DEPARTMENT OF ECOLOGY
State of Washington

Standard Operating Procedure EAP108, Version 2.0

Collecting In Situ Water Quality Data

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Purpose of this document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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Standard Operating Procedures for Collecting In Situ Water Quality Data

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Date – 5/3/2022

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
1/25/22	2.0	Complete recertificaion	All	Brian Engeness

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for measuring in situ water quality in rivers and streams for the Watershed Health Monitoring program (WHM) or related studies during a Data Collection Event (DCE).

1.2 This SOP includes procedures for sites sampled with the Narrow and Wide Protocols. See SOP EAP106 (Merritt, 2021), which describes the site verification and layout procedures for the WHM Narrow Protocol and SOP EAP105 (Hartman, 2020) which describes site layout for the Wide Protocol. It is also used by the Ambient Biological Monitoring Program.

2.0 Applicability

2.1 The methods were derived, in part, from Status and Trends Monitoring for Watershed Health and Salmon Recovery. Draft Field Data Collection Protocol: Narrow Streams (Merritt and Hartman, 2013) and Collection, Processing, and Analysis of Stream Samples (Ward, 2012).

2.2 This SOP is used in combination with other SOPs to complete a DCE for the WHM program. This method explains how to measure in situ water quality with a multi-parameter probe and includes: temperature, specific conductivity, pH, dissolved oxygen (DO) and oxygen percent saturation (PSAT). Follow the procedures in this SOP at the start of the day before the site verification and layout procedures have been completed (Merritt, 2020, and Hartman, 2020). Repeat the procedures at the end of the work day prior to leaving the site.

3.0 Definitions

3.1 DCE: The Data Collection Event is the sampling event for the given protocol. Data for a DCE are indexed using a code which includes the site ID followed by the year, month, day, and the time (military) for the start time of the sampling event. For example: WHM07620-000222-DCE-YYYY-MMDD-HH:MM. One DCE should be completed within one working day, lasting 4 - 6 hours, on average.

3.2 DI: Deionized water.

3.3 DO: Dissolved Oxygen. The concentration of dissolved oxygen in a water sample. Reported in mg/L.

3.4 EAP: Environmental Assessment Program

3.5 Ecology: The Washington State Department of Ecology

3.6 Index station: The distinct point location mapped by the site coordinates obtained from the Washington Master Sample 2020 (Larson, in prog.) list. The index station is called "X" and is generally located at major transect F; however the point may occur at any elevation in the stream between transects A and K.

3.7 LDO: Luminescent dissolved oxygen; dissolved oxygen values are measured by pulses of LED light.

3.8 Lotic: Flowing water systems such as streams and rivers.

3.9 Narrow Protocol: The set of Watershed Health Monitoring SOPs that describe data collection at wadeable sites with an average bankfull width of less than 25 m at the index station.

3.10 pH: a measure of hydrogen ion concentration; a measure of the acidity or alkalinity of a solution. Aqueous solutions at 25°C with a pH less than seven are acidic, while those with a pH greater than seven are basic or alkaline.

3.11 PSAT (% sat): Percent saturation of oxygen is calculated as the percentage of dissolved oxygen relative to that concentration which occurs when completely saturated at the ambient temperature, pressure, and salinity. Temperature has the largest effect (WOW 2004)

3.12 QAMP: Quality Assurance Monitoring Plan. The QAMP for WHM is Cusimano *et al.* (2006). An updated version will be released in 2020.

3.13 Site: A site is defined by the coordinates provided to a sampling crew and the boundaries established by the protocol's site layout method (Hartman, 2020 (SOP EAP105) for the Wide Protocol; Merritt, 2021 (SOP EAP106) for the Narrow Protocol). Typically, a site is centered on the index station and equal in length to 20 times the average of 5 bankfull width measurements. Sites cannot be longer than 2 km nor shorter than 150 m. Narrow Protocol sites are 150 m to 500 m long. Wide Protocol sites are greater than 500 m up to 2 km long. The most downstream end of a site coincides with major transect A; the most upstream end coincides with major transect K.

