Lake Pend Oreille WATERKEEPER®

Water Quality Monitoring Program Volunteer Guide

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LPOW Region

Lake Pend Oreille WATERKEEPER®, as part of the WATERKEEPER® Alliance, has committed to defend the Pend Oreille community against anything that threatens their right to clean water in their region (WATERKEEPER® n.d.). The LPOW region includes the entirety of Lake Pend Oreille and the surrounding rivers and streams that empty into it.

The majority of the LPOW region is located in the Pend Oreille Lake Watershed (17010214 HUC), which is located in the Idaho panhandle and contains Lake Pend Oreille, the state's largest body of water (Fig. 1). It's the fourth deepest lake in the United States at 1,158 feet deep. Lake Pend Oreille combined with the Pend Oreille River downstream to Albeni Falls Dam contains approximately 122,000 surface acres of water (Ekstrom 2010).

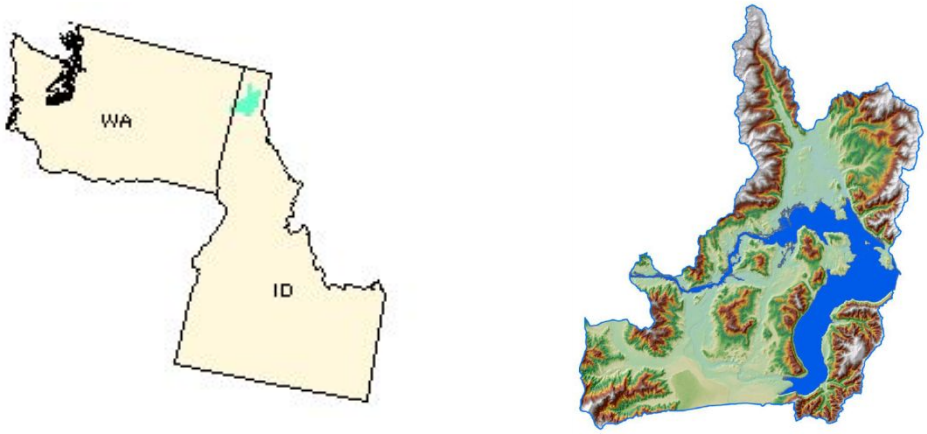

Figure 1. Pend Oreille Lake Watershed (US EPA 2009; NRCS 2006)

The primary source for Lake Pend Oreille is the Clark Fork River, which collects the water of all the rivers in northern Montana west of the continental divide. Sand Creek, Pack River, and many other streams flow into Lake Pend Oreille, as well. The Pend Oreille River flows out of the lake to the west, then turns north and empties into the Columbia in Canada. The LPOW region also extends from the Cabinet Gorge Dam on the Clark Fork River to the Albeni Falls Dam on the Pend Oreille River.

At the southern end, Lake Pend Oreille drains into the Spokane Valley/Rathdrum Prairie Aquifer, a sole source aquifer for the drinking water and needs of the Spokane/Coeur d' Alene metropolitan area and its approximately 600,000 inhabitants (Ekstrom 2010).

Water Quality Monitoring

The goal of LPOW's citizen-based Water Quality Monitoring Program (WQMP) is to produce reliable, scientifically credible data that lends insight into the water quality of Lake Pend Oreille and its affiliated waterways. The high quality data collected by Lake Pend Oreille WATERKEEPER® can be referenced by regulatory agencies, such as the Idaho Department of Environmental Quality (IDEQ), when making decisions about the "health status" and management of Lake Pend Oreille and the Pend Oreille River. Regular monitoring will establish baseline levels for a range of parameters that are indicators of water quality. Continued sampling on a seasonal basis will allow LPOW to detect changes and potential threats to water quality in our lake and river.

Citizen-based Water Quality Monitoring:

Due to the extensive nature of LPOW's jurisdiction and the need to monitor multiple locations, LPOW relies on the generosity of volunteers to assist in monitoring efforts. Volunteers collaborate with LPOW staff to collect water samples on a monthly basis. Volunteers are provided with the necessary equipment and supplies and are trained to properly collect water samples, perform certain analyses in the field, and store other samples for subsequent laboratory analyses. Volunteers agree to arrange for the delivery of samples to LPOW or SVL Analytical, the processing lab in CDA.

