Sierra Nevada Network Lake Monitoring Protocol
SOP 8. Water Sampling Methods

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Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	6/22/09	A. Heard	Filtering 1000 ml per particulate filter instead of 500	Concentrations were too low	1.01

Contents

1. Overview

The Water Sampling SOP covers methods for recording field observations, collecting water samples, and processing samples. The SOP is based on standard lake sampling methods. Significant portions of these procedures were adapted from Irwin (2006), O'Ney (2005), and Sickman (2007). Water sampling methods for both outlet and mid-lake sampling are described. This SOP should be used in conjunction with SOP 2 (Safety), SOP 4 (QAPP), SOP 6 (Chain-of-Custody), and SOP 7 (Equipment Disinfection).

2. Field Equipment Checklist

Crews are responsible for ensuring they have the necessary sampling equipment. The following checklists should be used prior to going into the field:

2.1. All Sites

- Field notebook
- Pencils and Sharpies
- Data sheets: 1) water, 2) amphibian, and 3) map
- Research permit (yose)
- Chain-of-custody forms
- Water and amphibian sampling SOPs and YSI instructions
- Amphibian id cards
- Digital camera (w/ empty memory card and charged battery)
- GPS unit
- 1 1-liter HDPE bottle
- 1 4-liter cubitainer
- YSI sonde and handheld display
- DO membrane kit
- 125-ml pre-labeled sample bottles
  (total bottles= 2 x # sampling stations x # lakes)
- 60-ml pre-labeled sample bottles
  (total bottles= 1 x # sampling stations x # lakes)
- 47 mm Pall A/E filters (total = 4 x # sampling stations x # lakes)
- 1 µm polycarbonate filters (total = 3 x # sampling stations x # lakes)
- Petri dishes (total = 2 x # sampling stations x # lakes)
- In addition to above, bring extra bottles, filters, and Petri dishes
- Label tape
- Two 140 cc filtering syringe
- Two Nuclepore filter holder and spare 'O' ring
- Two 500 ml graduated cylinder
- Two Filter forceps
- Ziploc bags

- Powder-free gloves—various sizes
- Spray bottle
- Bleach

2.2. Mid-lake Sampling Sites (in addition to above)

- Boat and oars
- Pump or inflation bag
- Personal flotation device
- Mesh anchor bag
- Anchor rope (braided polypropylene)
- Sonar depth finder
- Hand pump with inlet tubing (10 m) and outlet tubing (~.3 m)
- 5 4-liter cubitainers
- 3 gallon collapsible bucket or dry bag

3. General Techniques

The following are general procedures and approaches that should be followed when conducting water sampling.

3.1. Preventing Contamination

Adapted from O'Ney (2005)

Field technicians should be aware of and record potential sources of contamination at each field site.

- Wear appropriate disposable, powderless gloves (see section 3.2):
    - Change gloves before each new step during sample collection (and processing).
    - Avoid hand contact with contaminating surfaces (such as equipment, coins, food).
- Use only equipment that has been cleaned according to prescribed procedures.
- Field rinse equipment, as directed.
- Use correct sample-handling procedures:
    - Minimize the number of sample-handling steps.
    - Use Clean Hands/Dirty Hands techniques when two technicians are available
- Obtain training for and practice field techniques under supervision before collecting water samples.
- Collect a sufficient number of appropriate types of quality-control samples.

3.2. Disposable Gloves

Adapted from O'Ney (2005) and Wilde (2004).

Use of disposable, powderless gloves is required when handling equipment for collecting and processing water-quality samples. Wearing gloves serves to protect field personnel from contact with contaminants and chemical preservatives, and protects the sample from contamination transmitted by sample handling. Although common glove types include those made of vinyl, latex and nitrile, nitrile is in standard use for USGS sampling work because of its resistance to most of the chemicals to which it typically will be exposed for the length of exposure (usually under 15 minutes). Field personnel are cautioned that direct contact with materials such as latex or nitrile can cause severe allergic reactions in some individuals and should be monitored.

• Wear powderless nitrile gloves when handling equipment and chemical solutions. Do not allow the water that enters the sample bottle to contact gloved (or bare) hands.

