Proposed Long Lake Integrated/ Adaptive Lake Management Plan

2017-2021

May 2016

Prepared for:
Kitsap County and CILL

Tetra Tech, Inc.
1420 Fifth Ave, Suite 550
Seattle, WA 98101

TETRA TECH

Table of Contents

Restoration History

Long Lake was studied by personnel from the University of Washington for 20 consecutive years from 1976 to 1995 in order to evaluate the effectiveness of several restoration techniques (Welch, 1996). During the summer of 1979, the lake water level was drawn down about 6 feet (1.8 m) to desiccate previously submersed rooted plants and to consolidate the flocculent sediment. While lake sediments dried substantially in laboratory experiments, they failed to consolidate in the lakebed itself because seepage water prevented sediment drying. Although exposed plants were desiccated and biomass was low the following year (1980), the aquatic plants began to recover by 1981 and were back to maximum biomass by 1984 (Jacoby et al., 1982). A small area in the north end was dredged during the 1979 drawdown in order to widen and deepen the outlet, but the dredging was too localized to affect internal phosphorus (P) loading throughout the lake.

In the fall of 1990, the lake was treated with alum to inactivate sediment P. A dose of 5.5 mg/L aluminum (Al) was used. In the meantime, rooted plants were mowed with a harvester during the summer of 1988, 1989 and 1990, removing 10, 43 and 69% of the peak plant biomass per year, respectively.

The first alum treatment was highly effective for the first four years and maintained modest water quality improvement on average for the next seven years, compared to pretreatment total phosphorus (TP; Figure 1). The high summer mean TPs of 69 and 78 µg/L, which occurred in 1977 and 1978, did not recur during that eleven-year period, although TP and chlorophyll (chl) were rather high (66 and 36 µg/L, respectively) in 1985, due mostly to a rooted plant-die-off, and in 1990 (55 and 40 µg/L), prior to the second alum treatment (Figure 2). These were the highest chl concentrations during the twenty-year period. Note that transparency varied in inversely with chl, with the highest transparency occurring with the lowest chl (Figure 2). Transparency also varied directly with macrophyte biomass (Jacoby et al., 2001).

The second alum treatment was applied in late summer 1991 at the same dose of 5.5 mg/L Al. The following summer, TP averaged only 20 µg/L, the lowest summer mean ever. The summer mean for the four-year post treatment was slightly above 30 µg/L and chl averaged less than 10 µg/L, similar to the four-year mean following the 1980 treatment (Figure 1).

Monitoring of the lake by UW ceased after 1995, but was resumed in 2006 as part of a long-term project by Kitsap County and Citizens for Improving Long Lake (CILL) to improve the lake's quality. As part of the planned control measures, alum was again added to the lake at a low dose of 2.5 mg/L Al during August 1-4, 2006 to achieve short-term control of TP and to minimize late summer algal blooms. Alum was applied again during April 11-14, 2007 at a high dose of 17.5 mg/L Al, based on sediment P concentration, for sediment P inactivation and long-term control (Welch and Gibbons, 2010).

Sampling of Long Lake for the previous long-term project by Kitsap County and CILL was continued through 2010. Historical data were compared with 2006-2010 data in the annual report on Long Lake Water Quality, February 2010. For that report, 2010 data were integrated with 2006-2009 data to show that summer TP gradually increased, but was still below the 2006 pretreatment level, while chl remained well below pretreatment levels averaging less than 10 µg/L (Figure 1). Transparency averaged about 0.5 m greater during the last four years of monitoring than the pretreatment depth of visibility in 2006 (Welch and Gibbons, 2010).

