



Sweeney Lake aeration study

Located in Golden Valley, Sweeney Lake is beloved by nearby homeowners and members of the community who benefit from recreational use. In 2004, however, the 67-acre lake was designated as an “impaired water” by the Minnesota Pollution Control Agency (MPCA). The problem? Too many nutrients (phosphorus).

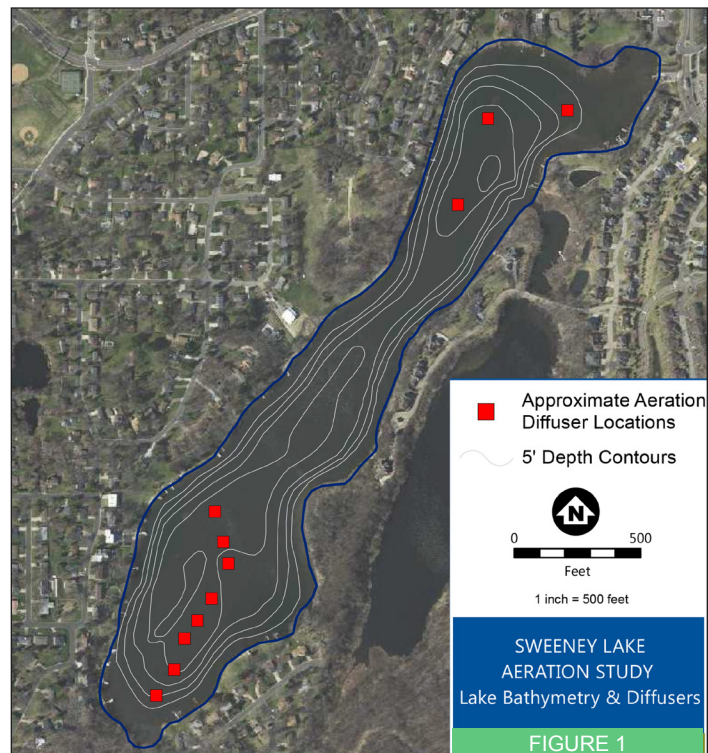
Sweeney Lake homeowners have long been concerned about the lake’s water quality. In fact, for the past 40 years they have operated an aeration system year-round to oxygenate the water—hoping to improve conditions for native fish and reduce the buildup of phosphorus, the nutrient that contributes to algae growth. The system consists of 11 diffusers and nine compressors (Figure 1 at right).

The Bassett Creek Watershed Management Commission (BCWMC) has also been concerned about Sweeney Lake. The Commission monitors the lake each year, measuring summer averages of phosphorus, chlorophyll-a (an indicator of algae), and water clarity to see if they meet state standards (see table at right). In 2011, the BCWMC also completed a total maximum daily load (TMDL) study for Sweeney Lake. The TMDL creates a plan for restoring the lake by identifying the maximum amount of pollutants it can receive while still meeting water quality standards. While the TMDL establishes a specific path toward better water quality, there is still a question about whether the lake’s aeration system is part of the problem or the solution. To answer that question, the BCWMC began a study of the aeration system in 2017. The potential effects of an alum treatment for the lake were also examined (see page 4).

This factsheet provides study results, as well as some background on lake systems.

About Sweeney Lake

Location (city)	Golden Valley
BCWMC classification	Priority 1 deep lake
Watershed area	2,397 acres
Lake size	67 acres
Average depth	12 feet
Maximum depth	25 feet
Ordinary high water level	827.7 feet
MPCA impairments	Nutrients, chloride
Aquatic invasive species	Curly-leaf pondweed
Lake access	Private boat launch and public carry-in canoe launch
Minnesota Pollution Control Agency/BCWMC Water Quality Standards for Sweeney Lake	
Total phosphorus	≤ 40 micrograms/liter
Chlorophyll-a	≤ 14 micrograms/liter
Secchi disc transparency (clarity)	≥ 1.4 meters (4.6 feet)



Lake stratification and aeration

To understand the situation in Sweeney Lake, it's helpful to know a little about lake stratification. In lakes without aeration, stratification occurs each summer when lake water separates or stratifies into three distinct layers. Because of the temperature differences, the layers (described below) usually have stable boundaries and don't mix during the summer.

