Outcomes - Ann Lake Stakeholders Meeting #1 - 9/29/21
Ogilvie Civic Center, 6:30 – 8:30 pm

In attendance:

Ann Lake residence: Erik Peterson, Rich Anderson; Kanabec Twp. Supervisor: Bruce Berg; Fish Lake Improvement Assn.: Jim Kutil; Ann Lake Twp. Supervisors: Paul Hoppe, Vern Bossen; ALWA: Sharon Smith, Jeff Hamme, Margot Kohl; Knife Lake Twp. Rep.: Gerald Evenson; Kanabec Co. Cms.: Craig Smith, Dennis McNally; SWCD Supervisor: Jon Sanford, SWCD Staff: Deanna Pomije, Josh Votruba

Purpose Statement: This is the first of two meetings for the various stakeholder or representatives of Ann Lake to meet and discuss potential treatment options for Ann Lake. Treatments meant to address the high nutrient content in the lakes' bottom sediment. The goal is to decide on the best treatment for Ann Lake or for the no treatment option.

Due to internet technical difficulties the meeting was not able to be shared through the remote platform, WebEx. An estimated 13 people were reported on the remote call. These difficulties were communicated to those on the call. Two people were able to show up for the in-person meeting; that were previously on the WebEx call. Apologies were sent out the following day to those not able to attend. These meeting outcomes will be shared with everyone and posted on the SWCD website.

Deanna Pomije with Kanabec SWCD presented information on each of the proposed treatments and answered some of the questions regarding the treatments. See at the bottom, the treatment comparison – pros / cons sheet for reference. This meeting covered the six treatment options currently being explored by the SWCD and Ann Lake Watershed Alliance (ALWA) to treat the high internal load of phosphorus in Ann Lake. These options included:

- Aluminum Sulfate
- Phoslock
- Polyaluminum Chloride
- Hypolimnetic Aeration
- Dredging
- Drawdown

Questions Posed & Answers Presented:

<u>Researching underlined questions yet.</u>

(Starting on p. 17 below – A brochure explaining Alum from the WI DNR from 2003)

1. What part of lake is to be treated with Alum and how many acres?
   The deepest part of the lake, the western basin is planned location for all the three elemental treatments (Alum, Phoslock & Polyaluminum Chloride). To be treated would be the 15 the foot

contour and deeper area off Indian Point and to the west. This is the area with the highest concentration of sediment phosphorus. This area to be treated is estimated to be 60 acres.

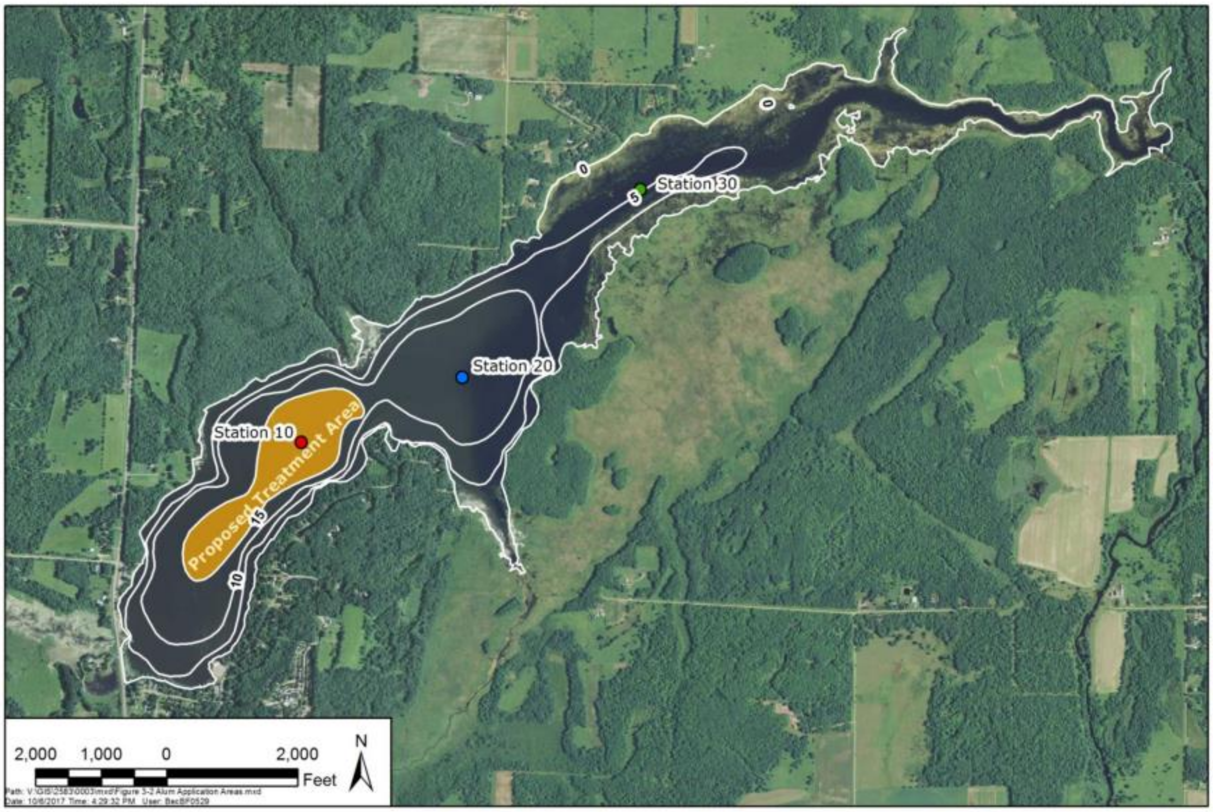


Figure 3-3. Proposed internal load treatment area for Ann Lake.

