New Mexico Environment Department
Surface Water Quality Bureau

Standard Operating Procedure

for

# TEMPERATURE DATA LOGGERS (THERMOGRAPHS)

Approval Signatures

Gary Schiffmiller — 3 Apr 2013
Gary Schiffmiller
Subject Matter Expert — Date

Jodey Kougioulis — 4/3/13
Jodey Kougioulis
Quality Assurance Officer — Date

Shelly Lemon — 4-3-2013
Shelly Lemon
Acting Program Manager — Date

## 1.0 Purpose and Scope

The purpose of this document is to describe the procedure for deploying and maintaining thermographs and managing thermograph data.

## 2.0 Personnel Responsibilities

Personnel who deploy thermographs, upload or manage thermograph data, or who are responsible for thermograph accuracy are responsible for implementing this procedure. Field staff are responsible for deploying thermographs and for interim uploading of thermograph data.

One individual within each section (MASS, WPS etc.) is designated as the Thermograph Manager (manager). A second individual is designated as the Alternate Thermograph Manager (alternate) and fulfills the manager's responsibilities when the manager is unavailable. The manager maintains thermographs, associated hardware software, instruction manuals, and accessories in working order and available for staff to use.

The manager keeps a record of the disposition of each thermograph. The record includes the thermograph serial number, current status of each thermograph (available for use, launched and awaiting deployment, deployed, or retrieved and awaiting upload), deployment location, person responsible for the thermograph, date of checkout, and any other pertinent information. The manager also keeps a record of the disposition of all thermograph-related accessories, such as optic shuttles and base stations.

## 3.0 Background and Precautions

Do not wade a stream to deploy a thermograph if the depth (ft) of the stream times the stream velocity (cfs) is greater than ten (The "RULE OF 10"). Site conditions or project-specific data collection objectives may necessitate the use of alternative field procedures not included in this SOP. The use of field methods other than those presented in this SOP must be approved by the Program Manager and alternative methods must be accurately documented. This procedure is based on the capabilities of the Onset HOBO thermographs described in Section 5.0.

**4.0 Definitions**

Thermograph - A small portable device that logs temperature data at predetermined intervals.

**5.0 Equipment and Tools**

The thermographs that the Bureau uses are manufactured by:

Onset Computer Corporation
470 MacArthur Blvd.
Bourne, MA 02532
Mailing address: PO Box 3450, Pocasset, MA 02559-3450
Phone: (508) 759-9500 or (800) LOGGERS
Fax: (508) 759-9100
Email: loggerhelp@onsetcomp.com
Internet: <http://www.onsetcomp.com>

The specific model currently used is the HOBO® Water Temp Pro v2 which requires HOBOware Pro® software. The Bureau currently uses Version 3.0.0.

In addition to thermographs, the following equipment may be useful for thermograph deployment, retrieval, and upload:

**Table 1 Equipment**

| Item | Comment |
|---|---|
| Plastic wire ties | 8 inch length to secure thermograph to rebar |
| Surveyor's flagging tape | To mark thermograph deployment location |
| rebar stakes | 3/8 or 1/2 inch diameter steel (two to four feet long) to anchor thermograph in stream bed |
| Steel T-posts | 6 and 8 foot; to anchor thermograph in sediment-dominated stream beds |
| T-post Driver | To set T-post in the stream bed |
| Sledgehammer | 3 to 4 pounds; to drive rebar stakes |
| Tie wire | To secure thermographs to rebar or T-post |
| Diagonal pliers and lineman's pliers | To cut and twist tie wire or to cut zip ties |
| Digital camera | To photo-document the location of the thermograph |
| GPS unit | To record the coordinates of the thermograph location |
| 30m measuring tape | To measure the distance from the thermograph to nearby landmarks to facilitate retrieval |
| Metal detector | To facilitate thermograph location upon retrieval |
| Modified mattock | With a V-notch cut for pulling rebar from the substrate during retrieval |
| Bumper jack and chain | For retrieval of T-post, which is usually not possible to remove by hand |
| Waterproof shuttle | Onset Computer Corp. Part # U-DTW-1; to upload thermograph without having to remove it from the water |

| | |
|---|---|
| Laptop computer | To launch, download, upload, or otherwise operate thermographs in the field |
| Power inverter | To power the laptop in the vehicle |
| Thermograph Field Forms | For Deployment, Download, and Retrieval |

**6.0 Step-by-step Process Description**

*6.1 General Guidance*

Thermographs may be deployed in the water (a stream or lake) or in the air. The number and locations of thermographs, and whether an air thermograph is deployed should be described in the Field Sampling Plan.