• Check the manufacturer's chemical resistance chart for any compound, such as acid, base or organic solvent, to which the glove might be exposed.

Physical properties to consider when selecting disposable gloves are glove length, slip protection, puncture resistance, heat and flame resistance, cold protection and comfort. These factors can vary between manufacturers. Gloves should be inspected visually for defects. Check for tears, punctures and other flaws that can prevent the glove from being an effective shield. After putting the gloves on, rinse them with water while gently rubbing hands together to remove any surface residue before handling sampling equipment.

3.3. Clean Hands/Dirty Hands Technique

Adapted from O'Ney (2005) and Wilde (2004).

Clean Hands/Dirty Hands techniques require two or more people working together. At the field site, one person is designated as Clean Hands (*CH*) and a second person as Dirty Hands (*DH*). Although specific tasks are assigned at the start to CH or DH , some tasks overlap and can be handled by either, as long as the prescribed care is taken to prevent contaminating the sample. Both CH and DH wear appropriate disposable, powderless gloves during the entire sampling operation and change gloves frequently, usually with each change in task. (Wearing multiple layers of gloves allows rapid glove changes.)

CH takes care of all operations involving equipment that contacts the sample; for example, CH:

- Handles the surface-water sampler bottle.
- Handles the discharge end of the surface-water sample tubing.
- Prepares a clean work space.
- Sets up field-cleaning equipment and cleans equipment.

DH takes care of all operations involving contact with potential sources of contamination; for example, DH:

- Works exclusively exterior to processing area.
- Prepares and operates sampling equipment.
- Handles instruments for field measurements.

- Handles stream-gaging or water-level equipment.
- Sets up and calibrates field-measurement instruments.
- Measures and records water levels and field measurements.

Often two people are not available; in this case samples may be collected by an individual. This may be achieved by changing gloves when switching between clean-hands and dirty-hands tasks.

4. Field Observations

Upon reaching a site fill out the general information (Lake Name, date/time, crews etc.) on the field data sheets.

Record the following field observations on the field data sheet:

- Identify sampling locations on the pre-printed lake maps. (Refer to Rose 2010.)
- Take 3 photographs: 1) of the lake from the outlet, 2) of the outlet sampling location, capturing the streamflow, and 3) a landscape view of the lake. Record the photo numbers. Note any additional photos taken during the visit.
- Weather observations
- Fish presence—check box if any fish are observed
- Qualitative outlet flow: Take a photo of the outlet and, on the data sheet, circle the most accurate flow description using one of the choices in Table SOP 8.1.
- Comments regarding site access.

Table SOP 8.1. Outlet flow descriptions.

Choices	Description
DRY	No visible water in stream (typical of dry period for an ephemeral/intermittent stream).
NO FLOW	Discrete pools of water with no apparent connecting flow (at surface).
LOW	Base flow for a stream or flow within roughly 10% to 20% of base flow condition.
NORMAL	When stream flow is considered normal (greatest time that stream is characterized by this in terms of flow quantity, level, or general range of flow during a falling or rising hydroperiod, but above base flow).
ABOVE NORMAL	Bank full flow or approaching bank full (generally within upper 20% of bank full flow condition).
FLOOD	Flow extends outside normal bank full condition or spreads across floodplain.

5. Collecting Water Samples

Before collecting water samples, all equipment must be disinfected following procedures in SOP 7 (Equipment Disinfection).

5.1. Outlet Sampling

In the event that the outlet has no or too little flow, collect a grab sample from the shoreline. Use GPS to record the shoreline sampling station and describe the location in the field book.

1. Collect a grab sample from the lake outlet using a 1 liter HDPE bottle and cubitainer.
    a. Wear a clean pair of powder-free gloves.
    b. Rinse sample bottle and cubitainer 3 times with lake-outlet water. Dump rinse water downstream so you do not stir up sediments at the sampling location. Don't insert your hand in the water above the glove.
    c. Fill cubitainer directly or use1 liter sample bottle to fill container. Collect the sample from the main flow and not from standing water or pools.

    Contamination Note: protect the inside of the sample bottle and sample lid and the threads from contacting anything (e.g. fingers, gloves, vegetation, soil particles).

