

SOP 2.4: Quality Assurance and Control Procedures

This document summarizes MIDN water quality data quality procedures. Quality assurance (QA) is integral to the success of the protocol which is why these procedures occur at every stage of monitoring from preparing for field work to data management. Quality control (QC) data generated during this process is used to prevent the collection of and/or censor erroneous data, apply corrections to biased data, and rate the accuracy of data. As methods are conceptually similar, procedures for discrete and continuous data are presented together here unless specifically noted.

Contents

I. Field Preparation Quality Assurance Procedures	1
A. Acquisition of Supplies.....	1
B. Sensor Maintenance and Repair.....	2
C. Calibration Procedures	2
D. Pre-Field Deployment Sensor Checks.....	2
II. Field Data Acquisition Quality Assurance Procedures	2
A. Discrete Field Data Acquisition Procedures.....	2
B. Continuous Monitoring Field Data Acquisition Procedures.....	2
III. Post-Field Data Acquisition Quality Assurance Procedures.....	3
IV. Data Management Quality Assurance Procedures.....	3
A. Discrete Data Management Procedures.....	3
B. Continuous Data Management Procedures.....	4
V. Data Certification Procedures.....	4
A. Discrete Data Certification.....	4
B. Continuous Monitoring Data Certification	6

I. Field Preparation Quality Assurance Procedures

A. Acquisition of Supplies

A variety of consumable products are used throughout the procedures found in this protocol. It is important that these items are kept on-hand but are used or discarded prior to expiry dates if applicable. In an effort to maintain stocks within these parameters, calibration supplies are purchased to supply a six month period and ordered twice a year where all expiry dates are a minimum of one year from the purchase date (SOP 1.2). All calibration supplies must be stored in a climate controlled facility to ensure protection from extreme temperatures.

B. Sensor Maintenance and Repair

Procedures for maintaining and repairing sensors are provided in SOP 1.2. Many sensors require periodic maintenance or replacement to ensure accuracy. In addition to regular maintenance events, sondes/sensors are subject to periodic failure and require service or replacement. A log book is maintained for each sonde/meter which documents all maintenance and repair activities (SOP 1.2).

C. Calibration Procedures

To ensure high quality data is collected, strict calibration procedures are followed for water quality equipment (SOPs: 1.4, 1.5, and 1.6). Guidelines for rejecting calibrations based on observed data during the calibration process are presented within these procedures. If a sensor fails to meet calibration criteria then the sensor must be brought into working condition prior to the collection of field data or the data for the faulty sensor is not recorded. All calibration procedures are based on USGS methods or manufacturer guidance as appropriate for the sensor.

D. Pre-Deployment Sensor Checks

Prior to collection of water quality data all sensors are evaluated to ensure that accuracy and precision limits (sensor check error limits) are met. This is accomplished by checking sensor performance either with a standard solution close to the range of values expected in the field (e.g., SpC is calibrated at 1412 $\mu\text{S}/\text{cm}$ and the sensor is checked at 100 $\mu\text{S}/\text{cm}$) or confirmation of calibrated value (e.g., 100% DO calibration performance; SOPs: 1.4, 1.5, and 1.6). Guidelines for rectifying a failing sensor are presented in the SOPs and data is not collected if a sensor does not pass pre-deployment sensor checks.

II. Data Acquisition Quality Assurance Procedures

A. Discrete Data Acquisition Procedures

All field observations recorded during discrete monitoring site visits are either accepted or rejected (censored) based on quality control data acquired during calibration, pre-field deployment, and post-field deployment sensor error checks. However, while collecting field data several steps are taken to ensure accurate data is collected including confirming site locations, proper placement of sensors in the stream, and ensuring stability of observations in the field (SOP 1.9).

