Save Auburn Ravine Salmon and Steelhead (SARSAS)

Water Quality Sampling Procedures for Auburn Ravine Citizen Scientists

Water Quality Monitoring Sampling Procedures

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Sampling Procedures

1. **Arrive at the site and unpack the instruments and field gear on the stream bank:**
    - Field Sampling Sheet, Water Quality Sampling Procedures
    - SPARK Science Learning System
    - PASPort Water Quality Sensor or Advanced Water Quality Sensor
        - Conductivity meter
        - pH meter
        - Dissolved Oxygen Probe
        - Thermometer
    - PASPort Turbidity Sensor
    - Sample Containers (Wash Bottle, Waste Container)
    - Deionized water (gallon and 500 ml spray bottle)
    - Metal guard for Dissolved Oxygen Probe
    - pH 7.00 and 10.00 buffers (large and small bottles)
    - Conductivity standard 84.0 us/cm (large and small bottles)
    - KimWipes Tissues
    - Nutrient sample bottles (quarterly)
    - Bacteria whirl pack, Sample Gloves, Sample Cooler (quarterly)

2. **Fill out the information on the top of the Field Sampling Sheet including:**
    - Name
    - Date and Time
    - Weather Information
    - Fill out pack and meter numbers

3. **Complete the following steps to prepare the equipment for calibration and use:**

    - **Turbidity:** Shake the 100 NTU cuvette (vial) vigorously for one minute to stir up particles, then allow the vial to stand undisturbed for 5 minutes to remove air bubbles.
    - **Dissolved Oxygen:** Prepare the dissolved oxygen sensor for calibration following these steps:
        i. Prepare the standard for dissolved oxygen calibration: Spray deionized water into the Dissolved Oxygen Probe Cover to thoroughly moisten the sponge inside the end of the Probe Cover. Refill the spray bottle from the gallon of water as needed. Pour out any excess water from inside the cover, after letting the sponge soak up the water.
        ii. Place the dissolved oxygen sensor into the Probe Cover and sponge for 5 to 10 minutes.

- **Conductivity:** Soak the end of the conductivity electrode in deionized water for 5 minutes in the Wash Bottle.
- **pH:** Hold the electrode vertically, then unscrew and remove the storage bottle from the pH electrode, *being careful not to spill the storage solution*. Push the O-ring and bottle cap up the pH electrode handle (out of the way of the electrode). Soak the pH electrode in deionized water with the conductivity electrode until use. If bubbles are visible in the electrode bulb, gently shake the electrode downward, as with shaking a thermometer.

4. **While waiting for the dissolved oxygen, conductivity, and pH sensors, begin calibrating the Turbidity Sensor.**

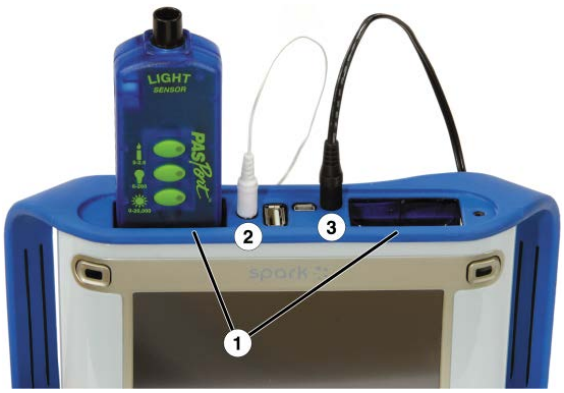

Figure 1: SPARK SLS showing the location of the PASPORT ports (1)

5. **Calibrate the Turbidity Sensor prior to use following these steps:**

   Preparation:

   - Connect the Turbidity Sensor to one of the two PASPORT ports (Figure 1) and turn on the SPARK Science Learning System (SPARK SLS) unit.
   - Fill an empty vial to the brim (~6 ml) with deionized water, tighten the cap, then clean and dry the outside of the vial while holding the vial by the cap. Use this same vial throughout the calibration and measurement process.
   - Gently invert the 100 NTU vial five times. Hold the vial by the cap and wipe the outside of the vial clean using the tissues provided.
   - Put the vial with the deionized water into the sensor Sample Compartment and close the lid.

