# Quality Assurance Project Plan

## Volunteer Water Quality Monitoring

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

State of Oregon
**Department of Environmental Quality**

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# 1. Project Management

## 1.1. Distribution List

The following DEQ personnel will be emailed regarding all aspects of this Quality Assurance Project Plan (QAPP).

This QAPP will be posted on Q-Net (DEQ's internal website) at https://webp01.deq.state.or.us/qnetasp/lab/documents.asp and will be made available on the DEQ Volunteer Monitoring Resources web page. As prescribed by the laboratory's document control procedures, the official signed document will be filed at the DEQ laboratory. This project is expected to continue through multiple seasons, thus revisions should be anticipated. The PM may make revisions to this plan, which must be approved by the signatories on the approval page. The DEQ is not responsible for the control of reprinted copies from web sites or photo copies of the original plan. It is the responsibility of the reader to ensure that they are using the most current QAPP. The QAO will replace posted network files as the plan is revised.

**Table 1 – Distribution List**

| Name | Phone | Email |
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DEQ personnel performing tasks under this QAPP will use the Volunteer Monitorng Program Q-Time number (43511) to track their time spent on the project.

## 1.2. Acronyms and Definitions

### 1.2.1 Acronyms

AWQMS Ambient Water Quality Monitoring System
CBO Community Based Organization

| | |
|---|---|
| CCV | Continuing Calibration Verification |
| CFR | Code of Federal Regulations |
| DEQ | Oregon Department of Environmental Quality (also ODEQ) |
| DQL | Data Quality Level |
| EPA | Environmental Protection Agency |
| LCS | Laboratory Control Sample |
| LIMS | Laboratory Information Management System (Also called ELEMENT™ developed by Promium) |
| LDO | Luminescent Dissolved Oxygen technology |
| LEAD | Laboratory and Environmental Assessment Division |
| LOD | Limit of Detection |
| LOQ | Limit of Quantitation |
| MOMS | Mode of Operations Manuals |
| NIST | National Institute of Standards and Technology |
| ORELAP | Oregon Environmental Laboratory Accreditation Program |
| PM | Project Manager |
| QA | Quality Assurance |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| SAP | Sampling and Analysis Plan |
| SOP | Standard Operating Procedure |
| USGS | United States Geological Survey |
| WQM | Water Quality Monitoring |

### 1.2.2 Definitions

**Continuous Sample:** Analytical parameters measured in situ over a period of time. The measurements are typically discrete measurements occurring at a set frequency.

**Data Submission:** The grouping of all the samples collected for a project during specific time period and provided to the DEQ.

**Grab Sample:** A sample captured in a container or absorbed to medium for further analysis. For the purposes of this QAPP, instantaneous measurements of in situ parameters are defined as grab samples.

**Sampling Event**: A group of samples collected and/or shipped under a single chain of custody; by an individual or individual sampling team (usually a single day's sampling activity).

**Survey**: The grouping of all the samples collected for a project during specific time period. The specific grouping and time periods must be defined in the QAPP or SAP. (Example: spring sampling for all of the samples in a specific basin). The QAPP/SAP completeness goal is based on a review of the data within a survey.

**Survey Batch**: The survey batch is a subset of the survey and is used to reflect how the samples are grouped relative to project Field QC samples. The survey batch defines what samples are associated with specific QC samples. (Example: Samples taken for a one week period by a specific sampling team may only have 1 Duplicate or one blank. All of the samples associated with the Duplicate and Blank are in the sample survey batch. The Survey Batch for each project must be defined in the QAPP or SAP.

# 1.3. Project/Task Organization

Community Based Organization (CBO) volunteer monitoring studies are coordinated efforts lead by the CBO with the technical support of the DEQ. It is important to organize a project team as this will provide a framework for conducting the sample collection tasks to meet study objectives. The organizational structure and function also facilitate project performance and adherence to Quality Control (QC) procedures and Quality Assurance (QA) requirements. Key roles are filled by those persons responsible for ensuring program planning, sample collection, data generation, data verification, as well as the persons responsible for validating data for usability with final products and deliverables.

The **Volunteer Monitoring Program Coordinator** will provide technical assistance in monitoring design, equipment use, data management and analysis. The coordinator will provide guidance, review and approval of project SAPs. The coordinator will manage aspects of data processing, review and analysis when additional efforts are required to prepare data for DEQ use. The program coordinator is also responsible for advocating appropriate project monitoring strategies that reflect program priorities.

The DEQ Field or Laboratory **Quality Assurance Officer** will be responsible for final approval and version tracking of all program QAPPs and SAPs.

The **Community Based Organization Staff / Volunteers** will act as project manager(s) and/or field operation coordinator(s). Organizational structures will vary within a CBO based on staffing and project, but it is important to designate roles and responsibilities to participating individuals. It is equally important to update and maintain these designations if changes in organization staffing or volunteer availability occur during the project timeline. **Project Managers** will develop a SAP, supervise staff and manage program workloads and budgets. These managers are ultimately responsible for ensuring that the project planning, sample collection, sample processing, data management, and data reporting are conducted in accordance to the approved SAP, QAPP, and other materials developed to support the project. The **Field Operations Coordinator(s)** will review all field records for accuracy, and ensure that any problems encountered outside normal operating conditions are documented and addressed. The field operations coordinator(s) will also verify that all field QA/QC procedures, which are identified in this QAPP, are followed.

The **DEQ Water Quality Monitoring (WQM) Staff** will conduct, when necessary, training of CBO Staff and Volunteers to ensure proper sampling techniques. When required, DEQ Staff will also participate in split sampling, following sampling procedures listed within the progam QAPP and project SAP.

## Table 2 – Project/Task Responsibilities

| Name | Project Title/Responsibility |
|---|---|
| Nick Haxton-Evans | DEQ Volunteer Monitoring Program Coordinator |
| CBO Staff / Volunteers | Sampling and Analysis Project Plan preparation, project management, sample collection, data analysis, and data submittal |
| Chris Moore | DEQ Field Quality Assurance Officer |
| Sara Krepps | DEQ Laboratory Quality Assurance Officer |
| DEQ WQM Staff | Training and Split Sampling, if required |

DEQ personnel performing tasks under this QAPP will use the Q-Time number 43511 (Volunteer Monitoring) to track their time spent on the project.

# 1.4. Problem Definition/Background

The DEQ's Volunteer Monitoring Program's (here after referred to as "the program") goal is to involve Oregonians in identifying and solving the State's water quality problems. The program provides support including technical assistance in monitoring design, equipment use, data management and analysis. CBO's participating in the program are eligible to receive high quality monitoring equipment on loan. The purpose of the program is to improve the quality and quantity of data collected by groups around Oregon such that the data may be used locally by the CBO's and by the DEQ.

The goals of this of this plan are to (1) document CBO data quality, and (2) provide consistent, basic quality assurance procedures for all partner CBO's.

**The purpose of monitoring projects conducted by specific CBO's must be identified in each group's Sampling and Analysis Plan (SAP).** CBO's agreeing to adopt this QAPP must prepare a SAP to be approved by the Volunteer Monitoring Coordinator. The foundation of the SAP will be a concise, answerable monitoring question. The prepared SAP must sufficiently describe the monitoring project, reference the appropriate quality assurance standards within this QAPP, and explicitly define any planned variances from these standards. To assist CBO's with SAP development, a template is available from the program.

Data generated using State funds, whether it be to pay for analysis and/or the use of program monitoring equipment, must be submitted to the DEQ for inclusion in the DEQ's Ambient Water Quality Monitoring System (AWQMS). Data in AWQMS are publicly accessible over the internet and may be used by the DEQ for 303(d) list determination, total maximum daily load development, preparing status and trend reports for watersheds of interest, or other agency reporting purposes. In order for the DEQ or outside data users to apply CBO monitoring data appropriately it is essential that the quality of this data be defined. This QAPP includes quality assurance procedures to be followed by the CBOs and the processes used by CBOs and DEQ to quantify the quality of data collected as part of DEQ's volunteer monitoring program.

# 1.5. Project Task/Description

CBO's collect instantaneous grab samples for chemical, physical and biological stream parameters as well as continuous chemical and physical parameter monitoring. The SAP describes specific information regarding what data will be collected where, the kind of samples taken, the conditions to be sampled (storm events, summer baseflow, etc.), how samples will be analyzed, and a timetable for the monitoring. Unless otherwise specified in an approved SAP, CBO's will collect and analyze samples as described in this QAPP and the DEQ Mode of Operations Manuals (MOMS). Quality control tests described in these materials must be followed and the results of these QC tests reported with the submitted data.

In addition to basic QC tests for specific parameters, the CBO and DEQ shall make a good faith effort to participate in side by side sampling events called split samples. Section 2.5.4 covers different types of split samples in more detail.

The critical project points related to quality assurance for DEQ are listed below as bullets.

- Defining monitoring question- DEQ works with CBO's to identify an appropriate monitoring question.
- Completing an approved SAP- The Volunteer Monitoring Coordinator provides technical assistance to CBO's in completing the SAP and reviews the plan before forwarding it to the DEQ Field QAO.
- Training- DEQ staff provides training in appropriate sample collection and analysis methods.

- Sample collection and analysis- CBO conducts field work to collect data.
- Technical assistance- DEQ provides technical assistance to solve data quality issues that are identified through QC sampling by the CBO
- Split sampling- DEQ conducts side by side sampling with the CBO as a check for biases in data.
- Data submission- DEQ receives a standardized data submission from the CBO containing all the required metadata, QC results and analytical results from a defined period of time.
- QC summaries- The DEQ prepares a summary of all available QC data relevant to submitted CBO data.
- Data quality review- DEQ reviews and assigns data quality levels to each reported result before finalizing the data into the DEQ database.

For CBO's an example timetable of important quality assurance elements is listed in Table 3.

### Table 3 – Example project timetable for CBO's critical quality assurance elements

| Project QA Processes | PROJECT TIMELINE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Develop monitoring objectives & study design | | | | | | | | | | | | |
| Write SAP | | | | | | | | | | | | |
| Equipment & supplies procurement and training | | | | | | | | | | | | |
| Collect field and lab data | | | | | | | | | | | | |
| QC data assessment and response actions | | | | | | | | | | | | |
| Compile and manage data | | | | | | | | | | | | |
| Submit data to DEQ | | | | | | | | | | | | |
| Assess and interpret data | | | | | | | | | | | | |
| Convey results and findings | | | | | | | | | | | | |

# 1.6. Quality Objectives and Criteria

For water quality data to inform decision making it is critical that the quality of the results themselves be assessed in order to understand the sampling error and the error of the measurements themselves.

Sampling error is influenced by the inherent variability of the target condition over space and time, the sample collection design, and the number of samples. It is usually impractical to measure the entire space, and limited sampling may miss some features of the natural variation of the measurement. Sampling design error occurs when the data collection design does not capture the complete variability within the environment, to the extent appropriate for making conclusions. Sampling design error can lead to random error (i.e., variability or imprecision) and systematic error (bias) in estimates of system conditions. Sampling error should be addressed in the CBO SAP to make sure the site selection, total number of samples, frequency and method of collection minimize sampling error.

Measurement error is influenced by imperfections in the measurement and analysis system. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, and data processing.

