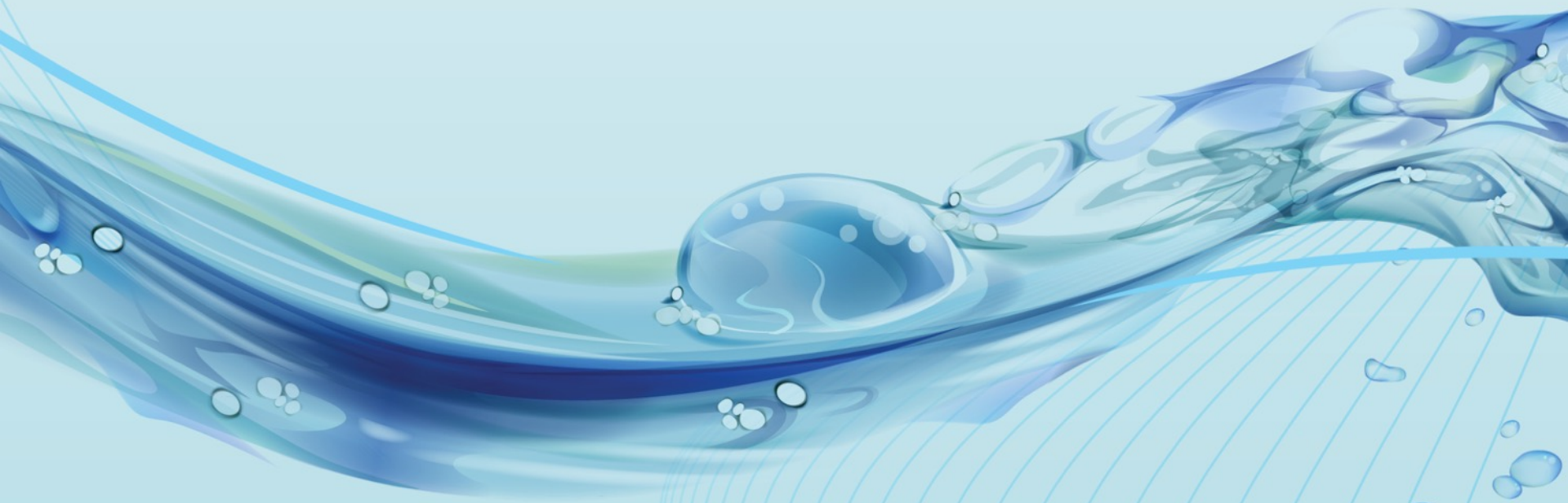
Use of Alum to Improve Lake Water Quality

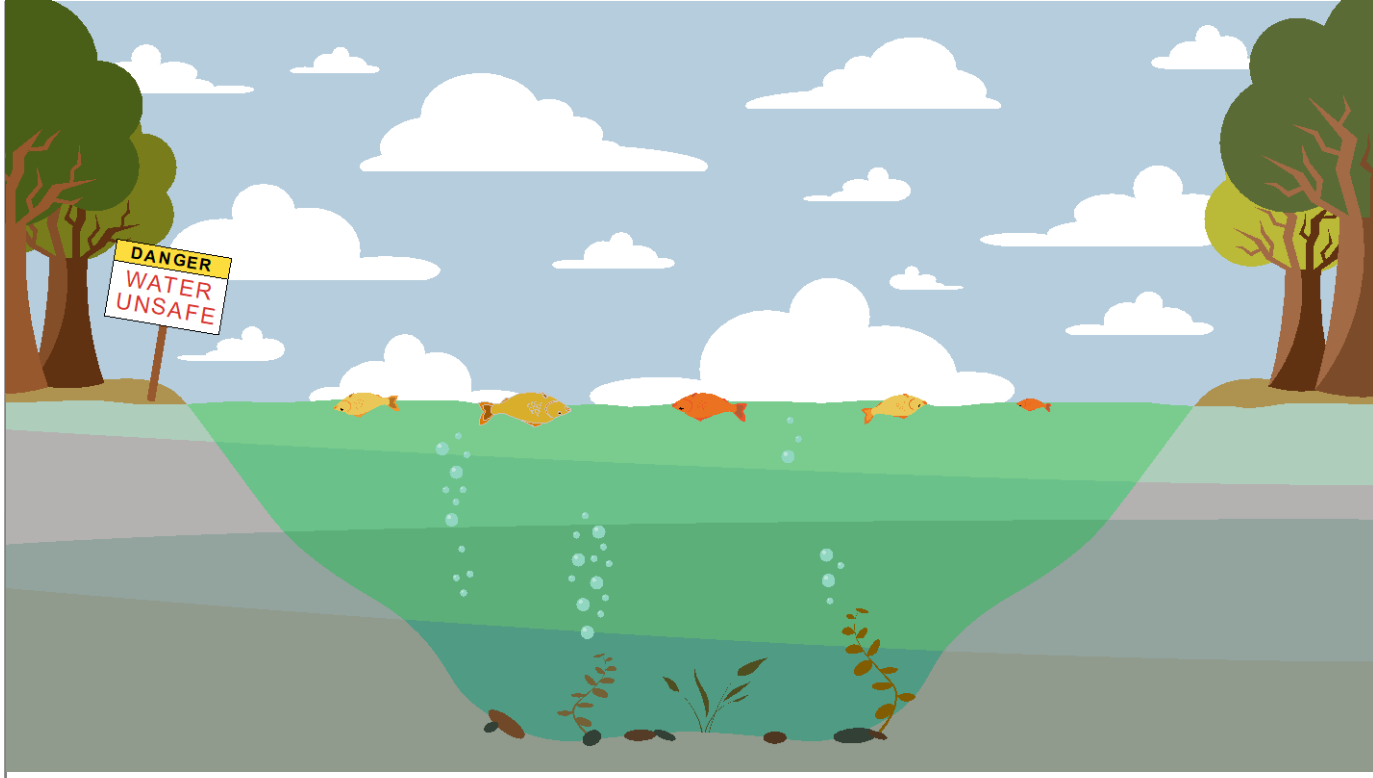


HAB Aquatic Solutions

John C. Holz, PhD
HAB Aquatic Solutions

Alberta Lake Management Society
September 28, 2018

The Problem: Poor Water Quality



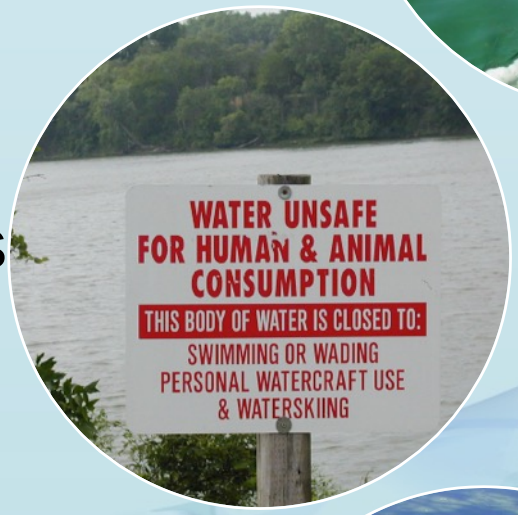
- Poor water quality in lakes has many symptoms, most of which are associated with *excessive algal growth*.

HAB
AquaticSolutions

The Problem: Poor Water Quality

- NUISANCE ALGAL BLOOMS

- ALGAL TOXINS



- LOW WATER CLARITY
- NOXIOUS ODORS
- LOW OXYGEN LEVELS

HAB AquaticSolutions

The Problem: Poor Water Quality

- POTENTIAL FISH KILLS

- REDUCED RECREATIONAL VALUE
- REDUCED PROPERTY VALUES

HAB AquaticSolutions

Property Values

* Canadian dollars

BEMIDJI STATE UNIVERSITY

- Examined 1205 residential property sales on 37 lakes from 1966-2001in Minnesota
- “We concluded that water clarity is very significant related to the price per foot of lakeshore”

EXAMPLE: LEECH LAKE

- A 1 m INCREASE in water clarity increased property values $740 per foot or $29,600 gain on a 12 m lake front lot
- A 1 m DECREASE in clarity would cut values by $870 per frontage foot, or $34,800 decline on a 12 m lake front lot

