Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 071-B**

Alum's Critical Role in Controlling Algae and Phosphorus

Category: B. Water Resources

Total Project Budget: $ 264,400

Proposed Project Time Period for the Funding Requested: 2 years, July 2017 – June 2019

Summary:

Algal bloom reduction requires control of phosphorus accumulated in lakes. Alum is critical to phosphorus control. We will deliver cost benefit, guidance, and outreach on controlling phosphorus through alum treatment.

Name: Keith Pilgrim

Sponsoring Organization: Barr Engineering Co.

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Photograph of alum-treatment barge. Photographs showing a lake before and after alum treatment. Diagram showing reduction in phosphorus loading due to aluminum-bound phosphorus in lake-bottom sediments.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: *Alum's Critical Role in Controlling Algae and Phosphorus*

I. PROJECT STATEMENT

Primary funding priority: B.1.iii.; Secondary priorities: A.1. and C.1: Our team will be led by state and nationally recognized leaders in alum treatment, water quality, and TMDL/WRAPS studies—Keith Pilgrim and Greg Wilson. Notably, Keith is a published researcher and inventor of alum-treatment protocol.

1. Phosphorus released by lake sediment is a major cause of algal blooms (including harmful algal blooms), impaired recreation, and diminished property values. Methods to remove phosphorus are limited, with alum treatment one of the most effective methods. However, the long-term cost-effectiveness of using alum is unknown. Many citizens and local governments are reluctant to use chemicals (including alum) without better guidance on whether alum treatment will or will not be useful for lake-phosphorus and algal-bloom reduction for a particular lake of interest.
2. The goal of this project is to conduct research and develop guidance that local practitioners and state government can use to decide when alum treatment will be a cost-effective phosphorus-control and lake-restoration tool. Questions to be answered include: (a) To restore lakes, do lake sediments need to be treated with alum or are watershed BMPs enough?; (b) How much alum is needed?; (c) How long will treatment last?; (d) Can the timing of alum treatments be optimized?; and (e) Which lakes are good candidates for alum treatment?
3. Alum-treated (40 in MN) and untreated, but impaired lakes, will be studied to answer the questions posed in #2 above. Data will come from existing sources; sediment samples collected from treated and untreated lakes; sediment laboratory experiments; and from lake mathematical models.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Investigate phosphorus reductions for 40 alum-treated MN lakes.* **Budget: $62,650**

Collect data (existing and new data) for existing alum-treated lakes and identify and evaluate lake and watershed characteristics that determine how to optimize alum applications for phosphorus reduction.

Outcome	Completion Date
1. Cost of treatments vs. effectiveness. Reveal effect of lake characteristics and watershed size on phosphorus reduction (effectiveness) for alum-treated lakes.	*1/1/2018*
2. Use collected, alum-treated lake sediments to determine how lake sediment properties relate to long-term phosphorus removal and control.	*1/1/2018*
3. Categorize successful and failed lake treatments and outcome determinants.	*4/1/2018*

Activity 2: *Quantify phosphorus-removal capacity of alum-treated lake sediment.* **Budget: $70,750**

Collect sediment from alum-treated and untreated lake-bottom sediments for laboratory experiments.

Outcome	Completion Date
1. Experimentally determine phosphorus removal by alum-treated sediments.	*1/1/2018*
2. Determine the effect of alum dose, sediment phosphorus concentrations, and alum ageing effects on phosphorus-removal effectiveness.	*3/1/2018*
3. Determine effect of organic phosphorus on alum-treatment effectiveness.	*6/1/2018*

Activity 3: *Determine alum-treatment optimization to effectively control phosphorus.* **Budget: $78,550**

Use a water quality model (CE QUAL W2) to determine whether lakes can be restored and TMDL requirements can be met by controlling watershed phosphorus loads without alum treatments.

Outcome	Completion Date
1. Choose appropriate study lakes (impaired lakes with TMDLs) and collect data.	*7/1/2018*

2. Determine the time (years) and watershed phosphorus reductions needed to reduce internal phosphorus release and ensure that lake phosphorus standards are met without an alum treatment.	*1/1/2019*
3. Identify characteristics of lakes that will need alum treatment.	*1/1/2019*

Activity 4: *Develop guidance and outreach on lake water quality recovery time.* **Budget: $52,450**
Determine need and effectiveness of alum to control phosphorus in lakes by using tools generated from Activities 1–3.

