

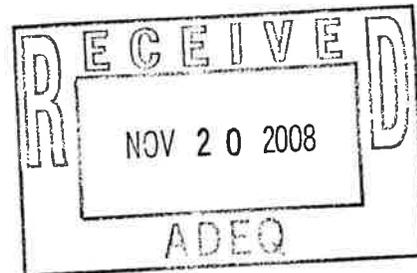
**FREEMPORT-McMORAN
COPPER & GOLD**

Freeport-McMoRan Sierrita Inc.
6200 W. Duval Mine Rd.
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Green Valley, Arizona 85622-0527

November 19, 2008

Via Certified Mail #7007 3020 0001 8578 1814
Return Receipt Requested

Joey Pace
Project Manager/Hydrologist
Voluntary Remediation Program
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007



Re: Response to ADEQ Comments to the Quality Assurance Project Plan and Sampling and Analysis Plan for the Freeport-McMoRan Sierrita Inc Voluntary Remediation, Green Valley, Arizona - VRP Site Code: 100073-03

Dear Ms. Pace:

This letter provides Freeport-McMoRan Sierrita Inc. (Sierrita) responses to comments presented in Arizona Department Environmental Quality's (ADEQ) May 29, 2008 letter addressing Sierrita's Voluntary Remediation Program Investigation Work Plan dated April 30, 2008. Sierrita provides two copies of the attached Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) addendum in response to ADEQ's comments. For clarity, Sierrita reproduced ADEQ comments below followed by Sierrita's responses.

ADEQ COMMENT #1. The VRP acknowledges that the 2006 Quality Assurance Project Plan (QAPP) was prepared as a data management plan for the Aquifer Characterization Plan contained in the Work Plan to Characterize and Mitigate Sulfate with Respect to Drinking Water Supplies in the Vicinity of the Phelps Dodge Sierrita Tailing Impoundment, Pima County, Arizona. The VRP has reviewed this document for quality assurance and quality control (QA/QC) topics which would be applicable, relevant, or related to the VRP investigation(s). By approving the QAPP submittal, the VRP is not approving or amending any requirements of the ADEQ Aquifer Protection Program (APP) and/or the conditions set forth or required by in the 2006 Mitigation Order on Consent Docket No. P-50-06.

Sierrita's Response to COMMENT #1. Acknowledged; no revisions to the QAPP are necessary based on this comment.

ADEQ COMMENT #2. The QAPP submittal does not directly address surficial soil sample collection, soil boring sample collection, and soil boring drilling activities, which are the key components to the VRP investigative activities. However, Freeport has adequately addressed these deficiencies in the SAP section of the VRP Investigation Work Plan. As such, the VRP respectfully requests the SAP is resubmitted, as written, in the VRP SAP/QAPP Addendum.

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Sierrita's Response to COMMENT #2. Sierrita concurs with this comment. The attached SAP/QAPP Addendum includes Sections 4.0 and 5.0 of the work plan as well as the changes noted in this comment response form.

ADEQ COMMENT #3. The QAPP states that Freeport will use Arizona Department of Health Services (ADHS) approved laboratories for sample analysis. The VRP approves of this proposal and requests Freeport include the ADHS laboratory certification number when reporting any analytical data in a submittal to the VRP. In addition, if Freeport has selected laboratories in advance, the VRP would like a list of these laboratories (and certifications) included in the VRP SAP/QAPP Addendum

Sierrita's Response to COMMENT #3. Sierrita concurs with this comment. Once laboratories have been selected, Sierrita will provide ADEQ with names and will add the known laboratories and their certification numbers to the SAP/QAPP Addendum. Additionally, URS and Sierrita will include ADHS certification numbers on analytical data submittals.

ADEQ COMMENT #4. The table lists the published Aquifer Water Quality Standard (AWQS) for arsenic as 0.05 milligrams per liter (mg/L). Although this is the correct AWQS for arsenic, ADEQ defaults to the more stringent Environmental Protection Agency (EPA) safe drinking water standard of 0.010 mg/L when known receptors are downgradient of a site.

This table should be revised and submitted in the VRP SAP/QAPP Addendum.

Sierrita's Response to COMMENT #4. Sierrita acknowledges this comment. Table 2 will be revised in the SAP/QAPP Addendum to include references to both the AWQS and the more stringent EPA MCL for arsenic. Sierrita reserves its rights regarding the applicability of the two standards at any particular location and to any particular set of circumstances.

ADEQ COMMENT #5. The table lists trivalent chromium and total chromium, but does not list hexavalent chromium as a "relevant soil standard". The 2007 revisions to A.A.C. Title 18, Chapter 7, Article 2, effective May 5, 2007, eliminated the Soil Remediation Level (SRL) for total chromium. Trivalent and hexavalent chromium now have individually established SRLs, while the Groundwater Protection Level (GPL) for total chromium remains in guidance.

If Freeport chooses to run trivalent and total chromium analyses, please be advised that the resulting calculated hexavalent chromium result will be taken into consideration by the VRP when determining if hexavalent chromium is a contaminant of concern at this site. As such, Freeport should amend Table 3 to show the SRL for hexavalent chromium, as it is a relevant soil standard at this site.

This table should be revised and submitted in the VRP SAP/QAPP Addendum.

Sierrita's Response to COMMENT #5. Sierrita concurs with this comment. Based on site history, the presence of hexavalent chromium is not anticipated. However, as requested by ADEQ, if total chromium levels exceed the hexavalent chromium SRL then the soil samples will be also be analyzed for hexavalent to differentiate the hexavalent and trivalent species. Total, trivalent and hexavalent chromium results will be used for comparison to SRLs and GPL.

Table 3 has been revised to reflect the SRL for hexavalent chromium.

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ADEQ COMMENT #6. In Section 3.0 of the Investigation Work Plan, Freeport proposes to investigate potential historical release(s) in order to determine if potential releases impacted the subsurface, groundwater, or area washes. Freeport must clarify whether the intention of this proposal is to determine if releases to the washes are a potential source to groundwater, or if the intention is to investigate potential environmental impacts on the washes.

If the intention is to investigate environmental impacts on the washes, the Numeric Water Quality Criteria (NWQC) for acute aquatic and wildlife use of an ephemeral surface water body (A&We) is the applicable surface water standard [Ref. A.A.C. Title 18, Chapter 11, Appendix A, Table 2]. Freeport must endeavor to sample the five main washes at this site during overflow events, stormwater run-off events, and/or monsoon events in order to collect surface water samples that can be compared to the NWQC.

A table with the NWQC should be submitted in the VRP SAP/QAPP Addendum.

Please Note: The Santa Cruz River and some of its named tributaries are also governed by the NWQC [Ref. A.A.C. Title 18, Chapter 11, Appendix B]. These surface waters are held to the following numeric standards: Aquatic and Wildlife warm water (A&Ww), Full Body Contact (FBC), Fish Consumption (FC), Agricultural Irrigation (AgI), and Agricultural Livestock Watering (AgL), as applicable. If an investigation of environmental impacts to the washes reveals contamination to be present, additional investigative activities may be warranted to ensure the water quality is preserved for the Santa Cruz River.

Sierrita's Response to COMMENT #6. It is not the intent of this phase of the VRP investigation to characterize potential environmental impacts to the washes or to determine if surface water is a potential source to groundwater. However, limited sediment sampling is proposed within some small alluvial channels that flow from the historic site areas into Demetrie Wash. This sampling is proposed to confirm that COI releases have not occurred to sediment in these drainage channels. Additionally, alluvial groundwater samples are proposed immediately downgradient of solution ponds to confirm that releases from these ponds to groundwater has not occurred.

The intent of this investigation is to identify/verify potential source areas. If specific areas are identified as having the potential to release COIs to surface water or sediments then subsequent characterization would be implemented. It is not the intent to characterize the entire mine property and its potential to release COIs to the area washes.

Because the scope of this investigation is not directed at surface water quality characterization, surface water and sediment standards are not applicable.

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ADEQ COMMENT #7. The VRP concurs with the proposed analytical methods listed in Table 4 of the QAPP. The methods proposed for fixed-based laboratory analyses include, but are not limited to:

- Soil: Total Metals: SW846/6010B/7471A for mercury
- Soil: Anions: 300.0
- Soil: pH: SW-846/9045C
- Soil: Radium-226 by EPA 9315
- Soil: Radium-228 by EPA 9320
- Soil: U-234, U-235, and U-238 by Eichrom ACW03 [SEE COMMENT #8]
- Water: U-234, U-235, and U-238 by Eichrom ACW03 [SEE COMMENT #8]
- Water: Dissolved Metals: EPA 200.7 and 200.8
- Water: Anions: EPA 300.0
- Water: pH: SW-846/9040B
- Water: Gross Alpha & Beta by EPA 900.0
- Water: Radium-226 by EPA 903.0
- Water: Radium-228 by EPA 904.0

Although not listed in the QAPP, the VRP also recommends adding Toxicity Characteristic Leaching Procedure for metals by EPA Methods 1311/6010B/7471A and Synthetic Precipitation Leaching Procedure by EPA Methods 1312/6010B/7471A.

Any deviation from these proposed methods must be thoroughly explained in the QA/QC discussion of any submittal to the VRP.

Sierrita's Response to COMMENT #7. Sierrita concurs with this comment. It is the intent to hold all soil samples until the metals analysis are received and validated. Should concentrations exceed the minimum GPLs for metals then Sierrita will request SPLP analysis on the remaining soil sample material. This resulting data will be used to develop site-specific GPLs as necessary.

Because TCLP analysis is used to determine if a material is to be treated as hazardous waste, this analysis is not applicable to this situation.

The SAP/QAPP Addendum reflects this procedure.

ADEQ COMMENT #8. The target uranium isotopes for the VRP groundwater investigation include U-234, U-235, and U-238. Please note ADHS has not approved the use of Eichrom ACW03 as of this time. ADEQ will work with ADHS on getting the method approved, however ADHS may suggest alternative analyses for uranium isotopes at their discretion. Although the VRP will approve the use of this method for characterization and screening purposes, if Freeport intends to use any of the isotope data to make a case for NFA, Freeport may need to switch analytical methods for ADHS-acceptable compliance/closure data.

Response to COMMENT #8. Sierrita concurs with this comment. Once selection of analytical laboratories is finalized, Sierrita will work with the lab to select an appropriate ADHS acceptable method, if available.

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ADEQ COMMENT #9. The VRP concurs with the QC sample collection proposed in Table 4 of the QAPP. The ratio proposed is approximately one field duplicate sample for every twenty samples collected. In addition, matrix spike/matrix spike duplicate samples are proposed for metals and radionuclides at a rate of one sample for every twenty samples analyzed.

Sierrita's Response to COMMENT #9. Acknowledged; no revisions to the QAPP are necessary based on this comment.

ADEQ COMMENT #10. The VRP approves of the proposed procedures for containers and preservation, chain of custody preparation, and sample packaging and transport. Freeport must report and discuss any variations, including samples exceeding the $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ temperature range, in any submittal to the VRP which includes laboratory data.

Sierrita's Response to COMMENT #10. Acknowledged; no revision to the QAPP are necessary based on this comment. Sierrita will ensure that any variations in the proposed procedures will be reported with the laboratory data.

ADEQ COMMENT #11. Although rhenium does not have an SRL, GPL, or AWQS, rhenium is known to cause interference for manganese during Inductively Coupled Plasma analysis due to its similar chemical structure. However, laboratories do have the ability to choose different primary wavelengths for identification of a specific metal if they are aware of a known interference. As such, Freeport should notify the laboratory when samples are submitted if they have the potential for the presence of rhenium.

Sierrita's Response to COMMENT #11. Acknowledged; no revisions to the QAPP are necessary based on this comment. If rhenium is suspected the laboratory will be notified. Sierrita will discuss alternate manganese analytical methods with the laboratory. The SAP/QAPP Addendum will be modified accordingly.

APPENDICES. The appendices appear in the bound copy of the QAPP as follows:

- Appendix A: Phelps Dodge QA/QC Plan for Water Monitoring
- Appendix B: BESST Inc. Hydrobooster System
- Appendix D: ADEQ Data Qualifiers (2002) - [referred to below as D¹]
- Appendix C: URS Field Forms
- Appendix D: ACZ Laboratory QAPP
- Appendix E: ADEQ Data Qualifiers (2000)

The VRP has the following specific comments (Comment #12 and #13) regarding the appendices:

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ADEQ COMMENT #12. Appendix D1 (located before Appendix C) includes the ADHS-approved Arizona Laboratory Data Qualifiers, Revision 1.0 (March 2002). The Arizona Laboratory Data Qualifiers have been updated twice since this version, with the most recent update published in September 2007. The VRP will require Freeport's laboratory data submittals to conform to ADHS's most recent published revision at the time of report submittal. A copy of the most recent version to date can be found at <http://azdhs.gov/lab/license/tech/azdqrev3.pdf> and should be included in the VRP SAP/QAPP Addendum.

Sierrita's Response to COMMENT #12. Sierrita concurs with this comment. The most recent (September 2007) Arizona Laboratory Data Qualifiers are included in the attached SAP/QAPP Addendum.

ADEQ COMMENT #13. As indicated above, the Arizona Data Qualifiers included in Appendix E are outdated and should be removed. In addition, both appendices (D¹ and E) indicate these are ADEQ Laboratory Data Qualifiers. They are ADHS Laboratory Data Qualifiers.

Sierrita's Response to COMMENT #13. Sierrita concurs with this comment. The attached SAP/QAPP Addendum includes the ADHS Laboratory Data Qualifiers.

ADEQ COMMENT #14. Page 56 of the QAPP states, "[d]ata validation is not expected for this project. Data validation would require a thorough review of all the field data and/or the analytical laboratory results to provide data documentation consistent with EPA Level IV requirements. This level of review will not be performed unless there are persistent concerns regarding the quality of field or laboratory data."

This statement is not consistent with the level of data management expected by the VRP. ADEQ's Quality Management Plan (1999) allows for ADEQ, at its discretion, to set the level of data validation which will be required at a site. The VRP requests a minimum of 10% of data packages containing compliance and closure samples to be validated at EPA Level IV by a third party reviewer.

This revision to the proposed data management plan should be included in the VRP SAP/QAPP Addendum.

Sierrita's Response to COMMENT #14. Sierrita concurs with this comment. The attached SAP/QAPP Addendum includes a third party EPA Level IV data validation on ten percent of the data packages containing compliance and closure samples.

ADEQ COMMENT #15. The VRP approves the soil sample types, soil sample frequencies, and soil sampling locations, as proposed in the SAP. The VRP may request additional characterization, pending the results of the first phase of sampling at each of the locations.

Sierrita's Response to COMMENT #15. Acknowledged; no revisions to the QAPP are necessary based on this comment.

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ADEQ COMMENT #16. As discussed in the meeting held on May 27, 2008 between Freeport and ADEQ, the VRP is tentatively approving the SAP as written, including the locations where investigative activities are proposed in order to expedite future closure proceedings with the Aquifer Protection Program (APP).

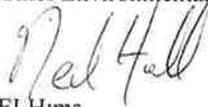
However, after meeting with the APP Unit, the VRP may modify or limit the approved areas of investigation, based on APP requirements. Should such modifications become necessary, the VRP will include these modifications in the forthcoming Comments on the April 2008 Investigative Work Plan.

Sierrita's Response to COMMENT #16. Acknowledged; no revisions to the QAPP are necessary based on this comment.

Please contact me at (520) 648-8857 if you have any questions regarding this submittal.

Sincerely,

E. L. (Ned) Hall
Chief Environmental Engineer



ELH:ms
Attachments
20081119_001

xc: Stuart Brown – Bridgewater Group, Inc.
 L. Steven Vaughn – URS Corporation
 Dal Moellenberg – Gallagher & Kennedy

**ADDENDUM TO SAMPLING & ANALYSES PLAN (SAP) &
QUALITY ASSURANCE PROJECT PLAN (QAPP)
VOLUNTARY REMEDIATION PROGRAM (VRP)
FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA**

SEPTEMBER 2008

Prepared for:

Freeport-McMoRan Sierrita Inc.
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4	QC Sample Summary and Sample Containers and Preservatives
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A	Sierrita VRP Sampling & Analyses Plan (Investigation Workplan Sections 4 and 5)
B	Field SOPs
C	Field Forms
D	ACZ Laboratory Quality Assurance Plan
E	Arizona Laboratory Data Qualifiers

**APPROVAL SHEET
SAP/QAPP ADDENDUM
Sierrita VRP
September 2008**

Ned Hall, Project Manager
Freeport-McMoRan Sierrita Inc.
(520) 648-8857

Date

Marianne Burrus, Quality Assurance Officer
URS Corporation – Phoenix Office
(602) 861-7473

Date

Joey Pace, Project Manager
Arizona Department of Environmental Quality
(602) 771-4574

Date

1.0 INTRODUCTION

URS Corporation (URS) has prepared this Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPP) Addendum on behalf of Freeport-McMoRan Copper & Gold Sierrita Inc (FCX Sierrita) formerly Phelps Dodge Sierrita Inc. in support of site characterization activities conducted at the Sierrita Mine located near Green Valley, Arizona. The site characterization is to be performed under the Arizona Department of Environmental Quality's (ADEQ) Voluntary Remediation Program (VRP). ADEQ's VRP program is defined by Arizona Revised Statutes (ARS) Title 49, Sections 49-171 through 49-188.

This SAP-QAPP Addendum is intended to be used as a supplement to the established QAPP currently used by Sierrita titled, *Quality Assurance Project Plan for Aquifer Characterization Plan*, dated August 11, 2006 (Hydro Geo Chem 2006). By using this established QAPP as the basis for continued work at the Sierrita Mine, Sierrita hopes to promote consistent standards and procedures for data collection throughout the project area.

Together, this document (referred to as "SAP-QAPP Addendum") and the April 2008 VRP Investigation Workplan provide field and laboratory personnel with instructions regarding activities to be performed before, during, and after field sampling activities. These instructions are intended to ensure data collected for use in project decisions will be of the type and quality needed and expected for their intended purpose.

The purpose of this SAP-QAPP Addendum, is to designate and document the specifications and methods that will be employed to establish technical accuracy and precision, statistical validity, and documentary evidence of environmental data generated during the VRP sampling program. Where the two documents differ, this Addendum takes precedence over the established QAPP for the VRP sampling program. Sections 4 and 5 of the April 2008 VRP Investigation Work Plan for Freeport-McMoRan Sierrita provide the Sampling and Analyses Plan for this work and are included as [Appendix A](#).

The following table contains a cross-reference between the Sierrita QAPP and the SAP-QAPP Addendum including the required elements specified by the United States Environmental Protection Agency (EPA) and ADEQ. This cross-reference is provided to assist the reader in determining where the required elements are addressed in the QAPP and SAP-QAPP Addendum.

QUALITY ASSURANCE /R-5 ELEMENTS	COMMENT ADDRESSED	
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A1 Title and Approval Sheet	-	i
A2 Table of Contents	-	ii
A3 Distribution List	-	Table 1.0
A4 Project Organization	-	Section 2.0
A5 Problem Definition/Background	-	Section 1.0
A6 Project/Task Description	-	Section 1.0
A7 Quality Objectives and Criteria for Measurement Data	Section 3.3	Section 3.0
A8 Special Training/Certification	Sections 4.1	Sections 4.1/5.1
A9 Documents and Records	Sections 4.6/5.6	-
B1 Sampling Process Design	-	Section 4.0
B2 Sampling Methods Requirements	-	Section 4.0
B3 Sample Handling and Custody Requirements	Sections 4.2.3/5.2	-
B4 Analytical Methods Requirements	-	Sections 4.4/5.2
B5 Quality Control Requirements	-	Sections 4.5/5.3
B6 Instrument/Equipment Testing, Inspection and Maintenance	Sections 4.5/5.5	-
B7 Instrument/Equipment Calibration and Frequency	Section 5.5	Tables 5/6
B8 Inspection/Acceptance of Supplies and Consumables	Section 4.5	-
B9 Data Acquisition For Non-Direct Measurements	NA	N/A
B10 Data Management	Section 6.0	-
C1 Assessments and Response Actions	-	Sections 4.7/5.3.2
C2 Reports to Management:	Sections 5.6/6.4	-
D1 Data Review, Verification, and Validation	Section 6.2	-
D2 Verification and Validation Methods	Section 6.2	Section 6.0
D3 Reconciliation with User Requirements	Sections 3.3/ 6.2	-

1.1 PROJECT DESCRIPTION

On June 19, 2007 Sierrita submitted an application to enter into the ADEQ's VRP program to evaluate certain operations and constituents that are not considered by other regulatory programs such as the Mitigation Order On Consent, Docket No. P-50-06, and the Sierrita area wide Aquifer Protection Permit (APP) No. P-101679. Those operations include:

- facilities that ceased operation and/or were closed prior to implementation of the Sierrita APP (historical operations),
- selected operations exempt from regulation under the APP,
- operations "to be closed" under the APP, and
- active operations with the potential to release mining related constituents.

Additionally, uranium impacts to groundwater will be evaluated.

The primary objectives of this work plan are to:

1. Assess potential impacts to soil, groundwater and sediment from past releases and historical Sierrita operations for constituents of interest (COIs). COIs shall include uranium and other mining-related metals (aluminum, antimony, arsenic, barium,

beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, sodium, thallium and zinc).

2. Assess potential impacts to sediment and groundwater for COIs at areas downgradient of active Sierrita operations.
3. Evaluate background uranium concentrations in groundwater through the installation of monitoring wells at background locations in mineralized bedrock formations.
4. Refine the preliminary site conceptual model for uranium in groundwater with respect to sources and migration pathways, including consideration of background conditions.

The scope presented in the Work Plan is intended to be the first phase of the site characterization to be completed under the VRP. The primary focus of the first phase of work will be to assess potential releases from former areas of operation, and to develop a concise conceptual site model and background conditions for uranium in groundwater. [Appendix A](#) contains the SAP for the first phase of work, as presented in Sections 4 and 5 of the April 2008 VRP Investigation Workplan. If needed, the second phase of work will include follow-up investigation of operations where releases to soil, sediment or groundwater have been identified in the first phase of the characterization, and a further refinement of the groundwater conceptual site model through additional groundwater well installation and/or sampling.

More detail description of project specific objectives is presented in the VRP Work Plan, Section 1.0.

1.2 PROJECT SCHEDULE

An estimated schedule for the planning and first phase of site characterization activities will be developed for the project. The field activities starting with pre-mobilization are estimated to begin following review and approval of the VRP Work Plan and QAPP.

2.0 PROJECT ORGANIZATION

The organizational structure is designed to provide project control and proper quality assurance/quality control (QA/QC) for the VRP sampling program. The distribution list for this Addendum and a project directory is included in [Table 1](#). The roles and responsibilities of the key personnel are described below.

2.1 ADEQ PROJECT MANAGER

Ms. Joey Pace, the ADEQ Project Manager, will conduct regulatory oversight of the work plan and provide regulatory review and approval of documents, reports, schedules, and other communications submitted pursuant to the VRP.

2.2 PROJECT DIRECTOR

Mr. Stuart Brown, the Freeport-McMoRan Copper and Gold Inc. (FCX) Project Director, has the overall responsibility for implementing the work plan. He will direct the schedule and scope of the project and provide fiscal oversight for resources required.

2.3 SIERRITA PROJECT MANAGER

The Sierrita Project Manager, Ned Hall, will direct Sierrita sampling activities and has the responsibility to ensure that Sierrita personnel are properly trained and to ensure the quality of the data collected by Sierrita. He will work with the URS Project Manager to provide resources for implementation of VRP tasks. Mr. Hall will be the primary point of contact with the ADEQ Project Manager.

2.4 SIERRITA QUALITY ASSURANCE MANAGER

The Sierrita QA Manager, Billy Dorris, will provide QA documentation, review, and verification of field and laboratory data collected by Sierrita. He will also ensure that records are properly stored in Sierrita files and electronic databases and coordinates transfer of data with the URS QA Manager.

2.5 URS PROJECT MANAGER

The URS Project Manager, Steven Vaughn, will direct field activities for the VRP, and ensures that all personnel are properly trained, and adequate resources are available. The URS Project Manager will also work with the URS QA Manager to provide QA checks of data quality and to

implement corrective actions. The URS Project Manager is responsible for providing final review and approval of documents, reports, plans, schedules, and other communications submitted to ADEQ pursuant to the VRP. The URS Project Manager will periodically review and provide any needed updates to the QAPP.

2.6 URS PROJECT QUALITY ASSURANCE MANAGER

The URS Project Quality Assurance (QA) Manager will work directly with the Sierrita Project Manager and other project personnel. Ms. Marianne Burrus of URS will serve as the URS Project QA Manager. Ms. Burrus will have the responsibility to ensure all laboratory procedures follow those protocols established in the QAPP and meet the regulatory guidance. Ms. Burrus' additional responsibilities for the project include coordinating data receipt from the laboratory and performing data verification/validation tasks. If the URS QA officer determines that laboratory procedures do not adhere to the established protocols and the data integrity may be impacted, it is his/her responsibility to inform the URS Project Manager.

2.7 URS PROJECT HEALTH AND SAFETY MANAGER

The URS Project Health and Safety Manager (HSM), Armando Jimenez, will work directly with the URS Project Manager and other project personnel. The HSM has the responsibility to monitor and verify that the work is performed in accordance with the HSP. The URS HSM will advise the URS Project Manager regarding health and safety issues but will function independently of the URS Project Manager.

2.8 URS SITE SAMPLE MANAGER

The URS Site Sample Manager, Rick Smith will report to the URS Site Manager and be in communication with the field staff and Project Chemist. The URS Site Sample Manager will inspect samples to confirm adequate sample volume has been collected for analyses requested, complete preservation, if required, and perform a radiation screen of the samples. The URS Site Sample Manager will be responsible for documentation, packaging, and shipment of samples to the analytical laboratory. Documentation to be completed will include:

- Chain-of-Custody (COC) form
- Sample label
- Custody seal

- Courier/transportation forms
- Records retention at the site

2.9 PROJECT STAFF

Each member of the project staff will be responsible to the URS Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing their project tasks along with associated QA/QC procedures.

2.10 FIELD AND LABORATORY SUBCONTRACTORS

URS may delegate to others, in writing, the responsibility of establishing and executing certain portions of the project, but shall retain responsibility for their conformance with contractual scopes of work. When organizations other than URS are involved in the execution of activities covered by the requirements of the QAPP or project-specific Sampling and Analysis Plan (SAP), the activities will be monitored by the URS Project Manager and URS project staff as appropriate. Subcontractor activities shall be monitored against technical requirements specified in the Scope of Work, which is generated during the procurement process. When non-conformances are identified, the URS Project Manager and URS QA Manager will determine if the project objectives have been affected. Resolution of non-conformances will be made and, if necessary, corrective actions implemented. In the case of ACZ Laboratory (ADHS Certification #AZ0102), the subcontracted laboratory, performance will be measured through the data review and validation process. The laboratory QA Manager will be responsible for assuring data generated are of the quality specified in the scope of work and for documenting any non-conformances and associated corrective actions required during the analysis of project samples.

2.11 ADDENDUMS TO QAPP

Addenda and/or revisions to this QAPP can be initiated by ADEQ, URS, or ACZ Laboratories; however, the appropriateness of an addendum or revision is determined by the Sierrita project manager. In general, an addendum will be written when unforeseen or significant changes have occurred. A revision will not be required for minor changes in scope. The revision shall be inserted into the document, replacing the original pages and a copy shall be given to all parties (ADEQ, URS, and ACZ Laboratories).

3.0 DATA QUALITY OBJECTIVES

This section addresses the data quality objectives (DQOs) process applied in development of the Sierrita VRP QAPP. The DQO process is a systematic planning tool based on the Scientific Method for establishing criteria for data quality and for developing data collection designs. Establishing formal DQOs during the QAPP stage of a project allows clear and unambiguous definition of project objectives, decisions, and decision criteria so that data of sufficient type, quality, and quantity are generated to meet project objectives. The formal implementation of a DQO process brings structure to the planning process, thereby resulting in defensible decision making.

3.1 SPECIFYING QUALITY OBJECTIVES

This section provides the output from the DQO process applied for the Sierrita VRP. The work plan focuses on groundwater, surface and subsurface soil, and stream sediment at the Sierrita Mine and Background Areas. The VRP work plan has been divided into two primary areas: (1) facilities investigations and (2) site wide groundwater study.

For the first phase of the VRP sampling program, there are 10 facilities to be closed. These facilities primarily consist of historic operations that may have impacted local soil, sediment, or groundwater. In addition, the groundwater investigation will focus on radionuclides and metals present in groundwater upgradient and downgradient of the Sierrita Mine. The specific sampling rationale for each facility and groundwater are presented on [Tables 4-1 and 4-3](#) of the VRP Work Plan (see [Appendix A](#)). The table presents the problem statement, impacted media, objective of the investigation, and the proposed sampling approach to satisfy the objective.

3.2 RELEVANT ACTION LEVELS

There are numerous regulatory standards that are potentially relevant to the Sierrita Mine VRP Investigation. [Tables 2 and 3](#) summarize potentially relevant action levels and the laboratory method reporting limits for metals and radionuclides in groundwater and soil, respectively. As [Tables 2 and 3](#) indicate, the method reporting limits for each metal and radionuclide are lower than their respective Aquifer Water Quality Standard (AWQS), Soil Remediation Level (SRL) and Groundwater Protection Limit (GPL). The following paragraphs present a brief discussion of each action level.

- Aquifer Water Quality Standards (AWQS) are groundwater quality standards set by ADEQ, for the protection and maintenance of aquifer water quality, effective December 31, 2002.
- The Groundwater Protection Level (GPL) is considered a screening method for determining levels protective of groundwater and is considered a “worst case” correlation between total metals in the soil and the leachable fraction. The minimum GPLs are conservative, assuming that all of the “worst case” leachable metals reach groundwater regardless of depth.
- Soil Remediation Levels (residential and non-residential) were promulgated into rule in 1997 under the Arizona Administrative Code R18-7-201 and amended by final rulemaking effective May 5, 2007. They were originally derived from Arizona Health Based Guidance Levels that were formulated in 1990. Residential site-specific remediation level means a level of contaminants remaining in the soil after remediation that results in a cumulative excess lifetime cancer risk between 1×10^{-6} and 1×10^{-4} and a Hazard Index no greater than 1 based on residential exposure assumptions. Non-residential site-specific remediation levels means a level of contaminants remaining in soil after remediation that results in a cumulative excess lifetime cancer risk between 1×10^{-6} and 1×10^{-4} and a Hazard Index no greater than 1 based on non-residential exposure assumptions.

4.0 FIELD ACTIVITIES

The quality of data collected in an environmental study is critically dependent upon the quality and thoroughness of field sampling activities. General field operations and practices and specific sample collection and inventory will be well planned and carefully implemented. [Table 4](#) presents the analytical parameters for this project. The VRP site characterization SAP provides detailed descriptions of the sampling program.

4.1 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

In addition to the training and certifications listed in Section 4.1 of the established QAPP, the following is required during the VRP sampling program.

- All employees will have 40-hour Hazardous Waste operations and Emergency Response training with current 8-hour refresher training in accordance with 29 CFR 1910.120.
- All employees will have Mine Safety and Health Administration (MSHA) training with current 8-hour refresher training as required by 30 CFR Subpart 48.
- At least one employee at the site will have current first aid and cardiopulmonary resuscitation (CPR) training and the URS Site Manager will have site supervisor training.
- All site personnel will also participate in an initial site orientation meeting and daily “tailgate” safety meetings to discuss the effectiveness of health and safety procedures, control measures, and the need for their revision.
- U.S. Department of Transportation and International Air Transport Association (IATA) regulations require that employees involved with transporting hazardous materials complete specific training requirements. Site personnel will be trained regarding hazardous materials transportation prior to shipment of any hazardous materials.

4.2 SAMPLE COLLECTION AND PREPARATION PROCEDURES

Standard sample collection procedures and data collection forms have been developed for sampling and related data gathering activities. The purpose for these procedures is to obtain samples that represent the environment under investigation. The procedures that will be used for sample collection and preparation for this investigation are included in the project SOPs ([Appendix B](#)), while the data collection forms used to document this investigation are included as [Appendix C](#).

A description of sample equipment to be used and a discussion of steps taken to mitigate sample contamination are included in the Work Plan and supporting SOPs. A discussion of sample type (grab or composite), location and collection technique is also included in the Work Plan. Sample preservation, container, volume, and maximum holding time requirements are summarized in [Table 4](#). As available, certified clean sample containers will be procured from a subcontracted analytical laboratory or vendor for use in sample collection.

4.3 FIELD DECONTAMINATION PROCEDURES

Disposable sampling equipment will be used when possible. Dedicated purging and sampling pumps will be used to collect groundwater samples. Non-expendable equipment used to collect, handle, or measure samples will be decontaminated. The general decontamination procedures for equipment include (1) an initial washing in a solution of Alconox® and water, (2) thoroughly rinsing them with tap water, and (3) then final rinsing with deionized water.

Down-hole drilling and sampling equipment will be decontaminated prior to arrival on-site. This cleaning process shall consist of a high-pressure hot water cleaning. The subcontractors will also decontaminate all down-hole drilling equipment, that may come in contact with sampled media, by steam cleaning prior to advancing to the next boring or location. Decontamination fluids will be contained and containerized for proper disposal as described in the following section.

4.4 FIELD SCREENING METHODS

The following screening methods will be performed in the field at the time of groundwater sampling: pH, temperature, specific conductance, Eh, turbidity, and dissolved oxygen. These measurements will be taken at the sampling location using portable field instruments at the time of sample collection. Calibrations, QC checks, frequency of QC checks, acceptance criteria, and corrective actions for the field parameters and all other screening methods is summarized in [Table 5](#). All field instrument calibration, QC check, and corrective action information will be recorded in a field log book. Field equipment that will be used during this investigation is listed in the Work Plan.

Field equipment will be stored in a clean, secure location when not in use. Equipment will receive routine maintenance checks in order to minimize equipment breakdowns in the field. The maintenance of the equipment will be performed in accordance with manufacturer operation manuals and documented in maintenance logbooks. Daily inspections for visible signs of wear or breakage will be performed. If a piece of equipment is unusable due to breakage, it will be repaired if possible, removed from service, or replaced. Instruments such as the pH/conductivity/

temperature/turbidity meter(s) will also be checked daily for proper operation using calibration standards or standard reference materials.

4.5 FIELD QC SAMPLES

Field QC samples will be collected to verify sampling and analytical precision, accuracy, and representativeness. During this sampling program field QC will include the collection of equipment blanks, field duplicates, and performance evaluation samples (as described below). A summary of the number of QC samples to be collected and analyzed during this investigation is presented in [Table 4](#).

4.5.1 Equipment Blank

An equipment blank is a sample of reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures used to prevent cross-contamination between sampling locations. The frequency of collection for equipment blanks shall be a minimum of 1 equipment blank for every 20 environmental samples collected with a given type of sampling equipment, and only for sampling equipment which is decontaminated and reused to collect environmental samples. Equipment blanks will be prepared in a manner identical to samples and shall be analyzed for all laboratory analyses requested for the environmental samples collected at the site using the subject equipment.

4.5.2 Field Duplicate

A field duplicate sample is a second discrete sample volume collected at the same location as the original sample; homogenization is not performed between the original sample and the field duplicate. Aqueous field duplicate samples are collected from successive volumes from the same sample source and device (e.g., bailers). Sediment field duplicates are collected in succession from the same sample source and device. Duplicate samples are collected using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Field duplicate sample results are used to assess precision of the sample collection process. The frequency of collection for field duplicates is a minimum of 1 duplicate sample from each group of 20 environmental samples of a given matrix.

4.5.3 Performance Evaluation Samples

Double blind performance evaluation (PE) samples may be submitted to ACZ Laboratories during any sampling program at the direction of ADEQ or URS. The following QC issues may trigger the need for the submission of PE samples:

- continued quality issues detected through the data verification/validation process
- unexpected or unexplained sample results

If requested, double blind PE samples will be prepared by Environmental Resources Standards, or a similar supplier, in similar sample containers as the project field samples and shipped from the field to the laboratory for analysis. The double blind PE samples will be prepared using National Institute of Standards and Testing certified standards. The project-specific PE samples will contain known concentrations of the analytes of interest. Laboratory results will be evaluated against the original Certificates of Analyses for precision and accuracy. URS will provide to ADEQ an analysis of the PE results including required corrective action, if any.

4.6 INVESTIGATION DERIVED WASTE

URS will manage and track all waste materials generated during the investigation activities. URS will coordinate with Sierrita to establish a waste accumulation area for temporary storage of field generated waste, such as personal protective equipment (PPE), soil cuttings, drilling fluids, and development water and purged water. Other wastes will include discarded materials resulting from field activities that, in their present form, possess no inherent value such as disposable sampling tools, bags, paper towels etc. The wastes will be divided into soil, water, and PPE. All waste will be properly labeled, sampled, and inventoried for future disposal.

URS and its subcontractors will contain small quantities of soil and potentially-contaminated water in 55-gallon drums. Roll off bins may be used for containing soil cuttings. Samples of solid and liquid IDW will be collected and submitted to an analytical laboratory for analysis. Based on analytical results received, soils and sediments may be re-used if concentrations are below residential SRLs or recycled if the material has legitimate copper or molybdenum values. Liquid IDW may be re-used or recycled through mine operations if the liquid is free of excess contamination or if the liquid has legitimate copper or molybdenum values, respectively. IDW

that is not recycled or re-used by Sierrita will be transported to an approved disposal. Sierrita will retain copies of load tickets and disposal manifests.

4.7 SAMPLING CORRECTIVE ACTION PROCESS

During pre-mobilization activities for the VRP field investigation, a field reconnaissance will be completed to locate and stake each proposed sampling location. Any location accessibility problems will be identified at that time and the Site Manager will propose an alternate location meeting the data need intended by the original location. This decision would be made with concurrence from the URS Project Manager. If an alternate location is not available or accessible which still meets the original data need, the URS Project Manager will determine the proper course of action. Any changes to the QAPP and SAP will be documented in the field logbook.

Any serious flaws noted during implementation of the SAP will be documented in the field logbook and brought to the attention of the URS Project Manager as necessary to determine what corrective actions might be necessary and appropriate.

Any serious flaws noted prior to demobilization from the VRP field investigation which result in lost data will be rectified as achievable prior to demobilization. For example, any missed sample holding times may require the collection of additional sample prior to demobilization to satisfy the original data need.

5.0 ANALYTICAL LABORATORY PROCEDURES

This section describes the analytical laboratory procedures to be used to provide data necessary to meet the project objectives. Upon receipt of samples from the field activities, the analytical laboratory will be responsible for sample handling, analysis, and reporting. The analytical laboratory for this sampling program will be ACZ Laboratory of Steamboat Springs, CO. The laboratory selection process and general QC requirements for the designated laboratory are summarized below.

5.1 LABORATORY SELECTION

The designated laboratory for non-radionuclide analysis, ACZ Laboratory, is licensed by Arizona Department of Health Services (ADHS Certification #AZ0102) to perform each analysis requested, as required by ADHS. Any additional laboratories contracted to complete analytical work should, at a minimum:

- Have the ability to accept radioactive material.
- Have the ability to meet the selected regulatory action levels. The relevant action levels area listed in [Tables 2](#) and [3](#).
- Have the ability to complete the required QA/QC elements outlined in this Addendum.

Additionally, the laboratory completing radiological parameters should:

- Possess an appropriate Nuclear Regulatory Commission and/or state radioactive materials license, or be federally exempt from being required to possess such a license for the radionuclides.
- Demonstrate successful participation in nationally recognized QA programs such as the Quality Assurance Program for the Department of Energy; or the December 1998 discontinued EPA/Las Vegas Inter-comparison Program for Groundwater.

AZC Laboratory's Quality Assurance Plan and ADHS certification is included as [Appendix D](#). ACZ Laboratory's SOPs for the required methods are controlled documents prepared by the laboratory and are not included in this QAPP Addendum. These documents are on file with Arizona Department of Health Services, the State of Arizona's laboratory licensing agency.

The turn around time for sample analysis and data reporting will be determined based on the laboratories selected and the project schedule once a field investigation start date has been

established. Laboratory-required turn around times will be defined in the laboratory technical SOW.

5.2 ANALYTICAL METHODS

This section identifies the analytical methods used during the analysis of samples and calibration procedures and frequencies for laboratory instruments that will be used for the generation of data. [Table 4](#) summarizes the analyses that will be completed during this investigation. All definitive methods and some screening methods will be conducted at the analytical laboratory. [Tables 5](#) and [6](#) present a summary of the calibration and QC procedures for screening and definitive methods. For all definitive methods of analysis used during this investigation, method performance requirements are specified in the methods, and augmented by this QAPP.

The required limits of detection for the laboratory data will depend on the potentially relevant action levels selected for this sampling program. A summary of potentially relevant action levels for metals and radionuclides in groundwater and soil is given in [Tables 2](#) and [3](#). The designated laboratory's practical quantitation limit (PQL) for a constituent must be below its action level. The PQLs listed are analytical goals and should be attained when analyzing clean samples. However, sample dilutions may be necessary to bring high-level analyte concentrations into an accepted calibration range. Detection limits for non-detected analytes within those samples will be raised according to the level of the necessary dilution. Additionally, for a given method, intra-element interference and/or matrix effects may preclude the attainment of the desired detection limits.

All soil and sediment sample results will be reported on a dry-weight basis. However, laboratories will also report the percent solids for each sediment sample analyzed. The end use of the data may be either a wet-weight basis or a dry-weight basis depending on the criteria to be satisfied.

5.3 LABORATORY QUALITY CONTROL

The purpose of this QA/QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC materials. QC samples will be collected as part of the overall QA/QC program. Analytical parameters, sample quantities, types and numbers of containers, number and types of QA/QC samples, sample preservatives, and sample holding times are listed in [Table 4](#).

The laboratory QC samples have been selected based on established analytical method requirements. The required laboratory QC samples are outlined below; however, additional QC samples may be required by the designated laboratory to satisfy the laboratory internal QC policies. In addition, the analytical laboratory must adhere to ADEQ Policy No. 0154.000, *Addressing Spike and Surrogate Recovery as They Relate to Matrix Effects in Water, Air, Sludge and Soil Matrices Policy* and Policy 0155.000, *Analytical Methods Having Provisions for a One-point Calibration and Continuing Calibration Verification Constraints*.

5.3.1 QC Procedures and Samples

QC procedures used to assess data quality include the assessment of QC samples, a comparison of total and dissolved metals concentrations, a cation-anion balance, and a reconciliation of data quality with end-use objectives.

Laboratory QC samples (e.g., blanks and laboratory control samples) shall be included in the preparation batch with the field samples as applicable for each given method. An analytical batch is a number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. The term analytical batch also extends to cover samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap). This analytical batch is a number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and analyzed sequentially. The identity of each analytical batch shall be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples.

Additional QC checks for the definitive analytical methods are specified in the methods and will be followed. The additional checks may include initial calibration, continuing calibration checks, calibration blanks, post digestion spikes, and dilution tests. The acceptance criteria for each of these checks are specified in the analytical methods and the laboratory SOPs. The general QC acceptance criteria and corrective actions for the required non-radiological analytical methods are listed in [Tables 5 and 6](#).

5.3.1.1 Laboratory Control Sample

The laboratory control sample (LCS) is well-characterized, laboratory-generated sample used to monitor the laboratory's day-to-day performance of analytical methods. The LCS may be a purchased standard, or a method blank spiked with known concentrations of target analytes. The LCS is carried through each step of the preparation and analytical method. An LCS shall be

included at the frequency specified in each method. LCS should be reported in %R and used to assess the accuracy and precision (use of LCSD) of the analytical process independent of matrix effects. Controlling lab operations with LCS (rather than surrogates or MS) offers the advantage of being able to differentiate low recoveries due to procedural errors with those due to matrix effects. It is recommended that all target analytes be included in the LCS.

Whenever an analyte in an LCS is outside the acceptance limit, method-specified corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, all samples in the analytical batch shall be reanalyzed for the out-of-control analyte(s).

5.3.1.2 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) and matrix spike duplicate (MSD) is an aliquot of sample spiked with known concentrations of all or a subset of analytes. The spiking occurs prior to sample preparation and analysis. The MS/MSD shall be designated on the chain of custody. The MS/MSD is used to document the bias of a method due to sample matrix. Consequently, MSs and MSDs are not used to control the analytical process. A minimum of one MS and one MSD sample shall be analyzed for every 20 environmental samples of a given matrix. Project-specific MS/MSD are required for this project.

5.3.1.3 Surrogates

Surrogates (sometimes referred to as system monitoring compounds) are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but that are not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogate spikes are generally added for organic analyses only. Surrogates shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

Whenever a surrogate recovery is outside the acceptance limit, method-specified corrective action must be performed. After any system problems have been resolved and system control has been reestablished, re-prepare and re-analyze the sample.

5.3.1.4 Internal Standards

An internal standard (IS) is a standard of known concentration added to each sample and carried through the entire determination procedure as a reference for calibrating and controlling the precision bias of the analytical method.

When the IS results are outside of the acceptance limits, method-specified corrective actions shall be performed. After any system problems have been resolved and system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed.

5.3.1.5 Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations. The ICS is used to verify background and interelement correction factors and is run at the beginning and end of each run sequence.

When the interference check sample results are outside of the acceptance limits stated in the method, corrective action shall be performed. After any system problems have been resolved and system control has been reestablished, reanalyze the ICS. If the ICS result is acceptable, reanalyze all affected samples.

5.3.1.6 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure and is used to document contamination resulting from the analytical process. A method blank shall be included in every analytical batch.

The presence of analytes in a method blank at concentrations equal to or greater than the method-specified thresholds indicates a need for corrective action. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples in the analytical batch shall be re-prepared and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks.

5.3.1.7 Cation-Anion Balance

Cation-anion balance will be evaluated for groundwater samples for which both cation and anion concentrations are reported. Concentrations of dissolved major cations (calcium, magnesium, sodium, potassium, and others as appropriate) and total ammonia will be compared to concentrations of major anions (sulfate, chloride, carbonate, bicarbonate, and others as appropriate). If the cation-anion ratio does not balance, the laboratory may be requested to re-digest (cations) and/or reanalyze the subject samples.

5.3.2 Corrective Action

The analytical laboratories will be required to submit case narratives with each analytical data package. The case narrative must document out-of-control events. In addition, any out-of-control occurrence must be reported to the Project QA Manager or designee as soon as possible so that the Project QA Manager can assess the out-of-control event and determine the appropriate course of action based on the overall project objectives, critical nature of the data and project schedule. At a minimum, the laboratory will report the types of out-of-control occurrences, how these occurrences are documented, and who is responsible for correction and documentation. Corrective action will be taken at any time during the analytical process when deemed necessary based on analytical judgment or when QC data indicate a need for action. Laboratory corrective actions may include, but are not limited to:

- Reanalysis,
- calculation checks,
- instrument recalibration,
- preparation of new standards/blanks,
- re-extraction/digestion, and
- additional training of analysts.

The following items must be documented for out-of-control incidents so that corrective action may be taken to set the system back “in control.” These items will constitute a corrective action report and will be signed by the laboratory director and the laboratory QA contact:

- where the out-of-control incident occurred,
- when the incident occurred and was corrected,
- who discovered the out-of-control incident,
- who verified the incident,
- the scope of the problem,
- the corrective action implemented, and
- who corrected the problem.

6.0 DATA REVIEW AND QUALIFICATION

During this sampling program, in addition to the data review requirements outlined in Section 6.2 of the established QAPP, the following elements are required.

- The designated laboratory must qualify all outliers according to Arizona Laboratory Data Qualifiers (see [Appendix E](#)).
- ADEQ requires that 100% of the data be verified in accordance with an approved checklist detailing the review. URS will provide, with the data verification memo, a data validation catalog table. Included on the table will be the list of all samples collected and required parameters.
- Per ADEQ requirements, URS will perform full validation of 10% of the data packages containing compliance and closure samples.

TABLES

TABLE 1
DISTRIBUTION LIST AND PROJECT DIRECTORY

Name	Project Role	Street Address	City and State	Zip Code	Phone and Fax Numbers
Joey Pace	ADEQ Project Manager	1110 West Washington Street	Phoenix, AZ	85007	Phone: 602-771-4574 Email: pace.joey@azdeq.gov
Stuart Brown	Bridgewater Group Project Director	4500 SW Kruse Way Suite 110	Lake Oswego, OR	97035	Phone: 503-675-5252 Email: sbrown@bridgeh2o.com
Ned Hall	Sierrita Project Manager	6200 West Duval Mine Road P.O. Box 527	Green Valley, AZ	85622-0527	Phone: 520-648-8857 Email: Ned_Hall@fmi.com
Steven Vaughn	URS Project Manager	333 E Wetmore Rd, Suite 400	Tucson, AZ	85705	Phone: 520-407-2845 Email: steven_vaughn@urscorp.com

TABLE 2
RELEVANT GROUNDWATER STANDARDS & LABORATORY REPORTING LIMITS
(milligrams per liter unless noted)

	AWQS (mg/L)	Laboratory Method Reporting Limit (mg/L)
Aluminum	NE	0.03
Antimony	0.006	0.0004
Arsenic	0.05 0.01 (EPA MCL)	0.0005
Barium	2	0.003
Beryllium	0.004	0.0001
Cadmium	0.005	0.0001
Calcium	NE	0.2
Chromium (total)	0.1	0.01
Cobalt	NE	0.01
Copper	NE	0.01
Iron	NE	0.02
Lead	0.05	0.0001
Magnesium	NE	0.2
Manganese	NE	0.005
Mercury	0.002	0.0002
Molybdenum	NE	0.01
Nickel	0.1	0.01
Potassium	NE	.3
Selenium	0.05	0.0001
Sodium	NE	0.3
Thallium	0.002	0.0001
Zinc	NE	0.01
Gross Alpha (pCi/L)	15 pCi/L	2 pCi/L
Beta emitters (pCi/L)	4 millirem/year*	4 pCi/L
Radium 226+228 (pCi/L)	5 pCi/L	1 pCi/L
Uranium	NE	0.0001
Uranium Isotopes (pCi/L)	NE	0.2 pCi/L
Alkalinity as CaCO3	NE	2
Chloride	NE	1
Fluoride	NE	0.1
Sulfate	NE	10
Nitrate+Nitrite	NE	0.02

Key: pCi/L - PicoCuries per Liter
 NE – None Established
 *AWQC is 4 millirem/year or approximately 50 pCi/L

TABLE 3
RELEVANT SOIL STANDARDS AND LABORATORY REPORTING LIMITS
(milligrams per kilogram unless noted)

Analyte	GPL	Residential SRL			Non-residential SRL	Laboratory Method Reporting Limit (mg/Kg)
		Carcinogen				
		10 ⁻⁶ Risk	10 ⁻⁵ Risk	Non-Carcinogen		
Aluminum	NE			76,000	920,000	3
Antimony	35			31	410	0.04
Arsenic	290	10	10	10	10	0.05
Barium	12,000			15,000	170,000	0.3
Beryllium	23			150	1,900	0.2
Cadmium	29			39	510	0.01
Chromium (total)	590			NE	NE	20
Chromium III	NE			120,000	1,000,000	1
Chromium VI	NE	30			65	0.005
Cobalt	NE	900	9,000	1,400	13,000	1
Copper	NE			3,100	41,000	1
Iron	NE			NE	NE	2
Lead	290			400	800	0.01
Magnesium	NE			NE	NE	20
Manganese	NE			3,300	32,000	0.5
Mercury	12			23	310	0.02
Molybdenum	NE			390	5,100	1
Nickel	590			1,600	20,000	1
Potassium	NE			NE	NE	30
Selenium	290			390	5,100	0.1
Sodium	NE			NE	NE	30
Thallium	12			5.2	67	0.01
Zinc	NE			23,000	310,000	1
Radium 226+228 (pCi/g)	NE			NE	NE	1.5
Uranium	NE			16	200	0.01
Uranium Isotopes (pCi/g)	NE			NE	NE	0.3

Key: GPL - Groundwater Protection Level
SRL - Soil Remediation Level
NE - None Established
pCi/g - PicoCuries per gram

TABLE 4
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (or equivalent)	Definitive or Screening Method	Sample Matrix	Estimated Number of Samples					Preservation	Number/ Minimum Volume of Container(s)	Sample Hold Time (from collection)
				Estimated Number of Field Samples	LAB QC Samples		FIELD QC Samples				
					MS	MSD or DUP	Field Dup	Equip. Blank			
Metals	SW-846 6010B/ 6020/7471A	Definitive	Soil/ Sediment	380	19	19	19	19	Cool to 4 °C	1 4-oz glass	180 days
Diss. Metals	EPA 200.7/ 200.8/245.1	Definitive	Water	328	16	16	16	16	pH < 2 with HNO ₃	1 1-liter poly	180 days
Anions	EPA 300.0	Definitive	Water	328	0	0	16	0	Cool to 4°C	1 250-ml poly	48 hours for NO ₂ , 28 days for all else
Anions	EPA 300.0	Definitive	Soil/ Sediment	380	19	19	19	19	Cool to 4°C	1 16-oz glass	28 days
pH	SW-846 9040B	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
pH	SW-846 9045C	Screening	Soil/ Sediment	380	0	0	19	0	Cool to 4 °C	1 4 oz. Poly or glass	Analyze Immediately
Temperature	EPA 170.1	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
Specific Conductance	EPA 120.1	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
Eh	ASTM 1498	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
Turbidity	EPA 180.1	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
Dissolved Oxygen	EPA 360.1	Screening	Water	328	0	0	16	0	NA	Poly or glass	Analyze Immediately
TDS	EPA 160.1	Screening	Water	328	0	0	16	0	Cool to 4 °C	1 100-ml poly	7 days
Alkalinity	Std. Method 2320B	Screening	Water	328	0	0	16	0	Cool to 4 °C	1 250-ml poly	14 days
Gross Alpha Gross Beta	EPA 900.0	Screening	Water	328	0	0	16	16	pH < 2 with HNO ₃	1-gallon poly	6 months
Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312/ 6010B/ 7471A	Definitive	Soil/ Sediment	380	19	19	19	19	Cool to 4 °C	1 4-oz glass	180 days

TABLE 4
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (or equivalent)	Definitive or Screening Method	Sample Matrix	Estimated Number of Samples					Preservation	Number/ Minimum Volume of Container(s)	Sample Hold Time (from collection)
				Estimated Number of Field Samples	LAB QC Samples		FIELD QC Samples				
					MS	MSD or DUP	Field Dup	Equip. Blank			
U-234, U-235, U-238	Eichrom ACW03	Definitive	Water	328	16 (a)	16 (a)	16	16	pH < 2 with HNO ₃	1-gallon poly	6 months
U-234, U-235, U-238	Eichrom ACW03	Definitive	Soil/ Sediment	380	19 (a)	19 (a)	19	19	None	1 4-oz glass	6 months
Ra-226	EPA 903.0	Definitive	Water	328	16 (a)	16 (a)	16	16	pH < 2 with HNO ₃	1-gallon poly	6 months
Ra-226	EPA 9315	Definitive	Soil/ Sediment	380	19 (a)	19 (a)	19	19	None	1 4-oz glass	6 months
Ra-228	EPA 904.0	Definitive	Water	328	16 (a)	16 (a)	16	16	pH < 2 with HNO ₃	1-gallon poly	6 months
Ra-228	EPA 9320	Definitive	Soil/ Sediment	380	19 (a)	19 (a)	19	19	None	1 4-oz glass	6 months

Notes:

(a) As spiking standards are available.

SW846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.

EPA: USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983

Std. Methods: Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989

QC: Quality Control

MS: Matrix Spike

MSD: Matrix Spike Duplicate

DUP: Matrix Duplicate

Equip: Equipment

Eh: Oxidation reduction potential

Diss: Dissolved

TDS: Total Dissolved Solids

COD: Chemical Oxygen Demand

HCl: Hydrochloric Acid

oz: ounce

pH: negative log, hydrogen ion activity

HNO₃: Nitric Acid

H₂SO₄: Sulfuric Acid

°C: Degrees Celsius

ml: milliliter

poly: polyethylene

NA: Not Applicable

TABLE 5
SUMMARY OF GENERAL CALIBRATION AND QC PROCEDURES
FOR NON-RADIOLOGICAL SCREENING METHODS

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action*
EPA 120.1	Conductance	Calibration check with KCl standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards, and probe; recalibrate
		Method blank (using DI water)	Once per day at the beginning of testing	< Quantitation Limit (1µS/cm)	Check meter, replace if necessary, check water, recalibrate
		Standard check	At each sample location	± 5%	Correct problem, recalibrate
		Method duplicate	10% of field samples	RPD ≤ 10%	Correct problem, repeat measurement
EPA 180.1	Turbidity	Calibration check with one formazin standard per instrument range used	Once per day at the beginning of testing	± 5 units 0-100 range ± 0.5 units 0-0.2 range ± 0.2 units 0-1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate
		Method blank (using DI water)	Once per day at the beginning of testing	< Quantitation Limit (1 NTU)	Check meter, replace if necessary, check water, recalibrate
		Method duplicate	10% of field samples	RPD ≤ 20%	Correct problem, repeat measurement
SW-846 9040B & 9045C	pH (water & sediment)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration
		pH 7 buffer (standard check)	At each sample location (water only)	± 0.2 pH units	Correct problem, recalibrate
		Method duplicate	10% of field samples	± 0.2 pH units	Correct problem, repeat measurement
EPA 170.1	Temperature	Method duplicate	10% of field samples	± 1.0 °C	Correct problem, repeat measurement
		Factory calibration	Once at factory	± 1.0 °C	Check meter, replace if necessary
EPA 360.1	Dissolved Oxygen	Calibration (as applicable for instrument used)	Once per day	To barometric pressure uncorrected for altitude	NA
		Method Duplicate	10% of field samples	± 0.2 mg/L	Correct Problem, repeat measurement

**TABLE 5
SUMMARY OF GENERAL CALIBRATION AND QC PROCEDURES
FOR NON-RADIOLOGICAL SCREENING METHODS**

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action*
		Colorimetric check	10% of field samples	RPD \leq 20%	Correct problem, repeat measurement
ASTM 1498	Eh	Sensitivity Verification	Daily	Eh should decrease when pH is increased	If Eh increases, correct the polarity of electrodes. If Eh still does not decrease, clean electrodes and repeat procedure
		Calibration check with one standard	Once per day	Two successive readings \pm 10 millivolts	Correct problem, recalibrate
		Standard check	At each sample location	\pm 10 millivolts	Correct problem, recalibrate
		Method Duplicate	10% of field samples	\pm 50 millivolts	Correct problem, repeat measurement
EPA 160.1	Filterable Residue	Analytical Balance check with a standard weight	Once per day at the beginning of testing	\pm 0.1 milligram	Correct problem, adjust balance
		Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
EPA 160.2	Non-filterable Residue	Analytical Balance check with a standard weight	Once per day at the beginning of testing	\pm 0.1 milligram	Correct problem, adjust balance
		Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
Std. Method 2320B	Alkalinity	Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data

*All corrective actions shall be completed as necessary upon QC check failure, documented, and the records shall be maintained.

SW846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.