3.14 Specific Conductivity: Electrical conductivity is a measure of waters ability to conduct electricity and a measure of ionic activity and content. It is the reciprocal of specific resistivity. Specific conductivity is conductivity adjusted to 25˚ C (reported in µS/cm at 25˚ C). This is what most field conductivity meters report.

3.15 Thalweg station: One of one hundred (100) equidistant measurement locations in the thalweg across a site. For example, the thalweg stations at/above each major transect are named as follows:

- A0, A1, A2, A3, A4, A5, A6, A7, A8, A9,
- B0. B1, B2, B3, B4, B5, B6, B7, B8, B9,
- C0, C1, C2, C3, C4, C5, C6, C7, C8, C9,
- …
- J0, J1, J2, J3, J4, J5, J6, J7, J8, J9, and
- K0.

3.16 µS/cm: micro-Siemens per centimeter, the unit that we use for measurement of electric conductance.

3.17 WHM: Watershed Health Monitoring, a status and trends monitoring program within the Environmental Assessment Program at the Washington State Department of Ecology.

3.18 Wide Protocol: The set of WHM SOPs that describes the sample and data collection at sites that are non-wadeable or greater than 25 m average bankful width. Wide Protocol is an abbreviated version of the Narrow Protocol and is typically done by rafts.

4.0 Personnel Qualifications/Responsibilities

4.1 This SOP pertains to all Ecology staff in EAP and any other technicians collecting and entering data for the WHM program.

4.2 All field staff must comply with the requirements of the EA Safety Manual (Ecology, 2019). A full working knowledge of the procedures in Chapter 1 "General Field Work," especially the sections "Working in Rivers and Streams," and "Fall Protection," is expected. Sampling from a boat requires one person onboard to be a qualified boat operator as defined by the EAP Boating Plan in Chapter 3 of the EA Safety Manual. All persons onboard must be familiar with Chapter 3 of the EA Safety Manual, "Boating."

4.3 All field staff must have completed the annual WHM program field training and be familiar with the WHM protocol to be used for the given DCE. All field staff must be familiar with the electronic data recording tablet and web-based field forms that one uses to record and submit data for the WHM program. Contact the WHM Data Coordinator for further information.

4.4 The field crew leaders must be knowledgeable of all aspects of the project's Quality Assurance Monitoring Plan (QAMP) to ensure that credible and useable data are collected. All field staff should be briefed by the field crew leader or project manager on the sampling goals and objectives prior to arriving to the site.

4.5 All field staff must be familiar with the electronic data recording tablet and web-based field forms that one uses to record and submit data for the WHM program.

4.6 Field staff must be annually trained to minimize the spread of invasive species. See SOP EAP070: https://www.ecology.wa.gov/quality.

5.0 Equipment, Reagents, and Supplies

5.1 Field tablet (charged), electronic field forms

5.2 Clip board with blank paper data forms and pencils (contingency)

5.3 HQ40d Calibration Form (Appendix)

5.4 HQ40d Portable Multi-Parameter Meter (Figure 1)

5.5 PHC28101 IntelliCAL pH Ultra Electrode (Figure 2)

5.6 LDO101 IntelliCAL Standard Dissolved Oxygen (DO) Probe (Figure 2)

5.7 CDC401 IntelliCAL Standard Conductivity Probe (Figure 2)

5.8 Hach "Singlet" Single-Use pH Buffers; 4.01, 7.00, 10.01

5.9 Thermo Scientific Orion Pure Water pH Buffer; 7.01

5.10 Hach IntelliCAL™ 2.44M KCl PHC281 filling solution for pH probe

5.11 Pipettes to remove filling solution

5.12 Ricca Chemical Conductivity/TDS Standard; 100 µmho/cm

5.13 De-ionized water (DI) to rinse equipment

5.14 Lab tissues (e.g., Kim-wipes®)

5.15 Hach HQ40d Multi-Parameter User Manual

5.16 4 AA batteries

5.17 500 ml plastic container

5.18 Wading/rafting gear (pre-cleaned of organisms)

5.19 Disinfection solutions, brushes, or other equipment necessary to minimize the spread of invasive species from site to site. See SOP EAP070 for more information.