HAB
AquaticSolutions

Property Values

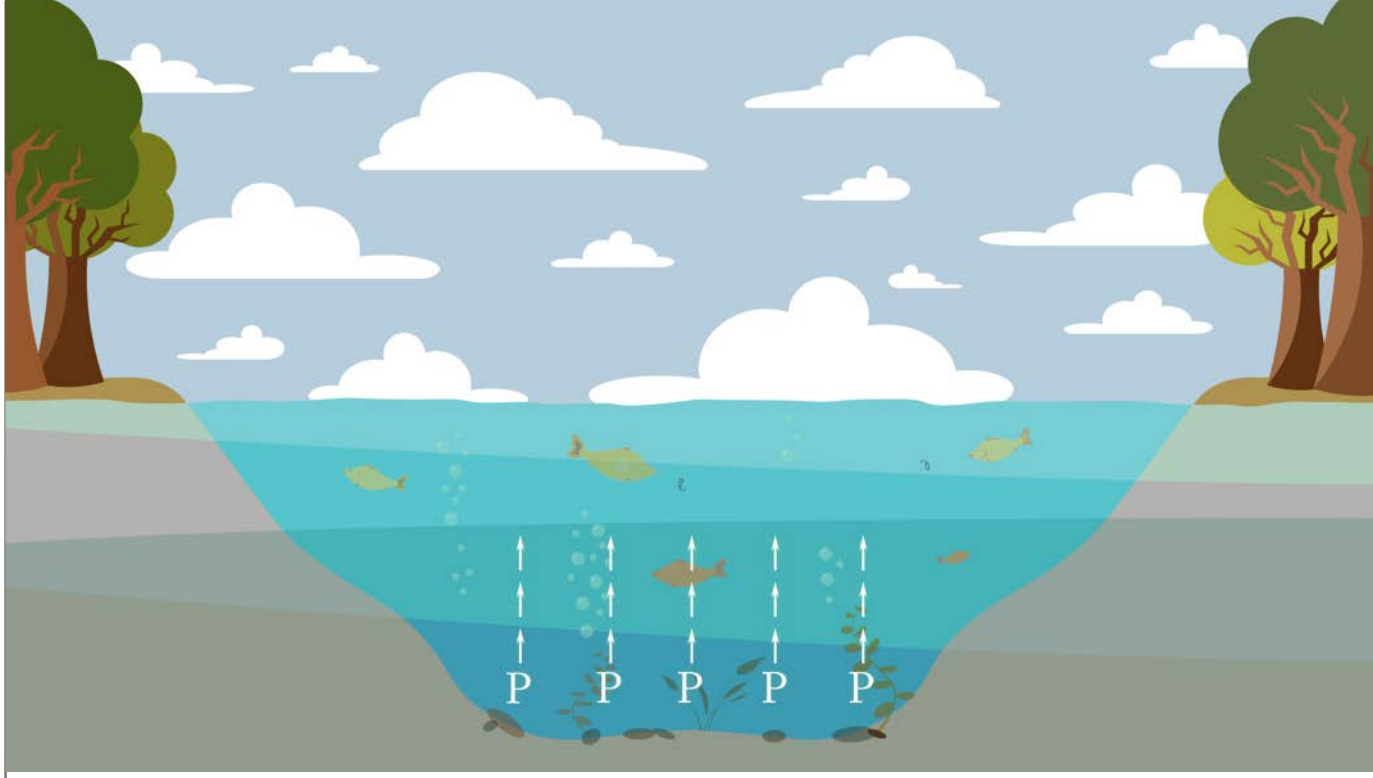
* Canadian dollars

UNIV OF WISCONSIN – EAU CLAIR

- Examined 324 recent residential property sales on lakes from in northern Wisconsin
- Reported a 3-16% increase in home value with a 1 m increase in water clarity
- Average values increased by $32,760 ($306,684 to $339,444) with a 1 m clarity improvement

HAB
AquaticSolutions

The Cause: Excessive Amounts of Phosphorous



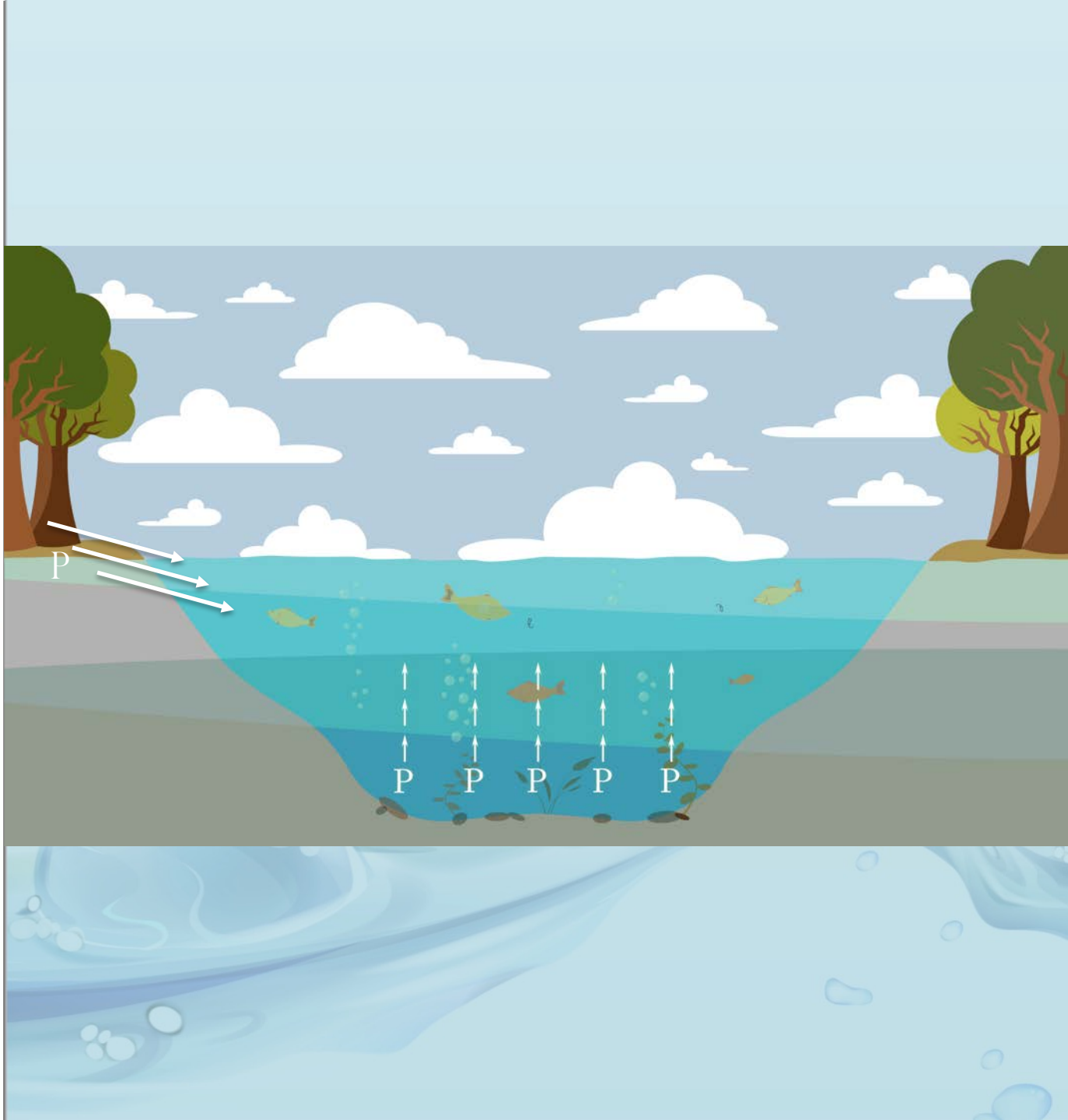
- High phosphorus levels lead to nuisance algal blooms and associated water quality problems

HAB
AquaticSolutions

Where Does The Phosphorus Come From?

