

## CHAPTER IV. GENERAL QUALITY ASSURANCE MEASURES

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This chapter describes quality assurance in general, describes quality assurance measures, and recommends specific quality control measures for each indicator that involves lab analysis recommended in Chapter III. It includes the following sections:

- A. About Quality Assurance
- B. Quality Assurance for Sampling and Analysis
  - Common Internal Quality Controls and How They Are Assessed
  - Common External Quality Controls and How They Are Assessed
  - Recommended Quality Controls To Meet VEMN Data Quality Goals
- C. Quality Assurance for Data Management

### A. About Quality Assurance

**Quality Assurance (QA)** measures are the operating procedures that you use to assure and assess the quality of the information you collect. It's designed to assure that the information you collect meets your data quality goals.

Quality assurance includes procedures for sampling and analysis and data management.

*Quality Assurance for Sampling and Analysis* includes training, documentation, quality control, and quality assessment.

*Quality Assurance for Data Management* includes measures to assure that the data are properly recorded on field and lab sheets and accurately transferred to a computer or summary sheet.

### B. Quality Assurance for Sampling and Analysis

**Training** is a form of quality assurance that has already been covered in this workbook. In the quality assurance section of your study design, you simply describe the training procedures to ensure that your field and laboratory personnel are properly trained. Describe any training workshops or other types of training that volunteers must undergo before they can collect and analyze samples. Some programs even require that program personnel certify in writing that each volunteer has completed a training workshop or series.

**Documentation** of your field and laboratory procedures is critical for quality assurance. In fact, your study design itself is an example of this type of quality assurance. Other examples include your field and laboratory manuals

that the volunteers will use to collect and analyze samples, written directions to the sampling locations, sample labels, and your field and laboratory data recording sheets. This also includes a set of procedures known as “chain of custody.” Chain of custody refers to documenting each person that handled the sample. Unless your data is going to be used in some legal or regulatory proceeding, it can be as simple as having places on your field and data sheets for samplers and analysts to sign when they take custody of and complete their work on a sample.

**Quality Control (QC)** consists of the steps you take during the collection and analysis of your samples to ensure the *accuracy* (how close to the real result you are) and *precision* (how reproducible your results are) of your monitoring. The purpose of quality control procedures is to let you know right away if you have a problem, so that you can correct it. Quality control procedures include both *internal checks* performed by the project field volunteers, staff, and lab and *external checks* performed by non-volunteer field staff and a lab (or “quality control lab”). Common types of quality control samples and how they are assessed are listed in the next two sections.

**Quality Assessment** is your assessment of how accurate and precise your data actually are after you’ve collected and analyzed the samples. This involves calculating the accuracy and precision of your quality control samples and comparing them to your data quality requirements (See Step 3 of Part I for definitions of these terms). Assessment of quality control samples is described in the next section.

For some quality control results, the following statistical measures are used:

**Standard deviation** is used to compare how closely three or more values are clustered around the average value. It is expressed as  $a \pm$  from the average value. The lower the value, the more precise the results.

**Coefficient of Variation:** This is the standard deviation as a percentage of the average. The lower the percentage, the more precise the results.

**Relative Percent Difference** is used to compare how close the result from a water sample is to the true result. It is expressed as either a positive difference (the sample result is higher than the true value) or negative difference (the sample result is lower than the true value). The lower the value, the more precise the results.

**% Recovery:** This is the percentage of the substance added to a spiked sample (see below) that is detected. It’s the difference between the concentration detected in the spiked sample and that detected in the unspiked sample, divided by the concentration of the substance added to the spiked sample.

Your study design should describe the measures you will take if you don't meet your data quality requirements. Examples might include not using some of your data, changing laboratory methods, equipment, or field procedures; requiring more training; changing the field or lab sheets, etc.

**COMMON INTERNAL QUALITY CONTROLS AND HOW THEY ARE ASSESSED**

These are checks performed by the project field volunteers, staff, and lab.

**Trip (Field) Blanks:** A trip blank (also known as a field blank) is de-ionized water which is poured into a sample container in the field as if it were a river or lake sample. Trip blanks are usually collected at 10% of the sampling sites. They are used to identify errors or contamination in sample collection and analysis.

*Assessment of Results:* The results should be “0.”

**Negative and Positive Plates (For bacteria):** *Negative plates* result when the buffered rinse water (the water used to rinse down the sides of the filter funnel during filtration) has been filtered the same way as a sample. This is different from a field blank in that it contains reagents used in the rinse water. There should be no bacteria growth on the filter after incubation. It is used to detect laboratory bacteria contamination of the sample. *Positive plates* result when water known to contain bacteria (such as wastewater treatment plant influent) is filtered the same way as a sample. There should be plenty of bacteria growth on the filter after incubation. It is used to detect procedural errors or the presence of contaminants in the laboratory analysis that might inhibit bacteria growth. Positive and negative plates are usually run before the first water sample is filtered, every ten samples thereafter, and after the last sample has been filtered.

*Assessment of Results:* The results for negative plates should be “0.” The results for positive plates should be “too numerous to count.”