2. What time of year would Alum be applied?
   Alum is applied as a liquid just below the water's surface during the growing season.
   Below are added resources provided by our consultant Wenck on the Alum impacts to wild rice.

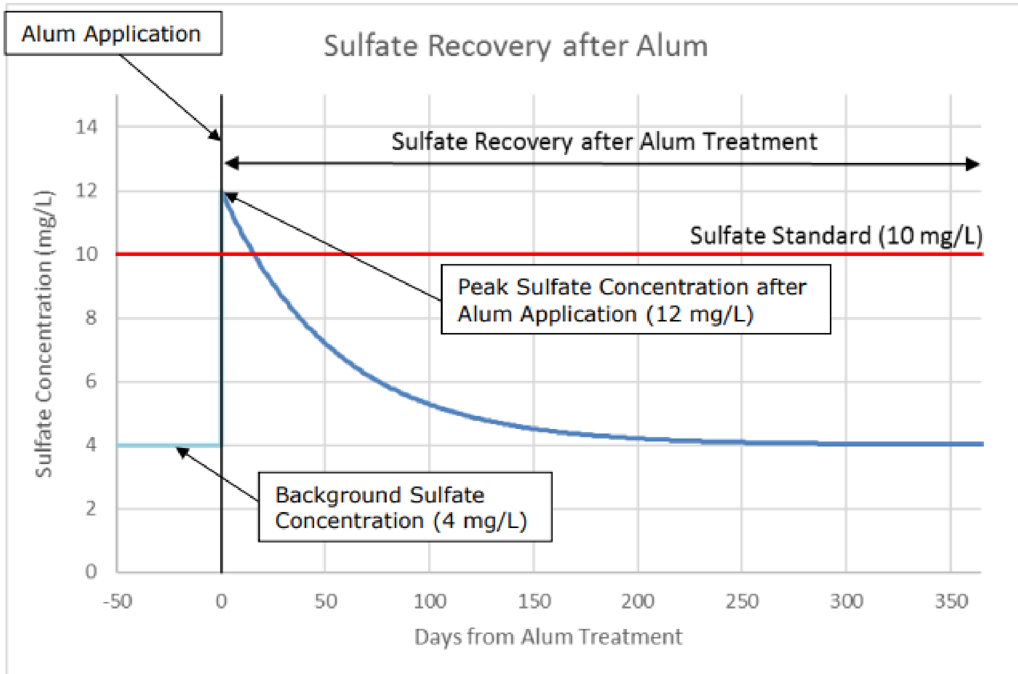
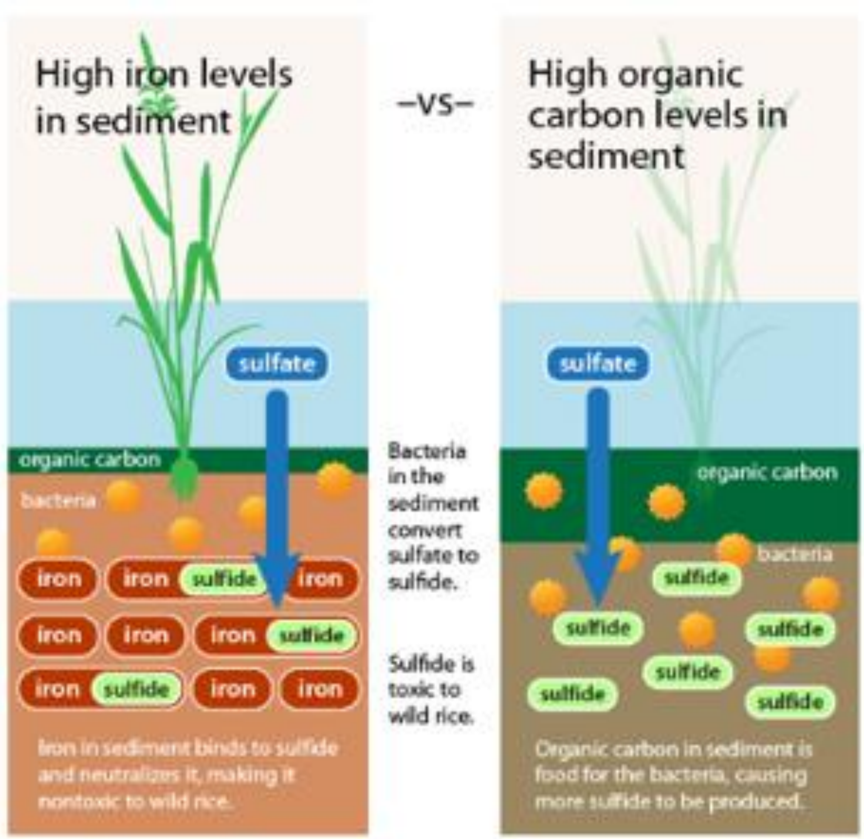


Figure 4-2. Modeled sulfate concentration in Ann Lake after aluminum sulfate treatment.

The sulfate standard for wild rice water bodies is 10 mg/L. See above, Wenck estimates a short-term exposure above this standard, of about 2 weeks.



3. Were there any studies prior to 2004 showing slow buildup of phosphorus internal load?
   No, not prior to 2004. There have been 2 core samplings completed in Ann Lake: in 2011 & 2016.

