LAKE KETCHUM ALGAE CONTROL PLAN

1 EXECUTIVE SUMMARY

PROBLEM STATEMENT

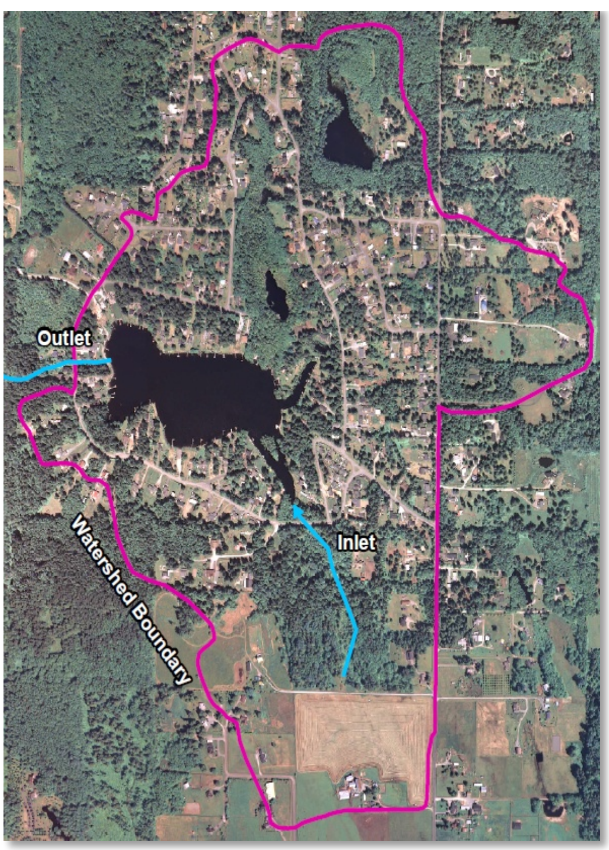
Lake Ketchum is a 25-acre public lake located in northwest Snohomish County two miles north of the City of Stanwood. The lake supports swimming, fishing, boating, aesthetic enjoyment, and wildlife habitat. Historically, it was the drinking water supply for the City of Stanwood.

ALGAE BLOOM AT LAKE KETCHUM

Although the lake setting is still beautiful, Lake Ketchum is now the most polluted lake in Snohomish County, if not the state. The lake suffers from thick growths, or blooms, of blue-green algae. The algae problems severely impair the public use and enjoyment of the lake. Furthermore, the algae blooms are also frequently toxic, threatening the health of people and pets that use the lake.

The algae problems are caused by extremely high levels of phosphorus in the lake. The main original source of pollution is from a former dairy farm that drains to the Lake Ketchum inlet stream. Over time, the phosphorus from the farm has built up in the lake bottom. The phosphorus stored in the lake sediments has now become the major source of pollution to the lake. The long-term summer phosphorus concentration at Lake Ketchum is 277 micrograms per liter (µg/l or parts per billion). This level of phosphorus is an order of magnitude higher than that found at all other lakes in Snohomish County and more than 13 times higher than the State phosphorus criterion of 20 µg/l for Puget Sound lowland lakes. For this reason, the Washington State Department of Ecology has officially listed Lake Ketchum as an "impaired" waterbody and as a regional priority for restoration.