   Calibration:

   - Press and release the green Calibration Button on the sensor. The LED in the button should turn on.
   - When the LED in the button begins to blink, replace the vial with the 100 NTU Standard vial, align the arrow on the cap with the screw, close the lid, and press and release the Calibration Button.
   - When calibration is complete, the button LED light will turn off. Return to the Home screen and confirm calibration was successful by checking the Turbidity value (it should read ~100 NTU). Repeat the above steps if the value is not close to 100 NTU.
   - If the LED turns red, disconnect the Turbidity Sensor from the SPARK SLS and repeat the steps above.

6. **After calibration, proceed to the sample location in Auburn Ravine *with the vial used during calibration* (empty out the deionized water). Approach the sample location from downstream, so the sample area is not disturbed.**

7. **Collect a water sample from a 1 m^2 sample location in Auburn Ravine, filling the vial with water from the ravine.**

8. **Wipe the vial glass clean and dry with a tissue, holding the vial by the cap to avoid touching the glass with your fingers. Put the sample vial into the Sample Compartment and close the lid.**

9. **Observe the turbidity values on the SPARK SLS home screen. Wait for readings to stabilize (about 5-10 seconds), and then record a turbidity value on the Field Sampling Sheet. Turbidity values will continue to decrease as particles settle out.**

10. **Repeat steps 7-9 until a total of three water samples have been collected and analyzed for turbidity. Collect all three samples from the same 1 m^2 sample area. Record all three values on the Field Sampling Sheet.**

11. **Disconnect the Turbidity Sensor after completing the third measurement and store the turbidity sensor and vials in the storage box. Do not discard the contents of the 100 NTU standard.**

12. **Prepare the Advanced Water Quality Sensor or Water Quality Sensor for measurements, ensuring the procedures in Step 3 have been completed.**

13. **Connect the included probes (pH, DO, Conductivity, Temperature) to the Advanced Water Quality Sensor following the setup in Figure 2, if they are not already connected.**

14. **Select a range for conductivity on the Sensor by pressing and holding the top button on the sensor (select 0 – 1,000 uS/cm, or the glass of water, depending on which Water Quality Sensor interface you have).**

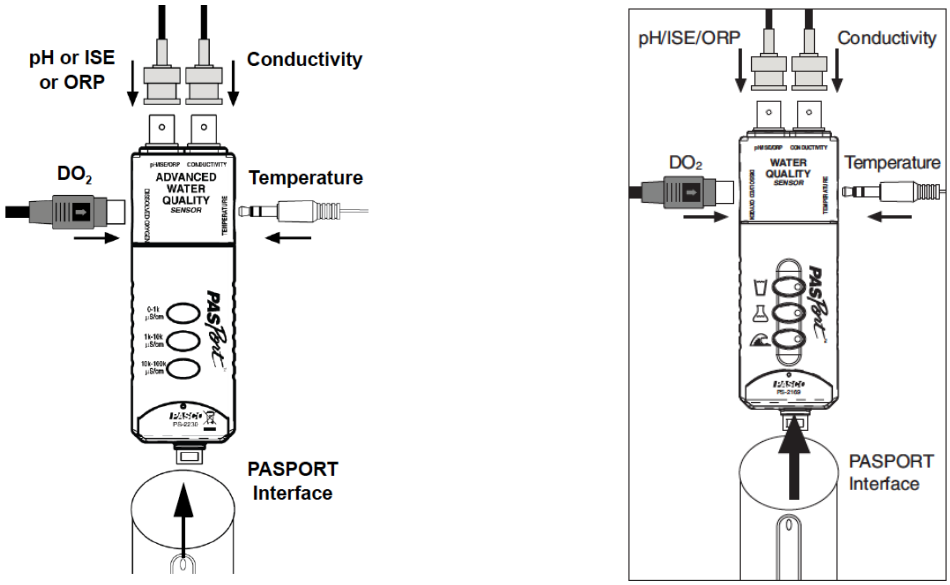

Figure 2: PASPORT Advanced Water Quality Sensor and Water Quality Sensor interfaces and probe connection setup.

