Standard Operating Procedure

Instantaneous Water Quality Field Meter

WQDWQPBFM-06, Version 2.0
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Water Quality Planning Bureau

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The Montana Department of Environmental Quality (DEQ) Water Quality Planning Bureau (WQPB) Standard Operating Procedures (SOPs) are adapted from published methods or developed by in-house technical and administrative experts. Their primary purpose is for WQPB internal use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. DEQ may provide SOPs to other programs or partners. Distribution of these SOPs does not constitute a requirement to use a particular procedure or method unless stated in other binding communications. This document does not contain regulatory or statutory requirements unless specified.

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Although the WQPB follows this SOP in most cases, there may be situations where an alternative methodology, procedure, or process is used to meet specific project objectives. In such cases, the project manager is responsible for documenting deviations from these procedures in the Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), and end of project summary reports.

Document Revision and Version History

Revision Date	Version Number	Summary of Change(s)	Revised Sections(s)	Revised By
April 2020	1.0	Initial document	All	Elizabeth McWilliams
June 2025	2.0	1. Clarified sensor calibration and meter storage procedures, 2. Updated calibration documentation practices, 3. added Appendix C and Appendix D.	Sections 9.0 through 11.1, Appendix A, C, and D. Minor edits throughout.	Ella Bushnell

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ACRONYMS

BP	barometric pressure
DEQ	Montana Department of Environmental Quality
DI	deionized
DO	dissolved oxygen
EC	electrical conductivity
FNU	formazin nephelometric units
µs/cm	microsiemens per cm
mg/L	milligrams per liter
mmHg	millimeters of mercury
NIST	National Institute of Standards and Technology
NTU	nephelometric turbidity units
QAPP	quality assurance project plan
SAP	sampling and analysis plan
SC	specific conductance
SDS	safety data sheet
SOP	standard operating procedure
T	temperature
WQPB	Water Quality Planning Bureau

1.0 PURPOSE

This document describes the Montana Department of Environmental Quality (DEQ) Water Quality Planning Bureau (WQPB) Standard Operating Procedure (SOP) for using, calibrating, and maintaining instantaneous field meters (meters). There are many types of meters on the market, but there are common procedures to follow when calibrating, maintaining, and using most of these meters. The meter may be able to report the results in a variety of units. A project's quality assurance plan (QAPP) or sampling and analysis plan (SAP) will describe which field measurements and units are required and which meter will be used.

2.0 APPLICABILITY

The following field parameters discussed in this document are useful to collect during water quality investigations and are common in WQPB's monitoring projects:

- Temperature (T)
- Electrical Conductivity (EC)
- pH
- Dissolved Oxygen (DO)
- Turbidity (limited availability for meters)

Many meters are applicable for all waterbody types and seasons, but it is important to understand any limitations that any one meter will have by reviewing the appropriate guides and manuals before use. All relevant information reported by the meter must be recorded on the appropriate form. The WQPB's Site Visit Form includes a section that is used for this purpose for the common parameters (**Section 12.1**).

Specific meters will be used as examples in this document; however, principles such as calibration procedures and field use may be applicable to other models of meters.

NOTE: 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 DEQ.

3.0 METHOD SUMMARY

There are many different types of meters that may be used to collect one or more of the parameters discussed in this document. "Pen-type" meters typically only measure a few parameters (e.g., T, EC, or pH), handheld cabled meters can measure multiple parameters and sensors may be changeable, and other meters may be specifically designed to measure one parameter (e.g., turbidity). The general calibration process for each parameter (pH, EC, DO, etc.) will be similar for all meter models. All calibration and maintenance done to a meter must be recorded in the meter's Calibration/Maintenance log (**Section 12.2**). A meter is ready to collect data after it is calibrated. When it is not in use, the meter should be put into the appropriate short or long-term storage (**Section 10.0**).

Appendix A includes more information on how to use a few specific types of meters:

- YSI Professional Plus
- Hach 2100Q Portable Turbidity Meter

NOTE: All users should be familiar with the appropriate user manual or guidance document before using any equipment.

Meter readings are recorded at the time chemistry samples are collected in the field (Makarowski 2020). The appropriate readings must be recorded on the Site Visit Form (**Section 12.1**) or another appropriate form before field personnel leave the site. Field personnel should choose a location at the sampling site that is well mixed and representative of the waterbody before collecting information. Avoid collecting readings in slack or back water areas, but bear in mind that intermittent streams are often a series of disconnected pools and collecting data from these pools is representative of the stream's condition.

4.0 DEFINITIONS

Meter: a field meter that collects instantaneous information.

Benchtop meter: a field meter that is designed to analyze data on a flat stable surface.

Cabled meter: field meters that have sensors attached to a cable and are placed in a waterbody to analyze data.

DI water: deionized water, provided by a lab and used for rinsing sensors during calibration (never used for sensor storage). Distilled water may be used for rinsing if deionized water is unavailable.

Rinse Solution: calibration solution that has been previously used for a calibration and can be used only for rinsing the meter before calibrating. Bottles of this type of solution are marked "Rinse". Do not use rinse solution to perform an instrument calibration.

Station Pressure: the absolute air pressure at a given reporting station. The air pressure is directly proportional to the combined weight of all air in the atmosphere located in a column directly above the reporting site (NOAA 2019).

5.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware of job hazards associated with collecting instantaneous water quality data that could result in personal injury or loss of life. Driving, boating, wading, tool use, and chemical safety are especially pertinent to the procedures contained in this SOP. Personnel should be aware of unstable banks, loose substrate, and swift currents when wading and standing in flowing water. DEQ field personnel should review the Water Quality Division Job Hazard and Acknowledgement form and the Waterborne Operations Procedure before collecting data (DEQ 2016).

All personnel must adhere to the appropriate use, storage, and disposal for any calibration solution. See the appropriate safety data sheet (SDS) for more information.

6.0 CAUTIONS

Field personnel must be cautious when using equipment around water. Water may damage electronics if seals are damaged or left open. Do not allow any equipment to be washed downstream. Do not allow the meter or sensors to become stuck in cobbles or riprap. Maintain appropriate equipment care and

maintenance (i.e., batteries, sensor cleanings, firmware updates, O-ring, or other seal replacement) during use. Installed batteries should be removed from meters when not being used for an extended period of time (3+ months) to avoid damaging the housing or circuity.

Some sensors such as pH or DO may need to be stored in a certain condition to maintain sensor accuracy. Review **Sections 10.1 and 10.2** and the appropriate user manual for sensor storage instructions. Accuracy typically decreases if sensors are stored incorrectly.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Field personnel must be trained by experienced personnel and must demonstrate proficiency in all applicable field protocols as described in this SOP before collecting data in the field.

Field personnel must be able to troubleshoot common problems with a meter when in the field (e.g., replacing batteries or sensors, calibrating, etc.). **Always keep a copy of the manual and/or appropriate user guides for troubleshooting when in the field.**

8.0 EQUIPMENT AND SUPPLIES

Equipment and supply lists vary for each type of meter. Users must make sure that all required items are acquired before following the calibration procedures in **Section 9.0**. General calibration and field check lists are provided here to cover the basic needs for these activities but may not be inclusive for all meters.

8.1 GENERAL CALIBRATION SUPPLIES

- ❑ Meter with sensors installed
- ❑ Calibration/storage cup
- ❑ Necessary calibration buffer and solutions (EC, pH, turbidity)
- ❑ DI water
- ❑ Meter Manual

8.2 GENERAL FIELD SUPPLIES

- ❑ Meter with sensors installed
- ❑ Sensor storage cup/sleeve
- ❑ Sensor guard (if applicable)
- ❑ Power supply (batteries or charger)
- ❑ Philips head screwdriver
- ❑ Case
- ❑ Calibration/maintenance log
- ❑ Meter manual
- ❑ Air temperature thermometer
- ❑ Maintenance kit (if applicable)
- ❑ Calibration solutions (if checks or calibrations are performed in the field)
- ❑ Kim wipes (if DO calibration is required in the field)
- ❑ Collection vessel (for turbidity meter)

NOTE: If a calibration solution is taken into the field it is recommended to include the corresponding SDS and calibration solution information (serial number, lot number, expiration date, etc.).

