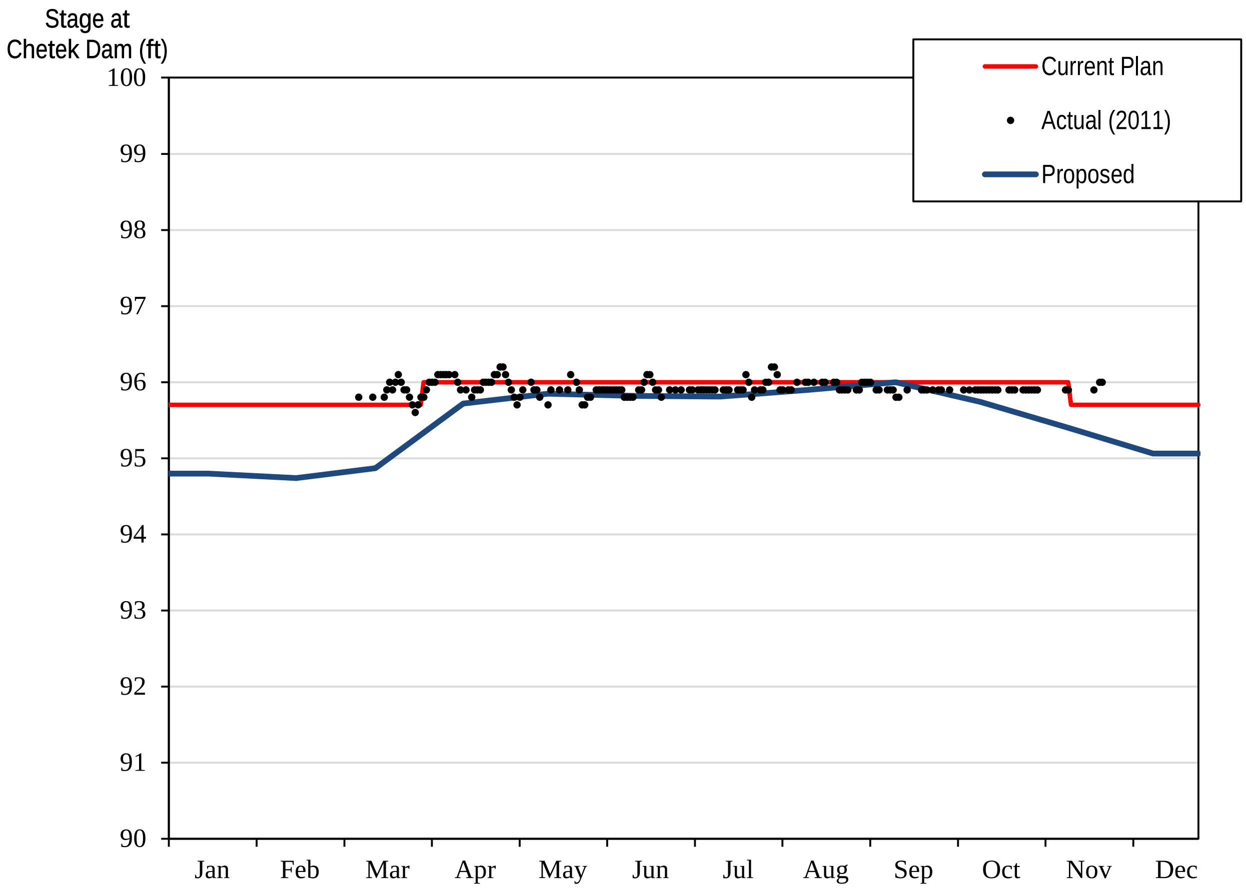

Figure 14 – Current and Proposed Chetek Dam Water Levels

The cost for implementing this management alternative is nearly $0 as the dam is currently monitored and managed on a nearly daily basis and the changes to the plan are easily reversible. During discussions with the Association, City, and WDNR, the biggest and potentially only hurdle to overcome may be community acceptance.

4.2.2 Biomanipulation

The presence of large populations of zooplanktivorous fish such as panfish and benthivorous fish such as carp and bullheads reduces the possibility of top-down control of zooplankton on phytoplankton. While carp are not a problem in the lakes at this time, it is important to point out that young panfish and other gamefish are zooplanktivorous and a large population can be detrimental to a shallow lake ecosystem. Of 14 lakes evaluated by Sondergaard and other (2007) that practiced biomanipulation (via fish removal), 7 had chlorophyll *a* levels reduce by more than 50% in the first 3 years of removal. Lake Wingra in Madison, WI recently underwent a switch from an algae-dominated to a clear water plant-dominated lake following and extensive carp removal effort. Conversely, the Clam Lakes in Burnett County recently switched to algae dominance following the maturation of a large age class of carp and harvesting efforts are underway. Lake Wingra is now managing aquatic plant growth and the Clam Lakes went from managing nuisance aquatic plant growth to trying to get the plants back. In both cases, even with the recreation boating "problems" aquatic plants can create, the public is more satisfied with clear water and a reduced exposure risk to blue green algae toxins than plant-free, algal-turbid water (Lathrop and others, 2013).

Biomanipulation is currently not supported by Stakeholders as the pan fishery is important to the lake community and tourism alike. A higher minimum size limit to reduce angler harvest and maintain a high predator population would likely benefit the lake and may be accepted due to the sport fishery nature of the lakes. The Association currently supports a catch and release policy and has completed a number of walleye habitat projects. Biomanipulation is an important aspect to shallow lake management and will be considered annually as management activities progress.

Biomanipulation in the Chetek Lakes would currently cost essentially $0 and only require a change in fishing regulations as there currently is no large rough fish population (such as carpt and black bullhead) in need of control.

4.2.3 Dredging

The amorphous and highly organic sediment found throughout the lakes provides poor spawning habitat, prevents the establishment of aquatic plants, are high in nutrients, and are readily re-suspended by wave and wake action. During discussions with the Barron County Fishery Biologist, dredging is supported as a management alternative to enhance spawning habitat (a firmer substrate) and it's potential to improve dissolved oxygen levels by removing organic matter.

Internal mechanisms can prevent or delay the recovery of lakes. Internal loading of phosphorus from sediment is an important mechanism in the Chetek Chain of lakes that, due to its large contribution to the phosphorus budget, would likely delay recovery for decades even if external nutrient loads are dramatically reduced. An evaluation of over 35 lakes completed by Jeppesen and others in 2005 found that sediment release can delay recovery by 10 to 15 years after external loads are reduced. Sediment release of phosphorus is the largest source of phosphorus within the direct drainage area of the lakes—removing this sediment can substantially reduce this 8,500 pound load.

Preliminary sediment analyses completed by Barron County from Lake Chetek (Aagot Bay, center of lake, and Moose Ear bay) and Tenmile Lake (deep hole) suggest that the sediments may be suitable for beneficial uses. Beneficial uses of dredged material involve the placed of the material for some productive purpose. Examples include agricultural, forestry and horticultural uses, top soil and soil manufacture, development of parks and recreational facilities (trails, wildlife viewing areas), mine reclamation (fill, soil amendment), and habitat development (wetland restoration or creation)

Dredging costs vary depending on methods and disposal. Hydraulic dredging is most appropriate for the Chetek Lakes due to the mucky nature of the sediment and does not require a drawdown. Hydraulic dredging is where a sediment and water slurry is sucked up and piped to a disposal area. It is the most cost effective method for large projects and costs vary from about $5 to $15 per cubic yard including design and construction of a disposal basin.

The Barron County SWCD is currently evaluating the effectiveness and cost of a manure dredge (used in the large manure lagoons of CAFOs) as a means for dredging the Chetek Chain. Contact was made with Ernie Sunstrom of Colfax who is familiar with dredges constructed in New Richmond Wisconsin at Liquid Waste Technology, LLC. These dredges can operate to depths up to 15 feet and as shallow as 18 inches. A double auger, similar to a snow blower, feeds the sediment to the pump and creates only a small plume under water.

It is anticipated that dredge material would then be pumped to tanker trucks or to a hose connected to a tractor pulling an injection device and spread on surrounding agricultural lands. Placing the dredged materials in geo bags (essential large filter cloth bags) to dewater prior to sale and hauling is also under consideration. The cost of manure dredging is typically $5 to $10 per 1000 gallons, which is in the ballpark of the nutrient value of the Chetek Chain sediments—potentially making suction dredging a break-even proposition. The County noted that funding and coordination beyond its capacity will be needed, however it is a worthwhile pursuit.

4.2.4 Re-directing Flow

Methods of reducing nutrient concentrations in reservoirs include the use of flow by-passes and hypolimnetic (bottom) water withdrawal. The primary reason to by-pass flow is to prevent flows which are high in nutrients from gradually mingling throughout the chain of lakes. In the past, re-directing flow has been briefly discussed at the Draw between Ojaski and Prairie Lake and at the historic Tenmile Lake outlet where a levy now exists. Hypolimnetic withdrawal has not been look at in detail until recently. Each of these methods has the potential to greatly reduce the nutrient load in the lake and are discussed below.

The road crossing at 24th Street provides a site for a water control structure between Ojaski and Prairie Lakes. The structure would remain closed preventing the flow of water between the lakes. The benefits to the chain of lakes are substantial:

- Reduce the annual phosphorus load to Prairie Lake by 27%. The 1999 Management Plan determined 27% of the annual phosphorus load to Prairie Lake is from Ojaksi Lake. Closing The Draw will reduce the Prairie Lake annual load by over 3,000 pounds per year. Ojaski Lake is the second largest phosphorus contributor to Prairie Lake. The largest contributor to Prairie Lake is surrounding agricultural lands in the direct drainage area which contribute approximately 4,900 pounds per year (44% of the 11,147 pound annual phosphorus load).

- Decreased water residence time in Ojaski and Pokegama Lakes. This may regulate hypolimnetic anoxia by promoting exchange, mixing, and thermal instability. Preventing the development of persistent anoxia would further reduce the internal loading from sediment.

- Reduce boat traffic in shallow waters—no traffic through The Draw and fewer boats using The Draw—which will reduce sediment re-suspension, rooted plant destruction, and shoreland erosion, thereby reducing phosphorus release and algal blooms.

The Tenmile Lake levy was modified in the mid-2000s to purposefully raise the crest to force all flow from Tenmile Creek to the Chetek Dam. The County retained ownership of the Tenmile Lake levy when dam repair work was completed. To direct flow from the inlet to over the levy during high streamflows—which are the periods of maximum nutrient runoff into the lake—a spillway should be constructed at the levy. Overflow at the levy would "short-circuit" the nutrient load to the Chetek Lakes and reduce the residence time of the high nutrient waters in the impoundment. Danz and others (2010) of the USGS found that in northern Wisconsin nearly 50 per cent of the annual total phosphorus load from streams is from storm events. Therefore, short-circuiting Tenmile Creek would eliminate an estimated 4,500 pound load from the system (50 per cent of the 9,083 pound load determined in 1999).

Flow by-passing is not a new idea for the Chetek Chain. Review of historic studies and documents show recommendations as described above dating back to at least 1974. Unfortunately little in depth consideration has been given to this management alternative. For example, a spillway on the Tenmile Lake levy was not even in consideration as an alternative in 2006, primarily due to the private ownership at the time. Currently, the design and construction of a spillway at the Tenmile Lake levy is estimated to cost between $10,000 and $30,000 ($5,000 for hydraulic design, remainder for construction costs) and upwards of $10,000 for a control structure at the Draw, depending on permanence and operability of the structure. These by-passes remain viable alternatives to control and direct nearly 8,000 pounds of phosphorus in the system.

4.2.5 Phosphorus Inactivation — Alum and Iron

The soft water of the lakes and the extended hypereutrophic state of the system makes alum (aluminum sulfate) an inappropriate method for use in the Chetek Lakes at this time. Alum applications add 1.3 pounds of sulfur for every 1 pound of aluminum. This addition can shift the respiration system further towards hydrogen sulfide production which will remove more iron from the system (see discussion in Section 2.1.1). Aluminum sulfate treatment costs range from $280 to $700 per acre with an average cost of about $450 per acre.

If iron in the lake sediment is found to be lacking, it can be restored by adding mineral ferric iron compounds as a sediment amendment. Iron would then be available for phosphorus removal from the water column. Iron can also be added to the lake specifically for remediation purposes. The Rush Lake Improvement Association in Chisago County, Minnesota is currently evaluating the use of iron (ferric chloride) for sequestering phosphorus. Iron has been used in lakes throughout the world and is also used to remove phosphorus from the St. Paul drinking water supply (water sourced from Vadnais Lake) and from drain tile effluent in western Minnesota.

Research has determined a general rule that if the available iron to available phosphorus ratio is greater than 15:1 iron will sequester phosphorus, in the range of 2 to 3:1 little sequestration will occur, and moderate sequestration occurs in the range of 8 to 12:1. The Association will be following the results of the Rush Lake iron augmentation study, for which a final report will be available in late 2014.

4.2.6 No-Wake Zones

Boats affect water clarity and can be a source of nutrients and algae growth in lakes. Motor boats are a well-known forward switch mechanism in shallow lakes. Shallow lakes, shallow parts of lakes, and channels connecting lakes are the most susceptible to impacts. The prop wash from a 150 HP outboard motor can penetrate to a depth of 15 feet and re-suspend sediment (Asplund, 2000).

The Advisory Committee felt that instituting depth-based no-wake zones would be met with criticism by the community. For example, a no-wake zone for waters 8 feet deep or less would cover nearly all of Ojaski Lake and Tenmile Lake in areas commonly used by boaters for cruising. No-wake zones were noted as being difficult to enforce and are often violated, including the current state regulations; however it was recognized that breaking the law is still breaking the law even if an officer is not present.

No-wake zones are an important management tool in shallow lakes and should be implemented based on a lake use and community acceptance. Many of the sloughs, bays, and The Draw could have no-wake zones extended to cover their entire area. The process of implementing no-wake zones will require substantial public input, education, and participation in order to balance recreational needs and the protection of water quality.

4.2.7 Hypolimnetic Withdrawal

Hypolimnetic withdrawal is the selective discharge of nutrient rich bottom waters to enhance nutrient removal from a lake and is an efficient restoration activity in stratified lakes. This is often done by running a siphon tube or pump from the deepest part of the lake to the outlet. Chetek Lake stratifies for most of the growing season in its deepest parts and all the lakes stratify for periods during the summer months. Sediment phosphorus release analyses show that the Chetek Lakes sediments release phosphorus even under oxic (un-stratified) conditions making this management alternative viable as a means of decreasing the fertilizing effect of bottom waters on upper waters.

Unlike sediment phosphorous inactivation techniques that increase sediment phosphorus, hypolimnetic withdrawal decreases the internal phosphorus. The largest disadvantage to hypolimnetic withdrawal is the effect on downstream waters: eutrophication, oxygen depletion, and odor development. For this reason it is often overlooked as a management alternative or discontinued. The Chetek Lakes have a somewhat ideal situation with a water treatment plant located downstream of the dam where hypolimnetic water can be treated prior to moving downstream. There is a potential for phosphorus trading credits in such a scenario. If capacity of the treatment plant does not allow for continuous treatment of hypolimnetic water, treated water can be used to for dilution

Hypolimnetic withdrawal of a sorts is occurring in the lakes currently in Baptist Bay east of the Chetek Airport. A local farmer is using lake water for irrigation purposes and is drawing from waters approximately 8 feet deep. Like many of the bays in the chain of lakes, Baptist Bay has periods of anoxia during the summer months, suggesting a high release of phosphorus from the sediment occurs. Surface water is preferred for irrigation for a number of reasons, particularly is it warmer than groundwater and it is significantly less expensive to pump water horizontally than vertically. Surface water has the additional benefit of some dissolved nutrients such as phosphorus not commonly found in groundwater.

A conservative estimate of the phosphorus removal potential from irrigation was calculated and follows. Over a four year period, 39 million gallons of water were pumped from Baptist Bay. To put that volume in perspective, 47 million gallons of water flow over the Chetek Dam during normal baseflow conditions (for example, late June 2013) each day. Assuming a total phosphorus concentration of 250 µg/L, just over 20 pounds of phosphorus were removed annually. According to residents around Baptist Bay, the water

Barron County identified 3,725 acres of irrigated farm land around the Chetek Lakes as shown in **Figure 14**. If each of these properties would irrigate using water from the Chetek Lakes, nearly 970 pounds of phosphorus will be removed from the system each year. This is a conservative estimate based summer total phosphorus concentrations in the upper and middle portions of the water column of about 250 µg/L. During stratification, total phosphorus in bottom waters has been measured at over 2,000 µg/L—the phosphorus removal may be an order of magnitude greater, over 7,500 pounds. The timing of irrigation coincides with the development of stratification in the shallow lakes, which is more likely to occur when inflows are minimal, that is during dry periods. Withdrawals for irrigation would therefore be pulling a larger amount of phosphorus.

To maximize phosphorus removal, a baffle system of 30-in perforated pipes located in deeper portions of the lakes as a means to preferentially draw deeper nutrient rich water from the lakes and spread out to prevent destabilization of the thermocline would likely be most beneficial. The baffle system can be connected to multiple pumping points on the shore.

Currently, the permitting system and open communications will keep withdrawals from becoming detrimental to the system and apportioning of withdrawals will not likely be necessary. The size of the lakes and the inflow to the lakes can support irrigation of all current groundwater irrigators near the lakes identified by the County. The lakes cover 3,562.6 acres and the irrigated lands cover 3,725 acres; if it were possible for all the producers were to pull 1 inch of water from the lakes simultaneously, the water level would drop by just over 1 inch (assuming the entire 1 inch was immediately withdrawn and there was no inflow from tributaries). Considering the volume of water flowing into the lakes during mid-range flow conditions, up to 30 million gallons of water per day could be withdrawn from the lakes during mid-range (normal) flow conditions and outflow from the lakes would maintain baseflow in the Chetek River.

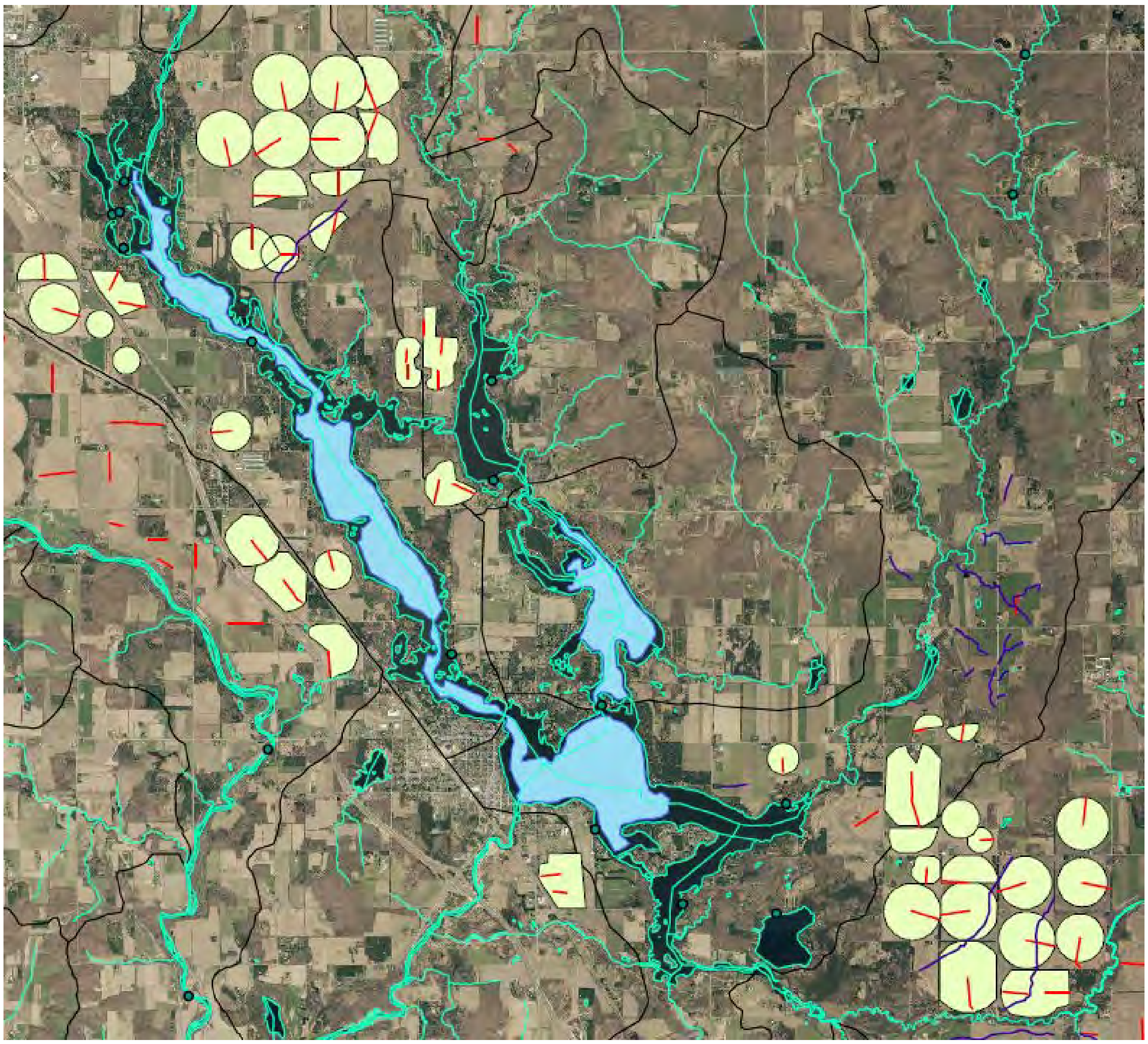

Figure 15 – Irrigated Fields around the Chetek Lakes

The cost of a feasibility study for hypolimnetic withdrawal over the dam is about $5,000. Data to determine hypolimnetic phosphorus concentrations, spatial and temporal limits of stratification, and potential effects downstream has been collected. A bioassay of hypolimnetic water would be beneficial to complete to determine critter survival rates in raw water and limitations for biological oxygen demand (BOD), ammonia, phosphorus, dissolved oxygen, suspended solids, and pH (limitations are used for planning permit issuance).

4.2.8 Aeration and Artificial Circulation

Aeration and artificial circulation are techniques typically applied to deep, stratified lakes to oxygenate the hypolimnion and prevent or break stratification and the ensuing release of phosphorus from lake sediments. Aerators and artificial circulation are generally used in shallow lakes to address depleted oxygen conditions. Although not present on the Chetek Lakes, fountains are a means of artificial circulation and aeration also utilized on many shallow lakes. As mentioned previously, many of the bays and backwaters of the Chetek Lakes have periods of anoxia during the summer where anoxic conditions are present immediately below the water surface. This anoxia is caused by the use of oxygen during the decomposition of plant matter and algae and because the bays are sheltered from wind-driven wave action.

An aerator was installed and operated by Gopher Point near Ekern Bay (west side of The Draw) to oxygenate the water during the growing season. Anecdotal reports from surrounding property owners indicate that the water quality was better (higher water clarity, less smell) than previous years with no aerator. Aerators can reduce algae can potentially reduce algae through a number of processes including: algae sinking and mixing into deeper, darker parts of the lake reducing growth rates; changes in water chemistry from higher oxygen levels leading to a shift from cyanobacteria to less offensive green algae and diatoms; and, zooplankton mixing into deeper, darker water where their chances of being consumed by fish are reduced (more zooplankton, more algae consumed).

Prairie Lake has a history of winterkill caused by low oxygen levels. To combat the low oxygen levels, a winter aeration system has been used in the lake since 1992. The aeration system is maintained under a cooperative agreement between the WDNR, Barron County, the City of Chetek, and Towns of Chetek, Dovre, Stanley, and Prairie Lake. The aerator system and barrier is set up by WDNR Fisheries staff and CLPA volunteers. The average annual operating costs of this system are about $1,750. This alleviates the extremely low winter dissolved oxygen levels and prevents winterkill, but does not address sediment phosphorus release.

Because aerators don’t immediately address the underlying problem (aeration keeps phosphorus in the sediment, but doesn’t remove it from the lake), the Advisory Committee decided not to focus on aeration as rehabilitation activity other than for sustaining the fishery in winter months. The Association will support the installation and maintenance of aerators by individuals and groups, such as at Gopher Point, because the fishery and wildlife in the Chetek Lakes undoubtedly benefit from the use of aerators. It is important that aerators are positioned correctly in the water column to ensure the anaerobic zone is getting aerated and that bottom sediments are not being re-suspended due to the diffuser being place on to too close to the lake bottom.

4.2.9 Expand City Sewer Service

Although not supported by the Association or the City at this time, expanding the City of Chetek sewer system is a management alternative that would benefit the lake, albeit at a high cost for little return. Septic systems are estimated to contribute only a small fraction of the overall phosphorus budget to the lakes (1.9% or 864 pounds). It is important to note that septic systems contribute nutrients and other chemicals to groundwater and lakes even if they are working properly; septic systems are designed to remove solids and pathogens, not necessarily dissolved nutrients.

In septic systems, phosphorus is initially retained in the soil, but once the soil retention capacity is exceeded, septic system can and often do discharge high concentrations of phosphorus to the groundwater which ultimately reaches the lakes. Nitrogen is rarely retained and travels with the water. All of the soils in the near shore area of the Chetek Lakes are rated Very Limited for septic tank absorption fields. A Very Limited rating indicates that the soil has one or more features that are unfavorable for the specified use and poor performance and high maintenance can be expected. The limitations generally cannot be overcome without major soil reclamation, special design (for example, tertiary treatment systems), or expensive installation procedures.

In shoreland areas it is particularly important to maintain septic system properly because soil and water conditions near shore may make the system less efficient in treating wastewater. Incomplete treatment can result in health risks for humans and water quality problems. The association will update their webpage to include information on septic system maintenance. Many other things can be done if property owners are actively thinking about and have been educated about what can be done when the opportunity presents itself. The installation of new drain fields as far from the lake shore as possible; installation of alternative or additional treatment system that can remove nutrients (nitrogen and phosphorus); and consideration of community or other group wastewater treatment options are just a few possibilities.

Due to the limited nutrient reduction estimated to be had by expanding the city sewer, it is not recommended at this time. Property owners need to be made aware of their potential impacts to the system and a feasibility study for sewer expansion along the near shore area should be conducted that evaluates current, full build-out, and limited development scenarios. A feasibility study for expansion would cost an estimated $7,500.

4.2.10 Near shore and In-Lake Nutrient Loading Control

Riparian landowner efforts to improve runoff quality and shoreland habitat will barely tip the needle on the phosphorus load to the lakes. These activities will, however, be essential to maintaining a clear water state (particularly restoring a wetland fringe) and enhancing fishery and wildlife habitat and therefore should be encouraged in the fullest.

The recently completed Wisconsin Healthy Lakes Implementation Plan is designed to protect and improve the health of our lakes by increasing lakeshore property owner participation in habitat restoration and runoff and erosion control projects. The plan includes 5 relatively simple and inexpensive best practices that lakeshore property owners can implement, all of which are appropriate for the Chetek Lakes. These practices include Fish Sticks woody habitat structures, native plantings (see Figure 15 below, note wetland fringe), water diversion practices in the near shore and upland areas, rock infiltration basins, and rain gardens. The 14-page document is included as Appendix B in this plan. Fact sheets detailing each practice are also included in Appendix B and can be found online at: http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/healthylakes/default.aspx
(last accessed November 14, 2014)

The WDNR created a Lake Protection – Plan Implementation sub-category for Healthy Lakes Grants. The gateway to seek the funding requires an eligible sponsor, such as the Association, to adopt the Plan by resolution or integrate it into a complimentary planning effort such as this comprehensive plan. Grant applications are due February 1 of each year, beginning in 2015. The funding is designed to encourage committed property owners with shovel-ready projects. Therefore, each grant has a standard timeline with an April 15 start date and June 30 end date a little more than 2 years later.

Photo credit: WDNR (P. Toshner)

Figure 16 – Grant-funded Shoreland Restoration in Bayfield County

4.2.11 Watershed Nutrient Loading Control

The Advisory Committee agreed that Barron County in partnership with the WDNR and the NRCS will continue to spearhead agricultural conservation practice implementation in the watershed. The Association, with its limited resources, will offer support primarily through identification of problem areas. This began and continues with photo-documentation of excessive runoff, erosion, and things that “just look wrong.” As partnerships develop with the farming community, the Association will gradually take on a larger role in watershed management, but at this time will focus on in-lake and near shore activities. The Association will assess annually if more involvement in watershed activities are warranted based on their workload and the needs of partners such as Barron County. Citizen based monitoring of streams in the watershed will continue by Association volunteers and additional Water Action Volunteers will be encouraged.

The County has reviewed the 2012 synoptic sample data to target areas where pollution and erosion are disproportionately severe and the potential for improving water quality and preventing soil loss is disproportionately great. The information collected also provides a snapshot of the watershed to evaluate the effectiveness of management activities over time. Funding for the sample collection was provided by a WDNR Lake Grant and in-kind volunteer match provided by the Chetek Lakes Protection Association and Barron County provided the funding for data analyses.

Techniques known as precision conservation have been developed that utilize high-resolution elevation data, or LiDAR (Light Detection and Ranging), to target where on the landscape best management practices will be most effective. Applications of such techniques are underway in Wisconsin. LiDAR data exists for Barron, Chippewa and Rusk Counties, covering the entire Chetek Lakes watershed. Alone, these counties do not currently have the resources to fully utilize this valuable data for terrain analyses that help water restoration and protection projects target critical areas of the landscape.

Identifying where the projects will be the most effective in meeting water quality goals will allow time, energy and dollars to be used with the greatest payback. The Association should partner with the various conservation Departments to develop a strategy for employing the LiDAR data. Such a strategy may entail a lake protection grant application in partnership with other lake management groups also interested in utilizing such data, and University and Government agencies or private consultants to complete the data analysis.

4.3 Funding Sources

With few exceptions, lake and watershed management is an ongoing effort. It is unrealistic to expect that any investment in the ongoing management of the Chetek Lakes can be sustained from sources outside the lake community and by a limited number of sources within the lake community. The WDNR Lake Grant program provides a source of funds for planning activities and implementation, but these funds are limited and the grants are becoming more competitive. With more applicants there is also the potential for a "spread the wealth" approach to grant funds where important aspects of projects can be delayed or overlooked in order to fund other projects. It is also important to note that grant funds do not cover costs many activities appropriate for the rehabilitation of the Chetek Lakes including: dredging; damp repair, operation or removal; water safety patrols; or, the design of sanitary sewers or septic systems.

The Chetek Lakes Protection Association has been educating and advising the lake communities and local governments on their responsibilities and commitments to sustain lake and watershed management efforts. A reliable source of funding is available through the formation of a Lake District. A lake district is considered a governmental body and has taxing authority over the properties included within its boundaries. A mill rate is established each year by the Lake District Board, and must be approved by the membership. There are limitations on how high a mill rate can be set (0.0025), but there is no limit to how low it can be set. The value of a lake district is outlined in the 2012 Aquatic Plant Management Plan and the Association will continue informing the public of this need for an anticipated vote for district formation by 2017.

The Association will continue to work with the County and WDNR to identify and secure appropriate grant funding until such a time that the lake community can support management efforts.

5.0 Proposed Management Actions and Implementation Plan

A list of proposed management actions that can be implemented to achieve objectives and targets was developed from the alternatives analysis and discussed during Advisory Committee meetings. The implementation plan includes a recommended timeline of key events, responsible parties, and potential funding sources.

Objectives include identifying lake improvement projects throughout the watershed, establishing a willingness to participate in these projects by the agricultural, residential, and urban community, and assessing the cost and feasibility of multiple projects aimed at improving or enhancing water quality and lake use. Because many of the elements necessary for shallow lake rehabilitation will likely be met by social resistance, public education, outreach, and information sessions to develop a community understanding of shallow lake ecosystems will be important for success. The lake community must be presented with the two alternative states—clear water, plant dominated or turbid, algae dominated—and that a middle ground is cost prohibitive and unsustainable.

5.1 Community Forums

Providing information to the public can prove to be difficult if it’s not know where to start outside of Association functions. Below is a listing of some of the forums available. In some cases, distributing information is as simple as talking with your neighbors and listening to their concerns. Though not exhaustive, and not all encompassing, these provide a launching point for established and new ideas alike.

Township and City meetings will be a primary source of distributing information and developing partnerships. The Association will have a representative at each township and city meeting to present pertinent information to local governments and citizens at monthly meetings. Local governments also provide a means to distribute information; for example, information on septic system maintenance and inspection can be included in town mailings.

The Chetek Alert is the local newspaper and shows an interest in covering the work being done on the Chetek Chain. The newspaper should be notified of projects large and small being undertaken. This includes nutrient management projects being undertaken in the watershed that work to improve water quality including those on farms and within the City of Chetek.

The Association will update it’s webpage to a more modern web portal. Links to resources and a calendar of events will be included on the webpage. An interactive, informative website can be a clearinghouse of information, a place to send those with questions or in need of more information and is accessible by nearly everyone nearly anywhere. If a steward for a social media site (for example Facebook or Twitter) can be found, the Association will also utilize these resources for disseminating information.

The association will work with the Realtors Association to develop a welcome packet for distribution to new property owners. Existing publications such as “Protecting Your Waterfront Investment” by the WNDR and UW-Extension along with the most recent Association newsletter will be included in the packet, not to forget relevant stickers and other goodies.

While much of this is free in the sense that volunteer time is the only cost, website development is a larger undertaking. Costs vary widely depending on development requirements and maintenance, ranging from $1,000 to $20,000. Having an existing website places the Association at the lower end of the range. There are a number of web developers that can be contacted for quotes. The Association will review websites of other lake associations and districts (for example, http://www.rllakedistrict.org/, http://www.bigroundpine.com/) to develop a list of web developers to contact. A selection of developers and quotes for site construction and maintenance will be in hand by January 2015.

5.2 Biomanipulation

The Chetek Chain is managed as a bass-panfish fishery with a stocked walleye population. There is currently a desirable fishery present with abundant panfish populations with good growth rates. The walleye population is currently less than desired and stocking by the WDNR will continue, preferably large fingerling, to improve the walleye population in lakes.