15. **Plug the Water Quality Sensor into one of the two PASPORT ports located on the top of the SPARK SLS.**

16. **After connecting the Advanced Water Quality Sensor to the SPARK SLS, real-time monitoring data is displayed on the Home Screen. If the Home Screen is not visible, touch the Home Screen button (below) to return to the Home Screen.**

17. **Calibrate the pH sensor following these steps:**
    - There are four bottles with pH buffers: two large (250 ml, 8 oz) bottles and two small (30 ml, 1 oz) bottles. Use the buffer solutions in the small bottles for the calibration process.
    - On the Home Screen, touch pH, and then touch Show. The screen will show a graph display of pH and Time.
    - Touch Experiment Tools  to open the Experiment Tools screen.
    - Touch Calibrate Sensor to open the Calibrate Sensor screen. Touch the Sensor button and select the Water Quality Sensor. Touch the Measurement button and select pH. Touch the Calibration Type box and ensure 2-point is selected. Touch Next to proceed with the Calibration and open the Calibrate Sensor Enter Values screen.

- Rinse the end of the pH electrode in deionized water and then wipe the electrode dry using a tissue. Place the pH electrode into the small bottle with the pH 7.00 buffer solution. Check to ensure the electrode bulb is submerged in the buffer solution.
- Under Calibration Point 1, click the Standard Value box and Enter the value 7.00, the pH of the buffer solution. Under Calibration Point 1, click Read From Sensor.
- Remove the electrode from the first buffer solution, then rinse the end of the electrode with deionized water, and wipe the electrode dry using a tissue.
- Place the pH electrode into the small bottle with the pH 10.01 buffer solution. Check to make sure the bulb of the electrode is submerged in the buffer solution.
- Under Calibration Point 2, click the Standard Value box and Enter the value 10.01, the pH of the second buffer solution. Under Calibration Point 2, click Read From Sensor.
- Touch OK until the screen of the graph display returns. Touch the Home Screen icon in the top left corner to return to the Home Screen. Select No if prompted to Save the Experiment.
- Rinse the pH electrode and soak in deionized water, put away the pH standards, and proceed to calibrating the conductivity sensor.

18. Calibrate the conductivity sensor following these steps:

- There are two bottles with the 84.0 µS/cm conductivity standards: a large (250 ml, 8 oz) and a small (30 ml, 1 oz) bottle. Use the conductivity standard in the small bottle for the calibration process.
- On the Home Screen, touch Conductivity (10x Probe), and then touch Show. The screen will show a graph display of Conductivity and Time.
- Touch Experiment Tools  to open the Experiment Tools screen.
- Touch Calibrate Sensor to open the Calibrate Sensor screen. Touch the Sensor button and select the Water Quality Sensor. Touch the Measurement button and select Conductivity (10x Probe). Touch the Calibration Type box and ensure 1-point Adjust Slope Only is selected. Touch Next to proceed with the Calibration and open the Calibrate Sensor Enter Values screen.
- Place the conductivity electrode into the small bottle with the conductivity standard.

- On the Calibrate Sensor Enter Values screen touch the Standard Value box and Enter 84.0. Touch OK to leave the keypad. Click Read From Sensor.
- Touch OK until the screen of the graph display returns. Touch the Home Screen icon in the top left corner to return to the Home Screen. Select No if prompted to Save the Experiment.
- Rinse the conductivity sensor and soak in deionized water, put away the conductivity standard, and proceed to calibrating the Dissolved Oxygen sensor.

