Bone Lake Alum Committee Report 4.16.19

EXECUTIVE SUMMARY

At the August 2018 annual meeting of Bone Lake Management District (BLMD), formation of the alum (aluminum sulfate) committee was approved. The committee's mission was to evaluate the use of alum to treat Bone Lake's internal load and to make a recommendation to use or not to use alum to the board of commissioners and District membership at the 2019 annual meeting.

The reason for investigating the use of alum to treat our internal loading was because two studies completed in 2018 found that 50 percent of Bone Lake's phosphorus loading is coming from our lake sediments (internal loading). In prior years we had estimated our internal loading to be 15 percent. While we have practices in place to reduce the phosphorus loading coming from other sources (septic systems, curly leaf pondweed, runoff from lakefront properties and streams), we have no active program to reduce our phosphorus from internal loading.

The studies by Bill James, University of Wisconsin Stout, and Steve Schieffer, Ecological Integrity Services, indicated that internal phosphorus loading from bottom sediments is contributing to water quality impairment in Bone Lake. Bill James' study also suggests the recommended alum dosing is expected to control internal load phosphorus loading. With alum treatments, the Secchi disk readings would improve by approximately three feet in late summer/early fall from 3.5-to 4-foot range to 6.5 to 7.0-foot range.

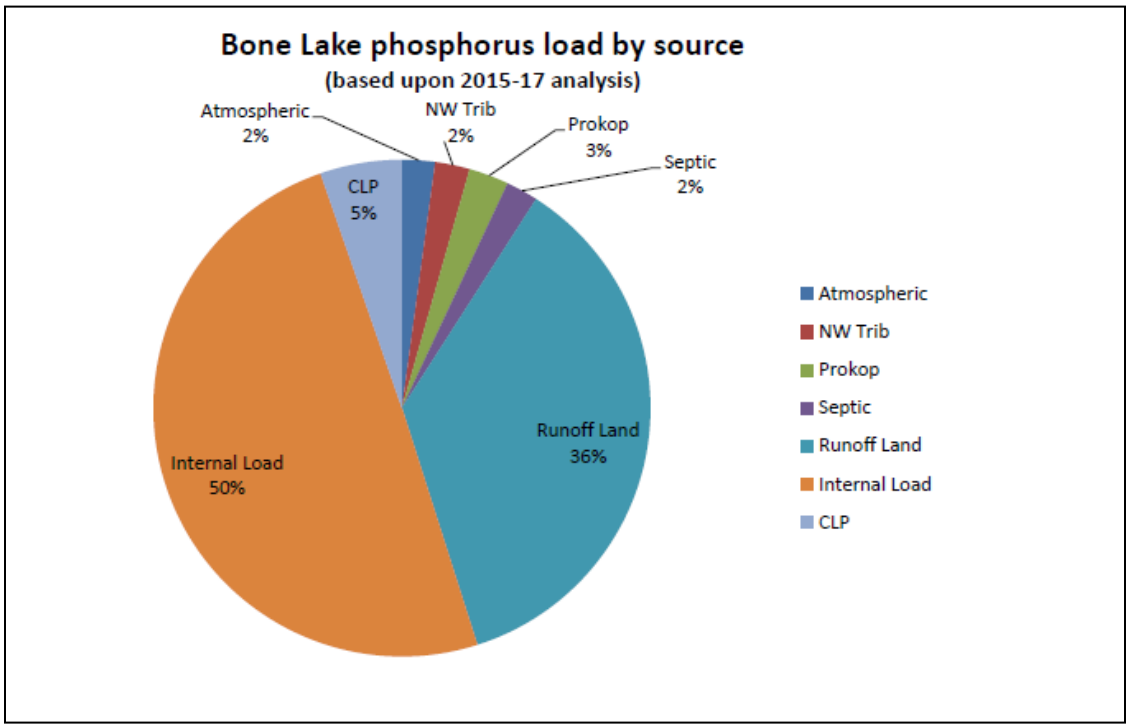
The application and financing costs for the initial round of alum treatments would be approximately $2.3 million and be financed using a 10-year term loan with multi draws. Depending on the number of DNR grants received, the cost to property owners is estimated at $82 to $107 per year per $100,000 in assessed value for first 10 years and then a reduced cost for subsequent treatments.

