Equipment Considerations

National Water Quality Monitoring Conference
Field Protocols Workshop

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Equipment for Continuous Water Quality Monitoring

Many different options!

- Sensors & sondes have become more affordable
- Can be deployed year-round, seasonally, etc.
- Can measure single or multiple parameters:
  - Temperature, water level, DO, conductivity, turbidity, pH, nutrients
- Can be set to record measurements at desired intervals (15-minute, 30-minute, etc.)




Considerations when selecting equipment

Depends on the objective of your study…

Common considerations:

- Waterproof? Durable? Can withstand ice cover?
- Measurement range?
- Accuracy/precision?
- Memory?
- Cost?
- Battery options?
- Compatibility? If purchasing multiple sensors, buying the same model is often the most cost-effective.

Considerations when selecting equipment

Sample specifications for temperature sensors used at Regional Monitoring Network (RMN) sites

Characteristic	Water sensor	Air sensor
Submersible/waterproof	yes[1]	optional
Programmable start time and date	yes	yes
Minimum accuracy[2]	±0.5°C[3]	±0.5°C
Resolution[4]	<0.5°C	<0.5°C
Measurement range – able to capture the full range of expected temperatures	−5 to 37˚C will typically work	depending on the location, −20 to 50˚C might be necessary (a typically available range)
Memory	Sufficient to record measurements at 30-minute intervals during deployment period	
Battery life	Sufficient to remain active during deployment period	

Accuracy, precision & resolution

Accuracy

- How close the measurement is to its “true” value, or its “correctness”
- Varies depending on the range of values
  - Ensure that the sensor can accurately record measurements over the range you expect the sensor to commonly experience
  - Generally better when sensor covers a small range of values

Precision

- Degree to which repeated measurements produce the same results, assuming conditions are unchanged (also referred to as variance or “tightness”)

Resolution

- Smallest change that the sensor can detect, or the “fineness” to which the sensor can be read

Batteries

How long will they last?

- Some last five years or longer. Others may last a year or less (depends on numerous factors).

Are the batteries replaceable?

- Some, yes; others, no.

If so, can the user replace the battery?

- Some yes; others, the manufacturer must replace them.

Check battery life during site visits when possible.

Document the sensor's use/expected battery life so that you know when to remove them from circulation and can budget/plan for their replacement.

Measuring water level

Methods for measuring continuous water level include: using a float, bubbler or a pressure, optic or acoustic sensor.

Measured data is either transmitted in real time or stored on the sensor for download

This presentation and EPA's guidance document focus on the use of pressure transducers because they are:

- Cost effective
- Relatively easy to install and maintain
- Readily available

Frequently asked questions

How do pressure transducers work?

They record **absolute pressure (air pressure + water pressure)**, from which air pressure must be subtracted to yield water pressure.

Software can then be used to convert water pressure to **water level** using the density of water.

Because atmospheric pressure changes with weather and altitude, **compensating for barometric variations is necessary.**

Frequently asked questions

United States Environmental Protection Agency

What is the difference between vented and non-vented pressure transducers?

Non-vented

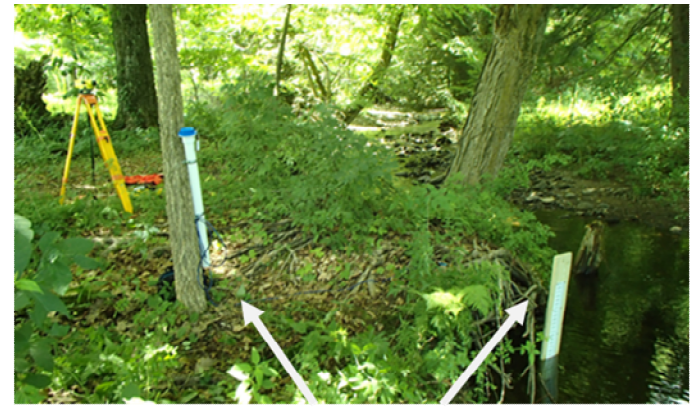
2 sensors* -

1 in the water,
1 on land

*there may be exceptions

Vented

Sensor in the water, cable runs to data logger on land



Cable runs from data logger to transducer

Vented pressure transducers

Pros

- Does not need to be removed from the stream to download
- Data are automatically corrected for barometric pressure

Cons

- Vented cable must be maintained
  - Desiccant
  - Damage to cable
- Cable lengths are fixed
- More visible than non-vented transducers

Non-vented pressure transducers

Pros

- Data loggers are internal
  - Less visible than vented transducers
- No vented cable or desiccant
  - Less maintenance

Cons

- Must deploy a second pressure transducer to collect barometric pressure
  - Data must be corrected post-download
- Transducer removed from the stream to download data

Frequently asked questions

If I am using a non-vented transducer, is it ok to use barometric pressure data from the nearest active weather station instead of deploying an on-land transducer?