    Safety Note: Be extremely careful near fast moving water. During high flows, make sure you are standing on a secure spot. Sampling the edge of the stream during high flows is fine and preferable.
2. Calibrate dissolved oxygen on YSI sonde.

3. Measure temperature, specific conductance, DO and pH in situ using the YSI sonde. Record results and meter id no. on the field data sheet.
4. Use GPS to record sampling location.

5.2. Mid-lake Sampling

Adapted from Sickman (2007).

1. Calibrate DO meter.
2. Fill mesh anchor bag with rocks.
3. Inflate boat. Put on PFD.
4. Carefully, carry boat to lake shore. Boats can easily be punctured. It's best to wade into the lake and climb into the boat where it's at least 1–2 feet deep to avoid scraping the bottom.
5. Paddle to lake center and drop anchor. Take the following equipment with you:
    - Anchor bag with rocks
    - Anchor rope
    - Field notebook or datasheets
    - Pencil
    - Depth probe
    - GPS
    - YSI meter
    - Hand pump and tubing
    - 4 cubitainers

6. Use GPS to record sampling location.
7. Technician on shore should photograph the sampling location and the outflow sampling site.
8. Record lake depth using the depth probe.
9. Record temperature/DO profile and specific conductance.
    a. Take first readings at the surface.
    b. Take subsequent readings at 1 meter intervals (cable is marked every meter). The meter cable is ~17 m long. If the lake depth is less than 17 m than the last measure should between 1–2 feet above the lake bottom. Avoid putting probe directly into lake sediments. If the lake depth is greater than 17 m, take measurements until you reach the end of the cable. Temperature data for the top 15 m will generally be enough to determine if these lakes are stratified (Sickman 2007, personal communication).
    c. Record depth (m), temp (C), DO (mg/l) in field notebook or data sheets.
10. Determine if lake is stratified or mixed. In a mixed lake temperature readings will be similar at all depths; stratified lakes will exhibit a temperature gradient, especially at the

thermocline, where water temperatures change rapidly. In deeper Sierra Nevada lakes, the thermocline usually occurs between depths of 12–15 meters. If the lake is well-mixed, sample once at the epilimnion. If the lake is stratified collect sample from the epilimnion (sample from 1 m below lake surface) and the hypolimnion (sample below the thermocline).

11. Collect epilimnion sample (at 1 m below surface):
    a. Lower hand pump inlet tubing to 1 m below the lake surface.
    b. Pump water through tubing and pump to rinse (~100 revolutions).
    c. Insert outlet tubing into cubitainer.
    d. Pump about 200 ml of water into cubitainer. Repeat.
    e. Rinse both cubitainers, labeled epilimnion, 3 times.
    f. Fill 2 cubitainers and cap.
    g. Record sampling depth.
12. Collect hypolimnion sample
    a. Lower hand pump inlet tubing to desired depth (tubing is marked in 1 m intervals).
    b. Pump water through tubing and pump to rinse (~100 revolutions).
    c. Insert outlet tubing into cubitainer.
    d. Pump about 200 ml of water into cubitainer. Repeat.
    e. Rinse both cubitainers, labeled hypolimnion, 3 times.
    f. Fill 2 cubitainers and cap.
    g. Record sampling depth.
13. Return to shore.
14. Transfer measurements from field book to field data sheet, if applicable.

6. Sample Processing

Adapted from Sickman (2007).

You will be processing unfiltered water samples, filtered water samples, and particulate filter samples. Processing will be identical for each sampling station. The sample stations include the outlet, epilimnion, and hypolimnion. Note that not every station will be sampled at each lake. For each station you will return with a total of 2 125 ml bottles, 1 60 ml bottle, and 4 filters (Table SOP 8.2**)**. Periodically, qa/qc samples will also be collected. These will be coordinated by the Protocol Lead and Crew Lead before going into the field.

Table SOP 8.2. Sample types with corresponding bottle and filter types.