**Field Duplicates:** A field duplicate is a duplicate river or lake sample collected by another sampler or team. Field duplicates are usually collected at 10% of the sampling sites. They are used to determine total (both sampling and laboratory analysis) precision.

*Assessment of Results:* The results for two samples should be compared using the relative percent difference between them. The results for three or more samples should be compared using the standard deviation among them. Results are compared with data quality requirements.

**Lab Duplicates:** A lab duplicate is a sample that is split into two or more sub-samples at the lab. Each sub-sample is then analyzed and the results compared. Usually, 10% of the samples are split into lab duplicates. They are used to determine the precision of the laboratory analysis.

*Assessment of Results:* The results for two samples should be compared using the relative percent difference between them. The results for three or more samples should be compared using the standard deviation among them. Results are compared with data quality requirements.

**Equipment Calibration:** All analytical equipment should be calibrated according to the manufacturer's instructions. Three common techniques are the calibration blank, calibration standards, and calibration to a reference device:

*Calibration Blank:* A calibration blank is de-ionized water processed like any of the samples and used to "zero" the instrument. It is the first "sample" analyzed and used to set the meter to zero. This is different from the field blank in that it is "sampled" in the lab. It is used to check the measuring instrument periodically for "drift" (the instrument should always read "0" when this blank is measured). It can also be compared to the field blank to pinpoint where contamination may have occurred.

*Assessment of Results:* The results of periodic checks should be "0."

*Calibration Standards:* Calibration standards are used to calibrate a meter. They consist of one or more "standard concentrations" (made up in the lab to specified concentrations) of the indicator being measured, one of which is the calibration blank. Calibration standards can be used to calibrate the meter before running the test, or they can be used to convert the units read on the meter to the reporting units (for example, absorbance to milligrams per liter).

*Assessment of Results:* The meter should read the expected concentration.

*Calibration to Reference Device:* A reference device is an instrument known to produce accurate and precise readings. The most commonly used reference device is a "precision thermometer" certified by the National Institute of Standards and Technology (NIST). Readings from your thermometers are checked against one that is NIST certified. Readings from your thermometers are corrected depending on how closely they match readings from the precision thermometer.

*Assessment of Results:* The instrument should read the same result at the reference device. If not, an acceptable correction factor should be applied.

**Spike Samples:** A sample is split into two subsamples in the lab. One is analyzed according to the specified procedure. The other is treated by adding a known amount and concentration of the indicator being measured, then running the specified procedure. This should increase the concentration in the spiked sample relative to the unspiked sample by a predictable amount. Usually, 10% of the samples are split and spiked. They are used to test the accuracy of the laboratory method.

*Assessment of Results:* The percent of the indicator "recovered" by comparing the spiked to the unspiked sample is determined. Results are compared with data quality requirements.

**COMMON EXTERNAL QUALITY CONTROLS AND HOW THEY ARE ASSESSED**

These are checks performed by non-volunteer field staff and a lab (also known as a “quality control lab”). The results are compared with those obtained by the project lab.

***Outside Lab Analysis:*** Some analyses are very difficult for volunteer labs to perform accurately and precisely. For these, the best answer may simply be to send your samples to a professional state or EPA-certified lab. This lab should have an EPA-approved Quality Assurance Project Plan that covers the indicator(s) you wish them to analyze.

***External Field Duplicates:*** An external field duplicate is a duplicate river or lake sample collected and processed by an independent (e.g. professional) sampler or team. It is used to estimate total (sampling and laboratory) analysis accuracy.

*Assessment of Results:* The results for two samples should be compared using the relative percent difference between them.

***Split Samples:*** A split sample is a sample that is split into two sub-samples at the lab. One sub-sample is analyzed at the project lab and the other is analyzed at the independent lab and the results compared. Usually, 10% of the samples are split.

*Assessment of Results:* The results for the two samples should be compared using the relative percent difference between them.

***Taxonomic Verification (for Benthic Macroinvertebrates):*** Benthic macroinvertebrate samples identified by volunteers should be preserved and archived. Usually, 10% of these samples are identified to the same taxonomic level as the volunteers by a professional biologist or entomologist. A reference collection should be assembled with representatives of key taxa.

*Assessment of Results:* The identifications are compared.

***Knowns:*** The quality control lab sends samples for selected indicators, labeled with the concentrations, to the project lab for analysis prior to the first sample run. Usually, three knowns are supplied that contain concentrations at the low end, in the middle, and at the high end of the range likely to be found in the water samples. These samples are analyzed and the results compared with the known concentrations. Problems are reported to the Quality Control Lab.

*Assessment of Results:* The results for the two samples should be compared using the relative percent difference between them.

***Unknowns:*** The quality control lab sends samples to the project lab for analysis for selected indicators, prior to the first sample run. The concentrations of these samples are unknown to the project lab. Usually, three unknowns are

supplied that contain concentrations at the low end, in the middle, and at the high end of the range likely to be found in the water samples. These samples are analyzed and the results reported to Quality Control Lab. Discrepancies are reported to the project lab and a problem-identification and solving process will follow.