5.20 Bubbler (aerator for dissolved oxygen quality control check)

5.21 Paper towel

5.22 Plastic bag

5.23 Q-tips

5.24 Small glass vials (for conductivity solution and pH buffers)

5.25 125 ml Nalgene amber plastic container

Figure 1: HQ40d Multi-Parameter Meter

Figure 2: PHC28101 IntelliCAL pH Ultra Electrode, CDC401 IntelliCAL Standard Conductivity Probe, and LDO101 IntelliCAL Standard Dissolved Oxygen Probe.

6.0 Summary of Procedure

6.1 General Considerations for Using Conductivity, DO and pH Probes

6.1.1 Calibrate Conductivity, DO and pH probes at the beginning of the work week and after every two to three days if working a longer scheduled work week (example: eight days on, six days off). Perform calibrations at the Operations Center wet lab instead of in the field. Calibrate in a hotel if you are unable to use the wet lab.

6.1.2 Perform a quality control (QC) check on all three probes the same day before and after a DCE event. If the probes were calibrated on the same day, before a DCE event, the probes do not need a quality control check beforehand. Perform the QC check in a hotel room when traveling so that the solutions used in the process have a consistent temperature.

6.1.3 If a probe fails the quality control check on the morning of a sampling event, recalibrate the probe. If the probe fails the recalibration, collect a water sample in a 1000 ml sterilized plastic container as outlined in SOP EAP095 (Hartman, 2017). Submit the sample to the lab so they are able to accurately take measurements. Be sure to leave no air in the sample bottle.

6.2 Calibrate the pH electrode

6.2.1 Replace the IntelliCAL™ 2.44M KCl PHC281 solution in the probe every two weeks. Invert the pH probe, open the electrolyte filling hole and use a pipette to remove the solution. Fill the chamber with filling solution (Figure 3) so the pH electrode is full. Close the electrolyte filling hole after each use to avoid spillage.

6.2.2 Fill four small glass vials (in calibration/QC kit) with new packets of color coded Hach single use calibration buffers and a packet of the NIST traceable 7.01 buffer solution. Use new packets each time the probe is calibrated. Ensure that the temperatures of the buffers are 15˚ C or higher (but not above 30˚C). Conduct the three-point calibration with pH 4.01, 7.00 and 10.01 calibration buffers.

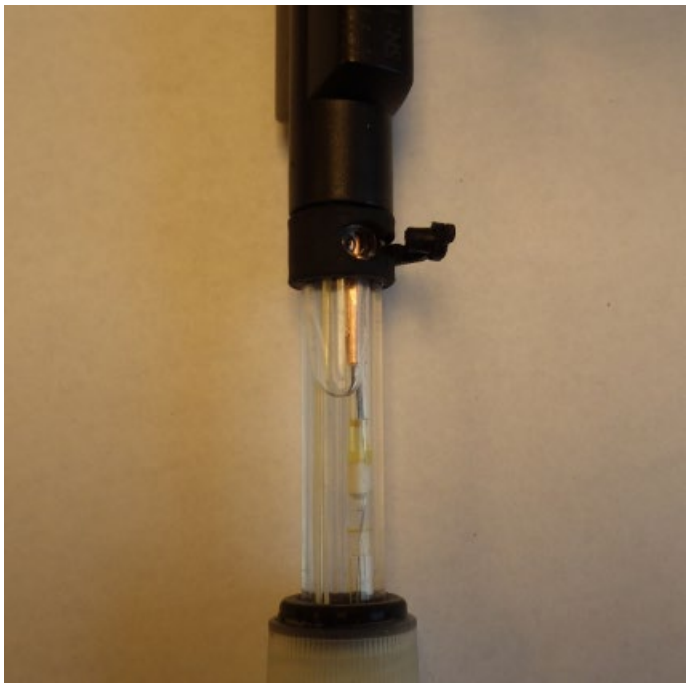

Figure 3: Close-up of electrolyte filling hole on pH probe

6.2.3 Remove the electrode from the soaker bottle by unscrewing the bottle base from the bottle cap (Figure 2). This will ensure that electrolyte is not suctioned out of the probe. Remove the bottle cap from the probe and and put it aside with the bottle base where they will not spill or become contaminated. Lastly, open the electrolyte fill hole and keep open during calibration and QC checks.