Appendix A includes meter specific checklists for the following meters:

- YSI Professional Plus
- HACH 2100Q Portable Turbidity Meter

9.0 CALIBRATION PROCEDURAL STEPS

All meters must be calibrated and tested before being used for data collection. Each type of meter make/model may have different calibration methods; however, general calibration guidelines will be described in this SOP. The YSI Pro Plus meter (Pro Plus) and Hach 2100Q turbidity meter (2100Q) will be used in this SOP as examples.

NOTE: The YSI Pro Plus and Pro Quatro meters follow the same calibration process.

Many calibration processes require the sensors to be placed in a solution. To prevent contamination and dilution, the sensors should be prepared beforehand by cleaning and rinsing. WQPB uses “rinse solution” as part of the calibration procedure to remove the previous solution from the sensors and to prepare the sensors for the next calibration solution. “Rinse solution” is calibration solution that has been previously used for a calibration and is kept in a separate bottle marked “Rinse”. Once the solution has been used one time to rinse the sensors it should be properly disposed of; do not place rinse solution back into the rinse container after using it to rinse sensors.

Follow the procedure below for any calibration process that requires sensors to be placed in a solution:

1. Ensure that the calibration/storage cup is clean.
2. Ensure that the sensors are clean and do not have any fouling.
3. Rinse cup and sensors once with deionized water (DI).
4. Rinse the cup and sensors twice with the corresponding rinse solution (marked “Rinse” on the bottle).
5. Fill calibration/storage cup with the appropriate amount of calibration solution and perform sensor calibration.

For a two-point calibration, repeat steps 3-5 for the second calibration solution.

NOTE: Never accept a questionable calibration. If there are warning messages – stop calibrating and determine why there is an error. Refer to the appropriate manual or calibration guide for any troubleshooting.

All calibration and maintenance procedures must be recorded in the appropriate Calibration/Maintenance Log (**Section 12.2**)

9.1 TEMPERATURE ACCURACY CHECK

- Accuracy Check Frequency: Annual before field season, and repeated if there is a concern for inaccurate data
- Units: Degrees Celsius (°C)

Temperature sensors are not user-calibrated but must have the accuracy checked before continuing with other calibrations as it is a foundational field parameter that is necessary for other parameters to be reported accurately. There are two ways to ensure that a temperature sensor is reading accurately. Either in a stable water bath or in stable ambient air. All temperature check readings should be compared to a NIST approved thermometer.

To check the temperature accuracy the user needs to know where the sensor is located on the meter. Depending on the model of meter and the cable set up, the temperature sensor may be integrated into the cable. WQPB uses a Pro Plus with a Quatro cable that has an installed combined conductivity and temperature sensor.

Using a water bath to check temperature readings is the preferred way to check for accuracy as it provides a stable medium for testing. Fill a container (e.g., bucket, cooler, large beaker) full of water and let it equilibrate with the air temperature for at least 4 hours. Stirring the water occasional can prevent any concern about temperature stratification. Equilibrium is reached after the NIST approved thermometer readings are within ±0.1°C for 10 minutes. Put the temperature sensor in the container and compare the reading to a NIST approved thermometer for at least 10 minutes. The sensor is reading accurately if the readings are within the reported accuracy of the sensor (see the appropriate specification table for the sensor, typically found in the user manual).

An ambient air temperature check can be used if a water check is unavailable (such as if in the field or if checking in the office). Leave the meter and a NIST approved thermometer on a tabletop for 30+ minutes in a stable temperature environment and compare the readings once equilibrium is reached.

NOTE: The ambient air temperature check cannot be performed if any sensors on the cable require a hydrated environment for storage (such as pH sensors) as all sensors on the meter must be left in the same environment.

9.2 ELECTRICAL CONDUCTIVITY SENSORS

- Calibration Frequency: Monthly during field use
- Units: Specific Conductivity microsiemens per centimeter (µS/cm)

Electrical conductivity (EC) is temperature dependent and must be reported in specific conductivity that is temperature corrected to 25°C.

9.2.1 Electrical Conductivity Maintenance

If the EC sensor has flow cells, use a small wire brush to clean the flow cells before calibrating (YSI 2020):

1. Rinse the maintenance brush in clean DI water.
2. Insert brush into each flow cell 10 to 12 times.
3. Rinse the flow cells with DI water.

NOTE: If necessary, a mild detergent can be used to clean any deposits that have formed on the electrodes (YSI 2010).

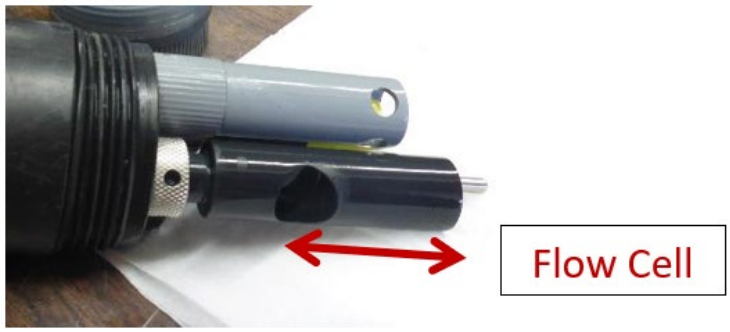

Figure 9-1: Electrical Conductivity sensor flow cell

9.2.2 Electrical Conductivity Calibration

YSI recommends calibrating conductivity before other sensors, as the reading from the conductivity sensor is used to determine the dissolved oxygen mg/L measurement. The calibration method for an EC sensor is typically a one-point specific conductivity (SC) calibration in a solution of 1,000 µS/cm. For projects based in eastern Montana, it is recommended to calibrate with a solution of 1413 µS/cm. If 1413 µS/cm calibrant is the only standard available, it is suitable for calibrating an instrument to be used in western Montana.

NOTE: Some meters may prompt the user to enter the calibration value as mS/cm and the user will have to convert µS/cm to mS/cm before calibrating (1,000 µS/cm = 1 mS/cm).

For the sensor to accurately measure the SC, the calibration cup must be filled with enough calibration solution to completely cover the flow cell holes. Make sure that there are no bubbles in the flow cell chamber when calibrating.

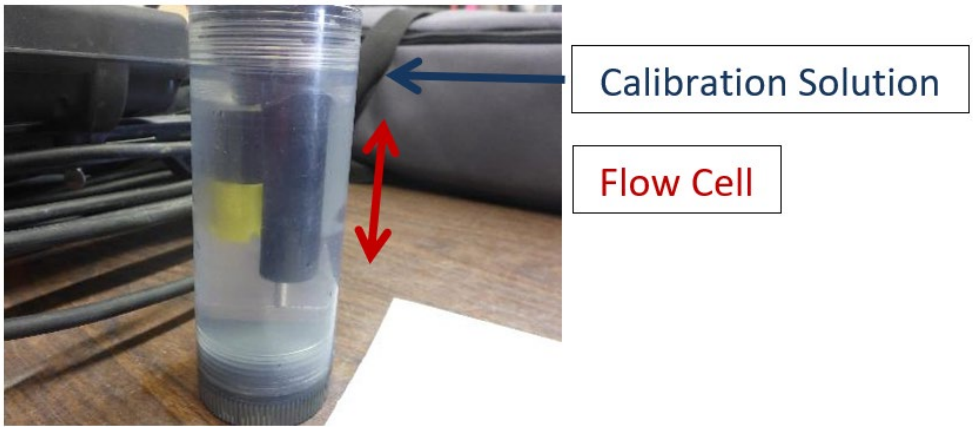

Figure 9-2: Electrical Conductivity sensor in calibration solution

Conductivity may be calibrated using one of three methods: specific conductance, conductivity, or salinity. It is recommended to calibrate using specific conductance for greatest ease. To calibrate, enter the calibration value of the standard used, observe the actual reading for approximately 1 minute, then accept the calibration when there is no significant change in the reading. After the calibration, check what the EC sensor is reporting in the same calibration solution to verify that it was calibrated accurately. If necessary, investigate any problems with the calibration before using in the field.

