Quality Assurance Project Plan

Giffin Lake (Yakima County) Verification Monitoring

October 2012

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Publication Information

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

The plan for this study is available on Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/1203118.html

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, MIKA0001.

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Quality Assurance Project Plan

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Abstract

Giffin Lake was once a popular recreation site, particularly for anglers. An overabundance of macrophytes degraded the waterbody to the point that it was no longer an attractive location for fishing, hunting, or other recreational activities. The rampant macrophyte growth was attributed to an excess of nutrients resulting from a combination of internal lake processes and the input of nutrient-rich water from external sources.

Water samples collected in 1990 and 1991 at Giffin Lake showed elevated levels of phosphorus were present in the waterbody. The high concentration of phosphorus in the lake resulted in it being placed on the 303(d) list of impaired waters.

This study will provide the information required to assess whether Giffin Lake should remain on the 303(d) list for phosphorus. In order to provide a complete picture of the health of the waterbody, a broader set of chemical and physical data will be collected concurrently with the phosphorus samples.

Background

Location and Characteristics

Giffin Lake is located on the Sunnyside-Snake River Wildlife Area in Yakima County, Washington about three miles northwest of the town of Mabton and five miles south-southwest of Sunnyside, Washington (Figure 1). At 107 acres, it is the largest of six oxbow lakes formed by the Yakima River found on the Sunnyside Headquarters unit of the wildlife area. The lake is relatively shallow, with a maximum depth of 7 to 9 feet and a mean depth of 4 feet, and does not become thermally stratified. Fragrant water lilies (*Nymphaea odorata*) have become so dominant in the lake that they have negatively impacted both other species and recreational use.

Input to Giffin Lake is primarily by return flows from the Sunnyside Valley Irrigation District (Moore et al, 1992). Most of the water in these returns originates from the Yakima River. There is also evidence that at least one spring feeds Giffin Lake in addition to diffuse groundwater input. The direct drainage area feeding the lake is 7,985 acres, though it effectively drains a much larger area during the irrigation season. Giffin Lake is below the floodplain for the Yakima River and it is occasionally inundated by the river at higher stages.

Land use in the Giffin Lake watershed is primarily agricultural (Table 1). Some change in land use has likely occurred since 1992, but the overall distribution of land uses is probably similar to that shown in the table. Major crops in the area include hops, alfalfa, grains, and grapes. The Sunnyside Headquarters Unit also supports commercial agriculture. Approximately 468 acres of the 2,786 acre wildlife area are under agricultural lease, with about 344 acres irrigated and the rest in dryland crops (WDFW, 2012a). Not all of that acreage directly impacts Giffin Lake, however.