It depends.

Barometric pressure can vary over very small distances, so evaluate on a **site-by-site basis**.

Bottom line: whichever data source is used, **it is critical that the barometric pressure readings accurately represent on-site conditions** because failure to account for pressure variations will result in erroneous water level measurements.

Additional considerations:

- Is the weather station expected to remain in operation during the period of deployment? Are the data QC'd?
- How frequently are data collected, and do they need to be interpolated to match with the in-stream transducer data?

Frequently asked questions

If different sites have different makes and models of sensors, how much variability will this introduce?

For temperature and water level, we don't expect this to be a big issue, provided the proper accuracy checks are performed to ensure that sensors meet the specifications quoted by the manufacturers.

This could be a bigger issue for other parameters, such as turbidity.

Accessories

Typically you also need:

- A **data offload device** that is compatible with the model of the sensor
- A **computer** with **software** that is compatible with the data offload device

If purchasing multiple sensors, **buying the same model may be most cost-effective** (only one data offload device and one software package may be necessary for that particular model of sensor)

Data offload devices

Options vary. Some sensors have options for:

- **Non-waterproof** base stations
- Portable **waterproof** device - can be used to temporarily store the data and can also serve as base stations

  Main benefits of the **waterproof** shuttles:

  - Field personnel **can work with them in inclement weather**
  - **Easy to carry in and out of remote sites** where bringing a laptop is impractical

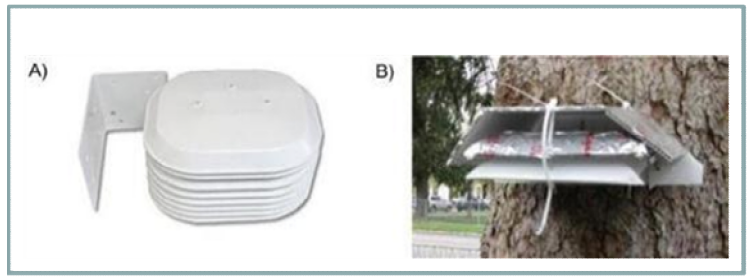
Additional equipment – Radiation shields

Purpose: prevent direct solar radiation from hitting the sensors and biasing the readings; can also serve as protective housing

Many options! Here are some examples…

Pressure transducer housings

Water temperature sensor shields



Air temperature sensor shields

Can be purchased from a manufacturer or constructed less expensively from materials purchased at a local hardware store (e.g., polyvinyl chloride (PVC) canisters)

Additional equipment

- Hardware, tools, etc. for installations and maintenance
- Staff gages
- Elevation surveys
- Streamflow/discharge measurements

Measuring streamflow

Several different types of equipment for measuring streamflow, including:

- Current Meter, either mechanical (e.g. pygmy, Price AA) or electromagnetic (e.g. Marsh McBirney)
- Acoustic Doppler Current Profiler (ADCP)

Meters come at various price points and levels of accuracy

Some meters integrate detailed quality checks and can measure direction and angle of flow

For wading measurements, current meter or ADCP will need to be attached to a wading rod

EXTRAS - Cameras

Deploy time lapse camera at site

Useful for:

- Tracking ice cover
- Verifying water level measurements (flow extremes, reference markers, etc.)

Digital photos can be particularly useful at certain times of the year!

February 13

February 18

February 23

March 2

March 3

Photos provided by Jeremy White (USGS)

EXTRAS – Crest gages

Crest gages can be used to obtain the elevation of the flood crest.
They are simple, economical, reliable and easily installed.

Photos provided by Jeremy White (USGS)

Bottom cap contains regranulated cork.

As the water rises inside the pipe the cork floats on its surface.

After the water reaches its peak and starts to recede, the cork adheres to the staff inside the pipe, thereby retaining the crest stage of the flood.

EXTRAS –
Multi-parameter sensors

Sensors are also available that measure additional parameters continuously, such as conductivity, dissolved oxygen (DO), turbidity, pH and nutrients.

Pros - provide a wealth of data

Cons - more expensive and more complicated to work with, and require more maintenance and QC for data to be defensible (e.g., should collect discrete measurements to validate; calibration is also a consideration – some can be calibrated, some cannot).

EXTRAS –
Real-time data

Some stations are set up to provide real-time data (like USGS gages). The data are sent to satellites or cell phone towers or by radio waves, and can be viewed from your desktop.

Pros –

- you don't have to go out to the site to download the data!
- you can catch problems faster

Cons –

- more expensive and more complicated to work with, and may require more maintenance

Satellite telemetry station (courtesy of Michelle Craddock)

Cellular telemetry station (courtesy of Michelle Craddock)

Some sensors are also available that are Bluetooth capable, which allows you to download data to a device like a tablet without having to retrieve the sensor from the water.

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QUESTIONS? COMMENTS?

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