UTAH DIVISION OF WATER QUALITY

QUALITY ASSURANCE PROGRAM PLAN FOR ENVIRONMENTAL DATA OPERATIONS

Final Plan

Revision No. 1.0
Effective September 5, 2014

Utah Division of Water Quality
Utah Department of Environmental Quality
195 North 1950 West
Salt Lake City, Utah 84116

UTAH DWQ QAPP

Agency Approvals:

5-8-14

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25 April 2014

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4/16/14

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for Trisha Johnson 4/16/14

Trisha Johnson, Assistant Quality Assurance Officer — Date
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REVISION PAGE

Date	Revision #	Summary of Changes	Sections	Other Comments
5/1/2014	0	Not applicable	Not applicable	Creation of document; began document control/revision tracking.
9/5/2014	1.0	Updated links to webpages embedded within the document Updated personnel	Various sections throughout document text Distribution List & Figure 1	QA Officer will recheck hyperlinks at least annually as DEQ updates its webpages frequently

REVIEWERS

This document was prepared by Trisha Johnson and James Harris.

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DISTRIBUTION LIST

The following individuals (or the current position holder) will receive a copy of this QAPP, along with any subsequent revisions. The QAPP will also be available online and is recommended reading for all personnel within the Division collecting, handling, or analyzing environmental data.

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
AWQMS	Ambient Water Quality Monitoring System
CoC	Chain of Custody
CWA	Clean Water Act
DO	Dissolved Oxygen
DEQ	Department of Environmental Quality
DM	Database Manager
DOC	Demonstration of Capability
DPM	Designated Project Manager
DQI	Data Quality Indicator
DQO	Data Quality Objective
DTS	Department of Technology Services
DWQ (or Division)	Division of Water Quality
DWR	Department of Wildlife Resources
EPA (or USEPA)	United States Environmental Protection Agency
GSL	Great Salt Lake
IR	Integrated Report
MLID	Monitoring Location ID
MOU	Memorandum of Understanding
MRL	Minimum Reporting Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NIST	National Institute of Standards and Technology
NPS	Nonpoint Source
OSHA	Occupational Safety and Health Administration
PDR	Portable Data Recorder
QA	Quality Assurance
QA/QC	Quality Assurance and Quality Control
QAC	Quality Assurance Council
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project/Program Plan
QC	Quality Control
QMP	Quality Management Plan
QPC	Quality Process Coordinator
QS	Quality System
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SMP	Strategic Monitoring Plan

SOP	Standard Operating Procedure
SRM	Standard Reference Materials
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
UCASE	Utah Comprehensive Assessment of Stream Ecosystems
UIC	Underground Injection Control
UPDES	Utah Pollution Discharge Elimination System
USEPA (or EPA)	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WQX	Water Quality Exchange
XML	Extensible Markup Language

INTRODUCTION AND SCOPE

The United States Environmental Protection Agency (USEPA or EPA) requires participation in a centrally managed quality assurance program by all agencies whose monitoring and measurement efforts are supported or mandated through contracts, grants, regulations, or other formalized agreements with the USEPA. To meet this requirement, the State of Utah (the State) Department of Environmental Quality (DEQ) documented its quality system in a Quality Management Plan (QMP). The QMP was approved by EPA in October 2010 and can be accessed online at http://www.deq.utah.gov/Admin/Planning/EPA_QMP.htm. Under the QMP, DEQ's Quality Assurance Council (QAC) must approve quality assurance project/program plans (QAPPs) for each of its divisions/programs collecting or processing environmental data. This document meets that requirement for the Utah Division of Water Quality (DWQ or Division).

This QAPP documents how quality assurance and quality control (QA/QC) are applied to environmental data operations within DWQ to ensure that the results obtained are of known and suitable quality and quantity needed to meet the Division's goals and objectives. This QAPP was prepared in accordance with the following EPA guidance documents: *EPA Requirements for Quality Assurance Project Plans*, *EPA QA/R-5* (USEPA, 2001) and *EPA Guidance for Quality Assurance Project Plans*, *EPA QA/G-5* (USEPA, 2002). This QAPP addresses all of the elements suggested for inclusion by EPA (see **Table 1**). This document was also developed in accordance with the requirements outlined in DEQ's QMP.

This QAPP does not cover DWQ's monitoring programs for which the QA/QC requirements are covered under separate documents: Surface water permitting and compliance monitoring for the Utah Pollution Discharge Elimination System or UPDES (addressed in individual permits), ambient ground water quality monitoring (addressed in an existing EPA-approved QAPP), ground water permit compliance monitoring (addressed in Ground Water Quality Protection rules and individual permits), and the Underground Injection Control (UIC) program (addressed in an existing EPA-approved QAPP).

This QAPP is meant to be an umbrella document outlining the minimum QA/QC requirements for environmental data collection within the Division. Due to the various and diverse monitoring and assessment projects identified in DWQ's SMP, specific details for each environmental monitoring program/project will be outlined in program/project-specific SAPs rather than requiring individual project-specific QAPPs. Development and implementation of a SAP is required for all DWQ projects that produce environmental data, no matter how small or limited in duration. SAPs will be prepared before environmental data collection begins and may be revised during the life of a project. A SAP may be written for a specific project, for activities at a specific sampling site, or for activities falling under a larger monitoring program.

Project-specific SAPs must align with this Division QAPP and should address the key elements of the EPA's *Guidance for Quality Assurance Project Plans*, *EPA QA/G-5* (USEPA, 2002). A project-specific SAP should address specific project aspects such as the purpose of monitoring, project-specific data quality objectives (DQOs) and measurement criteria, number and locations of representative samples, frequency of sample collection, sample types and collection methods, analytical methods, sample handling and chain of custody, any project-specific quality assurance requirements such as type and frequency of quality control samples, assessment and review, record keeping, data handling and storage, and project team roles and responsibilities. SAPs from a regulated or cooperating third party may be used if approved by the Division. Project-specific SAPs will be reviewed and approved by DWQ and will not be sent to the QAC for approval.

DWQ program/project managers, hereafter referred to as Designated Project Managers (DPMs), are responsible for designing monitoring strategies, setting project-specific DQOs, and developing project-specific SAPs. DPMs are responsible for making sure all personnel involved with the project are briefed and/or trained on the procedures to be used. **Appendix A** of this QAPP is a DWQ guidance document for the preparation of project-specific SAPs. The guidance document includes many helpful tools such as checklists to ensure that SAPs contain all of the informational requirements listed in this Division QAPP.

Both the QAPP and SAPs will reference detailed standard operating procedures (SOPs). DWQ generates SOPs for any sample collection/processing, sample handling, or data management procedure that becomes routine, even when published methods are utilized. The use of SOPs ensures data comparability, defensibility, accuracy, and reduced bias.

Table 1. List of QAPP elements.

Group A Elements: Project Management	Group B Elements: Data Generation and Acquisition	Group C Elements: Assessment and Oversight	Group D Elements: Data Validation and Usability
A1 Title and Approval Sheet	B1 Sampling Process Design (Experimental Design)	C1 Assessments and Response Actions	D1 Data Review, Verification, and Validation
A2 Table of Contents	B2 Sampling Methods	C2 Reports to Management	D2 Verification and Validation Methods
A3 Distribution List	B3 Sample Handling and Custody		D3 Reconciliation with User Requirements
A4 Project/Task Organization	B4 Analytical Methods		
A5 Problem Definition and Background	B5 Quality Control		
A6 Project/Task Description	B6 Instrument/Equipment Testing, Inspection, and Maintenance		
A7 Quality Objectives and Criteria	B7 Instrument/Equipment Calibration and Frequency		
A8 Special Training/Certifications	B8 Inspection/Acceptance of Supplies and Consumables		
A9 Documentation and Records	B9 Non-direct Measurements		
	B10 Data Management		

A. PROGRAM MANAGEMENT

This first section of the QAPP addresses program administrative functions and program concerns, goals, and approaches to be followed.

A.1 Title and Approval Sheet

See Pages 1-2.

A.2 Table of Contents

See Page 6.

A.3 Distribution List

See Page 5.

A.4 Project/Task Organization

The Division of Water Quality, directed by Walt Baker, administers water quality programs for the State of Utah. Assistant Directors Leah Ann Lamb and John Whitehead manage the two branches within the Division - the Engineering and Water Quality Branch, and the Permits, Compliance, and Watershed Branch, respectively. See **Figure 1** for a DWQ organizational chart emphasizing Quality Assurance responsibilities.

The Division lead on quality assurance matters is the Quality Assurance Officer (QAO), assisted by the Quality Assurance Staff (QA Staff) as described in **Section A.4.1** below. However, as stated in DEQ's QMP, responsibility for quality data resides with each staff member, and particularly with Designated Project Managers (DPMs). The DPM is the staff member responsible for a specific project (or program) and has immediate managerial or technical control of that project. The DPM is responsible for developing SAPs and specifying the quality of the data required for each project. Whenever DWQ data collection activities are performed by DWQ personnel or DWQ contractors, the DPM has responsibility for ensuring that all QA/QC requirements are met. The oversight and improvement of quality assurance implementation and performance is vested with DPMs and also the Division's QA Staff, Section and Branch managers, and the Division Director. The Division Director has the final authority regarding QA/QC-related decisions.

A.4.1 Quality Assurance Staff

Department-Level

Paul Harding, Office of Planning and Public Affairs, serves as the Utah DEQ Quality Process Coordinator (QPC) and operates independently of direct environmental data generation. The QPC works directly with the Quality Assurance Committee (QAC), which is made up of one or more representatives from each DEQ Division/program that requires a QAPP. The QAC is responsible for regularly reviewing and approving Division/Program QAPPs, along with major revisions and is also available to assist with quality assurance matters. Ideally, those serving on the QAC will have been involved in drafting the QAPP for their own Division/program and are knowledgeable about quality assurance issues. The QPC and the Department-wide representation to the QAC provide sufficient authority to assure independent oversight of each Division's program QAPP.

Division-Level

The QA Staff for the Division of Water Quality is housed in the Monitoring Section and consists of the Quality Assurance Officer (QAO), Assistant QAO/Lab Liaison, and the Database Manager (DM). Current assignments for these roles are as follows:

QAO: James Harris
Assistant QAO/Lab Liaison: Trisha Johnson
DM: Lenora Sullivan

The QAO is the point of contact for all data quality concerns for monitoring programs, is the DWQ representative to the QAC, and reports to DWQ upper management regarding QA/QC issues. The other Division QA Staff members handle all day-to-day QA/QC activities and tasks. They review, revise, and maintain the QA/QC documentation for the Division including the QAPP, SOPs, and SAPs as well as coordinate distribution of all QA documents (See **Section A.9.1**), manage and maintain water quality data within the database, perform data review, validation, and reporting, assist the DPMs in their QA/QC activities, and serve as liaisons to the Utah Public Health Laboratory and other analyzing laboratories. The QA Staff is independent from data generation in that they do not generally perform environmental data collection. In an "all-hands-on-deck" scenario where the QAO and/or QA Staff are needed for data collection, a DPM or senior field personnel not involved with the data collection effort will perform the data review normally performed by the QA Staff. The Assistant QAO and DM report directly to the QAO. The QAO reports to the Director. Currently the QAO is also the Monitoring Section Manager. However, DWQ plans to make this a stand-alone position completely separate from data collection and section management duties in the future. It is important to note that the QAO does not routinely make decisions on data rejection or data usability alone. More often they generate a report on recommendations for usability of data that is discussed within the Division with the other QA Staff and the

DPM. Final and/or unresolvable decisions regarding data usability will be made by the DWQ Director.

A.4.2 Data Collection Activities

The majority of environmental data collection within the Division is performed by trained field personnel within the Monitoring Section. Other Division staff (TMDL Coordinators, for example) also assist with environmental data collection. DWQ also utilizes data collected by non-DWQ cooperators who are trained in DWQ methods. Core monitoring programs involve the collection of physical habitat, macroinvertebrates, algae, diatoms, fish, and water chemistry samples in streams, lakes and wetlands. Each of these activities is performed under specific programs/projects with unique monitoring and data quality objectives. Therefore, detailed collection information is provided in approved SAPs and related SOPs.

A.4.3 Laboratory Activities

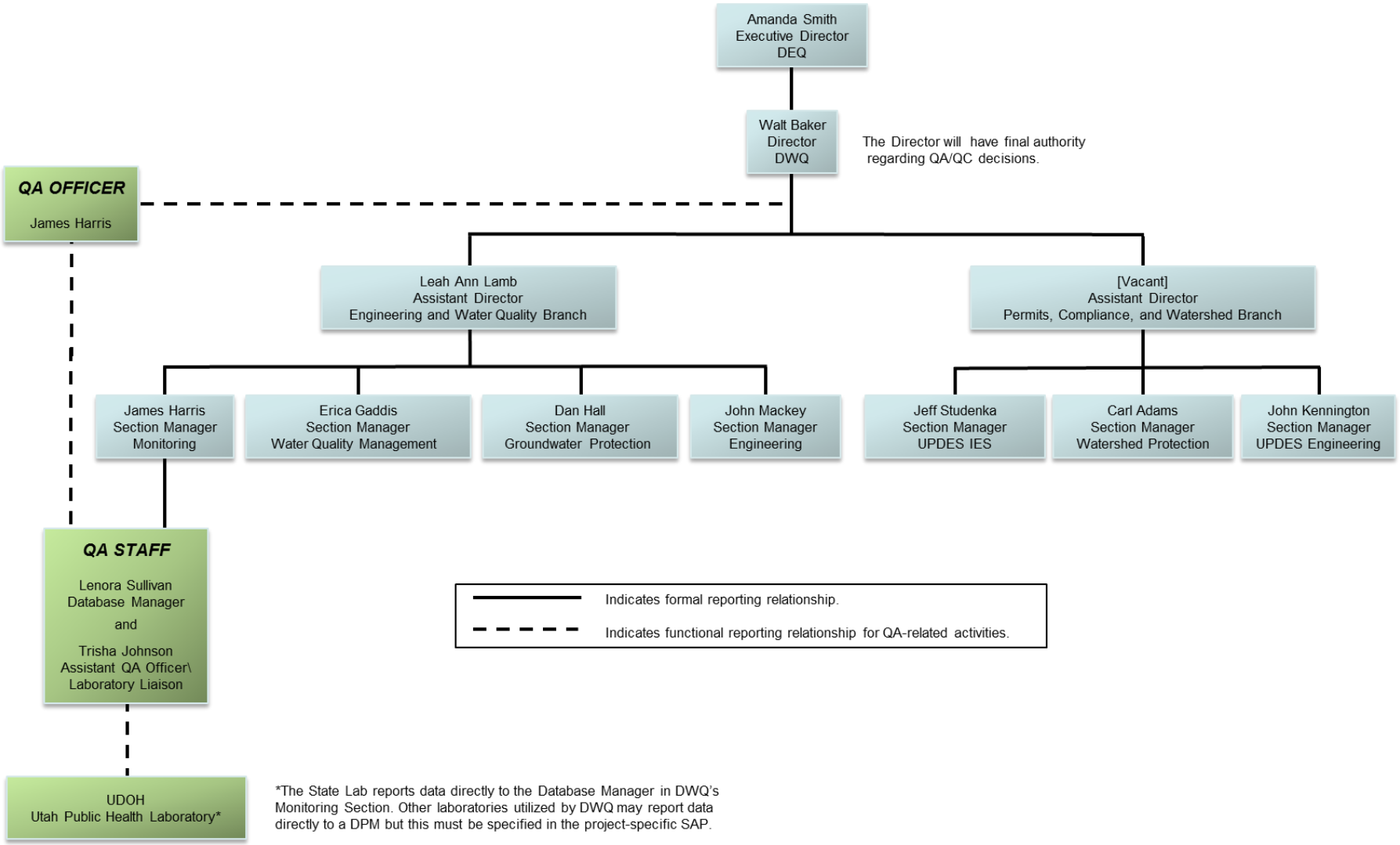
Any laboratories contracted by the Division must have documented quality assurance plans and standard operating procedures approved by the Division to ensure support of the Division's data quality objectives. This documentation will be kept on file at DWQ and labs will be contacted by the QA staff on an annual basis to inquire if their QA/QC procedures have undergone any significant changes. In addition, laboratories must agree to meet any DWQ project-specific QA/QC requirements not included in the laboratory's QAPP. It is highly recommended that project-specific QA/QC requirements be discussed between DWQ and the laboratories before data collection begins. For project-specific analyses, QA procedures should be documented in the project-specific SAP and the appointed DPM should obtain a copy to be provided to the Division QA staff to be filed with other QA/QC documentation.

The majority of water samples collected by DWQ are analyzed for chemical constituents by the State of Utah's Public Health Laboratory (hereafter referred to as the State Lab), Chemical and Environmental Services Laboratory (4431 South 2700 West, Taylorsville, Utah, 84119, 801-965-2400). The State Lab maintains an in-house Quality Assurance Program Plan. The State Lab QAPP is referenced throughout this document and is included as **Appendix B**.

Biological sample analysis (except for *E. coli*) is not performed by field staff. Biological samples must be analyzed by an accredited or certified taxonomy laboratory, operate under an EPA-approved Quality Assurance Plan, or otherwise approved by DWQ.

Fish tissue samples processed by DWQ are routinely sent to the USEPA Region 8 Laboratory for mercury analysis. The Region 8 Lab occasionally performs other types of analyses for specific monitoring projects. The Region 8 Laboratory QAPP is kept on file at DWQ. The lab's Quality Assurance Officer is William Batschelet, at 303-312-7792, 16194 West 45th Drive, Golden, Colorado, 80403.

Figure 1. Utah DWQ organizational chart it relates to QA/QC responsibilities. Names of all current staff members can be found at http://www.waterquality.utah.gov/WQstaff.htm#ewqb.



A.5 Problem Definition/Background

Environmental data collection by the DWQ provides the core set of data and information to supply a variety of programmatic needs. The objectives, design, data analysis, assessment methods, and reporting requirements for these monitoring programs are each discussed in detail in DWQ's Integrated Report (IR) to EPA which can be accessed online at http://www.waterquality.utah.gov/WQAssess/currentIR.htm and DWQ's 10-year Strategic Monitoring Plan (SMP), which can also be accessed online at http://www.deq.utah.gov/Compliance/monitoring/water/planstrategic.htm. The SMP covers the period from 2010 to 2020 and organizes the Division's anticipated monitoring activities using an adaptive tiered approach. Tier 1 consists of Probabilistic Surveys, Tier 2 consists of Targeted Monitoring, and Tier 3 consists of Programmatic Monitoring. Each tier is discussed briefly in the following sections and is illustrated in **Figure 2**. For more details, please refer to the SMP and IR.

A.5.1 Tier 1 - Probabilistic Surveys

Probabilistic Surveys are designed to meet the reporting requirements of the Clean Water Act's (CWA) 305(b) report to EPA which is an assessment of the condition of "all waters of the State" while working within the time and budget constraints of Division staff and resources. Probabilistic surveys assess all waters of the state by randomly selecting and monitoring water bodies within one of the six major watersheds (management basins) in Utah for one water year (see **Table 2** for the rotating basin schedule for the next several years). The Probabilistic Survey is revisited in that basin every 6th year. **Figure 3** is a map delineating the six major rotating basins. The information collected from the environmental surveys will be used to: (1) assess the attainment of various designated uses (e.g., aquatic life, recreational uses) and (2) better understand the pollutants of concern and distribution of pollutants within the particular basin, and eventually, throughout Utah. The Utah Comprehensive Assessment of Stream Ecosystems (UCASE) Program evaluates aquatic life beneficial uses in running waters. UCASE monitoring is the primary method used in the Probabilistic Survey.

A.5.2 Tier 2 - Targeted Monitoring

Environmental surveys within this tier will be performed annually to develop the CWA's 303(d) impairment status reports that are required by the EPA. Using the water quality concerns that are identified during monitoring efforts in Tier 1 as a guide, site-specific monitoring plans in Tier 2 are developed to assess the biological and chemical conditions of a specific waterbody. These more intensive surveys take place 2 years after the probabilistic survey in each basin (see **Table 2**) and allow managers to better understand the scope and extent of water quality problems within the particular basin. The Targeted Monitoring program includes, but is not limited to the following:

- Chemical monitoring has been performed by DWQ historically and is ubiquitous throughout all monitoring tiers; however, water chemistry collection during Targeted Monitoring supports assessment of aquatic life uses and supports the development of the IR for rivers and streams as well as lakes.

- The Bacteriological Monitoring Program focuses on human health and is used to develop statewide assessments of recreation beneficial use support of Utah's streams, lakes, and reservoirs.

- Although UCASE monitoring is the primary method used in the Probabilistic Survey, further Targeted Monitoring is necessary when uses are not being met or when further information is needed.

- The Lake Monitoring Program focuses on sampling of lakes and their tributaries within the current intensive basin (see **Table 2**) to support assessment of aquatic life and recreational beneficial uses.

- The Great Salt Lake (GSL) Monitoring Program has historically focused on water quality monitoring by DWQ, performed alongside quarterly brine shrimp monitoring by the Utah Division of Wildlife Resources (DWR). DWQ also partners with the United States Geological Survey (USGS) to track discharge and loads from major inflows into the lake. A numeric water quality standard for selenium has been established for the GSL and the Division is in the process of gathering data in order to establish additional water quality standards and assess designated uses for this unique ecosystem. Targeted data collection will better the understanding of GSL water quality, enable the development of additional water quality criteria, and support assessments of beneficial use support.

- The Wetlands Monitoring Program is relatively new and still in its developing stages. Data collection is focused on the GSL wetlands but will eventually be expanded to wetland classes throughout Utah, developing assessment criteria for each class, and monitoring to identify impaired wetlands for the 303(d) list in the IR.

A.5.3 Tier 3 - Programmatic Monitoring

The data derived from routine water chemistry monitoring efforts in Tier 3 is used to meet the programmatic needs of the Division. The implementation of Programmatic Monitoring is largely driven by program needs and schedules on an annual basis and strategies to achieve the program goals are discussed in individual Sampling and Analysis Plans (SAPs). The main objectives and goals of each monitoring program are described in detail in DWQ's Strategic Monitoring Plan (SMP). Programmatic monitoring includes but is not limited to the following:

- Total Maximum Daily Load Program (TMDLs)

- Nonpoint source (NPS) monitoring program

- Point source investigations
- Contaminants in fish tissue and waterfowl
- Cooperative monitoring and citizen volunteer monitoring
- Water quality standards development and development of new assessment methods
- Monitoring for wasteload analysis models (i.e. Qual2K) and other model development
- Other special studies

Figure 2. Utah's adaptive tiered monitoring approach (from Strategic Monitoring Plan).

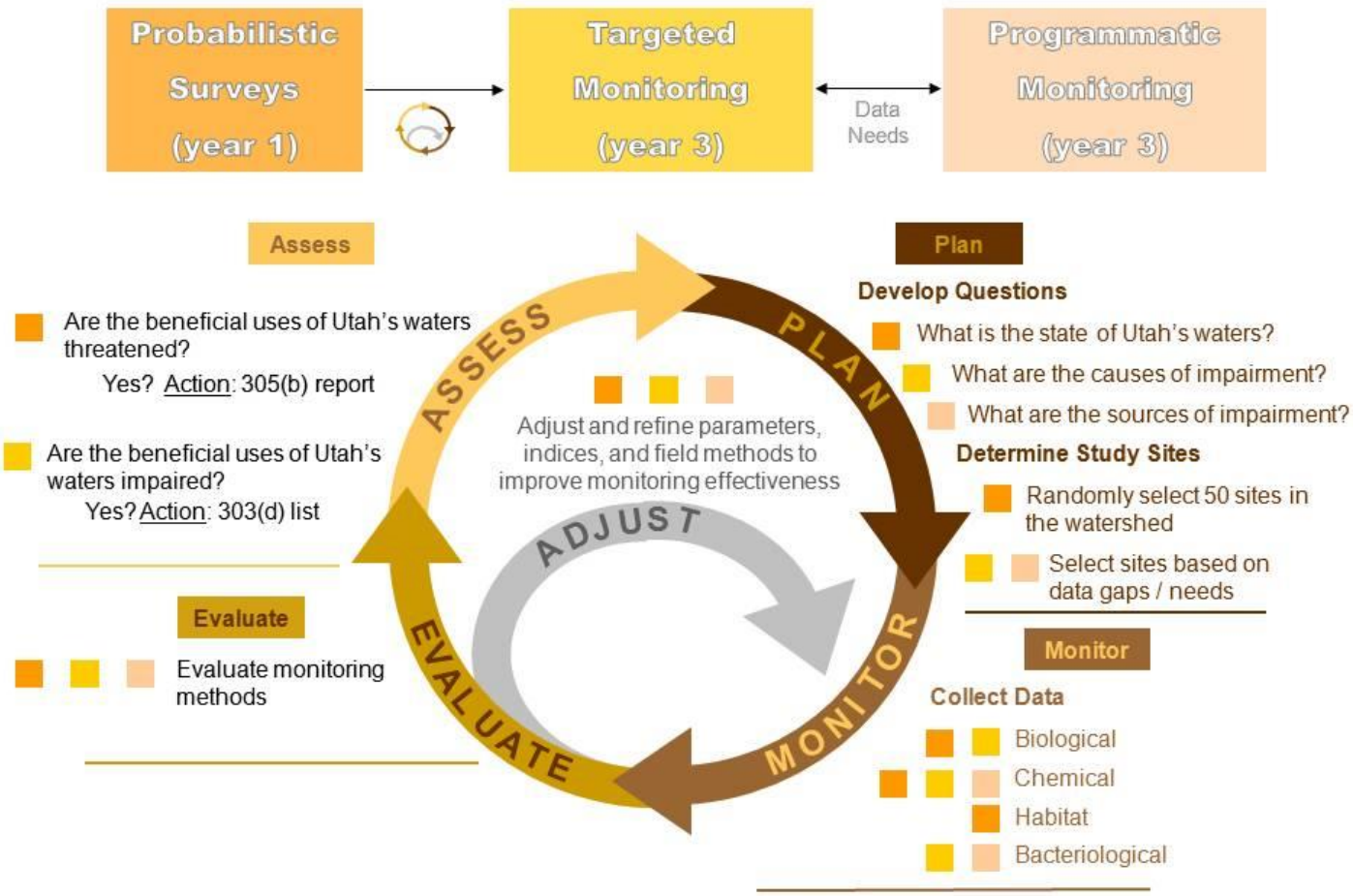


Table 2. Long-term monitoring schedule - Watershed Management Units (from Utah's Strategic Monitoring Plan).