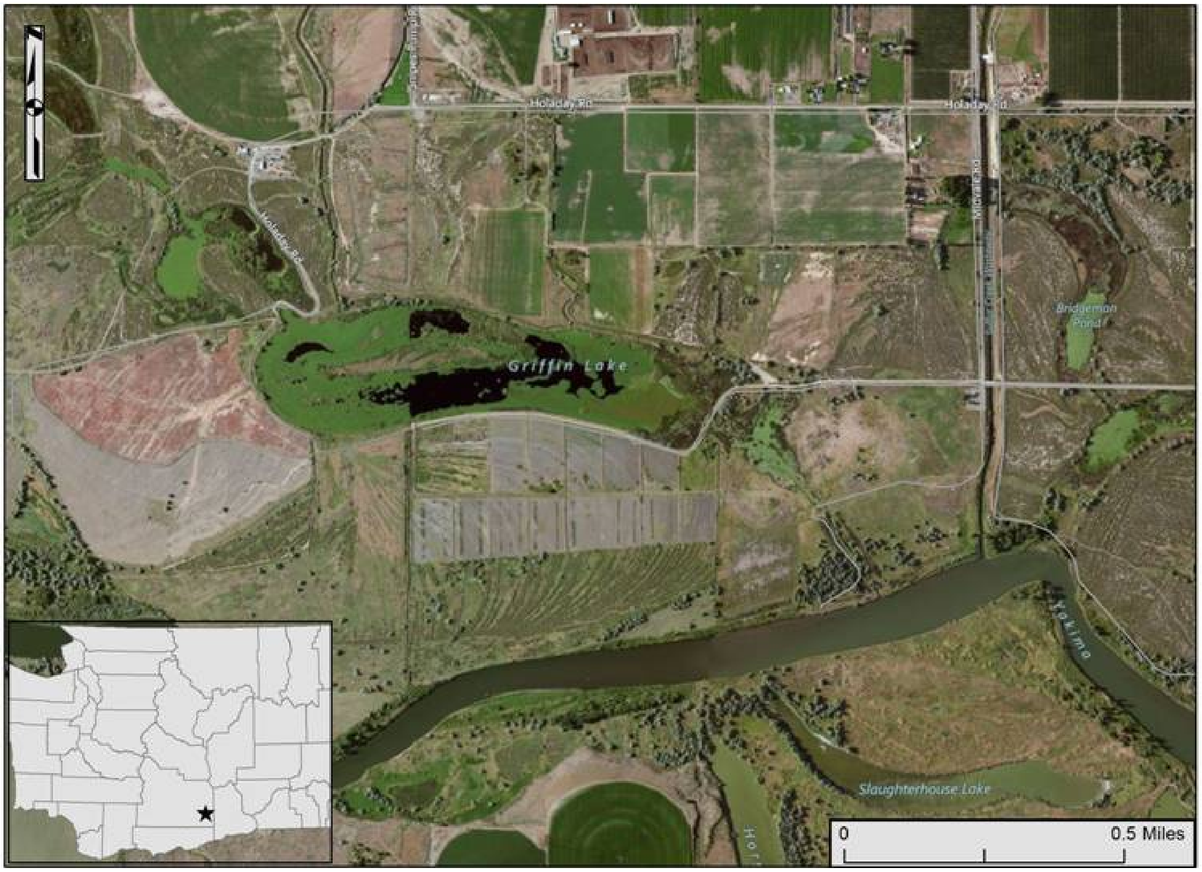

Figure 1. Giffin Lake and surrounding area.

(The name of the lake is misspelled on the aerial image.)

Table 1. Land use in the Giffin Lake Drainage, circa 1992 (from Moore et al., 1992).

Land Use	Area (ha)	Watershed (%)
Agriculture		
Cultivated	1,580.3	48.9
Non-cultivated	678.8	21.0
Livestock	213.3	6.6
Other open land	601.1	18.6
Residential (low density)	3.2	0.1
Transportation	12.9	0.4
Marsh	61.4	1.9
Water	77.6	2.4
Total	3,228.5	99.9

The lake itself has historically been used for both irrigation and recreation. Irrigation use has diminished greatly since the creation of the Sunnyside Valley Irrigation District. Lake water is used by the Washington Department of Fish and Wildlife (WDFW) to flood artificial wetlands used in waterfowl banding efforts on an "as needed" basis. Angling is the predominant historical recreational use. WDFW lists Giffin Lake as having stocks of largemouth bass, pumpkin seed, and carp (WDFW 2012b). Rainbow trout were once stocked in the lake, but WDFW discontinued that effort due to poor habitat conditions and decreased interest by the public, both largely due to the explosion of macrophyte growth in the lake. The lake is still used by waterfowl hunters, though even their ability to establish blinds and deploy decoys has been hampered by the lilies.

Historical Studies

In 1992, the Washington Water Research Center, in cooperation with the WDFW, the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (Ecology) published a Phase I Federal Clean Lakes Restoration Project report on Giffin Lake (Moore et al., 1992). The purpose of the study was to find the cause(s) of rampant macrophyte growth in the lake and recommend approaches to restoring it to an improved condition.

The authors of the Phase I study determined that Giffin Lake had been impacted by nutrients from anthropogenic sources over a long period of time. Excessive nutrient loading from both internal and external sources led to water quality problems, including excessive growth of aquatic macrophytes. The trophic state of the lake was eutrophic to hypereutrophic. The study also found that plant growth in Giffin Lake was nitrogen-limited rather than phosphorus-limited.