Specific QA Objectives for the volunteer monitoring water quality program are:

- Collect a sufficient number of samples, sample duplicates, and field blanks to evaluate the sampling and measurement error.
- Analyze a sufficient number of QC standards, blanks and duplicates during analysis to effectively evaluate results against numerical QA goals established for precision and accuracy.
- Implement sampling techniques in such a manner that the analytical results are representative of the media and conditions being sampled.

CBO's are responsible for collecting the QC data needed for determining whether their data quality objectives are met. The DEQ reviews QC information before assigning data quality levels to the data in the AWQMS database.

## Figure 1 – Sources of Error

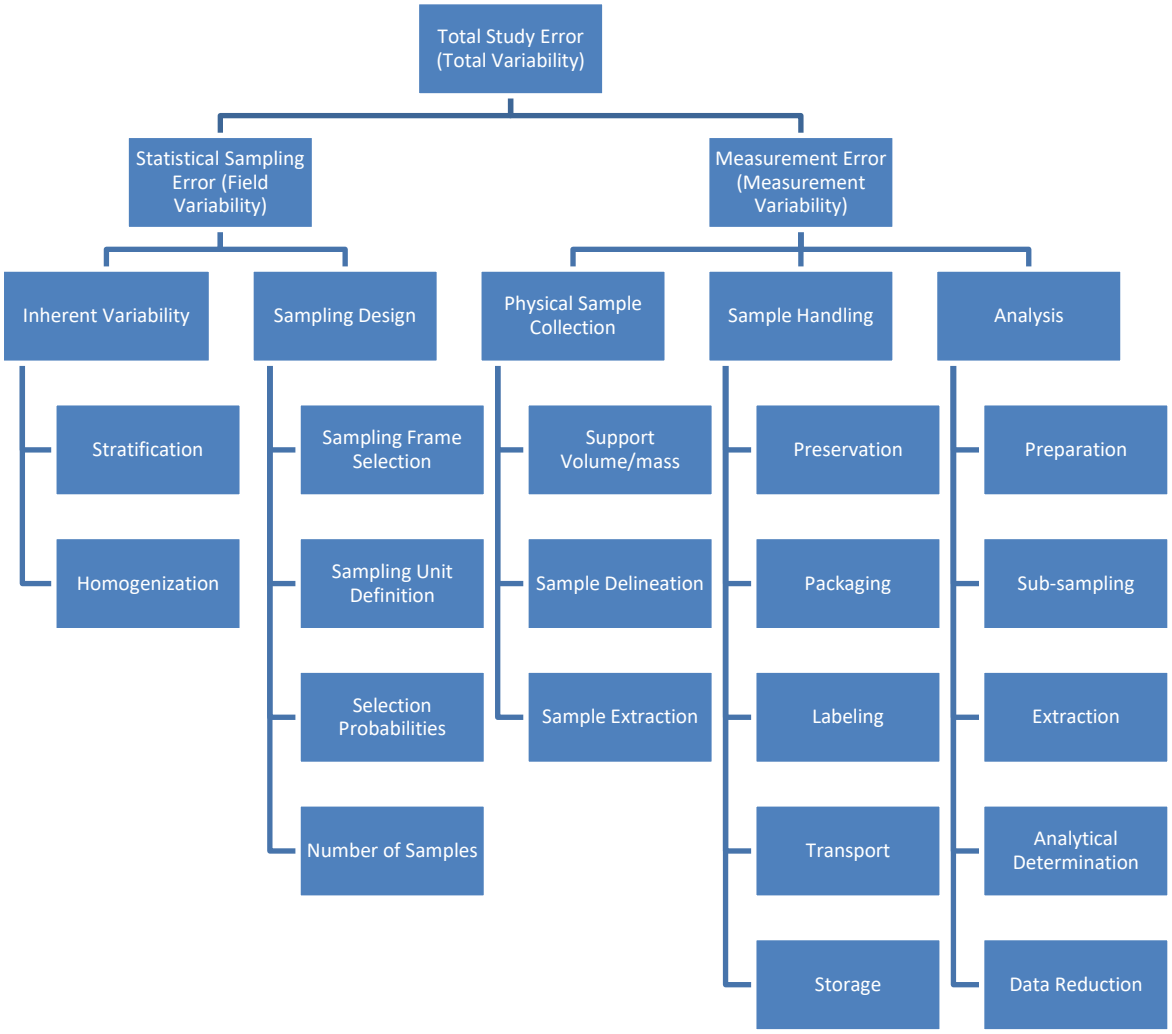


Figure 1 illustrates where errors can occur in procedural steps used for generating environmental data. During many of these procedural steps, QC measurements can be taken or QC samples can be introduced into the process thereby making it possible to estimate the error attributable to a specific protocol. With each procedural step that a QC element can be implemented, environmental data will be batched with the QC result in which the samples or data were processed. Section 2.4 will further describe how to distribute QC to sampling data to be used for this project. With the knowledge of an unacceptable error in the QC measurement, environmental samples within the QC batch are either reprocessed after improvements are made to minimize the observed error, or the environmental data will be flagged as not meeting the quality control standard. Often it is physically impossible to reprocess samples or it is not cost effective, in which case data must be flagged in a manner that ensures the data user is aware of the data quality anomaly.

Data quality shall be evaluated through the use of the traditional Data Quality Indicators:

- Precision
- Accuracy/Bias
- Sensitivity
- Representativeness
- Comparability
- Completeness

Section 2.5 lists required accuracy and precision quality control measures for common water quality parameters.

### 1.6.1 Precision and Accuracy

Accuracy is a measure of the error between reported test results and the true sample concentration. Precision is the degree of agreement among repeated measurements. To ensure accuracy, all instruments must be calibrated using appropriate reference materials or standards. The performance of instruments is to be documented and maintained by the CBO. Precision shall be estimated by measuring the variability of duplicate measurements. Table 4 – Accuracy and Precision Targets lists the precision and accuracy targets for standard water quality monitoring parameters collected as part of the DEQ program. The accuracy and precision limits listed in the table represent target level data quality as defined by the DEQ's field Data Quality Matrix (DQM), DEQ04-LAB-0003-QAG, Version 5.0. Any data collected which does not meet the accuracy and precision limits defined below will be downgraded to a lower data quality level (DQL) in accordance with the DQM and should only be considered in analysis after considering the cause of the data quality downgrade. For numeric targets for lower DQL's see the complete DQM at **http://www.oregon.gov/deq/FilterDocs/DataQualMatrix.pdf**.

## Table 4 – Accuracy and Precision Targets

| Matrix | Parameter | Precision | Accuracy | Measurement Range |
|---|---|---|---|---|
| Water | Temperature | ± 0.5 °C [i] | ± 0.5 °C | -5 to 35 °C |
| Water | pH | ± 0.3 SU | ± 0.2 SU | 0 to 14 SU |
| Water | Specific Conductivity | ± 10% Relative percent difference | ± 7% of Std. Value | ≤ 1 to 4999 µS/cm |
| Water | Turbidity | ± 20% Relative percent difference<br>(± 3 NTU if NTU < 20) | ± 10% of Std. Value | ≤ 1 to 1000 NTU |
| Water | E. coli | Absolute difference between log-transformed values<br>P ≤ 0.6 log | NA | ≤ 1 to >2419 |
| Water | Dissolved Oxygen (LDO) | ≤ + 0.4 mgL<br>> - 0.3 mgL | ± 0.3 mg/l | ≤ 0.1 to 20 mg/l |

| | | | | |
|---|---|---|---|---|
| Water | Stream Discharge | ± 10 % Relative percent difference | ± 10 % of known | NA |
| Water | Laboratory Analytical Parameters | Defined by analytical laboratory; generally ± some Relative percent difference | Defined by analytical laboratory; generally ± some % difference from laboratory control samples and no detection for blank samples | Defined by analytical laboratory; generally ≥ Limit of quantification |

[i] Continuous field audit comparisons DEQ will employ linear extrapolation between logged temperatures to determine approximate logger temperature at the time of the audit

### 1.6.2 Sensitivity

Sensitivity relates to the ability of an analytical method to quantify concentrations relevant to a study and the ability of the study design to successfully answer the monitoring question.

Analytical method sensitivity for a parameter can generally be determined by comparing the labs lowest reporting ability to existing data in the watershed or other similar watersheds. The DEQ data management system, AWQMS (https://orwater.deq.state.or.us/Login.aspx), can be used to estimate the general magnitude of expected results in the project region. If the analytical facility's methods are not sensitive enough, then many samples will be reported as below the reporting limit. If it will be a problem to have many non-detects, then it may be appropriate to look for a different indicator or method.

Study design sensitivity is the power of the expected results to answer a CBO's intended monitoring question. The variability of the population being sampled, the number of samples collected, the timing and distribution of site visits, and the required confidence in answering your question are all factors in determining if a study design is expected to successfully meet a CBO's goals.

### 1.6.3 Significant Figures

Most results are reported to 3 significant figures. All results will be rounded according to standard rounding rules and then compared to the LOQ.

### 1.6.4 Representativeness

Representativeness is controlled by using well defined sampling and sample handling Standard Operating Procedures (SOP). Sampling procedures are designed so that results are representative of the matrix being sampled. Sample handling protocols for storage, preservation and transportation have been developed to preserve the representativeness of the collected samples. Proper documentation will establish that protocols have been followed and sample identification and sample integrity assured.

Samples must be collected to most accurately represent the population defined in the SAP. Generally, in stream studies where ambient conditions are targeted, samples should be collected at or near the center of the stream channel where the water is well-mixed. If a study targets secondary portions of a waterbody—cold water refugia, mixing zones, near shore conditions, etc.—then these environments should be explicitly identified both in the SAP and in the station description. The sample collection team shall record the date and time when the grab container is removed from the stream to the nearest 5 minutes. The location of the sample will be referenced to latitude and longitude coordinates.

For macroinvertebrate sampling, physical habitat or channel measurements, all sample and data collection should be done following DEQ MOMS or using an alternate method approved in the CBO's SAP.

### 1.6.5 Comparability

This monitoring program will ensure comparability with similar projects by following the standardized sampling protocols and procedures outlined in this plan. CBO's will follow procedures defined in the DEQ MOMS or an approved SAP. Data quality determinations by DEQ will be determined following the Data Quality Classification for Volunteer Monitoring Grab Water Quality standard operating procedures (DEQ06-LAB-0027-SOP).

### 1.6.6 Completeness

In determining the number of samples required a CBO should plan to over-sample, assuming not all planned site visits will result in actual data collection. It is usually only practical to budget for a 10% over-sampling from the desired number of samples.

For split sampling the target is to complete at least one split sample with all CBO's conducting water quality monitoring at least once a year. Sufficient valid data should be collected to fulfill any other contractual agreements.

If insufficient QC records are reported to the DEQ for assigning data quality levels, the data will be downgraded to "B- estimate", or "E- data of unknown quality" according to standard operating procedures (DEQ06-LAB-0027-SOP) and quality assurance guidance documents.

## 1.7. Special Training and Certification

A condition of the equipment loan agreement signed by CBO's when they receive DEQ purchased equipment is to follow maintenance and sampling procedures outlined in the DEQ MOMS and to receive training from the DEQ. The CBO's project manager will coordinate the training of all volunteers before any monitoring activities are initiated, and schedule refresher training sessions as needed. All volunteers should be trained by DEQ staff or by CBO staff who have been trained and have experience in the specific water quality testing method. CBO staff should receive training on sample collection, processing, analysis and safety considerations. Newly trained volunteers should be supervised until the CBO project manager is assured the new individuals are confident in conducting the tests. Additional duplicates or split samples conducted between CBO staff are good ways to acquaint new monitoring personnel with procedures and document the quality of their technique.