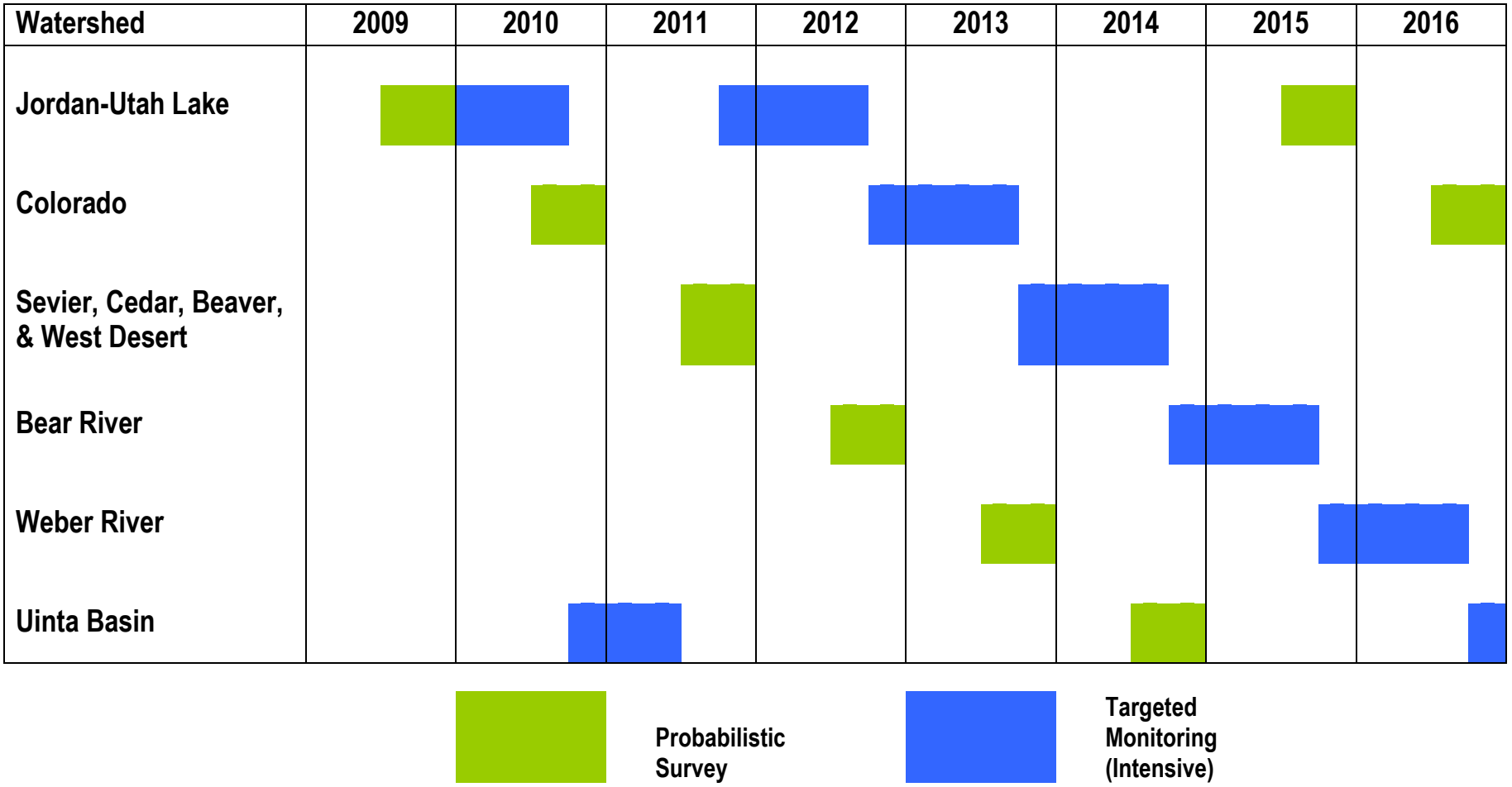
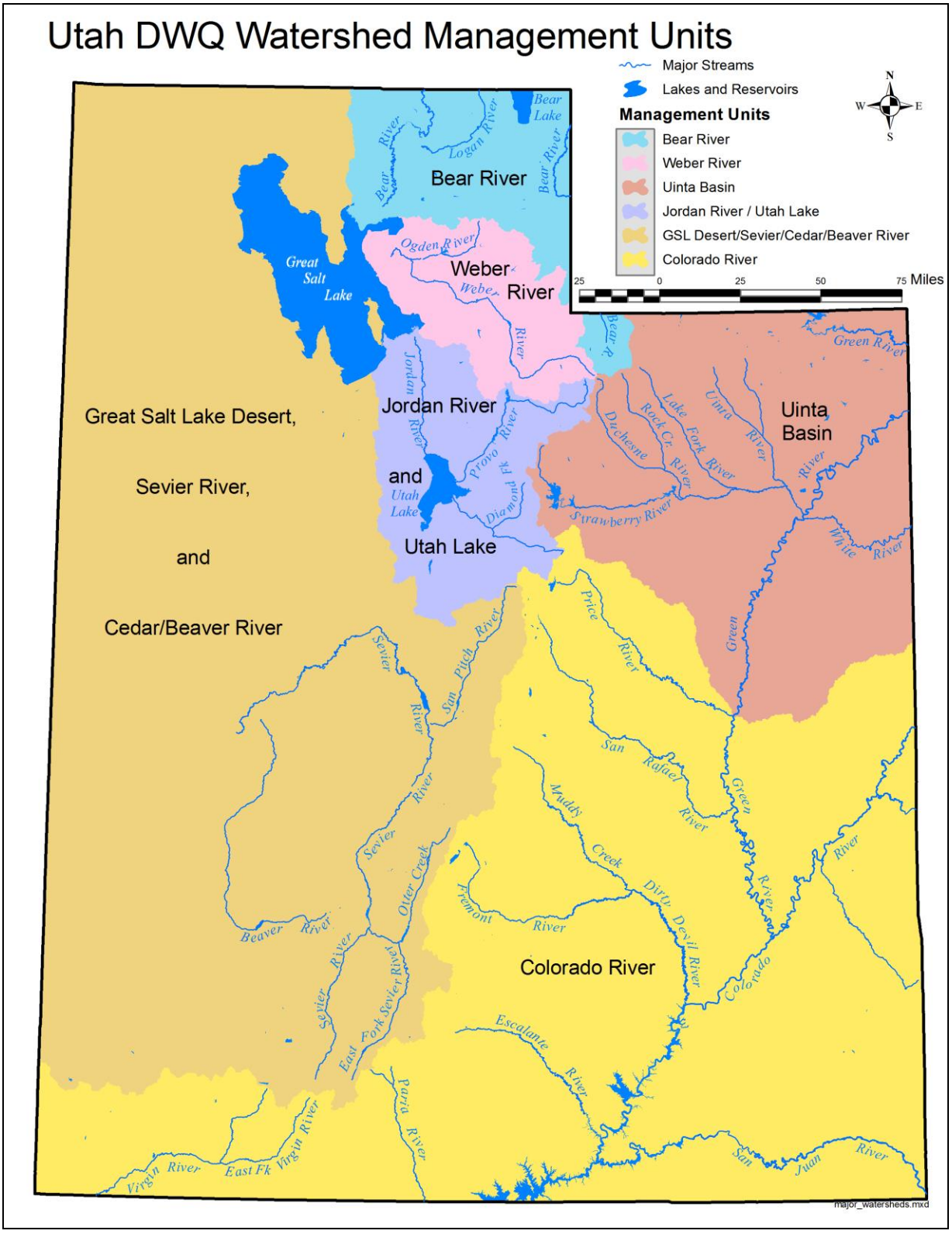


Figure 3. Watershed Management Units in Utah on the rotating basin schedule.



A.6 Project/Task Description

Project/task details are an essential component of project-specific SAPs. The following discussions in this QAPP are necessarily general.

A.6.1 General Project Schedule and Locations

The schedule for the Probabilistic and Targeted Monitoring is provided in **Table 2**. Probabilistic Surveys cycle through the six major basins (management units) of Utah every six years, spending one year at a time in each basin. Targeted Monitoring occurs in the unit two years after that basin was sampled via the Probabilistic Survey. This schedule allows DWQ staff to assess the Probabilistic Survey data, identify gaps, target key monitoring locations and select potential parameters of concern to collect/measure during the Targeted Monitoring cycle. Detailed monitoring schedules for all 3 tiers are included in the annual monitoring plan and in project/program-specific SAPs (one SAP each year for the Probabilistic and Targeted, respectively). Each SAP must also include a work schedule indicating critical project points such as start and completion dates for sampling, analysis, data review, and assessments.

A.6.2 Reporting Requirements

The most significant products generated from Division monitoring activities are the biennial 305(b) assessment and 303(d) list in the IR, submitted to the EPA as a reporting requirement under the CWA. The IR is due April 1st of even-numbered years. For waters identified as not meeting designated uses in the IR, TMDL reports are submitted to the EPA for approval as individual TMDLs are completed. Waters impaired by bacteria or contaminants in aquatic wildlife (e.g., mercury in fish tissue) are also reported via the Mercury Work Group (http://www.deq.utah.gov/workgroups/mercuryworkgroup/index.htm) and the *E. coli* Work Group (http://www.ecoli.utah.gov/), to the State and local Public Health Departments who have the authority to issue Public Health Advisories for fish consumption or water-based recreation. Compliance monitoring data are used to verify UPDES permits are being met and noncompliance may be reported in a Notice of Violation. NPS program monitoring results are reported in an annual Nonpoint Source Grant Report under Section 319(h)(11) of the CWA and for Project Implementation Plans, DWQ must submit progress reports and final reports to the Section 319 Grants Reporting and Tracking System. Reports required to document and justify changes to water quality standards include Use Attainability Analyses (UAAs) and technical reports and papers. Results from special studies may be reported in technical reports or peer-reviewed scientific literature.

A.6.3 Resources and Constraints

Each year DWQ will review and approve current SAPs, compile the annual monitoring plan, and generate a monitoring strategy for the coming water year (October 1 to September 30) that best meets programmatic needs. Development of the monitoring

strategy is a multi-phased process that requires coordination among many programs and program managers. First, data quality objectives are identified and data needs prioritized by DWQ staff and key cooperators. Second, a monitoring strategy and schedule is developed that will efficiently obtain the data required to meet multiple regulatory needs. Wherever possible, monitoring sites are selected that can serve multiple programmatic functions. The implementation of any new type of monitoring depends upon increases in funding from the Water Quality Board, Utah Legislature, or from EPA, either through grants or direct funding.

Weather, road conditions, or high stream flows sometimes make sampling sites inaccessible or make sampling unsafe. Safety for the field personnel is of the utmost importance. Individual SAPs will document the conditions necessary for sampling or re-sampling. Therefore, sampling may not occur at every planned site for every sampling event. Field personnel will make the determination at the time of sampling if the conditions are safe for environmental data collection activities.

A.7 Quality Objectives and Criteria for Measurement Data

A.7.1 Program-Wide Quality Objectives

The ultimate goal of DWQ water quality monitoring programs is to provide data of the appropriate type, quality, and quantity for the Division's decision-making and assessment purposes, compliance functions, and other project-specific goals. Data quality objectives (DQOs) are qualitative and quantitative statements derived from the systematic planning process that 1) clarify the study objective, 2) determine the most appropriate type of data to collect, 3) determine the most appropriate conditions from which to collect the data, and 4) specify the level of uncertainty that decision makers are willing to accept in the collected monitoring data while still meeting the project objectives, thereby establishing the quantity and quality of the data needed.

Many DWQ programs have similar DQOs because project objectives are based on whether or not measured parameters/constituents exceed Utah's water quality standards, and Probabilistic Surveys and Targeted Monitoring are designed to meet the needs of multiple programs. For these standards including numeric criteria for designated uses, refer to R317-2-7 of the Utah Administrative Code (Water Quality Standards.,) online at http://www.rules.utah.gov/publicat/code/r317/r317-002.htm#T9. However, some DWQ projects/programs also have project-specific DQOs that must be included in project-specific SAPs. Each DPM is required to develop DQOs for their programs/projects and is encouraged to do so following EPA's *Guidance on Systematic Planning Using the Data Quality Objective Process*, *EPA QA/G-4* (USEPA, 2006). **Appendix C** contains a helpful table for development of DQOs using EPA's DQO systematic planning process. Each project-specific SAP should include a detailed statement of the DQOs and goals/acceptance limits for measurement performance criteria.

All environmental data collected by and for the Division should meet the minimum requirements discussed in the following sections. Environmental data should be collected and processed according to the appropriate standard operating procedure (SOP) by well-trained staff. Laboratories should be certified for the specific methods by the Utah Bureau of Laboratory Improvement or if different methods are required to meet project objectives (such as a lower detection limit), those methods must be approved by the DWQ Director.

A.7.2 Measurement Performance Criteria

Measurement performance criteria are expressed in terms of Data Quality Indicators (DQIs) which include precision, bias, accuracy, representativeness, completeness, comparability, and method sensitivity. Definitions for DQIs below come from *EPA's Guidance for Quality Assurance Project Plans, EPA QA/G-5* (USEPA, 2002). Although there are many monitoring programs/projects within DWQ, the DQIs for each are assessed similarly through quality control samples such as blanks, spikes, and replicates and through data quality checks. Each project-specific SAP should incorporate a table listing each DQI, how it will be measured, and the performance criteria against which it will be evaluated. **Table 3** lists each of the DQIs discussed below and DWQ's recommended performance goals.

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; expressed as the relative percent difference. Overall precision for sampling and analysis is assessed via field duplicates/replicates – co-located samples are collected, processed, and analyzed to obtain information on sample acquisition, handling, shipping, storage preparation, and analytical processes and measurements. Additionally, laboratories perform their own replicate analyses, initial precision and recovery samples, and matrix spike/matrix spike duplicates to assess laboratory analytical precision. In the field, precision is maximized (variability is reduced) through strict adherence to SOPs for sampling methods and sample handling. A precision goal of 20% should be obtained for DWQ environmental data; however, project specific requirements may vary from the default value due to other considerations. Matrices other than water (soil, sediment, etc.) typically have a higher acceptance limit of 40%. The equation used for calculating sample precision is given below:

Calculated as Relative Percent Difference (RPD):

$$RPD\ (\text{in } \%) = ((|A-B|)/((A+B)/2)) \times 100$$

Where: A = first measured value and B = second measured value

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Probabilistic Survey site locations are chosen randomly to reduce bias in sampling site selection for assessing statewide water quality conditions. Field instruments are calibrated, maintained, and checked against standard reference

materials (SRMs) to ensure bias is not introduced during measurement of water quality parameters. Bias is also reduced in the field through the use of and adherence to SOPs. Field audits of field personnel collecting data are used to qualitatively assess bias. Laboratories test their instruments with reference materials and perform spiked matrix samples to ensure that instruments/instrument calibration or reagents and matrix effects, respectively, do not introduce bias during analysis (see equations under **Accuracy** below). The State Lab analyzes data from internal standards and keeps logs of control samples logs to note drift in their instrumentation. Bias can be calculated in absolute terms from these control samples using the following equation:

Bias (B) = $\overline{X} - T$,

Where: $\overline{X}$ = the mean value for the current testing system Control dataset and, T = the theoretical or target value of a performance evaluation sample (control sample)

Accuracy is a measure of the overall agreement of a measurement to a known value such as a reference or standard. It includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Laboratories test their instruments with reference materials to ensure accurate results and perform spiked matrix samples to assess accuracy (expressed as percent recovery). Lab splits (split a sample in the field and submit both subsamples for analysis to two different laboratories using identical analytical methods) can also address accuracy, precision, and bias between labs, especially when matrix effects are expected. Field instruments are calibrated, maintained, and checked against standard reference materials (SRMs) to ensure accurate measurement of water quality parameters. Additionally, accuracy is improved in the field through the use of and adherence to SOPs. A routine goal for laboratory accuracy for water samples is 85%-115%, but will depend on the analytical method and matrix interferences. Typically, ranges are wider (75%-125%) for non-water samples such as soil/sediment. Project specific requirements may vary from the default value due to other considerations.

The following formula is used to calculate accuracy of a laboratory control spike (LCS):

$\%R = (Q_{LCS}/Q_{KC}) \times 100$

Where: %R = Percent Recovery

Q_{LCS} = Quantity of the analyte found in the spike sample

Q_{KC} = Known concentration of the analyte in the spike sample

The following formula is used to calculate accuracy of a matrix spike or matrix spike duplicate sample (note that quantity may be used interchangeably with concentration):

$\%R = \{(Q_{SS} - Q_{UC})/ Q_S\} \times 100$

Where: %R = Percent Recovery

Q_{SS} = Quantity of the analyte found in the spike sample

Q_{UC} = Quantity of the analyte found in the unspiked sample

Q_S = Quantity of the spike added

Representativeness is a qualitative term that expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition" (ANSI/ASQC 1995). Representativeness is addressed through standardized sample collection procedures (SOPs) and adherence to the sample locations, times, and hydrologic conditions determined during development of the monitoring strategy and the SAP. Site photos and field notes are also important for describing any unusual conditions at the sampling location (e.g. extreme high or low flow, a contamination event, ice cover, etc.) that may affect the representativeness of the sample collected during that time. Samples are also evaluated for contamination introduction by the collector or analyzing laboratory through field and equipment blanks.

Comparability is a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made. Data collected with the same or equivalent collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols will be comparable. A later section of this QAPP discusses the extent to which data from outside sources (collected by volunteers/cooperators) is comparable with data collected by DWQ.

Completeness is a measure of the amount of valid data obtained from a monitoring program/project compared to the amount of valid data expected to be obtained. Completeness is calculated by dividing the number of valid measurements completed (samples collected and/or analyzed) by the total number of measurements planned for the project's dataset and is expressed as a percentage. Completeness is especially important when a certain number of samples are required for assessment purposes, to populate a model, or when project funds are limited, and should be addressed in a project-specific SAP. The DWQ's goal for completeness of environmental data sets is 95%. Project-specific requirements may vary from the default value due to other considerations.

Sensitivity is the capability of a laboratory method or instrument to discriminate between measurement responses representing different levels of the variable of interest. Sensitivity should be based on the action, or comparison values, specified in the DQOs. These are typically the numeric criteria defined in Utah's Water Quality Standards; however they may be different for special studies (e.g. lower limits may be needed for criteria development). Laboratories utilized for DWQ projects will have verified and/or determined the minimum concentration of attribute that can be measured

by a method (method detection limit), by an instrument (instrument detection limit), and by the laboratory (quantitation limit or reporting limit). Laboratories should report any estimated values between the method detection limit and quantitation/reporting limit, as these are more precise than reporting non-detect below a quantitation/reporting limit. The laboratory analysis method chosen for a specific project must have a sufficient sensitivity (i.e. low enough detection and reporting limits) to meet project goals. This is especially important if laboratory results are being compared to numeric water quality criteria for assessment purposes. Project-specific SAPs should clearly define action limits and required laboratory detection/quantitation limits.

Table 3. Data Quality Indicators for DWQ environmental data collection.

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended DWQ Goal[1]
Precision - measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; random error	Field duplicate/replicate pairs	RPD	For concentrations > MRL: Water samples, <20% Soil/sediment, <30% RPD for concentrations below or near the detection limit/reporting limit should be project-specific and defined in SAP
	Laboratory duplicates	RPD	Approve or modify percent RPD for laboratory duplicates established by the analyzing laboratory; define in SAP
	Matrix spike/matrix spike duplicate (MS/MSD)	RPD	Approve or modify percent RPD for MS/MSD established by the analyzing laboratory; define in SAP
Accuracy/Bias – measure of the overall agreement of a measurement to a known value such as a reference or standard; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations (**continued on next page**)	Randomized site selection for Tier 1 Probabilistic Surveys	Randomized process must be used for site selection	100% compliance; any relocating of sample site due to conditions on the ground must be documented
	Calibration and reference checks for field water quality instruments	Documentation of successful calibration and checks of instruments; documentation of recalibration if needed	100% compliance
	SOPs for environmental data collection	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	Field blanks	MDL	< MDL
	Equipment blanks	MDL	< MDL
	Trip blanks (for VOCs)	MDL	< MDL
	Method blanks	MDL	< MDL

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended DWQ Goal[1]
Accuracy/Bias – measure of the overall agreement of a measurement to a known value such as a reference or standard; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations (**continued from previous page**)	Laboratory Control Spike (LCS)	Percent Recovery of LCS	Approve or modify percent recovery limit for LCS established by the analyzing laboratory, usually 85-115% for water and 75-125% for soil; define in SAP
	Matrix spike/matrix spike duplicate (MS/MSD)	Percent Recovery	Approve or modify percent recovery limit and for MS/MSD established by the analyzing laboratory; define in SAP
	Split samples	RPD	For concentrations > MRL: Water samples, < 20% Soil/sediment, < 30% RPD for concentrations below or near the detection limit/reporting limit should be project-specific and defined in SAP
	Performance Evaluation Samples (Ampule Single Blind or Double Blind prepared in site-specific matrix)	Percent Recovery and RPD from known value	Lab should meet target RPD for MS/MSD and lab duplicates
Representativeness - the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition	SOPs	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	SAP requirements	Adherence to sampling design, location, time, and conditions	100% compliance unless approved by DPM and noted in field notes
	Photos/field notes	Document any variation from SAP or SOP	100% compliance
	Hold times	Hold times	100% compliance
	Field replicate pairs (co-located samples)	RPD	Water samples, < 20% and soil/sediment, <30%, also use to evaluate temporal variability of sampling matrix
	Field/trip/equip. blanks	MDL	< MDL

Data Quality Indicator	QC Check/QC Sample[2]	Evaluation Criteria	Recommended DWQ Goal[1]
[3]**Comparability** - qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made	SOPs (sample collection and sample handling)	Qualitative determination of SOP adherence and field audits	All data collected following SOPs
	Holding Times	Holding times	100% compliance
	Analytical Methods	EPA or DWQ-approved methods	100% use of approved methods
	Similar frequency and types of QC samples (field duplicates, blanks, lab QA, etc.)	Verify	Evaluate for comparability
Completeness - measure of the amount of valid data obtained from a measurement system compared to the amount of valid data expected to be obtained	Complete sampling	Percent valid data	95% completeness with respect to planned data set
Sensitivity - the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest; primarily a laboratory parameter	Laboratory DL or RL	Must be below action level required by SAP (numeric water quality criteria or other research-based level)	100% compliance

This table adapted from UDEQ-DERR QAPP.
Abbreviations: DL – Detection Limit, RL – Reporting Limit, RPD – Relative Percent Difference, MDL – Method Detection Limit, MS/MSD – Matrix Spike/Matrix Spike Duplicate, LCS – Laboratory Control Spike, DPM – Designated Project Manager, MRL – Minimum Reportable Limit
[1] Unless otherwise justified and approved in a project-specific SAP
[2]This list is not inclusive of all of the QC checks/samples run by analyzing laboratory, see laboratory QAPP
[3]As DWQ develops formal criteria for accepting non-agency data in the future, these requirements are expected to expand/change

A.8 Special Training/Certifications

A.8.1 General Training Requirements

DWQ field personnel must be experienced field team members; or have received training from a field team leader or DPM on requirements for sampling including proper use and maintenance of all sampling equipment, sample processing and handling, field documentation, data reduction and file management, and database entry. Field personnel must read this Division QAPP, SOPs they will perform, and SAPs they will work from annually and acknowledge that they have done so via a signature sheet kept on-file at DWQ. Each field team member will also have applicable health and safety training and will comply with Occupational Safety and Health Administration (OSHA) regulations. DWQ field personnel and other staff will also participate in annual training workshops intended to cover all of DWQ's SOPs and SAPs. The QAO is responsible for ensuring these general training/certification requirements are satisfied and properly documented.

All laboratories analyzing DWQ samples maintain their own documented quality assurance procedures which include training and certification requirements for their staff.

A.8.2 Specialized Training

Before DWQ field personnel and volunteers/cooperators collect and process *E. coli* samples for Utah's Bacteriological Monitoring Program, they must receive specialized training from DWQ, acknowledge that they have read the SOP and understand its contents, and perform a Demonstration of Capability (DOC). The training is renewed annually for each sampler/analyst and documentation is maintained on-file at DWQ.

The USEPA conducts periodic nation-wide water quality assessments for which DWQ field personnel perform the data collection for the chosen sampling sites within the State of Utah. DWQ field personnel receive specialized training from the USEPA before data collection for these national assessments is initiated.

Refer to the UCASE Field Operations Manual for specific sampling and safety training requirements for this monitoring program.

DPMs are responsible for ensuring that personnel collecting environmental data for their projects/programs are notified of any special conditions or safety requirements and have received the appropriate training. The Monitoring Section Manager is responsible for ensuring that all DWQ field personnel have received their appropriate training. Training-related documentation is maintained in DWQ files by either the DPM or the QAO.

Field audits, whether internal or EPA-led, are additional training opportunities to ensure that field personnel are following SOPs as well as project-specific requirements outlined in the SAP.

A.9 Documentation and Records

A.9.1 QA Documentation Dissemination and Maintenance

The assistant QAO is responsible for maintaining, updating, and editing this QAPP and its associated quality documents including SOPs. The QAO is responsible for making sure that Division personnel receive the most recently approved QAPP, SOPs, and other documents applicable to environmental data collection. Electronic copies will be distributed and posted online and notifications will be sent out via email. The QAC officially reviews the DWQ QAPP triennially. However, the QAPP and SOPs are reviewed within the Division and revised, if needed, on an annual basis. Division Staff are encouraged to make suggestions for changes throughout the year in a shared "QAPP revisions suggestions table". The QAO reports any annual significant QAPP changes to the QPC who in turn issues a report to the DEQ Executive Director and EPA Region 8. The most current version of the QAPP will be posted on the Division's webpage (http://www.deq.utah.gov/Compliance/monitoring/water/qaqc.htm). The QAPP, SOPs, SAPs, and any other quality assurance documentation incorporate document revision control and are stored on the DWQ server. Additional related documents include Field Audit Reports, QC summaries for datasets, training documentation, etc. and will also be stored on the DWQ server.

A.9.2 Field Documentation

Field records shall be generated and stored as specified in method-specific SOPs and project-specific SAPs. Any deviation in an SOP when obtaining, processing, or holding environmental samples must be documented and explained in field notes. Most field data is recorded electronically using portable data recorders (PDRs) or other handheld devices (such as water quality meters, flow meters, and GPS units). However, some sampling methods use handwritten field data sheets. Field personnel also record field notes in a field notebook maintained for each project. Chain-of-Custody (CoC) forms (or other sample tracking forms if legal CoC is not required) are to accompany each sample to the analyzing laboratory. Handwritten field data sheets, field notes, and copies of CoC forms must be scanned and stored on the DWQ server while hard copies are filed for storage at DWQ. Electronic field data is stored on the DWQ server and is transferred to the DWQ database after data reduction and review.

A.9.3 Laboratory Documentation

Laboratory documentation procedures and requirements are discussed in each laboratory's QAPP (for in-house lab documents) and SAPs should include required data package contents (a list of the minimum reporting requirements and documentation deliverables) expected by DWQ from analyzing laboratories. At the start of each

project, the DPM, QAO, and lab liaisons meet with the analytical laboratories to be utilized for the project and determine the laboratory documentation that is to be provided to the Division in a data package along with the sample results. DWQ meets with the State Lab on a regular basis and data package requirements are discussed. Required data package contents may at times be included in a service contract or Memorandum of Understanding (MOU).