The preferred restoration plan for Giffin Lake included dredging, alum treatment of the main inflow and nonpoint source pollution control in the basin. Ecology records show that Phase II of an EPA Clean Lakes Program Restoration Project was completed in 1996, but no documentation of what that entailed could be located. Phase II is the implementation of recommendations from a diagnostic/feasibility study. WDFW staff indicated that they believed no restoration was actually done due to a lack of funding.

Water Quality Impairments

Giffin Lake was placed on the 303(d) list for phosphorus, based on samples collected during the study by Moore et al. in 1990-1991. The 303(d) list is a list of impaired waters maintained by the states under the requirements of the Clean Water Act. The State of Washington uses ecoregion-specific criteria to determine a total phosphorus numeric action value at which a lake is considered impaired (Table 1). Lakes that exceed the action value for phosphorus can still be considered unimpaired if a lake-specific study establishes a background concentration higher than the action value and shows the lake is meeting its beneficial uses.

The Columbia Basin Ecoregion covers most of eastern Washington, including Giffin Lake. The action value for total phosphorus in that ecoregion is 35 micrograms per liter (ug/L). The lowest value recorded for Giffin Lake in the 1991-92 study was 70 ug/L and the highest was 792 ug/L.

Typical values were in the 100-200 ug/L range, though concentrations of 300 ug/L or higher were not uncommon.

Total nitrogen (TN) to total phosphorus (TP) ratio is also a concern at Giffin Lake. While no standard exists for TN/TP ratio, it is a factor in setting phosphorous limits in lake-specific studies (Ecology, 2004). A 10:1 ratio is considered necessary to prevent blue-green algae dominance in a waterbody. During the 1990-91 sampling period for the Phase I study, TN:TP ratios were 6:1 at the highest and 1:1 at the lowest. The mean TN:TP ratio was 3:1.

Table 2. The ecoregional and trophic-state action values for establishing nutrient criteria.

Coast Range, Puget Lowlands, and Northern Rockies Ecoregions:		
Trophic State	**If Ambient TP (µg/L) Range of Lake is:**	**Then criteria should be set at:**
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
Lower mesotrophic	>10-20	20 or less
	Action Value	
	>20	lake-specific study may be initiated
Cascades Ecoregion:		
Trophic State	**If Ambient TP (µg/L) Range of Lake is:**	**Then criteria should be set at:**
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
	Action Value	
	>10	lake-specific study may be initiated
Columbia Basin Ecoregion:		
Trophic State	**If Ambient TP (µg/L) Range of Lake is:**	**Then criteria should be set at:**
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
Lower mesotrophic	>10-20	20 or less
Upper mesotrophic	>20-35	35 or less
	Action Value	
	>35	lake-specific study may be initiated.

Project Description

Overview

The primary focus of this effort will be verifying the 303(d) listing for phosphorus. However, to understand the condition of the waterbody, it will also be prudent to sample for additional parameters, including other nutrients, chlorophyll-a, and basic physical and chemical parameters. The low TN:TP ratio is of particular concern. An argument can be made that using phosphorous to determine trophic state when it is not the limiting nutrient is a questionable approach. Chlorophyll-a and Secchi disk measurements are also used to determine trophic state and can confirm the findings from the phosphorus data. Washington Surface Water Quality Standards require that a minimum of four phosphorus samples be taken from the epilimnion during the critical period from June through September to determine the trophic state of a lake. These samples must be spread out across the critical season.

To maintain consistency between this effort and the prior study done at Giffin Lake, two sites on the lake will be monitored. One site will be on the eastern side of the lake and one at the western side. If possible, one sample will be collected from an area free from macrophytes.

The macrophyte density in the lake is of concern for two reasons. First, there is a concern that it may interfere with sample collection. The risk of being unable to collect sufficient samples is addressed by planning to collect more than the minimum required samples. Second, operating in an environment with such high plant density increases the risk of unintentional transport of plants between waterbodies. Fragrant Lily is a Class C noxious weed, which is the lowest priority category and has no specific requirement for control or eradication. Ecology's Environmental Assessment Program invasive species standard operating procedures will be strictly followed by all field staff.