Outcome	Completion Date
1. Identify study lakes (impaired) and gather necessary data to conduct analysis.	*7/1/2018*
2. Develop and apply methodology to determine time needed for a lake to comply with nutrient standards with TMDL implementation and with and without alum treatment.	*1/1/2019*

III. PROJECT STRATEGY

A. Project Team/Partners

Partner and role	*Funding Allocation*
Barr Engineering Co. Project Team: Hal Runke (Ph.D.), Principal; Keith Pilgrim (Ph.D.), Project Manager and Co-lead Investigator; Greg Wilson (M.S.), Co-lead Investigator; Kevin Menken (M.S.), Sediment Sampling and Analysis; Jay Hawley (M.S.), Water Quality Modeling	receiving funds
Minnesota Department of Natural Resources: Dave Wright: 100 hours for technical advisory and review	contributing in-kind resources only
Minneapolis Park and Recreation Board (MPRB): Deb Pilger and Rachael Crabb: Data compilation, sediment sampling, technical advisory and review	contributing in-kind resources only
Prior Lake-Spring Lake Watershed District (PLSLWD): Diane Lynch and Jaime Rockney: Data compilation, sediment sampling, technical advisory and review	contributing in-kind resources only
Three Rivers Park District: Rich Brasch: Data compilation, sediment sampling, technical advisory and review	contributing in-kind resources only

B. Project Impact and Long-Term Strategy

Identifying and appropriately applying cost-effective tools to reduce phosphorus and algae (including harmful algal blooms) in lakes will be a sizeable challenge. Guidance for watershed (external) phosphorus controls is abundant, but there is no guidance on in-lake phosphorus controls. Alum treatment is the main tool for in-lake phosphorus control, but it is poorly understood and judgement of alum-treatment success is wide-ranging. With global warming, increasing lake temperatures, greater and more frequent algal blooms in lakes, impaired recreation, and diminished property values, there is urgency to develop a better understanding of alum treatment and its role in mitigating these conditions. This study will compile and advance our understanding of the use of alum to reduce internal phosphorus loading. All project partners have committed to fund future in-lake alum-treatment projects within their respective jurisdictions. As a result, our project team is highly motivated to target available resources to those strategies that will optimize control of both internal and watershed phosphorus-loading sources.

C. Timeline Requirements

Project duration will be two years. Planning, field and laboratory experiments occur in year 1. Modeling occurs in year 2; analysis of all data, development of tools/guidance, and reporting also occur in year 2.

2017 Detailed Project Budget

Project Title: Alum's Critical Role in Controlling Algae and Phosphorus

IV. TOTAL ENRTF REQUEST BUDGET: 2 years

BUDGET ITEM	AMOUNT
Personnel:	$ -
Keith Pilgrim, Project Manager (31% salary, 29% benefits, 40% overhead); 16% FTE for year 1 and 16% FTE year 2	$ 70,912
Greg Wilson, Environmental Engineer, Co-Lead Investigator (31% salary, 29% benefits, 40% overhead); 14% FTE for year 1 and 14% FTE year 2	$ 67,168
Hal Runke, Principal in Charge; (31% salary, 29% benefits, 40% overhead); 3% FTE for year 1 and 3% FTE year 2	$ 13,788
Kevin Menken, Data Analysis/Sediment Chemistry Analyst (31% salary, 29% benefits, 40% overhead); 21% FTE for year 1 and 0% FTE year 2	$ 34,667
Jay Hawley, Environmental Engineer/Lake Modeling (31% salary, 29% benefits, 40% overhead); 0% FTE for year 1 and 35% FTE year 2	$ 47,865
Equipment/Tools/Supplies	$ -
Containers for sediment sampling	$ 200
Travel:	$ -
Travel to and from lakes for sediment sampling	$ 300
Additional Budget Items:	
Analytical expense for sediment (total aluminum (100 analysis) and iron (100 analysis). Competitive bid pending project approval.	$ 14,500
Analytical expense for sediment (lead 210 dating by the Science Museum Saint Croix Watershed Research Station). Total of 3, 1-meter long cores dated. Science Museum is the recognized expert for this analysis.	$ 15,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 264,400