Commitment:

In order to uphold the high standards that LPOW strives to achieve, volunteers need to participate in an annual training session to be introduced to the water quality monitoring techniques utilized by the WQMP. Subsequently, LPOW requests that volunteers perform water sampling at their designated station during the designated day of each month (May – September) and deliver the sample to LPOW or SVL Analytical within a reasonable time frame to adhere to holding times for analytical tests and quality standards. The preferable sampling day is Tuesday since SVL lab provides shuttle services from Sandpoint to CDA on Wednesday mornings. However, if this is not possible, LPOW will coordinate with volunteers to receive samples.

Quality Control and Quality Assurance

Through the citizen-based WQMP, LPOW wishes to generate high quality data, recognized by a variety of regulatory agencies for its accuracy, precision, representativeness, completeness, and comparability (US EPA 2002). Achieving this goal requires that volunteers undergo proper training, practice the correct sampling techniques, and maintain vigorous records of their field activities.

Field Notebooks:

Field notebooks are used to record data and observations in a consistent and credible manner. Field records must contain at minimum: the date of the monitoring activity, the name of the data collector, a description of the site location (including canopy cover, riparian zone, nearby sites), recent weather conditions (including air temperature, cloud cover, wind, and precipitation), location (name and GPS coordinates), name of test, actual readings, replicate readings when applicable, any values needed to obtain a final answer, and anything unusual. The desired format for record keeping is provided with the field notebook. Volunteers are expected to follow the format provided so field records can be easily proofed and entered into the WQMP database.

On a field record, **you should never erase what you think is an error**—instead, neatly cross it out and write in the correct answer above or next to the error with your initials and date of correction. This is to document an error that may have been carried through other
data measurements or calculations, and sometimes you were right the first time.

Be sure to use the appropriate number of digits in your answers, it is best to report the numbers as fully as the instrument reports them. Also, do not report values of zero. Instead, use “less than _____”, substituting in the lowest detectable value. This is only applicable to the dissolved oxygen testing, which will be done in the field. If a measurement was not taken, instead of leaving the space blank, write in “no data” or “ND.” An entry left blank may be interpreted as being forgotten rather than not applicable.

Schedule

Date	Time	Location	Event
June 4th and 10th	5:30 pm	City Beach Pavilion	Volunteer Orientation
Tuesday, June 16th		Independent stations	June Sampling
Tuesday, July 21st		Independent stations	July Sampling
Tuesday, August 18th		Independent stations	August Sampling
Tuesday, September 15st		Independent stations	September Sampling
TBD	5:30 pm	TBD	End of Season Party

Notes

- Sample collection will take place during the 3rd Tuesday of every month.
- Please arrange with LPOW for the delivery of your samples.
- If you have any questions, please contact:

Lake Pend Oreille WATERKEEPER®
Travis Dickson: 208-920-3621
Gray Henderson: 520-561-0643
LPOW Office: 208-597-7188
334 N. First Avenue
PO Box 732
Sandpoint, ID 83864

Lake Pend Oreille WATERKEEPER®: Volunteer Waiver Agreement

Lake Pend Oreille WATERKEEPER® (LPOW) is committed to conducting programs and activities in a safe manner and holds the safety of volunteers in high regard. LPOW strives to reduce such risks and asks that all volunteers follow safety rules and instructions that are designed to protect the volunteer's safety. However, volunteers must recognize that there is an inherent risk of injury when choosing to volunteer for any activity or program, including the Water Quality Monitoring Program (WQMP).

It is strongly urged that all volunteers review their own health insurance policy for coverage prior to participating in the WQMP. Each volunteer is solely responsible for determining if he or she is physically fit and/or properly skilled to safely participate in WQMP volunteer activities.

Please read the following carefully and be aware that in consideration of providing volunteer services, you will be expressly assuming the risk and legal liability as well as waiving and releasing all claims for injuries, damages, or losses which you may sustain as a result of participating in any and all activities connected with and associated with your volunteer services (including transportation services and vehicle operations if provided).

As a volunteer, I recognize and acknowledge that there are certain risks of physical injury to volunteers engaged in the WQMP, and I voluntarily agree to assume the full risk of any and all injuries, damages, or losses, regardless of severity, that I may sustain as a result of my volunteer services. I further agree to waive and relinquish all claims I may hold as a result of my volunteer services against Lake Pend Oreille WATERKEEPER® including its directors, officers, employees, or volunteers (hereinafter collectively referred to as "Parties").