Analytical laboratories, when used, should be ORELAP approved for the methods conducted, when possible. If a laboratory with non-ORELAP accredited analysis is selected, laboratory analysis must follow widely accepted scientific methods and protocols. These may include USEPA, USGS and Standard Methods for the Examination of Water and Wastewater. All acceptable methods include applicable precision and accuracy checks and must be listed in data submission templates. Reference Appendix C for basic analytical quality control elements. CBO's will communicate with the Volunteer Monitoring Program Coordinator prior to sampling if non-ORELAP approved analyses will be conducted to confirm that the proper methods and QC data can be provided.

## 1.8. Documentation and Records

In order to assure data quality over time CBO's should follow the document retention policy outlined in Table 5 for all documents relevant to their study.

**Table 5 – Document Retention Policy**

| Document or Record Name and Description | Storage Location | Storage Time |
|---|---|---|
| **Quality Assurance Project Plan (QAPP)-** DEQ04-LAB-0047-QAPP project description and assurance procedures. | DEQ Laboratory | 5 years |
| **CBO Sampling Analysis Plan-** specific sampling information for each groups activities. | DEQ Laboratory & CBO office | 5 years |
| **ODEQ Laboratory Mode of Operations Manual**- DEQ03-LAB-0036-SOP Methods manual | DEQ Laboratory | 5 years |
| **ODEQ Continuous Monitoring Standard Operating Procedures (SOP)-** DEQ20-LAB-0021-SOP Methods manual | DEQ Laboratory | 5 years |
| **Split Sampling: Sample and Analysis Plans -** Defining specifics of locations, parameters and dates of split sampling trips conducted by DEQ staff | DEQ Laboratory | 5 years |
| **Annual Split Sample Summary Reports -** Reporting summaries of ambient monitoring split samples | DEQ Laboratory: Reading File | 5 years |
| **QA Grab Data Submittal Reports -** Summarizing all split data available for a specific organization during the dates corresponding to the data submittal. | DEQ Laboratory: Final LIMS Report | 5 years |
| **Split Sample Trip Run Reports -** Short reports summarizing the results of a split sample conducted with a CBO | DEQ Laboratory: Reading File | 5 years |
| **Ambient monitoring field data sheets -** DEQ request for analysis forms stored raw field data collected a single sheet with all stations for each day's sampling. Stored electronically in pdf format. | DEQ Laboratory: Final LIMS Report | 5 years |
| **Split sampling monitoring field data sheets -** DEQ request for analysis forms stored raw field data collected a single sheet with all stations for each day's sampling. Stored electronically in pdf format. | DEQ Laboratory: Final LIMS Report | 5 years |
| **Original Record-** Data submitted to DEQ by CBO for review, reformatting and upload into LIMS. | DEQ Laboratory Vol_Data Drive | 5 years |
| **Equipment Notebooks -** records of quality control checks, calibrations and maintenance. | DEQ equipment boxes | 5 years |

# 2. Data Generation and Acquisition

## 2.1. Sampling Process Design

Each CBO must include in their individual SAP the logic for selecting their intended sampling locations and sampling time and frequency. Their SAP should also define how they will access sites, identify the total number of sites, what parameters will be measured at each site, and when (time of year/day,

environmental conditions, etc.). CBO's must submit a list of monitoring locations in their SAP, as well as any specific environmental conditions (ambient, summer base flow, runoff events, etc.) needed to answer a CBO's specific monitoring question. Parameters collected by CBOs may include any parameter described in the DEQ MOMS, or this QAPP. CBO's interested in monitoring other water quality parameters not specified in these documents should consult with the Volunteer Program Coordinator to clarify and include the appropriate quality assurance measures within the project SAP.

A CBO SAP should include a table of the monitoring locations that includes the following:

- Site Description including the waterbody name and a some geographic reference
- Latitude and longitude determined in NAD83 or WGS84 coordinate system, in decimal degrees
- Site identifier code (optional).

The most common study design for volunteer monitoring programs has been using targeted "integrator" sites with multiple samples collected at each location. In this scenario, each site should be considered a population. Some organizations may have the opportunity to use a statistically rigorous random sampling approach where a defined geographic area (example: sub-watershed) or basin characteristic (example: land use) is the population and in which each sample is collected at a different randomly selected location.

In both design scenarios, multiple samples are used to characterize each population using measurements of central tendency (average, median), variability (min/max, percentiles), or extreme values (7 day moving maximum, number of water quality standard exceedances) or differences in time or space (Mann-Kendall or Mann-Whitney tests, respectively). The data can then be used to define the status of sites, identify locations warranting restoration or protection, compare to water quality criteria, or detect differences between populations for the purposes of determining trends or the effectiveness of projects.

In addition to traditional water quality analytes, some studies may also collect data on explanatory parameters like streamflow or meteorological data to improve data analysis performance or explain watershed processes. When explanatory parameters are measured by the CBO, the project SAP should cover the parameters like any other parameters.

## 2.2. Sampling Methods

CBO's are required to identify the logistics for how sites will be visited for grab sampling surveys. During a sampling survey all the monitoring sites are visited either by (A) sending a sampling team to many sites; or (B) by having many teams each visit one or two sites each per sampling survey. Please refer to Section 2.5 Quality Control for details on Quality Control requirements and survey batching when determining sampling logistics.

Specific sampling protocols should be described by the CBO's in the SAP. These are expected to follow protocols described in the DEQ MOMS or appropriate DEQ SOP, unless justifications for variations or alternative methods are provided and the DEQ volunteer coordinator approves. These protocol descriptions will include collection processes such as sample homogenization, splits, filtering, etc. If a CBO experiences any problems with sample collection techniques they should contact the DEQ volunteer monitoring coordinator.

Water quality samples gathered by CBO's will be collected by wading or by using an approved sampling container such as a DEQ supplied stainless steel bucket. CBO's should always specify if sample bottles are filled in situ or from a secondary container. If a secondary container is used they should identify the type of container and how it is cleaned between sites. Likewise, field parameter measurements should be defined as in situ or from secondary container.

Continuous monitoring should be conducted following the procedures in Continuous Water Monitoring Procedures SOP (DEQ20-LAB-0021-SOP). Recording intervals should be 1 hr, 30 min or 15 min depending on the deployment and what is needed to meet the project goals. This information should be clearly stated in the SAP.

Benthic macroinvertebrate samples should be collected following the protocols from the DEQ MOMS unless, again, an alternative sampling method is proposed and approved by the DEQ Volunteer Program Coordinator.

DEQ sediment and channel sampling methods include a subset of the EMAP sediment and channel protocols. Each CBO should clarify in their SAP which parameters they will record to collect information on sediment composition (modified Wolman pebble count portion only) or to calculate the relative bed stability (slope, wet wood, thalweg, bankful height, bankful width). CBO's should contact the DEQ volunteer monitoring coordinator for documentation and potential updates on methods.

There are several methods for stream discharge measurements. It is suggested that these be collected following methods summarized in the DEQ MOMS based on USGS protocols described in the Water Resources Investigations Report 00-4036, "Measurement of stream discharge by wading". Contact the DEQ volunteer coordinator for approval of other methods.

# 2.3. Sample Handling and Custody Procedures

Using the most common equipment, surface water will generally be analyzed for temperature, dissolved oxygen, pH and conductivity in the waterbody while turbidity will be analyzed streamside from a secondary container. Analyzing as many parameters at the site as possible eliminates the potential for sample degradation or loss and allows for immediate follow-up sampling if problems or questionable results are identified. However, conductivity, pH and turbidity samples, when properly preserved, can all be measured at an office or laboratory at the end of the day as long as the holding time is honored.

Field results should be recorded immediately onto a field sheet, field notebook or field computer. Water samples and biological samples needing analysis at a laboratory should be stored in clearly labeled bottles with a chain of custody (COC) or field sheet documenting the origin of the sample with date, time, sample collector and location identifier. COC forms should describe all transfers of custody from time of sampling until arrival at the analytical laboratory. An example of an appropriate COC form is provided in Appendix A. Sample bottles, holding times, preservation requirements and shipping methods should all be confirmed with the analytical laboratory and documented in the CBO's SAP. Any required preservation or filtration by the CBO should be described in detail within their SAP.

*Escherichia coli* bacteria samples will be transported on ice, in a cooler, and analyzed within the designated holding time (8 hours or 24 hours).

Macroinvertebrate samples will be preserved in the field with 95% alcohol and returned to the lab for storage. Field preservative should be decanted off and replaced with fresh preservative within a week of collecting the sample. For samples with significant organic matter the process of replacing the alcohol should be repeated until the alcohol no longer turns a green or brown color after a week of contact with the sample. If the organic matter reduces the concentration of the alcohol to < 70% the bugs will decompose. The bottles should be marked according to the appropriate protocols as described in Chapter 3 of the DEQ MOMS. Macroinvertebrate sample jars will be labeled with a pencil on the outside with site name, date and time of collection, collectors, and sample jar number. The same information will be written on a piece of paper, in pencil and inserted into the jar. Transport of the samples to the laboratory conducting the taxonomic work should be pre-arranged. Standard chain of custody procedures from the lab doing the macroinvertebrate taxonomy should be followed and documented in the SAP.

**Table 6 – ODEQ Recommended sample container volumes, holding times and preservation for standard parameters**

| Parameter | Container | Volume | Preservation | Holding Time |
|---|---|---|---|---|
| Temperature | in-stream or sampling container | NA | none | immediately |
| Dissolved Oxygen (LDO) | in-stream or clean sampling container | NA | none; limit aeration | immediately |
| Conductivity | in-stream or clean sampling container | 250 ml | Refrigerate on ice at 4ºC | 28 days |
| pH | in-stream or clean sampling container | 250 ml | Refrigerate on ice at 4ºC | immediately (up to 24 hr.) |
| Turbidity | in-stream or clean sampling container | 50 ml | Refrigerate on ice at 4ºC | 48 hours |
| *Escherichia coli* / *Enterococcus*[i] | sterile bottle | 120 mL | Refrigerate on ice at 4ºC | 8 hours |
| Benthic Macroivertebrates | wide mouth bottle(s) | 1 L | ethanol | 6 weeks |

[i] Bacteria sampling details may vary based on specific laboratory requirements and analysis methods.

## 2.4. Analytical Methods

Standard protocols from the DEQ MOMS or the DEQ Continuous Monitoring SOP will be followed for stream temperature, pH, turbidity, conductivity, dissolved oxygen, E. coli and macroinvertebrates unless otherwise noted in the CBO's SAP.

Temperature and dissolved oxygen by LDO meter are the only field parameter methods that must be determined immediately at the site either in the waterbody or in a sampling container. Turbidity, pH, and conductivity and dissolved oxygen will be measured at the site or within their designated holding time when samples are preserved correctly. Waste generated from these field parameter tests should be collected and can be disposed of in the sink with running water.

*Escherichia coli* and *Enterococcus* will be processed in a lab. Protocols for bacteria analysis from chapter 4 of the DEQ MOMS will be followed if analysis is conducted by CBO staff. Waste generated from bacteria analysis must be sterilized before disposal.

Macroinvertebrate samples will be identified to the taxanomic level as stipulated within the CBO's SAP. Samples will be preserved with ethanol and should be disposed of appropriately after being analyzed, following local waste disposal guidelines.