HAB
AquaticSolutions

Sources of Phosphorus in Lakes



HAB
AquaticSolutions

External Sources of Phosphorus in Lakes

- SEPTIC SYSTEMS

- AGRICULTURE

HAB AquaticSolutions

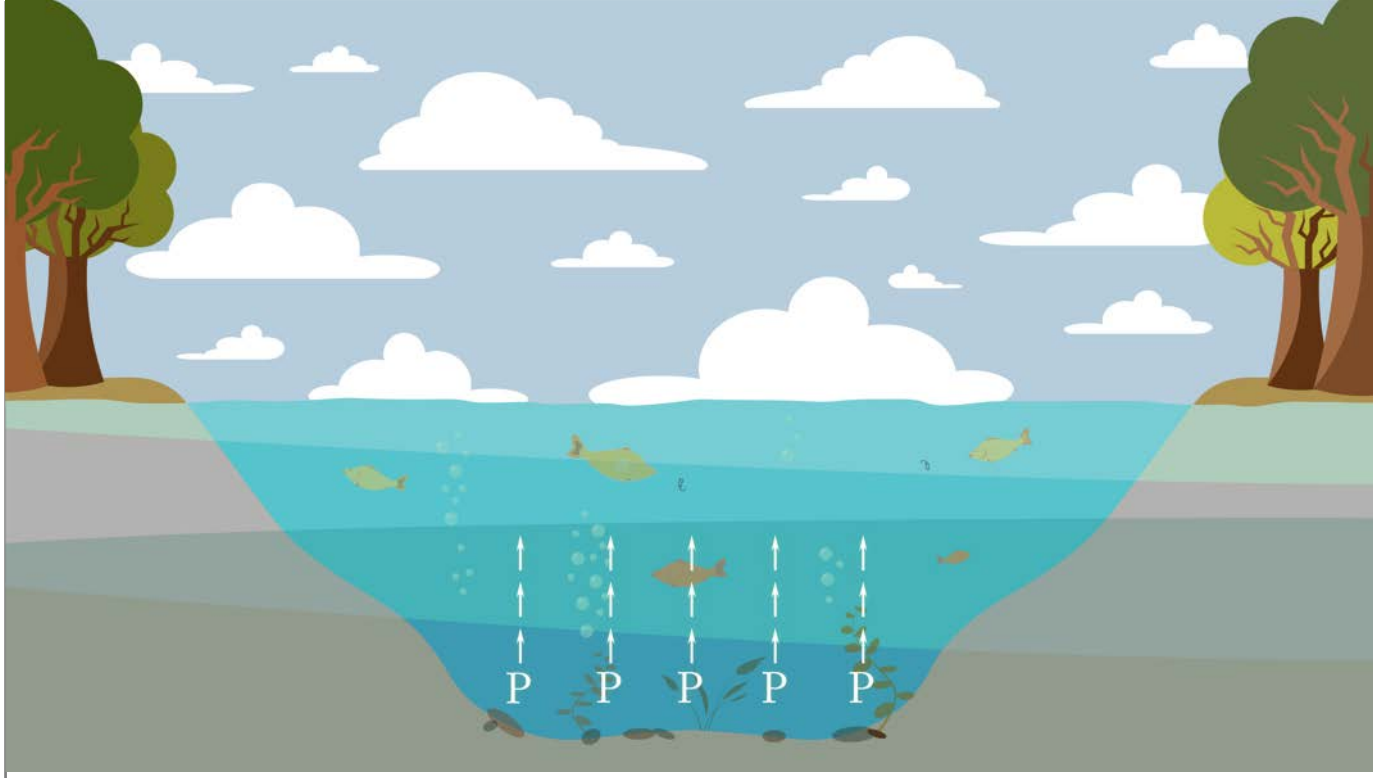
External Sources of Phosphorus in Lakes

- LAWN FERTILIZER

- STORMWATER

HAB AquaticSolutions

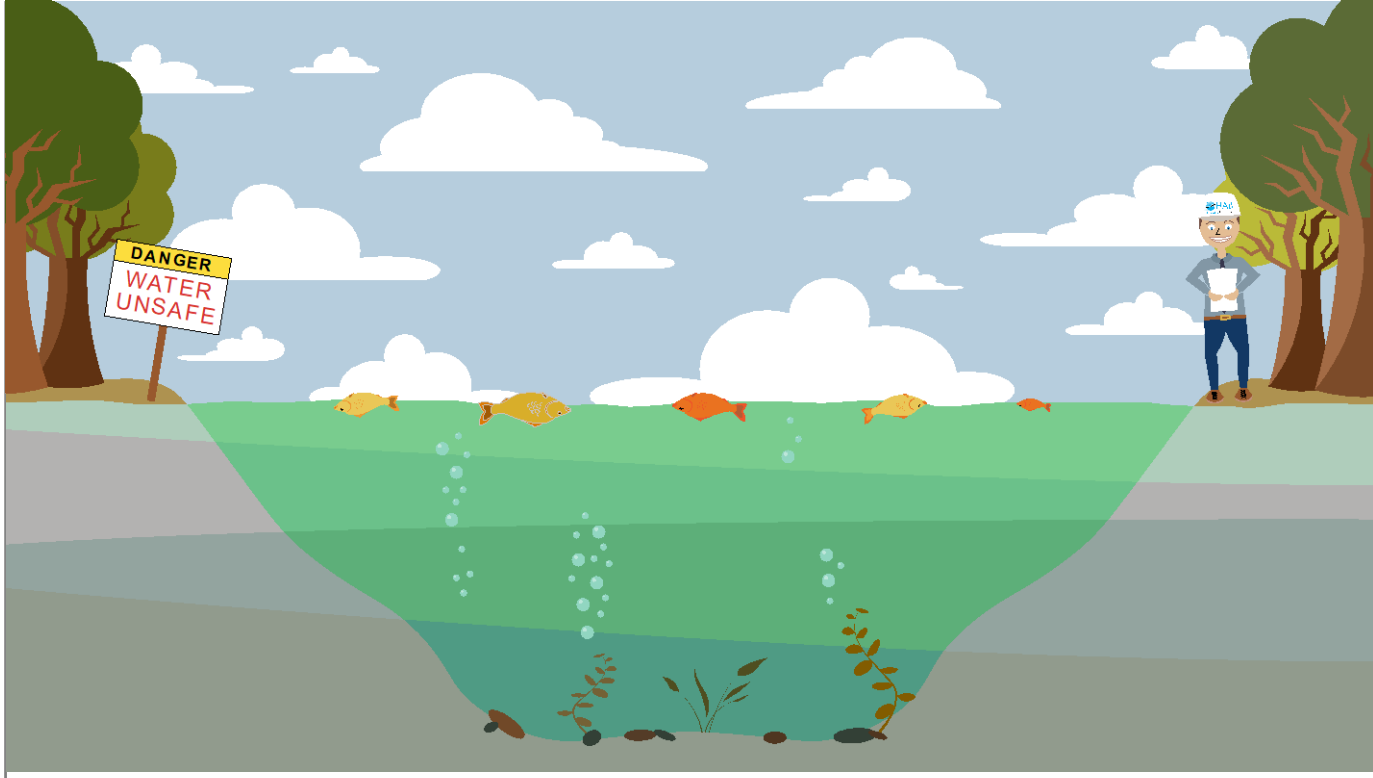
Internal Sources of Phosphorus in Lakes



- Phosphorus released from the bottom sediments triggers algae growth

HAB
AquaticSolutions

Measuring Internal Sources of Phosphorus



- Nutrient Budget Study
- Lakebed Coring Study
- Sediment Phosphorus Analysis
- Phosphorus Flux Study

HAB Aquatic Solutions

Alum Application Systems

“Resetting the Lake”

HAB
AquaticSolutions

What are Alum Applications?

- HAB uses an aluminum formulation that maximizes treatment effectiveness
- It retards phosphorus inputs from sediments, which ultimately reduces the amount of phosphorus available for the algae
- Not toxic to algae. It reduces amount of algae by reducing phosphorus and limiting growth

HAB
AquaticSolutions

History of Aluminum Sulfate Use

- Alum has been used for more than 200 years for drinking water clarification and it's use is essential in wastewater and drinking water treatment plants today
- First suggested for use in lakes in 1955
- First lake application in Sweden in 1968
- First USA application occurred in 1970 (Wisconsin)

HAB AquaticSolutions

Alum Safety

- Alum is common food additive and used to clean drinking water
- Drinking water grade alum is used in lakes
- Aluminum is the 3rd most abundant element in the Earth's crust
- Most food, water, air & soil contain aluminum and average adult consumes 7-9 mg/L (Maalox = 400 mg/L)
- Exposure to alum in lakes is very low

HAB Aquatic Solutions

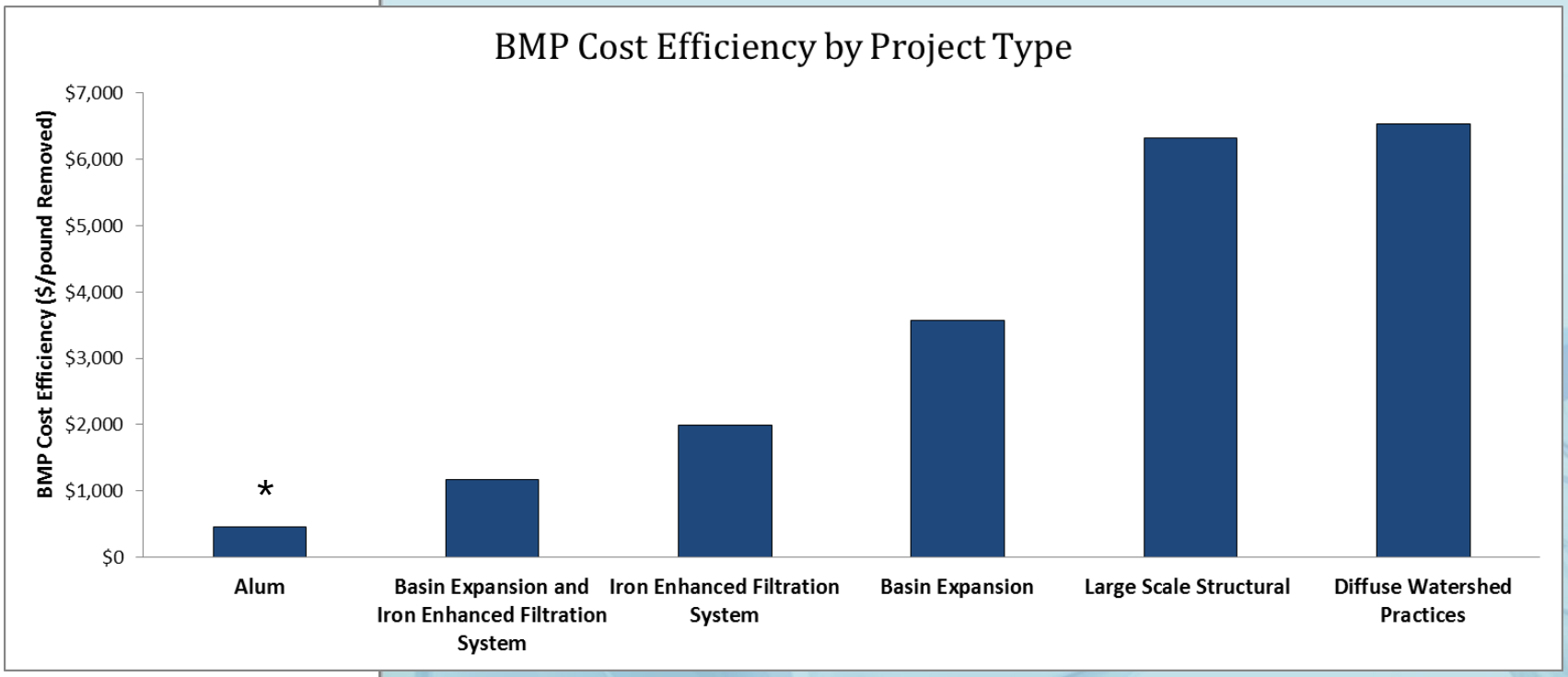
Alum Safety

- Many studies documenting the safe use of alum in lakes
- Use in lakes endorsed by the North American Lake Management Society
- Alum doesn't harm plants and fish. Fishery improvements common after alum due to increased clarity and habitat
- Many benefits of more aquatic plants
- Aquatic Plant Management Plans

HAB AquaticSolutions

Cost Effectiveness (US Dollars)