B. Continuous Monitoring Field Data Acquisition Procedures

In addition to the capture of quality control data during calibration and sensor checks (SOPs 1.5, 1.6); quality assurance procedures are implemented in the field during site visits. These procedures are presented in the Site Visit Procedures for Maintaining Continuous Monitoring Equipment SOP (1.10). Data regarding potential bias introduced to the logged data record by fouling of sensors during the deployment period is captured as a part of the sonde maintenance procedures (e.g., periphyton colonization). These quality control data are captured by comparing field readings prior to and after cleaning fouling from sensors. To ensure that changes in observations are due to fouling of sensors and not to changing conditions in the field, data is captured simultaneously with a second calibrated field meter before and after cleaning. These data are then used to determine the bias, if any, introduced to the data record from fouling of the sensors using USGS published methods (Wagner et al. 2006).

On a semi-annual basis comparisons of deployment site field readings and mean stream cross-section values are performed to ensure the deployment site is representative of stream conditions (see SOP 1.1 for cross-section procedures). The cross-section evaluation is performed during high and low discharge periods to ensure the data is representative of the stream conditions across the expected range of discharge values.

III. Post-Field Data Acquisition Quality Assurance Procedures

All sensors are evaluated after field deployments to ensure that data are within accuracy and precision criteria. Discrete monitoring equipment is subject to a post-field sensor error check (SOP 1.4). Quality control data captured at this point are used to either accept or reject (sensor) field data collected during the site visit procedures. After the post-field sensor checks are complete, field data sheets are reviewed to verify that sensors met quality control objectives. Continuous monitoring equipment is subject to the analogues calibration procedures and quality control data is captured during this process (SOPs: 1.5 and 1.6). For continuous monitoring equipment these data are then used in conjunction with fouling data and field notes (etc.) to verify the data record and document its quality (SOP 2.3).

IV. Data Management Quality Assurance Procedures

A. Discrete Data Management Procedures

A summary of discrete data management procedures (SOP 2.1) are:

- (1) Field Data Evaluation
 - a. On Field Data Sheet:
 - i. Check field data against the range of expected values
 1. Sensor or justify out of range values
 - ii. Check "Post-Field Data Calibration Check" table on field data sheet
 1. Ensure all sensors passed error limit check
- (2) Data Entry
 - a. Populate data entry templates:
 - i. Use park specific templates
 1. Templates contain features (e.g., pick lists) to limit data entry errors
 - b. Perform 100% verification of field data sheet values with data entry template
- (3) Import Templates into NPStoret
 - a. Check import metadata
 - i. Ensure appropriate number of observations successfully imported into the database
- (4) Evaluate Imported Data
 - a. Produce graphs of all imported data
 - i. Ensure all values are within expected ranges
 1. Sensor or justify out of expected range values
- (5) Change Status of Data within NPStoret
 - a. Verify all QA/QC procedures are complete

- i. Rectify discrepancies
 - b. Change “Value Status” from “Preliminary” (default on import) to “Final”
- (6) Accept final data for annual reporting and archiving (SOP 2.4)

B. Continuous Data Management Procedures

A summary of continuous data management procedures are:

- (1) Log File Evaluation (SOP 2.2)
 - a. Compare expected and recorded range of observations
 - b. Compare expected and recorded number of observations
- (2) Manual Data Entry (SOP 2.2)
 - a. Populate data correction template
 - i. Use park specific template
 - b. Perform 100% verification of field data sheet and calibration data sheet values with “QW_Ultimate” spreadsheet
- (3) Import log file into Aquarius database (SOP 2.2 and 2.3)
 - a. Compare imported number of records with expected number of records
- (4) Initial data evaluation (SOP 2.3)
 - a. Flag and annotate data which requires further evaluation
 - i. Missing data, anomalies, out of range values, etc.
 - ii. Censor low power observations
- (5) Apply data corrections (SOP 2.3)
 - a. Use Wagner et al. (2006) guidance to apply correction to data records
 - i. Annotate corrections applied
 - b. Censor out of range observations
 - i. Annotate censored observations
- (6) Apply data quality ratings (SOP 2.3)
 - a. Use Wagner et al. (2006) guidance to apply data quality ratings to data records
 - i. Annotate data quality ratings applied
- (7) Review data processing within Aquarius (SOP 2.4)
 - a. Compare corrections applied within Aquarius with quality control data
 - b. Compare data quality ratings applied within Aquarius with quality control data
 - c. Populate Record Processing Review Log

V. Data Acceptance and Archiving Procedures

Data captured as part of this protocol are accepted after the QA/QC procedures distributed throughout the standard operating procedures are completed. The acceptance of data occurs as the last step in the data management procedures for both discrete (SOP 2.1) and continuous data (SOP 2.3). On an annual basis the data is subject to an additional review and are ready for the production of annual reports.