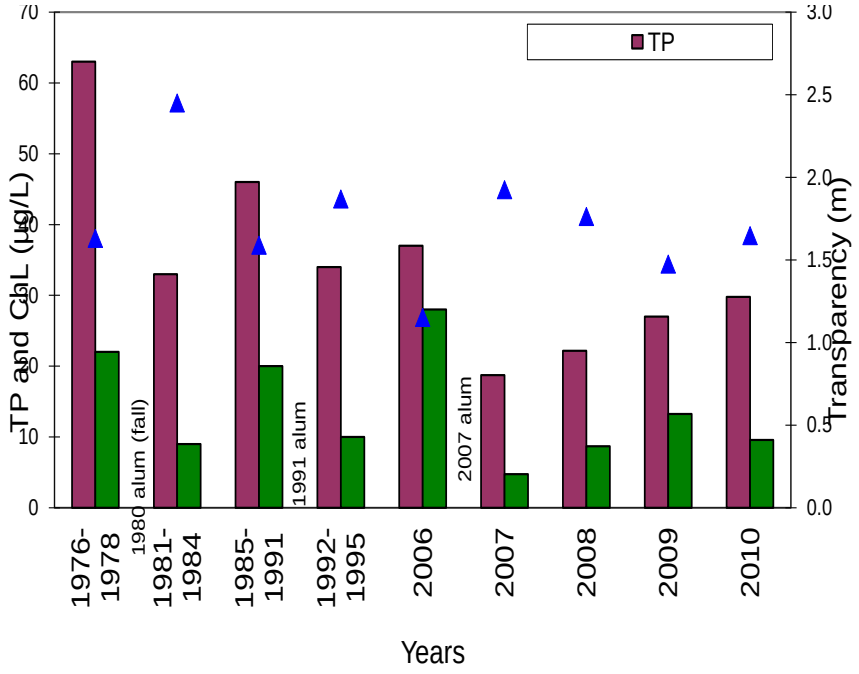

Figure 1. Mean whole-lake summer (June-September) TP, chl and Secchi transparency for groups of study years before and after three alum treatments in Long Lake, Kitsap. Pre 2006 data from Welch (1996). Data for 2006 serves as a partial reference for post-alum years 2007-2010.

Scope of Work - Long Lake Integrated/Adaptive Management Plan

The following scope of work describes the specific activities that will be performed in order to enable the Kitsap County's Long Lake Management District to meet the requirements of the Long Lake Integrated/Adaptive Lake Management Plan. Building upon the 2006-2010 lake management efforts, an integrated/adaptive lake management plan will be prepared and implemented. Targeted lake management will lead to an ecologically sustainable and balanced ecosystem with aesthetic appeal that supports water contact recreation, sport fishery, and salmon migration. The lake management program will limit internal phosphorus loading in order to reduce excessive phytoplankton production, will control excessive growth of rooted aquatic plants, and will eliminate, where possible, non-native plants such as Eurasian watermilfoil. The integrated management program for Long Lake includes six basic elements. Specific scope of work elements are outlined below:

Task 1 – Project Management

1.1 Project Management (PM) responsibilities shall include maintenance of project records, progress reports, and submittal of required performance items.

1.2 Efforts shall include conducting, coordinating, and scheduling project activities and assuring quality control.

Deliverables:

1. Effective administration and management of this project.

2. Maintenance of all project records.

3. Submittal of all required performance items, progress reports, invoices, and maintenance of all project records.

Schedule of Activities:

a) PM activities will be carried out throughout the project, from authorization to proceed in 2017 through December 2021.

Budget: $32,000

Task 2 – Planning and Permitting

2.1 Development of a QAPP for adaptive effectiveness evaluation.

2.2 Development of a 5-year integrated/adaptive management plan for the lake.

2.3 Application for necessary permits.

2.4 Citizen volunteer recruitment and training.

Deliverables:

1. A 5-year integrated/adaptive lake management plan that includes the QAPP.

2. Necessary permit applications for in-lake activities.

   The Kitsap County PM will lead the permit process and will maintain the permits.

Schedule of Activities:

a) Permit activities will be carried out annually throughout the project, from authorization to proceed in 2017 through December 2021.

b) The integrated/adaptive management plan will be completed within 90 days of the formation of the LMD.

Budget: $48,000

Task 3 – In-lake Activities Design and Implementation

3.1 Design phosphorus management activities (a sediment inactivation treatment and maintenance treatments).

3.2 Implement phosphorus management in-lake activities. The sediment inactivation treatment will be conducted in early spring 2017. Monitoring data will be used to assess the need for maintenance treatments, potentially in 2020.

3.3 Update the IAVMP (Integrated Aquatic Vegetation Management Plan) and prepare treatment specifications for management control effort for EWM (Eurasian Watermilfoil) and Brazilian elodea, as well as for management control of specific boating lanes.

3.4 Implement the annual aquatic plant management activities.

Deliverables:

1. Alum treatment design.

2. Implementation of in-lake phosphorus management activities – a sediment inactivation dose in 2017, and a water-stripping dose in 2020.

3. Updated IAVMP.

4. Implementation of aquatic plant management activities annually.

Schedule of Activities:

a) Phosphorus design elements will be completed within the first 4 months of LMD formation. On-going review and annual modifications to activities will carried out through September 2021.

b) The sediment inactivation treatment will be conducted in early spring 2017. Maintenance water column stripping treatments will be conducted as needed, i.e. 2020.

c) The IAVMP will be updated within 180 days of formation of LMD with annual updates based upon data results and lake requirements.

d) Aquatic plant control activities will be implemented as needed.