9.3 pH SENSORS

- Calibration Frequency: Monthly during field use with daily accuracy checks
    - During daily accuracy checks in the field, if the pH is reading ±0.01 from the buffer solution, recalibrate the pH sensor
- Units: pH is a unitless parameter; pH millivolts = mV

pH is temperature dependent and is based on the voltage difference between a known hydrogen ion concentration contained in the sensor and in the sampled solution. The pH mV should always be recorded and interpreted when calibrated. When the mV readings begin to drift away from what they should be, it is an indication that the sensor should either be cleaned (the glass bulb is fouled and there is interference) or replaced (the inner sensor solution has degraded). The typical working life of a pH sensor is 12-24 months (YSI 2010).

The acceptable pH mV outputs for the Pro Plus pH sensor in calibration solutions (YSI 2010):

- pH 7 mV value = 0 mV +/- 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

9.3.1 pH Maintenance

pH sensors must always be kept in a humid environment to preserve the solution in the sensor. See **Sections 10.1 and 10.2** for specific storage instructions.

Before calibrating:

Visually inspect the bulb for any damage or fouling.

- **If damaged: replace the sensor**
    - Damage includes scratches, cracks, and broken bulbs.

- **If fouled: clean the sensor** (YSI 2010)
    - Remove the sensor from the cable.
    - Soak the sensor 10 to 15 minutes in a clean tap water/dish soap solution.
    - If mechanical cleaning is necessary, gently wipe the sensor with a moistened (tap water/dish soap solution) cotton swab to remove any collected material. Never apply pressure to the glass bulb, loosen the cotton from a cotton swab to avoid applying pressure. If cotton swabs are not available, gently use a lint-free lab cloth (i.e., Kimwipe)
    - Rinse the sensor with clean tap water.

If the sensor remains fouled or inaccurate, additional cleaning methods may be performed. See the appropriate user manual for more guidance.

NOTE: Bubbles in the glass bulb are normal and do not interfere with the sensor's readings. Bubbles can be removed by securely holding the sensor with the bulb facing up and flinging downwards. The goal is to force the bubble back into the sensor body.

9.3.2 pH Calibration

The calibration method for a pH sensor is a minimum two-point calibration with pH 7 buffer and either pH 4 buffer or pH 10 buffer. The second buffer solution should bracket the natural water's pH (either 7 to 4 or 7 to 10). pH 7 buffer must always be included. A three-point calibration may be used with 7, 4, and 10 pH buffers if the water's pH range is unknown.

NOTE: For the Pro Plus, the order in which the calibration solutions are used does not matter. Other meter models may indicate a specific calibration sequence.

Many instruments including the Pro Plus will automatically adjust the calibration value based on the selected buffer and the ambient temperature. For each calibration point, allow the actual readings to stabilize for about 1 minute, then accept the calibration. Once all points are calibrated, finish the calibration. After the calibration is completed, check what the sensor is reading in pH 7 buffer to verify that it was calibrated accurately. Investigate any problems with the calibration if necessary before using in the field.

9.4 BAROMETER

- Calibration Frequency: Annual before field season, and repeated if there is a concern for inaccurate data. It is good practice to check the accuracy of the barometer prior to calibrating the DO sensor.
- Units: Millimeters of Mercury (mmHg)

Some meters have built in barometers and typically report the true barometric pressure. This is needed for accurate DO readings. Barometer readings should be verified against a local barometer (either from a lab or from a weather station) and calibrated as necessary.

One way to verify the true barometric pressure is to use the National Weather Service reports for station pressure at airports:

1. Visit (https://www.wrh.noaa.gov)
2. Search for the nearest city (example: Helena, MT)
3. Select "3 Day History" under "More Information" on the right.

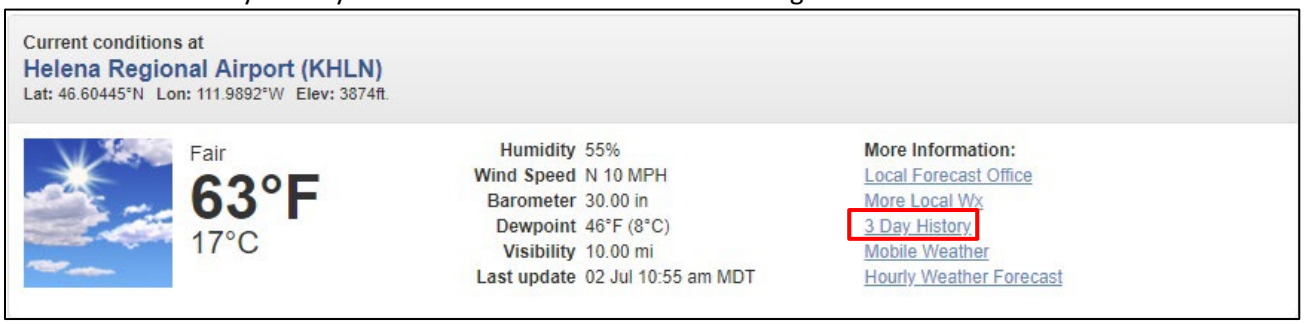

Figure 9-3: NOAA Helena Regional Airport front page (accessed 7/2/19)

That link will open a webpage with a table. One of the columns is titled "Station Pressure (inches)". Use this value when calibrating the meters barometer.

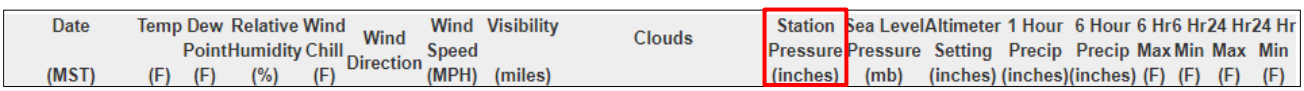

Figure 9-4: NOAA Helena Regional Airport 3-day history (accessed 7/2/19)

If the pressure is reported in inches of mercury, it must be converted into millimeters of mercury before calibrating the meter's barometer.

Table 9-1: How to convert units of mercury

1 inch of Hg =	25.4 millimeters of Hg
1 millibar of Hg =	0.02953 millimeters of Hg

At other locations, the barometric pressure may only be reported as "Sea Level Pressure." If this is the case, the data will need to be uncorrected before calibrating the meter's barometer. Use this equation to correct for the true barometric pressure (YSI 2010):

True BP in mmHg = Corrected BP in mmHg – [2.5 * (Local Altitude in ft. above sea level/100)]

Where BP = barometric pressure, and Corrected BP = sea level pressure.