19. Calibrate the Dissolved Oxygen Sensor following these steps:

- On the Home Screen, touch DO2 Saturation, and then touch Show. The screen will show a graph display of DO2 Saturation (%) and Time.
- Touch Experiment Tools  to open the Experiment Tools screen.
- Touch Calibrate Sensor to open the Calibrate Sensor screen. The screen shows the Sensor, Measurement, and Calibration Type. Touch the Sensor button and select the Water Quality Sensor. Touch the Measurement button and select DO2 Saturation (%). Touch the Calibration Type box and ensure 1-point Adjust Slope Only is selected. Touch Next to proceed with the Calibration and open the Calibrate Sensor Enter Values screen.
- Gently push the Dissolved Oxygen sensor's probe into the Probe Cover, making sure the probe comes into contact with the Sponge located inside the Probe Cover (you should be able to feel the probe in the end of the Cover). Wait about 30 seconds and then touch Read From Sensor.
- Touch OK until the screen of the graph display returns. Touch the Home Screen icon in the top left corner to return to the Home Screen. Select No if prompted to Save the Experiment.
- Remove the Probe Cover. Attach the metal guard to the Dissolved Oxygen Probe to protect the probe during use. The metal guard should screw onto the end of the probe. If it does not easily screw onto the probe, proceed to the next step, and make sure to be careful during sampling to not damage the plastic cover on the end of the probe.

20. Proceed to the sample location in Auburn Ravine and deploy the sensors in the water. ***Note that only the tips, bodies, and cables of the probes can be immersed in***

liquid. The connectors and body of the PASport Sensor and SPARK SLS should be kept dry at all times.

21. **Deploy the probes in the water and ensure the probes are submerged. Observe the temperature and pH values and ensure that the values stabilize before recording data (this may take a minute or two). Record values for each parameter on the Field Sampling Sheet (pH, dissolved oxygen, conductivity, temperature).**
22. **Move the probes to a second location within 1 m^2 of the first sample point, deploy the probes in the water and wait until the pH and temperature values stabilize, and then record a second measurement for each parameter on the Field Sampling Sheet.**
23. **Move the probes to a third location within 1 m^2 of the first two sample points, deploy the probes in the water and wait until the pH and temperature values stabilize, and then record a third measurement for each parameter on the Field Sampling Sheet.**
24. **Remove the probes from the water, and rinse with deionized water before storage. Disconnect the Water Quality Sensor from the SPARK SLS interface.**
25. **Put away all equipment in the proper storage container and ensure the SPARK SLS is turned off. Store the pH electrode in the pH storage solution. Ensure the conductivity electrode is dry, and return it to the storage container. Store the dissolved oxygen probe in the Probe Cover with a moistened sponge (do not allow the probe to dry out).**
26. **Put away all supplies, buffers, and standards. Use the pH and conductivity solutions in the small bottles for a period of 3 months. After 3 months, discard the solutions from the small bottles into the Waste Container. Refill the small bottles with pH and conductivity solutions from the large bottles. Refill the deionized water wash bottle as needed.**
27. **OPTIONAL: Collect three water samples from the sample location in Auburn Ravine for nutrient analysis. Rinse each bottle three times before collecting a sample. Store the samples in the sample cooler for transport. (Refer to the detailed sampling procedure on page 16).**

28. **OPTIONAL: Put on sample gloves and collect a bacteria sample using a whirl-pak. Put the sample upright in the cooler for transport. (Refer to the detailed sampling procedure on page 15).**
29. **Record any other observations or comments on the Field Sampling Sheet. Ensure calibration information is recorded on the data sheet.**
30. **Based on prior arrangements with Bob Johnson:**
    - **Leave site and return home, OR**
    - **Return equipment, samples, and field sheet to Bob Johnson in Lincoln, CA.**
31. **If returning home after sampling, provide a copy of the Field Sampling Sheet to Bob Johnson within a few days of sampling. Either scan or take a photo of the field sheet and email it to Bob Johnson at johnsonbb1524@gmail.com. Bob will complete the Rec'd portion at the top of the Sampling Sheet after receiving the sheet.**

