Quality Assurance Project Plan

Lake Loma
Total Phosphorus Technical Study

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Cover photo: Lake Loma from the public boat launch site.

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EAP: Environmental Assessment Program

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Abstract

Lake Loma is on the Washington State Department of Ecology's 2008 303(d) list of impaired waters for total phosphorus based on monitoring conducted by Snohomish County Public Works Surface Water Management and others. The Department of Ecology intends to address this total phosphorus listing through the Straight-to-Implementation (STI) process. To support this STI project, total phosphorus loads will be estimated based on best available information. In addition, the project will identify load reduction targets using best available information. No new data will be collected and modeling will be limited to an analysis of annual phosphorus loading estimates from the watershed and internal sources. Comprehensive lake phosphorus cycling (loading and export) will not be conducted. The results will be summarized in the text and the technical appendix to the Water Quality Program's Lake Loma STI report.

Background

The Washington State Department of Ecology (Ecology) intends to address water quality impairments on the 303(d) list in the Lake Loma watershed through a Straight-to-Implementation (STI) process in lieu of a Total Maximum Daily Load (TMDL). The STI approach does not require extensive technical study because the causes of water quality problems in this watershed are well documented and the solutions already known. STI is typically used in watersheds where either the vast majority or all of the pollution is nonpoint, with few or no point source contributions.

Project Description

Study Area

Lake Loma is a shallow, eutrophic lake in Snohomish County (Figure 1). The 21-acre lake has a maximum depth of 8.5 meters and an average depth of 3.4 meters (Snohomish County Public Works Surface Water Management, 2003). The lake volume is 230 acre-ft (284,000 m^3). No perennial streams feed the lake that is fed by seasonal runoff and groundwater from its 134-acre watershed. The outlet stream flows into Crabapple Lake, upstream of Lake Goodwin, and eventually into Tulalip Creek and Possession Sound.

Low-density residential land uses dominate in the watershed, with some forest and other land covers. The number of houses in the watershed increased from 53 in 1973 to 58 in the mid 1990s to over 60 today. All homes are served by onsite sewage systems. Snohomish County identified the increase in developed area as a potential contributor to the declining trend in water clarity (Snohomish County Public Works, 2003). A public boat launch allows access for human- or electric-powered boats; gas-powered boats are prohibited.

Waterfowl include migratory ducks as well as Canada geese and domestic ducks. Fish species include rainbow trout stocked by the Washington Department of Fish and Wildlife annually, largemouth bass, and pumpkinseed sunfish. The lake was fertilized in the 1950s to enhance fish production. Aquatic plants currently fringe the entire lake, dominated by yellow water-lily and native milfoil (Snohomish County Public Works, 2003). A 1997 survey found Brazilian elodea, a non-native aquatic weed, but no other elodea has been reported.

Stormwater from the Snohomish County municipal separate storm sewer system (MS4) discharges to Lake Loma at several locations. These point sources are covered by the Snohomish County Phase 1 National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit. Grassy swales along the Snohomish County roadway infiltrate much of the stormwater.

Potential residential nutrient sources include fertilizer, septic systems, land clearing, runoff piped to the lake, and pet waste (Williams and Burghdoff, 2011). Other potential sources to the lake or surrounding watershed include waterfowl, recreational users, boat launch activities, groundwater, and atmospheric deposition. Recent legislation may reduce phosphorus from detergents and lawn fertilizers. In addition, internal loading from sediment phosphorus releases likely contributes to total phosphorus concentrations in the lake (Williams and Burghdoff, personal communication).

Lake Loma has tested positive for toxins (Williams and Burghdoff, 2011). Microcystin was found in June 2005, June 2007, and June through September 2009. Results were negative for microcystin and anatoxin-A in February 2010 and were negative for microcystin in June 2011 (www.ecy.wa.gov/programs/wq/plants/algae/monitoring/index.html).