Sampling Design

A field crew will collect samples at Giffin Lake during the critical period from June to September. Samples will be collected at approximately the same locations as those in the 1992 study.

Profiles of depth, pH, conductivity, dissolved oxygen, and temperature as well as Secchi depths will be measured at each sampling site.

Due to the shallow depths in the lake, samples will be collected at only one depth. These samples will be collected using a Kemmerer Sampler at a depth of 0.5 meters.

The sampling locations, number of sites, or length of the sampling period may be altered if required by conditions in the field. Specifically, there is some concern that rampant macrophyte growth may make one or more sampling sites inaccessible during the study period.

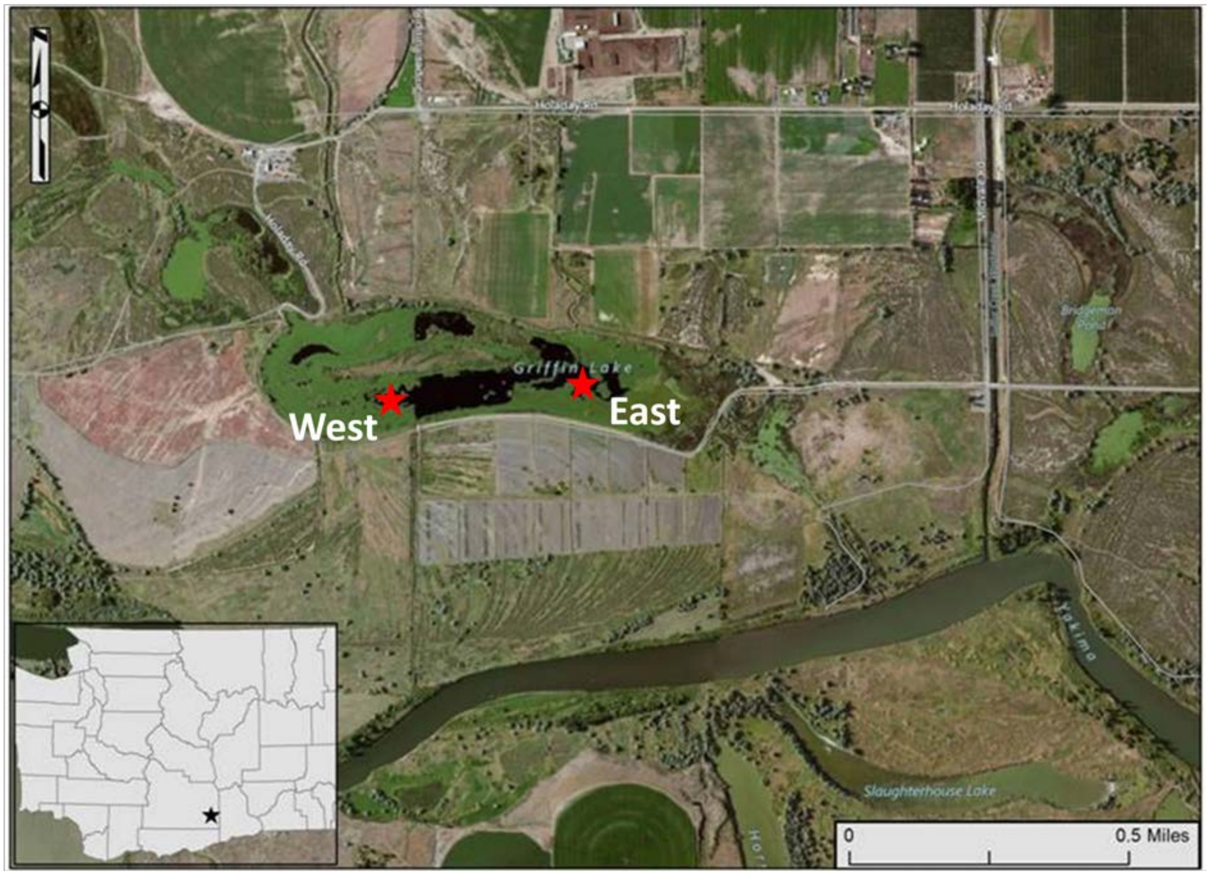

Figure 2. Proposed sampling sites on Giffin Lake.