A. Discrete Data

- (1) Gather review materials for the reporting period (October – September):

- a. Paper Data Sheets (SOPs 1.4 and 1.9)
 - i. Field Data Sheets
 - ii. Calibration Logs
 - iii. Pre/Post Sensor Check Logs
 - b. Export preformatted data products from NPStoret (SOP 2.1)
 - i. Annual data tables
 - ii. Annual data graphics
 - iii. Station Reports
 - c. Field data "Accepted_Rejected Log" forms
- (2) Review data record for completeness
- a. Review field data sheets
 - i. Note any missing or censored data
 - b. Compare censored/missing data from field sheets to "Accepted_Rejected" Log
 - i. Note and rectify any discrepancies- see Management of Discrete, Monthly Water Quality Data for guidance (SOP 2.1)
 - 1. Update "Accepted_Rejected" Log
 - c. Compare annual data tables export from NPSTORET with "Accepted_Rejected" Log
 - i. Note and rectify any discrepancies- see Management of Discrete, Monthly Water Quality Data for guidance (SOP 2.1)
- (3) Review annual data graphics
- a. Visually inspect for missing data or anomalies
 - i. Ensure any missing/censored data matches "Accepted_Rejected" Log
 - b. Compare plots to the range of expected values (Table 1)

Table 1. Range of expected values for MIDN streams.

Parameter	Expected Range
Water Temperature (°C)	-1.0 - 35
Barometric Pressure (mm Hg)	700 - 800
DO (% Saturation)	0 - 200
DO (mg/l)	0 - 20
Sp. Conductance (µS/cm)	20 - 1000*
pH (pH units)	3 - 10
Air Temperature (°C)	-20 - 45
Stream Width (m)	0.25 - 25
Stream Depth (cm)	0 - 300

* can be higher in karst systems (e.g., VAFO)

- c. Investigate and rectify any missing values not accounted for in the Accepted_Rejected" Log
- (4) After all QA/QC procedures are complete the data is considered accepted
- (5) Once final, MIDN staff:
- a. Produce annual reports
 - b. Archive annual data
 - c. Transfer NPSTORET back end to NPS WRD

B. Continuous Monitoring Data

- (1) Gather review materials for the reporting period (October – September):
 - a. Paper Data Sheets (SOPs 1.5, 1.6, and 1.10):
 - i. Site Visit Field Notes
 - ii. Calibration Logs
 - iii. Fouling Check Logs
 - iv. Pre-Deployment check
 - b. Excel sheets (SOPs 2.2 and 2.3):
 - i. “QW_Ultimate” Spreadsheet Log
 - ii. Record Processing Review Log
 - c. Launch Aquarius and export annual data products:
 - i. Annual data tables
 - ii. Annual data graphics
 - iii. Annual Change List report
 - d. Export Station Reports from NPSTORET (description of field site location)
- (2) Review data record for completeness
 - a. Compare censored/missing data from Record Processing Review Log to annual data tables/graphics
 - i. Note and rectify any discrepancies- see Management of Continuous Monitoring Water Quality Data (SOP 2.2) and Aquarius specific documentation for guidance
- (3) Review data corrections
 - a. Compare Record Processing Review Logs and QW_Ultimate spreadsheet
 - i. Note and rectify any discrepancies
 - b. Compare Record Processing Review Logs and annual data tables/graphics
 - i. Note and rectify any discrepancies
- (4) Review annual data graphics
 - a. Visually inspect for missing data or anomalies
 - i. Ensure any missing/censored data matches Record Processing Review Logs
 - b. Compare plots to the range of expected values (Table 1)
 - c. Investigate and rectify any missing values not accounted for in the Record Processing Review Logs
- (5) After these procedures are complete the data is considered accepted
 - a. Produce annual reports
 - b. Archive annual data
 - c. Make data available in the NPS’ Aquarius WebPortal