   Three sediment cores were taken from Ann Lake in 9/11/16, their results:

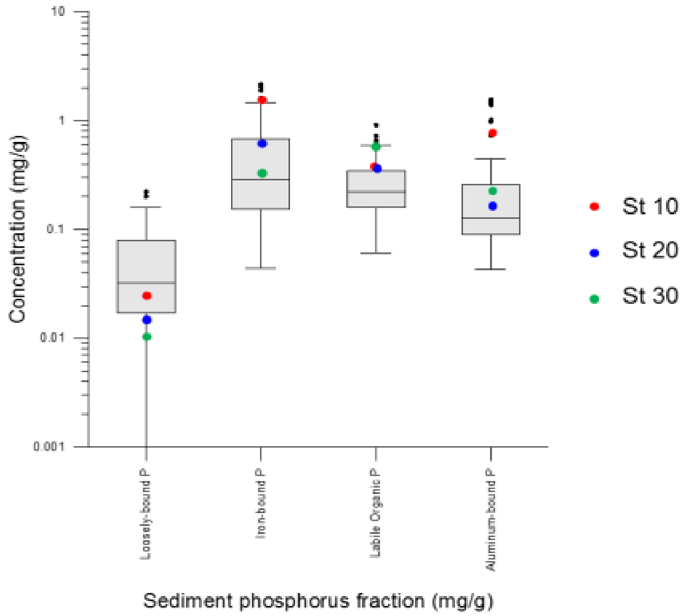


Figure 3-1. Sediment phosphorus fractionation in Ann Lake compared to other lakes in Minnesota.

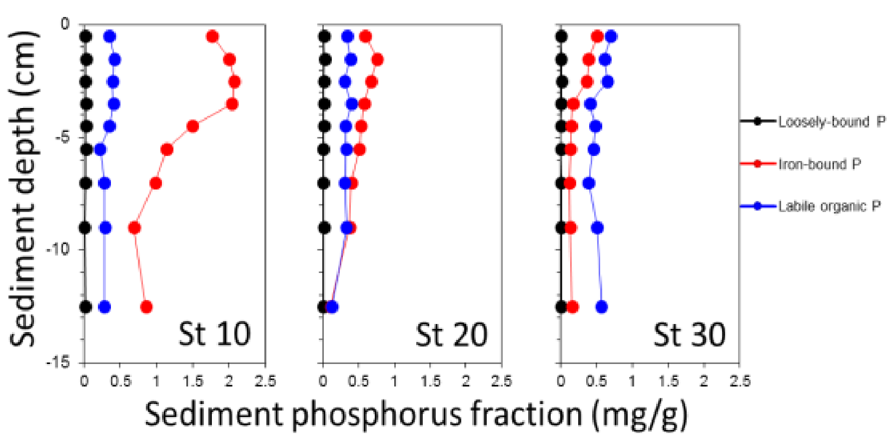


Figure 3-2. Mobile phosphorus fractions in Ann Lake sediment.

Sediment cores were taken from the central basin of Ann Lake in 2/2011, prior to the TMDL report of 2013 - appendix H, Results below:

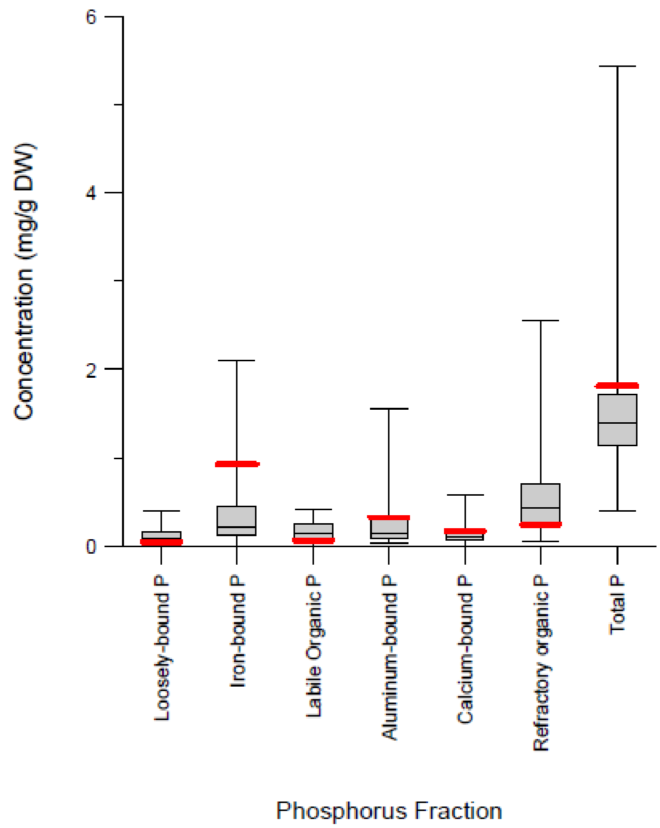


Figure 4. Box and whisker plots comparing various sediment phosphorus (P) fractions measured for Ann Lake sediments (red line) with statistical ranges (n=40) for lakes in the Minneapolis-St. Paul area. Loosely-bound, iron-bound, and labile organic P are biologically-labile (i.e., subject to recycling) and aluminum-bound, calcium-bound, and refractory organic P are more are more inert to transformation (i.e., subject to burial). See Figure 2 for legend.

Comparing the 2011 to the 2016 iron bound Phosphorus (P) – In 2011 the iron bound P was just under 1 mg/g in concentration vs. in 2016 this same P component was just below 1.5 mg/g concentration.

4. What is the cost per gallon for Alum?

Table 4-1. Ann Lake alum application cost estimate.