I do hereby fully release and forever discharge the Parties from any and all claims for injuries, damages, or losses that I may have or which may accrue to me, arising out of, connected with, or in any way associated with my volunteer services.

Volunteer's Name: _____

Volunteer Signature: _____

Date: _____

If under the age of 18, this document must be read and signed by a parent or guardian.

Parent Name:
_____

Parent Signature:
_____

Date: _____

Lake Pend Oreille WATERKEEPER® Landowner Release Form

I, _____

do hereby release the owner of property at _____

_____ from any responsibility for any physical harm that may befall me while using the above mentioned land for the purposes of biological or chemical monitoring for the Lake Pend Oreille Water Quality Monitoring Program.

Signature_____ Date

_____

To verify the identity or intent of the volunteer in question, or for any other information, contact:

Travis Dickson, Associate Director
Lake Pend Oreille WATERKEEPER®
Travis Dickson: 208-920-3621
Gray Henderson: 520-561-0643
LPOW Office: 208-597-7188
334 N. First Ave.
PO Box 732
Sandpoint, ID 83864

Safety Precautions

- Never risk your safety to obtain a sample!
- Never work alone. A companion not only provides a second set of hands, but added security in remote locations and invaluable help should an accident occur.
- Make sure someone always knows where you are going.
- All reagents and equipment should be stored away from children and animals.
- Read the labels on all reagent containers before you use them. Some labels provide important antidote information.
- Avoid contact between reagents and your skin, eyes, nose, and mouth. Follow the antidote instructions should contact occur.
- In the event of poisoning, call the local Poison Control Center. Be prepared to give the name of the reagent and code number when available.
- Read and understand all testing procedures before you do field work.

General Guidelines for Sampling

- Always sample in a consistent location, discussed and approved by LPOW. If possible, use GPS guidance to locate the coordinates of the station.
- Try to sample around the same time of day, as certain parameters vary throughout the day.
- Please adhere to the record keeping guidelines provided in the field notebook. Please record any irregularities that may occur in addition to routine data collection.
- Please do not touch the openings of bottles. Keep bottles clean to prevent contamination.
- Please do not allow bottle lids to touch the ground. Keep lids clean to prevent contamination.
- Please be careful not to stir up bottom sediments before or during sampling.
- Follow the instructions provided with your vertical point water sampler to determine the appropriate sampling depth (corresponds to “Secchi” depth).
- Please wash the sampling containers (DO, pH) with distilled water after each sampling event and allow them to dry completely before storing.

Determining the Appropriate Sampling Depth

Please collect your sample at the “Secchi” depth, which should correspond to the highest level of biological productivity in the water column. See the section on Transparency for specific instructions.

Parameters

The parameters listed here and detailed in the following pages were selected because they are common types or indicators of water quality pollution sources in Lake Pend Oreille and the Pend Oreille River.

Chemical parameters:

- Ortho Phosphate
- Total Phosphorus
- Nitrate+Nitrite
- Total Organic Carbon
- Dissolved Oxygen
- pH/alkalinity

Biological:

- Total Coliform Bacteria and *E. Coli*.
- Chlorophyll a (*at selected locations only in August and September)

Physical:

- Water Temperature
- Transparency

Materials

*This is the list of materials provided to volunteers by LPOW and should encompass all that you need to collect water samples excluding a boat, extension pole, GPS capable device, and other site specific needs.

- Field Notebook w/example entry
- Pen and Sharpie (Sharpie is for filling out sample labels)
- Gloves
- Thermometer (found on interior of the Vertical Sampler)
- Distilled water and phosphate-free detergent
- Vertical Point Water Sampler (includes thermometer)
- 150 mL sample bottle pre-preserved with sodium thiosulfate (Total Coliform/E. Coli)
- 2, 1 liter HDPE bottle with foil (Chlorophyll a) (if assigned)
- 250 mL HDPE bottle (Ortho-Phosphorous)
- 250 mL HDPE bottle pre-preserved with sulfuric acid (Total Phosphorous, Total Kjeldahl Nitrogen, Nitrate + Nitrite)
- 40 mL VOA vial pre-preserved with sulfuric acid (Total Organic Carbon)
- Amber 500 mL Round Wide Mouth Storage Bottle (with screw cap)

    This sample bottle will be used to transport sample-water to office for O2 and pH measurements.