The committee developed a draft proposed communication strategy if the committee did approve the use of alum.

After several meetings, the committee voted, by 6 to 5, to not recommend the use of alum for our internal load treatment at this time. The primary reasons for voting against alum is the lake clarity was perceived to be not impaired enough to warrant the cost. The committee did recommend that an internal load committee be formed to continue to evaluate our internal load, develop communications with property owners, and recommend, if needed, any future treatment program.

BONE LAKE INTERNAL LOAD WHY CONSIDERING TREATMENT OPTIONS

From 2015 to 2017, Bone Lake Management District learned more about how lake sediment (internal load) influences our algae growth. Phosphorus (P) is the key nutrient for the growth of algae. The lake sediment contains a lot of P which gets released into the water when there is no oxygen in the bottom layer of water, a condition called anoxia. When the lake is no longer stratified (layered), the phosphorus is brought to the surface and becomes available for algae growth. Previously we had estimated that of Bone Lake's total P loading, lake sediment was contributing approximately 15 percent. The recent three-year studies indicates it is closer to 50 percent.



The studies by Bill James, PhD, University of Wisconsin Stout, and Cheryl Clemens, Harmony Environmental, along with Steve Schieffer, Ecological Integrity Services, suggests that internal P loading from bottom sediments is contributing to water quality impairment in Bone Lake. (These studies are on our website bonelakewi.com). Anoxia occurred for 58 to 69 days over this three year period. The lake was stratified, but weakly, especially in 2015 and 2016. In each of the three years from 2015 to 2017, the lake was fully mixed in the early to mid-August, leading to substantial P release with resulting algae blooms and impaired water clarity.

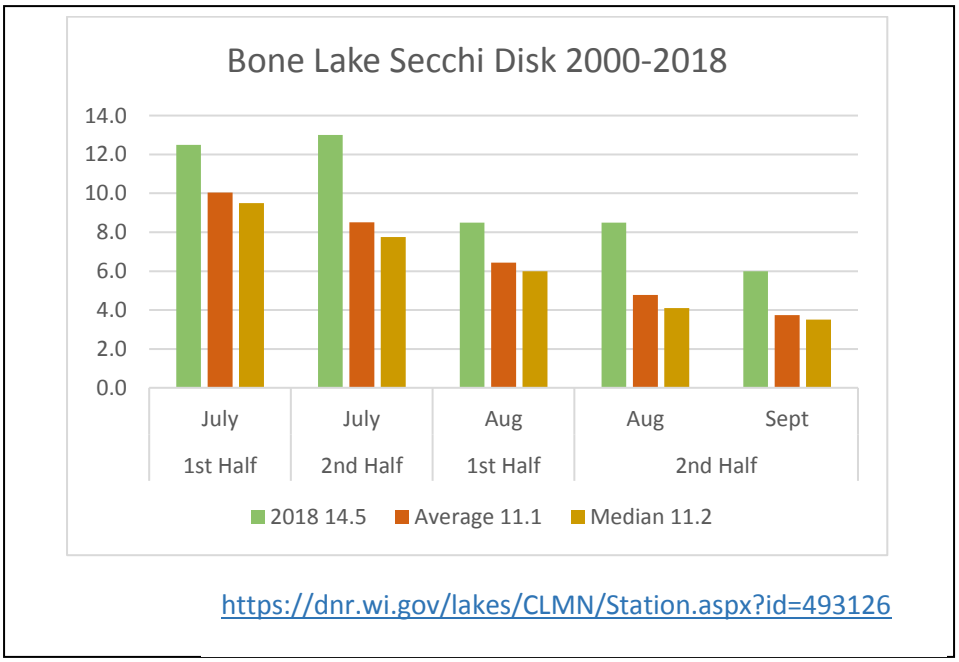
With this updated information regarding phosphorus loading, we updated our phosphorus reduction goals for the next ten years.