9.5 Dissolved Oxygen Sensors

- Calibration Frequency: Before field use **and** daily in the field
  - Membrane caps should be replaced monthly during field use (polarographic sensor)
- Units: Milligrams per liter (mg/L) and percent saturation (%)

Dissolved oxygen (DO) is temperature, salinity, and barometric pressure dependent. Always calibrate a DO sensor with an EC sensor installed. There are multiple types of dissolved oxygen (DO) sensors. This procedure will cover how to maintain and calibrate a polarographic sensor with a membrane cap such as the ones used on a Pro Plus. Polarographic DO sensors require 5 to 15 minutes to warmup (YSI 2020). **Field personnel must turn on the meter for approximately 10 minutes before collecting data or calibrating.**

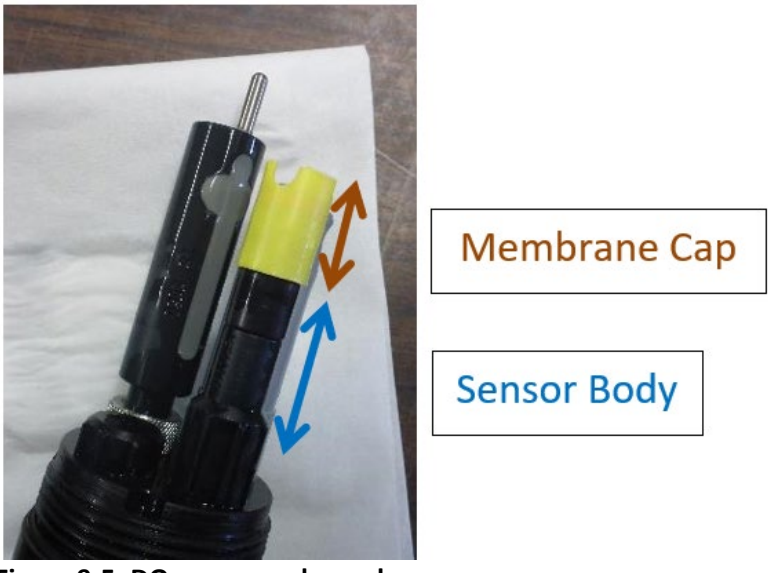

Figure 9-5: DO sensor and membrane cap

9.5.1 Dissolved Oxygen Maintenance

DO sensors have membrane caps that must be replaced regularly depending on the type of DO sensor being used. WQPB uses polarographic DO sensors that require the membrane cap be replaced every 30 days

during regular use. The membrane cap is filled with an electrolyte solution and is installed onto a sensor tip that has a gold cathode and silver anode. During field use, if any bubbles are visible under the membrane, dried electrolyte is visible, or sensor readings are unstable, replace the membrane cap.

How to Replace the sensor cap:

If applicable, make sure to check that sensor and membrane type are correctly entered into the DO sensor set up before replacing the sensor cap (**Appendix A**).

1. Unscrew the old membrane cap.
2. Rinse sensor tip with DI water.
3. Dry with a lint-free lab cloth (i.e., Kim wipe).
4. Inspect the condition of the gold cathode and silver anode.
    - If the cathode or anode is heavily tarnished, follow the mechanical cleaning process described in the manual (YSI 2020). Ensure both are well rinsed with DI water post-cleaning.
5. Fill a new membrane cap with the electrolyte solution.
    - Do not touch the membrane.
6. Lightly tap the side of the cap to release any trapped bubbles.
    - Put a drop or two of electrolyte solution on the gold cathode; this helps prevent bubble inclusion during installation of the cap.
7. Thread the cap onto the sensor. It is normal for a small amount of electrolyte solution to overflow.
8. Ensure no bubbles have been trapped inside the membrane cap.

WQPB keeps bottles of premade electrolyte solution with the calibration solutions, and there are small bottles in the DO membrane kits if a replacement is needed in the field. Follow the instructions on the bottle to prepare the electrolyte solution.

9.5.2 Dissolved Oxygen Calibration

Follow the manual or guide's instructions on how to calibrate the DO sensor. YSI recommends calibrating DO% using the water saturated air method (YSI 2020). Calibrating in % will also calibrate mg/L.

Note: YSI instruments offer three options for calibrating DO. DO% uses water saturated air, DO mg/L uses a solution of known DO determined by a Winkler Titration, and a Zero Point uses a solution of zero DO. YSI recommends performing a DO% water saturated air calibration for ease of use and accuracy (YSI 2020).

To calibrate the DO sensor using the water saturated air method:

1. Ensure the calibration/storage cup is clean. Bacterial growth may consume oxygen and interfere with the calibration (YSI 2010).
2. Place a small amount of clean tap water in the cup (~1 cm).
3. Gently dry the DO membrane and temperature sensor with a delicate task wipe (i.e., Kim wipe).
    - Do not damage the membrane when drying.
    - Make sure that there are no droplets of water on the membrane or the temperature sensor.
4. Screw on the storage cup and then disengage 2 threads or so to allow atmospheric venting.
    - Make sure that the DO membrane and temperature sensor are not touching the water.
5. Turn the meter on and wait approximately 15 minutes for the water to saturate the air in the storage cup and allow the sensors to stabilize. Carry out calibration following the appropriate calibration sequence for DO%.
6. Accept calibration.

If the meter or container is disturbed and water is splashed onto the membrane or temperature sensor, start the calibration processes over again, including the 15-minute wait time. If necessary, investigate any problems with the calibration before using in the field.

9.6 FIELD TURBIDITY METERS

Calibration Frequency: Every 3 months
Units: Nephelometric turbidity units (NTU) or formazin nephelometric units (FNU)

Turbidity is a measurement of light bouncing off particles in a solution. The type of light source and the collected light refracting angle determines the type of unit that the result has. Tungsten filament lamp light produces results with NTU, whereas LED lamp light produce results with FNU. The conversion rate between the NTU and FNU is 1:1.

Some meters may have optical turbidity sensors that use an LED lamp. Field benchtop meters typically use a tungsten filament lamp source but can use an LED lamp. This procedure will discuss how to collect turbidity data using a benchtop meter, using the HACH 2100Q turbidity meter as an example.

9.6.1 Turbidity Meter Maintenance

Use a slightly damp cloth or dust/lint free cloth to clean the exterior surface of the meter. If necessary, a mild soap solution can be used on the exterior surface (Hach 2017).

Sample cells and caps need to be kept clean and free from any scratches. A silicone oil is provided to mask any minor scratches in the glass. See the manual on how to properly apply the silicone oil.

NOTE: It is important to use the provided silicone oil with the sample cells as the refractive index has been matched by the manufacturer (Hach 2017).

Sample cells are to be stored with DI water in them, the insides should not be left to dry. The outsides of the sample cells should be dried with a soft cloth (Hach 2017).

See the appropriate manual for any additional maintenance that may be needed.

9.6.2 Turbidity Meter Calibration

The calibration process for a portable turbidity meter may differ based on manufacturer and model. The 2100Q recommends using StablCal® prepared calibration cells (shelf life ~ 1 year) or user-prepared formazin standards to calibrate the meter every 3 months. The calibration is a 3-point calibration of 20, 100, and 800 NTU. The calibration process is simple and described in the manual. The meter should be verified with 10 NTU after each calibration.

10.0 METER STORAGE

There are typically two types of storage for a meter: short-term and long-term storage. Storage conditions should be described in the meter's manual or guide. See **Appendix A** for storage conditions for the Pro Plus and the 2100Q turbidity meters. Short-term storage should be used during the field season when the meter

is being regularly used. Long-term storage should be used if a meter is not being used for several months, for example over the winter.

10.1 SHORT-TERM STORAGE

All sensors on a Pro Plus should be kept in a 100% water-saturated air environment when being used regularly during the field season (YSI 2020). This is achieved by keeping a small amount of **tap water** at the bottom of the storage cup (~1 cm). Do not use DI or distilled water for sensor short term storage. Do not fully submerse sensors in water. Some sensors such as pH should never dry out, but if they do, it may be possible to recondition and rehydrate them. See the appropriate manual for reconditioning instructions.

Field benchtop turbidimeters typically have a case that stores the meter, sample cells, and calibration cells.