The maximum interval for SWQB monitoring of standards attainment using a thermograph is one hour. Shorter intervals provide a more precise estimate of the duration of daily maxima, and they may be used without a negative impact to data quality. Intervals of less than five minutes may cause the memory capacity of the thermograph to be exceeded within one field season. A one hour interval is considered adequate for typical assessment purposes.

Monitoring should include the period of maximum expected temperatures. In New Mexico, this is generally from June through August, when incident solar radiation angles are high and ambient air temperatures are most likely to be at maxima. Knowledge of local temperature patterns is necessary if the monitoring period is to vary from this.

Thermographs may be checked out for use from the manager, who will launch the thermograph (i.e., set the recording interval and start time, etc.) according to the Field Sampling Plan or the staff member's specifications.

*6.2 Deploying the Thermograph*

**A.** Select thermograph locations according to the Field Sampling Plan, typically in each Assessment Unit (AU) for standards assessment monitoring. For stream restoration effectiveness monitoring, thermographs are deployed upstream and downstream of the project reach. Additional locations may be monitored as needed.

Select locations representative of ambient conditions. Deploy the thermograph in water with a consistent flow. Avoid locations in shallow riffles or in deep pools with poor circulation. Locate the thermograph in a transition between a riffle/run and a pool, and if possible, at the toe of a pool as it becomes shallower, prior to entering a run or riffle. If there is only shallow water available, attempt to find a shaded location to reduce the effect of direct solar gain. Ensure that under expected flow conditions, the thermograph will be continually submerged but not buried in sediment.

If an air thermograph is deployed, locate it at a location that will be shaded throughout the day, typically on a tree branch near the trunk. Detail the actual conditions of thermograph deployment on the deployment field sheet.

**B.** Unless another stationary object is available, drive a rebar stake or T-post into the stream bed using a small sledgehammer or T-post driver. Secure the thermograph to the rebar using at least two plastic wire ties. In very cold water, plastic wire ties may be too brittle to tighten without breaking. If this occurs, steel tie wire may be used. For soft sediment or deeper streams, secure the thermograph to a steel T-post. In areas frequented by the public, take precautions against vandalism, theft, and accidental disturbance by additionally securing, concealing, or camouflaging of equipment.

**C.** Provide a detailed description of the precise deployment location. Complete the deployment field sheet as extensively as possible, including the GPS latitude/longitude (in decimal degree format) of the thermograph location (not the station latitude/longitude). Draw a sketch map, clearly indicating the direction of flow, left and right bank, and other features that would enable staff not present at the deployment to easily locate the thermograph for retrieval. As necessary, take one or more photographs showing the precise deployment location, typically with a person indicating the location of the rebar or T-post and/or flag the locale with surveyor's tape to facilitate location upon return.

**D.** Because thermographs are subject to loss for a variety of reasons beyond staff control (e.g. vandalism, theft, high flows), it is advisable to upload data periodically (typically once a month) during the deployment period. The waterproof shuttle is the most efficient method to upload data in the field, but a laptop computer can be used in the field if necessary. It is not necessary to remove the thermograph from the water to upload data to the shuttle, however one wire tie typically must be cut. Make sure the communication end of thermograph is clean, insert this end into the shuttle, aligning arrows on each device, and press the coupler lever. An amber LED light will flash during download. Do not remove until LED light turn to flashing green. The shuttle automatically re-launches the thermograph after interim upload or it can be left in recording mode during the upload if using the laptop. Assign a file name, consisting of the station name and thermograph serial number, to each data set upon the initial interim upload (this is done when transferring data from the shuttle to the computer, or at the time of upload if using the laptop in the field). Record the interim upload date and time on the deployment field sheet.