6.2.4 Thoroughly rinse the electrode with DI water prior to calibration and in between buffers. Shake off excess water.

6.2.5 Let the pH electrode acclimate in each calibration buffer for at least one minute before taking a reading. Stir the electrode gently during this process and do not rest the electrode on the bottom or sides of the container.

6.2.6 Acclimate the pH probe in the pH 4 buffer solution, press “calibration” and “read”. Place the probe in each subsequent solution as prompted by the Hach. Rinse the probe with DI in between each buffer and shake off excess water. After completing the calibration, select “done”, by pressing the up arrow, and record to the calibration form (slope, offset, r2, etc.) (Appendix A). Use the scroll arrows to view more of the screen. Press “store” to retain the readings.

6.2.7 Place the probe into the NIST 7 QC buffer (in the white packet), measure and record this pH under "QC 7 reading" on the calibration form. Find the expected pH, "QC 7 True", by looking at the table on the right side of the calibration form. Use the probe temperature (right side of screen upon pressing "read") and look up the NIST pH 7 value that corresponds with it. Record this value on the calibration form and compare this to your reading. Recalibrate if the difference is greater than 0.1 pH units.

6.3 Procedure for pH quality control check

6.3.1 Follow the procedure outlined in 6.2.2 and 6.23, rinse the electrode with DI water and connect the pH probe to the Hach.

6.3.2 Place the probe into the vial containing the QC buffer 7.0 solution and gently stir for one minute before pressing "read" on the Hach. Record the results under "reading" in the Daily QC section on the calibration form.

6.3.3 The "true" reading is acquired from the table on the right side of the calibration form. Use the probe temperature (right side of screen upon pressing "read") and look up the NIST pH7 value that corresponds with it.

6.3.4 Compare the "reading" to the "true" value. If the difference is within 0.1 pH units, circle "N" for "recal?" on the calibration form. If the difference is greater than 0.1 pH units, recalibration of the probe is required. Before beginning recalibration, check if the QC buffer 7.0 solution was contaminated. Dump the solution and replace with fresh solution from a new packet. Follow the procedure 6.3.1. If the difference between the expected value and the reading is still greater than 0.1 pH units, then recalibrate the probe.

6.4 Maintenance of the pH probe

6.4.1 Inaccurate and unstable readings can be caused from a clogged pH probe. When a clog occurs, it is necessary to clear the pH reference junction in the tip of the probe using the following procedure:

6.4.2 Attach the probe soaker bottle to the tip of the probe and seal the cap. Open the probe fill hole and pull the probe soaker bottle down with slight pressure to suction at least ½ inch of the filling solution out of the probe.

6.4.3 Refill solution into the fill hole using a pipette.

6.4.4 If clogs continue, follow steps outlined in 6.2.1.

6.4.5 Look for and remove any air bubbles stuck in the filling solution. Wait for all bubbles (by tapping the probe gently with fill hole open) to work their way to the top of the probe column and ensure that the column is full of filling solution.

6.4.6 Before placing the probe into the electrode filling solution bottle rinse the probe with DI water. Screw the bottle into the lid, and then close the electrode fill hole.

6.4.7 Periodically rinse the bottle with DI water and replace the electrolyte filling solution to eliminate contamination of the probe.

6.4.8 If the fill hole on the pH probe is open and submerges in water, follow steps in 6.2.1 to prevent future inaccurate readings.

6.5 **Calibrate the conductivity probe**

6.5.1 Conductivity probes are cleaned and stored dry after each sampling season. Re-hydrate the probe for a minimum of 24 hours in a water bath prior to sampling season. Rinse with DI water and store the probe in water when not using during the field season. For use in the field, place the probe in a moistened paper towel, inside a plastic sealable bag. Rinse and replace the towel often to prevent growth of mold.