LAKE KETCHUM WATERSHED

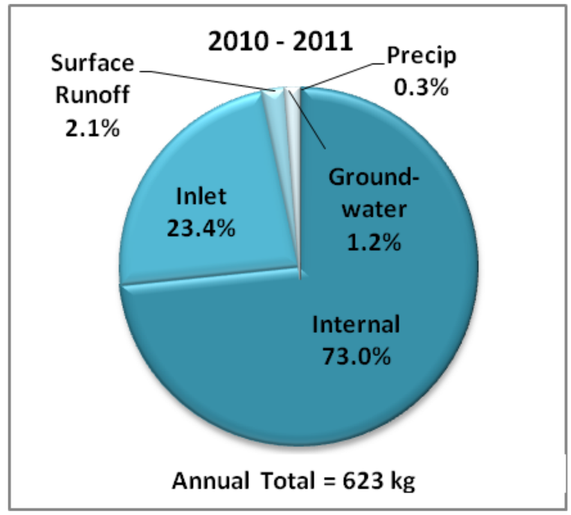


PROJECT BACKGROUND

The water quality problems at Lake Ketchum have been ongoing for decades. In 1996, the Snohomish County Surface Water Management Division (SWM) completed an initial Phase I study that identified the farm soils and the lake sediments as the primary pollution sources. However, actions to clean up the lake were never taken due to lack of funding. In response to continued severe toxic algae blooms and the ongoing frustrations from Lake Ketchum residents, SWM initiated a new project in 2010 to work towards a feasible clean-up plan for Lake Ketchum. The project goal is to achieve long-term restoration of Lake Ketchum by reducing the amount of phosphorus in the lake to control future blooms of algae. SWM was awarded a grant from the Department of Ecology to help fund a one-year lake study to identify the best methods of controlling the internal and external phosphorus sources and to develop a plan that guides implementation of cleanup actions. The project objectives are to 1) identify current phosphorus amounts and sources; 2) identify effective treatment methods for both external and internal phosphorus; 3) develop an algae control plan, with costs and funding sources; and 4) work with citizens to gain support for the plan and begin steps toward implementation.

STUDY RESULTS

LAKE KETCHUM PHOSPHORUS SOURCES



After a year of intensive water quality and hydrologic monitoring, a Lake Ketchum phosphorus model was developed to understand the sources and quantity of phosphorus flowing into and out of the lake. By far the largest source (73%) of the phosphorus which causes algae growth in the lake is the “internal” source. Internal refers to the phosphorus built up in the lake sediments that is re-released into the lake each year.

The other major phosphorus source is the main inlet stream, accounting for 24% of the total. The inlet drains from the former dairy farm. The phosphorus levels in this stream are much lower than in 1996 during the original study. However, the phosphorus concentrations are still extremely high compared to other streams in the area. Runoff from the rest of the watershed (the land area that drains to Lake Ketchum – see photo) and from shallow groundwater accounts for roughly 3% of the phosphorus and is primarily from residential sources. Common residential phosphorus sources include: lawn and garden fertilizers poorly maintained septic systems, pet and animal wastes, stormwater runoff from roofs and driveways, and erosion from bare soils and shorelines (phosphorus is carried on soil particles).

LAKE RESTORATION ALTERNATIVES

Several lake restoration methods were evaluated to identify the most feasible and effective actions to reduce phosphorus levels in Lake Ketchum to a target of less than 40 µg/l during the summer. Achieving this target level of phosphorus will significantly reduce the frequency and duration of blue-green algae blooms and will restore beneficial uses of the lake.

The best and only feasible method for inactivating the internal phosphorus from the lake sediments is one or more aluminum sulfate (alum) treatments of the lake sediments. Alum permanently binds phosphorus in the lake water and the sediments. Alum treatments are the most successful method used around the world to inactivate phosphorus to alleviate algae problems. Alum is also a safe treatment that is widely used to remove phosphorus and other impurities from drinking water supplies and to rehabilitate lakes.

The preferred method to address the main external source of phosphorus flowing from the farm through the inlet stream is to modify or remove the soils from the farm. However, this method cannot be pursued without the cooperation of the private land owners, which is currently not possible. In addition, much of the phosphorus from the farm is now sequestered in the soils of the wetland that is located between the farm and the lake. Phosphorus in this wetland cannot be removed without destroying the wetland. Protecting the wetland area is critical to ensure that the wetlands continue to capture a portion of the phosphorus from the farm.

The only remaining option to control the external inflow from the main inlet stream is to intercept the phosphorus as it reaches the lake or soon after it enters the lake. Two methods were examined in detail to inactivate the inflowing phosphorus. The first method is to construct a small mechanical treatment plant that would inject alum into the stream as it enters the lake. The second method is to annually conduct a small alum treatment of the lake water (the water column). The annual alum treatment would be performed each spring to remove the phosphorus that has washed into the lake during the rainy period.

Four lake restoration alternatives involving combinations of these phosphorus control methods were developed. The alternatives were analyzed using the phosphorus model to predict the response of the lake to implementation of each alternative over a four-year time period. Only Alternatives #3 and #4 were shown to consistently meet the restoration target of 40 µg/l; however, Alternative #3 would cost $601,000 over four years while Alternative #4 would cost $338,000.