SPARK SLS Management

- **Always charge the SPARK SLS prior to use in the field** 
- **Press the Power Button on the bottom of the SPARK SLS to turn on the unit**
- **When charging the status light indicates battery status** 
  - **Constant green: fully charged**
  - **Flashing green: battery sleep mode**
  - **Constant red: low battery**
  - **Flashing red: charging**
- **Battery Status is indicated by the icons full (green), low (yellow), and nearly empty (red)** 
- **Touch the Home button to return to the Home Screen** 
- **Touch the Date/Time/Battery icon to open the Device Tools screen** 

  - **Adjust screen brightness**
    - **Touch Display Settings to open the Display Settings screen and touch the Screen Brightness arrows to adjust the screen brightness. Touch OK and then Done.**
  - **Set Date/Time**
    - **Touch Set Date & Time to open the Set Date and Time screen. After setting the Date and time Touch OK and then Done.**

- **Sleep Mode: If the SPARK SLS has received no input for several minutes, it may go into Sleep Mode**
  - **Touch the Screen to reactivate the SPARK if it is in Screen Sleep Mode**
  - **Press and Hold the Power Button if the above step does not reactivate the SPARK SLS**
- **Press and Hold the Power Button to turn off the SPARK SLS unit**

Water Quality Parameter Background Information

Water Temperature Background Information

Water temperature is a measure of the concentration of heat energy in a stream (Poole and Berman, 2001). Water temperature is an important factor for aquatic organisms, as temperature can control the rate of metabolic and reproductive processes, nutrient cycling, and influence the life history of aquatic organisms. Temperature can also have an effect on the Dissolved Oxygen concentration in water, with colder water capable of holding more dissolved oxygen than warm water.

Water Temperature and Salmonids:

- Migration: Studies suggest that adult spring-run Chinook salmon tolerate water temperatures ranging from 38°F–56°F (3.3°C–13.3°C), and adult fall-run Chinook salmon tolerate water temperatures ranging from 51°F–67°F (10.6°C–19.4°C) (Bell 1991). The upstream migration of adult Chinook salmon from the Delta to the San Joaquin River is reported to have been prevented by water temperatures above 70°F (21.1°C). Upstream migration of adult Chinook salmon was reported to resume when temperature cooled to 65°F (18.3°C) (Boles et al. 1988).
- Holding: Records indicate that spring-run Chinook salmon in the Sacramento-San Joaquin River system spend the summer holding in large pools where temperatures are usually below 69.8°F–77°F (21°C–25°C) (Moyle et al. 1995). In the Sacramento River, adult immigrants held at hatcheries at water temperatures greater than 60°F (15.6°C) and less than 38°F (3.3°C) exhibited poor survival (Boles et al. 1988). Pools in holding areas need to be sufficiently deep, cool, and oxygenated to allow over-summer survival of Chinook salmon (DWR et al. 2000).
- Spawning: Spawning occurs in a range of water temperatures extending from 39.9°F–64.4°F (4.4°C–18°C), although water temperatures greater than 55°F (12.8°C) increased mortality to females prior to spawning (Raleigh et al. 1986). Fall-run Chinook salmon reportedly spawned at water temperatures ranging from 41°F–56.1°F (5.0°–13.4°C) (Raleigh et al. 1986). Mature females subjected to prolonged exposure to water temperatures above 60°F (15.6°C) or below 38°F (3.3°C) results in poor adult survival and egg viability (U.S.Fish and Wildlife Service 1995). Chinook salmon spawned in water temperatures ranging from 42.1°F–57°F (5.6°C–13.9°C) (Reiser and Bjornn 1979) (Allen et al. 1986).
- Egg Incubation: Studies suggest that before deposition, eggs begin to experience mortality above 14°C (McCulough, 1999). Studies by Bell (1991) suggest that optimal egg incubation temperatures are between 5 and 14.4°C. Additional studies suggest that the upper range for egg incubation success is 16°C (Alderdice and Velsen, 1978) and that cooler temperatures result in greater survival success. Maximum embryo survival occurs at water temperatures ranging from 41°F–55.4°F (5°C–13°C) (Moyle 2002b). Water temperatures ranging from 35°F–58°F (1.7°C–14.4°C) are recommended for successful egg incubation (Yoshiyama et al. 2001).