A higher minimum size limit to reduce angler harvest and maintain a high predator population would likely benefit the lake and may be accepted due to the sport fishery nature of the lakes. The Association will discuss this option with the Fishery Biologist. The Association will continue to supports a catch and release policy and will work with WDNR Fisheries to identify the need for additional walleye habitat projects. Biomanipulation is an important aspect to shallow lake management and will be considered annually as management activities progress.

5.2.1 Hypolimnetic Withdrawal

Hire a resource professional to conduct a feasibility study for hypolimnetic withdrawal over the dam (cost of approximately $5,000, can be private entity or WDNR). Much of the necessary data has been collected (as part of previous studies and Citizen Lake Monitoring efforts) to determine hypolimnetic phosphorus concentrations, spatial and temporal limits of stratification (timing of bottom withdrawal), and potential effects downstream. A bioassay of hypolimnetic water to determine critter survival rates in raw water and limitations for biological oxygen demand (BOD), ammonia, phosphorus, dissolved oxygen, suspended solids, and pH will also be conducted as part of the feasibility study. Materials required and cost of installation and maintenance will also be included.

In partnership with the County (SWCD) and local farmers (initially Troy Bol of Sugar Bol Farms), the Association will make contact with surrounding farmers to determine who is currently utilizing surface water for irrigation, from what source, and identify those interested in utilizing surface water.

5.3 Re-directing Flow

The Association and County will hire an engineer to design a spillway at the Tenmile Lake levy to allow storm flows to short-circuit. Costs for design are estimated at $5,000. Following approved design, the County will need to identify a source of funds (approximately $25,000 depending on design) outside of lake protection grants for construction. Once funds are secured, bids for permitting and construction will be let.

The Association will determine community acceptance and promote the water quality benefits (*Section 4.2.4*) of closing The Draw. Association volunteers will utilize public forums identified in *Section 5.1* to disseminate information and garner public feedback. Options to be presented include completely closing the draw via fill or designing and constructing a small boat lock and dam.

5.4 Aeration and Artificial Circulation

The Association approves of the installation and maintenance of aerators by individuals and groups but at this time will not pursue their implementation as a management activity undertaken by the Association other than winter aeration in Prairie Lake.

5.5 No-wake Zones

Developing a lake-use plan to help implement no-wake zones and to avoid conflicts that arise from incompatible lake uses will help make users more aware of how their actions impact the lakes. Lake-use plans can take many forms. Some include the use of lake zones to designate areas of the lake for certain uses such as fishing, swimming, power boating, wildlife refuges, and so on. Time restrictions also may be considered and have been implemented on a number of lakes in Wisconsin. A combination of lake-use zones and time restrictions may be the most effective for reducing conflicts. A plan must be flexible and dynamic to respond to changing needs in the lake community.

The Association will invite a WDNR warden to their annual meeting to discuss common lake use violations. Information and maps about current and suggested no-wake zones will be provided on the Association website and maps displayed at boat launches. The figures below indicate high priority areas to implement no-wake zones and will be presented to Town boards for discussion for implementation of no-wake zone ordinanaces. The areas indicated were chosen due to the shallow water and the patchy nature of the current no-wake zone 100 feet from the shore required of boats (personal watercraft have a no-wake zone of 200 feet from the shore). These areas are not final and should be modified based on lake use and user input. Other priority areas will be determined following implementation/modification of these areas and the Association will promote a no-wake in waters shallower than 8 feet deep boating practice.

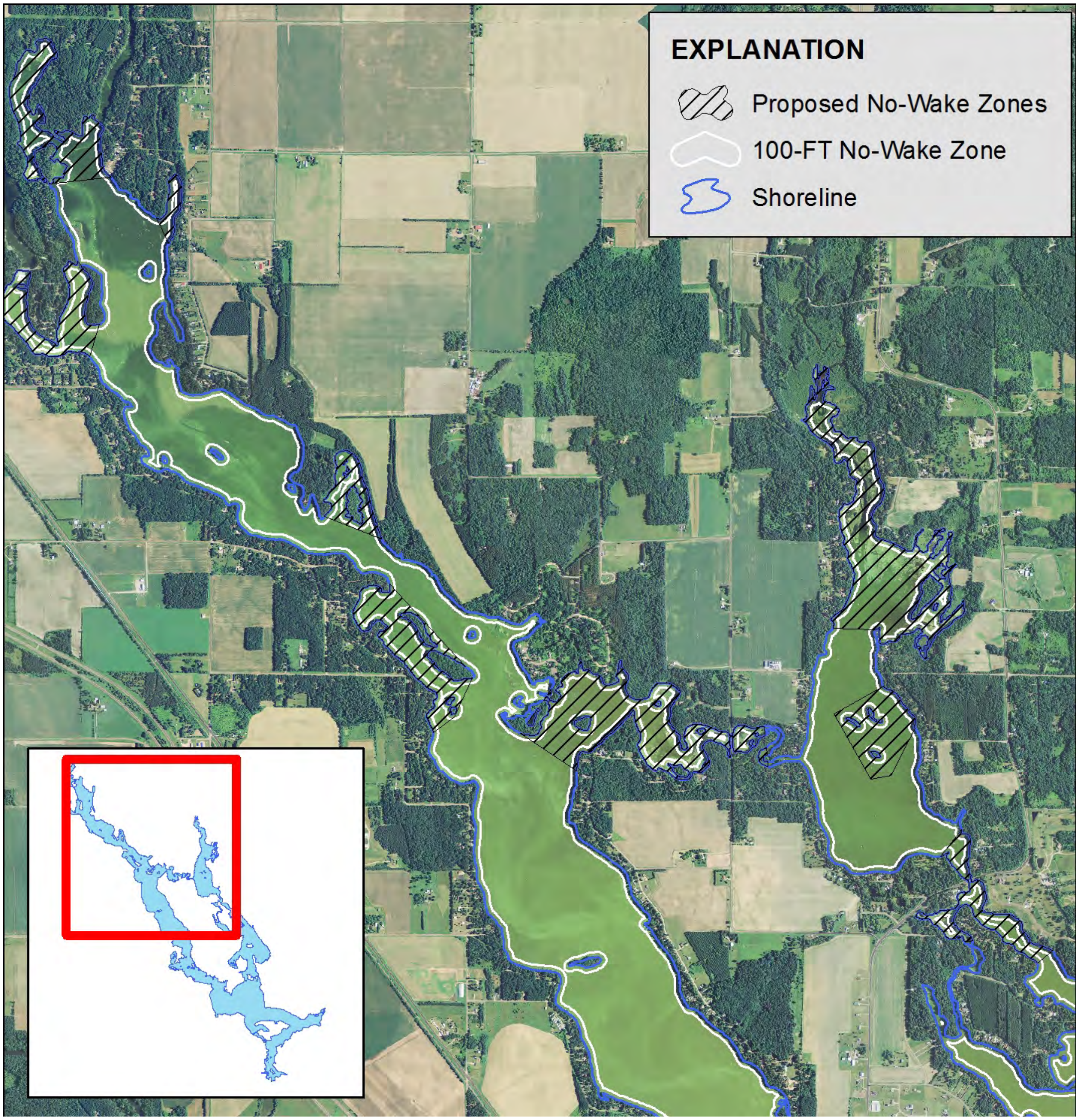

Figure 17 – Priority No-Wake Zones in the North Part of the Chetek Lakes.

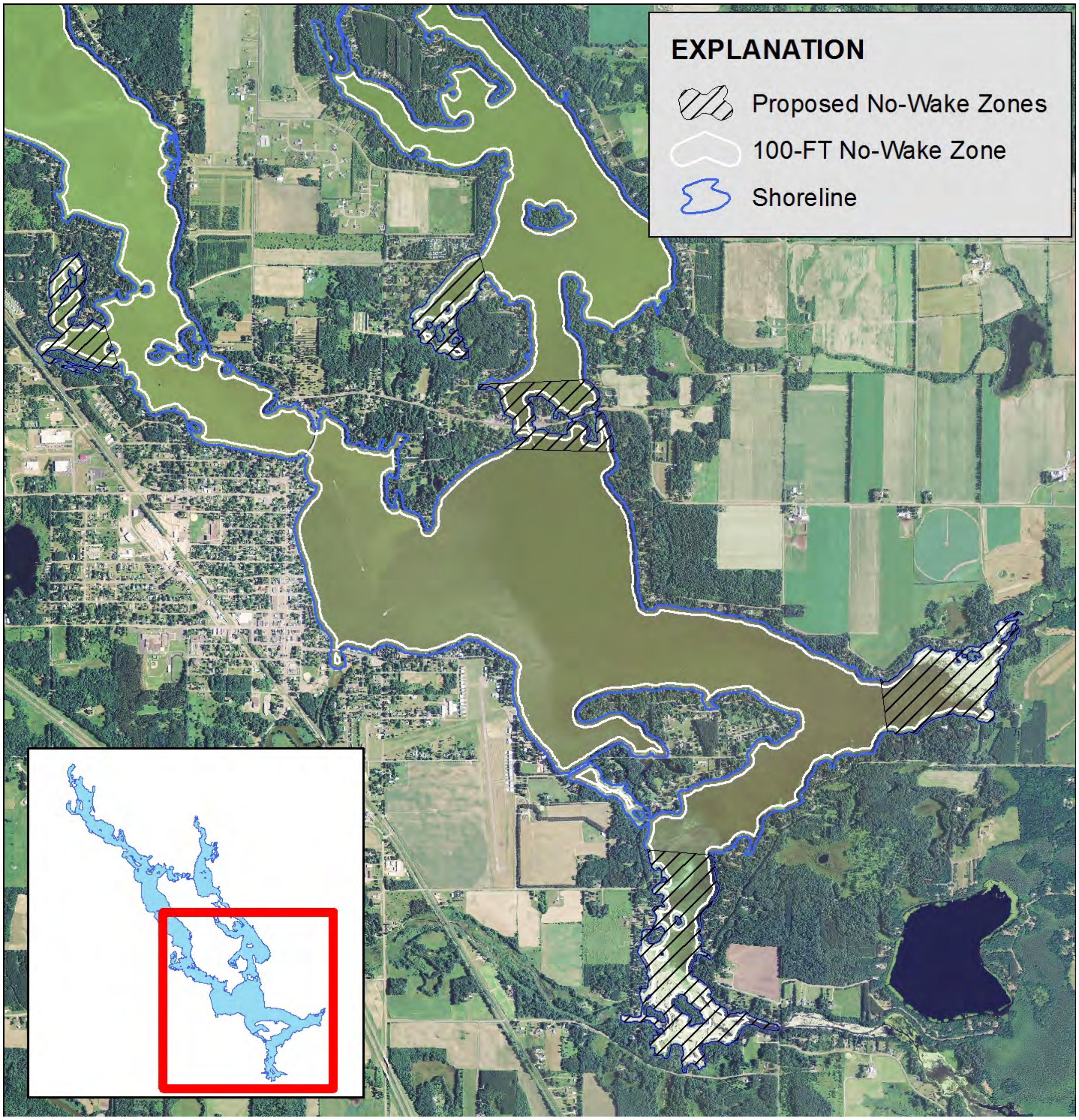

Figure 18 – Priority No-Wake Zones in the South Part of the Chetek Lakes.

5.6 Lake Level Management

The County and City, with support from the Association will work to implement a 1.0-foot over winter drawdown to occur each year. In 2014, and the extended drawdown will begin in mid-November and end by December 15 (**Figure 19**). Future drawdowns will be completed following the schedule below and may be completed at depths closer to 1.5 feet (stage of 94.5 feet) following an evaluation of a 1.0 foot drawdown the first year (2015). Association volunteers will monitor dissolved oxygen levels under the ice at the sites monitored during the winter of 2013-2014 for comparison to the 1.0 drawdown.

A press release informing the general public about the drawdown will be completed and submitted to the Chetek Alert and other local news outlets of note. It is anticipated that questions and complaints will be received by the city, county, and Association during the drawdown. Records of comments received will be kept by all three parties.

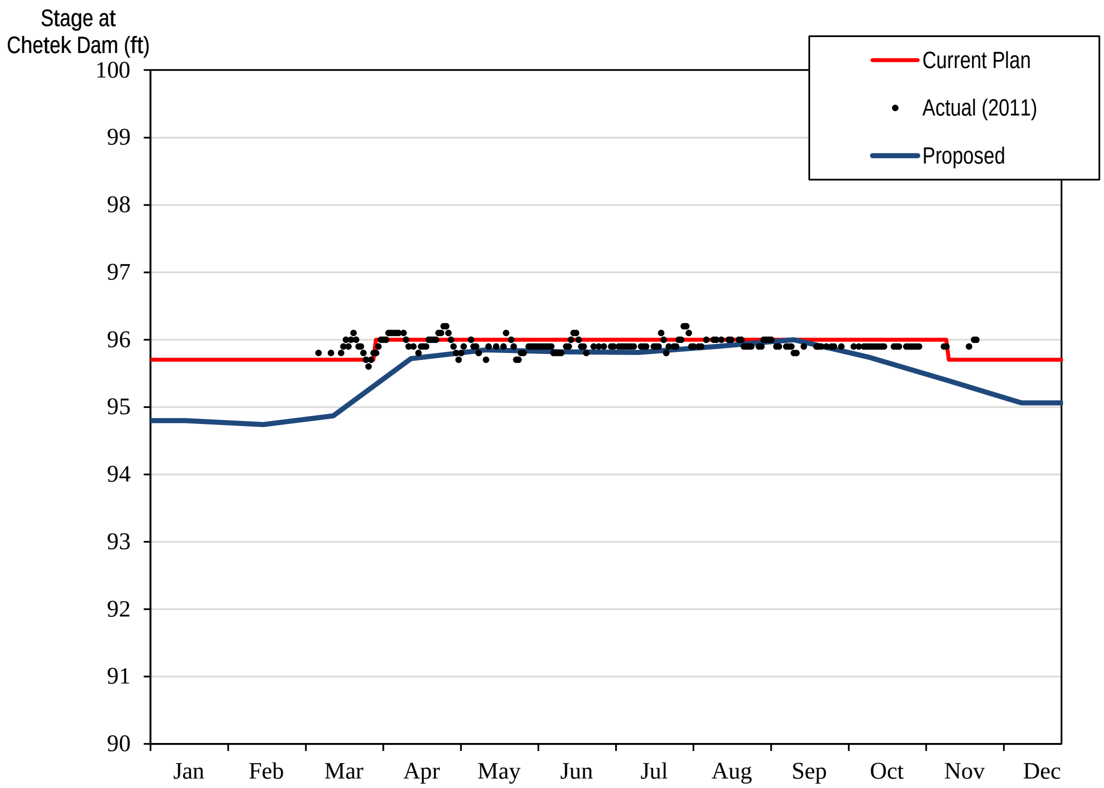

Figure 19 – Proposed Lake Level Management at the Chetek Dam.

April 15 — October 1: Levels maintained between stage of 95.8 and 96.0 (management remains the same as historic)

October 1 — December 1: Drawdown from 96 to 95.0 feet over a two month period. Extended drawdown allows for the migration of aquatic animals to deep waters for over wintering.

December 1 — March 15: Drawdown stage of 95.0 feet maintained over winter.

March 15 — April 15: Begin filling to level of 96 feet over a month-long period. Dependent on ice conditions; should be completed following ice out and after majority of spring snowmelt passes through the system. Filling should extend for a month to allow for the establishment and growth of aquatic plants.

5.7 Aquatic Habitat

The Wisconsin Healthy Lakes Implementation Plan (HLIP) will be utilized to enhance fishery and wildlife habitat. The plan includes 5 relatively simple and inexpensive best practices that lakeshore property owners can implement, all of which are appropriate for the Chetek Lakes. These practices include Fish Sticks woody habitat structures, native plantings, water diversion practices in the near shore and upland areas, rock infiltration basins, and rain gardens. The Association will identify property owners willing to participate in these activities. This will be accomplished via press releases detailing the HLIP and noting that the Association will provide assistance with acquiring grant funding. Grant funding will be sought if 15 or more property owners are willing to participate.

5.8 Dredging

Dredging in the Chetek Lake will be a multi-year effort. The Association will partner with the County for planning activities, permitting, and securing funding. Planning activities can be funded through WDNR Lake Grants, but the actual costs of dredging must be paid for outside of the Lake Grant program.

Aagate Bay was selected as the first area to have dredging completed for a number of reasons. The bay is a small (approximately 20 acres), shallow, oxygen depleted bay with poor spawning sediment and blue-green algae blooms during the summer. Anoxic conditions have been documented by volunteer data collectors as beginning one foot below the water surface. The water clarity conditions is at times is measured in centimeters. Anecdotal evidence suggests that portions of the bay that were once sand or gravel bed materials have become covered in organic muck. The bay is also close to County Road SS, which provides close access for transport of dredge materials.

Nutrient and metals testing of the sediment was completed in 2014 by Barron County. These data indicate the dredged material is appropriate for use as a topsoil amendment for agricultural fields, lawns and gardens, and for site restorations (for example, building up islands—to create an in-lake wetland to upland gradient—or transporting off site for other restorations such as at non-metallic mine sites). A map of potential sediment routes and uses from Aagate bay is presented in **Figure 20**. A brainstorming exercise to create routing maps such as this will be created for other areas of the lake and landowners willing to purchase the dredge material identified through partnerships with the farming community facilitated by Barron County SWCD.

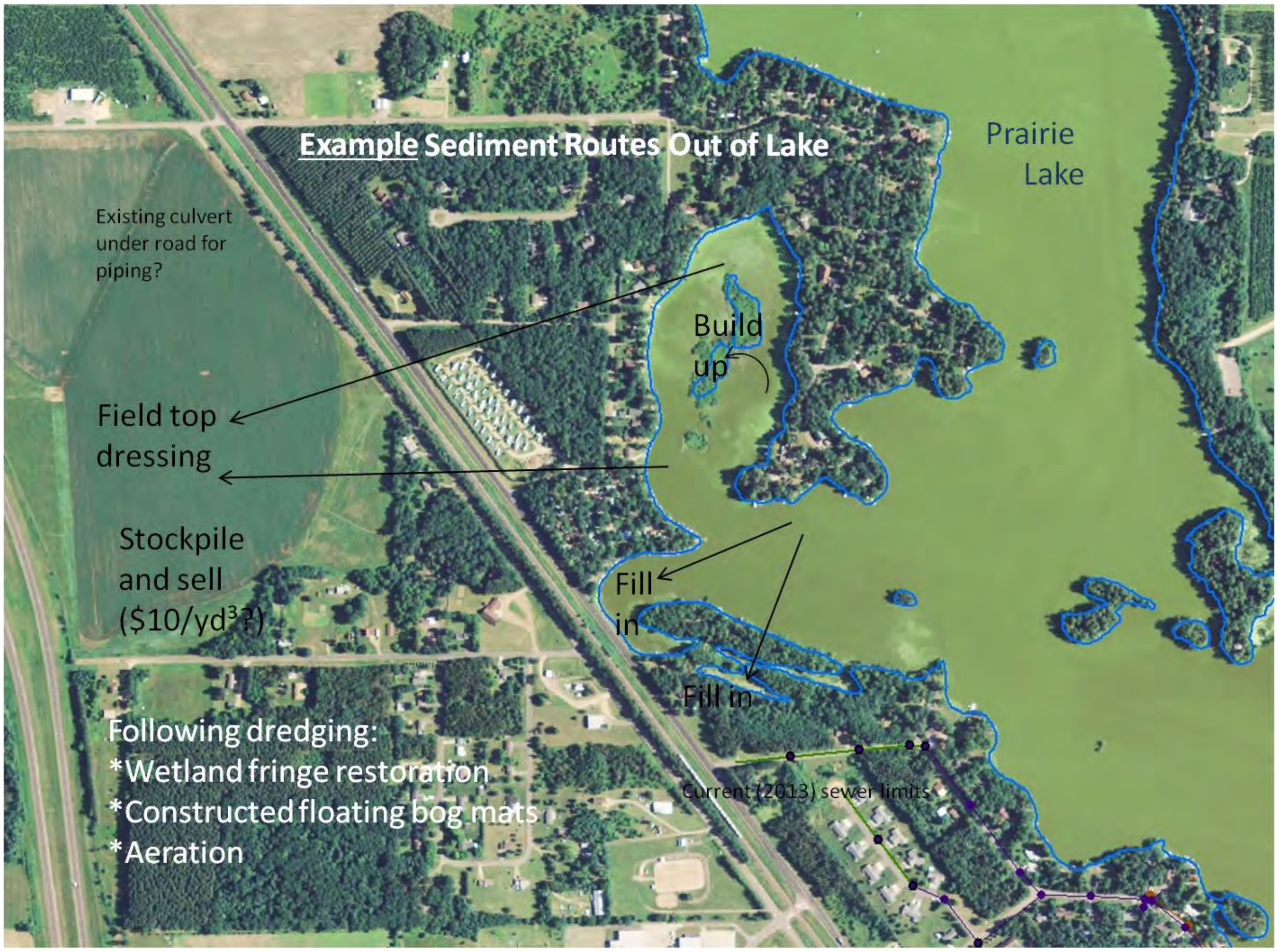

Figure 20 – Potential Dredge Material Utilization for Aagate Bay, Prairie Lake.

The Association will work with the county to continue developing a dredging strategy for Aagate bay as a trial for larger scale dredging utilizing slurry dredges. The Association will measure the soft sediment depth to determine the amount of material to be removed. The depth of soft sediment will be assessed by following a grid with a GPS unit. A Secchi disk will be lowered until it is resting on top of the sediment to record the depth of water. A three-quarter inch galvanized steel pipe with capped ends and marked at one-foot intervals will be pushed into the sediment until reaching hard sediment or rock, also known as the “point of refusal.” The one-foot interval markings on the pipe will allow for quick assessment of total depth of the sediment and water combined. The difference in the measurements will provide a soft sediment thickness that will be used to generate maps of sediment thickness and total amount of material to be dredged.

Initially, soft sediment up to three feet deep will be removed. If soft sediment depths exceed 3 feet, six-foot core samples will be taken to determine if and where low sediment phosphorus levels exist. This will be done as there is the possibility of exposing soft sediments with a *higher* phosphorus release rate than current surface sediments.

Dredging the bay following standard hydraulic dredging procedures would cost about $150,000; however, dredging using a slurry dredge and selling the material for its nutrient cost may have the potential to break even, or at least recoup some of the cost. Based on anoxic sediment release rates in other parts of Prairie Lake, phosphorus loading to the system could be reduced by over 1 pound *per day* by dredging Aagate Bay alone.

5.9 Operation and Maintenance Plan.

The Association will keep an updated list of management practices and contact information for all grant funded projects. The operation and maintenance period for any grant-funded management practices (for example, grant-funded shoreland restoration projects) will be 10 years.

Participation in the Citizen Lake Monitoring Network (CLMN) Water Quality Monitoring Program will continue. At a minimum, water clarity, temperature, dissolved oxygen, total phosphorus, and chlorophyll *a* monitoring should be continued at the each of the sites labeled in **Figure 2** and **Figure 3** on a monthly basis from ice on to ice off. Continuing to collect this information will help identify the factors leading to changes to water quality (for example, from the implementation of management activities), changes in the watershed land use, and the response of the lakes to environmental changes.

This plan will be evaluated in full on an annual basis and updated as necessary to ensure goals and community expectations are being met.

6.0 Implementation and Evaluation Strategies and Considerations

The management goals for the Chetek Lakes were developed as a collaborative effort between the Association, local stakeholders, Barron County and the WDNR. The goals were developed to be inspirational, believable and actionable. This plan is not intended to be a static document, but rather a living document that will be evaluated on an annual basis and updated as necessary to ensure goals and community expectations are being met.

The prioritization and implementation of management activities can be completed in a number of ways. Below is a list of implementation strategies assembled by Patrick Goggin of the UW- Extension Lakes program (note: all internet links active on September 16, 2014).

Phased Approach — Incremental vs. System Functionality

- Do we want/need all activities/function/services available “Day One”?
- Can we absorb that level of change at one time?
- Can we take on that level of implementation work at one time?
- If not, based on the priorities of project goals and depending on the time and resources that can be allocated:
    - What functions do we want/need immediately?
    - In what sequence should we add the other functions?
    - Over what time period?

Money or Time Notion

- Some lake organization put pledges in from the memberships, asking them to either volunteer for lake management projects for 4 hours per season, or commit to making a financial contribution to pay for 4 hours of worker time as match to ongoing grant work.

***Lake List* Tool and Learning from Other Lake Citizens, Consultants, and Businesses**

- The Wisconsin Lake List is the UW-Extension’s directory of lake organizations.
- Use the Lake List to find a lake organization or an officer, to find out how folks deal with lake management issues by checking out their management profile, and to find contact information for many businesses that service the needs of lake organizations. If you’re not sure of the spelling, enter a partial name to search.
- http://www4.uwsp.edu/cnr/uwexlakes/lakelist/

Structure Committees to Implement Assorted Lake Management Planning Themes

Match People with Their Skill-sets and Interests — Community Assets Idea

- Community-asset based stakeholder participation: http://www.abcdinstitute.org/

Behavioral Change/Community-based Social Marketing

- Social marketing consists of several basic components including: exchange, positioning, focusing on behaviors, understanding the target audience, creating and delivering messages that will prompt people to change certain behaviors, and forming strategic partnerships with community resources.
- Challenge of the 10-year average flip of lakefront properties
- Background information on community-based social marketing (CBSM): http://www4.uwsp.edu/cnr/uwexlakes/ecology/shorelands/community_based_social_marketing.asp

Communication

- Lake Coordinator, contractors or service providers, organization members, town and county boards, county zoning and land and water conservation department, etc.
- Newsletters, blogs, websites, workshops, special sessions, forums, fact sheets, etc.
- *Lake Tides* and *Lakes Connection* stories can be utilized.

Words Matter: Framing Your Message and the Language of Conservation

- Water Words That Work LLC is a for-profit company with a mission to protect nature and control pollution; they do this by helping non-profit organizations: www.waterwordsthatwork.com/
- Language of conservation analysis: http://dnr.state.md.us/irc/conservationcoursedocs/lesson8/languageofconservation.pdf
- Readability statistics with Microsoft Word spell check — look for Flesch-Kincaid Grade Level: http://office.microsoft.com/en-us/word-help/display-readability-statistics-HP005189601.aspx

Try to Make It Fun

- Lake maps, t-shirts and sweatshirts and other lake gear, tables, boat parades, potlucks and social gatherings.

Some Common Contributing Factors to Implementation Failure

- Lack of planning: unclear vision, goals, and approach; not aligned with vendor/service provider incentives; schedules; other program priorities and other resource responsibilities.
- Incomplete, unclear, and (or) changing requirements.
- Lack of executive/community support and commitment.
- Lack of resources dedicated to the project (staff, time, money, participant involvement, project management, and IT support).

Other Factors Contributing to Implementation Failure

- Unrealistic expectations for what can be accomplished and how quickly it can occur.
- Believing the vendor/service provider will assume responsibility for all tasks.
- Hoping the vendor/service provider will fix your operations and personnel problems.
- Fear of change.
- Fear of technology.

Implementation Team Members Should Include

- People skilled and knowledgeable about plan contents.
- Lake community leadership/change agents.
- Local lake community representation – people who make up your lake community – lake leaders, county LWCD, WDNR, UWEX, etc.
- Networkers, connectors and communication specialists – web sites, newsletter, blog, email lists, etc.
- Trainers, educators, and mentors.

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Appendix A

Aquatic Plant Management Plan Goals, Objectives and Actions

Chetek Lakes APM Plan Goals, Objectives, and Actions

Goal 1 Increase native aquatic plant diversity, distribution, and density in the Chetek Lakes

Objective Protect and enhance existing native aquatic plant beds

Action Prevent reductions in the diversity and distribution of native plant beds that can be attributed management actions

Assessment. Comparison of pre and post treatment survey results annually and to 2011 survey results

Objective Increase the time the depth of the littoral zone in the lakes remains at spring levels

Action Implement management actions that target the expansion of the summer littoral zone

Assessment. Comparison of 5-yr year mid-season aquatic plant survey results to 2011 survey results

Objective Re-establish an emergent vegetation fringe through restoration/re-introduction projects

Action Identify landowners willing to implement wetland fringe/shoreland buffer restoration projects

Assessment. Annual documentation of willing landowners

Action Implement wetland fringe/shoreland buffer restoration projects

Assessment. Annual documentation of restoration projects and a comparison of 5-yr mid-season aquatic plant survey results to 2011 survey results

Objective Protect and enhance existing wild rice beds

Action Prevent reductions in wild rice distribution and density that can be attributed to management actions

Assessment. Comparison of wild rice bed mapping results annually and to 2011 survey results

Action Identify landowners willing to participate in wild rice introduction projects

Details *Work with the Great Lakes Indian Fish and Wildlife Commission and other resources to help identify suitable locations for wild rice introductions, and then contact landowners to promote the projects*

Assessment. Documentation of introduction sites

Action Implement wild rice introduction projects

Assessment. Annual monitoring to determine success

Objective Restore more natural water level fluctuations

Action Develop a lake level management plan that will promote greater native aquatic plant distribution, diversity, and density

Details *Educate landowners, lake users, and resource personnel about the benefits of a more ecologically based lake level management plan to promote greater aquatic plant growth*

Details *Work with the CLPA, City of Chetek, Barron County, and the WDNR to develop a new lake level management plan*

Action Implement a lake level management plan that promotes greater native aquatic plant distribution, diversity, and density

Assessment. Comparison of changes in aquatic plant distribution, diversity, and density in the 5-yr mid season survey to 2011 results

Goal 2 Complete AIS management that: 1) reduces levels of the target AIS, 2) encourages greater native plant growth, 3) reduces phosphorus inputs caused by decaying vegetation, 4) does not negatively impact the fishery, and 5) provides nuisance and navigation relief for lake users.

Objective Integrated management of CLP in the system

Action Physical removal anywhere in the system by lake users and/or landowners

Details *Physical removal as defined in NR 109*

Assessment. Documented time and estimated amount removed

Action Low dose herbicide application in designated areas and adjacent to public access sites impacted by dense growth CLP

Details *Endothal or other approved active ingredient; liquid or granular depending on conditions; early spring as soon as water temperature reaches 50-55°F, in water depths of 4.5 to 7.5 ft*

Details *Applied by licensed applicator and repeated for at least three years*

Assessment. Annual treatment plans, pre- and post- treatment surveys, completed WDNR chemical application permit, and applicator records

Action Mechanical harvesting of navigation channels through dense growth CLP within abundant native vegetation beds

Details *One time cutting of pre-determined channels up to 40-ft wide between May 1^{5th} & June 1^{5th}; cutting depth not to exceed 2/3 the water depth; no cutting in water < 3-ft deep or in high value (sensitive) areas; existing channels will be followed if possible*

Action Mechanical harvesting of riparian access corridors to open water through dense growth CLP

Details *One time cutting of pre-determined access corridors up to 20-ft wide between May 15th and June 15th; cutting depth not to exceed 2/3 the water depth; no cutting in water < 3-ft deep; existing access corridors will be followed if possible*

Assessment. Annual harvesting plans, total landowner and lake user requests and complaints, completed WDNR harvesting permits, and harvesting records

Action Establish harvested aquatic plant off loading and dumping sites near to actual harvested areas

Details *Off loading sites and vegetation dumping sites will be established as close to recommended harvest areas as possible.*

Landowner, local town, and county approval will be sought once dumping sites are identified.

Action Secure annual herbicide and harvesting permits

Details *All herbicide application and mechanical harvesting projects will be covered under single permits prepared by the CLPA or their retainers with all fees paid for by the CLPA*

Objective Complete CLP Monitoring and Management Assessment

Action Annual pre- and post-treatment aquatic plant monitoring

Details *Completed by resource professionals contracted by the CLPA and according to WDNR pre-post monitoring guidelines*

<u>Assessment.</u> Annual pre and post treatment reports

Action Annual spring bed mapping of entire system

Details *Completed by trained mapping crews (possibly through the Chetek Charter School) or resource professionals contracted by the CLPA*

<u>Assessment.</u> Annual bed mapping report and GIS based maps

Action Turion density monitoring

Details *Completed in consecutive years (once management begins) by a resource professional contracted by the; survey points determined by treatment areas*

<u>Assessment.</u> Turion Density Reports

Objective Integrated management of Purple Loosestrife

Action Physical removal by flower head cutting, hand pulling, or digging

Action Herbicide application

Details *Application of glysophate in concert with flower head cutting*

Action Biological control using Gallerucella beetles

Details *CLPA volunteer collecting and/or rearing beetles to be distributed on larger beds*

Objective Japanese Knotweed Management

Action Partner with Barron County to continue monitoring and control efforts

Details *Provide training on identification and control to lake volunteers; report any new sites to Barron County, work with Barron County to continue implementation of controls*

Goal 3 Provide late season (native aquatic plant) navigation and open water access relief for lake users and riparian owners

Objective Determine areas where native aquatic plant growth impairs navigation or landowner access to open water

Action Visit previously identified sites and new site requests annually

Details *Sites where native plant management occurred in the previous year, and new sites based on landowner requests received prior to June 30, will be visited annually by trained CLPA volunteers or resource professionals contracted by the CLPA prior to actual treatment to determine eligibility for management*

Details *Site documentation will follow guidelines provided in Appendix I*

Objective Complete aquatic plant management that will provide navigation and open water access relief for lake users and landowners

Action Mechanical harvesting of navigation channels through dense growth native aquatic vegetation

Details *One time cutting of channels 40-ft wide prior to July 31; cutting depth not to exceed 2-ft or 1/3 the water depth whichever is less; no cutting in water < 3-ft deep and not in high value (sensitive) habitat area; existing channels will be followed if possible*

Action Mechanical harvesting of riparian access corridors to open water through dense growth native aquatic vegetation

Details *One time cutting of access corridors 20-ft wide prior to July 31; cutting depth not to exceed 2-ft or 1/3 the water depth whichever is less; no cutting in water < 3-ft deep; existing access corridors will be followed if possible*

Assessment. Annual harvesting plans, completed WDNR harvesting permit, and harvesting records

Action Secure annual harvesting permits

Details *All mechanical harvesting projects will be covered under single permits prepared by the CLPA or their retainers with all fees paid for by the CLPA*

Goal 4 Education, Monitoring, Prevention, and Fundraising

Objective Educate and inform lake users about aquatic invasive species currently in the Chetek Lakes and those that could be introduced

Action Provide information and education opportunities for lake users to learn about and identify AIS

Details Educational workshops, informational materials, newsletters, webpage, public events

Objective Establish a Proactive and Consistent AIS Monitoring Program for the Chetek Lakes

Action Continue and expand an in-lake and shoreline AIS monitoring program

Details *In-lake monitoring will be completed by the CLPA or its retainers following UW-Extension Lakes Citizen Lake Monitoring Network AIS Monitoring Guidelines*

Details *If EWM is discovered in the Chetek lakes, provisions set up in the EWM Rapid Response Plan (Appendix E) will be followed*

<u>Assessment.</u> Submit AIS monitoring results to the WDNR SWIMS database

Action Consider hiring an AIS Coordinator annually to aid in AIS education, monitoring, and control work

Objective Work to prevent AIS from entering and leaving the Chetek Lakes

Action Continue and expand watercraft inspection at public and private lake accesses

Details *Follow UW-Extension Clean Boats Clean Waters (CBCW) guidelines, and encourage private access owners to monitor their landings*

Action Maintain, update, and improve AIS signage at all Chetek Lakes public and private accesses

Details *Evaluate existing signage at the landing and update or make improvement as needed; encourage private access owners to post their landings*

<u>Assessment.</u> Submit watercraft inspection data to the WDNR SWIMS database

Objective Monitor water quality in the Chetek Lakes

Action Continue and expand participation in the CLMN Water Quality Monitoring Program

Details Complete Secchi, temperature, dissolved oxygen, total phosphorous, and chlorophyll-a sampling on all five lakes in the spring, June-Aug, and Oct.