Goal to reduce Phosphorus (P) Loading by 48% next 10 years

	Current Loading	Reduction	Impact to Loading
Septics	2%	22%	- 1%
Prokop/NW trib	5%		
Waterfront Runoff /Streams	36%	7% *	- 2 %
Lake Surface precipitation	2%		
CLP	5%	19%	- 1%
Internal load	50%	90% **	- 44%
Impact to total P Load	100%		- 48%

- Source Cheryl Clemens and Phil Foster
- ** Source Bill James University Wisconsin Stout

Bone Lake is listed as an impaired lake by the Wisconsin DNR due to excess algae growth caused by phosphorus. 2018, though, was an exception to our normal year, due perhaps to the late ice-out, and less wind and rain than usual. The water clarity was excellent as the lake remained stratified until early September resulting in record Secchi disk readings in August and September.



https://dnr.wi.gov/lakes/CLMN/Station.aspx?id=493126

We have practices in place to reduce the phosphorus coming from septic systems, curly leaf pondweed and runoff from lakefront properties and streams. While these practices are very important, they will not reduce P loading as much as internal load management. Internal load reduction could demonstrate great improvement because it contributes 50% of the load and it can be controlled at a high rate. We currently have no active program in place to manage this internal load P. The committee focus was to investigate the use of alum to manage internal load.

For additional information on the relationship between water clarity, algae and lake vegetation, please see attached article titled " Improving Water Clarity on Bone Lake: Algae, Bacteria, and Aquatic Plants."

ALUM BACKGROUND: HISTORY, SAFETY AND HOW IT WORKS

What is alum?

Alum (aluminum sulfate) is a nontoxic liquid. Alum is also a common food additive and has also been used for decades to clean our drinking water before consumption. The same alum that has been used to clean drinking water is applied to lakes to improve water clarity. Aluminum, the main ingredient of alum, is the third most abundant element in the earth's crust and naturally occurs in lake sediments.

Is alum safe?

Virtually all food, water, air, and soil contain aluminum. The average adult consumes 7 to 9 milligrams of aluminum every day. The FDA supports the safe use of alum as a food additive and a single dose of Maalox contains 400 milligrams of aluminum. Alum use in lakes results in an especially low exposure to aluminum as very low amounts of aluminum are added during an application, and the alum remains undissolved in the lake sediments.

The Environmental Protection Agency (EPA) provides recommended aquatic life criteria for aluminum in freshwater depending on a site's water chemistry. Aluminum is considered a non-essential metal because fish and other aquatic life don't need it to function. Elevated levels of aluminum can affect some species ability to regulate ions, like salts, and inhibit respiratory functions.

EPA United States Environmental Protection Agency

Office of Water
EPA 822-F-18-003
December 2018

Fact Sheet: Final 2018 Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwaters

The EPA updated its recommended aluminum criteria in 2017 to reflect the latest science and to provide users the flexibility to develop criteria based on site-specific water chemistry. The document provides a scientific assessment of ecological effects and is not a regulation. https://www.epa.gov/wqc/aquatic-life-criteria-aluminum

There is a large body of scientific literature documenting the safe use of alum in lake environment conditions, which has allowed the North American Lake Management Society (NALMS) to endorse its use.

North American Lake Management Society

PO Box 5443 • Madison, WI 53705-0443 • 608 233 2836 • www.nalms.org

The Use of Alum for Lake Management

"Alum is a safe and effective method to mitigate excess phosphorus in lakes and reservoirs. Alum applications should be designed and controlled to avoid concerns with toxicity to aquatic life. Watershed management is an essential element of protecting and managing lakes." https://www.nalms.org/nalms-position-papers/the-use-of-alum-for-lake-management/ Alum toxicity is avoided by keeping pH in a neutral range during application. If there is not enough alkalinity in the water, this is accomplished with the use of buffered alum.

Aquatic plants are generally less sensitive to aluminum than fish and other aquatic life. Increased water clarity following alum applications can have the unintended effect of increasing light availability and, therefore, increasing the area of rooted aquatic plant growth in treated lakes.

How does alum work?

The use of alum in lakes began in the early 1970's to reduce the amount of phosphorus in the water. It is most often used to control phosphorus release from lake bottom sediments (internal loading).