- Cooler + ice packs
- Secchi Disk

Collecting a Sample with the Vertical Point Water Sampler

1. Cock the sampler device, making sure it is secure.
2. Rinse the vertical sampler three times with surface water.
3. Deploy the sampler to the depth in the water column determined from the transparency test (this is the ”Secchi” depth), holding the messenger in hand and maintain tension so the sampler remains upright and cocked.
4. Drop the messenger, waiting for a tug on the line and the associated sound, indicating the stoppers have closed.
5. Carefully remove the sampler to the surface, maintaining tension on the line; hold it by the rope or with a hand held over the bottom.
6. Return the sampler to the surface and record the water temperature from the built in thermometer.

Transferring the Water Sample to the Sample Bottle

1. Push up on the spring of the sampler, release pinch clamp, or turn nozzle (depending on the model used) to begin the water flow from the plastic tube on the bottom.
2. Place the tube just above the sample bottle mouth and fill each bottle according to test instructions. Do **not** insert the tube into the sample bottle.
3. When filling the 1L HDPE for pH and DO tests, rinse the bottle 3 times with lake water from the bottle sampler, then fill the HDPE with the water you will use for these tests.

Cleaning and Maintenance

*After sampling, please immediately rinse off all equipment. This helps maintain the equipment in good condition, as well as protect future samples from contamination.

All glassware and plastics except waste jug (glassware from dissolved oxygen kit, pH kit, etc.)

1. Fill about one-third full with distilled water.
2. Cap and shake well.
3. Dispose of water.
4. Repeat twice (for a total of 3 rinses).
5. Let air dry.

Secchi Disk

1. Rinse off disk and rope with tap water.
2. Let air dry.

Vertical Point Water Sampler and 1 liter HDPE sample bottle

1. Rinse the inside and outside of the sampler, as well as the rope, with tap water plus 1% phosphate free detergent (by volume). 1% is equal to 10 mL or ~0.3 oz of detergent.
2. Let air dry.

Transparency

Sources:

- Soil erosion
  - Agricultural, construction and logging practices
  - Snowmelt, storm events, other hydrological factors
  - Eroding stream banks
- Waste discharge
- Urban runoff
- Re-suspension of bottom sediments
  - Large numbers of bottom feeders (such as carp)
  - Weather/Season-related
- Excessive algal growth (All above US EPA 2010).
- Phytoplankton
- Dredging or Channelization

Facts:

Turbidity and transparency are measures of how clear a water sample is. When solids are suspended in the water, it can become murky. The murkier the water appears from these solids, the higher the measured turbidity and the lower the transparency. Water quality problems correlated to high turbidity and low transparency include:

- Increased water temperatures (darker water absorbs more sunlight)

- Reduction in dissolved oxygen
- Reduction in photosynthesis and macrophyte growth (when sunlight cannot penetrate water)
- Damage to aquatic habitat
- Increased fill-in rates to water bodies
- Physical effects on fish eggs, larvae and benthic macroinvertebrates
- Influx of metals and organic contaminants that attach to solids

Sampling:

In the field, transparency is often measured instead of turbidity. Transparency measures water clarity by utilizing inexpensive tools that result in "an integrated measure of light scattering and absorption" (EPA 2010). It is important to note that turbidity does not quantify the amount of total suspended solids (TSS). Tests for TSS are often time consuming and costly. Turbidity and transparency measurements are cost-effective ways to estimate the TSS.

Secchi transparency is one way of measuring how far light can penetrate the water. The Secchi disk is weighted and split into alternating black and white quadrants. The disk is lowered into the lake until it can be no longer seen by the tester. The depth that this occurs, called the Secchi depth, measures the transparency of the water. Generally, the more algae and the more silt in the water, the less the Secchi transparency.

Items needed:

- Secchi disk with calibrated nylon line

Procedure:

1. Remove sunglasses, and position yourself so the sun is at your back. If you're on a boat, move forward and away from any obstructions and do this test on the shaded side of the vessel.
2. Slowly lower the Secchi disk straight down into the water.
3. Stop lowering the disk when you can't see it anymore. Place one clothespin on the rope where it emerges from the surface of the water.
4. Slowly pull the disk up until you can see it again. Place a second clothespin on the rope where it emerges from the surface of the water.
5. Pull the Secchi disk out of the water and bring the two clothespins together to make loop.
6. Use a third clothespin (or remove one of the others) to mark the center of the loop.
7. Record the distance from the center of the loop to the disk.
8. Repeat steps 2-7.