- Juvenile Rearing: Rearing juvenile Chinook salmon can tolerate water temperatures ranging from 32°F–75.2°F (0°C–24°C) (Raleigh et al. 1986). At Nimbus Hatchery on the American River, juvenile Chinook salmon achieve optimum growth under lab conditions at maximum ration at water temperatures ranging from 54°F–60°F (12.2°C–15.6°C) (Rich 1987b). In a lab study, juvenile American River Fall-run Chinook salmon achieved maximum growth and food conversion efficiency at a water temperature of 66°F (19°C). The experiments were conducted at oxygen levels greater than 90% of saturation levels and pathogen free waters (Cech et al. 1999). In the Sacramento River, the upper lethal temperature for long-term exposure to increased water temperatures is 78.5°F (25.8°C), although higher temperature can be tolerated for brief periods of time (Boles et al. 1988).

Dissolved Oxygen Background Information

Dissolved oxygen (DO) is molecular oxygen (oxygen gas) dissolved in water. Although all water molecules contain oxygen atoms, this oxygen is chemically part of the water molecule and not available as oxygen the aquatic organisms need for "breathing". Rapidly moving water tends to contain a lot of dissolved oxygen, while stagnant water contains little. DO in water is obtained by atmospheric re-aeration and photosynthetic activities of aquatic plants. DO is then used by the organisms living in the creek, such as macroinvertebrates and fish, for their metabolic activities. Altitude affects dissolved oxygen because water holds less oxygen at higher altitudes.

Dissolved Oxygen and Salmonids:

- Dissolved oxygen (DO) conditions must remain above 5 mg/L for successful spawning to occur (Bjorn and Reiser, 1991) and DO conditions below 4 mg/L delayed fry emergence from eggs (Geist et al., 2006). Adult Chinook migration ceases at DO concentrations below 4.5 mg/L (Hallock et al., 1970).
- Survival from embryo to fry is highest at 10.5 mg/l DO and lowest at 3.5 mg/l for all water temperatures tested (Raleigh et al. 1986)
- Minimum dissolved oxygen concentration required is reported as 8 mg/l. Chinook salmon juveniles can survive short term exposure to 3 mg/l DO at temperatures 41°F (≤5°C). Reported optimal levels of dissolved oxygen are greater than 9 mg/l at water temperatures less than 50°F (10°C) and 13 mg/l at water temperatures greater than 50°F (10°C) (Raleigh et al. 1986).
- Egg incubation is reported as optimal when water is saturated with dissolved oxygen. Dissolved oxygen concentrations of less than 1.6 mg/l are lethal (Allen et al. 1986).

pH Background Information

The pH value is very important for various aquatic organisms and many have adapted to living in water with a specific pH range. Changes in pH can greatly affect these organisms and can be lethal, which is especially true for certain aquatic macroinvertebrates and fish fry and eggs. pH is a measure of the acidity or basicity of a solution or rather the concentration of hydrogen ions (H^+) or hydroxide ions (OH^-). pH is measured on a logarithmic scale and ranges from 0 to 14.

