Quality Assurance Project Plan

Silver Lake Water Quality Testing

Grant ID: WQC-2018-CwCoHH-00092

Grant Name: Silver Lake Sediment and Water Quality Testing plus Engagement Project

May 14, 2019

Publication Information

Each study supported by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan (QAPP). The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Cowlitz County will post the final report of the study to the Internet.

This publication is one of two required QAPPs for the project *Silver Lake Sediment and Water Quality Testing Plus Engagement Project*, and pertains specifically to water quality sampling activities. This QAPP is available on Cowlitz County's website at http://www.co.cowlitz.wa.us/index.aspx?NID=2403. An additional separate QAPP pertains to the sediment testing activities (contaminants of concern (COCs) and phosphorus).

Data for this project will be available on Ecology's Environmental Information Management (EIM) website: EIM Database. Search on Study ID: WQC2018CwCoHH00092.

Project Funding

This project has been funded, in part, by Ecology with Centennial Clean Water Program funds (WQC-2018-CwCoHH-00092). This project is also financially supported by Cowlitz County and Silver Lake Flood Control District, and is dependent on volunteer contributions from Silver Lake Watershed Advisory Council (SLWAC).

Author and Contact Information

Hilarie Larson, REHS
Environmental Health Unit
Cowlitz County Health Department
207 4th Ave North
Kelso, WA 98626
Phone (360) 414-5599 x 6248
http://www.co.cowlitz.wa.us/index.aspx?NID=2403

Quality Assurance Project Plan

Silver Lake Water Quality Testing

May 2019

Approved by:

Signature:	Date: 5/14/2019
Leanne Whitesell, Water Quality Specialist, Washington State Department of Ecology	
Signature:	Date: 5/17/2019
Season Long, MS Environmental Health Manager, Cowlitz County Environmental Health Unit	
Signature:	Date: 5/17/2019
Hilarie Larson, REHS, Project Manager, Cowlitz County Environmental Health Unit	
Signature:	Date: 5/17/2019
Elizabeth Harris, Lab Project Manager, ALS Global Laboratory	

Signatures are not available on the Internet version.

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Distribution List

Gary Fredricks, Director
WSE Extension / Cowlitz County
garyf@wsu.edu
360-577-3014 x 3

Del Gilkerson, Member
Silver Lake Watershed Advisory Council
delgil@cni.net
360-751-2231

Elizabeth Harris, Project Manager
ALS Global Laboratory
Elizabeth.harris@alsglobal.com
360-274-3057

Season Long, Environmental Health Director
Cowlitz County Health Department
longs@co.cowlitz.wa.us
360-414-5599 x 6446

Leanne Whitesell, Grant Project Manger
Washington Department of Ecology
Leaw461@ecy.wa.gov
360-407-6295

2.0 Abstract

Every study conducted with funding provided by the Washington Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan (QAPP). The QAPP outlines the procedures that a monitoring project will use in order to ensure that the data it collects and analyzes meets project requirements and are of suitable quality and quantity. Data for this project will be available on Ecology's Environmental Information Management (EIM) website: https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database.

This QAPP covers the water quality sampling components of Silver Lake Sediment and Water Quality Testing Plus Engagement Project (WQC-2018-CwCoHH-00092), herein referred to as the Project. One water quality sampling component includes testing of the major inlet creeks, at sites both above and below agriculture. These results will also be compared to the water quality of the lake itself, building on lake water quality assessment from the grant; Water Quality Testing and Improvement at Two Cowlitz County Lakes (WQC-2015-CwCoHH-00129).

3.0 Background

3.1 Introduction and problem statement

Silver Lake is a shallow, warm water 3,000 acre wetlake lake, located in southwest Washington between the towns of Castle Rock and Toutle (Figure 1). With a mean depth of 5 ft and a maximum depth of 10 ft, lake size is most often reported as 1,650 acres (Bhagat, 1975) and (Moore, 1990). Some websites and residents will report and refer to the lake as being 3,000 acres (www.lakelubbers.com , Wikipedia.org, and Del Gilkerson). Del Gilkerson, a longtime lake committee member and lake resident, explains the difference in numbers as the larger number accounting for all the wetland areas formed bv the lake.

Figure 1: Map of Project Location

Due to fluctuating lake levels in the 1960s, a flood control structure was installed in 1971. As a result, excessive weed growth was observed, and the *Study of Silver Lake Eutrophication – Current Problems and Possible Solutions* (Bhagat, 1975) was "undertaken as a response to public concern over the accelerated eutrophication and accompanying loss of recreational potential of Silver Lake."

Cowlitz County and Ecology funded the *Silver Lake Restoration Phase I: Diagnostic/Feasibility Study*," in which author Moore stated that "without intervention, the lake will probably become essentially a marsh, without any open water areas, within the next decade," and recommended the utilization of management areas and the application of dredging, biological macrophyte control, waterfowl management, bottom screening, watershed management, and septic tank effluent evaluation and controls. (Moore, 1990)

The biological macrophyte control recommendation was implemented during May and June of 1992 with the installation of 83,000 grass carp. (Houpt, 1994)

An unexpected consequence of the grass carp developed, as described by KCM consultant Scherer, "The grass carp have eaten essentially all the submersed plants in Silver Lake…The project goal of reducing the cover of submersed plants by 40 to 60 percent has been greatly exceeded." Furthermore, the carp did not affect the frequency of the algal blooms (KCM, 1998).

Public health cautionary postings for algal blooms occurred six times between 2009 and 2013. Some of these blooms have resulted in thick, carpet-like growth of cyanobacteria, which in turn has elevated public concern. In the summer of 2018 the lake was posted with warning signs due to the presence of cylindrospermopsin. Cyanobacteria toxins can be harmful and potentially lethal to humans and pets.

This project will provide information regarding the water quality of the inlet creeks, compared to that of the lake. It will also provide precursory information on the lake bottom sediment that will be helpful in order to plan a dredging project.

3.2 Study area and surroundings

As described in Silver Lake Watershed Management Plan, Silver Lake was formed about 2,500 years ago when very large mudflows deposited into Outlet Creek and damned its valley and formed Silver Lake. The resulting dam did not allow efficient drainage of the lake, and lake levels were known to fluctuate greatly before the flood control structure was installed in 1971. (Houpt, 1994)

The Silver Lake watershed encompasses approximately 26,000 acres (Figure 2). The topography of the watershed is that of a depressional area, characterized by the lake, surrounded by rolling hills. Elevation ranges from 486.5 feet at the crest of the containment structure to 2500 feet at the watershed divide in Hemlock Creek. Eighty percent of the watershed lies to the south of the lake. Steams feeding the lake include Hemlock Creek (38% of the watershed), Sucker Creek (14% of the watershed), and numerous unnamed tributaries. (Moore, 1990)

The climate of the Silver Lake watershed is controlled mainly by the prevailing westerly winds from the Pacific Ocean. The area is characterized by cool summers and mild, wet winters. The average January temperature is 38 degrees F, and the average July temperature is 63.5 degrees F. Average annual precipitation for the watershed is 62 inches, with most precipitation occurring as rainfall between October and March. (Bhagat, 1975)

According to Washington Department of Fish and Wildlife, “Silver Lake is an excellent fishery for Largemouth Bass. Catchable Rainbow Trout are planted in the spring.” The lake also offers good fishing for Yellow Perch, Bluegill Sunfish, Brown Bullhead, and both Black Crappie and White Crappie. (https://wdfw.wa.gov/fishing/locations/lowland-lakes/silver-lake-cowlitz). Additional animals in the watershed include otters, beaver, ducks, and geese. Large animals include black bear and deer. Principal tree species are Douglas fir, red alder, western red cedar, big leaf maple, western hemlock, black cottonwood, Oregon white oak, cascara, and Oregon ash. Plants include salal, salmonberry, swordfern, blackenfern, vine maple, elderberry, hazel, evergreen blackberry and willow (Call, 1974).

Silver Lake is used for recreational boating including jet and water skiing, as well as swimming and wading. Bird watching and camping along the shoreline are also popular activities. The Mount St. Helens Visitor Center and Seaquest State Park are popular visitor attractions located adjacent to Silver Lake. Many tourists continue up route 504, past Silver Lake, to visit the Forest Learning Center and Johnston Ridge Observatory. Several private resorts and RV parks are located along the way.