Continuous monitoring equipment may be used to collect field parameters. Refer to DEQ's Volunteer Monitoring web page for resources used to validate and submit continuous data to DEQ.

Table 7 lists the recommended type of equipment used for each parameter. The equipment used for a project should be specified by the CBO their SAP.

**Table 7 – Recommended CBO analytical methods and equipment**

| Parameter | Method | Units | Location | Equipment |
|---|---|---|---|---|
| Field Temperature | Thermistor[i] | Celcius | Field | NIST Traceable thermometer or other device equipped with a NIST Traceable thermistor |
| Continuous Temperature | Temperature Data Loggers | Celcius | *In situ* | ONSET Temperature Data Loggers |
| Specific Conductance | Wheatstone Bridge[i] | µSiemens/ cm | Field or Lab | YSI Model 30 SCT meter |
| pH | Electrometric[i] | S.U. | Field or Lab | Meter with Orion Ross Electrode |
| Dissolved Oxygen | Luminescent[ii] | mg/L | Field | YSI Pro Series Meter, Orion Star A329, Hach HQ40d meters |
| Turbidity | Nephlometric[i] | NTU | Field or Lab | HACH 2100P or 2100Q |
| Benthic Macroinvertebrates | Standard DEQ Protocols[i] | Various | Field or Lab | 500 µm Mesh D-Frame Kick Net |
| Stream Discharge | Velocity-Area | Cubic feet/sec. | Field | Top setting rod, Approved Current Meter, Tag Line |

[i] ODEQ Laboratory Mode of Operations Manual (DEQ03-LAB-0036-SOP)

[ii] Field Measurement of Dissolved Oxygen using Luminescent-Sensor Probes (DEQ11-LAB-0001-SOP)

When it is necessary for the CBO to subcontract analytical work, the DEQ recommends the CBO use ORELAP accredited laboratories, which should provide assurances that lab data will be of known quality. Analytical organization, methods, units and equipment must be provided in an approved SAP for each analytical parameter analyzed at a laboratory.

# 2.5. Quality Control

### 2.5.1 Survey Batch

As previously stated, a survey batch defines what survey samples are associated with specific QC samples. CBO's must define how survey batches will be structured for a survey. For projects with multiple sampling individuals, consideration must be given to collect sufficient QC samples for each of the various samplers and/or sampling teams. Where appropriate, a CBO's SAP will define how they intend to form sampling teams. Each unique sampler or sampling team is required to collect quality control samples and identify their survey batches as part of data submission to the DEQ. If there are questions about appropriate ways to structure survey batches, contact the DEQ Volunteer Monitoring Coordinator.

### 2.5.2 CBO Field Data

Unless otherwise defined in a CBO's approved SAP, quality control procedures should follow the recommended list below in the bullets, and in Table 8.

- Precision of grab samples shall be evaluated by measuring the difference in duplicate samples--samples collected within 15 feet and 15 minutes of each other. Each sampling team collects duplicates for all grab water quality measurements at a minimum of 10% of the total number of monitoring sites (1 duplicate for every 10 sites) during each sampling survey.
- For sampling teams collecting only 1-2 samples per sampling survey, all grab parameters must be duplicated on their first sampling expedition. After the initial duplicate, future duplicates should be collected at a rate of one every ten samples or at least once every 6 months, whichever generates more duplicates. When duplicates are applied in this way, sampling team members must be tracked and reported with the water quality data to DEQ using a consistent notation.
- **Duplicates are required even for parameters measured in the waterbody**, like temperature or conductivity. When parameters are measured in the waterbody, measurement procedures should be repeated to record two readings to serve as a duplicate.
- Accuracy checks for equipment measuring pH, conductivity, turbidity and dissolved oxygen (electrometric) will be conducted at the beginning and end of each sampling day unless otherwise noted in the CBO's approved SAP. If utilizing the Winkler titration method for dissolved oxygen, specify appropriate quality control methods in the SAP and follow to ensure accuracy. If accuracy checks at the start of the day show inaccuracy outside of the limits from the DQM for "A" level data, then the equipment should be calibrated and retested for accuracy. If an accuracy check at the end of the day shows a meter is not reading within these limits for accuracy, then data from that day should be downgraded as stated in Section 3.1.1. The meter should be calibrated before being used again.
- IDEXX Colilert reagents will be tested with IDEXX Quanti-Cult culture to test the media at the start and end of the monitoring year. Incubator temperatures will be checked at the beginning and end of each incubation and recorded in a log book kept with the incubator along with date, time and who completed the equipment check.
- Continuous data precision is measured by collecting a grab sample at the monitoring site and comparing results of the grab and the continuous monitoring device result at the time the grab sample was collected. For continuous monitoring devices, a minimum of one audit at the time of deployment and one at the time of retrieval are required to assess data quality. Additional audits during the course of continuous device deployment are recommended.
- Accuracy of continuous data requires pre- and post-deployment accuracy checks. For continuous temperature data loggers, the procedures described in the Temperature Loggers section of chapter 5 in the DEQ MOMS for warm and cold water baths monitored with a NIST traceable thermometer will be followed. For multi-parameter datasondes the accuracy check requirements should be outlined in the CBO's approved SAP.
- For aquatic macroinvertebrate sampling, a field duplicate and inner-lab duplicate will be collected and identified for 10% of the total macroinvertebrate stations. In addition, 10% of the

macroinvertebrate samples will be cross-checked by another taxonomist.

## Table 8 – Required quality control measurements for common water quality tests

| PARAMETER | ACCURACY<br>(1) When<br>(2) How<br>(3) Data Quality Levels | PRECISION<br>(1) When<br>(2) How<br>(3) Data Quality Levels |
|---|---|---|
| Continuous Temperature | (1) Before and after each field season<br>(2) Warm and cold water baths as described in OWEB guidebook<br>(3) "A" level is difference from master thermometer of ≤ 0.5 C° | (1) At deployment and retrieval as an absolute minimum.<br>(2) Field audits with NIST traceable digital thermometer<br>(3) "A" level is difference from field audit of ≤ 0.5 C° when recording at half hour intervals |
| Grab Temperature | (1) Annually<br>(2) 5 temperature water baths<br>(3) Acceptable level is difference from master thermometer of ≤ 0.5 C° | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples, in stream measurements are done sequentially<br>(3) "A" level difference between duplicates of ≤ 0.5 C° |
| Specific Conductivity | (1) Bracketing your sample results, preferably at the start and end of each day<br>(2) Tests against secondary standard in the ranges of 1400 and/or 140 µS/cm<br>(3) "A" level is difference from standard of ≤ 7% of standard value | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples, in stream measurements are done sequentially<br>(3) "A" level is relative percent difference[i] ≤ 10% |
| pH | (1) Start and end of each monitoring day at a minimum.<br>(2) Tests against 7 and 10 buffers, recalibrate if off by 0.1 from buffer<br>(3) "A" level is difference from buffer of ≤ 0.2 S.U. | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples<br>(3) "A" level is difference between duplicates of ≤ 0.3 S.U. |
| Dissolved Oxygen by Winkler Methods | (1) Not required<br>(2) Side by side testing with DEQ, or "blind" samples sent to test titrations<br>(3) "A" level is difference from DEQ of ≤ 0.3 mg/L or for blind titration ≤ 0.2 mg/L | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples<br>(3) "A" level difference between duplicates of ≤ 0.3 mg/L |
| Dissolved Oxygen by Electrometric Methods | (1) Start and end of each monitoring day with saturated air checks.<br>(2) Comparisons against saturated air.[ii]<br>(3) "A" level is difference from saturated air of ≤ 0.3 mg/L for both results bracketing data | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples<br>(3) "A" level difference between duplicates of ≤ 0.3 mg/L |

| PARAMETER | ACCURACY<br>(1) When<br>(2) How<br>(3) Data Quality Levels | PRECISION<br>(1) When<br>(2) How<br>(3) Data Quality Levels |
|---|---|---|
| Turbidity | (1) Start and end of each monitoring day.<br>(2) Tests against secondary standards. Secondary standards are certified and relabeled every 3 months after calibration of meter with primary standards in the lab<br>(3) "A" level is difference from standard of ≤ 5% of standard | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples<br>(3) "A" level is relative percent difference between duplicates is ≤ 5% |
| *E. coli* and *Enterococcus*[iii] | (1) Upon receipt of reagents at DEQ (done by DEQ staff). [iii]<br>(2) Estimates can be done by doing side by side samples with DEQ<br>(3) "A" level is difference of the logs of the side by side samples ≤ 0.6 log units | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Duplicate samples<br>(3) "A" level is a difference between the logs of the values ≤ 0.6. |
| Laboratory Analytical Parameters | (1) Each analytical batch processed<br>(2) Method blanks, laboratory control samples, calibration verifications, and matrix spikes.<br>(3) See Table 14 | (1) Every day or at 10% of sampling sites, whichever is greater[i]<br>(2) Field duplicate and lab duplicate samples<br>(3) See See Table 14 |

[i] Under monitoring programs where samplers only collect 1 -2 stations per sampling event, each sampler should have duplicate for all grab parameters on their first sampling (for each season if only seasonal sampling is done); and duplicates for all grab parameters for ≥ 10% of the samples they collect or once every 6 months (whichever is greater).

[ii] Confirmation of the quality of saturated air accuracy checks should be established initially during each survey with a saturated water check. A survey being the sampling frequency defined in the SAP, often monthly, quarterly or during a storm event.

[iii] Quality control checks on dilution and blank water should be run using spikes comparable to Quanti-Cult® to test for promotion or inhibition of *E. coli* or *Enterococcus* growth. If sampling conditions require use of a secondary sampling container frequent blanks should be conducted at targeted locations most likely to be contaminated to assess possible serial contamination. These tests are completed by the sampling/analytical organization.

### 2.5.3 Laboratory Analytical Data:

Again, when it is necessary for the CBO to subcontract analytical work, the DEQ recommends the CBO use laboratories that have ORELAP accredidation for the analysis being conducted. This will provide assurances that lab data will be of known quality. Analysis done by laboratories for CBO's must provide sufficient information about the analysis for the results to be assessed for data quality. Individual SAP's should identify what QC data will be reported by the analytical laboratory to the CBO and DEQ. Minimum information required includes:

- Analytical method reference (like Standard Methods, or specific manufacturer's methods)
- Analytical instrumentation
- Reporting units (including, where appropriate, whether concentrations are molecular, like mg/L

as NO3, or atomic, like mg/L as N)

- Target reporting limit as defined by the laboratory following established procedures in the CFR, or based on the lowest concentration of their calibration standards.
- Expected accuracy as measured against laboratory control samples (LCS)
- Expected precision as measured by field or lab duplicates
- QC results including method blanks and LCS results for all the analytical batches used to process the CBO's samples.
- DEQ's quality control limits for a number of common analytes is presented in Appendix A: DEQ Quality Control Limits. Each CBO project may establish their own targets based on how their data will be used.

### 2.5.4 Split Sampling Data:

Side by side sampling with independent analysis (split sampling) is an excellent way of assessing data quality issues. CBO's are encouraged to conduct one split sampling event with DEQ staff each year. Split samples will also be used as a measure of bias for CBO results. Two types of split sampling opportunities exist with DEQ: routine ambient monitoring with split sampling or specific split sampling trips.