6.5.2 Use 100 µS/cm Ricca Chemical Conductivity/TDS buffer to calibrate the conductivity probe. Store the buffer in a small glass vial halfway full. For use outside of the lab, place the vial within a 125 ml amber Nalgene plastic bottle. Store additional buffer in another 125 ml amber Nalgene plastic bottle with no head space.

6.5.3 Remove the probe from the moist towel wrap and use DI water and a cotton swab to gently scrub the contacts inside the tip of the probe. Rinse with DI and shake off excess before placing into the glass vial half full of conductivity solution within the brown bottle. Allow the probe to acclimate in the conductivity solution for a few minutes while gently stirring so that the reading can stabilize.

6.5.4 Connect the probe to the Hach, stir gently for one minute and press the folder button. Select “view probe data”, then “view current calibration” and record the cell constant (“K” on the Hach screen) of the current calibration into the field “initial cell constant” on the calibration form. Exit out of the folder back to the main screen, press “read” and record the conductivity to the calibration form.

6.5.5 Press “calibrate” on the Hach and then “read” to calibrate the probe. Record the cell constant under “Final Cell Constant” and the conductivity under “Cond W/O temp corr.” on the calibration form.

6.5.6 Press “done” and the “store” buttons to retain the calibration. Read the conductivity solution a final time and record this as the “final standard reading”. Compare this reading to the expected reading of 100.0 µS and recalibrate again if the difference is > 10.0 µS.

6.6 Procedure for conductivity probe quality control check

6.6.1 Follow the procedure outlined in 6.5.1 and connect the probe to the Hach. Gently stir the probe in the glass vial of conductivity solution to stabilize and press “read”. Record this reading and compare to the “true” reading of 100.0 µS.

6.6.2 If the QC check is within 10 µS of the expected value, circle “N” for “recal?” and the check is complete. If the difference is greater than 10.0 µS, use the conductivity solution in the full bottle to replace the solution in the glass vial. If this does not remedy the reading discrepancy then recalibrate the probe using the fresh conductivity solution.

6.7 Calibrate the DO probe

6.7.1 DO probes are cleaned and stored dry after each sampling season. Re-hydrate the probe for a minimum of 24 hours in a water bath prior to the sampling season. Rinse with DI water and store the probe in water when not using in the field. For use in the field, place the probe in a moistened paper towel, inside a plastic sealable bag. Rinse and replace the towel often to prevent growth of mold.

6.7.2 Remove the probe from the moist towel wrap, and use DI water and a cotton swab to gently wipe the DO cap inside the housing of the probe. Rinse with DI and place in the calibration bath. Let the DO probe sit in the oxygenated water bath for at least 30 minutes. In the comments area or to the side of the calibration form, record the water temperature using a NIST thermometer and pressure from the barometer in the lab. Use these values and the USGS O_2 Solubility table in the lab to find the expected DO concentration. Record this value on the calibration form under the Pre-calibration section.

6.7.3 Connect the probe to the Hach and press “read”. Record the pre-calibration reading on the calibration form. Calculate the difference between the expected and the reading and record on the calibration form.

6.7.4 Select “calibrate”, “read” and “done” on the Hach. Record the slope, offset, temperature, and pressure (inHg) on the calibration form. Then press “store” to retain the results.

6.7.5 Measure the DO of the oxygenated water again and compare the result to the USGS DO tables. Record these values in the calibration form under “Post calibration”. If the difference is greater than 0.5 mg/L, calibrate again.

6.7.6 Temperature in celcius (C) is obtained from the DO probe. Temperature on the DO probe is calibrated in a lab at the beginning and end of the field season.

6.7.6.1 To calibrate the temperature on the DO probe, compare the measurements from the temperature probe to measurements of a NIST thermometer. Verify the probe measurements are within 1˚ C of the NIST thermometer in a cold and warm water bath. Use a different probe if it does not meet this criteria.

6.8 **Procedure for DO probe quality control check**

6.8.1 Remove the probe from the moist towel wrap, rinse with DI, shake off excess water, and place the probe in a container of water that has stabilized to room temperature. Turn on the bubbler in the water container for at least 15 minutes before taking any readings.