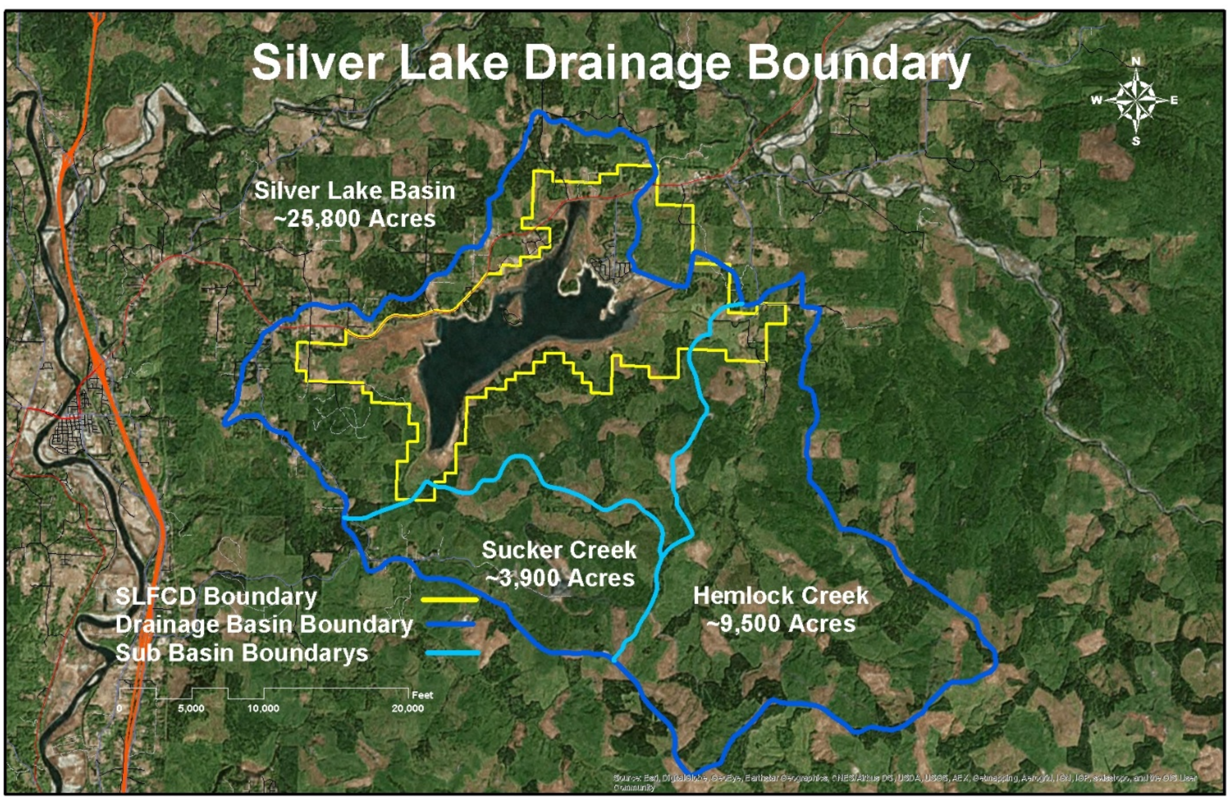

Figure 2: Map of Silver Lake with Drainage Boundaries

3.2.1 History of study area

In the 1975 report *Study of Silver Lake Eutrophication – Current Problems and Possible Solutions,* Bhagat et al referred to reports from Department of Game in 1947 on excessive weeds and the use of poisons to clear lanes for fishing purposes, as evidence that eutrophication had been present for several decades. However, observers reported that the problem markedly increased since the installation of the flood control structure in 1971, and Bhagat described "profuse growth of aquatic weeds and algae blooms." The 1975 study recommended selective harvesting of aquatic plants, short-circuiting or by-passing Hemlock Creek flows, lake-level management, nutrient reduction from adjacent land use activities, and controlling the input of nutrients from septic systems, as the practical and economical means to control the excessive growth of aquatic plants (Bhagat, 1975, p. 161).

The Silver Lake Rehabilitation Program Grant Application was submitted in 1976. However, little activity occurred until the Centennial Clean Water Fund (CCWF) legislation passed in 1986. Cowlitz County and Ecology initiated the Silver Lake Restoration Project Phase I in 1987, and Washington State University was funded to prepare a diagnostic and feasibility study for the restoration of Silver Lake (Moore, 1990). This study identified phosphorus as the nutrient of concern in the lake and suggested several restoration schemes to be considered for a Phase II Silver Lake Restoration Project. Suggestions included dividing the lake into three management zones, biological macrophyte control, dredging, bottom screening, waterfowl management, watershed nutrient diversion, and public information and education. Moore concluded, "Without intervention, the lake will probably become essentially a large marsh, without any open water areas, within the next decade. As such, the lake can be expected to become totally unsuitable for supporting any fish populations of recreational or economic value."

Cowlitz County was granted funding through Ecology's CCWF to begin Phase II of the Silver Lake Restoration Project in 1991. The three tasks accomplished include the introduction of 83,000 grass carp in 1992, several years of long-term water quality monitoring (provided by KCM consultants), and assistance with a Watershed Management Plan (WMP) (completed in 1994 by Cowlitz Conservation District).

An unexpected consequence of the grass carp developed, as described by KCM consultant Scherer, "The grass carp have eaten essentially all the submersed plants in Silver Lake…The project goal of reducing the cover of submersed plants by 40 to 60 percent has been greatly exceeded." Furthermore, the carp did not affect the frequency of the algal blooms (KCM, 1998). Algae blooms continue to be the main concern of citizens, especially when they disrupt beneficial use of the lake during the summer months.

3.2.2 Summary of previous studies and existing data

Water quality monitoring was conducted under grant *Agreement WQC-2015-CwCoHH-00129 Water Quality Testing & Improvement at Two Cowlitz County Lakes* between September 2015 and September 2018. The average total phosphorus over the course of the study was 0.053 mg/L. The average summer chlorophyll *a* concentrations during 2016 and 2017 was 26.9 mg/m3. Year round Secchi measurements averaged 2.0 ft. deep. Carlson's trophic state index, which uses algal biomass for trophic state classification (Carlson, 1977) was calculated as 63, placing Silver Lake in the eutrophic classification. As a result, some of the uses of Silver Lake are affected to varying degrees. The most severe interference occurs during algal blooms, as they are publically perceived to be a problem for all uses, and can pose a health threat to both people and pets.

SLWAC monitoring occurred before grant testing between August 2012 and May 2015. Full annual data was collected in 2013 and 2014. The average total phosphorus in 2013 was 0.046 mg/L, while in 2014 the average was higher at 0.063 mg/L.

Prior to the SLWAC monitoring, The Cowlitz County Silver Lake Phase II Restoration Monitoring report (June 1998) noted that the 1997 weighted mean for total phosphorus was 0.034 mg/L. The first WSU study (Bhagat, 1975) reported a mean of about 0.030mg/L.

3.2.3 Parameters of interest and potential sources

This QAPP describes the water quality testing portion of the grant, as referred to in Task 2 of Agreement No. WQC-2018-CwCoHH-00092. The potential effects of toxic algal growth in Silver Lake is a major public concern. The three parameters most commonly used to measure the algal condition of a lake include Secchi depth (a measure of water clarity and, indirectly, of algal density), chlorophyll *a* (a more reliable indicator of algal density); and total phosphorous (a measure of nutrient availability). (EPA, 1991). This study will generate data points for all three of these constituents. *Escherichia coli (E. coli)* will also be measured to help identify possible sources of contamination and to ensure the safety of popular recreation areas. Potential sources of *E. coli* include improper or failing septic systems, and animal waste.

3.2.4 Regulatory criteria or standards

This study will not be used to determine compliance with regulatory standards or criteria. Silver Lake is listed in section 303(d) of the Clean Water Act (CWA) for dioxin and PCBs of fish tissue. Silver Lake is not listed for dissolved oxygen, temperature, pH, bacteria or sediment. No Total Maximum Daily Loads (TMDLs) are yet established for Silver Lake for phosphorus. Cowlitz County does not currently qualify for governance under the Growth Management Act, except for critical areas and lands planning only. Washington Administrative Code (WAC) 173-201A-230 indicates that lake specific studies may be initiated to set specific ambient total phosphorus range for values over 0.02 mg/L in Puget Lowlands Ecoregion. This standard has been exceeded in Silver Lake.

WAC 173-201A-200 sets aquatic life criteria for indigenous warm water species and recreational *E. coli* standards, as described below.

<u>For Aquatic Life:</u>
Temperature: Highest 7-DADMax 20°C (68°F) DO: Lowest 1 Day Minimum of 6.5 mg/L
Turbidity: Shall not exceed 10 NTU over background when the background is 50 NTU or less; or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
pH: shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units.

For Primary Contact Recreation: (applies to activities including wading, swimming, jet skiing, watger skiing, and kayaking*:*
E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL. Ecology recently updated the recreation bacteria indicator from fecal coliform to *E. coli* (2019). This standard applies to water activities including wading, swimming, jet skiing, water skiing, and kayaking.

4.0 Project Description

This project will provide the data necessary to evaluate the concentrations of water quality constituents in Silver Lake and to compare it to the constituents of the major inlet creeks. In one of the inlet creeks, sampling will occur prior to and after agriculture uses.

Grab sampling will include total phosphorus, chlorophyll *a*, and *E. coli*. At the time of all grab sampling, a digital, handheld multi-parameter probe will be used to gather data on water temperature, pH, dissolved oxygen and turbidity. Secchi depths will be determined at the three deep lake sampling sites concurrently with grab sampling.