10.2 LONG-TERM STORAGE

After the field season is complete and sampling is no longer occurring regularly, the meter can be put into long-term storage. These processes are described in meter-specific user manuals but is typically done by following the steps listed below.

10.2.1 Storing a handheld meter (T, EC, pH, and DO)

1. Inspect and clean the meter and sensor bodies.
2. Clean the storage case, cable, and cable management system.
3. Remove batteries.
4. Remove the pH sensor.
    a. Place the pH sensor in the provided small storage cup with pH 4 buffer.
    b. Make sure the now empty port is clean and dry, seal the vacant port with a port plug.
5. Keep temp/conductivity and DO sensors on the cable.
    a. Remove the DO membrane cap and thoroughly rinse the sensor with clean water. Dry the sensor tip completely (using compressed air or allowing to air dry). Install a clean, dry, new membrane cap to keep the sensor tip dry and protect the electrodes.
    b. The temperature/conductivity probe should only be removed if absolutely necessary.
6. Store meter and sensors in case.

10.2.2 Storing a turbidity meter

1. Inspect and clean the meter and case.
2. Inspect the sample cells, fill with DI water.
3. Inspect calibration vials for expiration date.
4. Store meter, sample cells, and calibration vials in the case.

NOTE: Remember to record all daily/weekly/monthly calibrations, maintenance, and winterization in the corresponding Calibration/Maintenance Log (**Section 12.2**).

11.0 USING A METER IN THE FIELD

Turbidity meters are calibrated before the first field use, verified weekly, and recalibrated every 3 months. See **Table 11-1** for the daily, weekly, and monthly requirements for EC, pH, and DO sensors on Pro Plus meters.

Table 11-1: Pro Plus calibrations and checks

Daily	Weekly	Monthly
• Check pH 7 – calibrate pH sensor using 2 points if it is not reading within ±0.1 of buffer @ temperature • Calibrate DO sensor	• Check pH 7 and pH 10 - calibrate pH sensor using 2 points if it is not reading within ±0.1 of buffer @ temperature • Check EC sensor • Calibrate DO sensor	• Calibrate EC sensor • Calibrate pH sensor • Replace the DO sensor membrane cap • Check barometric pressure • Calibrate DO sensor

Meter readings are collected in the field at the time of chemical sampling activities. It is important that other sampling activities (water sampling, benthic sediment sampling, etc.) do not interfere with meter readings (e.g., collecting readings in the path of stirred sediment).

Field personnel are responsible for maintaining the meter during the field season. When collecting measurements in the field, the site locations will be specified in the project SAP. Field personnel are responsible for locating a well-mixed/representative location to record a reading. Avoid collecting readings in slack or back water areas, but bear in mind that intermittent streams are often a series of disconnected pools and collecting data from these pools is representative of the stream's condition.

11.1 SAMPLING WITH A PEN OR CABLED METER (T, EC, PH, AND DO)

When field personnel arrive at the site:

1. Turn on the meter and leave it in a shaded area for at least 10 minutes to allow the DO sensor to warmup.
    a. If there is a storage cup, unscrew a few threads to vent sensor to atmosphere.
2. Screw the sensor guard onto the cable (if applicable).
3. Submerge the sensors in the water and gently shake to remove any air bubbles that may interfere with sensor readings.
4. Position the sensors perpendicular to flow if possible.
    a. Hold pen meters in the flow so that the screen is visible, and results can be read.
5. Make sure that there are no obstructions upstream of the probe (i.e., rocks, macrophytes, debris).

If water is not flowing past the sensors and an alternate location with laminar flow is unavailable, gently move the probe from side to side to circulate the water around the probe.

6. Allow the sensor to stabilize. Readings should not be consistently increasing or decreasing.
7. Record the appropriate readings onto the Site Visit Form (see **Section 12.1**).
8. Inspect sensors and clean cable/sensors in the stream or with clean tap water before storing.

NOTE: Replace the water in the storage cup with clean tap water when it becomes fouled.

11.2 SAMPLING WITH A TURBIDITY METER

When field personnel are ready to collect a turbidity reading:

1. Place the turbidity meter on a stationary level surface, avoiding direct sunlight.
2. Turn on the meter.
3. Collect a representative sample with a clean collection vessel.

4. Fill a clean sample cell with the sample.
5. Wipe the outside of the sample cell with a lint free cloth to remove water spots and fingerprints.
    a. Take care not to add fingerprints to the sample cell by handling the sample by the cap.
6. Apply a thin film of the provided silicone oil as described in the manual.
7. Gently invert the sample to ensure the sample is homogenous.
8. Place sample cell in the compartment so that the orientation marks align with the meter.
9. Push the Read button.

The turbidity result will be displayed after the sample is analyzed and will be stored on the meter.

10. Remove the cell.
11. Empty the cell.
12. Rinse and fill the cell with DI water.
13. Dry the outside of the cell with a lint free cloth.

12.0 DATA AND RECORDS MANAGEMENT

All hardcopy documentation of the data collected, such as completed Site Visit Forms, are kept and maintained by the Water Quality Planning Bureau. Data collected will be reviewed, verified, and stored based on the WQPB Quality Control and Quality Assurance procedures (**Section 13.0**) and the Quality Assurance Project Plan (QAPP) for the project.

All calibrations, checks, and maintenance are to be recorded in the Maintenance/Calibration Log for each meter.

12.1 RECORDING ON SITE VISIT FORM

Field personnel are to document the meter's serial number at the top of the Site Visit Form and record the meter's readings in the Field Measurements section after the readings have stabilized. An example Site Visit Form is available in **Appendix B**.

Field Measurements		Time: am pm
Water Temp: °C °F		Air Temp: °C °F
Bar. Pressure: mm/Hg		SC: uS/cm
pH:	DO: mg/L	Turbidity: NTU
Turbidity: Clear ☐ Slight ☐ Turbid ☐ Opaque ☐		
Flow: ft3/sec (Dry Bed ☐ Stranded Pools ☐)		
Meter ☐ Meter-Auto ☐ Float ☐ Gage ☐ Visual Est. ☐		

Figure 12-1: The Field Measurements section of a site visit form

Field personnel must remember to:

- Record the time of the reading (preferably in military time, but if not, circle am or pm); the time of readings should be the actual time recorded and not the same time as the site arrival time recorded at the top of the form,
- Circle the correct units where needed (°C or °F),
- Record all field meter values, and

- Make a visual assessment of the water's turbidity and check either clear, slight, turbid, or opaque.

The visual assessment of turbidity must always be completed, and if a turbidity NTU measurement was not collected, leave "Turbidity: _____ NTU" blank.

12.2 MAINTENANCE/CALIBRATION LOG

Field meters should have a water-resistant maintenance/calibration log dedicated to that meter. Each log must include the manufacturer, model, and serial number of the meter to distinguish it from other meter's logs. All maintenance (i.e., battery replacement, cleaning, sensor replacement) and daily/weekly/monthly calibrations must be recorded in the equipment's log. See **Appendix C** for an example calibration log form for Pro Plus calibrations.

Each entry in the log must include:

- Who did it (first initial and last name).
- When it was done (date of calibration).
- What was done (i.e., calibrations, battery replacement, probe replacement, repairs, cleanings, and any corrective actions).
- Any relevant information (e.g., batteries leaked and damaged circuitry, etc.).

If a calibration was done, include:

- What calibration was done (the calibration type, number of points).
- What solution was used (manufacture, type, and lot number).
- At what temperature the calibration was performed.
- Record the post calibration reading and units.
- Note if the meter passed or failed the calibration.

NOTE: Someone should not come back and modify a previous entry in a log. When possible, use appropriate pens and markers to prevent erasure.

13.0 QUALITY CONTROL AND QUALITY ASSURANCE

It is the responsibility of the field personnel to collect good and accurate data and ensure that forms are properly filled out and the information is recorded correctly.