EPA: USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983

Std. Methods: Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989

QC: Quality Control

KCl: Potassium Chloride

%: Percent

°C: Degrees Celsius

RPD: Relative Percent Difference

mg/l: milligrams per liter

NA: Not Applicable

TABLE 6
SUMMARY OF GENERAL CALIBRATION AND QC PROCEDURES
FOR NON-RADIOLOGICAL DEFINITIVE METHODS

Analytical Methods	Analysis	Quality Control Check	Frequency and Acceptance Criteria	Corrective Action
EPA 300.0	Anions by IC	Initial calibration curve	Daily $R \geq 0.995$	Rerun calibration standards
		Instrument Performance Check Sample (IPC)	Analyze after ICAL $\pm 10\%$	Reanalyze IPC; if second analysis still out, recalibrate and reanalyze all samples since last compliant IPC
		Calibration Blank	Analyze with each IPC $< MDL$	Determine cause of blank problem, reanalyze all samples since last compliant calibration blank
		Laboratory Reagent Blank (LRB)	One per batch or one per 20 samples, whichever is more frequent $< PQL$	Determine cause of blank problem, reanalyze set if necessary
		Lab Fortified Blank	One per batch (one per 20 samples) $\pm 10\%$	Correct problem and reanalyze batch
		Spiked Samples	One per batch (one per 20 samples) $\pm 20\%$	If LFB OK flag sample suspect due to matrix
		Duplicates	One per batch (one per 20 samples) 25% RPD	Reprep dups and reanalyze
SM2320B	Alkalinity	Method Blank	One per batch (one per 20 samples) $< PQL$	Determine cause of blank problem, reanalyze set if necessary
		Lab Control Samples	One per batch (one per 20 samples) $\pm 10\%$	Reprep batch and reanalyze
		Duplicates	One per batch (one per 20 samples) 20% RPD	Reprep batch and reanalyze
EPA 200.7	ICP Metals	Initial calibration minimum of a blank and one standard	Per instrument manufacturer's specifications $R \geq 0.995$, Attachment C, SOP #7.04, Section 9	Rerun calibration standards.
		Continuing calibration Instrument Performance Check (IPC)	Beginning, end and after every 10 samples After initial cal; $\pm 5\%$ after subsequent cal; $\pm 10\%$	Re-analyze standard; if second analysis out, recalibrate, re-run all samples since last compliant IPC
		Lab Fortified Blank	One per batch (one per 20 samples) $\pm 15\%$	Rerun batch

**TABLE 6
SUMMARY OF GENERAL CALIBRATION AND QC PROCEDURES
FOR NON-RADIOLOGICAL DEFINITIVE METHODS**

Analytical Methods	Analysis	Quality Control Check	Frequency and Acceptance Criteria	Corrective Action
		Calibration blank	After each IPC < IDL	Rerun blank, if second CCB analysis out, recalibrate and reanalyze all samples since last compliant CCB
		Laboratory Reagent Blank/ Method Blank	One per 20 samples < 2.2x the analyte MDL or < 10% of sample concentration	Determine cause of problem, redigest set if necessary and reanalyze
		QC check standard (second source)	Beginning, end and after every 10 samples ± 10%	Recalibrate
		Laboratory Duplicates	One per 10 samples (if MSD not analyzed) Attachment C, SOP #7.04, Section 9.10	
		Spike Samples (Lab Fortified Sample Matrix)	One per 10 samples ± 30 %, ≤ 20 RPD	Redigest, or if LFB OK flag data as suspect due to matrix interference
SW846 6010B	ICP Metals	Initial Calibration – minimum of a blank and one standard	Per instrument manufacturer’s specifications	Recalibrate
		Initial Calibration Verification (ICV)	At the beginning of operation and as needed ± 10%	Recalibrate
		Continuing Calibration Verification (CCV)	Beginning, end and after every 10 samples < ± 3x IDL unless the results are < 1/10 th of the action level and no sample is within 10% of the action level	Recalibrate and reanalyze all samples since last compliant calibration blank
		Internal Standards (IS)	± 20% intensity level agreement between ICV and CCV	Recalibrate and reanalyze all samples
		Method Blank	One per batch (one per 20 samples) Not > MDL	Determine cause of problem, redigest set if necessary
		Spiked Samples (MS)	One per batch or 20 samples, whichever is more frequent	Flag data as suspect due to matrix interference
		Matrix duplicates	One per batch or 20 samples, whichever is more frequent 20% RPD if sample value > 10x IDL	Re-prep samples and reanalyze
		Interference Check Sample (ICS)	Beginning and every 8 hours % R = 90 - 110	Recalibrate and rerun all samples since last compliant check sample

TABLE 6
SUMMARY OF GENERAL CALIBRATION AND QC PROCEDURES
FOR NON-RADIOLOGICAL DEFINITIVE METHODS

Analytical Methods	Analysis	Quality Control Check	Frequency and Acceptance Criteria	Corrective Action
		LCS	One per batch or 20 samples, whichever is more frequent $\pm 20\%$	Recalibrate
SW846 7470A	Mercury	Initial calibration (5 std, 1 blank)	Each day of analyses $R \geq 0.995$	Recalibrate
		Continuing calibration)	After each 10 samples $\pm 20\%$	Recalibrate, reanalyze previous 10 samples
		Matrix spike/matrix spike duplicate	One per batch (one per 20 samples) $\pm 15\%$	Reanalyze batch or run by MSA
		Method Blank	One per batch (one per 20 samples) < 2.2x MDL or < 10% of sample concentration	Reprocess samples
		Continuing Calibration Blank (CCB)	After ICAL, every 10 samples, and end of run < RL	
		QC Check Standard	After each calibration $\pm 10\%$	Recalibrate
		LCS	One per batch (one per 20 samples) $\pm 10\%$	Recalibrate

SW846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.
EPA: USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983
SM: Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989

APPENDIX A
VRP SAMPLING & ANALYSIS PLAN

4.0 SAMPLING AND ANALYSIS PLAN

This section presents the Sampling and Analysis Plans (SAP) for the VRP site characterization. The purpose of the SAP is to present the objectives of the sampling; identify sample types, locations, and frequency; and provide procedures on equipment, documentation, sample handling, and analysis.

This section presents the sampling approach that will be implemented at each facility. The specific sampling rationale for each facility is presented on **Table 4-1**. Section 5.0 describes specific sampling procedures that will be implemented during the site characterization, and Appendix B provides the Quality Assurance Project Plan (QAPP).

Soil and sediment samples collected from areas of investigation as described in Sections 4.1 through 4.5 of this work plan will be analyzed for total uranium, COI metals, and radionuclides. Specific constituents for each analytical category are as follows:

- Radionuclides to include total uranium, isotopic radium (Ra-226 and Ra-228), and isotopic uranium (U-234, U-235 and U-238)
- COI metals to include total analyses for antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc

Analyses proposed for groundwater samples to be collected from existing, proposed, and alluvial monitor wells are described in Section 4.6, Groundwater Sampling and Analyses Plan.

4.1 DEMETRIE WASH

The Demetrie Wash area primarily consists of historical facilities that Sierrita is planning to close. Historical facilities located in the Demetrie Wash area include:

- Former CLEAR Plant, a closed historical operation not regulated under the APP
- Former E Pond, a closed historical pond associated with the Former CLEAR Plant and not regulated under the APP
- Former Evaporation Pond, a closed historical pond associated with the Former CLEAR Plant and not regulated under the APP
- Old D Pond, regulated under the APP as a facility “to be closed”
- Former Esperanza Mill, a closed historical operation not regulated under the APP

- Former C Pond, a closed historical pond not regulated under the APP
- Former Raffinate Pond, a closed historical pond not regulated under the APP

These facilities are illustrated on **Figure 4-1**. The following sections present the proposed sampling approach for each facility.

4.1.1 Former CLEAR Plant

The Former CLEAR Plant is an inactive, historic operation that is not an APP regulated facility. The Former CLEAR Plant comprises an area of roughly 59 acres encompassing the Former Evaporation Pond and Former E Pond. Section 3.1.1 describes the results of past sampling and analysis of soils and groundwater collected at the CLEAR Plant by Hydro Geo Chem. This sampling event included 12 surface soil samples, 24 subsurface soil samples, and two groundwater samples. The surface soil samples were collected from the top 3 inches of soil and may represent fill material which is known to have been placed over portions of the CLEAR Plant area.

To provide additional data representing in-place soil, a sampling grid with 200-foot centers will be established over the approximate 59 acre site. Soil samples will be collected to bedrock or tool refusal from 10 randomly selected grid nodes on the systematic sampling grid. In addition, three judgmental sampling locations have been selected at locations representing the highest detected arsenic and lead concentrations identified during the Hydro Geo Chem characterization. Sediment samples will be collected from each drainage originating at the CLEAR Plant area. Groundwater will be characterized through the installation of one upgradient (MW-2008-01) and one downgradient (MW-2008-02) monitor well as noted on **Figure 4-2**. The following is a summary of the proposed CLEAR Plant samples.

Grid Samples

At 10 randomly selected grid nodes illustrated on **Figure 4-2**, soil samples will be collected from multiple depth intervals using Geoprobe[®] direct push techniques. At each random sampling location, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. The soil borings will be advanced using Geoprobe direct push techniques. Attempts will be made to collect one composite sample from each of the following intervals:

Former CLEAR Plant Grid Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former CLEAR Plant	0 to 1.5	Soil	10	10
	1.5 to 3	Soil	10	10
	5 to 7	Soil	10	10
	10 to 12	Soil	10	10
	15 to 17	Soil	10	10
	20 to 22	Soil	10	10
Total			60	60

ft bgs = feet below ground surface
COI = constituents of interest

Judgmental Samples

Judgmental sampling locations have been selected based on previous sampling results (Figure 4-2). Three locations were selected representing the highest detected arsenic and lead concentrations identified during the Hydro Geo Chem characterization (Hydro Geo Chem, 2008). At each judgmental sampling location, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. The soil borings will be advanced using Geoprobe direct push techniques. Attempts will be made to collect one composite sample from each of the following intervals:

Former CLEAR Plant Judgmental Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former CLEAR Plant	0 to 1.5	Soil	3	3
	1.5 to 3	Soil	3	3
	5 to 7	Soil	3	3
	10 to 12	Soil	3	3
	15 to 17	Soil	3	3
	20 to 22	Soil	3	3
Total			18	18

ft bgs = feet below ground surface
COI = constituents of interest

Sediment Samples

Five shallow surface drainages originate and flow from the CLEAR Plant area eastward to Demetrie Wash and one drainage flows south towards Old D Pond. To evaluate potential sediment impacts, two sediment samples will be collected from each of the five drainage areas

illustrated on **Figure 4-2**. One composite sediment sample will be collected from each of the following intervals using Geoprobe direct push techniques.

Former CLEAR Plant Sediment Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former CLEAR Plant	0 to 1.5	Soil	10	10
	1.5 to 3	Soil	10	10
Total			20	20

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater underlying the CLEAR Plant will be characterized by installing one monitor well immediately upgradient to the west-northwest direction and one monitor well immediately downgradient of the CLEAR Plant location to the east. The monitor wells will be installed using air rotary methods. The locations of the proposed monitor wells are shown on **Figure 4-2**. The proposed monitor wells will be constructed in the alluvial and shallow fractured bedrock aquifer. It is anticipated that the wells will be approximately 20 to 30 feet deep. Groundwater samples will be collected from these wells for four consecutive quarters.

Former CLEAR Plant Groundwater Sample Summary

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-01 Upgradient	20-30 feet	Groundwater	4	4
MW-2008-02 Downgradient	20-30 feet	Groundwater	4	4
Total			8	8

COI = constituents of interest

4.1.2 Former E Pond

The Former E Pond is an inactive, backfilled pond located near the southeast corner of the Former CLEAR Plant. This pond was historically used to contain surface water runoff and possibly process solutions from upset conditions at the Former CLEAR Plant, as described in Section 3.1.1.

Characterization of the Former E Pond will be performed through collection of soil samples from two judgmental locations and the installation and sampling of one monitor well immediately

downgradient of the Former E pond as shown on **Figure 4-2**. The following is a summary of the proposed Former E Pond sampling.

Judgmental Samples

Judgmental sampling locations will focus on the pond area since it is not included in the CLEAR Plant random sample area grid. One location on the western portion and one location on the eastern portion of the former pond will be sampled (**Figure 4-2**). At each judgmental sampling location, the boring will be advanced to bedrock or tool refusal, estimated at roughly 22 feet bgs. The soil borings will be advanced using Geoprobe direct push techniques. Attempts will be made to collect one composite sample from each of the following intervals:

Former E Pond Judgmental Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former E Pond	0 to 1.5	Soil	2	2
	1.5 to 3	Soil	2	2
	5 to 7	Soil	2	2
	10 to 12	Soil	2	2
	15 to 17	Soil	2	2
	20 to 22	Soil	2	2
Total			12	12

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater will be evaluated at Former E Pond by installing one monitor well (MW-2008-03) immediately downgradient of the former pond using air rotary drilling methods (**Figure 4-2**). Groundwater observations made during the soils investigation will be used for monitor well depth and screen placement. This monitor well will be used to evaluate potential impacts from the Former E Pond. The proposed monitor well will be constructed in the alluvial and shallow fractured bedrock aquifer. It is anticipated that the well will be approximately 20 to 30 feet deep. Upgradient groundwater conditions will be evaluated using analytical data collected from monitor well MW-2008-01, installed upgradient of the CLEAR Plant (Section 4.1.1). Groundwater samples will be collected from this well for four consecutive quarters.

Former E Pond Groundwater Sample Summary

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-03 Downgradient	20-30 feet	Groundwater	4	4
Total			4	4

COI = constituents of interest

4.1.3 Former Evaporation Pond

The Former Evaporation Pond is an inactive pond located at the south end of Clear Plant. This pond was historically used to contain process solutions from the Former CLEAR Plant operations as described in Section 3.1.1.

Characterization of the Former Evaporation Pond will be performed using the systematic sampling grid for CLEAR Plant, as shown on **Figure 4-2**. One monitor well will be constructed immediately downgradient of the former pond. The following is a summary of the proposed Former Evaporation Pond samples.

Judgmental Samples

Two grid nodes from the CLEAR Plant grid are located within the boundaries of the Former Evaporation Pond (**Figure 4-2**). One judgmental soil boring at each grid node will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. The soil borings will be advanced using Geoprobe direct push techniques. Attempts will be made to collect one composite sample from each of the following intervals:

Former Evaporation Pond Soil Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Evap. Pond	0 to 1.5	Soil	2	2
Evap. Pond	1.5 to 3	Soil	2	2
Evap. Pond	5 to 7	Soil	2	2
Evap. Pond	10 to 12	Soil	2	2
Evap. Pond	15 to 17	Soil	2	2
Evap. Pond	20 to 22	Soil	2	2
Total			12	12

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater will be evaluated by installing one monitor well (MW-2008-04) immediately downgradient of the Former Evaporation Pond (**Figure 4-2**). Groundwater observations made during the soils investigation will be evaluated for possible monitor well depth and screen placement. The proposed monitor well will be constructed in the alluvial and shallow fractured bedrock aquifer. It is anticipated that the well will be approximately 20 to 30 feet deep. Upgradient groundwater conditions will be evaluated using analytical data collected from monitor well MW-2008-01, installed upgradient of the CLEAR Plant (Section 4.1.1). Groundwater samples will be collected from this well for four consecutive quarters.

Former Evaporation Pond Groundwater Sample Summary

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-04	20-30 feet	Groundwater	4	4
Total			4	4

COI = constituents of interest

4.1.4 Old D Pond

Old D Pond is an inactive pond located approximately 0.25 mile south of CLEAR Plant. Old D Pond is an APP regulated facility designated for closure. Old D Pond will be characterized by drilling and collecting soil samples from soil borings within the former impoundment, collecting sediment samples from unnamed washes upgradient and downgradient of the former pond, and the installation and sampling of two monitor wells in the shallow alluvial and fractured bedrock aquifer. Proposed sampling locations are illustrated on **Figure 4-3**. The following is a summary of the proposed Old D Pond samples.

Soil Samples

Two soil borings will be drilled within the Old D Pond using Geoprobe direct push techniques (**Figure 4-3**). At each location, the boring will be advanced to bedrock or tool refusal, estimate at 22 feet bgs. An attempt to collect one composite sample from the each of the following intervals:

Old D Pond Soil Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
D Pond	0 to 1.5	Soil	2	2
D Pond	1.5 to 3	Soil	2	2
D Pond	5 to 7	Soil	2	2
D Pond	10 to 12	Soil	2	2
D Pond	15 to 17	Soil	2	2
D Pond	20 to 22	Soil	2	2
Total			12	12

ft bgs = feet below ground surface
COI = constituents of interest

Sediment Samples

Sediment samples will be collected from four locations in the unnamed wash flowing from the north through the Old D Pond (**Figure 4-3**). Sediment samples will be collected from two locations in the wash downstream of Old D Pond, flowing east to Demetrie Wash. One composite sediment sample will be collected from each of the following depth intervals using Geoprobe™ direct push techniques.

Old D Pond Sediment Sample Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
D Pond Wash	0 to 1.5	Soil	6	6
D Pond Wash	1.5 to 3	Soil	6	6
Total			12	12

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater will be evaluated at Old D Pond by installing two monitor wells using air rotary methods (**Figure 4-3**). The exact locations of the monitor wells will be dependant upon physical access restrictions. Groundwater observations made during the soils investigation will be used to determine final monitor well depth and screen placement. The proposed monitor wells will be constructed in the alluvial and shallow fractured bedrock aquifer. It is anticipated the monitor wells will be approximately 20 to 30 feet deep. Groundwater samples will be collected from these wells for four consecutive quarters.

Old D Pond Groundwater Sample Summary

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-05 Downgradient	20-30 feet	Groundwater	4	4
MW-2008-06 Upgradient	20-30 feet	Groundwater	4	4
Total			8	8

COI = constituents of interest

4.1.5 Former Esperanza Mill

The Former Esperanza Mill is an inactive, historic mill operation that is not an APP regulated facility. The Esperanza Mill comprises an area of roughly 80 acres encompassing the former mill, two thickeners, raw water pond, the Former Raffinate Pond, and Former C Pond.

Figure 4-4 illustrates a sampling grid with 200-foot centers that will be established over the site area. Soil samples will be collected from 10 randomly selected grid nodes on the systematic sampling grid. The following is a summary of the proposed Esperanza Mill samples.

Grid Samples

At 10 randomly selected grid nodes illustrated on **Figure 4-4**, soil samples will be collected from multiple depth intervals using Geoprobe direct push techniques. At each random sampling location, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. Attempts will be made to collect one composite sample from each of the following intervals:

Former Esperanza Mill Soil Sampling Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former Esperanza Mill	0 to 1.5	Soil	10	10
	1.5 to 3	Soil	10	10
	5 to 7	Soil	10	10
	10 to 12	Soil	10	10
	15 to 17	Soil	10	10
	20 to 22	Soil	10	10
Total			60	60

ft bgs = feet below ground surface
COI = constituents of interest

4.1.6 Former C Pond

Former C Pond is an inactive, backfilled pond located within the Esperanza Mill area. This former pond measured roughly 600 feet by 600 feet or 8.3 acres and is located in the eastern most portion of the Esperanza Mill area. This pond was periodically mucked-out using a dredge line, with the spoils placed on the east side of Duval Canal.

Characterization of the Former C Pond will be performed using the Esperanza Mill area systematic sampling grid as illustrated on **Figure 4-4**. The pond area will be investigated by drilling and collecting soil samples from five soil borings within the former impoundment. Two groundwater monitor wells will be installed, one upgradient and one downgradient of the former pond. The following is a summary of the proposed Former C Pond samples.

Judgmental Soil Samples

At 5 designated grid nodes illustrated on **Figure 4-4**, judgmental soil samples will be collected from multiple depth intervals using Geoprobe direct push techniques. At each grid node, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. Attempts will be made to collect one composite sample from each of the following intervals.

Former C Pond Soil Sampling Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former C Pond	0 to 1	Soil	5	5
	1 to 3	Soil	5	5
	5 to 7	Soil	5	5
	10 to 12	Soil	5	5
	15 to 17	Soil	5	5
	20 to 22	Soil	5	5
Total			30	30

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater will be evaluated at the Former C Pond area by installing one upgradient monitor well (MW-2008-07) and one downgradient monitor well (MW-2008-08) as shown on **Figure 4-4**. Groundwater observations made during the soils investigation will be considered for monitor well depth and screen placement. The proposed monitor wells will be constructed in the alluvial and shallow fractured bedrock aquifer. It is anticipated that the wells will be approximately 20 to

30 feet deep. Groundwater samples will be collected from these wells for four consecutive quarters.

Former C Pond Groundwater Sampling Summary

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-07 Upgradient	20-30 feet	Groundwater	4	4
MW-2008-08 Downgradient	20-30 feet	Groundwater	4	4
Total			8	8

COI = constituents of interest

4.1.7 Former C Spoils

Dredged material from the Former C Pond was reportedly placed in an area located between Duval Canal and Demetrie Wash, as described in Section 3.1.4. The area measures roughly 300 feet by 700 feet. This area appears to have been re-vegetated with grass and trees, and overlaps the 404 mitigation area as shown on **Figure 4-4**.

Characterization of this area will be performed through the completion of four soil borings at designated grid nodes within the area of dredged spoil. At each designated grid node, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. Prior to bedrock or refusal, an attempt will be made to collect one composite sample from each of the following intervals:

Former C Pond Spoils Soil Sampling Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former C Pond Spoils	0 to 1.5	Soil	4	4
	1.5 to 3	Soil	4	4
	5 to 7	Soil	4	4
	10 to 12	Soil	4	4
	15 to 17	Soil	4	4
	20 to 22	Soil	4	4
Total			24	24

ft bgs = feet below ground surface
COI = constituents of interest

4.1.8 Former Raffinate Pond

Former Raffinate Pond is an inactive, unlined and backfilled pond located within the Esperanza Mill area as described in Section 3.1.5. This former pond measured roughly 400 feet by 800 feet.

Characterization of the Former Raffinate Pond will be performed using the sampling grid for Esperanza Mill area as illustrated on **Figure 4-4**. Soils from five grid locations will be sampled to either a maximum depth of 22 feet bgs, to bedrock, or to groundwater. Two judgmental samples will be collected from soils/sediments visually noted to be impacted. Two groundwater monitor wells will be installed, one upgradient and one downgradient of the former pond. The following is a summary of the proposed Former Raffinate pond sampling.

Judgmental Soil Samples

At 5 designated grid nodes illustrated on **Figure 4-4**, judgmental soil samples will be collected from multiple depth intervals using Geoprobe direct push techniques. At each grid node, the boring will be advanced to bedrock or tool refusal, estimated at 22 feet bgs. Attempts will be made to collect one composite sample from each of the following intervals:

Former Raffinate Pond Soil Sampling Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former Raffinate Pond	0 to 1	Soil	5	5
	1 to 3	Soil	5	5
	5 to 7	Soil	5	5
	10 to 12	Soil	5	5
	15 to 17	Soil	5	5
	20 to 22	Soil	5	5
Total			30	30

ft bgs = feet below ground surface
COI = constituents of interest

Judgmental Sediment Samples

Judgmental sampling locations have been selected based on visible stained sediments. At each judgmental sampling location, the boring will be advanced to 3 feet bgs. One composite sample will be collected from each of the following intervals.

Former Raffinate Pond Judgmental Sediment Sampling Summary

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Former Raffinate Pond	0 to 1	Sediment	2	2
	1 to 3	Sediment	2	2
Total			6	6

ft bgs = feet below ground surface
COI = constituents of interest

Groundwater Samples

Groundwater will be evaluated by installing one upgradient monitor well (MW-2008-11) and two downgradient monitor wells MW-2008-09 and MW-2008-10 to characterize downgradient groundwater quality as shown on **Figure 4-4**. Groundwater observations made during the soils investigation will be considered for monitor well depth and screen placement. Groundwater samples will be collected from these wells for four consecutive quarters.

**Former Raffinate Pond
Groundwater Sampling Summary**

Monitor Wells				
Area	Well Depth	Media	Analyses	
			Radionuclide	COI Dissolved Metals
MW-2008-09 Downgradient	40-60 feet	Groundwater	4	4
MW-2008-10 Downgradient	40-60 feet	Groundwater	4	4
MW-2008-11 Upgradient	40-60 feet	Groundwater	4	4
Total			12	12

ft bgs = feet below ground surface
COI = constituents of interest

4.2 AMARGOSA WASH

The primary objective of the site characterization activities in Amargosa Wash are to confirm that the existing solution impoundments have not impacted the alluvial groundwater. Characterization of facilities in Amargosa Wash will consist of collecting samples from the active SX ponds and collection of alluvial groundwater samples downgradient of each impoundment. Facilities of interest in Amargosa Wash include:

- Leach stockpiles and SX facilities that are used to collect and hold process solutions. All of these facilities are active and regulated under the APP. The VRP will be used to confirm that releases of COIs have not occurred from these facilities.
- Historical impoundments (A Pond and B Pond). These impoundments are regulated as “to be closed” facilities under the APP. As with the active APP regulated facilities, these facilities are potential sources of COIs. The VRP will be used to confirm that releases of COIs have not occurred from these facilities.
- Launderers Facility is a “to be closed” facility in the APP; however, the APP reports that the facility is to be closed upon mine closure under the Mine Closure Reclamation Plan.

The VRP will be used to confirm that releases of COIs have not occurred from this facility, in advance of final mine closure.

In general, the potential impact to the environment from historical activities at existing facilities located along Amargosa Wash and regulated under the APP will be investigated. The following sections present the proposed samples that will be collected at facilities located in Amargosa Wash. **Figure 4-4** illustrates sample locations and **Table 4-2** summarizes the proposed samples and analysis.

4.2.1 Headwall No. 1 and Bailey Lake

Headwall No. 1 and Bailey Lake are APP facilities used to collect PLS from the active sulfide leach stockpiles. To profile the solutions contained in these impoundments one PLS sample from each impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Amargosa Wash alluvial aquifer have not occurred, two temporary alluvial groundwater monitor wells will be installed immediately downgradient of Bailey Lake (**Figure 4-5**). The temporary wells will be installed using Geoprobe direct push techniques. The temporary wells will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.2.2 Raffinate Pond No. 2

Raffinate Pond No. 2 is used to contain copper depleted solutions discharged from SX Plants No. 1 and No. 2. To profile the solutions contained in this impoundment one solution sample will be collected for four consecutive quarters.

To confirm that releases of COIs to the Amargosa Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of the impoundment (**Figure 4-5**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.2.3 Former A Pond

Former A Pond was an unlined pond located between Amargosa Pond and Former B Pond. Former A Pond was used to retain stormwater or leach solutions that would overflow Amargosa Pond. The pond has been razed; however, no analytical data has been collected to determine potential impacts this pond may have on the underlying alluvial aquifer.

To confirm that releases of COIs to the Amargosa Wash alluvial aquifer have not occurred, one temporary groundwater monitor well will be installed immediately downgradient of Former A Pond (**Figure 4-5**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.2.4 Former B Pond

Former B Pond is an unlined impoundment located in Amargosa Wash immediately upgradient of the confluence of Amargosa and Demetrie washes. The impoundment was historically used to retain potentially impacted stormwater or leach solutions that would overflow Amargosa Pond.

If the impoundment contains water at the time of sampling, one surface water sample will be collected.

To confirm that releases of COIs to the Amargosa Wash alluvial aquifer have not occurred, one temporary groundwater monitor well will be installed immediately downgradient of Former B Pond (**Figure 4-5**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.2.5 Launderers Facility

The Launderers Facility consists of concrete bins where PLS was pumped to precipitate copper onto iron surfaces. The facility and operation was abandoned in 1987; however, the concrete bins remain in place.

To confirm that releases of COIs to the Amargosa Wash alluvial aquifer have not occurred, one temporary groundwater monitor well will be installed immediately downgradient of the Launderers Facility. The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.3 ESPERANZA WASH

The primary objective of the site characterization activities in Esperanza Wash is to confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred. Characterization of facilities in Esperanza Wash will consist of collecting samples from the active SX ponds and collection of alluvial groundwater samples downgradient of each impoundment. Current

operating facilities located in the Esperanza Wash include leach stockpiles and SX facilities regulated under the APP, including:

- Headwall No. 2
- Headwall No. 3
- Raffinate Pond No.3
- Headwall No. 4 (SX-3 Stormwater Pond)

In general, the potential impact to the environment from historical activities at existing facilities located along Esperanza Wash will be investigated. The following sections present the proposed samples that will be collected at facilities located in Esperanza Wash. **Figure 4-6** illustrates sample locations and **Table 4-2** summarizes the proposed samples and analysis.

4.3.1 Headwall No. 2

Headwall No. 2 is an APP facility used to collect PLS from the active sulfide leach stockpiles. To profile the solutions contained in this impoundment one PLS sample from the impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of the impoundment, adjacent to Channel No. 2 (**Figure 4-6**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.3.2 Headwall No. 3

Headwall No. 3 is an APP facility used to collect PLS from the active sulfide leach stockpiles. To profile the solutions contained in this impoundment one PLS sample from the impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of the impoundment (**Figure 4-6**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.3.3 Raffinate Pond No. 3

Raffinate Pond No. 3 is an APP facility historically used to contain raffinate from SX Plant No. 3. The pond is currently used to collect PLS from Headwalls No. 3 and No. 5. To profile the solutions contained in this impoundment one PLS sample from the impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of the impoundment (**Figure 4-6**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.3.4 Headwall No. 4 (SX-3 Stormwater Pond)

Headwall No. 4 was formerly used to contain potential overflows from Headwall No. 3 and is currently a stormwater pond. To profile the solutions contained in this impoundment one water sample from the impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of the impoundment (**Figure 4-6**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.4 TINAJA AND UNNAMED WASHES

The primary objective of the site characterization activities in Tinaja and Unnamed washes are to confirm that the existing operations have not impacted the alluvial groundwater. Characterization of facilities in Tinaja and Unnamed washes will consist of collecting samples from the active SX ponds and collection of alluvial groundwater samples downgradient of each impoundment. The facility of interest in Tinaja and Unnamed washes include Headwall No. 5.

4.4.1 Headwall No. 5

Headwall No. 5 is an APP impoundment used to collect PLS from the active sulfide leach stockpiles near the headwaters of an unnamed tributary to Tinaja Wash. To profile the solutions contained in this impoundment one PLS sample from the impoundment will be collected for four consecutive quarters.

To confirm that releases of COIs to the Esperanza Wash alluvial aquifer have not occurred, one temporary alluvial groundwater monitor well will be installed immediately downgradient of Headwall No. 5 (**Figure 4-7**). The temporary well will be installed using Geoprobe direct push techniques. The temporary well will remain in place for 1 year and alluvial groundwater samples will be collected for four consecutive quarters.

4.5 TAILING IMPOUNDMENTS

4.5.1 Rhenium Ponds

The Rhenium Ponds consisted of three cells excavated into the surface of the Esperanza Tailing Impoundment. The cells were used for the storage and evaporation of process solutions from the Rhenium Plant (Montgomery Watson, 1999). Each cell measured 250 feet long, 65 feet wide, and 10 to 12 feet deep and were lined with geosynthetic; however, the integrity of the lining was uncertain (MWH, 2005).

Characterization of this area will be performed using judgmental sampling locations. Soil samples will be collected to a total depth of 7 feet bgs from two locations at the former pond location. Approximate sampling locations are illustrated on **Figure 4-8**.

Judgmental Samples

Judgmental sampling locations have been randomly selected within the footprint of the former ponds. At each judgmental sampling location, one composite sample will be collected from each of the following intervals:

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Rhenium	0 to 1	Sediment	2	2
	1 to 3	Sediment	2	2
	5 to 7	Sediment	2	2
Total			6	6

ft bgs = feet below ground surface
COI = constituents of interest

4.5.2 Esperanza Tailing Impoundment

The Esperanza Tailing Impoundment is the older of the two tailing impoundments and operated over a time span of approximately 23 years receiving tailing from both the Esperanza Mill and Twin Buttes operations. This impoundment overlies the basin fill deposits where the analysis of groundwater has detected radionuclides. However, insufficient data exist to determine if

groundwater radionuclides are a result of leaching from the tailing or due to naturally occurring conditions.

To assist with this evaluation, URS proposes to drill and sample two borings through the Esperanza Tailing Impoundment, and collect and analyze tailing and soil samples through the entire depth of the boring. One boring will be drilled on the south-central side of the impoundment at the approximate location of the Twin Buttes tailing placement and one boring will be drilled on the north-central side of the impoundment as illustrated on **Figure 4-8**.

Lithology of the borings will be recorded in the field by the site geologist. The composite samples will be analyzed for metals and radionuclides. The borings will be drilled with hollow stem augers, collecting samples on 5-foot intervals as described in Section 5.3. One composite samples will be collected at the following each of the following intervals using procedures described in Section 5.3.

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Esperanza Tailing	0 to 20	Composite Soil	2	2
	20 to 40	Composite Soil	2	2
	40 to 60	Composite Soil	2	2
	60 to 80	Composite Soil	2	2
	80 to 100	Composite Soil	2	2
Total			10	10

ft bgs = feet below ground surface
COI = constituents of interest

4.5.3 Sierrita Tailing Impoundment

The Sierrita Tailing Impoundment is the most recent impoundment used since approximately 1970. The Sierrita Tailing Impoundment also overlies basin fill deposits where the analysis of groundwater has detected radionuclides. However, insufficient data exist to confirm that radionuclides in groundwater are not a result of leaching from the tailing and may be due to naturally occurring conditions, or other source(s).

To assist with this evaluation, URS proposes to drill and sample four borings through the Sierrita Tailing Impoundment and collect and analyze tailing and soil samples through the entire depth of the boring. Approximate boring locations are illustrated on **Figure 4-8**. Lithology of the borings will be recorded in the field by the site geologist. The composite samples will be analyzed for metals and radionuclides. Proposed analyses are summarized on **Table 4-2**.

The borings will be drilled with hollow stem augers, collecting samples on 5-foot intervals as described in Section 5.4. One composite sample will be collected from each of the following intervals using procedures described in Section 5.4.

Frequency and Depth of Samples				
Area	Interval (ft bgs)	Media	Analyses	
			Radionuclide	COI Total Metals
Sierrita Tailing	0 to 20	Composite Soil	4	4
	20 to 40	Composite Soil	4	4
	40 to 60	Composite Soil	4	4
	60 to 80	Composite Soil	4	4
	80 to 100	Composite Soil	4	4
	100 to 120	Composite Soil	4	4
	120 to 140	Composite Soil	4	4
	140 to 160	Composite Soil	4	4
	160 to 180	Composite Soil	4	4
	180 to 200	Composite Soil	4	4
	200 to 220	Composite Soil	4	4
Total			44	44

ft bgs = feet below ground surface
COI = constituents of interest

Monthly sampling of reclaim pond water, and tailing decant solution and analyses for U mass and COI metals will be conducted for one year. The monthly sampling is recommended to assess temporal and seasonal variation of the solution quality, with the goal of providing a more complete characterization of the solutions. Once per quarter, the reclaim pond water and tailing decant solution samples will be analyzed for the following parameters.

- Radionuclides; including gross alpha, gross beta, isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and dissolved U mass
- Dissolved metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc
- Field analyses; including pH, conductivity, temperature, dissolved oxygen, turbidity and redox potential
- General chemical parameters; including total dissolved solids, major cations (calcium, magnesium, sodium, and potassium) and major anions (sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate)

4.6 GROUNDWATER SAMPLING AND ANALYSIS PLAN

As described in Section 3.6, localized elevated concentrations of uranium and certain metals in groundwater have been measured in various areas on the Sierrita property. Existing data indicate that uranium and metals occur naturally in the mineralized bedrock formations of the Sierrita batholith which underlies most of the Sierrita Mine, and areas to the north and northeast of the mine. Elevated concentrations of U mass and various metals have been measured in various process solutions. Uranium and metals concentrations in various process solutions will be obtained as presented in Sections 4.1 through 4.5 for each area to be evaluated. The objective of the proposed groundwater characterization presented in this section is to obtain and evaluate hydrogeologic and groundwater analytical data that will allow an assessment of potential impacts to groundwater from natural and anthropogenic sources, and to improve the understanding of U and metals in site groundwater.

The initial phase of this groundwater characterization program will include:

1. sampling and analysis of groundwater from 27 existing monitor wells for four consecutive quarters
2. sampling and analysis of groundwater for four consecutive quarters from 11 new monitor wells to be constructed in the former CLEAR Plant and Esperanza Mill areas
3. Installation of 4 background monitor wells followed by sampling and analyses of groundwater from these monitor wells for four consecutive quarters
4. Installation of temporary alluvial wells downgradient of process solution impoundments, and sampling of groundwater from these temporary alluvial wells for four consecutive quarters
5. Evaluation of resulting data and refinement of the conceptual site model for groundwater pathway

4.6.1 Sampling of Existing and Proposed Groundwater Monitoring Wells

Currently, Sierrita collects groundwater samples from 24 existing groundwater monitor wells for analyses of radionuclides and dissolved metals as part of ongoing monitoring programs. Sampling of these wells will continue on a quarterly basis for four consecutive quarters. These wells include:

- BW-02 and BW-03
- PZ-02, PZ-03, PZ-04, PZ-05, PZ-06, PZ-07, and PZ-08

- PZ-16
- MH-14, MH-15W, and MH-16W
- MH-17, MH-18, MH-19, MH-20, MH-21, MH-22, and MH-23
- MH-27, MH-28, MH-29, and MH-30

In addition to these existing APP and other monitoring program wells, groundwater sampling will also be attempted from three existing wells, if access to the wells is readily available. These three wells are being proposed for sampling because of their location with respect to local geology and/or to specific upgradient facilities. These wells are:

- BW-04 – Located in Amargosa Wash immediately downgradient of Former B Pond and immediately upgradient of the Demetrie Wash confluence. This well is screened in the Ruby Star Granodiorite.
- PZ-2007-05 – Located at the eastern edge of the Esperanza Tailing Impoundment.
- PZ-01 – Located in the southwest corner of the Sierrita property screened in the Tinaja Peak Formation and hydraulically upgradient of Sierrita facilities. This well represents background groundwater conditions for the Tinaja Peak Formation and has only been sampled and analyzed twice for U mass with the last event occurring in 1997.

Eleven additional monitor wells will be constructed in the Former CLEAR Plant and Esperanza Mill areas as described in this section. These wells will also be sampled and analyzed for four consecutive quarters. The geologic and analytical data obtained during installation and sampling of these wells will be used to further refine the site conceptual model for groundwater pathway.

In summary, thirty-eight existing and newly installed monitor wells will be sampled for four consecutive quarters to identify any seasonal or temporal trends in groundwater quality. Upon completion of the four quarters of groundwater sampling and evaluation of the analytical data, the need to continue quarterly sampling of all listed wells will be evaluated, and plans for any subsequent sampling will be developed.

Table 4-3 lists the monitor wells that will be sampled, and the justification for sampling at each location. For the existing monitor wells, the depth of the screened interval and the geologic formation in which each well is screened are also listed. Groundwater samples collected from each well will be analyzed for:

- Radionuclides; including gross alpha, gross beta, isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and dissolved U mass

- Dissolved metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc
- Field analyses; including pH, conductivity, temperature, dissolved oxygen, turbidity and redox potential
- General chemical parameters; including total dissolved solids, major cations (calcium, magnesium, sodium, and potassium) and major anions (sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate)

4.6.2 Installation and Sampling of Background Wells

Additional background bedrock monitor wells will be installed to further assess natural conditions of groundwater within two primary mineralized geologic units. As described in Sections 2.3 and 3.6, analytical results for background monitor wells MH-21 and MH-17 have shown consistently greater concentrations of U mass than many of the downgradient wells. Monitor wells, MH-21 and MH-17, are screened in the Ruby Star Granodiorite and Harris Ranch Quartz Monzonite formations, respectively.

A review of geologic research conducted by Conoco in 1978 demonstrates that well MH-21 is screened within the hornblende-rich Ruby Star Granodiorite, containing naturally elevated levels of uranium. **Figure 4-9** illustrates the approximate location of Conoco sampling locations and delineates the approximate area of the hornblende rich Ruby Star Granodiorite.

To further characterize background groundwater conditions within the Ruby Star Granodiorite, two monitoring wells (MW-2008-12 and MW-2008-13) will be constructed at the approximate locations illustrated on **Figure 4-9**. Analytical results from the sampling of groundwater in these two wells will be used to assess if the U mass concentrations associated with MH-21 are a result of naturally occurring uranium. Two monitor wells are recommended in the Ruby Star Granodiorite because the presence of hornblende is highly variable. These proposed locations for the two new wells are within the area identified by Conoco as having naturally elevated concentrations of uranium. The exact locations of the new wells will be dependant upon physical access restrictions.

A second existing background well, MH-17, is located in the southwestern corner of the Sierrita property and is screened in the Harris Ranch Quartz Monzonite. As discussed in Section 2.0, the Harris Ranch Quartz Monzonite has similar characteristics as the Ruby Star Granodiorite with elevated uranium concentrations compared to other plutonic rocks in the district and the presence

of hornblende which contains uranium. Analyses of groundwater samples collected from MH-17 indicate elevated concentrations of U mass.

To further characterize the background groundwater conditions of the Harris Ranch Quartz Monzonite and to determine if the U mass concentrations in MH-17 are a result of naturally occurring uranium, one additional monitor well (MW-2008-15) will be constructed and sampled at the location illustrated on **Figure 4-9**.

A third existing background well, PZ-01, is located in the southwestern corner of the Sierrita property and is screened in the Tinaja Peak Formation. To further characterize the background groundwater conditions within the Tinaja Peak Formation and to determine if the U mass concentrations associated with PZ-01 are a result of naturally occurring uranium, one additional monitor well (MW-2008-14) will be constructed at the location illustrated on **Figure 4-9** and sampled.

Samples of rock from at least three intervals in each new bedrock boring will be collected and analyzed for radionuclides including isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and U mass. Samples will be collected from representative portions of the formations encountered and from any mineralized vein deposit noted below groundwater elevation.

Monitor wells will be installed and developed following borehole drilling. Following well installation and development, samples of groundwater from each well will be collected. Samples collected from each well will be analyzed for:

- Radionuclides; including gross alpha, gross beta, isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and dissolved U mass
- Dissolved metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc
- Field analyses; including pH, conductivity, temperature, dissolved oxygen, turbidity, and redox potential
- General chemical parameters; including total dissolved solids, major cations (calcium, magnesium, sodium, and potassium) and major anions (sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate)

Sampling and analyses of the new background monitor wells over four consecutive quarters is proposed to assess any seasonal or temporal trends in groundwater quality.

4.6.3 Alluvial Groundwater Sampling

Currently, only one monitor well, MH-22, is constructed and screened in alluvial materials at the Sierrita property. Well MH-22 is located in Demetrie Wash and is 20 feet deep, screened entirely in alluvium. This well has been sampled 37 times between 1997 and 2007. Measureable levels of groundwater have been present in the well during every sampling event. Analytical results for U mass range from 133 to 509 micrograms per liter ($\mu\text{g/L}$).

Installation of twelve temporary alluvial monitor wells is proposed in Sections 4.1 through 4.5 at locations adjacent to active and inactive process impoundments. The depth to groundwater and surface elevation will be recorded at each location, and groundwater samples will be collected from each of the twelve temporary wells for four consecutive quarters. Samples collected from each well will be analyzed for:

- Radionuclides including gross alpha, gross beta, isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and dissolved U mass
- Dissolved metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc
- Field analyses including pH, conductivity, temperature, dissolved oxygen, turbidity, and redox potential
- General chemical parameters including total dissolved solids, major cations (calcium, magnesium, sodium, and potassium) and major anions (sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate)

4.6.4 Data Analysis and Refining of the Conceptual Site Model for Groundwater Pathway

Following the installation of proposed groundwater monitor wells and the collection and analyses of groundwater as described in the preceding sections, the resulting data will be summarized and evaluated. The outcome of this data evaluation will be further refinement of the groundwater conceptual site model for groundwater.

Geochemical data obtained from background and existing groundwater monitor wells, alluvial groundwater wells, and process solutions as described in this section will be used collectively to

assess potential sources of suspected uranium, radionuclides, and metals in groundwater beneath the site.

These data will be used to evaluate inherent relationships, if any, of potential source media geochemistry to the groundwater compositions found beneath the source area and in groundwater downgradient of the source area. Hydrogeochemical data will be used to determine if mixing of soil leachate or process solutions releases with the underlying groundwater results in the observed groundwater compositions and constituent distributions, or whether the suspected radionuclide and metal constituents detected in groundwater are sourced from the natural mineralization present in the area. These hydrogeochemical relationships will be assessed using a variety of approaches including as appropriate: major and trace element chemistry fingerprints, element ratios such as Cu/U, U-234/U-238; Piper and Stiff diagrams; simple mixing relations; and geochemical modeling. Multivariate statistics may be used.

Following data evaluation and refinement of the groundwater conceptual site model for groundwater pathway, remaining data gaps will be identified. If necessary, subsequent groundwater monitor well installation and/or sampling will be recommended to further refine the conceptual site model.

5.0 FIELD ACTIVITIES

5.1 SITE RECONNAISSANCE

An initial reconnaissance and characterization will be performed and will include (1) surveying site and surrounding features including land use and access, (2) evaluating the condition of existing on-site monitor wells, and (3) identifying collection points for pond sampling.

5.1.1 Conducting the Survey

A land surveyor registered in Arizona will survey the sampling grids, sample locations, and other areas as needed. A map of the area of investigation indicating the features to be included in the survey will be provided to the surveyor. The survey will include:

- Identifying or establishing on-site benchmarks for future surveying reference
- Locations of pertinent structures and appurtenances
- Locations and surface water elevations of water bodies (Amargosa Wash)
- Location and identification of above and below ground utility lines, if applicable
- Coordinates and elevations of existing monitor wells and piezometers
- Coordinates and elevations of soil sample locations

The surveyor will permanently notch and survey the north side of the top of monitor well and piezometer casings, including existing wells if not marked and those installed during the field investigation, for consistency in measuring water levels and preparing potentiometric maps. The surveyor will provide a survey data file to URS for the preparation of report graphics.

5.1.2 Evaluating Existing Monitor wells

As part of site reconnaissance, this work will consist of locating and evaluating the condition of existing monitor wells including (1) inspecting the surface seal, well vault, protective casing, bollards, and well cap; (2) measuring the depth to water; and (3) measuring the total depth of each monitor well. If the surface seal needs repair, the repairs will be carried out during the monitor well installation by the drilling contractor. If excessive sediments are measured in a monitor well, the well will be redeveloped.

5.2 MOBILIZATION

Initial field activities will include obtaining utility clearances and mobilizing to the site. These activities are described in Sections 5.2.1 through 5.2.2.

5.2.1 Clearing Utilities

Prior to and during mobilization activities, reasonable measures will be undertaken to locate above ground and underground utilities before work begins in accordance with Sierrita policies. A locator service may be used to locate utilities. If utilities are identified in an area to be excavated or drilled, the utilities will be clearly marked with paint, plumes, stakes, flagging, or other appropriate marker. Intrusive work will not begin until utility locations are identified and marked, and clearance is issued by Sierrita, if applicable.

5.2.2 Mobilization

Appropriate personnel, equipment, and materials will be identified for mobilizing and demobilizing to and from the site to conduct each task of the field investigation. The mobilization will include URS personnel, utility locating subcontractor(s), Geoprobe® subcontractor(s), drilling subcontractor(s), and state of Arizona registered land surveyors.

5.3 SAMPLING PROCEDURES

This section describes the equipment and procedures that will be used during the sampling activities, including brief descriptions of Geoprobe soil and sediment sampling, soil boring sampling, geophysical logging, groundwater sampling, and process water sampling.

5.3.1 Geoprobe Soil and Sediment Sampling

Subsurface soil sampling equipment will be advanced to various depths using direct push Geoprobe technology. Soil samples will be collected at the intervals specified in Section 4. One composite sample will be collected from each interval. The composite sample collected from each interval and will be homogenized prior to filling the sample container. At each location, the penetration will be filled to ground surface with granular bentonite after sampling is completed.

The Geoprobe sampling method consists of advancing the sample rods by hydraulically pushing or driving the rods to the desired sample collection depth. URS will collect soil samples with a Macro-core® sampling device to maximize sample volume. The Macro-core sampler collects a soil core in a non-reactive plastic or acetate liner that is 4 feet long and 1.5 inches in diameter.

The Geoprobe stainless steel tube will be lined with a clear acetate sleeve and driven to a target depth or refusal. The exterior of the acetate sleeves will be labeled with a permanent marker; to indicate sample station number, top and bottom, and depth intervals bgs. The Geoprobe unit will be moved to the next sample location, and the procedure repeated. Sleeves containing soil samples will be transported to a centralized sample preparation area, where they will be logged and processed for analysis.

Acetate sleeves will either be cut into sections (i.e., sample intervals) with a hacksaw, or cut open lengthwise. Using the interval markings as a guide, soil samples will be placed into 2-gallon bags, then sealed and labeled with the sample number; which includes the sample medium, station number, depth interval, and date and time collected. When a sample portion is selected for laboratory analysis, the soil will be transferred into laboratory containers using disposable spatulas or spoons. Sample station number, depth interval, date and time, and analyses requested will be noted on the boring logs and in the field logbook. Chain-of-custody forms will be completed in accordance with standard industry protocols.

A field geologist will describe and identify the soil samples using ASTM D 2488, the visual manual procedure, according to the Unified Soil Classification System (USCS). The following information will be recorded on the lithologic logs:

- Grain size distribution (percent by visual estimation)
- Angularity of coarse grained particles
- Consistency
- Cementation
- Plasticity
- Moisture conditions
- Color using the Munsell Color charts

5.3.2 Soil Boring Sampling

Soil borings within the tailing impoundments will be advanced using a CME 1250 track-mounted drilling rig equipped with hollow stem augers. Soil samples will be collected on 5-foot intervals and composited every 20 feet. URS will use the following general sampling procedures, which may be modified at the site depending on actual site conditions.

- The borings will be drilled using 4 1/4-inch inner diameter (ID) hollow stem augers, creating a borehole of approximately 8 7/8 inches in diameter. The borings will be drilled to depths of approximately 100 feet bgs in the Esperanza tailing impoundment and 220 feet bgs in the Sierrita tailing impoundment.
- Soil samples will be collected from each boring on 5-foot intervals, beginning at ground surface. The soil samples will be collected using a California modified split spoon sampler. Upon removal from the split spoon, the soil samples will be placed into a 2-gallon bag, sealed, and homogenized; and labeled with the sample number which includes the sample medium, boring number, and depth interval.
- Every 20 feet, a 4-part composite will be homogenized into a separate 2-gallon bag using a clean or disposable spatula or spoon, and then placed into a laboratory container for shipment to the laboratory.
- Water generated during the decontamination will be contained in 55-gallon drums and labeled as investigation derived waste (IDW). The drums will be stored at each boring until approval is received to empty them onto the tailing impoundment.
- Upon completing each boring, the soil cuttings will be backfilled into the borehole. Non-shrink bentonite grout will be placed in the upper 2 feet of the borehole and hydrated with water. The drilling contractor will restore the work area to a reasonable condition and remove any trash generated during the work. Excess cuttings will be spread out on the tailing impoundment.

A field geologist will describe the soil samples using ASTM D 2488, the visual manual procedure, according to the USCS. Although tailing is expected to be relatively homogeneous, the following information will be recorded on the lithologic logs:

- Grain size distribution (percent by visual estimation)
- Angularity of coarse grained particles
- Consistency
- Cementation
- Plasticity
- Moisture conditions
- Color using the Munsell Color charts

5.3.3 Groundwater Sampling

Monitor wells will be sampled after well development using low-flow purging and sampling procedures (Section 5.4.6).

5.3.4 Process Water Sampling

Process fluids from the ponds will be sampled. Grab samples will be collected from a sampling port or other point in the system to obtain representative samples. If not available, URS will collect grab samples from the ponds using a pole sampler.

5.4 MONITOR WELL ACTIVITIES

This section describes the equipment and procedures that will be used for monitor well installation, development, purging, and sampling. Monitor wells will be installed in accordance with Standard Operating Procedure (SOP)-002a.

5.4.1 Geoprobe Monitor Well Installation

Geoprobe direct push technology (DPT) will be used to create a borehole for installing temporary wells downgradient of active and inactive process solution ponds. Temporary well screens will be set in selected boreholes that encounter alluvial groundwater and the installation consists of the following steps:

- Prepacked screens will consist of a standard, slotted polyvinyl chloride (PVC) well screen pipe surrounded by a stainless steel mesh. Sand will be factory-packed between the slotted PVC and the stainless steel mesh. A 2.5-inch outer diameter (OD) prepack well assembly with a 1-inch Schedule 40 PVC riser will be used. This well assembly will be installed with 3.25-inch OD probe rods. All casing and screen material will be received in original factory packaging.
- The bottom of each screen will be sealed with a flush-threaded end cap.
- The annulus around the well screens will be filled with a sand pack consisting of size 20/40 sand. In addition, 20/40 sand will be used above the screen as a barrier. With the barrier in place, granular bentonite will be installed in the annulus to form the well seal.

5.4.2 Permanent Monitor Well Installation

Boreholes for monitor wells within the mill areas will be advanced using a CME 1250 track-mounted drilling rig equipped with air rotary casing hammer (ARCH) technology. These wells

will be collocated with judgmental boring locations. URS will use the following general sampling and well installation procedures, which may be modified at the site depending on actual site conditions:

- The monitor well borings will be drilled using a 9 5/8-inch diameter downhole hammer bit, creating a borehole of approximately 8 7/8-inches in diameter. The ARCH drill rig will use steel drive casing to create and stabilize the borehole. This method uses a casing hammer to advance steel casing concurrently with drilling. Compressed air will be used to lift cuttings from the borehole, which will be discharged through a cyclone and into a portable hopper. ARCH drilling reduces the potential for cross contamination of the aquifer and allows for direct placement of annular well materials during well construction.
- A field geologist will collect cuttings on 5-foot intervals from the cyclone. The cuttings will be logged in accordance with the USCS. Disturbed cuttings will be logged to establish basic borehole lithology, and cannot be relied upon alone for correlating or establishing stratigraphy. The following information will be noted on the lithologic logs:
 - Grain size distribution (percent by visual estimation)
 - Angularity of coarse grained particles
 - Consistency
 - Cementation
 - Plasticity
 - Moisture conditions
 - Color using the Munsell Color charts
- Well riser and screen material will be 4-inch, Schedule 80 PVC with flush-threaded joints. Well screen material will be 10 feet long and factory slotted with a slot size of 0.020 inches. All casing and screen material will be received in original factory packaging.
- The bottom of each well will be sealed with a flush-threaded end cap. Casing and screen materials will be installed to ensure that the wells are plumb and correctly aligned.
- The annulus around the well screens will be filled with a sand pack consisting of size 8/12 sand extending from the bottom of the boring to about 5 feet above the screen section. The filter pack will be placed into the borehole through a tremie pipe. The

drilling subcontractor will continuously monitor the depth of the filter pack with a weighted measuring tape.

- A 3-foot thick bentonite seal will be placed directly above the filter pack. The seal will be composed of commercially manufactured bentonite pellets or chips (0.25-inch diameter). The bentonite pellets will be placed into the borehole and hydrated before the rest of the well annulus is sealed. The drilling subcontractor will confirm the proper depth of the seal with a weighted measuring tape.
- An annular seal will be placed above the 3-foot bentonite seal. The annular seal will be a cement grout consisting of a mixture of Portland cement, bentonite, and water. The grout ratio will consist of about 7.5 gallons of water mixed with 4 pounds of bentonite, then mixed with one 94-pound bag of cement. The cement grout will be tremied into the borehole. The tremie pipe will be placed no more than 3 feet above the top of the bentonite seal. The grout will be conveyed via tremie pipe into the borehole and will continue until undiluted grout returns to the top of the borehole (at the ground surface). The quantity of grout used will be recorded on the well log.
- Monitor wells will be completed above grade with a locking steel shroud. The top of the PVC well riser pipe will be surrounded by an oversized diameter steel casing set in 3,000-pound-per-square-inch concrete at least 3 feet above ground surface. A vented well cap will be installed on each well casing. Locks will be brass and will be keyed alike. If requested, locks provided by Sierrita will be installed.
- A concrete apron (5 feet by 5 feet by 4 inches thick) will be constructed, with the concrete surface sloped away from the well.
- Protective bollards will be concreted outside of the concrete apron. Four, 3-inch diameter, 6-foot long bollard posts will be set in concrete, and spaced equally around the concrete pad. The bollards will set at 36 inches high, and will be painted with yellow reflective paint.
- A well completion diagram form will be completed for each well. All well materials and quantities used will be described in the field logbooks.

5.4.3 Well Development

Monitor wells will be developed in accordance with SOP-0023. The well development process will include surging and bailing to remove fines from the filter pack material, followed by pumping to remove suspended solids. The wells will be further developed after completion using

a Smeal development rig or equivalent. Well development will be conducted after the well has been allowed to stabilize for a minimum of 72 hours.

Temperature, pH, specific conductivity, dissolved oxygen (DO), and turbidity will be monitored during surging and pumping. Surging and pumping will continue until these parameters stabilize (less than 0.2 pH units or a 10 percent change for the other parameters between three consecutive readings), and the water exhibits a nephelometric turbidity unit (NTU) reading of 10 or less. If the parameters have not stabilized after 3 hours, development will cease with the well being recorded as developed. Well development information will be recorded on a well development form.

Development water will be containerized in portable tanks for proper characterization and disposal. Development water will be treated as IDW.

5.4.4 Pumps

After well development is complete, URS will install dedicated micropurge bladder pumps in each monitor well. The pumps will be stainless steel with Dura-Flex Teflon[®] bladders, 316 stainless steel intakes, 3/8-inch Teflon-lined polyethylene tubing for discharge, and 1/4-inch polyethylene tubing for supply air. The pump intakes will be set at mid-screen in each of the wells.

5.4.5 Surveying

The monitor wells will be surveyed by an Arizona registered land surveyor following pump installation. For each well, the coordinates and elevation of the north side of the top of the well casing and the rim of the well vault will be surveyed. The vertical data will be referenced to mean sea level using the National Geodetic Vertical Datum (NGVD) 29 reference system.

5.4.6 Well Purging and Sampling

Newly installed monitor wells, temporary wells, and existing monitor wells will be purged and sampled in accordance with SOP-005. Low-flow sampling methodology will be used for newly installed wells. Existing monitor wells with dedicated (submersible) pumps will be sampled using existing equipment and the total well volume methodology.

5.4.6.1 Low-Flow Purge Methodology

For the low-flow purging methodology, the well will be purged until field parameters (pH, temperature, turbidity, DO, oxygen reduction potential [ORP], and conductivity) have stabilized.

Readings will be taken at a rate commensurate for the flow involved, but no sooner than every 3 minutes. Low-flow purging rates on the order of 0.1 to 1.0 liter per minute will be used depending on the site-specific hydrogeology. The maximum allowable drawdown during low-flow purging is 0.3 feet. If the maximum allowable drawdown limit of 0.3 feet is exceeded and cannot be achieved, then the Total Volume Purge Method described in Section 5.4.6.2 will be followed. Background wells being sampled for metals must attain a turbidity of 10 NTUs or less before sample collection unless a written variance (on a well-specific basis) is acquired. The turbidity goal for non-background samples is 15 NTU, but samples with higher turbidity are acceptable if turbidity readings are stabilized and the other conditions of low-flow purging have been met.

