6.5 PROTOCOL FOR AUTOMATED SAMPLING (MULTI-PROBES)

Overview

In situ measurements of variables such as pH, DO (dissolved oxygen), temperature, conductivity, and turbidity are routinely taken automatically over time (long-term deployment). Typically, the data are collected using multi-probe instruments called sondes that are positioned at mid-depth in rivers and streams. Long-term deployment of a multi-probe system provides an almost continuous record of temporal changes in parameters that can be used for a variety of purposes. Weather may limit year-round operations for some automated stations in Canada.

The location of each potential site depends on the purpose of the study, accessibility, safety, stream morphology, seasonal flow patterns and cross-section variability. All automated water-quality sampling stations must be accessible (near a road or by aircraft such as, helicopter), safe (shallow sloping banks), and have a minimal chance of being damaged or destroyed by natural forces (windfall of trees, snow pack and ice). Protection from vandalism is imperative. In general, the three components to keep secure are the sonde (use protective deployment tube), the accessory equipment (data logger, batteries, and additional power sources), and the cables.

There must be a pool of water removed from riffle areas in which the sensor can be deployed. A straight stretch of stream above and below the sampling location is required to minimize the cross-sectional variability. During high flow periods, the instruments may be removed from the stream. The variation in the water chemistry across the stream at the sampling site should be determined before the station is established.

Sources

B.C. Ministry of Environment (2006), United States Geological Survey (2006)

Special safety concerns

Refer to the Protocols for working near swift water and working in remote areas

How they differ

The reader is referred to the actual references cited because the protocols for different situations and types of equipment can vary significantly and the detailed procedures for operating these stations are beyond the scope of this manual. This manual provides only a general overview of techniques.

At a glance

Components

1 Equipment used in automated sampling has three parts: the sensors used to collect the data; the accessory equipment which

includes a combination of a data logger, power source and a means of retrieving the data; and the cables and adapters. These individual parts must work together and be protected.

2 **Sensors** (electrical, electrochemical, or optical) respond to changing water conditions with an output signal that is processed, displayed and recorded. The choice of sensor depends on the parameters, the required specifications, the operating conditions and required life span. Several sensors are usually contained in a multi-sensor sonde (Photo 9).

3 **Data loggers** may be contained within a sonde or connected externally. Data filtering and processing is completed within the data loggers. The time interval of the recorded samples is determined by the user. The duration of individual samples is a function of the sensors.

4 Possible **sources of power** are internal batteries (which are contained within the sonde), external batteries and solar panels (used for satellite transmission). **Cables** (instrument and site-specific) connect the external batteries to the sonde or the solar panel to the external battery. The connection process is not addressed in this manual. Depending on the capacity required (amp-hours); external batteries should be a good quality gel-cell type, or a deep discharge sealed lead-acid style. Residential (110V) and solar power sources can be used as auxiliary power to the primary battery for recharge purposes. Residential and solar power sources should not be directly connected to an instrument, as voltage spikes can occur and cause the entire system to fail. Use of a voltage regulator is recommended when connecting an auxiliary power source to the primary battery.

5 **Communication and data retrieval** can be done on-site with a laptop or hand-held display. Data retrieval can also be achieved remotely in real-time using phone or satellite communication.

6 **Deployment** refers to the way that the sensor comes into contact with the ambient water. There are two main deployment methods. The sensor is either placed in the stream or the stream water is brought out of the stream to the sensor. The former is called an *in situ* or in-stream system and the latter is called a "flow-through-system" or a side-stream system. With *in-situ* systems the sensor may be placed in tubes that are fixed vertically or positioned at an angle to the stream bank, or contained in a retractable boom (Figure 8). This reduces the movement of the instrument and the possibility of it being swept away in high flow.

Monitoring basics

frequency of

To ensure the integrity of the data being recorded, all multi-probes must be serviced. During the servicing, the stream data

field visits

can be downloaded and collected for analysis and review. Servicing an instrument is completed during a field visit.