All equipment users must be familiar with the equipment and be able to troubleshoot common problems in the field. Routine inspections and repairs (or notification of need for repair) are necessary to ensure quality of collected data. It is up to the user to be thorough with observations and quick with repairs or notifications. Otherwise, loss of data may occur.

All equipment must be checked and verified before field use. Field personnel are to follow the monthly, weekly, and daily calibration schedule provided in **Section 11.0.** All calibrations, checks, and maintenance are to be recorded in the Maintenance/Calibration Log.

14.0 REFERENCES

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APPENDIX A – EQUIPMENT HELP SHEETS

Users should always reference the appropriate meter manual. These sheets are to help personnel prepare equipment for the field and for use in the field.

- YSI Pro Plus Setup, Calibration and Field Help (YSI Pro Plus and Pro Quatro devices follow the same calibration and field use procedures)
- Hach Turbidimeter 2100Q Setup and Field Help

If the equipment is calibrated or has maintenance done, record the following information in equipment Calibration/Maintenance Log:

- Date (when it happened)
- User (who did it)
- What was done (i.e., battery change, zero check and adjust, battery removal)
- Calibration solution information (manufacturer, lot number, serial number, etc.)
- Calibration value
- Any relevant information

YSI PRO PLUS SETUP

- 2 C Batteries (Approx. 80 continuous working hours) – requires Philips head screwdriver.
    - If batteries are changed within <2 min of power loss, date and time will not be erased. If the meter has been without battery power for more than 2 minutes (or dead batteries have been left in the meter) the date and time will have to be re-entered. Press "ESC" after date and time have been entered.

When Installing Sensors onto a Quatro Cable:

- Ports must be dry
- O-rings are clean, undamaged, and lightly greased:
    - Grit will stick to and damage the O-rings if too much grease is applied
- Finger-tighten all sensors:
    - DO and pH sensor - white O-rings must not be visible.
    - Do not force sensors (will cause threads to strip).
    - Use metal tool on the final 2-3 turns of the EC/T sensor.
- Use yellow membrane caps (1.25 mil polyethylene) for DO sensors.

Installation Order:

Install in this order (1→4), remove in reverse order (4→1)

1. Port 2: Port Plug
2. DO Port: DO sensor only
3. Port 1: pH
4. CT Port: Conductivity and Temperature sensor only. Never remove this probe unless absolutely necessary.

Setting Up the Meter:

<u>"Probe" Button</u>

- Setup: Where user tells handheld what sensors are installed
    - DO: Enabled, and list the correct Sensor and Membrane type

  - EC: Enabled
  - ISE1: Enabled, Select pH [USA]
  - ISE2: OFF (unless an additional sensor is installed)
- Display: Where user tells handheld what units to display on the dashboard
  - Temperature: °C
  - DO: DO% and DO mg/L
  - Conductivity: Sp. Conductance, SPC-uS/cm
  - pH: pH and pH mV
  - Barometer: mmHg

"File" Button

- View Data: If data is logged on the Dashboard it can be viewed later.
  - Find the data by narrowing the selection by selecting the Site, Folder, Begin Date/Time, or the End Date/Time. Not all filters are needed but help when looking for a specific collection.
  - Select "Show Data" when ready
  - Each Date and Time collection will show on one row. Scroll up and down until the correct line is found.
  - Scroll to the right and left to view the data file
  - There is a maximum limit of 100 data records being shown at one time.

- Site List
  - New sites can be added, and existing sites can be edited
  - It is recommended to use a short-hand description of the site or the Station ID as a Site Name

- Folder List
  - New folders can be added, and existing folders can be edited
  - It is recommended to create folders based on project and per trip: "Smith050819"
    - This way all data collected for that trip can be viewed at once by selecting the folder.

- Dashboard – Logging Data
  - "Log One Sample"
  - Select "Site" and "Folder" as necessary
  - Select "Log Now!"

YSI PRO PLUS CALIBRATION STEPS

1. Ensure that the calibration/storage cup is clean.
2. Ensure that the sensors are clean and do not have any fouling.
3. Rinse the cup and sensors once with deionized water (DI).
4. Rinse the cup and sensors twice with the calibrating solution that is marked “Rinse”.
   - **Rinse Solution**: Calibration solution that can be only used for rinsing the meter. Bottles of this type of solution are marked “Rinse”. Discard used rinse solution appropriately.
5. Fill calibration cup with the proper amount of calibration solution and perform sensor calibration.

If doing a two-point calibration repeat steps 3-5 for the second calibration solution.

Calibration Errors – NEVER accept a calibration that is reporting an error. Check if the cup is clean, the expiration date of the solution, and sensor condition. Recalibrate. If an error persists, check the troubleshooting section of the manual.

CALIBRATION SEQUENCE

1. Press “Cal”
2. Select the sensor type to calibrate
3. Select type of calibration
4. Follow “Calibration Steps” listed above
5. Ensure that calibration value is correct
6. Wait for stabilization (about 1 minute)
7. Select “accept calibration”
8. Repeat steps 4-7 if doing a 2- or 3-point calibration (pH)
9. Press “Cal” to complete the calibration. “Esc” button cancels the calibration.

BAROMETRIC PRESSURE CALIBRATION

- Calibrate at the beginning of the field season and as needed. Barometric pressure calibrations are typically accurate for the entirety of the field season.
- Follow the calibration sequence for “barometer”, enter the station pressure reported from the nearest airport or weather station as the calibration value (**Section 9.4**).
- Regularly check the accuracy of the instrument’s barometric pressure reading, especially prior to DO calibrations.

TEMPERATURE CHECK

- Test temperature at the beginning of the field season and as needed if inaccurate readings are suspected.
- Fill a bucket full of water and let sit to equilibrate with the air temperature for at least 4 hours, stirring occasionally.
- Place NIST certified thermometer in the bucket of water and let temperature reading stabilize for about 10 minutes or until the reading is holding stable (within ±0.1 degrees C).
- Place the temperature sensor in the bucket, let temperature reading stabilize.
- Compare sensor temperature to thermometer temperature, they should read within ±0.1 degrees C of each other.

CONDUCTIVITY MAINTENANCE

- Clean the flow cells of the conductivity sensor before calibration (use mild dish soap if necessary).
    - Dip the maintenance brush into clean water and insert it into each flow cell hole 10 to 12 times.
    - Rinse the flow cells with clean water.

CONDUCTIVITY CALIBRATION

- Calibrate specific conductivity with a 1-point calibration (1,000 uS/cm standard for W MT, 1,413 uS/cm standard for E MT—although 1,413 µS/cm may be used for W MT if 1,000 µS/cm is not available).
- Follow the Calibration Sequence for “Sp Conductance”.

pH MAINTENANCE

- The working life of pH sensors is approximately 12-24 months depending on usage, storage, and maintenance.
- If the bulb is damaged, replace the probe (damage includes scratches, cracks, and broken bulbs.)

NOTE: Bubbles in the glass bulb are normal but should be removed before calibrating. Hold the sensor bulb up and carefully fling downwards towards the ground to remove the bubble from the glass bulb.

- If the bulb is fouled, chemically clean the sensor
    - Remove the sensor from the cable. Soak the sensor 10 – 15 minutes in a clean tap water/dish soap solution.
    - Rinse thoroughly with tap water.
    - If mechanical cleaning is necessary, loosen the cotton from a swab to avoid applying any pressure to the bulb and lightly clean to remove any contaminants.
    - Re-rinse with clean tap water.