This QAPP also covers protocols for the use of the probe during sediment testing, which is covered in a separate QAPP.

4.1 Project goals

The long-term project goal is to improve the water quality of Silver Lake for the public's health and recreational benefit, minimizing the health risks posed by toxic algae growth events that limit the recreational potential of the lake. The immediate overarching goal of this subproject is to obtain current water quality data from Silver Lake and its tributaries to inform an update of SLWMP in order to plan, execute, and evaluate improvement actions. The updated SLWMP will be provided to local citizens and stakeholders to address community concerns of *E.coli*, toxic algae blooms, toxic fish, and contaminated sediments and possible dredging feasibility. Providing public access to the SLWMP and project results, are additional goals.

4.2 Project objectives

The Project grant objectives that apply to this QAPP include:

1) Mange the project, satisfying the conditions of Ecology and facilitating the involvement of community partners.
2) Collect 72 total phosphorus samples from lake.
3) Collect 144 total phosphorus samples from streams.
4) Take 42 chlorophyll *a* samples from lake
5) Take 258 *E. coli* samples from both the lake and the streams.
6) Take temperature, dissolved oxygen, pH, and turbidity measurements with the probe in the lake, and in the streams as possible.

7) Take temperature, dissolved oxygen, pH, and turbidity measurements with the probe in the lake at the sites of sediment collection, during the time of sediment collection. Sediment collection is covered by a separate QAPP.

4.3 Information needed and sources

A key component of this study entails gaining access to Weyerhaeuser privately owned land. The County obtained authorization during the grant application process. However, the protocol for participating in studies and allowing access to Weyerhaeuser land has since changed. It is now necessary for the Weyerhaeuser research team to review and approve study protocols prior to allowing activities to occur. April Deal, Land Use Manager with Weyerhaeuser, will facilitate this.

4.4 Tasks required

The following tasks are required to complete the Stream and Lake Monitoring Evaluation portion of Ecology Agreement No. WQC-2018-CwCoHH-00092:

Project Administration / Management, referred to as Task 1 in Scope of Work:

- Carry out all work necessary to meet Ecology grant administration requirements, including but not limited to: maintenance of project records, submittal of requests for reimbursements and corresponding backup documentation; progress reports; and a recipient closeout report (including photos).
- Maintain documentation demonstrating compliance with applicable procurement, contracting, and interlocal agreement requirements; application for, receipt of, and compliance with all required permits, licenses, easements, or property rights necessary for the project; and submittal of required performance items.
- Manage the project including, but not limited to: conducting, coordinating, and scheduling project activities and assuring quality control. Make every effort to maintain effective communication with CCHD staff, Ecology, and all affected local, state, or federal jurisdictions; and any interested individuals or groups. Meet completion dates per agreement WQC-2018-CwCoHH-00092.

Stream and Lake Monitoring and Evaluation, referred to as Task 2 in Scope of Work:

- (2A) Develop and submit a Quality Assurance Project Plan (QAPP) to the Ecology Project Manager before beginning monitoring activity. Upload the signed QAPP to EAGL.
- (2B) Train community volunteers to help conduct water quality monitoring.
- (2C) Submit samples to an accredited lab. Catalog results and make the data available to the public via a public website.
- (2D) Submit all data to Ecology using the Environmental Information Management System (EIM) once per year at the end of each full year of sampling.
- (2E) Perform statistical analysis of the data collected. Produce a water quality monitoring report summarizing the results of the data and analysis, submit a draft to Ecology’s Project Manager, upload the final to EAGL, and post it on the public website.

- (2F) Repair, replace, and/or purchase additional monitoring equipment, as necessary, due to normal attrition of existing equipment, to facilitate monitoring and provide accurate data.
- (2G) At the same five sites sediment is collected once for testing COCs, collect in-situ water quality data for temperature, pH, DO, and turbidity. The sediment collection is covered by a separate QAPP.
- (2H) At the same five sites sediment is collected quarterly for testing phosphorus, collect in-situ water quality data for temperature, pH, DO, and turbidity for one year.
- (2I) Sample Chlorophyll *a* at three lake sites during 6 months (April-Sept) for two years. Conduct in-situ testing at same sites for temperature, pH, DO, and turbidity.
- (2J) Sample *E. coli* and total phosphorus at six creek sites and three lake sites monthly for two years. Sample *E. coli* at four additional sites of primary recreation during four months (May-August) monthly for two years. Conduct in-situ testing at all sampling sites for temperature, pH, DO, and turbidity, in as much as water levels allow.

4.5 Systematic planning process used

This document serves as the systematic planning process for this project.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1. Organization of project staff and responsibilities

Personnel	Title	Responsibility	Phone
Season Long	Environmental Health Manager	Department Mngt	360-414-5599
Hilarie Larson	Environmental Health Specialist	Project Mngt & Implementation	360-414-5599 x 6428
Matt Swanson	Environmental Health Specialist	Data Analysis & Back up Sampling	360- 414-5599 x 6429
Del Gilkerson	SLWAC Advisor & Sampler	Planning & Data Management, & Sampling	360- 751-3321
Dave York	SLWAC Advisor & Sampler	Planning & Boat Pilot & Sampling	206-817-1016
Larry Kimble	SLWAC Advisor & Sampler	Planning & Sampling & Back up Boat Pilot	425-281-5278
Elizabeth Harris	Project Manager at ALS Global	Manage Lab Tasks	360-501-3293
Leanne Whitesell	Ecology Grant Manager	Ensures QAPP is consistent with the scope of work, schedule and budget in the grant agreement. Coordinates Ecology review of the QAPP and approves the final QAPP.	360-407-6295
Dale Norton	Western Operations Section Manager	Reviews technical components of the draft QAPP and provides feedback prior to approval.	360-407-6596

5.2 Special training and certifications

The Cowlitz County Health Department (CCHD) and SLWAC will provide personnel for this project. The county has retained key staff from the previous Centennial Clean Water Program grant, "Water Quality Testing and Improvement at Two Cowlitz County Lakes." Season Long, M.S, was previously the Environmental Health Lead, and is now the Environmental Health Manager. She provides oversight of the project. Hilarie Larson, a Registered Environmental Health Specialist, was hired to manage and implement the previous grant, and will do the same for this project. Matt Swanson, Environmental Health Specialist, will provide statistical analysis of data, and will function as the county's back up sampler. Three additional environmental health specialists, including Jeremiah Maschmann, Nic Bakotich and Brian Hetland, all have previous experience at an environmental lab and serve as important resources for laboratory information.

SLWAC member, Del Gilkerson, managed the collection and data of SLWAC samples from August 2012-2015, and has many years of experience in research and quality control laboratories, and in sampling for a mosquito control program. He managed the compilation and presentation of data for the 2015-2018 grant, and will retain the same role for this project. He will also help with stream sampling.

SLWAC member, Dave York, has been a shoreline resident for over 30 years, and is an avid boater with extensive knowledge of the lake history and navigation. He was a sampler during the 2012-2015 SLWAC testing, and was both a sampler and boat operator during the 2015-2018 Centennial Clean Water Program grant testing. He will provide the primary boat for this project and will continue to help with sampling.

SLWAC member, Larry Kimble, is a retired supervisor for King County Parks and Recreation, where duties included large project planning, and occasionally, water quality and sediment sampling. He participated in the 2015-2018 Centennial Clean Water Program grant as a back up boat operator. He also took some preliminary lake bottom sediment samples for SLWAC in 2018. He will assist with sediment sampling and will also be the back up for providing a boat.

SLWAC member, Neil Skogland, is a resident on Walden Island, which can only be accessed via boat on Silver Lake. He is a mechanical engineer with over 30 years of experience with design and manufacture of custom-engineered machinery. His career has included technical writing, and he and his wife were the authors of the grant application for the 2015-2018 Centennial Clean Water Program grant. He will be involved with reviewing documents and with sediment sampling activities.

5.3 Organizations

Four organizations are involved with this project: Ecology, CCHD, SLWAC, and Weyerhaeuser. Ecology has awarded a task-specific grant to CCHD. CCHD is responsible for administering and managing the project, and must meet Ecology administrative and technical requirements and documentation. The grant was awarded because of demonstrated volunteerism of SLWAC members, and is dependent on their involvement in providing a boat and assisting with sampling tasks. Weyerhaeuser had agreed to provide access to some of the key sampling sites on Hemlock Creek, but now requires a review of the project and methods beforehand.