6.8.2 When you are ready to perform the QC check, record the date, time and site ID on the calibration form under "Daily QC Check".

6.8.3 Connect the probe to the Hach and press "read". Record the reading on the QC line of the calibration form and look up the "true" value on the USGS table using the temperature and pressure reading from the DO probe (right side of Hach screen after pressing "read").

6.8.4 If the QC check is within 0.5 mg/L of the expected value, circle "N" for "recal?" on the calibration form. Turn off the bubbler and place the probe back into the moist towel wrap.

6.8.5 If the QC check is > 0.5 mg/L, recalibrate the probe according to the procedure outlined starting in section 6.8. If calibrating at a location other than the lab, use the water the probe is already in and use the probe temperature and pressure.

General consideration for taking in situ measurements at a stream or river

6.8.6 In situ measurements should be one of the first and last tasks you complete at a site. Record the time (military) and location (thalweg transect) when in situ measurements are taken. Measurements should always be taken between transects A0 and K0. Collect beginning and ending in situ measurements from the same location when wading. Collect in situ measurements at the top of the site (upstream) and at the bottom of the site (downstream) when rafting.

6.8.7 Choose a sample location that is representative of the site. This location should be relatively deep and non-turbulent. Sample near the thalweg or predominant downstream current if possible. Avoid back eddies and side channels.

6.8.8 Measure parameters before you and other crew members enter the stream to avoid sample contamination. Make sure to not disturb sediment from the stream bed.

6.8.9 Avoid getting in the stream and take in situ measurements at a location from the stream bank. If it is difficult to take measurements from the stream bank, enter the stream and take measurements with the probe upstream of where you are standing.

6.8.10 Measure from near the bow while the boat is pointed upstream when sampling from a boat.

6.9 In Situ Measurements

6.9.1 Thermally acclimate the pH electrode. Collect a sample of stream water with the 500 mL container (Figure 4) and place it in a shallow, calm, edge section of the stream. Open the pH electrode fill hole and carefully remove the pH electrode soaker bottle. Place the pH electrode upright in the container and let it sit for 3-5 minutes. Be sure that you do not submerge the electrode fill hole.