Details Three sites in Prairie Lake and at one site each in Chetek, Tenmile, Pokegama, and Mud lakes

Assessment. Submit all CLMN water quality data to the WDNR SWIMS database

Objective Create a Lake Protection and Rehabilitation District to increase revenues for implementing management actions

Action Form a committee of stakeholders to plan the formation of a Lake District

Action Form a Lake District within the five years from the implementation of this APM Plan

Goal 5 Instill an Appreciation for Aquatic Ecosystems and Habitat in the Lake Community

Objective Educate and Inform the Lake Community about the Importance of Aquatic Plants

Action Provide information and education opportunities for lake residents and users

Action Develop and distribute at least one annual newsletters updating AIS activities

Action Host at least one annual event to promote involvement in lake activities

Details *Examples: Lake fair, aquatic plant identification workshop, shoreland restoration workshop, wild rice seminar, etc*

Details *Can be combined with regularly scheduled events , or done in partnership*

Action Maintain a webpage

Details *Post aquatic plant and lake management documents for public viewing*

Objective Encourage riparian owner participation in wildlife monitoring programs including, but not limited to, loons, bald eagles, fur-bearers, and amphibians

Action Provide lake users, landowners, and the community with information and education opportunities related to wildlife and wildlife monitoring programs

Details *Examples: Loonwatch, Frog and Toad Survey, Waterfowl Surveys*

Goal 6 Reduce total nutrient inputs from non-point sources to the Chetek Lakes

Objective Complete a Comprehensive Lake Management Plan for the Chetek Lakes

Action Identify and quantify all sources of phosphorus to the Chetek Lakes; make recommendations to reduce phosphorus inputs to the system; establish an implementation plan for the recommendations

Action Provide information and education opportunities for stakeholders to learn about what impacts the lakes and how

Objective Reduce nutrient loading caused by agricultural practices

Action Promote and support efforts to educate and inform agricultural producers about practices that can protect and improve the lakes

Details *Partner with Barron County, local agricultural producers, to determine how best to accomplish this action*

Action Offer public support and recognition to agricultural producers who implement BMPs and ACPs that protect and improve the lakes

Details *Annual recognition of local agricultural producers by the CLPA in local media outlets and/or by special awards or incentives*

Action Support efforts by Barron County and other resources to get and keep livestock out of riparian zones and tributaries

Details *Identify and document all areas where this occurs and report them to Barron County*

Objective Reduce nutrient loading caused by on-site waste water treatment systems

Action Educate and inform riparian landowners about the importance of maintaining and/or improving proper septic system function

Details *Provide information and education opportunities for riparian landowners to learn about proper septic system function*

Details *Encourage individual landowner testing of on-site waste water treatment systems and repair of those systems if determined to be operating incorrectly*

Details *Encourage landowners to channel "gray" water into septic systems rather than overland*

Action Install alternative or additional treatment systems that can remove nutrients (nitrogen and phosphorus).

Action Consider community or other group wastewater treatment options.

Objective Reduce nutrient loading caused by shoreland development

Action Educate and inform riparian landowners about the importance of shoreland restoration, BMPs that reduce shoreland runoff, and habitat improvement projects

Details *Provide riparian owners with general shoreland improvement information and education opportunities and encourage them to implement*

Details *Provide riparian owners with general shoreland runoff reduction information and education opportunities and encourage them to implement*

Objective Reduce the impact of motorized watercraft in the lakes

Action Educate and inform lake users about the problems associated with motorized boat use is shallow water and the benefits of "no wake" zones

Action Distribute maps of legally recognized and suggested "no wake" areas in the lakes

Action Encourage voluntary compliance by lake users in all recommended "no wake" areas

Action Increase enforcement of compliance in established no wake areas

Details *Sponsor Citizen Water Patrols on the Chetek Lakes*

Appendix B

Wisconsin's Healthy Lakes Implementation Plan


Green Lake, Green Lake County - Lisa Reas

Healthy Lakes

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

2014-2017

WISCONSIN DEPT. OF NATURAL RESOURCES

Wisconsin Lakes Partnership

TABLE OF CONTENTS

Team Members:
Dave Ferris, Burnett County Land and Water Conservation Department
Pat Goggin, Lake Specialist, UW-Extension Lakes
Jane Malischke, Wisconsin DNR Environmental Grants Specialist
Tom Onofrey, Marquette County Zoning Department
Carroll Schaal, Wisconsin DNR Lakes and Rivers Section Chief
Pamela Toshner, Wisconsin DNR Lake Biologist

The statewide Healthy Lakes initiative is a true, collaborative team effort. The Healthy Lakes Implementation Plan describes relatively simple and inexpensive best practices that lakeshore property owners can implement. The Plan also includes funding/accountability, promotion, and evaluation information so we can grow and adapt the Plan and our statewide strategy to implement it into the future. Working together, we can make Healthy Lakes for current and future generations.

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Design and layout by Amy Kowalski, UWEX Lakes

INTRODUCTION

Wisconsin's lakes define our state, local communities, and our own identities. Fond memories of splashing in the water, seeing moonlight reflect off the lake, and catching a lunker last a lifetime. With over 15,000 lakes dotting the landscape, it's no surprise that fishing alone generates a $2.3 billion economic impact each year , and the majority of property tax base rests along shorelines in some of our counties. Unfortunately, we've learned through science that our love for lakes causes management challenges, including declines in habitat and water quality. In fact, the loss of lakeshore habitat was the number one stressor of lake health at a national scale. Lakes with poor lakeshore habitat tend to have poor water quality. Working together to implement *Wisconsin's Healthy Lakes Implementation Plan* (Plan), we can improve and protect our lakes for future generations to enjoy, as well.

This Plan identifies relatively simple habitat and water quality best practices that may be implemented on the most typical lakeshore properties in Wisconsin. We encourage do-it-yourselfers to use these practices but have also created a Wisconsin Department of Natural Resources (DNR) Lake Classification and Protection Grant *Healthy Lakes* sub-category for funding assistance. Furthermore, local partners like lake groups and counties may choose to integrate the Plan into their lake management, comprehensive planning, and shoreland zoning ordinance efforts.

It's important to consider this plan in the context of the lake and local community's management complexity. The best practices' effectiveness will increase cumulatively with additional property owner participation and depend on the nature and location of the lake. For example, if every property owner implemented appropriate Healthy Lakes best practices on a small seepage lake, also known as a pothole or kettle lake, within a forested watershed, the impact would be greater than on a large impoundment in an agricultural region of Wisconsin. Nevertheless, all lakes will benefit from these best practices, and even with limited impact, they are a piece of the overall lake management puzzle that lakeshore property owners can directly control. More lakeshore property owners choosing to implement Healthy Lakes best practices through time means positive incremental change and eventually success at improving and protecting our lakes for everyone.

GOALS AND OBJECTIVES

Wisconsin's Healthy Lakes Implementation Plan goal is to protect and improve the health of our lakes by increasing lakeshore property owner participation in habitat restoration and runoff and erosion control projects.

- Statewide objective: single-parcel participation in Healthy Lakes will increase 100% in 3 years (i.e. 2015 to 2017).
- Individual lake objective: lake groups or other partners may identify their own habitat, water quality, and/or participation goal(s) through a local planning and public participation process.
    - Partners may adopt this Plan, as is by resolution, or integrate the Plan into a complimentary planning process such as lake management or comprehensive planning.

Wisconsin's Healthy Lakes Implementation Plan, and the diversion and rock infiltration practices in particular, are not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design. Technical assistance and funding are still available for these sites; contact your county land and water conservation department or local DNR lakes biologist for more information.

The target audience for this Plan and implementation of the associated practices is lakeshore property owners, including: permanent and seasonal homeowners, municipalities, and businesses.

It will be necessary to do additional planning work to implement Wisconsin's Healthy Lakes Plan and, again, the level of effort will depend on the complexity of the lake and its local community. Planning could be as simple as site-specific property visits and development of design plans, to integrating the Plan into a broader and more comprehensive effort. Your lake group, county land and water conservation department, non-profit conservation association, UW-extension lakes specialist or local educator, and/or DNR lake biologist can provide planning guidance or contacts.

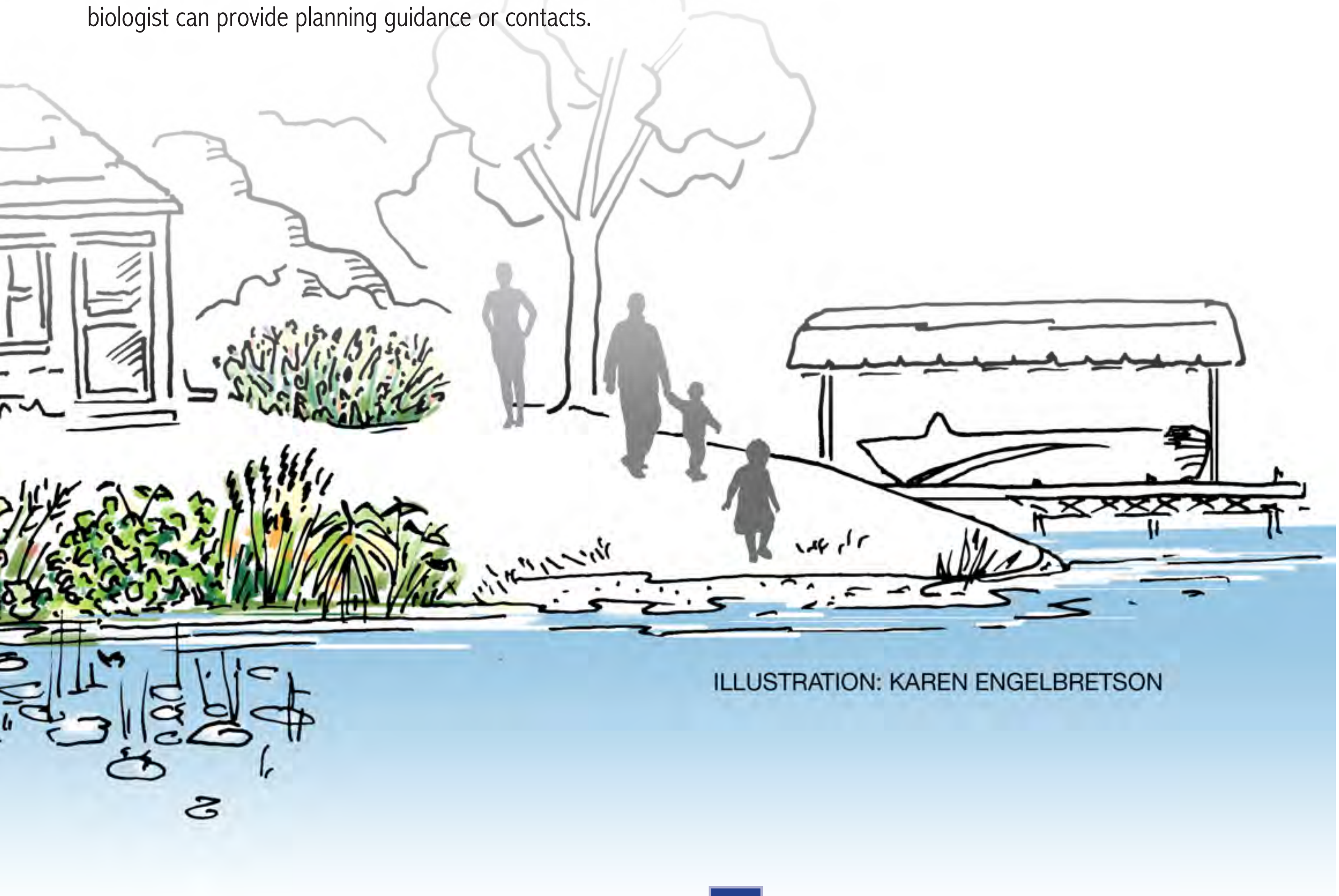


ILLUSTRATION: KAREN ENGELBRETSON

DEFINITIONS

Best practice: a working method, described in detail, which has consistently shown results.

Divert: redirect runoff water.

Habitat: where a plant or animal lives.

Infiltrate: soak into the ground.

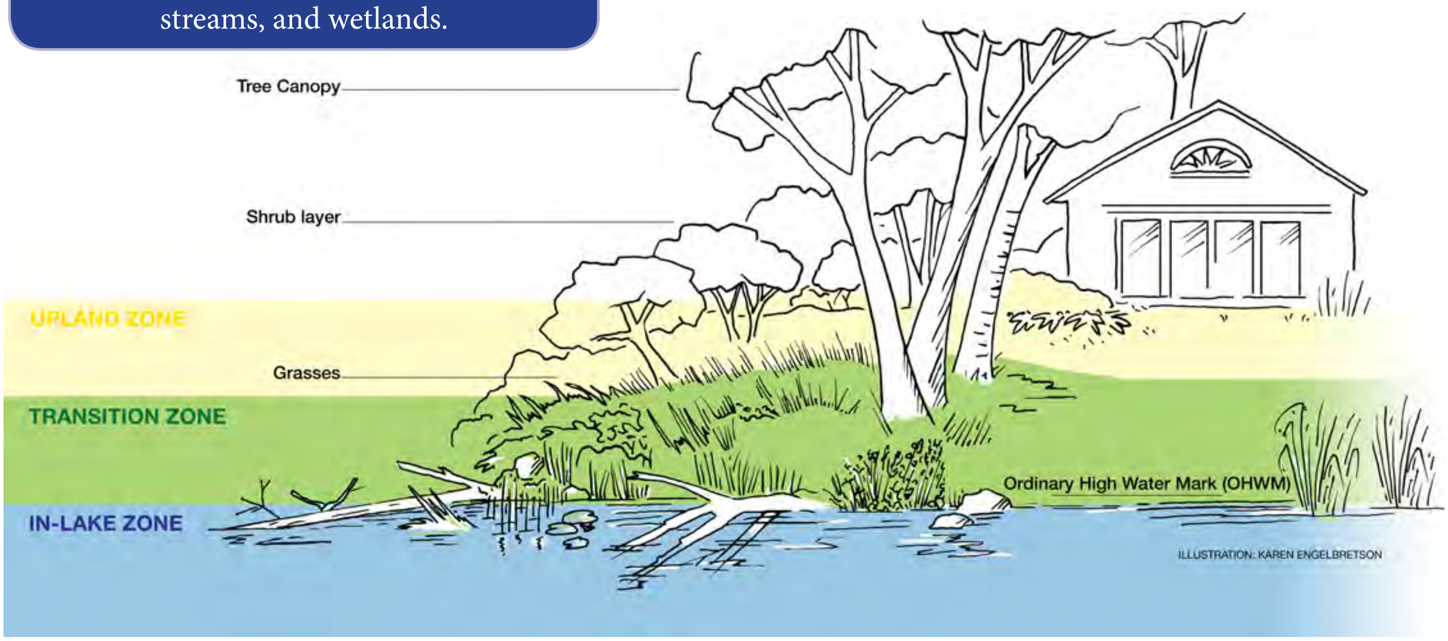
Installed: project cost that includes all materials, labor, and transportation.

Runoff: rain and snowmelt that doesn't soak into the ground and instead moves downhill across land and eventually into lakes, streams, and wetlands.

Wisconsin's Healthy Lakes Implementation Plan divides a typical lakeshore parcel into the following 3 management zones: 1) in-lake, 2) transition, and 3) upland (see illustration below). Best practices are identified for each zone. A team selected these practices based on customer feedback. These practices are:

- relatively simple and inexpensive to implement,
- appropriate for typical lakeshore properties, and
- beneficial to lake habitat and/or water quality.

The Plan also provides cost ranges and averages and technical, regulatory, and funding information for each practice. Fact sheets for each best practice support the Plan and provide more technical detail, and additional guidance is referenced if it currently exists. There is also a funding and administration FAQ fact sheet for those considering pursuing Healthy Lakes grants.



HEALTHY LAKES PLAN

BEST PRACTICES

Best practice descriptions follow. Each description defines the practice, identifies lake health benefits, provides cost ranges and averages based on recent projects, and identifies additional technical and regulatory information. The costs provided are installed costs, which include all materials, labor, and transportation but do not include technical assistance, including design and project management/administration work. Cost ranges are a result of geographic location, property conditions like soils and slopes, and contractor supply and proximity to the project site.

ZONE 1: IN-LAKE

PRACTICE 1 | FISH STICKS

...large woody habitat structures that utilize whole trees grouped together resulting in the placement of more than one tree per 50 feet of shoreline. Fish Sticks structures are anchored to the shore and are partially or fully submerged.

Bony Lake, Bayfield County - Pamela Toshner

LAKE HEALTH BENEFITS	Improve fish and wildlife habitat Prevent shoreline erosion
COSTS	Range - $100-$1000 per cluster (3-5 trees), installed Average - Cost per unit (3-5 trees) averages $500, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Fish Sticks* http://tinyurl.com/healthylakes DNR Fish Sticks Best Practices Manual http://dnr.wi.gov (search for *Fish Sticks best practices*)
REGULATORY INFORMATION	DNR: **Habitat Structure - Fish Sticks General Permit** ($303 fee unless DNR grant-funded) Fish Sticks must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/cluster of 3-5 trees Fish Sticks may be a stand-alone grant activity only if the vegetation protection area (i.e. buffer) complies with local shoreland zoning. If not, the property owner must commit to leaving a 350 ft^2 area un-mowed at the base of the cluster(s) or implement native plantings (Practice 2).

PRACTICE 2 | 350 FT² NATIVE PLANTINGS

...template planting plans with corresponding lists of native plants suited to the given function of the plan. The 350 ft² area should be planted adjacent to the lake and include a contiguous area, rather than be planted in patches. Functions are based on the goals for the site. For example, one property owner may want to increase bird and butterfly habitat while another would like to fix an area with bare soil. Native planting functions include the following: lakeshore, bird/butterfly habitat, woodland, low-growing, deer resistant, and bare soil area plantings.

Green Lake, Green Lake County - Lisa Reas

LAKE HEALTH BENEFITS	Improve wildlife habitat Slow water runoff Promote natural beauty
COSTS	<u>Range</u> - $480-$2400 for 350 ft² area, installed <u>Average</u> - $1000 per 350 ft², installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *350 ft² Native Plantings* http://tinyurl.com/healthylakes 350 ft² Native Plantings Best Practices Manual
REGULATORY INFORMATION	DNR: an aquatic plant chemical control permit may be necessary if using herbicides in or adjacent to the lakeshore. Native plantings must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/350 ft² native plantings installed and implemented according to the technical requirements. Only one 350 ft² native planting per property per year is eligible for funding. The native plantings dimension must be 350 ft² of contiguous area at least 10 feet wide and installed along the lakeshore. Final shape and orientation to the shore are flexible.

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

ZONE 3: UPLAND

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 4 | ROCK INFILTRATION PRACTICE

Deer Lake, Polk County - Cheryl Clemens

...ian excavated pit or trench filled with rock that reduces runoff by storing it underground to infiltrate. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, pre-treat, and redirect water to the pit or trench. Pit and trench size and holding capacity are a function of the area draining to it and the permeability of the underlying soil.

LAKE HEALTH BENEFITS	Divert runoff water. Clean runoff water. Infiltrate runoff water.
COSTS	<u>Range</u> - \$510-\$9688 per rock infiltration practice, installed <u>Average</u> - \$3800 per rock infiltration practice, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rock Infiltration Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Rock infiltration practices must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of \$1000/rock infiltration practice installed and implemented according to the technical requirements. Healthy Lakes rock infiltration practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

ZONE 3: UPLAND

PRACTICE 5 | RAIN GARDEN

...a landscaped shallow depression with loose soil designed to collect roof and driveway runoff.

Shell Lake, Washburn County - Brent Edlin

LAKE HEALTH BENEFITS	Improve wildlife habitat. Divert runoff water. Clean runoff water. Infiltrate runoff water. Promote natural beauty.
COSTS	Range - $500-$9000 per rain garden, installed Average - $2500 per rain garden, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rain Garden* http://tinyurl.com/healthylakes *Rain Gardens: A How-to Manual for Homeowners* http://dnr.wi.gov/topic/Stormwater/documents/RgManual.pdf
REGULATORY INFORMATION	DNR: none. Rain gardens must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rain garden installed and implemented according to the technical requirements. Healthy Lakes rain garden grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

FUNDING AND ACCOUNTABILITY

Administrative details and the application process are described in detail in the DNR's Water Grant Application and Guidelines (http://dnr.wi.gov/ search for surface water grants) and the Healthy Lakes website (http://tinyurl/healthylakes) and *Administration and Funding FAQ* fact sheet.

Healthy Lakes grant funding highlights:

- 75% state share grant with a maximum award of $25,000, including up to 10% of the state share available for technical assistance and project management. Technical assistance and project management do not include labor and are based on the entire state share of the grant, not the best practice caps.
- 25% match from sponsors, participating property owners or other partners. The grant sponsor may determine individual property owner cost share rates, provided the state's share of the practice caps ($1000) and total grant award (75%) are not exceeded. The grant sponsor's match may include technical assistance and project management costs beyond the state's 10% share.
- Sponsor may apply on behalf of multiple property owners, and the property owners do not have to be on the same lake.
- Standard 2-year grant timeline to encourage shovel-ready projects.
- Landowners may sign a participation pledge to document strong interest in following through with the project.
- Standard deliverables, including a signed Conservation Commitment with operation and maintenance information and 10-year requirement to leave projects in place. Also:
    - Native plantings must remain in place according to local zoning specs if within the vegetation protection area (i.e. buffer).
    - Fish Sticks projects require a 350 ft^2 native planting at shoreline base or commitment not to mow, if the property does not comply with the shoreland vegetation protection area (i.e. buffer) specifications described in the local shoreland zoning ordinance.
- Standardized application and reporting forms and process.
- 10% of projects randomly chosen each year for self-reporting and/or professional site visits.

PROMOTION

Wisconsin's Healthy Lakes Implementation Plan will be supported and promoted as a statewide program. Lake groups, counties, towns, villages, cities, and other partners may choose to adopt and implement the Plan as is or to integrate into their own planning processes. Statewide promotion, shared and supported by all partners, includes the following:

- A Healthy Lakes logo/brand.
- A website with plan, practice, and funding detail to be housed on the Wisconsin Department of Natural Resources' and University of Wisconsin-Extension Lakes' websites. It may also include the following:
    - Link to science and supporting plans.
    - Shoreline restoration video.
    - How-to YouTube clips.
    - Tips on how to communicate and market healthy lakeshores.
    - Maps with project locations without personally identifiable information.

EVALUATION OF RESULTS

Wisconsin's Healthy Lakes Implementation Plan and results will be evaluated annually and updated in 2017, if warranted. Best practices may be modified, removed, or added depending on the results evaluation.

Lime Lake, Portage County - Robert Korth

The following information will be collected to support an objective evaluation:

- County and lake geographic distribution and participation in Healthy Lakes projects.
- Lakeshore property owner participation in Healthy Lakes projects, including numbers and locations of best practices implemented.
- Standardized Healthy Lakes grant project deliverable report including:
  - Numbers of Fish Sticks trees and clusters.
  - Dimensional areas restored.
  - Structure/floral diversity (i.e. species richness).
  - Impervious surface area and estimated water volumes captured for infiltration.

The results may be used to model nutrient loading reductions at parcel, lake, and broader scales and to customize future self-reporting options, like plant mortality and fish and wildlife observations, for lakeshore property owners.

ACKNOWLEDGEMENTS

Amy Kowalski

L to R: Patrick Goggin, Jane Malischke, Pamela Toshner, Carroll Schaal, Tom Onofrey, Dave Ferris

Wisconsin's Healthy Lakes Implementation Plan and corresponding technical information and grant funding are the results of a collaborative and participatory team effort. We would like to thank the staff, agency, business, and citizen partners, including *Advanced Lake Leaders*, who provided feedback for our team, including the many partners who completed a customer survey and provided valuable comments during the public review of proposed DNR guidance. We would like to express our gratitude to the following contributors and information sources, respectively: Cheryl Clemens, John Haack, Dave Kafura, Amy Kowalski, Jesha LaMarche, Flory Olson, Tim Parks, Bret Shaw, Shelly Thomsen, Scott Toshner, Bone Lake Management District, Maine Lake Smart Program, and Vermont Lake Wise Program.

We appreciate your continued feedback as our Healthy Lakes initiative evolves into the future. Please contact DNR Lake Biologist Pamela Toshner (715) 635-4073 or pamela.toshner@wisconsin.gov if you have comments or questions.

Healthy Lakes

FACT SHEET SERIES:

DIVERSION

http://awwatersheds.org

MAINTENANCE

COSTS

- Range: $25 – $3750 *(average = $200)*
- Healthy Lakes grant funding available: *$1000 per diversion practice*

MATERIALS

- Shovel or excavating equipment
- Clean gravel or crushed stone
- Treated lumber and rebar
- Landscaping fabric
- Seed

DNR PERMIT

A DIVERSION PRACTICE, a transition zone and upland best practice, includes a diverter, water bar, and broad-based dip. These practices use treated lumber, a shallow trench, and/or a berm to intercept runoff from a path or driveway and redirect it into a well-vegetated dispersion area or infiltration practice. Depending on the site, multiple diversion practices may be necessary.

PURPOSE

A diversion best practice redirects runoff that would otherwise move downhill into the lake to a dispersion area where it can soak into the ground. It may be used in connection with a rock infiltration or rain garden practice. By increasing the frequency of diversion practices, runoff volume can be kept low, decreasing erosion.

HOW TO BUILD

It may be necessary to work with your local land and water conservation department or a landscaper to design and/or construct this practice, particularly in regards to placement. Check with your local zoning department to determine if any permits, such as floodplain permits, are necessary.

Detailed guidance is found here: http://www.burnettcounty.com/DocumentCenter/Home/View/119.

1. Find a location

Install diverters and water bars on moderately steep paths with concentrated flows and broad-based dips across driveways not exceeding a 10% grade. Select a location where the practice outlet can drain to a stable, well-vegetated area. Install multiple diversion practices as needed and space closer together on steeper slopes as directed in the guidance.

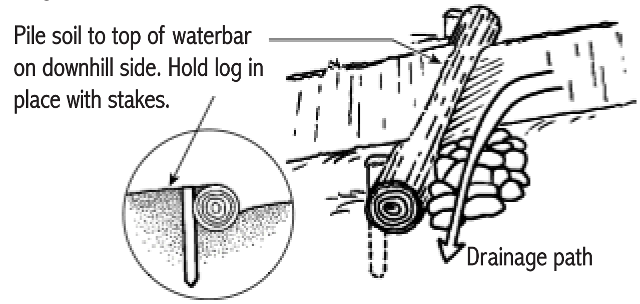
2. Size and orient the practice

The steeper the slope, the more diversion practices will be necessary. In general, diversion practices are angled 30-60° downhill across the path or driveway. Keep in mind that broad based dips, in particular, often integrate an upgradient berm and armored approach and outlet into the design so plan for these features accordingly.

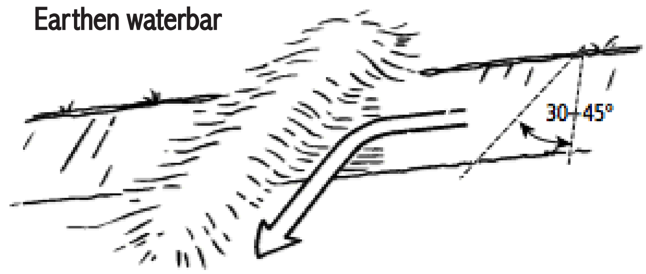
PROJECT TIMELINE

SITE PREP	INSTALLATION	PROJECT END	
< 1 DAY	1-2 DAYS	< 1 YEAR	Ongoing maintenance checks subsequent years.

Log waterbar



Earthen waterbar



3. Create a design

Sketch the design and dimensions to be sure you understand what area it will cover and how it may function or fit into your landscape. Consider the following:

- How will water flow from the practice?
- Is there adequate vegetation to capture the diverted water, or is a rain garden or rock infiltration practice necessary?
- Will the diverter or water bar be placed in an area free of motor vehicle traffic, and will the broad-based dip be able to accommodate not only motor vehicle traffic but activities such as snowplowing?

4. Lay out the best practice

Lay out the shape and boundary of the project based on the design. Before you start digging, contact http://www.diggershotline.com/.

5. Construct the practice

Install silt fence downslope of the practice location. Dig a trench that extends off both sides of the path or driveway. The trench should be deep enough that the top of the log or berm will be almost flush with the trail or driveway on its downhill side once in place. Soil and rock excavated from the trench can be heaped on the trail or driveway to be used later as backfill or a berm.

If constructing a water bar or diverter, place the log or timber in the trench. Any rot-resistant type of wood, such as cedar, spruce, fir or hemlock logs can be used for a water bar or diverter. For logs, the diameter should be at least 8" at the small end. The length should extend past the edge of the path on both sides. The log should fit snugly in the trench with no high point or voids under the log. Secure the it with large stones, rebar pins or wooden stakes. If using stones, partially bury on downhill side. If using re-bar, drill ½" holes 6" in from each edge and pound in 18" pieces of rebar so that the rebar is flush or slightly recessed with the top. Dig a 12" wide and 6" deep trench along the uphill side of the bar. Fill the trench with crushed stone, leaving a few inches of the timber exposed. Place a flared apron of stones to armor the practice outlet. Pack soil and gravel up against the downhill side of the practice so that the top of it is flush with the trail. Cover all disturbed soil with seed and mulch or leaf litter.

Broad-based dips should be rock armored on the bottom and on the berm and constructed with excavating equipment.

$ FUNDING NOTE

Healthy Lakes diversion practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

MAINTAINENCE

- Check the practice periodically and after storm events to ensure that material is not eroding behind the structure or at the outlet.
- Any needed repairs should be made as soon as possible.
- Periodically remove accumulated leaves and debris from behind the diversion practice.
- The diversion practice(s) must remain in place for 10 years if Healthy Lakes grant-funded.

LINKS

Healthy Lakes Website – http://tinyurl.com/healthylakes
Controlling Runoff and Erosion on Your Waterfront Property: A Guide for Landowners http://tinyurl.com/healthylakes
Vermont Lake Wise Program: http://www.watershedmanagement.vt.gov/lakes/htm/lp_lakewise_standards_bmps.htm
DNR Lake Protection Grants – http://dnr.wi.gov/aid/lakeclassificationprotection.html

For more information contact Pamela Toshner at 715-635-4073 or pamela.toshner@wi.gov.

WISCONSIN DEPT. OF NATURAL RESOURCES
WISCONSIN LAKES PARTNERSHIP
Design and layout by Amy Kowalski, UWEX Lakes

FACT SHEET SERIES:

FISH STICKS

Bony Lake, Bayfield County - Pamela Toshner

MAINTENANCE

COSTS

- Range: $100 – $1000 *(average = $500)*
- Healthy Lakes grant funding available: *$1000 per Fish Sticks Cluster*

MATERIALS

- Whole, live trees from outside shoreland vegetation protection area
- Cables/cabling gear
- Heavy equipment including snowplow and chainsaw
- Safety gear

DNR PERMIT REQUIRED

FISH STICKS, an in-lake best practice, are large woody habitat structures that utilize whole trees grouped together, resulting in the placement of more than 1 tree per 50 feet of shoreline. Fish Sticks are anchored to the shore and are partially or fully submerged. Fish sticks are not tree drops since the trees utilized for the projects come from further than 35 feet from shore, thus they don't "rob from the bank" of trees that may otherwise grow and fall in naturally.

PURPOSE

This fish and wildlife habitat best practice creates food, shelter, and breeding areas for all sorts of creatures from small aquatic insects, to fish, to turtles, ducks, and songbirds. Fish Sticks can also help prevent bank erosion – protecting lakeshore properties and your lake.

HOW TO BUILD

It may be necessary to work with your local DNR fisheries biologist, county land and water conservation department, or landscaper to design and/or construct this practice. Logging companies may assist with tree supply, cutting, and transportation. Check with your local zoning department to determine if any permits are necessary.

Detailed guidance is found here: http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html.

