Unifying Concepts in Environmental Restoration Planning:

Quality Assurance & Quality Control

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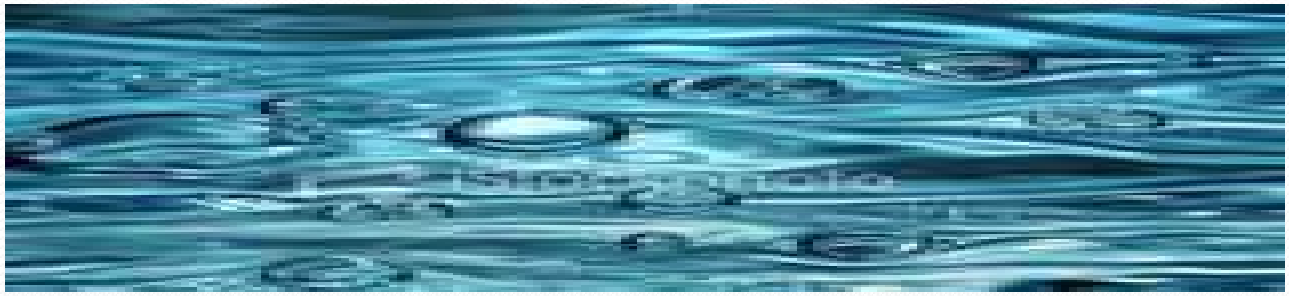

Purpose

- Environmental restoration decision-making is based on sound legally defensible science and sound legally defensible science is based on verifiably scientifically valid data.
- To obtain quality data Quality Assurance (QA) and Quality Control (QC) must be incorporated into the program at every step of the data life cycle
- The design and evolution QA/QC in the South Florida Water Management District's Mercury Program in the period 1992-2004 will be used to illustrate the application of QA/QC to an environmental pollutant at ultra-trace levels with ubiquitous sources of contamination.

Quality Assurance and Quality Control

- **Quality Assurance (QA):** is the overall system of activities whose purpose is to provide the producer or user of environmental data the assurance that it meets defined standards of quality with a stated level of confidence.
- **Quality Control (QC**): is the system of activities whose purpose is to document and control the quality of environmental data so that they meet the needs of the users.

Quality Assurance

- Decision Making Objectives
- DQOs
- QA Plan : Program and Project Specific
- Project Specific Monitoring Plan
- SOP's
- Training
- Audits Field, Lab and Database
- Quarterly and Annual Reports
- Performance Evaluation
- NELAC Certification
- Data Validation
- Data Verification

Standard Measures of Data Quality

- Reproducibility: The degree of fluctuation in the measurement of replicated sampling or analysis is indicative of the "precision" of the results

  - s.d or % difference of replicates

- Bias: The degree of agreement between a measurement and its true value is indicative of the "accuracy" of the results.

  - % difference relative to a spiked matrix or reference material

- Representativeness: The measurement reproduces the state of the environment at the specified location and time under the reported conditions without artifacts introduced in the process of sampling, transport, storage, preparation, or analysis

Standard Measures of Data Quality

- Comparability: The degree to which results can be reproduced by different field crews and laboratories for each matrix over a wide variety of environmental conditions and matrix characteristics

  - s.d or % difference of replicates in side-by-side field sampling studies and laboratory round robins

- Completeness: The degree to which the program is achieving its DQOs to support robust, reliable decision-making

  - % of samples passing QC filters

Precision and Accuracy

- The degree of fluctuation in the measurements is indicative of the “precision” of the assay.
- The closeness of measurements to the true value is indicative of the “accuracy” of the assay.
- Quality Control is used to monitor both the precision and the accuracy of the assay in order to provide reliable results.