Alum is applied to lakes using specialized equipment and barges that ensure the precise placement in the lake. On contact with the water, the liquid alum forms a fluffy aluminum hydroxide precipitate called floc. Aluminum hydroxide binds with the phosphorus to form an aluminum phosphate compound. The compound is insoluble in water and the bound phosphorus can no longer be used to fuel the algae.

As the floc settles, phosphorus and particles are removed from the water column leaving the lake noticeably clearer. The floc then forms a thin layer on the bottom that binds the phosphorus as it leaches out of the bottom sediments during internal loading events. The floc layer keeps the phosphorus from entering the overlying water and makes it unavailable to the algae.

The result is a reduction in the frequency and intensity of nuisance algal blooms rather than the total elimination of algae. Repeated alum applications are typically required to control the internal phosphorus release. For more information, see http://bonelakewi.com/docs/ALUM/Alum%20information.pdf

POTENTIAL IMPACT OF WATER CLARITY ON PROPERTY VALUES

Bemidji State University examined 1205 residential property sales on 37 lakes from 1966-2001, concluding that "water clarity is very significant related to the price per foot of lakeshore." For example, on Leech Lake in Minnesota, a 3 foot increase in water clarity increased property values $590 per foot, or $23,500 gain on a 40 foot lake front lot. A 3 foot decrease in clarity would cut values by $700 per frontage foot, or $28,000 decline on a 40 foot lake front lot.

A University of Wisconsin, Eau Claire study examined 324 recent residential property sales on lakes in northern Wisconsin. It reported a 3-16% increase in home value with a 3 foot increase in water clarity. Average values increased by $26,000 ($243,400 to $269,400) with a 3 ft. clarity improvement.

An Ohio State University study demonstrated that Buckeye Lake in Ohio lost $101M in home values in the six years between 2011-2016 due to algal blooms.

ALUM CASE STUDIES REVIEWED

Bald Eagle Lake, St Paul, MN

Joe Bischoff of Wenck Associates and Matt Kocian, project manager at Rice Creek Watershed District (RCWD) participated in a conference call with our subgroup.

Bald Eagle Lake, suburban St. Paul, is a 1270 acre lake that had total P of 80 ppb, chlorophyll a of 30 ppb, and water clarity of 1 meter (3 feet) with nuisance algae blooms and violation of state phosphorus standards. Alum was chosen over aeration and hypolimnetic withdrawal because of:

- Lower cost

- Anticipated equal or better cost-effectiveness
- Track record
- Low maintenance – doesn't require infrastructure

They expect 50% effectiveness at 15 years, and expected longevity of 20-30 years.

Funding was achieved by creating a special tax district within RCWD and charging property owners $150/year for first period (7-10 years) and $75/year for properties with deeded access. This covered ½ of expense; other ½ came from RCWD. Two years remain on the term; then it will be extended at a lower rate.

Two applications were done in 2014 and 2016. Results were as follows:

	1980-2014	2014-present
Phosphorus	72 ppb	24 ppb
Water Clarity	1.4M	2.3M

Improvements:

- 66% improvement in phosphorus
- 63% improvement in water clarity
- High satisfaction with water clarity among property owners

Cedar Lake, New Richmond, WI

- 1120 acre lake on border of Polk / St. Croix Counties
- Low dose (20%) covered a little over half of the lake (682 acres)
- P dropped significantly in 2017, and began to increase in 2018.
- 2nd dose (22%) will be administered 2019
- Big reduction in the amount of algae
- Significant majority of the 278 property owners were in favor

Long Lake, Polk County, WI

- 272 acres; max depth 17 ft; avg depth 11 ft
- 2012: Total P 146 µg/L; avg secci depth 2.1 ft; avg chlorophyll 82 µg/L
- History of algal toxins
- Treated in June 2018
- P reduced from 146 to 30 µg/L

Ann Lake, Mora, MN

A 2018 engineering study by Wenck for Ann Lake near Mora MN reviewed the following methods:

- Alum $ 651,000

- Phoslock –relatively new $1,325,000
- Aluminum chloride – works similarly to alum $ 870,000
  More commonly used in Europe
- Hypolimnetic aeration $2,016,000
  Includes $29K/yr operating expense x30 years

We were not been able to determine whether Ann Lake moved forward with a decision.

