

MassDEP

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| **Massachusetts Department of Environmental Protection**  **Division of Watershed Management** |

STANDARD OPERATING PROCEDURE

**Continuous Conductivity Monitoring**

CN 349.0

September, 2015

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### *\* see pdf version for valid signatures*

# List of Revisions

|  |  |  |
| --- | --- | --- |
| Revision Date | Revision | Pages #s |
| Sept. 2015 | --- | --- |
| June 2017 | Added references, time correction procedures… |  |
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**1.0 SCOPE AND APPLICATION**

Automated, cost-efficient, continuous conducutivity data are collected as a general indicator of pollution levels and to estimate chloride levels in water using regression equations.

This SOP addresses the procedures in use by WPP for continuous conductivity deployments in streams and rivers.

**2.0 SUMMARY**

The majority of procedures are specified in the manufacturer instructions (Appendix A). In addition, WPP-specific procedures are also provided.

**3.0 SAFETY CONSIDERATIONS**

There are no SOP-specific, additional safety “rules”, other than to apply standard safety protocols for all field work.

**4.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING**

In cases where water samples are collected for QC purposes or to establish/maintain correlation data (e.g., chloride), follow WPP standard protocols for water sample collection (CN 1.24). Samplers.should stay upstream of continuous loggers when collecting samples.

See Section 8.0 for discussion regarding field measurements for QC accuracy checks.

**5.0 APPARATUS, EQUIPMENT AND MATERIALS**

The following materials and procedures can be used to collect continuous conductivity data (see Appendix A for additional information regarding sensor specifications):

Sensing and Data Retrieval: Onset HOBO U24 conductivity sensors, optic shuttles, optic base stations and Hoboware Pro software (Onset Computer Corp.). The 6” long, sealed polycarbonate optic sensors are initially launched (data logging initiated) using Hoboware. All sensors must be deemed fit to use and re-launched prior to placement in rigid plastic tubes for field use. At the same time, the optic shuttle (used for field downloading without a laptop) and the optic base station (for data transmittal from a sensor or the shuttle to the PC) are also tested to make sure they are working satisfactorily. After placement in the plastic tubes, the sensors are anchored at representative stream/river locations at each location.

Sensor Housing and Anchoring Assembly: To protect each sensor, each unit is placed in a 9-12” long, 2” O.D. ABS plastic pipe with caps on both ends. Several ¾” holes are drilled into each pipe section to reduce buoyancy. Also, the enclosures are numbered to keep track of which sensors are at which locations. Flexible plastic coated cables with looped ends and locks are used to secure the units at each location.

Field Deployment and Retrieval: Units are typically deployed with the tube secured off the bottom with rocks and/or concrete block. Vertical orientation preferred (to avoid bubbles on the sensor). The cable must be hidden as much as possible. The pipe number, station name and number, exact time and other relevant field data are documented on dedicated deployment fieldsheets.

Accuracy checks: Attended specific conductance readings can be collected in the lab prior to deployment and in the field to check sensor accuracy. NOTE: Measurements in specific conductance at 25C must be corrected to conductivity at the ambient collection temperature using appropriate equation (see Appendix B). At a minimum in the field, checks should be made both at deployment and at retrieval (required), with a minimum preferred frequency of monthly in-situ checks.

Data Upload: After retrieval, units are transported back to the office for upload to PC. Units are cleaned and dried. The optic base stations are used to connect the loggers to the PC. Using READOUT, each logger’s datafile is uploaded into Hoboware Pro, where they are then exported to read-only EXCEL files. Data processing is done using EXCEL.

Data Validation, Management and Analysis: Data are exported to MS EXCEL or other database tool(s) for trimming, validation, analysis and graphics.

#### 6.0 REAGENTS

NA

**7.0 CALIBRATION**

Units are factory-calibrated. Pre- and post-survey quality control checks (and field QC checks), however, are required to verify accuracy. NOTE: QC measurements in specific conductance at 25C must be corrected to conductivity at the ambient collection temperature (see also Appendix B) by solving for *Cm*

in the following equation:

*C25 = Cm /(1 + TCV (tm – 25))*

*C25* = corrected conductivity value adjusted to 25C;

*Cm* = actual conductivity measured before correction; and

*tm* = water temperature at time of *Cm* measurement

*TCV=Temperature Coefficient of Variation (for fresh water, use 0.02; ~2.0%/deg C; Barron and Ashton, 2007)*

**8.0 PROCEDURE**

For all instructions related to the conductivity sensor units, see Appendix A.

Documentation:

1. Use probe deployment fieldsheets for all fieldwork, including deployment, QC audits and sensor retrieval. Important “metadata” to document at each site include on exact sensor location, flow, water velocity, average water depth, channel width, habitat type, riparian cover, weather .

Launching and Pre-Testing of Sensors/Software:

1. Follow manufacturer’s steps to initiate data logging for each sensor using office PC and Hobo software. Set measurement interval (**30 minutes** typical) and **delayed start date/time on the ½ hour**.