The upper layer: epilimnion

Water in this layer is warmer and has more oxygen and light. These characteristics promote algal growth and support zooplankton and fish. However, if nutrient levels become too high, algal blooms may occur (see photo at top of page 3).

The middle layer: metalimnion

This is the "transitional" middle layer, which effectively divides the lake in two. It is cooler than the epilimnion.

The lowest layer: hypolimnion

This layer contains dense, cooler, and relatively "quiet" water. The decomposition of plants and other organisms in this layer steals oxygen from the water, often leaving this layer anoxic (without oxygen). Anoxic conditions promote the release of phosphorus from bottom sediments.

In spring and fall, when there is less variation in the temperature of the layers, wind "mixes" the layers. This is known as "lake mixing" or "turnover."

The aerators in Sweeney Lake disrupt the normal stratification of the lake. Figure 2 shows how Sweeney Lake would stratify during the summer without aeration; Figure 3 is a representation of the lake's aeration system. In this system a diffuser is placed on the bottom of the lake that circulates air from a compressor through the hypolimnion, up through the epilimnion layer, and back down. One effect of aeration is that it prevents lake stratification and stirs up the bottom layer, distributing phosphorus throughout the water column. This could be particularly problematic in Sweeney Lake where a significant portion of the lake's phosphorus is coming from internal sources, like sediments.

Figure 2 Thermal stratification

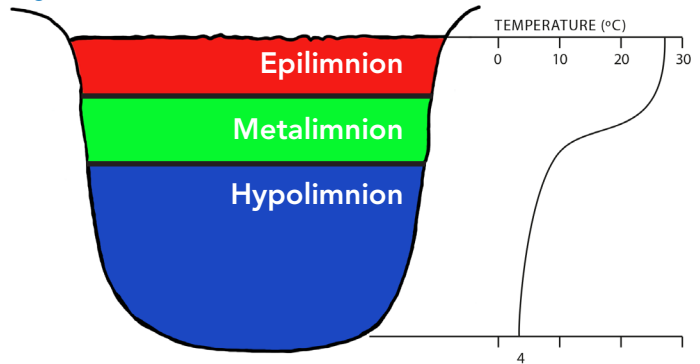
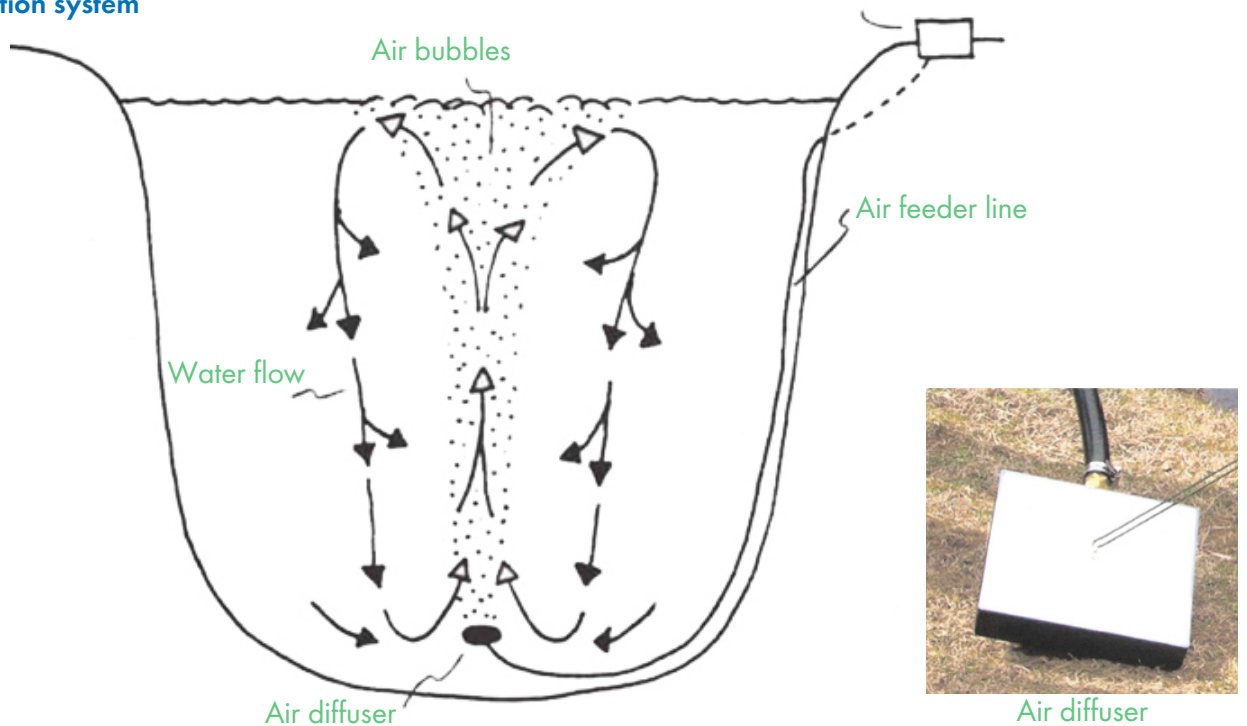