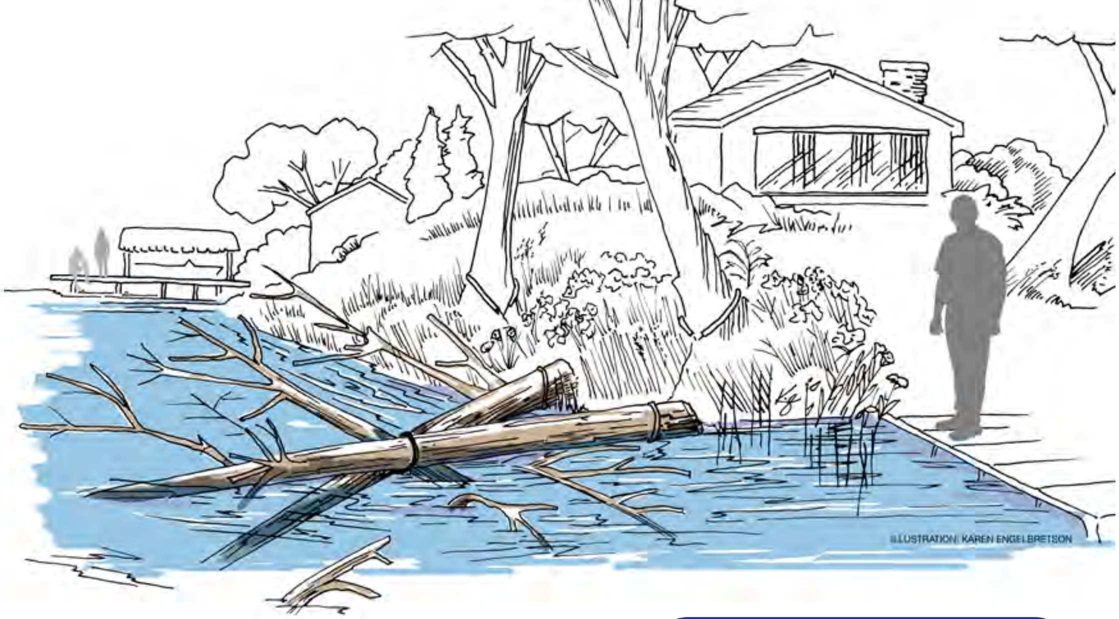
1. Find a location

Ideal Fish Sticks sites have low ice energy – places like protected bays and shorelines leading to and from bays. High ice energy areas on lakes greater than 250 acres require alternate methods that ensure they remain in place.

Typically a single Fish Sticks cluster occupies 50 linear feet of shoreline, so it should be placed on an area of your lakeshore that is not used for pier(s) or swimming. If you have a lot of frontage, you may choose to add more than a single Fish Sticks cluster.

PROJECT TIMELINE

SITE PREP	INSTALLATION	MAINTENANCE	PROJECT END
2 MONTHS	**< 1 DAY**	Spring safety check	**3 YEARS**
winter ice road			cable removal



2. Create a design

Fish Sticks structures are commonly made up of three to five whole trees. The butt ends of the trees, at the water's edge, are cabled to live trees on shore.

Sketch the design and dimensions to be sure you understand what area it will cover and how it may function or fit into your landscape. Consider the following:

- Is the water deep or shallow? Trees sink and settle with branches breaking off soon after installation, but more trees can be placed in a deepwater cluster.
- Is your lakeshore mowed adjacent to the proposed Fish Sticks site? If so, and if you would like DNR Healthy Lakes grant funding, you must commit to not mowing a 350 ft^2 area at the base of the cluster or installing a 350 ft^2 native planting.

$ FUNDING NOTE

In order to be eligible for Healthy Lakes grant funding, properties must comply with local shoreland zoning vegetation protection area (i.e. buffer) standards. If not, the property owner must commit to a 350 ft^2 no-mow zone at the base of the Fish Sticks cluster(s) or to installing a 350 ft^2 native planting.

3. Apply for a permit

The DNR recently streamlined the water regulation permits to make it easier for you to install Fish Sticks. Eligibility standards and application materials are on the DNR website http://dnr.wi.gov/Permits/Water/.

Scott Toshner

4. Lay out the best practice

Flag the area(s) along your waterfront property where Fish Sticks will be installed. This is important because most projects take place in the winter, making it more difficult to identify landscape features and location preferences.

5. Construct the practice

Installing Fish Sticks on ice is the most practical and inexpensive method. Identify an ice road and maintain with snow plowing until ice is adequate thickness for installation (18 inches). Cut live trees from outside the shoreline vegetation protection area, which is usually at least 35 feet from the water's edge. Transport and place the trees in criss-cross clusters or stacks and then cable and anchor them to a live tree on shore.

MAINTAINENCE

- Check on the site soon after spring ice out to be certain all the trees remain in place.
- The cables should be removed approximately three years after installation so they don't damage the live trees or litter the shore.
- Trees should remain in place for ten years if funded through a DNR Healthy Lakes grant.

LINKS

Healthy Lakes Website – http://tinyurl/healthylakes
Fish Sticks Guidance – http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html
DNR Lake Protection Grants – http://dnr.wi.gov/aid/lakeclassificationprotection.html

For more information contact Pamela Toshner at 715-635-4073 or pamela.toshner@wi.gov.

WISCONSIN DEPT. OF NATURAL RESOURCES

WISCONSIN LAKES PARTNERSHIP

Design and layout by Amy Kowalski, UWEX Lakes

FACT SHEET SERIES:

NATIVE PLANTINGS

Green Lake, Green Lake County - Lisa Reas

MAINTENANCE

COSTS

- Range: $480 – $2400 *(average = $1000)*
- Healthy Lakes grant funding available: *$1000 per 350 ft² area*

MATERIALS

- Black plastic or herbicide
- Native plants
- Bulb auger or hand trowel
- Mulch
- Watering equipment

DNR PERMIT

POSSIBLY REQUIRED

(if using herbicides in or adjacent to lakeshore)

NATIVE PLANTINGS, a transition zone best practice, are template planting plans designed for a contiguous area of at least 350 ft². Each template has a corresponding list of native plants suited to the given soil conditions and function of the plan, including lakeshore, bird/butterfly habitat, woodland, low-growing, deer resistant, and bare soil area plantings.

PURPOSE

Native plantings improve wildlife habitat, slow runoff water, and promote natural beauty.
Each template described above serves all of these functions to some degree, but one may be better than another given your property's unique site characteristics and areas of concern. For example, the bird/butterfly template includes flowers that attract these types of wildlife.

HOW TO BUILD

It may be necessary to work with your local land and water conservation department or a landscaper to design and/or install these plantings. Check with your local zoning department to determine if any permits are necessary. Planting specifications and densities follow Wisconsin Biology Technical Note 1: Shoreland Habitat.

Detailed guidance is found here: http://tinyurl.com/healthylakes.

1. Find a location

350 ft² native plantings should begin, if possible, at the typical lakeshore edge (i.e. Ordinary High Water Mark), be at least 10 feet wide – parallel or perpendicular to the shore, and contiguous rather than planted in patches. The final shape and orientation to the lakeshore are up to you. Choose an area of turf grass you wish to revert back to a more natural state or an already vegetated area you would like to augment. Try to choose a location in full or partial sun.

2. Determine soil type

It's important to understand what type of soil is in the planting location because that will determine which native plants can survive and thrive. The fact sheet links provide tools and guidance to help determine your soil type. Most of the template plans have two plant lists – one for moister soils and one for drier soils.

PROJECT TIMELINE

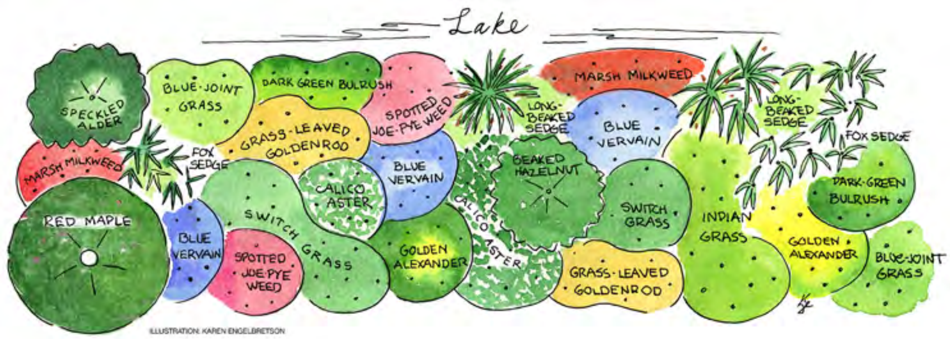
SITE PREP	INSTALLATION	MAINTENANCE	PROJECT END	
6 WEEKS - 6 MONTHS	1-2 DAYS	2 YEARS	3 YEARS	Ongoing weeding may be necessary in subsequent years.

3. Choose your template and design shape

By planning your 350 ft² native planting on paper first, you will be able to create the best appearance possible and you will understand how the practice will function and fit into your landscape.

4. Choose your plant list

Native plants are used because they are best adapted for our climate and provide ideal habitat for our wildlife. The 350 ft² native planting templates include a mixture of grasses, sedges, wildflowers, ferns, shrubs, and trees, depending on the desired function and site's soil type (i.e. dry, medium, moist, or wet).



5. Lay out the planting

Lay out the shape and boundary of the 350 ft² native plantings based on your design. Before you start digging, contact http://www.diggershotline.com/.

6. Prepare the site

Removing lawn grass is critical to native planting success. The 2 most common ways to do so are with herbicide and black plastic. Black plastic may be preferential to herbicides, especially if you are near the water, which may require a chemical control permit for herbicide use. If you already have some native plants growing, you might consider removing weeds and planting among what is already growing. The designs provided in the fact sheet links assume you are removing lawn grasses and starting from scratch.

Lay mulch or wood fiber blanket down prior to planting. This will conserve moisture and reduce weed growth within the planting area. Wood chips (2 inches deep), straw, or fallen leaves (each 3-4 inches deep) may be used as mulch.

7. Plant

Follow the design specifications by placing your plants in the approximate positions described in the template plan. Step back and look at the 350 ft² native planting area. Plants should be placed about 1.5 feet apart from each other. When ready use a hand trowel, bulb planter, or bulb auger drill bit attached to an electric drill to plant them. If grant funded, the 350 ft² native planting must be in a contiguous area. In other words, the plants cannot be put into the ground in patches.

> **$ FUNDING NOTE**
> Only one 350 ft² native planting per property per year is eligible for funding.

8. Water and critter-proof the plants

Good water techniques and maintenance are the keys to native planting success. Be ready to water them as soon as they are in the ground and to continue to water them daily for the first few weeks or until the plants are well established. Once plants are established, water only if prolonged dry periods occur. If grant funded, watering is required.

A temporary fence or animal deterrent sprays may be necessary in areas prone to deer browse, rabbits, and other critters. Fencing specifications are found in the 350 ft² Native Planting Best Practices Manual. If grant funded, fencing may be required depending on geographic location.

MAINTAINENCE

- Water the plants a minimum of 1 inch per week and more during dry periods for 1-2 years.
- Become familiar with weeds and invasive species, in particular, and remove them frequently.
- The standing dead plants may be left in place through the winter for wildlife cover and food and then cut back when new spring growth emerges.
- Native plantings must remain in place according to local zoning specifications if within the vegetation protection area (i.e. buffer).
- The 350 ft² native planting must remain in place for 10 years if Healthy Lakes grant-funded.

LINKS

Healthy Lakes Website – http://tinyurl.com/healthylakes
Controlling Runoff and Erosion on Your Waterfront Property: A Guide for Landowners – http://tinyurl.com/healthylakes
350 ft² Native Planting Best Practices Manual – http://tinyurl.com/healthylakes
DNR Lake Protection Grants – http://dnr.wi.gov/aid/lakeclassificationprotection.html

For more information contact Pamela Toshner at 715-635-4073 or pamela.toshner@wi.gov.

WISCONSIN DEPT. OF NATURAL RESOURCES
WISCONSIN LAKES PARTNERSHIP
Design and layout by Amy Kowalski, UWEX Lakes

RAIN GARDEN

Shell Lake, Washburn County - Brent Edlin

MAINTENANCE

COSTS

- Range: $500 – $9500 *(average = $2500)*
- Healthy Lakes grant funding available: *$1000 per rain garden*

MATERIALS

- Black plastic or herbicide
- Shovel or excavating equipment
- Compost
- Native plants
- Bulb auger or hand trowel
- Mulch
- Watering equipment

DNR PERMIT

A RAIN GARDEN, an upland best practice, is a landscaped shallow depression with loose soil and native plants designed to collect roof, path, and driveway runoff while also creating wildlife habitat and natural beauty.

PURPOSE

Rain gardens capture and infiltrate runoff allowing about 30% more water to soak into the ground than conventional lawn and can be used with any soil type. Rain gardens collectively protect lakes by preventing polluted runoff from entering them. They also simultaneously provide habitat for birds, butterflies, and beneficial insects and promote natural beauty. Rain gardens are designed to drain within 1-2 days, which means they won't pond water long enough to grow more mosquitos who need 7-12 days for a successful hatch.

HOW TO BUILD

Rain gardens can vary in size from 5-50% of the drainage area, depending on soil type. Rain gardens for single-family homes will typically range from 150 to 600 square feet, but even a smaller one will help reduce water pollution. It may be necessary to work with your county land and water conservation department or a landscaper to design and/or construct this practice. Check with your local zoning department to determine if any permits are necessary.

Detailed guidance is found here: http://dnr.wi.gov/topic/stormwater/raingarden/.

1. Find a location

Place the garden at least 10 feet away from your home to prevent flooding. You should try to choose a naturally occurring low spot in your yard or position the garden where your downspouts or sump pump outlet can be used to direct rainwater into your garden. A grassy swale or diversion practice may be necessary to redirect runoff water into the rain garden. Do not locate the garden over a septic field or where water already ponds. Try to choose a location in full or partial sun.

2. Measure drainage area

If you are building the rain garden in a low spot in your yard you do not need to measure the drainage area. Just ensure the area receives water regularly during a rainstorm.

PROJECT TIMELINE

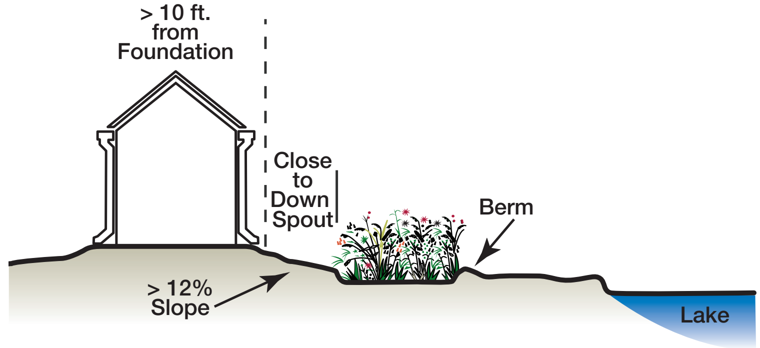
SITE PREP	INSTALLATION	MAINTENANCE	PROJECT END
1 DAY - 6 WEEKS	1-2 DAYS	2 YEARS	3 YEARS

Ongoing weeding may be necessary in subsequent years.

FACT SHEET SERIES: RAIN GARDEN

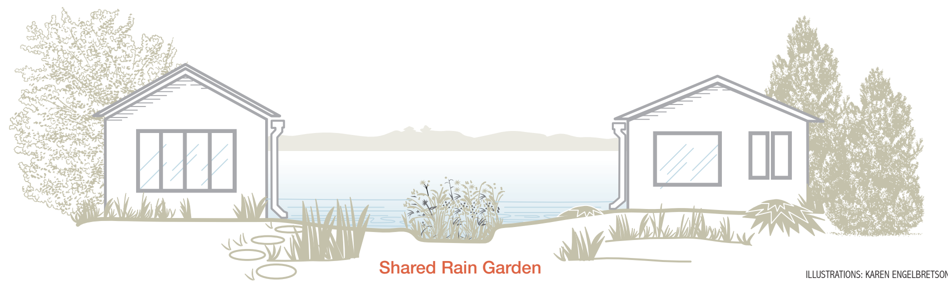
If you are capturing water from a roof or other hard surface you will need to measure the specific drainage area of that surface and multiply by the number associated with the type of soil you have. For sandy soil multiply by 10%, for loam use 20% and for clay use 45%. These numbers are somewhat inflated but they will ensure the garden holds as much water as possible.

3. Create a design
Whether your garden is large or small the same basic principles apply. By planning your garden on paper first, you will be able to create the best appearance possible for your rain garden.



4. Choose your plants
Native plants should be used because they are best adapted for our climate and provide ideal habitat for our wildlife. You will want to choose plants (flowers and grasses) that will grow well in both moist and dry areas because the rain garden will temporarily fill with rainwater from time to time.

5. Lay out the garden
Lay out the shape and boundary of the garden based on your design. Before you start digging, contact http://www.diggershotline.com/.



Shared Rain Garden

6. Dig the garden
Install silt fence downslope of where the garden will be constructed. Remove the turf grass and dig your garden approximately 6-18 inches deep for sandy soil; 6-12 inches deep for loamy soil; and 6-8 inches deep for clay soil. The bottom of the garden should be flat to evenly disperse water. Use the soil to build a berm around the garden edges if necessary. The berm must be totally level so it does not blow out.

7. Prepare the soil
Amend the soil with 2”-3” of compost. Mix in well.

8. Plant the flowers and grasses
Follow the design and place your plants in the approximate positions. Step back and look at the garden and the design. Plants should be placed about 1 foot apart from each other. Once you are satisfied you can start planting the flowers and grasses using a hand trowel.

9. Mulch the garden or plant through a wood fiber blanket
Use coarse, fibrous, shredded woodchips, straw, or leaves. Apply the mulch about 2-3 inches deep. This will help to keep the moisture in and the weeds out.

10. Water and arrange downspouts
After you’ve planted the garden, water every other day for 2 weeks if it doesn’t rain until the garden looks to be growing on its own. Good water techniques and maintenance are critical to a quality rain garden.

MAINTAINENCE

- Water the plants a minimum of 1 inch per week and more during dry periods for 1-2 years.
- Weeding is most important the first year and by the third year should no longer be necessary.
- The standing dead plants may be left in place through the winter for wildlife cover and food and then cut back when new spring growth emerges.
- The rain garden must remain in place for 10 years if Healthy Lakes grant-funded.

LINKS

Healthy Lakes Website – http://tinyurl.com/healthylakes
Rain Garden Guidance – http://dnr.wi.gov/topic/stormwater/raingarden/
Controlling Runoff and Erosion on Your Waterfront Property: A Guide for Landowners – http://tinyurl.com/healthylakes
DNR Lake Protection Grants – http://dnr.wi.gov/aid/lakeclassificationprotection.html

For more information contact Pamela Toshner at 715-635-4073 or pamela.toshner@wi.gov.

Design and layout by Amy Kowalski, UWEX Lakes

FACT SHEET SERIES:

ROCK INFILTRATION

Healthy Lakes

Deer Lake, Polk County - Cheryl Clemens

MAINTENANCE

COSTS

- Range: $510 – $9688 *(average = $3800)*
- Healthy Lakes grant funding available: *$1000 per rock infiltration practice*

MATERIALS

- Shovel or excavating equipment
- Clean crushed stone
- Landscaping fabric
- Catch basin (possible)
- Perforated drainage pipe (possible)

PERFORMANCE STANDARD

- Capture - one year 24-hour storm runoff

DNR PERMIT

A ROCK INFILTRATION PRACTICE, an upland best practice, is an excavated pit or trench filled with rock that reduces runoff by storing it underground to infiltrate. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, redirect, and pre-treat water. Pit and trench size and holding capacity are a function of the area draining to it and the permeability of the underlying soil.

PURPOSE

This infiltration best practice captures, cleans, and infiltrates runoff that would otherwise move downhill into the lake. It is appropriate for sandy to loamy soils only (not clay!) and may require a catch basin or diversion practice to redirect runoff water to it.

HOW TO BUILD

It may be necessary to work with your local land and water conservation department or a landscaper to design and/or construct this practice, particularly in regards to size and placement. Check with your local zoning department to determine if any permits are necessary.

Detailed guidance is found here: http://tinyurl.com/runoffguide.

1. Find a location

Place the practice at least 10 feet away from your home to prevent flooding. It can be placed closer to structures without basements or foundations. It should also be 50 feet from drinking water wells, especially if the well is old, and should not be placed uphill from or over a septic field. If the rock infiltration pit is backfilled/buried, a spillway outlet will be necessary; be sure the outlet drains away from the lake. Dig a hole to be certain there is at least three feet of soil depth before groundwater is reached. You will also want to be sure the soil is sandy to loamy.

The rock infiltration practice may function better if you locate it where incoming runoff first moves and cleans itself across a grassy area. Alternatively, identify a catch basin location at the base of a downspout. The gutter should lie on top of the catch basin and not be a sealed connection in the event

PROJECT TIMELINE

SITE PREP	INSTALLATION	PROJECT END	
1 DAY	1-2 DAYS	< 1 YEAR Same growing season	Ongoing maintenance checks subsequent years.

of backup. You may need to use a gutter extension to be sure the catch basin is several feet from the foundation.

2. Measure drainage area and size the practice

The size of the practice will depend on the soil type and its infiltration rate as well as the size of the surface area it drains. The fact sheet links provide some tools to measure drainage area and practice size.

3. Create a design

Sketch the design and dimensions to be sure you understand what area it will cover and how it may function or fit into your landscape. Consider the following:

- How will water flow from the practice if/when it overflows?
- Will you have adequate access to properly maintain it?
- Will it be placed in a location free of motor vehicle traffic or other activities that cause soil compaction?

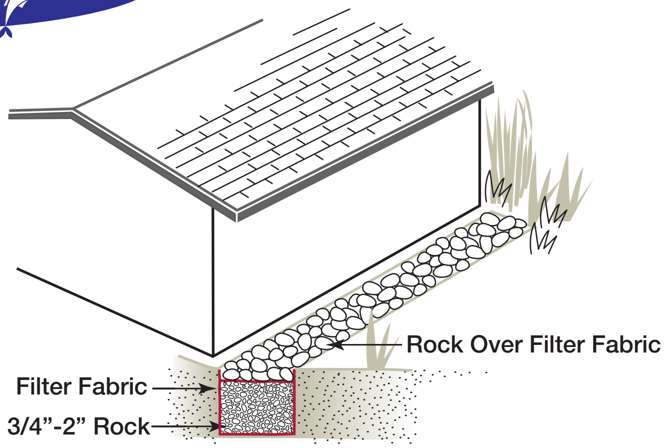


ILLUSTRATION: KAREN ENGELBRETSON

4. Lay out the best practice

Lay out the shape and boundary of the project based on the design. Before you start digging, contact http://www.diggershotline.com/.

5. Construct the practice

Install silt fence downslope of where the practice will be constructed. Dig the pit or trench in a location downslope and deep enough to drain the area calculated in Step 2. It shouldn't be deeper than 5 feet because the soil below will compact and not drain effectively. Line the trench with landscape fabric and fill with ¾-2" rock to no more than within 6" of the top of the pit. Lay filter fabric over the top and cover the remaining space with 4-6" of clean rock. The top layer of larger rock and filter fabric can be removed and replaced for maintenance and cleaning purposes.

If using a catch basin with drain tile, install the catch basin at the base of a downspout, dig a trench in a location downslope and deep enough to allow for 6-12" of stone to be placed around the drain tile. A standard trench is about 1.5 feet deep and 10-12"wide, varying based on the size of the pipe chosen (usually 4-6") and the desired depth. Line the trench with landscape fabric and place 6-12" of stone in the bottom of the trench. Install a 4" or 6" perforated drain tile and surround the pipe with stone and then backfill with soil. The landscape fabric should be wrapped all of the way around the stone to prevent mixing of the surrounding soil into the stone. This will keep the porous spaces in the stone open for the water to flow through. The trench should be sloped enough to move water through the drain tile to the desired destination and have an outlet at the end for extreme storm events.

$ FUNDING NOTE

Healthy Lakes rock infiltration practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

MAINTAINENCE

- Mark the location of the practice above the ground, if it is backfilled, to avoid compaction, and do not drive across the area.
- Remove materials like leaves and pine needles that collect on top of the system and in/around the catch basin and/or overflow pipe.
- Inspect the practice and remove, wash and/or sift, and replace surface layer rock as necessary. If filter fabric is used to line the bottom of the practice, the smaller rock may also need to be removed and washed to clean out accumulated sediment.
- The rock infiltration practice must remain in place for 10 years if Healthy Lakes grant-funded.

LINKS

Healthy Lakes Website – http://tinyurl/healthylakes
Controlling Runoff and Erosion on Your Waterfront Property: A Guide for Landowners http://tinyurl.com/runoffguide
Vermont Lake Wise Program: http://www.watershedmanagement.vt.gov/lakes/htm/lp_lakewise_standards_bmps.htm
DNR Lake Protection Grants – http://dnr.wi.gov/aid/lakeclassificationprotection.html

For more information contact Pamela Toshner at 715-635-4073 or pamela.toshner@wi.gov.

Design and layout by Amy Kowalski, UWEX Lakes

Appendix C

Advisory Committee Meeting Materials

MEETING AGENDA

Re: Chetek Lakes Comprehensive Lake Management Planning: Advisory Committee Kickoff Meeting

Date of Meeting: May 23, 2013

Project Manager: Jacob Macholl

Time of Meeting: 4:30 - 6:30 PM

SEH No.: CHLPA 124347

Location of Meeting: Wieckowicz Law Office
325 Knapp Street
Chetek, WI 54728

Invitees:

Jennifer Blatz, Chetek Chamber of Commerce
Troy Bol, Sugar Bol Farms
Tyler Florczak, The Chetek Alert
Tyler Gruetzmacher, Barron County
Frank Keller, Resort Owners Assoc.
Dan Knapp, City of Chetek
Jacob Macholl, SEH, Inc.
Earl Novotney, Edina Realty
John Plaza, Chetek Lakes Protection Assoc.
Neil Rafferty, Gopher Point Homeowners Assoc.
Jack Schnell, Chetek Lakes Protection Assoc.
Alex Smith, Wisconsin Dept. of Natural Resources

Please review the attached project plan document prior to the meeting. The following items are to be discussed at the above referenced meeting:

I.	Welcome and introductions	(Schnell)
II.	Overview of project objectives, deliverables and work plan	(Macholl)
III.	Needs and visions of project partners	(Group)
IV.	Define assignments	(Macholl)
V.	Revise work plan and timeline as appropriate	(Group)
VI.	Key success factors	(Macholl)
VII.	Discuss project communications	(Macholl)
VIII.	Question and answer session	(Group)
IX.	Summary	(Macholl)

If there are errors contained in this document, or if relevant information has been omitted, please contact Jacob Macholl at 715.861.1944 or jmacholl@sehinc.com.

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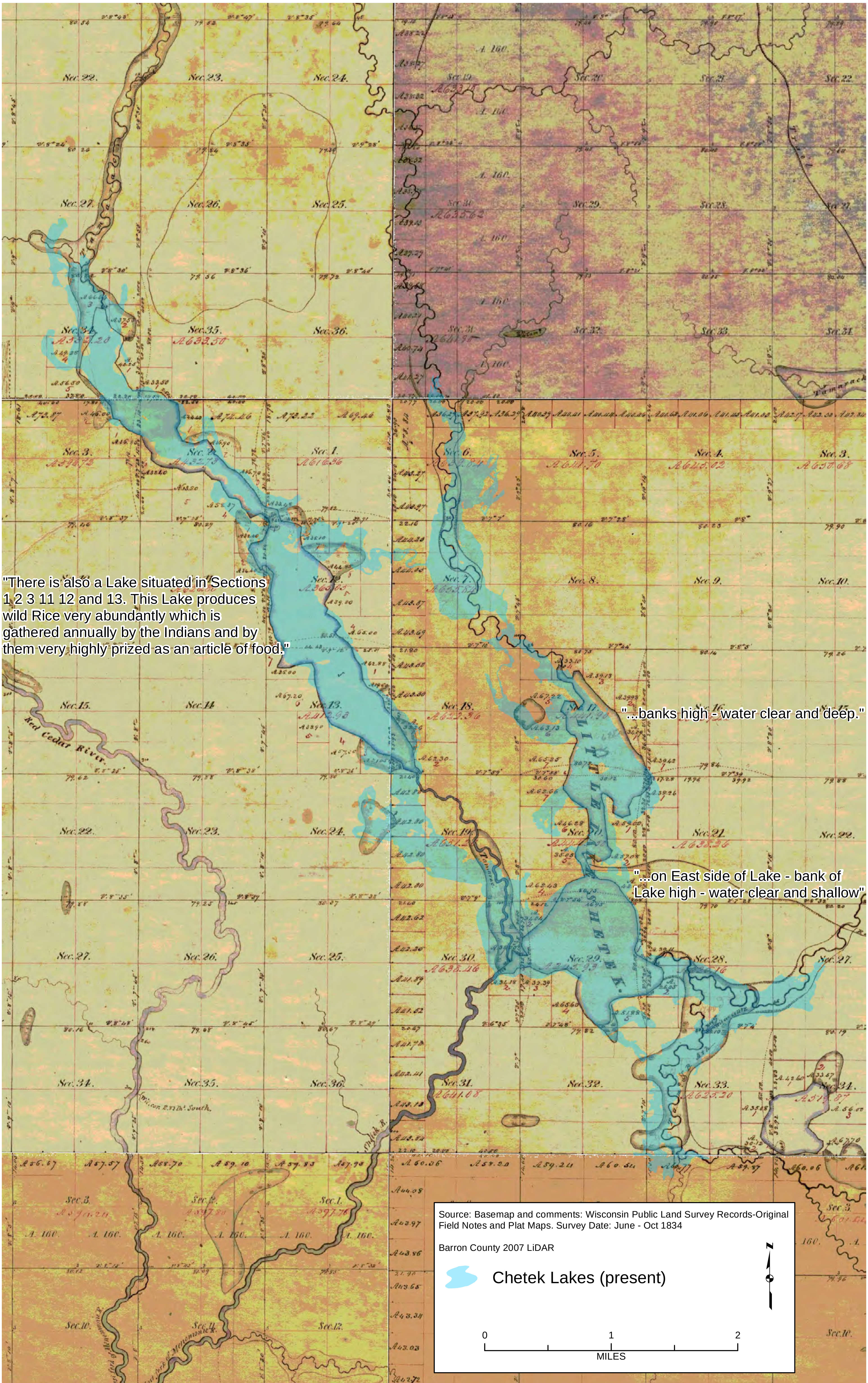

"There is also a Lake situated in Sections 1,2 3 11 12 and 13. This Lake produces wild Rice very abundantly which is gathered annually by the Indians and by them very highly prized as an article of food."
"...banks high - water clear and deep."
"...on East side of Lake - bank of Lake high - water clear and shallow"
Source: Basemap and comments: Wisconsin Public Land Survey Records-Original Field Notes and Plat Maps. Survey Date: June - Oct 1834
Barron County 2007 LiDAR
Chetek Lakes (present)
0
1
2
MILES
Red Cedar River

Chetek Lakes Comprehensive Lake Management Planning Project

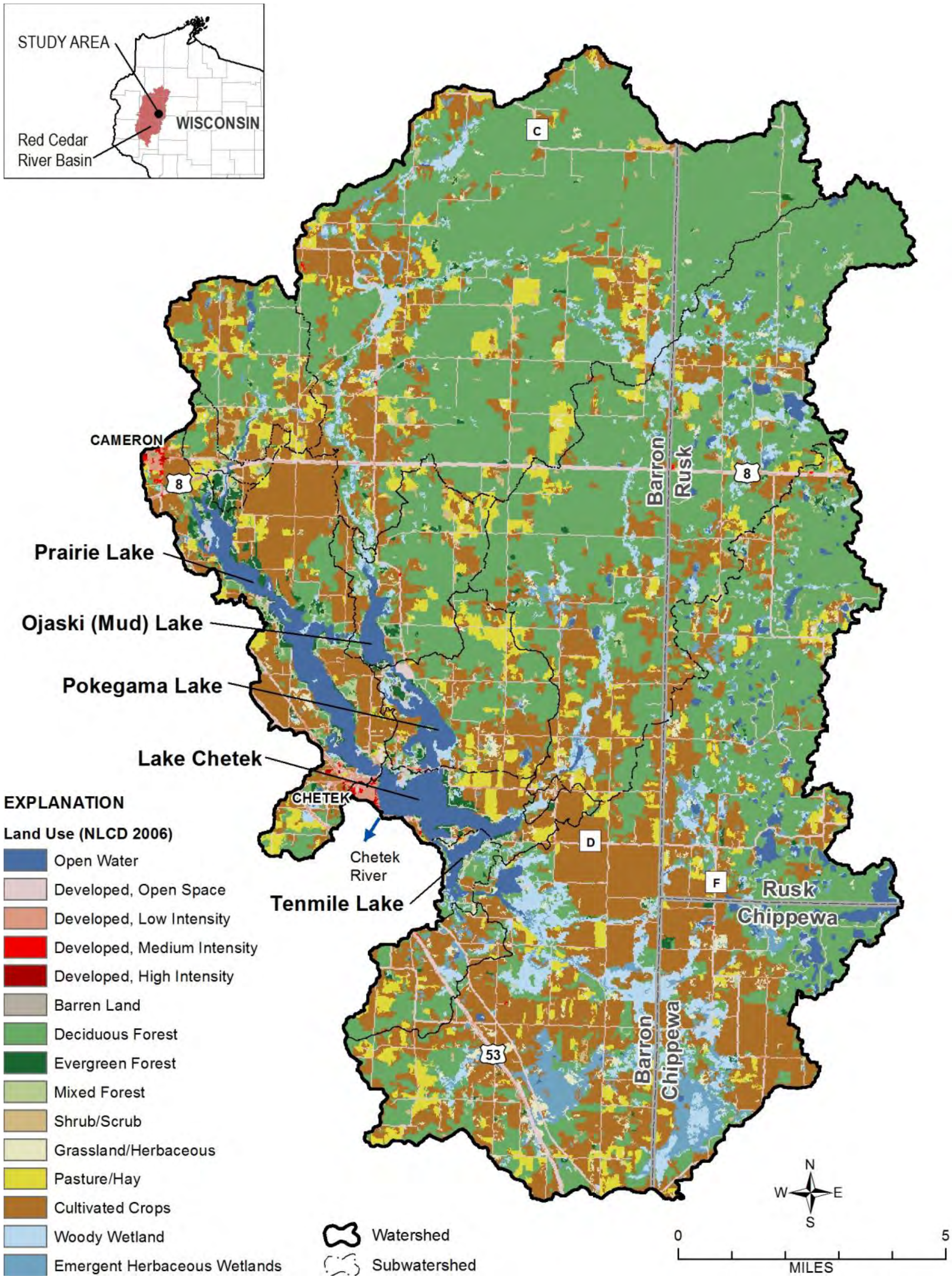
Project Plan

Exerpt from
February 2013 Grant Application

SEH No. CHLPA 124347

May 23, 2013

Project Location and Boundaries—The Chetek Lakes Watershed



1.0 Description of Project Area

The Chetek Lakes – Chetek, Ojaski (Mud), Pokegama, Prairie, and Tenmile – are a chain of lakes in south eastern Barron County. This project includes the Chetek Lakes and its watershed. All of the lakes are well-developed with the City of Chetek located along the shores of Lake Chetek. Together they have a surface area of more than 3,700 acres, with more than 60 miles of shoreline. The mean depth in all five lakes is 8.6 feet ranging from 4 feet in Ojaski Lake to 13 feet in Lake Chetek. The maximum depth averages 16.8 feet and ranges from 12 feet in Tenmile Lake to 22 feet in Lake Chetek. The lakes are used for recreational purposes including water-skiing, fishing, and boating. There are more than 30 resorts and other facilities providing lodging to support seasonal tourism that is so important to the community and surrounding area. There is a public beach, and two church camps also associated with the lakes.