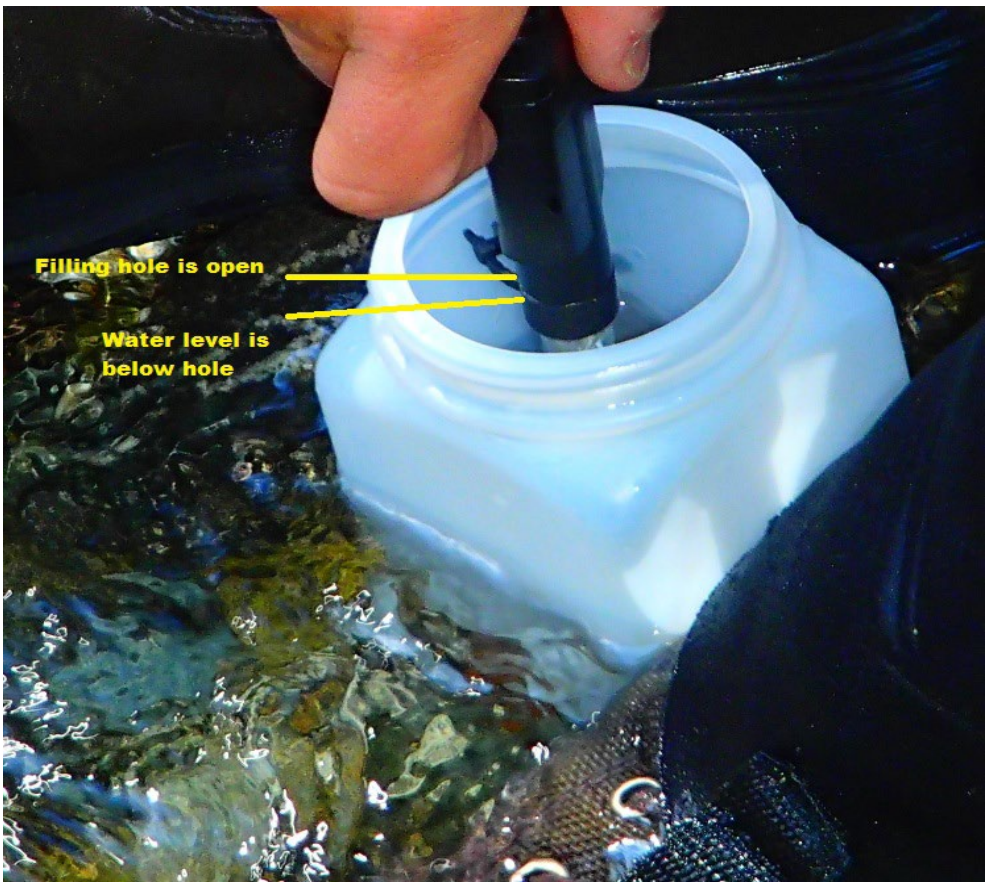

Figure 4: Measuring pH at equilibrated temperature and outside of streamflow.

6.9.2 Protect the pH electrode from flow-induced error. Measuring pH in flowing water can be problematic, so do not place the electrode directly into the stream. Instead, measure from a fresh re-fill of stream water (Figure 4). Keep the filled container partially submerged in stream water while taking the measurement in order to measure close to ambient stream temperature.

6.9.3 Measure the pH of the contained water. Gently stir the pH electrode for several seconds while obtaining a stable sample measurement. Repeat this process until consecutive stable readings are within 0.02 pH units and the millivolts (Mv) readings are within 0.1 Mv of each other. Navigate to the Chemistry Page on the field tablet. Select the "Get Time" button to record the time of the in situ measurements. Record the station ID and record pH to the nearest hundredth (Figure 3).

6.9.4 Once you have recorded a stable stream pH value (Figure 5), close the probe fill hole, shake off the stream water and place it in the soaker bottle. Make sure there is enough clean filling solution in the soaker bottle to cover the pH bulb (about ½ full). Detach the pH probe and connect the DO and conductivity probes.

6.9.5 Thermally acclimate the DO and conductivity probes. Find a spot in the stream where the water is well mixed but not overly turbulent. Hold the DO and conductivity probes so that they are immersed below the surface of the water. Do not allow the barometer port or box on the DO probe cord to get wet or submerged. Let them sit for 3-5 minutes.

6.9.6 In situ DO and conductivity measurements can be taken at the same time with both probes simultaneously connected to the probe, or individually with one probe connected at a time.

6.9.7 Ensure the probes are not resting on the stream bed and are fully submerged. Use an intermediate container for in situ measurements if this situation is not possible,.

6.9.8 After the probes are thermally acclimated, press "read" to measure the four parameters in flowing water. On the *Chemistry* sampling page (Figure 5), record temperature (˚ C, nearest tenth), specific conductivity (µS/cm at 25˚ C, nearest tenth), dissolved oxygen (mg/L, nearest tenth), and oxygen percent saturation (nearest tenth). Temperature should be measured using the DO probe (for consistency). Take measurements with the DO probe until the temperature stabilizes.

6.9.9 After recording DO and conductivity in situ measurements, disconnect the probes, shake off the stream water, and place back into the moist paper towel inside the bag.

6.9.10 Follow steps 6.11.1 through 6.11.9 at the beginning and end of the DCE.

6.9.11 If any of the probes malfunction in the field, or if they fail a calibration pre or post check, flag the measurement by clicking the "J" box in the eforms and add a comment in the notes box (Figure 5).

Figure 5: E-Form's chemistry page. Record measurements at the beginning and end of the DCE.

7.0 Records Management

7.1 Contact the Watershed Health Monitoring Data Coordinator for the latest guidance document describing how to validate, complete, and load WHM field forms to the WHM database.

8.0 Quality Control and Quality Assurance Section

1.1 PROJECT QA/QC procedures are discussed in the Quality Assurance Monitoring Plan (Cusimano et al., 2006); a new version will be available 2022.