9. Average the two entries and record the value as average on the data sheet.

Secchi disk measurement will determine the depth that samples are collected.

Nitrogen

Sources:

- Soil erosion
- Organic matter/debris (leaves, decomposing plants)
- Sewage/failing septic systems
- Fertilizers
- Animal waste/agricultural runoff

Facts:

Nitrogen in aquatic systems is found in many forms, including ammonia, nitrates and nitrites. Nitrogen is an essential plant nutrient but in high quantities can cause excessive plant growth. Microbial metabolism can decompose organic nitrogen (plants) into ammonia, which may be oxidized into nitrites then further oxidized to nitrates. All forms are soluble in water and are closely related. High nitrogen levels can cause increased plant and algae growth, low dissolved oxygen (DO) levels, and increased temperature.

Nitrogen has higher solubility in water than phosphorus and quickly travels into rivers and streams. Because of this phosphorus, rather than nitrogen, is the limiting nutrient for plant growth. When sampling for nutrients it may be advisable to include both phosphorus and nitrogen testing to determine the nitrogen to phosphorus ratio (N:P).

The EPA mandates nitrogen and phosphorus limits through National Pollutant Discharge Elimination System (NPDES) permits, which are often based on the assessed ability for dilution by the receiving waters.

Sampling:

The most common nitrogen tests include both nitrites and nitrates. Nitrates are the form available to plants as nutrition. Nitrites are a byproduct of ammonia oxidization and are unstable in aqueous environments and therefore rarely detectable. Detectable nitrite levels therefore may be indicative of an ammonia source.

Total Kjeldhal Nitrogen (TKN) is the sum of organic nitrogen, ammonia, and ammonium in a water body. A high measurement of TKN can mean sewage and manure discharges are present in the water body.

Nitrate+Nitrite, Total Phosphorus and Total Kjeldahl Nitrogen

Method ASTM D-5176	
Holding Time	28 Days
Additives	Sulfuric Acid as Preservative (H_2SO_4)
Refrigeration Needed	Yes

Items needed:

- Pre-labelled 250 mL sample bottle pre-preserved with sulfuric acid (H_2SO_4)
    - This is the same samples bottle used to collect (Total Phosphorus and TKN)
- Gloves
- Cooler/Ice

Sampling Procedure:

1. Fill in the sample bottle label with the site number, date, and time.
2. While wearing gloves, remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.

3. Using the water collected in the bottle sampler, carefully fill the bottle to the base of the neck.
4. Recap the bottle carefully, remembering not to touch the inside.
5. Dry the bottle.
6. Be sure to note bottle number, corresponding site number and GPS location, time and date in your field notebook.
7. Place the sample bottle in the provided gallon Ziploc bag and store on ice in cooler for transport to the office refrigerator or lab.

Phosphorus

Sources:

- Natural decomposition of rocks and minerals
- Stormwater runoff and snow melt
- Erosion and sedimentation
- Atmospheric deposition
- Direct input by animals/wildlife
- Agricultural runoff
- Detergents and cleaning fluids
- Failing septic systems
- Lake mixing: internal loading of phosphorus from sediment/water interface
- Wastewater treatment plants and permitted industrial discharge
- Fertilizer

Facts:

Phosphorus is a nutrient that supports aquatic life by encouraging growth of aquatic plants, which in turn increases the productivity of a water body. However, adding too

many nutrients may cause the growth of aquatic plants to become excessive. This is known as cultural eutrophication. This excessive plant growth can reduce water quality when the plants eventually die. Bacteria are responsible for decomposing the dead plants, during which they need to consume oxygen. This process reduces the dissolved oxygen in the water, possibly to the point where it is no longer capable of supporting fish. Other deleterious effects of cultural eutrophication include reduced clarity, nuisance algal growth (some species which may produce toxins harmful to humans and wildlife), decrease in diversity, food supply and habitat destruction.