Based on the model results and the projected costs of each alternative, Alternative #4 is both effective and the most economical solution for Lake Ketchum. Therefore, Alternative #4 is the preferred restoration alternative.

LAKE RESPONSE TO POTENTIAL RESTORATION ALTERNATIVES

Lake Restoration Alternatives[1]	Upper Waters Summer Average Total Phosphorus Concentrations (µg/l)			
	Year 1	Year 2	Year 3	Year 4
Modeled Existing Conditions	173	175	175	175
Alternative 1 Whole-Lake Sediment Inactivation Alum Treatment	46	70	71	71
Alternative 2 Whole-Lake Sediment Inactivation Alum Treatment Repeated in Two Years	46	70	31	54
Alternative 3 Whole-Lake Sediment Inactivation Alum Treatment **AND** Alum Injection at Inlet	46	36	36	36
Alternative 4 Whole-Lake Sediment Inactivation Alum Treatment **AND** Annual Water Column Alum Treatments	41	39	39	39

[1]*Note: all alternatives would also include implementation of residential best management practices and wetland protection.*

RECOMMENDED ALGAE CONTROL PLAN

Five primary elements are included in the final recommended algae control plan. The first two elements are to implement Restoration Alternative #4 by conducting a whole lake sediment inactivation and annual water column alum treatments. These two elements will address the internal phosphorus as well as the primary external phosphorus from the lake inlet. The third plan element is to continue to protect the wetlands between the lake and the farm. Keeping these wetlands intact will allow for the continued capture of phosphorus from the farm runoff. The fourth element is to reduce residential phosphorus pollution. By making changes in household practices, less phosphorus will flow into the lake, helping the alum treatments be more effective. Finally, monitoring of lake conditions will be needed to evaluate results and allow for active management of lake treatments.

ELEMENTS OF RECOMMENDED ALGAE CONTROL PLAN

- **Element 1** – Whole Lake Sediment Alum Treatment (Alternative 4)
- **Element 2** – Annual Water Column Alum Treatments (Alternative 4)
- **Element 3** – Continue to protect wetlands
- **Element 4** – Implement changes in residential practices
- **Element 5** – Monitor lake water quality and revise plan as needed

COSTS & FUNDING

The estimated costs of each control plan element are outlined in the table below. The funding to implement the recommended Algae Control Plan will challenge the resources of the local residents and Snohomish County, especially for the large Year 1 and 6 costs. Funding assistance from the State through grants or other sources will be critical if the lake is to be restored. Potential funding sources for portions of the costs include:

- Lake shore property assessments through the existing LID (RCW 90.24).
- Formation of a Lake Management District (RCW 36.61).
- Snohomish County Surface Water Management funds.
- Department of Ecology Centennial Clean Water Fund grant.
- Department of Ecology Freshwater Algae Control Program grant.

COSTS FOR RECOMMENDED ALGAE CONTROL PLAN

Plan Elements	Cost in $1000s (2011 dollars)					
	Year 1	Year 2	Year 3	Year 4	4-Year TOTAL	10-Year TOTAL
Whole-Lake Sediment Inactivation Alum Treatment	$194	0	0	0	$194	$368[1]
Annual Water Column Alum Treatments	$36	$36	$36	$36	$144	$324[2]
Residential BMPs and Wetland Protection	$20	$20	$8	$8	$56	$104
Monitoring/Adaptive Management	$14	$14	$12	$12	$52	$124
TOTALS	**$264**	**$70**	**$56**	**$56**	**$446**	**$920**

[1]Sediment Alum Treatment may need to be repeated in Year 6. [2]No Water Column Treatment proposed in Year 6.

CONCLUSION

The residents and users of Lake Ketchum have suffered with poor lake water quality for many years. Implementation of the Algae Control Plan will have major benefits for the health of Lake Ketchum. Controlling internal and external phosphorus sources will result in less frequent and less intense algae blooms. Fewer blooms will decrease the health risks from toxic algae. Enjoyment of the lake for swimming, boating, and other uses will improve significantly.