Kitsap County Health District
Water Protection Program

KITSAP LAKE PHOSPHORUS REDUCTION PLAN

Final Report

June 30, 2011

Funded By:

Washington State Department of Ecology,
Freshwater Algae Control Program, and

Kitsap County Health District
Water Quality Program

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1. Background and Problem Statement

Summary

Kitsap Lake is a 238-acre lake with a maximum depth of 9 meters, located in the City of Bremerton and unincorporated Kitsap County (Figure 1). Dense residential development and numerous recreational opportunities make Kitsap Lake a popular destination among Kitsap County residents. Kitsap Lake has two public parks with swimming area beaches and two public boat ramps. Kitsap Lake is a popular water skiing and jet skiing lake and has a year round trout and bass fishery.

Cyanobacteria lake closures and public health advisories have kept the general public from using the lake as a water skiing and jet skiing area during peak summer usage times. From a public health perspective, the popularity of Kitsap Lake makes this water body a high priority area to identify and correct sources of phosphorous loading.
It is critical to understand how much phosphorus pollution is from external and internal sources. By understanding the source of pollution, management plans can be developed to meet phosphorus compliance standards for the lake. The primary goal of this project was to produce a plan to control and eliminate sources of phosphorous loading thus reducing the public health exposure risks associated with toxic cyanobacteria blooms.