Sampling:

The "pure," elemental form of phosphorus (P) is rarely found in nature. Phosphorus most often exists within a phosphate molecule (PO_4). Both inorganic and organic forms of phosphates can be found in aquatic systems. It is the inorganic form, orthophosphate (PO_4^{3-}) that is available to plants and animals. However, orthophosphate levels in water bodies fluctuate daily, because plants consume it quickly. Therefore, Total Phosphorus (TP) measurements are most commonly used. Total Phosphate testing involves converting all forms of phosphorus that exist in a sample of water to the simpler inorganic form of orthophosphate. By doing this, the phosphorus contained in both organic and inorganic forms can be quantified (US EPA 2010)

Ortho-phosphate Sampling

Holding Time	48 Hours
Additives	None
Refrigeration Needed	Yes

Items needed:

- Pre-labelled 250 mL sample bottle(s)
- Gloves
- Cooler/Ice

Sampling Procedure:

1. Fill in the sample bottle label with the site number, date, and time.
2. While wearing gloves, remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
3. Using the water collected in the bottle sampler, carefully fill the bottle to the base of the neck.
4. Recap the bottle carefully, remembering not to touch the inside.
5. Dry the bottle.
6. Be sure to note bottle number, corresponding site number and GPS location, time and date in your field notebook.
7. Place the sample bottle in the provided gallon Ziploc bag and store on ice in cooler for transport to the office refrigerator or lab.

Total Organic Carbon

Sources:

- Decaying natural organic matter (NOM)
    - Humic acid
    - Fulvic acid
    - Amines
    - Urea
- Agricultural and storm water runoff
    - Pesticides
    - Fertilizers
    - Herbicides
    - Industrial chemicals
    - Detergents and cleaners

Facts:

Total organic carbon (TOC) measures the total carbon along with the inorganic carbon, which is equivalent to the amount of dissolved carbon dioxide and carbonic acid salts, present in the water body. This provides an assessment of water quality in regards to the safety of its consumption, as it can help determine the amount of natural organic matter in the water body. If water containing NOM goes for treatment, it can react with the chlorine, increasing the amount of carcinogens in the treated water. In this case, it is important to test for TOC to assure an additional safeness of drinking the treated water from the source.

Sampling:

Total Organic Carbon Sampling

Holding Time	28 days
Additives	Sulfuric Acid as Preservative (H_2SO_4)
Refrigeration Needed	Yes

Items needed:

- Pre-labelled 40 mL sample VOA vial pre-preserved with Sulfuric Acid (H_2SO_4)
- Gloves
- Cooler/Ice

Sampling Procedure:

1. Fill in the sample bottle label with the site number, date, and time.
2. While wearing gloves, remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
3. Using the water collected in the bottle sampler, carefully fill the bottle to the base of the neck.
4. Recap the bottle carefully, remembering not to touch the inside.
5. Dry the bottle.
6. Be sure to note bottle number, corresponding site number and GPS location, time and date in your field notebook.
7. Place the sample bottle in the provided gallon Ziploc bag and store on ice in cooler for transport to the office refrigerator or lab.

Total Coliform Bacteria and *E. Coli*

Sources:

- Animal, waterfowl, human feces
    - Failing septic systems
    - Water treatment spillage
    - Agricultural runoff
    - Swimmer defecation (diapers - hopefullu)
    - Stormwater runoff

Facts:

Ideally, water bodies could be tested directly for microbial pathogens. However, waterborne pathogens can exist at very low concentrations and yet be highly infectious.

Culturing and monitoring pathogens directly would be expensive due to the quantity of assays needed.

Currently, the government standard for establishing and regulating Total Maximum Daily Loads (TMDLs) is accomplished by utilizing indicator bacteria. These bacteria are not usually pathogenic themselves, but their presence my indicate disease causing pathogens associated with sewage (U of MN 2007). The EPA has established regulatory limits for several indicator bacteria including total and fecal coliform limits, *E.coli*, coliphage and fecal enterococci. The amounts allowable are dependent upon whether the water is used for drinking, for shellfish harvesting, or for recreation.

Human feces contamination is considered a health threat because of the possibility of shed viruses such as Hepatitis A, or bacteria such as *Shigella spp*. or *Vibrio cholera*, while wild or domestic animal feces may contain parasites such as *Giardia spp*., *Cryptosporidium spp*., or *Salmonella*. In addition to health risks associated with elevated levels of fecal bacteria, cloudy water, unpleasant odors, and an increased oxygen demand may also result (US EPA 2010).