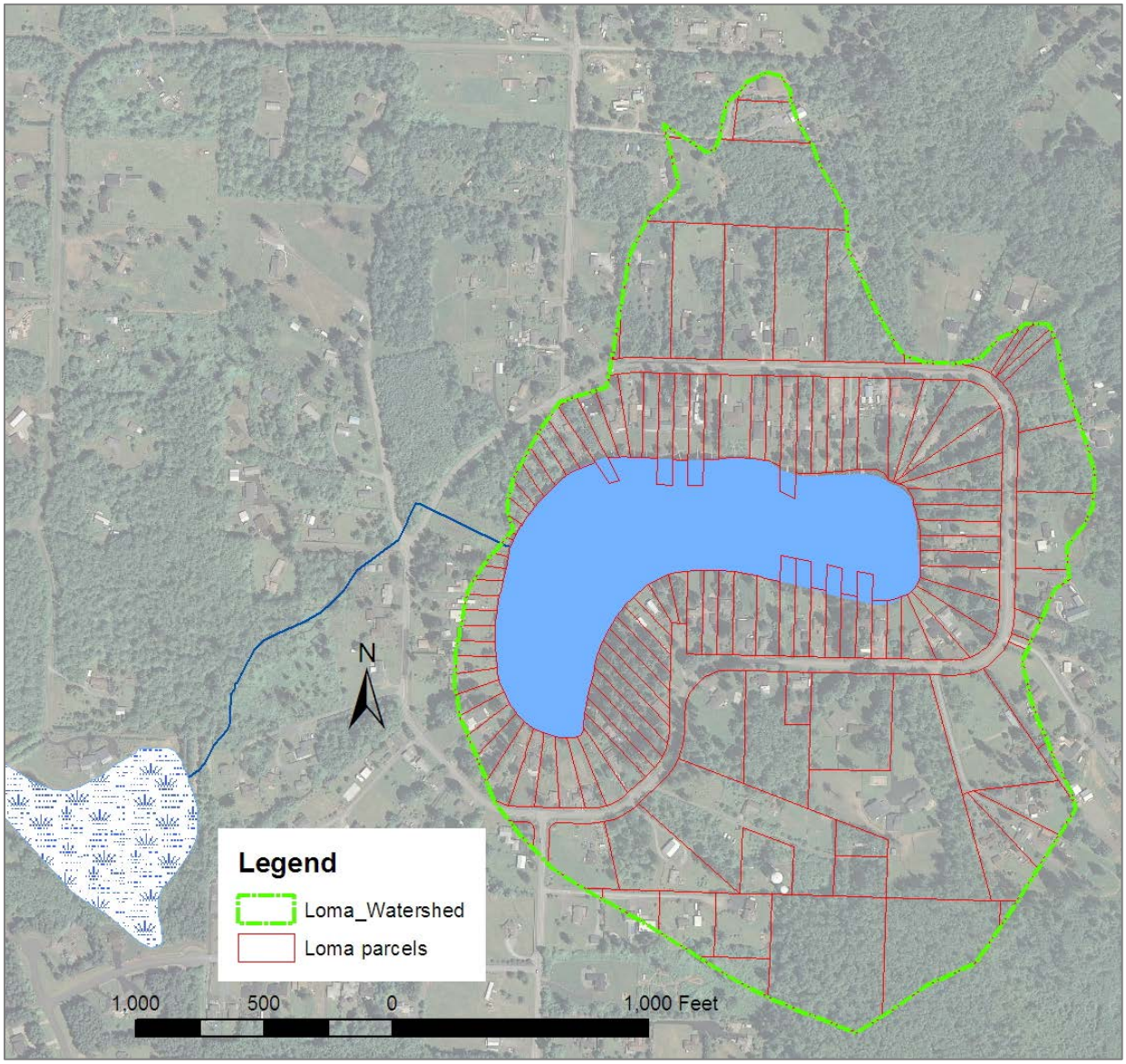

Figure 1. Lake Loma watershed in Snohomish County.