Goals and Objectives

To provide sufficient information for Ecology's Water Quality Program to make a determination of Giffin Lake's 303(d) status going forward, the following objectives need to be accomplished:

- Collect samples in the critical period between June and September.
- Sample in a manner that is comparable with the original effort that resulted in the listing of Giffin Lake, is consistent with current Ecology practices, and is cost effective.
- Provide field crews with instruction and hands-on training to ensure that data is collected in a manner consistent with the methods described in this document.
- Produce a technical memo after the project has been completed which includes:
    - A summary table of chemical and physical data collected.
    - Discussion of data quality and the significance of problems encountered.
    - Narrative evaluation of the data collection effort and results.
    - Assessment of the trophic state of Giffin Lake.
    - Comparison of data collected to numeric water quality standards.

Organization and Schedule

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

Table 3. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Gregory Bohn Water Quality Program Central Regional Office Phone: (509) 454-4174	Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Michael Anderson Freshwater Monitoring Unit, EOS Phone: (509) 662-0480	Project Manager	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Eiko Urmos-Berry EOS Phone: (509) 575-2397	Field Lead	Helps collect samples and records field information. Assists with data review and entering data into EIM.
Amy Cook EOS Phone: (509) 454-4244	Field Assistant	Helps collect samples and records field information.
Jenifer Parsons EOS Phone: (509) 457-7136	Acting Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Joel Bird Manchester Environmental Laboratory Phone: (360)871-8801	Director	Approves the final QAPP.
William R. Kammin Phone: (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP: Environmental Assessment Program
EOS: Eastern Operations Section
EIM: Environmental Information Management database
QAPP: Quality Assurance Project Plan

Table 4. 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	November 2012	Michael Anderson
Laboratory analyses completed	December 2012	
Environmental Information System (EIM) database		
EIM user study ID	MIKA0001	
Product	Due date	Lead staff
EIM data loaded	January 2013	Michael Anderson/Field Staff
EIM quality assurance	February 2013	TBD
EIM complete	March 2013	Michael Anderson
Final Memo to Client		
Author lead / Support staff	Michael Anderson / Eiko Urmos-Berry/ Amy Cook	
Due Date	April 2013	

Table 5. Laboratory cost estimate.

Sample Type	Parameter	Sites	QA (replicate)	Visits	Field Blanks	Analytical cost per sample[1]	Subtotal
Surface Water	Nutrients[2]	2	1	4	1	$78.90	$789.00
	Chlorophyll	2	1	4	0	$44.64	$401.76
						Total laboratory cost estimate:	$1,191.00

[1]Costs include 50% discount for Manchester Laboratory.
[2]Includes ammonia, nitrate-nitrite, total persulfate nitrogen, orthophosphate, and total phosphorus.

Quality Objectives

Bias

Bias is defined as the difference between the population mean and the true value of the parameter being measured (Lombard and Kirchmer, 2004). Bias attributed to sampling and field measurement techniques will be minimized by following appropriate protocol and standard operating procedures (SOPs) discussed and referenced in this Quality Assurance Project Plan (QAPP). Procedures described in this QAPP are used to collect representative samples and field measurements of the highest quality possible. The issue of sample bias is largely investigated at Manchester Environmental Laboratory (MEL), where standard analytical techniques are applied.

Precision

Precision is the measure of the variability in the results of replicate measurements due to random error (Lombard and Kirchmer, 2004). This random error is inherently associated with field sampling and laboratory analysis. Field and laboratory errors are minimized by adhering to strict protocols for sampling and analysis. Precision will be expressed as percent relative standard deviation (%RSD) between sets of duplicate field samples (Mathieu et al., 2006).