2.0 Description of Problem to be Addressed by Project

The Chetek Lakes are a very productive (nutrient rich) system. A long history of excessive nutrients has lead to an ongoing problem of nuisance algal blooms, particularly in the many small, shallow bays located throughout the lakes. Cyanobacteria blooms throughout the growing season make many bays nearly unbearable to property owners and lake users and are the source of many concerns. Concerns about the severely degraded water quality are also raised by the businesses that rely on the tourism industry. The Chetek Lakes are listed on the Wisconsin “Impaired” water list for total phosphorous levels and eutrophication caused by non-point sources. This designation means that the lakes are not meeting their expected uses due to impaired water quality.

Historic management activities have treated the symptoms of over-fertilization (excessive algae and excessive plant growth) rather than the cause (non-point and in-lake sources of nutrients). The rehabilitation of the Chetek Lakes requires many activities including monitoring and management of aquatic invasive species (AIS), native plant restoration, and the implementation of Best Management Practices (BMPs) and Agricultural Conservation Practices (ACPs) throughout the watershed.

The Chetek Lakes Protection Association (CLPA) is a local non-profit volunteer-based organization whose vision is to preserve and protect the Chetek Lakes and their surroundings and to enhance the water quality, fishery, boating, safety, and aesthetic values of the Chetek Lakes as a public recreational facility for today and for future generations. In 2011 the CLPA received a Wisconsin Department of Natural Resources Aquatic Invasive Species Grant to complete an Aquatic Plant Management (APM) Plan for the Chetek Lakes. Through the development of the APM Plan, the need for a Comprehensive Lake Management Plan became evident and was a primary recommendation in the APM Plan. A previous Lake Management Plan completed in 1999 for the Chetek Lakes also recommended the completion of a Comprehensive Lake Management Plan.

This project will complete a Comprehensive Lake Management plan for the Chetek Lakes to address the poor water quality currently afflicting the lakes. The management plan will further prioritize lake management needs set forth in the APM plan and set goals and specific objectives for the long-term management of the Chetek Lakes and its watershed. Human recreational uses, the fishery and other biological uses will be considered in the plan.

3.0 Discussion of Project Goals and Objectives

The goal of this project is to complete a Comprehensive Lake Management Plan for the Chetek Lakes. Data will be compiled and incorporated from a number of sources including the 1999 Chetek Lakes Management Plan, the 2012 Chetek Lakes Aquatic Plant Management Plan and data collected in conjunction with development of that plan (including the public input survey, watershed-wide stream water quality synoptic surveys, and a watershed land use analysis completed by Barron County), and data collected during 2012 and as part of this project.

Objectives include compiling existing data and incorporating it into the plan, identifying lake improvement projects throughout the watershed, establishing a willingness to participate in these projects by the agricultural, residential, and urban community, and assessing the cost and feasibility of multiple projects aimed at improving or enhancing water quality and lake use.

4.0 Description of Methods and Activities

Only Lake Chetek is considered a deep lake and the others can be classified as shallow lakes. Shallow lakes generally exist in one of two alternative states: the algae-dominated turbid water state and the plant-dominated clear water state. Each alternative state can persist over a wide range of nutrient concentrations. Aquatic plants can dominate without threat at total phosphorus concentrations below about 25 to 50µg/L (or total nitrogen below about 250 to 500 mg/L). At total phosphorus levels greater than about 50 µg/L, such as found in the Chetek Lakes, either plant- or algae-dominated systems can exist, though at these higher nutrient levels there is a greater risk of the system switching from plant to algae dominance.

The steps for shallow lake restoration follow a series of graded steps[1]:

1. Forward switch detection and removal
2. External and internal nutrient control
3. Restructuring the ecosystem by a reverse switch (biomanipulation)
4. Plant establishment, including wetland fringe
5. Stabilizing and managing the restored system

This project will address each of these steps to develop a comprehensive lake management plan to improve the Chetek Lakes and its watershed. This plan will be a comprehensive assessment and management strategy for in-lake and watershed pollution sources, emphasizing sediment and phosphorus sources.

4.1 Data Inventory

Previous studies of the Chetek Lakes and their watershed (identified in section 3.0 above) collected much of the information needed to develop a comprehensive management plan including:

- identification of the need for rehabilitation and restoration;
- a characterization of the lakes historic and current water quality and habitat conditions;
- an assessment of the watershed including nutrient loading and sources;
- a determination of lake uses and issues.

[1]Moss B., Madgwick J., and Phillips G., 1996 A Guide to the Restoration of Nutrient Enriched Shallow Lakes. Environment Agency, Broads Authority & European Union Life Programme, Norwich.

Additional information to be compiled in the inventory include: the institutional framework (i.e., the geographic extent and functional responsibilities of civil divisions and special-purpose units of government), a comparison of existing and future land uses and estimated annual phosphorus loads, a determination of other watershed characteristics (e.g., geology, soil types and characteristics, slopes, hydraulic connectivity), an assessment of the lakes fishery and habitat, an update and evaluation of water quality trends, and further evaluation of the extensive public input survey completed in 2011 with a focus on water use, expectations, and objectives.

Aquatic plant info will include results from cyanobacteria monitoring completed in 2010 and 2011 by CLPA volunteers as part of the Freshwater Phytoplankton Monitoring Network project sponsored by the Centers for Disease Control, Mote Marine Laboratory, and the National Oceanic and Atmospheric Administration. CLPA volunteers took surface water samples and looked for five toxin-producing classes of phytoplankton every other week. Volunteers tracked the species, took photographs, submitted data via computer, and mailed samples of interest to the FPMN for further evaluation. The CLPA involvement was a direct response to the severity of algae growth on the lakes in2009.

The fishery is very important for lake users and drives much of the local economy. The fishery assessment completed during this project will be a comprehensive review of the WDNR goals and objectives regarding the Chetek Lakes and includes a meeting with the WDNR fishery biologist for the lakes. The primary objective of this inventory is to determine the fishery goals for the Chetek Lakes, what the short term and long term plans for the lakes entail, what drives management activities (e.g. what are the implications of the soon to be completed creel survey), how the lakes are managed (as individual waterbodies or as a group), what are the WDNR's needs (surveys, data), and identify the areas of the lake are deemed high value for the fishery (historic spawning habitat maps will be updated and digitized to aid in management decision making).

Existing fishery management goals and objectives will be summarized and presented to the Advisory Committee (see section 4.5 below) and incorporated into the comprehensive planning. The tributary fishery goals and issues as they relate to trout streams in the watershed will also be reviewed and incorporated into the comprehensive plan (for example, over 300 feet of continuous cattle-trampled stream bank was documented along a Class 1 trout stream in the summer of 2012).

The data inventory will provide the foundation for the analysis of alternative management actions.

4.2 Analysis of Alternative Management Actions

A feasibility analysis of management measures to reduce nutrient loading and improve water quality and habitat in the lakes and watershed will be completed that considers those alternatives which are applicable to the Chetek Lakes and their watershed. The alternatives analyzed will be based on the lake and watershed inventory. Watershed and in-lake alternatives to be evaluated include maintain the status quo, land use and land cover management (e.g., BMPs and ordinances), water-level management, fishery management, institutional development, and other alternatives as outlined in the Itemized Expenses and that may arise following the inventory. Cost estimates for specific alternatives may be determined to aid in assessing applicability and funding sources.

4.3 Proposed Management Actions and Implementation Plan

A list of proposed management actions that will be implemented to achieve objectives and targets will be developed from the alternatives analysis. Previous near-shore studies (e.g., the land use/cover mapping shoreline survey completed as part of aquatic plant management planning) will be used to develop a shoreland restoration and protection program which includes the restoration need and potential actions. An implementation plan will be developed that includes a recommended timeline of key events, responsible parties, and potential funding sources.

4.4 Development of Comprehensive Management Plan

The data, information, and public input gathered during the inventory and management planning portion will be compiled into a report titled *A Comprehensive Management Plan for the Chetek Lakes*. A draft will be presented to the public at an open meeting and public comment will be addressed for development of the final plan. The final plan will be submitted to appropriate entities including the CLPA and the WDNR for approval and determination of funding eligibility.

4.5 Advisory Committee Meetings

The Chetek Lakes system has a number of parties interested in improving the water quality of the lakes. An advisory committee consisting of members from the CLPA, the agricultural community, the Chetek Area Chamber of Commerce, the Chetek Resort Owners Association, and the City of Chetek, the WDNR ,and other involved parties will be formed and meet on a quarterly basis to discuss objectives, outcomes, and plan direction. The first meeting will be a project kick-off to discuss available information, further define the project timeline, and discuss the management strategy and expected outcomes of the project. Subsequent meetings will discuss planning progress, compiled and new information and implications to the management strategy, and other relevant concerns and findings. The final meeting will focus on public comment regarding the plan.

4.6 Historical control actions

There is a long history of chemical control in the Chetek Lakes with records dating back to the 1940s. Up to the 1980s, thousands of pounds of copper sulfate were used for algae control. There are some areas of the lake in which copper levels are inhibiting or preventing aquatic macrophyte growth. CLPA volunteers will go through the WDNR Aquatic Nuisance Control files for the Chetek Lakes (2 file boxes of documents) and map the locations and amounts of herbicide and algaecide used throughout the lakes to identify potential copper sulfate hot spots. These data will be entered into a GIS for management and analysis. An open source GIS such as MapWindow may be used by volunteers to digitize application locations.

4.7 Watercraft Inspection and Aquatic Invasive Species Monitoring

The Chetek Lakes currently have known infestations of curly-leaf pondweed, purple loosestrife, and Japanese knotweed. Eurasian watermilfoil has not been found in the lakes following extensive surveying in 2011. To contain those aquatic invasive species present and prevent the introduction of new aquatic invasive species, the CLPA will complete at least 200 hours of watercraft inspection following the UW-Extension Clean Boats—Clean Waters guidelines at public launches around the lakes. It is expected that this time will be generated by volunteers, but paid inspectors may also be hired for monitoring. Monitors will also examine signage and information kiosks and report to the CLPA with any updates or repairs that may be required.

CLPA volunteers will complete aquatic invasive species monitoring following the guidelines established by the UW-Extension Lakes Citizen Lake Monitoring Network. At least 5 teams of volunteers will monitor for AIS including Eurasian watermilfoil, purple loosestrife, Japanese knotweed, zebra mussels, and rusty crayfish. Monitoring events and results will be recorded in the WDNR SWIMS database by CLPA volunteers.

Curly-leaf pondweed bed and distribution mapping will be completed in June 2013 in each of the Chetek Lakes. Volunteers or paid resource professionals will record curly-leaf locations using a handheld GPS unit. Bed and high density area (as defined in the 2011 aquatic plant surveys) boundaries will be delineated using the GPS and clusters of plants or individual plants will be marked with a point.

4.8 Photo-documentation

Due to the sandy nature of the watershed, most runoff events are short-term and the result of spring runoff or high intensity rain events. There are a few areas in the watershed that have been photographed during spring runoff and large rain events showing excessive runoff. This project will attempt to photo-document the entire watershed during spring runoff and large events (>1 inch of rain in 12 hours) with a focus on the lakes' near-shore area and major tributaries. CLPA volunteers will drive around the watershed and boat around the lakes taking photographs of high flow areas; sheet, rill and gully flows; and other areas of concern. The locations of photographs will be documented using a GPS or text description. Photographic evidence can provide valuable information for site selection and planning for BMPs and ACPs.

4.9 Stream Crossing and Culvert Survey

CPLA volunteer groups will identify stream crossings and culverts throughout the Chetek Lakes watershed. This survey will determine the location of culverts and bridges (both public and private including driveways) in the watershed. Site locations will be recorded using a handheld recreational grade GPS (e.g. Garmin) and a text description. Other variables to be collected include the culvert shape and diameter, flow direction, a basic determination of ecological barrier status (e.g., hydraulic drop and countersink status).

4.10 Water Quality Monitoring

Volunteers will take temperature and dissolved oxygen profiles at 19 sites two times in mid-winter (February) and at 7 sites in early (Dec-Jan) and late winter (March), conditions permitting. Temperature and dissolved oxygen will be measured at 7 sites every two weeks from April through October (growing season).

Measurements will be taken with a Hach water quality probe at maximum intervals of 1.5 feet. In shallow sample sites (≈6 feet or less), a measurement will be taken at the water surface (probe submerged, ≈6 inches below water surface) at 1 to 1.5 feet above the lake bed and at the mid-point of these measurements. Secchi disk measurements will be taken in conjunction with the growing season profiles. All data will be entered into the SWIMS database by volunteers.

4.11 Dialogue with Agricultural Community

The CLPA will open and maintain a dialogue with agricultural producers in the watershed. A meeting between members of the CLPA and at least 5 agricultural producers will be facilitated by Karl Hakanson, Red Cedar River Project Coordinator with River Country Resource Conservation and Development or if necessary Barron County, the WDNR, or another resource. As a community driven effort, CLPA volunteers will invite 3 to 5 of the primary agricultural producers (identified through existing contacts) in the watershed to the meeting.

The primary discussion will be to determine what the agricultural community is already doing, what they might be willing to do, what limitations exists (e.g. funding, technical assistance), and what it would take to implement best management practices (BMPs) and agricultural conservation practices (ACPs) to improve water quality conditions in the watershed. This is not intended to be a technical forum, but rather a discussion of the needs, wants, and expectations of the Chetek Lakes watershed community. The agricultural community will be invited to submit proposals for funding projects that benefit water quality, wildlife habitat, and recreation such as stream buffers, cattle crossings, and nutrient management plans. The agricultural community will also be invited to share projects that have been completed which may be showcased on the CLPA website and in newsletters.

5.0 Description of Project Products or Deliverables

The primary deliverable of this project will be a Comprehensive Lake Management Plan in paper and digital format. The report will be comprised of a lake and watershed inventory section and a management planning section. The inventory section will include a summary of past and current data and analyses of the watershed and of lake water quality, biota, and water use. The management planning section will include an alternatives analysis, recommended management actions including a water quality monitoring strategy, and an implementation plan that includes a proposed timeline of events, responsible parties, and potential funding sources for recommendations.

6.0 Description of Data to be Collected

The Data Inventory will compile information from Barron County, state and national sources (e.g. the SSURGO database), and previous studies completed in the lakes and watershed see the Itemized Breakdown of Expenses for an outline of the information to be collected and analyzed). The current and future land use information will be obtained from Barron County 2010-2030 Comprehensive Plan, tabulated, and standard runoff coefficients will be used to determine estimated future phosphorus loading in the watershed. Environmentally sensitive areas in the watershed will be identified using data collected by volunteers and from Barron County (e.g. potentially restorable wetlands and seasonal drainage ways). The nutrient budget (updated as part of the aquatic plant management planning project in anticipation of comprehensive planning) and partitioned subwatershed loads will also be included in the Data Inventory.

Temperature and dissolved oxygen profiles will be collected throughout the year to further define stratification (specifically to determine stratification period, depth and relative thermal resistance to mixing) in the Chetek Lakes. These data will be used to evaluate hypolimnetic withdrawal as a management alternative, fill a data void (there are little data pertaining to winter conditions in the Chetek Lakes), and provide habitat information for fishery management. Secchi monitoring will continue long-term data collection for developing seasonal and annual trends.

Stream crossing and culvert survey data will be used to evaluate the hydrologic connectivity of the Chetek Lakes watershed. These data can also provide valuable information for developing a hydrologically conditioned high-resolution digital elevation model (DEM) for the Chetek Lakes watershed. Barron County currently has LiDAR elevation data, but the data are not conditioned to represent actual flow across the landscape by removing "digital dams." The culvert survey will be used to correct the LiDAR DEM in the watershed. The conditioned DEM will be used to and indentify surface runoff patterns and steep slopes. High-resolution hydrologically condition DEMs have many applications, including predicting locations of concentrated water flows and of field gully erosion; finding depressional areas for potential water storage to reduce runoff, flooding, and sediment loads; targeting best management practices; and prioritizing restoration and protection projects.

Maps and data related to historical algae control (focused on copper sulfate usage) will be used to identify areas that may not be able to support aquatic plants based on adverse amounts of copper sulfate. These areas could require sediment sampling in the future to determine the best approach for management (for example, hazardous materials disposal).

Interest levels within the agricultural community for implementing BMPs and ACPs will be determined from the facilitated meeting and subsequent dialogues. Interest levels will help focus and guide future project selection for implementation. The meeting will also collect information for designing and implementing communication, education, and outreach programs. This activity will provide the CLPA with the opportunity to further develop partnerships with the agricultural community in the watershed. Future meetings will be encouraged and could include technical professionals to discuss BMPs that work to protect surface water quality, the effectiveness and relative cost of best management practices, and cost-sharing and funding sources for implementation.

Curly-leaf pondweed mapping will be used to track the distribution of curly-leaf (recommended in the Aquatic Plant Management Plan) and guide potential aquatic plant management activities. Results of the mapping will be stored in a GIS for management, analysis, and ease of sharing.

7.0 Description of Existing and Proposed Partnerships

The Chetek Lakes Protection Association works closely with Barron County Zoning and Land Conservation, the City of Chetek, local townships, local clubs and organizations, and the WDNR to plan and implement lake management activities. These partnerships will continue and be further developed during and beyond this project. It is anticipated that a stronger partnership will be developed with the agricultural community in the watershed and with the Natural Resources Conservation Service to assist with activities in this agriculturally-dominated watershed. The Chetek Lakes Protection Association will continue to solicit additional input from lake residents, both those who are and those who are not current members of the lake association.

8.0 Discussion of Role of Project in Planning and/or Management of Lake

This project will complete a Comprehensive Lake Management Plan for the Chetek Lakes as recommended in the 1999 Lake Management Plan and the 2012 Aquatic Plant Management Plan. This Plan will guide future management of the Chetek Lakes and its watershed. It will incorporate and evaluate new findings along with recommendations and activities presented in previous investigations.

This project implements specific recommendations from the Barron County 2011 Land and Water Resource Management Plan, including Clean Boats—Clean Waters monitoring, encouraging the development of wildlife corridors, and working with farm operators to reduce runoff and cattle access to streams. Results from this project, including recommendations and successful workflows, will be incorporated into the next update of the Barron County Land and Water Resource Management Plan. For example, Barron County has expressed great interest in fully utilizing the conservation planning capabilities of LiDAR data, which will be greatly enhanced by the stream connectivity survey and resulting DEM conditioning. The county will also be provided with an overlay of agricultural lands, steep slopes, and highly erodible soils to target farms for implementation of farm plans and resource management systems.

The Barron County 2010-2030 Comprehensive Plan has identified the following issues related to the quality of lakes, streams, rivers, wetlands, and groundwater: topsoil erosion, lakeshore erosion, the fragmentation of the riparian and littoral corridors, and eutrophication in some of the area lakes. These concerns are shared by the CLPA and addressed in this project for the Chetek Lakes watershed.

9.0 Timetable for Implementation of Key Activities

This project will be completed by 30 April 2014 with the majority of the field work completed in 2013. Monitoring will be done during the 2013 growing season and during winter 2013/14. It is anticipated that the Data Inventory will begin upon reward of the grant and will continue as information is collected throughout the project. Management planning will be ongoing as data becomes available, but will begin in earnest following the 2013 field season. Planning and outreach will be an ongoing process throughout the project.

Preliminary Timetable

	2013									2014			
Activity	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Advisory Committee Meeting		■			■				■			■	
AIS and Watercraft Inspection		■	■	■	■	■							
Water Quality Monitoring	■	■	■	■	■	■	■			■	■	■	
Photo-documentation	■	■	—rain events—									■	■
Stream Crossing Survey		■	■	■									
Dialogue with Ag Community									■				
Presentation: Draft plan												■	
Presentation: Final Plan													■

10.0 Plan for Sharing Project Results

All required records, data results and other information will be included in the deliverables. The CLPA website, newsletters and meetings will keep the community and stakeholders informed on the progress of this project and offer education and outreach opportunities to enhance local understanding of the water quality and factors which affect the lakes. The Comprehensive Lake Management Plan will be completed and delivered to the CLPA, Barron County, and the WDNR in paper and digital copy. The digital copy will include findings and maps and all related GIS files. Pertinent data will be entered into the SWIMS database. The CLPA will seek WDNR approval of plan recommendations and a determination of Lake Protection Grant eligibility.

MEETING AGENDA

Re: Chetek Lakes Comprehensive Lake Management Planning: Advisory Committee Meeting 2

Date of Meeting: September 26, 2013

Project Manager: Dave Blumer

Time of Meeting: 4:30 - 6:00 PM

SEH No.: CHLPA 124347

Location of Meeting: Wieckowicz Law Office
325 Knapp Street
Chetek, WI 54728

Invitees:

Jennifer Blatz, Chetek Chamber of Commerce
Troy Bol, Sugar Bol Farms
Tyler Florczak, The Chetek Alert
Tyler Gruetzmacher, Barron County
Frank Keller, Resort Owners Assoc.
Dan Knapp, City of Chetek
Jacob Macholl, SEH, Inc.
Earl Novotney, Edina Realty
John Plaza, Chetek Lakes Protection Assoc.
Neil Rafferty, Gopher Point Homeowners Assoc.
Jack Schnell, Chetek Lakes Protection Assoc.
Alex Smith, Wisconsin Dept. of Natural Resources

Please review the attached project plan document prior to the meeting. The following items are to be discussed at the above referenced meeting:

I.	Welcome and introductions	(Schnell)
II.	Overview of project objectives, deliverables and work plan	(Macholl)
III.	Needs and visions of project partners	(Group)
IV.	Nutrient sources to the lakes	(Macholl)
V.	Management units in the watershed and roles	(Macholl)
VI.	Water quality goal development	(Group)
VII.	Question and answer session	(Group)
VIII.	Summary	(Macholl)

If there are errors contained in this document, or if relevant information has been omitted, please contact Jacob Macholl at 715.861.1944 or jmacholl@sehinc.com.

c:\users\jmacholl\workspace\lakes\chetek\comprehensive planning\project management\meeting agenda - clm planning meeting 2 sept 26 2013.docx

From:	John Plaza
To:	jmacholl@sehinc.com
Cc:	Tyler; 'Alex Swanson'; 'Augie Bleske'; 'Bill Hackett'; 'Donald Freeman'; 'Jack Schnell'; 'Kristina Olson'; 'Mike Steiner'
Subject:	Runoff 4-4-2013
Date:	04/04/2013 09:12 PM

Taken 6 PM on 4-4-2013 at South end of 24 ¾ St. West of M. Water is pouring out of this field into a culvert and then into the lake. I'm sure with 1000s of gallons of water we are also introducing a great deal of chemicals.

Videos:

http://youtu.be/7Ua3_qwAuKk

http://youtu.be/XDZ5GHx_k78

Photos:

http://youtu.be/HxC-9TCiCig

Regards,

John

Chetek Lakes Watershed 2012 Synoptic Sample Survey Results

Submitted to the Chetek Lakes Protection Association
and the
Barron County Soil & Water Conservation Department

Prepared by:

Dave Blumer: Project Manager/Lake Scientist
Jacob A. Macholl: Lake Scientist
Short Elliott Hendrickson Inc
1701 W. Knapp Street, Suite B
Rice Lake, WI 54868-1350

April 5, 2013

1.0 Introduction

The Chetek Lakes are a chain of lakes (Chetek, Ojaski, Prairie, Pokegama, and Tenmile Lakes) in southeast Barron County, Wisconsin created by the impoundment of Pokegama Creek, Moose Ear Creek, and Tenmile Creek. The Chetek Lakes are on the 303(d) list of impaired waters due to eutrophication caused by excessive phosphorus. A synoptic water quality survey was completed for analysis of nutrients and other substances to characterize background nutrient, sediment, and pollutant loading in the Chetek Lakes Watershed. The objective of the synoptic sampling was to determine the total amount or load of various nutrients, sediment and pollutants that move past a monitoring station during a particular period of time. To approximate growing season baseflow loads of these constituents, water quality samples were collected during in the early and late part of the growing season and averaged.

The data collected will aid with targeting areas where pollution and erosion are disproportionately severe and the potential for improving water quality and preventing soil loss is disproportionately great. The information collected also provides a snapshot of the watershed to evaluate the effectiveness of management activities over time. Funding for the sample collection was provided by a WDNR lake grant and in-kind volunteer match provided by the Chetek Lakes Protection Association and Barron County provided the funding for data analyses.

2.0 Methods

A total of 29 sites were selected to be sampled in June and September throughout the Chetek Lakes watershed. Sites were selected based on changes in land use/cover in the stream's watershed, accessibility, and distribution about the Chetek Lakes watershed. Sampling was undertaken at least 4 days after rainfall events totaling more than 0.25 inches to ensure baseflow conditions. Mr. Mike Steiner and students from the Chetek Environmental Charter School collected water quality samples and streamflow was measured by SEH using either a SonTek FlowTracker or Marsh-McBirney Flo-Mate velocimeter following the U.S. Geological Survey 6/10 depth method.

Grab samples were collected at the upstream end of a bridge or culvert crossing to avoid the possible effects of roads, bridges, or scour pools on water quality, unless it was safer to sample at the downstream end. The location of sampling with respect to the crossing was documented at each site. The samples were collected just below the water surface at mid-stream. Samples were stored on ice and shipped to the Wisconsin State Lab of Hygiene for analysis of chloride, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus (TP), dissolved reactive phosphorus, and total suspended solids (TSS). The total nitrogen (TN) was calculated as the sum of the total Kjeldahl nitrogen, ammonia, and nitrate+nitrite. Results reported as below detection limits were substituted with one-half the detection limit for analysis. Stream flow measurements were taken at the time of sample collection using the float method and using a flow meter following the 0.6-depth method.

Reference concentrations, also referred to as background (natural) or potential (obtainable) water quality concentrations, for TP and TN in Wisconsin have been developed by Robertson and others (2006). Values for environmental phosphorus zone (EPZ) 1, in which the Chetek Lakes Watershed is located, were compared to the concentrations measured during the synoptic survey. The median reference concentration was used as the reference (background) concentration, and 75th and 90th percentiles for EPZ 1 were used to categorize concentrations from moderate to excessive.

Calculating the loads requires streamflow data, pollutant concentration data, and a timeframe. For this investigation, data from each sampling event were converted to loads of pounds per day and averaged. The load in pounds per day was computed by multiplying product of the concentration in mg/L and the flow in cubic feet per second by a conversion factor of 5.3938.

The unit area load, or yield, is used to compare the pollutant runoff from different watersheds and is used to identify critical areas for pollutant load reduction consideration. The yield is calculated by dividing the load by the watershed area. For example, the growing season TSS load from site CW-28 (Tenmile Creek at Co. Rd. D) is 11,977 pounds and the load from CW-17 (Moose Ear Creek at Co. Rd. D) is larger at 17,581 pounds; however, the yield from CW-28 is 0.99 pounds per acre, higher than that of CW-17 which has a yield of 0.73 pounds per acre. This indicates that a larger mass of TSS is passing the CW-17 site, but the mass of TSS entering the stream per acre of land is greater in the CW-28 watershed. In this example, CW-28 would take priority for TSS reduction activities.

Yields for prioritizing individual segments of drainage areas (the area between two monitoring sites) were calculated by subtracting the influent (upstream) station load to obtain a net load. The net load was then divided by the drainage area between the sites. The yields mapped for prioritizing catchments therefore do not show cumulative impact from upstream activities. It is possible to have negative net loads for a subwatershed segment using this approach when downstream loads are less than upstream loads. Negative load values can represent measurement errors, residual effects of data censoring, or an actual net loss of constituents within the subwatershed.

3.0 Results and Discussion

Synoptic sample surveys were conducted in June and September of 2012 in the Chetek Lakes Watershed. The location of the sample sites and a description of the site location are shown in Figure 1 and Table 1, respectively. Of the 29 sample sites selected, two sites (CW-16 and CW-27) during the June sample round and 3 sites (CW-16, CW-19, and CW-27) during the September sample round had no flow and therefore were not sampled. Summary statistics of the June and September synoptic sample events are shown in Table 2 and Table 3, respectively. The water quality data from the June and September synoptic surveys, data analyses, and GIS data developed for this report can be found in Attachment 1-Digital Data.

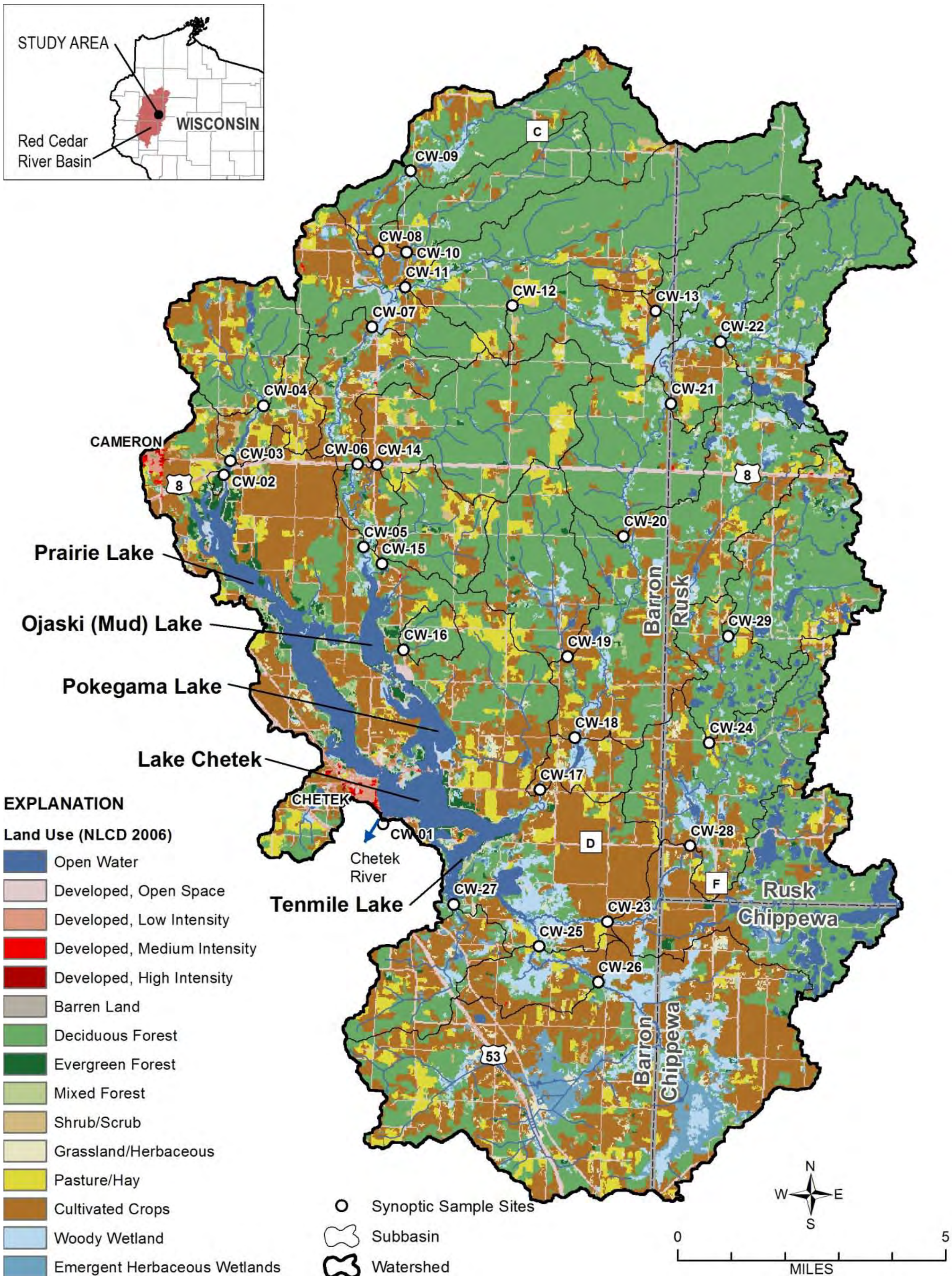


Figure 1. Summer 2012 synoptic sample site locations in the Chetek Lakes Watershed.

Table 1. Summer 2012 synoptic sample site locations.