5.4 Proposed project schedule

Table 2. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports

Field and laboratory work	Due date	Lead staff
Field work completed (includes 24 monthly events et al)	May 2021	Hilarie Larson
Laboratory analyses completed	May 2021	
Environmental Information System (EIM) database		
EIM Study ID	WQC2018CwCoHH00092	
Product	Due date	Lead staff
EIM data loaded	July 2020 and July 2021	Hilarie Larson
EIM data entry review	Aug 2020 and Aug 2021	EIM Coordinator
EIM complete	Aug 2020 and Aug 2021	Hilarie Larson
Final report		
Author lead / Support staff	Hilarie Larson with Matt Swanson and Nic Bakotich	
Schedule		
Draft due to supervisor	June 2021	
Draft due to client/peer reviewer	June 2021	
Draft due to external reviewer(s)	July 2021	
Final (all reviews done) due to publications coordinator (Joan)	Aug 2021	
Final report due on web	Aug 2021	

5.5 Budget and funding

This project has been funded, in part, by Ecology with Centennial Clean Water Program funds (WQC-2018-CwCoHH-00092). This project is also financially supported by Cowlitz County and Silver Lake Flood Control District, and is dependent on volunteer contributions from Silver Lake Watershed Advisory Council (SLWAC).

Table 3. Project budget and funding.

Total Project Budget for Both Lakes				
Task ID	**Task Description**	**Budget**	**Ecology Share 75%**	**Project Match 25%**
1	Project Administration / Management	$26,020	$19,515	6,505
2	Stream and Lake Monitoring and Evaluation	$105,997	$79,498	26,499
3	Public Engagement and Education	$15,272	$11,454	3,818
4	Digitize & Evaluate Watershed Management Plan	$26,179	$19,634	6,545
	Total	$173,468	$130,101	43,367

6.0 Quality Objectives

6.1 Data quality objectives (DQO)

The main data quality objective (DQO) for this project was determined using a 95% success rate for all scheduled samples, with the exception of using only 75% success rate for probe measurements in creeks due to anticipated low water levels.

Table 4. Data Quality Objectives (DQO)

Data Quality Objectives (DQO) Minimum Number of Samples and Measurements			
Type:	**Constituent(s)**	**Formula = Scheduled Samples * success rate**	**Target Minimum # of samples collected or measurements taken**
Lab Sample	Total Phosphorus	216 * 95%	205
Lab Sample	Chlorophyll *a*	32 * 95%	30
Lab Sample	*E. coli*	248 * 95%	236
Secchi Measurement	Secchi Depth	72 * 95%	68
Probe Measurement – lake sites correlative to water sampling	Temperature °F pH Dissolved Oxygen Turbidity	72 * 95% for each	68 for each probe constituent
Probe Measurement – lake sites correlative to sediment sampling	Temperature °F pH Dissolved Oxygen Turbidity	20 * 95% for each	19 for each probe constituent
Probe Measurement – creek sites correlative to water sampling	Temperature °F pH Dissolved Oxygen Turbidity	144 * 75% for each	108 for each probe constituent

6.2 Measurement quality objectives (MQO)

6.2.1 Targets for precision, bias, and sensitivity

Table 5. Measurement quality objectives

MQOs for Secchi Disk and YSI ProDSS Digital Multiparameter System Precision & Bias in Field Constituents				
Analyte	**Accuracy (deviation of % deviation from true value**	**Resolution**	**Bias (% deviation from true value)**	**Estimated Range**
Secchi Depth	NA	+/- 20%	NA	0.25 to 5 ft
Temperature	+/- 0.2 ° C	0.1° C	NA	1-24 °C
pH	+/- 0.2 pH units	0.01 pH units	NA	6-10 pH units
Turbidity	At 0 to 999 FNU: the greater of 0.3 FNU or +/- 2% of reading	0.1 FNU	NA	0 to 50 FNU
Dissolved Oxygen	At 0 to 20 mg/L: +/- 0.1 mg/L or 1% of reading, whichever is greater. At 20 to 50 mg/L: +/- 8% of reading	0.01 mg/L and 0.1%, or 0.1 mg/L and 1% (user selectable)	NA	2-12mg/L

6.2.1.1 Precision

At concentrations near the lowest concentration of interest, it will not be possible to meet the percentage MQOs indicated above because errors expressed as a percentage increase at lower concentrations. However, at lower concentrations, the acceptable error is generally greater. Chlorophyll, which is inherently more variable, has a less stringent MQO.

The above MQO tables are intended to indicate the quality of the result from a particular sample (or pooled set of samples) and therefore, to apply to lab or field *splits*. Field duplicate samples (i.e., sequentially collected), which include some environmental variability, may be used to determine if MQOs have been met; however, some judgment may be required regarding the amount of environmental variability in the sample.

6.2.1.2 Bias

Sampling bias will be minimized by strictly adhering to the protocols discussed and referenced herein. This QAPP provides procedures for collecting representative and valid samples. However, as is true for all sampling, some sampling bias is likely present in the results even if not measurable or confirmed. Assessment and management of bias will occur mostly at the laboratory.

6.2.1.3 Sensitivity

Table 6. Measurement Quality Objectives - Sensitivity

MQOs – Sensitivity				
Water Quality Parameter	**Measurement Range**	**Accuracy**	**Resolution**	**Instrument or method**
Water clarity	0-20 feet	NA	NA	Secchi disc
Turbidity	0-4000 FNU	0-999 FNU: 0.3 FNU or 3% (whichever is greater), 1000 to 4000 FNU: +/- 5% of reading	0.1 FNU	ProDSS
Temperature	-5 to 70 °C	+/- 0.2°C	+/- 0.1°C or 0.1°F	ProDSS
pH	0 to 14 pH units	+/- 0.2 pH units	0.01 pH units	ProDSS
Dissolved Oxygen	0 to 50 mg/L	0 to 20 mg/L +/- 0.1mg/L or 1%, whichever is greater. 20 to 50 mg/L +/- 8%	0.01 mg/L and 0.1% or 0.1 mg/L and 1% (user selectable)	ProDSS
Total phosphorus	0.01 to 100 mg/L	0.01 mg/L +/- 10%	0.004 mg/L	EPA 365.3
Chlorophyll-a	0.2 to 1000 mg/L	0.2 µg/L +/- 10%	0.08 mg/L	SM 10200H
E. coli	MPN/100mL	NA	NA	SM9223B

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

All measurement and analytical procedures are documented so that the data will be comparable with samples collected and analyzed in a like manner according to attached SOPs.

6.2.2.2 Representativeness

The sampling will span over two years, and conditions of sampling are expected to vary. Because the lake is shallow, with a mean depth of 5 feet, grab samples taken at 3 feet are considered to be representative.

Additional weather and lake water data collected weekly will provide the opportunity to correlate sampling results with other lake conditions. Additional data will include:

- Lake level compared to Dam Crest from stationary dock water level measurement systems, as in place at Del Gilkerson's and Dave York's residence.
- Qualitative observations (still, windy, choppy, etc.)
- From National Weather Service; high/low air temperature of sampling event day.

- From National Weather Service: precipitation (inches) approximately 24 hours prior to sampling event, as listed on website.

The summer *E. coli* sampling sites were chosen to represent the areas of the lake where primary recreational contact occurs most frequently.

Two of the lake sampling sites represent the deepest area of the lake, and the other one represents the outlet. All three lake sampling sites are retained from the previous grant.

6.2.2.3 Completeness

There are no legal or compliance uses anticipated for the Silver Lake data. In addition, there is no fraction of the planned data that must be collected in order to fulfill statistical criteria. It is expected that at least 95% of the sampling events will occur, with the exception of expecting at least 75% of stream measurements to occur via the probe due to expected low water levels.

6.3 Acceptance criteria for quality of existing data

This data will expand upon previous data collected in *Final Report (2 of 2) for: Agreement: WQC-2015-CwCoHH-00129* by going beyond the lake and into the creeks.

6.4 Model quality objectives

NA

7.0 Study Design

7.1 Study boundaries

This project includes the waters of Silver Lake which is located in the north sections of T9N, R1W, and the southeast sections of T10N, R1W at 148m elevation (KCM, 1993).

7.2 Field data collection

Sample sites are shown below. Lake sites include Outlet Creek (a), Deep West (b) and Deep East (c). Seasonal sites include Streeters (f), Tree House (i), Silver Resort (g), and Walen (h). Creek sites include Outlet gate (z), Sucker Creek Upper (r), Hemlock Canal Rd (j), and Hemlock Rd 1390 (k).