**E.** Upon return from the field, copy the data to the manager's thermograph folder on SWQB Public (and, optionally, to the survey lead's computer). The data may be left in raw form (i.e., not exported to an Excel spreadsheet) at this time if desired. Provide copies of the interim deployment field sheet to the thermograph manager.

**F.** At the end of the deployment period retrieve the thermograph along with rebar or T-post. If installed properly the rebar or T-post is difficult to remove. Rebar stakes can be removed using the modified mattock with the V-notch, much like pulling a nail from wood with the claw of a hammer. A T-post is more difficult to remove and may require the bumper jack connected by a chain or heavy duty strap. A flat piece of plywood is useful as a base to keep the jack from sinking into the substrate. Extra caution is advised when using the bumper jack as there is a greater risk of injury due to the amount of force applied.

**G.** After retrieval, return the thermograph to the thermograph manager, along with a copy of the final deployment field sheet. Place original in survey binder.

*6.3 Uploading and Thermograph Data*

Data can be uploaded in the field using the waterproof shuttle or using a laptop computer. If not uploaded in the field, the thermograph manager uploads the data when the field staff returns the thermograph. Whether uploaded in the field or in the office, there process for uploading data is as follows:

(Field Team Member)
**A.** Return the thermograph and deployment form to the thermograph manager.
(Thermograph Manager or Alternate)
**B.** Upload data from each thermograph or shuttle.
**C.** Assign file names if not previously done (the file name consists of the station name followed by the thermograph serial number followed by "air" if the data are for air temperature).
**D.** Export the data to an Excel spreadsheet.
**E.** Add a row to the top of the spreadsheet and in it indicate the Station ID (not station name) and latitude/longitude of deployment location (not station lat/long).
**F.** Delete any data points that were recorded either before or after the actual deployment.
**G.** Record status of thermograph in thermograph log.
**H.** Return thermograph to storage

*6.4 Thermograph Accuracy*

Before each field season, the thermograph manager verifies that each thermograph is reading within ±0.5°C of an accuracy-certified thermometer. The SWQB uses the State Laboratory Division of the New Mexico Department of Health (SLD) to certify thermometers for accuracy at no cost. The certified thermometer should be certified annually at two temperatures. See SOP 6.4 for V&V procedures, data management, and NMEDAS upload instructions of long term deployment data loggers.

The manager verifies the accuracy of the thermographs according to the following procedure:

**A.** Program thermographs to record simultaneously at intervals of no longer than fifteen minutes.
**B.** Set up a water bath in an insulated cooler that is allowed to equilibrate to room temperature.
**C.** Place the thermographs in the water bath and allow them to stabilize for at least twenty minutes.
**D.** Check and record the temperature of the water with a certified thermometer at the same time that the thermographs are set to record, taking care to ensure that the bath is well mixed and has not stratified by the time the thermographs are set to record. Allow the thermographs to record for one hour.
**E.** Verify that the thermographs record temperatures within ±0.5°C of the certified thermometer.
**F.** Record in the thermograph log each unit's test date, temperature discrepancy, and the reference thermometer used.
**G.** Return to the manufacturer any thermographs that fall outside the acceptable accuracy range.

**Table 2 Calibration Criteria and Maximum Allowable Limits for Data Adjustment**

| Measurement | Standard | Standard Value | In-calibration Range | Linear Interpolation Range (Max Allowable Limits) |
|---|---|---|---|---|
| Temperature, °C | Certified Thermometer | Ambient Temperature | ± 0.5 | ± 2 |

**7.0 Related Forms**

Thermograph Deployment/Upload/Retrieval Field Sheets
HOBO® U22 Water Temp Pro v2 Instruction Manual
HOBO® Waterproof Shuttle Instruction Manual
HOBO® Optic USB Base Station Instruction Manual

**8.0 Revision History**

Revision 1 – 3/15/2013 – Minor editorial changes.
Original modified from SOP 2007.

**9.0 References**

None