Ann Lake Alum Application Cost Estimate				
Item	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
1st Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
2nd Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
3rd Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
4th Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
5th Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
6th Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
7th Aluminum Sulfate Dose	Gal $Al_2(SO_4)_3$	46,142	$1.80	$83,056
Application Total				$581,392
Application observation and monitoring				$15,000
Bidding, Permitting, and Specification Development				$15,000
Follow Up Monitoring				$40,000
Total Cost Estimate				**$651,392**

(From p. 4-2 of the 2018 Feasibility Study)

- Watershed BMPs
  - Efficient practice = $1,000/lb of TP removed
  - Ann Lake TMDL watershed reduction goal = 217 lbs/year
  - Potential cost for watershed practices= $217,000

- Internal Load Alternatives
  - Ann Lake TMDL internal reduction goal = 4,096 lbs/yr
  - Alum = $159/lb of TP removed
  - PaCl = $212/lb of TP removed
  - Phoslock® = $323/lb of TP removed
  - Hypolimnetic Aeration = $492/lb of TP removed

5. Has the fish population of Ann Lake been negatively impacted by the high phosphorus internal load?

6. Wouldn't the internal load of phosphorus slowly go down over time since it is being released from sediment over time?
   No, not really. The lake is a complex cyclic system. Yes, phosphorus is being released and can cause excess growth of aquatic plants and algae. However, when the plants and algae die; their nutrients are cycled back into the lake. They may settle in the bottom and decompose, using up oxygen and cycling back their nutrients in the process. (If decomposition is in excess, this can cause other concerns with low oxygen levels.)

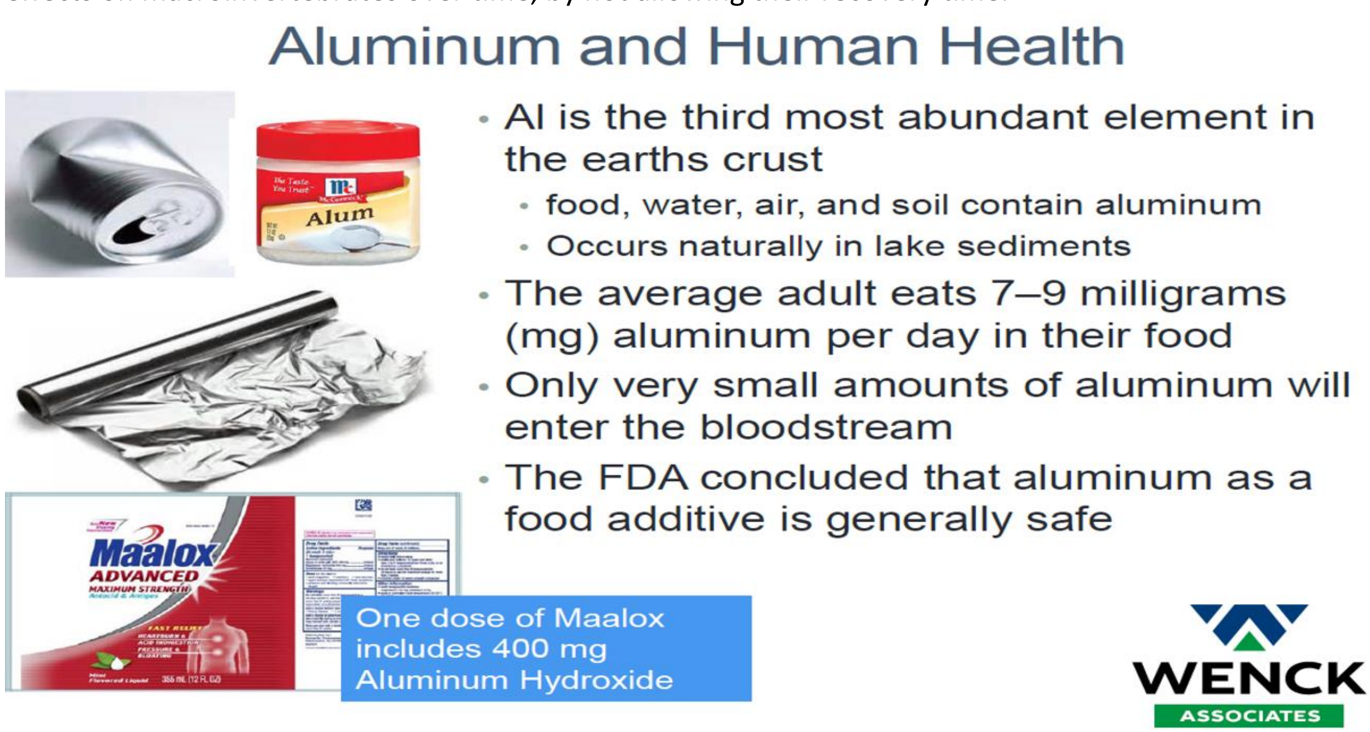
We also have continuous nutrients coming into the lake from various sources in the watershed. (leaky septics, livestock runoff, nutrients from developed lakeshore) Yes, conservation projects have been completed in recent years to lower some of these nutrient sources. There are also some sources of nutrients coming from nature, wildlife feces and wetland.