Sampling Station	Sample Type	Bottle	Filter
Outlet	Dissolved constituents	(1) 125 ml HDPE (1) 60 ml HDPE	1 µm polycarbonate
	Sp. Cond., pH, ANC	(1) 125 ml HDPE	— —
	Particulate N and C	— —	(2) 47mm Pall A/E filter
	Particulate P	— —	(2) 47mm Pall A/E filter
Epilimnion	Dissolved constituents	(1) 125 ml HDPE (1) 60 ml HDPE	1 µm polycarbonate
	Sp. Cond., pH, ANC	(1) 125 ml HDPE	— —
	Particulate N and C	— —	(2) 47mm Pall A/E filter
	Particulate P	— —	(2) 47mm Pall A/E filter
Hypolimnion	Dissolved constituents	(1) 125 ml HDPE (1) 60 ml HDPE	1 µm polycarbonate
	Sp. Cond., pH, ANC	(1) 125 ml HDPE	— —
	Particulate N and C	— —	(2) 47mm Pall A/E filter
	Particulate P	— —	(2) 47mm Pall A/E filter

6.1. Water samples

Sample bottles should be pre-labeled (before going into the field) with *Sampling Station Code, Date,* and *Filtered* or *Unfiltered*. You will need to fill in the date.

1. Wear a clean pair of gloves.
2. Unscrew the filter holder and, using forceps, place a 1 µm polycarbonate filter inside the holder. Screw filter holder back together.
3. Pull the plunger out the large syringe and attach the filter hold to the syringe barrel.
4. Pour water out of the cubitainers into the syringe barrel and insert the plunger.
5. Test that the apparatus is correctly assembled by applying moderate pressure to the syringe plunger.
6. Rinse all water bottles three times with 15–20 mls filtered sample.
7. Fill all filtered sample bottles and securely cap. *The 125 ml bottles should be filled to the top—minimize the air bubble as much as possible. For the 60 ml bottles, do not fill to the top*—these samples will be stored frozen and therefore, some space must be left for the ice to expand.
   While filtering, do not push too hard on the plunger—this may cause the filter to tear. If filtering becomes difficult:
   a. Check if the filter is ‘vapor-locked’, by detaching the syringe and filter holder. This will release air/pressure.

   b. If ‘a’ does not work, the filter is clogged. Replace filter and continue filtering. Be sure to run about 50 mls of sample through the new filter to rinse it before collecting any water.

8. Triple rinse and fill unfiltered sample bottles directly from the cubitainer or 1-liter bottle.
9. Record samples collected and sample id numbers on the datasheet.
10. Create chain-of-custody forms for each sample bottle.

6.2. Particulate Samples

We are sampling for particulate nitrogen (PN), phosphorus (PP), and carbon (PC). Particulate samples are collected on 47 mm Pall A/E filters. PN and PC are analyzed from the same filter. Duplicate filters are collected for each analysis (PN + PC, PP); therefore, there will be a total of 4 filters for each sampling station.

1. Unscrew the filter holder and, using forceps, place a 47 mm Pall A/E filter inside the holder. Screw filter holder back together.
2. Attach syringe to the filter holder, with the plunger out.
3. Pour water out of the cubitainers or 1 liter bottle into the syringe barrel and insert the plunger.
4. Filter ***1000 ml*** through ***one*** filter.
   a. Apply moderate and even pressure to the syringe. Filter the water into the graduated cylinder.
   b. Filter 1000 ml through one filter into the graduated cylinder. Since you are using a 500 ml graduated cylinders, you will need to fill it twice. Keep track using rocks or a tally sheet in the field book.
   c. If filtering becomes difficult, check if the filter is ‘vapor-locked’, by detaching the syringe and filter holder. This will release air/pressure.
   d. If filtering 1000 is impossible, stop, record the amount of water that has passed through the filter and place the filter into the Petri dish as described below.
5. Remove filter from the filter holder, using forceps.
6. Fold filter in half (with sample on inside) and place in one side of the Petri dish.
7. Once two filters have been placed in a Petri dish, tape closed with lab tape. Label with *Sampling Station Id, Sample Id, Date, Volume Filtered*.

   Contamination Note: Do not directly touch or let debris/vegetation touch the inside of the sample bottles, sample lids, filters, inside of syringe, inside filter holder, filter holder outlet, and any surface the water sample touches.