Low-flow purging is complete only when all required field parameters have stabilized (temperature, pH, turbidity, conductivity, DO, and ORP). Stabilization is achieved when two consecutive readings show temperature is within \pm one degree Celsius, pH values are within \pm 0.1 pH unit, turbidity is less than or equal to 10 NTUs or within \pm 10 percent, conductivity is within \pm 5 percent, DO is within \pm 10 percent, and ORP is within \pm 10 millivolts (mV). The Site Manager/Field Task Leader will determine if redevelopment of any monitoring well is necessary and appropriate.

5.4.6.2 Total Well Volume Purge Methodology

If a water level drawdown greater than 0.3 feet occurs at a purge rate of 0.1 liter per minute or less, or if it is deemed necessary due to an existing dedicated pump, the total well volume purge methodology will be used. Using the total well volume purging methodology, the well will be purged until a minimum of three total well casing volumes have been removed and field parameters (pH, temperature, turbidity, conductivity, DO, and ORP) have stabilized. A pumping rate will be established to minimize drawdown and will not exceed 2 liters per minute. When purging by this methodology, if parameters have not stabilized after six well casing volumes, then purging will cease and samples will be collected. Background wells being sampled for metals must attain 10 or less NTUs before sample collection unless a written variance (on a well-specific basis) is acquired. The turbidity goal for non-background samples is 15 NTU, but samples with higher turbidity are acceptable if turbidity readings are stabilized and the other conditions of total well volume purging have been met.

The volume of water in the well will be calculated based on the length of the saturated thickness in the well and the screen diameter (see below for calculation of volumes). The well volume will be calculated in gallons using the following equation:

$$\text{Well Volume (V) (in gallons)} = H \times F$$

where V = one well volume

H = the difference between the depth of the well and depth of water (feet)

F = factor for volume of one foot section of casing (gallons) from the table below

Diameter of Casing (inches)	F Factor (gallons)
1.5	0.09
2.0	0.16
3.0	0.37
4.0	0.65
6.0	1.47

F can also be calculated from the following equation:

$$F = H (D/2)^2 \times 7.48 \text{ gal/ft}^3$$

where D = the inside diameter of the well casing (feet)

The well will be sampled immediately following purging without moving or adjusting the position of the pump. Necessary precautions will be taken to prevent spilling potentially contaminated water. The water will need to be containerized and appropriately disposed of or treated prior to discharge.

If the well is purged dry with a flow rate of less than 2 liters per minute, it will be sampled as soon as possible after the minimum sample volume of groundwater has recharged the well. The requirements of a minimum of three well volumes purged and stabilization of field parameters will not be applied to sampling a well that has been purged dry if the pumping rate was less than 2 liters per minute.

Total well volume purging is complete only when all required field parameters have stabilized (temperature, pH, turbidity, conductivity, DO, and ORP) or six well casing volumes have been removed, whichever comes first. Water parameters will be measured after removal of each volume and approximately every 5 minutes after the first two well casing volumes. Stabilization is achieved when two consecutive readings show temperature is within ± 1 degree Celsius, pH values are within ± 0.1 pH unit, turbidity is less than or equal to 10 NTUs or within ± 10 percent, conductivity is within ± 5 percent, DO is within ± 10 percent, and ORP is within ± 10 mV. The

Site Manager/Field Task Leader will determine if redevelopment of any monitoring well is necessary and appropriate.

5.4.6.3 Records

Field notes will be kept in a bound field logbook and on a Monitoring Well Purging Form as required by SOP-019, *Field Activity Records*. The following information will be recorded using waterproof ink:

- Names of sampling personnel
- Weather conditions
- Project title
- Location and well number
- Date and time of sampling
- Condition of the well
- Decontamination information
- Initial and final static water level, total well depth
- Equipment calibration information
- Method of purging
- Volume of water purged before sampling
- Purge start/stop times
- Pumping rate, if applicable
- Field parameter measurements during purging
- Method of sample collection
- Sample identification numbers
- Photo documentation, if applicable
- Quality Assurance/Quality Control (QA/QC) samples collected
- Irregularities or problems

5.5 DECONTAMINATION

Equipment decontamination will be conducted in accordance with SOP-021. Before undertaking any sampling activities, the Geoprobe and drilling subcontractors will construct decontamination pads for the equipment used at the site. Down-hole drilling, sampling, and geophysical logging equipment will be decontaminated.

Reusable equipment used to collect, handle, or measure samples will be decontaminated in accordance with SOP-021. The decontamination procedure will match the degree of contamination on the sampling equipment. All items that will come in contact with potentially contaminated media will be decontaminated before each use. If decontaminated sampling equipment is not used immediately, it will be covered with plastic. Decontamination episodes and deviations from decontamination procedures will be recorded in the designated field logbook. The general decontamination procedures for equipment includes (1) an Alconox[®] and water solution wash, (2) thorough tap water rinse, and (3) final deionized water rinse.

5.6 INVESTIGATION-DERIVED WASTE MANAGEMENT

IDW will be managed in accordance with SOP-020. A waste accumulation area will be used for the temporary storage of field generated waste, such as soil cuttings, drilling and well development fluids, purge water, decontamination fluids, and personal protective equipment (PPE). Other wastes will include discarded materials resulting from field activities that, in their present form, possess no inherent value such as disposable sampling tools, bags, paper towels, etc. Waste materials generated during the investigation activities will be managed and tracked. The wastes will be divided into soil, water, and PPE.

To ensure the appropriate disposal of IDW, a tracking system will document the information necessary to determine the amount of contamination present in the waste. Waste tracking will be performed by a field manager and includes the following activities: segregation by waste type, waste container labeling, waste container movement, waste container storage, and waste disposal.

Soil cuttings and potentially contaminated water will be contained in 55-gallon drums, roll-off bins, and portable water tanks on site near each sampling location. Disposable PPE, including Tyvek[™] coveralls, gloves, and booties will be decontaminated and disposed of as non-hazardous waste.

URS and its subcontractors will contain small quantities of soil and potentially-contaminated water in 55-gallon drums. Roll off bins may be used for containing soil cuttings. Samples of

solid and liquid IDW will be collected and submitted to an analytical laboratory for analysis. Based on analytical results received, soils and sediments may be re-used if concentrations are below residential SRLs or recycled if the material has legitimate copper or molybdenum values. Liquid IDW may be re-used or recycled through mine operations if the liquid is free of excess contamination or if the liquid has legitimate copper or molybdenum values, respectively. IDW that is not recycled or re-used by Sierrita will be transported to an approved disposal.

5.7 SAMPLE HANDLING AND ANALYSIS

This section describes sample handling, sample analysis, QC requirements, field instrumentation, and data management.

5.7.1 Sample Designation

Each sampling location will be identified with an alphanumeric designation according to the following sample classifications:

- **Grid Sample Designation** – Grid samples include soil and sediment samples collected at grid nodes from grid systems of 200-foot-square grid units. The grid sample designation will include three fields that are separated by dashes; consider the following example: **B03-0.0-0.5**.

The first field, “**B03**,” identifies the grid node numbering. The single-digit alpha character (B) represents the vertical grid lines, and double-digit numeric character (03) represents the horizontal grid lines. The grid node is the point where the grid lines intersect.

The second field “**0.0**,” represents the top of the sample interval measured in feet bgs.

The third field “**0.5**,” represents the bottom of the sample interval measured in feet bgs.

- **Judgmental Sample Designation** – Judgmental samples include soil and sediment samples that are not considered grid samples. The judgmental sample designation will include three fields that are separated by dashes; consider the following example: **JS04-2.0-4.0**.

The first field, “**JS04**,” identifies the judgmental sample number. The first two alpha characters are the designation for judgmental sample (JS). The numerical characters (04) that follow JS are the distinct number for that judgmental sample location.

The second field “**2.0**,” represents the top of the sample interval measured in feet bgs.

The third field “**4.0**,” represents the bottom of the sample interval measured in feet bgs.

- **Sediment Sample Designation** – Sediment samples include only those samples that are collected from the channels of washes or pond bottoms. The sediment sample designation will include three fields that are separated by dashes; consider the following example: **SD01-0.5-1.0**.

The first field, “**SD01**,” identifies the sediment sample number. The first two alpha characters are the designation for sediment sample (SD). The numerical characters (01) that follow SD are the distinct number for that judgmental sample location.

The second field “**0.5**,” represents the top of the sample interval measured in feet bgs.

The third field “**1.0**,” represents the bottom of the sample interval measured in feet bgs.

- **Soil Boring Sample Designation** – Soil boring samples include the (5 part) composite samples collected at the tailing impoundments. The soil boring sample designation will include three fields that are separated by dashes; consider the following example: **SB01-50-100**.

The first field, “**SB01**,” identifies the soil boring.

The second field “**50**,” represents the top of the sample interval measured in feet bgs.

The third field “**100**,” represents the bottom of the sample interval measured in feet bgs.

- **Groundwater Sample Designation** – Groundwater samples include groundwater samples from temporary and permanent monitor wells. The groundwater sample designations will include two fields that are separated by a dash; consider the following examples: **MW2008-01** and **TW2008-01**.

The two alpha characters in the first field, “**MW**,” or “**TW**” identifies whether the sample came from a permanent monitor well (MW) or a temporary monitor well (TW) followed by the year, 2008.

The second field “**01**,” represents the numerical designation of the MW or TW.

- **Field Duplicate Sample Designation** – Field duplicate samples will be identified by adding a “D” to the end of the sample designations described above; for example **MW-01D** and **SD01-0.5-1.0D**.
- **Matrix Spike/Matrix Spike Duplicate Sample Designation** – Matrix spike/matrix spike duplicate will be identified by adding an “MSD” to the end of the sample designations described above; for example **MW-01MSD** and **SD01-0.5-1.0MSD**.
- **Trip and Field Blank Sample Designations** – Trip and field blank samples will be identified sequentially beginning with **Trip-1** and **Field-1**, respectively.

5.7.2 Sample Container, Volume, Preservatives, and Holding Time Requirements

Table 5-1 specifies the required sample volume, container type, preservation technique, and holding time for analysis. This table includes aqueous and solid sample matrices, and includes information for organic, inorganic, and general chemistry parameters in each matrix. Required containers, preservation techniques, and holding times for field QC samples (such as duplicates, field blanks, trip blanks, and matrix spike/matrix duplicates) are the same as for investigative samples.

5.7.3 Sample Management and Tracking

Each sample will be traceable from the point of collection through analysis and final disposition to ensure sample integrity. URS will use standard EPA procedures to identify, track, monitor, and maintain chain-of-custody for all samples. These procedures are discussed further in the generic QAPP and include the following:

- Field chain-of-custody procedures
 - Field Procedures
 - Field logbooks
- Laboratory chain-of-custody procedures

5.7.4 Sample Analysis

This section describes analytical procedures for samples collected during field activities. **Table 5-1** lists the laboratory analytical methods and more details are provided in the attached QAPP. In all cases, appropriate methods of sample preparation, cleanup, and analysis are based on specific analytical parameters of interest, sample matrices, and required detection limits.

- Radionuclides; including gross alpha, gross beta, isotopic radium (Ra-226 and Ra-228), isotopic uranium (U-234, U-235, and U-238), and dissolved U mass
- Dissolved metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc
- Field analyses including pH, conductivity, temperature, DO, turbidity, and redox potential
- General chemical parameters including total dissolved solids, major cations (calcium, magnesium, sodium, and potassium) and major anions (sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate)

5.7.5 Quality Control

Field and laboratory QC samples and measurements will be used to verify that data meet the QA objectives. Field QC samples are collected to assess how sampling activities influence data quality. Similarly, laboratory QC samples will be used to assess how a laboratory's analytical program influences data quality.

Field QC samples will be collected and analyzed to assess the influence of sampling activities on data quality, and will include field duplicate and equipment rinsate samples. Trip blanks and field blanks will not be collected since the COIs do not include volatile organic compounds (VOCs).

Laboratory QC samples will include Matrix Spike/Matrix Duplicate (MS/MD) samples. Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will not be collected since the COIs do not include VOCs.

Field Duplicate – Samples are independent samples collected as close as possible, in space and time, to a sample. Field duplicate samples can measure the influence of sampling and field procedures on the precision of an environmental instrument. They can also provide information on the heterogeneity of a sampling location. Immediately after a sample is collected, the field duplicate sample is collected using the same collection method. Field duplicates are collected at a frequency of one for every 20 investigative samples of the same matrix type and are analyzed for the same analytes as the original sample.

Equipment Rinsate – Blanks are collected when devices, such as trowels and split spoons, are used to collect samples. These data are used to assess the cleanliness of the sampling equipment

and the effectiveness of equipment decontamination. Equipment rinsate blanks are collected by pouring analyte-free water over the surfaces of sampling equipment that contacts sampling media. Equipment rinsate blanks are collected after sampling equipment has been decontaminated but before the equipment is reused for sampling. Equipment rinsate blanks are typically collected at a frequency of one for every 20 or fewer samples and are analyzed for all total analytes. Equipment rinsate blanks will not be used when disposable or dedicated sampling equipment is used.

Matrix Spike/Matrix Duplicate (MS/MD) – Samples will be used to measure the accuracy and precision of laboratory analyses of inorganic and general chemistry parameters. MS samples will be used to measure accuracy, while MS/MD samples will be used to measure precision. Each of these QC samples will be collected and analyzed at a frequency of one for every 20 investigative samples per matrix.

Frequency of Field Quality Control Samples

Field Quality Control Sample	Frequency	
	Aqueous Matrix	Solid Matrix
Field Duplicate	1 per 20 samples (all analyses)	1 per 20 samples (all analyses)
Equipment rinsate blank	1 per 20 samples (all analyses)	None
Matrix spike/matrix duplicate (inorganics only)	1 per 20 samples (inorganics and general chemistry)	1 per 20 samples (inorganics and general chemistry)

QC checks for field measurements will consist mainly of initial and continuing calibration checks of field equipment. When applicable, QC check standards independent of the calibration standards may be used to check equipment performance. For example, to check the accuracy of field equipment such as a pH meter, standard buffer solutions independent of the calibration standards may be used. Precision of field measurements will usually be checked by taking replicate measurements. The types and frequencies of field QC measurements and the QC limits for these measurements will follow EPA-approved methods.

5.8 FIELD INSTRUMENTATION

This section outlines procedures and guidelines that will be followed to ensure equipment and instruments function accurately and consistently.

5.8.1 Field Instrument and Equipment Testing, Inspection, and Maintenance Requirements

The following summarizes testing, inspection, and maintenance procedures for field equipment and instruments. Instrument testing, inspection, and maintenance procedures are based on the following:

- The type of instrument
- The instruments' stability characteristics
- The required accuracy, sensitivity, and precision of the instrument
- The instrument's intended use, considering project-specific data quality objectives (DQOs)
- The instrument manufacturer's recommendations
- Other conditions affecting measurement or operational control

For most instruments, preventative maintenance is performed in accordance with procedures and schedules recommended in (1) the instrument manufacturer's literature or operating manual, or (2) SOPs associated with particular applications of the instrument.

In some cases, testing, inspection, and maintenance procedures and schedules will differ from the manufacturer's specifications or SOPs. Procedures or schedules can differ, for example, when a field instrument is used to make critical measurements or when the analytical methods associated with a laboratory instrument require more frequent testing, inspection, and maintenance.

Once arrived at the site, field equipment and instruments will be inspected for damage. Damaged equipment and instruments will be replaced or repaired immediately. Battery-operated equipment will be checked to assure full operating capacity; if needed, batteries will be recharged or replaced. Critical spare parts—such as tape, paper, pH probes, electrodes, and batteries—will be kept on site to minimize equipment downtime.

Following use, field equipment will be properly decontaminated before being returned to its source. When equipment is returned, copies of any field notes regarding equipment problems will be included so that necessary repairs are carried out.

5.8.2 Field Calibration and Frequency

Field sampling and measurement equipment will be examined upon arrival by the URS Field Team Leader to verify that it is in good working condition by checking the instrument with calibration standards, or testing the operation or function of the equipment. The manufacturer's operating manual and instructions that accompany the equipment will be consulted to ensure that calibration procedures and user directions are followed. The precision of field measurements will be checked by taking replicate measurements. Field measuring equipment will be calibrated daily.

TABLES

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
Demetrie Wash				
Former CLEAR Plant	Former operations included process that used solutions containing COIs. Limited data exist to confirm that the CLEAR Plant has not adversely affected the environment.	Surface and subsurface soil	Gather data to confirm that there has not been a release of COIs from CLEAR Plant to soil.	Establish a systematic grid with 200 foot centers over the entire plant area. Collect soil samples from the surface to bedrock at 10 random grid locations.
	Historical soil sampling identified several locations with elevated levels of antimony, arsenic, copper, and lead.	Surface and subsurface soil	Gather data to further delineate the areas having highest concentrations of COIs.	Collect soil samples from the surface to bedrock at 3 judgmental locations having the highest concentrations of COIs.
	No data exist to confirm that overflows and/or runoff from the facility have not impacted drainage channels and sediment.	Sediment	Confirm that releases of COIs from the CLEAR Plant have not occurred to sediment in drainage channels.	Collect sediment samples from 2 locations in each of the five drainage paths.
	Facility managed large quantities of process solutions stored in above ground storage tanks and impoundments. Samples have not been collected to confirm that the facility has not adversely impacted underlying groundwater. There are no existing monitor wells in this area.	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the CLEAR Plant.	Install one upgradient monitor well to characterize background groundwater quality. Install one monitor well immediately downgradient of the plant area to characterize groundwater quality. Collect groundwater samples for four consecutive quarters.
Former E Pond	Unlined impoundment reportedly collected surface runoff from CLEAR Plant. Samples have not been collected to confirm that the pond has not adversely impacted subsurface soils.	Subsurface Soil	Confirm that the pond did not release elevated concentrations of COIs from solutions to subsurface soil.	Collect soil samples from the surface to bedrock at 2 judgmental locations drilled within the pond area.
	Samples have not been collected to confirm that the pond has not adversely impacted underlying groundwater. There are no existing monitor wells to monitor this area.	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the Former E Pond.	Install one monitor well immediately downgradient of the pond to characterize groundwater quality. Collect groundwater samples for four consecutive quarters.

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
				Resulting groundwater data will be compared to CLEAR Plant upgradient well
Former Evaporation Pond	Process solutions were stored in this lined pond. Samples have not been collected to confirm that the pond has not adversely impacted subsurface soil.	Subsurface Soil	Confirm that the pond did not release elevated concentrations of COIs from process solutions to subsurface soils.	Collect soil samples from the surface to bedrock at 2 judgmental locations drilled within the pond area.
	Samples have not been collected to confirm that the pond has not adversely impacted underlying groundwater. There are no existing monitor wells to monitor this area.	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the Former E Pond.	Install one monitor well immediately downgradient of the pond to characterize groundwater quality. Collect groundwater samples for four consecutive quarters. Resulting groundwater data will be compared to CLEAR Plant upgradient well.
Old D Pond	Process solutions were stored in this unlined pond. Samples have not been collected to confirm that the pond has not adversely impacted subsurface soil.	Subsurface Soil	Confirm that the pond did not release elevated concentrations of COIs from process solutions to subsurface soils.	Collect soil samples from the surface to bedrock at 2 judgmental locations drilled within the pond area.
	No data exist to confirm that overflows and/or runoff from the facility have not impacted drainage channels and sediment.	Sediment	Confirm that releases of COIs from the Old D Pond have not occurred to sediment in drainage channels.	Collected sediment samples from 4 locations upgradient and 2 locations downgradient of the pond.
	Samples have not been collected to confirm that the pond has not adversely impacted underlying groundwater. There are no existing monitor wells to monitor this area.	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the Old D Pond.	Install one upgradient monitor well to characterize background groundwater quality. Install one monitor well immediately downgradient of the pond to characterize groundwater quality.

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
				Collect groundwater samples for four consecutive quarters.
Former Esperanza Mill	Historic mill that separated copper using floatation process included mill, thickeners, and raw water pond. Historical soil sampling identified several locations with elevated levels of arsenic.	Surface and subsurface soil	Gather data to confirm that there has not been a release of COIs from Former Esperanza Mill to soil.	Establish a systematic grid with 200-foot centers over the entire plant area. Collect soil samples from the surface to bedrock at 10 random grid locations.
Former C Pond	Historic unlined pond used to contain run-off from Sierrita Mill area. Limited data exist to confirm that the pond has not adversely impacted surface and subsurface soils.	Surface and subsurface soil	Gather data to confirm that there has not been a release of COIs from Former C Pond to soil.	Collect soil samples from the surface to bedrock at 5 judgmental locations drilled within the pond area.
	Samples have not been collected to confirm that the pond has not adversely impacted underlying groundwater. There are no existing monitor wells to monitor this area.	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the Former C Pond.	Install one monitor well upgradient and one monitor well immediately downgradient of the pond to characterize groundwater quality. Collect groundwater samples for four consecutive quarters.
Former C Pond Spoils	Sediments dredged from Former C Pond were disposed to the ground surface immediately east of the Former C Pond. No data exist to confirm that the spoils have not adversely impacted surface and subsurface soils.	Surface and subsurface soil	Gather data to confirm that there has not been a release of COIs from Former C Pond Spoils to soil.	Collect soil samples from the surface to bedrock at 4 judgmental locations drilled within the spoils area.
Former Raffinate Pond	Historical unlined pond used to hold raffinate solution potentially containing COIs. Limited data exist to confirm that the pond has not adversely impacted surface and subsurface soils.	Surface and subsurface Soil	Gather data to confirm that there has not been a release of COIs from Former Raffinate Pond to soil.	Collect soil samples from the surface to bedrock at 5 judgmental locations drilled within the pond area.

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
	<p>Samples have not been collected to confirm that the pond has not adversely impacted underlying groundwater.</p> <p>There are no existing monitor wells to monitor this area.</p>	Groundwater	Confirm that releases of COIs to groundwater have not occurred from the Former Raffinate Pond.	<p>Install one upgradient monitor well to characterize background groundwater quality.</p> <p>Install two monitor wells immediately downgradient of the pond to characterize groundwater quality.</p> <p>Collect groundwater samples for four consecutive quarters.</p>
Amargosa Wash				
Headwall No. 1 and Bailey Lake	Active ponds used to collect PLS. Headwall No. 1 and Bailey Lake were sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from each Headwall No. 1 and Bailey Lake for four consecutive quarters.
	Samples have not been collected to confirm that the ponds have not adversely impacted groundwater.	Groundwater	Confirm that the ponds have not released elevated concentrations of COIs from process solutions to groundwater.	<p>Install and sample two temporary alluvial wells immediately downgradient of the ponds.</p> <p>Collect groundwater samples from the wells for four quarterly sampling events.</p>
Raffinate Pond No. 2	Active pond used to contain copper depleted solutions. Raffinate Pond No.2 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Raffinate Pond No. 2 for four consecutive quarters.
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	<p>Install and sample one temporary alluvial well immediately downgradient of Raffinate Pond No.2.</p> <p>Collect groundwater samples from the well for four quarterly sampling events.</p>
Former A Pond	<p>Former A Pond was used to retain stormwater or leach solutions that overflow Amargosa Pond.</p> <p>Samples have not been collected to confirm that the pond has not adversely</p>	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	<p>Install and sample one temporary alluvial well immediately downgradient of Former A Pond.</p> <p>Collect groundwater samples from the well for four quarterly sampling events.</p>

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
	impacted groundwater.			
Former B Pond	Former B Pond was used to retain stormwater or leach solutions that overflow Amargosa Pond. Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of Former B Pond. Collect groundwater samples from the well for four quarterly sampling events.
Launders Facility	Inactive facility where concrete bins were used to contain PLS. Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of the Launders Facility. Collect groundwater samples from the well for four quarterly sampling events.
Esperanza Wash				
Headwall No. 2	Active pond used to collect PLS. Headwall No. 2 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Headwall No. 2 for four consecutive quarters.
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of Headwall No. 2. Collect groundwater samples from the well for four quarterly sampling events.
Headwall No. 3	Active pond used to collect PLS. Headwall No. 3 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Headwall No. 3 for four consecutive quarters.
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of the pond. Collect groundwater samples from the well for four quarterly sampling events.
Raffinate Pond No. 3	Active pond used to contain copper depleted solutions. Raffinate Pond No. 3 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Raffinate Pond No. 3 for four consecutive quarters.

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of Raffinate Pond No. 3. Collect groundwater samples from the well for four quarterly sampling events.
SX Plant No. 3	Samples have not been collected to confirm that the plant has not adversely impacted groundwater.	Groundwater	Confirm that the plant has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of SX Plant No. 3. Collect groundwater samples from the well for four quarterly sampling events.
Headwall No. 4	Active pond used to collect PLS. Headwall No. 4 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Headwall No. 4 for four consecutive quarters.
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Confirm that the pond has not released elevated concentrations of COIs from process solutions to groundwater.	Install and sample one temporary alluvial well immediately downgradient of Headwall No. 4. Collect groundwater samples from the well for four quarterly sampling events.
Tinaja and Unnamed Washes				
Headwall No. 5	Active pond used to collect PLS. Headwall No. 5 was sampled once in 1998.	Not applicable	Characterize COIs in process solution.	Collect one sample from Headwall No. 5 for four consecutive quarters.
	Samples have not been collected to confirm that the pond has not adversely impacted groundwater.	Groundwater	Characterize immediately underlying alluvial groundwater	Install and sample one temporary alluvial well immediately downgradient of Headwall No. 5. Collect groundwater samples from the well for four quarterly sampling events.
Tailing Impoundments				
Rhenium Ponds	Historical lined pond used to hold rhenium process solutions. Limited data exist to confirm that the Rhenium Ponds have not adversely impacted surface and subsurface soils.	Surface and subsurface soil	Gather data to confirm that there has not been a release of COIs from Rhenium Ponds to soil.	Collect soil samples from the surface to bedrock at 5 judgmental locations drilled within the footprint of the former Rhenium Ponds.

**Table 4-1
Sierrita VRP
Sampling Rationale**

Area of Interest	Problem Statement	Potentially Impacted Media	Objective	Proposed Sampling
Esperanza Tailing Impoundment	No data exist on the constituent make up of the tailing or the potential for leaching of COIs to groundwater.	Groundwater	Gather data to characterize COI concentrations and leachability of the tailing constituents.	Collect tailing samples every 10 feet (composite 2 samples each 20 foot) from 2 soil borings drilled through the Esperanza Tailing Impoundment into underlying basin and fill deposits.
Sierrita Tailing Impoundment	Limited data exist on COI concentrations in the reclaim pond.	Not applicable	Gather data to characterize COI concentrations in reclaim water.	Collect samples from the reclaim pond and tailing decant solution monthly to evaluate temporal and seasonal variation of solution quality.
	Only limited data on the constituent make up of the tailing or the potential for leaching of COIs.	Groundwater	Gather data to characterize COI concentrations and leachability of the tailing constituents.	Collect tailing samples every 10 feet (composite 5 samples each 50 foot) from 4 soil borings drilled through the Sierrita Tailing Impoundment into underlying basin and fill deposits.

**TABLE 4-2
SIERRITA VRP
SUMMARY OF FREQUENCIES AND LOCATIONS OF SAMPLES**

Sample Location Area	Interval (ft bgs)	Media	ANALYSES						
			SOIL / SEDIMENT		GROUNDWATER/SOLUTION				
			Metals ⁽¹⁾ (SW-7000 Series)	Radiochemistry ⁽²⁾	Dissolved Metals ⁽³⁾ (E200 Series)	Radiochemistry ⁽⁴⁾	Major Anions (SW-846 9056 or EPA 300.0)	TDS (Method 160.1)	Field Water Quality Parameters ⁽⁵⁾
Former CLEAR Plant	0 to 1	Soil	13	13					
	1 to 3	Soil	13	13					
	5 to 7	Soil	13	13					
	10 to 12	Soil	13	13					
	15 to 17	Soil	13	13					
	20 to 22	Soil	13	13					
	0 to 1	Sediment	20	20					
	1 to 3	Sediment	20	20					
20 to 40	Groundwater			8	8	8	8	8	
Former E Pond	0 to 1	Soil	2	2					
	1 to 3	Soil	2	2					
	5 to 7	Soil	2	2					
	10 to 12	Soil	2	2					
	15 to 17	Soil	2	2					
	20 to 22	Soil	2	2					
	20 to 40	Groundwater			4	4	4	4	4
Former Evap. Pond	0 to 1	Soil	2	2					
	1 to 3	Soil	2	2					
	5 to 7	Soil	2	2					
	10 to 12	Soil	2	2					
	15 to 17	Soil	2	2					
	20 to 22	Soil	2	2					
	20-40	Groundwater			4	4	4	4	4
Former D Pond	0 to 1	Soil	2	2					
	1 to 3	Soil	2	2					
	5 to 7	Soil	2	2					
	10 to 12	Soil	2	2					
	15 to 17	Soil	2	2					
	20 to 22	Soil	2	2					
	0 to 1	Sediment	6	6					
	1 to 3	Sediment	6	6					
	20-40	Groundwater			8	8	8	8	8
Former Esperanza Mill	0 to 1	Soil	10	10					
	1 to 3	Soil	10	10					
	5 to 7	Soil	10	10					
	10 to 12	Soil	10	10					
	15 to 17	Soil	10	10					
	20 to 22	Soil	10	10					
Former C Pond	0 to 1	Soil	5	5					
	1 to 3	Soil	5	5					
	5 to 7	Soil	5	5					
	10 to 12	Soil	5	5					
	15 to 17	Soil	5	5					
	20 to 22	Soil	5	5					
	20 to 40	Groundwater			8	8	8	8	8

**TABLE 4-2
SIERRITA VRP
SUMMARY OF FREQUENCIES AND LOCATIONS OF SAMPLES**

Sample Location Area	Interval (ft bgs)	Media	ANALYSES						
			SOIL / SEDIMENT		GROUNDWATER/SOLUTION				
			Metals ⁽¹⁾ (SW-7000 Series)	Radiochemistry ⁽²⁾	Dissolved Metals ⁽³⁾ (E200 Series)	Radiochemistry ⁽⁴⁾	Major Anions (SW-846 9056 or EPA 300.0)	TDS (Method 160.1)	Field Water Quality Parameters ⁽⁵⁾
C Pond Spoils	0 to 1	Soil	4	4					
	1 to 3	Soil	4	4					
	5 to 7	Soil	4	4					
	10 to 12	Soil	4	4					
	15 to 17	Soil	4	4					
	20 to 22	Soil	4	4					
Former Raffinate Pond	0 to 1	Soil	5	5					
	1 to 3	Soil	5	5					
	5 to 7	Soil	5	5					
	10 to 12	Soil	5	5					
	15 to 17	Soil	5	5					
	20 to 22	Soil	5	5					
	0 to 1	Sediment	2	2					
	1 to 3	Sediment	2	2					
	20 to 40	Groundwater			12	12	12	12	12
Headwall No. 1	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Bailey Lake	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Raffinate Pond	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Headwall No. 3	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Raffinate Pond No. 3	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Headwall No. 4	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
SX Plant No. 3	NA	Process Solution			4	4	4	4	4
	NA	Process Solution			4	4	4	4	4
Headwall No. 2	NA	Process Solution			4	4	4	4	4
	10 to 20	Alluvial Groundwater			4	4	4	4	4
Rhenium Ponds	0 to 1	Soil	2	2					
	1 to 3	Soil	2	2					
	5 to 7	Soil	2	2					
	10 to 12	Soil	2	2					
	15 to 17	Soil	2	2					
	20 to 22	Soil	2	2					
Esperanza Tailing Impoundment	0-20	Sediment/Tailing	2	2					
	20-40	Sediment/Tailing	2	2					
	40-60	Sediment/Tailing	2	2					
	60-80	Sediment/Tailing	2	2					
	80-100	Sediment/Tailing	2	2					

**TABLE 4-2
SIERRITA VRP
SUMMARY OF FREQUENCIES AND LOCATIONS OF SAMPLES**

Sample Location Area	Interval (ft bgs)	Media	ANALYSES						
			SOIL / SEDIMENT		GROUNDWATER/SOLUTION				
			Metals ⁽¹⁾ (SW-7000 Series)	Radiochemistry ⁽²⁾	Dissolved Metals ⁽³⁾ (E200 Series)	Radiochemistry ⁽⁴⁾	Major Anions (SW-846 9056 or EPA 300.0)	TDS (Method 160.1)	Field Water Quality Parameters ⁽⁵⁾
Sierrita Tailing Impoundment	0-20	Sediment/Tailing	4	4					
	20-40	Sediment/Tailing	4	4					
	40-60	Sediment/Tailing	4	4					
	60-80	Sediment/Tailing	4	4					
	80-100	Sediment/Tailing	4	4					
	100-120	Sediment/Tailing	4	4					
	120-140	Sediment/Tailing	4	4					
	140-160	Sediment/Tailing	4	4					
	160-180	Sediment/Tailing	4	4					
	180-200	Sediment/Tailing	4	4					
200-220	Sediment/Tailing	4	4						
Subtotal for Soil/Sediment Samples			380	380					
Field Duplicate	NA	Soil/Sediment	38	38					
QA/QC MS/MD	NA	Soil/Sediment	19	19					
Total for Soil/Sediment Samples			437	437					
Existing Monitor Wells ⁽⁶⁾	NA	Groundwater			108	108	108	108	108
Proposed Background Wells ⁽⁷⁾	NA	Groundwater			12	12	12	12	12
Sump B	NA	Groundwater			4	4	4	4	4
Sump C	NA	Groundwater			4	4	4	4	4
Reclaim Pond	Surface	Pond			12	12	4	4	12
Decant Solution	NA	Solution			12	12	4	4	12
Subtotal for Water Samples					256	256	240	240	256
QA/QC MS/MD	NA	Water			13	13	0	0	0
QA/QC Rinsate	NA	Water			13	13	0	0	0
QA/QC Field Duplicate	NA	Water			26	26	24	24	0
Total for Water Samples					307	307	264	264	256
TOTAL SAMPLES FOR ALL MEDIA			437	418	307	307	264	142	256

NOTES:

NA Not Applicable

⁽¹⁾ Metals: antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc

⁽²⁾ ²²⁶Radium, ²²⁸Radium, uranium isotopes ²³⁴U, ²³⁵U, ²³⁸U, uranium mass

⁽³⁾ Metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, sodium, thallium, and zinc

⁽⁴⁾ ²²⁶Radium, ²²⁸Radium, uranium isotopes ²³⁴U, ²³⁵U, ²³⁸U, gross alpha and gross beta, dissolved uranium mass

⁽⁵⁾ Temperature, pH, specific conductivity, dissolved oxygen, turbidity, Eh

⁽⁶⁾ BW-02, BW-03, BW-04, PZ-01, PZ-02, PZ-03, PZ-04, PZ-05, PZ-06, PZ-07, PZ-08, PZ-16, MH-14, MH-15W, MH-16W, MH-17, MH-18, MH-19, MH-20, MH-21, MH-22, MH-23, MH-27, MH-28, MH-29, MH-30, PZ-2007-05

⁽⁷⁾ MW-2008-12, MW-2008-13, MW-2008-14, MW-2008-15

bgs below ground surface

MS/MD Matrix spike/matrix duplicate

QA/QC Quality assurance/quality control

Table 4-3
Sierrita VRP
Groundwater Sampling Justification

Well Identifier	Location	Screened Formation	Depth to Top of Screen (ft-bgs)	Depth to Bottom of Screen (ft-bgs)	Justification
Existing Monitor Wells					
BW-02	Esperanza Wash downgradient of Headwall No. 3, Raffinate Pond No. 3, SX-3 Drain Pond and Stormwater Pond	Demetrie Volcanics	19	95	Confirm no releases have occurred from process solution ponds located in Esperanza Wash.
BW-03	East bank of Demetrie Wash downgradient of the Amargosa Wash confluence	Ruby Star Granodiorite	30	93	Evaluate potential releases from upgradient process areas along the west side of Demetrie Wash and potential influence from Amargosa Wash.
BW-04	Amargosa Wash downgradient of B Pond and B Sump		6	20	Evaluate potential releases from B pond and Amargosa Wash area in general. May assist with determining effectiveness of B Sump.
MH-10	Southern edge of STI, east of Demetrie Wash	Clay/arkosic bedrock	280	600	Evaluate groundwater quality on southern edge of STI in vicinity of Demetrie Wash.
MH-14	Downgradient of STI in northern portion of well field	basin fill	376	501	Evaluate basin fill groundwater quality in northern portion of well field.
MH-15W	Downgradient of STI in central portion of well field	basin fill	320	445	Evaluate basin fill groundwater quality in central portion of well field.
MH-16W	Downgradient of STI in southern portion of well field	basin fill	315	440	Evaluate basin fill groundwater quality in southern portion of well field.
MH-17	Background well located in the southwest corner of the Sierrita property	Harris Ranch Quartz Monzonite	58	108	Represents background groundwater conditions in the Harris Ranch Quartz Monzonite.
MH-18	Near Tinaja Wash downgradient of the waste rock stockpile	Tinaja Peak Formation	60	178	Evaluate impacts from waste rock stockpile and possibly represents groundwater conditions generally upgradient of Sierrita.
MH-19	Unnamed Wash downgradient of the active leach areas and Headwall No. 5	Tinaja Peak Formation	40	70	This well is screened at a shallower elevation than well PZ-15. Evaluate shallower aquifer impacts from sulfide leach area and Headwall No. 5.
MH-20	Esperanza Wash downgradient of Headwall No. 3, Raffinate Pond No. 3, SX-3 Drain Pond and Stormwater Pond. Further downgradient of well BW-02	Demetrie Volcanics	120	176	This well is screened at a deeper elevation than well BW-02. Evaluate deeper aquifer impacts.
MH-21	Upgradient well located on the east bank of Demetrie Wash upgradient of the mill area	Ruby Star Granodiorite	28	79	Verify background COI concentrations in the Ruby Star Granodiorite and compare results to newly installed background wells.
MH-22	Alluvial well located in Demetrie Wash downgradient of the Amargosa Wash confluence	Alluvium	6.5	16.5	Evaluate alluvial groundwater in Demetrie Wash to identify potential releases from Demetrie and Amargosa washes.

Table 4-3
Sierrita VRP
Groundwater Sampling Justification

Well Identifier	Location	Screened Formation	Depth to Top of Screen (ft-bgs)	Depth to Bottom of Screen (ft-bgs)	Justification
MH-23	Bedrock well collocated with MH-22 in Demetrie Wash. Will compare a	Ruby Star Granodiorite	18	78	Evaluate potential influence of alluvial water with underlying bedrock groundwater.
MH-27	East of the sulfide leach stockpile and east of Headwall No. 2	Demetrie Volcanics	20	80	Evaluate quality of bedrock groundwater in vicinity of Headwall No. 2.
MH-28	Downgradient of STI in northern portion of well field	basin fill	355	485	Evaluate basin fill groundwater quality in northern portion of well field.
MH-29	Downgradient of STI in southern portion of well field	basin fill	340	470	Evaluate basin fill groundwater quality in southern portion of well field.
MH-30	Downgradient of STI in northern portion of well field	basin fill	430	530	Evaluate basin fill groundwater quality in northern portion of well field.
PZ-01	Background well located in the southwest corner of the Sierrita property	Tinaja Peak Formation	140	190	Represents background conditions in the Tinaja Peak Formation.
PZ-02	East of the sulfide leach area and southeast of Headwall #1 and Bailey Lake	Demetrie Volcanics	49	108.32	Evaluate quality of bedrock groundwater downgradient of sulfide leach stockpile and in vicinity of Headwall No. 1 and Bailey Lake.
PZ-03	Southern portion of the mill area downgradient of the SX circuit	Ruby Star Granodiorite	20	80	Evaluate bedrock groundwater quality in Amargosa Wash and possibly part of the Esperanza Mill area. Provides an additional Ruby Star Granodiorite monitoring point.
PZ-04	Center of the mill area downgradient of Sierrita Mill	Ruby Star Granodiorite	20	70	Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.
PZ-05	East central mill area generally downgradient of most operations in mill area	Ruby Star Granodiorite	19	69	Evaluate bedrock groundwater quality in the general mill area and provides an additional Ruby Star Granodiorite monitoring point.
PZ-06	Upgradient of the mill area and downgradient of waste rock stockpiles	Ruby Star Granodiorite	18	78	Evaluate bedrock groundwater quality upgradient of the mill area.
PZ-07	North of Esperanza Tailing Impoundment	basin fill/Ruby Star Granodiorite	100	150	Evaluate groundwater quality at northern edge of basin fill and northern Sierrita property boundary.
PZ-08	South of Esperanza Tailing Impoundment	Demetrie Volcanics	185	275	Evaluate southern portion Sierrita property boundary and groundwater quality before it flows beneath Sierrita Tailing Impoundment.
PZ-16	Unnamed Wash downgradient of the active leach areas and Headwall No. 5	Demetrie Volcanics	20	80	Evaluate quality of bedrock groundwater in vicinity of Headwall No. 5.
PZ-2007-05	Eastern edge of the Esperanza Tailing Impoundment	Tailing and basin fill	232	288	Evaluate basin fill groundwater quality immediately downgradient of the Esperanza Tailing Impoundment and near the Sierrita Tailing Impoundment reclaim pond.

**Table 4-3
Sierrita VRP
Groundwater Sampling Justification**

Well Identifier	Location	Screened Formation	Depth to Top of Screen (ft-bgs)	Depth to Bottom of Screen (ft-bgs)	Justification
Proposed Monitor Wells					
CLEAR Plant Wells					
MW-2008-01	Background well west of Former CLEAR Plant	Ruby Star Granodiorite	20	40	Evaluate groundwater quality upgradient of the Former CLEAR Plant Area.
MW-2008-02	West of Former CLEAR Plant	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former CLEAR Plant.
MW-2008-03	East of the Former E Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former E Pond.
MW-2008-04	East of the Former Evaporation Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former Evaporation Pond.
MW-2008-05	East of Old D Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Old D Pond.
MW-2008-06	West of Old D Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality upgradient of the Old D Pond.
Esperanza Area Wells					
MW-2008-07	West of Former C Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately upgradient of the Former C Pond.
MW-2008-08	East of Former C Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former C Pond.
MW-2008-09	East of Former Raffinate Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.
MW-2008-10	East of Former Raffinate Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality immediately downgradient of the Former Raffinate Pond.
MW-2008-11	West of Former Raffinate Pond	Ruby Star Granodiorite	20	40	Evaluate groundwater quality upgradient of the Former Raffinate Pond.
Background Wells					
MW-2008-12	Northeast of mill area and north of MH-21	Ruby Star Granodiorite	NA	NA	Evaluate background concentrations in hornblende-rich Ruby Star Granodiorite.
MW-2008-13	Northeast of mill area and north of MH-21	Ruby Star Granodiorite	NA	NA	Evaluate background concentrations in hornblende-rich Ruby Star Granodiorite.
MW-2008-15	Southwest Corner of property	Harris Ranch Quartz Monzonite	NA	NA	Evaluate background concentrations in Harris Ranch Quartz Monzonite.
MW-2008-14	Southwest Corner of property	Tinaja Peak Formation	NA	NA	Evaluate background concentrations in Tinaja Peak Formation.
Notes:					
ft bgs = feet below ground surface					
NA = Not Applicable					
STI = Sierrita Tailing Impoundment					

**TABLE 5-1
SAMPLE SUMMARY, CONTAINERS, AND METHODS**

Analytical Paramter	Extraction/Method	Sample Matirx	Preservation	Number/Minimum Volume of Container(s)	Sample Hold Time (from collection)
Ra 226	SW3050/E903.0	Soil/Sediment	None	4oz Glass	6 months
Ra 228	SW3050/E904.0	Soil/Sediment	None	4oz Glass	6 months
U-234, U-236, U-238	SW3050/E907.0	Soil/Sediment	None	4oz Glass	6 months
Uranium	SW3050/E908.0	Soil/Sediment	None	4oz Glass	6 months
Total Metals (ICP)	SW7000 Series	Soil/Sediment	Cool to 4°C	4oz Glass	6 months
Ra 226	E903.0	Water	pH < 2 with HNO ₃	2000 mL plastic	6 months
Ra 228	E904.0	Water	pH < 2 with HNO ₃	2000 mL plastic	6 months
U-234, U-236, U-238	E907.0	Water	pH < 2 with HNO ₃	2000 mL plastic	6 months
Gross Alpha & Gross Beta	E900.0	Water	pH < 2 with HNO ₃	2000 mL plastic	6 months
Dissolved Metals & Major Cations ¹ (ICP)	E200 Series	Water	pH < 2 with HNO ₃	250 mL poly	180 days
Major Anions	Sw-846 9056 or EPA 300.0	Water	Cool to 4°C	250 mL poly	48 hours for NO ₂ , 28 days for all else
TDS	EPA 160.1	Water	Cool to 4°C	100-mL poly or glass	7 days
Field Parameters					
Eh	ADTM 1498	Water	NA	Field Measurement	Analyze Immediately
pH	SW 846-940B	Water	NA	Field Measurement	Analyze Immediately
Temperature	EPA 170.1	Water	NA	Field Measurement	Analyze Immediately
Specific Conductance	EPA 120.1	Water	NA	Field Measurement	Analyze Immediately
Turbidity	EPA 180.1	Water	NA	Field Measurement	Analyze Immediately
Dissolved Oxygen	Field Instrument	Water	NA	Field Measurement	Analyze Immediately

Notes: ¹Filtered in the field

Ra - radium

mL - milliliter

TDS - total dissolved solids

Eh - oxidation reduction potential

pH - negative log hydrogen ion activity

U - uranium

Total Metals (ICP): antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, uranium, and zinc

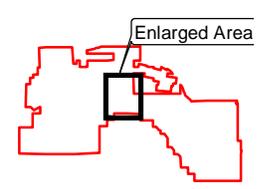
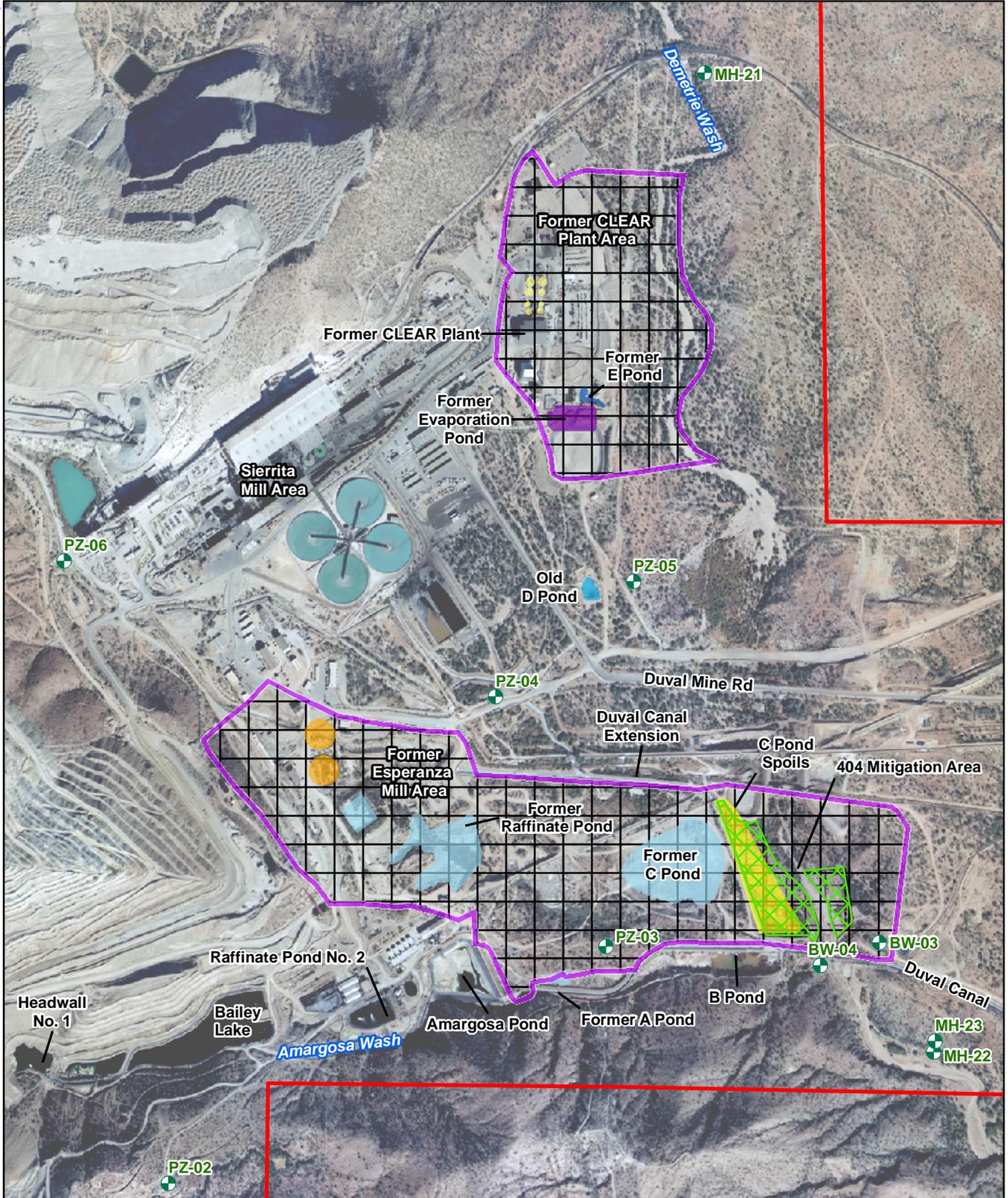
Dissolved Metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, uranium, and zinc

Major Cations: calcium, magnesium, sodium, and potassium

Major Anions: sulfate, nitrate, nitrite, chloride, bicarbonate, and carbonate

Radiochemistry: 226 radium, 228 radium, uranium isotopes U-234, U-235, and U-238

FIGURES



LEGEND

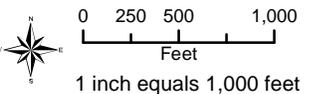
- Sierrita Property Boundary
- 404 Mitigation Area
- Sampling Grid (200 ft Spacing)
- Monitor Wells and Piezometers

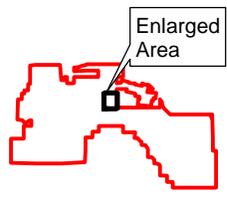
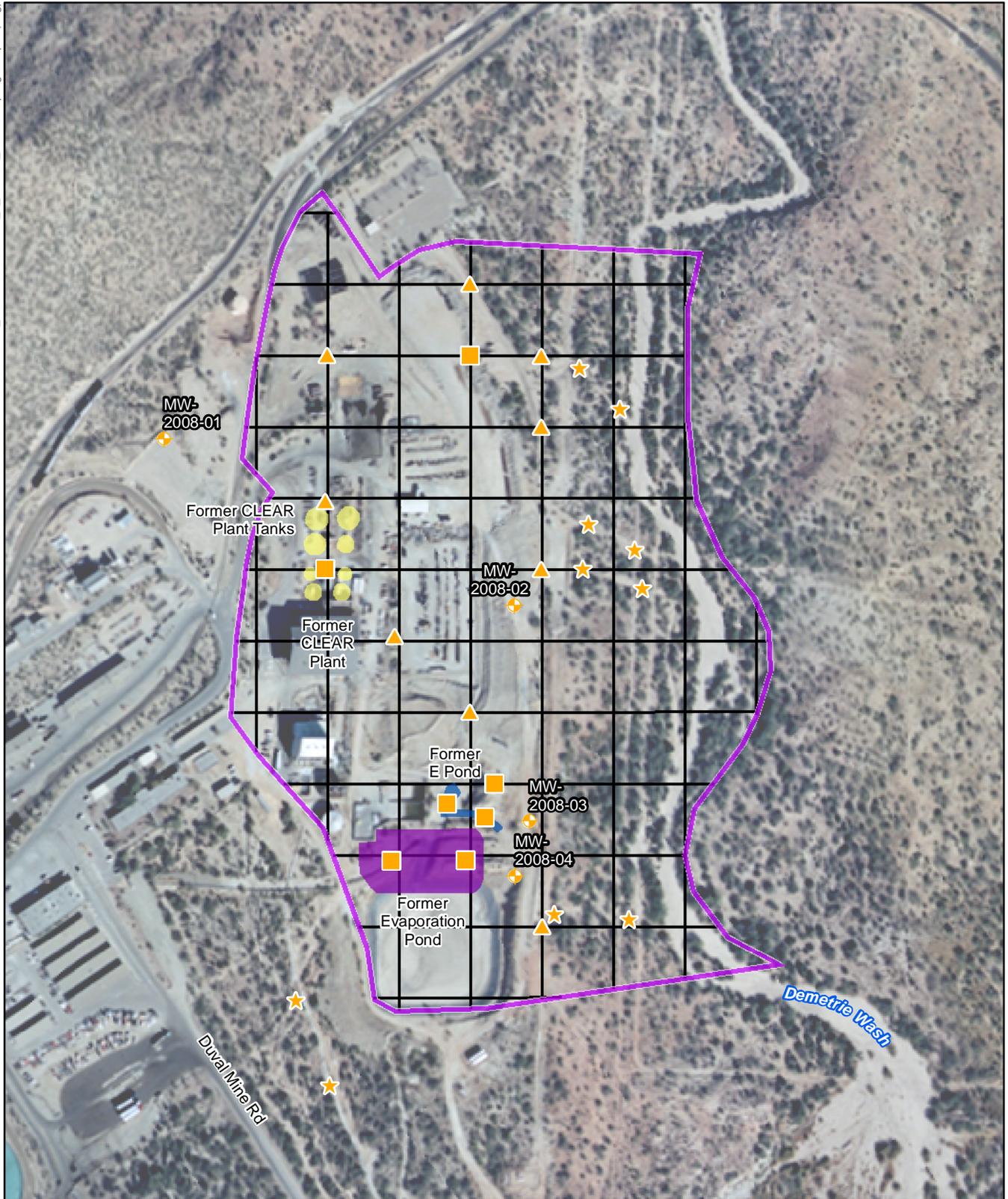
- Sierrita Facilities**
- Area of Interest
 - Former Pond
 - Former CLEAR Plant Tanks
 - Former E Pond

- Former Evaporation Pond
- Old D Pond
- Former Thickener
- C Pond Spoils

Figure 4-1

Sierrita Mill Area
Freeport-McMoRan
Sierrita Inc.





Source:
Imagery -
Cooper Aerial Co. 2006



LEGEND

Sampling Grid
(200 ft Spacing)

- Proposed Monitor Well
- Proposed Sediment Sample
- Proposed Judgmental Soil Boring
- Proposed Random Soil Boring

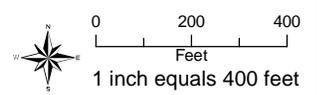
Sierrita Facilities

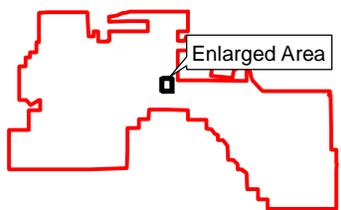
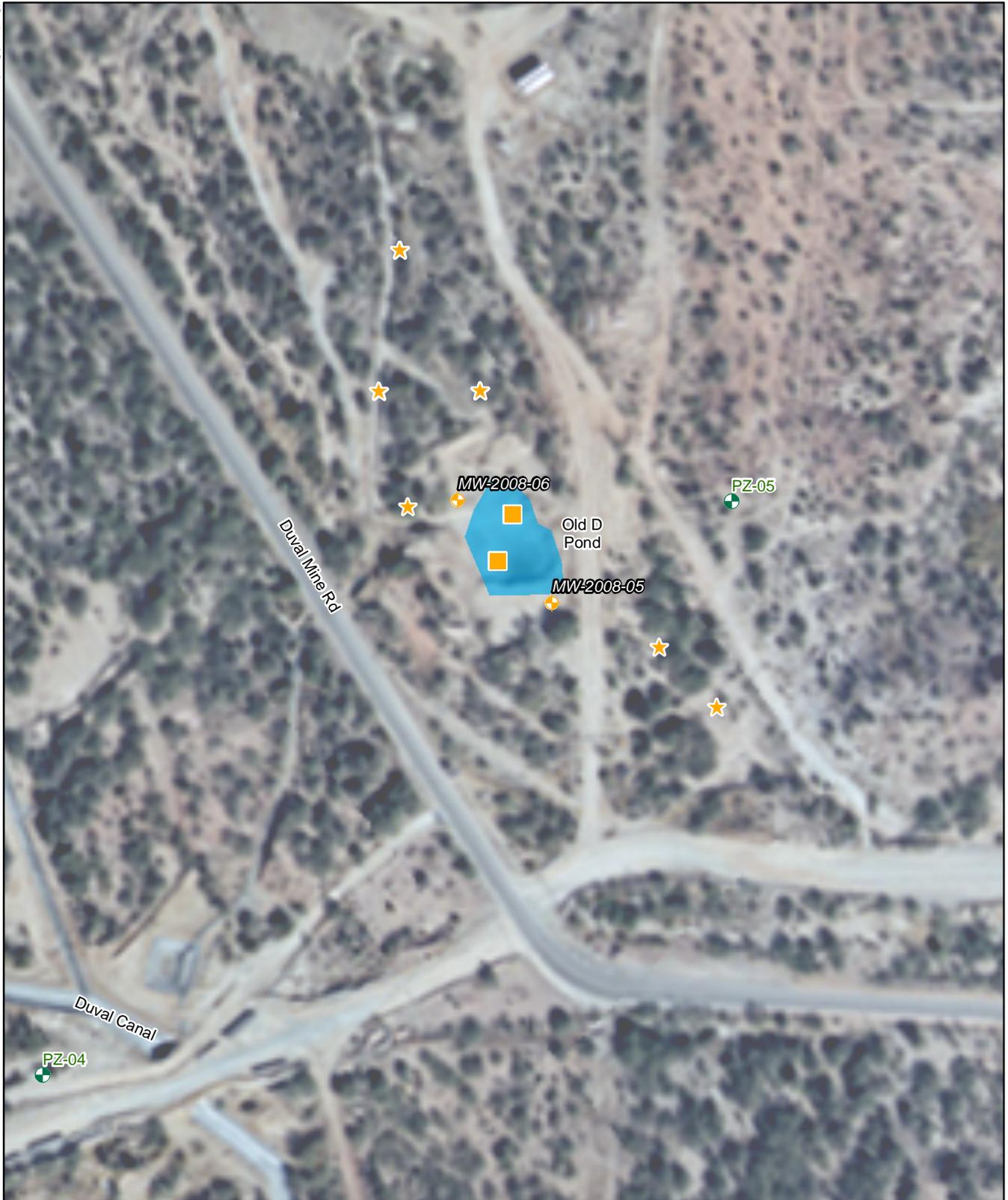
- Area of Interest
- Former CLEAR Plant Tanks
- Former Evaporation Pond
- Former E Pond

Figure 4-2

**Former CLEAR Plant
Sampling Grid**

**Freeport-McMoRan
Sierrita Inc.**

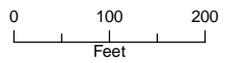




URS
Source:
Imagery - Cooper Aerial Co. 2006

- LEGEND**
-  Old D Pond
 -  Monitor Wells and Piezometers
 -  Proposed Monitor Well
 -  Proposed Sediment Sample
 -  Proposed Judgmental Soil Boring

Figure 4-3
Old D Pond Sampling
Freeport-McMoRan
Sierrita Inc.