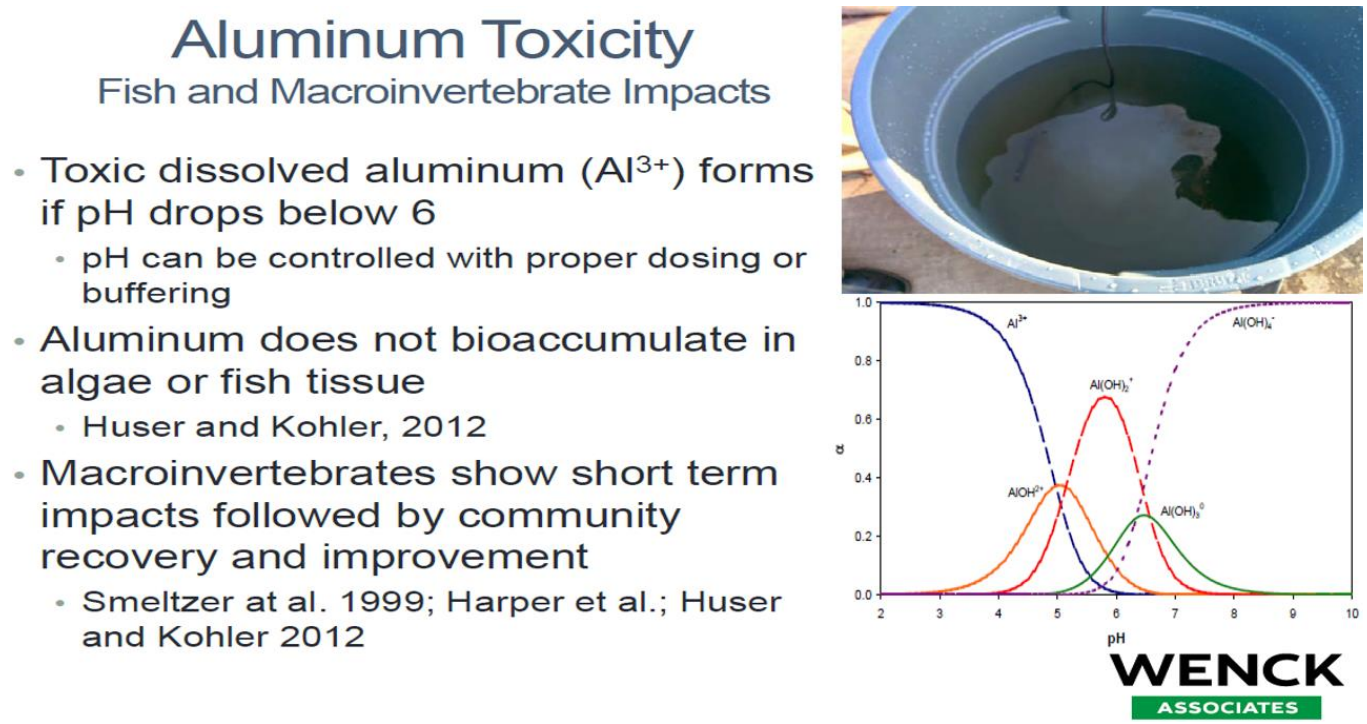
7. Why would you aerate the lake in winter?

8. Would Fish Lake also be treated if it rains after Ann Lake treatment? Would Phoslock or Alum go down Ann River into Fish Lake?
   Alum, under most conditions is insoluble in water, so it's not anticipated to runoff with the water flow downstream into the Ann River or Fish Lake.

9. How would Phoslock be applied?
   We believe this to be applied as a solid, similar to how an Alum treatment is applied, over the water surface in the deepest part of Ann Lake.

10. Does Alum affect human health? Would it affect people swimming in lake day of treatment?
    Alum is safe for both humans and lake organisms. There should be no impact to people swimming in the lake the day of an Alum treatment. Aluminum does not bioaccumulate in algae or fish tissue. Macroinvertebrates (bugs) show a short-term negative impact followed by recovery and improved bug populations. However, our treatment schedule of every other year may have more adverse effects on macroinvertebrates over time, by not allowing their recovery time.





11. If we were to pursue grants for the treatment; who would be the grant applicant and holder?
    The Kanabec SWCD.

12. Where would we get the 10 - 40% required match from, for a potential grant?
    This has yet to be determined. Pomije explained a grant application scenario: Apply for a state and federal grant so the grant for one could be used towards the match of the other. Would propose to apply initially for only ½ of the multi-year proposed treatment plan. Monitoring between treatments and the compilation of an Environmental Assessment Worksheet (EAW) would be incorporated as part of the grant. The grants applied for could be a combination of the following, with the 1st grant(s) set up to pay for ½ of the treatment and the other grant(s) for water quality work (conservation practices) within the watershed to help satisfy the match for the 1st grant. So, the 2nd grant(s) will need local funding to satisfy the match. This local funding in-part could come from landowners installing conservation practices on their land within this watershed. We have done much voluntary conservation work already in this watershed (Ann River, both Ann & Fish Lakes), which makes continued conservation work more difficult. We've already worked on the low hanging fruit, the easier projects. Some local match funds would still be needed.
    - State BWSR grants, 25% match
    - State 1w1p Implementation grant, 10% match
    - Federal 319 Clean Water Partnership Project Grant, 40% match
    - Other Grants…

13. What can be used for in-kind for a potential grant?
In-kind work is just one form of match that can be counted to satisfy a grant's requirements. On state grants match can be provided by landowners, land occupiers, private organizations, local governments or other non-State sources and can be in the form of cash or the cash value of services or materials contributed to the accomplishment of grant objectives. Each grant may have specific requirements on what counts toward satisfying the required match.

According to the Board of Water and Soil Resource (BWSR) – Clean Water Fund Grant Policy FY 2022, list of ineligible activities for funds or match:

4. Ineligible Activities The following activities are ineligible for these funds. The Clean Water Fund Competitive RFP may identify program specific ineligible activities.

4.1 Activities that do not have a primary benefit of water quality.
4.2 Water quality monitoring such as, but not limited to, routine, baseline, diagnostic, or effectiveness monitoring. This includes both surface and groundwater monitoring activities.
4.3 Household water conservation appliances and water fixtures.
4.4 Wastewater treatment with the exception of Subsurface Sewage Treatment Systems (SSTS).
4.5 Municipal drinking water supply facilities or individual drinking water treatment systems.
4.6 Storm water conveyances that collect and move runoff, but do not provide water quality treatment benefit.
4.7 Activities that outlet landlocked basins.
4.8 Development and delivery of educational activities and curriculum that do not support or lead to the implementation of prioritized and targeted water quality practices.
4.9 Replacement, realignment or creation of bridges, trails or roads.
4.10 Aquatic plant harvesting.
4.11 Routine maintenance or repair of best management practices, capital equipment and infrastructure within the effective life of existing practices or projects.
4.12 Feedlots: a. Feedlot expansions beyond state registered number of animal units. b. Slats placed on top of manure storage structures.
4.13 Subsurface Sewage Treatment Systems (SSTS):
   a. Small community wastewater treatment systems serving over 10,000 gallons per day with a soil treatment system, and
   b. A small community wastewater treatment system that discharges treated sewage effluent directly to surface waters without land treatment.
4.14 Any project that contributes to, or otherwise is used to replace wetlands impacted under the Wetland Conservation Act (per Minn. Rules. 8420).
4.15 Fee title land acquisition or easement costs, unless specifically allowed. If not specifically allowed, land acquisition and easement costs can count toward the required match if directly associated with the project and incurred within the grant period.
4.16 Buffers that are required by law (including Drainage Law and Buffer Law).