Water Quality Impairments

Lake Loma (NHD reach code 17110019001060) is on the 303(d) list for total phosphorus (category 5 – polluted waters that require a TMDL). The listing is based on 2004 and 2005 monitoring conducted by the Snohomish County Lake Management Program, which found summer epilimnetic mean total phosphorus concentrations exceeding the 20 ug/L action value for this ecoregion. Chlorophyll a levels ranged from 1.8 to 30 ug/L, and total phosphorus ranged from 29 to 143 ug/L.

The lake also has a category 2 (waters of concern but not enough to require a TMDL at this time) fecal coliform listing. Data more than 20 years old indicated an impairment, but no more recent data exist and the county reports no evidence that bacteria concentrations remain a concern.

Table 1. 303(d) listings in the Lake Loma watershed.

Waterbody	Listing ID	Listing Category	Waterbody ID	Township	Range	Section
Loma Lake	6350	Total phosphorus (Category 5)	1222514481342	31N	04E	35

Existing and Ongoing Studies

Snohomish County maintains a Lake Management Program that includes routine monitoring, management, and education/outreach (www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/SWM/L/). For 2012, Snohomish County will continue its long-term citizen monitoring program that includes monthly or bimonthly results from May through October. Monthly water quality samples are collected and analyzed for total phosphorus (1- and 7-meters deep) and chlorophyll a (1-meter deep). Citizens also record dissolved oxygen and temperature profiles.

In addition to continuing the long-term monitoring, Snohomish County also will characterize toxins and related parameters under a program funded by the Centers for Disease Control. Water quality monitoring will include total phosphorus, total nitrogen, chlorophyll a, dissolved oxygen, and temperature, and may include nitrogen or phosphorus species as well. Biological monitoring includes zooplankton, microcystin, anatoxin-A, saxitoxin, cylindrospermopsin, and phytoplankton.

Snohomish County Public Works, Surface Water Management developed a state of the lakes report, including a section on Lake Loma, in 2003 (Snohomish County, 2003). The report summarized historical studies including monitoring conducted by Ecology (Rector, 1996; Smith and Rector, 1997), Entranco Engineers (1986), and USGS (Bortleson et al., 1976; Sumioka and Dion, 1985).

The report noted summer water clarity worsened from 2.0-2.2 meters in 1992-94 to 0.8-1.0 meters in 1999-2000. Summer epilimnetic total phosphorus averages ranged from 23 to 37 ug/L from 1996 to 2002, with higher levels in the hypolimnion attributed to sediment releases (internal sources). The report also noted high nitrogen concentrations that could limit algal growth when phosphorus concentrations are so high that the nitrogen-to-phosphorus ratio shifts to nitrogen-limited growth. Chlorophyll a concentrations were below 10 ug/L in 1973, 1981, 1983, and 1994 but moderate to high levels have occurred recently.

The 2011 update to the State of the Lakes report indicates the long-term summer average clarity is 1.5 meters with a statistically significant declining trend indicating worsening conditions (Snohomish County, 2011). Temperature data from 2011 indicate strong stratification that also limits mixing of oxygen-rich waters to the hypolimnion until fall turnover. Long-term average epilimnetic total phosphorus is 33 ug/L but no trend was noted within the high interannual variability. Chlorophyll a values averaged 14 ug/L from 2002-2011 but spiked to 37 and 28 ug/L in 2010 and 2011. Blooms of cyanobacteria occur, and some produce toxins unhealthy for people and pets. The grant from the Centers for Disease Control will continue monitoring in 2012, as described above. The update notes that “Loma Lake is not meeting the targets set forth in the 2003 State of the Lakes Report, which were to improve water clarity and reduce phosphorus levels.”