A.9.4 Record Storage and Retention

All raw electronic data downloaded from PDRs or other handheld devices is stored on DEQ servers which are backed up routinely by the Utah DTS (Division of Technology Services). After electronic data (field and lab) has been verified it is uploaded and stored permanently in the Division water quality database. The Division's database is also stored and backed up on DEQ servers. Electronic data (including scanned copies of hand-written documents) may be stored indefinitely. Hard copies of hand-written records will be stored at least as long as required by the retention schedule in the Retention and Classification report for DEQ. Language applicable to DWQ can be found at (http://archives.state.ut.us/cgi-bin/pdfreport.cgi?agency=1268&A=B). However, project-specific SAPs may define a longer or indefinite retention schedule.

B. DATA GENERATION AND ACQUISITION

This section of the Division QAPP addresses data generation and data acquisition and management activities.

B.1 Sampling Process Design

Sampling process design is developed as part of the initial project planning and DQO process and is individualized to each DWQ monitoring project/program. The SMP and IR outline the general sampling design for DWQ's ongoing monitoring programs. However, project-specific SAPs should outline sampling design details for specific projects and should include the items covered in **Appendix A**.

The annual monitoring plan includes the combined detailed schedule of all planned monitoring activities for the Division for the current monitoring year. It includes lists of all planned sampling sites, the number of times each site is to be sampled, types of samples and other data to be collected during each sampling event (including QC samples), the project/program(s) for which the samples are collected, and the applicable SAP. This combined Division monitoring schedule is a flexible planning document and is therefore subject to change during the field season.

B.2 Sampling Methods

The use of standardized methods and trained personnel help to ensure that samples are collected consistently both between sampling locations and teams. Although there are numerous monitoring programs/projects within DWQ, sampling methods employed

by the Division are standardized, consistent, and follow EPA or EPA-approved methods where possible. All project-specific SAPs must list all sampling/field methods to be used for the program/project.

DWQ SOPs are written for each sampling method (or field sample processing method); with the possible exception of methods used only infrequently or for research projects testing new sample collection methods. In these cases, sampling methods are carefully documented and kept on-file at DWQ. If any method gains routine use within the Division, an official DWQ SOP is developed. An SOP may be drafted by any DWQ staff member but must be approved by the QAO. DWQ SOPs are written in accordance with EPA's Guidance for Preparing Standard Operating Procedures (SOPs) (EPA, 2007). DWQ's SOPs are listed in **Appendix D** and the current versions can be downloaded from http://www.deq.utah.gov/Compliance/monitoring/water/qaqc.htm. For the UCASE program, sampling methods are described in the UCASE Field Operations Manual (online at http://www.deq.utah.gov/Compliance/monitoring/water/qaqc.htm).

B.2.1 Corrective Actions for Problems Occurring in the Field

Backup plans should always be made in case of equipment malfunction, breakage or loss, vehicle breakdowns, dropped bottles, etc. DWQ field personnel carry contact numbers for vehicle problems and for reaching technical support for specialized equipment. Tool kits are packed to allow battery replacement, probe replacement, and maintenance to field instruments. Additional calibration standards are packed to allow for recalibrations of field water quality meters. Additional bottles are packed in case of bottle breakage or sample loss. Additionally, corrective actions and equipment and supply lists are included in individual SOPs and project-specific SAPs. The Monitoring Section Manager is the point-of-contact for all issues that arise in the field.

B.3 Sample Handling and Custody

Sampling handling requirements (bottle type, sample label, preservation and storage, holding times, delivery to the laboratory or shipping instructions) are discussed in detail in each DWQ SOP (where applicable), project-specific SAPs, and some laboratory QAPPs.

Each sample is associated with a Site Code. This is a unique site identifier typically composed of seven digits and corresponding to a Monitoring Location ID, or MLID, (historically, a STORET ID) in DWQ's water quality database. In addition to Site Code, samples are also labeled with a site description, a unique date and time of collection, a Trip ID (identifies all samples collected during a week of sampling or sampling event), and details on collection method.

Each sample or batch of samples delivered or shipped to a laboratory must be accompanied by sample tracking documentation. For routine samples not requiring legal CoC, a "Lab Sheet" or sample tracking form describing what sample types were collected, the requested analyses, and field water quality parameters, takes the place of

a formal CoC form. Individual SOPs indicate the type of custody documentation required for the analyzing laboratory. For EPA projects such as the National Aquatic Resource Survey, EPA provides DWQ with official documentation (sample tags, labels, forms and seals). Each project-specific SAP should include all necessary sample-tracking documentation as an attachment. Legal CoC is required for emergency sampling, spill response, certain compliance samples, or sampling that may involve litigation. Refer to DWQ's SOP for Chain-of-Custody Samples for legal CoC requirements.

B.4 Analytical Methods

Analytical methods will be selected that provide comparable, sensitive, and accurate data for the sample matrix and range of expected values for the constituents being analyzed. For water chemistry analysis, it is important that method detection limits be at or below numeric water quality criteria. Whenever possible, approved and published methods from EPA or another accepted entity (such as USGS, Standard Methods, or ASTM) will be used. All compliance-related water/soil chemistry samples must be analyzed at a laboratory meeting the minimum standards as defined in Utah Administrative Code Rule R444-14 - Rule for the Certification of Environmental Laboratories, available online at http://www.rules.utah.gov/publicat/code/r444/r444-014.htm#T3). Each laboratory utilized by DWQ must also have documented analytical method protocols available for DWQ to review. Non-EPA methods must be reviewed and preapproved by DWQ. Routinely-used analytical methods are also described in many DWQ SOPs for sample collection. All project-specific SAPs must list all analytical methods per matrix and detection limits to be used for the program/project. SAPs should also include needed laboratory turnaround times and it recommended that turnaround times are discussed with the laboratory prior to the start of sample collection. When analytical failures occur, whether recognized by the DPM or by DWQ's QA staff, DWQ's lab liaison will be notified to begin a dialogue with the analyzing laboratory to remedy the error/issue. In addition, any issues with analytical data will be communicated to the DM so that she is able to isolate potentially problematic data before it is uploaded to the water quality database.

B.5 Quality Control

B.5.1 Field Quality Control Activities

Field QC checks and samples will be performed at a frequency defined by a DPM in a project-specific SAP. Each project-specific SAP should list each required QC check or sample, the associated performance goal, and corrective actions in the case that the performance goal is not met.

B.5.2 Field QC Samples

Quality control samples are used to estimate the precision, representativeness, and accuracy/bias of field activities or field plus lab activities. At a minimum, the following

quality control samples should be collected at the frequency described below. Field quality control samples will be prepared in accordance with EPA-approved procedures or DWQ SOPs, and labeled, documented, handled, and analyzed the same as regular samples, and should remain "blind" to the laboratory when possible to ensure indiscriminate handling. Field and/or equipment blank samples are primarily applied to chemistry samples and are inappropriate or unnecessary for some types of biological samples and this should be noted in DWQ's SOPs and project-specific SAPs. At a *minimum*, quality control samples should consist of:

- One **equipment blank** per 10 samples collected, or one per sampling trip if less than 10 samples are collected. Reagent-free water must be run through each piece of sampling and/or sample-processing equipment, collected in appropriate sample bottles, and analyzed for the same constituents as the regular samples planned for that trip. If equipment is prepared by DWQ staff but not used for multiple samples (therefore not decontaminated between samples), the equipment blank should be performed before the first sample is collected to confirm that the equipment was properly cleaned/prepped prior to sampling. If sampling equipment is decontaminated in the field between samples, the equipment blank should be performed after decontamination and before the next sample is collected to confirm that the equipment was properly cleaned between samples. If no sampling equipment or sample processing is performed, no equipment blanks are required. For example, grab sampling for non-filtered constituents requires no equipment blank.

    - Performance Goal: below detection limit or "non-detect"

- One **trip blank** (also known as a travel blank) per cooler containing volatiles when collecting volatile organic compound (VOC) samples. Trip blanks are prepared by the laboratory using analyte-free water, transported to the field, and handled in the same manner as other samples; they are not to be opened in the field.

    - Performance Goal: below detection limit or "non-detect"

- One **field blank** per trip (sampling event) per sampling crew per each sample type collected, as appropriate. Field blanks are used to assess potential sample contamination due to sample bottles, preservative, ambient site conditions, or cross-contamination during transport. Sample bottles should be filled at a sampling location defined in the SAP with analyte-free water, and handled in the same manner as other samples. Bottles containing preservative are not to be rinsed. Unpreserved bottles should be triple-rinsed with analyte-free water before filling, as is done for regular samples.

    - Performance Goal: below detection limit or "non-detect"

- One **duplicate/replicate** sample per 20 samples (5%) collected for a particular monitoring project/program or more frequently depending on project-specific goals. The sampling conditions, volume of sample needed, and whether or not a sampling device is used will determine whether sample pairs are duplicates (homogenized and split into bottle pairs) or replicates (not homogenized, co-located samples) and should be defined in the project-specific SAP.

    - Performance Goal: < 20% RPD for water and < 30% RPD for non-water matrices

There are other optional field quality control samples such as field split samples to assess accuracy and comparability of results between two analytical methods or laboratories and field matrix spikes to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency for a given matrix. Project-specific SAPs may specify a higher frequency of quality control sample collection than listed above. When planning QC sample type, frequency, and collection locations, DPMs should consider performing additional equipment blanks if a “dirty” site must be sampled in the middle of a trip (ideally less contaminated sites are sampled before more contaminated sites during a trip) or targeting contaminated sites for duplicate/replicate and field split samples to evaluate the effect of challenging matrices on target analyte recovery (ask for MS/MSD to be performed on those samples).

B.5.2.1 Field QC Checks

Field-based QC checks should include at a minimum:

- Daily calibration of water quality field meters and post-calibration checks using unexpired and certified calibration standards or standard reference materials (SRMs).

    - Performance Goal: 100% compliance and completed documentation, SOPs followed

- Review of field water quality parameters for reasonable values.

- Review of all field documentation for accuracy and completeness before leaving the sampling location. Field sheets for routine monitoring projects should include checklists to ensure all samples are collected and all field measurements are performed.

- Repeat calibration and documentation in the event of a violation of a water quality standard based on numeric criteria (i.e. pH>9). Note that waterbodies may be listed as impaired for field readings outside of Utah’s Water Quality Standards numeric criteria for pH and D.O.

B.5.2.2 Corrective Actions

Specific corrective actions for failure to meet performance goals for field QC activities should be described in each project-specific SAP. Field personnel are responsible for performing immediate corrective action in the field if a QC issue is found during field QC checks; typically this corrective action will involve instrument maintenance or recalibration. Field personnel will document this type of corrective action in the field notes. Other corrective actions are the responsibility of the DPM and, when they involve monitoring staff, the Monitoring Section Manager. Each failure must be investigated and addressed for the cause of non-compliance if possible (for example, decontamination procedures, inadequate training of staff, improper sample handling). The DPM must address the quality control issue and any actions taken to resolve the matter (retraining of field staff, purchase of new reagent/bottles, replacement of equipment, etc.) should be documented in the project files. The DPM may perform re-sampling and analysis, amendment of sampling and/or analysis procedures, or may accept the data with acknowledgment of the level of uncertainty surrounding the analytical results. The QAO will be notified for any systemic problems unable to be addressed by the DPM alone.

B.5.3 Laboratory Quality Control Activities

Internal laboratory quality control samples will be performed as defined in each laboratory's quality assurance manual and corrective actions are the responsibility of the laboratory. Results of these QC tests will be reported to DWQ in the data report package as agreed upon during contraction of service. DWQ and its analyzing laboratories will cooperate to ensure laboratories receive ample sample to run QC tests such as lab duplicates, matrix spikes, and matrix spike duplicates if the SAP specifies they should be run on DWQ samples. Lab sample request sheets will specify which sample should be used for QC tests. Or the SAP may specify a matrix requirement such as QC tests must be run on challenging, high TDS samples rather than the lowest TDS sample in the batch (which may be a blank sample) which would not provide useful information on method performance for the other samples in the batch.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

DWQ SOPs describe maintenance, inspection, and testing procedures for flow meters, water quality meters, pressure transducers, sampling equipment, fish shockers and other instruments/equipment. Individual DWQ field personnel are assigned to these tasks and are responsible for sending equipment out when it needs repair and for ordering replacement parts. Calibration and maintenance logs are kept with each meter or in the appropriate DWQ project files. In addition, a board is placed on the wall where the equipment is stored to let field personnel know if a piece of equipment is awaiting repair, requires a replacement part, or has been sent out for repair. Individual DWQ field personnel are also assigned to vehicle maintenance and inspection tasks, including boats and all-terrain vehicles. DWQ field personnel with these duties report to the Monitoring Section Manager. In addition, field personnel are required to record

instrument/equipment problems or needs in the project field notes as a reminder to address the issues upon returning from the field and notify the DPM and Monitoring Section Manager.

B.7 Instrument/Equipment Calibration and Frequency

Instrument/equipment calibration and calibration frequency are described in DWQ SOPs. The primary instruments requiring calibration are water quality meters. Individual field personnel are responsible for calibrating the equipment they will be using according to the applicable DWQ SOP. At a minimum, these instruments must be calibrated before leaving for the field as well as on a daily basis each day of the sampling trip. SOPs indicate when recalibration may be needed. Calibration and maintenance logs are kept with each meter or in the appropriate DWQ project files. A NIST-traceable thermometer will be used annually to check all thermistors. SOPs are not a substitute for the instrument user manual and manufacturer's instructions; the user manual should be kept with the instrument at all times for reference.

B.8 Inspection/Acceptance of Supplies and Equipment

Individual DWQ field personnel are assigned to ordering and maintaining stocks of supplies and equipment. These individuals interact with the vendor, track receipt of supplies/equipment, verify that supplies/equipment are in the condition expected, are responsible for maintaining and restocking these supplies/equipment, pay close attention to product expiration dates, and interact with the Monitoring Section to anticipate supply/equipment needs during the field season. Analyzing laboratories prepare bottles for water chemistry analyses and DWQ field personnel frequently pick up batches of bottles to use in the field. Deionized reagent-free water used during instrument calibration and equipment rinsing in the field is prepared and provided to DWQ by the State Lab.

B.9 Non-direct Measurements and Data from External Sources

DWQ does not have a formal policy for accepting data from external sources nor is Credible Data Criteria for DWQ programs written into the Utah Administrative Code. However, the current policy is fully described in the IR and will be described briefly here. The majority of data from outside sources is water quality monitoring data from cooperating government agencies using standard State or Federal sampling procedures, coupled with chemical analyses performed at State or Federally-certified labs. In general, these data sources are of sufficient quality to be comparable with DWQ data and can be used for assessment purposes. Data collected by other outside entities that have not previously collaborated with DWQ is evaluated on a case by case basis to determine how it will be used by DWQ. If it is determined that data is not of sufficient quality and comparability to be used by DWQ directly for assessment, it will be summarized and used to augment other data sources, in a weight of evidence approach, to make assessment decisions.

Some DWQ monitoring or modeling projects, or assessment methods incorporate existing data obtained from secondary (non-DWQ) measurement sources including climatological/meteorological, stream discharge, GIS (geographical information system) data, and also rates/constants/values published in the scientific literature. Secondary data, whether obtained from federal, state, or local governmental agencies, universities, or other entities, must be approved for use by the Division. Secondary data, at a minimum, must have been collected and validated using documented procedures and must include the appropriate associated metadata so that the Division may assess its content, characteristics, quality, and condition. For projects utilizing secondary data, the Sampling and Analysis Plan should identify these secondary data sources, describe how the data will be used, and discuss the acceptance criteria and any limitations for using such data. Designated Project Managers must document (in a SAP or final report) how they determined that a secondary data set was of sufficient quality; it is not enough to assume that a data set is reliable simply because it was collected by a well-known or trusted source.

B.10 Data Management

B.10.1 General

Computer hardware and software general use and security procedures are described in the DEQ QMP. Environmental database systems are maintained by DEQ. Each system is fully backed up each Wednesday and incremental back-ups occur on other days.

Once in electronic format, all field and laboratory data are stored on the DWQ server in appropriate project files and, after review by the Database Manager (DM), are uploaded for permanent storage into DWQ's customized water quality database known as AWQMS (Ambient Water Quality Monitoring System). AWQMS is an Oracle database that supports EPA's national Water Quality Exchange (WQX) schema, allowing for the submission of water quality data directly to the EPA using a standardized data flow in XML (eXtensible Markup Language). Other features include long-term data storage on DEQ's servers and full backups of the database overseen by the Utah Department of Technological Services, a web-based batch loading tool to import water quality data into the database, data quality checks/validation built into the import process, web-based user interface to view, edit, and retrieve data in the database, and ability to set permission rights for editing data. Access to UWQX is ultimately controlled by the responsible Database System Administrator in the Department of Technology Services (DTS), Rob Sandberg. The DWQ DM is given authorization by DTS to control access (Division-wide and public) to the database functions via a webpage application.

Each DPM is responsible for making sure data relevant to their program/project have been managed and stored properly. Any data management procedures specific to a monitoring project/program should be described in the project-specific SAP. Once received, data and database management is the responsibility of the DM.

B.10.2 Field Data

Field data management is discussed in **Section A.9**, in individual DWQ SOPs, and in project-specific SAPs.

B.10.3 Laboratory Results

B.10.3.1 Chemistry Data

The State Lab is utilized for the majority of water, soil, and sediment chemistry analyses as well as chlorophyll analyses (water column or periphyton). The State Lab provides DWQ with electronic data results files, which the DM uploads to WQX. The raw electronic files are maintained indefinitely on DWQ's server. Once validated in the database, the data are stored in WQX indefinitely. The State Lab also provides various hard copy documents to DWQ which are stored in DWQ files, including an Environmental Chemistry Master Log which is a running inventory of samples analyzed for the year. Organic chemistry data, when provided by the State Lab in hard copy format, is hand entered by DWQ staff and data entry is checked by another staff member or the DM.

B.10.3.2 Biological Data

Biological sample results (macroinvertebrates, diatoms, zooplankton, phytoplankton, *E. coli*, etc.) are received by DWQ in various formats (mostly electronic) and are stored electronically on DWQ's server. Currently, *E. coli* data is the only biological data uploaded to UWQX. The raw data files are stored indefinitely in project files on the DWQ server. DWQ's goal is to have a database capable of housing all biological data as well as physical habitat data and continuous monitoring data, which are currently housed on the DWQ server in project files or access databases.

B.10.4 Compliance Data for Permitted Sites

Compliance-related data collected by DWQ field personnel and other DWQ staff at permitted sites is stored and maintained like other water chemistry and field data collected by DWQ. The DM notifies the permit writer and/or sample collector when the lab results are available, giving the permitting staff the ability to review the compliance data and quickly follow up with the permitted facility regarding the results in relation to their permit requirements.

C. ASSESSMENT AND OVERSIGHT

This section of the Division QAPP addresses assessments or evaluations to occur both during and after data collection in order to determine whether the project plan is being implemented as approved.

C.1 Assessments and Response Actions

DPMs are responsible for assessing the quality of the work done for their program/project. Assessment activities may be initiated by DPMs or the QAO/Monitoring Section Manager. Examples of assessment activities that may be performed for DWQ environmental data operations include independent assessments of field and lab activities conducted by a third party, internal DWQ field and lab audits, data validation of selected data sets by DWQ or contractor staff, or internal audits performed by contractors themselves (for permitted facilities). Each project-specific SAP shall include a list and schedule for assessment activities to be conducted during that project and identify the individuals to be involved. In addition, any DPM or the QAO/Monitoring Section Manager may initiate an assessment activity at any time throughout the course of a project/program. Any improvement needs will be addressed at the staff level with the DPM. Issues that cannot be resolved at this level shall be brought to the attention of the Division QAO. Changes will be made to environmental data collection operations to improve quality. These corrective actions will be documented and kept in project files by the DPM or if systematic changes are made they will be documented and kept on file by the QAO.

C.1.1 Field Assessments

Field audits will be performed as often as is appropriate and practical during field sampling, at a frequency defined by a DPM in a project-specific SAP or as initiated by the QAO/Monitoring Section Manager. The recommended frequency is quarterly for each program or once if field work is completed within a quarter. Each project-specific SAP should list each required field assessment activity, the associated acceptance criteria (performance goal), and corrective actions if acceptance criteria is not met. If field audits reveal systemic field data quality issues, the QAO/Monitoring Section Manager will be notified. Results of field audits will be documented by the QA staff and maintained by the DPM in the project files.

Field data is assessed continuously by field personnel, in the field and back in the office. If temperature, dissolved oxygen (DO) or pH readings are found to be illogical (based on best judgment) or exceeding water quality numeric criteria for the site being sampled, staff will check or recalibrate the field instrument to be certain of the values measured. In addition, project-specific SAPS should list the circumstances for recalibration of water quality instruments in the field. Recalibration guidelines may depend on the instrument being used and the best judgment of the field personnel. Upon returning from the field, field personnel review their field data and sample collection completion using checklists.

C.1.2 Laboratory Audits

Internal and external laboratory audits will be performed as defined in each laboratory's quality assurance manual and are the responsibility of the lab. Results of these audits are kept on file by the laboratory but may be requested by a DPM as part of the project-

specific SAP. Audits relating to project-specific performance criteria should be discussed with the laboratory during project planning stages, if possible. In addition, DWQ may also perform laboratory audits or submit Performance Evaluation samples which are commercially purchased target analytes at known concentrations submitted "blind" by DWQ to the laboratory for analysis.

The State Lab is audited by EPA triennially and these results can be requested by DWQ. EPA also sends the State Lab proficiency test samples quarterly and the results are shared with DWQ. In addition, DWQ receives the results of other Performance Evaluation audits performed by other DEQ Divisions (such as Drinking Water, Solid and Hazardous Waste, etc.).

At the start of a monitoring project, the DPM should discuss laboratory audits with the analyzing laboratories, especially for laboratories performing new, non-EPA-approved, or research methods. Decisions regarding non-traditional analyses should be documented in the SAP or a final report and it should be noted whether a laboratory was or was not willing to grant DWQ the opportunity to perform an audit.

C.1.3 Record Checks

Record checks will be performed at a frequency defined by a DPM in a project-specific SAP, or at a minimum, on an annual basis. Each project-specific SAP should list each required record checking activity (e.g. completeness of field forms and field notes), the associated acceptance criteria (performance goal), and corrective actions if acceptance criteria is not met. If record checks reveal systemic data management issues, the QAO will be notified.

C.2 Reports to Management

The project-specific SAP should identify the authorship, recipient, contents, frequency, and distribution of reports issued to inform management of project status and QA issues. Projects of a short duration may have only one final report. Ongoing monitoring projects may have regular reporting such as quarterly or semi-annual reports. If stated in the SAP, the DM (or other Monitoring Section QA staff) or DPM will analyze data against water quality standards on a regular basis per project-specific requirements. In addition, these types of exceedance reports can be autogenerated by any user of UWQX using the database reporting tools. If reports reveal data quality issues or identify that DQOs are not being met, the DPM will make the appropriate changes to improve quality. Issues that cannot be resolved at the DPM level shall be brought to the attention of the QAO. Monitoring Section QA Staff will perform generalized assessments of data quality quarterly.

D. DATA VALIDATION AND USABILITY

The final section of this Division QAPP addresses the final project checks to determine if the data obtained will conform to the project's objectives (DQOs), and to estimate the

effect of any deviations. The database has the ability to characterize data's "Result Status" as Preliminary, Accepted, Validated, Final or Rejected. These statuses will be used to track data through the QA/QC process. No datasets will be made "Final" until all expected results are received and validated. Data used for 305b or 303d reporting in the IR will be given a result status of "Final" when it is submitted to EPA.

D.1 Data Review, Verification, and Validation

The level of detail and frequency for performing data review, verification, and validation activities will depend on the complexity of the monitoring project, and the importance of the decision to be made based on the data.

D.1.1 Data Review

Data review, as defined by EPA, is the in-house examination to ensure that data have been recorded, transmitted, and processed correctly and includes the following activities: checking for data entry, transcription, calculation and reduction, and transformation errors. Activities also include generating a list of all samples collected (regular samples, blanks, duplicates) as well as the sample information (shipping dates, verification of sample receipt, verification that proper preservatives were used and holding times were met) to ensure that the samples/parameters planned are the same number and type as those actually collected. Each project-specific SAP should include a list of all data review activities, a schedule or frequency for performing data review tasks, a list of personnel assigned to perform the tasks, and helpful checklists to ensure all tasks are completed. Data review may occur on a frequent basis for ongoing data collection programs or may only occur a few times during a shorter data collection project. The DPM is ultimately responsible for ensuring that all data is reviewed but the data review tasks can be assigned to DWQ field personnel, the DM and other Monitoring Section QA staff, as well as the DPM. Uploaded data passing initial data review are given a status of "Accepted" in AWQMS.

D.1.1.1 Laboratory Data

Laboratory results are initially reviewed and reported by the analyzing laboratory. DWQ should request a list of the analyzing laboratory's data review tasks for approval during the initial stages of a monitoring project or during SAP creation. The reviewed data package is then submitted by the laboratory to the DWQ DM or the DPM. The DM or DPM also conducts their own review of the lab data using a checklist that is continually adapted and maintained by the DM. Some (not all) of these checks include making sure Site Codes are correct, reviewing laboratory comments, comparing total to dissolved values, checking for the presence of expected detection/quantitation limits based on the analytical method, reviewing non-detect data, checking to see if/when dilutions were performed, making sure holding times were met, making sure all analyses for a sample are complete, looking for duplicate records or incorrect dates, etc. The laboratory liaison will follow up with the laboratory QA officer or individual analysts if any missing or suspect data are identified.

Laboratory results passing this initial level of scrutiny are then uploaded for storage in DWQ's electronic database and the raw data files are saved on the DWQ server indefinitely. When data are uploaded to AWQMS, the database performs some automated checks of the data against thresholds based on the characteristics as well as expected combinations of characteristic name, unit of measure and fraction. The database also checks for completeness (i.e. blank result fields must contain a value or a result qualifier and detection limit). Import configurations also check data files against defined translations and other expected values. Error messages are generated as a .txt file and reviewed and addressed at the time of import either within AWQMS or in the raw file. The error logs are saved as a .txt file, along with the import log prior to addressing the errors and re-validating the import file, as well as after to document error messages and changes made.

D.1.1.2 Field Data

DWQ field personnel, DPMs, and the Monitoring Section QA Staff (including the DM) will work together to verify quality of field data (electronic and hard copy). Field data for the entire trip will be reviewed by a member of the field team both during and after the trip. This review must be completed within 2 weeks of trip completion and includes the following: checking field documentation and electronic field data for data entry, transcription, calculation and reduction, and transformation errors as well as completeness, proper format, and initial filing into the proper location. The field personnel performing this task will sign/initial any hard copy field forms/notes that they have reviewed. Next, the field documentation will be sent to the QA Staff for review. The QA Staff will perform a secondary check of the above-listed items, follow up on questionable data points, sign/initial the hard copy field data, and file it in the project folder. Field personnel enter the electronic field data into the UWQX staging area and correct any errors generated during upload. Field data that has been uploaded to the database staging area will be assessed on a bi-weekly basis by the DM before it is migrated into the database for permanent storage. DPMs should review field data (hard copy and electronic) quarterly at a minimum.