WHY ALTERNATIVE INTERNAL LOAD TREATMENTS NOT RECOMMENDED

The committee reviewed the alternative options of hypolimnetic aeration and Clarus, a sponge-like device being tested at the University of Minnesota. Findings were as follows:

Aeration

Companies that design and install aeration systems were contacted and the following experts were consulted:

- Jennifer Jermalowicz-Jones, PhD, owner of Restorative Lake Sciences, which manages over 100 lakes in Michigan
- John Tucci of EverBlue Lake Solutions, which installs AerForce™ systems and is testing BioBlast™, beneficial bacteria for use along with aeration.

EverBlue uses laminar flow to maintain O_2, with the objective of eliminating anoxia by continuously mixing the lake. Photos of lakes treated, equipment used, and track record were reviewed. Case studies for Indian Lake in MI and Toa Vaca Reservoir in Puerto Rico were presented. Lakes treated were much smaller than Bone Lake and most were in Michigan.

According to Jones and Tucci, the **Pros** of aeration are:

- Improves the lake's health and improves its ability to handle future internal loading:
  - Should increase water clarity
  - Should reduce nutrients in the water column and sediments
  - Should improve the fishery
- May be more cost-effective than alum (would need a preliminary engineering design with installation, operation and maintenance costs)

They also reviewed the **Cons** of aeration:

- Requires equipment to be installed and maintained
  - Compressors, diffusers, air lines
- If not properly designed (coverage), operated and maintained, it can increase internal P loading by mixing P released from the hypolimnion to the lake surface, where algae can grow

- Might be more costly than alum
- It's newer technology
    - Hasn't yet been implemented on a lake as large as Bone Lake
    - It hasn't been studied as extensively as alum

The committee concluded, after evaluating the benefits and limitations of alum vs. aeration, that alum would be the treatment of choice.

	Alum	Aeration
Benefits	• Long track record • Improved water clarity, decreased P, chlorophyll, and blue-green algae demonstrated in Bald Eagle, Long and Cedar Lakes locally as well as many others. • Extensive research published in peer-reviewed scientific literature • Longevity up to 20 years • Low maintenance – no infrastructure needs	• No environmental concerns
Limitations	• Cost • Event-based restoration	• Cost: set-up plus operating expense for electricity and service usually exceeds alum • Labor-intensive: requires dedicated operator achieving peak performance to get result • Must continue in perpetuity • If size wrong, can make it worse • May not be effective for internal load control • Paucity of data; little in peer-reviewed literature • Hasn't been used in large lakes like Bone • Requires equipment installed on lake shore • More commonly used in water treatment than in recreational lake restoration

Clarus

Clarus is the sponge-like device being developed at the University of Minnesota to absorb P. In their first attempt, results weren't successful. They will try again, most likely

testing on a smaller scale. Availability of the product, if successful, it maybe 5-10 years out. It is therefore not an option for Bone Lake at this time.

ALUM PROPOSED DOSAGE STRATEGY FOR BONE LAKE

Bill James in his report dated Dec 2017, *Examination of sediment phosphorus fluxes and aluminum sulfate dosage considerations for Bone Lake, Wisconsin,* recommends a dosage strategy. This full report is on the website bonelakewi.com.

A certain alum concentration is required to react with mobile P in the sediment. Bill James recommends a dose of 100 g Al/m2 applied to depths greater than 30 feet (563 acres) and split in three applications over five years. An example of an adaptive management approach in which Al dose is split into smaller applications follows:

Table 9. An example adaptive management scenerio approach in which the Al dose is split into smaller applications. A smaller dose is applied to lake sediments in year 1. The second Al application and dose is determined via annual sediment profile monitoring. In this example, annual sediment core vertical profiling indicated that a second application should occur in year 3 at a dose estimated from similar core analysis.

