Grassroots Ecology Water Quality Monitoring Protocols

Staff Protocols

Equipment Maintenance

- YSI - manual
    - Calibration
        - Calibrate every month before each use
        - Fill out the calibration form
        - Check YSI battery levels - replace batteries if needed and ensure backup batteries and a screw driver are in the monitoring supplies.
        - Steps
            - DO
                - Place a small amount of water in the calibration/storage cup and place it over the sensors. When screwing the calibration cup onto the sensor bulkhead, only engage one or two threads. Do not screw the calibration cup completely onto the sensor bulkhead. The goal is to have air exchange between inside and outside the calibration cup.
                - Press the “Calibration” button and select “DO”, “%”.
                - Wait approximately 5 to 15 minutes for the storage container to become completely saturated and to allow the sensor to stabilize.
                - After accepting the calibration, navigate to the GLP menu and record the DO sensor’s value (sensor current in uA). The acceptable sensor current when calibration is performed at 25°C, in a 100% saturated air environment at 760 mmHg is: Average 6.15 uA (min. 4.31 uA, max. 8.00 uA).
                    - If you receive a warning message stating that the calibration is questionable, do not continue with the calibration. Instead, select ‘No’ and investigate what is causing the questionable results. Typical causes of a calibration error message include: a bad membrane or a sensor that needs reconditioned.

        - To change the electrolyte solution, remove the sensor guard or cal cup to access the sensor tip. Unscrew and remove any old membrane cap by holding the sensor when unscrewing the membrane cap. Discard the used membrane cap. Thoroughly rinse the sensor tip with distilled or DI water. Fill a new membrane cap with the appropriate electrolyte solution that has been prepared according to the directions on the bottle. Be very careful not to touch the membrane surface during this process. Lightly tap the side of the membrane cap to release air bubbles that may be trapped. Thread the membrane cap onto the sensor. It is normal for a small amount of electrolyte to overflow.
- If significant deposits are visible on the membrane, replace the membrane. If excessive deposits are visible on the sensor and readings are jumpy, sand it down using the sand paper provided in the YSI Maintenance Kit. Wet 400 grit wet/dry sand paper with a small amount of clean water then gently wrap it around the sensor anode and twist it a few times to lightly sand the anode (the goal is to sand off any build-up without scratching or removing layers of the anode itself). Usually, 3 to 4 twists of the sanding disk are sufficient to remove deposits. However, in extreme cases, more sanding may be required to remove all of the deposits. After completing the sanding procedure, repeatedly rinse the electrode with clean water and wipe with lens cleaning tissue to remove any grit left by the sanding disk. Thoroughly rinse the entire tip of the sensor with distilled or deionized water and install a new membrane.
- Conductivity
    - Always use a new conductivity calibration solution when calibrating the conductivity sensor. The shelf life of conductivity solution is one month after being opened. This is due to potential changes in the value of the solution caused by evaporation which can occur after opening the bottle.
    - Pre-rinse the clear storage cup and sensors with a small amount of calibration standard and discard.
    - Fill the cup with calibration solution until it covers the top vent hole of the conductivity sensor.

- After placing the sensor into the solution, gently move the sensor up and down to remove any air bubbles that may be trapped in the conductivity sensor.
- Press the “Calibration” button, select “Specific Conductance” and wait for numbers to stabilize. Make sure the value is 1.0 mS before selecting “Accept Calibration”.
    - If you receive a warning message stating that the calibration is questionable, do not continue with the calibration. Instead, select ‘No’ and investigate what is causing the questionable results.
    - Typical causes for this error message include: incorrect entries (entering 1000 uS/cm instead of 1.0 mS/cm), not using enough solution to cover the vent holes, air bubbles trapped in the sensor, calibrating in conductivity instead of specific conductance, dirty conductivity electrodes, and/or bad calibration solution.
    - Cleaning the sensor: dip the small cleaning brush included in the Maintenance Kit in clean water and insert it into each hole 10-12 times. In the event that deposits have formed on the electrodes, it may be necessary to use a mild detergent (laboratory grade soap or bathroom foaming tile cleaner) with the brush. Rinse thoroughly with clean water, then check the response and accuracy of the conductivity sensor with calibration solution.
- After accepting a good calibration, navigate to the GLP file and check the conductivity cell constant for the calibration. For highest accuracy, the cell constant should be 5.0 +/- 0.5. However, the acceptable range is 5 +/- 1.0. A cell constant outside of this range indicates that a questionable calibration was accepted.

- pH
    - Remove the nitrate sensor by twisting it counterclockwise and plug the port. Use calibration solutions 4, 7 and 10 (3 point calibration).
    - Pre-rinse the cup and sensors with a small amount of the 1st calibration standard and discard.
    - Fill the cup with calibration solution until it covers the sensor.