D.1.2 Data Verification

Data verification, as defined by EPA, is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. It essentially evaluates performance against pre-determined specifications, for example, in an analytical method, or a software or hardware operations system.

D.1.2.1 Laboratory Data

Some analytical data verification occurs concurrently with data review as discussed above and is performed by both the analyzing laboratory and DWQ. In addition, the DPM should use sample tracking to verify that the laboratory is meeting the contractual requirements agreed upon during project planning stages. Data verification is also

supported by laboratory audit activities. Data verification is discussed with the State Lab on an annual basis, at a minimum, during a DEQ/State Lab Coordination Meeting. At this time, MOUs can be revised, results of EPA audits can be discussed, and any systemic data quality issues can be addressed. DPMs should initiate communication with analyzing laboratories other than the State Lab and may ask the DWQ laboratory liaison to participate in these discussions.

D.1.2.2 Field Data

Field data verification occurs concurrently with data review as discussed above and is also supported by field audit activities. DPMs should ensure that data is being collected according to the appropriate SOP. The DPM should continuously be assessing the completeness, representativeness, and comparability of the dataset during data collection and should specify in the project-specific SAP when and how these will be evaluated and reported.

D.1.3 Data Validation

Data validation, as defined by EPA, is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. It focuses on the project's specifications or needs, is designed to meet the needs of the decision makers/data users and should note potentially unacceptable departures from the SAP or QAPP. Data validation is primarily the responsibility of the DPM because they are the most familiar with the project-specific goals, although some data validation tasks general enough to apply to all monitoring will be performed by the DM and other QA staff. The specific criteria for deciding to accept, reject, or qualify project data in an objective and consistent manner must be determined for each program/project and discussed in the program/project SAP. These decisions are based on the quality criteria set forth for each program/project in its DQOs and Criteria for Measurement Data. The minimum performance criteria listed in **Sections A.7 and B.5** should generally be met for all monitoring programs/projects unless otherwise justified and described in the SAP. The DPM or QA staff may flag or qualify results or add result comments to data records in the database. Data in the database will never be deleted, although if it does not pass data validation, it will be given a "Rejected" result status. The result status of the data in AWQMS that passes validation will be changed from "Accepted" to "Validated".

The potential effects of any deviation from ideal data quality will be evaluated during the final data quality assessment (see below). But initial data validation should be performed in the earliest stages of a project or on an ongoing basis for long-term monitoring programs, in order for DPMs to perform any necessary corrective actions or adjustments to the project-specific SAP before the rest of the dataset is collected. For example, the first batch of analytical data for a project should be reviewed by the DPM immediately to determine if detection limits are adequate to perform comparisons to action levels, such as numeric water quality criteria. The quality control samples and

activities as prescribed in the SAP should be evaluated by the DPM, with the help of the QA Staff, and should continue to be evaluated on at least a quarterly basis throughout the life of the project. If there are issues, the DPM or QAO/Monitoring Section Manager will follow up with corrective actions as necessary. Blanks will be evaluated immediately after data is received from the laboratory and the results reported by the DM to the DPM and the laboratory personnel so they may follow up with immediate corrective action if needed to address sample contamination issues. The DPM should download the project dataset (both field and lab data) on at least a quarterly basis, perform validation activities, summarize the results in a narrative form to be kept in the project-file, and notify the DM when the validation of that dataset is complete. The DM will make any changes to the data that are necessary as a result of the validation.

D.2 Verification and Validation Methods

See also the previous section. Each project-specific SAP should include a description of how project data will be verified and validated, how any issues found will be resolved and who will resolve them, how the results will be conveyed to the data user(s), examples of any forms or checklists to be used during data verification/validation, and identification of any project-specific calculations to be used. Any verification and validation methods to be used other than those mentioned above should be described explicitly in the project-specific SAP. There are specific data verification activities (e.g. outlier analyses) that are described in the final report for a monitoring project or program, such as those performed for the IR, Qual2K modeling, or a TMDL analysis. Those methods must be thoroughly documented in those reports and explain any changes that were made to the dataset to enable analysis.

D.3 Reconciliation with Data Quality Objectives and User Requirements

This data quality assessment is the culmination of the entire QA process for a monitoring project/program. DQOs for each DWQ program/project should be clearly defined and documented. An assessment of the usability and limitations of all data collected and validated, with respect to the original DQOs, must be documented after completion of data collection activities, or for ongoing projects, once a year following the field season. The DPM is ultimately responsible for performing this final assessment of the data quality but will be assisted by the DM and other Monitoring Section QA Staff. Each project-specific SAP must describe how the validated data obtained from the project will be evaluated to determine if it answers the original questions asked (DQOs). The SAP will also describe how issues will be resolved and discuss how limitations on the use of the data will be reported to decision makers. The SAP will describe how and when this information will be reported to data users/decision makers (formal report, graphs, tables, charts, narrative statement, etc.). For ongoing monitoring programs, this process is critical for future planning purposes and addressing systemic data quality issues. The final data quality assessment should be documented either as a stand-alone document or as part of a final report.

REFERENCES

American National Standards Institute/American Society for Quality Control (ANSI/ASQC). 1995. Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (E4-1994). American National Standard.

USEPA. 2001. EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA/240/B-01/003)

USEPA. 2002. EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5 (EPA/240/R-02/009).

USEPA. 2007. Guidance for Preparing Standard Operating Procedures (SOPs), EPA QA/G-6 (EPA/600/B-07/001).

Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8) (EPA/240/B-02/004, November 2002)

APPENDICES

Appendix A

SAP Checklist

Utah Division of Water Quality
Checklist of Essential Elements for Sampling and Analysis Plans (SAPs)[1]

Monitoring Project/Program:_____
Preparer(s):_____
Reviewer(s):_____
Date Submitted for Review:_____
Date of Review:_____
Parent QAPP or Equivalent Document:_____

Instructions for Preparers:

As required by DWQ's Quality Assurance Program Plan for Monitoring Programs (DWQ QAPP), any monitoring activity conducted or overseen by DWQ must have a SAP, excluding one-time response actions (such as a spill) or compliance sampling. The SAP must be reviewed and revised for each field season/monitoring year. SAPs are approved and kept on file by the Monitoring Section QA Staff and must be distributed to everyone involved with a monitoring project. Use the template and checklist below to help create your SAP. The SAP should contain or reference all the elements in this checklist but need not have the same format. Rather than extensive text, include as much information as possible in the form of tables, which are easier to refer to in the field. The SAP should be a usable, stand-alone document that can be taken into the field by Monitors. Therefore, if you choose to use an element directly from the DWQ QAPP that needs to be viewable when reading the SAP, copy and paste it into the SAP rather than just referencing the QAPP so that Monitors do not have to read through both documents while in the field. The Monitoring Section QA Staff are available to assist you in preparing your SAP and you may view other DWQ SAP examples on the shared drive, U:\WQ\PERMITS\MONITORS\QAQC\SAPs.

Definitions and Acronyms:

DPM- Designated Project Manager. As defined by DEQ's Quality Management Plan (QMP), the DPM is the staff member responsible for a specific project and has immediate managerial or technical control of that project. The DPM is responsible for specifying the quality of the data required for each project and initiating corrective actions when quality control is not being met. The DPM may also be a program manager. The DPM is responsible for designing monitoring strategies, setting project-specific DQOs, and developing project-specific SAPs. DPMs are responsible for making sure all personnel involved with the project are briefed and/or trained on the procedures to be used. Roles of DPMs are further discussed throughout the DWQ QAPP.

IR – Integrated Report

SMP – Strategic Monitoring Plan

[1] Thanks to the Montana Department of Environmental Quality's public Quality Assurance webpage for providing the template for this checklist.

Table of Contents (Provide a TOC for quick reference to document sections)

1. Introduction and Background Information (This can be brief if it references some previous documentation or the IR or SMP, etc.)

- Site history
- Regulatory framework
- Summary of previous investigations
- Location/characteristics of any known pollution sources at the site or in the area
- Site location map showing area at a broad scale

2. Objectives and Design of the Investigation (This should be very specific to the project and should be a result of discussions between DPM, data users, stakeholders, science panel, etc.)

- Specific objectives of <u>this</u> study (describe how they support broader program goals/objectives or regulatory framework)
- Provide the study design (i.e. spatial/temporal limits, sample characteristics, the smallest population, area, volume, or time frame for which decisions will be made).
- Discuss representative sampling conditions and instructions for field personnel if they encounter non-representative sampling conditions
- Describe parameters of concern (narrative – must conform to list(s) in sections 3 and 5)
- Number, location, and frequency of samples and quality control samples
- Identify the Trip ID for the project – have the Database Manager help you wit this.
- Sampling Site Locations
    - Rationale for site selection
    - Site map(s) showing sampling locations and "control" sites and any other pertinent features such as land use, etc. within the sampling area

3. Special Precautions and Safety Plan

- Detailed itemization of any specific safety concerns
- Reference an applicable safety plan
- Any additional safety training required for project

4. Field Sampling Methods and Documentation

- Any special training needed beyond those discussed in DWQ QAPP, and where training documentation will be kept
- Include a table listing each field instrument to be used (equipment, describe operation or indicate where operation manual is kept for field event, include calibration procedures, if any)
- Include a table listing each sampling method to be used (sampling equipment if needed, cite method in SAP, attach applicable SOPs)
- For any sampling equipment used, describe operation or indicate where operation manual is kept for field event, include decontamination procedures, if any, attach applicable SOPs
- If not found in SOPs, include equipment lists, sampling trip organizing checklists,
- List corrective actions for problems that may occur in the field
- Discuss what field documentation is required, and how field records shall be generated and stored

5. Laboratory Sample Handling Procedures

- Describe sample containers, preservatives, holding times
- Describe field documentation (COC) and sample labeling procedures
- Describe shipping plan for sample transport to laboratory

6. Analytical Methods and Laboratory Documentation

- Chemical – list parameter, cite prep method and analytical method, list required sensitivity
- Biological – cite method or desired taxonomic level and organism target count, etc.
- Required reporting procedures (e.g. hardcopy, electronic deliverables) and turn-around times
- Be sure DWQ has obtained QA documentation for each laboratory used (check with Monitoring Section QA Staff), reference this information and any new/research analytical methods being used (obtain these protocols if available from lab)
- List the required data package contents from the analyzing laboratories [or reference a service contract or Memorandum of Understanding (MOU)]

7. Project Quality Control Requirements

- Table of QC limits for field instruments (operation range, accuracy, and precision)
- Table listing each Data Quality Indicator (precision, accuracy, bias, etc.), how it will be measured, and the performance criteria against which it will be evaluated (use the table in the DWQ QAPP and adapt it to *this* project if needed)

- Analytical (internal to lab) QC limits for chemical analyses (acceptable precision, accuracy, and negative control – lab method blank)
- Field sample QC limits for chemical analyses [Acceptable precision (field duplicates) and negative control (field or trip blanks)]
- QC limits for biological analysis [Acceptable precision (% diff in enumeration, 5 taxonomic difference)]

 QC limits, schedule, and descriptions of planned field/lab audits/assessments

 Data quality assurance review procedures

- Describe system of data qualification
- Describe measure of completeness relative to planned design
- Corrective actions for non-conformance

8. Data Analysis, Record Keeping, and Reporting Requirements

 Data interpretation approach (include means to temper decision-making if limited completeness of design occurs)

 Describe project record keeping procedures and archive (hardcopies, electronic data)

 Describe how and when DPM wishes to be notified of available laboratory/field results

 Describe expected content and format of final project report and who will receive original/copies.

9. Schedule and Budget

 Table or figure showing project schedule with key project milestones

 List funding sources for project and include anticipated equipment, consumables, personnel purchases/costs

 Sample costs/lab resources per fee schedule

10. Project Team and Responsibilities

 Identify DPM

 Identify project team responsibilities and personnel

 Identify sampling personnel

 Identify subcontractors (e.g. chemical and biological labs)

References (Include references to DWQ-prepared documents)

Appendices and Attachments (Include SOPs, Chain of Custody forms, Field Forms, Sample Labels, etc.)

Appendix B

State Lab QAPP

Unified Health Laboratory Quality Assurance Plan

Quality Assurance Program Plan
Utah Public Health Laboratory
Bureau of Environmental Chemistry and Services

Address:	4431 S. 2700 W. Taylorsville, Utah 84119
Responsible Official:	Patrick Luedtke M.D. Phone Number (801) 965-2400
	Sanwat Chaudhuri, Ph.D. Phone Number (801) 965-2470
Bureau QA Officer:	Dorinda Arch, Ph.D. Phone Number (801) 965-2503
Bureau QA Manager,	Larry Scanlan Phone Number (801) 965-2510
Lab QA Coordinator:	David Mendenhall, MPA MT (ASCP) Phone Number (801) 965-2530

Plan Coverage: This is a document describing the State of Utah's Public Health Laboratory Quality Assurance Program Plan. The plan covers all environmental chemistry and microbiology data generated from sampling done in the State of Utah and submitted to the Laboratory for analysis. The coverage in this plan will be as resources and priorities allow.

Approval for Agency:

Name: Sanwat Chaudhuri, Ph.D.
Title: Bureau Director

Signature: _____ **Date:** _____

Name: Patrick Luedtke M.D.
Title: Laboratory Director

Signature: _____ **Date:** _____

2.0 TABLE OF CONTENTS

QAP Sections

QAP Appendices

3.0 Program Organization and Responsibility

3.1 Laboratory Staff. Laboratory director, bureau director, QA coordinator, bureau QA officer, bureau QA manager, section chiefs, analysts, and sample receiving staff are responsible for the quality of work produced in the bureau. The QA team is comprised of the Laboratory director, bureau director, QA coordinator, QA officer, QA manager, bureau section chiefs, and the sample-receiving technicians who have specific roles in assuring implementation of the Quality System.

3.2 Laboratory Director

3.2.1 The QA/QC responsibilities of the director:
3.2.2 Gives final approval to the laboratory's Quality Assurance program plan.
3.2.3 May suspend testing when documented quality for a method is in question.

3.3 Bureau Director

3.3.1 The QA/QC responsibilities of the director:
3.3.2 May suspend testing when documented quality for a method is in question.
3.3.3 Maintain current information on regulations and approved methodologies for the various programs that the laboratory serves.
3.3.4 Oversee implementation of the QA program within the bureau.
3.3.5 Tracks corrective actions.
3.3.6 Responds to customer concerns.
3.3.7 Arranges for annual management review.
3.3.8 Maintains and updates QA manual.
3.3.9 Prepares for onsite audit.

3.4 Section Chief

3.4.1 The QA/QC responsibilities of the section chiefs:
3.4.2 Responsible for training of staff in the section.
3.4.3 Ensures compliance with laboratory's QA manual, approved methodology and SOP.
3.4.4 Reviews or assures that the data is verified and validated before reporting.
3.4.5 Initiates corrective action forms as necessary. Reports persistent or recurring out-of-control situations to the bureau director.
3.4.6 Notifies clients of any problems with their samples discovered during the analysis and/or during data verification.
3.4.7 Oversees the disposal of samples.
3.4.8 Oversees the section's instrument repair and maintainance.
3.4.9 Approves standard operating procedures (SOPs).
3.4.10 Responds to performance audit report.

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3.5 Analyst

3.5.1 The QA/QC responsibilities of the analysts:
3.5.2 Participates in the improvement of the QA/QC program plan.
3.5.3 Responsible for the implementation the method's quality control.

3.5.4 Performs analytical procedures and data recording in accordance with SOPs that have been approved by the section chief.

3.5.5 Performs data processing and data verification.

3.5.6 Initiates appropriate corrective action for out-of-control situations, such as instrument malfunction, calibration failure, contamination or other non-conformance as appropriate. Reports of persistent or recurring out-of-control situations to the section chief. All communications and information, collected during a Corrective Action Investigation, must be archived. The analyst and/or the QA manager will accomplish this by storing images of hardcopy and records of e-mail files.

3.5.7 Writes and updates SOPs.

3.5.8 Assists with sample disposal as assigned.

3.5.9 Assists in training new staff and in crosstraining staff.

3.5.10 Reports errors and problems to section chief.

3.5.11 Performs routine maintenance of instruments, performs scheduled instrument maintenance, maintains instrument logbook.

3.5.12 Assists section chief in solving problems.

3.6 Bureau QA Officer

3.6.1 Responsible for the implementation of the Quality System.

3.6.2 Responsible for the oversight and review of QA data.

3.6.3 Reviews and analyzes Method QC data archives, to insure that the current Laboratory Quality Control Objectives and method QC requirements are being met.

3.6.4 Maintains current information on regulations and methodologies.

3.6.5 Provide training on method development, reporting requirements, and legal defensibility. Provides the staff with periodic updates on regulations.

3.6.6 Performs in depth internal audits of the methods and operations listed in Appendix A.

3.6.7 Submits in writing monthly QA Report to Bureau Director. The monthly report will consists of internal audit report, QA activities for the month and reports on precision and accuracy of methods plus corrective actions taken for any out-of-control problems.

3.6.8 Investigates persistent or recurring out-of-control problems, write report of findings, submits to section chief and bureau director.

3.6.9 Works with analysts and section chiefs to troubleshoot method problems, prepares report of findings.

3.6.10 Responds to external performance audit report.

3.6.11 Conducts internal performance audit.

3.7 Bureau QA Manager

3.7.1 Coordinates the distribution of proficiency testing samples. Provides response to certification authorities with respect to any identified problem areas.

3.7.2 Maintains a log of all performance on proficiency test (PT) samples.

3.7.3 Initiates corrective action for failed PT study.

3.7.4 Suggests modifications to the QA program, which could improve the efficiency and

quality of test results.

3.7.5 Calls attention to newly developed method requirements and monitors their implementation into the existing laboratory procedures.

3.7.6 Assists with the interpretation and resolving of issues on the QA summary or audit report.

3.7.7 When called upon, performs performance audits of individual analytical methods from sample receipt to the final report. The results of these audits are used to guide the improvement of laboratory processes. Submits reports of method audits of the laboratory to the bureau director.

3.7.8 Maintains current list of SOP revisions.

3.7.9 Provides training on QA requirements and specific topics as requested by the analyst and/or section chief. This may include providing guidelines for QA orientation to a newly hired analyst and providing QA review training as needed.

3.7.10 Assist in responding to external performance audit report, if needed.

3.8 Laboratory QA Coordinator

3.8.1 Provide input to the Quality Assurance Program Plan documents and revisions.

3.8.2 Serves as an agent for the Laboratory director for all QA activities.

3.8.3 Serves in the QA team and functions as administrator.

3.8.4 Reviews and verifies completion of responses to external audits.

3.9 Sample Receiving

3.9.1 Promptly log samples into computer. Maintain a review system to ensure correct entry. Contact the appropriate section chief or designee for assistance as needed, such as non-routine samples, rush, and samples from special projects.

3.9.2 Notify the section chief or designee of rush, high priority samples upon arrival in the lab.

3.9.3 Deliver to the lab or analyst the samples and a copy of the request forms as soon as possible after sample receipt.

3.9.4 For chain of custody samples, a copy of the chain of custody form must be given to the analyst or section chief.

3.9.5 Must keep the chain of custody refrigerator organized so that samples may be easily retrieved.

3.9.6 Samples with very short holding times, 48 hours or less, must be logged in as soon as possible and delivered to the labs within two hours of receiving them. Turbidity, pH, Temperature, TDS, TSS, and TVS samples fall into this group. BOD sample bottles must be delivered immediately or refrigerated in the sample receiving area.

3.9.7 One member serves on the QA team.

3.10 Bureau LIMS - Staff Roles and Responsibilities

3.10.1 Whenever a change is made in a LIMS system, the programmer will document the change made in the program code. The bureau director will notify all LIMS users of the effects of the change by email.

3.10.2 All LIMS program changes, requested by the users, must be pre-approved by the bureau director or his designee.

3.10.3 The bureau computer programmer will assist in training new analysts. He will also assist in training analysts when changes are made in the LIMS programs.

3.10.4 The bureau programmer will assist analysts and section chiefs in solving computer program problems.

4.0 Lab Quality Assurance Systems and Definitions

4.1 Authorities and Agencies The Bureau of Chemistry and Environmental Services (BCES) is a part of the Unified State Laboratories: Public Health (USL:PH). USL:PH is the common name for the Division of Epidemiology and Laboratory Services (DELS) which is the analytical component of the Utah Department Of Health (UDOH). The Utah Department of Environmental Quality (UDEQ) is composed of several Divisions which are the Utah State agencies which implement and enforce the State and Federal statutes prescribed under the US Environmental Protection Agency (US EPA) rules and regulations. The analytical services that USL:PH provides to Utah DEQ are therefore subject to the US EPA Rules, Regulations and Policies.

4.2 Quality Assurance Plan (QAP) BCES has prepared a Quality Assurance Plan covering all operations and services that generate environmental data for State and Federal regulatory compliance. The QAP undergoes a comprehensive review and update once a year to insure compliance with the current Quality Assurance Objectives of our clients, see Section 5.0 and 6.0.

4.3 USL:PH does not perform sampling services The BCES QAP will be confined to the quality assurance protocols for sample handling, sample analysis, data analysis and documentation of all actions performed from the time samples are submitted for analysis.

4.3.1 Safety and Waste Disposal Requirements The Standard Operating Procedures covering these operations are found in the respective Division manuals.

4.4 Analytical Method A testing procedure recognized and authorized by a published government regulation as acceptable for generating data for the detection and monitoring of a specific contaminate for compliance with a specific regulation.

4.5 Method Calibration Definitions Calibration covers the procedures used to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or instrument. The levels of the applied calibration should bracket the range of the planned or expected sample measurement.

4.5.1 Standard Traceability - The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

4.5.2 Standard Reference Material (SRM) – A second source standard of a known concentration other than the source which was used to prepare the Working Standard Solutions. Whenever available, second source standards that is traceable to a national standard should be purchased and used to verify initial calibration curves. The "certified solutions" some suppliers are selling can come from a common lot source sold by another supplier. Verify and request lot numbers and the source when purchasing materials.

4.5.3 Neat Standard Material - A pure form of a single analyte. May be purchased from any supplier but must be at least 96% pure. Example: Ultra high purity grade chemicals. Verify or request lot numbers of neat sources when purchasing materials.

4.5.4 Standard Preparation Logbook - Analysts must verify all standard and spike solutions before use in the laboratory and document the verification with a routine determination of analyte content and the source of the determination (date/file/analyst). New solutions must be traceable to a verified standard. The verifications should *also* be documented in the Standard Preparation Logbook.

4.5.5 Stock Standard Solution - A concentrated material containing a verified standard that is a method analyte, or a concentrated solution of a single analyte prepared in the laboratory from a Neat Standard Material. Examples: Barium at 1000 mg/l or Benzene at 1000 µg/l.

4.5.6 Primary Standard Solution - A solution of several analytes prepared in the laboratory from the Stock Standard Solution or purchased from an outside source and diluted as needed to prepare Working Standard Solutions and other needed analyte solutions.

4.5.7 Working Standard Solutions - Solutions prepared from the Primary Dilution Standard Solution or Stock Standard Solution at concentration levels applicable for the linear range of the instrumentation. The Working Standard Solutions are used to calibrate the instrument's response with respect to analyte concentration. The Working Standard Solutions or Primary Standard Solutions are verified, when appropriate with a Reference Material before use.

4.5.8 Calibration Method - A defined procedure for performing a calibration.

4.5.9 Calibration Standard - A substance or reference material used to calibrate an instrument. (NELAC, QAMS)

4.5.10 Calibration Curve - The graphical relationship between the known values such as concentrations of a series of calibration standards and their instrument response.

4.5.11 Initial Instrument Calibration - The calibration process directly used for quantitation. Initial instrument calibration may be generated on the day of sample analysis. In some instances, initial instrument calibration may be performed prior to the day of sample analysis.

4.5.12 Continuing Instrument Calibration Verification - When an initial instrument calibration is not performed on the day of analysis, the validity of the initial instrument calibration must be verified before analyzing samples.

4.5.13 Internal Standard (IS) - When used, a known amount of standard is added to every calibration standard, field sample and QC Sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. These compounds also serve to monitor the integrity of the system.

4.5.14 Surrogate Standards - Compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate. The surrogate recoveries are used to monitor method extractions for each sample analyzed.

4.6 Method Accuracy Definitions: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations. The following QC indicators are used to measure accuracy in laboratory testing:

4.6.1 Laboratory Spiked Blank (LSB) or Laboratory Fortified Blank (LFB) or QC check sample or Laboratory Control Sample (LCS) - An aliquot of a clean reference matrix (see 4.8.3) that has been spiked with a known quantity of the method target analyte(s). The LSB is analyzed exactly like a sample (including digestion, extraction, etc.). Its purpose is to determine the accuracy and precision for the test method. In addition, laboratory policy sets an acceptance range for each method for the Laboratory Fortified Blank. The LFB must pass in order for the analytical batch to be accepted.

4.6.2 Laboratory Spiked Sample Matrix (LSM) or Laboratory Fortified Sample Matrix (LFM) or Matrix Spike (MS) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LSM is analyzed exactly like a sample, and its purpose is to determine the effect of matrix on the measurement efficiency of the testing method. The background concentrations of the analytes in the sample matrix must be determined in a separate sample aliquot and the measured values in the LSM corrected for background concentrations.

4.7 Method Precision Definitions Precision is the measure of the degree of repeatability of an analytical method under normal operation. As individual measurements becomes more scattered, the analytical measurement becomes less precise. Precision is usually expressed as standard deviation or relative standard deviation (standard deviation divided by the mean, expressed as a percent, or RSD.

4.7.1 Laboratory Spiked Blank (LSB) or (LFB) and the Laboratory Spiked Blank Duplicate (LSBD) or (LFBD) - Separate aliquots of reagent water to which known amounts of the method analytes are added in the laboratory. The LSB and LSBD are spiked and analyzed exactly like a sample and their purpose is to give a measure of precision associated with laboratory procedures, not the sample collection, preservation, or storage procedures.

4.7.2 Laboratory Spiked Sample Matrix Duplicate (LSMD) or Laboratory Fortified Sample Matrix Duplicate (LFMD) or Matrix Spike Duplicate (MSD) - A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

4.8 Sample Contamination Definitions: Blank samples, that has not been exposed to the analyte of interest, are processed along with the field samples in order detect any contamination that may have occurred during sampling, transport, storage or analysis of the field samples.

4.8.1 A Field Blank is prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken.

4.8.2 An Instrument Blank (IB) is a clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument problems such as contamination or “drift”.