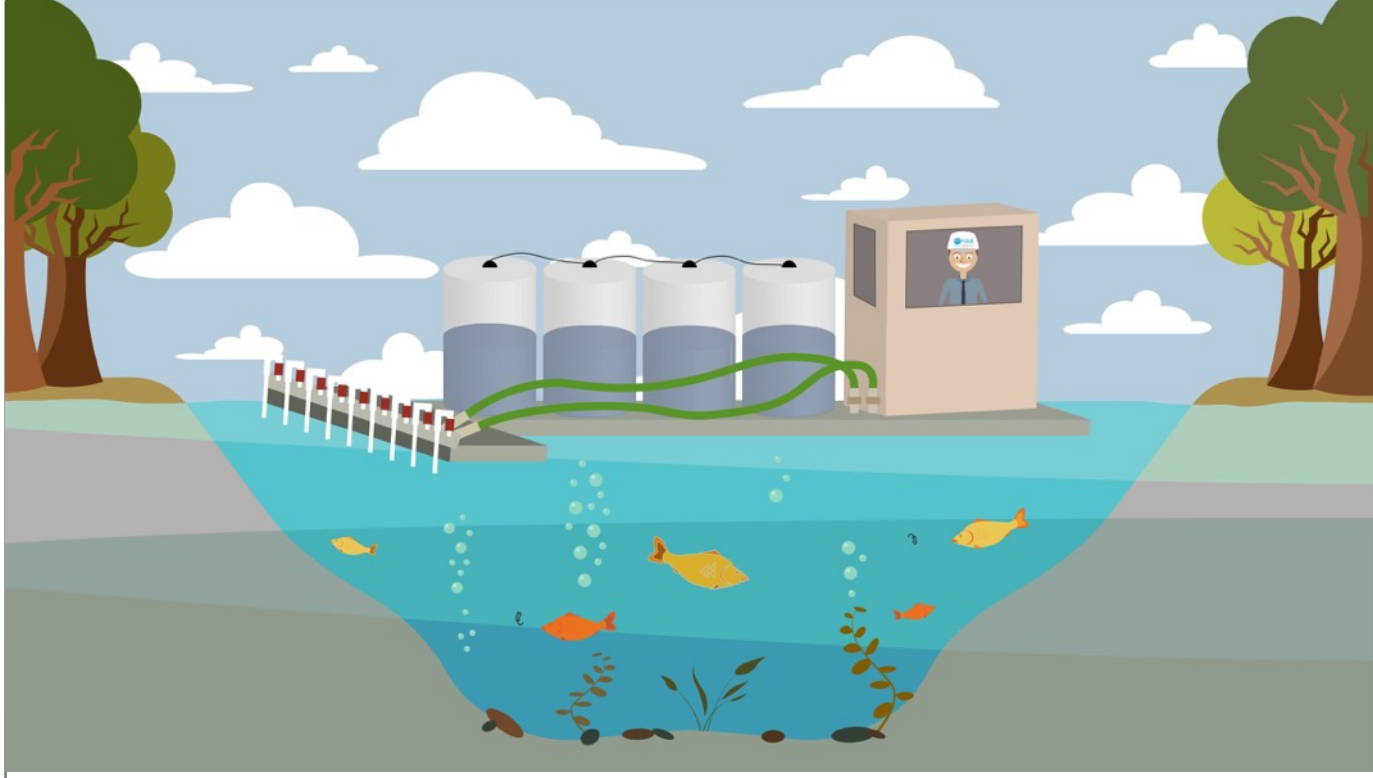
Wenck Associates



HAB Aquatic Solutions

*$70 to remove a pound of phosphorus

How Alum Applications Work



- The treatment forms a chemical barrier between the bottom sediments and the water

HAB AquaticSolutions

HAB's Application Vessels

INTERMEDIATE VESSELS

HAB
AquaticSolutions

HAB's Application Vessels

- LARGE VESSELS

HAB AquaticSolutions

How Alum Applications Work

- Alum arrives on tanker trucks and is stored on the shore

- The product is added to the water with a barge and forms a colloidal aluminum hydroxide floc which binds to phosphorus

HAB Aquatic Solutions

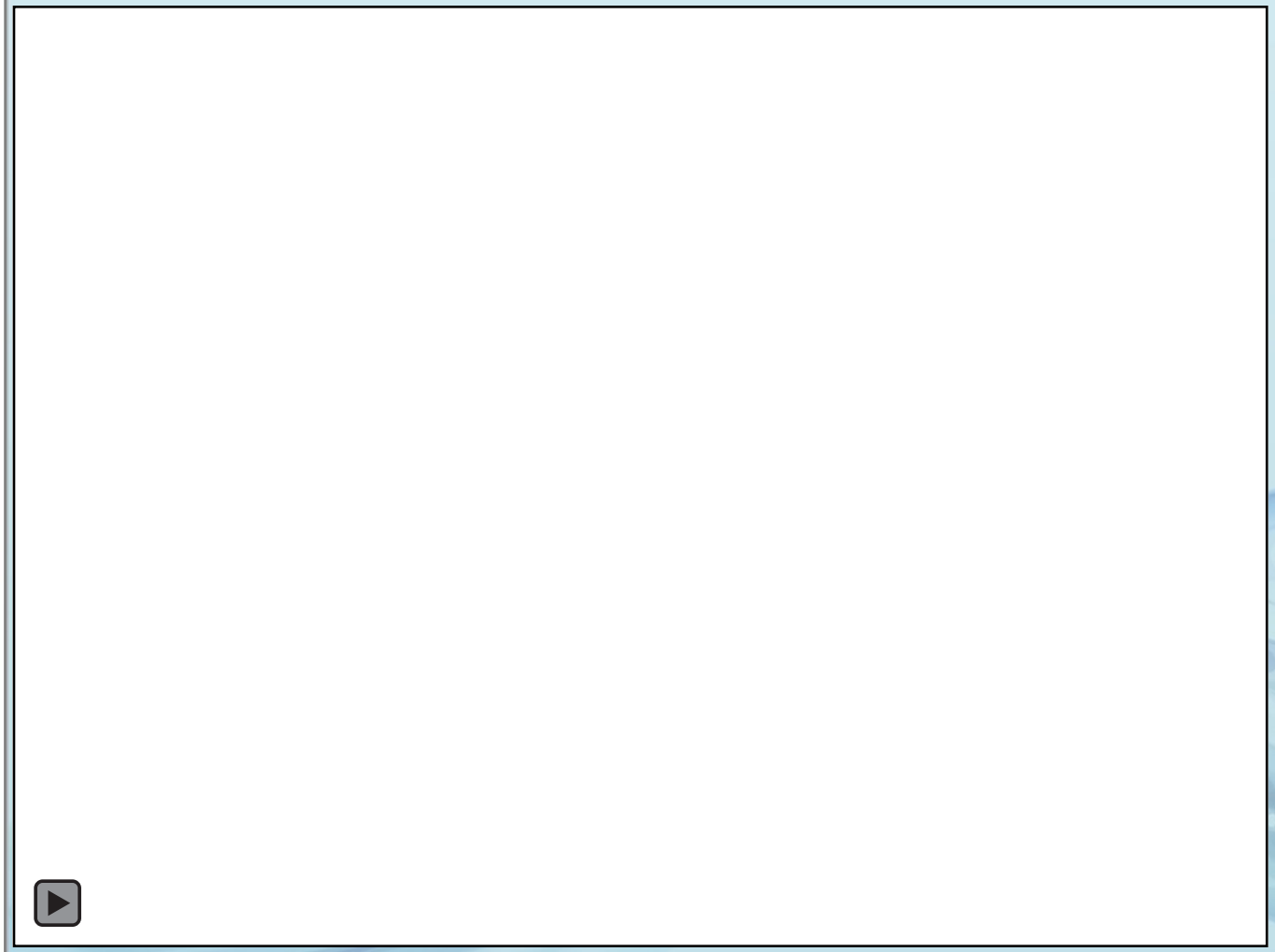
How Alum Applications Work

- Floc settles to the sediment and continues to bind and retain phosphorus for years