Sampling:

Bacteria levels in waterways are strongly correlated to rainfall. Therefore it is important to differentiate between wet weather and dry weather sampling, and correlate only within the same weather conditions (US EPA 2010). Coliforms may survive for weeks in water and sediment; however, sampling after storm events may be the best indicator of failing septic, or storm water systems.

SVL Analytical uses Quanti-Tray testing which includes both Total Coliform (TC) and *E. coli*. Samples are poured into a Quanti-Tray (a sanitary, disposable tray with multiple wells) and inserted sealed for incubation. Tray wells positive for TC and *E. coli* fluoresce different colors under a UV lamp.

Bacteria Sampling

Coliforms + E. coli	
Holding Time	*30 hours*
Additives	bottle contains Sodium thiosulfate preservative
Refrigeration Needed	Yes

*The standard method holding time for non-drinking water Coliform/E.Coli is 8 hours. However, given the nature of this sampling program, SVL has agreed to process LPOW samples with a 30 our hold time. This has been agreed upon with the understanding that results will remain accurate.

Items needed:

- Pre-labelled 150ml sterile sample bottles pre-preserved with sodium thiosulfate
- Gloves
- Cooler/Ice

Sampling Procedure:

1. Fill in the sample bottle label with the site number, date, and time.
2. While wearing gloves, remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
3. Fill sample bottle as a grab sample directly from the waterway (lake or river). Hold bottle by the bottom and dip into the water at an angle, being careful that the water entering the bottle does not flow over your hands.
4. Recap the bottle carefully, remembering not to touch the inside.
5. Dry the bottle.
6. Be sure to note bottle number, corresponding site number and GPS location, time and date in your field notebook.
7. Place the sample bottle in the provided **quart** Ziploc bag and store on ice in cooler for transport to the office refrigerator or lab.

Chlorophyll a (For selected sites only)

Sources of chlorophyll a:

- Cyanobacteria (phytoplankton) or planktonic algae

Facts:

All oxygenic photosynthetic organisms contain chlorophyll a, a particular form of chlorophyll most commonly used in photosynthetic pigment. This type of chlorophyll absorbs blue, red, and violet wavelengths in the visible spectrum, releasing the chemical energy and creating oxygen in the oxygenic photosynthesis process. Some organisms use chlorophyll a, but do not produce oxygen, as they undergo an anoxygenic photosynthesis process. This phototrophic process takes light energy and converts it into ATP (used in cells to transport chemical energy for metabolism), but does not generate oxygen.

Given this, the presence of chlorophyll a can indicate excess nutrients in the water body, such as those that facilitate algae growth and the increase of other phototrophic bacteria. In fresh water, the limiting nutrient is phosphorous. This means that at a particular level off total phosphorous, chlorophyll levels increase, generally from phytoplankton.

Sampling:

Chlorophyll a Sampling

Chlorophyll a	
Holding Time	Same day - 48 hours
Additives	None
Refrigeration Needed	Yes

Items needed:

- 2 pre-labelled 1 liter HDPE sample bottle(s)
- Foil
- Gloves
- Cooler/Ice

Sampling Procedure:

1. Wrap each sample bottle in foil so that no light can penetrate the bottle. Leave the cap exposed.
2. Fill in the sample bottle label with the site number, date, and time. Apply a duplicate label to the outside of the foil wrapping.
3. While wearing gloves, remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
4. Repeat the vertical sampling process from the beginning, and carefully fill the bottle to the base of the neck using this water.
5. Recap the bottle carefully, remembering not to touch the inside.
6. Dry the bottle.

7. Be sure to note bottle number, corresponding site number and GPS location, time and date in your field notebook.
8. Place the sample bottle in the cooler for transport to the office refrigerator or lab.

pH

Sources:

- Low (Acidic)
    - Carbon dioxide
        - Decomposition of organic material within water body
        - General emissions
        - Fertilizers/agricultural runoff
    - Acid rain—nitrogen oxide and sulfur dioxide
        - Automobile and coal-fired power plant emissions
    - Coal mine drainage—iron sulfide creates sulfur dioxide when mixed with water

- High (Basic/Neutral)
    - Bedrock such as limestone (neutralizing tendencies)
    - Lack of plant growth/carbon dioxide release from photosynthesis
    - Detergents, cleaners, etc.
    - Fertilizers with a high ammonia content

Facts:

The acidity of water can be measured by finding the pH. The pH scale ranges from 0 to 14, where 0 corresponds with the most acidic and 14 corresponds with the most basic, and each number represents a tenfold change. A pH of less than 7 indicates acidity, while a pH greater than 7 indicates a base, where, for example, a pH of 3 would be ten times more acidic than a pH of 4, or a pH of 12 would be ten times more basic than a pH of 11.