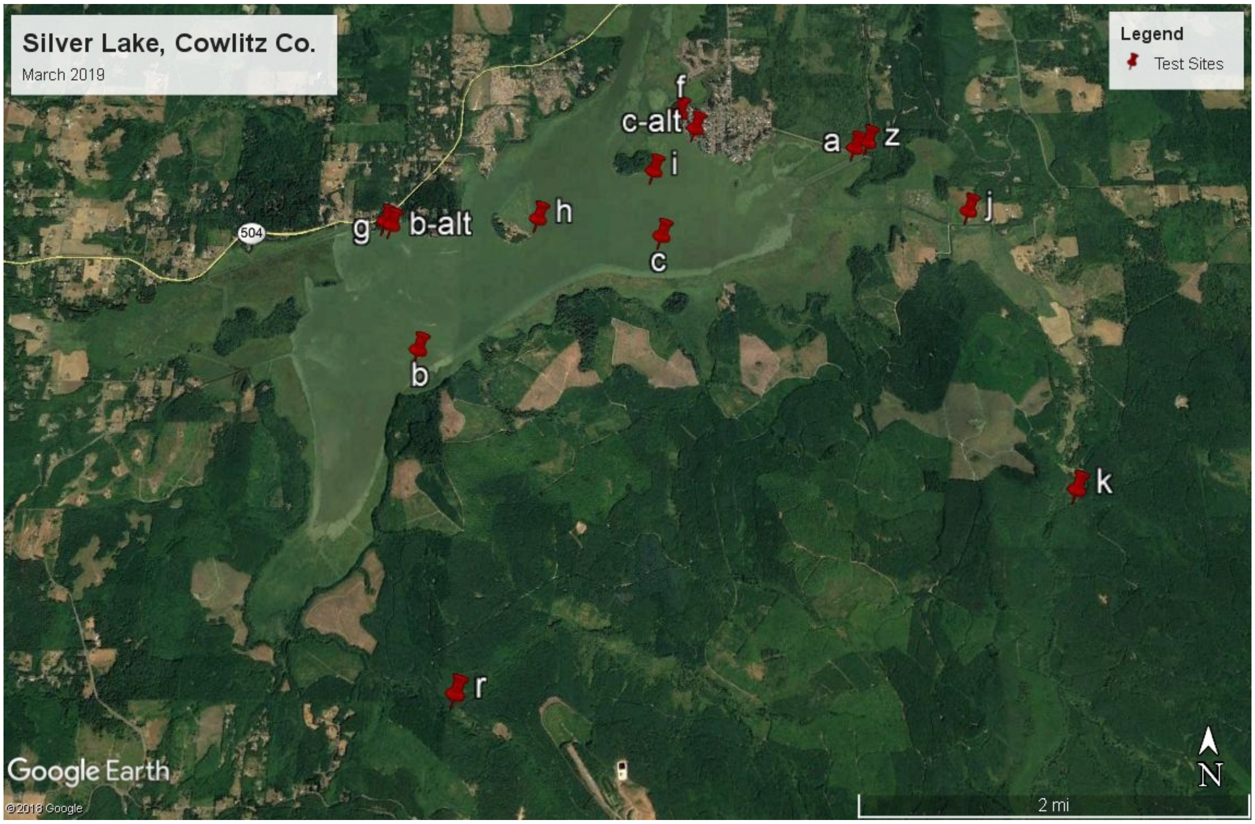

Figure 3: All Water Sampling Sites

Lake Sites – Main Monthly: a. Outlet Creek, b. Deep West, c. Deep East
Lake Sites – Seasonal Swim: f. Streeters, i. Tree House, g. Silver Resort, h. Walen
Creek Sites – z. Outlet Gate, r. Sucker Creek Upper, j. Hemlock Canal Rd, k. Hemlock Rd 1390

7.2.1 Sampling locations and frequency

Sampling locations, including GPS coordinates and access methods, are listed in the appendix of the SOPs, as found in this document, Chapter 16, Appendix D, Section 5. The year round water sampling will be conducted at 3 lake sites and 5 stream sites. Year round lab analytes include total phosphorus and *E. coli*. Chlorophyll *a* will be measured for six months out of the year when the results are most valuable. Four additional lake sites will be testing during the summer for *E. coli*.

All sampling events will also include the field parameters of temperature, pH, dissolved oxygen, and turbidity. Secchi depth will be measured during the sampling events at the three deep lake sites.

Table 7. Water Quality Sample Schedule

Water Quality Sample Schedule with QC April 2019 – March 2021							
#	**Target Date**	Lake TP	Lake Secchi	**Stream TP**	**Lake chlor *a***	***E. coli* *Lake + stream + swim + QC***	**Cost $**
1	May 2019	3	3	5	3	3 lake + 5 stream	613
2	Jun 2019	3 + Q	3	5 + Q	3	3 lake + 5 stream + 4 swim + Q	809
3	Jly 2019	3	3	5	3 + Q	3 lake + 5 stream + 4 swim	780
4	Aug 2019	3 + B	3	5 + B	3 + B	3 lake + 5 stream + 4 swim + B	864
5	Sep 2019	3 + Q	3	5 + Q	3	3 lake + 5 stream + 4 swim + Q	809
6	Oct 2019	3	3	5	3 + Q	3 lake + 5 stream	668
7	Nov 2019	3	3	5	None	3 lake + 5 stream	448
8	Dec 2019	3 + Q	3	5 + Q	None	3 lake + 5 stream + Q	532
9	Jan 2020	3	3	5	None	3 lake + 5 stream	448
10	Feb 2020	3	3	5	None	3 lake + 5 stream	448
11	Mar 2020	3 + Q	3	5 + Q	None	3 lake + 5 stream + Q	532
12	Apr 2020	3	3	5	None	3 lake + 5 stream	448
13	May 2020	3	3	5	3	3 lake + 5 stream	616
14	Jun 2020	3 + Q	3	5 + Q	3	3 lake + 5 stream + 4 swim + Q	809
15	Jly 2020	3	3	5	3 + Q	3 lake + 5 stream + 4 swim	780
16	Aug 2020	3 + B	3	5 + B	3 + B	3 lake + 5 stream + 4 swim + B	864
17	Sep 2020	3 + Q	3	5 + Q	3	3 lake + 5 stream + 4 swim + Q	809
18	Oct 2020	3	3	5	3 + Q	3 lake + 5 stream	668
19	Nov 2020	3	3	5	None	3 lake + 5 stream	448
20	Dec 2020	3 + Q	3	5 + Q	None	3 lake + 5 stream + Q	532
21	Jan 2021	3	3	5	None	3 lake + 5 stream	448
22	Feb 2021	3	3	5	None	3 lake + 5 stream	448
23	Mar 2021	3 + Q	3	5 + Q	None	3 lake + 5 stream + Q	532
24	Apr 2021	3	3	5	None	3 lake + 5 stream	448
total		82	72	130	42	234	$13,545

QC = Quality Control
Q = QC Sample (Field Duplicate or Replicate) **B** = Field Blank

Sample Sites Specified:
3 lake = a .Outlet, b. Deep West, c. Deep East
4 swim = f. Streeters, i. Tree House, g. Silver Resort, h. Walden
5 stream = q. Easy St, z. Outlet Gate, r. Sucker Upper, j. Hemlock Canal rd., k. Hemlock Rd 1390

This QAPP also covers the procedures for taking measurements via the digital handheld multiparameter probe at the sites of all sediment extractions, locations indicated below.

Table 8. Dredge Testing Sites

Dredge Testing Sites with Concurrent Field Water Quality Testing			
Site		N Latitude	W Longitude
1	Sucker Cr	46.2566	-122.7949
2	Deep West	46.2842	-122.8011
3	Deep East	46.2944	-122.7718
4	Hemlock Cr	46.2724	-122.7241
5	TBD	TBD	TBD

7.2.2 Field parameters and laboratory analytes to be measured

Table 9. List of Parameters and Analytes

Laboratory Analytes	Total phosphorus Chlorophyll *a* *E. coli*
Field Parameters	Temperature pH Dissolved Oxygen Turbidity
Secchi Visibility	Secchi depth

7.3 Modeling and analysis design

N/A

7.3.1 Analytical framework

N/A

7.3.2 Model setup and data needs

N/A

7.4 Assumptions in relation to objectives and study area

The main assumptions underlying this design is that total phosphorus and *E.coli* results upstream of farmland may differ than that of downstream farmland and the landfill. We are also assuming that Silver Lake is influenced by both major inlet streams, with Sucker Creek having a greater influence than Hemlock Creek.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

The lake is easily accessible via state route 504. Inclement weather could interfere with sampling events, but should be of short enough duration to reschedule within the same month. Summer lake level draw down, both natural and that facilitated by the lake committee, could interfere with boating access. Contingency plans for shoreline sampling are identified.

7.5.2 Practical constraints

Winter sampling may need to be rescheduled due to inclement weather. Late summer and fall sampling may be interrupted due to low water levels. The project schedule allows for flexibility to recover from a cancelled sampling event due to weather conditions.

7.5.3 Schedule limitations

The above schedule provides enough flexibility to recover from a cancelled sampling event due to weather conditions. SLWAC also provides sufficient volunteers that the schedule should not be compromised if a volunteer experiences boating equipment problems. If the digital probe experiences a malfunction or mechanical problem, then a gap in some water quality parameters could occur, due to the time it takes for out-of-state shipping and repair.