4.17 Activities required under the Groundwater Protection Rule. 4.18 Components of projects needed to meet the statutory requirements of 103E Drainage Law.

14. Would we be able to apply Phoslock or Alum during the winter, so as not to interfere with wild rice growth?

15. Can you apply Phoslock on the ice?

16. How deep would we dig for dredging?

17. Is an environmental assessment worksheet needed for a treatment?
    That would be dependent on the treatment that is decided upon. More than likely yes. The cost of this could be written into the grant and completed by a consultant.

18. Is drawdown a viable option?
    We don't believe so. Given the height of the dam; a drawdown would not empty out the deepest part of the lake. Could a pump be used to partially empty the deepest area? It is unclear the benefits to a drawdown to address the high internal phosphorus load in the deepest part of the lake. A drawdown is expected to consolidate the sediment substrate in the shallower, littoral area of the lake. A drawdown would provide a great opportunity to plant more native aquatic plants for generally better water quality. An education component would be needed to demonstrate the benefits of aquatic plants.

19. Would a drawdown affect phosphorus in the deepest lake sediment?

20. Is a treatment supported by Ann Lake residents?
    ALWA has endorsed a treatment for the high internal load of phosphorus but has not specified which treatment. Half a dozen citizens on the lake support a treatment.

21. Where did treatment options come from? Are there more options?

Four of the treatment options considered come from the Ann Lake Internal Load Feasibility Study from 2018; Alum, Phoslock, Polyaluminum chloride and Hypolimnetic Aeration. The dredging and drawdown options came from discussions on treatment options. For other possible treatment options (chemical, physical and biological) see the MN State and Regional Govt. Review of Internal Phosphorus Load Control, starting on p. 15.

Next, 2nd Ann Lake Stakeholder's Meeting Date: in-person and remote option

Wed., December 1, 6:30-8:30pm

ALUMINUM SULFATE (ALUM)	PHOSLOCK	POLYALUMINUM CHLORIDE	HYPOLIMNETIC AERATION	DREDGING	DRAWDOWN
$651,000	$1,325,000 – 1,527,500	$870,000	$1,250,000 & $29,000 Annually	$6,800,000	
PROS					
• Option most used in US • Least expensive • P Load reduction (+90%) like ALUM	• Longevity (30 yrs.), binds forever • No apparent environmental concerns • Well documented internal load reductions in Europe • CA study results: decrease TP >80% & free reactive P >95%	• Fast & effective removal of phytoplankton species • No sulfate concerns • P Load reduction (+90%) like ALUM • No long-term effects • Rapidly transforms into non-toxic complexes	• No foreign elements introduced into lake	• No foreign elements introduced into lake	• No foreign elements introduced into lake • Opportunity to plant native plants in lake

ALUMINUM SULFATE (ALUM)	PHOSLOCK	POLYALUMINUM CHLORIDE	HYPOLIMNETIC AERATION	DREDGING	DRAWDOWN
CONS					
• Longevity estimate 23-30 years; polymictic lake like Ann – 10 yr. longevity • Spikes Sulfate levels – concern over impact to wild rice; may require environmental impact statement & more monitoring • Negative impact to benthic invertebrates – recovers after ~2 yrs. • pH concerns – using a buffering solution (added expense) we may alter application schedule	• Expensive • Used more abroad, not in US • Lanthanum bioaccumulates, but no effects observed	• Longevity like ALUM, 23-30 yrs. • Used more in Europe, not in US • Short-term effects on primary consumers	• Expensive • High annual maintenance cost • Thin ice danger	• Expensive • Direct impact to fish / invertebrate & plant communities • High cost – placement of dredged materials • Toxic dredged materials	• Depending on length, loss recreation • Not publicly favored • Fish removal • High engineering costs

ALUMINUM SULFATE (ALUM)	PHOSLOCK	POLYALUMINUM CHLORIDE	HYPOLIMNETIC AERATION	DREDGING	DRAWDOWN
COMMENTS					
• Could adjust treatment schedule • Liquid aluminum sulfate – Al binds with highly mobile redox P (90%) – settles to bottom	• 5% lanthanum (inert soft metal) + 95% bentonite clay • Phoslock slowly adsorbs P over time	• Al binds with highly mobile redox P (90%) – settles to bottom • Multiple doses allow for increased contact time with P • Efficiency depends on pH & organic matter concentration • Removes bioavailable P & precipitates cyanobacteria from the water	• Vadnais Lake MN used ferric chloride & aeration – improved water quality but needed continuous aeration to maintain		• Given the logistics of Ann Lake, it may require pumping to draw down the deepest part of the lake, may not be feasible Effectiveness in Question: • Dam may have limitations • Large in-flow to lake, may not be feasible

Table 1. Internal loading management options (see Appendix A for additional information on each treatment option).