9.0 Safety

9.1 All field staff must comply with the requirements of the EAP Safety Manual (Ecology, 2019).

10.0 References

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11.0 Appendix A – Calibration Form

Hach Electrode Calibration and Daily QC Checks — Draft version 1.2

Stream/Site ID:	Stream/Site ID:	Stream/Site ID:
Date/ Time:	Date/ Time:	Date/ Time:
Operator:	Operator:	Operator:
pH Elect. #	Cond Elect. #	LDO Elect. #

Calibration[a]

pH Calibration[b] Empty Electrode Solution and Refill

Calibrate at beginning of week or when QC check is off by > 0.10 units. Buffers must be >15°C and <25°C

Date/Time	Slope	%	Offset	r2	Temp °C	MV 4	MV 7	MV 10	QC 7 True	QC7 reading

LDO Electrode calibration

Calibrate only when QC check is off by > 0.5 mg/L

NIST		Pre calibration[c]			Calibration[d]				Post calibration QC		
Date/Time		1) Expected mg/L (USGS)	2) Reading mg/L	Diff of 1&2b	Slope	Offset	Temp	inHg	1) Expected mg/L (USGS)	2) Reading mg/L	Diff of 1&2

Conductivity Electrode Calibration[e]

Calibrate only when QC check is off by > 10 µS/cm

Date/Time	Initial Cell Constant	Initial Reading	Cond W/O temp corr.	Final Cell Constant	Final Standard Reading

Daily QC checks AM/PM

if AM QC check is OK then no calibration is needed.

SiteID:	Date	Time	True	Reading	Recal?
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N
SiteID:	**Date**	**Time**	**True**	**Reading**	**Recal?**
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N
SiteID:	**Date**	**Time**	**True**	**Reading**	**Recal?**
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N

Temp °C	Hach pH7	Hach pH10	NIST pH7	NIST pH 10
8	*	*	7.07	10.21
10	*	*	7.06	10.18
12	*	*	7.05	10.16
14	*	*	7.04	10.13
16	7.04	10.1	7.03	10.11
18	7.03	10.08	7.02	10.08
20	7.02	10.05	7.01	10.06
22	7.01	10.03	7.01	10.04
24	7	10.01	7	10.02
26	*	*	6.99	10.01

Expected Cal. Ranges (and w/in run range)

Slope #: -57.5 to -58.8 (<0.7)	pH4: 165 to 178 (<5)
Slope %: 98 to 100	pH7: -5 to +6 (<5)
Slope r^2: >0.9995	pH10:-168 to+179 (<5)
Offset: -3 to +8 (<4)	Cond: 0.375 to 0.425 (<0.02)

Footnotes

[a] *See above for expected ranges.*

[b] *If electrode pH is >± 0.10 units, recalibrate; if > ± 0.15 units, recalibrate, re-read sample, & "I" data since last calibration*

[c] *See USGS O_2 Solubility Table (USGS DO table)*

[d] *Recalibrate if difference is ± 0.50 mg/L.*

[e] *If electrode conductivity is >± 10µs/cm, recalibrate, re-read sample, & "I" data since last calibration.*

Comments

Electrode Calibration and Daily QC Checks — Draft version 1.2

Stream/Site ID:	Stream/Site ID:	Stream/Site ID:
Date/ Time:	Date/ Time:	Date/ Time:
Operator:	Operator:	Operator:
pH Elect. #	Cond Elect. #	LDO Elect. #

Daily QC checks AM/PM

if AM QC check is OK then no calibrations is needed.

SiteID:	Date	Time	True	Reading	Recal?
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N
SiteID:	**Date**	**Time**	**True**	**Reading**	**Recal?**
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N
SiteID:	**Date**	**Time**	**True**	**Reading**	**Recal?**
pH QC Check AM					Y/N
Cond QC Check AM					Y/N
LDO QC Check AM					Y/N
pH QC Check PM					Y/N
Cond QC Check PM					Y/N
LDO QC Check PM					Y/N