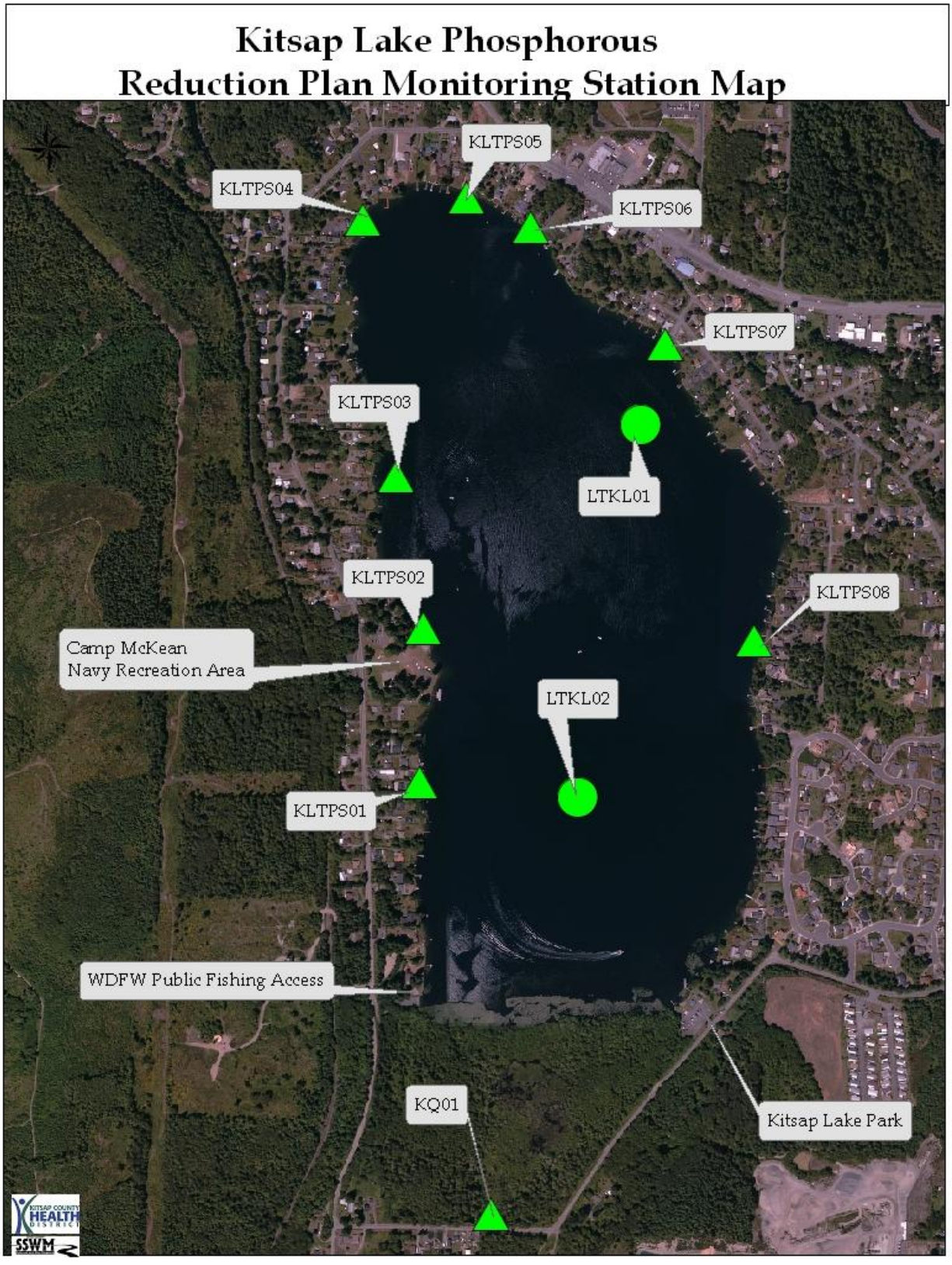
2. Project Description

The Kitsap Lake Phosphorus Reduction Plan objective is to identify, reduce, and control phosphorous loading in Kitsap Lake. The project assessed the phosphorous inputs into Kitsap Lake from streams, storm water, and internal lake cycling. Assessment took place over 12 continuous months of sampling stormwater and stream inputs to the lake and the lake's water column. A supplemental trophic sampling event was conducted in August of 2010 to compare summer phosphorus levels between years 2009 and 2010.

This project also addresses phosphorous pollution loading problems in Kitsap Lake, by identifying and correcting phosphorous sources from failing onsite sewage systems (OSS), inadequate storm-water controls, poor animal waste management, failing public sewer collection systems, and reducing homeowner applications of phosphorous laden fertilizers.

Please see **Figure 1** for a description of the project area.

FIGURE 1


Kitsap Lake Phosphorous
Reduction Plan Monitoring Station Map
KLTPS05
KLTPS04
KLTPS06
KLTPS07
KLTPS03
LTKL01
KLTPS02
KLTPS08
Camp McKean
Navy Recreation Area
LTKL02
KLTPS01
WDFW Public Fishing Access
KQ01
Kitsap Lake Park
KITSAP COUNTY HEALTH DISTRICT
SSWM

3. Project Goals and Objectives

The goal of this project was to understand the sources of phosphorus pollution in the Kitsap Lake system. The project outcome was to also estimate phosphorus loads from internal and external loading and to what extent the lake flush rates affects phosphorous loads in a given year.

4. Lake and Lake Input Monitoring

4.1 Monitoring Station Locations

Monitoring station locations are shown in **Figure 1**.

Table 2
List of Kitsap Lake Monitoring Stations

Station ID	*Location description*	*Latitude*	*Longitude*
KLTPS01	12" Pipe at Shoreline	47.56958	-122.70866
KLTPS02	Input at North Boundary of Camp McKean	47.57229	-122.70909
KLTPS03	Small stream at Point on West Shoreline	47.57537	-122.70943
KLTPS04	Kitsap Creek Outlet	47.57935	-122.71078
KLTPS05	Small Stream East of "J" Shaped Dock	47.57975	-122.70772
KLTPS06	Small stream West of Large White House of	47.57918	-122.70621
KLTPS07	Francis Street Stormwater Outfall	47.57723	-122.70274
KLTPS08	1363 Lakehurst unmapped Outfall	47.57520	-122.70028
KQ01	Kitsap Quarry Creek at Kitsap Lake Road Crossing Downstream Culvert	47.56189	-122.70274
LTKL01	KCHD Lake Trophic Monitoring Station	47.57588	-122.70334
LTKL02	Additional Lake Trophic Monitoring Station	47.5694	-122.70474