8.0 Field Procedures

8.1 Invasive species evaluation

Lake is listed in Washington's 303(d) list of impaired waters for invasive species including Brazilian elodea in the year 2000. However, it is believed that the pervasive presence of grass carp have resulted in the disappearance of this aquatic vegetation, as well as all or most other aquatic vegetation except lily pads. Nonetheless, per EAP070 section 6.1, field activities will be conducted to minimize the contact between equipment and potential sources of invasive species, particularly aquatic plants, sediment and fish. Methods of minimization may include sampling from areas of less weed growth to more dense weed growth, not running the boat onto sediment, not getting plants, sediment and fish inside boats or other sampling gear, not driving or walking through areas of mud and high weed growth, to the extent possible as the sampling team navigates to each specific sampling site.

Per EAP070 section 6.2, after field work all equipment leaving the site will be inspected, cleaned and drained. The sampling team will inspect and clean all equipment that contacted (terrestrial or aquatic) soil, vegetation, or water. They will remove any visible vertebrates, invertebrates, plants, algae or sediment. If necessary, they will use a scrub brush and rinse with clean water either from the site or brought for that purpose, until the equipment is clean. In addition, the sampling team will drain water in bilges, samplers or other equipment that could hold water from the site, if such equipment is being removed from the waterbody.

8.2 Measurement and sampling procedures

SOPs in Appendix D.

All field measurements taken via Ysi ProDSS including ambient air temperature, water temperatures, pH, conductivity, dissolved oxygen, and turbidity will strictly follow the ProDSS User Manual Document #626973-01 REF (https://www.ysi.com/ProDSS).

8.3 Containers, preservation methods, holding times

Table 10. Sample containers, preservation, and holding times

Analyte(s)	Container	Preservation Technique	Analysis Holding Time
Total Phosphorus	125 mL Plastic H_2SO_4	9N H_2SO_4: Cool to 4± 2ºC	28 days
(Analysis of) Chlorophyll *a*	Unfiltered: 1 L glass amber bottle unpreserved	Unpres.; Cool to 4± 2ºC, No light exposure	Filter within 48 hrs. from collection
(Preparation)	Field Filtered: Glass Fiber Filter	Frozen	28 days
E. coli	100 mL Plastic Sterile Cup Na2S203	Cool to < 10ºC (4± 2ºC after 2hrs)	8 hrs from collection

8.4 Equipment decontamination

N/A

8.5 Sample ID

Standard sample ID protocol for each laboratory will be followed, according to chain of custody report.

8.6 Chain-of-custody

Standard ALS Chain of Custody forms will be used, as shown in Appendix A.

8.7 Field log requirements

Field logs will be printed on waterproof paper, numbered, and bound in a notebook. Permanent, waterproof ink will be used for all entries. Corrections will be made with single line strikethroughs, initials and date of correction. White-out or correction fluid will not be used.

See Appendices B and C.

8.8 Other activities

SLWAC field volunteers have been involved with sampling for several years now. The project lead will hold an initial briefing to go over new QAPP approved sampling methods, emphasizing any identifiable differences between past sampling techniques and QAPP approved techniques. The project lead will provide on-going supervision of sampling activities, as it is anticipated that the project lead will be present in order to administer the probe testing. Minimally, field staff will receive an informal audit on a quarterly basis by the project lead as they conduct their sampling activities.

Maintenance for field instrumentation will be conducted according to manufacturer's recommendations and specifications.

9.0 Laboratory Procedures

9.1 Lab procedures table

Table 11. Measurement methods

Measurement Methods Table		
Lab Procedures Table		
Analyte	**Matrix**	**Sample Number**
Total Phosphorus	Water – lake and creeks sites	192
Chlorophyll *a*	Water – lake sites only, for 6 months per year	36
E. coli	Water – lake and creek sites, plus swim sites 4 months per year	224
Supporting Field Analysis Table		
Secchi Depth	Water - lake sites only	72
Temperature	Water – lake sites, and creek sites as possible	up to 248
pH	Water – lake sites, and creek sites as possible	up to 248
Dissolved Oxygen	Water – lake sites, and creek sites as possible	up to 248
Turbidity	Water – lake sites, and creek sites as possible	up to 248

9.2 Sample preparation method(s)

Per laboratory SOPs.

9.3 Special method requirements

N/A

9.4 Laboratories accredited for methods

CCHD has confirmed that that ALS Environmental is accredited for the specific methods.

10.0 Quality Control Procedures

10.1 Table of field and laboratory quality control

Table 12. Field and Laboratory Quality Control

Parameter	Field		Laboratory			
	Blanks	Field Replicates	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes
Probe Measurements						
Temp	NA	Each event	NA	NA	NA	NA
pH	NA	Each event	NA	NA	NA	NA
Dissolved O2	NA	Each event	NA	NA	NA	NA
Turbidity	NA	Each event	NA	NA	NA	NA
Lab Samples						
Total Phosphorus	Annually	Quarterly	1 per Batch or 1 per 20 samples	1 per Batch or 1 per 20 samples	1 per Batch or 1 per 20 samples	1 per Batch or 1 per 20 samples
Chlorophyll *a*	Annually	quarterly	1 per Batch or 1 per 20 samples	1 per Batch or 1 per 20 samples	Per client request	NA
E. coli	Annually	Quarterly	+/- Control Checks	NA	Per client request	NA

Probe measurements will be collected using Ysi ProDSS datasonde, calibrated and used according to manufacturer's instructions (https://www.ysi.com/ProDSS). The probe will be calibrated every 30 days or less. A minimum of three data points will be captured per site, and after comparison for reasonableness, the last one will be recorded in order to allow the most time for the measurements to stabilize. However, the project lead will utilize judgement of such things as the probe disturbing the lake bottom, and will use the data point that is deemed most accurate.

For the lab tests including total phosphorus, chlorophyll *a*, and *E. coli*, two co-located samples will be collected once every three months to estimate overall variability due to sampling and analysis. The site chosen for the co-located (replicate) sample will be chosen at random and documented by the project lead. Total phosphorus will be taken from the same collection jar and will qualify as a duplicate sample. Chlorophyll *a* and *E. coli* samples will be replicates, taken at the same location and depth as the original sample.

Contamination will be assessed by the submission of field blanks. Once a year, fresh distilled water will be submitted rather than the co-located samples. Blank results are expected to be below reporting limits.

Laboratory QC will follow each lab's internal procedures.

Profile data will be collected using Ysi ProDSS datasonde, calibrated and used according to manufacturer's instructions (https://www.ysi.com/ProDSS).

10.2 Corrective action processes

If analytical results fall outside of the quality control acceptance criteria, and the analytical method does not state the consequence, then the results should be flagged as such and the project lead will assess the best course of action.

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

The laboratory verifies its measurement results. In addition, the following procedures will be followed and are the responsibility of the project lead:

- Standard lab and field QC procedures will be adhered to.
- The data will be checked for data entry errors and completeness.
- Results will be checked for reasonableness
- Lab and Field QC results will be evaluated to ensure that the measurement quality objectives (MQOs) were met. Data failing to meet MQOs will be either coded or discarded.

11.2 Laboratory data package requirements

Lab results will be submitted in EIM compatible format.

11.3 Electronic transfer requirements

Data will be imported onto the project's comprehensive excel spreadsheet to limit reentry issues and facilitate the analysis of the data.

11.4 EIM/STORET data upload procedures

Annually, at the end of each full year of sampling, all data will be input into Ecology's EIM.

11.5 Model information management

N/A

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

The project lead will perform a technical systems audit (a qualitative audit of conformance to the QA Project Plan) within the first three months of the commencement of work. A brief report will be generated discussing the relevant sections of the QAPP, any necessary corrective actions, and included in the progress and final report.

Proficiency Testing is worked into the schedule with duplicate samples submitted to lab once a quarter.

12.2 Responsible personnel

All audits and reports will be the responsibility of the project lead.

12.3 Frequency and distribution of reports

CCHD will submit progress reports to Ecology quarterly as described in the grant's scope of work. In addition, the project lead will email Ecology with a brief description of the technical systems audit results.

12.4 Responsibility for reports

The CCHD project lead will write the final report.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

The following procedures will be followed and are the responsibility of the project lead:

- Standard field QC procedures will be adhered to.
- The data will be checked for data entry errors and completeness by the project lead.
- Results will be checked for reasonableness by the project lead.

- Field QC results will be evaluated to ensure that the measurement quality objectives (MQOs) were met. Data failing to meet MQOs will be either coded as estimates or discarded.
- In this study, data is generated by the lab, the volunteers, and the project lead. The project lead will perform the data verification.

13.2 Laboratory data verification

Lab data verification will be according to internal QC procedures.

13.3 Validation requirements, if necessary

Not Applicable

13.4 Model quality assessment

Not Applicable

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

The project manager will evaluate if the project outcomes have met the original objectives in the final report, examining if the collected data was consistent with the study design methods, and if study procedures followed the final approved QAPP, and if enough of the data are deemed usable after verification.