- Press the “Calibration” button, select “pH” and make sure the mV value is within the acceptable ranges for each calibration point:
    - pH 7 mV value = +/- 50 mV
    - pH 4 mV value = +165 to +180 from 7 buffer mV value
    - pH 10 mV value = -165 to -180 from 7 buffer mV value
- Wait for the pH to stabilize in each buffer and then press enter to accept each calibration point.
- Rinse the sensor and cup with a small amount of the next buffer between calibration points.
- After pressing enter to accept your last calibration point, press “Cal” to complete the calibration.
    - If you receive a warning message stating that the calibration is questionable, do not continue with the calibration. Instead, select ‘No’ and investigate what is causing the questionable results. Typical causes for this error message include: a dirty sensor or bad buffer solution.
    - Cleaning is required whenever deposits or contaminants appear on the glass surface or when the sensor’s response slows. Moisten a KimWipe to remove all foreign material from the glass bulb.
    - If good pH response is not restored, soak the sensor for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid. Gently clean the glass bulb by rubbing a KimWipe soaked in the cleaning solution.
    - If good pH response is still not restored, soak the sensor for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). Rinse the sensor in clean water, wipe with a KimWipe moistened with clean water (not DI water), and then re-rinse with clean water. To be certain that all traces of the acid are removed from the sensor crevices, soak the sensor in clean tap water for about an hour with occasional stirring.
    - If the pH sensor is still not calibrating after performing this cleaning, replace the sensor.

    - After accepting a good calibration, navigate to the GLP file and check the pH Slope and Slope % of ideal. A good slope should be between 55 and 60 mVs while the ideal is 59 mV. If the slope drops below 53, the sensor should be reconditioned and recalibrated.
    - Remove the plug and replace it with the nitrate sensor
- Nitrate
    - Rinse the sensors and cal cup with a small amount of nitrate solution (1 mg/L for the first point and 100 mg/L for the second point). Fill the cup so that the nitrate sensor tip, the temperature sensor and the conductivity sensor are submerged in solution. The salinity reading from the conductivity sensor is used in the algorithm for the nitrate measurement.
    - After entering the calibration screen, change the calibration value if necessary.
    - Record the NO3 millivolts for each calibration point. The acceptable mV outputs for each calibration solution are: NO3 1 mg/L = 200 mV +/- 20 mV (new sensor only), NO3 100 mg/L = 90 to 130 mV < 1 mg/L mV value
    - Wait for the nitrate and temperature readings to stabilize in each calibration solution and then press enter to accept each calibration point.
    - Rinse the sensor and cal cup between calibration points with a small amount of the next buffer.
    - After pressing enter to accept your last calibration point, press cal to complete the calibration. Otherwise you will continue calibrating up to 3 calibration points.
        - If you receive a warning message stating that the calibration is questionable, do not continue with the calibration. Instead, select ‘No’ and investigate what is causing the questionable results.
        - Typical causes for this error message include: a dirty sensor or bad buffer solution. Ensure the nitrate solutions are not expired.
        - The membranes may become coated with a deposit or scoured with fine scratches which may cause a slow or reduced response (low slope) or unstable readings. Deposits may be removed with a fine jet of deionized water or rinsing in alcohol

followed by soaking in 100 mg/L nitrate calibration standard for several hours or overnight.

- Sensor and standard replacement
  - Conductivity
    - Replace after 1 month of being opened.
  - pH
    - Working life is 12-24 months.
    - Clean and recondition the sensor if a slow response in the field has been reported or if it takes more than 90 seconds to stabilize in pH buffer.
    - Replace after after 6 months of being opened.
  - DO
    - The electrolyte solution should be changed once every 2-8 weeks.
  - Nitrate
    - Working life is 3-6 months.
- Post calibration - after equipment is returned to the office
  - Cleaning
    - Rinse all sensors with tap water to remove any debris or salts that might have accumulated throughout the day.
    - Can use soap and water and a non-abrasive towel to clean off hard to remove gunk - be careful with the pH bulb!
    - Sampling tube can be filled with soapy water and allowed to soak to loosen up material possibly stuck inside.
  - Do a post calibration as soon as possible to ensure there was no drift in measurements
    - Following the same methods as for the calibration procedure, place the probe in each of the different calibration standards. Compare the readings on the display to the value of the solution. If the readings have drifted more than the accuracy specification of the sensor, fill out the Post-monitoring drift check form.
    - Replace the protective cup (with holes) with the clear solid storage one. Fill it with a few mls of tap water (only up to about ¼ inch so the probes are not touching the water) to prevent the sensors from drying out and place grey sleeve over the cup.