Type of treatment	Treatment	Lake morphology	Longevity	Permits required*	Impacts to Biological community: x-direct, 0-indirect**, z-more study needed			Problems or considerations
					Fish	Invertebrates	Aquatic macrophytes	
Chemical	Aluminum additions	shallow/deep	4 - 21 years - stratified 1 - 11 years - shallow	MPCA (approval letter)	0 - Macroalgae is primary fish habitat. May impact community composition and abundance. Toxic to fish if pH decreased (acidified) resulting in toxic Al^{3+} ions.	x - Short term impacts related to the settling of the floc layer 0-macroalgae are habitat for invertebrates	x - Toxic to macroalgae if the pH decreases (acidified) resulting in release of toxic Al^{3+} ions.	To be effective might require pH buffering. Whole lake treatments generally limited to smaller basins (<500 acres). Larger lakes might require targeting of higher loading areas in the lake. Can also be added to tributary inflows.
	Iron filings	shallow/deep	Short term, iron tends to bind P only in the presence of O_2 so first anoxic period may release large quantity of bound P	MPCA (approval letter)	z	z	z	Used in low sulfate waters (sulfide competes with phosphate for precipitation with Fe). Aeration or artificial circulation may have to accompany applications to prevent the breakdown of the oxidized barrier.
	Ferric Chloride	deep	Variable effective time, O_2 depletion can limit longevity	MPCA (approval letter)	z	z	z	May work better combined with O_2 injection.
	Lanthanum	shallow	Unclear, but P inactivation treatments typically are not effective for more than 15 years	MPCA (approval letter)	z	x - Short term impacts related to the settling of the floc layer	z	Works well under anoxic conditions. Turbidity increases immediately after application - turbidity decreases after settling. Not as common as Alum or Iron.
Physical	Dredging	shallow	Depends on incoming loads and material removed	MDNR public waters work permit; MPCA management of dredge material permit	x - Impact community composition and/or abundance	x - Impact community composition and/or abundance	x - Impact community composition and/or abundance	Goal to remove high P sediments. High cost and placement of dredged materials. Potentially toxic materials such as trace elements and organic pesticides. Can also be used to increase depth for recreation.
	Drawdown	shallow	Depends on macrophyte community, area exposed, length of time, and reintroduction of bottom disturbing fish	ACoE Section 404 permit; MDNR public waters work permit, water appropriation permit and aquatic plant management permit; MPCA 401 certification, NPDES construction permit and management of dredge materials permit; MNDOT work in ROW permit	x - Impact community composition and/or abundance	x - Impact community composition and/or abundance	x - Impact community composition and/or abundance	Disposal of water from drawdown. Expensive, engineering costs. Manually remove accumulations of dead fish as basins are dewatered. Vegetation maintenance.
	Dilution	shallow/deep	Long term although not very practical, limited conditions where possible	MDNR public waters work permit; ACoE Section 404 permit	z	z	z	Costs for pumping or rerouting waters; effects of altering water sources and flows; generally limited to small lakes.
	Oxygen injection	deep	Continual treatment primarily during growing season	MDNR aeration permit	x - Impact community composition and/or abundance	0 - Could alter community composition/abundance by changing area of lake bottom that has higher D.O. levels	z	Costs for initial setup; sizing system to lake for desired effect. Maintenance and operation costs annually. Can create thin ice areas in winter months.
	Hypolimnetic withdrawal	deep	Depends on magnitude and duration of TP transport from hypolimnion	MDNR water appropriation permit and public waters work permit	z	0 - Could impact community composition and/or abundance depending on withdrawal severity and changes in D.O. and/or nutrient availability	z	Multiple options: withdrawal and return, withdrawal and discharge, withdrawal and treat and return; winter aeration causes ice instability.
	Hypolimnetic aeration	deep	Continual treatment	MDNR aeration permit	z	0 - May alter community composition and abundance	0 - May alter community composition and abundance	Goal to eliminate the loss of O_2, either by injecting O_2 or increasing mixing of water column. Can create thin ice areas in winter months.
	Circulation and aeration	shallow/deep	Continual treatment	MDNR aeration permit	x - Decreases winterkill, may alter community composition and abundance	0 - May alter community composition and abundance	z	Can create thin ice conditions in winter months; used to prevent winterkill.

Biological	Fish removal	shallow/deep	Depends on the re-introduction of bottom disturbing fish	MDNR permit	Disturbance of lake sediments and includes targeting bottom disturbing fish such as common carp; black and brown bullheads and/or complete fish community removal utilizing pesticides such as rotenone.	0 - Increasing bluegill numbers to eat common carp eggs can increase predation of invertebrates	0 - May alter community composition and abundance (for positive or negative)	Physical fish capture and disposal are the primary cost drivers. Creative alternatives to the capture and disposal of targeted fish species will reduce costs. Requires consideration of barrier installation to prevent reintroduction of problem species. Reintroduction of appropriate fish and other related aquatic species should be considered when whole community removal is attempted.
	Mechanical aquatic plant removal	shallow/deep	Continuous, multiyear obligation; removes nutrients directly from system	MDNR aquatic plant management permit	x - Direct mortality - Fish, amphibians are often unintended targets of harvesting 0 - May alter community composition and abundance - predator/prey and depending on scale of application - oxygen depletion could lead to fish kill	0 - May alter community composition and abundance	0 - May alter community composition and abundance	A relatively short-term solution and targets invasive aquatic plants. Risk in spreading invasive plants by fragmentation or seeds. Harvesting programs are typically developed for recreation purposes; increase lake access. Limited TP removal relative to the whole internal load.

* List of permit requirements not intended to be comprehensive. Permit requirements could vary by method and local jurisdiction. Please contact identified state and federal agencies as well as local authority to obtain required permits/approvals prior to beginning work.