1 inch equals 200 feet

P:\WRES\2344522\23445222_Sierra(GIS)\Plots\4_4_Esperanza_Mill_Sampling.pdf (deg)

Figure 4-4 Former Esperanza Mill Sampling Grid

Freeport-McMoRan Sierrita Inc.

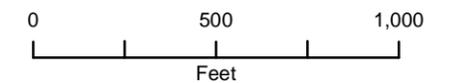
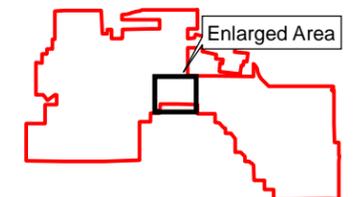
Legend

- Monitor Wells and Piezometers
- Proposed Monitor Well
- Proposed Sediment Sample
- Proposed Random Soil Boring
- Proposed Judgmental Soil Boring
- Area of Interest
- Sampling Grid (200 ft Spacing)
- Former Mill Building
- Former Pond
- Old D Pond
- Former Thickener
- C Pond Spoils
- 404 Mitigation Area

General Features

- Sierrita Property Boundary

Source:
Imagery - Cooper Aerial Co. 2006



1 inch equals 500 feet



Figure 4-5 Amargosa Wash Sediment Sample Locations

Freeport-McMoRan Sierrita Inc.

Legend

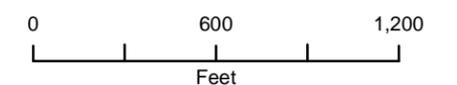
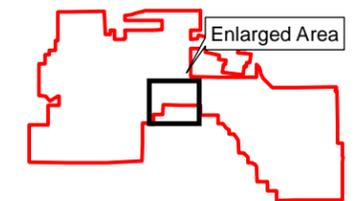
-  Monitor Wells and Piezometers
-  Proposed Process Solution Sample
-  Proposed Temporary Alluvial Well
-  Former A Pond

General Features

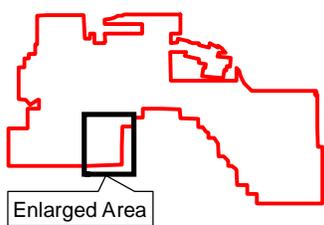
-  Sierrita Property Boundary



Source:
Imagery - Cooper Aerial Co. 2006



1 inch equals 600 feet

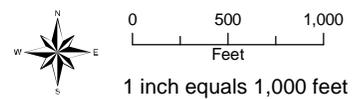


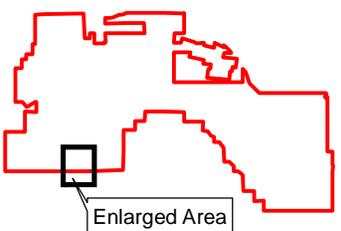
Enlarged Area

LEGEND

- Sierrita Project Boundary
- ⊕ Monitor Wells and Piezometers
- ✱ Proposed Process Solution Sample
- ⊕ Proposed Temporary Alluvial Well

Figure 4-6
Esperanza Wash
Sampling Locations
Freeport-McMoRan
Sierrita Inc.



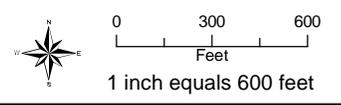


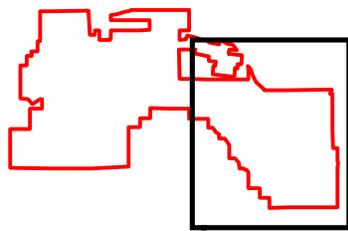
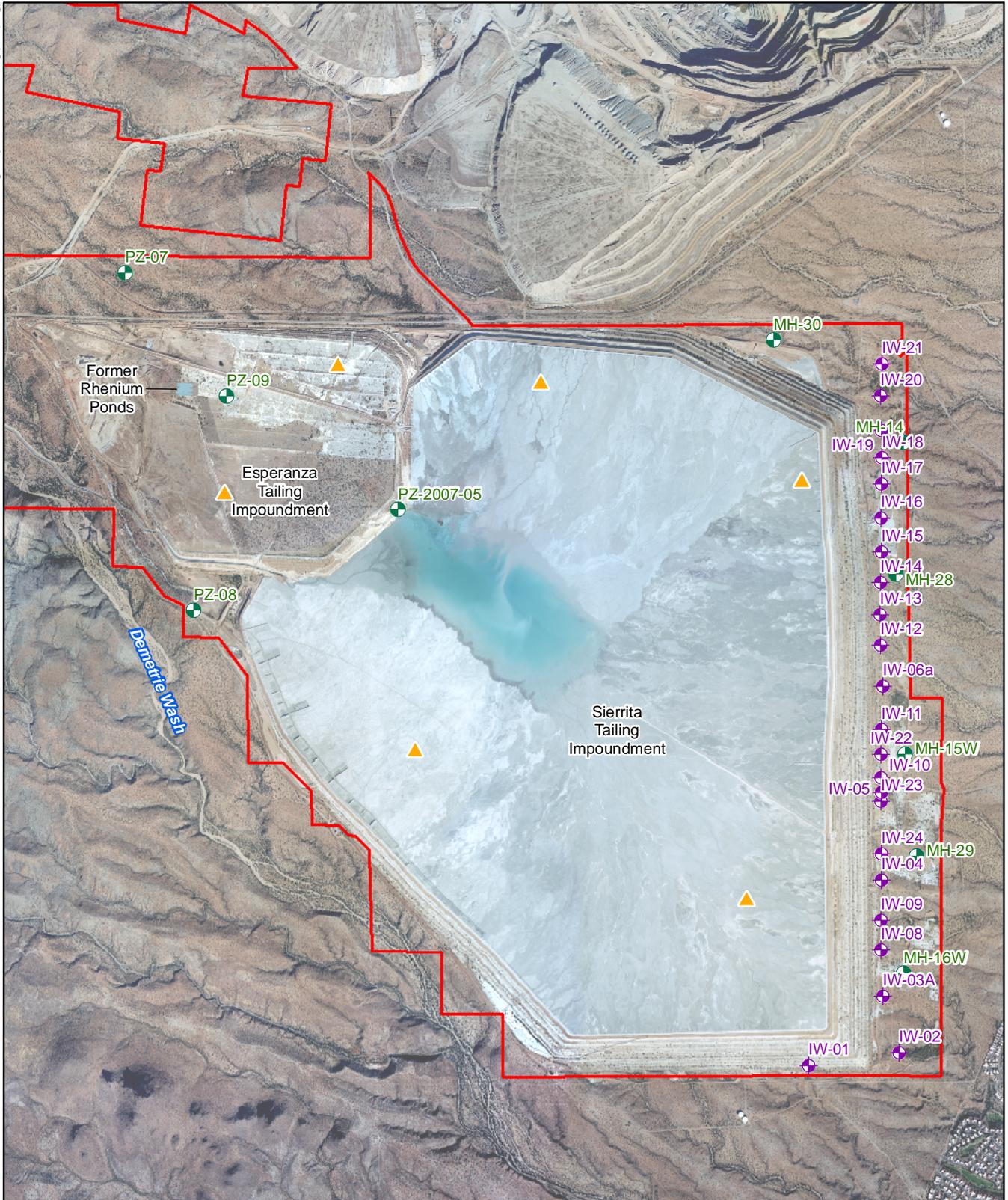
URS
 Source:
 Imagery - Cooper Aerial Co. 2006

- LEGEND**
- Sierrita Project Boundary
 - ⊕ Monitor Wells and Piezometers
 - ⊕ Proposed Temporary Alluvial Well
 - ✱ Proposed Process Solution Sample

Figure 4-7
Tinaja and Unnamed Wash
Sediment Sample Locations

Freeport-McMoRan
Sierrita Inc.





- LEGEND**
- Sierrita Property Boundary
 - Former Rhenium Ponds
 - Monitor Wells and Piezometers
 - Pumping/Interceptor Wells
 - ▲ Proposed Random Soil Boring

Figure 4-8
**Tailing Impoundments
 Soil Boring Locations**
*Freeport-McMoRan
 Sierrita Inc.*

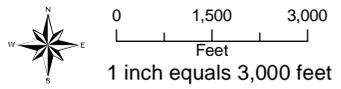


Figure 4-9 Background Well Locations

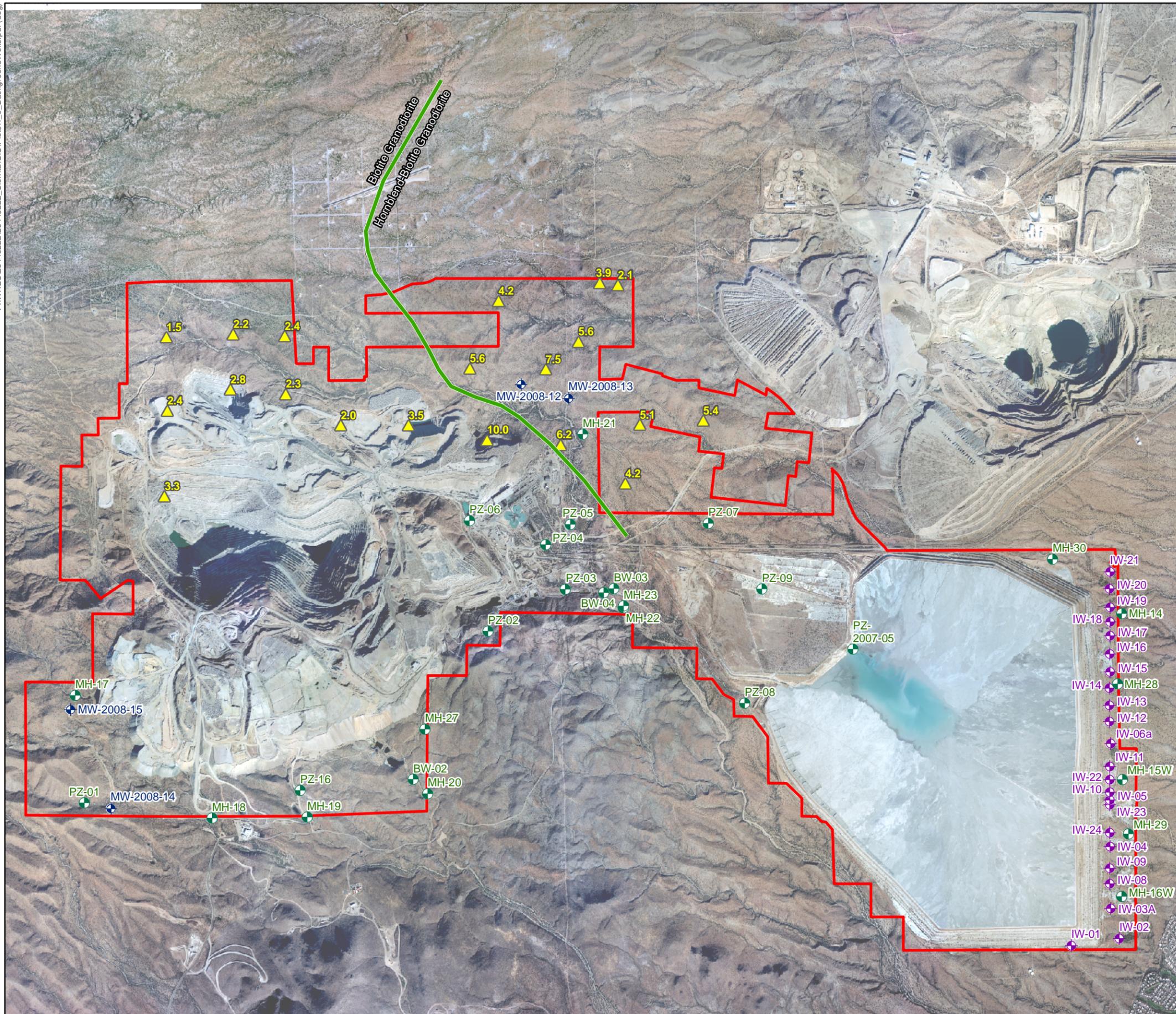
Freeport-McMoRan Sierrita Inc.

Legend

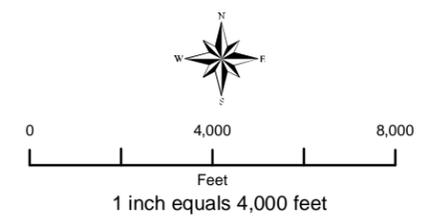
-  Monitor Wells and Piezometers
-  Pumping/Interceptor Wells
-  Background Wells
-  Approximate Uranium Sample Points
(Values in ppm)
-  Approximate Ruby Star Biotite Granodiorite
and Hornblend-Biotite Granodiorite Division

General Features

-  Sierrita Property Boundary



Source:
 Imagery - Cooper Aerial Survey Co. 2006
 Base Map - ALRIS 1997 - 2007
 Granodiorite Division - Conoco 1978



APPENDIX B
URS FIELD SOPS

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to describe procedures to reduce the risk of contact with buried or above ground utility service lines.

2.0 SCOPE

This Standard Operating Procedure applies to all work involving field activities where there is possible contact with subsurface utilities or above ground utilities.

3.0 METHOD

3.1 General

Buried utilities of concern are typically electrical, water, gas, sewer, storm drains, industrial waste lines, and fiber-optic communication lines. Several types of geophysical methods may be used to locate buried utilities, including ground-penetrating radar, pipe and cable locator, electromagnetic survey, and magnetometry.

3.2 Procedures

The following procedures apply to determining the locations of buried and above ground utility lines, and for associated recordkeeping.

3.2.1 Buried Utilities

Any available property maps, as-built drawings, and utility maps will be reviewed before beginning activities on site. During a site inspection, any discrepancies or new information regarding utilities will be added to the work site maps.

3.2.1.1 Public Utilities

Arizona Blue Stake (800-STAKEIT) will be contacted for a utility markout prior to initiating intrusive sampling activity other than surface soil sampling. A utility clearance form (Form 103) will be completed and approved for all sampling locations. As a general rule, utilities are marked using the following color code:

- White - work location;
- Red - electrical;
- Yellow - gas or oil;
- Orange – telephone, communication, cable, and fiber optic;
- Blue - water; and
- Green - sewer.

All uncovered utilities must be supported. Any repairs or modifications to existing utility lines require the line to be locked-out/tagged-out by the utility company prior to work.

For borings located in areas of dense utility distribution or in areas where specific utility locations are uncertain or unknown, a hand auger pilot hole will be advanced to a minimum depth of 7 feet (or refusal, whichever comes first) for utility presence verification.

3.2.1.2 Private Utilities

A private utility locator will be subcontracted to locate using geophysical methods and mark subsurface private utilities at each soil boring location where such utilities may exist. Private utilities may include some or all of the utilities listed in 3.2.1.1 that were not installed by public utilities.

3.2.2 Above Ground Power Lines

The minimum clearances for working near overhead power lines are as follows:

<u>Normal Voltage</u>	<u>Minimum Clearances</u>
0 - 50 kilovolts (kV)	20 feet or one mast length, whichever is greater
50 kV +	20 feet plus four inches for every ten kV over 50 kV; or 1.5 mast lengths, whichever is greater

If it is necessary to work without the minimum clearance, the overhead line must be re-routed or de-energized by the utility company or authorized contractor.

A Utility Clearance Permit will be completed to document utility location(s).

4.0 REFERENCES

Occupational Safety and Health Act (OSHA) 1910.333 - *Selection and Use of Work Practices in Subpart S - Electrical.*

OSHA 1926.650 through 1926.652 - *Excavations.*

OSHA 1926.955 - *Provisions for Preventing Accidents Due to Proximity to Overhead Lines.*

5.0 RECORDS

The Field Manager/Task Leader must complete the Utility Clearance Permit. The Site Manager/Field Task Leader, in collaboration with the SSO, must approve any deviations from this Standard Operating Procedure.

6.0 ATTACHMENTS

Utility Clearance Form.

Attachment 1 Utility Clearance Permit

Project: _____ Completed by: _____

Site Location: _____ Date: _____

Reason for Clearance: _____

Description of Activity	Yes	No	N/A	Date	INT
1. Review of Existing Maps					
2. Interviewed Personnel Familiar With Area?					
3. Above Ground Utilities					
a) marked on site maps					
b) necessary to lockout					
c) document procedures used to lockout or re-route					
4. Underground Utilities					
a) State Agency called: (specify)					
Ticket number:					
b) Additional Utility Company(s) called: (specify)					
Ticket number:					
c) Geophysical clearance method(s) used: (specify)					
By:					
d) Utility locations marked with appropriate color code:					
By:					
e) Utilities marked on site map (attached)					
By:					
5. Hand augering completed to:					
By:					
6. Trench/Excavation probed:					
By:					
a) Hand Clearance required:					
7. Clearance Approval:					
Site Manager: _____		Date: _____			
Client Representative:					
8. Deviations Approval:					
Project Manager: _____		Date: _____			
HSSO or Safety Manager:					

Describe Deviations: _____

Justification: _____

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to ensure that borings, monitoring wells, and piezometers are properly installed.

2.0 SCOPE

This Standard Operating Procedure applies to all contractor personnel and subcontractors installing borings, monitoring wells, and piezometers for environmental investigations and monitoring programs.

3.0 METHOD

3.1 General

Drilling techniques to be used for borehole and monitoring well installation will be either sonic, air rotary, direct push technology (DPT) or hollow-stem auger (HSA).

Boreholes that are not converted to monitoring wells will be abandoned per SOP-007, *Well Abandonment/Borehole Plugging* and *ADWR Well Abandonment Handbook* (Appendix D).

3.2 Procedures

The following procedures apply to borehole drilling and monitoring well installation.

3.2.1 Borehole Drilling

Each of the borehole drilling methods and their usage are described below:

- Sonic involves the advancement of sampling tools into the subsurface by hydraulic pressure combined with high frequency vibration. The sonic sampling tool is typically advanced in 10-foot or other various increments. After the sampling tool has advanced to the required depth, the tool is retrieved from the subsurface and the sample is extruded in various foot lengths into plastic bags. The bags are cut open by the Field Geologist and the soil sample screened, logged, and collected for chemical analysis. Samples may be collected continuously or at specific depths.

The sonic drill head is a technologically advanced, hydraulically activated unit that imparts high frequency sinusoidal wave vibrations into a drill string to effectuate a cutting action at the bit face. The resultant cutting action forces a circular continuous core of the formation up into the drilling string. Due to the high forces developed by the Sonic head and the external flush nature of the drill string, excess formation material generated by the cutting face of the bit is forced into the borehole wall thus resulting in the generation of no cuttings during the drilling process other than the generated core sample. Using telescopic Sonic casing advancement, wells or borings can be installed through multiple or connected water bearing units without risking cross contamination by casing off those zones while drilling. Depth discrete water sampling is possible.

If necessary due to unanticipated subsurface conditions that limit sonic penetration, HSA drilling with split-spoon sampling may be used as an alternative technique for soil borings. DPT or air rotary could be alternative techniques.

- Air rotary has the advantage of advancing the borehole without the need for introduction of drilling fluids. Air rotary drilling is similar to direct mud rotary drilling except that compressed air is used to transport the cuttings to the surface. An air-operated downhole casing advancement system is sometimes used. This casing advancement system consists of an air-operated down-the-hole hammer drill that is fitted with a specialized bit that has an eccentric reamer that cuts the hole large enough for the casing to follow. The hammer drill is designed to be used inside and at the bottom of the drill casing so that the bit and eccentric reamer are below the casing. Using compressed air, the hammer pulverizes the material below the casing, then blows it back through the casing to the top of the hole. As the hammer drives through material it also reacts against an interior shoulder bevelled on the drill casing shoe, which pulls the casing down the hole as the hammer drill is advanced. This method is well suited for drilling through difficult material such as rock fill. The major drawback is the high air pressure and large air volume required for operation.
- HSA drilling is commonly used for soil boring and monitoring well installation at relatively shallow depths (<100 ft). The drill rig will be mounted on a heavy-duty truck or an all terrain vehicle. Soil samples will be collected with a split-spoon sampler. At boring locations where monitoring wells will be installed, hollow stem augers of sufficient outer diameter (OD) should be used to ensure 2 inches annular space between the outside of the well casing and the borehole (i.e., 8 ¼ inch OD augers or larger for a 4-inch diameter well).
- DPT is a technique that uses both static force and percussion to advance sampling and logging tools into the subsurface. The DPT machine is typically mounted on a truck or a track-mounted terrain vehicle. Soil samples are usually collected with an acetate-lined core barrel. Specific procedures for soil sampling with DPT are described in SOP-013, *Soil Sampling*. DPT equipment can seldom reach depths greater than 50 feet bgs and, therefore, are limited to shallow deposits.

3.2.2 Monitoring Well Construction

All monitoring wells will be constructed in accordance to state and local regulations and shall be supervised by a competent geologist. The contractor shall obtain all permits, applications, and other documents required by state and local authorities. Drill rigs and sampling devices shall be decontaminated according to the guidelines in SOP-021, *Equipment Decontamination Procedures*. Ensuring a successful well installation requires that the procedures used for installing each component of the well are followed and well documented.

3.2.2.1 Well Casing Requirements

Wells will be constructed in accordance to state and local regulations. The casing requirements that will be followed are the following:

- All casing will be new, unused, and decontaminated according to the decontamination procedures provided in SOP-021, *Equipment Decontamination Procedures*. Certifications of cleanliness for manufacturer's pre-cleaned materials must be documented in project files. The pre-calculated and actual quantities of materials used in the well installation must be documented in the field logbook.
- All casings will be flush threaded, and no solvents or glues will be allowed to join casing, and casings shall be joined only with compatible welds or coupling that shall not interfere with the planned use of the well.
- All monitoring wells will be constructed using PVC or stainless steel riser. All PVC shall conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
- The casing will be sufficiently straight and plumb within the tolerance stated for the borehole and to allow passage of pumps or sampling devices and the driller will cut a "V" notch in the top of the casing on the north side of the well casing to be used as a permanent reference mark for measuring water levels.
- The drilling subcontractor will make provisions to prevent PVC shavings from entering the well during cutting of the casing for stick-up height and for the water level measurement point notch.

3.2.2.2 Well Screen Requirements

Well screen requirements are the following:

- All requirements that apply to casing will also apply to well screen, except for strength requirements.
- Monitor wells shall not be screened across more than one water-bearing unit.
- All monitoring wells will be constructed using PVC or stainless steel sumps and PVC, stainless steel machine-slotted, or continuous wrapped wire-wound well screen. The cap will be joined to the screen by threads or stainless steel screws.
- Screens shall be factory slotted or wrapped.
- The standard screen to be used is number 10 slot (0.010-inch slot) and/or shall be sized to prevent 90% of the filter pack from entering the well. The standard filter pack may be 20 to 40 mesh size or other size to allow unrestricted flow of

groundwater through the well screen while minimizing inflow of fine sediment material.

3.2.2.3 Well Casing and Screen Installation Procedures

The following procedures will be used when installing well casings and well screens:

- All well casing and screen material will be assembled and installed with sufficient care to prevent damage to the sections and joints.
- Sections of well casing and screen must be connected by flush threading.
- Prior to installing the section(s) of well screen into the well boring, an end cap must be placed at the bottom of the well screen.
- During installation of the well pipe, the drill depth must be periodically measured to ensure that the well boring remains clean of sloughed sidewall material.
- The casing must be suspended to provide a minimum of six inches of filter pack below the end cap. Casing will remain suspended until placement of filter pack and transition seal has been completed and has set.
- Prior to the addition of the filter pack and annular seals, a cap will be placed on top of the casing to avoid well materials from entering the well casing.

3.2.2.4 Filter Pack

The standard filter pack will be 20 to 40 mesh size paired with 10 slot well screen to allow unrestricted flow of groundwater through the well screen while minimizing inflow of fine sediment material. Other acceptable well screen/filter pack sizes are to be sized to prevent 90% of the filter pack from entering the well. Filter pack materials must be poorly graded (well sorted) to ensure good permeability and hydraulic conductivity of the materials near the screen. The materials used should be chemically inert, well rounded, and slightly coarser than the surrounding formation.

Filter pack material will be obtained from known clean sources and should be washed and properly packaged for handling, delivery, and storage. Filter pack will meet the National Science Foundation (NSF) standards and be packaged in properly sealed and marked packages.

3.2.2.5 Filter Pack Installation Procedures

The following procedures will be used during installation of the filter pack:

- The well boring should allow for placement of filter pack around the well screen and approximately six inches of filter pack below the well end cap.
- The chemical composition and manufacturer's contaminant-free certifications for the filter pack materials will be readily available and documented.

- The volume of the well annulus (i.e., filter pack required) must be pre-calculated and documented in the field logbook, and the volume of filter pack installed must be monitored and documented to ensure that the filter pack placement is complete. All discrepancies must be explained and reported to the Site Manager/Field Task Leader.
- For all shallow wells, the filter pack will be dropped directly down the annulus of the well with care taken to ensure that bridging of material does not occur. In deeper wells a tremie pipe will be used to emplace the filter pack.
- The depth to top of the filter pack must be periodically monitored using a sounder or weighted measuring tape, and noted to ensure uniform placement.
- Filter pack must be allowed to settle for approximately five to ten minutes prior to final top-off. Additional filter pack will be placed as required to return the level of the pack to a minimum of two feet above the screen. The depth to the top of the filter pack will be measured to verify its thickness.

3.2.2.6 Bentonite Seal

A bentonite seal is used to prevent communication between the filter pack and the natural cave-in material above the screen. The permeability of the seal should be one to two orders of magnitude less than the surrounding formation. The seal must be chemically compatible with the anticipated contaminants and chemically inert so it does not offset the quality of groundwater samples.

Powdered, granular, pelletized, or chipped bentonite and pre-formed bentonite “doughnuts” are acceptable as an annular sealant.

The bentonite seal requirements that will be followed are the following:

- The bentonite seal will consist of 3 feet of bentonite between top of the filter pack and the casing grout.
- Bentonite will be dropped directly down the annulus of the well or installed by tremie pipe, and a tamping device will be used to prevent bridging.
- The bentonite seal will be allowed to cure for a minimum of 2 hours prior to installing the grout seal.
- Only 100 percent sodium bentonite will be used.

3.2.2.7 Bentonite Seal Installation Procedures

The following procedures will be employed for placement of the bentonite seal:

- The depth to the seal will be measured using a sounder or weighted measuring tape to ensure that the thickness of the transition seal meets the design requirements.
- The amount of water added to the bentonite will be consistent with the manufacturer's specifications. If there is no groundwater present in the borehole, potable water will be added in a sufficient quantity to properly hydrate the bentonite.
- The water added to the bentonite for hydration will be from an approved source that has undergone quality control laboratory analyses, and the volume of water added will be documented in the field logbook.
- Care must be taken to ensure that augers if applicable (or formation support casing) are removed as the bentonite is hydrated. Failure to do so in a timely manner may result in the bentonite expanding inside the augers (or formation support casing) and jacking the well casing out when removed.
- The bentonite seal will be allowed to hydrate for a minimum of 2 hours before well completion activities continue.
- The quantities used will be documented in the field logbook.

3.2.2.8 Annular Seal

The annulus between the well casing and the wall of the well boring must be effectively sealed to prevent it from constituting a preferential pathway for the vertical movement of pollution and contaminants in groundwater or from surface water recharge. The material used for an annular seal must be:

- Placed around the well casing from the top of the bentonite seal to the ground surface;
- Able to hydrate or develop sufficient set strength within a reasonably short time;
- Able to provide a positive seal between the casing and the adjacent formation(s);
- Chemically inert to formations or fluids with which it may come in contact;
- Permanent and stable, and able to resist chemical or physical deterioration;
- Sufficiently impermeable to fluids to ensure that the vertical permeability of the casing borehole system is lower than that of surrounding formation(s); and
- Able to prevent interformational flow between different groundwater-bearing units.

The annular seal requirements are the following:

- The annular seal will be mixed in the following proportions: the casing grout shall extend from the top of the bentonite seal to ground surface.
- The grout shall be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100% sodium bentonite powder, and not more than 8 gallons of potable water.
- The annular seal will be pumped in using a side-discharge tremie pipe, and pumping will continue until 20 percent of the annular seal has been returned to the surface. In wells where the bentonite seal is within 30 feet of the land surface, the 20 percent return is not necessary.
- For borings in which augers have traveled, resulting in a slightly larger diameter borehole than planned, an additional 30 percent grout volume will be added to the calculated amount required to fill the annular space.

3.2.2.9 Annular Seal Installation Procedures

The following tasks must be performed to achieve a positive annular space seal:

- The expected volume of the annular seal material will be pre-calculated for each well and included in field notes. The calculation will be the volume of the borehole minus the volume of the well casing for the depth interval of annular seal placement.
- The annular seal mixture should be properly mixed according to the manufacturer's specifications (or other acceptable and documented criteria).
- The water added to the annular seal material will be documented in the field logbook.
- The annular seal should be mixed prior to placement ensuring a thorough mixture without balls, clods, etc.
- The bentonite seal must be set according to manufacturer's instructions and allowed to cure a minimum of 2 hours prior to placing the annular seal.
- The annular seal will be emplaced by a side-discharge tremie pipe inserted within five feet of the top of the bentonite seal. A side-discharge tremie pipe must be used to lessen the possibility that the transition seal may be cavitated and grout introduced into the filter pack. The pipe must remain submerged in the sealing material while the grout is being emplaced.

- The augers must be withdrawn during grouting to provide a positive seal to the well boring. To prevent borehole caving, a minimum of two feet of annular seal must be maintained in the augers during removal.
- In wells where the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary as long as the tremie pipe is pulled back as the annular seal is emplaced. Excess annular seal that has been returned to the surface will be removed prior to installing the surface pad.

3.2.3 Surface Completions for Monitoring Wells

The following procedures will be used for both aboveground and flush-mount surface completions for monitoring wells.

3.2.3.1 Aboveground Surface Completions

The surface completion will begin after completing the annular seal. Note that an above-ground completion is the standard well completion; a flush-mounted completion should be used in wells installed in traffic areas.

- Well casing will extend two to three feet above the top of the well pad with a vented end plug or casing cap provided for each well.
- A steel protective casing will be installed around the well casing by placing the protective casing into the cement/bentonite surface seal while still wet and uncured. The protective casing will be positioned and installed in a plumb position.
- The protective casing must be vented to allow for the escape of possible gas buildups and to allow the water levels to respond naturally to barometric pressure changes. Additionally, a drain hole should be placed above the concrete level to allow for draining of any trapped water from installation and sampling of the well. The casing will be painted yellow or a client-directed color to be easily observable.
- A weatherproof locking cap will be installed on the protective casing, ensuring adequate clearance between the top of the well casing and bottom of the locking cap.
- A concrete surface pad (3 feet by 3 feet by 4 inches) will be placed surrounding the well protective casing. The pad will be sloped away from the protective casing to provide sufficient drainage away from the well.
- Well protection posts will be placed around wells in any area where vehicular traffic may occur. Posts will be concrete-filled and should be placed approximately two feet below ground surface and three feet above the top of the

pad (flush with the top of the well casing). The posts should not be placed in the concrete well pad. Posts will be painted yellow or a client-directed color to be easily observable.

3.2.3.2 Flush-Mounted Surface Completions

Flush-mounted surface completions may be used and will be installed similar to aboveground completions. Flush-mounted wells will include a well box set in the concrete pad. The well casing must be cut off below grade leaving enough space for the placement of a lockable expanding well cap. The surface seal will then be set to 2 inches above ground surface around the outside of the well box and up to 12 inches below ground surface on the inside of the well box. The concrete pad will be constructed with an outward slope to provide sufficient drainage of precipitation away from the well.

In circumstances where flush-mount completions are installed in paved areas where existing pavement is in excess of 4 inches thick, concrete or asphalt will be sawcut to a depth of 4" around the perimeter of a 4.5-foot by 4.5-foot square centered on the well casing and the concrete within the 2-foot by 2-foot area will be removed to a depth of 4 inches by jackhammer or other suitable means. New concrete will be placed to secure the well box, and new concrete will be sloped so as to provide positive drainage away from the well box.

The well box for flush mounted surface completions will be outfitted with a steel lid or manhole cover that has a rubber seal or gasket to prevent water from entering the vault. No flush-mount wells will be completed in areas known to be subject to surface water accumulation.

3.2.4 Well Security

All wells will be secured as soon as possible after drilling. Vented well caps will be placed on all completed wells. Corrosion-resistant locks for both flush and aboveground surface completions will be utilized. The locks must either have identical keys or be keyed for opening with one master key. The lock keys should be delivered to the appropriate Air Force personnel following completion of the field effort.

3.2.5 Borehole Backfilling Prior to Well Completion

In some instances, it may be necessary to backfill a borehole to achieve the required depth for the well screen interval. This usually is the result of intentionally overdrilling the depth of the well to verify the lithology of the underlying material. For example, a borehole is drilled to a depth of 25 feet but the depth of the bottom well screen to be installed is determined to be 20 feet. This means that there is five feet of open borehole below the planned bottom of the screen. It is unacceptable to fill this excess borehole depth with sand or other permeable material, as it will act as a vertical migration pathway. Therefore, the bottom five feet of the borehole must be abandoned.

Backfilling of an overdrilled borehole will be accomplished by the installation of a bentonite grout via tremie pipe as discussed in SOP-007, *Well Abandonment/Borehole Plugging* and *ADWR Well Abandonment Handbook (Appendix D)*. The backfill material will be placed into the borehole to a depth of 6 inches below the bottom of the proposed well screen. This will

allow for the placement of 6 inches of filter pack sand between the grout and the well screen. Once the bentonite grout is installed into the borehole, it will be allowed to cure for a minimum of 2 hours. The level of the grout will be checked and additional grout added, if necessary, prior to initiation well installation activities.

4.0 REFERENCES

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5.0 RECORDS

All materials and procedures used during installation of the well will be documented in field logbooks as detailed in SOP-019, *Field Activity Records*.

6.0 ATTACHMENTS

Attachment 1 – Well Construction Form, Stick-Up Well Completion
Attachment 2 - Well Construction Form, Flush Mount Well Completion

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to provide details, specifications, and requirements for establishing the horizontal and vertical position of sampling points and monitoring locations.

2.0 SCOPE

This Standard Operating Procedure applies to all professional land-surveying activities in support of environmental investigation.

3.0 METHOD

3.1 General

Land surveying services will be required to establish coordinates for sampling points and monitoring locations. These locations will include monitoring wells, soil borings, surface water/sediment sample locations, surface soil sample locations, and reference points used for stream gauging.

3.2 Procedures

To be provided by surveying subcontractor.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to describe the preferred methodology for collecting groundwater samples in the field using the low-flow purge/sample method and the conventional three well volume purge method.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who purge groundwater monitoring wells and collect groundwater samples.

3.0 METHOD

3.1 General

Every effort will be made during well construction to minimize the amount of silt and clay that enters the well casing by choosing appropriate screen and filter pack material. However, it should be anticipated that turbidity in groundwater monitoring wells may be a concern. To obtain representative groundwater samples, disturbances of the water in the well should be kept to a minimum. The reasoning behind the use of low-flow sampling techniques to sample monitoring wells is to minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. Another benefit of low-flow sampling techniques is the total volume of water purged is minimized. For the purposes of this procedure, “low-flow pumps” are defined as dedicated bladder pumps, or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 liters per minute (L/min) to greater than 1 L/min. If low-flow procedures are not possible or practical or a project specific need requires the standard three-well volume purge and sampling procedures may be used.

3.2 Supplies and Equipment

3.2.1 Major Equipment Items

- Variable-rate, submersible pump/hose assembly with control unit, electrical generator if required, and extension cord, air compressor or other air supply if required, and/or
- Gasoline and oil (for generator, if used);
- Soapy water mixture containers;
- Potable water containers;
- Deionized water containers; and
- Purge water drums or purge water tank.

3.2.2 Equipment Support Items

- Drum liners;
- Trash bags;
- Decontamination tub;
- Low phosphate detergent, such as Liquinox;
- Gloves (nitrile rubber);
- Graduated five-gallon buckets and/or graduated cylinder;
- Folding table;
- Folding chairs;
- Paper towels;
- Calculator; and
- Digital watch with stopwatch function.

3.2.3 Sampling Supplies

- Written description of wells including identification (ID) numbers, maps, well locations, elevations, well construction details, and (if available) records of previous development and/or purging and sampling;
- Well keys;
- Sample containers and applicable preservative;
- Chain-of-custody forms;
- Sample labels;
- Field data forms;
- Ice chest;
- Ice for sample preservation;
- Ziploc[®] bags;

- Field logbook; and
- Pen and waterproof permanent marker.

3.2.4 Monitoring Equipment

- Electronic water level indicator and, when necessary, oil/water interface probe;
- Water quality sampling field instrumentation (e.g., pH, temperature, specific conductance [conductivity], turbidity, dissolved oxygen [DO], oxidation/reduction potential [ORP] probes); and
- Photoionization detector (PID) or flame ionization detector (FID), if required.

3.2.5 Health and Safety Items

- First aid kit and emergency eye-wash kit;
- Fire extinguisher;
- Material Safety Data Sheet/emergency information packet (route to hospital, phone contacts); and
- Field radio or cell phone.

3.3 Procedures

3.3.1 General Equipment Decontamination

Before purging or sampling, all pumps and hoses, water level measurement devices, and any other sampling equipment that may come in contact with the sample will be decontaminated. If new dedicated equipment is used, it should be thoroughly decontaminated and rinsed with distilled water before placement in the well. While decontamination of the pump/hose assembly may generally be performed at a central decontamination area, mobile decontamination supplies will be made available so that some accessory equipment (e.g., electronic water level indicators) can be decontaminated in the field. Each piece of purging or sampling equipment will be decontaminated prior to and between sampling operations and wells. Depending on site conditions, the decontamination solutions may be replaced with clean solutions between wells. Purge water and decontamination solutions will be handled and disposed of as outlined in SOP-020, *Investigation-Derived Waste*. The procedures specified in SOP-021, *Equipment Decontamination Procedures*, will be followed for decontamination of field equipment and for personnel decontamination.

3.3.2 Measurement of Water Quality Parameters and Instrument Calibration

Electronic equipment used during purging and sampling may include a PID, FID, Multi-Gas Meter, a water level indicator, an oil/water interface probe, water quality measurement devices for temperature and pH, conductivity, turbidity, DO, and ORP. Before going into the field, the Field Task Leader will verify that these instruments are operating properly. Each probe of the water quality-measuring device must be calibrated prior to its use and checked at the beginning and end of each day for maintenance of calibration. Calibration procedures will follow the manufacturer's instructions. The PID or FID will be calibrated daily using standard calibration gas as specified by the manufacturer. If instrument readings become erratic during normal operations, recalibration will be conducted. Operating instructions for the PID and FID are detailed in SOP-022, *Organic Vapor Measurement*.

Person(s) responsible for calibrating equipment will complete the equipment specific calibration form, which includes identifying calibration standards and affixing a signature to the form.

Field measurements for temperature, pH, turbidity, conductivity, DO, and ORP will be made in accordance with procedures outlined in SOP-024, *Water Quality Measurements Using a Multiple Parameter Water Quality Meter*, along with the manufacturer's instructions.

3.3.3 Well Purging

The purpose of well purging is to remove stagnant water from the well and obtain a representative water sample from the geologic formation being sampled while minimizing disturbance of the water column during sample collection.

3.3.3.1 Low-Flow Purge Methodology

Using the low-flow purging methodology, the well will be purged until field parameters (pH, temperature, turbidity, DO, ORP, and conductivity) have stabilized. Readings will be taken at a rate commensurate for the flow involved, but no sooner than every three minutes. Low-flow purging rates on the order of 0.1 - 1.0 L/min will be used depending on the site-specific hydrogeology. The maximum allowable drawdown during low-flow purging is 0.3 feet. If the maximum allowable drawdown limit of 0.3 feet is exceeded and cannot be achieved, then the Total Volume Purge Method described in Section 4.3.4.2 will be followed. Background wells being sampled for metals must attain a turbidity of 10 Nephelometric Turbidity Units (NTUs) or less before sample collection unless a written variance (on a well-specific basis) is acquired. The turbidity goal for non-background samples is 15 NTU, but samples with higher turbidity are acceptable if turbidity readings are stabilized and the other conditions of low-flow purging have been met. See *EPA/540/S-95/504, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures (April 1996)*.

Purge water will be managed as outlined in SOP-020, *Investigation-Derived Waste*. Necessary precautions will be taken to prevent spilling of potentially contaminated water. The water will need to be containerized and appropriately disposed or treated prior to discharge.

For standard low-flow well purging, the following procedures will be performed at each well:

- The condition of the well completion (outer well casing, concrete well pad, protective posts, well label) and any unusual conditions of the area around the well will be noted in the field logbook. The well may also be photographed. Any deficiencies encountered will be reported to the Site Manager on the same working day.
- Set up and establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
- Don personal protective equipment (PPE) as specified in the Health and Safety Plan (HSP).
- Note if the reference point (measuring point) on the well is present. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
- The depth of the static water level will be measured with a water level indicator (to the nearest 0.01 foot) in accordance with SOP-006, *Static Water Level and Total Depth Measurement*. If a high concentration of organic vapors are detected in the well, an oil/water interface probe will be used to determine the presence of an immiscible phase light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL).
- The total depth of well will be measured from the same measuring point on the casing with a water level indicator and recorded. It is critical that the distance between the water sensor (zero point) and the end of the water level indicator probe be measured independently and added to each total depth measurement.
- Slowly lower the pump or pump tubing into the well casing to a point in the middle of the screened interval: 5 feet below the water table or, in instances where the well screen is submerged, 5 feet below the top of the screen. Reinsert the water level indicator to monitor water levels during purging.
- Start the pump. As soon as water is discharging, adjust the pump speed to a rate suitable to create minimal drawdown. During purging and sampling, the maximum allowable drawdown is 0.3 feet.
- Using a stopwatch and some type of graduated cylinder, measure the pumping rate. Monitor the water level, pumping rate, cumulative volume withdrawn, and field parameters (temperature, pH, turbidity, conductivity, DO, and ORP) approximately every three to five minutes.

Low-flow purging is complete only when all required field parameters have stabilized (temperature, pH, turbidity, conductivity, DO, and ORP). Stabilization is achieved when two consecutive readings show temperature is within \pm one degree Celsius, pH values are within \pm 0.1 pH unit, turbidity is less than or equal to 10 NTUs or within \pm ten %, conductivity is within \pm 5 %, DO is within \pm 10 %, and ORP is within \pm 10 millivolts (mV). The Site Manager/Field Task Leader has the responsibility of determining if redevelopment of any monitoring well is necessary and appropriate.

3.3.3.2 Total Well Volume Purge Methodology

If a water level drawdown greater than 0.3 feet occurs at a purge rate of 0.1 L/min or less, or if it is deemed necessary, the total well volume purge methodology will be used. Using the total well volume purging methodology, the well will be purged until a minimum of three total well casing volumes (WCV) have been removed and field parameters (pH, temperature, turbidity, conductivity, DO, and ORP) have stabilized. A pumping rate should be established to minimize drawdown and will not exceed 2 L/min. When purging by this methodology, if parameters have not stabilized after six WCVs, then purging will cease and samples will be collected. Background wells being sampled for metals must attain 10 or less NTUs before sample collection unless a written variance (on a well-specific basis) is acquired. The turbidity goal for non-background samples is 15 NTU, but samples with higher turbidity are acceptable if turbidity readings are stabilized and the other conditions of total well volume purging have been met.

The volume of water in the well will be calculated based on the length of the saturated thickness in the well and the screen diameter (see below for calculation of volumes).

The well volume can be calculated in gallons using the following equation:

$$\text{Well Volume } V \text{ (in gallons)} = H \times F$$

where V = one well volume
H = the difference between the depth of the well and depth of water (ft)
F = factor for volume of one foot section of casing (gallons) from the table below.

Diameter of Casing (inches)	F Factor (gallons)
1.5	0.09
2.0	0.16
3.0	0.37
4.0	0.65
6.0	1.47

F can also be calculated from the following equation:

$$F = \pi (D/2)^2 \times 7.48 \text{ gal/ft}^3$$

where D = the inside diameter of the well casing (ft)

The well will be sampled immediately following purging without moving or adjusting the position of the pump. Evacuated well water will be managed as outlined in SOP-020, *Investigation-Derived Waste*. Necessary precautions will be taken to prevent spilling potentially contaminated water. The water will need to be containerized and appropriately disposed of or treated prior to discharge.

If the well is purged dry with a flow rate of less than 2 L/min, it will be sampled as soon as possible after the minimum sample volume of groundwater has recharged the well. The requirements of a minimum of three well volumes purged and stabilization of field parameters will not be applied to sampling a well that has been purged dry if the pumping rate was less than 2 L/min.

For total well volume purging, the following procedures will be performed at each well:

- The condition of the well completion (outer well casing, concrete well pad, protective posts, well label) and any unusual conditions of the area around the well will be noted in the field logbook. The well may also be photographed. Any deficiencies encountered will be reported to the Site Manager on the same working day.
- Set up and establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
- Don PPE as specified in the HSP.
- Note if the reference point (measuring point) on the well is present. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
- The depth of the static water level will be measured with a water level indicator (to the nearest 0.01 foot) in accordance with SOP-006, *Static Water Level and Total Depth Measurement*. If a high concentration of organic vapors are detected in the well, an oil/water interface probe will be used to determine the presence of an immiscible phase (LNAPL or DNAPL).
- The total depth of well will be measured from the same measuring point on the casing with a water level indicator and recorded. It is critical that the

distance between the water sensor (zero point) and the end of the water level indicator probe be measured independently and added to each total depth measurement.

- Slowly lower the pump or pump tubing into the well casing to a point in the middle of the screened interval. Reinsert the water level indicator to monitor water levels during purging.
- Start the pump. As soon as water is discharging, adjust the pump speed. The pumping rate should never exceed 2 L/min.
- Using a stopwatch and some type of graduated cylinder, measure the pumping rate. Monitor the water level, pumping rate, cumulative withdrawal, and field parameters every ten minutes and/or per well volume. Field parameters including temperature, pH, turbidity, conductivity, DO, and/or ORP will be monitored.
- At a minimum, three total volumes must be purged for this method if the well is not purged dry with a pumping rate less than 2 L/min. If the well is purged dry with a pumping rate less than 2 L/min then the sample will be collected after a sufficient volume of water has recharged the well regardless of total volume purged and field parameter stabilization.

Purging is complete only when all required field parameters have stabilized (temperature, pH, turbidity, conductivity, DO, and ORP) or six WCVs have been removed, whichever comes first. Water parameters will be measured after removal of each volume and approximately every five minutes after the first 2 WCVs. Stabilization is achieved when two consecutive readings show temperature is within \pm one degree Celsius, pH values are within \pm 0.1 pH unit, turbidity is less than or equal to 10 NTUs or within \pm 10 %, conductivity is within \pm 5 %, DO is within \pm 10 %, and ORP is within \pm 10 millivolts (mV). The Site Manager/Field Task Leader has the responsibility of determining if redevelopment of any monitoring well is necessary and appropriate.

3.3.4 Sample Collection (Low Flow & Total Well Volume)

Using low-flow or total well volume sampling procedures, samples for chemical analysis will be collected immediately following purging. For wells that were purged dry, samples will be collected as soon as possible after a sufficient volume of groundwater is available in the well. The water quality samples will be taken from within the well screen interval. The following sampling procedure will be used at each well:

- Immediately following purging, the pump will be used to collect the groundwater sample. The pump should not be moved between purging and sampling, unless a peristaltic pump is used.
- Identification labels for sample bottles will be filled out for each well.

- The individual sample bottles should be filled in the order given below:
 - Volatile organic compounds (VOCs),
 - Semi-volatiles organic compounds (SVOCs),
 - Other organic parameters,
 - Metals (inorganics),
 - Inorganic anions,
 - Other parameters, and
 - Field test parameters (e.g., pH, conductivity, and temperature).
- VOC sample vials should be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial. If air bubbles are observed in the sample vial, discard the vial and collect another sample.
- Fill containers for SVOCs, inorganics, inorganic anions, and other parameter analyses until almost full. Samples will be preserved and managed as detailed in the Quality Assurance Project Plan (QAPP). The time of sampling will be recorded. When collecting samples using preservatives, the pH should be periodically checked. For non-VOC samples, a small amount of the preserved sample should be poured from the sample container directly onto the pH strip (rather than dipping the strip into the sample container, which can contaminate the sample). For VOCs, the pH check is best accomplished by filling an extra vial during collection, ensuring it is not overfilled, then dipping a pH strip into the sample vial to check that the sample is at or below the maximum pH allowed. This vial would then be disposed of as investigation-derived waste (IDW).
- After the samples have been collected, they should immediately be placed in an ice-filled cooler until relinquished to the on-site laboratory or shipped to the appropriate laboratory for analysis.
- After removing the pump and equipment from the well, replace and lock the well cap.

3.4 Quality Assurance/Quality Control (QA/QC) Procedures and Samples

The well sampling order will be dependent on expected levels of contamination in each well, if known, and will be estimated prior to sampling. To the extent practicable, sampling will progress from the least contaminated well to the most contaminated. QA/QC samples will be collected during groundwater sampling according to the QAPP.

QA/QC samples may be labeled with QA/QC identification numbers (or fictitious identification numbers if blind submittal is desired), and sent to the laboratory with the other samples for analyses.

3.5 Sample Identification, Handling, and Documentation

Samples will be identified, handled, and recorded as described in this Standard Operating Procedure and in accordance with standard sample handling protocols indicated in the QAPP.

4.0 REFERENCES

Ground Water Issue, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, April 1996 (EPA/540/S-95/504).

5.0 RECORDS

Field notes will be kept in a bound field logbook or Monitoring Well Purging Form (Attachment 1) as required by SOP-019, *Field Activity Records*. The following information will be recorded using waterproof ink:

- Names of sampling personnel;
- Weather conditions;
- Project title;
- Location and well number;
- Date and time of sampling;
- Condition of the well;
- Decontamination information;
- Initial and final static water level, total well depth;
- Equipment calibration information;
- Method of purging;

- Volume of water purged before sampling;
- Purge start/stop times;
- Pumping rate, if applicable;
- Field parameter measurements during purging;
- Method of sample collection;
- Sample identification numbers;
- Photo documentation, if applicable;
- QA/QC samples collected; and
- Irregularities or problems.

In addition to the logbook, the Monitoring Well Purging Form located in Attachment 1 will be completed.

6.0 ATTACHMENTS

Attachment 1 – Monitoring Well Purging Form.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to describe the equipment and methods used to accurately determine static water level and total depth in a groundwater monitoring well, pumping well, or piezometer.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who measure water levels and total depths in wells. The procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities which may disturb the water level, such as purging or aquifer testing.

3.0 METHOD

3.1 General

This procedure requires the use of an electronic water level device that employs a battery-powered probe assembly attached to a cable marked in 0.01-foot increments. When the probe makes contact with the water surface, a circuit is closed and energy is transmitted through the cable to sound an audible alarm. This equipment will have a sensitivity adjustment switch that enables the operator to distinguish between actual and false readings. The manufacturer's operating manual should be consulted for instructions on use of the sensitivity adjustment.

3.2 Procedures

3.2.1 Equipment

- Water level indicator with an audible alarm and a cable marked in 0.01-foot increments. The point on the probe that triggers the alarm corresponds to the zero point.
- If free-phase product is present on the water surface, then an interface probe capable of distinguishing between product and water will be used.

3.2.2 Calibration

The water level indicator or interface probe should be calibrated before use. The end of a probe should be placed in a bucket of water to ensure that the audible alarm is in working condition and responds when the electrical contacts encounter water. The marked length units on the probe line should be verified for accuracy by comparing to a standard steel tape measure. If there is any noted discrepancy between the water level indicator and the measuring tape, the difference in length will be noted on the field log and identified on the water level indicator. All subsequent water level measurements will be corrected as necessary.

3.2.3 Static Water Level Measurement

Before water level measurements are collected, all equipment will be thoroughly decontaminated as detailed in SOP-021, *Equipment Decontamination Procedures*. The static water level will be measured each time a well is sampled. This must be done before any fluids are withdrawn and before any purging or sampling equipment enters a well.

The measurements of static water level and total depth must be taken at an established reference point, generally from the top of the well casing at the surveyor's mark. The mark should be permanent, such as a notch or mark on the top of the casing. If the surveyor's point is not marked at the time of water level measurement, the north side of the casing should be used and marked. All equipment will be decontaminated before and after introduction of the equipment to the well following procedures in SOP-021, *Equipment Decontamination Procedures*.

If the well is sealed with an air-tight cap, allow time for equilibration of pressures after the cap is removed before water level measurement. Air-tight caps should be replaced by ventilated caps or a hole drilled in the well casing, where feasible, to allow the water to equilibrate to barometric changes.

With the water level indicator switched on, slowly lower the probe until it contacts the water surface as indicated by the audible alarm. Raise the probe out of the water until the alarm turns off. Three or more measurements will be taken on three minute intervals at each well until two measurements agree to within +/- 0.01 feet. Record the reading on the cable at the established reference point to the nearest 0.01 foot.

3.2.4 Total Depth Measurement

Slowly lower the water level indicator, with weight attached if necessary, until the cable goes slack. Raise and lower the probe until the precise location of the bottom is determined. Record the reading on the cable at the established reference point to the nearest 0.01 foot. Depending on the type of instrument used, the total depth measurement may need to be adjusted for the offset between the bottom of the probe and the water level sensor. Some instruments have the sensor at the bottom of the probe so the depth reading is accurate without an adjustment. However, the water indicator sensor on some probes is not located at the bottom of the probe. To get a true total depth reading, the distance from the water indicator sensors to the bottom of the probe housing must be added to the depth reading.

If it is not possible to measure the depth of a well in which pumping equipment is installed, then the as-built well construction diagram will provide the total depth.

3.2.5 Interface Probe Measurement

If there is the potential for free-phase product to be present on the surface of the water table in a well, then an oil-water interface probe will be used to collect water level measurements. Interface probes are used in the same manner as a water level indicator. The difference is that the interface probes have two different audible signals to differentiate between water and oil. If a layer of free-phase product is present, the probe will emit a different signal than for water. Most probes emit an intermittent beep when product is encountered, as opposed to a constant

tone for water. The alarm codes for individual probes are marked on the reel casing. If product is encountered, continue to raise and lower the probe until a precise level (within 0.01 foot) is determined. Record the measurement in the field log and identify it as a product measurement.

Next, slowly lower the probe until the water interface is encountered. Repeat the level measurement process and record the depth to water in the field logbook. Care should be taken during the measurement process to minimize disturbance of the product layer.

4.0 REFERENCES

Driscoll, F.G., 1986. *Groundwater and Wells*, 2nd Edition, Johnson Division, St. Paul, MN, pp. 1089.

Thornhill, J.T., 1989. *Accuracy of Depth to Ground Water Measurements*, from U.S. Environmental Protection Agency (USEPA) Superfund Ground Water Issue, USEPA/540/4-89/002.

U.S. Department of the Interior, 1981. *Groundwater Manual, A Water Resource Technical Publication*, Water and Power Resources Services, U.S. Government Printing Office, Denver, CO, pp. 480.

5.0 RECORDS

All field notes for water level and well depth measurements will be recorded in accordance with SOP-019, *Field Activity Records*.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to describe the general methodology for collecting soil samples in order to document the horizontal and vertical extent of contaminated soils at a site and to determine the geotechnical, hydrogeological, physical, and chemical properties of site soils.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who collect and/or handle samples of surficial and/or subsurface soil.

3.0 METHOD

3.1 General

Collecting soil samples is an important site characterization activity. Soil samples are used to determine the nature and extent of contamination, to identify hazardous substance source areas, and to determine the geotechnical, hydrogeologic, physical, and chemical properties of site soils. Field conditions at the site (e.g., direct push technology [DPT] or drilling refusal) may preclude collection at one or more predetermined sample locations. Additional soil sampling may be required, if unexpected subsurface conditions are observed during the course of the sampling activity. Proper sampling techniques, proper selection of sampling equipment, and proper decontamination procedures will eliminate cross-contamination and introduction of contaminants from external sources.

Soil conditions can vary widely at a site. These variations can affect the rate of contaminant migration through the soil. Therefore, it is important that detailed records be maintained during sampling activities, particularly with respect to location, depth, color, odor, lithology, hydrogeologic characteristics, and readings derived from field monitoring equipment. All soils will be classified in the field by a geologist, hydrogeologist, or soil scientist using the Unified Soil Classification System (USCS). All soils removed from borings that are not collected as samples will be disposed of according to the procedures in SOP-020, *Investigation-Derived Waste*.

3.2 Procedures

3.2.1 Equipment

Equipment that will be used to collect surficial and/or subsurface soil samples includes, but is not limited to, the following items:

- Stainless steel spoons/trowels;
- Stainless steel hand auger;
- Stainless steel split-spoon, split-barrel, or continuous sampler;

- Stainless steel closed-piston type soil sampler;
- T-handled sampler with disposable plastic syringes for VOC sampling;
- Stainless steel bowls/pans;
- Nitrile rubber gloves;
- Field notebook/logbook/boring log;
- Waterproof/permanent marker;
- Paper towels;
- Teflon[®] film in 3-inch squares;
- Aluminum foil;
- Appropriate decontamination equipment;
- Appropriate health and safety equipment;
- Sample cooler with ice;
- Sample jars and labels;
- Chain-of-custody forms;
- Munsell Soil Color Charts;
- Grain size charts;
- Hand lens; and
- Ziploc[®] freezer bags.

3.2.2 Decontamination

Before collecting any soil samples, all sampling devices shall be decontaminated.

Decontamination supplies will be available so that small equipment can be decontaminated on site. Each piece of sampling equipment shall be decontaminated before initiation of sampling operations and between each sample location or interval. Decontamination solutions may be replenished between each site as needed. Spent decontamination fluids will be containerized and handled according to SOP-020, *Investigation-Derived Waste*. All procedures presented in

SOP-021, *Equipment Decontamination Procedures*, will be followed for decontamination of field equipment and for personnel decontamination.

3.2.3 Volatile Organic Compounds

If volatile organic compounds (VOCs) are among the contaminants expected at a particular site, soil samples submitted for laboratory VOC analysis will be collected and preserved as discussed in Attachment 1.

3.2.4 Surface Soil Sampling

Surface soil is considered to be the top six inches of a soil horizon profile (i.e., soil from zero to six inches below ground surface [bgs]). All personnel who collect or handle the soil samples will wear disposable nitrile gloves to prevent cross-contamination and provide personal protection. New gloves will be donned between each soil sample, or whenever gloves are torn or otherwise compromised.

Any surface vegetation will be removed before sample collection with a decontaminated shovel or sampling spoon. Surface soil samples not analyzed for VOCs may be collected as either discrete or composite samples. Each surface soil sample will be collected using either a stainless steel spoon or trowel. The sampler, while wearing clean disposable nitrile gloves, will remove pebbles, roots, etc. from the mixture as the sample is collected. Except for VOCs, each sample will be collected by thoroughly homogenizing material from the zero to six-inch depth interval (unless stated otherwise in project-specific documents) from the respective soil sample location. The homogenized material will then be divided equally among the appropriate sample containers. The sample containers will then be sealed tightly, and handled according to SOP-018.

Each soil sample collected for analysis of VOCs by Method SW8260 will be collected and preserved in accordance with Method SW5035A as described in Attachment 1. The sample container will be sealed tightly and handled according to SOP-018, *Packing and Shipping of Environmental Samples*.