4.8.3 A Laboratory Reagent Blank (LRB) also known as “Method Blank”(MB) is a sample of a matrix similar to the batch of associated samples that is free from the analytes of interest. The LRB is carried through all method steps to determine any contamination or other effects that may be contributed by the reagents, glassware, equipment or laboratory environment involved in the test method.

4.8.4 A Trip Blank or Travel Blank are sample containers filled with laboratory reagent water and sealed. These go to the field and are stored and returned, unopened, along with the field samples. They are stored and analyzed with all other samples for the same requested tests.

4.9 General QA/QC Definitions:

4.9.1 Batch - Environmental samples that are prepared and/or analyzed together at the same time, with the same process and personnel, using the same lot(s) of reagents.

4.9.1.1 A Preparation Batch is composed of 1 to 20 environmental samples with the same matrix (see definition for matrix and matrix distinctions). The maximum time between the start of the processing of the first and last samples in the batch is 24 hours.

4.9.1.2 An Analytical Batch is composed of prepared environmental samples which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

4.9.2 Blind QC Sample- A sample for analysis with a composition known to the submitter. It is used to test the analyst's or laboratory's proficiency in the performance of the sample testing.

4.9.3 Chain of Custody- An unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples. See Appendix C for chain of custody procedures.

4.9.4 Compromised Samples- Samples which are improperly sampled, insufficiently documented, improperly preserved, collected in improper containers, or exceeding holding times when delivered to the laboratory. See paragraph 7.7 for a more complete description of what constitutes compromised samples and how to handle them.

4.9.5 Confirmation- Verification of the identity of an analyte and/or environmental contaminant through the use of an approach with a different scientific principle from the original test method.

4.9.6 Corrective Action- The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

4.9.7 Demonstration of Capability- A procedure to establish the ability of the analyst to generate acceptable accuracy.

4.9.8 Document Control- The act of ensuring documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

4.9.9 Duplicate Analyses- The analyses of the analytes(s) of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical precision of the test method.

4.9.10 Holding Times- The maximum times that samples may be held prior to analysis and still be considered valid and not compromised. (40 CFR Part 136)

4.9.11 Interference – The quantitative detection of the target analyte may be affected either positively or negatively by a non-target interfering material.

4.9.12 Laboratory Performance Checks (LPC) - A solution of various analytes used to check the gas chromatographic column performance and/or the instrument sensitivity.

4.9.13 Sample Matrix - The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

4.9.13.1 Aqueous- Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

4.9.13.2 Drinking Water- Any aqueous sample that has been designated a potable or potential potable water source.

4.9.13.3 Saline/Estuarine- Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

4.9.13.4 Non-aqueous Liquid- Any organic liquid with less than 15% settleable solids.

4.9.13.5 Biological Tissue- Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin.

4.9.13.6 Solids- Includes soils, sediments, sludges and other matrices with greater than 15% settleable solids.

4.9.14 Method Workstation Binder (MWB)- Each Analytical Workstation will have a MWB that is specific to that workstation and the analytical Method being performed at that workstation. The MWB is covered in detail in Section 9.3.

4.9.15 Negative Control- Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. An LRB is an example of a negative control.

4.9.16 Positive Control- Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. LFBs, LFMs and surrogates are positive controls.

4.9.17 Preservation- Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

4.10 Reporting Terminology

4.10.1 Minimum Detectable Limit (MDL) – The statistical estimation of the "best-case" sensitivity for a target analyte of the specified analytical method. The details for determining the MDL are found in 40 CFR Part136 Appendix B.

4.10.2 Minimum Reportable Limit (MRL) - The lowest concentration which will be indicated on a final analytical report for a particular method and matrix. All results found below the MRL shall be reported as less than the MRL. The MRL can be raised to account for matrix effects or dilutions if necessary. If the MRL is changed from the standard MRL for a particular analyte, an explanatory comment must be included in the final report.

4.10.3 Combined Standard Uncertainty (CSU) – As defined for radiological testing, the CSU is the sum of the standard uncertainties and the estimated co-variances of the inputs. The details for calculating the CSU are documented in the SOP for each radiological test.

4.11 References:

4.11.1 US EPA Quality Assurance Division
4.11.2 Uniform Federal Policy for QAPP, March 2005
4.11.3 Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Ed
4.11.4 International Standards Organization Guides 2, 30, 8402
4.11.5 National Environmental Laboratory Accreditation Conference
4.11.6 Multi-Agency Radiological Laboratory Analytical Protocols Manual

5.0 Quality Assurance Objectives (QAOs) – Client QA Program Plans

5.1 Data Quality Objectives (DQO) Unified State Laboratories: Public Health (USL:PH) supports the Local, State, and Federal government agencies with analytical services for both regulatory and non-regulatory investigative purposes. USL:PH therefore has established Standard Operating Protocols that implement the QA/QC requirements specified in local, State, and U.S. Federal Statutes.

5.2 Client Data Quality Objectives (DQO) Federal, Local, and State Statutes are the basic documents that define the minimum QA and QC requirements of the analytical services provided by USL:PH. USL:PH does not perform field-sampling services. Each data using organization is responsible for preparing the SOPs for the sampling procedures that will yield results that are representative of the system being measured. Specific details of the sampling criteria are addressed in their respective Quality Assurance Project Plans.

5.2.1 State of Utah Agencies USL:PH's principal clients are the agencies within Utah Department of Environmental Quality (UDEQ) which perform regulatory and non-regulatory work. Individual environmental personnel within the UDEQ Divisions determine the monitoring program requirements.

5.2.2 Utah Division of Water Quality (DWQ) Analysis of environmental water for content of metals, inorganic, organic analytes, physical parameters and radiologicals (Uranium, Gross Alpha + Beta, Radium-226, Radium-228 and Radon-222). Samples are obtained from lakes, streams, underground water and industrial effluents. Laboratory Methodology needs to be consistent with requirements of the Clean Water Act (CWA).

5.2.3 Utah Division of Drinking Water (DDW) Analysis of drinking water samples for content of metals, inorganic, organic analytes and physical parameters and radiologicals (Uranium, Gross Alpha + Beta, Radium-226, Radium-228 and Radon-222). Methodology needs to be consistent with the Safe Drinking Water Act (SDWA).

5.2.4 Utah Division of Solid and Hazardous Waste (DSHW) Support for hazardous waste site identification and characterization. Perform oversight monitoring for Treatment Storage and Disposal Facilities (TSDF) permits. Methodology involves SW-846 procedures for listed hazardous wastes and characteristics of hazardous waste for organics, metals and physical characteristics.

5.2.5 Utah Division of Air Quality (DAQ) Analysis of lead in air filters; PM-10s, and reactive acidic and basic gases.

5.2.6 Utah Division of Emergency Response and Remediation (DERR) Identification and characterization of unknown materials for the presence of hazardous compounds (organic and inorganic). Detection underground contamination from Superfund sites and Underground Storage Tanks.

5.2.7 Utah Division of Radiation Control (DRC) Analysis of environmental water and soil samples for Uranium, Gross Alpha + Beta, Radium-226 and Radium-228. Determination of gamma radiation from Uranium mine tailings, low-level radioactive disposal facilities and radioactive material spills.

5.2.8 Non-DEQ State Agencies The State Agencies outside the Utah DEQ normally request lab services as defined under the Utah UDEQ or Federal regulations.

5.3 Private Sector Clients USL:PH also provides analytical services to private sector clients, primarily to meet Local, State and Federal regulatory requirements. USL:PH therefore implements the same QA/QC requirements as are implemented for local, State, and U.S. Federal agencies.

5.4 Non-Compliant Analytical Services Requests When a request is made for services that do not comply with the regulatory DQOs, the client is instructed that the results cannot be used for regulatory purposes. As detailed in Section 7, a BCES Manager must review these requests and only they can approve the acceptance of this type of sample. The request, the review, and the acceptance is documented in the permanent records for these samples.

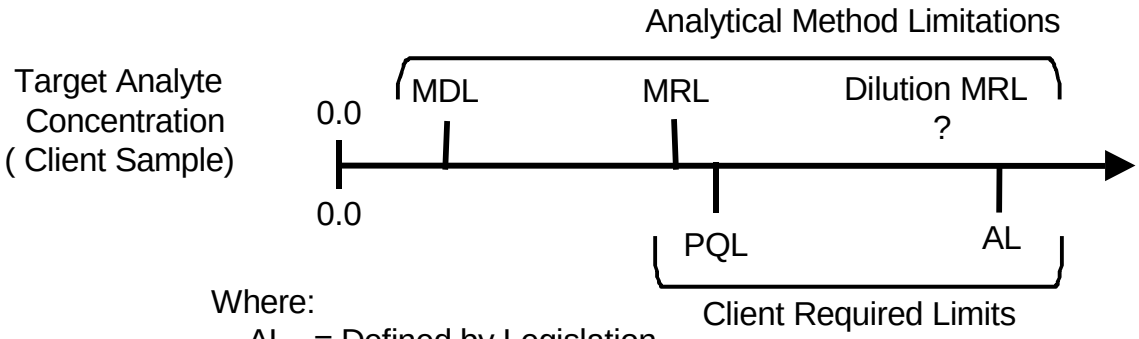
6.0 Quality Assurance Objectives - Laboratory Analytical Services
Precision, Accuracy, Representativeness and Comparability.

6.1 Data Quality Objectives (DQO). Federal, Local, and State Statutes are the basic documents that define the minimum QA and QC requirements incorporated into the analytical services provided by USL:PH.

6.2 DQO for Inter-laboratory Data Comparability. All data generated by the Division of Laboratory Services will be expressed in units consistent with the data generated by other laboratories reporting similar analyses to allow comparability of data among data using organizations. For soil and other solid samples, the results will be flagged with a comment indicating the manner in which the sample weight was determined, e.g., air dried, oven dried, or as is.

6.3 Analytical Method DQOs. The specific objectives for each data quality element (calibration verification, LSM, LSB, etc.) are described in section 4. Appendix A is a comprehensive list of Analytical methods and Supporting QA Systems. Standard Operating Procedures are required for each of these operations. The Analytical Method SOPs list the overall precision and accuracy QC objectives for the analyses. Where applicable, these QA/QC objectives are based on the historical performance of data quality indicators (LFM and LFM\D recoveries).

6.4 DQO Review and Update. Government agencies and private sector clients often have programs and projects for which they want to impose different and/or additional QA/QC requirements. As indicated below, the QA/QC limitations imposed on the analytical methods by legislative acts may not accommodate the proposed QA/QC requirements.



Where:
AL = Defined by Legislation
MDL = Defined by Method
MRL ˜ (3 to 10) x MDL
Low Cal STD = MRL
PQL = MRL
PQL ˜ (0.1 to 0.3) x AL

Therefore, USL:PH BCES management must meet on a regular basis with representatives of the State Regulatory Agencies and agree upon analytical Data Quality Objectives (DQOs) which will meet both the minimum requirements of the law and the additional

requirements of the clients. Thereafter, when a request is made for an analytical service that does not meet the DQOs, the client will be instructed that the results cannot be used for regulatory purposes and the request will be documented in the permanent records of the affected samples.

7.0 Client Samples – Containers, Documentation, and Acceptance

7.1 Sampling Responsibility. The DELS Bureau of Chemistry and Environmental Services (BCES) does not perform sampling. Sampling is the responsibility of the Client organizations and should be addressed in their respective Quality Assurance Project Plans (QAPP). DELS personnel will assist clients in the preparation of sample containers with preservatives or by providing sample containers and the agents necessary for the preservation of samples in the field. BCES will make the division's Sample Acceptance Policy, BCES QAP Manual Section 7, available to all using (Client) organizations.

7.2 Project specific QA/QC requirements are part of the contractual agreement between the client and BCES management. Client personnel may ask for and receive normal support services from the Sample Receiving personnel. However, if the client personnel have questions or complaints about project specific services being provided by BCES, the Sample Receiving personnel must put the client personnel in contact with BCES management in order that a Lab manager can resolve the situation under the client project contractual agreement. Every decision that deviates from the original Client project agreement must be documented and initialed by the BCES manager.

7.3 Project QA/QC begins with the creation of a sample and the associated documentation by the Client/Sampler. Thereafter, each person who handles and/or processes that sample and documentation package is responsible and accountable for the QA/QC requirements of that sample. Legally, the Sample/Document package (evidence) begins with the initial sampling and ends with the reporting of the final results.

7.4 Project Communications. All Sample and Project related conversations with Customers and Regulators must be documented and initialed.

7.5 Sampling Container Requirements. When BCES prepares containers for sample collection and/or accepts samples from Clients for Regulatory Testing (State or Federal), the following QA/QC requirements apply:

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Ammonia: Method EPA 350.3	Plastic[1]	500 ml	H_2SO_4 pH < 2 store at 4-6ºC	28 Days
Alkalinity(See Total Alkalinity SM2320B)	Plastic[1]	125 ml	Store at 4-6ºC	14 Days
Bacillus: Method	Sterile Plastic	200 ml	Sodium Thiosulfate, store at 4-6ºC	48 Hours
BOD_5: Method EPA 405.1	Plastic[1]	2 liter	No preservative, store at 4-6ºC	48 Hours

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
BTEX: Modified Method 602, Modified Method 8020	Glass[2] Teflon lined silicon septa	2/40 ml	1:1 HCl to pH < 2 store at 4-6ºC	14 Days
Carbamates: Method EPA 531.1	Amber Glass[2]with Teflon cap liner	40 ml	1.2 ml Monochloracetic Acid Buffer, store at 4-6ºC, Sodium Thiosulfate if residual chlorine present	28 Days
Chlorinated Pesticides (Soil): Method EPA 8150	Wide Mouth[3] Glass with Teflon Lined Lid	4 oz	Keep cool at 4-6ºC,	Extract within 14 Days, analyze within 40 Days
Chloride: Method EPA 323.3	Plastic[1]	2 Liter	Store at 4-6ºC	28 Days
Chlorophyll a: Method SM10200H	Opaque Plasic[1]	Variable Filtration Volume	Keep Frozen	21 Days
Chromium VI: Method SM3500-CD	Plastic[1]	250 ml	Store at 4-6ºC	24 Hours
C.O.D. (Chemical Oxygen Demand): Method EPA 410.4	Plastic[1]	500 ml	H_2SO_4 to pH < 2 Store at 4-6ºC	28 Days
Coliforms Total & Fecal Colilert – Drinking water & pools: Method SM9223B	Sterile plastic	100 ml	Sodium Thiosulfate, store at 4-6ºC	30 Hours
Coliforms Total & Fecal Membrane filtration – Surface waters: Method SM9222B, D	Sterile plastic	100 ml	Sodium Thiosulfate, store at 4-6ºC	8 Hours
Color: Method EPA 110.2	Plastic[1]	250 ml	No preservative, store at 4-6ºC	48 Hours
Conductivity EPA 120.1 (See Specific Conductivity)	Plastic[1]	125 ml	Store at 4-6ºC	28 Days
Copper/Lead: Method EPA 200.8	Plastic[1]	1 liter	4 ml HNO_3 to pH <2 add on arrival at the lab	6 Months

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Corrosivity (Characteristic of a Hazardous Waste): Method EPA 1110 **	Glass, Amber[2]	2 liter	None Required	7 Days
Crypto & Giardia Method EPA 1623	Envirocheck Filter Gelman #12110	10 liters filtered	No preservative, store at 4-6ºC	24 Hours
Cyanide (Total and amenable to chlorination): Method EPA 335.4	Plastic[1]	500 ml	NaOH to pH>12 Ascorbic acid in the presence of residual chlorine	14 Days
Dissolved Solids: Method SM2540C, EPA 160.1 (See Solids)	Plastic[1]	2 liter	Store at 4-6ºC	7 Days
Ethylene and Propylene Glycol: Method GC/FID	Amber Glass[2] with Teflon cap liner	40 ml	Store at 4-6ºC	28 Days
Fluoride: Method SM4500C	Plastic[1]	125 ml	None Required	28 Days
HAAs (Haloacetic Acids): SM6251B	Glass[2] with Teflon lined septum	4/40 ml	65 mg NH_4CI, store at 4-6ºC	Extract within 14 Days, analyze extract within 7 Days
Ignitability: Method EPA 1010 **	Wide Mouth Glass[2]	4 oz	Store at 4-6ºC	7 Days
Ion Chromatography Bromide, Chloride: Method EPA 300.0	Plastic[1]	125 ml	Store at 4-6ºC	28 Days
Ion Chromatography Bromate: Method EPA 300.0	Plastic[1]	125 ml	Store at 4-6ºC Ethylenediamine	14 Days
Ion Chromatography Chlorate, Chlorite: Method EPA 300.0	Plastic[1]	125 ml	Store at 4-6ºC	28 Days
Lead/Copper: Method EPA 200.8	Plastic[1]	1 liter	4 ml HNO_3 to pH<2 add on arrival at the lab	6 Months

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Maximum THM Potential: Method EPA 502.2	Glass[2], Cap with Teflon lined septum	2/40 ml	No preservative, store at 4-6ºC	Spike with Chlorine as soon as possible. Analyze within 14 Days after quenching
Metals: (See Total Metals)	Plastic[1]	250 ml	HNO_3 to pH<2	6 Months
Mercury: (See Total Metals)	Plastic[1]	250 ml	HNO_3 to pH<2	28 Days
MPA consensus method	Commercial LT-10 filter	100 – 1000 gallons	No preservative, store at 4-6ºC	48 Hours
Nitrate Plus Nitrite: Method EPA 353.2	Plastic[1]	120 ml	H_2SO_4 to pH<2 store at 4-6ºC	28 Days
Nitrite: Method EPA 353.2	Plastic[1]	125 ml	No preservative, store at 4-6ºC	48 Hours
Nutrients (Total phosphate: Method 365.1, Nitrate plus Nitrite Method EPA 353.2)	Plastic[1]	500 ml	H_2SO_4 to pH<2 Store at 4-6ºC	28 Days
Odor: Method EPA 140.1	Amber Glass[2]	250 ml	No preservative, store at 4-6ºC	24 Hours
Oil & Grease (Solids): Method SM5520 B	Wide Mouth Glass[2]	4 oz	Store at 4-6ºC	28 Days
Organohalides and PCBs: Method EPA 608	Glass[2] With Teflon lined lid	1 Liter	If residual chlorine present, 3 mg sodium thiosulfate, store at 4-6ºC	Extract within 7 Days, analyze extract within 40 Days
Organohalides and PCBs(Soil): Method EPA 8081	Wide Mouth Glass[2] with Teflon Lined Lid	4 oz	Keep cool at 4-6ºC	Extract within 14 Days, analyze extract within 40 Days
Organohalides and PCBs(water): Method EPA 8081	Amber Glass[2] with Teflon lined lid	1 liter	0.08 % sodium thiosulfate if residual chlorine, store at 4-6ºC	Extract within 7 Days, analyze extract within 40 Days

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Perchlorate: Method EPA 314.0	Plastic[1] or Glass[2]		None	28 Days
PCB Screening: Method EPA 508A	Glass[2] With Teflon lined lid	1 liter	Store at 4-6ºC	Extract within 14 Days and analyze the extract within 30 Days
Pesticides, Herbicides, Chlorinated Acids: Method EPA 515.1, EPA 508.1	Amber Glass[2] with Teflon cap liner	1 liter	Store at 4-6ºC, Sodium Thiosulfate if residual chlorine present	Extract within 14 Days and analyze the extract within 28 Days
pH: Method EPA 150.1	Plastic[1]	2 liter	No preservative	Analyze Immediately
Phosphate, total: Method EPA 365.1 (See Nutrients)	Plastic[1]	500 ml	H_2SO_4 to pH<2 Store at 4-6ºC	28 Days
Phenols: Method EPA 625	Amber Glass[2] with Teflon cap liner	2/1 liter	0.008% Sodium Thiosulfate, Store at 4-6ºC	Extract within 7 Days, analyze extract within 40 Days
Radiochemistry Gross Alpha and Beta: Method EPA 900.0	Plastic[1]	2 liter	HNO_3 to pH<2 (must preserved)	6 Months (within 5 Days)
Radiochemistry Radium 226: Method EPA 903.1, Radium 228: Method EPA 904.0, Uranium (Total and Dissolved): Method EPA 908.0, Gamma Emission: Method EPA 901.1	Plastic[1]	½ gallon	HNO_3	6 Months
Radon: Method EPA 913.0	Glass[2]	3/40 ml	No preservative, insulated packaging	72 Hours maximum, but prefer within 24 Hours
Reactive Cyanide and Sulfide: Method EPA 9030	Wide Mouth Glass[2]	4 oz	Store at 4-6ºC	7 Days

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Semi Volatile Organic Compounds: Method EPA 525.2	Amber Glass[2]	1 liter	50 mg sodium thiosulfate, to pH<2 with HCI, store at 4-6ºC	Extract within 14 Days analyze extract within 30 Days
Semi Volatiles Methods EPA 625	Amber Glass[2] with Teflon cap liner	2/1 liter	Store at 4-6ºC, If residual chlorine add 8 mg/L sodium thiosulfate	Extract within 7 Days, analyze extract within 40 Days
Semi Volatile Organics (Soil): Method EPA 8270	Wide Mouth Glass[2] with Teflon Lined Lid	4 oz	Keep cool at 4-6ºC	Extract within 14 Days, analyze extract within 40 Days
Semi Volatile Organics(Water): Method EPA 8270	Glass, Amber with Teflon lined lid	1 liter	0.08 % sodium thiosulfate if residual chlorine, store at 4^{o} C	Extract within 7 Days, analyze extract within 40 Days
Silica: Method EPA 370.1	Plastic[1]	2 liter	Cool 4-6ºC	28 Days
Solids: Total Suspended Method EPA 160.2	Plastic[1]	2 liter	Store at 4-6ºC	7 Days
Solids: Total Dissolved Method SM2540C, EPA 160.1	Plastic[1]	2 liter	Store at 4-6ºC	7 Days
Solids: Total Volatile Method EPA 160.4	Plastic[1]	2 liter	Store at 4-6ºC	7 Days
Solids: Settable Method EPA 160.5	Plastic[1]	1000ml	Store at 4-6ºC	48 Hours
Specific Conductivity: Method EPA 120.1	Plastic[1]	125 ml	Store at 4-6ºC	28 Days
Sulfate: Method EPA 375.2,	Plastic[1]	125 ml	Store at 4-6ºC	28 Days
Sulfide: Method EPA 376.2	Plastic[1]	125 ml	3 Drops Zinc Acetate & NaOH to pH>9	7 Days
Surfactants: Method SM5540C	Amber Glass[2]	1 liter	No preservative, Store at 4-6ºC	48 Hours
Suspended Solids: Method EPA 160.2 (See Solids)	Plastic[1]	2 liter	Store at 4-6ºC	7 Days

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
TCLP(Toxic Characteristic Leaching Procedure)-Metals: Mercury Method EPA 1311	Wide Mouth Glass[2] or Plastic[1]	16 oz solid or 4 L of Liquid	Preserve with Nitric Acid to pH <2 after TCLP	Mercury: 7 Days to TCLP, 28 Days to analyze
TCLP(Toxic Characteristic Leaching Procedure)-Metals: Other Metals Method EPA 1311	Wide Mouth Glass[2] or Plastic[1]	16 oz solid or 4 L of Liquid	Preserve with Nitric Acid to pH <2 after TCLP	Other Metals 7 Days to TCLP, 180 Days to analyze
TCLP(Toxic Characteristic Leaching Procedure)- Organics: Semi-VOAs Method EPA 1311	Wide Mouth Glass[2] with Teflon Lined Lid	8 oz (240 ml)[3]	Keep cool at 4-6ºC	Semi Volatiles: 7 Days to TCLP, 40 Days to Analyze
TCLP(Toxic Characteristic Leaching Procedure)-Organics: VOAs EPA 1311 ZHE	Wide Mouth Glass[1] with Teflon Lined Lid	8 oz (240 ml)[3]	Keep cool at 4-6ºC	Volatiles: 14 Days to TCLP ZHE 14 Days to Analyze
THM, Maximum Potential: Method 524.2	Glass[2] , Cap with Teflon lined septum	2/40 ml	No preservative, store at 4-6ºC	Spike with chlorine as soon as possible. Analyze within 14 Days after quenching.
THMs: Method EPA 502.2	Glass[2] , Cap with Teflon lined septum	4/40 ml	Sodium thiosulfate, store at 4-6ºC	14 Days
THM/TTHM: Method EPA 524.2	Glass[2] with Teflon lined septum	2/40 ml	4 mg sodium thiosulfate, Store at 4-6ºC	14 Days
T.K.N.: Method EPA 351.4	Plastic[1]	500 ml	H_2SO_4 to pH < 2 Store at 4-6ºC	28 Days

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
TOC: Method SM5310B, SM5310C	Amber Glass[2]	4 to 6 oz	H_2SO_4 to pH < 2 Store at 4-6ºC	28 Days
Total Alkalinity: Method SM2320B	Plastic[1]	125 ml	Store at 4-6ºC	14 Days
Total Chemistry (Various methods and analytes)	Plastic[1]	2 liter	Store at 4-6ºC	Variable, depending on analyte
Total Metals (Drinking and Wastewater): Methods EPA 200.7, EPA 200.8, EPA 200.9, EPA 245.1 (Mercury)	Plastic[1]	250 ml	HNO_3 to pH<2	Mercury: 28 Days Other Metals 6 Months
Total Metals (Soils/Sediments and Sludges): Methods EPA 6010, EPA 6020, and EPA 7471 (Mercury)	Wide Mouth Plastic[1] or Glass[2]	4 oz[3]	Store at 4-6ºC	Mercury: 28 Days Other Metals 6 Months
TPH: Method EPA 8015 (Modified)	Glass[2] with Teflon lined septum	2/40 ml	No preservative store at 4-6ºC	Extract within 14 Days, analyze extract within 40 Days
Turbidity: Method EPA 180.1	Plastic[1]	2 liters	Store at 4-6ºC	48 Hours
UV-254: Method SM5910B	Amber Glass[2]	4oz	No preservative store at 4-6ºC	As soon as possible, not to exceed 48 Hours
Volatile Organic Compounds: Method EPA 524.2	Glass[2] with Teflon lined silicon septum	3/40 ml Includes Trip Blank	25 mg ascorbic acid, to pH<2 with HCL, store at 4-6ºC	14 Days
Volatile Organic Compounds: Method EPA 624	Glass[2] with Teflon lined septum	2/40 ml	Store at 4-6ºC 10mg/L of sodium thiosulfate if residual chlorine present, If testing for aromatics, use HCl to pH < 2	14 Days

TEST: METHOD	CONTAINER TYPE	VOL.	PRESERVE	HOLDING TIME
Volatile Organic Compounds (Soil): Method EPA 8260	Wide Mouth Glass[2,3] with Teflon Lined Lid	4 oz	Keep cool at 4-6ºC	Extract with 14 Days, analyze extract within 14 Days
Volatile Organic Compounds(Water): Method EPA 8260	Glass[2] with Teflon lined septum	2/40 ml	store at 4-6ºC Add sodium thiosulfate, if residual chlorine present	14 Days
Volatile Solids: Method EPA 160.4 (See Solids)	Plastic[1]	2 liter	Store at 4-6ºC	7 Days

[1] All plastic containers, as specified by the Method, will be new, with the proper preservative added for the type of sample to be collected.