4.2 Scheduled Monitoring

Beginning on May 1st 2009, 26 sampling events occurred. The original plan called for sampling every two weeks, however ~~the~~ once the fall turnover had occurred monthly sampling was conducted. Parameters measured for the monitoring portion of this project included:

- Kitsap Lake (LTKL01 and LTKL02), field parameters include secchi depth, temperature, dissolved oxygen, pH, and conductivity. Total Phosphorous (Tp), Total Kendall Nitrogen(TKN), and chlorophyll *a* samples were collected as

composite of three samples taken from even spaced depths throughout the epilimnion based on Carlson's (1977) method for determining trophic state. An additional hypolimnion sample was taken and field data collected to determine the anoxic conditions and Tp concentrations in the hypolimnion.

- Kitsap Quarry Creek and Kitsap Creek (KQ01 and KLTPS04) Field parameters included TP, E.Coli, and total suspended solids (TSS). For storm sampling stations (KLTPS01-03 and KLTPS05-08) field parameters for TSS, Tp, and E.Coli.

- Flow data and lake levels were recorded. Unfortunately, this data has not been useful in determining lake balances due to flow interference from beaver dams causing lake levels fluctuations and rendering lake level data collected during the project inaccurate. Additionally many of the most useful lake input flow gathering stations became flooded during high lake levels and disturbed flow gathering at lake culverts.

5. Lake and Lake Input Findings (Task 2)

5.1 Lake Trophic Findings

Spring and Summer 2009
During the monitoring period from mid May through mid August Kitsap Lake's Tp levels ranged from 18 to 30 ug/l in the epilimnion. Secchi disk readings ranged from 3 to 5 meters between mid May and the end of July. The weather period was an abnormally warm, dry spring and early summer with highs reaching the low 100 degree mark in late July. Kitsap Lake first showed signs of stratification in mid June with dropping D.O. levels at the 6 meter depth at station LTKL01. By the end of June stratification was noted at 6 meters at station LTKL02 also, indicating a lake wide stratification taking place.

Monitoring results show July 14th Chlorophyll *a* concentrations climbed from a background average of 3 ug/l to 12 ug/l thus indicating an immediate inverse response to the anoxic condition developing at the 6 meter depth and below. On July 10th the Kitsap County Health District posted Kitsap Lake with a "Potentially Toxic Algae" advisory due to a cyanobacteria bloom. This advisory remained in place until mid November 2009.

Kitsap Lake stratified beginning in mid June and stayed stratified through the sampling event on August 25th. Oxygen levels show an inverse relationship with Tp concentrations in the hypolimnion. Anoxic levels bottomed out during the August 25th sampling event with levels of D.O. in the hypolimnion at 0.3 mg/l. Conversely, Tp levels were at an all time recorded high for this impoundment reading 420 ug/l.

Total phosphorous levels remained relatively stable in the epilimnion while steadily increasing concentrations in the hypolimnion of the lake until late August. In late August a strong summer storm caused mixing of the lakes epilimnion and hypolimnion causing the Tp levels in the epilimnion to range between 48 and 71ug/l from late August to mid December. A heavy cyanobacteria bloom was present with toxicity concentrations of over 8000 ug/l of microcystins throughout the fall of 2009.

Summer 2010
Supplemental sampling in August 2010 was conducted as part of this grant with the approval of the Department of Ecology. The purpose was to determine if this condition of heavy stratification and high Tp levels from the summer of 2009 was due to the extreme hot and dry summer or an annually occurring phenomenon caused by oxygen stratification and internal recycling of phosphorous from lake sediments.

The sampling took place on August 4th during a summer season exhibiting average temperatures and rainfall. LTKL01 was stratified at 6 meters. The Secchi disk was visible at 4.5 meters, Chlorophyll *a* concentrations were at 13ug/l, and Tp levels in the epilimnion were reported at less than 10 ug/l. However, in the hypolimnion D.O. levels were recorded at 0.3 mg/l and Tp concentrations were at 344 ug/l. This result indicates internal recycling in the hypolimnion that typically results in late summer toxic cyanobacteria blooms that persist into the fall annually at Kitsap Lake.