*Assessment of Results:* The results for the two samples should be compared using the relative percent difference between them.

**RECOMMENDED QUALITY CONTROLS TO MEET VEMN DATA QUALITY GOALS**

The following tables recommend quality controls for indicators requiring some type of lab analysis.

**Table 1** lists the controls recommended to meet the state and federal agency water quality assessment data quality goal.

**Table 2** lists the controls recommended to meet the education and awareness and the community and watershed assessment data quality goals.

**Recommended Quality Control Measures for State and Federal Water Quality Assessment**

These tables are guidance only. Many of the measures listed in the table require that you work with a quality control lab. Consult with your technical committee and your quality control laboratory for specific quality control measures for your program. Note particularly the indicators checked in the “Outside Lab Analysis” row. For these indicators, we recommend that you consider having a certified state or professional lab perform the analyses due to the expense and difficulty of the lab analysis.

**Table 1: Quality Checks for State and Federal Water Quality Assessment**

	FC/EC	DO	Turb	Secchi	T	pH	Alk
<b>Internal Checks</b>							
Field Blanks	√		√				
Field Duplicates	√	√	√	√	√	√	√
Lab Replicates	√♣	√	√			√	√
Positive Plates	√						
Negative Plates	√						
Spike Samples (Std. Add.)							√
Calibration Blank			√		√		
Calibration to Reference Device					√		
Calibration Standard		√*	√			√	
<b>External Checks</b>							
External Field Duplicates	√		√	√		√	√
Split Samples	√		√			√	√
Outside Lab Analysis•	√						
<b>Verification</b>							
Knowns		√	√			√	√
Unknowns		√	√			√	√
Phos=Total/Total Dissolved Phosphorus Solids=Total/Total Dissolved Solids * using an oxygen-saturated sample ♣ using subsamples of different sizes • analysis expensive or difficult - consider analysis by a certified lab instead of the project lab							

**Table 1 (cont.): Quality Checks for State and Federal Water Quality Assessment**

	Cond	Phos	Nitrog	Solids	Chlo	Benthics	Habitat
<b>Internal Checks</b>							
Field Blanks	√	√	√	√	√		
Field Duplicates	√	√	√	√	√	√	√
Lab Replicates	√	√	√	√	√		
Positive Plates							
Negative Plates							
Spike Samples (Std. Add.)		√	√				
Calibration Blank	√	√	√		√		
Calibration to Reference Device							
Calibration Standard	√	√	√				
<b>External Checks</b>							
External Field Duplicates	√	√	√	√	√	√	√
Split Samples	√	√	√		√		
Outside Lab Analysis•		√	√	√	√		
Verification						√	
Knowns	√	√	√			√	
Unknowns	√	√	√			√	
FC/EC=Fecal coliform/E. coli Chlo=chlorophyll a Nitrog=all species • analysis expensive or difficult - consider analysis by a certified lab instead of the project lab using an oxygen-saturated sample ♣ using subsamples of different sizes							

**Recommended Quality Control Measures for Education and Awareness and Community and Watershed Assessment**

Quality control for these data quality goals does not necessarily require external checks, so these are not listed in the table. However, you may decide to carry out a few to check your accuracy and precision either for educational purposes or because a local data user requires it.

**Table 2: Quality Checks for Education, Awareness, and Problem Screening**

	FC/EC	T	pH	Alk	DO	Secchi	Cond	Benthics	Habitat
<b>Internal Checks</b>									
Field Blanks	√						√		
Field Duplicates	√	√	√	√	√	√	√	√	√
Lab Replicates	√		√	√	√		√		
Positive Plates	√								
Negative Plates	√								
Spike Samples (Std. Add.)				√					
Calibration To Ref. Device		√							
Calibration Blank		√					√		
Calibration Standard			√		√*		√		
* using an oxygen-saturated sample									
♣ using subsamples of different sizes									

## C. Quality Assurance for Data Management

This includes measures to assure that the data are properly recorded on field and lab sheets and accurately transferred to a computer or summary sheet.

**Field and Lab Sheets:** These should be laid out clearly with the following information:

- Samplers' Names
- Site #
- Sample Container Type
- Container #
- Time the Sample Was Taken
- Sample Preservation (if any)
- Time the Sample Was Dropped off at the Lab
- Name of the Person Who Checked the Samples In (person transporting samples)
- Results in Analysis Units
- Results in Final Reporting Units
- Analysts Name
- Time Analysis Was Performed

**Data Entry and Validation:** If a computer is used, data should be entered by one person, if possible. The data entered into the computer must be checked against the raw data from the field and lab sheets to ensure that it has been entered correctly. Ideally, this should be done by someone other than the person who entered the data.

**Data Analysis:** Even if your results are entered correctly and meet your data quality objectives, you should be on the lookout for numbers which seem to be much higher or much lower than typical results. These are called outliers. Do you have confidence that these numbers are reliable? Verify that these numbers were transcribed or entered correctly.