[2] All glass containers, as specified by the Method, will be washed with soap and water, rinsed with de-ionized water, rinsed with distilled water, and oven dried.

[3] The above sample containers assume that the sample is 100% solids and uniform particle size. If the sample is less than 100% solid a larger sample volume is required.

** No longer performed at State Health Laboratory, but sample may be received preserved as indicated and then analyzed by a subcontracting laboratory.

7.6 The Bureau of Chemistry and Environmental Services, working with Bureau of Laboratory Operations staff, has the primary QA/QC responsibility for the accessioning of all environmental samples for storage or testing. The following paragraphs [Sect 7.7] describe the basic conditions and requirements under which BCES will accept environmental samples for analysis for regulatory compliance under the laboratory environmental QA plan. Samples, which cannot meet these conditions, will not be accepted by BCES without flagging the sample and any result produced from the testing of the sample.

7.7 Sample Acceptance Criteria. BLO staff receiving the samples will ensure that sample acceptance criteria are met. The Sample receiving staff will document and notify a BCES laboratory supervisor/manager when sample acceptance criteria are not met. Sample receiving staff will assign a laboratory accession number to each sample received, followed by entry of sample information and test requests into the BCES LIMS. A second staff member will review data entry in the LIMS to minimize error during entry of sample information into the DELS LIMS. All samples will be stored in storage areas as designated by BCES laboratory supervisor/manager or designee.

7.7.1 The Sample Documentation must be present in order for a sample to be accepted at DELS without flagging the sample and any result produced from the testing of the sample. At a minimum, the documentation must include the following information:

7.7.1.1 Sample identification that unambiguously matches the identification on each container of the physical sample, e.g., a field identification code. Currently this is being recorded as the SITE ID number in combination with a SOURCE code, e.g., the DEQ DWQ Storet code.

7.7.1.2 Any additional information necessary to describe and characterize the sample.

7.7.1.3 Sample matrix description, e.g., drinking water, solid, non-aqueous liquid, aqueous, saline/estuarine, chemical waste, biological tissue. Currently, this is being recorded as the SAMPLE TYPE code.

7.7.1.4 Location, date, and time of collection.

7.7.1.5 Collector's name, customer's name and customer ID code. Some customers may not know their ID Code. Currently for drinking water samples, the ID code is related to the water system number. The customer ID code will need to be determined and documented during sample check in.

7.7.1.6 Regulatory programs requiring compliance, if any. Currently, this is being indicated by the DELS cost code, e.g., CWA (CC 350), SDWA (CC 361), RCRA (CC 365), etc.

7.7.1.7 Regulatory methods and target analytes being requested, e.g., EPA525.1; SDWA SVOC organics.

7.7.1.8 Preservation applied in the field, e.g., packed in ice. Currently, chemical preservation information is printed on most of the sample container labels and the request forms which are provided by DELS to the customer.

7.7.1.9 Chain of custody documentation, if indicated by the client and/or regulator. The chain of custody forms and chain of custody seals must be sufficient to meet legal and evidentiary standards.

7.7.1.10 Documentation for field QC samples being required by the client to supplement the basic DELS QAPP QC Samples e.g., trip blanks, field blanks, equipment blanks, duplicates or other field-submitted quality control measures.

7.7.1.11 Comments recorded by DELS personnel, dated and signed, which detail actions taken at the time of sample receipt to bring a sample/document package into compliance with the DELS QA plan. Currently, these records are made on or attached to the request forms.

7.7.2 The Physical Sample must meet the following criteria, in addition to those prescribed in Section_7.5, in order for BCES to accept the physical sample for regulatory testing without qualifications.

7.7.2.1 Container type and volume for both field and QC samples as specified for the test method.

7.7.2.2 Container QA/QC identification, e.g., the container provided by DELS with DELS labels.

7.7.2.3 Container in satisfactory condition e.g. no cracks, no leaks, etc.,

7.7.2.4 Custody Seals, if required, should be tamper proof and intact with date and initials that matches those on the chain of custody form. The custody seals may be applied either to the individual caps on each sample container or to the shipping container in which they were delivered.

7.7.2.5 Durable sample labels and/or tags affixed and marked with information consistent with that on the accompanying documentation as described in Section 7.7.1.

7.7.2.6 The sample identification for each sample container must be unique (e.g., if multiple containers are provided for one test, e.g., VOC analysis, each container will be assigned an additional identifier such as A, B, C, etc.

7.7.2.7 Chemical preservatives added in the field should be recorded on each sample container label. Currently, this information for containers prespiked by DELS with chemical preservatives is being printed on both the container labels and the request forms.

7.7.2.8 Preservation characteristics designated for measurement at the time of receipt as found in Section 7.5 of the DELS QA plan, e.g., the temperature and/or pH.

7.7.3 Samples which do not meet the BCES Acceptance criteria, may be accepted under the following conditions:

7.7.3.1 If the BCES project manager, in contact with the sampler or client, is able to complete the requirements listed in paragraphs 7.7.1 and 7.7.2. All corrections must be recorded (dated and initialed) in the sample documentation. The sample may then be processed as a compliant sample.

7.7.3.2 If the BCES project manager, in consultation with the sampler/client and sample receiving staff, is unable to complete the requirements listed in paragraphs 7.7, the sample may be accepted for provisional testing which must be specifically authorized by the client. All client communications must be recorded (dated and initialed) in the sample documentation. In addition, all test results associated with the non-compliant sample must be flagged in the LIMS indicating that the sample did not meet established acceptance criteria. A COMMENT must be added to the Sample documentation and on the all TEST RESULTS reported to the client describing how the sample was deficient.

7.8 Preservation Check. Prior to or concurrent with testing (to avoid contamination), the contents of each sample container tested will be checked for preservation.

7.9 Test Method Requirements. For test Methods not listed in Section 7.5, the containers and preservatives will be utilized as described in the test Method.

8.0 Sample Custody- Storage and Final Disposition

8.1 Sample custody during field operations is the responsibility of the using organization and is addressed in their respective Quality Assurance Program Plans.

8.2 Sample Receipt At The Laboratory. Upon arrival at the Utah Public Health Laboratory samples will be logged in and identified. Inadequate or inappropriate samples will be noted and described upon receipt at the laboratory. Example of Chain of Custody Form is in Appendix C. The log entry recorded in the chain of custody record will show:

8.2.1 Laboratory sample number.
8.2.2 Date and time of collection.
8.2.3 Exact sampling location.
8.2.4 Name of sampler.
8.2.5 Storet or system identification number.
8.2.6 Source of sample.
8.2.7 Use of the water when applicable.
8.2.8 Analyses requested.
8.2.9 Date and time the sample is transferred to the Utah State Health Laboratory custody.
8.2.10 Signature of the sampler.
8.2.11 Signature of the receiver.
8.2.12 Condition of samples as received (sealed, unsealed, broken container, improper container, sample improperly preserved, sample QNS, or other pertinent remarks).

8.3 Sample Security. Insuring the integrity of the Chain of Custody sample is of utmost importance. The number of individuals handling the sample must be kept to a minimum. The Chain of Custody Custodian or a designated alternate shall review the forms, tags, seals and samples to see that all information described in 8.2 is completed. After the review and each entry has been addressed the sample and paperwork will be placed in secure storage.

8.3.1 Samples to be analyzed for volatile compounds will be stored in a separate refrigerated environment from the other samples. Sample storage area will remain locked at all times, to be opened only by the Chain of Custody Custodian or one of the designated alternates.
8.3.2 When an analyst needs a sample for testing they must contact the Chain of Custody Custodian to arrange for checking out the sample. The sample, or portion of the sample, will be released only to the responsible analyst and by signature with date, time and activity.
8.3.3 The analyst is responsible for the care and custody of the sample once it is released to them. They must be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was released from the custodian until it is returned to the custodian.
8.3.4 The analyst must return the sample to the custodian prior to the analysts leaving the area of the sample or provide secure storage for the sample.
8.3.5 When the analyst has no immediate need for the sample it must be returned to the custodian and received by signature with date, time and action.

8.3.6 Samples will be discarded after maximum holding times have been exceeded or after six months from time of receipt unless otherwise directed by the using organization. The sample containers will be discarded following current laboratory disposal procedures found in the laboratory safety manual.

8.3.7 In order that the Utah Public Health Laboratory demonstrate the reliability of its evidence for enforcement of action, it must be able to prove controlled possession of samples from receipt to discard.

8.4 Analytical results will be reviewed by the Section Chief before the final analytical report is submitted to the using organization. A copy of the final report will be given to the Custodian to be included with the Chain of Custody packet for each sample or sample set.

8.5 Copies of the completed reports will be included with the custody form to make up the chain of custody packet and kept in a secure area for 5 years from the date the sample was received.

8.6 Authorized Custodian. Following are the staff authorized or as custodian as alternates to the custodian for handling chain of custody samples.

8.6.1 Custodian Chris Peper
8.6.2 Alternate Steve Dickson
8.6.3 Alternate Sean Oman
8.6.4 Alternate
8.6.5 Alternate Larry Scanlan
8.6.6 Alternate David Dick

Others authorized only to receive chain-of-custody samples for the Division include;
8.6.7 Jack Oman
8.6.8 Sanwat Chaudhuri
8.6.9 Shauna Simmons

9.0 Analytical Procedures – Regulatory Methods and SOPs

9.1 BCES Analytical Methods Since our major clients are State and Federal regulatory agencies, the analytical Methods implemented in the BCES operations are primarily mandated by federally promulgated programs, see Section 5. All analytical methods that are routinely performed by BCES are cited in the Appendix A of this QAP.

9.2 Analytical Methods and their Target Analyte MRLs It is DLS policy to perform all analytical procedures, regulatory and non-regulatory, as stated in the Client Quality Assurance Objectives (QAOs) that are established in consultation with the client to meet client program needs, see QAP Sections 5 and 6.

9.2.1 If the Client program requires Methods with minor modifications, the deviations will be limited to those permitted by regulations, e.g., those that do not effect the chemistry of the procedure, such as changes in scale.

9.2.2 If the Client program require a major modification of a regulatory analytical procedure, all deviations from the referenced method will be cited in all reports of results produced with the modified procedure.

9.3 Method Workstation Binder Each workstation where an Analytical Method is performed will have a Method Workstation Binder. As defined in QAP Section 4.9.14, this binder will have:

9.3.1 Referenced Method. A copy of the current, approved regulatory Analytical Method.

9.3.2 BCES Method SOP. A copy of the current, approved BCES Method SOP implemented at that specific Method Workstation.

9.3.2.1 At least annually, the Method SOP will be reviewed, updated and signed by the Section Chief, the certified Analysts, and the QA Manager.

9.3.2.2 Each interim change to the current SOP must be read, initialed and dated by the responsible Section Chief and each certified analyst. The change will be included in the next official review and update of the SOP.

9.3.2.3 Discontinued SOPs will bear the date of archive.

9.3.2.4 Discontinued SOPs will be archived in the SOP historical files

9.3.3 Method-Analyte MRLs. A list of the Method analyte MRLs, to be specified by BCES management;

9.3.4 Instrument QC Control Charts. These are sequential, real-time charts that plot specific instrument raw data found for specific QC samples, e.g., the instrument response factor of a specific component in a low Calibration standard. The particular QC Sample and the associated instrument data may be specified by the referenced method.

9.3.4.1 Instrument QC Control Charts should be posted in the immediate area of the Instrument work station instead of in the MWB;

9.3.4.2 Established Control Limits should be plainly indicated.

9.3.4.3 Copies of Instrument Control Charts for past 12 months should be kept in the MWB. After that, the charts should be placed in section historical files.

9.3.5 Instrument QC Control Charts Evaluation. Instrument QC Charts provide visual notification to the Analyst of possible problems with the Analytical Instrumentation.

9.3.5.1 The Method SOP should have a section describing specific conditions under which the Instrument should be taken out-of-service and preventative maintenance initiated, e.g., the last data Point entered on the Chart exceeds the established operational Control Limits.

9.3.5.2 Instrument QC Charts can be visually scanned for patterns (trends) which are normally associated with changes in the testing system. These changes may, in turn, indicate an abnormal condition in the test system. The Method SOP should have a section describing Charted patterns that may be encountered with specific Instrumentation that are acceptable, acceptable with caution and unacceptable.

9.3.6 Method QC Decision Charts, summarizing the QC corrective actions to be followed by analyst as required by the BCES QA Systems, see the QAP Section 12;

9.3.7 Analyst Documentation Analysts, certified to perform the Method at that workstation, will insert current copies, along with supporting raw data, of the following items into the MWB:

9.3.7.1 The analyst IDC;

9.3.7.2 The analyst current ODC (QCS and PT results); and

9.3.7.3 The analyst current MDLs studies, as specified in regulatory Method.

9.3.8 Retired MWB documents will be archived at the back of the MWB. At a later date, to be determined, the retired documents may be transferred to State Archives.

9.4 Annual Section Review of Each MWB The MWB will be reviewed annually by the certified analyst and Section Chief for current completeness. This will include:

9.4.1 The Analytical Method SOP. Signatures will verify that the Analysts and Section Chief have read the most recent revisions;

9.4.2 The certified Analysts' IDCs, ODCs (PTs), and annual MDL studies.

9.5 Annual Internal QA Method Review QA/QC personnel will review each Analytical Method annually as part of the Annual Review cycle for all Lab Systems listed in QAP Appendix A. This will include:

9.5.1 Reviewing all the Method MWBs for current, up-to-date completeness;

9.5.2 Reviewing the annual history of Method QC samples:

9.5.3 Reviewing the annual history of PT results;

9.6 Reviewing Raw Data Packages of recent QA Batches for errors and completeness.

10.0 Analytical Procedures – Calibration and Frequency

10.1 Referenced Methods. It is the policy of BCES to follow, at a minimum, the Calibration procedures as specified in the referenced Methods. In order to accommodate the basic types of instrumentation and testing methodology, the calibration and verification procedures are divided in five categories.

10.2 Inorganic Chemistry In general, Inorganic methods specify standard calibration curves that are developed using a laboratory reagent blank (LRB) and at least 3 working standard solutions. Calibration will be verified after every ten (10) samples with Continuing Standard (CSTD) at a middle concentration and an Instrument Blank (IB). Some reference Methods specify calibration protocols that differ substantially from the general protocol, examples follow.

10.2.1 For Biochemical Oxygen Demand and Total Organic Carbon the standard working curve will only consist of a laboratory reagent blank and a working standard solution. Because of the limitation of the working space, availability of equipment and the supply of the reference materials, the whole calibration and verification items will only include one working standard, one standard reference material if the working standard is not run and one laboratory reagent blank.

10.2.2 For Chlorophyll-A, Odor and Settleable Solids no calibration is done.

10.2.3 For Total Dissolved Solids, Total Suspended Solids, Total Volatile Solids, pH and conductivity, calibration will include standards to bracket the range of samples encountered, but no blank.

10.2.4 Color is calibrated based on the comparison of 12 cobalt solutions that have been diluted fresh for each run.

10.2.5 Solutions for EPA regulated parameters will be prepared in accordance with the methodologies listed for each parameter in Appendix A.

10.3 Organic Chemistry Instrument calibration will be accomplished daily (or with each run) in accordance with the referenced method, SOP, and the instrument manufacturer's instructions. Sample peaks will be matched with standard peaks and a standard calibration curve will be determined in accordance with the method.

10.3.1 Each day of analysis, or with each run, working standard solutions will be used to tabulate area response versus the concentration of the reference material. The results will be used to prepare a calibration curve. If the ratio of response to concentration (calibration factor) is a constant over the working range (<15% relative standard deviation), linearity through the origin will be assumed and the average ratio or calibration factor will be used in place of a calibration curve. Working standard solutions will be prepared in accordance with the methodologies listed for each parameter in Appendix A.

10.3.2 The working calibration curve or calibration factor must be verified on each working day by the measurement of one or more calibration standards. If the response for any analyte varies from the predicted response by more than the method dictates, the test must be repeated using a fresh calibration standard. If the results still do not agree, a new calibration curve will be prepared or will use a single point calibration standard. The single point standards should be prepared at a concentration that produces a response close to that of the unknowns.

10.4 Metal Chemistry.

10.4.1 For Metals by ICP, Calibration includes a Calibration Blank and mixed Standards which includes a minimum of two Standards per element. Calibration is verified at the beginning and end of the run and after every 10 samples with an Instrument Blank and a Continuing Working Verification Standard (middle concentration). Method 200.7 calls the CWV STD an LPC (Laboratory Performance Check). Calibration includes a Calibration blank, Calibration Standards (three to five). Calibration is verified after every 10 samples with Continuing Working Verification Standard (middle concentration) and an Instrument Blank.

10.4.2 For Metals by ICPMS, calibration standards will be analyzed following EPA 200.8 unless otherwise specified.

10.5 Radio-chemistry The instrumentation is calibrated when it is put into operation by running a series of samples of known activity as specified in the analytical method. An instrument's efficiency is calculated and used throughout the run. Calibration includes for each run. For Gross (Alpha + Beta), Calibration is verified after every 10 samples by running Laboratory Reagent Blank and Gross (Alpha + Beta) Method Standard. For Ra-226, and Ra-228 Calibration is verified after every five samples by running Laboratory Reagent Blank and Ra-226, and Ra-228 Method Standard.

10.6 Microbiology. Instrument calibration will be accomplished daily (or with each run) in accordance with the referenced method, SOP, and the instrument manufacturer's instructions.

11.0 Analytical Procedures – Quality Control Sample Types

11.1 Quality Control for Sampling Procedures As stated in Section 7.1, USL:PH does not perform sampling in the field. Field QC samples (QCS) and their evaluations are the responsibility of the client organization and must be addressed in the Client Quality Assurance Project Plans and QAOs. USL:PH will assist the client in the preparation of transport Trip Blanks.

11.2 Laboratory Quality Control Samples (QCS) USL:PH will include the following QC sample types as specified by the referenced regulatory method.

11.3 Working Standard Solutions Working standard solutions will be prepared and used in accordance with the approved EPA methodology listed in Appendix A for all parameters. These working standard solutions will be verified by comparison with reference materials. Working standard solutions which do not agree within 10% of reference materials, or method specified limits, will not be used for analysis. Chlorophyll-A and settleable solids will not have a standard.

11.3.1 Internal/Surrogate Standards. Internal/surrogate standards will be used during organic analyses to monitor method performance, as per each method's requirements.

11.3.2 Laboratory Reagent Blank (LRB). LRBs will also be used during parameter analysis to determine interference levels.

11.3.3 Laboratory Instrument Blank (LIB). LIBs will be used to determine working standard curve for all parameters.

11.4 Standard Reference Material Reference materials will be acquired for routinely analyzed parameters, from sources separate of the standards. These samples will be used to verify working standard curves, except for Chlorophyll-A, Color, Odor, and Settleable Solids.

11.5 Reagent Checks Each analyst will prepare, cross check reagents and document the results. All reagents will contain information relating to documentation of contents, date of preparation/expiration and analyst's initials. Cross checks will be done according to the SOP.

11.6 LFB and LFM Analysis For inorganic chemistry an LFM will be analyzed each run, and an LFB every 20 samples or run if less than 20 samples are run, except for BOD, Chlorophyll-A, Suspended solids, specific conductivity and pH.

11.6.1 For organic chemistry LFMs and LFBs will be analyzed as required in the methodology.

11.6.2 For metals by ICP, ICP/MS a LFM, LFMD, Calibration Blank, and for metals by Cold Vapor an LFM, LFB and LFBD will be analyzed every 10 samples, or one per run if less than 10 samples are run, one SRM per run and Rinse Blank during the run.

11.6.3 For radiological tests, Gross (Alpha & Beta), Radium 226 and 228, a Laboratory Reagent Blank and sample Duplicate, or Spike Matrix Duplicate and LFB is analyzed with every batch of samples. However, Radiological testing QC

requirements are very Method/Instrument specific and subject to change. Therefore, the current QC requirements of the analytical Method referenced in the Method SOP are the definitive standards and must be met.

11.7 Duplicate Analysis

11.7.1 For inorganic chemistry one for every 20 samples (or as required by the method), or each run if less than 20 samples are run, except for: BOD, Oil and Grease, Cyanide, Phenol, Chlorophyll-A, Suspended Solids, Specific Conductivity, and pH.

11.7.2 For organic chemistry, as required in methodology.

11.7.3 For metals every 10 samples, or each run if less than samples are run.

11.8 Instrument Quality Control Charts Instrument specific Quality Control Charts will be defined for each Method Workstation and will be posted at the instrument workstation, see QAP Section 9.3. Instrument QC Charts will be updated for analytical batch.

11.9 Method Quality Control Charts Quality control charts will be kept for routinely analyzed target analytes.

11.10 Microbiology Laboratory Quality Control Checks will include:

11.10.1 The quality of reagent water will be tested annually for the Quality of Reagent Water ratio and Pb, Cd, Cr, Cu, Ni, Zn. The water will be checked monthly for conductivity, total chlorine residual and heterotrophic plate count. Results must be in the limits established by EPA.

11.10.2 Each batch of dilution/rinse water will be checked for sterility.

11.10.3 The Inhibitory Residue test is performed whenever a change in washing procedure or washing compound is made.

11.10.4 Sterility checks will be made on each lot of media prior to reporting results.

Analytical Procedures - Batch QC Decisions & Corrective Action

12.1 Sample Condition QA/QC. If the physical condition of a field sample or a laboratory sample preparation is compromised, then the reported test result must be qualified. Upon finding one of the following sample conditions, laboratory personnel must notify the BCES management as soon as possible. Upon notification, BCES management, or designated staff members, will initiate Client related actions.

12.1.1 Holding time of field sample preparation or the laboratory sample preparation has been exceeded as specified by the method.

12.1.2 Improperly preserved field sample or laboratory sample preparation.

12.1.3 Non-compatible sample characteristics as defined by the Referenced Analytical Test Method.

12.1.4 Lost or broken sample container or laboratory sample preparation.

12.2 QA Batches: Preparation Batches and Analytical Batches. The basic Quality Control structure in the laboratory is the Quality Assurance (QA) Batch. A QA Batch is composed of test samples and the associated QC samples that are analyzed by the same Analytical Method. The Method SOP specifies the requirements for the association of test samples and QC samples.

12.2.1 Preparation QA Batch. An Analytical Method may require that a test sample must be preprocessed into a particular form (a preparation) before it can be submitted for instrumental analysis. A preparation Batch is a group of test samples and QC samples that are associated for preparation under the same test method SOP. A Preparation Batch will have at a minimum all of the preparation QC samples as specified in the Method SOP (e.g., LRB, LFB and LFM) which are prepared (e.g., extraction or digestion) and processed along with the field samples.

12.2.2 Analytical QA Batch. An Analytical Test Series (analytical run) is a collection of samples or sample preparations arranged in the order of analysis (analytical sequence) as specified by the referenced test analytical method.

12.2.2.1 An Analytical Test Series is composed of samples from one or more Preparation Batches which are analyzed along with instrumental QC samples as specified in the referenced test method.

12.2.2.2 An Analytical Test Series usually begins with an initial standard calibration curve (STDs) which is followed by discrete groups of prepared samples which are bracketed, before and after, by a calibration verification standard (e.g., CSTD) and an Instrument Blank (IB).

12.2.2.3 The test method normally requires that the last sample in an Analytical Test Series should be a calibration verification standard (e.g., CSTD) and an Instrument Blank (IB).

12.2.2.4 If an adjustment is made to the instrumentation while an Analytical Test Series is being tested, it should be made carefully. If the instrumental analysis of an Analytical test Series deviates from the analytical test method SOP such that a new set of initial calibration

standards must be performed, then a new analytical test series has been initiated.

12.3 QA Batch Number. The LIMS Analytical files contain complete records of test data associated with each analytical test series that is uniquely identified with a QA Batch Number. Each QCS test result is uniquely identified within a QA Batch file with a unique sequence number. Since each sample test result is also identified with a QA Batch number and sequence number, the relationship of Sample test results to QCS test results is maintained within the LIMS system. Whenever a QC comment on a test result needs to be made, e.g., a fixed limit flag, the QC Comment is identified by linking the record to the QA Batch No. and the Sequence number.

12.4 Analytical Batch - QC Responsibilities. Whenever an Analytical Procedure QC parameter deviates from the range or condition specified in the Reference Analytical Test Method, the Analyst will initiate an investigation, qualify data (if needed) and document findings in the QA Batch Raw Data Package.

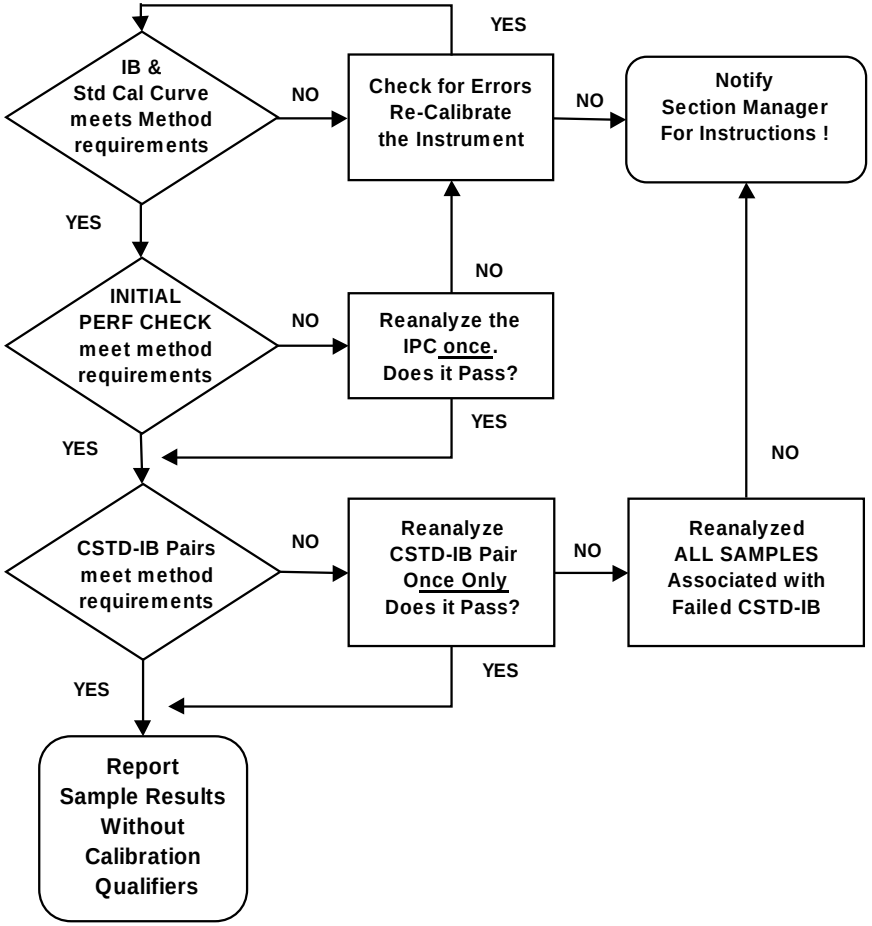
12.4.1 Samples in defective QA Batches will be re-analyzed in QA Batches with acceptable QC results.