8. Record samples collected and sample id numbers on the datasheet.
9. Create chain-of-custody forms.

Place all water and filter samples in the Ziploc bag and seal. Try and keep samples as cool as possible by storing in the shade.

7. Clean-up

1. Allow equipment to dry in the sun, as time permits.
2. Deflate boat or float tube. Make sure it is free of rocks or other particles that could cause a puncture.
3. Pack-up all gear.
4. Check that the field and chain-of-custody forms are completely filled out.
5. Double check that sampling area is clean before leaving.

8. Literature Cited

Irwin, R. 2006. Part B lite (Just the Basics) QA/QC review checklist for aquatic vital signs monitoring protocols for SOPs. National Park Service, Water Resources Division, Fort Collins, CO.

O'Ney, S. E. 2005. Standard Operating Procedure 6: Procedures for collection of regulatory parameters, version 1.0. *In* Regulatory water quality monitoring protocol, version 1.0, Appendix E. National Park Service, Greater Yellowstone Network, Bozeman, MT.

Sickman, J. O. 2007. Sierra Nevada diatom study protocol. Pages 12. Univeristy of California, Riverside, Riverside, CA.

Wilde, F. D., D. B. Radtke, J. Gibs, and R. T. Iwatsubo, editors. 2004 with updates through 2009. Processing of water samples, Version 2.2. Chapter A5 *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations. USGS, Washington, D.C. Available at http://water.usgs.gov/owq/FieldManual/chapter5/html/Ch5_contents.html.

9. Example Water Sampling Field Forms

For field use, print double-sided, full-size forms from the original pdf file (Water_FieldForm_SIEN_20080512). Forms are located on the network drive in lakes protocol folder.

SIEN Lake Water Sampling---Field Data Sheet

Visit Information

Crew: _____

Lake Name: _____
Lake ID: _____
Arrival Date/Time: _____
Depart Date/Time: _____

Photo Description	No.
Lake from outlet	
Outlet	

Weather Description:

Wind: 0 mph <5 5-20 >20 **Air Temp:**
Sky: clear fog overcast partly-cloudy
Precip (current): none heavy fog drizzle rain snow
Precip (24 hrs): none unknown <1" >1" yes-(amt unknown)

Fish Observed ☐

Comments:

Outlet

GPS: E_____N_____NAD83
GPS Id:_____
Date & Time collected:_____

Comments:

Sample Type	Bottle/Filter	Sample IDs
Dissolved constituents	(1) 125 ml HDPE	
	(1) 60 ml HDPE	
Sp. Cond., pH, ANC	(1) 125 ml HDPE	
Particulate N	(2) 47mm Pall A/E filter	
Particulate P	(2) 47mm Pall A/E filter	
Particulate C	(2) 47mm Pall A/E filter	

Flow: Dry No Flow Low Norm Above Norm Flood

Temp: _____ DO:_____
Sp Cond: _____ pH: _____

Meter Calibration: _____
Meter ID: _____

Indicate samples collected

QA/QC Sample Type	Bottle/Filter	Sample ID

Mid-lake

GPS: E_____N_____ (NAD83)
GPS Id:_____

Date & Time collected: _____

Temp/DO Profile Meter ID: _____

Depth (m)	DO (%)	Temp (C)	Sp. Cond (us/cm)

Comments:

Sample Type	Bottle/Filter	Sample ID (s)
Epilimnion	***Depth =*** ***m***	
Dissolved constituents	(1) 125 ml HDPE	
	(1) 60 ml HDPE	
Sp. Cond., pH, ANC	(1) 125 ml HDPE	
Particulate N	(2) 47mm Pall A/E filter	
Particulate P	(2) 47mm Pall A/E filter	
Particulate C	(2) 47mm Pall A/E filter	
Hypolimnion	***Depth =*** ***m***	
Dissolved constituents	(1) 125 ml HDPE	
	(1) 60 ml HDPE	
Sp. Cond., pH, ANC	(1) 125 ml HDPE	
Particulate N	(2) 47mm Pall A/E filter	
Particulate P	(2) 47mm Pall A/E filter	
Particulate C	(2) 47mm Pall A/E filter	

QA/QC Sample Type	Bottle/Filter	Sample ID

Hand Pump Id: _____