Each CBO should specify in their SAP whether ambient split samples or split sampling field trips will be required to obtain split samples. During split samples, duplicate samples will be collected at a minimum of 10% of the total number of monitoring sites, or at least once per split sampling event.

#### a) Split Sampling with Ambient Monitoring Program:

Routine ambient monitoring splits will be conducted by ODEQ Laboratory staff during normal sampling of the ambient network. CBO's will contact the volunteer monitoring coordinator to determine potential ambient monitoring sites within the study area. CBO staff will meet DEQ staff at a predetermined time at an ambient monitoring station and collect samples simultaneously with DEQ staff. Both the DEQ and CBO's will follow their normal sampling and analysis protocols as defined in their respective SAP. The number of stations where split samples are taken will vary on the availability of the CBO. Result values from the DEQ and CBO will be compared to determine the accuracy of the CBO's results relative to the DEQ. Ambient split samples may be used to compare any of the DEQ's ambient monitoring parameters also analyzed by the CBO.

Routine ambient monitoring splits may be conducted during any sampling run throughout the year. Most sites are sampled once every two months. A summary QC report will be submitted in a memo to the DEQ QA Officer for specific organizations when the group's grab water quality data is submitted for upload into the DEQ data management system. This memo will become part of the data's final report.

#### b) Specific Split Sampling Trips:

DEQ staff will conduct sampling trips with a CBO specifically for conducting split samples. On these trips the DEQ staff will accompany CBO staff on their routine sampling trips, collecting simultaneous samples at stations defined by the CBO. A minimum of 3 split samples will be collected per split sample, but if time and resources allow 5 to 10 split samples is preferred. Result values from the DEQ and CBO will be compared to determine the accuracy of the CBO's results relative to the DEQ. Generally these split samples will compare routine field parameter results and *Escherichia coli* concentrations but may include comparison of other parameters to be defined in specific SAPs.

# 2.6. Instrument/Equipment Testing, Inspection, and Maintenance

All reagents and supplies should be checked at the start and end of each sampling survey for expiration dates, damage, contamination or degradation. Problems with any supplies or equipment should be communicated to the DEQ as soon as possible to allow sufficient time for corrective action before the next sampling survey. CBO's must follow the maintenance and inspection recommendations below for all equipment lent them as part of the volunteer monitoring program's equipment loan program. As a general rule, all equipment should be cleared of any foreign material and rinsed with clean tap water or deionized water at the end of a sampling day, prior to storage.

## Table 9 – Standard equipment testing, inspection and maintenance requirements

| Equipment Type | Inspection Frequency | Type of Inspection |
|---|---|---|
| NIST Thermometer | Each monitoring day<br>and annual accuracy check | Cables and batteries |
| pH Meter | Each monitoring day | Accuracy checks at start and end of each monitoring day, pH probe connections, and reference solution and storage solution fluid levels. |
| Conductivity Meter | Each monitoring day and annual temperature accuracy check | Accuracy checks at start and end of each monitoring day, cables and batteries |
| Dissolved Oxygen Meter | Each monitoring day | Accuracy checks at start and end of each monitoring day, cables and batteries |
| Turbidity Meter | Each monitoring day | Accuracy checks at start and end of each monitoring day, batteries and look for scratches or smudges on vials. Clean and lightly oil sample and standards vials. |
| IDEXX QuantiTray Sealer | Yearly or as needed<br>(if there is an overflow) | Take apart and clean |
| Incubator | Prior to and at end of sample incubation | Check thermometer reading |
| D-Frame Kick Net and Sieve Bucket | Prior to and end of each site | Inspect net for rips or clinging organisms. |
| Marsh McBirney Flowmate Current Meter | a) Prior to each measurement<br>b) Start of monitoring season and every 3 months | a) Check for film upon or damage to probe<br>b) Zero check as per manual. |

| Equipment Type | Inspection Frequency | Type of Inspection |
|---|---|---|
| Standard Price AA or Pygmy Current Meter | a) Prior to and after each use<br>b) End of each monitoring day | a) Spin test (45 second and 120 second minimum for Pygmy and Price AA, respectively & no abrupt stop). Insert brass pin (Pygmy) or fasten raising nut (Price AA) when finished with each measurement.<br>b) Clean with tap water and if necessary apply small amount of supplied oil. |

# 2.7. Instrument Calibration and Frequency

Calibration requirements for common water quality monitoring equipment are listed in Table 10. Of the standard volunteer monitoring program equipment lent out to groups, the pH and dissolved oxygen meters are likely to need frequent calibration by CBO's based on accuracy check results. The turbidimeter will need to be calibrated annually with Hach StablCal standards, or equivalent, and new values assigned to the gel filled daily accuracy check vials. If other program equipment is in need of calibration, then the equipment will need to be returned to DEQ. CBOs that utilize their own monitoring equipment will maintain similar calibration frequencies. The DEQ may offer annual calibration services for non-DEQ owned equipment based on available resources year to year. If the DEQ cannot provide these services, CBOs owning their own equipment should find alternative options for calibration.

## Table 10 – Calibration requirements for standard ODEQ volunteer monitoring program equipment

| Equipment | Calibration Frequency | Standard | Responsible Party |
|---|---|---|---|
| NIST Traceable Thermometer | Annually or when > 0.5°C difference from NIST Certified Thermometer | NIST Certified Thermometer at 5, 10, 15, 20 and 25°C | DEQ will provide verification for Program loaned equipment |
| pH Meter | Daily or when > 0.1 S.U. from buffer value | Standard buffers 7 and 10 | Field personnel |
| Conductivity Meter | Annually or when > 7% difference from standard | Certified Primary Standard | DEQ will provide verification for Program loaned equipment |
| Dissolved Oxygen Meter | Daily or when > 0.3 mg/L difference from standard at a minimum | Saturated air as established by manufacturer methods | Field personnel |
| HACH 2100P or 2100Q Turbidity Meter | Annually or when ≥ 5% difference from secondary standard | HACH StablCal (<0.1, 20, 100 and 800 NTU) | DEQ or CBO Project QA Officer |
| Marsh McBirney Flowmate Current Meter | Calibrated if will not zero | Sent to Factory | Equipment Owner (DEQ or CBO) |

## 2.8. Inspection/Acceptance of Supplies and Consumables

Each CBO should specify where they will keep their equipment organized. Equipment and supplies should not be stored in an area where it would be exposed to extreme humidity, heat or cold. When supplies are consumed it must be reported to the CBO project manager immediately so the supplies can be restocked. Expirations dates of all supplies should be clearly labeled. Damaged or contaminated equipment or supplies should also be reported immediately to the CBO project QA officer who will determine if it can still be used.

### Table 11 – Supply inspection and acceptance requirements

| Supply | Location | Inspection | Responsible Party |
|---|---|---|---|
| pH filling, storage and pHisa solutions | pH Meter | Quantity and contamination | Field personnel |
| pH buffer 7 and 10 | CBO | Quantity, expiration and contamination | Field personnel |
| pH beaker, stir bar and stir plate | CBO | Presence and batteries | Field personnel |
| Turbidity secondary standards, vials, oil, and cleaning cloth | Turbidty meter box | Presence, quantity and contamination | Field personnel |
| Conductivity secondary standard | CBO | Quantity, expiration and contamination | Field personnel |
| Field sheets, clip board and pen | CBO | Presence | Field personnel |
| Sample collection bottles | CBO | Quantity and contamination | Field personnel |
| Cooler and Ice | CBO | Quantity | Field personnel |
| Permanent marker | CBO | Presence and condition | Field personnel |
| Safety cone and Orange safety vest | CBO | Presence and condition | Field personnel |
| IDEXX 120 mL Sterile sample bottles | CBO | Quantity and condition of sterile cap seal | Field personnel |
| Quanti-Tray 2000 | CBO | Quantity and contamination | Lab personnel |
| IDEXX test reagent (Colilert, Enterolert) | CBO | Quantity, expiration and contamination | Lab personnel |

A list of additional equipment needed for macroinvertebrate sampling includes the following:

- Long sleeve rubber gloves
- Sample Viewing Bucket w/mesh bottom
- Sample labels Pencil
- 1 ltr. Wide-mouth plastic sample jars
- Ethanol sample preservative
- Bug brush
- 500 micron D frame kicknet

## 2.9. Non-direct Measurements

Streamflow and weather data may be retrieved by CBO's online or by contacting directly the USGS, OWRD, and Oregon Climate Center for analysis and presentation purposes. Unless noted otherwise in the retrieved data, the quality of these results will be assumed to be of sufficient quality to use when analyzing CBO data. The limitations of all data collected will be referenced in any reports or presentations. Streamflow or weather data acquired from third parties will not be uploaded into AWQMS.

For DEQ, data acquisition is the primary, measurable benefit from the volunteer monitoring program. Data management and submission procedures defined in section 2.10 outline how data is acquired by the DEQ from CBO's.

## 2.10. Data Management

A CBO's internal data management procedures must be documented in the SAP for each project. All water quality data, including quality control results, generated by the CBO using equipment or supplies purchased by the state must be submitted to the DEQ for inclusion in the AWQMS database. Data must be submitted to the DEQ in electronic format described and approved in the CBO's SAP.

### 2.10.1 Monitoring Stations:

All data submitted to the DEQ's database must be associated with a physical location defined by a latitude and longitude. Regardless of the method used to determine coordinates, the method's datum (NAD83 or WGS84) must be reported with the coordinates. The volunteer monitoring coordinator and CBO's will be responsible for determining if sampling locations occur at existing data sampling locations within the DEQ database or if new stations will need to be created. A detailed map image of where new stations are should be sent to the volunteer monitoring coordinator for all monitoring locations needing a new station.

### 2.10.2 Submitting Data:

CBO's will use the most current formats for submitting grab and continuous water quality data, which can be found on the DEQ's web page at https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Resources.aspx. The following information about grab, continuous and macroinvertebrate data submission format should be followed, unless directed otherwise on the DEQ webpage. If there is any confusion about which submission to use, contact the DEQ Volunteer Program Coordinator.

**c) Grab Data Submittal**

At the time of this QAPP revision, the required data elements for grab water quality data submissions can be found at https://www.oregon.gov/deq/FilterDocs/VolGrabWQSubHelp.pdf. The submittal is composed of two parts, each on a separate worksheet.

First, a worksheet is provided listing metadata for the project and required information for each analyte including:

- method,
- units,
- whether analysis happened in the field or lab,
- analytical organziation,
- the limit of quantitation, and
- low level QC limit.

Second, the results are reported in a separate, flat formatted worksheet. The result data worksheet lists sample information on the left and accompanying result information in columns to the right in groups of columns for each parameter. The sample information includes a site description, latitude and longitude, sample timing information, sample depth information, sample collection information. In addition, a field is provided for grouping different samples together into a survey batch when they share QC data. **This field must be populated when batches require consideration of differing sampling crews or teams**. Refer to section 2.5.1 for a description for proper sample batch considerations. The CBO's SAP should specify which elements of site meta data are required for the project. Analytical result columns include the actual result value and a group of columns that define each result. The result metadata columns include duplicate values, analytical method, qualifier and comments and method column. Which columns from the standard template need to be populated should be defined in the CBO's SAP. The CBO should verify data submittal fields with their analytical laboratory to make sure the QC data provided by the contract lab will be suffient to meet DEQ's information requirements for assessing data quality. Lab reports from non-accredited analytes will need to provide QC data results associated with reported results.