12.4.2 Samples that cannot be re-analyzed in QA Batches with acceptable QC results will not be reported as acceptable for regulatory use. The Analyst must notify the BCES management as soon as possible. Upon notification, BCES management will initiate Client related actions and also initiate Corrective And Preventative Actions (CAPA).

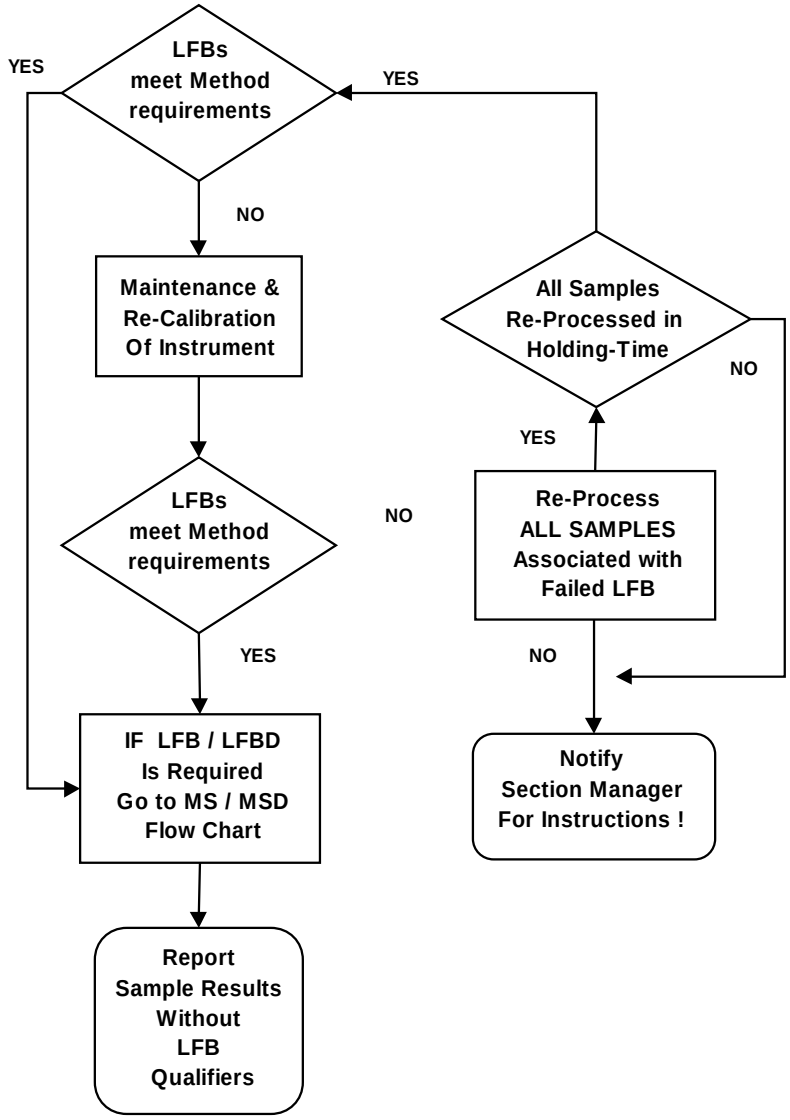
12.4.3 Analytical Method SOPs. Each Method SOP contains method specific summaries which itemize the QC samples, their requirements, and their QC limits as specified by each Reference Analytical Test Method.

12.5 QC Decision Flowcharts. The following QC Decision Flowcharts summarize the minimum, general requirements for QC Sample Types in an analytical QA Batch and the appropriate responses to the QC results. Each regulatory Method will specify additional QC samples that must also be analyzed and evaluated. Corrective actions must be taken as specified in the referenced method.

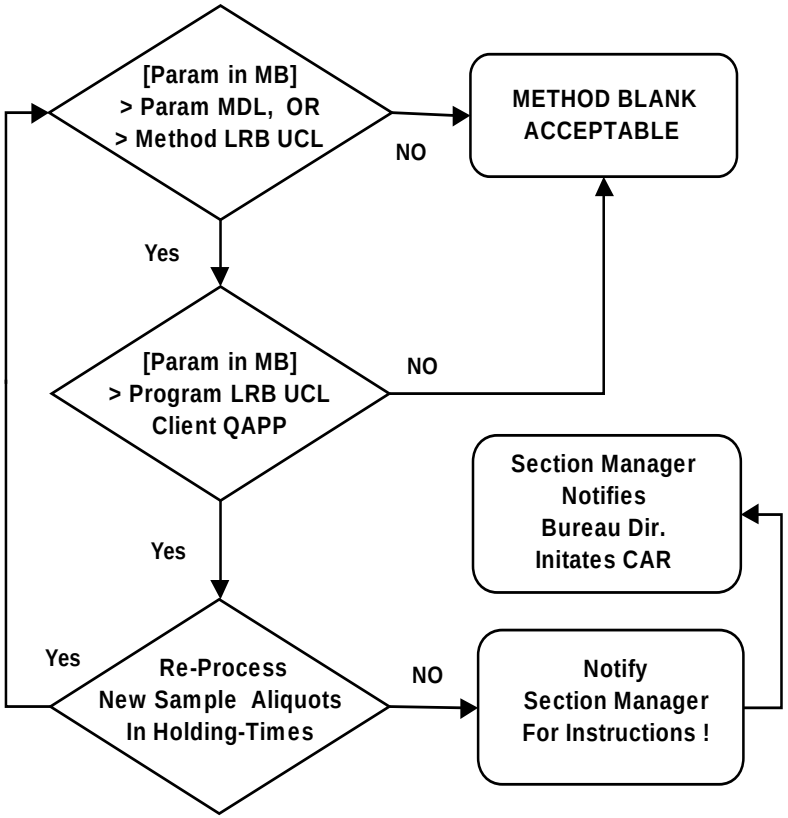
TEST BATCH QC DECISION FLOWCHART
CALBRATION STDS (STD, SRM, CSTD, IB)



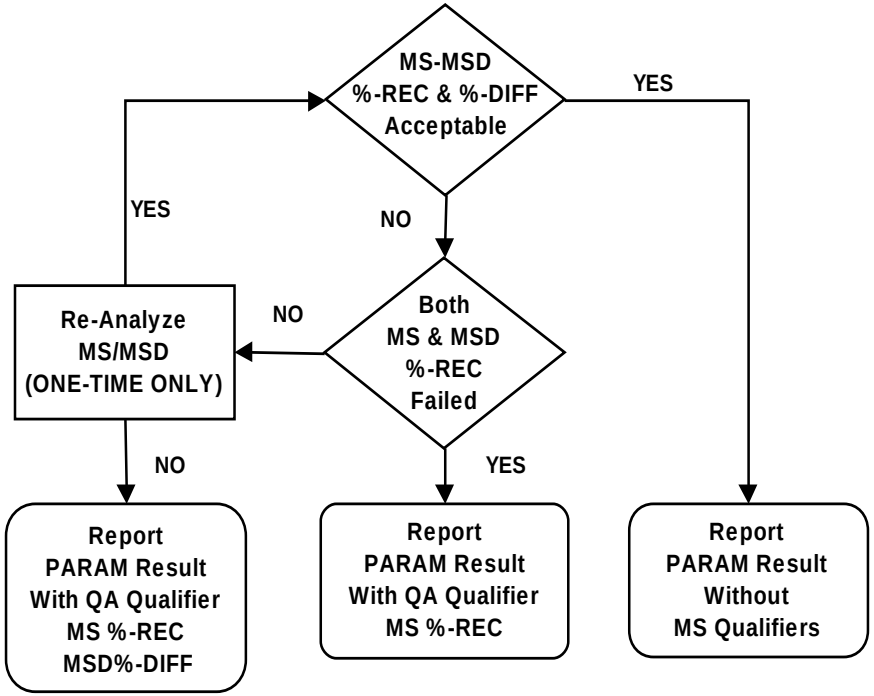
TEST BATCH QC DECISION FLOWCHART
LAB FORTIFIED BLANKS (LFB, LFBD)



TEST BATCH QC DECISION FLOWCHART
METHOD BLANK (MS) & LAB REAGENT BLANK (LRB)



TEST BATCH / SAMPLE QC DECISION FLOWCHART
SAMPLE MATRIX SPIKE / MATRIX SPIKE DUPLICATE



12.6 Analytical Batch - Instrumentation QC

12.6.1 STD, Initial Calibration Standard. If the analyst finds that one of the characteristics of the Calibration Curve, e.g., the linear regression coefficient, does not meet the requirement as specified in the referenced analytical test method, the analyst will stop and investigate the working standard solutions and the instrumentation for the cause. Once the cause of the abnormality is corrected, the analyst must reanalyze any samples associated with the defective standard curve.

12.6.1.1 STD Data Qualifications. If insufficient sample volume does not allow for reanalysis, the BCES management must be notified. Management will contact the client and the data will be qualified.

12.6.1.2 STD Documentation. Record findings in instrument logbook or sample logbook. Corrective Action Record is required if reported test data is qualified.

12.6.2 IB, Instrument Blank or Solvent Blank. The purpose of an Instrument Blank is to check the condition of the instrumentation, associated equipment, and the purity of the solvent. If the method requires an Instrument Blank, it must be analyzed. If the instrument blank test indicates a problem with either the equipment or the solvent, the analyst should stop and check for the cause. Possible causes are a contaminated detector, an abnormal baseline, an abnormal signal, or a solvent contaminant that might interfere with the analysis. Once the problem is corrected, the analyses may continue.

12.6.3 CSTD, Continuing Standard. The CSTD is used to periodically verify instrument performance during analysis. If CSTD does not meet the requirements as specified in the referenced analytical test method, the analyst will immediately investigate the possible sources of the failure. No additional samples should be prepared for testing until the source of the failure has been found and eliminated.

12.6.3.1 CSTD Data qualifications. Required if test results are reported from data acquired with a CSTD which does not meet the requirements.

12.6.3.2 CSTD Documentation. Record findings in instrument or sample logbook. Corrective Action Record required if reported test results are qualified.

12.6.4 Batch Termination QC. Each analytical QA Batch sequence must end with both an acceptable IB and an acceptable CSTD.

12.7 Analytical Batch - Method & Reagents QC.

12.7.1 LRB, Lab Reagent Blank or Sample Preparation Blank. If a LRB is required by the test method, the analyst will inspect the LRB for indications of contamination. If the analyst finds contamination as defined in the method, he should immediately investigate the possible sources. No additional samples should be prepared for testing until the source of the contamination has been found and eliminated. If possible new analytical samples should be prepared and analyzed.

12.7.1.1 LRB Data Qualifications. Required if contamination cannot be eliminated and the reported test result is calculated from data acquired with a Preparation Batch containing a contaminated LRB.

12.7.1.2 LRB Documentation. Record findings in sample preparation logbook or on batch summary sheet. Corrective Action Record is required if reported test result is qualified.

12.7.2 SRM Standards Reference Material. The SRM, is used for verification of prepared standards (e.g., calibration and spiking standards) and stock standards used for analyses performed by the referenced test method. QA data base control limits are derived from the referenced test method, and specified in appendix A of the QA manual.

12.7.2.1 SRM, Standards Verification. If the SRM recovery is not within verification control limits, the analyst will immediately investigate the possible causes (e.g., working standard solutions, source of standards, and instrumentation).

12.7.2.1.1 If it can be verified that degradation of the original SRM is the cause, then the original data can be reported without qualification. Verification is achieved through concurrent analysis and comparison of the original SRM, and a new SRM.

12.7.2.1.2 If it cannot be verified that degradation of the original SRM is the cause, the associated samples must be re-analyzed, if possible, along with a successful SRM.

12.7.2.2 SRM, Data Qualification. Sample test results should not be reported until they can be associated with, and validated by successful analysis of a SRM. If the SRM recovery is not within the control limits and the sample set can not be re-analyzed, the associated data may be reported; however, a qualification statement must be included in the final report indicating that the reported data could be suspect and cannot be verified. The analyst must immediately notify the section chief for appropriate customer relation action(s).

12.7.2.3 SRM, Documentation. Record findings in the instrument or sample logbook, and in the batch comments file of the QA data base or on batch summary sheet. If the sample data has been reported with qualifications, then a Corrective Action Record (CAR) must be initiated by the section chief, or analyst.

12.7.3 LFB Laboratory Fortified Blank. The LFB is used for assessment of method accuracy performance. QA data base control limits are derived from the referenced test method, and specified in Appendix A of the QA manual. If the LFB is derived from an alternate standard source, and is also intended to satisfy the SRM function, SRM QA data base control limits must be applied to the LFB for performing verification of standards (section?? which section??).

12.7.3.1 LFB, Method Accuracy If the LFB recovery is not within accuracy control limits, the analyst will immediately investigate the possible causes (e.g., spiking solution, calibration standard(s), and instrument

performance associated with the analysis), and perform the following actions:

12.7.3.1.1 LFBs not involving sample preparation steps. If possible, a new LFB, and the samples associated with the original LFB must be re-analyzed.

12.7.3.1.2 LFBs involving sample preparation steps. If it can be verified that instrument performance is the cause (e.g., instrument maintenance, calibration drift, etc.), and successful re-analysis of the original LFB and associated samples has been performed, the re-analyzed data may be reported without qualification. If re-analysis of the original LFB and associated samples is unsuccessful, then the section chief must be notified, and if possible, a new sample set prepared and analyzed.

12.7.3.2 LFB, Accuracy Qualification. Sample test results should not be reported until they can be associated with, and validated by successful analysis of a LFB. If the LFB recovery is not within the accuracy control limits, and, the sample set can not be re-analyzed, the data may be reported; however, a qualification statement must be included in the final report indicating that the reported data could be suspect, and cannot be verified. The analyst must immediately notify the section chief for appropriate customer relation action(s).

12.7.3.3 LFB, Documentation. Record findings in the instrument or sample logbook, and in the batch comments file of the QA data base. If the data has been reported with accuracy qualification statements, a Corrective Action Record (CAR) must be initiated by the section chief, or analyst.

12.7.4 LFBD, Lab Fortified Blank Duplicate. When the referenced analytical test method requires a LFBD, the percent difference (%D) between the LFB and the LFBD values is used to calculate the precision.

12.7.4.1 LFBD, Precision. The determination of the precision is defined in greater detail in Section 14.2. The precision, in general, is the range of %D values which the method or program defines as acceptable. If the %D for the LFBD is not within the precision control limits (the calculated range), then the analyst shall investigate the possible causes of the inconsistent spike recovery. If the cause cannot be determine and/or the spike results cannot be verified then the analyst should reanalyze all of the samples in the Preparation Batch if possible.

12.7.4.2 LFBD, Precision Qualification. If reanalysis does not verify the validity of the original data and the sample set can neither be reanalyzed nor resampled, the data may be reported but only with the qualification that the reported data is suspect and cannot be verified. The analyst must immediately notify the lab supervisor who will notify the Bureau Director or his designee for appropriate customer relation actions.

12.7.4.3 LFBD Documentation. If reanalysis of the original standard(s) and spiking solution is performed, the data shall be recorded and archived

(Chemist notebook, benchsheet). If the data has been reported with qualifications, then a Corrective Action Record must be initiated.

12.8 Analytical Batch - Sample Matrix and Sampling QC

12.8.1 LFM, Lab Fortified Matrix or Matrix Spike. The LFM can have a two-fold purpose. The LFM is used primarily to detect matrix interference. In addition, the LFM percent recovery data can be specified by the referenced analytical test method for calculating the accuracy instead of using Lab Fortified Blank data.

12.8.1.1 LFM, Matrix Effect. If the LFM percent recovery is low as defined in the reference method then a matrix interference must be confirmed by comparison of the LFM data with the LFMD data.(For further instructions see does not exist; which section??)

12.8.1.2 LFM, If used for Accuracy. If the LFM found value is not within the calculated accuracy limits and if the LFMD is also not within the accuracy limits, then the analyst will examine the spiking solution and the standard(s) used for the analysis. If the cause of the inconsistent spike recovery cannot be determined and the accuracy verified, then the sample set must be reanalyzed, if possible, using an LFB for the calculation of the accuracy.

12.8.1.2.1 LFM, Accuracy Qualification. If reanalysis is not possible and the samples cannot be resampled, the original Preparation Batch data can be reported but only with the qualification that the accuracy of the reported data cannot be verified.

12.8.2 LFMD, Lab Fortified Matrix Duplicate or Matrix Spike Duplicate. The LFMD data is used primarily to check for and to confirm a matrix interference. If the LFM percent recovery data is used to calculate the accuracy then the LFMD percent difference (%D) data is also used to calculate the precision.

12.8.2.1 LFMD, Matrix Effect. If the LFM and LFMD percent recoveries are consistently low or high as specified in the referenced analytical test method for matrix interference, then the sample data for that Preparation Batch may be reported with a sample specific qualification.

12.8.2.1.1 LFMD, Matrix Effect Qualification. If the sample result being reported has been demonstrated to exhibit a matrix interference, then the result for that one sample must be qualified. If the reference analytical test method requires that a matrix effect must be confirmed, then the qualification should state that a Matrix interference (or Matrix effect, or method non-compatibility) has been confirmed for the testing of this sample using the referenced analytical test method. If the referenced analytical test method does not require confirmation, the qualification must say that there is a possible matrix effect. A matrix interference is not a system failure, therefore a Corrective Action Record is not required.

12.8.2.2 LFMD, If used for Precision. The determination of the currently acceptable range for the precision is defined in greater detail in Section

14.2.1. If the %D for the LFMD is used for precision and is not within the current acceptable range of precision, then the analyst shall investigate the possible causes of the inconsistent spike recovery. If the cause cannot be determined and/or the results cannot be verified, then the analyst should reanalyze all of the samples in the Preparation Batch.

12.8.2.2.1 LFMD, Precision Qualification. If reanalysis is not possible and the samples cannot be resampled, the original data can be reported but only with the qualification that the reported data is suspect and cannot be verified.

12.8.3 DUP, Duplicate Sample (Matrix Duplicate). The result of the sample Duplicate analysis is compared with the result found for the original sample analysis. The Percent Difference is calculated. If the Percent Difference is not within the range specified in the reference method then the analyst must examine the sample collection and preparation records for possible causes. Large variations in results found for the same sample can be caused by a variety of conditions including but not limited to the following. The original field sample may be physically non-homogeneous. In which case the sample splitting procedure used to prepare the samples may not have produced a true, representative sample. If the results for the sample and its duplicate are low and nears the MRL, the standard deviation of results at this concentration will give large Percent Differences even on replicate analyses.

12.8.3.1 DUP, Duplicate Data Documentation and Qualification. If inconsistent duplicate results cannot be resolved by reanalyses, all the data should be documented and the sample result and sample duplicate result reported with the qualification that the results for that one sample are suspect due to a non-homogeneous sample matrix and the referenced sampling procedure or sample splitting procedure. A Corrective Action Record is only necessary if an in-house system error has been identified.

12.9 The Analyst Responsibility for Notification. The Analyst will notify the Section Chief as soon as possible when he has determined that one or more of the conditions described above will cause the final test results to be reported with flags, comments, or other qualifications.

12.10 The Lab Supervisor Corrective Actions. The Lab Supervisor is responsible for filing the Corrective Action Record (CAR) form documenting any condition which has affected the quality of analytical data including the following events. The Corrective Action Record should include the steps being taken to prevent future occurrences of these events.

12.10.1 Notification by the analyst or upon becoming aware that one of the QC conditions described in section (not correct)has occurred.

12.10.2 Review of the final results reveals the existence of one of the QC conditions described in Section (not correct)which has not been previously identified or documented.

12.10.3 Review of the final data and/or the final report reveals a computer file error.

12.11 The Bureau Director Corrective Actions. The Bureau Director will investigate and take appropriate action including filing a CAR if any of the following events occur. The bureau director may delegate responsibility to staff if he feels that it is necessary.

12.11.1 EPA Region VIII program audits which indicate deficiencies.

12.11.2 Client Complaints which relate to the quality of the laboratory analytical systems.

12.11.3 The Bureau Director Corrective Action Follow-up. The Bureau Director or his/her designee will document in a Corrective Action Record all corrective actions which have been implemented or proposed.

12.12 The QA Officer Responsibilities. The QA officer will be responsible for monitoring on-going quality by performing follow-up method and blind audits and report to bureau director. The Bureau QA officer investigates and takes appropriate action including filing a CAR if any of the following events occur:

12.12.1 Performance Evaluation (PE) Study audits results that indicate unacceptable values.

12.12.2 In-house System Audits by the QA staff (QA Officer and QA Manager) which indicate unacceptable conditions.

12.12.3 Intra-laboratory comparison studies which indicate out of normal range results.

12.12.4 EPA Region VIII program audits that indicate deficiencies.

12.12.5 Final Reports that require corrections after being transmitted out of the Lab.

12.13 The QA Coordinator Responsibilities. The QA coordinator will verify the implementation and documentation of the corrective actions proposed in Corrective Action Records filed by the Laboratory Supervisor and/or the Bureau Director. The QA coordinator is responsible for reporting to the Laboratory Director any QA issues that are not, in the opinion of the QA coordinator, being addressed in a timely manner by the Bureau Director or supervisory staff.

13.0 Analytical Procedures - Data Reduction and Validation, LIMS Processes, Client Reports and Retention of Records

13.1 Client Project Sampling Data. Data validation and Data integrity during sample collection and associated data reduction are the responsibility of the (Client) using organization and is addressed in their respective Quality Assurance Project Plans.

13.2 Lab Data Reduction and Peer Review. For all BCES Analytical Sections, Inorganic, Metals, Organics, and Radiologics, each analyst will review the raw data and verify that the analytical data produced for all parameters is within prescribed control limits, as defined by the reference Method, before entering the data onto the Laboratory Permanent Databases (APPX and ALLIANCE). Preliminary test results will not be entered into the LIMS such that the results are made available for reporting. Corrective Action will be initiated by the analyst when QC results do not fall within the prescribed control limits (incorrect section). The completed analytical QA Batch Raw Data Package, including any Corrective Action records, is authorized by the analyst, initialed and dated, as complete and accurate. After the QA Batch Raw Data Package has been reviewed by the assigned peer reviewer for completeness and correctness, the QA Batch Raw Data Package is filed in the BCES on-site archives.

13.3 Automated Data Consistency Checks. After all Inorganic & Metals tests for a sample have been completed, the test results are checked for interdependent consistency. The Inorganic Section Chief performs a final review of the results following an application of Standard Methods 1030 F, 19TH edition, "Data Quality: Checking Correctness of Analyses". The various checks involved have been automated in the LIMS system. Depending on the tests requested and performed for a sample, these checks include the following:

- **13.3.1** Anion-Cation Balance;
- **13.3.2** Anion Sum and Cation Sum versus the Electrical Conductivity;
- **13.3.3** Anion-Cation Sum versus the TDS;
- **13.3.4** TDS versus the Electrical Conductivity;
- **13.3.5** Analyte Results for the sample Filtered versus Unfiltered;
- **13.3.6** Analyte Result Found versus Historical average for the sample type;
- **13.3.7** QA/QC Flags set either by Analysts or automatically by the LIMS.

13.4 Manual Automated Data Consistency Checks. The QC details of the automated checks are prescribed in the SOP for SM1030F. The LIMS system is designed such that the Section Chief must manually review all results that do not pass the Check for Correctness of Analyses. After the results have been verified and/or corrected, the results are released for transmission to the client. The results of the analytical checks and the actions taken by the Section Chief are recorded and the hardcopy is filed.

13.5 Sample ReAnalysis. When testing is repeated for any reason and data that has been entered in the LIMS needs to be changed to reflect a higher quality result, the access to

change the previously entered results is limited to BCES Managers. After results are initially entered the following individuals are the only ones authorized to make changes:

13.5.1 Organic Chemistry - Organic Section Chief
13.5.2 Inorganic Chemistry – Inorganic Section Chief
13.5.3 Metals – Organic Section Chief
13.5.4 Microbiology – Environmental Microbiology Section Chief
13.5.5 Radiochemistry – Organic Section Chief

13.6 Transmission of Final Results. After all test requests for a sample are completed and reviewed, the results are reported to the customer. The format of results reported to the customer is determined during the consultation with the customer defining the Data Quality Objectives. These formats may take the form of hardcopy or of electronic file transfers. In no instance will data with suspect QC results be transferred without the qualifying statement. Results with special formats such as Radiological analyses will follow the formats specified in the Method reference by the Method SOP.

13.7 Amended Reports. When any result that has been reported to the customer is changed, a comment must be added to an "Amended" report indicating that the result was changed, the previously reported valued, and the initials of the individual making the change. The report must then be printed and mailed or electronically resent to the customer. Changed reports require formal corrective action and review by the QA committee.

13.8 Completed Raw Data Record Archives. Archived Records shall be kept for not less than 12 years with the two most current years kept on-site. These records shall include final reports with documentation of the technical review, all raw data, data collection sheets, calculations, instrument calibration/tuning and quality assurance in sufficient detail to validate each reported result. Prior to scheduled disposal of archived data, BCES will notify the customer. Archived data associated with litigation will be stored until the customer requests disposal.

14.0 QA Systems - Statistical Concepts and Definitions

14.1 Standard Deviation. When the same test is performed repeatedly on the same type of sample under approximately the same conditions, the resulting group of data points will be scattered around an average value, due to noise in the analytical system. The standard deviation, s, is a calculated estimation of how widely the data points are scattered around their average value, the mean.