5.2 Lake Inputs

Lake input data were collected from 10 stations between May 14th, 2009 and May 11th, 2010. The intent of the data collection was to identify potential sources of phosphorous loading and quantify such loading. E.Coli , Tp, and TSS were collected however flows were difficult to assess. The results from the sampling were as to be expected. Increased Tp and TSS loads(up to 330 ug/l in one event) were identified with summer and fall storms. Late winter loading was at expected background Tp levels for this area of between 20 and 40 ug/l.

The Kitsap Quarry Creek high turbidity question was answered from a site visit to quarry pit. A visit of the facilities showed very little surface mining taking place and no discharges to the creek system from the quarry area. However, heavy beaver activity was discovered in the creeks drainage basin with miles of beaver dams and backed up waters. During one visit, evidence of a beaver dam washout and the chain reaction of beaver dam washouts occurring downstream were demonstrated as being the source of occasional high turbidity events in Kitsap Quarry Creek.

Difficulties encountered during the assessment phase of this project (Task 2 B.1 & 2 B.2) included inaccurate and unusable flow data at the lake gauging station due to beaver dam activity both up and downstream of Kitsap Lake. During the spring and summer of 2009 beaver activity in the major stream inflow at Kitsap Lake, Kitsap Quarry Creek, and on Kitsap Lakes' outlet stream, Kitsap Creek, artificially raised the lake level causing erroneous lake gauge readings, and interfering with flow data collection at one storm monitoring station by raising lake levels into the culvert were flows were collected. Flow data on the outlet stream, Kitsap Creek, were gathered below a beaver dam, while beaver activity both above and below the stream gauging station at Kitsap Quarry Creek effected flow data. The dam on Kitsap Creek was removed via high water flows caused by the late fall 2009 storms.

6.0 Kitsap County Lake Stewardship Program (Task 3)

From the beginning of this project the Kitsap County Health District has worked with the Kitsap Neighborhood Association, the Wye Lake Community Club, and the Long Lake Community Club in an effort to educate the community and reduce pollution impacts to the Kitsap County Lakes. Six public meetings were held and members of these associations participated in the Kitsap County Stewardship steering committee to provide direction and input in the development of our "Lake Stewardship "brochures and "Phosphorous Free Fertilizer" yard signs.

Unfortunately, not all Kitsap County lake owners have organized associations. This was a barrier in reaching all lake owners to complete Task 3's required performance measure. Fortunately, the Kitsap County Water Quality program mission is to continue education and outreach to all lake residence and users to improve water quality in our counties lakes.

7.0 Final Conclusions, Goals, and Objectives

7.1 Kitsap Lake Phosphorous Reduction Plan

Lake trophic data collected and analyzed from the Kitsap Lake project has provided definitive data that suggests the cause of the cyanobacteria problem is indeed internal recycling of phosphorous from the sediments during low oxygen events occurring over a six week period each summer. A review of the data with Dr. Gibbons of Tetra Tech leads our office to believe the most effective avenue of remediation would be an alum treatment ~~of~~ over the course a multiple years.

7.2 Kitsap County Health Water Quality Program Responsibilities

Kitsap County's Water Quality program continues to be involved in the monitoring of Kitsap Lake having visited nearly 60 shoreline properties on Kitsap Lake conducting sanitary surveys and distributing educational materials since this project concluded in

January, 2011. Our office continues to offer guidance to the Kitsap Lake Neighborhood Association in moving toward a lake management district to help fund treatments that will be needed to protect the public from harmful algae blooms in this lake.

The Kitsap County Health District has committed to improving water quality along Kitsap County's lakes, streams, marine waters, and shorelines. With secure funding through our Surface and Storm Water Management program we will continue to monitor and correct pollution source in our communities. Our office continues to conduct educational outreach to local residents and recreational water users.