- Turbidimeter
  - Calibration
    - Calibrate once every 3 months (January, April, July, October).
    - Check Turbidimeter battery level - replace batteries if needed and ensure backup batteries are in the monitoring supplies.

- Steps
    - Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. **This does not apply to the <0.1 NTU Standard.**
    - Shake the standard vigorously for 2-3 minutes to resuspend any particles.
    - Allow the standard to stand undisturbed for 5 minutes.
    - Insert the <0.1 NTU Standard into the cell compartment by aligning the orientation mark (white diamond) on the cell with the mark on the front of the cell compartment and close the lid. Press I/O to turn on the Turbidimeter.
    - Press “CAL”. The CAL and S0 icons will appear (the 0 will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.
    - Press “READ”. The instrument will count from 60 to 0. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.
    - The display will show the S1 (with the 1 flashing) and 20 NTU. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, insert the 20 NTU standard into the cell compartment by aligning the orientation mark and close the lid.
    - Press: “READ”. The instrument will count from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.
    - The display will show the S2 (with the 2 flashing) and 100 NTU. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, insert the 100 NTU standard into the cell compartment by aligning the orientation mark and close the lid.
    - Press: “READ”. The instrument will count from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.
    - The display will show the S3 (with the 3 flashing) and 800 NTU. If the value is incorrect, edit the value by pressing the → key until

the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, insert the 800 NTU standard into the cell compartment by aligning the orientation mark and close the lid.

- Press: “READ”. The instrument will count from 60 to 0, measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.
- Press: “CAL” to accept the calibration. The instrument will return to measurement mode automatically.
    - Error messages, causes and corrective action:

Message*	Probable Cause	Corrective Action
E1	Dilution water is ≥ 0.5 NTU.	Start calibration over with better quality dilution water or use a membrane filter to filter the water before use.
E2	Two standards have the same value or their difference is less than 60 NTU. Not all standards were read during the calibration. Standard 1 is too low (<10 NTU).	Recheck preparation of standards and repeat calibration.
E3	Low light error.	Re-read measurement. Check lamp** Check for obstructed light path. Dilution may be necessary.
E4	EEPROM malfunction.	Check sum failed. Press **I/O**. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate.
E5	A/D overrange.	Check for obstructed light path. Call Hach Service.
E6	A/D underrange.	Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service.
E7	Light Leak.	Close lid before pressing **READ** key.
E8	Bad lamp circuit.	Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service.

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

Table 1. Solutions to potential error messages

- Standard replacement
    - Replace after 1 year.

- iPad
    - Charge iPad while calibrating equipment if battery level is low (<30%)
- Complete the equipment check-out/return form with volunteers