V. OTHER FUNDS

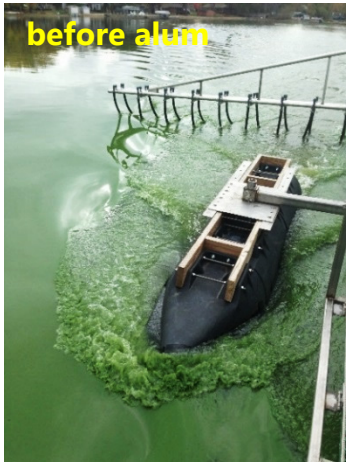
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	NA	NA
Other State $ To Be Applied To Project During Project Period:	NA	NA
In-kind Services To Be Applied To Project During Project Period:	$ 24,900	Secured
Minnesota Department of Natural Resources (Dave Wright): Technical Advisory Committee participation and review/comment of project work plan/deliverables, 100 hrs. @ $87/hr=$8,700		
Minneapolis Park and Recreation Board: Technical Advisory Committee participation and review/comment of project work plan/deliverables, 100 hrs. @ $80/hrs=$8,000, sediment sampling assistance and data compilation/dissemination, 100 hrs @$70/hr = $7,000		
Prior Lake-Spring Lake Watershed District: Technical Advisory Committee participation and review/comment of project deliverables, 100 hrs@$70/hr = $7,000, sediment sampling assistance and data compilation/dissemnation, 20 hours@$60/hr = $1200		
Three-Rivers Park District: Sampling assistance, $1,000		
Funding History:	NA	NA
Remaining $ From Current ENRTF Appropriation:	NA	NA

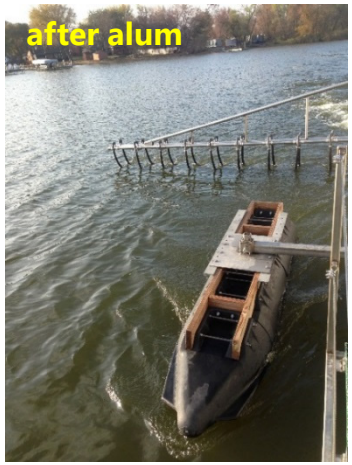
Alum's Critical Role in Controlling Algae and Phosphorus