- Suspended floc takes a few days to completely settle

HAB Aquatic Solutions

How Alum Applications Work



HAB AquaticSolutions

Case Studies

See www.habaquatics.com

for more info

HAB

AquaticSolutions

Bald Eagle Lake, MN

HAB
AquaticSolutions

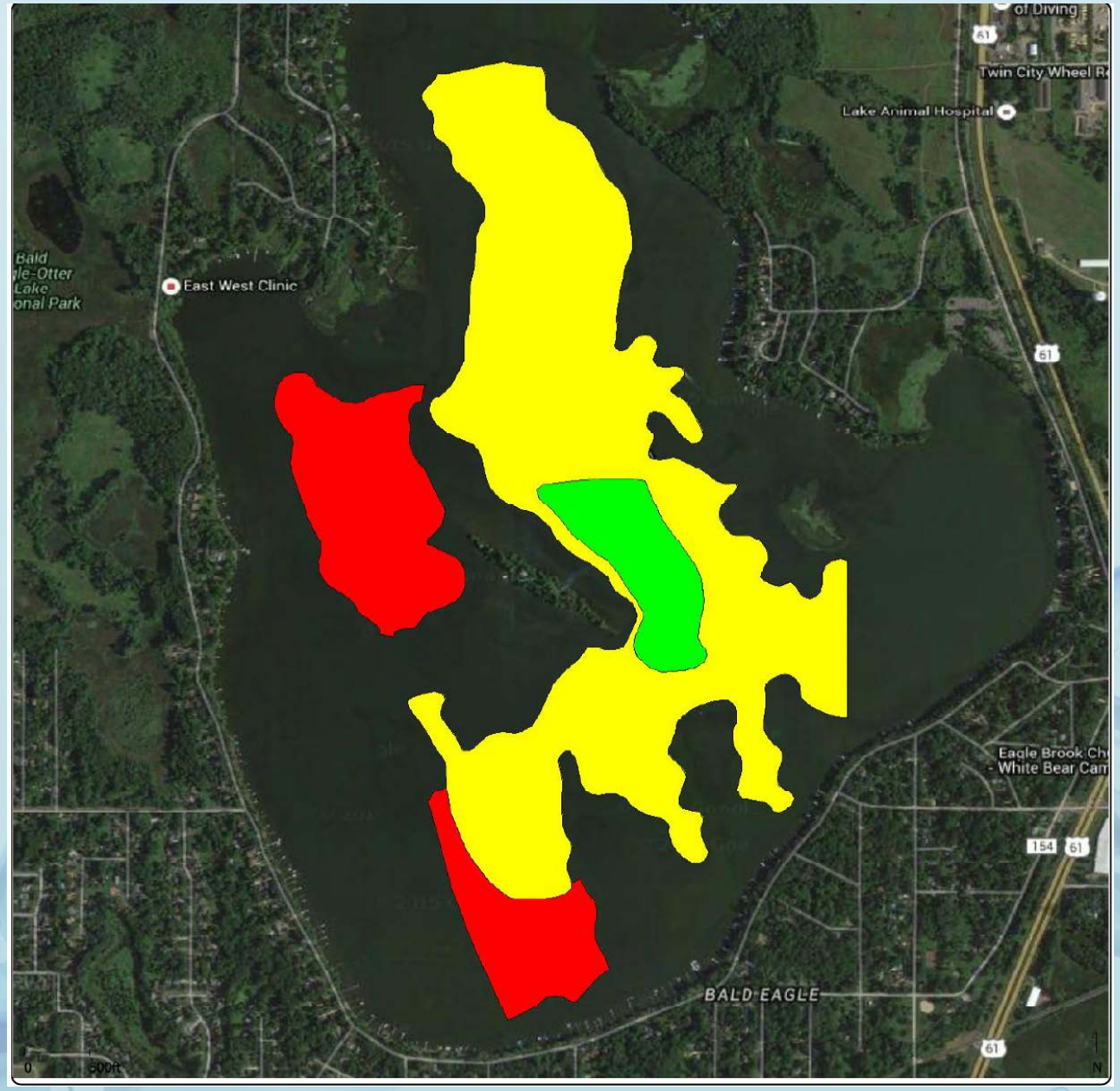
Bald Eagle

Lake, MN

- 1,270 acre (5.14 km^2) lake near Minneapolis, MN
  Total Phosphorus = 80 ppb
  Chlorophyll a = 30 ppb
  Water clarity = 1 meter
- Elevated phosphorus levels resulted in cyanobacteria blooms and a violation of state phosphorus standards
- A split dose alum application was designed and the first dose was applied in May 2014 and the second in 2016