If good pH response is not restored using this method, soak the sensor in one molar hydrochloric acid for 30-60 minutes then rinse with tap water. If biological contamination is suspected, soak the sensor in a 1:1 dilution of chlorine bleach for 1 hour. Rinse the sensor in clean tap water then soak in clean water for at least 1 hour, preferably longer. Re rinse the sensor with tap water and retest.

pH CALIBRATION

- Calibrate with a 2-point calibration. Buffer solutions should bracket the natural water, either 4 to 7 or 10 to 7. pH 7 buffer must always be included. The order of the solution used for calibrating does not matter.
- Follow the Calibration Steps and Calibration Sequence for each point. The sensor type is called “ISE1”.
- For each point, check that the mV is within the range provided in **Section 9.3.**

DO MAINTENANCE

- Replace the membrane:
    - Once a month
    - If dried electrolyte is visible.
    - If bubbles are visible under the membrane
    - Sensor reading is unstable.

- Unscrew the old membrane cap → rinse sensor with DI water → inspect the condition of the gold cathode and silver anode. If heavily tarnished, follow the mechanical cleaning process in the manual. Sanding disks are located in membrane replacement kits. Rinse with DI water.
- Fill a new membrane with KCl solution (Do not touch the sensor tip). Premade solution is located with calibration solutions.
    - If membrane needs to be replaced in the field, bottles of electrolyte solution in the membrane kits are available in all carrying cases. Fill the bottle with distilled water (never tap water).
- Lightly tap the side of the membrane cap to release any trapped bubbles.
    - Put a drop or two of electrolyte solution on the gold cathode, this helps ensure no bubbles will be trapped inside the cap.
- Thread the membrane cap onto the sensor; it is normal for a small amount of electrolyte solution to overflow. If **any** bubbles are visible, try again.

DO CALIBRATION

- Use DO % in Water-Saturated Air method.
- Ensure calibration/storage cup is clean.
- Place a small amount of clean tap water in the cup (~1 cm)
- Completely dry DO membrane and temperature sensor.
- Screw the cup on the cable and then disengage 2 threads to ensure atmospheric venting. The DO membrane and temperature sensor should not be immersed in water.
- Turn the Pro Plus on and wait 15 minutes for the container to saturate and for the sensors to stabilize.
- Follow the Calibration Sequence for “DO%”.

DO CALIBRATION CHECK

The accuracy of a DO calibration can be checked using the tables provided in **Appendix D**: “DO% Calibration Values” and “Oxygen Solubility Table” (Appendix A and B from the Pro Quatro User Manual) (YSI 2020). The DO concentration in mg/L can be easily calculated from known equations involving percent saturation, temperature, and salinity (YSI 2012).

STEP 1: In “DO% Calibration Values”, locate the calibration value DO% for the corresponding barometric pressure that the instrument was calibrated with.

The % saturation value at the time of calibration in water-saturated air reflects the value of the barometric pressure during calibration. The % saturation is the amount of dissolved oxygen relative to 1 atmosphere (760 mm Hg, sea-level). Percent saturation always decreases with increasing elevation above sea level. For example: a DO % saturation value of 89% means that the water contains 89% of the oxygen that would be expected if the water was sparged with air at sea level (1 atmosphere).

STEP 2: In “Oxygen Solubility Table”, locate the value in the second column “Chlorinity: 0 Salinity: 0” for the temperature that the instrument was calibrated with.

The values in the Oxygen Solubility Table show the International Standards Organization (ISO) values of DO that correspond to 100% saturation at various temperatures and salinities.

STEP 3: Multiply the DO% from step 1 (as a fraction, e.g., 0.89) and the value from the Oxygen Solubility Table from step 2. This will calculate the concentration in mg/L that the instrument should be reading after calibration. If the instrument is not reading within approximately ±0.1 mg/L of the table-calculated value, check the accuracy of the barometric pressure and temperature, check for any air bubbles under the membrane, and look for any tarnishing of the gold or silver, then try calibrating again.

YSI PRO PLUS FIELD HELP

Field Check List

- ❑ Pro Plus (handheld, cable, sensors, and case)
- ❑ Maintenance/Calibration Log
- ❑ Replacement C Batteries (2 are required)
- ❑ Replacement DO membrane kit (YSI 5908)
- ❑ Screwdriver (Philips, longer shaft)
- ❑ Calibration/Storage cup
- ❑ Sensor guard
- ❑ Air Temperature thermometer
- ❑ Calibration solutions (project based)
- ❑ Cable organizer (Optional)
- ❑ Meter Manual
- ❑ Kimwipes for DO calibration
- ❑ Maintenance Kit:
  - Grease
  - Sponge
  - Conductivity brush
  - EC/T sensor tool
  - O-rings, White: **For port plugs & sensors**
  - O-rings, Black: **For EC sensor**
  - Port Plug(s)

Daily	Weekly	Monthly
• Check pH 7 – calibrate using 2 points if it is not reading within ±0.1 of buffer solution @ temp • Calibrate DO	• Check pH 7 and pH 10 - calibrate using 2 points if it is not reading within ±0.1 of buffer solution @ temp • Check EC • Calibrate DO	• Replace the DO sensor membrane cap • Check barometric pressure • Calibrate DO sensor • Calibrate EC sensor • Calibrate pH sensor

FIELD USE

Turn on the meter 10 minutes before recording a DO reading. Unscrew the storage cup one to two threads for atmospheric venting and leave in a shaded area. When ready to sample, screw on metal guard and place meter in stream so that the sensors are perpendicular to the flow. Wait for reported results to stabilize before recording a reading.

Display Screen Contrast

Press backlight key and the left (lighter) or right (darker) arrow at the same time repeatedly.

Collecting data in the field

Sites can be created for each Station ID and folders can be created for each sampling trip.

Creating a Site: File → Site List → New Site: Enter Name/Choose Site: Edit or Delete
File → Folder List → New Folder

Log Information: Dashboard: Log Now! → Choose Site and Folder → Select "Log Now!" To save data

View Data: File → View Data → filter by Site, Folder, Date/Time → Select "Show Data"
Rows are Date and Time of logs. Additional data is seen by scrolling to the right.

HACH TURBIDIMETER 2100Q SETUP AND FIELD USE

Hach Turbidity Meter Field Check List

- ❑ 4 AA batteries
- ❑ Case
- ❑ Oil and cloth
- ❑ Sample cells
- ❑ Calibration cells
- ❑ Sample collection vessel

Batteries: 4 AAs, meter will power off after 10 minutes of inactivity.
Backlight: The backlight can be adjusted with the buttons located on the left side of the meter.

Sample IDs can be created for each Station ID under the Settings (Wrench Button) Menu. Sample IDs will have to be selected from the same menu before a sample is measured.

General Use:

- All readings must take place on a level stationary surface.
- Handle all cells by the cap
- It is important to match the arrows on the indexed calibration and sample cells to the arrow on the meter. See the manual (Pg. 17) for information on how to index additional sample cells.
- The sample compartment lid will click into place when properly closed.
- Clean and oil all cells before use (Pg. 11).
- Sample Cells are to be stored with DI water, cap on, and the outside dried with a soft cloth. Never let air dry.

Calibrate: Every 3 months and verified weekly.
Calibration is done with premade sealed cells of Hach StablCal® turbidity standards. Cells are to be gently inverted to redistribute the polymer in the solution until there is a homogenous mixture before using for calibration or verification (Pg. 13)

The calibration includes reading the 20, 100, and 800 NTU cells. The calibration is verified with the 10 NTU cell after calibration.

For samples up to 40 NTU the RapidCal setting can be used with the 20 NTU cell. The calibration is verified with the 40 NTU cell after calibration.

Reading Modes:

- Signal Average: 12 measures, good for homogenous samples of low turbidity that have a low settling rate.
- Rapidly Settling Turbidity (RST): Calculates and continuously updates to a confidence of 95%; only use for samples that are initially homogenous when starting to measure but have a rapid settling rate.