Variable	Year 1	Year 2	Year 3	Year 4	Year 5
Al application	50 g/m^2		25 g/m^2		25 g/m^2
Assessment[1]					

[1]Sediment core collection and vertical profile monitoring

Predicted Improvements as a result of alum treatment are as follows:

Parameter	2015-17 mean	No Sediment P Release	% Change
Total Phosphorus (mg/L)	54	34	37 ↓
Chlorophyll-*a* (mg/L)	22	12	45 ↓
Secchi Depth (ft)	5.9	8.5	44 ↑

The alum committee further reviewed Bill James' recommendation and, to spread out the costs, recommended the dosage of 100 g Al/m^2 applied over 6 years. The first year application would be 40 g/m^2; the third year, 30 g/m^2; and the sixth year, 30 g/m^2.

ALUM COSTS AND FUNDING

We formed a finance subcommittee comprised of Bob Murphy, Jim Widen, Pat Schmidt and Phil Foster to review and recommend items related to alum cost, financing and how to allocate costs to the BLMD property owners.

This is our estimated cost of three alum treatments over 6 years.

Estimated Costs over 10 years	
First Application @ 40g/m^2	$802,472
Second application @ 30 g/m^2 in 3 years	$632,348
Third application @ 30 g/m^2 in year 6	$670,289
Testing and misc. costs	$ 60,000
Financing costs of a 10-year term loan	$146,500
Total costs	$2,311,609
Funding:	
Cash from District	$200,000
Grants (minimum grants assumed)	$200,000
Balance from property owners	$1,911,609

The alum cost projection was received from John Holz from HAB Solutions, an alum applicator. It represents a projected first application cost for 2020 and then a 2% inflation thereafter. Aluminum sulfate pricing has been fairly stable these past five years, so we are being conservative in regard to future price increases.

Funding for alum cost is from three sources – District cash, grants and property owners with loan financing. The District has been building up cash to expend on a major lake improvement project, and there is an estimated $200,000 available. Wisconsin DNR grants are available for alum treatments – in $200,000 increments per treatment. The DNR grant application deadline is Feb 1 of each year and grants are awarded based on merit. Up to $600,000 grants (one $200,000 grant for each treatment) could be received. Our conservative assumption is to receive only one DNR grant for $200,000. The balance would be paid by BLMD property owners over a proposed 10-year term loan for the first 3 treatments. Then in year 11, we would start accruing for alum maintenance treatments which could start in year 15

Cost per property

Based on BLMD allocating costs on assessed valuation to all properties in the District and using a ten-year multi draw term loan, the following are our cost estimates:

Estimated costs to property owners

With one $200,000 DNR grant

First 10 years (first 3 treatments)	Per Year	Total for 10 Yrs.
Cost per $100,000 property	$107	$1,070
Cost per $350,000 property	$375	$3,745

With two grants totaling $400,000

First 10 years two grants	Per Year	Total for 10 Yrs.
Cost per $100,000 property	$ 94	$ 940
Cost per $350,000 property	$329	$3,299

With three grants totaling $600,000

First 10 years three grants		
Cost per $100,000 property	$ 82	$ 820
Cost per $350,000 property	$ 287	$2,887

Next 10 years- years 11 to 20 with alum treatment in year 15 (short term financing but no grants assumed)

Cost per $100,000 property	$ 60	$ 600
Cost per $350,000 property	$ 210	$2,100

Repayment Options

The finance committee evaluated several alternatives to pay for these treatments – pay as you go with special assessment, pay as you go without special assessment, and various options regarding loan financing (reference repayment options on Schedule A).

We recommended using a ten-year loan with a multi draw. We reviewed two funding sources for a loan – Frandsen Bank and the Board of Commissioners for Public Lands. Frandsen Bank required audited financial statements, legal approval for a nonprofit loan and would offer a loan up to ten years. The Board of Commissioners for Public Lands required no audit and offered competitive loan rates locked into the government bond rate for a ten-year term loan with multi draws. A resolution is required for any borrowing and that resolution must be sent to property owners prior to the annual meeting or special meeting. The loan interest rate was estimated at 3.25% to 3.50% for the initial and subsequent draws. We recommend using the Board of Commissioners for Public Lands with a ten-year term loan with mutli draws.

How to allocate costs to properties.

We reviewed various methods to distribute these costs to the District property owners. (Schedule B).