Quality Control

- Field , equipment and cleaning blanks
- Replicates Field and Lab
- Calibration Standards Field and Lab
- DI water for UT Mercury weekly graphs
- Field and Lab Note Documentation
- Spikes and Reference Material
- Zero to bubbler blank
- Method blanks
- Quarterly Control Chart
- Validation Acceptance Criteria

Data Management Life Cycle

- Study Inception
- Data Collection
- Data Submission
- Data Validation
- Database Upload
- Quality Assurance & Quality Control
- Data Verification
- Data Analysis
- Reporting
- Report Data Problems
- Migration
- Project Close-Out
- Records Archiving

Field Quality Control

- Define Criteria
- Validation
- Verification

Lab Quality Control

- Define Criteria
- Validation
- Verification

Database Quality Control

- Define Criteria
- Validation
- Verification

Planning Stage

Problems

- Unqualified Labs bid for contracts
- No station registration process or documentation
- Change in sampling locations, equipment, field methods or lab analytical method
- Participating agencies failed to adapt uniform uniform QAP

Solutions

- Prequalify Labs with blind replica samples, blanks, spikes, high and low samples
- Register site during planning stages
- Use coordinates from map to convert to GPS & flag location
- Demonstrate substantial equivalency before any change
- Include in multi agency MOA

Blank Contamination

Problems

- Contaminated teflon bottles from leaching
- Contaminated DI water
- Contaminated sample train
- MeHg contamination in glass bottle caps

Solutions

- Added lab blanks to detect and switched to glass
- Lab provided & analyzed DI water for each event
- Apply lot numbers to the sample train for tracking; inspect and replace
- Changed to acid pre-clean caps

Filters Contamination

Problems

- THG and MeHg Contamination in Gelman trace metal filters invalidated data
- Switched to Meissner filters without the acid-precleaning

Solutions

- Verify contamination in controlled study with replication
- Test alternatives using same protocol
- Adapt most cost-effective uncontaminated alternative
- Reduced to acceptable levels with acid-precleaning

Documentation

Problems

- Errors and irregularities on Chain of Custody (COC)
- Errors and irregularities in the field notes
- Lack of agreement between the COC and field notes.
- Lack of Signatures for COC transfer

Solutions

- Used field computers
- Training
- Validation
- Verification

Field Problems

Problem	Solution
• Field staff overlooked constituents for analysis in one or more media for a sampling cycle	• Review and sign off on field data sheets identifying constituents • Archive sample splits to allow for do-overs
• MeHg value > THG and poor precision	• Test bottle leaching
• Unapproved change of sampling location	• Overlap Stations to demonstrate equivalency • Retraining

To Field Preserve or Not?

Problem

- SOP requires field-acidification with ultra-trace Hg free HCl …
- .. but acidification step increases risk of spurious contamination during bottle preparation, introduces Hg not in environment, and additional expense for the ultra clean Hg free HCL

Solution

- Acidify in ultra-clean Hg free lab environment within 24 hours of receipt
- … because high DOC in surface water complexes Hg(II) and MeHg and transport and storage at 4°C minimizes spurious MeHg production or destruction

Shipping Problems

Problems	Solutions
• Shipping temperatures exceeded because dry ice evaporated too quickly	• Changed to blue ice
• Lab did not return blue ice with coolers	• Lab verification of sample temperature upon receipt
	• Buy more blue ice
• Samples lost in shipping, and waiting for lab to post missing samples too late	• Fax or email to verify receipt of samples by receiving lab
• Bottle Mix up	• If discovered after analysis and within holding time them rework; if not, resample

Metadata Management

Problems

- EDD and Final Lab Report did not agree
- Incorrect qualifier applied to data
- Incorrect criteria followed
- Unregistered projects stations and test rejected by database

Solution

- Compare and verify agreement
- Automate QC checks and qualifiers
- Field Computers

Conclusion

- The QA/QC element of the District's Mercury Program was ultimately successful, passing peer review and surviving threatened 3rd-party legal challenges …

  … but it evolved over time as a learning, adaptive process in response to reliable QC diagnostics
- Problems were detected early but the required changes to equipment or methods were slowed by the need to:

  -- verify that the problem was statistically significant

  -- reproduce the problem under controlled conditions to isolate its cause and develop a solution that didn't cause new problems

Conclusion

- Despite careful planning and peer review, you cannot think of everything, because nature, the lawyers, or human nature will throw you a curve (see Murphy's Law)
- But by planning, implementing and auditing a robust, rigorous QC program, when unanticipated problems emerge, they are readily detected and eventually corrected.
- Whatever you do, do not relax the QC criteria to accommodate substandard performance.
- Better to invalidate a sampling event or sampling or analytical method than to invalidate your program in the courts of science, law, and/or public opinion.