1. The frequency of the field visits depends on the stream conditions. New sites should be visited every two to three weeks. At sites where there is no remote real-time communication, the frequency should not be greater than the longest period of data that the operator is willing or allowed to lose. Some remote areas can be visited every 30 days.
2. Field visits include procedures to be undertaken on-site and/or in a stable environment (sheltered area with a stable temperature for working and storing calibration standards).
3. A cleaned portable sonde is used for comparison against the deployed field sonde. The portable sonde must be within the same specifications as the deployed sonde. There is the possibility that during deployment the parameter sensors become fouled, drift out of calibration or malfunction resulting in sensor error. (See source manuals). During transport of sondes, the parameter sensors must be kept from drying out and should be kept moist.
4. A list of field supplies should be prepared and consulted prior to and during each field visit.
5. Laboratory samples for some parameters (specific conductivity, dissolved oxygen, pH and temperature are field-measured variables) may be required. Several jurisdictions collect samples on each site visit. Other jurisdictions do not routinely collect samples and base the findings on the multi-sondes. This is acceptable if the data is obtained from sensors that are inspected and calibrated routinely.

minimize bubbles

6. Stream turbulence can produce bubbles that interfere with the readings on optical sensors (e.g., turbidity and chlorophyll-*a*). However wipers present on these sensors can remove the bubbles, this reduces the risk of an error reading. If the sensor does not have a wiper, angle deployment is preferred to prevent bubble accumulation.
7. The sensors must be placed effectively within a water column. It is important to ensure that there is a minimum distance from the surface, as this will eliminate the effects of solar radiation. There should also be a minimum distance from the substrate to obviate effects of bedload transport.

Recommended protocol

When cleaning or calibrating a multi-probe, ensure access to a temperature stable and protected location. Some chemical standards used to calibrate the multi-probe are temperature-sensitive and it is always important to reduce the likelihood of contamination. In most cases, the data is collected at the field site. Pre-cleaning data can be collected in stream water at the

field site. The post-cleaning data can be collected in stream water transported to the stable environment away from the field site (this may not be possible for all sites) or during re-deployment. To ensure the changes occurring during the transport of stream water are captured, each reading with the deployed (D) sonde is paired with a reading of the portable (P) sonde. The readings of the portable sonde are used to determine the change in the stream water during its transport from the stream to the stable environment.

1 Before a site visit, organize necessary field supplies, calibrate applicable portable sonde and ensure that the required laboratory supplies are available. In the very first site visit the deployed instrument will also have to be calibrated and prepared for long-term deployment.

2 At the field site, inspect the site for damage to equipment or any applicable changes to deployment site (i.e. high flow, turbid water). The logged deployment data can be downloaded. Compare the portable sonde against the field deployed sonde *in-situ* or from “a bucket of stream water”. If applicable collect stream samples. Clean the deployment tube of any debris or sediment that may be caught inside. Transport the sondes to a stable location for complete calibration and clean.

3 When the instrument is removed to a stable environment for calibration and cleaning, firstly inspect the condition of the sonde and its sensors, clean the instruments’ sensors as specified by the manufacture. Place the instrument "in a bucket of stream water" and record all data. Continue with calibration, record information on calibration standards, collect the calibration drift data (measurement in calibration solution prior to re-calibration), and calibrate (using standard calibration standards) or if necessary replace the sensors. Wrap the guard in a damp towel or replace the guard with some water in the calibration cup or with a moist sponge on the bottom of the calibration cup. Put the cap/plug on the sonde to protect the electronic connections and prepare the sondes for transport to the field.

4 The difference between portable sonde readings is a result of changes occurring in the natural environment of the stream. The difference in deployed sonde readings is the calculated difference due to fouling. The amount due to fouling is obtained by subtracting these two differences.

5 When re-deploying the field instrument, record the re-deployment data firstly "in a bucket of stream water”, and then *in situ*. Each new sampling period starts with freshly calibrated and cleaned sensors to minimize sampling drift during the deployment period.