** Successful treatments will result in less available nutrients in a waterbody increasing water clarity. Increasing water clarity will have indirect impacts on all aquatic biological communities. Submersed aquatic macrophytes will increase in abundance, which will expand habitat for invertebrates and provide additional food sources and cover for fish. Predator prey relationships may be altered as well as shifts in population composition and abundance.

For the full study: https://www.pca.state.mn.us/water/lake-protection-and-management

Minnesota State and Regional Government Review of Internal Phosphorus Load Control • August 2020 Minnesota Pollution Control Agency

ALUM TREATMENTS TO CONTROL PHOSPHORUS IN LAKES

March 2003

What is alum and how does it work?

ALUM (aluminum sulfate) is a nontoxic material commonly used in water treatment plants to clarify drinking water. In lakes alum is used to reduce the amount of the nutrient **phosphorus** in the water. Reducing phosphorus concentrations in lake water can have a similar clarifying effect by limiting the availability of this nutrient for algae production. Phosphorus enters the water either **externally**, from run-off or ground water, or **internally**, from the nutrient rich sediments on the bottom of the lake.

Phosphorus is released from the sediments under anoxic conditions that occur when the lake stratifies and oxygen is depleted from the lower layer. Even when external sources of phosphorus have been curtailed by best management practices, the internal recycling of phosphorus can continue to support explosive algal growth. Alum is used primarily to control this internal recycling of phosphorus from the sediments of the lake bottom. On contact with water, alum forms a fluffy aluminum hydroxide precipitate called **floc**. Aluminum hydroxide (the principle ingredient in common antacids such as Maalox) binds with phosphorus to form an aluminum phosphate compound. This compound is insoluble in water under most conditions so the phosphorus in it can no longer be used as food by algae organisms. As the floc slowly settles, some phosphorus is removed from the water. The floc also tends to collect suspended particles in the water and carry them down to the bottom, leaving the lake noticeably clearer. On the bottom of the lake the floc forms a layer that acts as a phosphorus barrier by combining with phosphorus as it is released from the sediments.

Why treat a lake with alum?

Increased nutrient loading, particularly phosphorus has accelerated eutrophication of lakes and consequently reduced their ecological health and recreational value. Frequent and pervasive algal blooms, low water transparency, noxious odors,

depletion of dissolved oxygen, and fish kills frequently accompany cultural eutrophication. External sources of phosphorus delivered in run-off from the watershed are often the main contributor of excessive phosphorus to lakes.

Typically, the first steps taken in a lake rehabilitation effort target the control the external sources of phosphorus and can include: encouraging the use of phosphorus free fertilizers; improving agricultural practices, reducing urban run-off; and restoring vegetation buffers around waterways.

Lake researchers have learned that lakes are very slow to recover after excessive phosphorus inputs have been eliminated.
Furthermore, it's extremely difficult to achieve recovery of lake conditions without additional in-lake management. This is due to the fact that lake sediments become phosphorus rich and can deliver excessive amounts of phosphorus to the overlying water. When dissolved oxygen levels decrease in the bottom waters of the lake (anaerobic conditions), large amounts of phosphorus trapped in the bottom sediments are released into the overlying water. This process is often called **internal** nutrient loading or recycling.

Is alum toxic to aquatic life?

Some studies have been conducted to determine the toxicity of aluminum for aquatic biota. Freeman and Everhart (1971) used constant flow bioassays, to determine that concentrations of dissolved aluminum below 52 μg Al/L had no obvious effect on rainbow trout. Similar results have been observed for salmon. Cooke, et al (1978) adopted 50 mg Al/L as a safe upper limit for post-treatment dissolved aluminum concentrations. Kennedy and Cooke (1982) indicate that: Since, based on solubility, dissolved aluminum concentrations, regardless of dose, would remain below 50 μg Al/L in the pH range 5.5 to 9.0, a dose producing post treatment pH in this range could also be considered environmentally safe with respect to aluminum toxicity.
Guidelines for alum application require that the ph. remain with the 5.5-9.0 range.

According to Cooke et al (1993) the most detailed study of the impact of alum treatments on benthic insects was that of Narf (1990). He assessed the long-term impacts on two soft water and three hardwater Wisconsin lakes. He found that benthic insect populations either increased in diversity or remained at the same diversity after treatment. The treatment of lakes with alkalinities above 75 mg/L as $CaCO_3$ are not expected to have chronic or acute effects to biota. Fish related problems associated with alum treatments have been primarily documented in soft water lakes. However, many soft water lakes have been successfully treated with alum, when the treatments are pH buffered.

Health concerns for people?

Concerns about a connection between aluminum and Alzheimer's have been debated for some time. More recent research points to a gene rather than aluminum as the cause. In addition, aluminum is found naturally in the environment. Some foods, such as tea, spinach and other leafy green vegetables, are high in aluminum.
Use of aluminum cookware has not been found to contaminate food sources.

How much does an alum treatment cost?

Costs of alum application are primarily dependent on the form of alum used (wet or dry), dosage rate, area treated, equipment rental or purchase, and labor. Liquid alum has been used when large alum doses were needed. Treatment costs range from $280/acre to $700/acre ($450=approximate average) depending on the dosage requirements and costs to mobilize equipment.

How effective are alum treatments, and how long do they last?

A number of case studies have been conducted on lakes that have undergone nutrient inactivation with alum. Eugene Welch and Dennis Cooke (1995) evaluated the effectiveness and longevity of treatments on twenty-one lakes across the United States. They concluded that the treatments were effective in six of the nine shallow lakes, controlling phosphorus for at least eight years on average. Applications in stratified lakes were highly effective and long lasting. Percent reduction in controlling internal phosphorus loading has been continuously above eighty percent. The study did however find that alum treatment of lakes with high external loading was not effective.

References

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