Figure 3 Aeration system





Blue-green algae at the Sweeney Lake Boat Launch

Phosphorus is key

When it comes to the water quality of Sweeney Lake, phosphorus is the key. While some phosphorus is necessary for plant and algae growth in healthy lake ecosystems, excessive levels of phosphorus lead to excessive algae growth (including toxic blue-green algae at times) and decreased water clarity. These are the conditions that concern the BCWMC, MPCA, and the Sweeney Lake community.

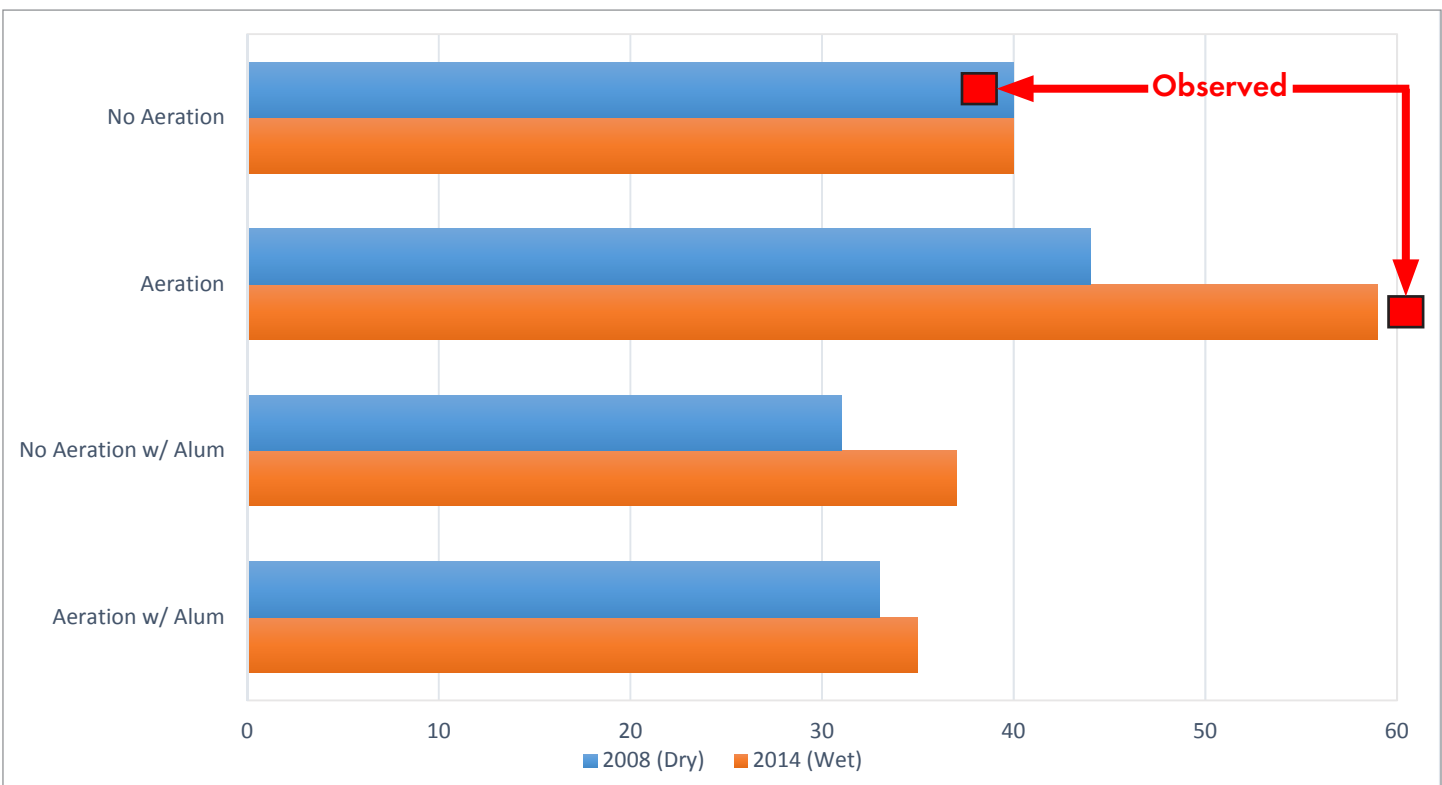
Three-dimensional water quality modeling