6 After each field visit data grades or ratings are calculated.

Other sources

ISO 2003 (b), ISO (2008 a), Nova Scotia Department of Environment and Labour Undated

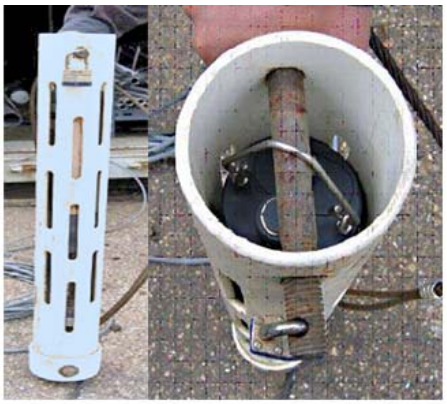

Photo 9 Left. A sonde with a number of probes and a wiper (Source: B.C. B.C. Ministry of Environment (2006))

Photo 10 Right. Slotted deployment tube (top view on right - prevents access to sonde and sensors and helps support sonde) (Source: B.C. Ministry of Environment (2006))

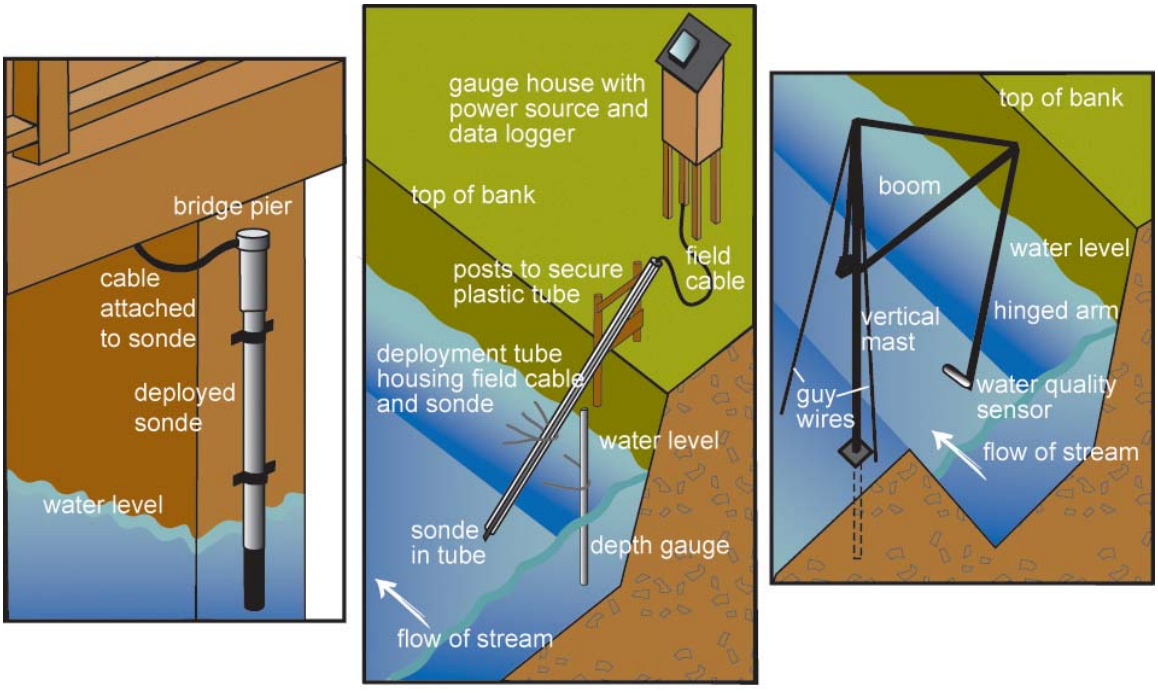

Figure 8. Deployment tubes (from left to right: vertical, angle and retractable boom) (Source: B.C. Ministry of Environment (2006))