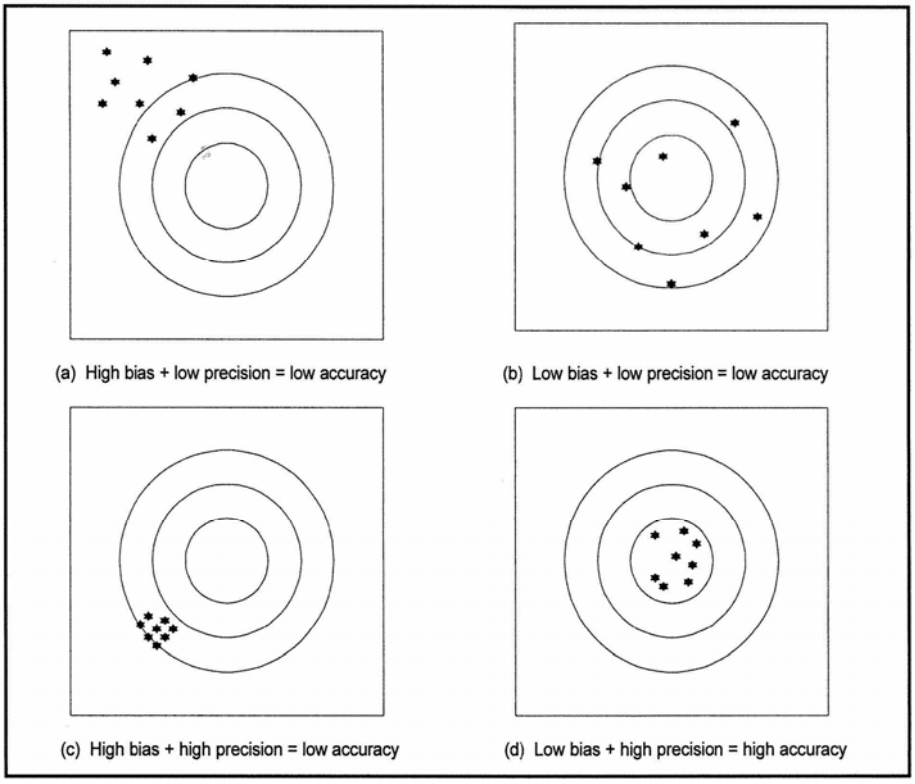
14.1.1 Calculation. The equation used by the LIMS to calculate an estimate of a standard deviation (S) is:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}\right]$$

14.1.2 Database assumptions. The use of this equation assumes that all available data points are being used to calculate the standard deviation. For example, eliminating data points which do not appear to be grouped around the average value can result in the calculation of a standard deviation which describes a smaller set of data points which is tighter and less scattered than the actual set of data points.

14.1.3 Testing Assumptions. The equation also assumes that the data points are distributed in a normal distribution around an average. This means that all aspects of the test, and its environment, always re-occur in exactly the same manner. In practical reality, things in the environment are always undergoing small changes, e.g., the room temperature, the light coming through a window, the building air pressure, the temperature of the sample, the temperature of the instrument, etc. When even small changes occur in the test conditions, the resulting distribution pattern of the measured data points can be very different from the normal pattern produced under extreme conditions of isolation and control. Therefore it is very important that environmental conditions should be kept constant whenever a particular analytical test method is being performed, i.e., always follow the method SOP.

14.2 Precision, Bias, and Accuracy. The following Chart demonstrates visually the relationship that exists between Precision, Bias and Accuracy for a group of points found on a scatter plot where the central point is the goal, the target.



14.2.1 Precision. The Precision is a measure of the average percent difference between duplicate test results, without regard to how close their average found value is to the actual known concentration. For example, data sets represented by C and D in diagram are both tightly grouped and are equally high precision but the average of set C is far from the center, true value. Currently the computer QC program determines the precision for a data set by calculating the difference between the results found for the Laboratory Fortified Blank (LFB) and its Duplicate, (LFBD), and then dividing the difference by the average of the two results. This is sometimes referred to as the relative percent difference,(RPD or %D). However, it is the referenced analytical test method that specifies how the Precision should be determined. In addition, most analytical test methods require that a QC Chart be plotted showing the standard deviation of the most recent precision determinations. Most analytical test methods also require that Fixed Limits be established for monitoring the Precision of a testing process and for determining the acceptability of the test data.

14.2.2 Bias. Bias is a measure of systematic error. When a sample of known concentration is tested repeatedly, the Bias is determined by how close the average test value is coming to the actual, known value. For example, the data sets represented by A and B in figure 14.2 are both very scattered showing low precision but the data in set D is averaged around the true value and therefore has a lower bias than the data in set B. A data set with low bias, such as in Panel D, is sometimes referred to as unbiased.

14.2.3 Accuracy. Accuracy is measure of a test's ability to produce a result that on average is close to the true value. Accuracy can be measured by determining the percent recovery (%R) by testing either a spiked blank, i.e., a LFB, or a spiked sample, i.e., a LFM. Unless the referenced analytical test method prescribes otherwise, only spiked blank test results will be used to calculate accuracy. Some analytical test methods require that a chart plotting the standard deviation of sequential accuracy measurements be maintained for monitoring the test system or for determining the acceptability of the data. Example calculation:

If [LFB] true = 14.2 and
If [LFB] found = 15.2 then
%R = (15.2/14.2) x 100%
%R = 107%

14.3 Method Detection Limit (MDL). The MDL, in general terms, is the minimum concentration of a specific material which when spiked into a specific matrix and tested, using a specific method, can be statistically recognized 99% of the time as actually being present and not just random background noise.

14.3.1 MDL vs. Reality. The MDL is estimated using statistical calculations. The MDL determination is therefore sensitive to all of the limitations and assumptions of statistics which are detailed in section 14.?. The analyst who is familiar with the test makes educated guesses for the initial test conditions. The initial spiking concentration which is recommended to be set at one to five times the target MDL. However, more than one series of different spiking concentrations may be required before test conditions are found which will yield a reliable standard deviation and a reasonable MDL.

14.3.2 MDL Determination. The MDL can be achieved by an experienced analyst operating a well-calibrated instrument on a routine basis. To determine the MDL, spike a blank, or the matrix of interest, to make a solution containing each method analyte at a concentration which is near the analyte estimated MDL. Analyze seven portions (or more) of this solution. Each solution is sent through the entire analytical test method procedure. This is not the same as testing seven spiked instrument blanks. The standard deviations s for each analyte are then calculated. From a table of the one-sided *t* distribution, select the value of *t* for 6 degrees of freedom (one less than the number of portions analyzed) at the 99% confidence level. This (6 degrees of freedom) gives a value of 3.14 for *t*. The product of 3.14 times each standard deviation s is the MDL for that analyte. Appendix B to Part 136 of Code of Federal Regulation explains in detail the official procedure for determining an MDL.

14.3.3 MDL Application Restrictions. An MDL found by the procedure referenced will be specific and will apply only to test data acquired under the same conditions that were present during the original MDL determination. These limitations on the MDL include:

14.3.3.1 the specific analytical test method;

14.3.3.2 the specific method SOP followed;

14.3.3.3 the specific method options followed; the specific sample matrix type;

14.3.3.4 the specified instrument;

14.3.3.5 and the specific lab personnel.

14.3.4 MDL Limitation on the MRL. The Method Reporting Limit (MRL) for an analyte shall be the lowest concentration which can be indicated on a final Analytical Report for a particular method and matrix. The MRL must be greater than the experimental MDL. However, If the analyte and method are for SDWA, then the MRL should be established at the program required detection limit, DL, or the method specified MDL, whichever is lowest. All results found below the MRL shall be reported as less than (<) the MRL. The MRL can be raised to account for matrix effects or dilutions if necessary. If the MRL is changed from the Quality Assurance Program Plan MRL for a particular analyte, an explanation must be included in the final report.

14.4 Quality Control Limits. When QC samples are analyzed, the test results can be evaluated against two different types of QC limits. The first type is the fixed QC Limit. Fixed control limits are employed as required by the Reference Test Method. The second type of QC limit is the statistical limit. In this type, the QC sample results are evaluated against statistically calculated limits in order to detect possible weaknesses in the test system before the system has a chance to fail. These monitoring criteria are normally expressed as statistical warning limits, normally set at the statistical average ± 2s, and statistical trends. Appendix A contains method specific summaries which itemize the QC samples, their requirements, and their QC limits as specified by each reference analytical test method.

14.4.1 Fixed Limits and Data Acceptability. Fixed control limits are usually stated as very specific ranges of concentrations or percentages of concentrations. The acceptable range is bounded by an Upper Control Limit, UCL, and a Lower Control Limit, LCL. The LIMS QC program automatically compares QCS Test results with these limits and flags QC points which exceed these limits. When specified in the referenced analytical test method, the Fixed limits for most methods must be met for the test results to be acceptable under a regulatory program QA Project Plan such as RCRA. Therefore, if a QC measurement exceeds the analytical test method specified fixed QC Limits, the data is considered suspect and should be immediately evaluated for acceptance or rejection following the procedures described in Section 12. However, even if the associated sample results are subsequently rejected and not reported, the QCS test data should be retained in the QC Files for calculation of future standard deviations.

14.4.2 Statistical limits and Test Monitoring. In practice, Statistical limits are used to monitor an Analytical Test Series as each QC Sample is processed. For most analytical test methods, the statistical limits are defined as the average of a fixed number of the most recent computer QC File data points plus or minus two standard deviation. The number of QC data points used to calculate the current standard deviation "s" will be defined for each analytical test method and listed by the Method SOP.

14.4.3 Outlier Limits. Theoretically, an "Outlier" is a term which should be limited to describing a test result which is known to be a false reading due to an isolated failure in the testing system, i.e., broken instrumentation, mixed up sample containers, contaminated samples, etc. In practice, a system failure may not always be noticeable at the time of testing. Therefore various statistical methods have been defined for detecting outliers. For this document, a statistical outlier is defined as a point which fall outside of an acceptable statistical limit, normally +/- five standard deviations. If a QCS test measurement exceeds the Outlier QC limits specified for the analytical test method, the data is considered invalid and an action appropriate to that QC sample type should be taken as specified in Section 12. The outlier QC data point can be entered into the LIMS QC Files but the data point will not be used to calculate the standard deviation by the LIMS QC programs.

14.5 Standard Quality Control Charts. Due to the quantity and detail of the QC data used for statistical monitoring, a visual format is generally required for displaying the current QC statistical monitoring limits. The APPX LIMS system can generate analytical test method specific graphs, QC Charts, which display The LIMS can generate three basic types of QC Charts for standard QC Sample Types: the Means Chart; the Precision Chart; and the Accuracy Chart. The LIMS Charts displays the current Fixed Limits and the calculated Statistical Limits plotted against the respective QC File batch number.

14.6 Instrument Quality Control Charts. Most of the referenced test methods also require QC Charts that monitor the real-time condition of the analytical instrumentation. This often requires plotting instrument specific information associated with a QCS sample, e.g. the instrument response factor found for the target analyte in a specific calibration Standard. This type of QC Chart should be posted at each instrument workstation, see the MWB in Section 09. This type of QC Chart can be visually scanned for patterns, trends, which are normally associated with changes in the testing system. These changes, in turn, may indicate an abnormal condition in the testing system that should be closely monitored. In addition to prescribed Control Limits and Corrective Actions, Instrument specific Control Conditions (patterns) should also be established and recorded in the MWB Method SOP. The test data produced under these conditions are acceptable unless indicated otherwise in the SOP. The following paragraphs describe examples of those types of patterns.

14.6.1 Group Bias Pattern. When six successive instrument QC points are consistently greater than or less than one s sigma of the historical average value, then the testing system is exhibiting characteristics that are possibly different from the system that generated the previous test system Control data. If Fixed Control Limits are not in danger of being exceeded, continue with the testing sequence. If this is an unusual condition for this test, the analyst should record his findings on the associated bench sheets and make a note in the MWB Method SOP for evaluation at the annual review of the SOP.

14.6.2 Sequential Drift Pattern. If an instrument QC test measurement is consistently rising or falling faster than historically "normal" as described in the SOP for the testing system, the analyst should examine the rate of drift to determine if the system is in imminent danger of exceeding the Fixed Control limit. If Fixed QC limits are not in danger of being exceeded, continue with the testing sequence.

Upon completion of the test sequence, the analyst should examine the analytical test system and determine if maintenance is required. If this is an unusual condition for the analytical test method, the analyst should record his findings on the associated bench sheets and make a note in the MWB Method SOP for evaluation at the annual review of the SOP.

15.0 QA Systems - Performance and System Audits

15.1 The Division of Epidemiology and Laboratory Services will participate in performance evaluation audits, both internal and external, in sufficient quantity to ensure the reliability of data quality. The laboratory shall ensure the quality of results provided to clients by implementing checks to monitor the quality of the laboratory's analytical activities.

15.2 External Performance Evaluation (PE) Audits. The Division of Epidemiology and Laboratory Services will participate in a proficiency testing (PT) study for all target analytes, where proficiency testing material is available, in each field of testing at least twice each year.

15.2.1 The Quality Assurance Manager will order, distribute and monitor and follow up all PT studies.

15.2.2 The bureau will order and participate in a supplemental PT study for each target analyte that fails.

15.3 Internal Performance Evaluation (PE) Audits. Project specific PE audits prepared in the field are the responsibility of the using organization and are addressed in their respective Quality Assurance Project Plans. These performance audits include "blind" audit samples, spiked samples, split samples, and blanks.

15.3.1 The Quality Assurance Officer (or Quality Assurance Manager) may arrange for blind PE audit samples for routine parameters. The audit may be prepared, using appropriate reference material, and submitted by the USL:PH QA officer; or by the using organization.

15.3.2 Internal Performance audits will be prepared from reference material stock separate from the materials used for calibration of the method. The QA officer will evaluate the results of internal performance audits and report in writing to the QA coordinator and bureau director. The QA coordinator will send final report to DEQ and Laboratory Director at the end of each audit when sample was submitted by DEQ.

15.3.3 This report will contain specific corrective actions taken to correct methodologies when results fall outside the 95% confidence acceptance limits.

15.4 Additional Internal QA/QC Checks may be used to ensure quality results such as:

15.4.1 Internal quality control procedures using statistical techniques;

15.4.2 Use of certified reference materials and/or in-house quality control using secondary reference materials;

15.4.3 Replicate testing using the same or different test methods;

15.4.4 Re-testing of retained samples;

15.4.5 Correlation of results for different but related analysis of a sample (for example, total phosphorus should be greater than or equal to orthophosphate).

15.5 External System Audits. The Public Health Laboratory will participate in a triennial external systems audit performed by the EPA.

15.6 Internal System Audits. Routine internal system audits will be performed by the Quality Assurance Officer, and/or other trained and qualified personnel who are independent of the activity to be audited.

15.6.1 The routine system audit will follow a predetermined schedule and include audit of test methods, associated sample receiving processes, sample preservation, method SOPs, sample preparation logs, instrument logs, standards, QA/QC samples, data packages, and final reports.

15.6.2 Where the audit findings cast doubt on the correctness or validity of the laboratory's test results, the laboratory shall take immediate corrective action and shall immediately notify, in writing, any client whose work was involved.

15.7 QA Systems Annual Management Review. The Bureau Director or Laboratory Director will arrange an annual review of the quality system and testing activities to ensure continuing suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations.

15.7.1 The review shall include:

15.7.1.1 Reports from managerial and supervisory personnel,

15.7.1.2 Results of recent internal audits,

15.7.1.3 EPA assessments,

15.7.1.4 Results of laboratory comparisons/proficiency testing,

15.7.1.5 Changes in the volume and type of work undertaken,

15.7.1.6 Clients feedback,

15.7.1.7 Client complaints,

15.7.1.8 Corrective Action and Preventative Action Reports

15.7.1.9 Other relevant factors.

15.7.2 Management should provide an outline for the final report.

15.7.3 Investigation Records and Files will be maintained and archived.

15.7.4 Specific Findings and Recommendations will be documented in the final report.

15.7.5 The Laboratory Director in cooperation with Bureau Director shall ensure that appropriate actions are discharged within an established time frame.

15.8 Corrective Actions. A Corrective Action Report is required for a PT study when any analyte fails. Corrective action is required for other performance audits when results fall outside of acceptance limits. Corrective action is required when procedures, quality control or processes are found to deviate from the QA plan requirements, see QAP Section 17.

16.0 Preventive Maintenance

16.1. The preventive maintenance tasks and schedules recommended by the manufacturers will be followed for all instrumentation. Documentation of preventive maintenance performed will be recorded.

16.2. Replacement parts essential for instrument operation will be kept on hand to eliminate costly delays. The supply of these essential parts will be the responsibility of each individual analyst and the Section Chief.

16.3. Reagent Water Testing. Within the first two weeks of each month one sample must be collected from the third floor water system for microbiology and one sample from the second floor water system for chemistry. The chemistry sample shall be tested for conductivity and total residual chlorine and a heterotrophic plate count. Within the first two weeks of each fiscal year, a sample from the third floor water system shall be tested for Pb, Cd, Cr, Ni, Zn and the "quality of reagent water". The sampling and documentation of results is the responsibility of Technical Services. Summary results must be sent to QA for review.

16.4. The quality of the reverse osmosis (RO) treated water for laboratory (DI water) is checked by recording the inline conductance of the product water from the RO system on each working day. Tanks are replaced when the conductance exceeds 0.1 micro siemens (usually every three months). In addition, the product water light is checked every day . When the light goes off, it is an indication of increased conductance which in turn indicates that the deionizing tanks (four-tanks) should be changed. The first two (charcoal) of the six tanks are changed every six months.

16.5. Support Equipment. These standards apply to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices (including thermometers and thermistors), thermal/pressure sample preparation devices and volumetric dispensing devices (such as Eppendorf®, or automatic dilutor/dispensing devices) if quantitative results are dependent upon their accuracy, as in standard preparation and dispensing or dilution into a specified volume.

16.6. All support equipment shall be:

16.6.1. maintained in proper working order. The records of all repair and maintenance activities including service calls, shall be kept.

16.6.2. All support equipment shall be calibrated or verified at least annually, using NIST traceable references when available, over the entire range of use. The results of such calibration shall be within the specifications required of the application for which this equipment is used or:

16.6.3. The equipment shall be removed from service until repaired; or

16.6.4. The laboratory shall maintain records of established correction factors to correct all measurements. Prior to use on each working day, balances, ovens, refrigerators, freezers, incubators and water baths shall be checked in the expected use range, with NIST traceable references (where possible) in the expected use range. Additional monitoring as prescribed by the test method shall be performed for any device that is used in a critical test (such as incubators or water baths) where available. The acceptability for use or continued use shall be according to the needs of the analysis or application for which the equipment is being used.

16.6.5. Mechanical volumetric dispensing devices including burettes (except Class A glassware) shall be checked for accuracy on at least an annual use basis.

16.6.6. For biological tests the sterilization temperature, cycle time, sterilization time, and pressure of each run of autoclaves must be documented by the use of appropriate chemical or biological sterilization indicators. Autoclave tape may be used to indicate by color change that a load has been processed, but not to demonstrate completion of an acceptable sterilization cycle. Demonstration of sterilization shall be provided by a continuous temperature recording.

17.0 QA Systems – Corrective And Preventative Actions (CAPA)

17.1 BCES Quality Assurance Committee. It is the goal of BCES to provide services that meet the exacting QAO requirements of our Client projects. In order to meet the challenge of managing QA and QC requirements as they change and develop, BCES has established an Environmental Quality Assurance Committee. The members of this committee meet on a biweekly basis to discuss the current status of the BCES Lab and Client Services operations. Specific assignments are made for QA System problems and for QA System developments.

17.2 Scheduled Quality Assurance Reports. The Quality Assurance Coordinator will provide regularly scheduled monthly (bi-weekly when needed) QA/QC Summary Reports to the Environmental Quality Assurance Committee and to the Laboratory Director. These will include:

- **17.2.1** Any new significant QA problems;
- **17.2.2** Current QA problems being tracked;
- **17.2.3** Current QA problems discussed and act on;
- **17.2.4** Current Corrective Actions in progress;
- **17.2.5** Current Client complaint summaries;
- **17.2.6** Current QA assignments and their status;
- **17.2.7** Listing of new test protocols and changes to old tests;
- **17.2.8** Proficiency Testing and makeup audits;
- **17.2.9** Internal audit findings;
- **17.2.10** QA Manual proposed amendments.

17.3 QA System Corrective Actions. In order to pursue QA Problems in a timely manner, the Quality Assurance Officer and Quality Assurance Manager will provide assistance to the Bureau Director and Bureau Supervisors with QA System problems, e.g., internal method audits. As the needs arise, status reports and recommendations for solutions will be provided both verbally and in writing.

17.4 Corrective And Preventive Action (CAPA). An effective Corrective Action and/or Preventive Action capable of satisfying the Client QOA needs and the basic Regulatory requirements is accomplished by implementing and fully documenting the following seven basic steps:

- **17.4.1** Identification of the problem, nonconformity, or incident or the potential problem, nonconformity, or incident.
- **17.4.2** Evaluation of the impact of the problem and potential impact on the laboratory operations and client services.
- **17.4.3** Develop an Investigation Protocol and assign responsibilities.
- **17.4.4** Analysis of Investigation results with appropriate documentation.
- **17.4.5** Create an Action Plan listing all the tasks that must be completed to correct and/or prevent the problem.
- **17.4.6** Implementation of the Action Plan.
- **17.4.7** Follow-up actions with verification of the completion of all tasks, and an assessment of the appropriateness and effectiveness of the actions taken.

17.5 Corrective Action Reports and Archives. A Corrective Action Report, summarizing each step of a CA or PA procedure, must be prepared and put into the BCES permanent archives. The hardcopy documentation acquired during the Investigation and Analysis must be placed in a CAR raw data package, cross- indexed and stored in archives. The end result will be a complete, well-documented investigation and solution that will satisfy regulatory requirements and form the basis for an effective, continuous improvement plan.

17.6 Proficiency Testing Summary Reports. The Quality Assurance Manager will provide the bureau director and bureau supervisors with current summary reports of Laboratory performance status in proficiency testing (PT).

17.7 BCES Quality Assurance Plan (QAP, QA Manual). The BCES QA Plan will be re-viewed annually by the BCES Management and BCES Lab staff. This review will be coordinated with the ongoing communications with the laboratory Clients about their current and proposed Data Quality Objectives.

17.8 Management Annual Review. At least once a year, the USL:PH management shall conduct a review of the environmental testing activities to insure the continuing completeness and effectiveness of the Laboratory Quality Systems as described in this QAP. This review shall be considered a Corrective and Preventative Action that requires a Corrective Action Report. The review shall cover at least the following activities over the past year.

- **17.8.1** Status of Lab Corrective Action Systems
  - **17.8.1.1** Corrective Action Reports
  - **17.8.1.2** Internal Audits of laboratory systems
  - **17.8.1.3** External Audits of Laboratory systems
  - **17.8.1.4** Compliance with US EPA Audit Recommendations
  - **17.8.1.5** Proficiency Testing (PT) results
- **17.8.2** Status of Lab Preventative Action Systems and QA Improvement
  - **17.8.2.1** Client Program feedback
  - **17.8.2.2** Client Complaints
  - **17.8.2.3** Review and update of BCES Management Policies, QAP Appendix E
  - **17.8.2.4** Lab adjustments to changes in Lab Workload
  - **17.8.2.5** Continuing unresolved QA Issues
  - **17.8.2.6** Staff training
  - **17.8.2.7** Staff communication issues

Appendix C

DQO’s Worksheet

Data Quality Objectives Worksheet

Use in conjunction with EPA's Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (EPA/240/B-06/001, February 2006)

DQO Step	DQO Description (EPA QA/G-4 February 2006)		DQO Outputs	Medium: Problem Type:	Medium: Problem Type:
1	State the Problem				
		a	Describe the problem to be addressed		
		b	Identify leader & members of the planning team, including decision-makers and/or principal data users		
		c	Develop a conceptual model of the environmental hazards(s) being investigated		
		d	Preliminary identification of data needed		
		e	Discuss alternative approaches to investigation in solving the problem		
		f	Determine Resources - budget, personnel & schedule		
2	Identify the Goal of the Study				
		a	Identify principal study question(s)		
		b	A list of potential outcomes or actions that result from answering the principal study question(s)		
		c	Decision Problem: Develop a list of decision statements that address the study question(s) Estimation Problem: Develop a list of estimation statements that address the study question(s)		
3	Identify Information Inputs				
		a	A list of environmental characteristics that will resolve the decision or estimate potential sources for the desired information inputs		
		b	The type of information needed to meet performance or acceptance criteria [iterates with Step 5 & 6]		
		c	Information of the appropriate sampling and analysis methods		
4	Define the Boundaries of the Study				
		a	Specify target population		
		b	Specify the sampling unit		
		c	Define spatial & temporal limits/boundaries		
		d	Timeframe appropriate for collecting the environmental data		
		e	Timeframe for making the decision of estimate		
		f	Define the appropriate scale for decision-making or estimation (risk, technological considerations, previous site knowledge, financial)		
5	Develop the Analytic Approach				
		a	Define the population parameter (e.g. mean, median, percentile, etc.) for making decisions or estimates		
		b	Develop logic for drawing conclusions from findings (Decision Rule): Decision Problem: Specify the Action level & define "if, then, else" action to be taken Estimation Problem: Specify the estimator to be used (mean, central tendency, etc.)		
6	Specify Performance or Acceptance Criteria				
		a	Decision Problem: Specify the decision rule as a statistical hypothesis test, examine the consequences of making incorrect decision from the test, and place acceptable limits on the likelihood of making decision errors Estimation Problem: Specify acceptable limits on estimation uncertainty		
7	Develop the Plan for Obtaining the Data				
		a	Select the resource-efficient sampling and analysis plan that meets the performance criteria		

Appendix D

DWQ's SOP List

DWQ's LIST OF SOPS

(as of May 1, 2014)

- DWQ's SOP for Aquatic Benthic Macroinvertebrate Collection in Running Waters (draft)
- DWQ's SOP for Calibration, Maintenance, and Use of Hydrolab Probes (final)
- DWQ's SOP for Calibration, Maintenance, and Use of YSI Probes (final)
- DWQ's SOP for Chain-of-Custody Samples (final)
- DWQ's SOP for Collection and Handling of *Escherichia coli* (*E. coli*) Samples (final)
- DWQ's SOP for Collection and Preparation of Fish Tissue Samples for Mercury Analysis (final)
- DWQ's SOP for Collection of Lake Water Samples (final)
- DWQ's SOP for Collection of Macroinvertebrates in Wetlands (draft)
- DWQ's SOP for Collection of Phytoplankton Samples in Wetlands (draft)
- DWQ's SOP for Collection of Sediment Samples in Great Salt Lake Wetlands (draft)
- DWQ's SOP for Collection of Water Chemistry Samples (final)
- DWQ's SOP for Collection of Water Samples for Microbial Source Tracking (final)
- DWQ's SOP for Collection of Zooplankton Samples using a Horizontal Tow (draft)
- DWQ's SOP for Decontamination of Monitoring Equipment (draft)
- DWQ's SOP for Determining Percent Cover of Aquatic Vegetation in Wetlands (draft)
- DWQ's SOP for *Escherichia coli* (*E. coli*) and Total Coliform Quantification using the IDEXX Quanti-Tray/2000 System (final)
- DWQ's SOP for Filtering Water-Column Chlorophyll-*a* Samples (final)
- DWQ's SOP for Lake Hydrolab Data Collection (final)
- DWQ's SOP for Pressure Transducer Installation and Maintenance (final)
- DWQ's SOP for Secchi Depth Readings (final)
- DWQ's SOP for Stream Flow Measurements (final)
- DWQ's SOP for Temperature Data Loggers (draft)

- DWQ's SOP for Turbidity Measurements using a Turbidity Tube (final)
- DWQ's SOP for Wetland Bird Surveys (draft)
- DWQ's UCASE Field Manual (final)
- Other SOPs being drafted include: Field Data Management, D.O. Continuous Monitoring, Groundwater Sampling, Automatic Samplers, how to perform various water quality data assessments and modeling, Organic Matter Characterization, Nutrient Limitation, etc.