Upon completion of sampling, if the sample is located in a residential yard setting, the hole will be filled with stockpiled soil or commercial topsoil to achieve the original grade. Sod will be replaced.

Each composite sample will be collected by placing equal amounts (or aliquots) of soil collected from multiple locations into a decontaminated collection container. The aliquots will then be homogenized using a spoon or trowel. The homogenized material will then be divided equally among the appropriate sample containers. The sample containers will then be sealed tightly and handled according to SOP-018. Composite samples will not be collected for VOCs.

3.2.5 Subsurface Soil Sampling

3.2.5.1 Shallow Subsurface Soil Sampling

Shallow subsurface soil samples not analyzed for VOCs may be collected as either discrete

(grab) or composite samples. Each subsurface soil sample location should be checked and cleared before intrusive activities according to SOP-001, *Utility Clearance for Intensive Activities*. Subsurface soil samples can be collected using a wide variety of sampling equipment and devices. Common equipment used to collect shallow subsurface soil samples include thin-wall tube samplers and various types of hand augers, including bucket-type hand augers, continuous-flight hand augers, and posthole hand augers. Of these sampling methods, only the thin-wall tube sampler collects an undisturbed soil sample. Depending on field conditions or sampling objectives, several types of sample collection equipment can be used to collect a soil sample at a single location.

Using a decontaminated hand auger or powered drill rigs, the soil borehole will be advanced to the depth immediately above the sampling interval, and all cuttings will be removed from the borehole. During advancement of the auger, cuttings from in and around the borehole will be periodically removed and placed on a plastic sheet or in a plastic bucket or tub. If the sample is to be collected using the same hand auger, the auger bucket will be decontaminated (or replaced with a decontaminated bucket) before collecting the sample. The discrete sample will then be collected by advancing the sampling equipment (e.g., hand auger bucket or thin-wall tube sampler) to the appropriate depth and retrieving the soil sample. Any sample collected for analysis of VOCs will follow the method presented in Attachment 1. The remaining soil in the sampling equipment will be placed in a decontaminated stainless steel, glass, plastic, or disposable collection container, and thoroughly homogenized using a decontaminated stainless steel spoon or trowel. The homogenized material will then be divided equally among the appropriate sample containers. Depending on the number of sample containers to be filled at each sample location, additional sample material may be required from the soil boring. The sample containers will then be sealed tightly, and handled according to SOP-018.

3.2.5.2 Deep Subsurface Soil Sampling

Equipment commonly used to collect deep subsurface samples includes, but is not limited to, split-spoon samplers, continuous core samplers, Shelby tubes, and ring-lined barrel samplers. These types of sampling equipment are used in conjunction with a drill or DPT rig, and are usually either hammered, drilled, or pushed into the interval to be sampled. The interval(s) to be sampled may be either predetermined as specified in the project-specific plans, or determined according to criteria observed during advancement of the drilling equipment (which will also be specified in the project-specific work plans).

3.2.5.2.1 Direct Push Technology (DPT) Drilling

DPT soil sampling equipment will be a hydraulically powered soil-probing machine that utilizes static force and percussion to advance small diameter sampling tools into the subsurface for collecting soil cores. This equipment is typically mounted on a truck or all-terrain vehicle capable of traversing rough and possibly muddy terrain.

Prior to initiation of the DPT borings concrete or asphalt surface at the selected sample locations will be removed (if necessary) by coring. Geoprobe[®] or other equivalent DPT sampling method will be used to collect soils by utilizing either the Macro-core[®] sampler (i.e., 48 inches long and 2 inches in diameter), or the Large-bore[®] sampler (i.e., 24 inches long and 1 inch in diameter).

Each Geoprobe[®] soil sampler will be equipped with a clear plastic liner and a closed-piston tip. The sampler will be driven down to the top of the desired sampling interval and the piston tip unlocked, then driven to the bottom of the desired interval (either 24 or 48 inches). Macro-core[®] catchers or an equivalent will be used in sandy intervals to minimize the potential for loss of sample recovery. The Field Geologist will collect the necessary samples for logging, field photoionization detector/flame ionization detector (PID/FID) screening, and laboratory analyses. Any sample collected for analysis of VOCs will be collected and preserved according to Attachment 1. The remaining soil in the sampler will be placed in a decontaminated stainless steel, glass, plastic, or disposable collection container, and thoroughly homogenized using a decontaminated stainless steel spoon or trowel. The homogenized material will then be divided among the appropriate sample containers. Sample containers will be sealed tightly, and handled per the Basewide FSP. Following sampling, soil boreholes will be abandoned per specifications in SOP-007, *Well Abandonment/Borehole Plugging*. The boreholes will be logged in accordance with the specific procedures provided in SOP-012, *Boring Log Development*. All equipment associated with collection of the soil samples will be decontaminated in accordance with the procedures provided in SOP-021, *Equipment Decontamination Procedures*.

3.2.5.2.2 Hollow-Stem Auger Drilling

Using the drilling equipment (e.g., hollow-stem augers and auger bit), the soil borehole should be advanced to the depth immediately above the sampling interval in accordance with American Society for Testing and Materials (ASTM) Method D-1586. During advancement of the auger, cuttings from around the augers will periodically be removed and placed on a plastic sheet or in appropriately labeled drums. The sampler will be inserted into the hollow-stem augers and lowered to the bottom of the borehole. The sampler will then be driven ahead of the augers by hammering into the undisturbed sampling interval. Blow counts for that sample will be recorded on the boring log, as well as the interval in which the sample was obtained. The sampler will be retrieved and split open. Any samples for analysis of VOCs will be immediately collected and preserved according to Attachment 1. The remaining soil in the sampler will be placed in a decontaminated stainless steel, glass, plastic, or disposable collection container, and thoroughly homogenized using a decontaminated stainless steel spoon or trowel. The homogenized material will then be divided among the appropriate sample containers. Sample containers will be sealed tightly, and handled per the Basewide FSP. Following sampling, boreholes will be abandoned per specifications in SOP-007, *Well Abandonment/Borehole Plugging*.

3.2.5.2.3 Sonic Drilling

With sonic drilling, the core barrel is vibrated into the ground 10 or 20 feet ahead of the outer drill casing. The outer drill casing is then advanced to the bottom of the core barrel and the core barrel is then removed from the hole and the core is extruded into a plastic sleeve. Any samples collected for analysis of VOCs will be collected and preserved as outlined in Attachment 1. The core is measured for recovery and recorded on the soil boring log. The sample will be inspected for changes in lithology, color, moisture, and density and recorded on the soil boring log. A stainless steel or plastic catcher should be used once the water table has been reached. The catcher prevents finer, wetter material from falling out of the core barrel and will improve recovery of the sample. The stainless steel catcher is usually welded into the bit to prevent material from being pushed up into the core barrel.

3.2.5.2.4 Air Rotary Drilling

Dual rotary soil samples will be collected directly from the air/cuttings discharge point. These samples may only be analyzed for geotechnical parameters. The depth of the sample will be determined by the Rig Geologist due to the travel time for the cuttings to move from the bottom of the borehole through the annulus to the cyclone. The driller shall be consulted for the time when penetration is initiated to measure the travel time.

4.0 REFERENCES

Barth, D.S. and B.J. Mason, 1984. *Soil Sampling Quality Assurance User's Guide*, U.S. Environmental Protection Agency (USEPA)-600/4-84-043.

Mason, B.J., 1983. *Preparation of Soil Sampling Protocol: Techniques and Strategies*, USEPA-600/4-83-020.

Penetration Test and Split Barrel Sampling of Soils, Method D-1586, Volume 04.08, ASTM, Philadelphia, PA, pp.216-219.

U.S. Environmental Protection Agency (USEPA), July 2002. SW-846 Final Update III A Method 5035A. Closed-system purge-and-trap and extraction for volatile organics in soil and waste samples.

USEPA, 1984. *Characterization of Hazardous Waste Sites - A Methods Manual, Available Sampling Methods*, Vol. II, 2nd Edition, USEPA-600/4-84-076.

5.0 RECORDS

All records shall be documented in a bound field logbook in accordance with SOP-019, *Field Activity Records*.

6.0 ATTACHMENTS

Attachment 1 - Soil Volatile Organic Compounds Sampling Procedure by USEPA Extraction Method 5035A.

Attachment 1 – Soil Volatile Organic Compounds Sampling Procedure by USEPA Extraction Method 5035A

This attachment presents the US EPA Extraction Method 5035A for the collection of volatile organic compound (VOC) samples of soils in the field. In summary, this method involves the collection of a fixed volume of soil using a specially designed disposable sampler, containerizing the sample in a prepared sample vial, and freezing the sample for delivery to the analytical laboratory. The advantage of this extraction method over previous methods is the resulting 14-day holding time, which allows more time for shipment and laboratory preparation over the 48-hour holding time required by the previous methods.

Sample Collection

The method requires that a fixed amount of soil be collected, usually as 5 gram or 10 gram samples. To achieve this, a specialized sampling tool has been developed that approximates these quantities at the time of collection depending on soil texture. The tool consists of a T-bar handled sampling device that is affixed with a disposable plastic soil syringe. To collect a sample, the Field Geologist sets the sampling device to the desired sample volume (5 or 10 grams) and inserts a new disposable plastic syringe. The Field Geologist then inserts the syringe portion of the sampler into the selected undisturbed soil sample. The soil is forced into the plastic syringe, pushing the syringe plunger out until it reaches the predetermined volume set on the sampling device handle. Immediately after the syringe has been filled with the soil sample, the Field Geologist will remove the syringe from the soil and place the open end of the syringe over a labeled pre-weighed sample vial containing a stir-bar and reagent grade water. The soil sample will then be extruded into the vial by pushing down on the sampler T-handle, depressing the plunger. Once the sample is extruded, the vial is capped and placed on ice. The used plastic soil syringe is removed from the sampler and discarded, a new syringe is placed in the sampler to collect the next sample.

The collected sample vials are taken to a prearranged location and weighed to the nearest 0.01 gram using a calibrated scale. The location used for weighing the samples should have a stable surface for the scale, a relatively constant temperature, and no wind or other significant disturbances, preferably indoors. The measured weight is recorded on the sample vial label and in the log book. The sample vials are then placed in a cooler on ice. The samples are then packed in coolers and shipped according to SOP-018, *Packing and Shipping of Environmental Samples*. All samples will be packed on ice for shipment to the laboratory.

Additional Equipment Needed

- T-bar sampler with 5 and 10 gram graduations;
- Disposable plastic soil syringes (equivalent to the AnalSys soil sampling device);
- 40-ml glass pre-prepared sample vials – the vials must include label, and magnetic stir bar and have been pre-weighed.
- Cooler with wet ice, capable of maintaining $4 \pm 2^{\circ}\text{C}$;

- Scale capable of measuring to the nearest 0.01 gram; and
- Scale calibration weights.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to assure representative environmental sample data by documenting the management of samples from time of collection through analysis and final disposition.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who collect and/or handle environmental samples.

3.0 METHOD

3.1 General

An essential part of the sampling/analytical portion of any environmental project is assuring the integrity of the sample from collection to data reporting. Projects where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The chain of custody (COC) form is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may skew the analytical accuracy of the laboratory results. Therefore, it is extremely important that COC forms be complete, accurate, and consistent.

Assuring sample integrity and accountability requires strict adherence to the proper use of the following six essential sampling components:

- Field Sampling Plans (FSPs);
- Sample labels;
- Sample logs;
- Sample custody seals;
- Field logbooks; and
- COC forms.

Successful implementation of these components requires a thorough understanding of sample custody requirements. A sample is under an organization's custody if:

- It is in an employee's physical possession;
- It is in view of an employee, after being in their physical possession;

- It was in an employee's physical possession and then locked up so no one could tamper with it; and
- It is in a designated and identified secure area, controlled and restricted to authorized personnel (or individuals accompanied by authorized personnel) only.

A sample remains in an organization's custody until relinquished in writing to another person or organization that is authorized to take custody of the sample.

3.2 Procedures

3.2.1 Sample Labels

Sample labels are required to prevent misidentification of samples. Sample labels will generally be pre-printed by a database technician and taken to the field.

The sample label will be affixed to the proper sample container at the time of the sampling event by the field sampler. The labels will contain the following pre-printed information:

- Sample identification number (ID);
- Site ID;
- Event ID (if applicable);
- Location ID;
- Analyses requested;
- Receiving laboratory;
- Type of sample container;
- Preservatives used;
- Sample matrix; and
- Matrix spike/matrix spike duplicate (MS/MSD) if required.

During a sampling event, the field sampler will write the following information on the label:

- Field sampler's initials;
- Date (mm/dd/yy or m/d/yy, i.e., 04/03/98 or 4/3/98 is April 3, 1998); and

- Time of sample collection (military format).

Custody seals are narrow strips of adhesive paper used to document that no sample tampering has occurred during transport from the time of collection to laboratory receipt. Custody seals will be signed, dated, and attached to all coolers so they tear if the cooler is opened.

3.2.2 Field Logbooks

All samples collected will be documented in field logbooks. All field documentation will follow SOP-019, *Field Activity Records*.

3.2.3 Chain-of-Custody Form

Every person involved with sample collection and handling will know and understand the COC form, discussed in detail in SOP-017, *Chain-of-Custody Form*. These procedures will be made available to all field personnel.

The sample shipper will complete the COC form while preparing the samples for shipment. This individual or other authorized person will sign the "Relinquished By" box and enter the shipper's name in the "Received By" box prior to sealing a sample shipping container for courier pickup after ensuring that samples and COC forms match (in other words, only samples identified on the enclosed COC(s) are in the container and all samples enclosed are listed on the COC(s) enclosed). The "Received By" box will be signed by the laboratory sample receipt staff. As long as COC forms are sealed inside the sample shipping container, commercial carriers are not required to sign the COC form.

Distribution of the COC form will be:

- Original and one copy - sealed in plastic bag and taped inside the top of the shipping container;
- One copy - file in appropriate Field Office project file; and
- One copy - submit to Data Management staff.

All changes to a COC form will be made by striking the incorrect information with a single line, initialing and dating the strike, and inserting the correct information. If changes are made to a COC form after the original distribution, the following steps will be taken:

- Make the change by striking the incorrect information with a single line, initialing and dating the strike, and inserting the correct information (in black or blue indelible ink). Add a comment as to why the change was made, as appropriate.
- Distribute copies of the corrected COC form as specified above.

Whenever a sample is split with a second party (e.g., client, agency) a separate COC form must

be prepared for those samples.

4.0 REFERENCES

US Environmental Protection Agency (US EPA), December 1984, *Characterization of Hazardous Waste Sites - A Methods Manual: Vol. II. Available Sampling Methods*, 2nd Edition, USEPA-600/4-84-076, p. D1-D11.

US EPA/NEIC, *User's Guide to the EPA Contract Laboratory Program*.

US EPA/NEIC, 1982. *Policies and Procedures*, 330/9/78/001-R.

5.0 RECORDS

Procedures for maintaining COC forms are described in SOP-017, *Chain-of-Custody Form*

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to ensure that the chemical integrity of a sample is maintained from time of collection until chemical analysis.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel involved with the collection, shipping and chemical analysis of environmental samples. The Standard Operating Procedure documents the protocols and chemicals to be used for the preservation of field samples. The environmental media addressed in this Standard Operating Procedure include soils, sediments, IDW, and aqueous samples.

3.0 METHOD

3.1 General

Most chemical and biological reactions and many physical processes are slowed by lowering the temperature. Therefore all samples except solids samples for volatile organic compound (VOC) analysis need to be cooled at the time of collection and maintained slightly above freezing until preparation for final analysis. Solid VOC samples are extracted within 48 hours of collection and the extracts are kept chilled.

Non VOC soil samples and other solid samples, including sediments, sludges and solid waste, will be preserved by cooling to $\leq 6^{\circ}\text{C}$. Soil and solid samples require no other preservatives, except for volatiles in soil and sediments, which are discussed in Attachment 1 of SOP-013, *Soil Sampling*. However, analysis must be performed within the method-specific holding time requirements.

Aqueous samples may be presumed to be homogenous and amenable to chemical preservation as applicable. In addition to keeping such samples cold, the following general approaches are employed depending on the analyte(s):

- Volatile acids (hydrogen cyanide, hydrogen sulfide) are rendered involatile in the presence of strong base (sodium hydroxide (NaOH), $\text{pH} > 12$).
- Volatile bases (ammonia) are rendered involatile in the presence of strong acid (sulfuric acid [H_2SO_4], $\text{pH} < 2$).
- Biodegradation of organic compounds is retarded under strongly acidic conditions (hydrochloric acid [HCl] or H_2SO_4 , $\text{pH} < 2$).
- Dehydrohalogenation (loss of HCl) of chlorinated solvents is counteracted in the presence of acid (HCl, $\text{pH} \leq 2$).

- Oxidation of target analytes by the chlorine found in drinking water is eliminated by destroying the chlorine with a reducing agent such as sodium thiosulfate.
- Many soluble metal salts tend to plate out on the walls of the container or form precipitates with time. This can be prevented by the addition of nitric acid to a pH of < 2 , which maintains the metals as soluble nitrate salts.

3.2 Procedures

3.2.1 General

All sample containers and disposable soil syringes for VOC sample collection will be supplied in advance by the subcontracting laboratories.

The required chemical preservatives for aqueous samples will normally be added to the appropriate containers by the subcontracting laboratories prior to delivery to the field. Pre-preserved sample containers are preferable so that the laboratory scheduled to do the analysis maintains control over sample integrity and container cleanliness. Sample preservatives should be identified on the sample label and the sample log form.

3.2.2 Soil, Sediment and Solid IDW

Following collection, solid samples, except for volatiles in any type of container, will be labeled and then immediately placed in an ice chest containing sufficient ice to maintain a temperature range of $0 - \leq 6^{\circ}\text{C}$ throughout the day. Ice chests with samples collected at the sampling site will be transported to the field sample control area in a timely fashion.

Samples are maintained in ice or in refrigerators, within a range of $0 - \leq 6^{\circ}\text{C}$, from the time they are collected until the samples are packed for shipment and relinquished to the shipper or other transport agent.

All soil and sediment samples are shipped in ice chests packed with sufficient ice to maintain a temperature range of $\leq 6^{\circ}\text{C}$ for at least 24 hours (refer to Standard Operating Procedure SOP 018, *Packing and Shipping of Environmental Samples*). The receiving laboratory will measure the temperature within the ice chest and then place the VOC samples in a freezer with a temperature between -7°C and -20°C immediately upon assuming custody of a shipment of samples. The temperature of all ice chests will be noted on the chain-of-custody form or addenda to the form.

Temperatures in excess of 6°C will be reported immediately to the Project Chemist. After consultation with the Project Chemist and QA Manager, the Project Manager will determine if resampling is necessary.

3.2.3 Aqueous Samples

With respect to procedures for maintaining a temperature range of $0 - \leq 6^{\circ}\text{C}$, aqueous samples will be treated the same as solid samples as described in Section 3.2.2.

The amount of acid preservative provided by the laboratory may not suffice to lower the pH to ≤ 2 in the case of highly buffered waters. The pH of such samples should be monitored on a regular basis (see SOP-005, *Groundwater Purging and Sampling*). A small amount should be poured from each container with preservative (except zero headspace samples) directly onto the pH strip. For volatile organic compounds, this is best accomplished by filling an extra vial during collection, ensuring it is not overfilled, then using pH strips or probe to check that the sample is at or below the maximum pH allowed. This vial would then be disposed of as Investigation-Derived Waste (IDW). Similar remarks apply to aqueous samples preserved with NaOH where the pH should be > 12 . With the exception of VOCs, if the pH of a sample is not at the required level, the appropriate chemical preservative will be added in the field until the required level is achieved. For VOCs, the sample containers cannot be reopened once the sample has been collected; therefore, the laboratory will be notified of all VOC samples which do not meet the target preservation pH. Those VOC samples will be prioritized by the laboratory so that the analyses are completed within the unpreserved holding time limits.

3.2.4 Reagents

Reagent-grade inorganic chemicals conforming to specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS) will be used as preservatives, including:

- Analyte-free reagent water, prepared per page 26 of Chapter One of *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 1985) or purchased high pressure liquid chromatography-grade water;
- Nitric Acid, ACS grade, 16N;
- NaOH, ACS grade, pellets;
- H_2SO_4 , ACS grade, 37N;
- HCl, ACS grade, 12N;
- Sodium Thiosulfate, ACS grade crystals; and
- Zinc Acetate.

4.0 REFERENCES

American Public Health Association, 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition.

Code of Federal Regulations (CFR), 1990, 40 CFR 136.

State of California, 1989. *Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure*, Leaking Underground Fuel Tank Task Force.

U.S. Environmental Protection Agency (EPA), June 1991. *Statement of Work for Organics Analysis*, Document No. OLMO1.0, Contract Laboratory Program.

EPA, November 1990. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition, Final Update I, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, March 1990. *Statement of Work for Inorganics Analysis*, Document No. ILMO1.0, Contract Laboratory Program.

EPA, December 1982. *Methods for Chemical Analysis of Water and Wastes*, USEPA-600/4-82-055.

5.0 RECORDS

A record of reagents used with corresponding lot control numbers will be maintained in the sample control area by the Sample Shipper/Controller.

6.0 ATTACHMENTS

Requirements for containers, preservation techniques, sample volumes, and holding times are provided in Table 5-1 of the Work Plan.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to delineate protocols for use of the chain-of-custody (COC) form.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel responsible for collecting, shipping and analyzing environmental samples.

3.0 METHOD

3.1 General

COC forms are used to legally track samples from time of collection through completion of laboratory analysis.

3.2 Procedures

The following information will be preprinted on the COC form when possible:

- Project name;
- Name and address of laboratory; and
- Potential analysis and method numbers.

The following information will be written on the COC form by the sample controller/shipper:

- Site name;
- Name of receiving laboratory;
- Sample IDs for all samples in a particular cooler/shipping container;
- Sample matrix or matrix code (e.g., SO for soil);
- Sample type (environmental, trip blank, equipment blank, etc.), which is encrypted in the sample ID code;
- Analysis requested by method number unless other arrangements are made with the receiving laboratory;
- Number of containers;
- Quality Control (QC) required (to indicate the sample is to be used for matrix spike/matrix spike duplicate analyses);

- Date of collection (mm/dd/yy or m/dd/yy: 04/03/98 or 4/3/98 is April 3, 1998);
- Time of collection (military format);
- Signature of individual who prepares the COC form;
- Cooler identification (ID);
- Carrier service and airbill number; and
- Signature of individual relinquishing samples along with the date and time of relinquishment.

Upon completion of the form, retain two copies and affix the original and one copy to the inside of the sample cooler (in a Ziploc[®] bag to protect from moisture), to be sent to the designated laboratory.

4.0 REFERENCES

U.S. Environmental Protection Agency (EPA), December 1990. *Sampler's Guide to the Contract Laboratory Program*, USEPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C.

EPA, January 1991. *User's Guide to the Contract Laboratory Program*, USEPA/540/0-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, Washington, D.C.

EPA, *Guidelines and Specifications for Preparing Quality Assurance Project Plans*.

5.0 RECORDS

Distribution of the COC record will be:

- Original and one copy - sealed in plastic bag with a custody seal (initialed and dated) and taped inside the top of the shipping container;
- One copy - file in Project File; and
- One copy - submit to URS Database Manager.

6.0 ATTACHMENTS

A sample of a chain-of-custody form is attached.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to provide guidance for the packing and shipping of environmental samples with the appropriate chain-of-custody (COC) forms. This is in accordance with all applicable transportation regulations, analytical requirements, and proper COC forms.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel involved in the packing and shipping of environmental samples. Samples determined to be hazardous will be managed in accordance with the requirements of the U.S. Department of Transportation (DOT) and the International Air Transportation Association (IATA) for shipping hazardous/dangerous goods by land or air.

3.0 METHOD

3.1 General

Environmental samples and quality control samples are collected, labeled, and sealed in the field, and COC is maintained, as defined in SOP-015, *Field Sample Management*.

40 Code of Federal Regulations (CFR) Part 261.4 describes sample shipping requirements. It states that:

"... a sample of solid waste or a sample of water, soil, or air, which is collected for the sole purpose of testing its characteristics or composition, is not subject to any requirements of this part (hazardous materials shipping requirements)... when:

- (i) The sample is being transported to a laboratory for the purpose of testing; or
- (ii) The sample is being transported back to the sample collector after testing.

In order to qualify for the(se) exemption(s)..., a sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector must:

- (i) Comply with DOT, U.S. Postal Service (USPS), or any other applicable shipping requirements; or
- (ii) Comply with the following requirements if the sample collector determines that DOT, USPS, or other shipping requirements do not apply to the shipment of the sample:
 - (A) Assure that the following information accompanies the sample:
 - (1) The sample collector's name, mailing address, and telephone number;

- (2) The laboratory's name, mailing address, and telephone number;
 - (3) The quantity of the sample;
 - (4) The date of shipment; and
 - (5) A description of the sample.
- (B) Package the sample so that it does not leak, spill, or vaporize from its packaging. The URS Hazardous Materials Shipping Hotline can be reached at 1.800.381.0664. Shipping experts are available via the hotline to answer any shipping questions you may have.

Samples will be assessed to determine potential hazard. Potentially hazardous samples are required by law to be properly handled and labeled.

PID readings greater than 1,000 parts per million will be used to identify a sample as hazardous. These measurements should be made on the sample headspace or directly over the sample as it is being collected. Good judgement on the part of the sample coordinator is also necessary to identify hazardous samples. Samples collected from chemical or fuel drums and tanks, stained or otherwise obviously contaminated soil, free product from a well, leachates, sludges, and samples with headspace readings noted above are all hazardous samples. Hazardous waste samples will be shipped according to DOT and IATA regulations.

Samples determined to be non-hazardous by the Sample Coordinator are environmental samples. They are to be labeled, packaged, documented, and shipped as described in Section 4.3.

3.2 Procedures

Determine the maximum allowable weight of each cooler (Federal Express limit for Priority Overnight shipping is 150 pounds).

Place each container in a Ziploc[®] bag and seal, squeezing as much air as possible from the bag before closing. Glass bottles and jars will be wrapped in bubble wrap.

Tape the cooler's drain plug shut on the inside and the outside, unless using dry ice in shipment.

Place a large size plastic bag (trash bag) in the cooler to contain samples.

Place the bottles upright in the plastic bag, with enough room for ice bags to be placed among and around the containers, and insulate with enough bubble wrap to deter breakage.

Place ice (double-bagged) among the containers along the walls and top of each cooler in a manner to ensure uniform cooling. When shipping soil samples, place one bag of ice along the bottom of the cooler as well. For water samples, it is possible to place the bottles upright in

absorbent material to provide additional stability. Do not use Blue Ice, as its heat capacity is lower than regular ice. If the Sample Shipper/Controller is informed by the laboratory that the samples are not being chilled sufficiently, additional ice may be required. Note that in summer months, more ice may be needed to ensure the samples arrive cold at the laboratory.

If shipping via commercial carrier (e.g., Federal Express), write the carrier's airbill number on the COC form, place the appropriate pages of the COC form inside a Ziploc[®] bag, and seal the bag with a signed, dated custody seal. The COC form has three pages. The original and one copy are sealed inside the Ziploc[®] bag and placed inside the cooler. One copy goes to project data management, and one copy (made by the Field Manager) is placed in field files. The COC form sent to the laboratory must be completed with all designated information, the pages must be originals (not photocopies), and the COC must be unique to the samples contained in the cooler.

If a courier from the laboratory is collecting the samples and delivering them to the laboratory, have the courier confirm that all samples listed are present and then sign the COC form.

Tape the Ziploc[®] bag with the COC form to the inside lid of the cooler, and close and latch the cooler.

Wrap strapping tape completely around the cooler on both sides of the latch.

Affix the shipping label with the address and telephone number of the laboratory and the contractor.

Affix signed custody seals on the front right and back left of the cooler across the lid, so as to tear if the cooler is opened during shipping.

The laboratory should be notified if the samples are being delivered via courier. They should be prepared to receive and check the samples and sign the COC form as the sample receiver.

4.0 REFERENCES

40 CFR 261.4, July 1990, Identification and Listing of Hazardous Waste, Federal Register, Chapter 1, p. 35.

Environmental Resource Center, 1992. *Hazardous Waste Management Compliance Handbook*, Van Nostrand Reinhold, New York.

EPA, 1987. *A Compendium of Superfund Field Operation Methods*, Office of Solid Waste and Emergency Response, Directive 9355.0-14.

EPA, 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*.

EPA, 1985. *Characterization of Hazardous Waste Sites: A Method Manual*, Vol. I, Site

Investigation.

5.0 RECORDS

Completed COC form.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to set site-wide criteria for content entry and form of field logbooks, and to document procedures employed in recording site activities photographically or using a video camera.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who record information in field logbooks, or employ photographic or video techniques to document site activities.

3.0 METHOD

3.1 General

An essential part of the sampling/analytical portion of any environmental project is assuring that proper documentation of all activities is accomplished. The primary document used to record site data is the field logbook. Tasks where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The field logbook may be used as evidence in legal proceedings to defend procedures and techniques employed during site investigations. Therefore, it is extremely important that field logbook documentation be factual, complete, accurate and consistent.

Likewise, when photographic or videographic techniques are used to document site activities, the goal of the records is a true representation of field activities that accurately portrays site conditions or procedures.

3.2 Procedures

3.2.1 Preparation

New field logbooks will be obtained as needed from the Field Manager/Task Leader. The individual using the field logbook will be responsible for its care and maintenance throughout the field task.

Field logbooks will be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. The following information will be recorded on the cover, binding, or inside the front cover of the logbook:

- Field document control number;
- Activity;
- Contractor's name;
- Phone number; and

- Site contact (Field Manager/Task Leader).

3.2.2 Operation

The following requirements must be followed when using a logbook:

- The date must be recorded at the top of each page.
- If data collection forms are specified by an activity-specific plan or procedure, the information need not be duplicated in the logbook.
- All changes must be made with a single line through the deletion. Changes must be initialed and dated.
- A diagonal line must be drawn through any space left at the bottom of each page.
- The bottom of each page will be signed by the author.
- Do not remove any pages from the logbook.

Entries into the field logbook will be preceded with the time of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged.

At each station where a sample is collected or an observation made, a detailed description of the location is required. If a map is not already available that shows the sample location, a sketch of the location is required. The sketch or diagram should be detailed enough for other individuals to locate the points at future times. A direction indicator or compass direction should be located on the sketch. It is preferred that maps and sketches be oriented so that north is towards the top of each page.

Events and observations that should be recorded include, but are not limited to:

- Changes in weather that may impact field activities;
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation;
- Problems, downtime, or delays;
- Upgrade or downgrade of personal protective equipment;
- All task members and visitors;

- Actual and background readings of health and safety monitoring equipment;
- Identification of equipment used, including model numbers and/or serial identification numbers;
- Start and end times of sample locations; and
- Decontamination times and methods.

When samples are collected, the following should be recorded:

- Sample location;
- Sample number;
- Sample methodology;
- Sample description;
- Sample collector;
- Sample depth;
- Sample type;
- Sample analyses requested;
- Sample preservation and confirmation; and
- Quality control (QC) sample numbers and types.

3.2.3 Visual Recordings

When visual recordings (photographs or video recordings) are made, they will be documented in the associated field logbook. At the start of the day, the weather conditions should be recorded; the weather should also be noted if site conditions change (e.g., weather goes from clear to overcast) throughout the day. For each photograph, the following information must be recorded:

- Location;
- Date and time;
- Photographer;

- Detailed description of subject of photograph;
- Direction of photograph (e.g., “taken facing northwest”);
- Identification of individuals in the photograph and their affiliation;
- Photograph number;
- Mechanical difficulties (if encountered) and corrective actions taken (and results).

A figure, map, or sketch of the site indicating the locations where photographs were taken is useful, especially if before and after photographs are to be taken at different times (potentially by different photographers, although using the same photographer is highly recommended).

For video recordings, the same information should be noted, along with the start and stop times on the recording. If the camera is capable of captioning with date, time, and text information to the recorded image, this is recommended. Such a captioning capability aids in later labeling and identifying the photographs or video recordings.

Photographs and/or video recordings should be taken with a camera-lens system having a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots are to be avoided unless previously approved by the client.

Most video cameras offer the cameraperson, or an accompanying field technician, audio recording capability that can be used to provide a running commentary on the activities recorded. This information is not a substitute for hard-copy documentation in a logbook (wind blowing across the microphone or technical difficulties may render the sound inaudible). Commentary should be pertinent and succinct.

3.2.4 Post-Operation

At the conclusion of a task or when a logbook has been completed, it will be submitted to the Field Manager/Task Leader for filing in the Project File.

Cameras will be returned to the location designated by the field task leader in the field office (the camera and film must be kept in a temperature and humidity controlled environment when not in use; camera batteries may need to be recharged overnight). Film and developed photographs should be protected from unnecessary exposure to light (to avoid fading), and video recordings must be protected from magnetic fields. The video cartridge must be labeled.

After the first day of work and on a regular basis thereafter, the Field Manager/Task Leader will perform a QC content check for compliance with this Standard Operating Procedure.

4.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), December 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods*, 2nd Edition, USEPA-600/4-84-076, pp. D1-D11.

USEPA/NEIC, 1982. *Policies and Procedures*, 330/9/78/011-R.

USEPA/National Enforcement Investigations Center (NEIC), *User's Guide to the USEPA Contract Laboratory Program*.

5.0 RECORDS

Documentation will follow all guidelines contained in this Standard Operating Procedure.

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that Investigation-Derived Waste (IDW) generated as the result of environmental investigations is managed:

- In a manner consistent with the federal and state applicable or relevant and appropriate requirements (ARARs) to the extent practical;
- To ensure that the potential of further contamination to the site from IDW is eliminated;
- To ensure the quantity of generated IDW is minimized;
- To provide labeling, tracking, and inventory of IDW; and
- To reduce health and safety concerns by reducing the potential for exposure.

2.0 SCOPE

This SOP applies to all contractor personnel and subcontractors generating, transporting, and handling IDW during environmental investigations and monitoring programs at Sierrita Mine. This SOP describes the minimum acceptable practices.

3.0 METHOD

3.1 General

The IDW generated should be considered part of the site that is being investigated and should be managed with other wastes from the site. The IDW should be managed in a protective manner and should comply with Arizona Department of Environmental Quality (ADEQ) and Resource Conservation Recovery Act (RCRA) requirements.

3.2 Procedures

3.2.1 Materials

The following materials may be used to comply with this Standard Operating Procedure:

- Ring-top 55-gallon drums (DOT-17-H);
- 20-yard (or similar capacity) roll-off boxes with tarps to cover;
- Roll-off liners;
- Drum labels;
- Field supplies such as pallets, Visqueen, rope, drum liners, paint pens, tape, and hand tools;

- Sampling and shipping supplies such as bottles, coolers, plastic bags, vermiculite, self-closing plastic bags, labels, tapes, and bubble wrap;
- Health and safety equipment such as PPE, first aid supplies from sites and vehicles, and eye wash stations;
- 250-gallon truck tank(s);
- Submersible pump(s);
- Hoses and clamps; and
- Spill kit that contains absorb booms or pads, vermiculite, hand tools, spill-related PPE.

3.2.2 Equipment

The following equipment will be needed to comply with this Standard Operating Procedure:

- Boom truck;
- Flat bed truck;
- Soil sampling equipment such as hand auger, trowels, bowls, sieves, drum thieves, disposable bailers, funnels, and bottles;
- Drum forks or clamps;
- Health and safety equipment and monitoring equipment (photoionization detector [PID], flame ionization detector [FID]);
- First aid supplies, eye wash station, splash protection PPE;
- Water polishing system, if applicable (Project-Specific Basewide sampling analysis plan [SAP] should contain the plans, designs, and equipment list for this system);
- Bulk tank(s); and
- Roll-off boxes.

3.2.3 Solid Investigation-Derived Waste

All waste that is generated, stored, processed, transported or disposed of in the state must be classified according to the provisions of Arizona Administrative Code Title 18, Article 2.

Non-indigenous Solid IDW such as disposable sampling equipment or tools will be disposed at a licensed landfill. Used PPE such as Tyvek® or Saranac® suits; latex, nitrile, or rubber gloves or booties; and spent respirator filters will be disposed as hazardous, non-hazardous, or radioactive waste in an appropriate designated drum/container/dumpster based on its generation. PPE generated from coming into contact with listed or characteristic hazardous waste, will be disposed in a separate drum/container/dumpster designated for hazardous waste and shipped to a TSD facility. However, PPE generated during the investigation from non-hazardous waste areas will be placed in a separate container and will be managed as non-hazardous waste.

Grossly contaminated PPE will be put into a ring-top 55-gallon drum lined with plastic bag drum liner. When the drum is full, the liner bag will be sealed, the lid closed, and the drum will be numbered, labeled, and moved to the secured site drum holding area.

Indigenous Solid IDW Any solids generated during an investigation will be collected and placed in appropriate designated drums/containers/dumpsters and manifested off-site for disposal based on its nature and characteristics as either hazardous waste, non-hazardous waste, or a radioactive waste. For solids where nature of contamination is not known, the contractor must first determine whether the waste is hazardous or non-hazardous using either historical information or sampling. Waste such as drill cuttings, and excess soil samples or other solid media that may be generated, will be stored at the sampling location and/or a designated location at Sierrita Mine. As the IDW is generated, it will be placed into clean ring-top 55-gallon drums or lined roll-off boxes. The drums to be used for the collection of wastes will be placed in new or reconditioned containers carrying the Department of Transportation (DOT) United Nations “performance oriented packaging standard” symbol. Containers storing hazardous waste must be marked using a yellow “Hazardous Waste” label with the name, address, city, state, zip code, EPA ID number, EPA waste number, accumulation start date, manifest document number and DOT proper shipping name.

3.2.3.1 Solid Waste Sampling and Characterization

Generators who characterize waste using analytical methods to classify their waste must follow all state requirements. Where required by the disposal facilities, additional samples from each drum/container may be required. The solid samples will be collected using either a trier or an auger (SW-846, Chapter 9, Sampling Plans, 1986). For each drum/container, the analytical data associated with the samples collected for characterization of the waste will be evaluated to determine if the IDW is hazardous waste. To determine the characteristic of the IDW, the analytical results will be compared to the TCLP regulatory limit (40 CFR 261.24).

The field sampler will accurately record field-screening data on the waste accumulation log. IDW at each site will be containerized, managed, and sampled as a single waste stream. The

non-segregated IDW may be bulk containerized with other non-hazardous solid IDW as necessary for efficient management of the waste.

Grossly contaminated non-indigenous IDW will be characterized as special or hazardous waste. The drums will be labeled, manifested, transported, and disposed of at a licensed RCRA hazardous/special waste landfill.

Indigenous solid IDW will be classified after analytical data are available. If soil is determined to be suitably free of contamination and can be classified as a Class 3 waste, it may be used as clean fill on site or taken out of the drums and put onto the ground at the location it was generated. The disposition of this investigation-derived waste and the container will be recorded on the IDW Inventory Table.

If the IDW is found to be either a special waste or a hazardous waste, then the container will be labeled, manifested, transported, and disposed of at a licensed RCRA hazardous/special waste landfill, or a municipal solid waste (MSW) landfill that can accept Special Wastes. The landfill will be certified according to 40 CFR 300.440, also known as the off site rule.

3.2.3.2 Analytical Methods

The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include ignitability, corrosivity, reactivity, and Toxicity Characteristic Leaching Procedure (TCLP) levels. In the TCLP procedure, samples are extracted by Method 1311, further analyzed for TCLP metals, TCLP volatile and semivolatile organic compounds. All waste streams shipped off-site for disposal will be analyzed for RCRA characteristics in accordance with 40 CFR 261 Subpart C. For purposes of determining accurate waste classification, any commercial laboratory capable of performing SW-846 analytical method, using internally derived quality control limits, are adequate to meet the DQOs for off-site disposal. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times and sample preparation.

All samples analyzed for IDW characterization will be performed in compliance with the project-specific plans.

3.2.4 Liquid Investigation-Derived Waste

It is expected that during sampling activities, liquids will be generated. The liquid IDW generated at each location, such as groundwater from the purging and development of monitoring wells and wastewaters from the decontamination of equipment will be characterized to determine types of contaminants present and management process required to handle the waste. Liquid IDW may at the Project Manager and Air Force direction be combined from several sites if the IDW is determined to be non-hazardous. Historical results may be used to make this determination. The disposal options for liquids include disposal by discharge into the sanitary sewer upon an appropriate modification into the NPDES permit, if necessary and approval from the City of Mesa. Any liquids that cannot be discharged into the sanitary sewers will be containerized and disposed properly as liquid wastes

Section 5.5 provides direction on the drum numbering scheme, labeling, and management of the IDW.

3.2.4.1 Liquid Waste Characterization

Before any data gathering activity occurs, the presence of a water-immiscible phase will be determined visually or using an oil/water interface probe. If a water-immiscible phase is present, then the IDW generated from that location will be pumped into 55-gallon drums. The drums, which will be sealed, numbered, labeled, and recorded on log sheets, will be left on pallets at the location. A composite sample will be taken and analyzed for hazardous waste characteristics. Before sampling, the drums of water with an immiscible layer will be inspected.

If the IDW is found to be a special or hazardous waste as defined in 30 TAC Chapter 335, or 40 CFR 261, Subpart D, or 30 TAC, Chapter 330.3 Subchapter A, then the container will be labeled, manifested, stored in a secured area with temporary berms, until it can be transported for disposal at a licensed RCRA hazardous/special waste disposal facility.

If analytical results from liquid samples demonstrate the IDW is non-hazardous but contains constituents at levels above City of Mesa guidelines, the wastes must be containerized and disposed at an offsite facility.

If the analytical results from liquid samples show the IDW to be hazardous the drummed IDW will be managed and disposed of as a hazardous waste.

Empty drums will be decontaminated and if structurally sound, will be reused. If the drum is not structurally sound, the drum will be decontaminated, crushed, and recycled as scrap.

3.2.4.2 Sampling Liquid IDW

Representative composite samples will be collected and analyzed to characterize the liquid IDW generated at each site and accumulated in bulk storage tanks, drums or other containers using a Coliwasa tube. The samples will be labeled, sealed, recorded on the chain of custody, packaged, and shipped to the laboratory for analysis.

3.2.4.3 Analytical Methods

The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include: Toxicity, ignitability, corrosivity, reactivity, and Toxicity Characteristic Leaching Procedure (TCLP) levels by Method 1311, further analyzed for TCLP metals, TCLP volatile and semivolatile organic compounds. For purposes of determining accurate waste classification, any commercial laboratory capable of performing SW-846 analytical method, using internally derived QC control limits, are adequate to meet the DQOs for offsite disposal. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times and sample preparation.

3.2.5 IDW Management Procedures

3.2.5.1 Drum Specifications

The drums to be used for the collection of wastes will be placed in new or reconditioned containers carrying the DOT UN “performance oriented packaging standard” symbol. Drums should be selected on their ability to hold hazardous, radioactive, and non-hazardous liquids and solids without damage to drum integrity. Special care should be taken in the selection of drums in areas where wastes will be collected and that are known to be reactive, corrosive, or contain organic solvents. The drums will be marked with weather proof indelible ink showing the sampling location (associated with the waste), and an identification number which will represent the location in the storage building where the drum is housed. These markings will be located on the top and side of the drum. Each drum will be stored in a manner so that the drum and attached labels can be inspected without moving the drum or surrounding drums.

3.2.5.2 Waste Tracking Labels

Container labels will be placed on the side and top of each container and will include the following information: Waste tracking number; generator; contents; the estimated depth collected (if solid); date the waste was first put in the container; date the container was closed; estimated quantity; and the name, address, and phone number of an emergency Point of Contact for additional information concerning the containers, and the words “Waste Solids or Waste Liquids”. The drums will comply with DOT regulations outlined in 40 CFR.

3.2.5.3 Transport of Drums and Rolloff Boxes

All drums will be placed on a flat bed truck or trailer using a forklift or Bobcat and transported to the designated central IDW staging area. Roll-off boxes will be transported on a flatbed trailer to the central IDW staging area when 2/3rds full or after the roll-off box is no longer needed. Straps will be used to secure the drums when they are placed on the flat bed and while being transported to the central IDW staging area.

3.2.5.4 Drum Inspections

The drums will be stored at the sampling location and/or designated location at Sierrita. The drums will rest directly on a gravel/soil substrate with a secondary containment. Any spills will be reported immediately to the Field Manager and the Project Manager. If drum integrity is compromised, it will be immediately corrected. All drums will remain closed at all times except during accumulation or when waste is being sampled or removed.

Drums will be inspected at least monthly by the Field Manager or his designee who will document in the field logbook or on a checklist the condition of each drum. Initiation of any necessary corrective actions will be the responsibility of Field Manager and coordinated with the Air Force. Any corrective actions will be discussed with the Air Force and its contractor’s project management personnel.

3.2.5.5 Storage Time Limitations

Potential RCRA hazardous IDW generated at each site(s) will be temporarily stored for no longer than 90 days from beginning date of collection. According to 40 CFR 262.34(a), a generator may accumulate hazardous waste on-site for 90 days or less without a permit or without having interim status provided that the requirements in 40 CFR 262.34(a) are met. The storage unit will conform to 40 CFR 262.34(a), having a secondary containment system lined with 10-mil plastic. All non-hazardous waste will be stored at the central IDW staging area no longer than one year.

4.0 REFERENCES

- 40 Code of Federal Regulations (CFR) 261, Subpart D;

5.0 RECORDS

The following records will be maintained by the Field Administrator and retained as project documents and included as appropriate in the Waste Management Report for client deliverables.

- Hazardous Waste Weekly Inspection Forms;
- IDW Inventory Sheet;
- Field log books;
- Certificates of Disposal;
- Water treatment logs, sample collection data sheets, and discharge records; and
- Receipts for material being recycled.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to provide the step-by-step procedures for field decontamination of equipment. Decontamination of equipment and personal protective equipment (PPE) is designed to ensure that the introduction and transfer of contamination is minimized.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel collecting environmental samples or operating in environments in which hazardous or contaminating substances are expected to be present.

3.0 METHOD

3.1 General

Decontamination consists of physically removing contaminants. To prevent the transfer of harmful materials and unwanted cross contamination, decontamination procedures continue throughout site operations.

A decontamination plan should be based on the worst-case scenario (if information about the site is limited). The plan can be modified if justified by supplemental information obtained as the field program evolves. Initially, the decontamination plan assumes all protective clothing and equipment that leave the exclusion zone are contaminated. Based on this assumption, a system is established to wash and rinse all non-disposable equipment. This Standard Operating Procedure will serve as the site decontamination plan.

The type of decontamination procedures and solutions needed at each site should be determined after considering the following project-specific conditions:

- The type of equipment to be decontaminated;
- The type of contaminant(s) present; and
- Extent of contamination.

3.2 Procedures

All sampling equipment used at the site must be decontaminated both before activities begin and after each sample is collected. All drilling equipment must be decontaminated both before activities begin and between each location.

3.2.1 Decontamination Site

Central decontamination areas for drill rigs and other large equipment will be located within Sierrita Mine Operations Area. A decontamination area will be chosen so that decontamination fluids and soil wastes can be easily discarded or discharged into controlled areas of

accumulation. A full-scale decontamination pad will be constructed. At a minimum, the pad must consist of a bermed liner large enough for equipment, have a nearby source of potable water, have a containment system for rinse water, and be equipped with a steam cleaner. After completion of drilling at a site, signs of gross contamination (if any) will be removed from the drill rig prior to moving the rig.

Smaller decontamination tasks, such as for groundwater, soil, and surface water/sediment sampling equipment, may take place at the sampling locations. In this case all required decontamination supplies and equipment will be mobilized to the site and all decontamination wastes containerized. Decontamination fluids will be disposed of according to WI-020, *Investigation-Derived Wastes*.

3.2.2 Decontamination Equipment

The following is a list of equipment that may be needed to perform decontamination:

- Bermed concrete or synthetic material-lined decontamination pad;
- Brushes (including long-handled brushes), garden-type water sprayers (without oil-lubricated moving parts), rinse bottles, flat-bladed scrapers;
- Portable steam cleaner;
- Sump or collection system for contaminated liquid;
- Wash tubs and buckets;
- Drums or tanks for containing decontamination fluids and solids; and
- Non-phosphate detergent,
- American Society for Testing and Materials (ASTM) Type II reagent grade water, isopropanol, methanol, hexane, or nitric acid.

3.2.3 Decontamination Procedure

3.2.3.1 Sample Bottles and Jars

At the completion of each sampling activity the outside of each sample bottle or jar must be decontaminated as follows:

- Be sure that the bottle or jar lids are snug.
- Wipe the outside of the bottle with a paper towel, if necessary to remove visible sample material from the bottle or jar.

3.2.3.2 Personnel and Personal Protective Equipment

Review the project HSP for appropriate personnel decontamination requirements.

3.2.3.3 Sampling Equipment

The following steps will be used to decontaminate small sampling equipment:

- Decontamination personnel will wear the appropriate personal protective equipment as required by the contractor specific HASP.
- The sequence of actual decontamination will be as follows:
 - Gross contamination on equipment will be scraped off at the sampling site.
 - Water-resistant equipment is placed in a wash tub containing Liquinox, or equivalent laboratory-grade detergent with potable water, and scrubbed with a bristle brush or similar utensil.
 - Equipment will be thoroughly rinsed with potable water in a second wash tub, and then rinsed using an ASTM Type II reagent grade water.
 - Rinse with pesticide-grade methanol if visible oil is present.
 - Rinse with pesticide-grade hexane if visible oil is present.
 - If methanol and hexane are used, rinse twice again with tap water and then rinse again using an ASTM Type II reagent grade water.
- Depending on site conditions and the number of samples collected at each location, rinse and detergent water may be replaced with new solutions between boreholes or sample locations.
- Following decontamination, equipment will be placed in a clean area to prevent contact with contaminated soil. All equipment should be allowed time to dry before re-use. If the equipment is not used immediately, it will be covered or wrapped in aluminum foil after drying to minimize potential airborne contamination.

3.2.3.4 Measurement Devices/Monitoring Equipment

Any delicate instrument that cannot be decontaminated easily should be protected while it is being used. These instruments can be covered with plastic sheeting, plastic bags, or aluminum foil to minimize contamination of the instrument. Openings can be made in the wrapping for sample intake.

3.2.3.5 Bailers

3.2.3.6 Groundwater Sampling Pumps

Proper pump decontamination between wells is essential for the integrity of samples. The following steps will be adhered to during decontamination:

- Potable water with a non-phosphate detergent such as Liquinox will be flushed through the pump and over the outside of the hoses. A minimum of three pump tubing volumes of soapy water will be purged through the pump.
- Potable water will then be flushed through the pump and over the outside of the hoses. A minimum of three pump tubing volumes of potable water will be purged through the pump to assure that all of the detergent solution has been removed.
- At least two pump tubing volumes of ASTM Type II reagent grade water will then be flushed through the pump. When applicable, the pump may then be used for the collection of an equipment blank.
- The pump is then allowed to dry and stored in the equipment area.

3.2.3.7 Drilling and Subsurface Soil Sampling Equipment

Drilling equipment, including the rig, augers, drill rods, and split-spoon samplers will be decontaminated by the drilling contractor prior to any drilling operations and between borings. Decontamination will take place at the fixed decontamination pad. All external surfaces of all drilling equipment, rigs, tools, drill bits, drilling stem, hoses, and all other appurtenant equipment will be thoroughly cleaned after each hole is completed. All tools used for soil sampling (i.e., split-spoon, split-barrel, Hydropunch samplers) will be decontaminated as specified in Section 4.3.3.3 prior to the collection of each sample. When collecting samples for geotechnical analysis only, soil sampling equipment will be decontaminated in the same manner as other drilling tools.

All drilling rigs and tools will be steam cleaned prior to commencement of drilling activities. All fluids will be contained and managed. Decontamination begins by completely removing all soil and visible contamination (i.e., soil, mud, hydraulic fluid) from the equipment with a high pressure steam cleaner, and thoroughly flushing the interior and exterior of all downhole tools, including drill pipes, collars, bits and tremie pipe with fresh, clean, potable water. Decontamination will take place at the decontamination pad where all rinse water will be containerized for disposition.

3.2.3.8 Decontamination of Heavy Equipment

Heavy equipment (e.g., drill rigs, bulldozers, backhoes, and trucks) is generally washed with water under pressure, if possible. Portable steam cleaners and handwashing with a brush and detergent, followed by a potable water rinse, can also be used. Decontamination of heavy equipment will be conducted at the decontamination pad where all rinse water can be containerized for treatment. Particular care must be given to the components in direct contact with contaminants, such as tires and buckets. Wipe sampling may be utilized to establish effectiveness of decontamination procedures.

3.3 Investigative Derived Material

All materials and wastes generated during decontamination will be managed as described in SOP-020, *Investigation-Derived Waste*.

4.0 REFERENCES

U.S. Environmental Protection Agency (EPA). *A Compendium of Superfund Field Operations Methods*, Vols. I and II, USEPA/540/P 87/001a&b.

5.0 RECORDS

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded in the field logbooks as per SOP-019, *Field Activity Records*. The information entered in the field logbook concerning decontamination should include the following:

- Date, start and end times;
- Decontamination personnel;
- Decontamination solutions used;
- Equipment identification numbers; and
- General decontamination methods and observations.

6.0 ATTACHMENTS

Not applicable.

1.0 PURPOSE

The purpose of this Standard Operating Procedure is to ensure that monitoring wells and other wells are properly developed after installation and prior to their designated use.

2.0 SCOPE

This Standard Operating Procedure applies to all personnel who develop or re-develop monitoring and other wells.

3.0 METHODS

3.1 General

Well development involves a reciprocating surge action causing inward water movement through the well screen, followed by pumping the well with the pump intake at various depths throughout the screen. Mechanical surging facilitates the removal of fine particles lodged in the well screen and filter pack. However, any number of techniques (e.g., jetting, airlifting) may be used in combination to help dislodge and remove sediment and achieve the well development objectives (detailed in section 4.3.3). Well development restores the aquifer properties disturbed during the drilling process, and improves the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen.

3.2 Procedures

The equipment needed for well development and the development procedures are discussed below. All newly installed wells will be developed no sooner than 24 hours after installation. All downhole development equipment will be decontaminated to prevent any cross contamination prior to developing each well. Decontamination procedures are detailed in SOP-021, *Equipment Decontamination Procedures*.

3.2.1 Equipment

The following equipment may be required to perform well development:

- Water level indicators;
- Equipment (e.g., surge blocks, work-over rig) capable of reciprocating surge action;
- Flow metering equipment (which could include graduated buckets or tanks and a digital watch with stopwatch function);
- Pump capable of flows up to 150 percent of the maximum planned well yield;
- Decontamination equipment;

- Logbook;
- Well development log form;
- Well construction log or information;
- In-line discharge valve or control;
- Pump electrical control system;
- Discharge settlement tank;
- Equipment for measuring water quality parameters (i.e., turbidity, temperature, pH, specific conductance);
- Leather work gloves;
- Nitrile rubber gloves;
- Hand-held radios and/or cellular telephones; and
- Photoionization detector (PID) to monitor the wellhead area.

3.2.2 Site Preparation

- Set up caution tape around work area (where necessary)
- If generator is used, place on plastic to contain fuel leaks and/or spills.
- Remove well cap and place it in a clean area. Take initial PID headspace reading.
- The depth of the static water level and total depth of the well will be measured with a water level indicator (to the nearest 0.01 foot) as described in SOP-006, *Static Water Level and Total Depth Measurement*.
- Calculate well volume and record on well development log form.

3.2.3 Development Activities

- If no water level measurement reference point has been made in the top of the well casing, create a small but visible notch in the casing with a small saw, file, or similar tool. Use proper hand protection (leather gloves) while making the mark, and take care to avoid getting PVC shavings into the well. Create the notch on the north side of the well casing if it is practical to do so.
- Prior to setting development equipment in the well, the water level and total depth of the well will be measured and noted in the field logbook.
- If there is an appreciable amount of sediment noted in the bottom of the well, it should be removed (preferably with a bailer or by pumping) prior to well surging.
- The well will then be pumped or bailed without surging for a minimum of ten minutes or until dry. Water level readings, flow rate and water quality parameters (turbidity, temperature, pH, and specific conductance) will be measured and logged.
- Assemble equipment to locate surge tool(s) within the screened interval. The surge tool(s) will be placed such that surge action will be performed over the entire length of the screen. Surging may be performed on one section of the screen at a time, striving for equal time devoted to each portion of the screen.
- After removing at least well borehole volume from the well either during or following surging, measure and record water quality parameters. Surge the well again, removing at least another well volume of water. Measure water quality parameters (temperature, pH, specific conductance [conductivity], and turbidity at a minimum) after each volume of water has been removed.
- Well development is complete when water parameters have stabilized for two consecutive readings (such as those collected after the second and third well volume of water has been removed). Stabilization is defined as follows:
 - Conductivity, temperature, and pH have stabilized to \pm ten percent conductivity, \pm one degree Celsius, and \pm 10% pH, over two consecutive readings, and;
 - The water is “relatively free of suspended solids.”
- Acceptable water quality parameters indicate that the well’s screened zone is properly developed. Once the water quality parameters have stabilized, the downhole development equipment (e.g., pumps, surge tools) will be removed, completing well development.

In some instances, low turbidity samples are difficult to obtain. This occurs primarily when the well is screened in a formation that contains a high level of fine material (silt and clay). Silt and clay can occasionally travel through the filter pack of a properly constructed well, resulting in turbid water. While selection of proper filter pack and screen materials minimizes turbidity, fine-grained particles can still flow through. In order for samples to meet turbidity criteria, additional development activities (e.g., pumping, surging) may be required. If the well is pumped dry, it will be allowed to recharge and the development process will be repeated as much as practical to reduce turbidity. If turbidity has not decreased to 10 or less NTU after 8 hours of development activities, development will cease provided conductivity, temperature, and pH have stabilized. The Field Manager/Task Leader will be notified. The possibility of additional development can be addressed on a well-specific basis.

3.2.4 Purge Water Treatment

All development and purge water generated will be contained and disposed of as described in SOP-020, *Investigation-Derived Waste*.

4.0 REFERENCES

American Society for Testing and Materials (ASTM), 1995. *Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers*, D5092-90, Vol. 04.09, ASTM, Philadelphia, PA, pp. 70-85.

Driscoll, F.G., 1986. *Groundwater and Wells*, 2nd Edition, Johnson Division, St. Paul, MN, 1089 pp.

Nielsen, D.M., 1991. *Practical Handbook of Ground-Water Monitoring*, Lewis Publishers, pp. 334-343.

U.S. Department of the Interior, 1981. *Groundwater Manual, A Water Resource Technical Publication*, Water and Power Resources Services, U.S. Government Printing Office, Denver, CO, 480 pp.

5.0 RECORDS

The Well Development Record is intended for use by contractor personnel and subcontractors for tracking and recording development method, purging information, water level(s) and water quality parameters.