Sensor Placement and Retrieval:

1. Place all **sensors** in locations in representative flowing conditions and shaded from direct sunlight during most/all daylight hours (this will prevent direct solar heat gain by the sensors).
2. Before actual deployment in-stream, take a few moments to observe the river’s flow patterns, streambank features, bedload type, meander pattern, possible anchor points, etc. Since the logger will be deployed for a long duration, anticipating river conditions at lower/higher flows may help to avoid problems, such as out-of-water.
3. If appropriate, anchor cables to fixed objects on the near shore for easier access, especially for wide, flashy rivers.
4. Camouflage sensor assembly (tube and cable) sufficiently and as needed. In most cases, employ “stealth” deploy protocols. Also, make sure deployment does not create a hazard (e.g., tripping, boating hazard).
5. Mark anchor points (e.g. tree) with unique flagging color to differentiate from other colors used. In some cases (e.g., boating), it may also be necessary to flag the cable line to notify boaters of the hazard.
6. Make sure encased sensors are properly secured and anchored in the water column (on large flat rocks or blocks off the sediment) for all anticipated water levels and velocities for the duration of the deployment. VERTICAL ORIENTATION RECOMMNEDED.
7. High flows and velocities can be mitigated against by using the largest rocks available to secure the tube in place AND anchoring the tube and cable to fixed objects on shore (not large in-stream objects such as LWD). For wider rivers, this may require the use of multiple cable lengths looped together. For meandering rivers, avoid anchor trees on the outer banks that appear that they might be swept downstream in the next big rain event. Inner bends are also problematic, as these are depositional areas where tubes can be buried under rocks and sediment as stream beds shift and realign.
8. For each deploy, fix the tube as low as possible in the water column to mitigate against lowered water levels, due to natural summertime low flows and/or tidal fluctuations, water withdrawals, etc. Use stable blocks to keep tube off the bottom for the duration of the deployment. For deep slow-moving rivers,
9. Beware of areas with recent or active beaver activity. If such conditions exist or are anticipated, choose the largest diameter trees available and attempt to anchor the cable as low as possible at the tree base. Alternatively, anchor to non-beaver food objects.
10. Due to the potential for older used locks to fail during the deployment, consider the use of additional mechanisms to secure the tube caps, such as cable/zip ties
11. During the deployment period, instruct crews performing other survey work to briefly inspect the deploy tube setup, and if problems have arisen since the last visit, to rectify problems immediately and document actions on the deployment fieldsheet (back at the office).
12. Place in locations that are well mixed horizontally and vertically, and outside any mixing zones from discharges. For placements downstream of a discharge, keep the sensor as close to the discharge as possible without mixing zone effects (site-specific).

Field Quality Control Sampling:

1. Perform adequate quality control accuracy checks. Co-located, simultaneous measurements are preferred.
2. Consider duplicate (side-by-side) deployed sensors to estimate sampling precision for the loggers, if possible
3. Beware that one or more sensors may fail before or during the monitoring period. Have additional, back-up sensors on hand to replace failed sensors. Weekly, bi-weekly or monthly data downloads using a “shuttle” device or laptop can be employed to verify sensors are in working order.

Data Upload and Post-Deploy QC:

1. After all units have been retrieved and cleaned, use Hobo software with base station to upload data from loggers to PC (READOUT). Set units to **degrees Celsius** for uploaded files.
2. Retain original raw uploaded files in Hobo software (unaltered) and also export files to EXCEL (.csv) as read-only.
3. All data files are stored electronically at DWM offices in Worcester, MA. to C:/ (working PC); W:/sop/temp (network temporary); W:/dwm/data/rawdata/year data/temperature; and in secure database areas.  **Immediately after upload, contact DB Manager and QA Officer for import to protected network locations.**
4. Use uploaded files for processing, validation and analysis.
5. Perform post-deploy QC by checking sensors against specific conductance standard solution.

Data Validation:

Data generated through the use of continuous temperature sensors must be validated prior to use. This is performed by DWM’s QA Analyst or database staff per WPP standard procedures.

Time corrections due to EST/DST shifts….

**9.0 QUALITY CONTROL**

Typical data quality objectives (DQOs) for use of continuous conductivity sensors are as follows:

Table 1: DQOs for Continuous COND/Temperature Sensors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Analyte** | **Units** | **Expected Range** | **Accuracy (+/-)** | **Resolution** | **Overall Precision (RPD)** |
| Conductivity | uS/cm | Low and high ranges | 3% or 15 uS/cm (low)  3% or 30uS/cm (high)  (vs. lab standard)  5% RPD (calculated SC vs. lab standard SC) | 1 uS/cm | +/- 10 uS/cm (low)  +/- 40 uS/cm (high) when compared to side-by-side field measurements |
| Temperature | °C | 0-35° | 0.2° (vs. NIST-traceable thermometer) | 0.01° C | < 0.5 difference when compared to side-by-side field measurements |
| Time (sensor internal clock) | minutes, seconds | --- | +/- 1 minute per month | 1 sec. | --- |

**10.0 INTERFERENCES**

See Section 8.0 for discussion of potential complications and problems related to sensor setup, location and poor quality control.

1. **PREVENTIVE MAINTENANCE**

Upon retrieval and transport back to the office, thoroughly wash and clean sensor units, cases, cables and anchors with soap and warm water. DO NOT SCRATCH SENSOR FACE. Store in labeled box/bin accordingly for the next user.

1. **CORRECTIVE ACTIONS**

Take the following corrective actions (as needed) during and following data collection:

1. Inspect sensor placement immediately following deployment and during data collection for problems related to sensor placement. If encased sensor is not in the water column, retrieve and replace correctly. Document on fieldsheet that sensor was re-positioned (even if for a moment).
2. **WASTE AND POLLUTION PREVENTION**

Consider the following in order to minimize waste during continuous temperature sensing projects:

1. Reuse sensor PVC/ABS cases as much as possible by cleaning and storing after use.

2. When planning QC field checks/audits of the sensors, combine the effort with water quality and/or other field surveys to save staff resources, gas, etc.

**14.0 REFERENCES**

Barron, J.J. and Ashton, C. The Effect of Temperature on Conductivity Measurement. http://www.reagecon.com/PerspectiveCMS/uploads/ Effect\_of\_Temperature\_TSP-07\_Issue3.pdf

Appendix A

Onset HOBO U24 Manual

(double click on object below to open manual)



Appendix B

Correction Factors for Conductivity – Specific Conductance

(double click on objects below)