**d) Continuous Data Submittal**

At the time of this QAPP update, the preferred method for submitting continuous data is the Continuous Data Submittal format at https://www.oregon.gov/deq/FilterDocs/ContDataSubTem3.xlsx , on the volunteer monitoring resources web page. This workbook contains separate worksheets for master site and logger information, pre and post accuracy check information, and field audit results.

(1) The site master information sheet ties monitoring locations to deployed loggers. The logger ID on this page must exactly match the logger ID's on all other worksheets.

(2) Pre and post accuracy check information is needed to confirm data quality and must include both the expected value and the measured value.

(3) The field audit sheet defines each logger's deployment period and for what parameter. For each parameter a logger reports there must be two rows—one at the start of the deployment and another at the end of the deployment. Generally these are the deployment and retrieval audits. The logged results do not need to be entered as they can be determined during reveiw. Also, if no deployment data is available the two rows with empty field audit cells still must be reported so the date and times can set the estimated deployment period. Missing field audit values will impact data quality; however, without a pair of rows showing a logger/parameter pair's approximate deployment and retrieval times the parameter will not be included even if the logged results are reported with the raw data.

(4) The continuously logged field data results are reported as separate worksheets for each logger. These logged field data worksheets should contain all data results from the time of deployment to time of

retrieval. Trimming the data is discouraged and including data points before deployment and after retrieval can be helpful in assessing the quality of deployment and retrieval audits.

**e) Macroinvertebrate Data Submittal**

The taxonomic results of macroinvertebrate data should be submitted using the most current submission template made available on the DEQ's web page at https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Resources.aspx.

Table 12 includes the major data management procedures for entering CBO generated data into the DEQ AWQMS database. Information for submitting benthic macroinvertebrate data, sediment data and channel data is not included in the table below and CBOs submitting these types of data should contact the volunteer monitoring coordinator.

## Table 12 – ODEQ Volunteer monitoring program data management procedures

| Input | Action | Responsible Party | Output |
|---|---|---|---|
| Instantaneous Grab Water Quality Data | | | |
| Instantaneous Grab Project information | Complete the DEQ grab data template with Sampling Organization, SAP title and date. For each analysis complete a row in the methods section. If one parameter is measured using more than one method, one line for each method should be completed. | CBO staff | Completed ProjectInfo datasheet for submittal to DEQ |
| Instantaneous Grab Raw Field Data and Quality Control Results | Internal data management at the CBO including review for reasonableness, completeness, data quality and existing DEQ Stations, entry into electronic data storage, and formatting of data, including duplicate data, and assigned data quality level into an approved electronic format. | CBO staff | Completed electronic data submittal file for DEQ. |
| Submitted Raw Instantaneous Grab Field Data (DEQ's "original record") | Review for formatting and completeness; create new DEQ Stations for new locations, assign appropriate DEQ parameter codes, sampling organization codes, and analytical organization codes. | ODEQ Volunteer Monitoring Specialist | • Completed template for R script processing and entery into VolWQdb.<br>• Valid values for all parameters, methods, etc. in VolWQdb |

| Input | Action | Responsible Party | Output |
|---|---|---|---|
| Completed template for instantaneous grab R script | Complete R scripts to load preliminary results into local DEQ database VolWQdb, with: flagged anomalous results, assigned DQL based on QC data or flagged for review, and exported QC result summary statistics and charts to aid in data review. | ODEQ Volunteer Monitoring Specialist | • Preliminary data in VolWQdb<br>• Summary statistics and charts to use for data review of batches with anomalous data. |
| Preliminary grab results in VolWQdb | Review all sampling batches for parameters with anomalous results in VolWQdb and assign final DQL | ODEQ Volunteer Monitoring Specialist | • Final data in VolWQdb with assigned DQL |
| Final VolWQdb instantaneous grab data | Export from VolWQdb and upload to AWQMS | ODEQ Technical Services staff | • Data accessible on the DEQ webpage |
| Verify instantaneous grab data load into AWQMS | Verify the sampling event was transferred and check 10% of sites to assure the sampling events are loading properly. | ODEQ Volunteer Monitoring Specialist | Verified data in AWQMS |
| Continuous Water Quality Data | | | |
| Site and equipment information for continuous data | Complete the SiteMasterInfo tab of the DEQ continuous data upload template. For site location use a verified DEQ Station ID or CBO's site ID, site description including waterbody name, decimal latitude and longitude in NAD83 datum, source of the latitude and longtitude, and deployment depth if appropriate | CBO staff | SiteMasterInfo datasheet for submittal |
| Field Audit Results for continuous data | For each logger a minimum of a retrieval and deployment date and time are required (two rows for each logger/ parameter combination). If no actual audit result was recorded the field may be left blank but the LOGGER_ID, Station ID, PARAMETER, DATE, TIME must all be completed. Additional rows of data should be used for any additional field audits. Data rows do not need to be in a specific order. The "LOGGER_RESULT" field does not need to be completed | CBO staff | FieldAuditResults datasheet for submittal |

| Input | Action | Responsible Party | Output |
|---|---|---|---|
| Accuracy checks from before and after deployment of continuous equipment | All available accuracy check data should be recorded in the PrePostResults to document data quality. Logger ID, parameter, unit, datetime, expected result **and** logger result need to be populated for QC assessment. | CBO staff | PrePostResults datasheet for submittal |
| Continuous Logger data | Download logger data and insert into separate worksheets for each logger in the DEQ data submittal Excel workbook. Name the worksheet with the logger ID so it exactly matches the logger ID from the SiteMasterInfo tab. Date and time must be in separate columns and each parameter should have its own column. | CBO staff | Logger datasheets for submittal |
| Continuous Data submittal workbook | Submit to DEQ | CBO staff | Data submittal complete |
| Submitted Raw Continuous Data submittal workbook (DEQ's "original record") | Review for formatting and completeness; create new DEQ Stations for new locations, assign appropriate DEQ parameter codes, sampling organization codes. | ODEQ Volunteer Monitoring Specialist | • Completed template for R script processing and review<br>• Valid values for all parameters, methods, etc. in AWQMS |
| Completed R template for continuous data | Load into Continuous Data R scripts, review QC data and charts, assign final DQL's, generate daily statistics and deployment charts. | ODEQ Volunteer Monitoring Specialist | Finalized, graded logger data and daily summary statistic, and AWQMS upload templates |
| AWQMS upload tempaltes | Load summary statistics and logger data into AWQMS. | ODEQ Technical Services staff | Data accessible on DEQ AWQMS webpage. |
| Verify data in AWQMS | Verify the sampling event was transferred and check 10% of sites to assure the sampling events are loading properly. | ODEQ Volunteer Monitoring Specialist | Verified data in AWQMS |

# 3. Assessment and Oversight

## 3.1. Assessment and Response Actions

The quality assurance procedures defined above are essential to document the quality of the data collected; however, improving the quality of the data can only be achieved by continually assessing quality control test results and taking appropriate response actions when problems arise. Field or lab personnel should report to the CBO project manager whenever quality control results do not meet the "A" level data quality objective and quality control results should be reviewed by the project manager after each survey is completed to assign overall data quality levels to the data being collected.

### 3.1.1 Accuracy

CBO's will determine accuracy for pH, dissolved oxygen, turbidity, and conductivity grab data by measuring standards before and after each sampling. Deviation from the expected value for the standard will be compared to accuracy ranges defined in the DQM (DEQ04-LAB-0003-QAG) to assign an accuracy classification for samples collected on that day for each parameter. Field personnel should assign accuracy DQL's based on the equipment they have used. Lab results not covered by the DQM should be assigned accuracy based on control samples, blanks and matrix spikes as appropriate for the method. For continuous data, pre and post accuracy checks will be used to determine the accuracy of data. The CBO's QAO will determine accuracy for the continuous data based on deployment conditions.

### 3.1.2 Precision

Duplicate sample results will be used by CBO's to determine the precision of grab water quality measurements by each sampling team. Field and lab personnel will compare differences between duplicate values against precision requirements outlined in the DQM (DEQ04-LAB-0003-QAG) to assign data precision classifications. The grab data R scripts generate summaries of duplicate performance and are used during data review. Having a space for assigning precision data quality levels on field sheets reminds field personnel to consider data quality at the time of analysis. Comparison between macroinvertebrate field and lab duplicates will be used to assess sampling and sub-sampling variability, respectively. Re-identification of macroinvertebrates by a second taxonomist will assess variability between taxonomists. Results should be compiled by the CBO's QA officer and reported with the data.

### 3.1.3 Laboratory Analytical Data

Samples analyzed by laboratories should report results to the CBO with a minimum of a method blank and LCS results for each batch of data analyzed. Method blanks should be less than the method reporting limit, and LCS results should be within the control limits identified in the CBO's approved SAP. Analytical reports submitted to the CBO should be reviewed immediately by the project manager or QA officer to make sure that the laboratory is meeting the project's data quality objectives. Data not within the control limits should be downgraded to "B" level data.

### 3.1.4 Split Sample Data

Field and lab results will be compared between samplers and and follow-up actions taken immediately if values for a group do not compare within "B" level precision limits defined in the DQM (DEQ04-LAB-0003-QAG). If comparisons do not meet the expectations of the DEQ Volunteer Monitoring Coordinator or the CBO staff, then additional training, equipment maintenance or other corrective action will be taken.

The CBO's project manager will be responsible for reviewing the entire monitoring project on a regular basis and initiating corrective actions with field and lab personnel when the data quality objective of "A" level data is not being met. Appropriate steps for resolving problems with data that occur during assessment are: re-sampling; checking for unusual sampling or analytical conditions documented in the comments; inspecting and testing equipment used to generate questionable results; and reviewing procedures to identify potential procedural errors or biases. The CBO project manager should contact the DEQ volunteer monitoring specialist if problems persist after reviewing sampling and analysis procedures with field and lab staff. The cause of data quality problems should be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained.

## 3.2. Reports

Each CBO's project SAP should identify how the results of quality control tests and other project assessments will be reported including to whom the information will be reported and when. Reporting should include the following:

- CBO field staff conducting accuracy and precision tests each day of sampling and should report the results on the field sheet unless noted otherwise in their approved SAP.
- Performance assessment results conducted by the CBO QAO will always be communicated immediately to field staff and the project manager.
- The DEQ volunteer monitoring specialist will complete summaries of QC data and provide the information to the CBO project manager and the DEQ QAO. For split sampling field trips, a short report on the results will be submitted to the CBO within 4 weeks of the data becoming available.

# 4. Data Validation and Usability

## 4.1. Data Review, Validation, and Verification

All data generated by the CBO will be reviewed by the CBO's project officer, QAO or technical committee to determine if it meets the group's objectives stated in their SAP. The CBO's SAP should clarify who will be reviewing the data. At the discretion of the CBO, state agency staff may be asked to review and comment on the data. A CBO's decisions to accept, qualify, or reject data will be made by the CBO's project manager or QAO.

Data received from CBO's by the volunteer coordinator shoud be recorded in the volunteer data database as a submission. Tracking of the data submission through processing, review and publishing in AWQMS (See Table 12) will be tracked in the volunteer data database.

The DEQ Volunteer Monitoring Specialist and the DEQ QAO will determine if the data collected meets the objectives of this QAPP. All data will be reviewed to assess the reasonablesness of results, performance against available QC limits, and available QC data by volunteer program employees following the procedures in DEQ06-LAB-0027-SOP. Decisions to accept, qualify, or reject data will be made by the volunteer monitoring specialist and/or the DEQ QAO. Additional information regarding the assessment of CBO generated data is described in section 2.10.