Station ID	Station Name	Latitude	Longitude	County
CW-01	Chetek Rv below Chetek Dam (upstream of WWTP)	45.311133	-91.647946	Barron
CW-02	Unnamed Spring at 21-1/2 Street	45.404509	-91.711769	Barron
CW-03	Rice Ck at Hwy 8	45.408332	-91.709501	Barron
CW-04	Rice Ck upstream of 15th Avenue	45.42346	-91.69715	Barron
CW-05	Pokegama Ck at 12-3/4 Avenue	45.385783	-91.657612	Barron
CW-06	Pokegama Ck at Hwy 8	45.408158	-91.660498	Barron
CW-07	Pokegama Ck at Co Rd M	45.445319	-91.656052	Barron
CW-08	Pokegama Ck at 18th Avenue	45.465814	-91.654261	Barron
CW-09	Pokegama Ck downstream of 25th Street	45.487804	-91.64249	Barron
CW-10	Silver Ck at 18th Avenue	45.465719	-91.643466	Barron
CW-11	Rock Ck downstream of 25th Street	45.456245	-91.643684	Barron
CW-12	UT to Rock Ck at 27th Street	45.451834	-91.602472	Barron
CW-13	UT to Rock Ck at 17th Avenue	45.451102	-91.54738	Barron
CW-14	German Ck at Hwy 8	45.4081	-91.65298	Barron
CW-15	UT to Ojaski Lk (N) at Co Rd M	45.381397	-91.650553	Barron
CW-16	UT to Ojaski Lk (S) at Co Rd M	45.35818	-91.641508	Barron
CW-17	Moose Ear Ck at Co Rd D	45.321062	-91.588163	Barron
CW-18	Moose Ear Ck at 9th Ave	45.335411	-91.575223	Barron
CW-19	UT to Moose Ear Ck at 10-1/2 Ave	45.357231	-91.578578	Barron
CW-20	Moose Ear Ck at 12-3/4 Avenue	45.390064	-91.558051	Barron
CW-21	Moose Ear Ck at County Line Rd (30th St)	45.426149	-91.54081	Rusk
CW-22	Moose Ear Ck downstream of Log Cabin Road	45.443233	-91.52225	Rusk
CW-23	Tenmile Ck at 29th Street	45.28577	-91.56132	Barron
CW-24	Tenmile Creek at Hogsback Rd	45.334732	-91.5236	Rusk
CW-25	Beaver Ck at 5th Avenue	45.278712	-91.587338	Barron
CW-26	Beaver Ck at 29th Street	45.269397	-91.564405	Barron
CW-27	Short Ck at 6th Avenue	45.28971	-91.62035	Barron

UT = Unnamed tributary

Table 2. Summary statistics for water samples from the Chetek Lakes Watershed, June 2012.

Constituent	Units	Limit of Detection	Samples censored	Minimum	Mean	Median	Maximum
Chloride	mg/L	1.0	0	1.3	3.7	3.6	6.9
Ammonia	mg/L	0.015	0	0.017	0.045	0.034	0.177
Nitrate + nitrite	mg/L	0.019	5	0.01	0.717	0.154	3.330
Total Kjeldahl nitrogen	mg/L	0.14	0	0.16	0.63	0.51	1.73
Total nitrogen	mg/L	n.a.	5	0.30	1.39	1.13	3.93
Total phosphorus	µg/L	5	0	47	140	128	446
Dissolved orthophosphate	µg/L	2	1	1	75	62	347
Total suspended solids	mg/L	2	3	1	5	3	39

Table 3. Summary statistics for water samples from the Chetek Lakes Watershed, September 2012.

Constituent	Units	Limit of Detection	Samples censored	Minimum	Mean	Median	Maximum
Chloride	mg/L	1.0	0	1.8	4.6	4.3	8.2
Ammonia	mg/L	0.015	10	0.008	0.059	0.019	0.775
Nitrate + nitrite	mg/L	0.019	6	0.01	0.975	0.284	4.530
Total Kjeldahl nitrogen	mg/L	0.14	5	0.07	0.43	0.25	2.69
Total nitrogen	mg/L	n.a.	10	0.12	1.46	0.72	5.22
Total phosphorus	µg/L	5	0	27	123	88	442
Dissolved orthophosphate	µg/L	2	0	9	64	31	342
Total suspended solids	mg/L	2	16	1	3.6	1	18

3.1 Chloride

Chloride is an indicator of human activities due to its low natural concentrations. A combination of road salt, fertilizer use, and septic system effluent are likely sources of elevated chloride concentrations. Because chloride is relatively un-reactive in the environment, is used throughout the watershed, and development increases in a downstream direction, it is expected that the chloride load will also increase in a downstream direction. This was the case in the Chetek Lakes Watershed and therefore net load decreases in other constituents (which coincide with chloride load increases) are assumed to represent an actual net loss, for example via biological activity or sedimentation, rather than a measurement error. A negative total suspended solids net load value for a subwatershed segment suggests sedimentation (deposition) is occurring. The negative nutrient net load from the Chetek Lakes suggests nutrients are being utilized in the lake trophic system. The chloride concentrations found during this study are not problematic to aquatic organisms. Figure 2 shows the average chloride concentration of the synoptic samples for each site.

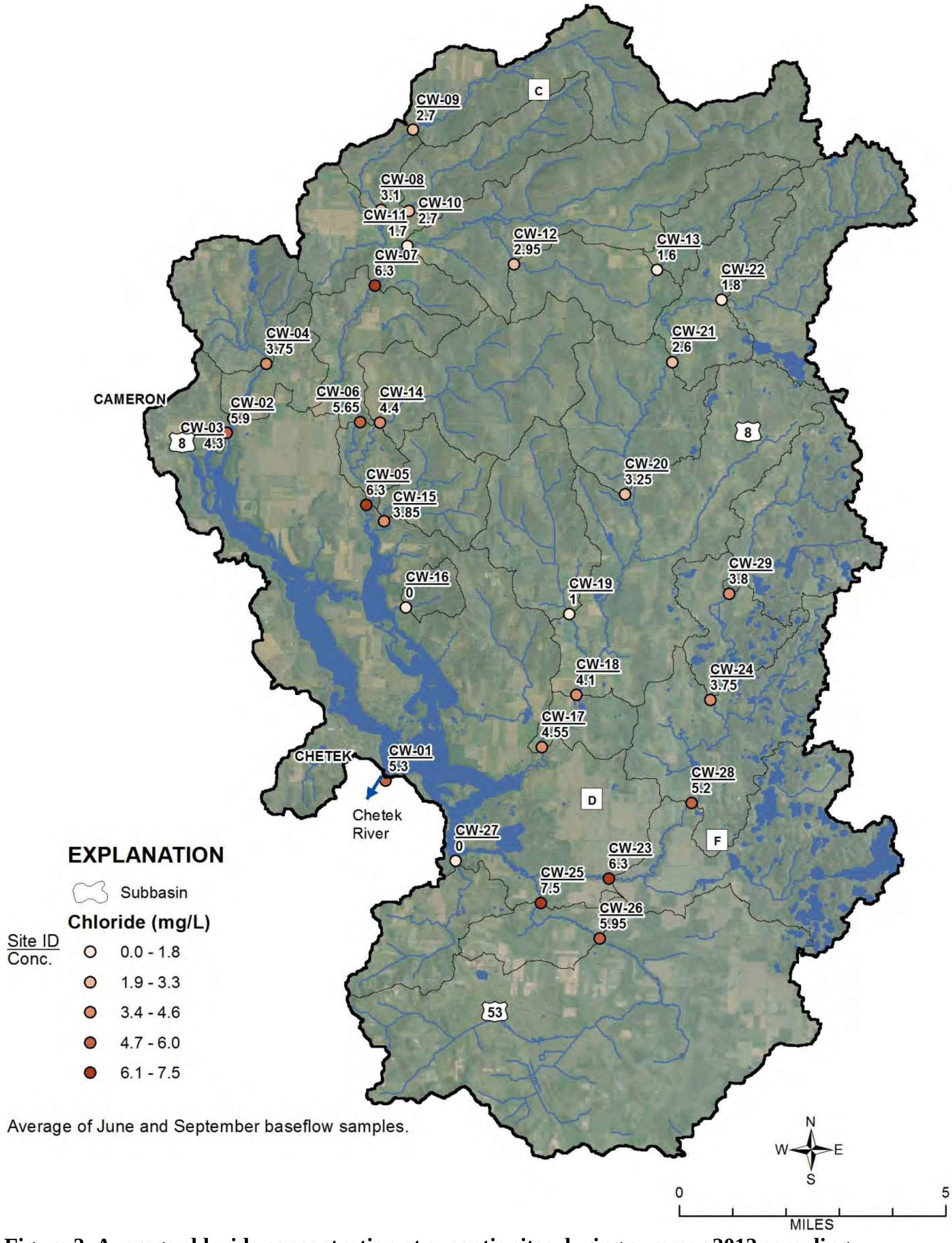


Figure 2. Average chloride concentration at synoptic sites during summer 2012 sampling.

3.2 Total Phosphorus

Total phosphorus concentrations ranged from 47 to 446 µg/L with a median of 128 µg/L for the June sample period and in September ranged from 27 to 442 µg/L with a median of 88 µg/L. Except for CW-07 in September, all of the sample sites had TP above the EPZ 1 median reference concentration of 32 µg/L and the majority had TP above the Wisconsin phosphorus criteria of 75 µg/L for streams. Figure 3 shows the average total phosphorus concentration of the synoptic samples for each site.

3.1 Total Nitrogen

The median TN concentration for the June samples was 1.13 mg/L and ranged from 0.30 to 3.93 mg/L. In September, TN was in general lower throughout the watershed with a median concentration of 0.72 mg/L and a range of 0.12 to 5.22 mg/L. It is common for TN to decrease as the growing season progresses due to plant uptake of nitrogen for growth. TN is elevated in the Chetek Lakes Watershed as the majority of sites in both June and September had TN well above the reference concentration of 0.557 mg/ L for EPZ 1. Three sites had values below 0.557 mg/L in June and 9 sites in September, all of which were fed by forested or headwater watersheds. Figure 4 shows the average total nitrogen concentration of the synoptic samples for each site.

3.2 Total Suspended Solids

Total suspended solids, which includes organic and inorganic materials suspended in the water, ranged from below detection limits (1 mg/L) to 39 mg/L in June and from below detection limits to 18 mg/L in September. The majority of streams during both sample rounds had TSS concentrations below 5 mg/L. Most people consider water with a TSS concentration less than about 20 mg/L to be clear, levels between 40 and 80 mg/L appears cloudy, and concentrations over 150 mg/L appears to be dirty; however, the nature of the particles may cause these numbers to vary. The only numerical limits for TSS are U.S. Environmental Protection Agency rules for municipal sewerage treatments plants, which must meet TSS limits of 30 mg/L as a monthly average and 45 mg/L as a 7-day average. Figure 5 shows the average total suspended solids concentration of the synoptic samples for each site.

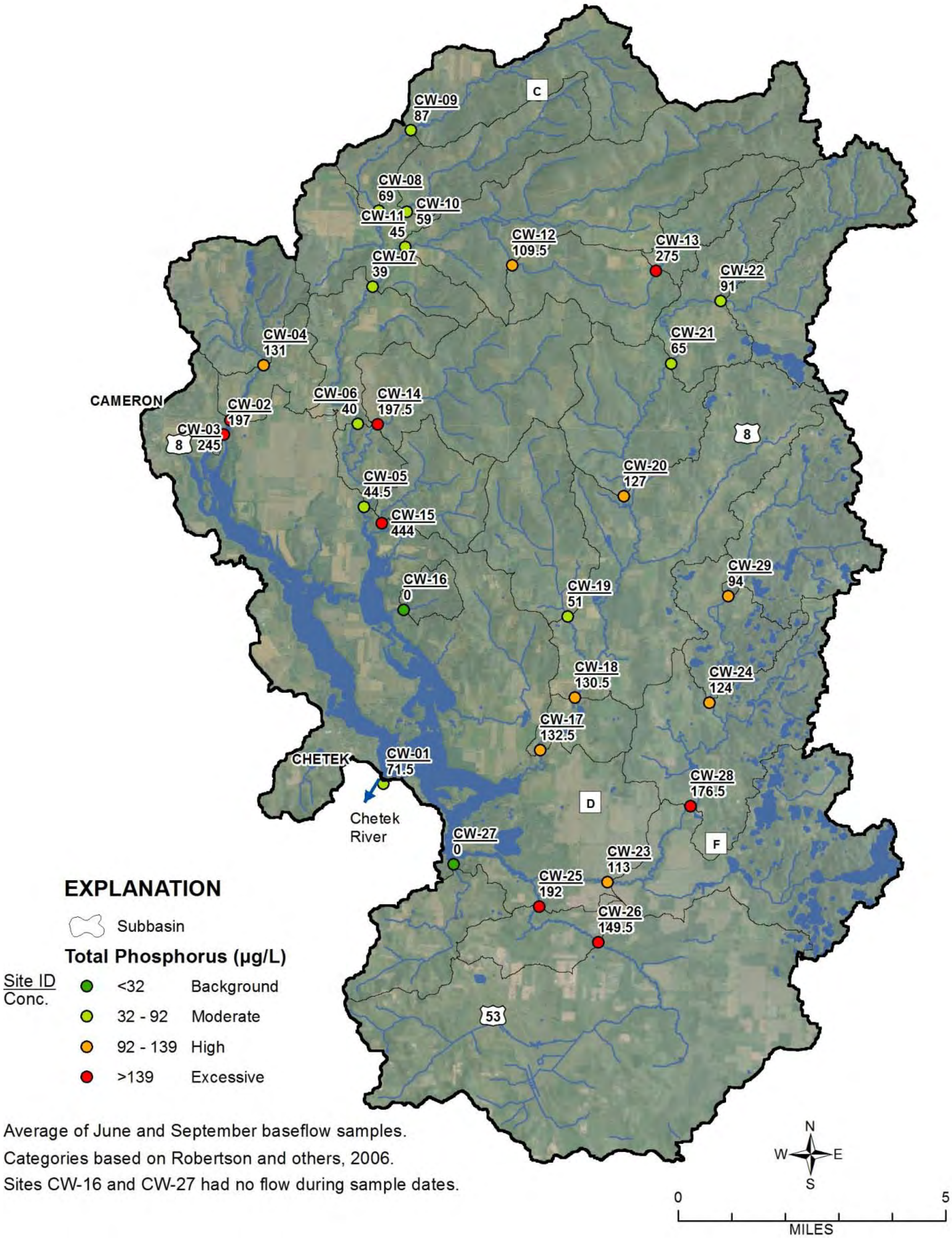


Figure 3. Average total phosphorus concentration at synoptic sites during summer 2012 sampling.

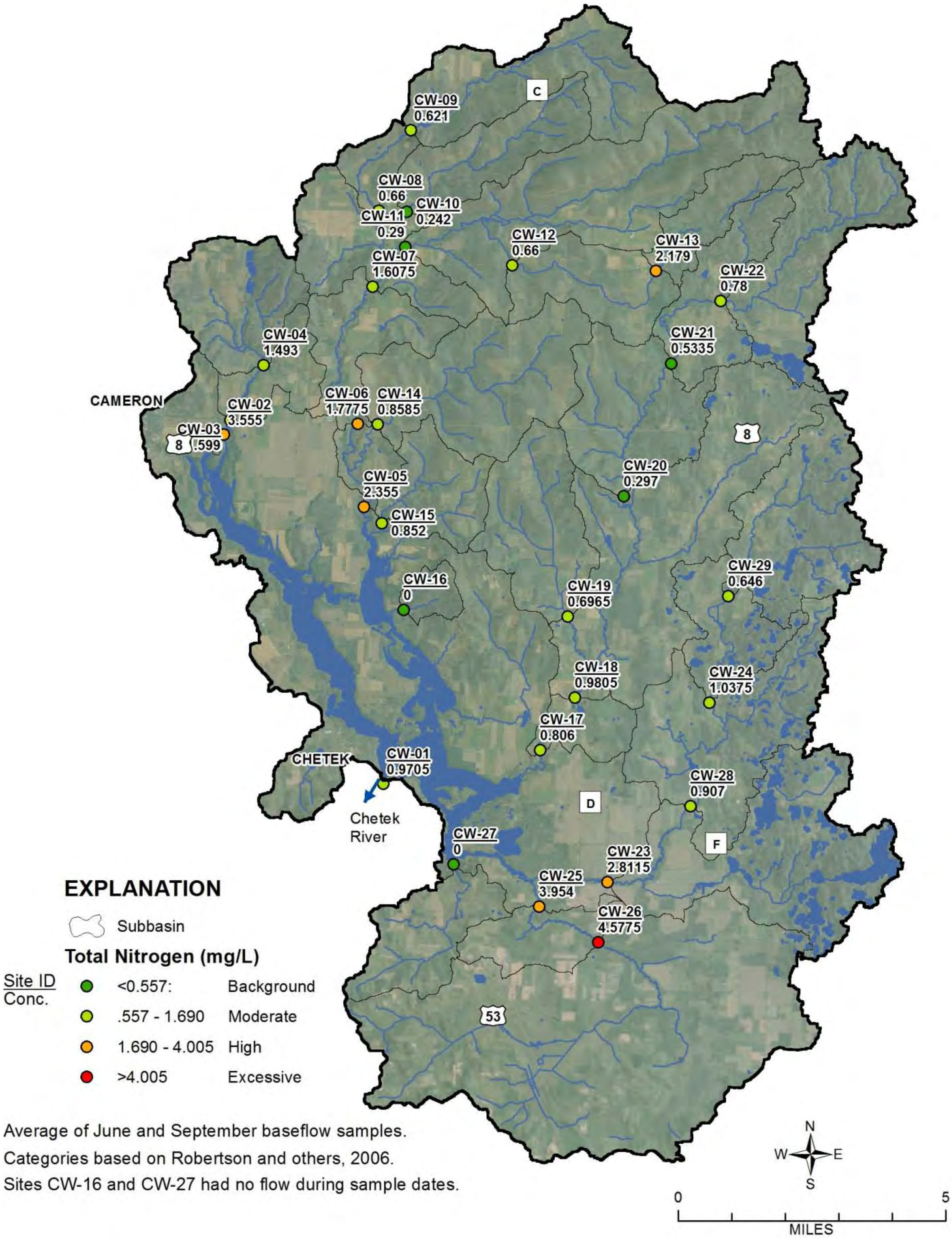


Figure 4. Average total nitrogen concentration at synoptic sites during summer 2012 sampling.

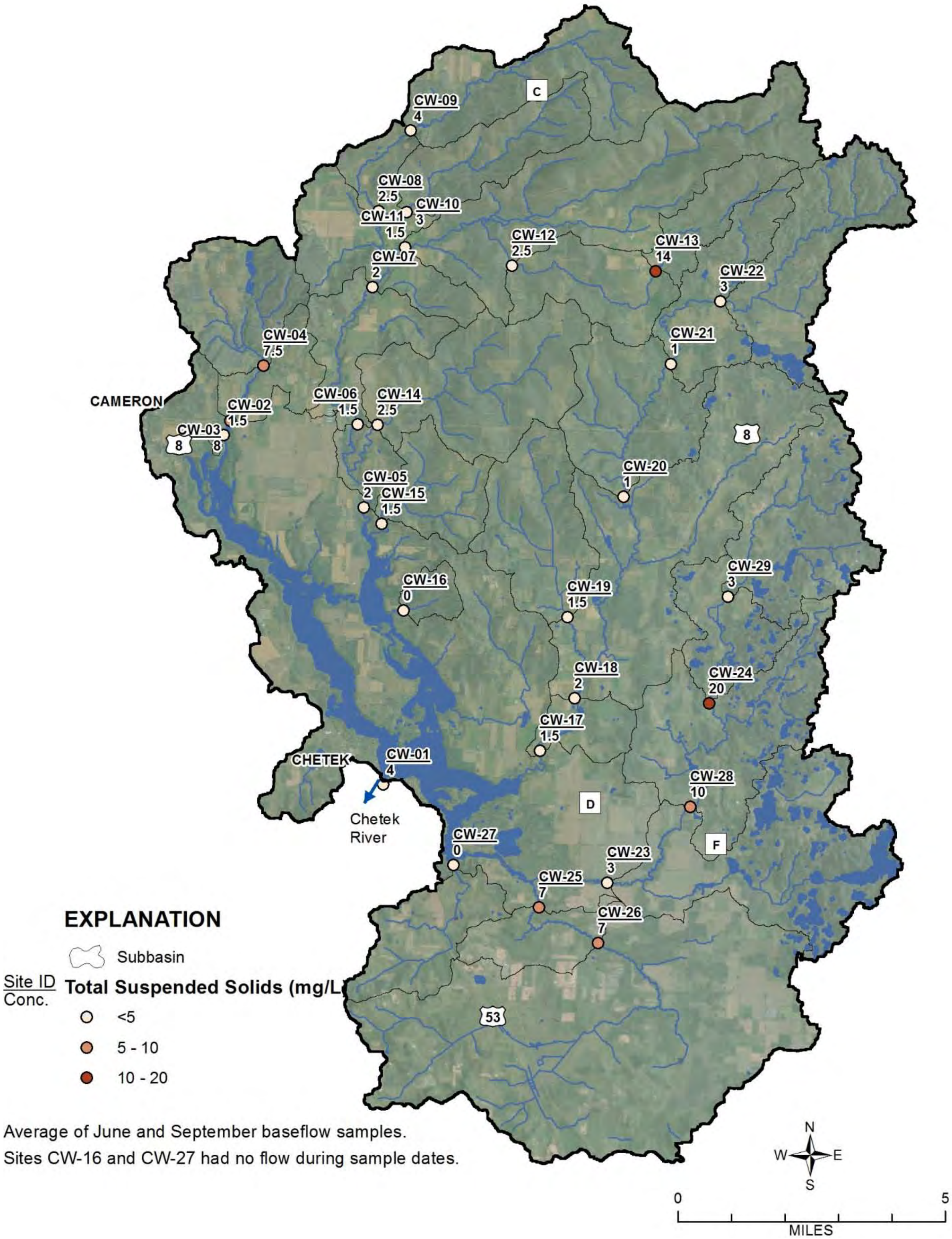


Figure 5. Average total suspended solids concentration at synoptic sites during summer 2012 sampling.

3.3 Flow Conditions

The 2012 growing season had below normal precipitation and baseflow conditions dominated. To estimate hydrologic conditions for the Chetek River, a flow duration curve was created for the Hay River in Wheeler, Wis., a U.S. Geological Service streamflow monitoring station (station number 058368000). The close proximity and similar land use in the Hay River watershed make the monitoring station a good candidate for estimating hydrologic statistics for the Chetek River. A flow duration curve for the Hay River site was created using the mean daily flows and a recurrence interval using the annual peak discharges for the period of record of 1950 – 2011 (Figure 6).

Streamflows corresponding with the synoptic sample dates and streamflow at CW-01 (Chetek River below the Chetek Dam) are highlighted on the flow duration curve in Figure 6. Based on the Hay River at Wheeler flow duration curve, samples in June were collected during mid-range flow conditions and samples in September were collected during dry conditions to low flows. On average, streamflows in September were 49.7 percent lower than streamflows in June.

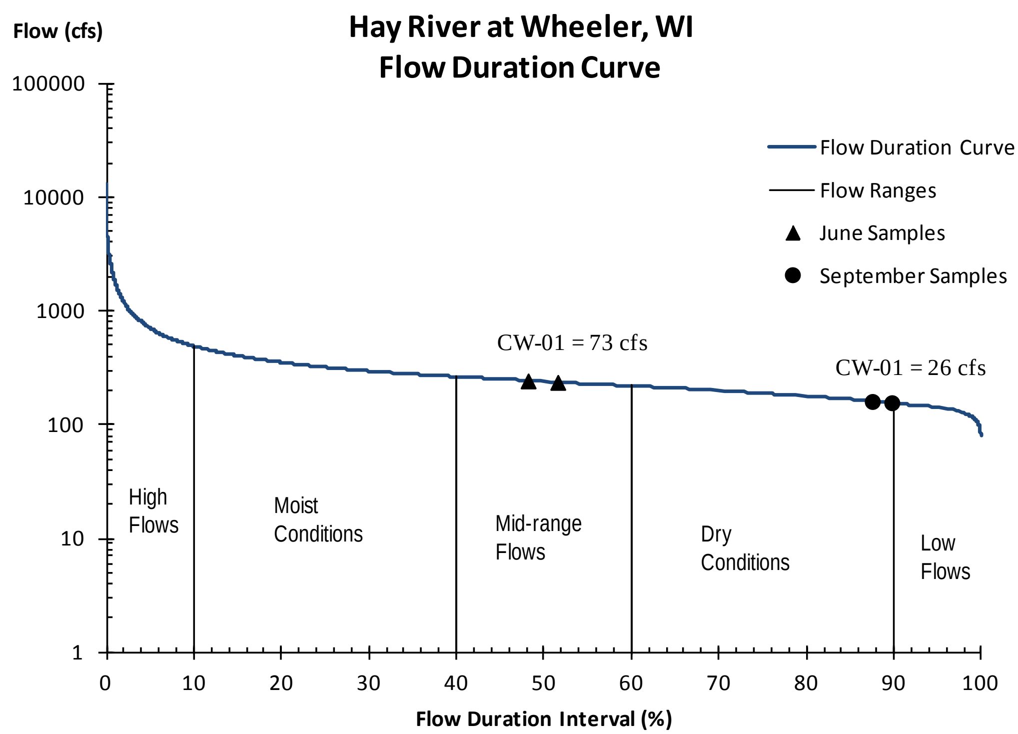


Figure 6. Flow duration curve for Hay River at Wheeler and corresponding synoptic sample dates. The flow at the Chetek Dam (CW-01) is shown.

3.4 Field Observations of Note

CW-01: Pokegama Creek at CTH M. Curly-leaf pondweed (*Potamogeton crispus*), an exotic aquatic plant, was noted in the stream channel during both the June and September sample rounds. A curly-leaf bed is located about 100 yards upstream from the road crossing. Also noted at the site in September was an adult American brook lamprey (*Lampetra appendix*), a non-parasitic lamprey native to Wisconsin.

CW-11: Rock Creek downstream of 25th Street. Cattle were noted in the stream during both sample rounds and the stream banks were trampled (Figure 7). It is evident that the road bridge is used as an underpass for cattle crossing.

CW-13: Unnamed Tributary to Rock Creek at 17th Avenue. Although not present at the time of sampling, it was evident that cattle had access to a large portion of the stream. The stream was widened due to shoreline trampling and trash was noted along the shore.

CW-24: Tenmile Creek at Hogsback Road. Cattle were noted in the stream during the September sample round. Steep banks had trampled and eroding areas. It is evident that the road bridge is used as an underpass for cattle crossing.

Figure 7. Cattle in stream and trampled banks at Rock Creek and 25th Street (CW-11), June 2012.

3.5 Nutrient and Sediment Yields

Prioritization of subwatersheds based on nutrient and sediment concentrations are shown Table 4 and in Figures 8 though 10. Headwater subwatersheds generally had lower total phosphorus yields and the higher yields were primarily in the Rice Creek watershed and the predominantly agricultural Moose Ear Creek and Tenmile Creek watersheds (Figure 8). Total nitrogen yields followed a similar pattern as total phosphorus, but were in general elevated in subwatersheds with larger proportions of row cropping regardless of landscape position (Figure 9).

The negative nutrient yields of the Chetek Lakes direct drainage area (CW-01) is attributed to the lakes acting as nutrient sinks. The daily phosphorus load into the lake was 43.9 pounds in June and 23.6 pounds in September, whereas the load out of the lakes was much lower: 27.8 pounds in June and 10.2 pounds in September. The nitrate load also decreased dramatically from inflow to outflow. In June, the daily load to the lake was 523.4 pounds and 18.4 pounds were exported. The total Kjeldahl nitrogen (organic nitrogen) export was much higher at 517.0 pounds than the load in of 151.2 pounds indicating uptake into the trophic system. The relatively high total suspended solids yield from the Chetek Lakes is attributed to the conversion of the nutrients into algae, which was noted in the samples collected at the Chetek Dam.

Table 4. Prioritization of subwatersheds for BMP evaluation and implementation based on nutrient and sediment yields. Monitoring sites are sorted by total phosphorus priority.

	Total Phosphorus		Total Nitrogen		Total Suspened Solids	
Site	Yield (lb/ac/day)	Priority	Yield (lb/ac/day)	Priority	Yield (lb/ac/day)	Priority
CW-02	0.00847	1	0.15285	1	0.0654	4
CW-03	0.00414	2	0.02145	5	0.1083	2
CW-17	0.00194	3	0.00011	26	-0.0068	28
CW-25	0.00184	4	0.02759	3	0.0467	5
CW-05	0.00177	5	0.12303	2	0.1243	1
CW-23	0.00099	6	0.02628	4	-0.0022	25
CW-28	0.00085	7	0.00173	12	-0.0121	29
CW-04	0.00053	8	0.00603	8	0.0300	6
CW-20	0.00048	9	0.00020	21	0.0028	15
CW-24	0.00038	10	0.00370	10	0.0929	3
CW-18	0.00038	11	0.00426	9	0.0089	9
CW-15	0.00030	12	0.00067	17	0.0012	19
CW-06	0.00026	13	0.01640	6	-0.0001	24
CW-07	0.00016	14	0.01397	7	0.0131	8
CW-22	0.00015	15	0.00138	13	0.0044	13
CW-26	0.00013	16	0.00337	11	0.0058	11
CW-08	0.00013	17	0.00116	14	0.0052	12
CW-13	0.00012	18	0.00081	15	0.0084	10
CW-29	0.00011	19	0.00072	16	0.0043	14
CW-09	0.00005	20	0.00048	18	0.0025	16
CW-14	0.00005	21	0.00022	20	0.0007	20
CW-12	0.00004	22	0.00016	24	-0.0024	26
CW-11	0.00004	23	0.00035	19	0.0019	17
CW-10	0.00003	24	0.00013	25	0.0018	18
CW-21	0.00003	25	0.00017	23	-0.0035	27
CW-19	0.00001	26	0.00017	22	0.0004	21
CW-27	0	27	0	27	0	22
CW-16	0	28	0	28	0	23
CW-01	-0.00058	29	-0.01072	29	0.0205	7

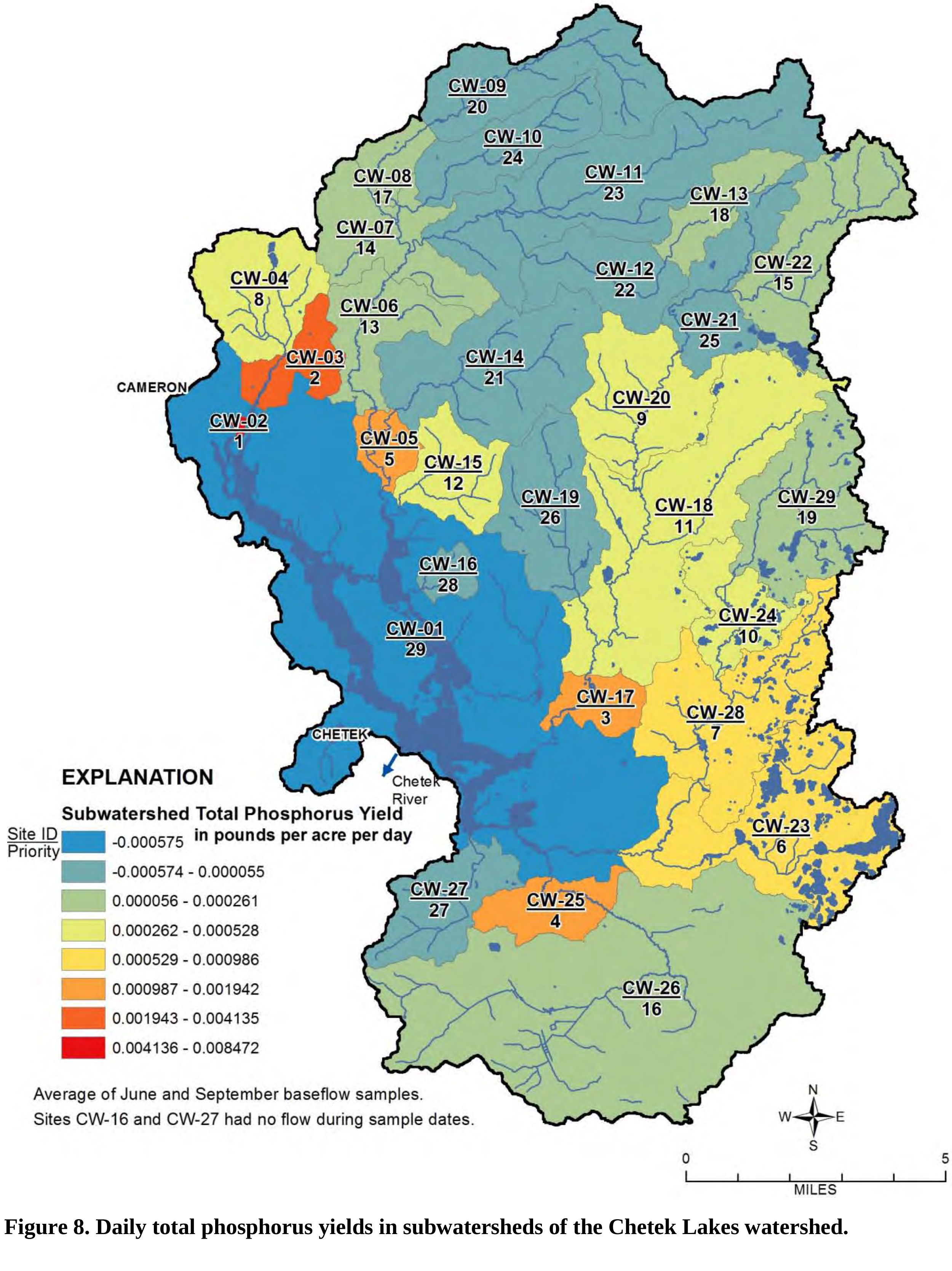


Figure 8. Daily total phosphorus yields in subwatersheds of the Chetek Lakes watershed.

