



What is Aeration?

Aeration is a management tool used to increase the concentration of dissolved oxygen in a waterbody.

Why is Oxygen Important in a Waterbody?

Reduced oxygen conditions in lakes, ponds, reservoirs, and other waterbodies can impair water quality and lead to excessive algae growth.

Aeration as a Tool to Manage Water Quality

In lakes, ponds, and reservoirs, respiration occurs naturally throughout the water column and may be most intense near the lake bed, where plant and other organic materials are decomposed by bacteria. In stratified lakes, reduced oxygen levels in deeper water can be exacerbated during summer months, when the heavy bottom lake layer is separated from sources of oxygen in the upper lake layer. As respiration occurs in the bottom layer, oxygen can become depleted. Seasonal oxygen depletion is a natural process that can be greatly accelerated by human activities that cause increased nutrient inputs.

Beginning in the 1960's, aeration systems were introduced as a method to slow down the effects of **eutrophication** by addressing low oxygen conditions in waterbodies.

Aeration has been used to improve fish habitat in stratified lakes experiencing oxygen depletion in deep water and in shallow ice-covered lakes. In drinking water reservoirs, aeration has been used to homogenize water quality and pH levels, which helps reduce treatment costs. Aeration is also used to

manage algae blooms through a variety of mechanisms, depending on the characteristics of the waterbody.

In recent years, aeration has been marketed to lake managers as a tool to potentially manage aquatic plants and accumulated organic material on a lake bottom, also referred to as "muck." Although there is a market for installing aeration systems for these uses and some experimental installations in place, the scientific literature does not support the use of aeration as a tool for managing muck or aquatic plants.



SolarBee Circulator installed in Lake Champlain, St. Albans

Eutrophication

Eutrophication is the process in which a body of water becomes enriched in dissolved nutrients (such as phosphorus) that stimulate the growth of aquatic plants and algae, usually resulting in the depletion of dissolved oxygen. The increased nutrient inputs come from sources within the surrounding watershed.



Diffused Air Compressor installed in Little Lake St. Catherine, Wells.

Limitations and Potential Adverse Impacts of Aeration in Lakes

Limitations

There are limitations to what aeration can accomplish in a waterbody due to physical, chemical, and biological characteristics of the waterbody and its watershed. Aeration techniques must be appropriately designed for the water quality goals and to function within a specific waterbody. Most commonly, the primary benefits of aeration installations include water quality improvements in dissolved oxygen content, ammonium concentration, pH, and trace metal concentrations (iron and manganese). There are some cases in which aeration can lower phosphorus concentrations. Aeration has been successful at reducing the phytoplankton biomass to reduce algae blooms in some lakes and reservoirs, but not generally in shallow lakes.



The scientific literature demonstrates that the effects of aeration can be very localized. The lateral effects of circulation should not be expected to be observed beyond twice the depth of bubble release or vertical pumping distance and effects completely diminish over a distance of about 20 times the vertical distance travelled by circulated water. Circulation can reduce the frequency of algae blooms, but rarely eliminate them.

In summary, aeration is a tool tailored to the unique characteristics of a waterbody to manage a specific water quality issue. Applying aeration incorrectly has the potential to prevent a waterbody from meeting water quality goals or even to degrade water quality.

Potential Adverse Impacts

Although there are potential benefits to using aeration, aeration installations do not always meet management goals, and in some cases, exacerbate the effects of eutrophication. **Aeration may:**

- Make phosphorus more available to aquatic plants, which may increase plant productivity.
- Make phosphorus more available to phytoplankton, increasing algal blooms, especially in shallow lakes.
- Decrease transparency due to increased algal biomass and silt.
- Increase water temperature.
- Increase nutrient recycling and primary productivity, thereby resulting in more organic material settling on sediments.
- Alter fish habitat and natural wetland habitats that rely on still water.
- Impact phytoplankton, zooplankton and other primary food sources that larval and juvenile fish species rely on in their early life stages.

Recommendations and Future Aeration Project Review

The Watershed Management Division uses the principles outlined in the Vermont Surface Water Management Strategy (SWMS) to guide water quality management throughout the state. SWMS emphasizes that **full protection and restoration of surface waters can only be accomplished when upstream and upland stressors are reduced to levels which support biological, physical and chemical integrity in receiving waters**. Under this policy, in most cases, in-lake management approaches are considered only when sufficient progress has been made on land immediately adjacent to the resource or deeper in the watershed. Using this watershed management approach, water quality management decisions can be efficient, predictable, consistent and support coordinated management actions.

The Department approaches the application of in-lake treatments with caution and on a case-by-case basis. Any potential future aeration projects will be reviewed in the context of SWMS and the list below. Proposed aeration projects shall:

- Clearly identify water quality problems and goals;
- Demonstrate that the aeration method proposed is scientifically established to address the problem and has provided results that are predictable and repeatable in efficacy and outcome.
- Be considered as low risk to the ecosystem and provide a public good, such as a public health benefit.
- Have a minimum of three years of pre-aeration water quality data available.
- Demonstrate that the waterbody is actively working toward implementation of watershed management actions to address the water quality concerns.

<http://dec.vermont.gov/watershed/map/strategy>