Water Quality Standards and Beneficial Uses

Designated Beneficial Uses

WAC 173-201A-600(1) establishes that "[a]ll surface waters of the state not named in Table 602 are to be protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values." WAC 173-201A-600(1)(a)(ii) adds that all lakes and all feeder streams to lakes must be protected for core summer salmonid habitat and extraordinary primary contact recreation. While these designated beneficial uses have numeric criteria for temperature, dissolved oxygen, and pH in streams and rivers, the separate lake criteria apply exclusively to lakes.

Phosphorus Criteria

WAC 173-201A-230(1) establishes the action value of 20 ug/L for Puget Lowland lakes with ambient total phosphorus concentrations >10-20 ug/L. These values apply to summer average epilimnetic concentrations. For lakes where ambient monitoring indicates concentrations above the action value, WAC 173-201A-230(2) identifies a series of steps to establish site-specific lake criteria.

This STI project will not propose or adopt a phosphorus criterion as established in the state water quality standards. Therefore, a comprehensive analysis of lake phosphorus cycling is not necessary. Load reduction targets will be based on the 20 ug/L epilimnetic total phosphorus action value for the Puget Lowland ecoregion, (WAC 173-201A-230(2)). This target value is based on general phosphorus concentrations of mesotrophic lakes in this ecoregion and is a sufficient estimate for calculating load reductions to improve the trophic state and designated uses of Lake Loma.

Organization and Schedule

Table 2 lists the people involved in this analysis. All are employees of the Washington State Department of Ecology. Table 3 presents the proposed schedule for this analysis.

Quality Objectives

The proposed project does not include any new data collection. The analyses that will be conducted to support the straight-to-implementation process rely on existing information alone. Data quality objectives will be assumed to be met because the data were sufficient to meet the criteria for the 303(d) list (a Quality Assurance Project Plan was followed).

Table 2. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Mindy Roberts MISU, SCS, EAP Phone: 360-407-6804	Project Manager and Principal Investigator	Writes QAPP, estimates total phosphorus loads, identifies total phosphorus reduction targets, and writes draft and final appendix to STI report.
Ralph Svrjcek WQP, NWRO Phone: 425-649-7165	Project Advisor	Reviews draft QAPP, approves final QAPP, reviews draft appendix, and writes draft and final STI report.
Tricia Shoblom WQP, NWRO Phone: 425-649-7288	Client	Reviews draft QAPP, approves final QAPP, reviews draft appendix, and writes draft and final STI report.
Dave Garland WQP, NWRO Phone: 425-649-7031	Client's Unit Supervisor	Reviews draft QAPP, approves final QAPP, and reviews draft appendix.
Kevin Fitzpatrick WQP, NWRO Phone: 425-649-7033	Client's Section Manager	Reviews draft QAPP, approves final QAPP, and reviews draft appendix.
Karol Erickson MISU, SCS, EAP Phone: 360-407-6694	Project Manager's Unit Supervisor	Reviews draft QAPP, approves final QAPP, and reviews draft appendix.
Will Kendra SCS, EAP Phone: 360-407-6698	Project Manager's Section Manager	Reviews draft QAPP, approves final QAPP, and reviews draft appendix.
Robert F. Cusimano WOS, EAP Phone: 360-407-6596	Section Manager for Study Area	Reviews draft QAPP, approves final QAPP, and reviews draft appendix.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews draft QAPP and approves final QAPP.

MISU: Modeling and Information Support Unit
EAP: Environmental Assessment Program
WQP: Water Quality Program
NWRO: Northwest Regional Office
WOS: Western Operations Section
QAPP: Quality Assurance Project Plan

Table 3. Proposed schedule for completing analytical work and reports.

Task	Date	Staff
Draft appendix to STI report due to supervisor, client, and peer review	July 2012	Mindy Roberts
Draft appendix to STI report due to external reviewers	August 2012	Mindy Roberts
Final appendix to STI report due to Water Quality Program for publishing with the STI report*	September 2012	Mindy Roberts

*No separate EAP report will be published.