Measurement Quality Objectives

EPA defines measurement quality objectives (MQOs) as " 'acceptance criteria' for the quality attributes measured by project data quality indicators. [They are] quantitative measures of performance…" (EPA, 2002).

In practice, these are often the precision, bias, and accuracy guidelines against which laboratory (and some field) quality control results are compared. Precision may be assessed by the analysis of laboratory duplicates or check standard replicates. Bias may be assessed by comparing the mean of blank and check standard results to known values (Hallock and Ehinger, 2003).

Table 6. Measurement quality objectives.

Analysis	Method	Bias (deviation from true value)	Precision (Replicate median RSD)	Method Lower Reporting Limit and/or Resolution	Expected Range
Field Measurements					
Water Temperature[1]	Hydrolab®	n/a	+/- 0.2° C	0.01° C	0 – 30° C
Specific Conductance[2]	Hydrolab®	n/a	5% RSD	0.1 µS/cm	20 – 200 µS/cm
pH[1]	Hydrolab®	n/a	0.20 s.u.	0.01 s.u.	1 to 14 s.u.
Dissolved Oxygen	Hydrolab®	n/a	5% RSD	0.1 mg/L	0.1 - 15 mg/L
Dissolved Oxygen[1]	Winkler Titration	n/a	+/- 0.2 mg/L	0.1 mg/L	0.1 - 15 mg/L
Laboratory Analyses					
Chlorophyll a -water	SM 10200H(3)	5%	20% RSD[3]	0.05 µg/L	0.1 – 100 µg/L
Total Persulfate Nitrogen	SM 4500-NO3-B	15%	10% RSD[3]	0.025 mg/L	0.025 – 20 mg/L
Ammonia	SM 4500-NH3-H	10%	10% RSD[3]	0.01 mg/L	0.01 – 20 mg/L
Nitrate/Nitrite	4500-NO3- I	15%	10% RSD[3]	0.01 mg/L	0.01 – 10 mg/L
Orthophosphate	SM 4500-P G	20%	10% RSD[3]	0.003 mg/L	0.003 – 1 mg/L
Total Phosphorus	SM 4500-PF	10%	10% RSD[3]	0.001 mg/L	0.005 – 10 mg/L

[1] as units of measurement, not percentages.
[2] as percentage of reading, not RSD.
[3] replicate results with a mean of less than or equal to 5X the reporting limit will be evaluated separately.
SM: Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA, 1998).

Representativeness

The study is designed to have enough sampling sites and sufficient sampling frequency to meet study objectives. Some parameter values are known to be highly variable over time and space. Sampling variability can be somewhat controlled by strictly following standard procedures and collecting quality control samples, but natural spatial and temporal variability can contribute greatly to the overall variability in the parameter value. Resources limit the number of samples that can be taken at one site spatially or over various intervals of time.

Sampling and Measurement Procedures

Field sampling and measurement protocols will follow those listed in an Environmental Assessment Program protocols manual (Ecology, 1993). Safety procedures detailed in the Environmental Assessment Program's Safety Manual (Ecology, 2006) will be followed for all sampling.

Field measurements will follow approved Environmental Assessment Program SOPs (Ecology, 2012):

- EAP011 Instantaneous Measurement of Temperature in Water
- EAP013 Determining Global Positioning System Coordinates
- EAP015 Manually Obtaining Surface Water Samples
- EAP023 Winkler Determination of Dissolved Oxygen
- EAP031 Measurement of pH in Freshwater
- EAP032 Measurement of Conductivity in Freshwater
- EAP033 Hydrolab® DataSonde and MiniSonde Multiprobes
- EAP034 Collection, Processing, and Analysis of Stream Samples
- EAP070 Minimizing the Spread of Aquatic Invasive Species from areas of Moderate Concern
- EPA 360.1 Dissolved Oxygen: Use section 3.2 for collection of dissolved oxygen samples for Winkler titration at depths of over 5 feet

The sampling sites will be located using a handheld Global Positioning System (GPS) and landmarks on the lake shore.

Secchi measurements will be collected at each location sampled.