14.2 Treatment of non-detects

As referred to in EPA web archive: http://archive.epa.gov/region02/water/dredge/web/html/nondetect.html
Region 2 Water Non-Detect Policy of elutriate data, non-detects will be treated in accordance with the below described method:

i) If a concentration of a specific contaminant in an elutriate sample is reported as "non-detect" and the method detection limit *was not* achieved, then the reported detection limit should be used as an estimate of the (maximum possible) concentration of the contaminant in the sample.

ii) If a concentration of a specific contaminant in an elutriate sample is reported as "non-detect" and the detection limit achieved *was at or below* the method detection limit, then half the achieved detection limit should be used as an estimate of the concentration of the contaminant in the sample.

14.3 Data analysis and presentation methods.

All results will be graphed, and further statistical analysis will include mean, variance, and standard deviation.

QA assessments for precision will be made by comparing calcualted standard deviations of split sample pairs to the larger of the percent relative standard deviation multiplied by the mean of the sample pair or the maximum standard deviation tabulated in the MQOs (Table 6). Standard deviation for paired samples may be calculated according to Equation 1:

$$s = \sqrt{(r_1 - r_2)^2 / 2}$$

where "s" is the standard deviation and "r_1" and "r_2" are paired results.

Where results are to be combined then QC pairs may be pooled using Equation 2:

$$s_p = \sqrt{\sum (r_1 - r_2)^2 / 2m}$$

where "s_p" is the pooled standard deviation and m is the number of pairs. The value "s_p" may then be compared to the MQOs in Tables 5 & 6.

14.4 Sampling design evaluation

The sample design is intended to help answer the questions; "Are the inlet creeks adversely influenced by agriculture or industry before they enter the lake?" and "How do the inlet creeks influence the lake?" To answer the first question, the upper sample sites of the creeks will be compared to the lower creek samples, and any difference will be assessed for statistical significance. To answer the second question, the data from the lower creeks will be compared to the data from the lake, and any difference will be assessed for statistical significance.

If sampling is one hundred percent complete, there will be one sample per month for each site over the course of two years, or twenty-four total samples per site. This is a relatively low sample number, so caution will be taken before making theories.

14.5 Documentation of assessment

Documentation of assessment will be included in the final report.

15.0 References

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KCM. 1998. *Silver Lake Phase II Restoration Monitoring*. KCM, Inc. Seattle, WA.

Moore, B.C., Funk, W.H. 1990 *Silver Lake Restoration Phase I: Diagnostic/Feasibility Study*. State of Washington Water Research Center. Report No. 73. Pullman, WA.

16.0 Appendices

Appendix A. Chain of Custody Form

ALS Environmental

CHAIN OF CUSTODY
95049

1317 South 13th Ave, Kelso, WA 98626 Phone (360) 577-7222 / 800-695-7222 / FAX (360) 636-1068
www.alsglobal.com

005

SR#
COC Set ____ of ____
COC# ____

Page 1 of 1

Project Name: Silver Lake WQ+	Project Number: 00092
Project Manager: Hilarie Larson	
Company: CCHD	
Address: 207 4th AVE North	
Phone #: 360.414.5599[redacted] x 6428	email: larsonh@co.cowlitz.wa.us
Sampler Signature: [signature]	Sampler Printed Name: Hilarie Larson

CLIENT SAMPLE ID	LABID	SAMPLING Date Time	Matrix	NUMBER OF CONTAINERS	28D 365.3 / Phos T	1	2	3	4	5	Remarks
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											

Report Requirements
___ I. Routine Report: Method Blank, Surrogate, as required
___ II. Report Dup., MS, MSD as required
___ III. CLP Like Summary (no raw data)
___ IV. Data Validation Report
___ V. EDD

Invoice Information
P.O.# ____
Bill To: Cowlitz County Hlth Dpt

Turnaround Requirements
___ 24 hr. ___ 48 hr.
___ 5 Day
___ Standard
Requested Report Date

Circle which metals are to be analyzed

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Special Instructions/Comments: Please call Hilarie at 360.414.5599 x 6428 if e.coli ≥ 200 MPN/100mL

*Indicate State Hydrocarbon Procedure: AK CA WI Northwest Other ____ (Circle One)

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature [signature]	Signature	Signature	Signature	Signature	Signature
Printed Name Hilarie Larson	Printed Name	Printed Name	Printed Name	Printed Name	Printed Name
Firm CCHD	Firm	Firm	Firm	Firm	Firm
Date/Time	Date/Time	Date/Time	Date/Time	Date/Time	Date/Time

Appendix B. Lake Field Form

Lake Field Form - Event #: Day High Temp: Day Low Temp:

Date: Precipitation 24 hr: Lake Level:

Names:

General Lake & Weather Conditions:

Sites – via route order	Time:	Adequate Depth for Probe?	T Phos	Chlor *a*	*E. coli*	QC	Comments
3 LAKE:							
c. Deep East							
a . Outlet							
b. Deep West							
q. Easy St							
4 SWIM:							
f. Streeters							
i . Tree House							
g. Silver Resort							
h. Walden							
OTHER:							

Appendix C. Stream Field Form

Stream Field Form -   Event #:   Day High Temp: Day Low Temp:

Date: Precipitation   24 hr:

Names:

General Lake & Weather Conditions:

Sites – via route order	Time:	Adequate Depth for Probe?	T Phos	Chlor *a*	*E. coli*	QC	Comments
z – Outlet gate							
r - Sucker Creek Upper							
s – Sucker Creek Upper 2							
j - Hemlock Canal Rd							
k - Hemlock Rd 1390							

Appendix D. SOP

1. General Information

This Standard Operating Procedure (SOP) is applicable to the collection of representative liquid samples from Silver Lake. The intent of the SOPs is to ensure safety of personnel and validity of results. Activities for each sample event are described in three segments: preparation, sampling and delivery.

After bottles are acquired, preparation is best accomplished at least a day in advance of the sampling day. Sampling, in general, should occur between 10 am and 3pm. However, there is flexibility in both the time and the day of the sampling event, especially in consideration of weather conditions. Common sense and good judgement dictate timing. Under no circumstances should personnel be on the water during electrical storms, high winds, heavy fog, or other unsafe conditions. Delivery should always occur immediately after sampling event, and preferably before 4 pm.

2. Preparation

TASK 1 – Consult *Silver Lake Sample Schedule with QC*, **and order applicable bottles from lab 1 – 2 weeks prior to desired sampling date.**

- Check *Silver Lake Sample Schedule with QC* to determine which samples are called for.
- Write an email to the lab project manager requesting the applicable bottes.

TASK 2 – Consult *Silver Lake Sample Schedule with QC*, **and confirm acceptable weather conditions and resources approximately 1 week prior to proposed sampling date.**

- Check the current and forecasted weather and decide if the conditions allow for safe sampling. This decision should be confirmed upon observing lake conditions prior to launching the boat and beginning the sampling trip.
- Communicate schedule with volunteers.

TASK 3 – Calibrate the Probe.

- Consult the YSI ProDSS User Manual, with Quick Start Guide and Probe Tutorial Notes 8/27/15, to calibrate the probe. Instead of one rinse as described, use three rinses.
- Record results in *ProDSS Calibration for 00092* filed under water>Probe – ProDss.
- Verify that current calibration was successful by checking "last calibrated date" on the handheld for each analyte.
- Ensure that the probe is properly storing information by taking an "in office" sample, and pressing the File menu, View Data.

TASK 4 – Obtain coolers from lab, and prep labels and reports.

- Fill out general information sections on bottle labels and label cap with site letter using upper case letter and a period after it.
- Complete the general info sections on the Chain of Custody Report

- Complete the general info sections on the Lake Field Form and Stream Field Form.
- On the day of sample event, check National Weather Service website (www.weather.gov) to obtain the daily high and lows for Toutle Washington, and the 24 hr precipitation info preceding the event by clicking on "3 Day History" for Toutle / Castle Rock.

TASK 5 – On sampling day, load sampling equipment and supplies including:

- The probe, box of gloves, personal floatation device, extra sample jar, and goggles in carrying case.
- Secchi disk with a measured line
- Water sampler instrument / pole
- Water sample collection containers in cooler with ice packs
- Clipboard, waterproof pens, and sampling forms including: Lake Field Form, Stream Field Form and Chain of Custody Form
- SOP manual with map of lake sample sites
- 3' grabbers (for *E. coli* direct sample)

TASK 6 – Check for boating safety equipment.

- Ensure that a personal flotation device is available for each person. Devices must be Coast Guard-approved, readily available, and the proper size.
- Ensure that a first aid kit is onboard.
- Check for other equipment that may be required by State and local boating laws.

3. Sampling

TASK 1 - Position boat at the designated sample site.

Locate the sample site on the water. The position should be verified using the shoreline landmark method (align two permanent landmarks from the boat, and then at an approximately 90° angle, align two additional ones). You may also use the GPS function on the probe or the boat.

TASK 2 - Complete the observations portion of the sampling form.

Record your observations about the lake and weather conditions on the sampling form. In addition, write down any unusual conditions that may affect the sampling results.