6.0 ATTACHMENTS

Well Development Log

APPENDIX C
URS FIELD FORMS

WELL BORING:

Total Depth
 Casing Diameter
 Depth Interval
 Casing Diameter
 Depth Interval
 Drilling Method

WELL CONSTRUCTION:

Casing length
 Material
 Diameter

Surface Seal
 Seal Material

Backfill
 Backfill Material
 Placement Method

Seal Interval
 Seal Material
 Placement Method

Transition Interval
 Transition Material
 Placement Method

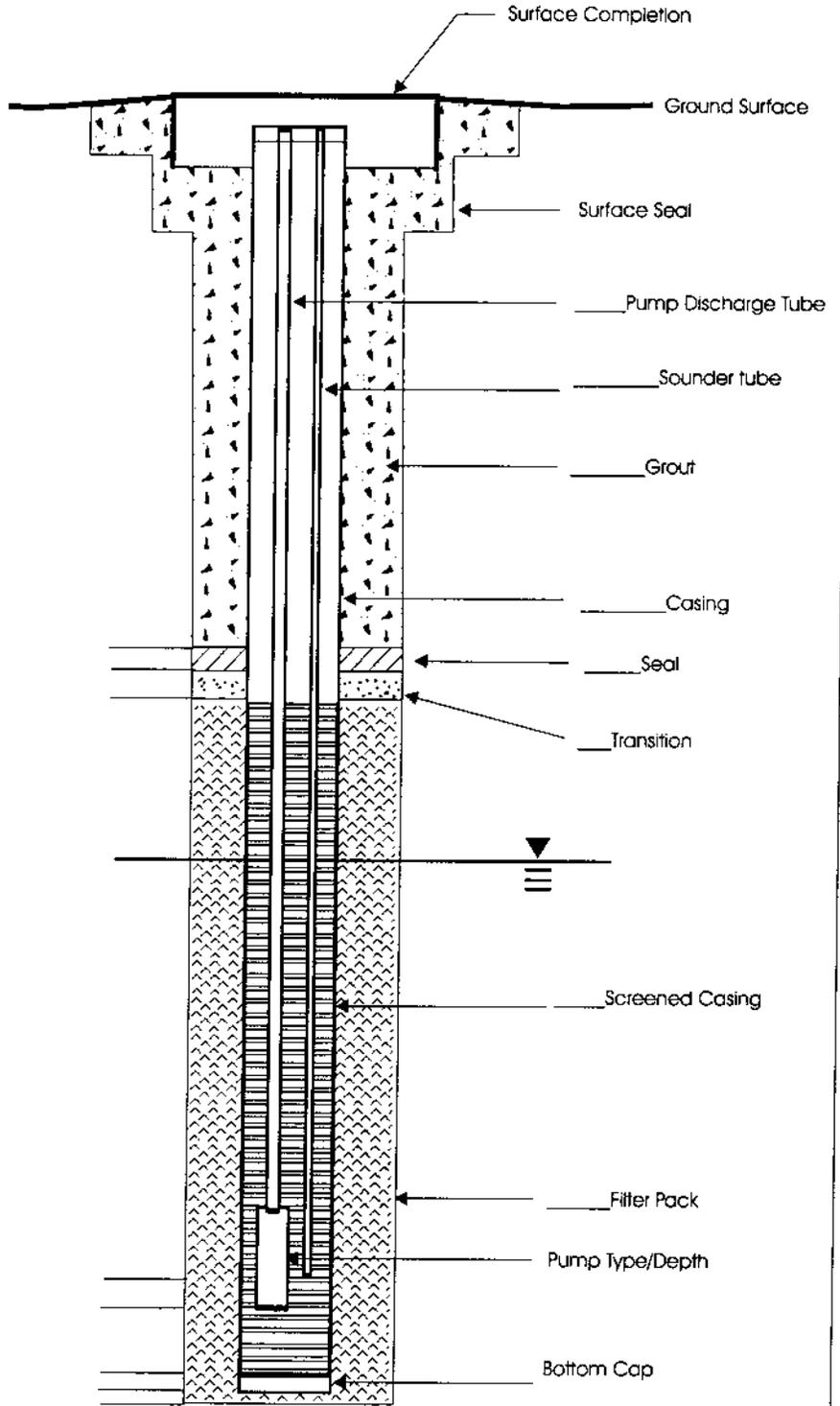
Gravel Pack Interval
 Gravel Pack Material
 Placement Method

Depth to Top of Perforation Zone ...

Screened Interval
 Perforated Type
 Perforation Size

SURFACE CONSTRUCTION:

Surface Completion
 Surface Casing Length
 Material
 Diameter



NOT TO SCALE

**Generalized Monitor Well Schematic
 Standard Well Completion**

Well Materials Tally

BLANK CASING					WELL NO.:	
Type:		Diameters		Total Length Required:	Delivery Date:	
Manufacturer:		I.D.:		Time:		
Vendor:		O.D.:		Project:		
		Thickness:		Driller:		
Actual Length	Diameter Checked	Installed Date/Time	Connection Checked	Comments	AS-BUILT DIAGRAM	
					AS-BUILT DIAGRAM	
SCREENED CASING					AS-BUILT DIAGRAM	
Type:		Diameters		Total Length Required:		Delivery Date:
Manufacturer:		I.D.:		Time:		
Vendor:		O.D.:		Project:		
		Thickness:		Driller:		
Actual Length	Diameter Checked	Installed Date/Time	Connection Checked	Comments		AS-BUILT DIAGRAM



WELL DEVELOPMENT RECORD

SITE _____ DATE _____

LOCATION _____ WELL NO. _____

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:

V = Static volume of well in gallons;

T = Depth of water in the well, measured in feet;

r = Inside radius of well casing in inches; and 0.163 = A constant conversion factor which compensates for r²h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).

1 well volume (v) = _____ gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509 x 10 ⁻³
1 1/2	0.092	0.0123	1.142	1.142 x 10 ⁻³
2	0.163	0.0218	2.024	2.024 x 10 ⁻³
2 1/2	0.255	0.0341	3.167	3.167 x 10 ⁻³
3	0.367	0.0491	4.558	4.558 x 10 ⁻³
3 1/2	0.500	0.0668	6.208	6.208 x 10 ⁻³
4	0.653	0.0873	8.110	8.110 x 10 ⁻³
4 1/2	0.826	0.1104	10.260	10.260 x 10 ⁻³
5	1.020	0.1364	12.670	12.670 x 10 ⁻³
5 1/2	1.234	0.1650	15.330	15.330 x 10 ⁻³
6	1.468	0.1963	18.240	18.240 x 10 ⁻³
7	2.000	0.2673	24.840	24.840 x 10 ⁻³
8	2.611	0.3491	32.430	32.430 x 10 ⁻³
9	3.305	0.4418	41.040	41.040 x 10 ⁻³
10	4.080	0.5454	50.670	50.670 x 10 ⁻³
11	4.937	0.6600	61.310	61.310 x 10 ⁻³
12	5.875	0.7854	72.960	72.960 x 10 ⁻³
14	8.000	1.0690	99.350	99.350 x 10 ⁻³
16	10.440	1.3960	129.650	129.650 x 10 ⁻³
18	13.220	1.7670	164.180	164.180 x 10 ⁻³
20	16.320	2.1820	202.680	202.680 x 10 ⁻³
22	19.750	2.6400	245.280	245.280 x 10 ⁻³
24	23.500	3.1420	291.850	291.850 x 10 ⁻³
26	27.580	3.6870	342.520	342.520 x 10 ⁻³
28	32.000	4.2760	397.410	397.410 x 10 ⁻³
30	36.720	4.9090	456.020	456.020 x 10 ⁻³
32	41.780	5.5850	518.870	518.870 x 10 ⁻³
34	47.180	6.3050	585.680	585.680 x 10 ⁻³
36	52.880	7.0690	656.720	656.720 x 10 ⁻³

- 1 Gallon = 3.785 liters
- 1 Meter = 3.281 feet
- 1 Gallon water weighs 8.33 lbs. = 3.778 kilograms
- 1 Liter water weighs 1 kilogram = 2.205 pounds
- 1 Gallon per foot of depth = 12.419 liters per foot of depth
- 1 Gallon per meter of depth = 12.419 x 10⁻³ cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____

WELL DEPTH (TD) _____

COLOR _____

ODOR _____

CLARITY _____

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) _____

WELL DEPTH (TD) _____

COLOR _____

ODOR _____

CLARITY _____

DESCRIPTION OF DEVELOPMENT TECHNIQUE _____

SAMPLING DATA SHEET

Sierrita VRP

Well ID:	Screen Interval:	Depth to Water:	Page _____ of _____
Project Name:	Well Diameter:	Date Measured:	
Project Number:	Total Well Depth:	Measured From:	
Task Code:	Dedicated Pump:	Well Volume	

3/8" - 0.0025 gal/ft. 1/4" - 0.0014 gal./ft.

FIELD INSTRUMENT CALIBRATION

pH: pH: 4.00=_____ at _____ °C pH: 7.0=_____ at _____ °C pH: 10.00=_____ at _____ °C

Turbidity: NTU: 0 = Reading _____ NTU: 10 = Reading _____ NTU: 1 = Reading _____ Other: NTU: _____ = Reading _____

Conductivity: Standard _____ umhos/cm at 25 °C Reading _____ umhos/cm at _____ °C

Dissolved Oxygen: Meter _____ mg/L at _____ °C PID: Calibration Gas Type _____ PPM _____ Span _____ Reading _____

Date / Time of Calibration(s): _____

Instrument Model and Serial Number(s): _____

WELL PURGING

Time	Discharge Rate	Dissolved Oxygen (mg/L)	Temp °C	Eh/ORP (mV)	pH	Spec. Cond (uS/cm)	Turbidity (NTU)	Gallons Purged	Casing Vol.	Depth to Water
Stabilization		(+/- 10%)	(+/- 1 deg.)	(+/- 10 mV)	(+/- 1)	(+/- 5%)	(+/- 10%)			(+/- 0.3 ft.)

SAMPLING INFORMATION

Sampling Method: _____ Dedicated Pump _____ Non-Dedicated Pump _____ Hand Bailer _____ Low Flow/Micropurge

Sample ID	Date	Time	Container Type	Number of Containers	Preservative	Filtered Yes/No	Analysis	Comments

Samplers Signature(s): _____



Health and Safety Program
INCIDENT REPORT FORM

Attachment 49-1

Revised: 5/08/01

ADMINISTRATIVE INFORMATION:

URS Division/Company: _____

Project Office: _____

Project Number: _____

Date/Time of Incident: _____

Location/Client: _____

FOR INJURIES / ILLNESSES:

Name of Injured Employee _____

Job Title _____

Phone Number _____ Age _____

Sex Male Female

See a Doctor? Yes No
If yes, attach a doctor's report.

Describe Injury:

TYPE OF INCIDENT (Check all applicable items)			
<input type="checkbox"/> Illness	<input type="checkbox"/> Injury	<input type="checkbox"/> Fire, Explosion, Flash	<input type="checkbox"/> Unexpected Exposure
<input type="checkbox"/> Property Damage	<input type="checkbox"/> Vehicular Accident	<input type="checkbox"/> Other (describe):	

DESCRIPTION OF INCIDENT: (Describe the facts contributing to the incident. Identify individuals involved, witnesses, and their affiliations. Attach additional sheets, drawings, or photographs as needed.)

APPENDIX D
ACZ LABORATORY QAPP

QUALITY ASSURANCE PLAN

v. 12

Effective Date: August 10, 2007

UNCONTROLLED COPY

Authorization Signatures and Dates:

Audrey Stover, President/CEO

Matt Sowards, Production Manager

Kristen Russell, QA/QC Officer

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1 INTRODUCTION

ACZ Laboratories, Inc. is an environmental testing laboratory that provides data to clients primarily for regulatory purposes. Samples are analyzed for compliance with federal programs including the Resource Conservation Recovery Act (RCRA), Safe Drinking Water Act (SDWA), and Clean Water Act (CWA). Environmental compliance and management decisions are based on the analytical data provided, which are critical to the expenditure of large amounts of money; are important to public health safety; are important in evaluating, monitoring, and protecting the environment; and are often essential in litigation. To this effect, analytical data must always be technically sound, accurate, and legally defensible or it is useless to the end user.

An effective Quality Assurance and Quality Control program is the cornerstone of the generation of reliable analytical data. ACZ's Quality Assurance Plan (QAP) outlines the quality assurance and quality control objectives, policies, and procedures determined to be necessary to meet the requirements of the EPA, federal government entities, state agencies, other regulatory authorities, and our clients. This document provides the necessary guidelines to ensure all ACZ employees have sufficient knowledge and training to perform their job responsibilities in a manner that guarantees all data reported to all of our clients is accurate, reliable, technically sound, legally defensible, and impartial.

For data to be accurate, it must be of known and documented quality. The word "quality" has many different meanings, but for the purposes of environmental testing activities can be stated simply as "conformance to requirements." Conforming to requirements allows objective measurements to be applied, rather than subjective opinions, to determine when work is of good quality. *Quality control* refers to all activities that ensure accuracy (i.e. good quality) of the data. It requires action(s) to be taken and is typically included as part of the procedure. *Quality assurance* provides the records of the results obtained from the required action(s) and refers to the ability of the laboratory to demonstrate or prove to an outside party that the quality of the data is what the laboratory states it is. Quality assurance relies heavily on documentation, and to be effective, the documentation must (1) assure the quality control procedures are being implemented as required (2) assure the reported data reflect the sample as it was received, meaning sample mix-up was avoided, the sample was properly preserved prior to analysis, etc. (3) facilitate traceability of an analytical result and (4) be subjected to reasonable precautions to protect data from loss, damage, theft, and internal or external tampering.

Quality Policy Statement: To maintain an effective QA/QC program, continually improve the quality of our environmental testing services, and consistently provide clients with technically sound and legally defensible data, in a timely manner, the management of ACZ recognizes the importance of its commitment to:

- Ensuring good professional practice by well-trained and qualified employees with the necessary experience and skills to carry out their organizational functions and to meet or exceed ACZ's standards for the quality and reliability of its testing services.
- Ensuring the data provided to our clients is of known and documented quality, accurate, and impartial.
- Ensuring that all quality assurance and quality control policies and procedures are communicated to and understood by all employees, and that they are implemented by all employees in their work.
- Ensuring that all aspects of the business operations are conducted in a manner that adheres to the NELAC Standards and all of ACZ's policies and procedures documented in the QAP, SOPs, emails, memos, etc.
- Upholding the spirit and intent of ACZ's Ethics Program and implementing the requirements of the program.

2 QUALITY SYSTEM OBJECTIVES & COMPONENTS

ACZ's QAP provides a framework that guides all technical staff and administrative personnel. The information presented is necessary to ensure all employees perform their duties in a manner that allows the company to achieve its objectives, thereby ensuring the precision, accuracy, completeness, and consistency of the analytical data reported to our clients. This framework is referred to as the Quality System. The Quality System encompasses every documented quality assurance (QA) and quality control (QC) policy and procedure and guides all business functions and laboratory operations by specifying standardized protocols to control both the short-term and long-term activities that influence the quality and defensibility of our testing services.

The Quality System is designed to be appropriate to the type, range and volume of the environmental testing undertaken. The Quality System is not a static entity and must function in a manner that allows for continuous evolution of all aspects of ACZ's business when improvements have been identified and have been determined to be necessary or beneficial. ACZ management recognizes that the staff is comprised of people who possess varied experience and knowledge and can contribute valuable insight and suggestions regarding these improvements. All employees are encouraged to be involved in this process. The following six (6) key elements form the foundation of ACZ's Quality System:

- Documents & Records
- SOPs
- Training
- Audits
- Corrective Actions
- Management Review of the Quality System

2.1 Documents & Records

The entire history of any sample must be readily understood through the associated documentation. To this extent, a formal and systematic control of documents and records is necessary for accurately reconstructing all events pertaining to any sample and for guaranteeing the quality and defensibility of the data. All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities (such as sample receipt, sample preparation, data verification and data reporting) must be documented, and all records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained. Documents and records must be safely stored (protected against fire, theft, loss, deterioration, and vermin), and must be held secure and in confidence to the client for a minimum of five (5) years. Refer to section 10.0 for details regarding the storage and control of ACZ's documents and records.

2.1.1 Documents

A document is a writing that contains information. All documents are reviewed for accuracy, approved for release by authorized personnel, and properly distributed. A document control system subsequently ensures that employees use only the correct and effective version of any form, Standard Operating Procedure (SOP), or other document, which are maintained through ACZ's LabWeb intranet. LabWeb is a computerized document control system based in HTML that can be accessed from any network computer within the facility. Documents can be queried by department and then organized in several ways by clicking the appropriate header. Click on the title of the document to view it as an Adobe Acrobat (*.pdf) file. The PDF has a "read only" qualifier and does not allow changes. Users may view SOPs but the documents may not be saved to another network drive and may not be printed. Forms may be viewed and printed but may not be saved to another network drive.

All documents are categorized by department and are assigned a unique document ID that is printed in either the header or footer section. The ID nomenclature starts with either SOP (procedure) or FRM (form), followed by the 2-letter department code, the unique document number, the month and year of issue, and the revision. The effective date for any SOP or other document is included on the title page and header section of each subsequent page and indicates the implementation date.

The QA/QC Officer has full responsibility of the Document Control System. Documents can be changed, overwritten, or saved as a different document only by employees with Domain Administrator computer rights (primarily IT and QA/QC staff). A new or revised document is reviewed, and following approval, the document control number is updated and the SOP or form is uploaded to Labweb. When a new version of an SOP is added to Labweb, the previous version is removed from the active list, date-stamped and electronically archived in a designated location on the network. This automatic process guarantees that ACZ can retrieve the version that was in effect at any given time. Controlled forms are not currently archived.

2.1.2 Records

A record is any information or data on a particular subject that is collected and preserved. Records are produced on a daily basis and contain original, factual information from an activity or study. For ACZ's purpose, this information may be recorded by the following means: LIMS database, logbooks, raw instrument data, worksheets, and notes (or exact copies thereof) that are necessary for the reconstruction and evaluation of the report of the activity or study. The record management system provides control of records for data reduction, validation, reporting and storage, and also provides control of all laboratory notebooks and logbooks. The system must allow for historical reconstruction of all laboratory activities that produced analytical data, must document the identity of personnel involved in sample receipt, preparation, calibration or testing, and must facilitate the retrieval of all working files and archived records for inspection and verification purposes. At a minimum, the following criteria for records must be met:

- 1) Instrument logbooks must be kept up-to-date on a daily basis. In general, document all relevant activities when the event occurs.
- 2) Dilution factors and observations must be recorded at the time they are made, and notes regarding the sample(s) or analysis must be identifiable to the specific task.
- 3) A detailed description of any departure from a documented procedure, and the reason for the departure, must be provided at the time it is performed.
- 4) All generated data must be recorded either by an automated data collection system or must be recorded directly, promptly and legibly in permanent ink (blue or black is preferred).
- 5) Erroneous entries (hard copy or electronic) cannot be destroyed by methods such as erasures, overwritten files or markings. Refer to section 16 for ACZ's error correction protocol.
- 6) Any change(s) to hard copy records must be clearly initialed and dated by the responsible staff. Changes to electronic records must also be traceable to the individual who made the change, and the reason for the change must be provided.
- 7) Records generated by computers must have hard copy or write-protected backup copies.

2.2 Standard Operating Procedures

A documented procedure is required for all phases of ACZ's business operations, from sample log-in through sample disposal. A Standard Operating Procedure (SOP) is a written document that details the manner in which an operation, analysis, or action is performed and thoroughly prescribes the techniques and procedures, which are the accepted process for performing certain routine or repetitive tasks. Analytical SOPs must be written with adequate detail to allow someone similarly qualified, other than the analyst(s) who routinely performs the procedure, to reproduce the procedure used to generate the test result. To the extent possible, administrative SOPs [non-technical] must include specific requirements pertaining to the process; however, the procedure itself may be a more general description so as to lend a degree of necessary flexibility to account for client requests and other circumstances, which may be outside of ACZ's control.

Proposed revisions to any test SOP must be noted on the SOP Revision Form (FRMQA030). Proper use of FRMQA030 ensures the SOP continues to include all requirements of the procedure. All procedural revisions must be reviewed and approved by QA/QC prior to implementation. Changes to provide additional clarification, correct typographical errors, etc. do not need to be approved but need to be noted on the revision form to ensure the changes are included during the next revision. Analytical SOPs must be reviewed annually using the SOP Review Form (FRMQA035), and Administrative SOPs must be reviewed regularly and revised if necessary to ensure the information is accurate and reflects current practice. Documenting changes in the controlled copy of any SOP is not permitted. Refer to section 10.5.1 for additional information on SOPs.

SOPs are proprietary documents and ACZ does not distribute them freely. Any copy sent electronically or otherwise to an outside party is considered uncontrolled, and the recipient understands that additional changes can be made without prior notification. The use of uncontrolled copies of SOPs is not permitted on site unless approved by QA/QC, and such documents will be initialed and dated by QA/QC personnel when issued.

Before a new procedure, application, or instrument can be implemented, an SOP must be developed. Following QA/QC review, an effective "working draft" will be issued to allow the user(s) to "fine-tune" the document. If a client requests a procedure for which there is not a published method or an existing SOP, ACZ will utilize the process described in the *SOP Client Service Policies and Procedures* (SOPAD043). Analytical SOPs are written in accordance with the NELAC Standards and must include or reference the following items, where applicable:

- 1) identification of the test method
- 2) summary, scope & application of the test method, including matrices & components to be analyzed
- 3) references, including documents provided by instrument / equipment manufacturer
- 4) sample collection, preservation, & storage
- 5) equipment & supplies
- 6) reagents & standards, including storage conditions & shelf-life for each
- 7) safety
- 8) interferences
- 9) complete procedure, including details and acceptance criteria for initial & continuing calibration
- 10) data review & assessment, including protocols for handling out-of-control or unacceptable data
- 11) quality control, including acceptance criteria & corrective action for handling failed quality control
- 12) calculation equations (dilution factors, RPD, % recovery, etc.) & calibration formulas
- 13) method detection limit & reporting limit
- 14) method performance, including Demonstration of Capability and Method Detection Limit procedures
- 15) pollution prevention & waste management
- 16) definitions
- 17) tables, diagrams, flowcharts

2.3 Training

It is the responsibility of ACZ's management to ensure the competence of all employees who perform environmental tests and other specific duties, operate equipment or instrumentation, give opinions and interpretations, evaluate results, and sign test reports. Additionally, ACZ management is responsible for formulating the goals and policies with respect to the necessary education, training, and skills of all personnel and for providing training that is relevant to the company's present and anticipated tasks.

Employees must possess the appropriate combination of education, experience, and skills to adequately demonstrate a specific knowledge of their particular functions and to carryout those functions in a manner that meets or exceeds ACZ's standards and expectations. Additionally, each staff member must demonstrate an understanding of laboratory operations, test methods, related quality assurance and quality control procedures, and management of records and documents to the extent necessary to successfully perform their job duties.

All full-time and part-time personnel must complete a formal training process for Safety, Ethics, Quality Assurance / Quality Control, and Sexual Harassment on the first day of hire and are subsequently responsible for complying with all requirements that pertain to their organizational functions. For all technical staff, training for analytical procedures must be completed prior to independent generation of client data, including Proficiency Testing samples. In general, any staff member who is undergoing training must be provided with appropriate supervision. It is the responsibility of each supervisor or manager to ensure personnel within his or her department is supervised, competent, and is working in accordance with ACZ's Quality System.

2.3.1 Safety Training

Safety training is scheduled with ACZ's Chemical Hygiene Officer and includes viewing a video of general laboratory safety, a complete review of ACZ's Chemical Hygiene Plan, and a building tour to identify the location of Material Safety Data Sheets, emergency showers, eye wash stations, and emergency exits. Following completion of the training, the employee takes an exam, which allows the CHO to evaluate his/her understanding of the material covered.

2.3.2 Ethics Training

ACZ is committed to fostering and enforcing an ethically sound work environment that encourages the conscientious production of accurate, technically sound and legally defensible data. Initial and follow-up ethics training is required for all full-time and part-time employees (permanent or temporary) as described in ACZ's *SOP Ethics and Proactive Prevention Program* (SOPAD039). Initial training provides a general introduction to ACZ's Ethics program, ACZ's Code of Conduct, Code of Ethics, and zero-tolerance policy. Each new employee is also introduced to the company's Ombudsman. Follow-up training is provided within 30 – 60 days and includes a more in-depth review of unacceptable practices. The employee is required to read SOPAD039 prior to attending the session. On an annual basis, a review of SOPAD039 and exercises in making ethical decisions, as well as other relevant information, are presented to all employees.

2.3.3 QA/QC Training

- 2.3.3.1 All full-time and part-time employees attend an initial orientation session, which is based on the most current version of ACZ's Quality Assurance Plan [QAP] and focuses on the relationship between quality control, quality assurance, environmental testing, and environmental monitoring.

2.3.3.2 Follow-up training is completed within 30 – 60 days and includes a more detailed review and discussion of QA/QC policies and procedures. By this time, employees are expected to be familiar with their responsibilities and have a general understanding of ACZ's operations. The employee must read ACZ's QAP and any pertinent supporting SOPs prior to attending the training, and should prepare questions in advance, as material in each document will be reviewed and an opportunity to seek clarification will be provided. The supervisor must schedule sufficient time for the employee to read all pertinent documents prior to follow-up training.

2.3.3.3 A performance review will be conducted for a new employee after 90 days from the hire date. The review is conducted by the supervisor and is based on general work performance, supervisor observations, and feedback from the QA/QC department.

2.3.4 Sexual Harassment Training

Sexual Harassment training is required for each new employee and includes viewing a video that demonstrates the identification, reporting, and remediation of harassment issues in the work place.

2.3.5 Technical personnel must be thoroughly trained in the analytical techniques and operating principles for all pertinent method procedures. Under no circumstances may any analyst independently generate or review client data for a test procedure before completing the required training and receiving the explicit approval of the QA/QC department. Section 5 provides details of ACZ's technical training program.

2.3.6 An employee performing only data AREV or SREV functions must be appropriately trained regarding QC requirements, corrective action(s), and data qualification criteria stated in the effective version of the test SOP. The trainee must first read the SOP, and then review all pertinent information with the department supervisor. Items covered during training must be documented using the appropriate form, and both the supervisor and the trainee must sign the form. Thereafter, the effective version of the test SOP must always be used for data review.

2.3.7 Continuing training must be documented and at a minimum, the documentation must certify that the employee has read, understands, and agrees to follow the effective version of a revised SOP or other in-house document. The department manager is required to meet with their staff to review the change(s) and to ensure each employee fully understands the change(s). Training is documented using either FRMQA023 or FRMQA030, whichever is most appropriate.

2.3.8 Training is required for all employees whose activities are affected by any procedural change(s) to an SOP and is considered to be complete once the department supervisor has reviewed the change(s) with all staff members and each employee has subsequently initialed and dated the changed item(s) on the SOP Revision form (FRMQA030). Alternatively, if the revisions have been incorporated into a new effective version of the SOP then training is documented using FRMQA023.

2.3.9 ACZ recognizes the benefit of continuing education and encourages employee participation in advanced training courses, seminars, and professional organizations and meetings.

2.4 Audits

The purpose of any audit is to verify performance and compliance to documented Quality Assurance and Quality Control policies and procedures, and to identify discrepancies when they exist. In the latter case, any problems must be addressed and resolved in an appropriate manner in order to assure the Quality System is continuously improved on all levels.

2.4.1 External Audits

External audits are conducted to ascertain compliance with rules, regulations, and additional criteria for certification, and will have a higher degree of formality than internal audits. Where mandatory records are required, compliance with such will be critically evaluated. The search for any corrective actions and the correction of problems identified in a previous audit will also be an important activity. The ease with which important records and information can be retrieved is a criterion for judgment of the management practices of a laboratory and may dictate the depth of the audit. Individual state agencies, its NELAC Primary Accrediting Authority, and current and potential clients typically audit ACZ.

The on-site assessment is generally a two to four day process during which the regulating agency conducts an entrance interview and tours the facility before performing an in-depth review of documents, workgroups, reports, electronic data files, etc. A critical aspect of the on-site assessment is review and verification of bench-level documentation and analyst interviews to determine actual laboratory practices. It is ACZ's policy to always have QA/QC personnel present during an interview. If necessary, the President or Production Manager may attend the interview. An exit interview is conducted upon completion of all on-site assessment activities, during which observations and findings are reviewed. The agency will submit a final report to ACZ, generally within 30 days, detailing all pertinent findings and recommendations.

Upon receipt and review of the agency's report, the QA/QC department will meet with each department manager to develop a corrective action plan, which must be submitted to the agency by the date indicated in their report. Each finding is addressed as a major corrective action as described in section 2.5.2. Employees may not make changes to any laboratory or other practice based on comments or opinions expressed by the regulating agency during an interview or any other stage of the on-site assessment. ACZ will revise policies and procedures as necessary upon completion of the major corrective action process. The audit report and all subsequent corrective actions are thoroughly documented, and all documentation is retained for at least five (5) years.

2.4.2 Internal Audits

ACZ is responsible for the quality of its data and must take reasonable efforts to assure itself and all interested parties of the confidence that can be placed in it. To this extent, internal audits of its activities must be conducted to verify continued compliance with the Quality System. It is the responsibility of the QA/QC Officer to plan, direct, and organize internal audits; however, a trained and qualified individual, independent from the area or system being audited, may be designated by the QA/QC Officer to conduct an internal audit. The area of activity audited, the audit findings, and subsequent corrective actions must be documented, and all documentation must be retained for at least five (5) years.

Whenever any internal audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the test results, timely corrective action must be taken, and the client(s) must be notified in writing, as soon as the extent of the problem can be determined, if investigations show that the laboratory results may have been affected.

At a minimum, internal audits are conducted for the following departments. Method audits performed for all analytical departments listed below encompass both qualitative evaluation of the operational details of the QA/QC program and quantitative evaluation of the accuracy of data generated by the laboratory staff. These evaluations do not include the real-time review of laboratory raw data or final reports for routine quality control sample verification.

- Log-In
- Reporting
- Wet Chemistry Manual
- Wet Chemistry Instrument (Prep and Analytical)
- Inorganic Instrument
- Inorganic Metals Prep
- Soils
- Radiochemistry (Prep and Analytical)
- Organics (Prep and Analytical)

More frequent internal audits may be scheduled depending on the following criteria:

- Number and type of corrective actions filed for a method or activity
- Client complaints
- Continued failure to achieve acceptable results for a Proficiency Testing sample
- Findings from an external audit
- Request from management

All findings from internal audits are directed through ACZ's corrective action system. Each finding is assigned a corrective action number (similar findings may be combined). A general description of the process is as follows:

- 1) Findings and observations are summarized in a memo.
- 2) The memo is distributed to the department supervisor, Production Manager, and President.
- 3) The supervisor reviews the memo with their staff and develops a response for each finding.
- 4) The supervisor informs the QA/QC Officer of all resolutions and expected implementation date(s) within two (2) weeks from the date indicated in the memo.

Additionally, an in-depth review will be conducted if there is any evidence of inappropriate actions or vulnerabilities related to data integrity. This review shall be handled in a confidential manner until a follow up evaluation, full investigation, or other appropriate actions have been completed and the issue(s) clarified. Refer to ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039). All documentation related to the investigation must be maintained for at least five (5) years.

2.4.3 Electronic Data Audits

Periodically ACZ hires a third party auditing firm to perform a full level audit of analytical data, either on-site or off-site. The auditing firm provides ACZ management with a report citing the deficiencies and recommendations. After review of these findings by management, the QA/QC Officer, and the production supervisor, corrective actions are initiated to ensure that any deficiencies are rectified.

2.4.4 Proficiency Testing [PT] Program

ACZ is required to participate in a formal Proficiency Testing Program at the frequency stipulated by regulating agencies. These “performance audits” are facilitated through the introduction of blind samples, purchased from approved vendors. ACZ analyzes PT samples for most accredited parameters twice in a calendar year, with each study being approximately six (6) months apart. These tests are analyte, matrix, and technology specific, but are not method specific, and provide useful information regarding the accuracy of the analytical data being produced. ACZ participates in the Water Supply (WS) study for SDWA, the Water Pollution (WP) study for CWA, the Soil and Underground Storage Tank studies for RCRA, and Radiochemistry PT study for Drinking Water.

Following log-in, the PT sample is prepared by the analyst according to the vendor’s instructions and is then analyzed in the same manner as client samples as described by the test SOP. **NOTE:** Analysts must record the date of preparation (and time of preparation if the holding time is ≤ 72 hours) on the subsample container and on the associated workgroup bench sheet(s). Analysis must be performed as soon as possible after diluting the concentrate, as indicated in the vendor’s instruction pamphlet. Metals analyses must be completed within 48 hours of diluting the concentrate, as indicated in ACZ CAR519.

Data is compiled by the QA/QC department and reported to the vendor no later than the study close date. The vendor evaluates the data as “acceptable,” “not acceptable,” or “check for error” by comparing the reported values to statistically derived acceptance criteria and issues a report within 21 days from the study close date. Upon receipt of the report, the QA/QC department initiates a major corrective action for the PT study if any “not acceptable” results were reported. Each production supervisor must investigate all “not acceptable” results for their department, indicate possible causes and determine the appropriate corrective action(s) by the designated due date. If necessary, the QA/QC department will order follow-up samples to confirm the system deficiency has been corrected. Refer to ACZ’s SOP *Proficiency Testing Program* (SOPAD011) for additional information.

Strict rules apply regarding the exchange of information for any PT sample:

- ACZ shall not send any PT sample, or a portion of a PT sample for accrediting purposes to another laboratory for any analysis.
- ACZ shall not knowingly accept any PT sample or a portion of a PT sample for accrediting purposes from any other laboratory.
- Employees of ACZ shall not discuss PT data results with any other person outside of the laboratory, in particular any person associated with another laboratory.
- Employees of ACZ shall not attempt to obtain the results or assigned values of any PT sample from our PT Provider prior to the close of the study.

2.5 Corrective Action

When any problem, deviation or failure is identified within the Quality System or when any change is made to a previously documented company-wide protocol, a corrective action must be initiated. Corrective actions are a fundamental element of ACZ's QA/QC Program, as a successful Quality System requires the identification of deficiencies and depends on the development, implementation, and documentation of effective contingency plans and resolutions to effectively address the deficiencies.

Problems can ordinarily be classified two ways: 1) undesirable but not critical or 2) critical and requiring immediate action. To this extent, ACZ utilizes two types of corrective actions: Minor and Major. A minor corrective action pertains to any temporary deviation from a policy or procedure and may be initiated by any employee in order to resolve an immediate problem that is isolated or may impact only one workgroup or several related workgroups. Minor corrective actions do not require QA/QC follow-up. Major corrective actions address system-wide errors or failures and require the root cause(s) of the error or failure to be determined and the resolution to be documented and implemented.

2.5.1 Minor Corrective Action

The minor corrective action report (FRMQA001) allows for complete documentation of any temporary deviation from the SOP or other protocol. The employee who initiates the corrective action will complete Section 1 of the report. Documentation must be accurate and must provide a complete detailed explanation of the situation for future reference. The department supervisor should always be informed of the need for a minor corrective action and may provide additional information in the appropriate section. The project manager may also provide additional information in the appropriate section if necessary. QA/QC does not need to close a minor corrective action; however, the employee may review the report with QA/QC personnel and request their signature in the appropriate section.

Complete documentation may be provided either on the workgroup bench sheet or on the data review checklist in lieu of using FRMQA001 if the deviation applies to a limited number of workgroups. Use FRMQA001 if the deviation applies to many workgroups and attach a copy of the completed form to each workgroup before the workgroup is scanned. If the report is generated after the workgroups have been scanned, then the workgroup must be retrieved and rescanned with the report include as part of the data package. In this case, a note is made on the front page of the workgroup package indicating the reason the workgroup was rescanned (i.e. "CAR attached, WG rescanned"). If appropriate, a minor corrective action will be addressed in the case narrative of the client report.

2.5.2 Major Corrective Action

It is the responsibility of the QA/QC Officer to notify laboratory management in writing of departures from the Quality System, and it is the responsibility of the laboratory management to ensure that any corrective action that arises is discharged within the time frame indicated on the corrective action report, or additional communication must be provided to the QA/QC Officer (see item 3 below).

A major corrective action is initiated whenever a system failure has been identified or whenever an audit finding or other circumstance casts doubt on the correctness or validity of the analysis result(s). The client must be notified in writing if their work is affected. The QA/QC department will work with the Project Manager to determine if a revised report must be issued to the client. See ACZ's SOP *Client Service Policies and Procedure* (SOPAD043) for details. A major corrective action may also be initiated when the need for preventive action has been identified (refer to section 2.5.4).

Only QA/QC department personnel may open and close a major corrective action. When opened, the corrective action will be assigned a unique tracking number (referred to as the CAR number) to ensure that ACZ maintains a complete and accessible record of all Quality System deviations or failures, root cause determinations and subsequent resolutions, and preventive actions. All associated documentation must be retained for at least five (5) years as described in Section 10.

Other examples of circumstances requiring a major corrective action include, but are not limited to:

- Contamination trends as indicated by blanks routinely above acceptable levels
- Spikes, surrogates and lab control samples continually outside acceptance limits
- Change to the MDL and/or PQL (RL) for a procedure
- Client inquiries about data anomalies
- “Not Acceptable” Proficiency Testing results
- Results of internal or external audits
- Discrepancies observed at any stage of data review or reporting
- Using expired reagents
- Hold times or deadlines routinely missed
- Evidence of insufficient or inadequate training

Following initiation, the procedure for a major corrective action proceeds to an investigation by the assigned individual to determine the root cause of the problem and to identify possible resolutions to rectify the problem. The action(s) most likely to eliminate the problem and prevent recurrence of the problem must be selected, documented and implemented, and pertinent staff members must be trained, if necessary. Changes resulting from the corrective action will be monitored, if necessary, to ensure the resolution(s) are shown to be effective. A general outline of the procedure is as follows:

- 1) Initiation: Any employee may initiate a corrective action by notifying QA/QC. The department manager should always be notified first of any problem and then inform QA/QC. If determined to be necessary, QA/QC personnel will open a corrective action and assign a unique tracking number.
- 2) Assignment: QA/QC assigns the corrective action to the person(s) responsible for performing the “root cause” determination.
- 3) Investigation and Action: Must be completed within two (2) weeks from the date the corrective action was initiated. The need for an extension must be communicated to the QA/QC department.
 - a. The assigned individual(s) perform a “root cause” determination to identify the suspected cause(s) of the problem.
 - b. A resolution to correct the problem and prevent its reoccurrence must be determined, and the estimated date by which the resolution will be completed and implemented must be indicated in the appropriate section of the form. Resolution may be done solely by the person(s) who investigated the root cause or it may require input from one or more additional departments.

- 4) Project Manager Review: If necessary, the PM will determine whether affected data will be accepted or rejected, contact the client, and reissue a revised report if necessary. Project Manager review may not be required for every major corrective action.
- 5) Conduct additional training if necessary. Training must be documented using the appropriate form and must include a description provided by the person who conducts the training. All trainees are required to sign and date the form to acknowledge he/she has received training, understands the change(s) and agrees to adhere to any change(s) in a policy or procedure.
- 6) Revise SOP(s). Proposed revisions must be documented on the SOP Revision form (FRMQA030) and approved by QA/QC before trained personnel initial / date and implement the changes. Use FRMQA023 if the changes are incorporated into the SOP and a new effective version is issued.
- 7) Submit all supporting documentation to QA/QC to be attached to the hard copy of the report.
- 8) QA/QC reviews the corrective action. If satisfactory, the corrective action is closed and the implementation date is documented in the space provided.
- 9) If necessary, QA/QC conducts follow-up within two (2) weeks from the implementation date. If the corrective action is determined to be ineffective, then a new major corrective action will be initiated and the process repeated.

2.5.3 Technical Corrective Actions

Technical corrective actions apply to departures or deviations from the quality control parameters stated in individual test SOPs. Each test SOP must include all required quality control that applies to the procedure (as stipulated by the method and other regulatory agencies) as well as the performance frequency, acceptance criteria and corrective action for handling failed quality control measurements. Each SOP must describe the procedures to be followed for reviewing and assessing data, including corrective action for handling out-of-control or unacceptable data. The required protocol for technical corrective actions is summarized below. ACZ's protocols are included within the [].

- 1) identify the individual responsible for assessing each nonconformance and initiating or recommending corrective action [analyst who performs AREV]
- 2) define how the analyst must treat data if associated quality control measurements are unacceptable [section 12 of SOP]
- 3) specify how non-conformance and subsequent corrective actions are to be documented [data review checklist]
- 4) specify how management reviews the corrective actions [reviewed during SREV]

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control then the corrective action described in the SOP must be performed. Alternatively, report data with the appropriate qualifier if reprocessing and reanalysis is not possible. The qualifier must be assigned to any sample(s) associated with the failed quality control measure. A current list of all extended qualifiers is available in the LIMS database and may be accessed by all employees.

2.5.4 Preventive Action

Preventive action is a pro-active process to identify opportunities for improvement rather than reacting to the identification of problems or complaints. Needed improvements and potential source(s) of any nonconformance, either technical or concerning the Quality System, must be identified and addressed.

Examples of preventive action include but are not limited to: maintaining a cross-trained staff; maintaining a supply of spare consumable parts; monitoring the performance of support equipment; performing routine maintenance on instruments; maintaining an adequate supply of standards/reagents; ordering supplies before running out; completing log-in review in a timely manner; ensuring ACZ can perform work before samples are accepted; correcting quotes before samples are logged in; and analyzing samples by the appropriate method.

2.6 Management Review of the Quality System

At least once per calendar year, ACZ's management conducts a review of its Quality System and all activities related to its environmental testing services to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. At a minimum, the review must take the following into account:

- Status, review, and discussion of major corrective actions
- Results of recent PT studies and corrective actions initiated / completed
- Review of recent external audits
- Review of internal audits
- Presentation of ideas to improve efficiency and productivity
- Presentation of ideas to improve service and data quality
- Status of state certifications
- Feedback from clients
- Feedback from employees
- Ethics Program
- Ombudsman
- Changes in the volume and type of work undertaken
- Other pertinent issues

2.6.1 Department Reports

Each department manager completes a Department Report (FRMQA041) prior to the Management Review meeting. Each item on the report is to be evaluated as it pertains to the individual department. FRMQA041 is provided in Appendix D.

2.6.2 Management Review Report

The completed department reports are submitted to ACZ's President by the specified due date, and the information from each report is reviewed and compiled to complete the Management Review Report (FRMQA042). A copy of the completed report is issued to each manager in advance of the Management Review meeting. At a date / time specified by the President, all managers meet as a group to discuss the report. Other formats may be utilized at the President's discretion. All reviews will be appropriately documented and all documentation retained for at least five (5) years as described in section 10 (Control & Storage of Records & Documents). FRMQA042 is provided in Appendix D.

3 ETHICAL AND LEGAL RESPONSIBILITY

All ACZ employees have an ethical and legal responsibility to produce data that is accurate, reliable, and legally defensible. ACZ's proactive program for the prevention and detection of improper, unethical or illegal actions includes the implementation in 2002 of an Ombudsman who acts as a neutral party and serves as a confidential liaison between ACZ employees and upper management regarding questions, problems, complaints, suggestions, or ethical dilemmas.

All employees are educated with regards to ACZ's Code of Conduct and Code of Ethics as well as ACZ's zero-tolerance policy, which is strictly enforced. Additionally, employees are informed about the processes in place to ensure employees are free from any undue internal or external commercial, financial or other pressures that may adversely effect the quality of an employee's work, endanger the trust in the independence of ACZ's judgment, or compromise the integrity of ACZ's environmental testing activities. A more detailed description of all aspects of the ethics program is provided in ACZ's *SOP Ethics and Proactive Prevention Program* (SOPAD039).

ACZ will not tolerate any unethical or improper activities or behavior. Violation of company policies may lead to repercussions ranging from a severe reprimand to termination, and possible criminal prosecution if warranted by the situation. ACZ has access to many resources that may be utilized at any time to help clarify any situation determined to be a "gray area." Employees are strongly encouraged to seek further guidance from a supervisor, ACZ's Ombudsman, President or QA/QC staff whenever doubt is raised. Activities that will not be tolerated include, but are not limited to:

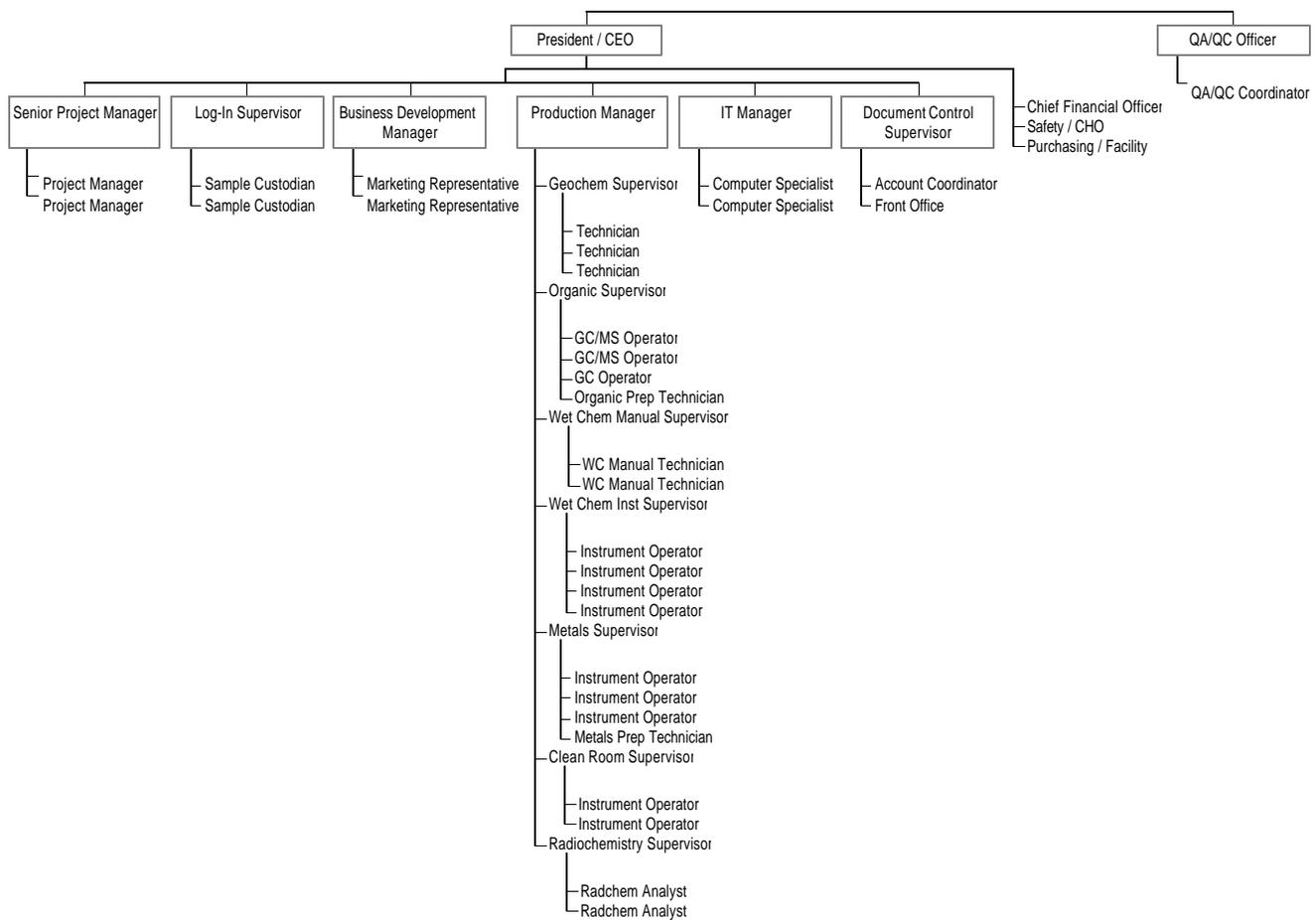
- **Misrepresentation of a procedure or documentation** – Intentionally performing a job duty in a manner that does not comply with a documented procedure, including but not limited to a test SOP or method used for sample analysis; providing inaccurate and misleading documentation associated with a data package or failing to provide the necessary documentation as part of a data package.
- **Falsifying Records** – Providing false information on personal credentials, resumes or educational transcripts, logbooks, raw data and client reports, or creating data without performing the procedure (also known as dry labbing).
- **Improper peak integration** – Intentionally performing improper integration of data chromatograms so quality control samples meet acceptance criteria. This is also known as peak shaving or peak enhancing.
- **Improper clock setting** – Readjusting the computer clock so that it appears samples were analyzed within hold times.
- **Improper representation of Quality Control samples** – Failing to treat batch quality control samples in the same manner as client samples (including Proficiency Testing samples) or misrepresenting any type of quality control sample associated with the preparation batch and/or analytical batch.
- **Improper calibration** – Intentionally performing improper manipulation of calibration data or forging tune data so that it meets acceptance criteria.
- **File Substitution** – Replacing invalid data with valid data from a different time so the analysis appears to be successful.

4 PERSONNEL AND RESPONSIBILITIES

Due to the nature of regulatory oversight and the increasing demands of the environmental lab industry, QA/QC issues permeate all aspects of our business, the largest and most critical of which are operations (production). On a daily basis, QA/QC and Production must efficiently function together to consistently provide our clients with technically sound and legally defensible data and to ensure the Quality System remains an integral part of all areas within ACZ. The President must rely on regular input and feedback from ACZ's QA/QC Officer and Production Manager, and to this effect, upper management is defined as ACZ's President, QA/QC Officer and Production Manager. It is the responsibility of upper management to document company policies, objectives, systems, programs, procedures, and instructions to the extent necessary to assure the quality and defensibility of all data.

ACZ is organized such that the President also works directly with and relies on input and feedback from the Senior Project Manager, Business Development Manager, Production Supervisors, Document Control Supervisor, IT Manager, Chief Financial Officer, and Chemical Hygiene Officer. These individuals are responsible for managing both the day-to-day operations and long-term goals within their respective areas. It is the responsibility of all managers to ensure that all documented ACZ policies and procedures, including those in the QAP and associated SOPs, are communicated to, understood by, made available to, and implemented by ACZ personnel.

Figure 4-1. Employee Organizational Chart



4.1 President/CEO

The President is ultimately responsible for all analytical and operational activities of the laboratory and must ensure that 1) the laboratory carries out all environmental activities in such a way as to meet the requirements of the NELAC Standards and 2) the laboratory satisfies the needs of the client and the regulatory authorities. General duties involve budgeting for all departments, making decisions on capital equipment and automation; developing company policies and benefits; addressing personnel issues such as hiring, firing, and promotions; and working with clients on various matters. Day-to-day responsibilities include providing direction to all laboratory departments including laboratory operations, accounting, marketing, QA/QC, and client services. Additional responsibilities are as follows:

- Work directly with ACZ's Ombudsman to provide and maintain a mechanism for confidential reporting of ethical/data integrity issues as well as issues that may directly affect current ACZ policies.
- Define the minimal level of qualification, experience, and skills necessary for all laboratory positions.
- Provide the QA/QC Officer with defined responsibility and authority for ensuring the successful development, implementation, and management of ACZ's Quality System.
- Provide the Production Manager with defined responsibility and authority for ensuring the technical operations and provision of resources needed to maintain the required quality of laboratory operations.
- Provide adequate supervision of environmental staff by persons familiar with methods and procedures, purpose of each test, and assessment of the test results.
- Ensure all technical staff has demonstrated capability in the activities for which they are responsible and ensure that the training of each member of the technical staff is kept up-to-date.
- Ensure the QA/QC Officer has access to the highest level of management at which decisions are made on laboratory policy or resources.
- Provide managerial staff the authority and resources needed to discharge their duties.
- Provide technical personnel the resources needed to discharge their duties.
- Specify and document the responsibility, authority, and interrelationship of all personnel who manage, perform or verify work affecting the quality of calibrations and tests.
- Implement appropriate and current guidelines for all lab methods and procedures to ensure data quality and efficiency of analyses. Ensure all method protocols utilized by ACZ meet the QC requirements as established by EPA or other governing agency.
- Document all policies and procedures related to the analytical and operational activities of the laboratory.
- Provide support to technical staff to ensure timely completion of all laboratory work, and develop contingency plans to ensure workflow progresses as planned.
- Meet quarterly (or more often) with the QA/QC Officer and Production Manager.

4.2 QA/QC Officer

The QA/QC Officer reports directly to the President; however, the QA/QC department is considered a separate entity from operations in order to assure data is evaluated objectively and assessments are performed without outside (i.e. managerial) influence. The QA/QC Officer has direct access to the President, and is therefore able to discuss and/or resolve all concerns, policies, etc. related to quality assurance or quality control. The primary responsibility of the QA/QC Officer is to develop, implement, and manage all aspects of ACZ's Quality System, and he/she may take any action necessary to ensure all ACZ employees adhere to all policies, procedures, and objectives documented in ACZ's QAP, SOPs, memorandums, emails, etc. If warranted, the QA/QC Officer has the authority to halt the performance of a single method or the production of a department, and if necessary, the operations of the entire laboratory, and will grant permission to resume when satisfied that the issue(s) have been resolved. Additional responsibilities include but are not limited to those stated in FRMAD060 and the following:

- Review and revise ACZ's QAP and provide training for all employees following approval of a new version.
- Provide QA/QC orientation to new employees.
- Meet quarterly (or more often) with the President and Production Manager.
- Work with department managers to develop and improve training protocols.
- Conduct department training sessions as needed to address specific problems and questions.
- Arrange for or conduct internal audits; notify management of deficiencies; and track corrective actions.
- Organize all external audits; notify management of deficiencies; and assign and track corrective actions.
- Review and approve SOPs (may designate responsibilities to QA/QC Coordinator).
- Meet at least quarterly with Production Supervisors to provide information, respond to questions, etc.
- Manage Proficiency Testing (PT) program (may designate responsibilities to QA/QC Coordinator).
- Coordinate and maintain all regulatory and client certification programs.
- Review and validate a determined percentage of all data packages from Log-in to Reporting.
- Work with marketing/client service representatives on QA/QC aspects of proposals.
- Work with Project Managers and the Production Manager to resolve client feedback regarding data quality.
- Review and maintain records and documentation for audits, certifications and all other QA/QC issues.
- Schedule electronic data audits with third-party.

Qualifications:

- General knowledge of the analytical test methods
- Documented training and/or experience in QA/QC procedures
- Knowledge of the Quality System as defined under NELAC

4.3 QA/QC Coordinator

The QA/QC Coordinator reports directly to the QA/QC Officer and assists the QA/QC Officer with the development, implementation, and management of the Quality System. Primary job responsibilities are as follows:

- Review and maintain records/documentation for employee training including DOCs, MDLs, etc.
- Provide initial QA/QC orientation to new employees.
- Provide follow-up QA/QC training to new employees.
- Schedule analyses and compile and report data for Proficiency Testing (PT) program, including DMRQA.
- Initiate and track corrective actions related to PT samples and manage all documentation associated with analyses.
- Review and approve SOPs.
- Conduct internal audits, notify management of deficiencies; and track corrective actions.
- Conduct department training sessions as needed to address specific problems and questions.
- Update control chart-generated QC limits in the LIMS database as needed.

Qualifications:

- General knowledge of the analytical test methods
- Documented training and/or experience in QA/QC procedures
- Knowledge of the Quality System as defined under NELAC

4.4 Production Manager

The Production Manager reports directly to the President. General duties involve working with analytical department supervisors on a daily basis to prioritize client projects and QA/QC deadlines and to track sample analyses in order to maintain acceptable turn-around-times for project completion. The Production Manager also addresses personnel, instrumentation, and reagent/supply issues that may affect the completion of the scheduled work and works directly with the QA/QC department to ensure all Quality System requirements pertaining to production are successfully completed in a timely manner. Additional responsibilities are described in FRMAD060.

- Conduct weekly meeting with Production Supervisors to discuss current and upcoming workload, scheduling, priority projects, QC requirements, instrument / equipment issues, personnel, etc.
- Schedule QA/QC work (MDL studies, DOCs, PT sample analysis, SOP revisions, etc.) with department supervisors in order to ensure QA/QC requirements are kept up-to-date.
- Meet at least quarterly with the President and QA/QC Officer.
- Communicate with Project Managers regarding project/instrument status. Notify PMs if problems exist that may affect the project completion date.
- Work with marketing/client service representatives on production aspects of proposals.
- Work with Project Managers and the QA/QC Officer to resolve client feedback regarding data quality.
- Perform checks of sample status using LIMS database to help the laboratory staff meet all established hold times and to determine that analyses can proceed as scheduled to meet required turn around times.
- Provide hands-on support to analysts when necessary to ensure timely completion of all laboratory work, and develop contingency plans to ensure workflow progresses as planned.
- Work with QA/QC Officer to develop and improve training protocols, conduct department work sessions to address specific problems and questions.

Qualifications:

- General knowledge of the analytical test methods
- Minimum four (4) years of laboratory experience
- Minimum two (2) years of supervisory experience
- General knowledge of lab-wide systems (including but not limited to log-in and reporting)

4.5 Production Supervisor

Each Production Supervisor is a full-time employee who reports to the Production Manager and exercises day-to-day oversight of laboratory operations for their specific area(s) of expertise. Each supervisor must be familiar with the test methods and related theory and instrumentation, as well as the assessment of results. In addition to monitoring the standards of performance, validity of all analyses, and quality of all data generated in their respective department(s), each supervisor is also responsible for ensuring that a new analyst has successfully completed all training requirements and is adequately prepared to commence work on client samples. Additional responsibilities are described in FRMAD060. If any supervisor is absent for more than 15 consecutive calendar days then another full-time staff member meeting the required qualifications will be assigned to perform the supervisor's duties.

Required Qualifications for a Production Supervisor:

- 1) Chemical analyses (Organics & Metals): BS or BA in chemical, environmental, biological sciences, physical sciences or engineering, with a minimum of 24 college semester credit hours in chemistry and at least two (2) years of experience in the environmental analysis of representative inorganic and organic analytes for the which the laboratory seeks or maintains accreditation. A masters or doctoral degree in one of the above disciplines may be substituted for one (1) year of experience.
- 2) Inorganic Chemical analyses (other than Metals): At least an earned associate's degree in the chemical, physical, or environmental sciences, or two (2) years of equivalent and successful college education, with a minimum of 16 college semester credit hours in chemistry and at least two (2) years of experience performing such analyses.
- 3) Radiological analyses: BS or BA in chemistry, physics, or engineering, with at least 24 college semester credit hours in chemistry and at least two (2) years of experience in the radiological analyses of environmental samples. A masters or doctoral degree may be substituted for one (1) year of experience.

4.6 Business Development Manager

ACZ's Business Development Manager reports directly to the President and supervises all Client Service Representatives, each of who conducts marketing and sales efforts on behalf of ACZ with potential, new and existing clientele, and develops and maintains long-term relationships with customers by working with Project Managers when necessary. Additional responsibilities of the Business Development Manager are described in FRMAD060. ACZ's Client Service staff is authorized to review all contractual agreements with clients, review all proposals and develop price quotations for routine and non-routine analytical projects.

4.7 Project Manager (PM)

The Senior Project Manager reports directly to the President and is responsible for overseeing the PM department. Additional responsibilities of the Senior PM are described in FRMAD060. Each Project Manager serves as the primary laboratory contact for each ACZ client, handles all client service requests, and investigates and resolves any problem brought to ACZ's attention by the customer. In order to provide consistency, each PM is assigned a list of clients, and it is the primary responsibility of each PM to ensure all of their client project needs are managed on a day-to-day basis and met in a timely manner and that all data submitted to the client is of high quality. All PMs work directly with the Production Manager and Production Supervisors regarding client data issues (due dates, hold times, retests, data quality, etc.), with Document Control regarding client reports and with the QA/QC department regarding data quality questions or concerns.