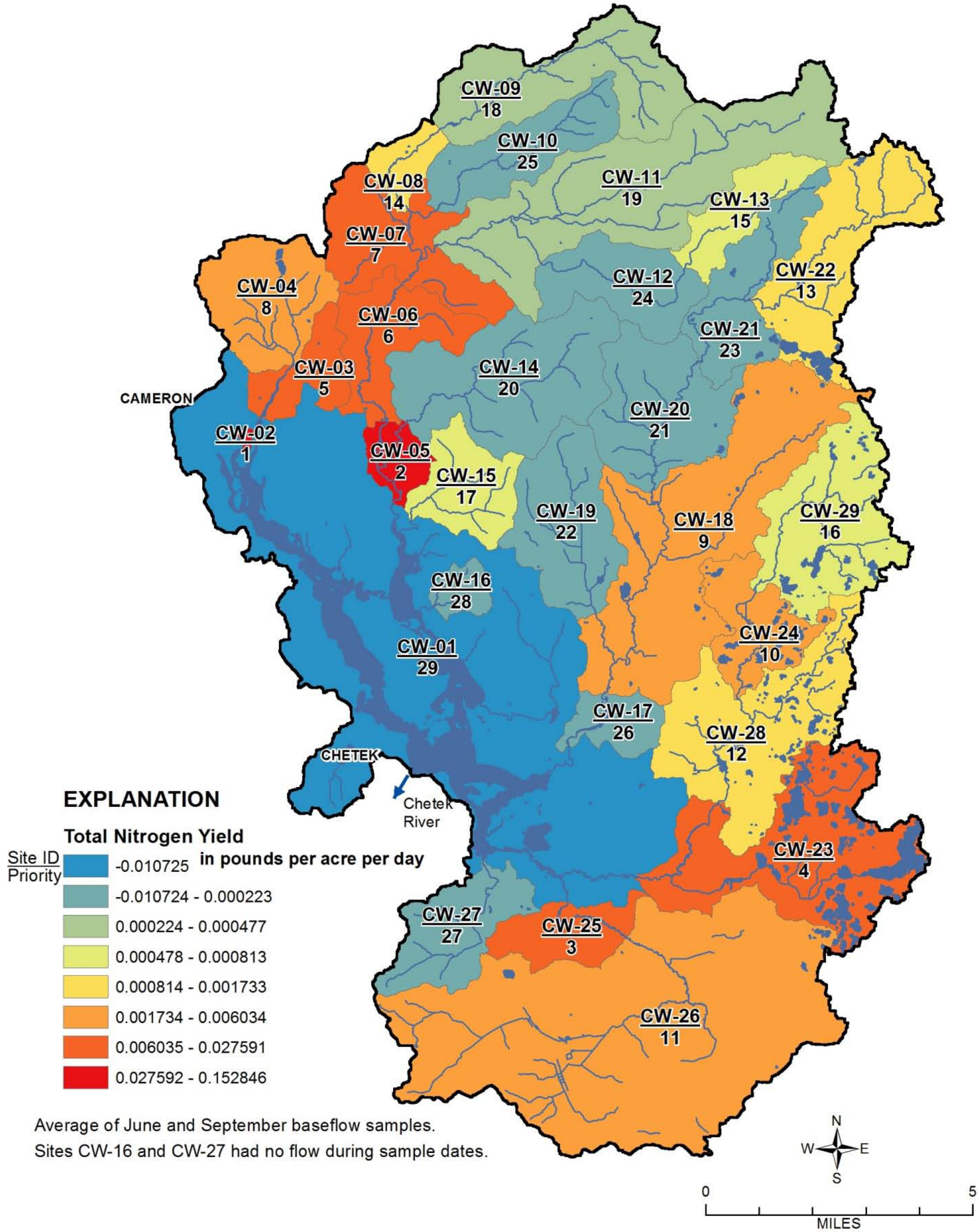


Figure 9. Daily total nitrogen yields in subwatersheds of the Chetek Lakes watershed.

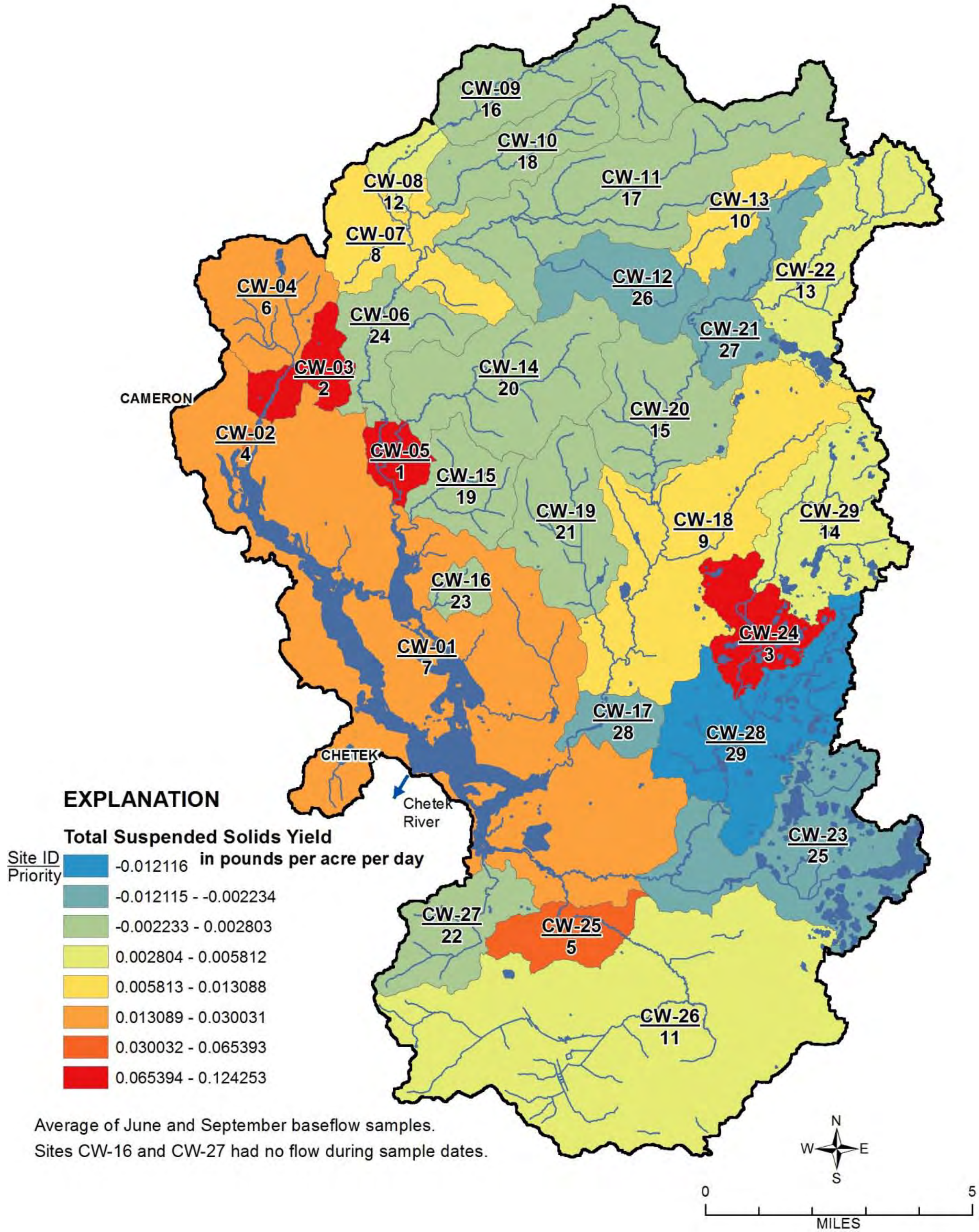


Figure 10. Daily total suspended solids yields in subwatersheds of the Chetek Lakes watershed.

4.0 Recommendations

The information collected during the synoptic surveys can be used to examine sources of nutrients to the lakes and explore management options. Because phosphorus limits production in the Chetek Chain of Lake during most of the growing season, implementation of BMPs should follow subwatershed ranking based on primarily on total phosphorus yields, that is, areas providing the most phosphorus should be evaluated first. Practices that should be evaluated for implementation that would benefit the Chetek Chain of Lakes and their watershed include grassed waterways, fencing livestock out of streams, nutrient management planning, manure management, and cover cropping.

The utilization of nutrients in the lakes is likely shadowing the loading from the primarily developed landscape in the direct drainage area. Because of its close proximity and direct impact to the lakes, the direct drainage area is also high priority for residential and agricultural non-point source BMPs. Monitoring site CW-13 had elevated nutrient and sediment concentrations (likely due to the cattle access to the stream) and should be a high priority for BMP implementation.

Site CW-02 a groundwater spring with a forested surface watershed, was found to have very high nutrient yields. This, coupled with the high nutrient concentrations measured throughout the watershed during this baseflow study, indicates that the landscape is well saturated with nutrients to the level where groundwater quality is affected. It is therefore important for BMP selection to be undertaken that also considers groundwater quality.

Other desktop analyses can further refine prioritization. For example, a GIS can be used to rank the subwatersheds based on soil loss characteristic (e.g., RUSLE K-factor) and runoff generating characteristics (e.g. RUSLE LS-factor). This additional information can be combined with yield and load data to develop an existing conditions model and further prioritize subwatersheds.

Field reconnaissance of the target subwatersheds should be completed to verify boundary delineations and existing BMPs, to identify optimal sites for specific BMPs and identify previously undetected treatment options, and to take site-specific notes for each potential BMP. The field recon data should be entered into a GIS for data management and tracking.

A treatment and costs analysis should be performed following the field recon. This entails quantifying pollutant removal for potential BMPs (using spreadsheets, RUSLE c-factor modification, or other methods) and estimating project costs for construction, planning and design, maintenance, and outreach. Once a cost analysis has been completed, grant funding should be sought for implementation using the catchment and cost analysis reports as primary references.

References

U.S. Environmental Protection Agency, 2000. Ambient water quality criteria recommendations—Information supporting the development of state and tribal nutrient criteria: rivers and streams in nutrient ecoregion VII. U.S. Environmental Protection Agency Office of Water Report EPA 822-B-00-018, 28 p. and 3 appendices.

MINUTES

Chetek Lakes Technical Advisory Commitee

Comprehensive Lake Management Planning

Sept 26, 2013

4:30pm - 6:00pm

Wieckowicz Law Office, 325 Knapp Street, Chetek

Copies to: John Plaza, Jack Schnell, Jennifer Blatz, Tyler Florczak, Frank Keller, Earl Novotney, Dan Knapp, Troy Bol, Tyler Gruetzmacher, Neil Rafferty, Alex Smith, Jacob Macholl

Call to Order; 4:34 PM

Roll Call; Attendees: John Plaza, Jack Schnell, Jennifer Blatz, Troy Bol, Tyler Gruetzmacher, Frank Keller, Dan Knapp, Jacob Macholl, Neil Rafferty & Alex Smith

I. **Welcome and Introductions (Plaza)**
   A. Welcomes by Jack, John and Jake
   B. Introductions

II. **Overview of project objectives, deliverables and work plan (Macholl and Plaza)**
   A. Reported on water monitoring – going well.
   B. AIS monitoring has well over 200 hours.
   C. Photographic documentation – yes – some rain events also.
   D. Stream crossings – Charter School to do. John is asking Mike.
   E. Dialogue with the Ag community will be in December.
   F. Draft Plan - TBD
   G. Final Plan – TBD
   H. Suction Dredging – applying to farm fields was discussed at length. Costs? Jake (SEH) will present at our next meeting. Cost/benefit info, bottom sediment analysis, etc.
   I. Fisheries – DNR to stock walleyes in the chain, 10 ea. 7 in. walleye per acre, all lakes, in Oct.

III. **Needs and visions of project partners (Group)**
   A. New ideas? Algae 25% reduction would be noticeable.
   B. Change dam from overflow to underflow (add tubes) - Lake Chetek does stratify. Idea would be to pull material (slurry) or low O2, high phosphorous water. Don't forget the back bays! Start putting together options with costs?
   C. Bol Farms are irrigating from a bay by Camp Chetek/Hydroflites. They have a DNR permit to do so. Troy will put some numbers together for the December TAC meeting.
   D. Gopher Point Aerators were new this year – no stench like before, approx. $30/mo. Electric, $2500 for the system. No blue-green algae appeared this year.
   E. Aagot Bay (between Wildwoods and Waltons) – Jack's testing showed no O2 except the top foot of water unless there was a SSW wind. Might be a good choice for an aerator.
   F. Synoptic test results were discussed.
   G. High nutrient levels were discussed.
   H. Ag nutrient management plans are VERY important.

IV. **Nutrient sources to the lakes (Macholl)**
    A. See above, not discussed separately.

V. **Management units in the watershed and roles (Macholl)**
    A. This was not discussed.

VI. **Water quality goal development (Group)**
    A. This was not discussed.

VII. **Question and answer session (Group)**
    A. Neil asked about starting a lake district. There are several in the area.

VIII. **Summary (Macholl)**
    A. Discussed, see Action Items.

IX. **Action Items (Group)**
    A. John will talk to Mike about Stream Crossing documentation project
    B. Jake will prepare a presentation on suction dredging for the next meeting
    C. Tyler will talk to Ernie – the local dredging expert
    D. John to start the historic chemical project
    E. Troy to get data on his irrigation from the lake

Adjourn; 6:19 PM.

Minutes by Jack Schnell 14-0129

MEETING AGENDA

Re:	Chetek Lakes Comprehensive Lake Management Planning: Advisory Committee Meeting 3	**Date of Meeting:**	January 30, 2014
Project Manager:	Dave Blumer	**Time of Meeting:**	4:30 - 6:00 PM
SEH No.:	CHLPA 124347	**Location of Meeting:**	Wieckowicz Law Office 325 Knapp Street Chetek, WI 54728

Invitees:

Jennifer Blatz, Chetek Chamber of Commerce
Troy Bol, Sugar Bol Farms
Tyler Florczak, The Chetek Alert
Tyler Gruetzmacher, Barron County
Frank Keller, Resort Owners Assoc.
Dan Knapp, City of Chetek
Jacob Macholl, SEH, Inc.
Earl Novotney, Edina Realty
John Plaza, Chetek Lakes Protection Assoc.
Neil Rafferty, Gopher Point Homeowners Assoc.
Jack Schnell, Chetek Lakes Protection Assoc.
Alex Smith, Wisconsin Dept. of Natural Resources

Please review the attached project plan document prior to the meeting. The following items are to be discussed at the above referenced meeting:

I.	Welcome and introductions	(Schnell)
II.	Overview of project objectives, deliverables and work plan	(Macholl)
III.	Historic Data Review	(Group)
IV.	Irrigation Use	(Bol, Macholl)
V.	Lake Sediments	(Macholl)
VI.	Dredging—Costs, Benefits, Expectations	(Macholl)
VII.	Updated on Lake District Formation	(Group)
VIII.	Question and answer session	(Group)
IX.	Summary	(Macholl)

If there are errors contained in this document, or if relevant information has been omitted, please contact Jacob Macholl at 715.861.1944 or jmacholl@sehinc.com.

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MINUTES

Chetek Lakes Technical Advisory Commitee

Comprehensive Lake Management Planning

Jan 30, 2014

4:30pm - 6:00pm

Wieckowicz Law Office, 325 Knapp Street, Chetek

Copies to: John Plaza, Jack Schnell, Jennifer Blatz, Tyler Florczak, Frank Keller, Earl Novotney, Dan Knapp, Troy Bol, Tyler Gruetzmacher, Neil Rafferty, Alex Smith, Jacob Macholl

Call to Order; 4:35 PM

Roll Call; Attendees: John Plaza, Jack Schnell, Troy Bol, Tyler Gruetzmacher, Frank Keller, Jacob Macholl, & Neil Rafferty

I. **Welcome (Macholl)**

II. **Overview of project objectives, deliverables and work plan (Macholl and Plaza)**
   - A. Fish Sticks – new permitting system is easier. Only $50, general permit and can add properties at N/C. A hand-out was passed out. Resort owners donated $2500 for fish sticks.
   - B. The WI grant program has changed. It's more streamlined with new dates for applications and awards. A hand-out was passed out.
   - C. Wake boats – recommend a lake use plan to stop or limit them. No wake zones were discussed. There are voluntary zones shown on the Resort Assoc. map, with a brief explanation. Enforcement and compliance will be issues.
   - D. Dredging – Jake presented. A hand-out was passed out. Bays go anoxic and really release phosphorous. Tyler G. spoke to his contact Ernie who does manure pit dredging. He said it was 0.5 to 1 cent per gallon to transport. We need to get the solids out of the sludge. We would need a dredge for years, moving it around the lakes. (similar to the Rice Lake weed cutters) We may need large sediment ponds to do this. Tyler and Troy will visit Ernie to discuss.

III. **Historic Data Review (Group)**
   - A. 80% done, it's eye-opening. Lots of chemicals were placed in the lakes.
   - B. Excellent aquatic plant growth would return if we can flip the lake back.

IV. **Irrigation use (Bol, Macholl)**
   - A. 81 pounds of phosphorous were pulled by Bol's irrigation last summer.
   - B. Jake, Tyler and Troy are thinking about a practical system to use elsewhere on The Chain.
   - C. Under flow from the dam was also discussed.
   - D. The amount of irrigation discussed would not be an issue for The Chain.

V. **Lake Sediments (Macholl)**
   - A. Discussed. A hand-out was passed out. "Internal Phosphorous Loading and Sediment Phosphorous Fractionation Analysis for the Chetek Chain of Lakes, Wisconsin"

VI. **Dredging – Costs, Benefits, Expectations (Macholl)**

A. See II. D. above.

VII. **Update on Lake District formation (Group)**

A. City of Chetek has asked John to speak.

B. All property owners have a vote. (even non-residents)

C. John went over the grant project list. Everything is complete or almost complete.

D. Example of project: Ten Mile/Beaver Creeks could do a spillway for high-flow times. (short circuit)

VIII. Question and answer session (Group)

A. Near shore plant give away feasible?

B. Core sample report was passed out.

IX. Summary (Macholl)

A. Will still have a couple or several more TAC meetings.

Adjourn; 6:40 PM.

Minutes by Jack Schnell 14-0615

Internal Phosphorus Loading and Sediment Phosphorus Fractionation Analysis for the Chetek Chain of Lakes, Wisconsin

1 September, 2011

William F. James
ERDC Eau Galle Aquatic Ecology Laboratory
W. 500 Eau Galle Dam Road
Spring Valley, Wisconsin 54767

OBJECTIVES

The objectives of this investigation were to determine rates of phosphorus (P) release from sediments under laboratory-controlled oxic (i.e., aerobic) and anoxic (i.e., anaerobic) conditions and to quantify biologically-labile (i.e., subject to recycling) P fractions in sediments collected in the Chetek Chain of Lakes, Wisconsin

APPROACH

Laboratory determination of rates of phosphorus release from sediment under oxic and anoxic conditions: Sediment cores were collected at 2 sites in Prairie Lake (Upper Prairie = 4.0 m deep, Middle Prairie = 5.1 m deep), and one site each in Mud (3.1 m deep), Pokegama (5.6 m deep), Chetek (6.1 m deep), and Ten-Mile Lake (2.2 m deep) for determination of rates of P release from sediment (Figure 1). Two intact sediment cores were collected at each site for duplicate determination of rates of P release under anoxic (i.e., anaerobic) conditions. At three sites (Middle Prairie, Chetek, and Pokegama), an additional two sediment cores were collected for duplicate determination of rates of P release under oxic (i.e., aerobic) conditions.

A gravity sediment coring device equipped with an acrylic core liner (6.5-cm ID and 50-cm length) was used to collect sediment. The core liners, containing both sediment and overlying water, were immediately sealed using stoppers and stored in a protective box until analysis. Additional lake water was collected from each lake for incubation with the collected sediment.

In the laboratory, sediment cores were carefully drained of overlying water and the upper 10 cm of sediment was immediately transferred intact to a smaller acrylic core liner (6.5-cm dia and 20-cm ht) using a core remover tool. The additional water, collected from each lake, was filtered through a glass fiber filter (Gelman A-E), with 300 mL then siphoned onto the sediment contained in the small acrylic core liner without causing sediment resuspension. Sediment incubation systems consisted of the upper 10-cm of sediment and filtered overlying water contained in acrylic core liners that are sealed with rubber stoppers. The sediment incubation systems were placed in a darkened environmental chamber and incubated at a constant temperature (20 C) for 2 weeks. The incubation temperature was set to a standard temperature for all stations for comparative purposes. The oxidation-reduction environment in each system was controlled by gently bubbling either air (oxic) or nitrogen (anoxic) through an air stone placed just above the sediment surface. Bubbling action insured complete mixing of the water column but did not disrupt the sediment.

Water samples for soluble reactive phosphorus (SRP) were collected daily over a 5 day period and at 2-day intervals during the second week of incubation. Samples were collected from the center of each sediment incubation system using an acid-washed syringe and immediately filtered through a 0.45 µm membrane syringe filter. The water volume removed from each system during sampling wase replaced by addition of filtered lake water preadjusted to the proper oxidation-reduction condition. These volumes were accurately measured for determination of dilution effects. SRP was determined colorimetrically using the ascorbic acid method (APHA 1992). Rates of SRP release from the sediment (mg m^{-2} d^{-1}) were calculated as the linear change in concentration in the overlying water divided by time and the area of the incubation core liner.

Sediment textural and chemical properties: The upper 10 cm sediment layer was sectioned from an additional core collected at each station for analysis of moisture content (%), sediment density (g/mL), loss on ignition (i.e., organic matter content, %), loosely-bound P, iron-bound P, and labile organic P (all expressed at mg/g). A known volume of sediment was dried at 105 ^{o}C for determination of moisture content and sediment density and ashed at 550 ^{o}C for determination of loss on ignition organic matter (Håkanson and Jansson 2002).

Phosphorus fractionation was conducted according to Hieltjes and Lijklema (1980), Psenner and Puckso (1988), and Nürnberg (1988) for the determination of ammonium-chloride-extractable phosphorus (loosely-bound P), bicarbonate-dithionite-extractable phosphorus (i.e., iron-bound P), and sodium hydroxide-extractable phosphorus (i.e., aluminum-bound P). A subsample of the sodium hydroxide extract was digested with potassium persulfate to determine nonreactive sodium hydroxide-extractable P (Psenner and Puckso 1988). Labile organic P was calculated as the difference between reactive and nonreactive sodium hydroxide-extractable P.

The loosely-bound and iron-bound P fractions are readily mobilized at the sediment-water interface as a result of anaerobic conditions that result in desorption of P from sediment and diffusion into the overlying water column (Mortimer 1971, Boström 1984, Nürnberg 1988). The sum of the loosely-bound and iron-bound P fractions are referred to as redox-sensitive P (i.e., the P fraction that is active in P release under anaerobic and reducing conditions). In addition, labile organic P can be converted to soluble P via bacterial mineralization (Jensen and Andersen 1992) or hydrolysis of bacterial polyphosphates to soluble phosphate under anaerobic conditions (Gächter et al. 1988; Gächter and Meyer 1993; Hupfer et al. 1995). The sum of redox-sensitive P and labile organic P are collectively referred to a biologically-labile P. This fraction is generally active in recycling pathways that result in exchanges of phosphate from the sediment to the overlying water column and potential assimilation by algae.

RESULTS AND INTERPRETATION

Phosphorus mass and concentration increased linearly and rapidly in the overlying water column of sediment systems maintained under anoxic conditions early during incubation period (Figure 2 and 3). By day 5 or beyond, P mass and concentration tended to reach a plateau in several systems (for instance, Middle Prairie, Mud, and Chetek Lakes) due to diminished diffusional concentration gradients at the sediment-water interface. This pattern is common for eutrophic lake sediments that exhibit high rates of P release (James, personal observation). For sediment cores collected at the Upper and Middle Prairie Lake stations, P concentrations exceeded 1.5 and 1.0 mg/L in the overlying water near the end of the incubation period. Peak overlying water P concentrations were ~ 1.0 mg/L for Chetek, 1.7 mg/L for Ten-Mile, 1.5 mg/L for Mud, and 1.5 mg/L for Pokegama sediment core incubation systems.

Mean rates of diffusive P flux under anoxic conditions ranged between 5.7 and 14.3 mg m^{-2} d^{-1} (Table 1). These rates were high and comparable to those measured for eutrophic systems in North America (Nürnberg 1988). Ten-Mile Lake sediment exhibited the highest mean anoxic rate of diffusive P flux at 14.3 (± 2.8 standard error; SE) mg m^{-2} d^{-1} followed by Pokegama Lake sediment at 9.7 (± 0.2 SE) mg m^{-2} d^{-1} (Figure 4). Upper and Middle Prairie Lake sediments exhibited anoxic diffusive P flux rates of 8.6 (± 1.2 SE) and 7.5 (± 0.3 SE) mg m^{-2} d^{-1}. In contrast, mean anoxic diffusive P flux rates were slightly lower sediment cores collected in Chetek and Mud Lakes at 6.8 (± 0.2 SE) and 5.7 (± 0.8 SE) mg m^{-2} d^{-1}, respectively (Figure 4).

Under oxic conditions, P mass and concentration increases in the overlying water column of sediment core incubation systems were generally much lower versus those under anoxic conditions (Figure 5). This pattern suggested that diffusive P flux from sediment in the Chetek Chain of Lakes may be coupled with iron (Fe). Under oxygenated conditions, Fe is in an oxidized state as an Fe oxyhydroxide (Fe(OOH)) and strongly adsorbs phosphate, resulting in low to negligible diffusive P flux from sediments. Fe(OOH) becomes reduced to Fe^{+2} in conjunction with bacterial metabolism under anaerobic conditions, resulting in desorption of phosphate and much higher rates of diffusive P flux (as observed for Chetek Chain of Lakes sediments incubated under anoxic conditions).

Nevertheless, P mass and concentrations increased linearly in the overlying water column during the first 5-10 days of incubation, indicating some net P diffusion out of the sediments and into the overlying water column even under aerobic conditions. The Pokegama Lake replicate 1 sediment system exhibited a moderately high initial increase in P concentration on day one of incubation. These sediments were very flocculent and probably temporarily disturbed during setup, resulting in the initial spike. However, overlying water column P mass and concentration stabilized in this particular system and behaved similarly to others by day 3 of incubation. Mean rates of diffusive P flux from sediments under oxic conditions ranged between ~ 0.9 and 1.2 mg m^{-2} d^{-1} for lake sediments examined (Table 1 and Figure 4). Although much lower compared to rates under anoxic conditions, oxic diffusive P fluxes on the order of ~ 1.0 mg m^{-2} d^{-1} can represent an important contribution to the P budget of these lakes.

Lake-wide rates of diffusive P flux can be estimated by considering the sediment areas of each lake that are typically exposed to oxic and anoxic conditions and the duration of anoxia (Nürnberg 1995). By weighting areas of each lake for oxic and anoxic sediment P release over the summer, and assuming an average summer water temperature of ~ 20 C (i.e., the temperature chosen for laboratory incubation), an estimate of summer internal P loading can be derived for comparison with other P inputs to the lake chain.

Sediment at all sites exhibited a high moisture content and low sediment density, indicating fine-grained, flocculent sediment (Table 2). Loss-on-ignition organic matter content was relatively high at 22 and 52%. Ten-Mile lake sediments exhibited the highest organic matter content at 52.3% while Mud Lake sediment was the lowest at 21.7%. Upper and Middle Prairie Lake sediments exhibited similar organic matter contents of ~ 44 and 48%, respectively. Pokegama and Chetek Lake sediment organic matter contents were moderate at ~ 31% compared to the other lakes.

The concentration of biologically labile P (i.e., the sum of loosely-bound, iron-bound, and labile organic P fractions) was relatively high (James, personal observation) for the Chetek Chain of Lakes, ranging between ~0.5 and 2.5 mg/g (Table 3). Biologically labile P concentrations were greatest for Chetek and Pokegama Lake sediments at ~ 2.5 mg/g, moderate for Ten-Mile Lake sediments, and lowest at 0.471, 0.610, and 0.728 mg/g for sediment cores collected in Mud, Middle Prairie, and Upper Prairie Lakes, respectively. With the exception of the Prairie Lake stations, the iron-bound P fraction dominated biologically labile P concentrations (Figure 6). Iron-bound P also overwhelmingly dominated the redox-sensitive P fraction (i.e., the sum of loosely-bound and iron-bound P) and was greatest in Pokegama, Chetek, and Ten-Mile Lake sediments. In contrast, loosely-bound P generally represented < 10% of the biologically labile P fraction. The labile organic P fraction was more constant among the lakes and ranged between 0.100 and 0.347 mg/g. For sediments other than those collected in Prairie Lake, it represented ~ 5% to 25% of the biologically labile P fraction.

Iron-bound P concentrations have been empirically related to rates of diffusive P flux under anoxic conditions (i.e., positive linear relationship between iron-bound P and anoxic diffusive P flux; Boström 1984, Nürnberg 1988). Thus, higher iron-bound P concentrations tend to be associated with higher rates of diffusive P flux from sediment under anoxic conditions. A significant linear relationship was not observed between iron-bound P and anoxic diffusive P flux for the Chetek Chain of Lakes. However, sediments with higher iron-bound P concentrations tended to be associated with higher rates of diffusive P flux under anoxic condtions (i.e., Chetek, Pokegama, and Ten-Mile Lakes). In addition, iron-bound P concentrations tended to be high in the Chetek chain of lakes and comparable to those measured in eutrophic Half Moon Lake (Eau Claire, WI; James 2011).

Overall, sediments collected in the Chetek Chain of Lakes were very flocculent with high organic matter contents. Iron-bound P concentrations in the sediment were relatively high and, thus, represented an important source of mobile P to the overlying water column. Rates of diffusive P flux under anoxic conditions were high and comparable to other eutrophic systems. Sediments in the Chetek system can contribute internal P loads to the overlying water column for algal uptake under aerobic conditions and may play a role in sustaining high algal productivity in addition to external tributary P loads.

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Table 1. Mean (1 standard error in parentheses; n=2) rates of phosphorus (P) release for sediments collected in the Chetek Chain of Lakes.

Station	Diffusive P Flux	
	Oxic ($mg\ m^{-2}\ d^{-1}$)	Anoxic ($mg\ m^{-2}\ d^{-1}$)
Upper Prairie		8.6 (1.2)
Middle Prairie	1.2 (0.1)	7.5 (0.3)
Chetek	1.1 (<0.1)	6.8 (0.2)
Ten-Mile		14.3 (2.8)
Mud		5.7 (0.8)
Pokegama	0.9 (0.1)	9.7 (0.2)

Table 2. Textural characteristics for sediments collected in the Chetek Chain of Lakes.

Lake	Moisture Content (%)	Bulk Density (g/cm^3)	Sediment Density (g/cm^3)	Loss-on-ignition (%)
Upper Prairie	95.3	1.017	0.058	43.8
Middle Prairie	95.5	1.015	0.046	48.0
Chetek	95.6	1.019	0.050	31.1
Ten-Mile	92.5	1.023	0.090	52.3
Mud	87.0	1.067	0.142	21.7
Pokegama	95.4	1.020	0.046	31.4

Table 3. Concentrations of biologically labile P for sediments collected in the Chetek Chain of Lakes. DW = dry mass, FW = fresh mass.

Station	Redox-sensitive and biologically labile P					
	Loosely-bound P (mg/g DW)	Iron-bound P (mg/g DW)	Iron-bound P (ug/g FW)	Redox-sensitive P (mg/g DW)	Labile organic P (mg/g DW)	Sum (mg/g DW)
Upper Prairie	0.024	0.357	17	0.381	0.347	0.728
Middle Prairie	0.012	0.259	12	0.271	0.339	0.610
Chetek	0.193	2.23	99	2.423	0.100	2.523
Ten-Mile	0.052	1.597	120	1.649	0.155	1.804
Mud	0.013	0.344	45	0.357	0.114	0.471
Pokegama	0.128	2.328	107	2.456	0.175	2.631

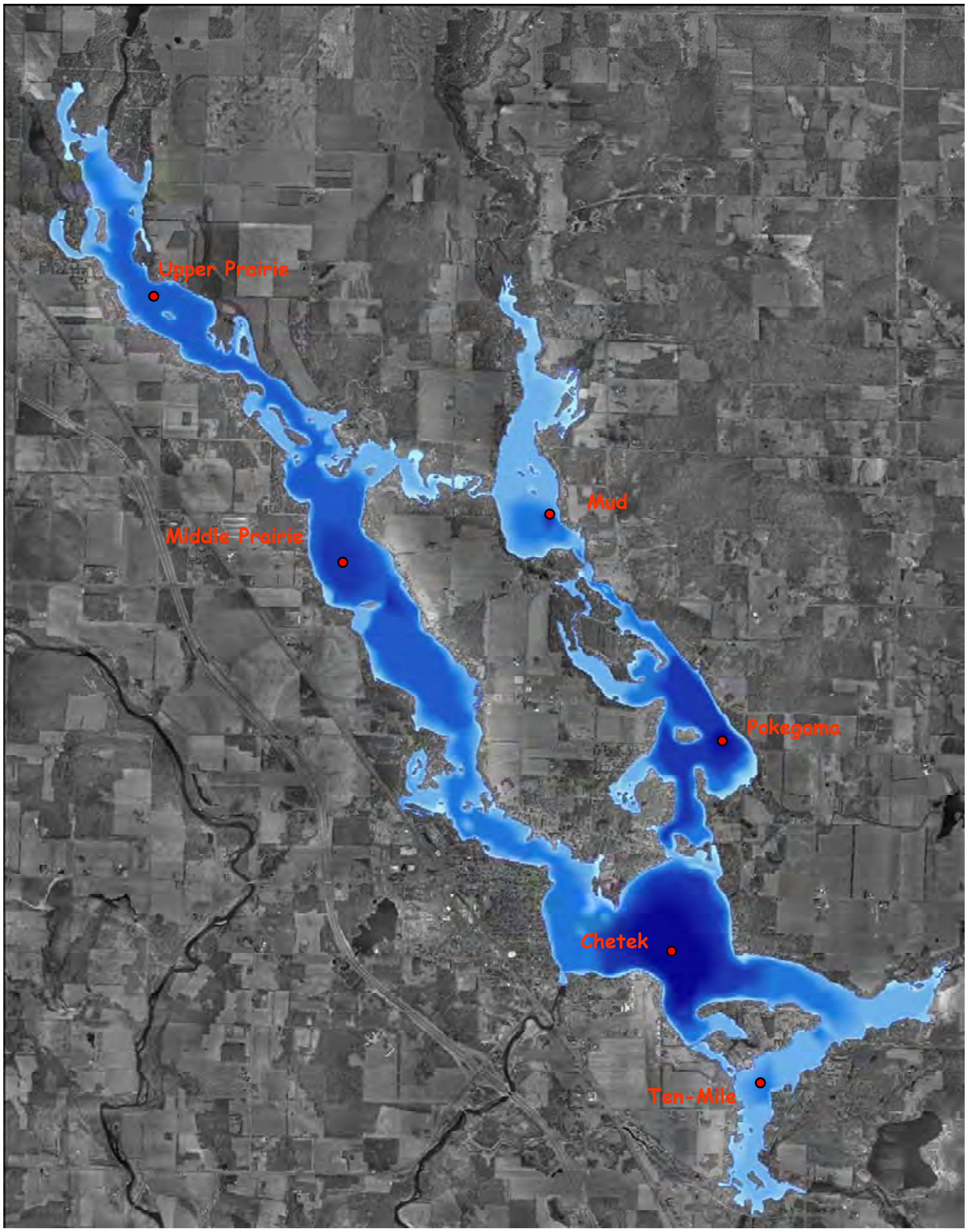

Figure 1. Station locations for sediment collection in the Chetek Chain of Lakes. Figure was provided by J. Macholl (SEH Inc.)