- Record water condition observations at the site including water color, suspended sediment and algae, aquatic plants, waterfowl activity, and odor.
- Record weather conditions on the form including the amount of cloud cover (when taking the Secchi disk reading), and water surface conditions. Indicate any unusual weather conditions that may have occurred in the previous week including storms, high winds, and temperature extremes.
- Record any other factors or conditions that make the sampling trip unusual or that may potentially influence sample results. For example, report any chemical, mechanical, or biological control of algae or aquatic weeds that may have been done recently on the lake.

TASK 3 - Probe Measurements

- Perform depth calibration, as described in the ProDSS User Manual, at water surface before every sample event.
- If the handheld part can be secured, turn it on and place the probe in water while other tasks are performed, in order to allow time for the pH reading to stabilize.
- Take at least two probe measurements at 3' when that depth is available. Read depth on the monitor via "vertical position" rather than "depth."
- If reading in creek, note if probe is laying horizontally in water due to shallow depth.

-

TASK 4 - Secchi disk depth

It is preferable to have the same individual take the reading at a site throughout the entire sampling season. Sunglasses should not be worn. The line attached to the Secchi disk must be marked according to ¼ feet increments, rounding up as necessary.

- Check to make sure that the Secchi disk is securely attached to the measured line.
- Lean over the non-sunny side of the boat and lower the Secchi disk into the water.
- Continue to lower the disk until it just disappears from view. Lower the disk another one foot, and then slowly raise the disc until it just reappears. Continue to move the disk up and down until the exact vanishing/reappearing point is found, and round to the nearest ¼ ft. Once obtained, repeat until consistent measurement is obtained.
- Record the observed measurement on the field form.

TASK 5 – Take *E. coli* sample directly into lab bottle – *Do not use intermediate jar*

- Take this sample first, donning new gloves.
- Remove the cap from a sterile collection bottle without touching the inside of the cap or the inside of the bottle. Gently place the cap, facing up, onto a stable flat surface.
- Secure the lab bottle with the tongs of the gripper pole to, and plunge it in a downward and motion into the water to a depth of 12-18".
- Using a forward sweeping motion, invert the bottle and bring it to the surface.
- If necessary, empty it slightly to leave a bit of air at the top, but make sure it is at or above the fill line.
- Carefully re-cap the container and place it in the cooler.
- Note: *E. coli* sterile sample bottles contain sodium thiosulfate, a chlorine neutralizing agent. This is the way that the lab purchases the bottles. The sodium thiosulfate is not necessary for this study

TASK 6 – Take the phosphorus and chlorophyll *a* samples using water sampler instrument and collection jar:

- When you arrive at each sampling location, rinse sample collection jar with surface water and shake dry.
- Attach sample collection jar to the Subsurface Jar Sampler.
- Lower the sampler gently into the water to the desired depth as marked on the pole.
- Pull the pull-ring extending from the handle to open the plunger on the telescoping pole. When bubbles stop rising from the sampler, release the pull ring to close the plunger and gently bring the sampler to the surface.
- Remove the sampling bottle from the pole and fill the lab bottles:

chlorophyll *a* sample bottle

- Move the chlorophyll *a* sample bottle into position and remove cap.
- Gently shake the container with the sample water to re-suspend any settled material.
- Gently pour the sample water into the lab bottle to a level just at the neck, taking care not to allow bottles to touch.
- Cap the sample bottle and place it into the shipment container with the frozen ice packs and close the lid so sunlight cannot reach it.

total phosphorus sample bottle

- Glasses or goggles required due to the powder acid in these bottles. Even the vapors should be avoided.
- Move the total phosphorus sample bottle into position and remove cap only when ready to pour, it's extremely susceptible to contamination.
- Gently shake the container with the sample water to re-suspend any settled material.
- Gently pour the sample water into the lab bottle to a level just at the neck, taking care not to allow bottles to touch each other.
- Cap the sample bottle and place it into the shipment container with the frozen ice packs and close the lid so sunlight cannot reach it.

quality control bottles

- Utilize the same capture jar for total phosphorus regular sample and duplicate sample.
- For chlorophyll *a*, pour half of the capture jar into the regular sample lab bottle and the other half into the QC sample bottle, and then repeat.
- Use distilled water for field blanks.

TASK 7 – Place bottles in cooler and check off applicable boxes on Field Forms.

4. Delivery

TASK 1 – Clean Equipment

- Clean the sampling and laboratory equipment for the next sampling trip. The Secchi disk and water sampler should be rinsed off with fresh tap water, and the sampling containers rinsed with distilled water.

TASK 2 – Transport Samples with Forms

Deliver in person to: ALS Global Laboratory, 1317 S. 13th Ave, Kelso, WA 98626 between 8am and 5pm Monday-Friday and between 8am and 12pm on Saturday. They prefer to receive by 4pm on weekdays and by 11am on Saturdays.

5. SOP Appendix

Silver Lake Sample Locations						
Site Type	Site Name	Site Letter	GPS Latitude	GPS Longitude	Comments	Access
Lake	Deep East	c	46.2944	-122.7718		boat
Lake	Deep West	b	46.2842	-122.8011		boat
Lake	Outlet Crk	a	46.3027	-122.7473		boat
Swim	Streeters	f	46.3061	-122.7694	summer *E. coli* only	boat or dock
Swim	Tree House	i	46.3005	-122.7727	summer *E. coli* only	boat
Swim	Walden	h	46.2960	-122.7871	summer *E. coli* only	boat
Swim	Silver Resort	g	46.2957	-122.8060	summer *E. coli* only	boat or dock
Lake-Alt	Dave's Dock	c-alt	46.3046	-122.7674	Deep East alt. site	dock
Lake-Alt	Silver Resort Dock	b - alt	46.2954	-122.8052	Deep East alt. site	dock
Stream	Sucker Crk Upper 1	r	46.2566	-122.7949	below landfill	Car – key needed
Stream	Sucker Crk Upper 2	s	tbd	tbd	at landfill	Car
Stream	Hemlock – Canal Rd	j	tbd	tbd	below agriculture	Car
Stream	Hemlock - Rd 1390	k	46.2724	-122.7241	above agriculture	Car – key needed
Stream	Easy Street	q	tbd	tdb	historic site	Lake

Appendix E. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Char: Fish of genus *Salvelinus* distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light-colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

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 (FC): 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 bacteria 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).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but 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.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Point source: Source of pollution that discharges 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 where more than 5 acres of land have been cleared.

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.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Fish that belong to the family *Salmonidae*. Species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

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 water body 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.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

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, requiring 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 standards and are not expected to improve within the next two years.

Acronyms and Abbreviations

CCWF	Centennial Clean Water Fund
CCHD	Cowlitz County Health Department
CWA	Clean Water Act
DO	(see Glossary above)
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FC	(see Glossary above)
GIS	Geographic Information System software
GPS	Global Positioning System
i.e.	In other words
MQO	Measurement quality objective
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
RSD	Relative standard deviation
SLWAC	Silver Lake Watershed Advisory Council
SLWMP	Silver Lake Watershed Management Plan
SOP	Standard operating procedures
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WMP	Watershed Management Plan

Units of Measurement

°C	degrees centigrade
cfu	colony forming units
ft	feet
g	gram, a unit of mass
m	meter
mm	millimeter
mg	milligram
mg/L	milligrams per liter (parts per million)
mL	milliliter
NTU	nephelometric turbidity units
ug/L	micrograms per liter (parts per billion)

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy*. (USGS, 1998)

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella. (Kammin, 2010)

Bias: The difference between the sample mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process. (USGS, 1998)

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. (Ecology, 2004)

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS. (Kammin, 2010; Ecology, 2004)

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run. (Kammin, 2010)

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system. (Kammin, 2010; Ecology 2004)

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean. (Kammin, 2010)

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading. (Kammin, 2010)

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity. (USEPA, 2006)

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.
(USEPA, 2006)

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010)

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability, and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier – data are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are rejected, cannot be used for intended purposes.
  (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set. (Ecology, 2004)

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero. (Ecology, 2004)

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis. (USEPA, 1997)

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport. (Ecology, 2004)

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples. (Kammin, 2010)

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples. (USEPA, 1997)

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects. (Ecology, 2004)

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness. (USEPA, 2006)

Measurement result: A value obtained by performing the procedure described in a method. (Ecology, 2004)

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed. (EPA, 1997)

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples. (Ecology, 2004; Kammin, 2010)

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero. (Federal Register, October 26, 1984)

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples. (Kammin, 2010)

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all "parameters." (Kammin, 2010; Ecology, 2004)

Population: The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data. (Ecology, 2004)

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

$$[Abs(a-b)/((a + b)/2)] * 100$$

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled. (USGS, 1998)

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

Sample (statistical): A finite part or subset of a statistical population. (USEPA, 1997)

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit. (Ecology, 2004)

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method. (USEPA, 1997)

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency. (USEPA, 1997)

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010)

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis. (Kammin, 2010)

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning. (USEPA, 2006)

References for QA Glossary

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