Data Management Menu:

Stores all readings, calibrations, and verify calibration Logs. Stores readings, date and time.
See the manual for any reported errors (pg. 22, Troubleshooting)

APPENDIX B – SITE VISIT FORM

This example Site Visit Form gives a general idea of the format used by the WQPB. Project-specific Site Visit Forms are created to reflect specific documentation requirements and project IDs.

Place Site Visit Label Here

Site Visit Form

Project ID:________________

Date: __________ **Time:** __________ **Personnel:** ____________________

Waterbody:____________________ Location: ____________________

Station ID: __________ HUC: __________ County: __________ AUID: __________

Latitude: __ __ . __ __ __ __ __ __ __ Longitude: __ __ __ . __ __ __ __ __ __ __ Elevation: ________ ft m

Field Duplicate to ☐ Field Blank ☐ Trip Blank ☐ Field Equipment Blank ☐

Samples Collected		**Sample ID**	**Sample Collection Information/Preservation**
Water	☐		GRAB EWI BACT
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Sediment	☐		SED-1
Analysis:			Preserved: None Other:
Benthic Chl-a	☐		Sample Method: C=Core H=Hoop T=Template N=None
Composite at Lab ☐ AFDW ☐ Visual Est. <50 mg/m2 ☐			Sample Location: R=Right C=Center L=Left
Transect: A__-__ B__-__ C__-__ D__-__ E__-__			F__-__ G__-__ H__-__ I__-__ J__-__ K__-__
Phytoplankton Chl-a	☐		D1 Filtered:______mL D2 Filtered:______mL
Phytoplankton CNP	☐		CN Filtered:______mL P Filtered:______mL
Algae	☐		PERI-1-MOD PERI-1 OTHER:
Macroinvertebrates	☐		MAC-R-500 OTHER: # of Jars:

Field Measurements	Time: am pm	**Field Assessments**
Water Temp: °C °F	Air Temp: °C °F	Photos ☐ Aquatic Plant Visual Assessment ☐ SAM ☐
Bar. Pressure: mm/Hg	SC: uS/cm	Aquatic Plant Tracking ☐ Rosgen ☐ NRCS ☐
pH: | DO: mg/L	Turbidity: NTU	EMAP ☐ Total Discharge ☐ Channel X-Section ☐
Turbidity: Clear ☐ Slight ☐	Turbid ☐ Opaque ☐	Wetland ☐ Bacteria ☐ Other:
Flow: ft3/sec (Dry Bed ☐	Stranded Pools ☐)	Only Transect F ☐ Total Site Length______m
Meter ☐ Meter-Auto ☐ Float ☐	Gage ☐ Visual Est. ☐	Transect Length_____m Average Wetted Width_____m

Data Loggers	
	Temperature ☐ YSI ☐ MiniDOT ☐ EC ☐ TruTrack ☐ AquaRod ☐ Weather Station ☐
	Deployed ☐ Cleaned/Checked ☐ Retrieved ☐

Chemistry Lab Information		
Lab Samples Submitted to:	Account #:	Term Contract Number:
Invoice Contact:		
Contact Name & Phone:		EDD ☒ Format: MT-eWQX Compatible
1) Relinquished By & Date/Time:	1) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	1) Received By & Date/Time:
2) Relinquished By & Date/Time:	2) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	2) Received By & Date/Time:

Lab Use Only - Delivery Temperature: Wet Ice_____°C Dry Ice_____°C

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APPENDIX C – EXAMPLE CALIBRATION LOG FORM FOR PRO PLUS

Page _____ of _____

Handheld SN:

Cable SN:

Instantaneous Field Meter Calibration and Checks

(One trip per page)

Project ID:

CALIBRATION				
Date Calibrated:		Staff Name:		
BAROMETRIC PRESSURE	Checked ☐ Calibrated ☐	Barometric Pressure reading: mmHg		
TEMPERATURE	Not checked ☐ Checked ☐	Temperature reading: degrees C		
PH	Calibrated ☐ Not Calibrated ☐	pH 7 manufacturer:	pH 10 manufacturer:	
		SB #:	SB #:	
		Lot #:	Lot #:	
		mV @ temp:	mV @ temp:	
CONDUCTIVITY	Calibrated ☐ Not Calibrated ☐	Solution:	uS/cm:	
		Lot #:		
		Conductivity reading before calibration:		
		Conductivity reading after calibration:		
DISSOLVED OXYGEN	Calibrated ☐ Not Calibrated ☐	Replaced 1.25 Yellow Membrane Cap? Y☐ N☐		
		mg DO/L @ temp:		
PROBES REPLACED	Y☐ N☐	Which? DO☐ Conductivity/Temp☐ pH☐		
		Reason:		
Notes:				

Page _____ of _____

Instantaneous Field Meter Calibration and Checks

(One trip per page)

CHECKS – to do daily in the field					
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:
Date:	Staff Name:	SVC:	pH check	Y☐ N☐	pH 7 reading @ temp:
			DO calibration	Y☐ N☐	mg DO/L @ temp:
			Conductivity check	Y☐ N☐	Conductivity reading:

If any pH checks trigger a calibration, record calibration information here:	If any conductivity checks trigger a calibration, record calibration information here:	Notes:
Staff Name: ____________________ Date: ____________________ SVC: ____________________ pH 7 mv @ temp: ________________ pH 10 mv @ temp: ________________	Staff Name: ____________________ Date: ____________________ SVC: ____________________ Conductivity reading before calibration: ____________________ uS/cm Conductivity reading after calibration: ____________________ uS/cm	
pH Buffer Solution Information:		
pH 7 manufacturer:		
pH 7 SB #:		
pH 7 Lot #:	**Conductivity Solution Information:**	
pH 10 manufacturer:	Solution:	
pH 10 SB #:	uS/cm:	
pH 10 Lot #:	Lot #:	

APPENDIX D – DO% CALIBRATION VALUES AND OXYGEN SOLUBILITY TABLE (YSI 2020)

6.1 Appendix A DO% Calibration Values

Calibration Value	Pressure			
D.O. %	in Hg	mmHg	kPa	mbar
101%	30.22	767.6	102.34	1023.38
100%	29.92	760.0	101.33	1013.25
99%	29.62	752.4	100.31	1003.12
98%	29.32	744.8	99.30	992.99
97%	29.02	737.2	98.29	982.85
96%	28.72	729.6	97.27	972.72
95%	28.43	722.0	96.26	962.59
94%	28.13	714.4	95.25	952.46
93%	27.83	706.8	94.23	942.32
92%	27.53	699.2	93.22	932.19
91%	27.23	691.6	92.21	922.06
90%	26.93	684.0	91.19	911.93
89%	26.63	676.4	90.18	901.79
88%	26.33	668.8	89.17	891.66
87%	26.03	661.2	88.15	881.53
86%	25.73	653.6	87.14	871.40
85%	25.43	646.0	86.13	861.26
84%	25.13	638.4	85.11	851.13
83%	24.83	630.8	84.10	841.00
82%	24.54	623.2	83.09	830.87
81%	24.24	615.6	82.07	820.73
80%	23.94	608.0	81.06	810.60
79%	23.64	600.4	80.05	800.47
78%	23.34	592.8	79.03	790.34
77%	23.04	585.2	78.02	780.20
76%	22.74	577.6	77.01	770.07
75%	22.44	570.0	75.99	759.94
74%	22.14	562.4	74.98	749.81
73%	21.84	554.8	73.97	739.67
72%	21.54	547.2	72.95	729.54

6.2 Appendix B
Oxygen Solubility Table

Solubility of oxygen in mg/L in water exposed to water-xaturated air at 760 mm Hg pressure.

Salinity = Measure of quantity of dissolved salts in water.

Chlorinity = Measure of chloride content, by mass, of water.

S(0/00) = 1.80655 x Chlorinity (0/00)

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.93	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	6.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72