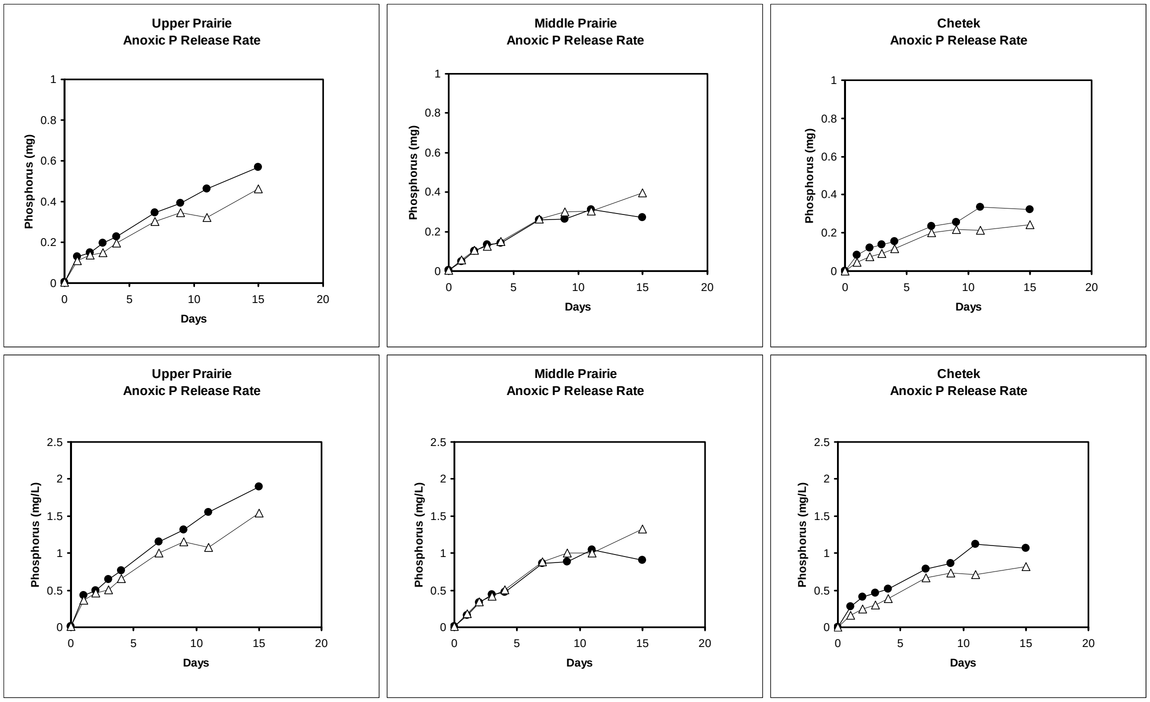

Figure 2. Changes in phosphorus (P) mass (upper panels) and concentration (lower panels) in the overlying water column under anoxic (i.e., anaerobic) conditions versus time for sediment cores collected in Upper Prairie, Middle Prairie, and Chetek Lakes.

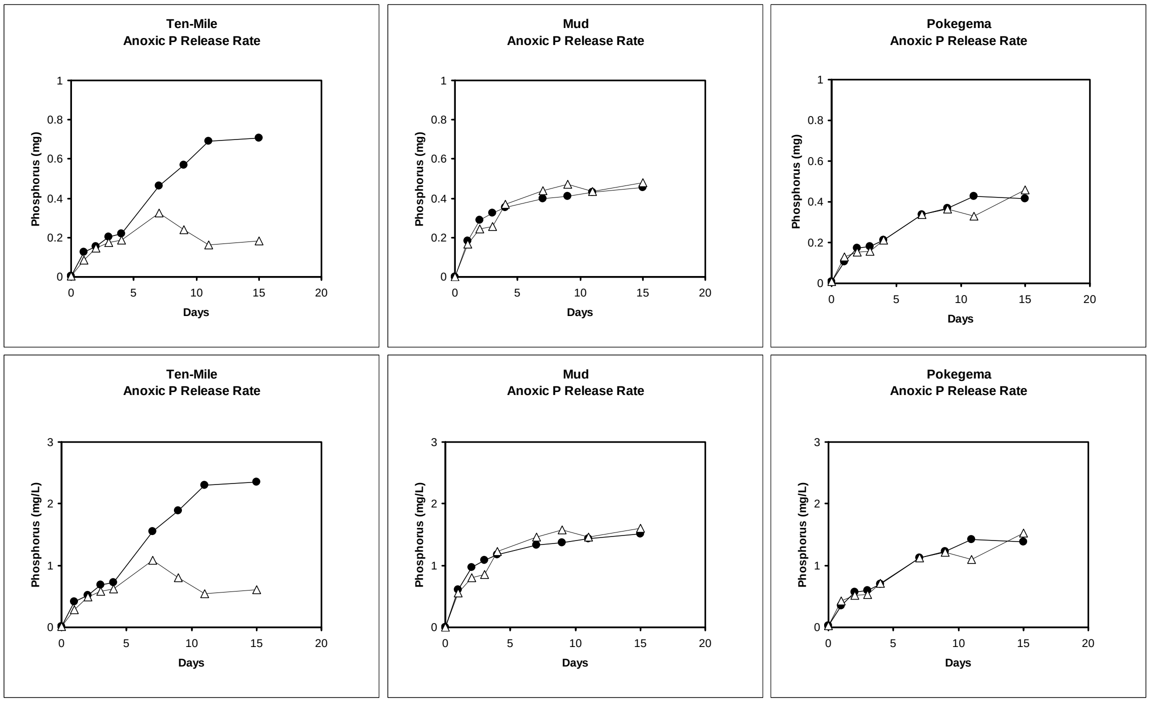

Figure 3. Changes in phosphorus (P) mass (upper panels) and concentration (lower panels) in the overlying water column under anoxic (i.e., anaerobic) conditions versus time for sediment cores collected in Ten-Mile, Mud, and Pokegama Lakes.

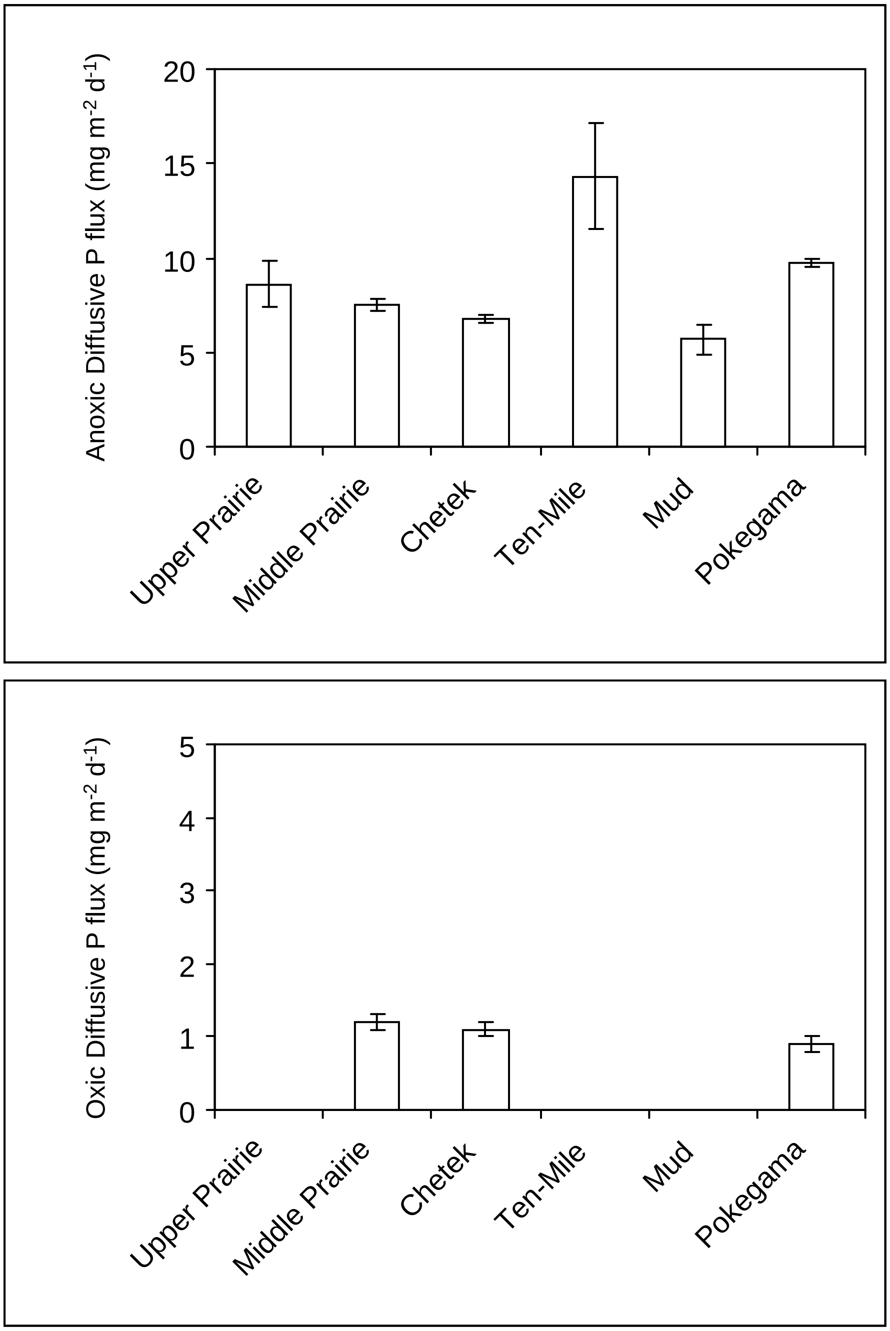

Figure 4. Mean (n=2) rates of diffusive phosphorus (P) flux under anoxic (upper panel) and oxic (lower panel) conditions. Vertical lines denote ± 1 standard error.

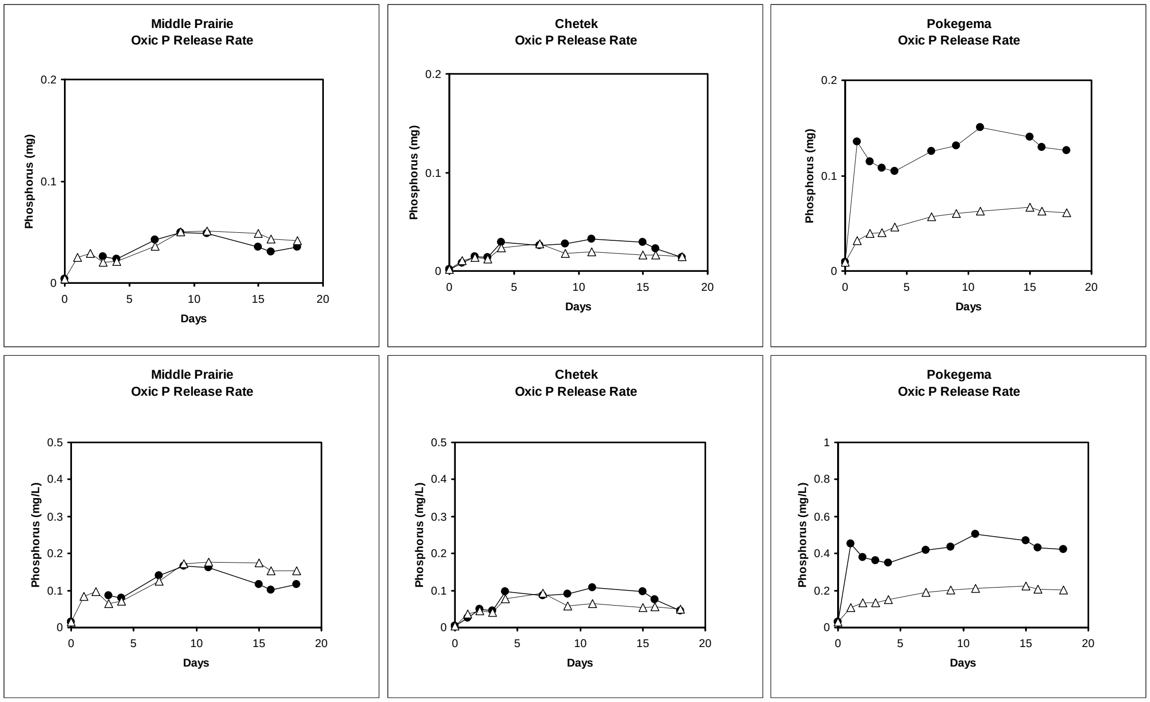

Figure 5. Changes in phosphorus (P) mass (upper panels) and concentration (lower panels) in the overlying water column under oxic (i.e., aerobic) conditions versus time for sediment cores collected in Middle Prairie, Chetek, and Pokegama Lakes.

DAIRYLAND LABORATORIES, INC.
Arcadia, WI 54612
Telephone 608-323-2123

MANURE ANALYSIS REPORT

019695

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

ANALYSIS RESULTS

SAMPLE ID

SAMPLE NAME: 2 AAGOT
MATERIAL: Dairy
STORAGE SYSTEM: Liquid

ACTUAL ANALYSIS

MOISTURE:	95.81%
SOLIDS:	4.19%
NITROGEN:	0.24%
AMMONIA NITROGEN:	0.01%
PHOSPHORUS:	0.01%
POTASSIUM:	0.01%
CALCIUM:	0.08%
MAGNESIUM:	0.01%
SULFUR:	0.04%
BORON:	1.98ppm
SODIUM:	65.21ppm
ZINC:	13.05ppm
IRON:	621.40ppm
MANGANESE:	11.82ppm
COPPER:	3.07ppm
ALUMINUM:	196.80ppm

	Total Nutrients	Estimated 1st year Available Nutrients — Time to incorporation		
		>72 hours or not incorporated	1 to 72 hours	<1 hour or injected
	lbs/1000 gal	lbs/1000 gal		
NITROGEN	19.92	5.98	7.97	9.96
PHOSPHATE	1.90	1.52	1.52	1.52
POTASH	1.00	0.80	0.80	0.80
SULFUR	3.32	1.83	1.83	1.83
AMMONIA NITROGEN	0.83			
CALCIUM	6.64			
MAGNESIUM	0.83			
BORON	0.02			
SODIUM	0.54			
ZINC	0.11			
IRON	5.16			
MANGANESE	0.10			
COPPER	0.03			
ALUMINUM	1.63			
TOTAL VALUE		$6.14	$7.28	$8.41

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Telephone 608-323-2123

MANURE ANALYSIS REPORT

019695

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

COMMENTS

Application of manure on the same field for 2 consecutive years increases availability of N, P, K, and S by 10%, and for 3 or more consecutive years by 15%.
Availability of N changes depending on application technique. Injection or incorporation within 3 days of application results in higher N availability.
Value based on commercial fertilizer costs as of 4/ 9/2014.

N (Urea)	0.57/lb
P2O5 (Triple Superphosphate)	0.65/lb
K2O (Potash)	0.38/lb
S (Elemental Sulfur)	0.80/lb

----------------------------BILLING INFORMATION-------------------------

SAMPLED BY: Tyler Gruetzmacher
SAMPLED FOR: CHETEK
PRODUCT: 2 AAGOT

Reference: 0138173
Date: 10/31/2014
Sample: 019695

$ 11.00 F/M NITROGEN
$ 11.00 F/M AMMONIA-N
$ 21.95 F/M MINERAL 12-PAK
$ 43.95 TOTAL INVOICE

DAIRYLAND LABORATORIES, INC.
Arcadia, WI 54612
Telephone 608-323-2123

MANURE ANALYSIS REPORT

019694

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

ANALYSIS RESULTS

SAMPLE ID

SAMPLE NAME: main lake 20'
MATERIAL: Dairy
STORAGE SYSTEM: Liquid

.03 / 6.92 = .4335% P
4335 ppm dry wt basis

ACTUAL ANALYSIS

MOISTURE:	93.08%
SOLIDS:	6.92%
NITROGEN:	0.06%
AMMONIA NITROGEN:	0.01%
PHOSPHORUS:	0.03%
POTASSIUM:	0.01%
CALCIUM:	0.09%
MAGNESIUM:	0.03%
SULFUR:	0.03%
BORON:	11.39ppm
SODIUM:	52.16ppm
ZINC:	18.23ppm
IRON:	3704.00ppm
MANGANESE:	46.66ppm
COPPER:	5.91ppm
ALUMINUM:	1059.00ppm

	Total Nutrients	Estimated 1st year Available Nutrients — Time to incorporation		
		>72 hours or not incorporated	1 to 72 hours	<1 hour or injected
	lbs/1000 gal	lbs/1000 gal		
NITROGEN	4.98	1.49	1.99	2.49
PHOSPHATE	5.70	4.56	4.56	4.56
POTASH	1.00	0.80	0.80	0.80
SULFUR	2.49	1.37	1.37	1.37
AMMONIA NITROGEN	0.83			
CALCIUM	7.47			
MAGNESIUM	2.49			
BORON	0.09			
SODIUM	0.43			
ZINC	0.15			
IRON	30.74			
MANGANESE	0.39			
COPPER	0.05			
ALUMINUM	8.79			
TOTAL VALUE		$5.20	$5.48	$5.76

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Telephone 608-323-2123

MANURE ANALYSIS REPORT

019694

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

COMMENTS

Application of manure on the same field for 2 consecutive years increases availability of N, P, K, and S by 10%, and for 3 or more consecutive years by 15%.

Availability of N changes depending on application technique. Injection or incorporation within 3 days of application results in higher N availability.

Value based on commercial fertilizer costs as of 4/ 9/2014.

N (Urea)	0.57/lb
P2O5 (Triple Superphosphate)	0.65/lb
K2O (Potash)	0.38/lb
S (Elemental Sulfur)	0.80/lb

----------------------------BILLING INFORMATION-------------------------

SAMPLED BY: Tyler Gruetzmacher
SAMPLED FOR: CHETEK
PRODUCT: main lake 20'

Reference: 0138172
Date: 10/31/2014
Sample: 019694

$ 11.00 F/M NITROGEN
$ 21.95 F/M MINERAL 12-PAK
$ 43.95 TOTAL INVOICE

$ 11.00 F/M AMMONIA-N

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Arcadia, WI 54612
Telephone 608-323-2123

MANURE ANALYSIS REPORT

019696

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

ANALYSIS RESULTS

SAMPLE ID

SAMPLE NAME: 7-8' moose ear
MATERIAL: Dairy
STORAGE SYSTEM: Liquid

ACTUAL ANALYSIS

MOISTURE:	93.74%
SOLIDS:	6.26%
NITROGEN:	0.17%
AMMONIA NITROGEN:	0.01%
PHOSPHORUS:	0.01%
POTASSIUM:	0.02%
CALCIUM:	0.13%
MAGNESIUM:	0.04%
SULFUR:	0.05%
BORON:	8.57ppm
SODIUM:	65.93ppm
ZINC:	16.25ppm
IRON:	2742.00ppm
MANGANESE:	40.18ppm
COPPER:	5.57ppm
ALUMINUM:	1429.00ppm

	Total Nutrients	Estimated 1st year Available Nutrients — Time to incorporation		
		>72 hours or not incorporated	1 to 72 hours	<1 hour or injected
	lbs/1000 gal	lbs/1000 gal		
NITROGEN	14.11	4.23	5.64	7.06
PHOSPHATE	1.90	1.52	1.52	1.52
POTASH	1.99	1.59	1.59	1.59
SULFUR	4.15	2.28	2.28	2.28
AMMONIA NITROGEN	0.83			
CALCIUM	10.79			
MAGNESIUM	3.32			
BORON	0.07			
SODIUM	0.55			
ZINC	0.13			
IRON	22.76			
MANGANESE	0.33			
COPPER	0.05			
ALUMINUM	11.86			
TOTAL VALUE		$5.81	$6.61	$7.42

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Telephone 608-323-2123

MANURE ANALYSIS REPORT

019696

SAMPLE NUMBER	SUBMITTED BY:	GROWER:
ACCT # 1	Tyler Gruetzmacher	CHETEK

DATE RECEIVED	DATE PROCESSED
10/31/2014	10/31/2014

,

COMMENTS

Application of manure on the same field for 2 consecutive years increases availability of N, P, K, and S by 10%, and for 3 or more consecutive years by 15%.

Availability of N changes depending on application technique. Injection or incorporation within 3 days of application results in higher N availability.

Value based on commercial fertilizer costs as of 4/ 9/2014.

N (Urea)	0.57/lb
P2O5 (Triple Superphosphate)	0.65/lb
K2O (Potash)	0.38/lb
S (Elemental Sulfur)	0.80/lb

----------------------------BILLING INFORMATION-------------------------

SAMPLED BY: Tyler Gruetzmacher

SAMPLED FOR: CHETEK

PRODUCT: 7-8' moose ear

Reference: 0138174

Date: 10/31/2014

Sample: 019696

$ 11.00 F/M NITROGEN

$ 21.95 F/M MINERAL 12-PAK

$ 43.95 TOTAL INVOICE

$ 11.00 F/M AMMONIA-N

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Arcadia, WI 54612
Telephone 608-323-2123

MANURE ANALYSIS REPORT

019697

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

ANALYSIS RESULTS

SAMPLE ID

SAMPLE NAME: ten mile 8'
MATERIAL: Dairy
STORAGE SYSTEM: Liquid

ACTUAL ANALYSIS

MOISTURE:	92.42%
SOLIDS:	7.58%
NITROGEN:	0.10%
AMMONIA NITROGEN:	0.01%
PHOSPHORUS:	0.02%
POTASSIUM:	0.01%
CALCIUM:	0.11%
MAGNESIUM:	0.03%
SULFUR:	0.04%
BORON:	13.12ppm
SODIUM:	45.64ppm
ZINC:	12.34ppm
IRON:	4320.00ppm
MANGANESE:	64.62ppm
COPPER:	4.11ppm
ALUMINUM:	790.10ppm

	Total Nutrients	Estimated 1st year Available Nutrients — Time to incorporation		
		>72 hours or not incorporated	1 to 72 hours	<1 hour or injected
	lbs/1000 gal	lbs/1000 gal		
NITROGEN	8.30	2.49	3.32	4.15
PHOSPHATE	3.80	3.04	3.04	3.04
POTASH	1.00	0.80	0.80	0.80
SULFUR	3.32	1.83	1.83	1.83
AMMONIA NITROGEN	0.83			
CALCIUM	9.13			
MAGNESIUM	2.49			
BORON	0.11			
SODIUM	0.38			
ZINC	0.10			
IRON	35.86			
MANGANESE	0.54			
COPPER	0.03			
ALUMINUM	6.56			
TOTAL VALUE		$5.14	$5.62	$6.09

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Arcadia, WI 54612
Telephone 608-323-2123

MANURE ANALYSIS REPORT

019697

SAMPLE NUMBER		SUBMITTED BY:	GROWER:
ACCT # 1		Tyler Gruetzmacher	CHETEK
DATE RECEIVED	DATE PROCESSED		,
10/31/2014	10/31/2014		

COMMENTS

Application of manure on the same field for 2 consecutive years increases availability of N, P, K, and S by 10%, and for 3 or more consecutive years by 15%.
Availability of N changes depending on application technique. Injection or incorporation within 3 days of application results in higher N availability.
Value based on commercial fertilizer costs as of 4/ 9/2014.

N (Urea)	0.57/lb
P2O5 (Triple Superphosphate)	0.65/lb
K2O (Potash)	0.38/lb
S (Elemental Sulfur)	0.80/lb

BILLING INFORMATION

SAMPLED BY: Tyler Gruetzmacher
SAMPLED FOR: CHETEK
PRODUCT: ten mile 8'

Reference: 0138175
Date: 10/31/2014
Sample: 019697

$ 11.00 F/M NITROGEN
$ 11.00 F/M AMMONIA-N
$ 21.95 F/M MINERAL 12-PAK
$ 43.95 TOTAL INVOICE

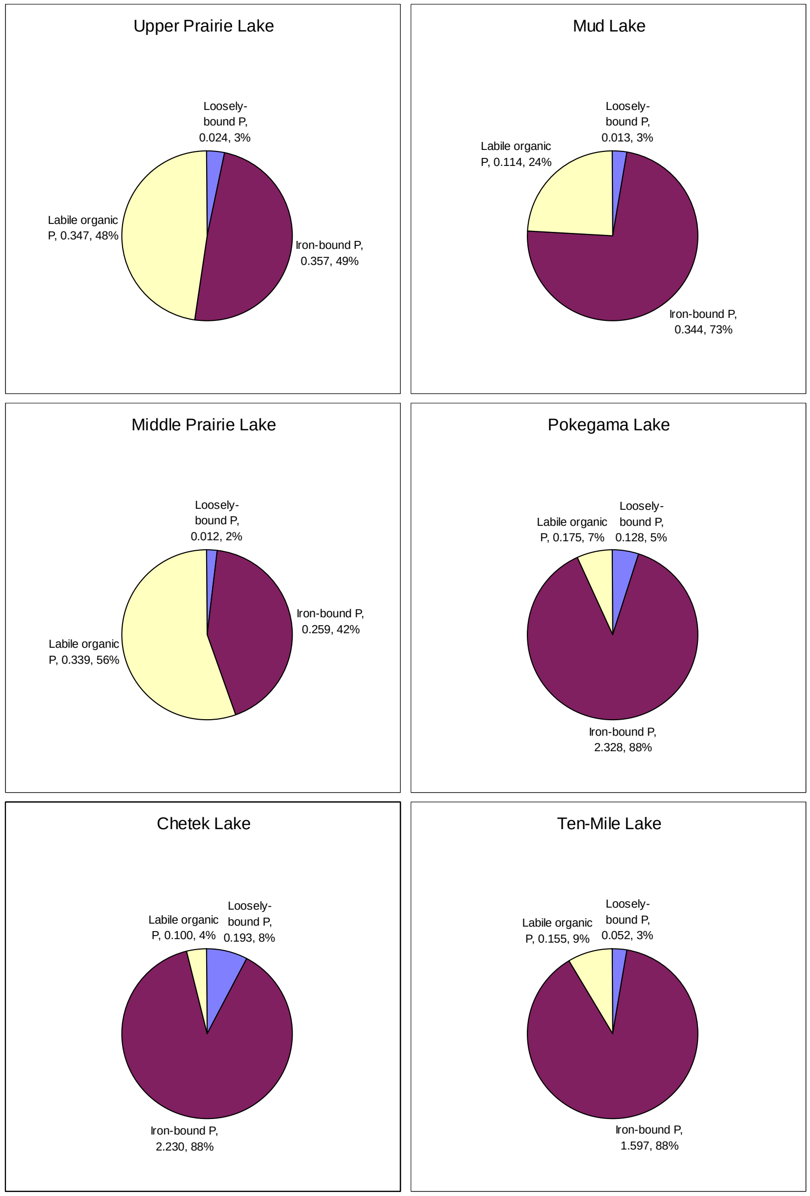


Figure 6. Composition of biologically labile phosphorus (P) concentrations for sediment collected in the Chetek Chain of Lakes.

Hydraulic Dredging

Cost: \$2.88 to \$7.23 per cubic yard. (Includes planning, dredging, and “disposal” costs)

Can be substantially decreased (transport distance, volunteer time and resources—e.g. hauling and spreading) or increased (exceed \$52.00 per yard if contaminated)

How much phosphorus? An example:

Aagate	(18 acres below 1 ft depth)	
72843.4	m^2	
7.5	$mg/m^2/day$ (anoxic release)	
546325.5	mg/day	
1.20444	lb/day	**Pounds per <u>DAY</u>**

If utilized for algae growth=

602.2201	pounds of algae

Remove top 2 feet of sediment

44405.34 cubic yards

Assume high cost @ 7.23/yd³

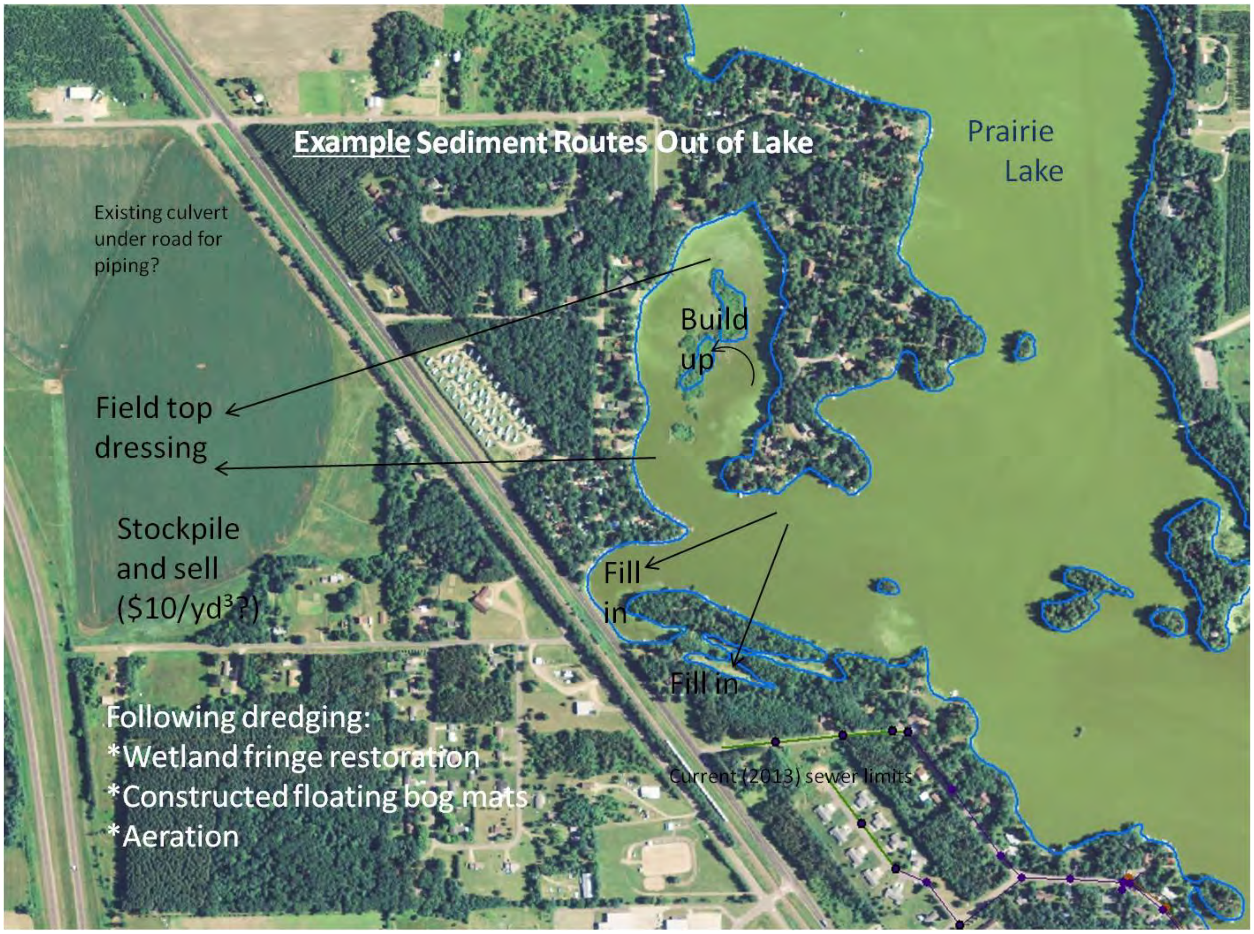
\$321,050.61

Assume low cost @ 2.88/yd³

\$127,887.38

Approx 1432 lake residents

High Cost	\$224.20	per person
Low Cost	\$89.31	per person



Example Sediment Routes Out of Lake
Prairie Lake
Existing culvert under road for piping?
Build up
Field top dressing
Stockpile and sell ($10/yd³?)
Fill in
Fill in
Following dredging:
*Wetland fringe restoration
*Constructed floating bog mats
*Aeration
Current (2013) sewer limits

CONVERSION OF POTOMAC RIVER DREDGE SEDIMENTS TO PRODUCTIVE AGRICULTURAL SOILS[1]

W. Lee Daniels, G. Richard Whittecar and Charles H. Carter III[2]

Abstract. River channel and harbor dredging activities in the eastern USA generate hundreds of millions of yards of dredge sediments annually with very little used beneficially. The Woodrow Wilson Bridge project across the Potomac River at Washington D.C. generated in excess of 450,000 m^3 of silt loam, high pH, low salt dredge spoils. The materials were barged to Shirley Plantation on the James River in Charles City Co. Virginia, and placed into an upland utilization area atop a previously reclaimed sand and gravel mine. The strongly reduced inbound sediments were very low in sulfides, pesticides, and other contaminants. The materials were dewatered, treated with varying rates of yardwaste compost and planted to wheat (*Triticum vulgare*) in the fall of 2001 and corn (*Zea mays)* in 2002 and 2003. Winter wheat yields in 2001 were similar to local agricultural lands despite animal damage and less than ideal establishment conditions. Average corn yields in 2002 were greater than long-term county prime farmland yields in a severe drought year (2002) and equaled county averages in a wet year (2003). Farmer measured yields in 2005 and 2006 remained at or above county averages. Soil pit and auger observations revealed significant oxidation and formation of a deep Ap-AC-C profiles with coarse prismatic structure within two years after placement. Overall, the chemical and physical properties of these materials are equal or superior to the best topsoils in the region, supporting federal initiatives to utilize suitable dredge materials in upland environments whenever possible.

Additional Key Words: Sand and gravel mining, oxidation, water quality, beneficial use.

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