To answer the question of whether aeration is helping or hindering lake water quality (specifically, phosphorus levels), a three-dimensional lake-water-quality computer model was used to compare the individual effects of climate, aeration, and alum treatment (see page 4) on lake water quality. As seen in Figure 4, below, the combined approach of ceasing aeration and applying an alum treatment produces the best result in terms of limiting phosphorus.

Key findings

- Modeling shows that whether the lake is aerated or not, phosphorus within the lake (internal loading) is the single largest source of phosphorus in the summer.
- Aeration exacerbates summer water quality problems in Sweeney Lake—surface water phosphorus concentrations were 10–30% higher with aeration.
- An alum treatment will greatly improve water quality and ensure that MPCA/BCWMC goals will be met for Sweeney Lake.
- Depending on sources of phosphorus coming from outside the lake and lake mixing, aeration after an alum treatment may not provide significant benefits.

Figure 4 Predicted summer average total phosphorus concentration (µg/liter)



About alum treatments

While studying the effects of aeration on Sweeney Lake, the potential use of aluminum sulfate (alum) to improve water quality was also examined. As indicated on page 3 of this handout, modeling showed that the use of alum would decrease phosphorus levels in the lake. (Twin Lake received alum in 2015 to help maintain excellent water quality.) Alum treatments are costly, however, so planning for a treatment will take time and coordination of resources. The paragraphs below provide answers to some frequently asked questions about alum.

What does alum do and how does it work?

Alum (aluminum sulfate) is derived from aluminum. It has been used in water purification and wastewater treatment for centuries and in lake restoration for decades. The chemical reduces the growth of algae by trapping phosphorus in the lake sediments. To treat a lake, alum is injected several feet below the water's surface. Upon contact with the water it becomes aluminum hydroxide, taking the form of a fluffy substance called floc. This floc works to improve water quality in two ways:

1. As it settles to the bottom of the lake, the floc interacts with phosphorus to form aluminum phosphate, an insoluble compound. In this state the phosphorus can no longer be used by algae for food. Other suspended particles are also collected by the floc, leaving the water noticeably clearer.

2. On the bottom of the lake, the floc forms a layer which binds with phosphorus as it is released from the sediment. This produces a "blanket" over the sediment, reducing internal loading.

How long does it take to complete alum treatment and how quickly are results seen?

Alum treatments are generally made either in the late fall or early spring over a period of 7–10 days. Lake transparency will increase dramatically, even within a few hours. Reductions in algae should be noticeable within one year.

How long will the alum treatment last?

Because Sweeney Lake receives a significant amount of its phosphorus from internal loading, the treatment could maintain water-quality improvements for as long as 15 to 20 years.

Is alum safe?

Yes. There is no evidence to suggest that aluminum ingested in water poses a health threat. Water treatment plants throughout the United States use hundreds of thousands of tons of alum annually and many municipalities use it for wastewater treatment. Upon settling to the bottom of the lake the floc is harmless to aquatic plants and animals. The Food and Drug Administration, the U.S. Environmental Protection Agency, and leading medical experts all concur that aluminum is not a risk factor for any diseases or health conditions.



Photos of Spring Lake before (left) and after alum treatment (right) by the Prior Lake-Spring Lake Watershed District