HAB AquaticSolutions

Bald Eagle Lake Application Zone

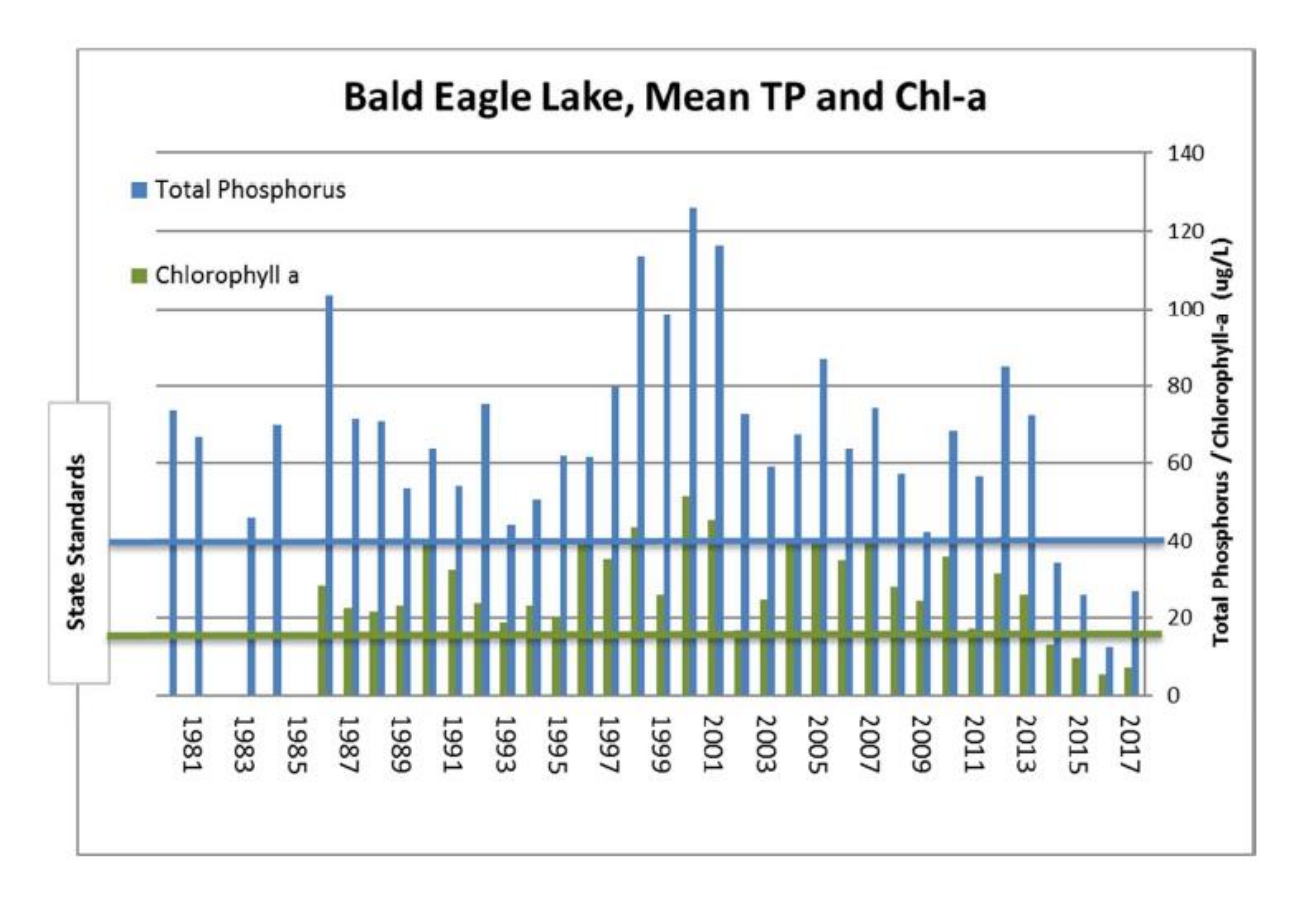


HAB
AquaticSolutions

Total

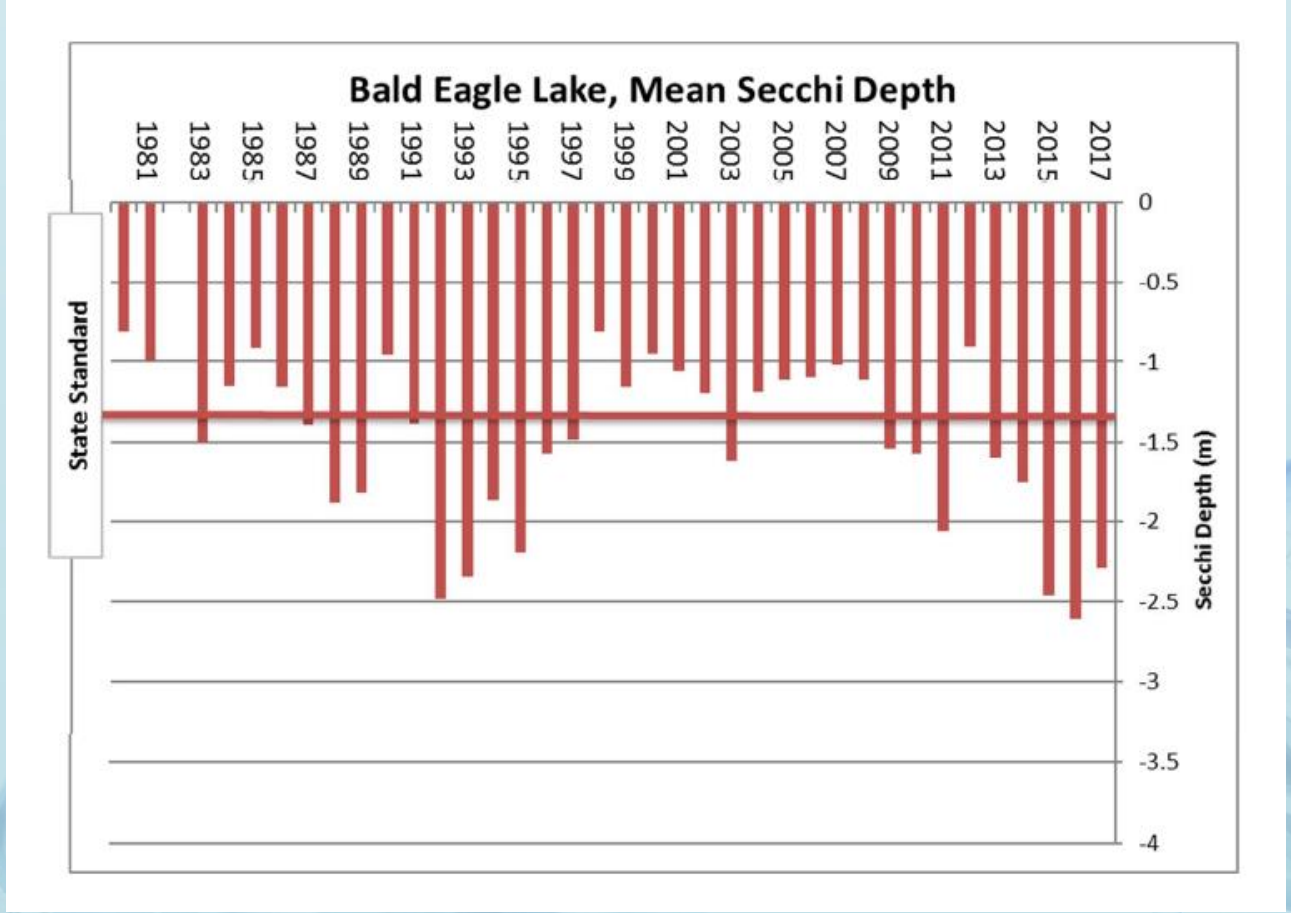
Phosphorus &

Chlorophyll *a*



HAB AquaticSolutions

Secchi Disk Depth



HAB AquaticSolutions

Cedar Lake, WI

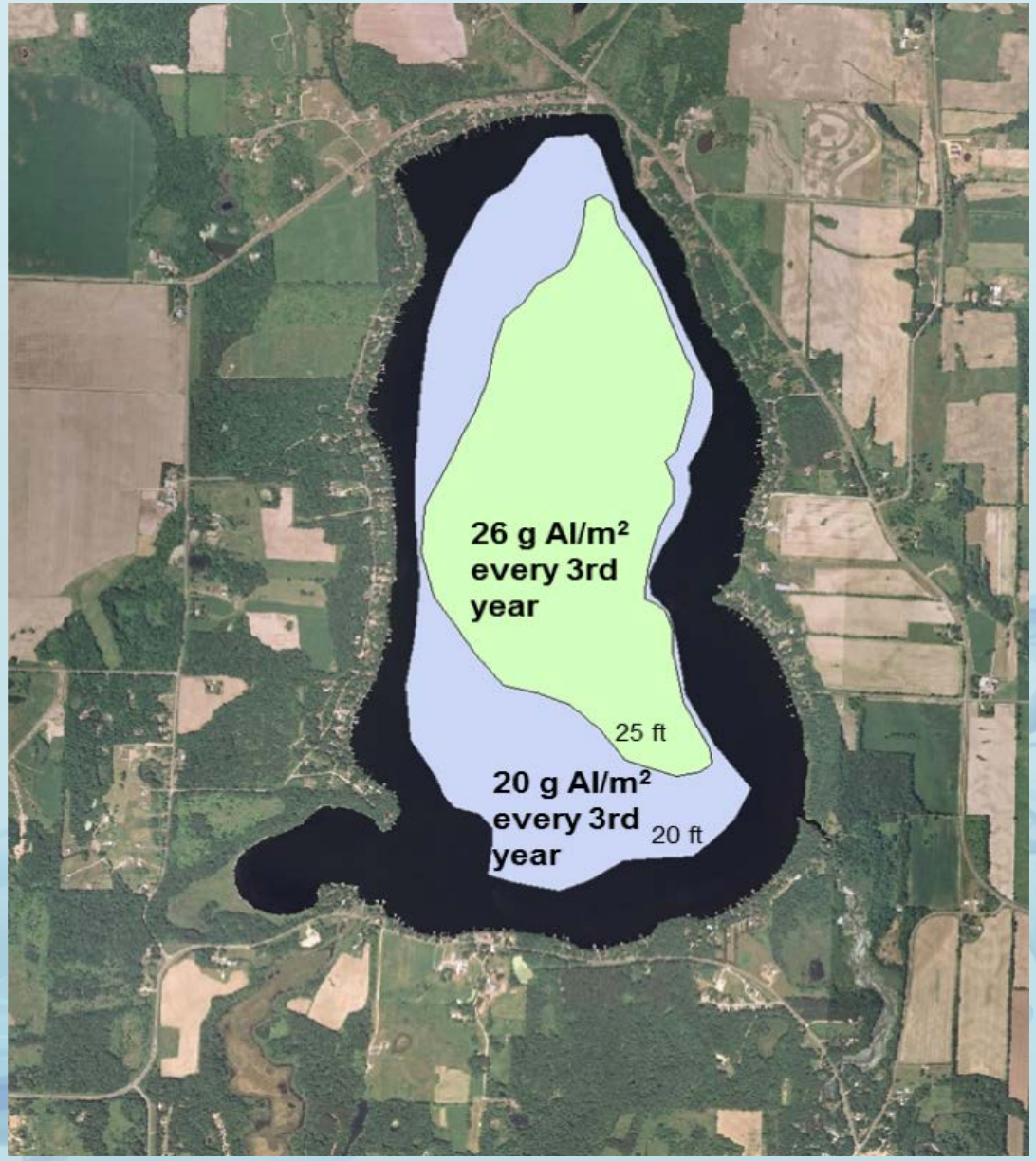
Alum Project

2017

1,118 acres; maximum depth = 34 feet

HAB AquaticSolutions

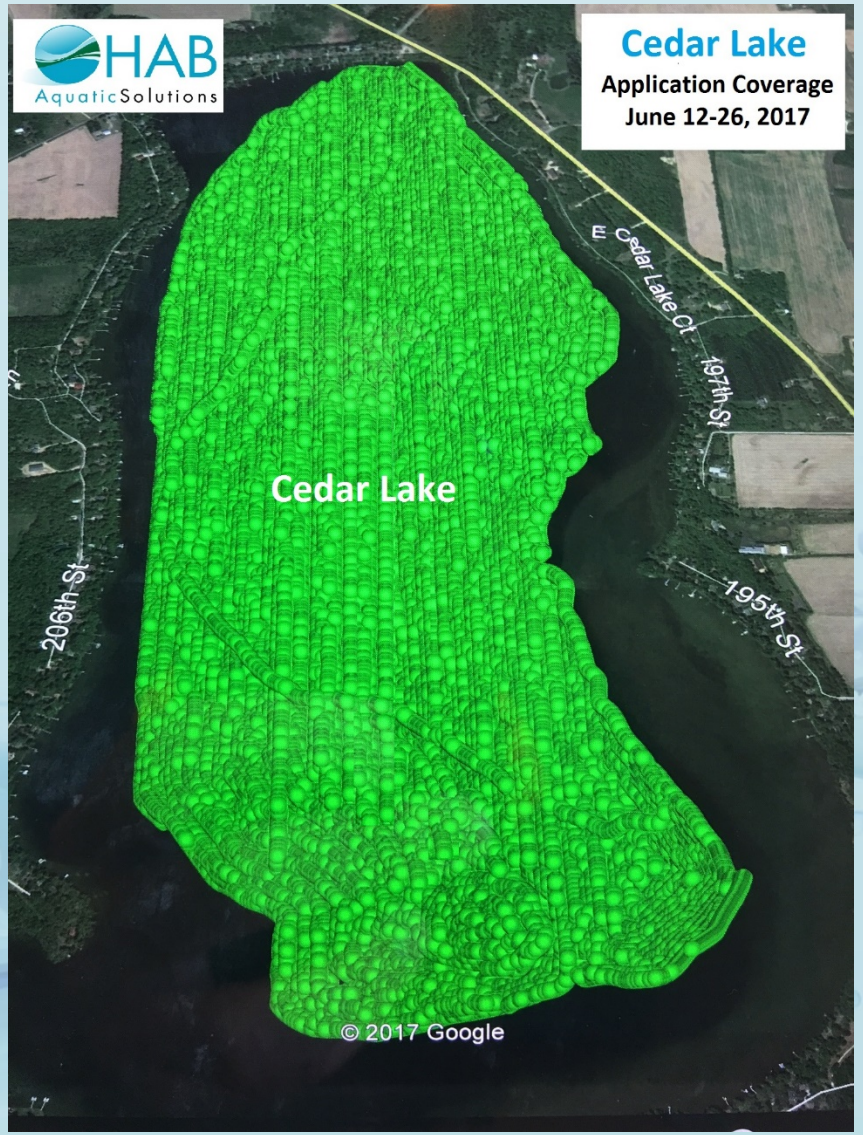
Application Strategy



HAB
AquaticSolutions

2017 Application

- 287,840 gallons of alum applied over 13 days
- 682 acres covered



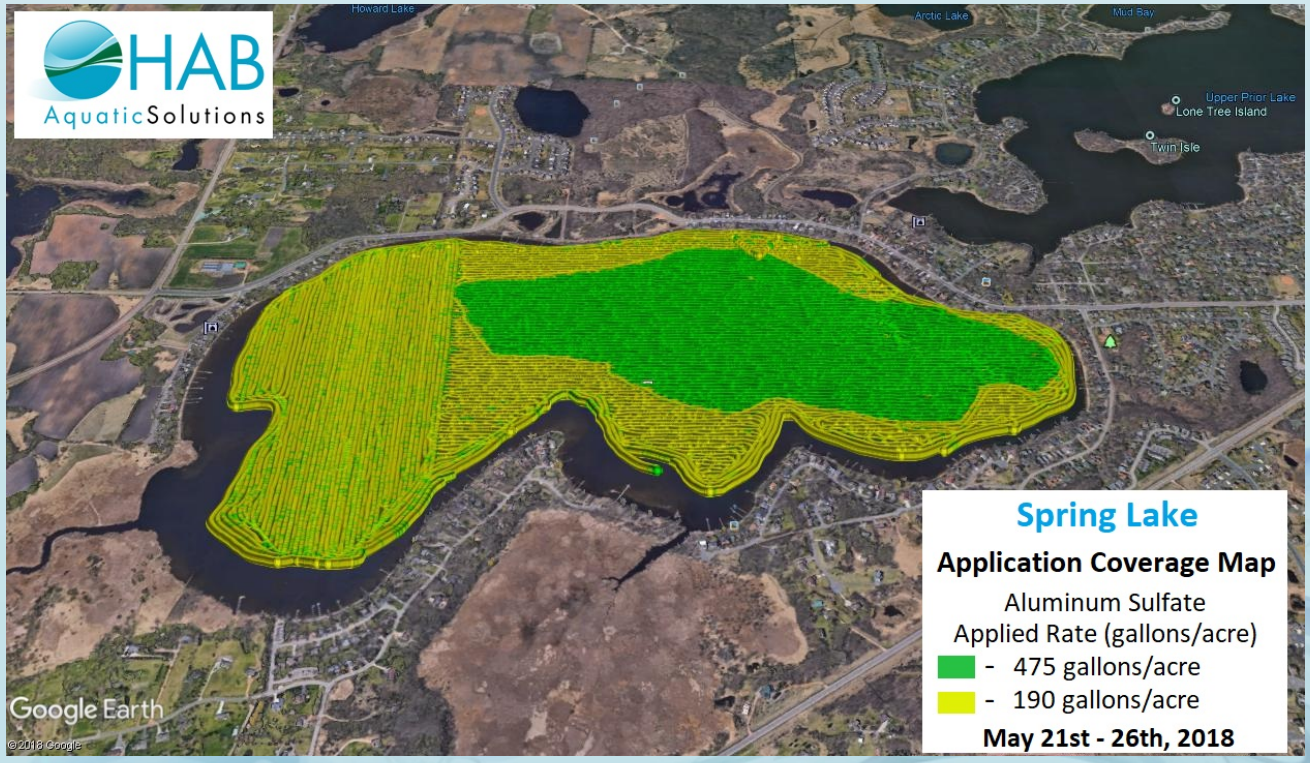
HAB
AquaticSolutions

Spring Lake, MN