## 4.2. Validation and Verification Methods

Validation and verification procedures for CBO's and DEQ personnel should include the following basic steps:

- Completeness: Each step of the data generation and management should be assessed for completeness as soon as possible. Both missing parameter results and sample information, like time, collector, equipment, etc., should be reviewed. Missing information may warrant qualifying data (i.e. "B" data).
- Reasonableness: Data generated should be reviewed for reasonableness to help catch any significant errors in result values and sample information. Data which appears unreasonable should be investigated and qualified when appropriate. At a minimum a comment should be added to explain unusual values.
- QC Data Review: All available QC data should be analyzed to estimate the accuracy and precision of generated results. All result values will be classified with a data quality level based on the Oregon DEQ's Data Quality Matrix Version 5.0 or later for field data (http://www.deq.state.or.us/lab/techrpts/docs/DEQ04-LAB-0003-QAG.pdf) or the Data Quality Classification for Volunteer Monitoring Grab Water Quality quality assurance guidance document DEQ06-LAB-0027-SOP.
- Data Transfer Errors: At least 10% of data should be verified against original records whenever data is transferred either electronically or manually from one system to another. This includes transcribing field sheet data to databases at the CBO, or when DEQ reformats submitted data for upload into LIMS and then AWQMS.

The DEQ Volunteer Monitoring Specialist will verify that these validation procedures are completed.

The DQLs are used to simplify database queries of quality data and as a simplified indicator of data suitability for the Volunteer Monitoring Program (the suitability of the data by others must be determined based on their own individual data needs). Data not meeting the data quality indicator control limits will receive a DQL other than "A". If a QC measure fails to meet control limits, personnel evaluating the QC must flag all results associated with the particular QC failure. The DQL will be set to "B" or "C" depending on the severity of the failure. Comments will be linked to the results explaining QC failures. If the CBO's QAO determines the data does not meet the data quality objectives described in section 1.6, the DQL of all affected results will be adjusted to the appropriate code defined in the DQM, DEQ04-LAB-0003-QAG, Version 5.01.6.1.

## 4.3. Reconciliation with User Requirements

CBO's are ultimately responsible for determining how they use data that does not meet their data quality objectives. The DEQ strives to use only the highest quality of data and generally only use "A" level, and sometimes "B" level data. Data that is designated as "E" level may be used to assist planning additional monitoring or other uses that do not make a determination about a site's water quality. If the data generated by a CBO is discovered to not sufficiently address a CBO's monitoring objectives, then the SAP should be revised or appended to describe any changes to the monitoring program to help the group better achieve their objectives.

# 5. Revision History

**Table 13 – Revision History**

| Revision | Date | Changes | Editor |
|---|---|---|---|
| 1.0 | 11/4/2004 | Original Document<br>1.26.2021 CM – No physical or electronic version exists | Steve Hanson |
| 1.1 | 11/14/2005 | Added<br>Table 11: QAPP Revision History<br>List of Tables and List of Figures<br>Captions to Tables and Figures<br>Text to B10 to include CBO's map images of sampling sites | Steve Hanson & Chris Redman |
| 2.0 | 9/21/2009 | Major revisions throughout document – list of changes noted in revision 2.0 revision history | Steve Hanson |
| 3.0 | 7/8/2021 | Migrated to new template, routine review and updates including removal of reference to LASAR and addition of reference to AWQMS | N. Haxton-Evans |
| | | | |

# Appendix A – Example Chain of Custody Form

| | |
|---|---|
| Entered Into Database: | Yes by |
| Database Reviewed: | Yes by |

SURVEY: _____ Date Sampled: _____

Major Basin: _____ Date Received in Lab: _____ Date Reported: _____

Collected by: _____ Weather: _____

BACTERIA ANALYSIS REPORT

| Item # | SITE # | SITE NAME | DO Poly | Time (HH MM) | Temp. (Deg.C) | FCond. (umhos) | D.O. (mg/l) | DO Sat. (%) | Field Turb. (NTU) | Bact Bottle | Date/Time in<br>Date/Time out | Temp in<br>Temp out | T. coliform<br>*E.coli* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |
| | | ACCUARCY DATA QUALTY LEVEL<br>BASED ON STANDARDS CHECKS | | | NA | | NA | NA | | **Cond**: A ≤ ±7%, B ≤ ±10%; **Turb** ≤ ±5%, B ≤ ±30% | | | |
| | | PRECISON DATA QUALITY LEVEL<br>BASED ON DUPLICATE SAMPLES | | | | | | | | **Temp:** A ≤ ±0.5,B ≤ ±1; **Cond**: A ≤ ±10%, B ≤ ±15%; **DO**: A ≤ ±0.3, B ≤ ±1; **Turb** ≤ ±5%, B ≤ ±30% | | | |

Bacteria Analyst: _____

**Comments:** _____

PAGE_____OF_____

# Appendix B – ODEQ Quality Control Limits

The list of quality control limits for common analytes analyzed by the DEQ laboratory follows below. Relevant acronym definitions include the following:

- CCV- Continuing Calibration Verification: Test to measure the stability of the calibration. This QC measure is conducted routinely during the analysis of the samples.
- ICV- Initial calibration verification: Test to measure the accuracy of the calibration. This QC measure is conducted immediately after calibration (before samples are run). The ICV should come from a source different from the calibration standard(s).
- LCS- Laboratory Control Sample: A test of a known QC sample that is carried through all sample processing steps.
- MS- Matrix Spike: A test of sample that has had added to it a known quantity of analyte.

## Table 14 – ODEQ Data Quality Indicators

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| **Field Measurements** | | | | | | | | |
| Dissolved Oxygen | mg/L | NFM 6.2.1 | 1 | ≤ ± 0.3 | N/A | N/A | + 0.4 mgL, > - 0.3 mgL[v] | ≤ ± 0.2[vi] |
| Flow | cfm | MOMS[vii] | 1 | N/A | N/A | N/A | N/A | N/A |
| Percent DO Saturation | % | | N/A | | N/A | N/A | N/A | N/A |
| Sample Depth | Ft | | 1 | | N/A | N/A | N/A | N/A |
| Temperature | °C | EPA 170.1 | 1 | ± 0.5 | N/A | N/A | N/A | ≤ ± 0.5[viii] |
| pH | S.U. | EPA 150.1 | Sensitivity to 0.1 | ± 0.3 | N/A | ± 0.2[ix] | N/A | ≤ ± 0.2[x] |
| Alkalinity | mg/L | Titration | 1 | ± 2 | – | N/A | N/A | ≤ ± 1 |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Specific Conductivity (@ 25°C) | µmhos/cm | EPA 120.1 | 1 | ± 10% | N/A | N/A | ±7% | ±7% |
| Turbidity | NTU | SM 2130 B | 1 | ± 5% | N/A | N/A | ±5% | ±5% |
| Redox | Mv | Electrometric probe | 1 | ± 20 | N/A | N/A | ± 10 | |
| **Microbiological Examination** | | | | | | | | |
| *Escherichia Coli (E.Coli)* | CFU / 100mL | SM 9223B | 1 | 0.6 (log) | N/A | Positive Confirmation | N/A | N/A |
| Enterococcus | CFU / 100mL | ASTM D6503 | 10 | 0.6 (log) | N/A | Positive Confirmation | N/A | N/A |
| Bacteria - Total Coliform only | CFU / 100mL | TBD | 1 | 0.6 (log) | N/A | Positive Confirmation | N/A | N/A |
| **Physical & Aggregate Properties** | | | | | | | | |
| Solids Ash Free Dry Weight | mg/L | TBD | 10 | | N/A | | | |
| Total Dissolved Solids | mg/L | 2540 C | 10 | ± 20% | N/A | ± 20% | N/A | N/A |
| Total Solids | mg/L | 2540 B | 10 | ± 20% | N/A | ± 20% | N/A | N/A |
| Total Suspended Solids | mg/L | 2540 D | 1 | ± 20% | N/A | ± 20% | N/A | N/A |
| Alkalinity | mg/L | 2320 B | 1 | ± 10% | N/A | ± 20% | ± 0.3 pH | ± 0.1 pH |
| Bicarbonate Alkalinity | mg/L | 2320 B | 1 | | N/A | | | |
| Conductivity | µmhos/cm | 120.1/2510 B | 1 | ± 5% | N/A | N/A | ± 5% | ± 5% |
| Salinity | Ppth | 2520 B | 1 | | N/A | | | |
| Settleable Solids | mL/L | 2540 F | 0.01 | | N/A | | | |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Turbidity | NTU | 180.1/2130 B | 1 | ± 20% | N/A | ± 10% | ± 10% | ± 10% |
| pH | SU | 150.1/4500-pH B | 0.1 | ± 0.2 pH | N/A | ± 0.1 pH | ± 0.3 pH | ± 0.1 pH |
| Color | CU | 2120 B | 1 | | N/A | | | |
| Density | g/ml | N/A | 0.1 | | N/A | | | |
| **Metals** | | | | | | | | |
| Mercury, Total | µg/L | 245.1/7470A | LOQ | ± 10% | ± 20% | ± 15% | ± 10% | ± 10% |
| Antimony by Graphite Furnace, Dissolved | µg/L | TBD | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Lead by Graphite Furnace, Total Recoverable | µg/L | TBD | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Thallium by Graphite Furnace, Dissolved | µg/L | TBD | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Calcium Hardness | mg/L | TBD | LOQ | ± 20% | N/A | ± 15% | ± 10% | ± 10% |
| Hardness by ICP-AES | mg/L | TBD | LOQ | ± 20% | N/A | ± 20% | ± 10% | ± 10% |
| **Metals by ICP, Total** | | | | | | | | |
| Aluminum | mg/L | TBD | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | |
| Chromium | mg/Kg wet | TBD | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 10% |
| Total Sulfur | mg/L | TBD | LOQ | | | | ± 10% | ± 10% |
| **Metals by ICP, Total Recoverable** | | | | | | | | |
| Aluminum | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Antimony | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units**[i] | **Method** | **Target**[ii] | **Precision**[iii] | **MS** | **LCS** | **CCV** | **ICV** |
| Arsenic | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Chromium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Copper | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Iron | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Lead | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Nickel | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Silicon | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Strontium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Thallium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Tin | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Titanium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Vanadium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| **Metals by ICP, Dissolved** | | | | | | | | |
| Antimony | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Arsenic | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Copper | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Lead | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Silica | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Strontium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Thallium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Titanium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Vanadium | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Drinking Water Metals by ICP AES | mg/L | 200.7 | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% |
| Metal Cations by ICP, Dissolved | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Indicator Metals #2, Dissolved | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals ICP Scan, Dissolved | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metal Cations by ICP, Total | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals by ICP Scan, Total | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Indicator Metals #2, Total Recoverable | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metal Cations by ICP, Total Recoverable | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals ICP Scan, Total Recoverable | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals by ICPMS[xi] | µg/L | 200.8 / 6020 | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 10% |
| Metals in Pesticide Samples by ICP-MS | µg/L | 200.8 / 6020 | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 10% |
| Metals in Pesticides by ICP AES | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Metals in Industrial Effluent by ICP AES | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals in Reagent Water by ICP | mg/L | 200.7 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 5% / ± 10% |
| Metals, Total Recoverable in Landfill Samples | mg/L | 6010B / 6020 | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 10% |
| TCLP Percent Solids-Metals | % | 1311 | LOQ | | | | | |
| Mercury,TCLP | mg/L | 1311 / 7470 A | LOQ | ± 10% | ± 20% | ± 15% | ± 10% | ± 10% |
| TCLP - Toxic Pollutant Metals by ICP #1 | mg/L | 1311 / 6010B | LOQ | ± 20% | ± 30% | ± 15% | ± 10% | ± 10% |
| **Inorganic Non-Metals** | | | LOQ | | | | | |
| Ammonia | mg/L | 4500NH3 B,H | LOQ | ± 20% | ± 20% | ± 20% | ± 10% | ± 10% |
| Chloride by Colorimetry | mg/L | 325.2/4500Cl E | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Nitrate by Colorimetry | mg/L | 353.2/4500$NO_3$F | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Nitrate/Nitrite | mg/L | 353.2/4500$NO_3$F | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Nitrite | mg/L | 353.2/4500$NO_3$F | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Total Kjeldahl Nitrogen | mg/L | 351.2/4500$N_{org}$D | LOQ | ± 20% | ± 20% | ± 20% | ± 10% | ± 10% |
| Total Nitrogen | mg/L | MOMS grab | LOQ | | | | | |
| Bromate | µg/L | 300.1 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Bromide by Ion Chromatography | mg/L | 300.0 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Chlorate | µg/L | 300.1 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Chloride by Ion Chromatography | mg/L | 300.0 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Chlorite | µg/L | 300.1 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Fluoride by Ion Chromatography | mg/L | 300.0 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Nitrate by IC | mg/L | 300.0 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Sulfate by IC | mg/L | 300.0 | LOQ | ± 10% | ± 20% | ± 10% | ± 10% | ± 10% |
| Biochemical Oxygen Demand,5 Day Diluted | mg/L | 5210 B | LOQ | ± 10% | N/A | ± 15% | N/A | N/A |
| Biochemical Oxygen Demand,5 Day Un-Diluted Stream | mg/L | TBD | LOQ | | | | | |
| Biochemical Oxygen Demand,Carbonaceous 5 Day Diluted | mg/L | TBD | LOQ | | | | | |
| pH for NonMetals workgroup (QC checks) | S.U. | TBD | LOQ | | N/A | | | |
| Chlorine, Free | mg/L | | LOQ | | N/A | | | |
| Chlorine, Total Residual | mg/L | 4500CL E,I | LOQ | ± 10% | N/A | ± 10% | N/A | ± 10% |
| Orthophosphate | mg/L | 4500P E | LOQ | ± 10% | ± 10% | ± 5% | ± 5% | ± 5% |
| Total Phosphorus | mg/L | 4500P B,E | LOQ | ± 10% | ± 10% | ± 5% | ± 5% | ± 5% |