Conductivity, temperature, pH, and dissolved oxygen will be profiled using a Hydrolab® multiprobe. The profile will consist of discrete measurements taken at depths of 0.5m, 1m, and then at 1-meter intervals to the bottom of the lake.

Nutrient samples will be taken using a Kemmerer sampler with a graduated rope to ensure that samples are taken from the correct depth. The Kemmerer sampler will be triple-cleaned with deionized water between each station. The process of lowering the open sampler will also provide a local-water rinse prior to sample collection. Individual samples will be emptied into the composite container, to form the composite sample. Sample bottles will be filled from the composite container. The composite container will be triple-rinsed with deionized water between each composite sample.

Table 7 lists the sample size, containers, preservation, and holding time for each parameter in this study. Sample containers will be provided by Manchester Laboratory. Sample containers will be filled, tagged, and put on ice.

Table 7. Sample containers, preservation, and holding times.

Parameter	Sample Matrix	Container	Preservative	Holding Time
Ammonia	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Nitrate/Nitrite	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Total Persulfate Nitrogen	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Orthophosphate	Surface water	125 mL amber poly with Whatman Puradisc™ 25PP 0.45um filters	Filter in field with 0.45um pore size filter; Cool to 4°C	48 hours
Total Phosphorous	Surface water	125 mL clear poly	1:1 HCl to pH<2; Cool to 4°C	28 days
Chlorophyll *a*	Surface water	1 L amber poly	None if unfiltered, 90% acetone filtered	24 hours unfiltered 28 days filtered

Quality Control Procedures

Field

Hydrolab meter measurements will conform to the quality control parameters in Table 6 and the calibration drift parameters in Table 8. Meter dissolved oxygen measurements will be compared to Winkler samples. At least one Winkler will be taken during each sampling event to assess dissolved oxygen meter accuracy or to correct results. Winkler samples will be collected using the Kemmerer sampler at depths corresponding to particular Hydrolab readings, simultaneously with those measurements. Winkler bottles will be filled by attaching a length of surgical tubing to the nozzle of the Kemmerer sampler and flushing the Winkler bottle from the bottom with three times the volume of the bottle, similar to the use of a standard dissolved oxygen funnel. Conductivity, pH, temperature, and dissolved oxygen data from the Hydrolab will be verified using pre- and post-deployment calibration checks, which will be recorded and kept with field data.

To assess field variability, a duplicate Hydrolab profile will be taken at least twice during the course of the project. The Secchi measurement will be replicated at the same time.

Table 8. Hydrolab® equipment individual probe calibration end drift requirements.

Parameter	Calibration Drift End Check
Dissolved Oxygen	± 4%
Temperature	± 0.2 °C
Conductivity	± 10%
pH	± 0.2 s.u.

Laboratory

Total variability for laboratory analysis will be assessed by collecting replicate samples. Quality control samples will be taken at intervals summarized in Table 9. This represents a 12.5% duplication for both nutrient samples and for chlorophyll samples. MEL routinely duplicates sample analyses in the laboratory (lab duplicate) to determine laboratory precision. The difference between field variability and lab variability is an estimate of the sample field variability.

Table 9. Sample quality control samples and intervals

Analysis	Field Replicates	Check Standard	Method Blank	Duplicate	Matrix Spikes
Total Nitrogen	1 replicate and one blank sample.	1/batch	1/batch	1/20 samples	1/20 samples
Ammonia Nitrogen		1/batch	1/batch	1/20 samples	1/20 samples
Nitrate + Nitrite Nitrogen		1/batch	1/batch	1/20 samples	1/20 samples
Orthophosphate		1/batch	1/batch	1/20 samples	1/20 samples
Total Phosphorus		1/batch	1/batch	1/20 samples	1/20 samples
Chlorophyll		N/A	1/batch	1/20 samples	N/A

A field blank and filter blank for nutrient parameters will be collected once during the study using the same sampling equipment and procedures used to take regular samples with the exception that the Kemmerer sampler will not be lowered into the water. The sampler will be triple-rinsed with DI water, then filled with DI water which will be poured into the compositor and then into individual sample bottles. Orthophosphate blanks will be run through a clean filter prior to bottling.