Budget: $388,000

Task 4 – Lake and Stream Monitoring

4.1 Design and conduct an on-going monitoring program to track general water quality conditions, phosphorus concentrations, phytoplankton production and the growth of aquatic macrophytes in Long Lake. This information will be used to assess management progress relative to the long-term integrated/adaptive management program and will be used to adjust the plan's activities for subsequent years, as needed.

4.2 Coordinate with citizen volunteers to arrange the use of a volunteer's boat during monthly sampling events.

4.2 Collect water samples from Long Lake at the previously established mid-lake station on a monthly basis. Dissolved oxygen, conductivity, temperature, and pH will be measured at meter intervals within the water column on each sampling date. During each monitoring event, water samples will be collected at a depth of 0.5 m for analysis of total phosphorus (TP), soluble reactive phosphorus (SRP), and

chlorophyll concentrations. A phytoplankton sample will also be collected. Between mid-May and mid-October, additional samples will be taken at 2.5 m depth for TP, SRP, and chlorophyll analysis. In conjunction with lake sampling, grab samples will be collected monthly from Salmonberry Creek for TP and SRP analysis. All collected water samples will be packed with ice and sent to Aquatic Research, Inc. in Seattle on the same day as they are collected.

4.3 Survey the distribution and speciation of aquatic macrophytes within the lake twice each year, during the spring and late summer.

4.4 Obtain stream gage data for Curley Creek from continuous gage operated by the Kitsap County Public Works Stormwater Division.

4.5 Install a level logger on Salmonberry Creek, as Kitsap County does not maintain a gage on this creek. Collect flow readings to calibrate the recorded data.

4.6 Install and maintain a data logger that records water level in Long Lake.

Deliverables:

1. Limnological data collection and data management.

2. Stream data collection and data management.

3. Aquatic plant data collection and data management.

4. Inlet and outlet surface water flow data collection and data management.

5. Lake level data collection and data management.

Schedule of Activities:

a) Monitoring activities will be carried out throughout the project from authorization to proceed in 2017 through December 2021.

Budget: $82,000

Task 5 – Reporting

5.1 Annual assessments of in-lake activities and monitoring data will be produced in a technical memorandum format. This memorandum will also recommend activities for the next year and will include revisions to the adaptive plan as dictated by the data.

5.2 Final project completion report will record data, finding and activities over the five-year LMD.

Deliverables:

1. Annual Summary Memos.

2. Draft and final LMD five-year report.

Schedule of Activities:

a) Annual technical memorandum will be produced every December through 2021, starting in 2017.

b) In December 2021 a draft and then final project report will be produced.

Budget: $42,000

Task 6 – Public Education

6.1 One (1) public information meeting will be held each year. At these meetings, the management activities will be discussed as will water quality and aquatic plant data. Public input will be taken relative to the perception of in-lake activities effectiveness and this information will be used to update the annual adaptive plan.

6.2 A Public Involvement and Education Plan (PIEP) for developing and implementing the public education and outreach for the citizens of Long Lake and its watershed will be produced by Kitsap County. The plan will specify the goals and objectives of the outreach efforts to inform citizens about water quality and aquatic plant data results, and to educate residents about actions they can take to reduce the amount of phosphorus that enters the lake.

Deliverables:

1. At a minimum, one public informational meeting annually.

2. Completion and implementation of a Public Involvement and Education Plan.

Budget: $38,000

Total Budget

$630,000

Itemized Budget by Task

Task	Total Cost from LMD
Task 1 – Project Management	$32,000
Task 2 – Planning and Permitting	$48,000
Task 3 – In-Lake Activities	$388,000
Task 4 – Lake and Stream Monitoring	$82,000
Task 5 - Reporting	$42,000
Task 6 – Public Education	$38,000
Total	**$630,000**

References

Jacoby, J.M., D.D. Lynch and E.B. Welch. 1982. Internal phosphorus loading in a shallow, eutrophic lake. *Water Res* 16:911-919.

Jacoby, J.M., E.B. Welch and I. Wertz. 2001. Alternate stable states in a shallow lake dominated by Egeria densa. *Verh Int Verein Limnol* 27:3805-3810.

Welch, E.B. 1996. Control of phosphorus by harvesting and alum. Water Res. Ser. Tech. Rep. no 152, Univ. of WA, Dept. of Civil and Environmental Engineering.

Welch, E.B. and H.L. Gibbons. 2010. Evaluating Effective restoration Techniques: Three Decades of Managing a shallow Eutrophic-Leaning Lake. *LakeLine* 30:38-44.