2018

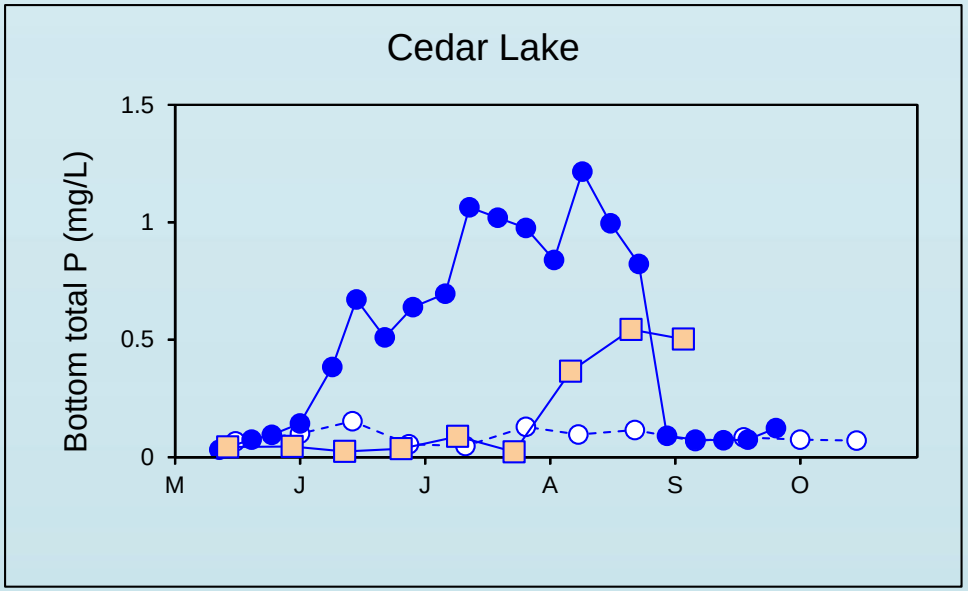
Dual Zone

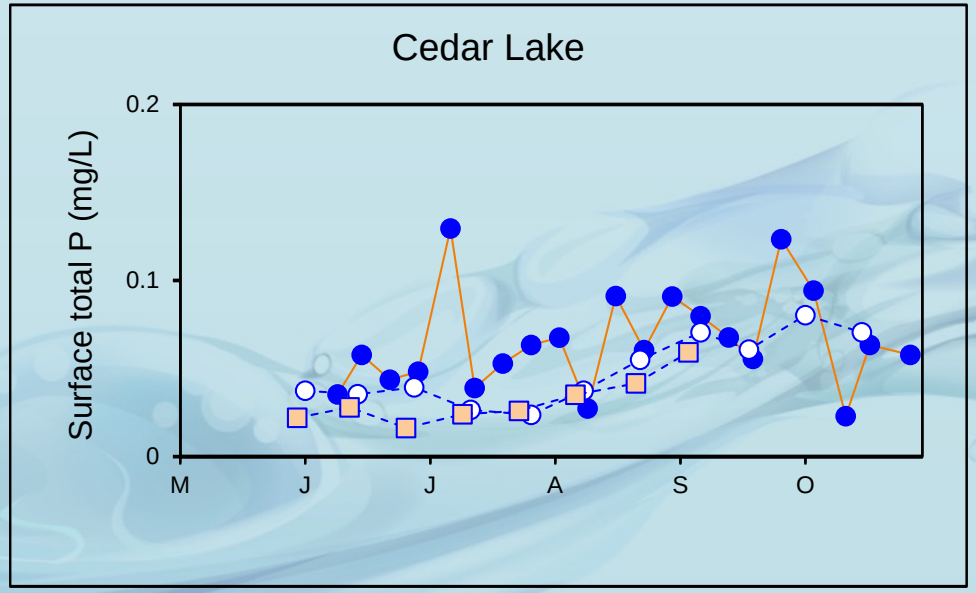
Application Map



HAB
AquaticSolutions

Total Phosphorus





HAB Aquatic Solutions

W. James, UW-Stout, unpublished data

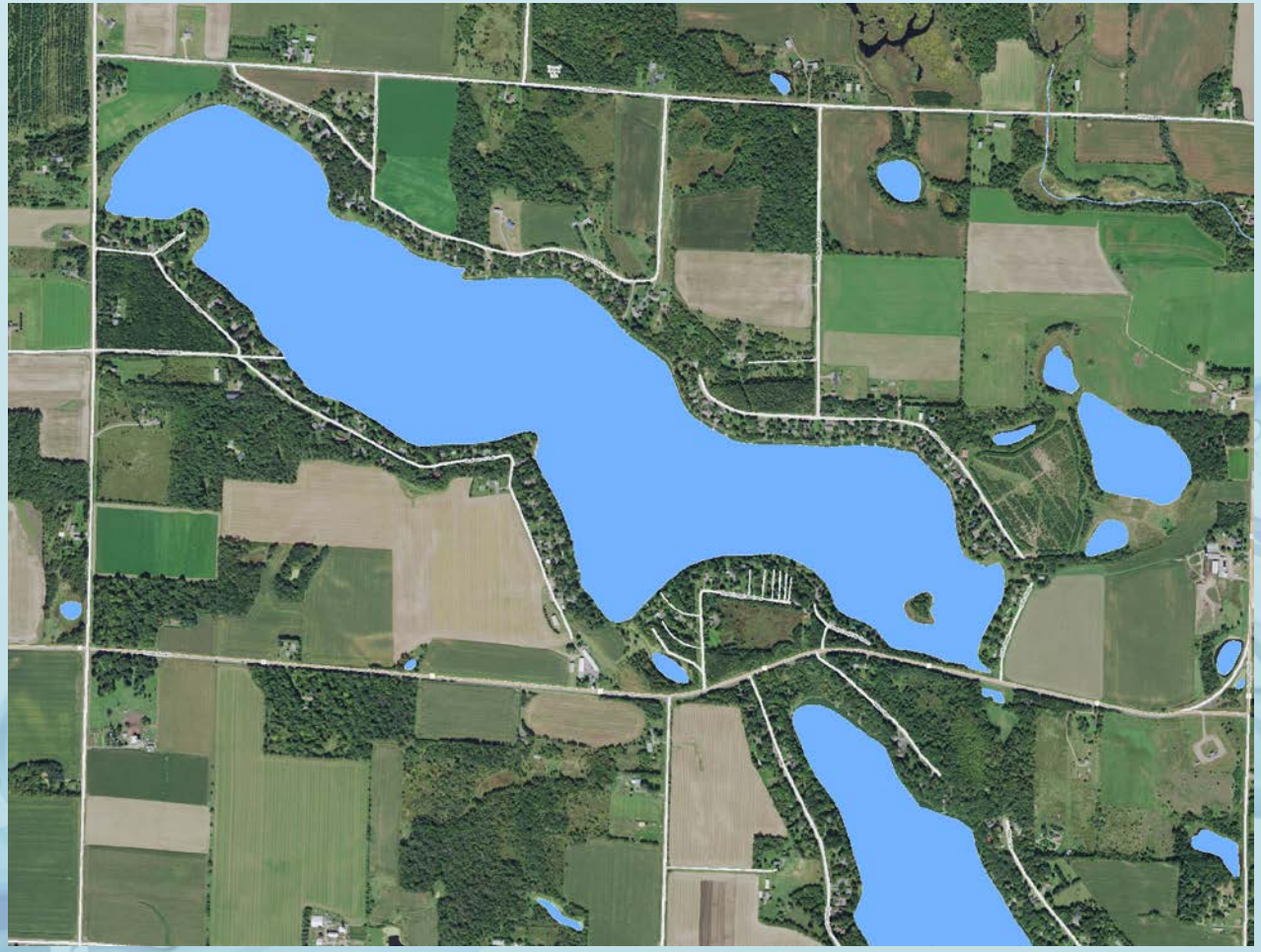
Long Lake, WI

- 272 acre seepage lake located near Balsam Lake, WI
- Average total phosphorus (2012) = 146 ug/L
  Average Secchi disk depth (2012) = 2.1 ft
  Average Chlorophyll (2012) = 82 ug/L
  History of algal toxins
- Total phosphorus criteria = 40 ug/L
  Preferred Chlorophyll = 30 ug/L or less
- Relatively shallow, unstratified lake
  Maximum depth = 17 ft
  Average depth = 11 ft