Assessing pH is important, as chemicals, including those in pollution, can affect its measurement. A low pH, indicating very acidic water, can be detrimental to the water's ecosystem, affecting fish and other living organisms. pH also determines the solubility and biological availability of chemical constituents, such as nutrients and heavy metals. Therefore, pH affects not only the form and quantity of such elements, but also is a determining factor in whether aquatic life can use them or not. Furthermore, low pH conditions can increase the solubility of heavy metals, which increases their toxicity.

A water body will have lower pH levels in the morning due to photosynthesis. During this time, the water contains higher amounts of carbon dioxide, which forms carbonic acid. The rate of photosynthesis increases as the sun rises and oxygen levels increase, causing the pH to increase during the day.

Ideally, the pH of a healthy freshwater ecosystem is neutral. Acidification can be an indicator of long-term climate change.

pH Testing (In Field)

pHydrion pH Test	
Holding Time	NA – Test performed in field
Additives	NA
Refrigeration Needed	NA

Items needed:

- 500 ml amber bottle with screw cap

Sampling: This test will be conducted in the LPOW office using YSI probe for quality assurances.

1. For in-office data collection: Collect water sample from the appropriate sample depth using the Vertical Point water sampler. Pour sample into Amber 500ml Round Wide Mouth Storage Bottle with screw cap (this is the same sample bottle used to transport the water-sample back to the office for Oxygen measurements using the YSI meter). Make sure a meniscus is present when attaching the lid to make sure NO oxygen bubbles are left in the bottle. Put the water-sample on ice and transport back to LPOW office.
2. Once back at LPOW office, remove the Amber 500ml sample bottle from cooler. Use YSI probe to gain pH and Oxygen measurements. Record data on the provided data sheet stored by the YSI meter in LPOW office.

Dissolved Oxygen (DO)

Sources of Oxygen:

- Atmospheric oxygen
- Byproduct of photosynthesis by aquatic plants and algae
- Waves and tumbling water

Facts:

Oxygen is essential for all fish, aquatic plants, and aerobic bacteria. The majority of oxygen comes from rooted aquatic plants, which release oxygen during photosynthesis. Because sunlight is a requirement for photosynthesis, the majority of dissolved oxygen (DO) in an aquatic system exists in the upper column where light penetrates. High nutrient content influences the level of DO by causing increased plant and algal growth. The bacteria that decompose plants and algae consume oxygen during their metabolic process. When more oxygen is consumed at a greater rate than it is produced, DO declines. In other words, low dissolved oxygen levels are indicative of excessive oxygen demand. Low DO levels are stressful to most aquatic organisms and may cause species death, weakening or relocation (US EPA 2010). The ability for water to hold oxygen is temperature dependent. Colder water can hold more oxygen than warmer water (DO also reflects thermal pollution). This results in both seasonal and daily patterns. Generally, DO levels are lowest in the summer months and higher in winter. Additionally, DO levels are lowest in the early morning.

Sampling:

Dissolved Oxygen Testing (In Field)

Hach DO Test	
Holding Time	NA – Test performed in field
Additives	NA
Refrigeration Needed	NA

Items needed:

- In-field data collection: Amber 500 ml Round Wide Mouth Bottle with screw cap.

Sampling: This test will be conducted in the LPOW office using YSI probe for quality assurances.

1. For in-office data collection: Collect water sample from the appropriate sample depth using the Vertical Point water sampler. Pour sample into Amber 500ml Round Wide Mouth Storage Bottle with screw cap (this is the same sample bottle used to transport the water-sample back to the office for pH measurements using the YSI meter). Make sure a meniscus is present when attaching the lid to make sure NO oxygen bubbles are left

in the bottle. Put the water-sample on ice and transport back to LPOW office.

2. Once back at LPOW office, remove the Amber 500ml sample bottle from cooler. Use YSI probe to gain pH and Oxygen measurements. Record data on the provided data sheet stored by the YSI meter in LPOW office.

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