Therefore a drop in 1.0 pH unit is equivalent to a 10-fold increase in acidity. Pure water is considered to be neutral when there is an equal amount of acidic and alkaline molecules and will have a reading of 7.0 at 25^{o}C. Solutions with a pH value less than 7.0 are said to be acidic and values above 7.0 are said to be basic or alkaline. The pH of a body of water is affected by several factors. One of the most important factors is the bedrock and soil composition that the water is exposed to. Some rock types such as limestone can, to an extent, neutralize acid, while others such as granite have virtually no effect on pH. Another factor that influences pH is the amount of plant growth and organic material within the stream. When this material decomposes carbon dioxide is released. The carbon dioxide combines with water to form carbonic acid, which is also produced when carbon dioxide dissolves into the water from the air. Although this is a weak acid, large amounts of it will lower the pH. There is also diurnal variation in pH values throughout the day.

pH and Salmonids:

- The largest variety of aquatic organisms prefer a pH range of 6.5-8.5, with the optimal range for salmonids of 6.8-8.0 (Raleigh et al. 1986).
- Lab and field studies found that pH values greater than 9.4 result in the death of rainbow trout, particularly at temperatures between 19-22°C, while values of 9.0 or greater caused significant stress responses (Wagner et al. 1997).
- Juvenile rainbow trout mortality increased at pH levels of 5.5 and lower, with no eggs surviving exposure to pH levels less than 4.5 (Weiner et al. 1986).
- Rainbow trout yolk-sac larvae approached 100% mortality after 5 days of exposure to pH 4.6 and 5.4, but exposure to pH 6.0 resulted in less than 3% mortality.

Conductivity Background Information

Conductivity is the measure of the ability of water to pass an electrical current and is highly dependent on the amount of ions such as salt (NaCl, sodium chloride) dissolved in the water. Specific conductivity is the term used for conductivity values that have been adjusted to 25^{o}C. Conductivity is affected by temperature: the warmer the water, the higher the conductivity. Pure water, such as distilled water, will have very low specific conductance whereas salt water will have a high reading.

The geology and rock composition of an area helps determine the chemistry of a watershed and the amount and types of available ions. Soil and rocks release ions into the waters that flow through or over them. Streams that run through areas with granitic bedrock tend to have low conductivity because granite is composed of more inert materials that do not ionize when washed into water. Conversely, streams that run through areas with clay or carbonate rocks, such as limestone, tend to have higher conductivity. Periods of high flow such as during storms, may cause periods of high conductivity due to the flushing of ions from uplands into streams. The Central Valley Regional Water Quality Control Board has established beneficial use criteria for conductivity in Central Valley waterbodies where salmon and steelhead are present:

- Sacramento River: Shall not exceed 235 uS/cm at Knights Landing above Colusa Basin Drain; or 340 uS/cm at I Street Bridge.
- Feather River: Shall not exceed 150 uS/cm in well-mixed waters of the Feather River

Turbidity Background Information

Turbidity is a measure of water clarity. Water clarity is affected by the presence of suspended and dissolved matter, such as clay, silt, finely divided organic matter, plankton, microscopic organisms, organic acids and dyes. Algae, suspended sediment, organic matter and some pollutants can cloud the water making it appear cloudy or muddy. Suspended particles diffuse sunlight and absorb heat, which can increase water temperature and reduce light availability for submerged aquatic vegetation and benthic (bottom-dwelling) macroinvertebrates. If the turbidity is caused by sediment, it can be an indicator of erosion, either natural or man-made. High sediment loads can clog the gills of fish. Once the sediment settles, it can foul gravel beds and smother fish eggs and benthic macroinvertebrates. The sediment can also carry pathogens, pollutants and nutrients. We often see high turbidity during storms.

Turbidity and Salmonids:

- Juvenile salmon are capable of tolerating turbidities as high as 1,000 ppm. The migration of adult salmon may be inhibited at turbidities greater than 4,000 ppm. Given a choice, Chinook salmon will avoid turbid waters (Allen et al. 1986).
- The Idaho Division of Environmental Quality adopted an instantaneous turbidity criterion of 50 NTU for the protection of coldwater species including salmonids based on data that suggests displacement of salmonids occurs at this turbidity (Lloyd et al. 1987). A 10-day criterion of 25 NTU was established based on literature that shows salmonid feeding and growth are affected by prolonged exposure to turbidities over 25 NTU (Sigler et al. 1984).