HAB AquaticSolutions

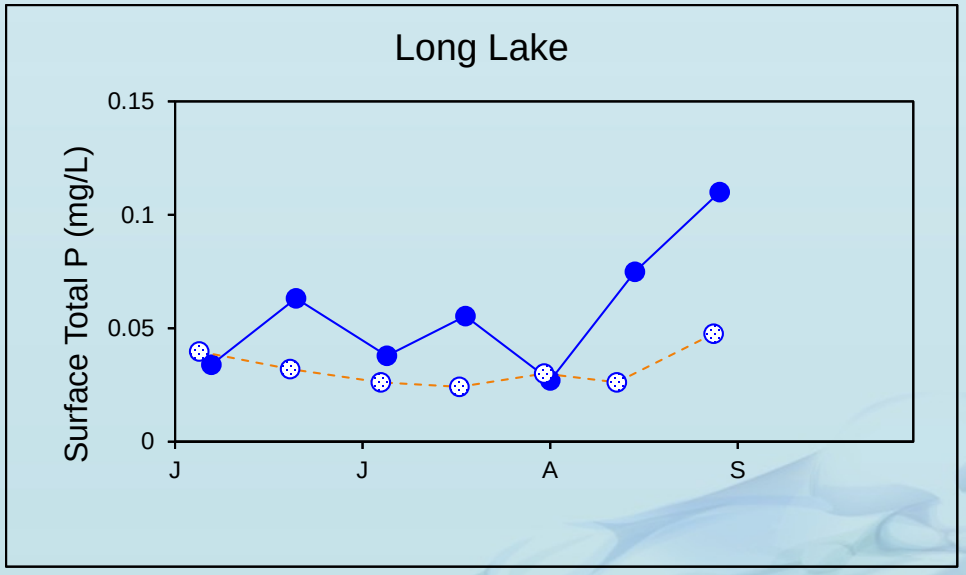
Long Lake, WI 2018 Application

- 42,246 gallons of alum
- 21,123 gallons of sodium aluminate
- 88 acres covered in 3 days



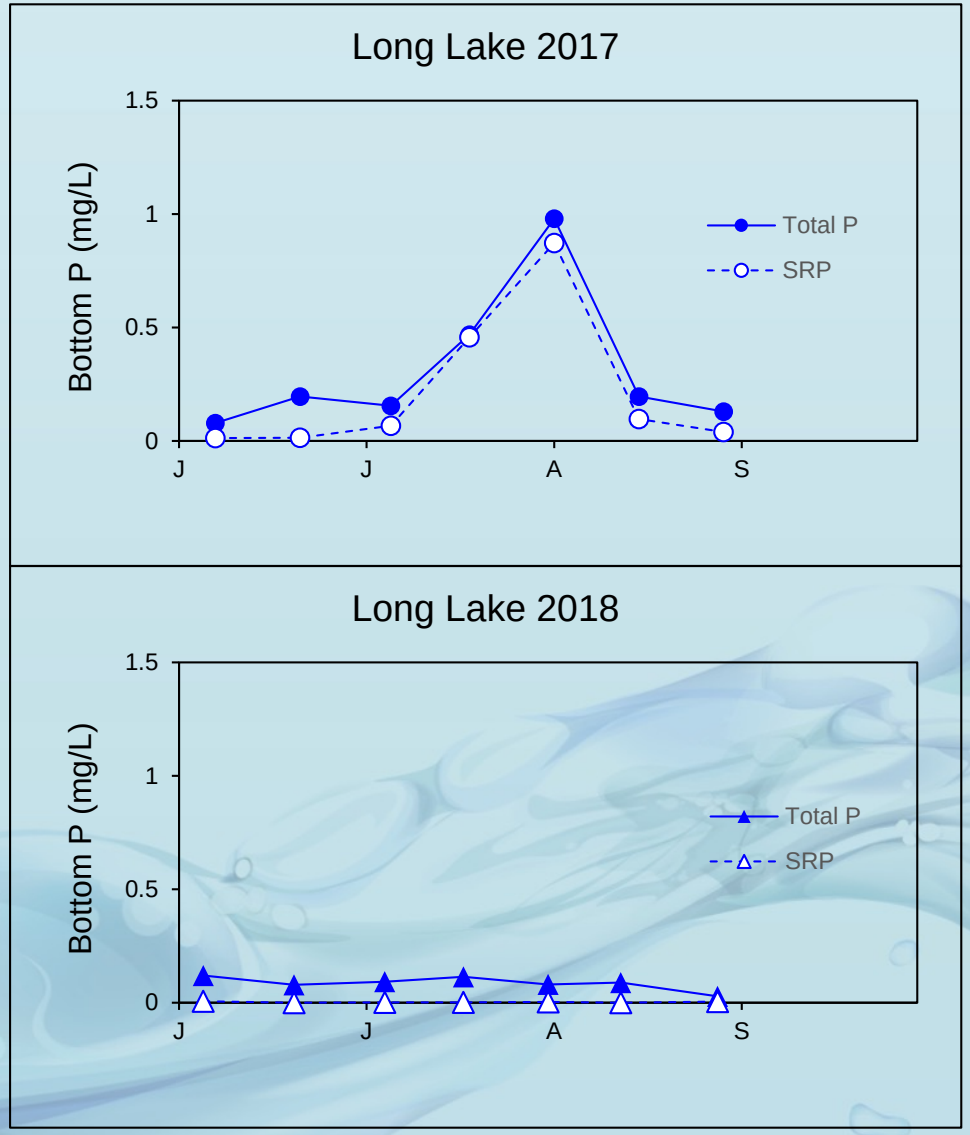
HAB Aquatic Solutions

Epilimnetic Total Phosphorus



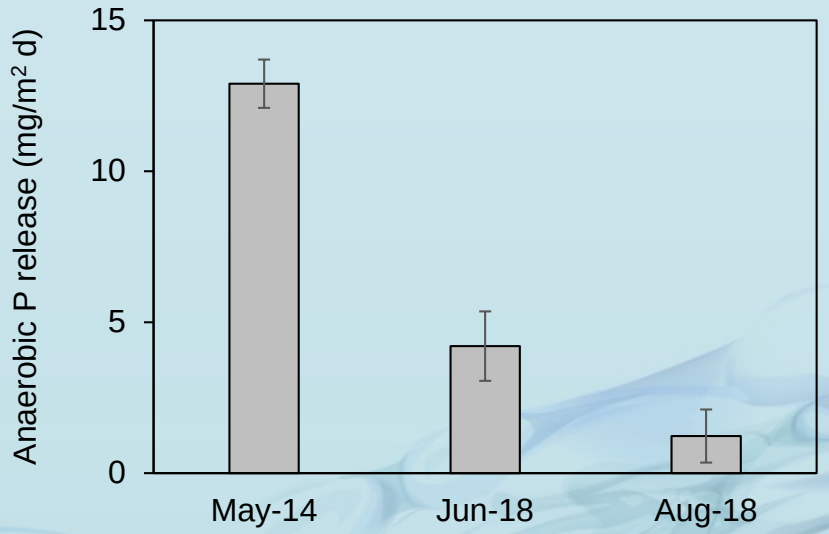
W. James, UW-Stout, unpublished data

Hypolimnetic Total Phosphorus



W. James, UW-Stout, unpublished data

Anaerobic Phosphorus Release



W. James, UW-Stout, unpublished data

HAB Aquatic Solutions

Grand Lake

St. Mary's, OH

HAB Aquatic Solutions

Grand Lake

St. Mary's, OH

- 2011
  - 29 day application period (June 1 – June 29, 2011)
  - 1,754,200 gallons of alum
    - 415 trucks (average = 14.3 trucks per day)
  - 877,100 gallons of sodium aluminate
    - 229 trucks (average = 7.9 trucks per day)
- 2012
  - 29 day application period (April 2 – April 30, 2012)
  - 1,808,888 gallons of alum
    - 429 trucks (average = 14.8 trucks per day)
  - 904,344 gallons of sodium aluminate
    - 241 trucks (average = 8.3 trucks per day)

HAB
AquaticSolutions

Why Alum?

Proven

- Long track record of successful use in lakes (50 yrs)
- Aluminum chemistry is well-studied, well-understood and predictable
- Large body of peer-reviewed scientific literature exists on the use of alum in lakes
- Scientifically Transparent

  -Dosing (accepted and effective binding ratio)

  -Independent review of dose

HAB Aquatic Solutions

Why Alum?

Safe

- Long history of safe use in lakes
- Commonly used in drinking water treatment. HAB uses the same alum/purity grade in lakes
- Well-understood/studied aluminum chemistry (pH driven)
- HAB's flawless safety record (76 projects to date). Safety plan developed and enforced for every project.

HAB
AquaticSolutions

Why Alum?

Cost Effective

- Alum is the most cost effective management tool
- Cost to remove inactivate a pound of P is $60-70 (USD)
- Function of cost and binding efficiency
- Alum is widely available and relatively inexpensive

HAB
AquaticSolutions

Why Alum?

Feasible

- HAB's application methodology is proven for small to large projects
- HAB has the required and proven application equipment
- HAB has relevant project management experience
- HAB has project experience in Canada
- Alum is locally available

HAB AquaticSolutions

Next Steps: Pigeon Lake

Next Steps:

-Obtain and review all reports and data

-Conduct nutrient budget study

-Conduct lakebed sediment coring study

-Determine amount of P to be inactivated

-Develop/confirm alum dose

-Negotiate alum pricing

-Develop alum application strategy and cost estimate

HAB AquaticSolutions

Final Thoughts

- Sediment P fractionation, P flux and internal loading studies
- High resolution P budget
- Alum for sediment P inactivation
- Alum for water column P inactivation
- Cost effectiveness of management practices ($/lb P removed)
- Economic value of the lake/property values

HAB
AquaticSolutions

Questions?

www.pintolakealum.com
www.cedarlakealum.com
www.fishlakealum.com

Please contact us at jholz@habaquatics.com