Project Goals and Analytical Approach

The technical analyses have two goals to support the implementation of management activities to control total phosphorus sources in the Lake Loma watershed:

1. Estimate total phosphorus sources in the Lake Loma watershed
2. Identify total phosphorus reductions needed

Total Phosphorus Sources

Load estimates will be based on best available information for the following potential sources:

- Land Cover – Unit-area total phosphorus loading rates by land cover type developed by Herrera Environmental Consultants (2011) will be used. Loads will be expressed as 25th, 50th, and 75th percentile values for both baseflow and stormwater, consistent with the source study. The stormwater estimates will be attributed to the MS4 in lieu of site-specific data.
- Onsite Sewage Systems – Loads will be estimated based on the best available information for population served by onsite systems, estimated failure rates, and assumed attenuation for functioning and nonfunctioning systems. Factors could include the age of the systems and proximity to the lake, along with the failure rates. These will be compared with the land cover-based estimates to assess whether the two load estimates are comparable.
- Fertilizer Applications – Loads will be estimated based on typical municipal or homeowner application rates and acreage in landscaping. These will be compared with the land cover-based estimates to assess whether the two load estimates are comparable.
- Animal Contributions – Per-animal rates will be multiplied by estimates of the number of domesticated animals and wildlife in the Lake Loma watershed.
- Fish Stocking – The load will be estimated based on the estimated mass of fish stocked in Lake Loma multiplied by typical phosphorus concentrations in fish.
- Recreation – Loads from recreational users will be estimated based on the number of users, amount of time spent on or near the lake, and proportion of people not managing human waste properly.
- Lake Sediment – Internal loads of phosphorus will be based on any site-specific information available for Snohomish County as well as literature values.
- Atmospheric Deposition – Atmospheric deposition of phosphorus to the lake surface will be estimated using National Atmospheric Deposition Program data or other similar source, if available. Atmospheric deposition to the watershed will be included in other estimates.
- Other Sources – If other potential sources are identified during the analyses, loads will be estimated and documented in the technical appendix.

Total Phosphorus Loading Reductions

Load reductions for total phosphorus will be developed based on action levels identified in the state water quality standards (20 ug/L for Puget Lowland lakes). No lake modeling is proposed.

Quality Control Procedures

The proposed project does not include any new data collection. Snohomish County data met 303(d) data quality requirements and are of suitable quality to compare with estimates. No additional quality control procedures apply to the study.

Data Management Procedures

The proposed project does not include any new data collection. Snohomish County data management procedures met 303(d) requirements and are of suitable quality for this purpose. No additional data management procedures apply to the study.

Audits and Reports

The project manager will prepare an appendix with the findings of the proposed analyses to the client for inclusion in the WQP STI report. The appendix will include the following items at a minimum:

- Descriptions of the potential sources of total phosphorus
- Load estimates based on available information
- Load reduction targets based on available information

Data Verification and Validation

The proposed project does not include any new data collection. The appendix will identify all data used to develop the loading estimates or reduction targets. Only final, published data will be used in the load estimates and reduction targets, and the sources will be cited appropriately.

Data Quality (Usability) Assessment

The proposed project does not include any new data collection. Only final, published data will be used in the load estimates and reduction targets.

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Appendix. Glossary, Acronyms, and Abbreviations

Glossary

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Eutrophic: Nutrient- rich and high in productivity resulting from human activities such as fertilizer runoff and leaky septic systems.

Fecal coliform: That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities. This includes, but is not limited to, atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Parameter: A physical chemical or biological property whose values determine environmental characteristics or behavior.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standard and are not expected to improve within the next two years.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
et al.	And others
NHD	National Hydrography Dataset
NPDES	(See Glossary above)
TMDL	(See Glossary above)
USGS	U.S. Geological Survey
WAC	Washington Administrative Code

Units of Measurement

ft	feet
g	gram, a unit of mass
m	meter
mg	milligram
mg/L	milligrams per liter (parts per million)
mL	milliliters
s.u.	standard units
ug/L	micrograms per liter (parts per billion)