4. Visual

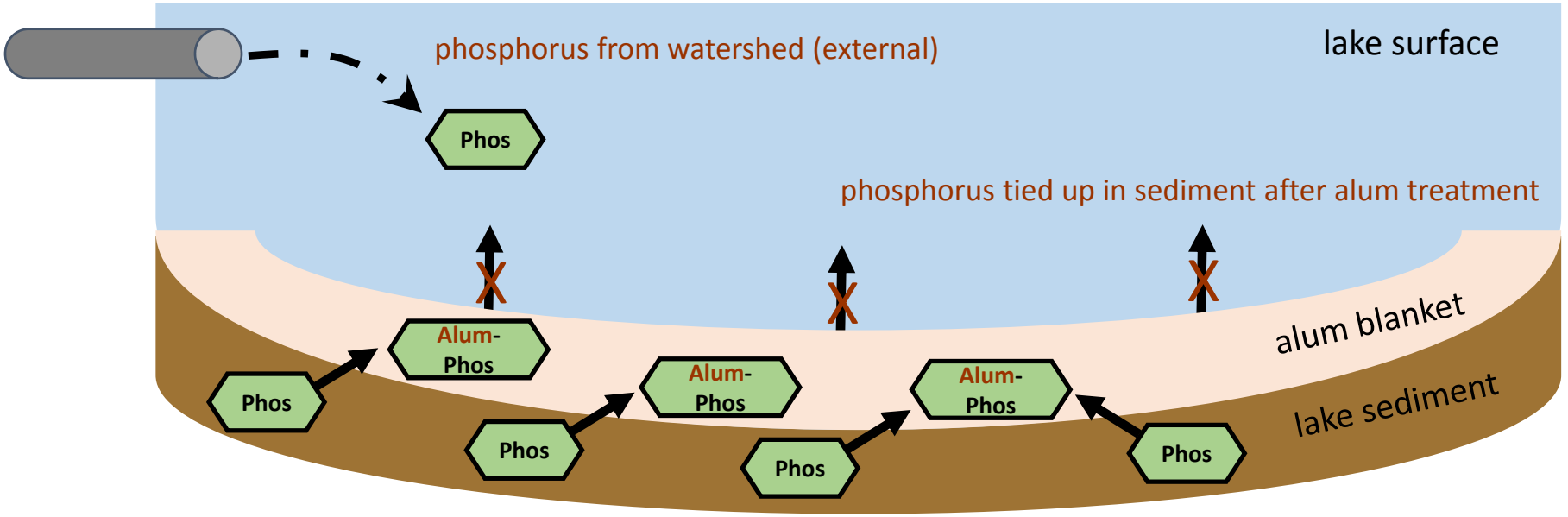
Alum-Treatment Barge

Algal Bloom Controlled by Alum Treatment





Phosphorus Reduction from Alum Treatment of Lake-Bottom Sediments



6. Project Manager Qualifications and Organization Description

Study project manager and co-lead investigator, Keith Pilgrim, is a recognized expert and leader in alum-treatment studies in Minnesota and the U.S., with over five publications on the subject, inventor of innovative and now standard alum-dosing procedures, and other alum-evaluation methods. He has been studying lakes, watersheds, in-lake phosphorus, and methods to control in-lake phosphorus sources (e.g., alum treatment) for over 18 years, starting with his PhD at the University of Minnesota (U of M) and continuing throughout his career at Barr (Keith's PhD work is the last time anyone has studied alum at the U of M). He has extensive experience with advanced water quality modeling to predict the effects of watershed and in-lake phosphorus inputs on lake water quality. Keith has also demonstrated his capacity to conduct research on behalf of the state of Minnesota, performing research to develop a new innovative stormwater BMP for phosphorus (Section 319-10 Nonpoint Source Management Grant, project #7132).

Co-lead investigator, Greg Wilson, has more than 25 years of experience in water quality monitoring/ modeling, TMDL preparation and reporting, limnology, watershed/lake management plan development and design, and public education/outreach. He has managed 15 recent TMDL/WRAPS studies in Minnesota and Wisconsin, as well as several in-lake alum-treatment projects; authored MPCA's *Detailed Assessment of Phosphorus Sources to Minnesota Watersheds*; and worked with the MDA as lead investigator to develop protocols to identify priority management zones and prioritization of optimum BMPs for TMDL implementation and WRAPS planning. His U of M master's thesis research included analysis of stormwater-runoff impacts within the Minneapolis Chain of Lakes watershed.

Barr Engineering Co.: Headquartered in Minneapolis, Barr's expertise covers all aspects of water quality research and management; pollutant and water-quantity monitoring and modeling; TMDL and WRAPS development; stormwater management and treatment; and BMP design. For over four decades, we have helped state and federal agencies, including the MPCA and MNDOT, water management organizations, municipalities, and industrial and utility clients solve water resources problems. With over 150 engineers and scientists engaged in water resources engineering and design, water quality, stormwater management, wetland management, limnology, and landscape ecology, we can deliver innovative solutions to any water resources challenge.

Minnesota DNR, Division of Ecological and Water Resources, Lakes and Rivers Unit: Among other responsibilities, the DNR manages the state's water resources, sustaining healthy waterways and ground-water resources. In particular, this division is charged with these core water resource areas: public waters protection; water supply management; and information for decision-making.

Minneapolis Park and Recreation Board (MPRB): As part of their mission to balance sound conservation and ecological practices within the city's Park System, MPRB is responsible for maintaining and improving water quality in Minneapolis' scenic and recreational bodies of water through studies, projects, and initiatives. The Minneapolis Chain of Lakes Regional Park is the most visited metro area regional park system, logging over 4,800,000 visits per year.

Three Rivers Park District: Serving the seven-county metro area, the district promotes environmental stewardship through recreation and education in a natural resources-based park system, which includes 27,000 acres of parks and trails and all or part of the shorelines of 34 lakes, two rivers, six streams, and hundreds of wetlands. Their Water Resources Management division is responsible for district water resources, including water quality management and improvement programs.

Prior Lake-Spring Lake Watershed District (PLSLWD): Located in Scott County, PLSLWD oversees efforts to conserve, protect, and manage district water resources. Ongoing activities include: water quality monitoring; land management (filter strips, wetland restoration); and lake water quality improvement efforts (aquatic plant management, water quality education, cost-share projects).