4.8 Instrument Operator

Instrument operators report directly to the respective Production Supervisor. The position involves the analysis of various matrices for trace level contaminants using specialized and technical instrumentation, and each operator must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The operator must demonstrate understanding of related theory, mathematics, analytical instrumentation and data interpretation. This work is predominantly intellectual and involves the continuous use of professional and sound judgment. The employee must meet or exceed all requirements for generation of litigation-quality data and must also continue to demonstrate increased proficiency regarding the interpretation of the data as well as the operation and troubleshooting of the assigned instrument(s). These improvements should be attainable through ongoing efforts in-house as well as through specialized instruction at off-site locations. Prerequisites regarding education and experience, as well as job responsibilities and performance expectations are described in FRMAD059. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science or a minimum of 3 years of relevant experience in lieu of degree
- Prior laboratory experience is preferred but is not required.
- Successful completion of training by supervisor or proficient instrument operator

4.8.1 Laboratory Analyst [Technician]

The laboratory technician reports directly to the respective Production Supervisor. The position involves analysis of various matrices using appropriate analytical techniques and support equipment as well as preparation of samples for instrument analyses. Each technician must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The technician must demonstrate understanding of related principles and mathematics, must possess common sense and mechanical skills, and must seek professional judgment from the supervisor as necessary. The employee must meet or exceed all requirements for generation of litigation-quality data as well as sample preparation tasks and routine analyses, and must also continue to demonstrate continuous improvements. These improvements should be attainable through ongoing training efforts in-house as well as through training opportunities at off-site locations. Prerequisites regarding education and experience, as well as job responsibilities and performance expectations are described in FRMAD058. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science is preferred but is not required
- Prior laboratory experience is preferred but is not required
- Successful completion of training period by supervisor or proficient technician

4.9 Information Technology (IT) Manager

The Information Systems Manager reports directly to the President and is responsible for the oversight of the IT department regarding the installation and maintenance of ACZ's computer network and all hardware and software and related equipment deployed on the premise. Additional responsibilities are described in FRMAD060. The department is also responsible for developing, maintaining, and improving custom written applications for laboratory automation and efficiency as well as for ACZ's Oracle database, Intranet (Labweb), Internet and electronic diskette deliverables (EDDs).

4.10 Log-In Supervisor

The Log-In Supervisor reports directly to the President and is responsible for the oversight and management of all department personnel and operations. Primary responsibilities include fulfillment and shipment of bottle orders to the client's destination in a timely manner, receipt of all incoming samples, evaluation of all incoming samples against ACZ's Sample Acceptance Policy, entering samples into the LIMS database, and performing timely review of all logged samples. Additional responsibilities are described in FRMAD060.

4.11 Document Control Supervisor

The Document Control Supervisor reports directly to the President and is responsible for the oversight of the Document Control department. Primary responsibilities include the generation of client reports and EDDs and the maintenance, organization and control of all hard copy data and records, including workgroup data, client reports, CCOCs, QA/QC records and documents. Additional responsibilities are described in FRMAD060.

4.12 Chemical Hygiene Officer

The Chemical Hygiene Officer (CHO) is primarily responsible for oversight of ACZ's documented Chemical Hygiene Plan, conducting initial and refresher safety training for all employees, monitoring exposures, and maintaining records for Material Safety Data Sheets, injury reports, chemical exposure reports, etc. Additional responsibilities include as working with management to develop and implement policies to improve the program. The person designated as CHO must have completed at least one basic laboratory safety course and has one year's experience performing laboratory work, preferably with responsibility for at least one area of laboratory safety.

4.13 Chief Financial Officer

ACZ's Chief Financial Officer (CFO) is primarily responsible for all financial matters including payroll, accounts receivable, accounts payable and financial statements; monthly and annual balance and profit and loss statements; and assisting with annual budget preparation. In addition, the CFO maintains and monitors the security system and electronic time clock, invoices client projects from the database, updates customer account information, acts as the administrator for 401k/Profit Sharing Plan, maintains and executes the Employee Benefits Manual and assists in hiring process by posting job openings, scheduling qualified candidates for interviews, checking references, and ensuring a new employee provides proof of education.

4.14 Purchasing Agent

Primary responsibilities include generating material requisitions and tracking all subsequent purchase orders; inspecting all incoming goods; generating PCNs for all incoming standards, reagents, and chemicals; tracking and maintaining an adequate supply of laboratory consumables.

5 TECHNICAL TRAINING

Prior to the independent generation or review of data for client samples (including PT samples), all analysts must undergo a formal, documented training process. Technical personnel must be thoroughly trained in the analytical techniques and operating principles and procedures for the methods utilized by ACZ. This process includes but is not limited to: reading the associated published method, reading all related SOPs, improving laboratory skills, learning troubleshooting, maintenance, and operating procedures for pertinent equipment and instruments, and creating workgroups and reviewing data through the LIMS database.

It is the responsibility of the department supervisor to determine that a new analyst is properly trained, has successfully completed all initial training requirements and is prepared to commence work on client samples. Under no circumstances may any analyst independently generate client data before receiving the explicit approval of the QA/QC department.

- 5.1 The effective version of the test SOP provides the framework for training for all sample preparation and analysis. The SOP is typically based on published approved methodologies (EPA or other) and incorporates any necessary activities and protocols not included in the published method(s) as well as requirements stipulated by other regulatory agencies.
- 5.2 Training for data AREV or SREV only must be documented as specified in section 2.3.6.
- 5.3 Each employee must be trained either by the department supervisor or by an analyst within the department who is proficient in the area of testing and has been designated by the supervisor. Anyone performing training must meet the following requirements:
 - 1) Documentation of training on the effective version of the test SOP.
 - 2) Documented approval for the analysis.
 - 3) A current IDOC or CDOC.
- 5.4 Initial training is documented using the Initial Method Training form (FRMQA004). Once training has been completed, the trainee and the instructor fill out the form together to ensure all pertinent information has been addressed and to ensure the trainee comprehends the material and is provided an opportunity to ask questions or request additional training. The trainee's signature is an attestation that he/she has read, understands, and agrees to always follow the effective version of the SOP.
- 5.5 To demonstrate an aptitude for the procedure, the analyst must perform a successful Initial Demonstration of Capability (IDOC) prior to independent preparation and/or analysis of client samples. Performance is documented using FRMAD023. The data is reviewed initially by the department supervisor and the analyst (AREV), and both individuals must initial and date the review checklist.
- 5.6 SREV for any preparation workgroup is performed by the department supervisor or a qualified analyst, and SREV for any analytical workgroup is performed by QA/QC.
- 5.7 Prior to performing an IDOC, a new analyst should be provided sufficient opportunity to practice the procedure. This confirms the analyst understands the procedure and feels comfortable performing the procedure independently. Data associated with any practice is not submitted to QA/QC.
- 5.8 It is not necessary for the first IDOC attempt to pass; however, the supervisor needs to review the analyst's techniques if multiple attempts do not pass.

- 5.9 A thorough review of the raw data is performed as part of initial method training and should include particular attention to details not presented in LIMS or on the final report, such as generating final sample concentration from the instrument response provided in the raw data (if applicable) and verifying correct standard and reagent traceability.
- 5.10 Where specified by the method or a regulating entity, and as stated in the test SOP, successful demonstration of performance such as Linear Calibration Range determination (LCR) or Method Detection Limit (MDL) study must be completed prior to independent analysis of client samples.
- 5.11 All initial training documentation must be submitted to the QA/QC department as a complete package. At a minimum, the package must include:
- 1) Initial Method Training form (FRMQA004), signed by the trainee and instructor (or department supervisor).
 - 2) IDOC documentation:
 - ✓ Completed and signed certification statement (FRMAD023)
 - ✓ Workgroup bench sheet, raw data, and all supporting documentation
 - 3) If applicable, MDL study for each instrument. Complete FRMAD031 and attach all related raw data and supporting documentation.
 - 4) If applicable, calibration range study for each instrument. Complete FRMQA029 and attach all related raw data and supporting documentation.
- 5.12 Following review of all pertinent training documentation, QA/QC will issue procedure-specific clearance for the trainee to independently generate and review data for client samples. This permission is tracked and may be viewed on a designated location on the public network drive.
- 1) Approval for preparation procedures is granted after the instrument data has been reviewed and approved.
 - 2) An unapproved analyst who is “shadowing” the trainer (observing, learning the organization of the lab, reagent room, etc.) may not assist with the procedure, and the workgroup documentation must bear only the initials of the trainer, who is fully responsible for the data.
 - 3) If the analyst has completed training for a procedure and generates client data or reviews client data prior to QA/QC approval, then any workgroup(s) or data review checklist must also bear the initials of a proficient analyst, with current approval for the method, who oversees the analyst’s work for the procedure and assumes full responsibility for the data. The primary analyst must always be aware that he/she is responsible for the workgroup. The use of another employee’s initials without their explicit approval is not permitted.
- 5.13 The supervisor is responsible for ensuring the training of each analyst is kept up-to-date. Each analyst must read, understand, and agree to follow the effective version of the SOP and continued proficiency must be demonstrated and documented annually for each analyst.
- 5.14 Each production supervisor routinely conducts department meetings to discuss procedures, work schedules, resources, questions and concerns, problems, QA/QC, etc.

6 SAMPLE COLLECTION & HOLDING TIMES

Sample collection procedures are well documented by the EPA and other agencies, and ACZ's clients are instructed to provide representative samples whenever possible. ACZ supplies its clients with the containers and other materials necessary to maintain sample integrity (to the extent possible) from the time of collection through analysis. Although ACZ does not perform sample collection activities, each project manager or client service representative will assist a client with specific sampling requirements as needed, or when necessary, will direct a client to other resources. The following sections include general information on sample containers, preservatives and holding times, which are essential components in maintaining the chemical and physical properties possessed by the sample at the time of collection.

6.1 Sampling Containers and Preservatives

The EPA outlines the requirements for sample container types, sample volume and preservation. ACZ inventory includes various sizes of plastic and glass containers that range from pre-sterilized to certified-clean by the supplier. Amber bottles are used when specified by the method. Glass containers are obtained from vendors that specialize in the sales of environmental sample containers, and all non-certified bottles are purchased from reputable lab/industry vendors. Refer to FRMAD045 and FRMAD046 for bottles types and preservation techniques for specific analyses. Refer also to Appendix A for additional information regarding EPA requirements container types and preservation.

All sample containers shipped to our clients are new, contain the appropriate preservative(s), and are color-coded to identify preservation and storage. Out-going containers are packed in clean coolers with a copy of ACZ's Sample Acceptance Policy, general directions for sample collection, bottle labels, ice packs, sampling information, blank chain of custody, return shipping labels, and custody seals. Trip blanks and rinsette water are included when requested by the client or when mandated by a specific analytical method. After samples have been collected they are cooled to a temperature $> 0\text{ }^{\circ}\text{C}$ and $< 6\text{ }^{\circ}\text{C}$. Samples that require thermal preservation must be maintained within this temperature range until all analyses have been completed.

6.2 Holding Times

The EPA has conducted lengthy studies of sample degradation versus time to establish a maximum holding time for each method, and the results of these studies are compiled into holding-time tables to provide guidelines for litigation purposes. Data for a sample prepared / analyzed outside of the established holding time are the most difficult to defend in court. Holding times will vary slightly from regulation to regulation, thus further emphasizing the need for a client to consult with their Project Manager prior to sample collection. The holding time begins from the time or date of collection in the field. Appendix A outlines holding times (a hold time stated in 40CFR supersedes the published method). **NOTE:** The sampling date for PT samples is the preparation date, which must be documented on the workgroup and the container of prepared sample.

If ACZ Laboratories, Inc. receives samples past holding times or near the expiration of the holding time, sample analysis will proceed unless the client has indicated on the CCOC that an attempt to contact the client must first be made. Analyses performed outside of holding time will be appropriately qualified on the final report. Holding times ≤ 72 hours are calculated based on the hour of the sample date/time. Holding times > 72 hours are calculated based on the day of the sample date/time.

In general, and unless otherwise noted in the test SOP, sample preparation and analysis must be completed within the stated holding time. For analyses that extend beyond the intended scope of the method for an analyte or matrix, the hold time stated in the SOP must be met, or samples must be appropriately qualified.

7 SAMPLE CUSTODY & SAMPLE HANDLING

Sample custody begins with the receipt of sample containers from the client and continues beyond preparation and analysis to the proper disposal of primary and secondary sub-samples. Complete and accurate documentation must be provided at all stages of custody. There are many key elements to sample custody including laboratory security, chain of custody records, sample storage, internal custody logs, sample tracking within the laboratory, control of subcontracted work, and sample disposal.

7.1 Laboratory Security

A secure facility is essential to maintaining sample and data integrity and to providing safety to employees and visitors. ACZ has an electronic security system based on anti-pass back protocols, which controls and limits access to only authorized personnel. The following steps have been taken to ensure this security:

- All entryways are armed and a proximity reader at the east entrance and west shipping entrance allows access to an employee only after he/she passes their card.
- Employees may enter/exit only through the west door at Log-In and the east door next to the lunchroom.
- During normal business hours, public access into the building can be made at the front entrance and the west shipping entrance. Both doors are equipped with a buzzer.
- The outside doors at the west shipping entrance remain unlocked; however, the doors between the vestibule area and sample receiving area are equipped with an anti-pass back system.
- Building access is limited to specific hours of the employee's shifts.
- All employees are required to use their access cards to enter and exit the building.
- If any employee does not have their access card, they must notify ACZ's CFO as soon as possible and must sign in and out during the day using the visitor's register at the front desk. This ensures a record is maintained of which personnel were in the building at any time.
- If employees fail to use their card, the anti-pass back system denies access for that card the next time it is used. The employee must report to ACZ's CFO if this occurs.
- Visitors must enter and exit through the main entrance and must sign the register at the front desk upon arrival and before departure.
- Lab personnel must escort visitors as long as they remain on the premises.
- Emergency Exit doors are to be used only for emergency purposes. If a door is opened, a siren alarm will sound.
- It is against company security policy to loan or transfer access cards to anyone, including other ACZ employees. Employees may not allow a non-shift employee to enter the building.
- Vendors and delivery services enter the building via the west shipping entrance.

7.2 Sample Receipt and Log-in

Upon delivery of samples to ACZ, Log-In personnel evaluate the condition of the cooler and custody seals. The custody seals are then broken to retrieve the Chain of Custody (COC), which must be signed by the sample custodian to document the transfer of possession of the samples to ACZ. Once a cooler is opened, the pH of each sample is checked, if necessary, to verify the method preservation requirements have been met. The pH check is documented along with cooler temperature, radioactivity screen and other pertinent sample information.

Any problems, such as expired hold times, lack of preservative or improper cooler temperature, are noted and the Project Manager must contact the client as soon as possible so that a contingency plan can be initiated if necessary. Samples are logged-in as outlined in the SOP *Sample Receipt & Log-In Procedure / Maintenance of Sample Integrity* (SOPAD016) and are delivered to the assigned storage areas. Following log-in, every project is reviewed by the assigned PM, and upon completion of the review, the client receives an electronic summary, referred to as the "Login Review Report" that details the project information. This summary allows the client an opportunity to make changes to the project before samples are analyzed. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

7.3 Internal Custody Logs

Some clients may specify additional custody tracking of the samples once they have been logged in. Internal custody may require that samples are stored in a manner that ensures limited access. The internal custody log (FRMQA015) shall accompany the samples from log-in through completed analysis. The person responsible for the work signs and dates each entry and/or page in the logbook. When all data from a sample set is compiled, copies of all logbook entries shall be included in the final report package. For projects requiring internal custody, ACZ will adhere to the procedure described in the SOP *Client Service Policies and Procedures* (SOPAD043).

7.4 Sample Tracking

Sample flow through the laboratory is facilitated by the use of an Oracle-based LIMS database (Laboratory Information Management System). Every product (requested analysis) logged into the LIMS for a sample has a specific, pre-determined department path. All products have default paths of at least Login Review and Reporting. Between these two departments, a product may go through, for example, Soil Prep and Metal Analysis or Soil Prep, Organic Prep and GC Analysis. At each department step in a product's path, the status can be updated and viewed at any time. Analytical product statuses are defined below. Additional information regarding sample tracking is available in the SOP *Client Service Policies and Procedures* (SOPAD043).

NEED	Prep or Analysis has not been started
WIP	Prep or Analysis has been started (Work In Progress)
PREP	Sample preparation is complete and sample is ready for analysis
UPLD	Analytical data has been uploaded into LIMS
AREV	Analyst has reviewed and accepted analytical data
SREV	Supervisor has reviewed and accepted analytical data
DONE	Analysis or task has been completed
REDO	Sample requires reanalysis
REDX	Sample requires re-digestion/extraction
CANT	Sample preparation or analysis cannot be performed

8 PROCUREMENT, INVENTORY & TRACEABILITY OF SUPPLIES

8.1 Procurement / Inventory

All consumable supplies are purchased from reputable vendors that have been evaluated for service, quality, and price. To the extent possible, materials traceable to national or international standards of measurement are purchased for use in technical operations. Supplies are purchased using ACZ's purchase order (PO) and inventory system database. The Purchasing Agent is not permitted to make a substitution for any material(s) specifically requested unless the department supervisor approves the substitution. Upon receipt, reagents, chemicals, standards, and other laboratory consumables are stored in the Chemical & Supply Room, which has limited access, or are delivered to the laboratory. Refer to ACZ's SOP *Purchase, Receipt, and Storage of Consumable Materials for Technical Operations* (SOPAD037) for additional information.

8.2 Glassware

ACZ uses only laboratory grade glassware. Prior to use, glassware is cleaned using Alconox[®] or Chemsolve[®] (or other appropriate detergent) and then rinsed with Type I water. Glassware for trace metals is subsequently rinsed with 50% Nitric Acid and rinse again with Type I water. Glassware for nutrients is subsequently rinsed with 10% Hydrochloric Acid and then with Type I water. All glassware for organic analyses is washed with Alconox[®] then rinsed with de-ionized water and kiln-baked. Glassware for radiochemistry analyses is washed first with Contrad70[®] and then with 50% Nitric Acid and is rinsed with Type I water. Clean glassware must be stored in an enclosed cabinet or other suitable container and/or covered with Parafilm or foil.

8.3 Other Supplies

Routine consumables (centrifuge tubes, autosampler tubes, pipette tips, etc.) are purchased through an automatic system managed by Fisher (RIMS). All other supplies are purchased on an as-needed basis through ACZ's Purchase Order and inventory system database. Refer to SOPAD037 for additional information.

8.4 Traceability of Standards and Reagents

To provide complete traceability, each data package must reference every standard and reagent used for sample preparation or analysis, including but not limited to acids, bases, preservatives, color reagents, pH indicators, buffers, instrument reagents. Each PCN and/or SCN must be documented either on the workgroup bench sheet, data review checklist, or a current standard/reagent form. The open date for all original containers is not tracked in LIMS; however, good laboratory practice dictates that the open date always be noted on the sample container.

8.4.1 Primary Control Number (PCN)

Upon receipt, all stock chemicals, standards, and reagents are assigned a unique PCN in LIMS for tracking and traceability purposes. A label with the PCN and the expiration date is affixed to both the container and the Certificate of Analysis (if applicable). Document Control enters the data for each PCN using the certified value(s) supplied by the vendor, as indicated on the Certificate of Analysis. Because the certified value is entered, the final concentrations for prepared standards may vary slightly from the theoretical value indicated in the test SOP. Non-certified values are not entered and are not used for quality control purposes. Document Control maintains certificates of Analysis, and a copy of the PCN report is generated and maintained. If data for any PCN is to be edited, then complete documentation must be provided as a major corrective action (FRMQA001).

NOTE: Only Document Control and QA/QC personnel are authorized to enter or edit PCN data.

8.4.2 Secondary Control Number (SCN)

To ensure complete traceability, a unique SCN must be created when any intermediate or working standard is prepared from one or more stock solutions, stock chemicals, or intermediate solutions. A standardized format is used for creating the SCN: a two-letter code indicates the lab section and is followed by the prep date and then by a daily sequential number. For example, the SCN **II051128-2** denotes the second standard prepared on November 28, 2005 in the Inorganic Instrument lab. An acceptable alternative is to let LIMS assign a unique number when prompted.

A SCN for any working standard subjected to a LIMS calculation must be created electronically in LIMS. The initial volume and concentration of each constituent and the final volume of the prepared solution are entered in the SCN Wizard program to calculate the final concentration(s) of each analyte using the formula $C_1V_1 = C_2V_2$. The preparation date, expiration date, and preparer's initials are included as part of this electronic record. A hard copy of the SCN report may be affixed to the standard/reagent logbook, depending on individual department practice; however, it is not required.

Prepared reagents do not require a SCN to be created electronically in LIMS; however, preparation must be recorded in the department's designated logbook. At a minimum, the logbook entry must clearly identify what reagent was prepared, its subcomponents, the preparer's initials, the preparation date, and the expiration date. This information is sufficient for color reagents, buffer solutions, instrument reagents, etc. because details of the preparation are stated in the test SOP.

8.5 Preparation and Expiration of Standards and Reagents

8.5.1 Preparation of Standards and Reagents

Refer to individual test SOPs for detailed information regarding standard and reagent preparation. In general, either Class A pipettes or mechanical pipettes are used to measure and dispense aliquots of any solution used to prepare a standard or reagent. Accurate delivery of mechanical pipettes must first be verified as described in ACZ's SOP *Control, Calibration, and Maintenance of Measuring and Test Equipment* (SOPAD013).

The term QS referenced in many test SOPs is the acronym for *Quantity Sufficient* and refers to the addition of appropriate diluent to the solution to achieve the final volume. All containers of prepared reagents and standards stored for more than one day must be properly labeled with the SCN (or other unique identifier), preparation date, and expiration date. Preparation of reagents and standards must be documented as described in 8.4.2.

8.5.2 Expiration of Purchased Standards and Chemicals (PCNs)

In general, purchased liquid standards or reagents are assigned a default expiration date of one year from receipt. When provided, the manufacturer's expiration date will be assigned in lieu of the default expiration date. Solid materials are assigned a default expiration date of five (5) years from receipt.

An expired stock material may continue to be used only if its reliability can be verified. For the purpose of ensuring transparency, the reason for extending the expiration date of a PCN must be documented as a QA/QC Issue Wizard assigned to QA/QC or the Document Control supervisor. Unusable materials must be replaced and the standard or reagent remade as soon as possible. Remove the container from the lab or the supply room and dispose of properly. Contact ACZ's CHO for assistance.

8.5.3 Expiration of Prepared Standards

Storage conditions and shelf life for prepared standards are provided in the individual test SOPs. The following guidelines may be used to determine the shelf life for a prepared standard:

- 1) A standard that has been prepared in-house may continue to be used after its assigned expiration date for as long as its reliability can be verified. For applicable procedures, instrument response should be considered when determining whether or not a solution is still reliable.
 - In cases where reliability has been verified, the expiration date of the SCN must be updated in LIMS or the standard/reagent logbook.
 - In the event the solution was used prior to updating the SCN then documentation must be provided as part of the workgroup to indicate the solution was used past the shelf life stated in the SOP (a minor corrective action may be used if more than one workgroup is affected). The expired standard must be remade as soon as its reliability becomes questionable – it is the responsibility of the analyst to use their best judgment.
- 2) The shelf life of any prepared standard with any analyte concentration < 10 mg/L is 90 days from the preparation date. This is a general guideline – if any constituent does not remain in solution for 90 days, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.
- 3) The shelf life of any prepared standard with analyte concentration \geq 10 mg/L is one year from the preparation date. This is a general guideline – if any constituent does not remain in solution for one year, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.
- 4) In general there are no manufacturer expiration dates for Radiological isotopes. If provided, these will be used; otherwise, the default expiration date of one year from receipt will be assigned when the material is received and can be subsequently updated at yearly intervals as needed for as long as the material remains useable. Because the shelf life of a radiological isotope is dependent on the half-life, the isotope will be deemed expired when it falls within 3 times the detection limit of the method.
- 5) In general, prepared Radiochemistry standards expire one year from the preparation date. The solution may be re-evaluated using control charts or other criteria and the expiration date extended by year intervals if the solution is still deemed usable. Refer to the specific test SOP for details.

8.5.4 Expiration of Reagents

In general, a reagent is a solution, other than a surrogate or internal standard, which is used for any step of sample preparation or analysis but does not contain the target analyte(s). Storage conditions and shelf life are stated in the individual test SOPs. The expiration date can be extended for a prepared reagent provided the criteria stated in 8.5.3.1) are met.

9 MAINTENANCE & CALIBRATION OF INSTRUMENTATION & EQUIPMENT

9.1 Maintenance of Instruments and Support Equipment

The best protocol for producing quality work is to prevent errors and non-conformances rather than to react to and correct problems after they occur. An essential part of this protocol is ensuring that all laboratory instrumentation and equipment used for the generation of data has been optimized and is functioning properly before commencing work on client samples. Performing routine maintenance and optimizing instrument-operating conditions prior to sample analysis minimizes instrument downtime, thereby improving productivity and ensuring quality of the data. It is the responsibility of the designated analyst(s) to perform and properly document daily and routine maintenance, instrument optimization, troubleshooting, any instrument servicing or repair, and any repair or replacement of parts.

All manufacturer-prescribed inspection and maintenance must be performed according to the schedule indicated in the operator's manual (or similar) provided by the manufacturer and must be documented either in the instrument logbook or a separate maintenance logbook or on the instrument maintenance checklist (available in LabWeb). ACZ management recognizes that performing all maintenance procedures at the frequency indicated by the manufacturer may not be economically feasible or a significant increase in workload may require the maintenance be performed at a later time if instrument performance is deemed to be acceptable; therefore, at a minimum, the instrument part(s) must be inspected regularly according to the schedule. The analyst must use their professional judgment to determine if maintenance or replacement is necessary at that time. Refer to ACZ's SOP *Control, Calibration and Maintenance of Measuring and Test Equipment* (SOPAD013) for details for each specific instrument or instrument type.

Additionally, all support equipment (any device that may not be the actual test instrument, but is necessary to support laboratory operations) must be monitored regularly to confirm proper functioning. The temperature of all drying ovens, refrigerators, freezers, and incubators must be checked each working day (except Sundays or holidays) and each check recorded on the associated Temperature Logsheet. Refer to SOPAD013 for more detail.

Equipment that has been subjected to overloading or mishandling, gives suspect results or has been shown to be defective or outside specified limits must be taken out of service and FRMAD029 attached to indicate the instrument or equipment is waiting for repair and cannot be used. During this downtime the department supervisor, Production Manager, and Project Manager may collectively determine it is necessary to sub-contract samples until correct performance of the repaired instrument or equipment has been demonstrated by a successful calibration or other suitable test. Document all contact with the manufacturer, as well as all repairs and other services, in the instrument or maintenance logbook to be used as a reference for solving future instrument problems. Additionally, when instrumentation or equipment goes outside of the direct control of the laboratory, the functioning and calibration status must be checked and shown to be satisfactory before it is returned to service. Refer to SOPAD013 for additional information.

To minimize downtime, each laboratory should maintain an adequate inventory of reagents, stock standards, glassware, etc. and should keep a sufficient supply of extra "critical" parts in-house rather than possibly delay sample analysis while waiting for parts to arrive. Keep in mind that parts from a vendor may be back-ordered and will not be available for immediate shipment. Additionally, an MDL study, MDL verification, calibration range determination, etc. must be performed for all methods on each instrument used to analyze client samples. This ensures any "backup" instrument can be utilized for analysis of client samples as soon as needed, rather than delaying production to first successfully complete any QC requirement(s).

9.2 Instrument Calibration

The accuracy of all instrument-generated data is ultimately dependent upon the proper initial calibration of the instrumentation used for any particular analysis. In order to perform quantitative measurements, the initial calibration must be established and verified, at the frequency required by the method or by the manufacturer (whichever is more stringent), before samples are analyzed. In general, calibration or standardization involves defining the relationship between instrument response and the amount or concentration of analyte introduced into the instrument. The graphical depiction of this relationship is referred to as the calibration curve. Calibration frequency must be performed in accordance with the manufacturer's guidelines, test method or other regulatory requirements, or client contract stipulations, whichever is most stringent. Every calibration or standardization must meet the acceptance criteria stated in the SOP and must be subsequently verified by analyzing an initial calibration verification standard (ICV) or other control standard (if specified in the SOP) that contains all target analytes and has been prepared or obtained from a different source than the one used to prepare the calibration standards.¹ Whenever possible, calibration standards and the second-source verification standard should be prepared on different days. If they are prepared concurrently, then another qualified analyst should prepare the second-source verification standard. This eliminates the possibility of the same analyst preparing both solutions incorrectly, an error difficult to detect.

A continuing calibration verification standard (CCV) containing all analytes of interest must be analyzed at the frequency stated in the test SOP to ensure the stability of the initial calibration curve has not varied over time due to any change in the analytical instrument and its detection system, such as instability of standards, instrument cleanliness, column performance, matrix effects, flow changes, and changes within the laboratory environment.

For applicable methods, all initial and continuing calibration steps must be clearly detailed in the test SOP. Additionally, each test SOP must specify the frequency and acceptance limits for the calibration and subsequent verification (ICV and CCV). In general, acceptance criteria are method-specific; however, the SOP may also include requirements of other regulatory agencies. Prior to resuming sample analysis, immediate corrective action must be taken if the calibration, ICV, or CCV is outside of the acceptance criteria. Technical corrective actions are described in the individual test SOPs. Refer also to section 11.2 for additional information.

General calibration guidelines are listed below and detailed information is provided in ACZ's SOP *Maintenance and Control of Calibration and Test Equipment* (SOPAD013).

- Understand the method requirements for calibration (minimum number of standards, etc.)
- Use the correct calibration model (linear, second-order, etc.)
- Include all target analytes in the calibration standards and second-source standard
- Analyze a calibration standard with a concentration less than or equal to the reporting limit.²
- Do not remove points from the middle of the calibration (only high or low standard may be dropped).
- Calibration is a single-event process. A retest of a calibration standard must be performed immediately.
- Documentation and resolution of calibration abnormalities is absolutely critical

¹ If a second source standard is not available then a different lot(s) of the same standard(s) may be used. If a different lot is not available then an analyst who did not prepare the calibration standards may prepare the calibration verification standard. The latter is an exception, and an attempt must first be made to purchase a different lot from the same vendor whenever a second-source standard is not commercially available.

² In general, the concentration of the low calibration standard is equal to the reporting limit, because lesser values are qualified as estimated; however, actual lab practice may differ and must be stated in the test SOP.

10 CONTROL & STORAGE OF RECORDS & DOCUMENTS

A formal and systematic control of records and documents is necessary for accurately reconstructing the entire history of any sample as well as to guarantee the quality and defensibility of the data. All information pertaining to instrumentation and equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, data verification and data reporting must be documented, must identify all personnel involved, and must be readily understood. All records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained, and the management system must facilitate the retrieval of all working files and archived records for inspection and validation purposes. Documents and records must be safely stored (protected against fire, theft, loss, environmental deterioration, and vermin) and must be held secure and in confidence to the client for a minimum of five (5) years. The hard copy of all records and documents must be maintained in a designated storage area with limited access. To the extent possible, hard copies for the most recent two (2) years are stored on-site, and if necessary, may be moved to off-site storage after two years. Off-site storage conditions must meet the same criteria that apply to on-site storage.

10.1 Workgroups

10.1.1 Changes made to any workgroup record (hardcopy or text file) must be documented.

- 1) If a workgroup is “dissolved” to change the status then all data must first be deleted, and the workgroup is then either re-reviewed or re-uploaded. In either case, the analyst is prompted in LIMS to provide an explanation of why he/she is performing the task.
- 2) Changes to text files must be documented in LIMS and on the hard copy of the workgroup.

10.1.2 Workgroup data that is re-uploaded *for any reason* must first be deleted. Use one of the following options in LIMS\Sx Analysis.

- 1) Choose “Delete workgroup data and set to WIP.”
- 2) In either the AREV or SREV function choose “Errors” and then “Reupload.”

If any of the data changes then a new Run Approval report must be printed and attached to the hard copy of the workgroup, and the workgroup must be rescanned.

10.1.3 Document Control or other administrative personnel use a multi-page scanner with its own PDF scanning software to scan all workgroups.

- 1) Before the workgroup is scanned, the top page is reviewed to make sure it has both the AREV and SREV initials and dates, and that errors have been properly corrected.
- 2) The person scanning the must initial and date in the lower right hand corner of the front page by the person. This provides a record of the scan date.
- 3) The workgroup is scanned to the designated network directory and is then moved through an automated process to the appropriate read-only LabWeb directory, which is accessible to all employees. When a workgroup is rescanned, the previous file is maintained. A copy will be automatically created so as not to overwrite any files and will have a letter appended; starting with “A” the first time the workgroup is rescanned. The most current file will not have a letter appended.

10.1.4 The hard copy is filed by workgroup number in a storage box. The front of the full storage box is labeled with the year and the workgroups contained in the box. The first box of each new calendar year is "1." Full boxes are consecutively numbered, transferred to a designated location and stored in numerical order. The storage room is locked at all times. Access is limited and is tracked through an access logbook.

10.1.5 Workgroups moved to storage may be accessed; however, a checkout card must hold the place of the workgroup in the file and must indicate who removed the workgroup, the workgroup number, and the date the workgroup was removed. When the workgroup is returned, then the checkout card is removed.

10.2 Electronic File Retention & Storage

All electronic records, stored either on instrument computers or on the network, are systematically backed up to tape. These records include Oracle data, instrument raw data, workgroups, client reports, instrument upload files, SOPs and other controlled documents, telephone records/voice mails, and department data. Tape backups are performed incrementally nightly Monday through Thursday, and a complete backup is performed each Friday. The tape from the first Friday of the month is pulled from service and placed in a secure, data-rated, 4-hour fireproof, safe that is located in the CFO's office. On a regular basis, the monthly tapes are moved to ACZ's safety deposit box at a local bank.

10.3 Instrument Data Files

Instrument raw data files are backed up by two different procedures: ACZ's Instrument Data Backup Application (IDBA) and StorActive. IDBA is a mandatory program that accesses local directories from instrument computers. Each night the program retrieves and backs up individual data files from the specified directory on each instrument computer. Refer to ACZ's *SOP Backup and Archive of Instrument Data Files* (SOPAD044) for details. StorActive LiveBackup is a third party program located on its own server that stores any saved version of all files located on any computer that employs LiveBackup (including files with the same name). This program is helpful in case a full restore is necessary or if multiple files overwritten by a saved version need to be retrieved. This program works for any computer utilizing Windows XP as its operating system.

10.4 Client Reports

10.4.1 Client reports are generated and signed electronically and are automatically stored as a PDF at a designated location on the network that has limited access. If a copy of any report exists on the network, and a new report is generated, then the existing copy will be renamed so that it is not overwritten. This way ACZ maintains a copy of all reports generated for a client.

10.4.2 Hardcopy documentation associated with a client project (CCOC, invoice, Login Review Form, etc) is filed by project number and stored in the document storage location.

10.4.3 Electronic Diskette Deliverables (EDD) are stored on the network at a designated location.

10.4.4 Changes to data may be necessary due to reporting requirements. These changes are made after the routine workgroup approval step and may include changes to reporting qualifiers, QC Summary qualifiers, report notes, etc. A record of the change must be made in the project

“Change Log.” Access the Change Log from the LIMS2000 menu/Reporting/Report Approval form. Refer to ACZ’s SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

10.4.5 The Change Log must be used when a reported parameter is moved from one workgroup to another. The preferred way to do this is for a PM to either document the necessary changes in the Change Log and then notify the reporting department of the required changes or notify the reporting department immediately that a change is necessary. In the case of the latter, the reporting department makes the changes and then logs this action in the Change Log. Refer also to ACZ’s SOP *Client Service Policies and Procedures* (SOPAD043).

10.4.6 Once a project has been invoiced, the directory on P:\Client is moved to the designated network location as a read-only PDF. If a project is un-invoiced, the project folder is copied to P:\Client where changes can take place.

10.4.7 In general, changes are not allowed to projects (including compilation) if the project has been invoiced. If a change needs to be made, the project must first be un-invoiced. At the time of un-invoicing, the user must provide a reason in LIMS to explain why the project was un-invoiced. This information is then stored in the Oracle database.

10.5 Documents

10.5.1 Standard Operating Procedures

10.5.1.1 Refer to section 2.2 for additional information pertaining to SOPs.

10.5.1.2 The original master copy of each SOP is maintained through a combined effort of QA/QC and Document Control. Master copies are organized in three-ring binders, which are kept in the Document Control office. An SOP Control Form (FRMQA003) is kept with each master copy and indicates each controlled copy of the SOP that was issued as well as the date and to which lab(s) the copies were distributed.

10.5.1.3 When a new version of any SOP becomes effective, the master copy of the previous version is retained and filed in the Document Control office. All controlled copies of the previous version are collected and disposed of. The collect date is documented on the SOP Control Form, which is maintained with the associated master copy SOP.

10.5.1.4 A controlled copy of the SOP is kept in each location the procedure is performed.

- 1) Each lab or department is issued one controlled copy of all relevant SOPs. The controlled copy must not be removed from the assigned area for an extended period of time and may not be photocopied. An additional controlled copy of any SOP or individual replacement pages of any SOP will be distributed upon request.
- 2) A SOP Revision Form (FRMQA030) is issued with each controlled copy. Any revision to a procedure must be noted on the form and must be approved by QA/QC before changes may be implemented. The revision form is kept in the laboratory SOP binder until the SOP is reviewed and revised. Once the next revision of the SOP becomes effective, the original revision form(s) are maintained with the master copy of the new version.

- 3) To ensure outdated information is not inadvertently used as a reference, an uncontrolled copy of any SOP is not allowed unless issued by QA/QC. Additionally, an electronic copy of any SOP becomes obsolete and must be deleted from a network drive or email once the effective version has been uploaded to LabWeb.

10.5.2 When documents are found to contain conflicting policies or procedures, the more recent document will be followed.

10.5.3 All controlled forms must be printed from LabWeb and may not be stored on a separate network drive. If photocopies are used then any unused copies of the expired version must be disposed of as soon as a new version is uploaded to LabWeb. This ensures that the effective version of any controlled form is in use at all times.

10.5.4 Any controlled SOP(s) issued to an employee must be collected upon resignation or termination.

10.5.5 Employees utilize an uncontrolled copy of the Ethics SOP or QAP for initial or continuing training purposes. All copies are collected following completion of the training session.

10.5.6 Only Document Control and QA/QC personnel are authorized to enter or edit data for a PCN.

10.5.7 The hard copy of each PCN report generated in LIMS is stored in a three-ring binder that is maintained by the Document Control department.

10.5.8 The original certificate of analysis for any stock material, if provided, is attached to the hard copy PCN report.

10.5.9 Accreditation certificates are scanned as a PDF to a designated network location. The original copy is maintained by Document Control. Certificates are also posted to ACZ's website.

10.5.10 Original calibration certificates and related documentation for support equipment (including but not limited to pipettes, thermometers, and glass micro liter syringes) are maintained by Document Control.

10.5.11 LIMS and other problems pertaining to IT are documented and managed by the electronic system called Issue Wizard. If an employee encounters a problem that requires attention, then that employee will submit a request through Issue Wizard. The request requires a priority to be assigned to the appropriate employee(s) for resolution. This system allows ACZ to track all changes made to computer systems. Reports are routinely generated to evaluate the status and eventual resolution of computer issues.

10.6 Records

10.6.1 Records include, but are not limited to: all logbooks; phone logs; raw data, derived data, and calibration data; training documentation (training forms, MDL studies, DOCs, etc.); proficiency testing results; calibration and certification records; internal audit reports; external audit reports; corrective action reports; management reports; and regulatory correspondence.

10.6.2 Records related to sample log-in are maintained as described in SOPAD016.

- 10.6.3 Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, dictated observations, and recorded data from automated instruments.
- 10.6.4 Original copies of records, except those pertaining to analytical data, are maintained by the QA/QC department or Document Control, and access is limited.
- 10.6.5 Relevant qualifications, training skills, and experience of technical personnel are maintained in the employee's training file.
- 10.6.6 Records such as transcripts, applications for employment, performance evaluations, etc. are maintained in the personnel files, which are stored in the secured office of the CFO.
- 10.6.7 The DOC certification statement (FRMAD023) and initial method training form (FRMQA004) are filed with the workgroup if the DOC was logged-in; otherwise, the training form is maintained in the employee's training file and the DOC form is filed with the data package.
- 10.6.8 Each employee's legal name, legal signature, and initials are documented on the New Employee Checklist (FRMAD043). The form is maintained in the employee's personnel file, which is stored in the Controller's office. A master signature/initial log is maintained for anyone employed at ACZ prior to the implementation of FRMAD043.
- 10.6.9 Each Organic Instrument ICAL data package is scanned to the designated network directory as a read-only PDF and the hard copy stored in labeled boxes. ICAL information that needs to be attached to any subsequent workgroup(s) must be printed from the PDF.
- 10.6.10 Logbooks must be maintained and controlled as described in SOPAD013.
- 10.6.11 Project Managers are responsible for maintaining all emails pertaining to a client and/or project. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043).
- 10.6.12 Procedural change(s) made to a SOP must be noted on the SOP Revision Form (FRMQA030) and approved by QA/QC prior to implementation. The date of the QA/QC approval denotes the effective date for the change.
- 10.6.13 Any correction to a hard copy record must be made by crossing through the error with a single line, and the correction must be clearly initialed and dated by the responsible staff. Erroneous entries cannot be destroyed by erasures, other markings or use of Whiteout®.
- 10.6.14 Changes to electronic records must be traceable to the individual who made the correction, and the reason for the change must be provided. Erroneous entries cannot be destroyed by methods such as overwritten files.
- 10.6.15 Record Storage and Retention
- 10.6.15.1 The minimum retention period of five (5) years may be increased dependent upon client request, regulatory requirement, or civil action order.

- 10.6.15.2 Records stored by a computer must have hard copy or write-protected backup copies.
- 10.6.15.3 Records stored only on electronic media must be supported by the hardware and software necessary for their retrieval and utilization in the proper format.
- 10.6.15.4 Records stored on electronic media must be stored in a way to provide protection from electronic or magnetic sources.
- 10.6.15.5 Scanned workgroups and client reports are backed up to an off-site data vault, which is secure, fireproof, and equipped with electronic data redundancy. Data backups occur daily (including Saturday and Sunday) after 12:00 am. After one year of storage off-site, data is transferred to a DVD, which is stored in a bank safety deposit box until all data on the DVD is at least five (5) years old. Obsolete DVDs are permanently destroyed.
- NOTE:** Data files that precede June 1, 2005 are stored to tape and/or DVD, which are kept in a bank safety deposit box.
- 10.6.15.6 If there is a change in ownership and/or a change in location, all records and documents will be made available to all accrediting authorities for five (5) years. Under no circumstances shall any records or documents be destroyed – all records and analyses performed that pertain to NELAC accreditation are subject to inspection by the NELAC accrediting authorities during this five (5) year period. A new owner of ACZ will assume possession of all records and documents.
- 10.6.15.7 If ACZ goes out of business, all records and documents will be stored and maintained according to protocol in a location to be determined at the time of closure. All records will be maintained for at least five (5) years and will be made available to all accrediting authorities.

10.6.16 Access to Archived Records

- 10.6.16.1 Access to archived information must be documented with an access log. A log is kept in each storage location, and any person entering a storage location must provide the required information in the log.
- 10.6.16.2 Hard copy records are stored in a locked environment with limited access. When a record is removed from its location, a “checkout card” must be filled out to indicate who removed the record, the date the record was taken, and a description of the record. The card marks the place in the storage box, and when the record is returned the card is pulled from the box.
- 10.6.16.3 Any changes to be made to archived data will require assistance from IT to do so.
- 10.6.16.4 Electronic data that has been archived to a more permanent media (such as tape, CD, or DVD) is stored in a bank safety deposit box. Access is limited and must be documented in the logbook maintained by Document Control.

10.6.17 Record Disposal

10.6.17.1 Records are disposed of in a manner to ensure client confidentiality.

10.6.17.2 Stored records will be reviewed to determine which ones can be destroyed. Any record older than five (5) years from the current date will be destroyed, unless client request, regulatory requirement, or civil action order dictates otherwise.

10.7 Computer Data and Records

10.7.1 Network File Server

Computer files pertaining to all aspects of ACZ's business are stored on a file/print server. To gain access, an employee logs on to the "LAB" domain. Each employee has a unique network user name so that security rules may be enforced. No "guest" logon is permitted. Every employee belongs to a specific "group" and directory security is enforced through privileges granted to these groups. Typically, an employee is granted access to files that pertain to their job functions; otherwise, read-only access or no access is granted.

Data generated and reported by ACZ is extremely confidential and the company may be liable for the consequences of the release of this data to any unauthorized person. The implementation of password security is not arbitrary and ensures data is protected and cannot be disclosed to outside parties. Weak, unchanging passwords make this scenario more likely.

In general, the network will prompt employees to change their password every 30 days. The password must be at least five (5) characters. Numeric characters are optional. Passwords may not be shared with other employees. The use of another employee's password (with the exception of common passwords for shared computers) is grounds for disciplinary action.

10.7.2 LIMS Server

- 1) Information stored on the LIMS server consists of all sample and client information needed for day-to-day production activities. The information is stored using an Oracle database application. Access is controlled through membership in "groups." Employees may update and change database records according to their job responsibilities. Otherwise, information is restricted to read-only access or no access.
- 2) No modifications to data can be made through applications not authorized by ACZ's IT department unless a CAR or Issue Wizard is submitted or documentation is provided on the hardcopy of the workgroup. Unauthorized applications include Attached Tables.
- 3) All tables that track changes (TrackInvoice, TrackWorkgroup, etc.) will be audited on a regular basis by a member of the IT department to ensure sufficient information is being supplied as to why changes occur. The explanations must be professional and specific.

10.7.3 Docs Server

Access to the docs server is read-only and is permitted through Internet Information Services (IIS) authentication and is logged in IIS log files. The server is updated on a regular basis by automated scripts.

11 ELEMENTS OF QUALITY CONTROL

A critical focus of ACZ's quality control policies and protocols involves monitoring sample preparation and measurement processes to determine matrix effects and to evaluate laboratory performance. Quality control samples are typically analyzed with every batch of environmental samples. Each test SOP provides detailed information regarding quality control sample types, acceptance criteria, and corrective actions, if applicable to the procedure, and reflects the requirements of the method and/or other regulatory authorities.

Performance control samples demonstrate precision or accuracy and expose out-of-control events. Matrix-specific control samples indicate possible effects of the matrix on method performance and may also identify data as in-control or out-of-control. Data that is out-of-control dictates corrective action ranging from re-extraction / re-analysis to reporting data with qualifiers. In general, the corrective action specified in the SOP must be performed if any quality control sample does not meet the acceptance criteria. Data associated with failed quality control cannot be qualified after the initial analysis without acceptable justification.

To the extent possible, client samples are reported only if all quality control measures are acceptable. If any measure is outside of the acceptance criteria, and the data will be accepted and reported to the client, then the appropriate data qualifier(s) must be assigned to all associated samples. The list of current extended qualifiers is maintained in the LIMS database.

11.1 Method Performance

11.1.1 Negative Control – Prep Blank (Method Blank)

The prep blank is used to assess possible contamination introduced during sample processing steps. A prep blank is prepared using Type I water or other similar matrix similar that is free of the target analyte(s) and contains all reagents in the same volumes used to prepare the client samples. The prep blank must be prepared, processed and analyzed in the same manner as the associated client samples. Unless specified in the test SOP, sample concentration may not be corrected for the prep blank value.

While the goal is to have no detectable contaminants, each prep blank must be carefully evaluated as to the nature of the interference and the effect on the analysis of each sample in the batch. Contamination in the prep blank results from four principle sources: the environment the analysis is performed in; the reagents used; the supplies and apparatus used; and the analyst performing the analysis. Contamination sources vary and the test SOP must be referenced to determine the appropriate corrective action(s).

When contamination is suspected, the source(s) must be investigated and measures taken to correct, minimize or eliminate the problem, and associated client samples must be reprocessed and reanalyzed. Alternatively, report data with the appropriate qualifier if reprocessing and reanalysis is not possible or if one of the following criteria applies:

- i) The concentration of a target analyte in the blank is at or above the acceptance limit and the measured concentration of the analyte in an associated sample is greater than 10 times the measured concentration of analyte in the blank.
- ii) The concentration of a target analyte in any associated sample is less than the MDL.
- iii) Corrective actions could not be performed or are ineffective. Thoroughly document any corrective action taken and the outcome.

11.1.2 Positive Control

11.1.2.1 Laboratory Fortified Blank (LFB)

An LFB is required for methods that do not include a Laboratory Control Sample but include a fortified matrix (spike). The LFB is an aliquot of reagent water to which a known quantity of each target analyte is added. It is treated exactly like a client sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. When the acceptance criteria for the LFB are exceeded (i.e. high bias) then any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualification.

11.1.2.2 Laboratory Control Sample [LCSW (Water) or LCSS (Soil)]

The performance of both sample preparation and analysis of each sample batch may be monitored by an LCS. The LCS is a matrix-specific standard (whenever possible) of known analyte concentration(s) that may be prepared by the laboratory or purchased pre-made. The LCS must be carried through the entire preparation and analytical schemes with the client samples. Analysis and evaluation of the LCS allows for confirmation of the applicability of the preparation procedure to the analytes. Evaluate data using the following guidelines:

- 1) When only an LCSW is analyzed, the results must be within the acceptance limits or the entire batch of samples must be re-prepped and retested.
- 2) An LCSW duplicate (LCSWD) may be prepared and analyzed with the batch, typically in lieu of a matrix duplicate or spike duplicate. Data is acceptable if the LCSW and/or LCSWD is within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if either of the following occurs:
 - LCSW/D RPD fails the acceptance criteria specified in the SOP.
 - % R of both the LCSW and LCSWD is outside the acceptance limits.
- 3) For a solid or semi-solid matrix, an LCSS and LCSSD are prepared and analyzed.³ The data is acceptable if the LCSS and/or LCSSD is within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if any of the following occurs:
 - LCSS/D RPD fails the acceptance criteria specified in the SOP.
 - % R of both the LCSS and LCSSD is outside the acceptance limits.
 - MS/D RPD fails the acceptance criteria specified in the SOP (if applicable).
- 4) When the acceptance criteria for the LCS are exceeded [i.e. high bias] then any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualifier.
- 5) Refer to section 11.1.3.3 for additional information regarding data assessment for solid-matrix workgroups prepared with both LCSS/LCSSD and MS/MSD.

³ Corrective action for Recommendation #5 cited in the 2002 ADHS audit report.

11.1.2.3 Radiological Tracers

Radiological tracers are used for Thorium and Uranium analyses. The tracer reacts in the same manner as the target isotope and is used to assess analyte recovery. The tracer is added to client samples, controls, and blanks in accordance with the requirements stipulated in the test SOP. Because the tracer recovery has a direct impact on the LLD, the recovery must be high enough to yield LLDs that are within the scope of the project or meet ACZ's acceptance criteria. Refer to the test SOP for evaluation criteria and corrective action(s) for out-of-control tracer recovery.

11.1.3 Sample Specific Controls

The effect of different sample matrices on the performance of any method can be profound; therefore, matrix spikes, duplicates, and surrogate compounds are analyzed to evaluate matrix effects on data quality. Each SOP includes specific information regarding the usage and evaluation of matrix-specific QC samples and also states the required corrective action to take if any matrix QC fails.

ACZ provides analytical services to numerous and varied clients; therefore, the possibility of routinely favoring one client is highly unlikely. Over the course of time, no single matrix type will always be spiked or duplicated, and no one client will be selected for a high percentage of spiked or duplicated samples. If either of these occurs, it is due entirely to chance. Samples are selected for a workgroup by due date or priority – not by client – and are presented in the workgroup in increasing numerical order according to project number. A client's samples will be grouped together within the batch – in this way, a single client cannot be selected for a spike or duplicate, unless all of the client samples in the batch are from the same project. ACZ recommends that the analyst, to the extent possible, select samples to spike or duplicate that are representative of the workgroup. Analysts are not to associate QC with a client sample known to be or believed to be any type of blank or Proficiency Testing sample. Several exceptions exist for selecting samples for spiking or duplicating:

- 1) A sample is not spiked or duplicated if the volume is inadequate, and the client sample and QC sample(s) would require dilution; however, if no other option is available then the client sample and QC sample should be prepared and analyzed on the same dilution whenever possible.
- 2) Use the same weights (or as similar as possible) to prepare duplicates of solid matrix samples.
- 3) A client may request that one or more of their samples be spiked or duplicated. A "RUN QC" comment is added when the sample is logged in to notify the analyst that QC must be performed for a specific sample or project. If a client requests that their sample(s) be spiked or duplicated then ACZ is obliged to accommodate the client.
- 4) If TDS data indicates a sample would require dilution, then the sample should not be selected for spiking. Performing dilutions increases the likelihood of introducing error due to pipetting, and it is possible that spike recoveries may be incorrectly influenced by this error. A high TDS value will not influence whether or not a sample is duplicated.
- 5) A reactive sample is unpredictable and is a poor choice for spiking or duplicating.
- 6) A PT sample is not a real-world sample and is a poor choice for spiking or duplicating, because the data does not provide any useful information about possible matrix effects. Spike or duplicate a PT sample only when there are no client samples in the workgroup.

11.1.3.1 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but are not normally found in environmental samples. Surrogates are included in the scope of Organic methods and are used to evaluate accuracy, method performance and extraction efficiency and shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

Whenever a surrogate recovery is outside the acceptance limits, the corrective action(s) stated in the test SOP must be performed. If corrective actions could not be performed or are ineffective, then the appropriate qualifier is applied to the sample results and reported to the client.

11.1.3.2 Matrix Spike Samples

A matrix spike sample (however named) is used to determine the level of bias (accuracy) associated with a particular matrix. For the purposes of this document, “MS” designates a matrix spike, and “MSD” designates a matrix spike duplicate. Spikes are prepared by adding a known and appropriate quantity of each target analyte to a replicate aliquot of client sample.

The required analytical frequency is specified by the method or other regulating entity and is indicated in the test SOP. Each result is evaluated against the acceptance criteria, and matrix effects are determined and reported to the client. The following evaluation criteria apply to spikes that are subjected to processing steps and post-digestion spikes (analytical spikes).

- Percent Recovery (%R) is considered for all spikes.
- %R is evaluated only if the theoretical concentration in the spiked aliquot is greater than or equal to the reporting limit; otherwise, each associated client sample must be reported with the appropriate qualifier, regardless of %R.
- If %R for the MS and/or the MSD is outside of the acceptance limits, the RPD passes, and all other pertinent prep and instrument QC passes, then each associated client sample may be accepted and reported with the appropriate qualification.

11.1.3.3 Matrix Duplicates and Matrix Spike Duplicates

The matrix-specific precision associated with an analysis is determined through the use of a matrix duplicate (DUP) or spike duplicate (MSD), which are performed at a frequency specified by the method or other regulating entity (refer to the specific test SOP). The results are evaluated, and the matrix effect on precision are determined and reported to the client.

- Relative Percent Difference (RPD) is considered for all duplicates except non-drinking water samples for radiochemical analyses (see 12.4.4).
- RPD for a spike duplicate is evaluated only if the observed concentration is greater than or equal to the reporting limit; otherwise each associated client sample must be reported with the appropriate qualifier.

- RPD for a matrix duplicate is evaluated only if the observed concentration is greater than 10 times the MDL; otherwise each associated client sample must be reported with the appropriate qualifier, regardless of RPD.
- In the absence of other contributing factors, a DUP failure for a solid or semi-solid matrix is attributed to non-homogeneity of the sample, and each associated client sample may be reported with the appropriate qualifier.
- For an aqueous matrix, if the DUP fails then all associated samples and the DUP must be retested. If permitted by the instrument software the sample and DUP can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.
- For an aqueous matrix, if the MS/MSD RPD fails then the associated samples must be reanalyzed. If permitted by the instrument software the sample and MS/MSD can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.
- If applicable, evaluate the LCS/LCSD if the RPD fails for a matrix duplicate or spike duplicate. Each associated client sample may be reported with the appropriate qualifier if the LCS/LCSD meets the criteria stated in 11.1.2.2.
- For a solid or semi-solid matrix, if both the LCSS and LCSSD recoveries pass but the RPD fails, then acceptable precision may be demonstrated by a passing RPD for the MS/MSD, and each associated client sample may be reported with the appropriate qualifier.

11.2 Instrument Specific Controls

All data must be associated with a passing instrument calibration and initial calibration verification. To the extent possible, all data must be associated with passing continuing calibration verification. If the initial calibration verification results (ICV/ICB) are outside of the acceptance criteria, then the source(s) of the failure must be identified, corrective action(s) performed if necessary, and the instrument recalibrated before proceeding with sample analysis.

If the continuing calibration verification results (CCV/CCB) do not meet the acceptance criteria then the source(s) of the failure must be identified and corrective action(s) performed, including recalibration if necessary, before continuing with sample analysis. If reanalysis of any sample(s) associated with failing calibration verification is not possible then the associated data must be reported with the appropriate qualification.

For instruments that permit the analysis of subsequent workgroups using the most recent calibration, two (2) consecutive attempts of the opening CCV/CCB are allowed. If both attempts fail to produce acceptable results then the source(s) of the failure must be identified and corrective action(s) performed, including recalibration if necessary, before commencing sample analysis.

Unless stated otherwise by the test SOP, passing calibration verification must always bracket all batch quality control samples, and results for additional instrument check standards, if applicable, must be within the acceptance criteria stated in the SOP. However, when the acceptance criteria for a CCV or CCB are exceeded (i.e. high bias) any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualification.

11.3 Other Control Indicators

11.3.1 Internal Standards

Internal Standards (IS) are measured amounts of certain compounds added after preparation or extraction of a sample to be analyzed by GC/MS or ICPMS. The IS is an analyte not likely to be found in the environment and is used in a calibration method to correct sample results affected by column injection losses, purging losses or viscosity effects. The IS is added to client samples, controls and blanks in accordance with the method requirements. When the results are outside of the acceptance limits for applicable quality control samples, corrective actions shall be performed. Once system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed. If corrective actions could not be performed or are ineffective then the data for each client sample must be appropriately qualified on the final report.

11.3.2 Trip Blank

The trip blank is a sample container filled in the laboratory with Type I water that is shipped to the collection site in the sample cooler, returned to the laboratory, logged-in, and analyzed in the same manner as the client samples. With the exception of Hg-1631, trip blanks are not opened in the field. If a target analyte is detected in the trip blank then the appropriate data qualifier is applied to pertinent results from those samples returned to ACZ in the same cooler as the trip blank. Trip blanks are typically prepared for Hg-1631, Cyanide, and VOA samples.

11.3.3 Instrument Blank

The instrument blank is an aliquot of Type I water processed only through the instrument steps of sample analysis and is used to determine presence of instrument contamination. For Organic instrument methods, neither surrogate nor IS standards are added.

11.3.4 Equipment Blank

An equipment blank is provided by the client and is used to assess the effectiveness of equipment decontamination procedures. Type I water is poured into (or over) or pumped through the sampling device, collected in a sample container and transported to the lab to be analyzed for all parameters requested for the environmental samples collected at the site. If any target analyte is detected then all associated sample results must be qualified on the final report.