MEL will inform the project manager or principal investigator as soon as possible if any sample is lost, damaged, has a lost tag, or gives an unusual result.

Data Management Procedures

Field measurement data will be entered into a field book with waterproof paper in the field and then entered into EXCEL® spreadsheets as soon as practical after returning from the field. This data will be used for preliminary analysis and to create a table to upload data into Ecology's Environmental Information Management (EIM) database.

Sample result data received from MEL by Ecology's Laboratory Information Management System (LIMS) will be added to a spreadsheet for laboratory results. This spreadsheet will be used to informally review and analyze data during the course of the project.

All monitoring data will be available in EIM, via the Internet, once the project data have been validated. The URL address for this geospatial database is www.ecy.wa.gov/eim/index.htm. All data will be uploaded to EIM by the EIM data engineer after the data have been reviewed for quality assurance and finalized.

All spreadsheet files, paper field notes, and Global Information System (GIS) device products created as part of the data analysis will be kept with the project data files.

Audits and Reports

At the conclusion of this study, the project lead will write a technical memo to the client, summarizing the study findings. This memo will include a brief analysis of whether the phosphorus concentrations of the samples exceed water quality standards based on the current listing policy (WQP Policy 1-11). The report will include a determination of the lake's trophic state and compare the concentrations of other nutrients to water quality standards.

Data Verification

Laboratory-generated data reduction, review, and reporting will follow the procedures outlined in the MEL *Lab Users Manual* (MEL, 2008). Lab results will be checked for missing and improbable data. Variability in lab duplicates also will be quantified using the procedures outlined in the *Lab Users Manual*. Any estimated results will be qualified and their use restricted as appropriate. MEL will send a standard case narrative of laboratory quality assurance/quality control results for each set of samples to the project manager.

Field staff will check field notebooks for missing or improbable measurements before leaving each site. The EXCEL® (Microsoft, 2007) Workbook file containing field data will be labeled DRAFT until data verification is complete. Data entry will be checked against the field notebook data for errors and omissions. Missing or unusual data will be brought to the attention of the project manager for consultation. Valid data will be moved to a separate file labeled FINAL.

The project manager will check data received from LIMS for omissions against the Request for Analysis forms. Field replicate sample results will be compared to quality objectives in Table 6. The project manager will review data requiring additional qualifiers.

After data verification and data entry tasks are completed, all field and laboratory data will be entered into a file labeled FINAL and then into the EIM system. Another field assistant will independently review EIM data for errors at an initial 10% frequency. If significant entry errors are discovered, a more intensive review will be undertaken.

Data Quality (Usability) Assessment

After the project data have been reviewed and verified, the project lead will determine if the data are of sufficient quality to meet the study objectives. The project memo from the project lead to the client will discuss data quality and whether project objectives were met.

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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.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

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

Epilimnion: The top layer of water in a thermally-stratified lake. It is the warmest layer, can directly exchange gases with the atmosphere, and is usually mechanically mixed by wind-surface processes.

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

Hypolimnion: The bottom layer of water in a thermally-stratified lake. Physical and chemical processes within the hypolimnion can result in anoxic and/or toxic conditions in the hypolimnion.

Metalimnion: A thin layer in a thermally stratified lake in which temperature decreases more rapidly with depth than in adjacent layers. The metalimnion acts as a barrier between the hypolimnion and the epilimnion. It is also commonly referred to as the thermocline.

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.

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: 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.

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

e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
EAP	Environmental Assessment Program
et al.	And others
i.e.	In other words
MEL	Manchester Environmental Laboratory
QA	Quality assurance
RSD	Relative standard deviation
SOP	Standard operating procedures
TMDL	(See Glossary above)
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

Units of Measurement

°C	degrees centigrade
mg/L	milligrams per liter (parts per million)
s.u.	standard units
µg/L	micrograms per liter (parts per billion)
µS/cm	microsiemens per centimeter, a unit of conductivity