Estimated number of BLMD properties

	Number	% of total	% of value
• Lake frontage lots	435	80%	93%
• Back lots with lake access	50	9%	5%
• Back lots with no lake access	60	11%	3%
• Total	545	100%	100%

We recommended allocating the costs on property valuation per the tax roles in BLMD. We included back lots owned by lake front property owners but were uncertain if we should exclude back lots that do not have lake front access. If we did exclude back lots with no lake access from paying for the alum treatment, the cost per allocated property would increase by approximately 3% from the above-mentioned numbers.

Grant Funding

At the time of asking for property owner approval, we do recommend asking for Alum approval contingent upon receiving one $200,000 grant award from the DNR. (See Schedule C)

COMMUNICATIONS - LEARNINGS FROM OTHER LAKES

We formed a communications subcommittee consisting of Shelley Rose, Jerry Lutgen, Cary Olson, Kathleen Killeen and Michael Downey to review and recommend strategies for communicating the results of the alum committee process to BLMD property owners.

We interviewed leadership from the lake districts of Long Lake and Cedar Lake, both in Polk County, WI regarding their communications strategies for evaluating and ultimately choosing alum treatment.

Cedar Lake, North of New Richmond, WI

Contact: Dan Early

Communications Strategies and Key Learnings:

- Main communications vehicle was newsletter mailed directly to homeowners; meeting minutes were not felt to be particularly effective
- Recommends trying to get as many property owners emails as possible; send announcements directing them to the website, which should be robust with information
- “More communication is better”
- Inform that while they will see positive change, there will still be some algae
- Sharing scientific data was key
- Reminded people that Cedar Lake is on Wisconsin Impaired Lakes list
- Developing a “pay as you go” financing plan, not incurring borrowing costs, was a turning point in gaining acceptance
- Suggests having everyone talk to 3-4 neighbors, directing them to the website for details
- Property value impact was an important selling point

Long Lake, West of Balsam Lake, WI

Contact: Anna Turk

Communications Strategies and Key Learnings:

- Develop a broad approach, coordinating :
    - Website
    - Facebook page
    - Newsletter
    - Emails
    - Handouts
    - Demo during the June 2018 application
- Provide small digestible bites, then start over and repeat.
- Begin with the basics: e.g., “what’s a Secchi disk?”
- Advice: start earlier!
- Will need to correct misinformation, rumors
- HAB: John Holz and staff very helpful with great materials to support communications

COMMUNICATIONS - PROPOSED COMMUNICATION STRATEGY

After the vote not to immediately recommend alum treatments for Bone Lake, the Alum Committee expressed a strong desire to continue its work to monitor internal phosphorus load and its effect on Bone Lake’s water clarity. To that end, an internal phosphorus load standing committee has been recommended to the board.

The Alum Committee will also report back to the BLMD Board and to Bone Lake residents. The Committee drafted this document to (1) report back to the Board on the action of the Alum Committee, and (2) capture the information and work reviewed by the Committee during the process.

The residents of Bone Lake will receive a variety of communications regarding the work of the Alum Committee including:

1) Spring 2019 newsletter article to communicate the Alum Committee work and the outcome of the vote as charged at the 2018 annual meeting.
2) Ongoing communications to educate residents on phosphorus, including that related to internal load, Secchi disk readings and water clarity, and alum as the treatment of choice to mitigate the effects of internal phosphorus load. These communications will be periodic electronic posts to the Bone Lake Facebook page and web site.
3) Finally, there will be a live presentation at the 2019 Annual BLMD Meeting.

Acknowledgements

A big thank you is extended to the members of the alum committee:

Bob Boyd
Michael Downey
Kathleen Killeen
Jerry Lutgen
Bob Murphy
Cary Olson
Shelley Rose
Pat Schmidt
John Ukura
Jim Widen
Wayne Wolsey
Cheryl Clemens (consultant, moderator)
Phil Foster (chair).

Supporting Documents

Financing Schedule A
Financing Schedule B
Financing Schedule C
Agenda 10.20.2018 meeting
Minutes 10.20.2018 meeting
Agenda 12.1.2018 meeting
Minutes 12.2.2018 Meeting
Agenda 2.16.2019 meeting
Minutes 2.16.2019 meeting
Improving Water Clarity on Bone Lake: Algae, Bacteria, and Aquatic Plants