Volunteer Protocols

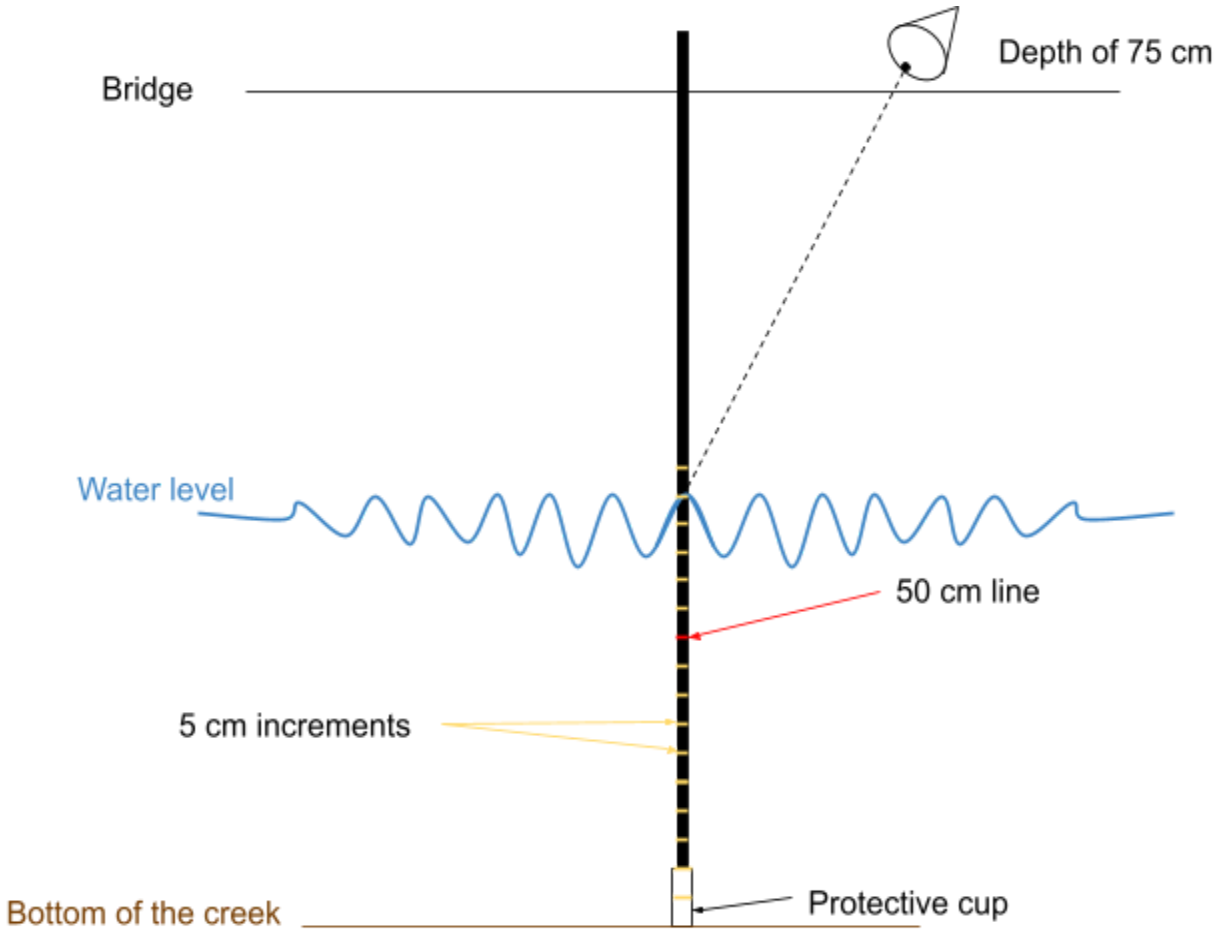
Monitoring Overview

- Monitoring of San Francisquito Creek, Matadero Creek, Barron Creek and Adobe Creek (and Stevens Creek?) is done every 2nd Saturday of each month. Three volunteers are responsible for picking up the equipment from the Grassroots Ecology office, filling out the equipment check-out form, going to all of the different sampling sites on the same day (see locations below), returning the equipment at the Grassroots Ecology office and filling out the equipment return form.
- Each volunteer will have a different task
    - Note taker
        1. Use the iPad to record all habitat observations, take a picture of the sampling location (see picture locations below) and transcribe the water quality parameters the YSI user and turbidity sampler will call out.
        2. Verify that the measurements are within the ranges specified in the in-field fact sheet. If they are not, alert GrE staff when returning the equipment.
        3. If the duplicate measurements are not within a reasonable range (Table 2), have the YSI user or turbidity sampler take a 3rd round of measurements.

Parameters	Duplicate Measurements
Temperature	Within 10% of previous reading
Specific conductivity	Within 10% of previous reading
Dissolved Oxygen (%)	Within 10% of previous reading
DO (mg/L)	Within 10% of previous reading
pH	Within 0.2 of previous reading
Nitrates	Within 10% of previous reading
Turbidity	Within 10% of previous reading

Table 2. Acceptance criteria of measurements

- YSI user - The YSI will be used to measure the water temperature, dissolved oxygen, conductivity, pH, nitrate and water depth
    1. Replace the YSI probe sampling cup with the protective one (it has holes).
    2. Place it into the center of the creek or as close as possible to ensure the water is deep enough and if possible flowing. Hold the probe in the water to a depth approximately ½ of the total depth, make sure to raise and lower the probe slightly to get water movement over the DO membrane, and wait until numbers stabilize.
    3. Tell the note taker the values of each parameter (water temperature, dissolved oxygen, conductivity, pH and nitrate).
    4. Pull the YSI probe out of the water and place it back in. Repeat step 2 and 3 to take a 2nd measurement.
    5. Measure the water depth using the ruler if sampling by the creek or using the taped cable if sampling from the bridge (see diagram below).
        - Using the taped cable - make sure the bottom of the protective cup is touching the bottom of the creek and the cable is taut. Look at where the water level is on the cable and count the number of tape lines to determine the water depth (lines are at 5 cm increments).



- Turbidity sampler
    1. Use the sampling cup attached to a bungee cord to collect a water sample from the creek. Place it into the center of the creek or as close as possible to ensure the water is deep enough and if possible flowing.
    2. Fill, shake and rinse the vial from the turbidimeter with creek water 3 times.
    3. Fill up the vial completely on the 4th filling.
    4. Clean the outside of the vial with kimwipes to make sure no water drops or fingerprints remain.
    5. Place the vial with the white diamond side facing the plastic notch in the turbidimeter.
    6. Turn the turbidimeter on and wait for the screen to show blank values. Make sure to close the lid before pressing the “Read” button.
    7. Read the values for the note taker.
    8. Empty the sampling cup and repeat step 1-7 to take a 2nd measurement.