| Parameter | Units[i] | Method | Target[ii] | Precision[iii] | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | MS | LCS | CCV | ICV |
| **Organic GC and HPLC** | | | | | | | | |
| Drinking Water - Chlorinated Pesticides by GC/ECD Method 508 | µg/L | 508 / 8081B | LOQ | ≤ 30% | ± 35% / CC[xii] | ± 30% | ± 20% | ± 20% |
| Chlorinated Pesticides by GC/ECD | µg/L | 508 / 8081B | LOQ | ≤ 30% | ± 35% / CC[xii] | ± 30% | /± 20% | ± 20% |
| PCBs as Arochlors | µg/L | 508/ 508A / 8082A | LOQ | ≤ 30% / 20% / 30% | 35% / 30% / CC[xii] | ± 30% / ± 20% | /± 20% | ± 20% |
| EDB/DBCP/TCP by GC/ECD | µg/L | 504.1 | LOQ | ≤ 30% | ± 35% | ± 30% | /± 20% | ± 20% |
| Nitrogen/Phosphorous Pesticides by GC/NPD | µg/L | 8141B | LOQ | ≤ 30% | CC[xii] | ± 30% | /± 20% | ± 20% |
| Volatile Organic Compounds by GC/MS | µg/L | 524.2 / 8260C | LOQ | ≤ 30% | ± 30% | ± 30% | ± 30% | ± 30% |
| Drinking Water Semi-volatile Organic Compounds by GC/MS | µg/L | 525.2 | LOQ | ≤ 30% | ± 30% | ± 30% | ± 30% | ± 30% |
| Semi-volatile Organic Compounds by GC/MS | µg/L | 8270D | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |
| Polynuclear Aromatic Hydrocarbons by GC/MS SIM | µg/L | 8270D | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |
| Phenoxy Herbicides by GC/MS | µg/L | 8270D | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| Phenoxy Herbicides by GC/ECD | µg/L | SM6640B | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |
| Solvent Extractable nonvolatile compounds by HPLC/TS/MS | µg/L | 8321B | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |
| Pharmaceutical and Personal Care Products by LC/MS/MS | µg/L | 1694 | LOQ | ≤ 30%[xiii] | Varies by comp. | Varies by comp. | ± 30% | ± 30% |
| Steroids and Hormones by HRGC/HRMS | µg/L | 1698 | LOQ | ≤ 30%[xiii] | Varies by comp. | Varies by comp. | ± 30% | ± 30% |
| NW Total Petroleum Hydrocarbons - Diesel Range | mg/L | NWTPH-D | LOQ | ≤ 30% | ± 50% | ± 30% | ± 20% | ± 20% |
| NW Total Petroleum Hydrocarbons - Gasoline Range | mg/L | NWTPH-G | LOQ | ≤ 30% | ± 50% | ± 30% | ± 20% | ± 20% |
| NW Total Petroleum Hydrocarbons Identification | Mg/L | NWTPH | LOQ | N/A | N/A | N/A | ± 20% | ± 20% |
| Algal Toxins by LC/MS-MS Anantoxin and Microcystin | µg/L | MOMS grab | LOQ | | | | | |
| Microcystin by ELISA | µg/L | MOMS grab | LOQ | | | | | |
| TCLP - Phenoxy Herbicides by GC/MS | mg/L | 1311/8270D | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |

| | | | | | Accuracy[iv] | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Units[i]** | **Method** | **Target[ii]** | **Precision[iii]** | **MS** | **LCS** | **CCV** | **ICV** |
| TCLP - Semivolatile Organic Compounds by GC/MS | mg/L | 1311/8270D | LOQ | ≤ 30% | CC[xii] | ± 30% | ± 20% | ± 20% |
| TCLP - Volatile Organic Compounds by GC/MS | mg/L | 1311/8260C | LOQ | ≤ 30% | ± 30% | ± 30% | ± 30% | ± 30% |
| TCLP - Chlorinated Pesticides by GC/ECD | mg/L | 1311/8081B | LOQ | ≤ 30% | CC[xii] | ± 30% | /± 20% | ± 20% |
| **Organic: Aggregate Constituents & Properties** | | | | | | | | |
| Oil & Grease | mg/L | 1664 | LOQ | ± 10% | | ± 10% | | |
| Chemical Oxygen Demand | mg/L | 5220D | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Dissolved Organic Carbon | mg/L | 415.1/5310B | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Total Organic Carbon | mg/L | 415.1/5310B | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Flash Point | °F | 1020B / ASTM D3278 | LOQ | | N/A | | | |
| Chlorophyll | µg/L | SM10200 H | LOQ | | N/A | N/A | ± 10% | ± 10% |
| Chlorophyll by Area | mg/m² | Calculation | LOQ | | N/A | N/A | N/A | N/A |
| Total Cyanide | mg/L | 9014/4500CN E | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Total Cyanide (SDWA) | mg/L | 4500CN E | LOQ | ± 20% | ± 10% | ± 10% | ± 10% | ± 10% |
| Cyanide Weak Acid Dissociable | mg/L | 4500CN C,G | LOQ | ± 20% | ± 25% | ± 15% | ± 10% | ± 10% |
| Fluorescein by Spectrometry | mg/L | TBD | LOQ | | | | | |

| Parameter | Units[i] | Method | Target[ii] | Precision[iii] | Accuracy[iv] MS | LCS | CCV | ICV |
|---|---|---|---|---|---|---|---|---|
| Lignin and Tannin | mg/L | TBD | LOQ | | | | | |
| NCASI Color | CU | TBD | LOQ | | N/A | | | |
| Phenolics | mg/L | TBD | LOQ | | | | | |

[i] The units of the QC (Target, Precision, and Accuracy) limits are listed in this column. If the QC limit is reported with a "%" sign it is unit-less.

[ii] The target level is the anticipated reporting level for this project. A target level of "LOQ" means the laboratory will use its current LOQ. If the requested target level is less than the laboratories LOQ, the laboratory will estimate the result down to the laboratory's LOD. The laboratory will not report values less than its LOD.

[iii] The precision control limit is to be used to evaluate both field duplicate and laboratory duplicate samples. Use the laboratory's current duplicate control limits, unless specified otherwise.

[iv] Actual laboratory control limits may vary, since laboratories are expected to revise control limits over time. Some QC measures are not applicable (NA) to the test method. Use the laboratory's current accuracy control limits, unless specified otherwise.

[v] If the Dissolved Oxygen (DO) probe method is used, verify the accuracy **daily** with end of day saturated air checks. If the Winkler method is used, there is not a recommendation for a CCV.

[vi] If the Dissolved Oxygen (DO) probe method is used, and a saturated air check was used for calibration, verify the accuracy with a saturated water check.

[vii] Stream flow measurements will be conducted according to the ODEQ methodology derived from USGS stream flow protocols.

[viii] Thermometer Accuracy checked with NIST standards.

[ix] Low ionic control sample.

[x] Low ionic control sample.

[xi] The Limit of Quantification (LOQ) is dependent on preparation technique TCLP, Dissolved, Total, and Total Recoverable.

[xii] Limits are based on laboratory historical data obtained from Control Charts

[xiii] Control limit for most compounds, some are > 30%.

# Appendix C Quality Control Considerations for non-ORELAP accredited laboratories

To ensure the data integrity, the following elements of quality control should be evaluated by CBO's when considering contract laboratories that are not ORELAP accredited. Additional questions should be directed to the Volunteer Monitoring Program Coordinator.

- Method Validation
    - Validation of Methods
    - Limit of Detection and Limit of Quantitation (However Named)
        - Detection Limit (DL)
        - Initial determination of the DL
        - Ongoing verification of the DL
        - Limit of Quantitation (LOQ)
            - Initial verification of the LOQ
            - Ongoing verification of the LOQ
            - Verification of DL/LOQ
            - Documentation
        - Evaluation of Precision and Bias
        - Evaluation of Selectivity
- Demonstration of Capability (DOC)
    - General
        - Initial DOC
        - Ongoing DOC
- Technical Requirements
    - Calibration
        - Initial Calibration
        - Continuing Calibration Verification (CCV)
    - Quality Control (QC)

- Negative Control – Method Performance: Method Blank
- Positive Control – Method Performance: Laboratory Control Sample (LCS)
- Sample Specific Controls
  - Matrix spike; matrix spike duplicates
  - Matrix duplicates
  - Surrogate spikes
- Data Reduction
- Reagent Quality, Water Quality, and Checks
- Selectivity

- Data Acceptance/Rejection Criteria
  - Negative Control – Method Performance: Method Blank
  - Positive Control – Method Performance: Laboratory Control Sample (LCS)
  - Sample Specific Controls
- Sample Handling