Bacteria Sampling Procedure

Water samples will be collected for bacteria on a quarterly basis with sterile whirl packs, using the following procedure:

1. Choose a location where the water is running, but not in a strong rifle.
2. Put on the sampling gloves.
3. Remove the whirl-pak from the ziplock bag. Ensure that the whirl-pak is properly labeled with the site # then tear off the top of the whirl-pak along the dotted line. The entire top piece of plastic on the whirl-pak should be removed.
4. Grasp the white tabs at both sides and pull to open. Do not touch the inside of the whirl-pak with your fingers.
5. Scoop water into the whirl pack and ensure that the sample reaches the 4 oz fill line.
6. Holding both sides of the yellow tab, pull to straighten and form a seal.
7. Quickly spin the pack (away from your face).
8. Bend ends of the yellow tab and twist to complete the seal.

9. Invert the sample and give it a slight squeeze to ensure that it does not leak. If the sample does leak, reseal and try again.
10. Place the sample in the cooler.

Bacteria Background Information

Surface waters will almost always contain some degree of bacterial contamination. This is due to exposure to animals, humans, aquatic life, etc. Bacteria are microscopic single-celled organisms that function as decomposers in a waterway, breaking down plant and animal remains. Bacteria live on the surface of water, in the water column, in sediment, on detritus, and in and on the bodies of plants and animals. Bacteria serve as food for other organisms; they also are involved in many chemical reactions within the water. While bacteria normally inhabit waterways as an integral part of the food web, human activities may introduce pathogenic bacteria into the system. The greatest public health concern is the introduction of fecal waste from humans or warm-blooded animals. Sources of fecal bacterial contamination include faulty wastewater treatment plants, livestock, sanitary landfills, failing septic systems, fecal waste from pets and wildlife, stormwater runoff, and sewage spills. Elevated levels of pathogenic bacteria can cause health problems, cloudy water, unpleasant odors, and an increased oxygen demand.

Coliforms are a group of bacteria which are readily found in soil, decaying vegetation, animal feces, and raw surface water. They are commonly used as "indicator organisms" in water microbiological analyses. They are common and generally not harmful.

E.coli or *Escherichia coli* is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of *E.coli* in water is a strong indication of recent sewage or animal contamination. Sewage may contain many types of disease-causing organisms. During rainfalls, snow melts or other types of precipitation, *E.coli* may be washed into waterbodies. *E.coli* O157:H7 is one example of a harmful strain of bacterium that produces a powerful toxin and can cause severe illness. Many other *E.coli* strains are harmless and live in the intestines of healthy humans and animals.

Nutrient Sampling Procedure

Nutrient samples will be collected in three 125 ml plastic sampling jars, and will be brought to Bob Johnson for storage and then the Sierra Streams Institute lab for same-day processing. The concentration of nitrates and orthophosphates are determined using a colorimeter at Sierra Streams Institutes lab.

1. Ensure that each nutrient bottle is properly labeled with your site name.
2. Stand downstream of your sampling location and pre-contaminate each nutrient bottle by rinsing it three times.
3. Fill each nutrient bottle, cap, and place in cooler.
4. Return the samples to Bob Johnson immediately after collection. Store in a refrigerator until sample processing.

Nutrient Background Information

Nutrients, such as nitrogen and phosphorus, are essential for plant and animal growth and nourishment, but an overabundance of certain nutrients in water can cause a number of adverse

ecological and health effects. Excess nitrogen and phosphorus can cause the overstimulation of growth of aquatic plants and algae. Excessive growth of these organisms can use up dissolved oxygen as they decompose and block light to deeper waters. Lake and reservoir eutrophication can also occur, which produces unsightly algae scums on the water surface and can cause fish kills due to oxygen depletion.

Nitrogen is abundant naturally in the environment but can be introduced through sewage and fertilizers. Phosphorus is a common constituent of agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. In fresh water ecosystems, phosphorus is often the limiting nutrient so excess phosphorus inputs can have detrimental effects.