11.3.5 Ambient Blank

The ambient blank consists of Type I water poured into a VOA vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared when samples are to be analyzed for VOA analytes and are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. The frequency of collection for ambient blanks is specified in the client's field-sampling plan and are not required for all projects.

12 EVALUATING QUALITY CONTROL SAMPLES

In general, acceptance criteria for quality control samples are method-specific; however, requirements of clients and regulatory or other accrediting agencies must also be included. Immediate corrective action must be taken if any quality control is outside of the acceptance criteria. Appropriate corrective actions are described in the test SOP. To the extent possible, client samples are reported only if all quality control measurements are acceptable. If a quality control measure is outside of acceptance criteria, and the data must be reported, then all samples associated with the failed QC must be reported to the client with the appropriate data qualifier(s). Clients will occasionally request limits different from those in a published method. If a client has data quality objectives that require modification of our guidelines then we may deviate from those guidelines only if more stringent controls are requested. ACZ's policy is to adhere to the strictest limits as a means of meeting all agency and client requirements.

For methods that do not specify acceptance criteria for any type of quality control measurement, limits may be generated by plotting historical data in a control chart once a minimum of 20 data points is available. A control chart application may be accessed through LIMS and allows the user to create limits, either from a specified number of data points or for a specific time period, that are set at ± 3 times the standard deviation from the mean percent recovery. Current control limits are also plotted to provide a direct comparison of the two sets of data. New limits developed from a control chart must be documented on FRMQA039 and must be reviewed by the QA/QC department prior to implementation. If the new limits are approved, then QA/QC personnel will update LIMS. Refer to ACZ's SOP *Control Charting Application and Procedure* (SOPAD041) for further details. Default acceptance criteria established by the Arizona Department of Health Services (ADHS) may be used in lieu of generating a control chart to establish limits; however the SOP must specify which limits are in use.⁴ **NOTE:** For all data evaluation, final results ending with 1 – 4 are rounded down and results ending with 5 – 9 are rounded up.

12.1 Accuracy

Accuracy is defined as "the degree of agreement of a measured value with the true or expected value of the quantity of concern."^{*} Control samples (LCS or LFB) and spiked samples are analyzed with every batch of samples or as stipulated by the specific test SOP to assess accuracy and matrix effects.

- Percent Recovery (%R) for a control sample is calculated as follows:

$$\%R = \frac{M}{S_p} \times 100 \quad \text{Where: } M = \text{Measured concentration of the control sample}$$
$$S_p = \text{True value of the control sample}$$

- Percent Recovery (%R) for a spike is calculated as follows:

$$\%R = \frac{M - S}{S_p} \times 100 \quad \text{Where: } M = \text{Measured concentration of the spiked sample}$$
$$S = \text{Measured concentration of the sample aliquot}$$
$$S_p = \text{True value of the spike concentration}$$

⁴ ADHS Information Update #87 (issued July 7, 2005)

* "Quality Assurance of Chemical Measurements," Taylor, J., 1987

12.2 Precision

Precision is defined as “the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions.” Matrix duplicates and spike duplicates are analyzed with every batch of samples or as stipulated by the test SOP to determine the precision associated with the analysis. If any method does not specify acceptance criteria for the RPD, then default criteria of $RPD \leq 20$ is used (a value that rounds to 20 is acceptable).⁵ The Relative Percent Difference (RPD) as an absolute value is calculated as follows:

$$|RPD| = \frac{(S - D)}{[(S + D) / 2]} \times 100 \quad \text{Where: } S = \text{Sample Value} \\ D = \text{Duplicate Value}$$

12.3 Other Calculations

- Solids Dilution Factor (assume 100% solid for “as received” samples):

$$\text{Dilution Factor} = \frac{V}{(W)(\% \text{ solid})} \quad \text{Where: } V = \text{Final digestate volume, in mL} \\ W = \text{Sample weight used, in g} \\ \% \text{solid} = \% \text{solid or air dry solid, as a decimal}$$

- Sample Concentration for Solids:

- wet weight [biota tissue, fruit or vegetable matter, etc.]: $\text{mg/Kg} = \frac{DF * C * V}{W}$

- dry weight [plant matter, grasses, soil, sludge, etc.]: $\text{mg/Kg} = SF * C * DF$

Where: DF = instrument dilution factor
C = raw data value, in mg/L
V = Final volume of digestate, in L
W = sample weight used, in Kg
SF = soil dilution factor

- Percent Difference for Serial Dilution (SDL):

$$|\%D| = \frac{[I - (s * 5)]}{I} \times 100$$

Where: I = initial sample result
s = serial dilution result (raw data value)

For SDL calculations in LIMS, “s” is multiplied by 5 and the resulting “reg value” is compared to the “found value” to calculate %D.

⁵ ADHS Information Update #87 (issued July 7, 2005)

12.4 Radiochemistry Calculations

12.4.1 Activity

The results of radioactivity are typically reported in terms of activity per unit volume or mass. Units are normally expressed in picocuries (pCi), which equal 2.22 disintegrations per minute (dpm). Specific formulas to determine activity are in the SOP for each method. The general formula is as follows:

$$C = \frac{R_{net}}{(e)(y)(i)(v)(u)}$$

Where: C = activity per unit volume (pCi/L)
 R_{net} = net counts per minute
 e = counting efficiency, cpm/dpm
 y = chemical yield
 i = ingrowth correction factor
 v = volume or mass being counted (L)
 u = units correction factor, 2.22 for cpm to pCi

12.4.2 Counting Error

Radiochemical data are considered incomplete without reporting associated random and systematic errors. For this reason all radiochemical results should be accompanied by a counting error at the 95% confidence level (1.96*standard deviation). The general counting error formula is as follows:

$$E = \frac{1.96(R_o / t_1 + B / t_2)^{1/2}}{(e)(y)(i)(v)(u)}$$

Where: E = counting error
 R_o = gross sample, cpm
 t_1 = sample count duration, min
 B = background, cpm
 t_2 = background count duration, min
 $e, y, i, v,$ and u are as previously defined.

12.4.3 Lower Limit of Detection (LLD)

LLD (also referred to as Minimum Detectable Activity or MDA) is considered the smallest quantity of sample radioactivity that will yield a net count for which there is a pre-determined level of confidence that radioactivity is present. At the 95% confidence level, the following equation calculates the LLD for any single nuclide. The calculation uses the standard deviation for the background counting rate, assuming the sample and background counting rates should be very similar at the LLD. The formula for determining LLD is as follows:

$$LLD_{95} = \frac{4.66S_b}{(e)(y)(i)(v)}$$

Where : LLD_{95} = Lower limit of detection at the 95% confidence interval
 S_b = Standard deviation of the instrument background counting rate, cpm
 e , y , i , v , and u are as previously defined

12.4.4 Precision

The normalized absolute difference, or Replicate Error Ratio (RER), between the sample and the laboratory duplicate, given by the following equation shall be used to determine that results do not differ significantly when compared to their respective 2* sigma uncertainty.

$$RER = \frac{|Sx - Dup|}{\sqrt{(Sx_{error})^2 + \sqrt{+(Dup_{error})^2}}}$$

Where: Sx = sample concentration in pCi/L
 Sx_{error} = sample counting error (in pCi/L) at the 95% confidence level.
 Dup = duplicate concentration in pCi/L
 Dup_{error} = duplicate counting error (in pCi/L) at the 95% confidence level.

NOTE: For Radchem Drinking Water samples, both RPD and RER are used to evaluate precision. For non-Drinking Water samples, only RER is used; however, data for both RER and RPD are uploaded to LIMS for all analyses. Use the following guidelines to correctly assess precision. Further details are provided in ACZ's Wiki and must be consulted to ensure data for each workgroup is correctly evaluated. Go to LabWeb \ Wiki \ Analytical Departments \ Radio Chemistry.

Drinking Water:

RPD \leq 20, RER $<$ 2.0 – Precision is judged to be in control
RPD \leq 20, RER $>$ 2.0 – Precision is judged to be in control; case narrative required for RER
RPD $>$ 20, [sx] $<$ 5x [LLD], RER $<$ 2.0 – Precision is judged to be in control; qualify data.
RPD $>$ 20, [sx] $>$ 5x [LLD], RER $>$ 2.0 – Precision of the prep batch is questionable.
RPD $>$ 20, [sx] $>$ 5x [LLD], RER $<$ 2.0 – Precision of the prep batch is questionable.

Non-Drinking Water:

RER $<$ 2.0, RPD \leq 20 – Precision is judged to be in control.
RER $<$ 2.0, RPD $>$ 20 – Precision is judged to be in control; RPD must be qualified.
RER $>$ 2.0, RPD \leq 20 – Precision of the sample prep batch is questionable.
RER $>$ 2.0, RPD $>$ 20 – Precision of the sample prep batch is questionable.

13 VALIDATION & REVIEW OF ANALYTICAL DATA

ACZ has the responsibility to always provide the best data possible to ensure our clients can make sound and cost-effective decisions regarding public health and the environment. In order to generate and report reliable data, the analytical systems used need to be properly functioning, and the review process must be conducted in a manner that is logical and reasonable and would be defensible if subjected to legal scrutiny. Decisions regarding data quality must be meaningful and must be backed by good science and sound professional judgments.

The entire validation and review process encompasses more than solely evaluating the final results for client and quality control samples. To this extent, the necessary steps must also be performed *prior* to sample preparation or analysis to ensure the quality of the data. Following sample analysis, data is uploaded to the LIMS database and then submitted to a variety of process chains such as calculations, rounding, application of qualifiers, etc. A multi-level data review process is utilized to verify the uploaded analytical data meets all documented ACZ requirements as well as any client-specific quality objectives. For additional details of the data reduction, review, and validation process, refer to ACZ's *SOP Data Review Process* (SOPAD032). At a minimum, the validation process must include the following steps, as applicable:

- Monitor the expiration dates for all stock, intermediate, and working standards, reagents, and chemicals.
- Prior to analysis, determine that holding times have not been exceeded. Unless otherwise specified by the test SOP, sample preparation and analysis must be completed within the holding time.
- Prior to analyzing samples, verify the correct set-up and operation of the instrument or equipment. Perform calibration, maintenance, and optimization as necessary to ensure proper functioning.
- In general, for QC frequency of 1 per 10 or less client samples, the first set of QC is associated with samples 1 – 10. If there are fewer than 20 samples in the workgroup, then the remaining client samples are associated with the second set of QC.
- Before completing workgroup creation, verify the correct PCNs and/or SCNs have been entered. Percent recovery for control samples and spikes is calculated using the information in LIMS for each.
- Verify the proper sub-sample (green dot, yellow dot, etc.) is being used for preparation or analysis.
 - Notify the supervisor or Production Manager as soon as possible if a sample cannot be located.
 - Document on the bench sheet if a sub-sample other than the type indicated in the SOP is used.
- Compare the Log-In number on the sample container to the Log-In number on the bench sheet and make a visible mark next to each sample on the workgroup to indicate the check has been performed.
- Clearly label tubes, beakers, autosampler cups, etc. to identify the sample (and dilution factor, if applicable).
- Manage sample volume to ensure all analyses from a bottle type can be completed.
- Document all dilution factors on the bench sheet at the time the dilution is performed.
- Record complete and accurate observations, as necessary, when an analysis, sample preparation, or sample matrix is unusual or problematic.

- Ensure transcription errors do not occur. Verify all data manually entered into LIMS is correct before completing the upload process.
- The calibration workgroup must be associated with all subsequent workgroups. Record the calibration workgroup number (or calibration file name) on the data review checklist.
- Provide complete traceability for all standards and reagents used for sample preparation and analysis.
- Quality control samples must be treated in the same manner as client sample, including preparation.
- If it is necessary to perform a calculation manually, use the values in the raw data [do not truncate] and then round the final result to no more than three (3) significant figures. If the final result passes the acceptance criteria then pass the QC in LIMS and note on the data review checklist that it passes.
- LIMS performs several additional QC calculations on the approved data including cation/anion balance (CAB) checks, calculated TDS versus actual TDS ratios, and Total versus Dissolved ratios. The Project Manager may update the status of the pertinent sample(s) to REDO if one of these calculations indicates a discrepancy with the associated data.
- If two attempts fail to produce acceptable data then notify the supervisor or Production Manager before taking further action. It may be necessary to first determine if a larger problem is interfering with the analysis. Investigate the problem before qualifying the associated data.
- If there is an indication that the analytical system is out of control then the issue(s) must be investigated. Notify the supervisor immediately. Conduct troubleshooting in an organized manner.
- All data must be reviewed initially in LIMS [AREV] by the analyst who performed the analysis or by another qualified individual who has previously been granted approval. The department supervisor or another qualified individual performs the secondary review [SREV]. The following are data review guidelines:
 - 1) A data review checklist must be completed during the review process. Verify all items listed and note any errors, problems or non-compliances and the corrective action(s) taken.
 - 2) If applicable, review the raw data to verify the analytical system was in control and to ensure no anomalies exist. Check for notes on the bench sheet regarding the preparation or analysis.
 - 3) For client samples and quality control samples, ensure all results are within the measurement range and are bracketed by a passing calibration and passing calibration verification [ICV/ICB or CCV/CCB]. Sample values outside of the measurement range must be appropriately qualified if reanalysis is not possible.
 - 4) The corrective action specified in the SOP must be performed if any quality control sample does not meet the acceptance criteria. Data associated with failed quality control cannot be qualified after the initial analysis without acceptable justification.
 - 5) Data is more acceptable if the preparation and analysis was performed within the holding time. If reprep or reanalysis will be conducted outside of the holding time, check first with the supervisor.

- 6) Confirm all dilutions are appropriate. A reasonable explanation must be provided on the bench sheet if a sample was diluted and the value is less than the reporting limit (refer also to section 15).
- 7) If the initial analysis indicates possible positive or negative matrix interference then the sample(s) should be retested on dilution to confirm. The sample needs to be retested only one time – if a background effect is still evident, then note the event on the data review checklist and qualify the associated data.
- 8) If a spike fails, determine if the sample concentration is disproportionate to the spike added. If the analyte concentration in the sample is $> 4x$ the spike added then note the failure on the checklist and appropriately qualify the associated samples.
- 9) If a spike recovery indicates the sample was not spiked, then re-prep / retest all associated samples.
- 10) Each associated client sample must be appropriately qualified if the matrix spike, matrix duplicate or spike duplicate data cannot be used for validation purposes.
- 11) Confirm failed QC by verifying the correct PCN or SCN was entered. Make corrections if necessary before proceeding with data review.
- 12) Verify all assigned qualifiers are appropriate. Does use of a particular qualifier make sense ? Could data be defended using the qualifier(s) assigned to the scenario or problem ?
- 13) If a case narrative is necessary, the reason for accepting and reporting the data must be sound and logical. Provide sufficient and accurate verbiage to ensure the data is legally defensible.
- 14) If a sample was retested in the same workgroup, verify the correct data will be reported. All other data for the sample must be failed – LIMS cannot report multiple data for the same sample.
- 15) Confirm all samples have the correct status (PASS, FAIL, REDO, REDX) before completing the review process. For multi-parameter workgroups, all analytes must have the correct status.
- 16) Refer also to section 11.0 for data evaluation criteria.

14 DETECTION LEVELS

Current practice identifies several detection levels, each of which has a defined purpose: Instrument Detection Limit (IDL), Method Detection Limit (MDL), and Reporting Limit (RL) or Practical Quantitation Limit (PQL). The MDL and RL (or PQL) are stated in each test SOP and are adjusted accordingly in LIMS when data is uploaded to reflect the use of smaller sample volume (dilution) or larger sample volume (concentration).

14.1 Instrument Detection Limit (IDL)

The IDL is the concentration of substance that produces a signal greater than three standard deviations of the mean noise level or the concentration that can be determined by injecting a standard to produce a signal that is five times the signal-to-noise ratio. The IDL should always be below the MDL and is not used for compliance reporting, but is useful for estimating the amount of analyte needed to produce a signal in order to calculate an estimated method detection level and for comparing the attributes of different instruments.

14.2 Method Detection Limit (MDL)

The EPA defines the MDL as the “minimum concentration of substance that can be measured by a specific testing protocol and reported with 99% confidence that the analyte concentration is greater than zero...” This confidence interval means that any substance detected at a concentration equal to the MDL is 99% likely to be present, but it also means there is a 1% chance that the substance will be considered falsely present (false positive). The MDL procedure is designed so that the probabilities of both false positive and false negative errors are acceptably small; however, the procedure has limitations. Data users must understand the limitations when evaluating low level data and must proceed with caution when interpreting data reported between the MDL and RL in order to minimize the risk of making poor environmental decisions.

MDLs are dependent on variables (temperature, instrument conditions, analysts, matrix, etc.) and are typically determined by processing, preferably over the course of several days, at least seven individual replicates of a fortified blank sample through the method’s preparation and analytical schemes. MDLs determined for the same method / matrix / technology must be compared to ensure they are in agreement.

ACZ maintains a current MDL for each method. Unless specified by a method or to meet the needs of a special project or client request, a MDL is considered current if no changes have been made to (1) extraction or analytical procedure, (2) type of column used, if applicable, (3) instrument location, (4) instrument sensitivity (i.e. no major repairs or extensive servicing), and (5) other modifications of this type. A qualitative verification of the MDL must be performed annually for each applicable method, analyte, instrument, and matrix and before a new instrument or method is utilized for client samples. Refer to ACZ’s SOP *Demonstration of Capability & Method Detection Limit Studies* (SOPAD001) for additional information.

14.3 Practical Quantitation Limit (PQL) / Reporting Limit (RL)

At the MDL, data is not quantifiable, and the uncertainty is $\pm 100\%$ (or \pm MDL). The PQL (RL) represents the lowest quantitative level that can be achieved with good certainty during routine operations. Because data reported at or above the PQL is reproducible, the client or other end user will be assured that the result is valid and independent of variable analytical conditions. This reproducibility allows for comparison of analytical results over a relatively long period of time, which is important to the monitoring of environmental data. ACZ defines the PQL as a value typically 2 – 10 times the MDL. Reported values less than the PQL are qualified as estimated. The region between the MDL and PQL is a continuum of uncertainty, lacking distinct cutoff points, and the error below the PQL is increased to the extent that the statistical validity of the result is questionable.

15 SAMPLE DILUTIONS

Sample dilution may be necessary for one or more of the following reasons: (1) sample concentration exceeds the established measurement range of the procedure / method (2) sample volume or material is limited (3) matrix interference is indicated or suspected (4) sample matrix is reactive (5) aqueous sample contains high sediment (6) color, odor or other physical characteristics are present (7) For ICP and ICPMS, TDS is greater than 2000 mg/L. In all cases, the analyst must use good professional judgment when determining the most appropriate dilution. Whenever possible, analyze a client sample and its associated matrix spike(s) and/or matrix duplicate on the same dilution. If circumstances prohibit retesting, including reanalysis that would occur past the holding time, then the data must be reported with the appropriate qualifier(s).

For samples that contain high concentration of analyte(s), the analyst will use their knowledge of the measurement range of the procedure to determine an optimal dilution that yields quantifiable data with minimal error propagation. In general, prepare the dilution so the final concentration is near the mid-point of the measurement range. A sample must be retested on a smaller dilution if analyte concentration is less than the reporting limit – exceptions must be explained on the bench sheet. For multi-parameter analyses, it may not be possible to report all analytes within the desired range, and the analyst must use their best judgment when determining a reasonable dilution factor.

The following requirements pertain to all dilutions:

- Document all dilution factors on the bench sheet when the dilution is performed
- Assign the appropriate “D” qualifier if data for the diluted sample is less than the reporting limit
- Retest sample on smaller dilution if the result is less than the reporting limit (or document justification for accepting the data on the bench sheet or data review checklist)
- Document the reason for any dilution on the bench sheet [not required for sample values that exceed the measurement range of the procedure]
- Provide accurate documentation for the benefit of preparation of a case narrative, data validation, review by a regulatory agency or other third party, and reconstruction of the sample’s history

16 ERROR CORRECTION PROTOCOL

When an error occurs in any type of record it must be crossed out with a **single line**, not erased, deleted, obliterated, or made illegible, and the correct value entered alongside. All changes to hard copy records must be initialed and dated by the person making the correction. Under no circumstances may White-Out® or any other substance be used to conceal data. Concealing or improperly altering data is fraudulent and may be cause for termination from ACZ. Equivalent measures must be taken to avoid loss or change of original data in the case of records stored electronically. Refer to section 10 for details of corrections made to electronic records. The following is an example of proper error correction:

fleece BWC 10-20-06

Mary had a little lamb, it's ~~feet~~ as white as snow. And everywhere that ~~Lary~~ went, the lamb was sure to go.

Mary BWC 10-20-06

17 COMPUTER / AUTOMATED PROCESSES

ACZ employs its proprietary LIMS2000 (Laboratory Information Management System) to acquire, record, process, store and archive our data. It is the primary application for all employees and encompasses the combination of hardware and software throughout the entire facility to provide the interface for tasks such as creating workgroups, reviewing data, and generating client reports. ACZ implements the defined standards of Good Automated Laboratory Practices (GALP) to establish a uniform set of procedures to assure that all LIMS data used by our clients are reliable, credible, and legally defensible.

17.1 Software

The software used to achieve GALP goals is a combination of industry standard commercial software and internally developed applications. Commercial software is purchased through professional and well-developed companies such as Oracle, Microsoft and Lab Vantage Systems that complete sufficient testing and quality control to assure their product(s) functions properly. Internal applications undergo testing before being implemented and distributed throughout the laboratory.

Instrument data is automatically backed up anytime a file is saved through a client-server process running on most instrument PCs. This ability allows ACZ to see any version of a file created or modified during data processing. Electronic records are protected, backed up and archived to prevent unauthorized access or amendment. Refer to section 10.0 of this document and ACZ's SOP *Backup and Archive of Instrument Data Files* (SOPAD044) for details.

17.2 Hardware

ACZ deploys many application servers using industry standard architecture. All critical servers are redundant so that one hardware failure will not cause a system failure. All servers run standard enterprise operating systems such as Microsoft Windows 2000 and SuSE Linux for file and print services, intranet, web hosting, several databases and the phone system. All servers are routinely backed up to tape to maintain a complete historical record of all data generated.

To the extent possible, instrument PCs comply with at least the recommendations of the instrument manufacturer and are connected to ACZ's network allowing transparent backup and access to computers by system administrators. On most instrument computers, a "bare metal" restore of the computer can be done for a minimum of down time in the event of a hardware failure.

17.3 Security

GALP security is controlled through a set of passwords. A log-in name and password are required to access the ACZ's network. User passwords must be at least five characters and must be changed when the user is prompted. Each user has a given set of network rights and is restricted to software necessary to complete their job functions as well as his/her own documents. Refer also to section 10.7.1 for additional information.

A very secure firewall protects the network from the outside world, or, Internet. The only traffic permitted access to the internal network is e-mail and World Wide Web access. Incoming and outgoing E-mail is scanned for viruses, then scanned for inappropriate content and quarantined if necessary. All web traffic that is potentially harmful is blocked by a scanning application running on a proxy server.

18 CLIENT SERVICES

18.1 Subcontracting

ACZ utilizes subcontract labs to perform analyses for various reasons. A subcontracted lab must, at a minimum, adhere to the same quality assurance standards implemented by ACZ and must be NELAC certified for the subcontracted analysis. When applicable, ACZ advises its clients in writing of its intentions to subcontract any portion of the testing to another party. Non-NELAC work performed by a subcontracted lab must be clearly identified in the subcontract lab's report. ACZ scans this report as an attachment to be included as part of ACZ's final report. A comment is added to ACZ's final report indicating which subcontracted laboratory performed the analyses. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

18.2 Data Reporting

Once all analyses and the entire review process have been completed, a client report is generated and submitted for final validation by the Project Manager. If necessary, a case narrative is written describing the details of the project and any non-conformances or other relevant issues. The PM electronically signs the report, and the Document Control department sends the report to the client in an electronic format. At a minimum, the following information appears on an ACZ analytical report:

Client Name	Sample Matrix
Client Address	Parameter/Analyte
Client Contact	Method Reference
Lab Sample ID	Result
Client Sample ID	Units
Client Project ID	LIMS Qualifier (U, B, J, H)
ACZ Report ID	MDL or LLD
Date/Time Sampled	PQL or RL
Date/Time Received	Analyst's Initials
Date/Time Analyzed	Extended Qualifiers (as separate page)

A complete electronic data package contains the analytical reports, the external chain of custody records, sample shipping documentation, and any other relevant project information. Department Reference Sheets explaining acronyms, qualifiers, and method references are also included. All of these documents are an integral part of the final data package and must always be viewed as a whole. To prevent the separation of reports, each page identifies the project number, the sequential page number, and the total number of pages in the data package. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

If requested by a client, custom and standard Electronic database deliverables (EDDs) are generated by the Document Control department. These deliverables, containing data in client specified format, are sent by e-mail with the client report. EDDs and analytical reports access data from the same Oracle tables, thus eliminating the possibility of inconsistent results. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

18.3 Data Confidentiality

ACZ has an obligation to each client to maintain custody of samples, data, and reports and to keep all data or other information confidential. To uphold this responsibility, ACZ retains custody of the information at all times – data or other client information obtained by ACZ is not allowed to leave the premises. This includes but is not limited to Chains of Custody, raw data, workgroups, run logs, logbooks, reports, QC summaries, data packages and other media containing data. Client data cannot be released to anyone except the client (as directed on the Chain of Custody) or the client's designated representative, and project data, including any client information, is not to be discussed with anyone other than ACZ employees and/or the client without first receiving written permission from the client. Additionally, client-specific information is not to be documented on raw data, workgroups, logbooks, or other records that may be provided to any client as part of an extended data package. All information must be referenced using only the ACZ log-In number. Refer to ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039) for additional details of policies pertaining to confidentiality.

With the rapid advances of computer and information technology, it is possible for an employee to work at home and access the same electronic data and documents they could access while at ACZ. Accessing data from outside of ACZ could potentially compromise security, confidentiality and custody issues. ACZ's policy on external computer access is as follows:

External access to the ACZ network is limited to employees that may need to access information remotely. Employees requiring such access use ACZ's Virtual Private Network (VPN). The VPN client is setup on the employee's computer so that it adheres to ACZ security standards. These standards include (1) a unique user name (2) a password with at least 12 characters, and (3) 128 bit encryption of data to and from the client from the ACZ servers. After the VPN server has authenticated the employee, the employee must logon to the ACZ domain through normal domain security in order to access any ACZ network resources. Most employees initiate a "Remote Desktop" connection to their office PCs, thus ensuring that ACZ data is never accessible from the client PC hard drive. For portable computers that must directly access the ACZ network, an additional security measure is mandatory –any portable ACZ PC must have an additional "BIOS" password. Without the additional password, the PC will not boot. This security measure is in place to prevent the portable PC from being used in case of loss or theft of the computer.

ACZ has implemented the latest available technology to protect our network from malicious attacks. The bridge/router connecting the internal network to the Internet is protected by the latest implementation of a Linux firewall. Only SMTP (e-mail) and HTTP traffic are allowed between the network and the Internet. Exchange server blocks all "dangerous" attachments, such as executables, macros and VB scripts.

18.4 Client Feedback

Handling client feedback is a joint effort between QA/QC, Project Managers, Production Supervisors, and Client Service representatives. If a client has a concern or complaint, either a Project Manager or Client Service Representative takes the call and initiates the feedback procedure by documenting the complaint or problem and requesting the assistance of the Production Supervisor and/or QA/QC Officer. If the issue cannot be easily resolved then it must be documented using FRMAD024, which is routed from the initiator to other appropriate parties, including the QA/QC Officer if necessary. All client feedback is submitted to upper management as part of the Management Review of the Quality System. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

19 RADIOCHEMISTRY INSTRUMENTATION

Radioanalytical instrumentation is located adjacent to the radiochemistry prep lab. In order to maintain appropriate temperature control in the instrument lab, separation must be maintained. The door between the two lab areas must be kept closed when not in use. Except as noted, instrument checks and other determinations must be performed and documented annually, or more often if necessary.

NOTE: To eliminate potential contamination, planchets must be stored in a covered container or in a drawer.

19.1 Gas-Flow Proportional Counter

19.1.1 *Instrument Reliability Test (Voltage Plateau Determination)* – The proper voltage plateau for alpha and beta is where the counting rate is consistent (should not exceed > 5% over a 150 volt change in anode voltage).

19.1.2 *Cross Talk (Carryover) Check* - Cross talk is defined as the percentage of alpha counts represented on the beta plateau. Once the amount of cross talk is determined, the cross talk settings are adjusted on the instrument to eliminate cross talk.

19.1.3 *Detector Efficiency Curve (Self Absorption)* - Efficiency curves are graphs plotting counts versus sample density and determine the efficiency of the alpha and beta counter based on sample density. This factor is part of the overall determination of sample activity.

19.1.4 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. Placing an empty planchet in the counting chamber and counting it for as long as the longest sample-counting duration can determine the background rate (or a background check can be completed overnight). An overnight background determination must be completed at least quarterly. The daily background rate must be analyzed daily for each detector.

19.1.5 *Instrument-Response Check Source* - This continuing calibration check verifies the instrument response and stability and is performed daily for each detector. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the check source is outside the ± 2 sigma-warning limit, then the variability should be further investigated. If the check source is outside the ± 3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. If insufficient data exists for control charts, $\pm 10\%$ of the initial value is considered acceptable.

19.2 Liquid Scintillation Counter

19.2.1 *Optimal Window* - When determining radionuclides by liquid scintillation, it is necessary to select the optimal window by counting a standard for five minutes and generating a sample spectrum. For better clarity, a log scale for the channel number axis should be used. On the graph, the region of interest is determined by the energy of the peak one is trying to quantitate. The optimal window is formed by extending this region by 10% on each side of the alpha peaks.

- 19.2.2 *Efficiency Quench Curve* – The liquid scintillation instrument, a Beckman LS 6000TA, automatically corrects for quenching by the H - Method. Refer to SOPRC010 for details.
- 19.2.3 *Background Check* - Two background sources must be checked while preparing the liquid scintillation counter for analysis. The electronic (or instrument) background is the electronic noise of the system and can be determined with an empty counting chamber and a dark vial typically filled with graphite. Count as long as a sample is typically counted. The second source of background is chamber background, which is caused by contamination from instrument parts, counting room construction materials, and/or proximity of radioactive sources. Chamber background can be determined by using a vial containing liquid scintillator and a 10mL volume of Type I water (low background water). For both checks, the counting duration should be equivalent to the longest sample counting duration. Both checks must be performed on a daily basis and recorded in the instrument logbook.
- 19.2.4 *Instrument-Response Check Source* - This continuing calibration check verifies instrument response and stability and must be performed daily. If the source count is within two standard deviations (σ) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ± 2 sigma-warning limit then the variability should be further investigated. If the source check is outside the ± 3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a new efficiency curve, background checks, and/or instrument maintenance. If insufficient data exists for control charts, $\pm 10\%$ of the initial source value is considered acceptable. The source for this check is a Tritium standard.

19.3 Alpha Spectrometer

- 19.3.1 *Energy vs. Channel Calibration* - Each alpha spectrometer has a set number of channels associated to it. To associate these channels to a specific alpha particle, the channels must be calibrated. One known calibrated solid source is placed into the detector and analyzed for five minutes to determine its associated channel to its calibrated energy peak. Since the energy is linear across the channels, all of the channels now have an associated energy. This determination is performed on an annual basis, or whenever maintenance is performed that could potentially affect the calibration.
- 19.3.2 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. Placing an empty planchet in the counting chamber and counting it for as long as the longest sample-counting duration can determine the background rate (or a background check can be completed overnight). An overnight background determination must be completed at least quarterly.
- 19.3.3 *Instrument-Response Check Source* - This continuing calibration check verifies the instrument response and stability and is performed daily. If the source count is within two standard deviations (σ) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ± 2 sigma-warning limit, then the variability should be further investigated. If the source check is outside the ± 3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a background check, and/or instrument maintenance. If insufficient data exists for control charts then $\pm 10\%$ of the true value is considered acceptable.

19.4 Gamma Spectrometer

- 19.4.1 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. The background rate can be determined by placing a blank water sample within a Marinelli beaker in the counting chamber and counting it for as long as the longest sample-counting duration, or a background check can be completed overnight. A background check must be performed for every workgroup.
- 19.4.2 *Instrument-Response Check Source* - This continuing calibration check verifies instrument response and stability. This check is performed for every workgroup. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ± 2 sigma-warning limit, then the variability should be further investigated. If the source check is outside the ± 3 sigma control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a background check, and/or instrument maintenance. If insufficient data exists for control charts then $\pm 10\%$ of the true value is considered acceptable.

APPENDIX A Required Container Type, Preservation Techniques, and Holding Times

Parameter	Container	Preservation ^{a, b}	Maximum Holding Time ^c
Alkalinity	HDPE or Glass	4 °C	14 days
Acidity	HDPE or Glass	4 °C	14 days
Ammonia (N-NH ₃)	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days
Anions	HDPE	4 °C	28 days (Br ⁻ , F ⁻ , Cl ⁻ , SO ₄ ²⁻)
BOD, CBOD	HDPE or Glass	4 °C	48 hours
COD	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days
Color	HDPE or Glass	4 °C	48 hours
Conductivity	HDPE or Glass	4 °C	28 days
Cyanide	HDPE or Glass	4 °C; NaOH to pH > 12	14 days
Chromium (VI)	HDPE or Glass	4 °C	Refer to SOP for holding time
Dissolved Oxygen	Glass	None required	Analyze immediately
Metals (except Cr ⁶⁺ , Hg)	HDPE or Glass	HNO ₃ to pH < 2	180 days
Mercury	HDPE or Glass	HNO ₃ to pH < 2	28 days
N – NO ₂ / NO ₃	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days (48 hours if unpreserved)
N – NO ₃	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days (48 hours if unpreserved)
N – NO ₂	HDPE or Glass	4 °C	48 hours
Nitrogen, Total Kjeldahl	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days
Oil & Grease	Glass	4 °C; HCl or H ₂ SO ₄ to pH < 2	28 days
Orthophosphate	HDPE or Glass	4 °C	48 hours
pH	HDPE or Glass	None required	Analyze immediately
Phenols	Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days
Phosphorus (Total)	HDPE or Glass	4 °C; H ₂ SO ₄ to pH < 2	28 days
Sulfide	HDPE or Glass	4 °C; Zn acetate + NaOH to pH > 9	7 days

APPENDIX A Continued

Parameter	Container	Preservation	Maximum Holding Time
Sulfite	HDPE or Glass	4 °C; EDTA	Analyze immediately
Settleable Solids	HDPE or Glass	4 °C	48 hours
Total Organic Carbon	Glass only	4 °C; HCl or H ₂ SO ₄ to pH < 2	28 days
Turbidity	HDPE or Glass	4 °C	48 hours
Total Dissolved Solids	HDPE or Glass	4 °C	7 days
Total Suspended Solids	HDPE or Glass	4 °C	7 days
Total Solids	HDPE or Glass	4 °C	7 days
Total Volatile Solids	HDPE or Glass	4 °C	7 days
Radon-222	Glass Vial ^d		4 days
Total Volatile Hydrocarbons	Glass Vial or jar ^d	4 °C; HCl to pH < 2 (water)	Refer to SOP for holding times
Total Petroleum Hydrocarbons	Amber Glass	4 °C	Refer to SOP for holding times
BTEX / MTBE	Glass Vial or jar ^d	4 °C; HCl to pH < 2 (water)	14 days
Organochlorine Pesticides	Glass Vial or jar ^d	4 °C; pH 5 – 9	Refer to SOP for holding times
PCBs	Amber Glass	4 °C	Refer to SOP for holding times
PAHs	Amber Glass	4 °C	Refer to SOP for holding times
BNAs (semi-volatiles)	Amber Glass	4 °C	Refer to SOP for holding times
VOAs (volatiles)	Glass Vial or jar ^d	4 °C; HCl to pH < 2 (water)	Refer to SOP for holding times
TCLP	Glass ^d	4 °C	Refer to SOP for holding times
Radchem (except Rn-222)	HDPE cube	HNO ₃ to pH < 2	180 days

- a. No pH adjustment for soil
- b. Preservation with 0.008% Na₂S₂O₃ required only when residual chlorine is present.
- c. Unless otherwise specified in the test SOP, complete sample preparation and analysis within holding time.
- d. Teflon-lined septa or lid

APPENDIX B Utah BLI Certificate and List of Certified Parameters



State of Utah
JON HUNTSMAN Jr.
Governor
GARY HERBERT
Lieutenant Governor

Utah Department of Health
David N. Sundwall, MD
Executive Director

Epidemiology and Laboratory Services
Patrick F. Luedtke, MD, MPH
Director of Public Health Laboratories

Bureau of Laboratory Improvement
David B. Mendenhall, MPA, MT (ASCP)
Bureau Director



NELAP
Recognized

**STATE OF UTAH
DEPARTMENT OF HEALTH**

**ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM
CERTIFICATION**

is hereby granted to

ACZ Laboratories, Inc.

**2773 Downhill Drive
Steamboat Springs CO 80487**

Scope of accreditation is limited to the
State of Utah Accredited Fields of Accreditation
Which accompanies this Certificate

Continued accredited status depends on successful
Ongoing participation in the program

EPA Number: CO00028
Expiration Date: 4/30/2008

A handwritten signature in black ink, reading "Patrick F. Luedtke".

Patrick F. Luedtke, MD, MPH.
*Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services*



46 North Medical Drive • Salt Lake City, UT 84113-1105 • phone (801) 584-8469 • fax (801) 584-8501
www.health.utah.gov/eis/labimp/





State of Utah
JON HUNTSMAN Jr.
Governor
GARY HERBERT
Lieutenant Governor

Utah Department of Health

David N. Sundwall, MD
Executive Director

Epidemiology and Laboratory Services

Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories

Bureau of Laboratory Improvement

David B Mendenhall, MPA, MT (ASCP)
Bureau Director



NELAP
Recognized

6/1/2007

ACZ Laboratories, Inc.
Bradley Craig
2773 Downhill Drive
Steamboat Springs CO 80487
Director,

ID # ACZ
EPA ID: CO00028

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Safe Drinking Water Act and authorized to perform the following methods, for the analytes and matrix listed:

Drinking Water

Inorganics and Metals

200.8 [1994] Antimony
200.8 [1994] Arsenic
200.8 [1994] Barium
200.8 [1994] Beryllium
200.8 [1994] Cadmium
200.8 [1994] Chromium
200.8 [1994] Nickel
200.8 [1994] Selenium
200.8 [1994] Thallium
200.8 [1994] Uranium
245.1 [1994] Mercury
335.4 [1993] Cyanide
4500 (F-) C Fluoride by Ion-Selective Method

Nitrate

353.2 [1993] Nitrate/Nitrite

Nitrite

353.2 [1993] Nitrite

Pb/Cu

200.8 [1994] Copper
200.8 [1994] Lead

Radionuclides

900.0 Gross Alpha & Beta Radioactivity in Drinking Water Evaporation Technique
900.0 Gross Alpha
900.0 Gross Beta
903.1 Radium 226 in Drinking Water Radon Emanation Technique
904.0 Radium 226 in Drinking Water Radiochemical Technique



The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

46 North Medical Drive • Salt Lake City, UT 84113-1105 • phone (801) 584-8469 • fax (801) 584-8501
www.health.utah.gov/els/labimp/



ACZ Laboratories, Inc.
Safe Drinking Water Act
Page 2 of 2

The effective date of this certificate letter is: 5/24/2007.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.

Respectfully



Patrick F. Luedtke, MD, MPH.
*Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services*

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.



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State of Utah
JON HUNTSMAN Jr.
Governor
GARY HERBERT
Lieutenant Governor

Utah Department of Health

David N. Sundwall, MD
Executive Director

Epidemiology and Laboratory Services

Patrick F. Luedtke, MD, MPH,
Director of Public Health Laboratories

Bureau of Laboratory Improvement

David B Mendenhall, MPA, MT (ASCP)
Bureau Director



NELAP
Recognized

6/1/2007

ACZ Laboratories, Inc.
Bradley Craig
2773 Downhill Drive
Steamboat Springs CO 80487

ID # ACZ
EPA ID: CO00028

Director,

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Clean Water Act and authorized to perform the following methods, for the analytes and matrix listed:

Non-Potable Water

Inorganics and Metals

160.4 [1971]	Residue, Volatile (Gravimetric, Ignition at 550-C)
1631 C	Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry
1664 A [1999]	Oil & Grease and Total Petroleum Hydrocarbons
180.1 [1993]	Turbidity
200.7 [1994]	Aluminum
200.7 [1994]	Antimony
200.7 [1994]	Arsenic
200.7 [1994]	Barium
200.7 [1994]	Beryllium
200.7 [1994]	Boron
200.7 [1994]	Cadmium
200.7 [1994]	Calcium
200.7 [1994]	Chromium, Total
200.7 [1994]	Cobalt
200.7 [1994]	Copper
200.7 [1994]	Iron
200.7 [1994]	Lead
200.7 [1994]	Lithium
200.7 [1994]	Magnesium
200.7 [1994]	Manganese
200.7 [1994]	Molybdenum
200.7 [1994]	Nickel
200.7 [1994]	Potassium
200.7 [1994]	Selenium
200.7 [1994]	Silica
200.7 [1994]	Silver
200.7 [1994]	Sodium
200.7 [1994]	Strontium
200.7 [1994]	Tin
200.7 [1994]	Titanium



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Inorganics and Metals

200.7 [1994]	Vanadium
200.7 [1994]	Zinc
200.8 [1994]	Aluminum
200.8 [1994]	Antimony
200.8 [1994]	Arsenic
200.8 [1994]	Barium
200.8 [1994]	Beryllium
200.8 [1994]	Cadmium
200.8 [1994]	Chromium
200.8 [1994]	Cobalt
200.8 [1994]	Copper
200.8 [1994]	Lead
200.8 [1994]	Manganese
200.8 [1994]	Molybdenum
200.8 [1994]	Nickel
200.8 [1994]	Selenium
200.8 [1994]	Silver
200.8 [1994]	Thallium
200.8 [1994]	Uranium
200.8 [1994]	Vanadium
200.8 [1994]	Zinc
2310 B	Acidity (Nephelometric)
2320 B	Alkalinity (Titration)
2340 B	Hardness (Calculation)
245.1 [1994]	Mercury
2510 B [19th ED]	Conductivity (Laboratory) [SM 19th ED]
2540 B [19th ED]	Total Solids Dried at 103-105-C [SM 19th ED]
2540 C [19th ED]	Total Dissolved Solids Dried at 180-C [SM 19th ED]
2540 D [19th ED]	Total Suspended Solids Dried at 103-105-C [SM 19th ED]
2540 F [19th ED]	Settleable Solids [SM 19th ED]
300.0 [1993]	Bromide
300.0 [1993]	Chloride
300.0 [1993]	Fluoride
300.0 [1993]	Sulfate
3114.8 [19th ED]	Selenium [SM 19th ED]
335.4 [1993]	Cyanide, Total
350.1 [1993]	Nitrogen, Ammonia
3500 (Cr) D [19th ED]	Chromium VI (Colorimetric) [SM 19th ED]
351.2 [1993]	Nitrogen, Total Kjeldahl
353.2 [1993]	Nitrogen, Nitrate-Nitrite
365.1 [1993]	Phosphorous, Total
410.4 [1993]	Chemical Oxygen Demand
420.4 [1993]	Phenolics, Total
4500 (Cl-) E	Chloride (Fermicyanide, Automated)
4500 (CN-) I	Weak Acid Dissociable Cyanide
4500 (F-) C	Fluoride (Ion-Selective Electrode)
4500 (H+) B [19th ED]	pH (Electrometric) [SM 19th ED]
4500 (SO42-) D	Sulfate (Gravimetric, Drying of Residue)
5210 B [19th ED]	Biochemical Oxygen Demand 5-Day Test [SM 19th ED]
5210 B [19th ED]	Carbonaceous Biochemical Oxygen Demand (CBOD) [SM 19th ED]
5310 B [19th ED]	Total Organic Carbon (Combustion-Infrared) [SM 19th ED]

Organics

624	Purgeables
624	Bromodichloromethane

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Clean Water Act
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Organics

624	Bromoform
624	Bromomethane
624	Carbon Tetrachloride
624	Chlorobenzene
624	Chloroethane
624	2-Chloroethylvinyl Ether
624	Chloroform
624	Chloromethane
624	Dibromochloromethane
624	1,2-Dichlorobenzene
624	1,3-Dichlorobenzene
624	1,4-Dichlorobenzene
624	1,1-Dichloroethane
624	1,2-Dichloroethane
624	1,1-Dichloroethene
624	trans-1,2-Dichloroethene
624	1,2-Dichloropropane
624	cis-1,3-Dichloropropene
624	trans-1,3-Dichloropropene
624	Ethylbenzene
624	Methylene Chloride
624	1,1,2,2-Tetrachloroethane
624	Tetrachloroethylene
624	Toluene
624	1,1,1-Trichloroethane
624	1,1,2-Trichloroethane
624	Trichloroethene
624	Trichlorofluoromethane
624	Vinyl Chloride
625	Base/Neutrals and Acids
625	Acenaphthene
625	Acenaphthylene
625	Anthracene
625	Benzidine
625	Benzo(a)anthracene
625	Benzo(b)fluoranthene
625	Benzo(k)fluoranthene
625	Benzo(g,h,i)perylene
625	Benzo(a)pyrene
625	Benzyl Butyl Phthalate
625	bis(2-Chloroethyl)ether
625	bis(2-Chloroethoxy)methane
625	bis(2-Ethylhexyl)phthalate
625	bis(2-Chloroisopropyl)ether
625	4-Bromophenyl Phenyl Ether
625	2-Chloronaphthalene
625	Chrysene
625	Dibenz(a,h)anthracene
625	Di-n-butylphthalate
625	3,3'-Dichlorobenzidine
625	Diethyl phthalate
625	Dimethyl phthalate
625	2,4-Dinitrotoluene
625	2,6-Dinitrotoluene

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Organics

625	Di-n-octylphthalate
625	Fluoranthene
625	Fluorene
625	Hexachlorobenzene
625	Hexachlorobutadiene
625	Hexachlorocyclopentadiene
625	Hexachloroethane
625	Indeno(1,2,3-cd)pyrene
625	Isophorone
625	Naphthalene
625	Nitrobenzene
625	N-Nitrosodimethylamine
625	N-Nitrosodi-n-propylamine
625	N-Nitrosodiphenylamine
625	Phenanthrene
625	Pyrene
625	1,2,4-Trichlorobenzene
625	4-Chloro-3-methylphenol
625	2-Chlorophenol
625	2,4-Dichlorophenol
625	2,4-Dimethylphenol
625	2,4-Dinitrophenol
625	2-Methyl- 4,6-dinitrophenol
625	2-Nitrophenol
625	4-Nitrophenol
625	Pentachlorophenol
625	Phenol
625	2,4,6-Trichlorophenol

Radiological

900.0	Gross Alpha
900.0	Gross Beta
903.0	Radium
903.0	radium-226
903.1	radium-226
904.0	radium-228

Solid & Chemical Materials

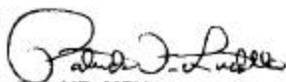
Inorganics and Metals

Sludge	Inorganic Pollutants
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The effective date of this certificate letter is: 5/24/2007.

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Respectfully,



Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services



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Bureau of Laboratory Improvement

David B. Mendenhall, MPA, MT (ASCP)
 Bureau Director



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 Recognized

5/11/2007

ACZ Laboratories, Inc.
 Bradley Craig
 2773 Downhill Drive
 Steamboat Springs CO 80487

ID # ACZ
 Account # 8003345493

Director,

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Resource Conservation and Recovery Act and authorized to perform the following methods, for the analytes and matrix listed:

<u>Characteristics</u>			
	Solid	Non-Potable Water	
1010 A	✓	✓	Ignitability
1311	✓	✓	Toxicity Characteristic Leaching Procedure Metals
1311	✓	✓	Toxicity Characteristic Leaching Procedure Semi-Volatiles
1311	✓	✓	Toxicity Characteristic Leaching Procedure Volatiles
1312	✓	✓	Synthetic Precipitation Leaching Procedure (TCLP Approval)
<u>Inorganics</u>			
	Solid	Non-Potable Water	
9012 B	✓	✓	Total and Amenable Cyanide
9013	✓		Cyanide Extraction Procedure for Solids and Oils
9040 C		✓	pH
9045 D	✓		Soil and Waste pH
9070 A		✓	Total Recoverable Oil and Grease
<u>Metal Digestion</u>			
	Solid	Non-Potable Water	
3005 A		✓	Acid Digestion Total Recoverable or Dissolved Metals
3010 A		✓	Acid Digestion for Total Metals
3050 B	✓		Acid Digestion of Sediments, Sludges and Soils
3051 A	✓		Microwave Acid Digestion of Sediment, Sludges, Soils & Oils
3052	✓		Microwave Acid Digestion of Siliceous and Organic Matrixes
3060 A	✓		Alkaline Digestion for Hexavalent Chromium

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ACZ Laboratories, Inc.
 Resource Conservation and Recovery Act
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	Metals		
	Solid	Non-Potable Water	
6010 B	✓	✓	Aluminum
6010 B	✓	✓	Antimony
6010 B	✓	✓	Arsenic
6010 B	✓	✓	Barium
6010 B	✓	✓	Beryllium
6010 B	✓	✓	Boron
6010 B	✓	✓	Cadmium
6010 B	✓	✓	Calcium
6010 B	✓	✓	Chromium
6010 B	✓	✓	Cobalt
6010 B	✓	✓	Copper
6010 B	✓	✓	Iron
6010 B	✓	✓	Lead
6010 B	✓	✓	Lithium
6010 B	✓	✓	Magnesium
6010 B	✓	✓	Manganese
6010 B	✓	✓	Molybdenum
6010 B	✓	✓	Nickel
6010 B	✓	✓	Potassium
6010 B	✓	✓	Selenium
6010 B	✓	✓	Silica
6010 B	✓	✓	Silicon
6010 B	✓	✓	Silver
6010 B	✓	✓	Sodium
6010 B	✓	✓	Strontium
6010 B	✓	✓	Thallium
6010 B	✓	✓	Tin
6010 B	✓	✓	Titanium
6010 B	✓	✓	Vanadium
6010 B	✓	✓	Zinc
6020 [1994]	✓	✓	Aluminum
6020 [1994]	✓	✓	Antimony
6020 [1994]	✓	✓	Arsenic
6020 [1994]	✓	✓	Barium
6020 [1994]	✓	✓	Beryllium
6020 [1994]	✓	✓	Cadmium
6020 [1994]	✓	✓	Chromium
6020 [1994]	✓	✓	Cobalt
6020 [1994]	✓	✓	Copper
6020 [1994]	✓	✓	Lead
6020 [1994]	✓	✓	Manganese
6020 [1994]	✓	✓	Molybdenum
6020 [1994]	✓	✓	Nickel
6020 [1994]	✓	✓	Selenium
6020 [1994]	✓	✓	Silver
6020 [1994]	✓	✓	Thallium
6020 [1994]	✓	✓	Vanadium
6020 [1994]	✓	✓	Zinc
7196 A	✓	✓	Chromium, Hexavalent (Chromium, VI)
7470 A		✓	Mercury
7471 A	✓		Mercury

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ACZ Laboratories, Inc.
 Resource Conservation and Recovery Act
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Organic Extraction

	Solid	Non-Potable Water	
3510 C		✓	Separatory Funnel Liquid-Liquid Extractions
3520 C		✓	Continuous Liquid-Liquid Extraction
3540 C	✓		Soxhlet Extraction
3550 C	✓		Ultrasonic Extraction
3560 A	✓		Waste Dilution

Organic Instrumentation

	Solid	Non-Potable Water	
8015 B	✓	✓	Diesel Range Organics (DROs)
8015 B	✓	✓	Gasoline Range Organics (GROs)
8015 B	✓	✓	Nonhalogenated Organics Using GC/FID
8021 B	✓	✓	Aromatic and Halogenated Volatiles
8021 B	✓	✓	Benzene
8021 B	✓	✓	Ethylbenzene
8021 B	✓	✓	meta-Xylene
8021 B	✓	✓	ortho-Xylene
8021 B	✓	✓	para-Xylene
8021 B	✓	✓	Toluene
8021 B	✓	✓	Xylenes, Total
8082	✓	✓	Aroclor-1016 [PCB-1016]
8082	✓	✓	Aroclor-1221 [PCB-1221]
8082	✓	✓	Aroclor-1232 [PCB-1232]
8082	✓	✓	Aroclor-1242 [PCB-1242]
8082	✓	✓	Aroclor-1248 [PCB-1248]
8082	✓	✓	Aroclor-1254 [PCB-1254]
8082	✓	✓	Aroclor-1260 [PCB-1260]
8082	✓	✓	PCBs
8260 B	✓	✓	1,1,1,2-Tetrachloroethane
8260 B	✓	✓	1,1,1-Trichloroethane
8260 B	✓	✓	1,1,2,2-Tetrachloroethane
8260 B	✓	✓	1,1,2-Trichloroethane
8260 B	✓	✓	1,1-Dichloroethane
8260 B	✓	✓	1,1-Dichloroethylene (-ethene)
8260 B	✓	✓	1,1-Dichloropropene
8260 B	✓	✓	1,2,3-Trichlorobenzene
8260 B	✓	✓	1,2,3-Trichloropropane
8260 B	✓	✓	1,2,4-Trichlorobenzene
8260 B	✓	✓	1,2,4-Trimethylbenzene
8260 B	✓	✓	1,2-Dibromo-3-chloropropane (DBCP, Dibromochloropropane)
8260 B	✓	✓	1,2-Dibromoethane (EDB, Ethylene dibromide)
8260 B	✓	✓	1,2-Dichlorobenzene
8260 B	✓	✓	1,2-Dichloroethane
8260 B	✓	✓	1,2-Dichloropropane
8260 B	✓	✓	1,3,5-Trimethylbenzene
8260 B	✓	✓	1,3-Dichlorobenzene
8260 B	✓	✓	1,3-Dichloropropane
8260 B	✓	✓	1,4-Dichlorobenzene
8260 B	✓	✓	2,2-Dichloropropane
8260 B	✓	✓	2-Chloroethyl Vinyl Ether
8260 B	✓	✓	2-Chlorotoluene

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ACZ Laboratories, Inc.
 Resource Conservation and Recovery Act
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	Solid	Non-Potable Water	
8260 B	✓	✓	2-Hexanone
8260 B	✓	✓	4-Chlorotoluene
8260 B	✓	✓	4-Methyl-2-pentanone (MIBK, Isopropylacetone, Hexone)
8260 B	✓	✓	Acetone
8260 B	✓	✓	Acrylonitrile
8260 B	✓	✓	Benzene
8260 B	✓	✓	Bromobenzene
8260 B	✓	✓	Bromochloromethane
8260 B	✓	✓	Bromodichloromethane
8260 B	✓	✓	Bromoform
8260 B	✓	✓	Carbon Disulfide
8260 B	✓	✓	Carbon Tetrachloride
8260 B	✓	✓	Chlorobenzene
8260 B	✓	✓	Chlorodibromomethane [Dibromochloromethane]
8260 B	✓	✓	Chloroethane
8260 B	✓	✓	Chloroform
8260 B	✓	✓	cis-1,2-Dichloroethene (-ethylene)
8260 B	✓	✓	cis-1,3-dichloropropene
8260 B	✓	✓	Dibromomethane
8260 B	✓	✓	Dichlorodifluoromethane
8260 B	✓	✓	Ethylbenzene
8260 B	✓	✓	Hexachlorobutadiene
8260 B	✓	✓	Isopropylbenzene
8260 B	✓	✓	meta-Xylene
8260 B	✓	✓	Methyl bromide [Bromomethane]
8260 B	✓	✓	Methyl chloride [Chloromethane]
8260 B	✓	✓	Methyl Ethyl Ketone (MEK, 2-Butanone)
8260 B	✓	✓	Methyl-t-Butyl Ether (MTBE)
8260 B	✓	✓	Methylene Chloride
8260 B	✓	✓	n-Butylbenzene
8260 B	✓	✓	n-Propylbenzene
8260 B	✓	✓	Naphthalene
8260 B	✓	✓	ortho-Xylene
8260 B	✓	✓	para-Xylene
8260 B	✓	✓	sec-Butylbenzene
8260 B	✓	✓	Styrene
8260 B	✓	✓	tert-Butylbenzene
8260 B	✓	✓	Tetrachloroethylene (Perchloroethylene -ethene)
8260 B	✓	✓	Toluene
8260 B	✓	✓	trans-1,2-Dichloroethylene (-ethene)
8260 B	✓	✓	trans-1,3-Dichloropropylene (-propene)
8260 B	✓	✓	Trichloroethene (Trichloroethylene)
8260 B	✓	✓	Trichlorofluoromethane
8260 B	✓	✓	Vinyl Acetate
8260 B	✓	✓	Vinyl Chloride
8260 B	✓	✓	Volatile Organic Compounds
8260 B	✓	✓	Xylenes, Total
8270 C	✓	✓	1,2,4-Trichlorobenzene
8270 C	✓	✓	1,2-Dichlorobenzene
8270 C	✓	✓	1,3-Dichlorobenzene
8270 C	✓	✓	1,4-Dichlorobenzene

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 Resource Conservation and Recovery Act
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	<u>Organic Instrumentation</u>		
	Solid	Non-Potable Water	
8270 C	✓	✓	2,4,5-Trichlorophenol
8270 C	✓	✓	2,4,6-Trichlorophenol
8270 C	✓	✓	2,4-Dichlorophenol
8270 C	✓	✓	2,4-Dimethylphenol
8270 C	✓	✓	2,4-Dinitrophenol
8270 C	✓	✓	2,4-Dinitrotoluene (2,4-DNT)
8270 C	✓	✓	2,6-Dinitrotoluene (2,6-DNT)
8270 C	✓	✓	2-Chloronaphthalene
8270 C	✓	✓	2-Chlorophenol
8270 C	✓	✓	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
8270 C	✓	✓	2-Methylnaphthalene
8270 C	✓	✓	2-Methylphenol (o-cresol, 2-Hydroxytoluene)
8270 C	✓	✓	2-Nitroaniline
8270 C	✓	✓	2-Nitrophenol
8270 C	✓	✓	3,3'-Dichlorobenzidine
8270 C	✓	✓	3-Methylphenol (m-cresol, 3-Hydroxytoluene)
8270 C	✓	✓	3-Nitroaniline
8270 C	✓	✓	4-Bromophenyl Phenyl Ether
8270 C	✓	✓	4-Chloro-3-methylphenol
8270 C	✓	✓	4-Chloroaniline
8270 C	✓	✓	4-Chlorophenyl Phenyl Ether
8270 C	✓	✓	4-Methylphenol (p-cresol, 4-Hydroxytoluene)
8270 C	✓	✓	4-Nitroaniline
8270 C	✓	✓	4-Nitrophenol
8270 C	✓	✓	Acenaphthene
8270 C	✓	✓	Acenaphthylene
8270 C	✓	✓	Anthracene
8270 C	✓	✓	Azobenzene
8270 C	✓	✓	Benzo(a)anthracene
8270 C	✓	✓	Benzo(a)pyrene
8270 C	✓	✓	Benzo(b)fluoranthene
8270 C	✓	✓	Benzo(g,h,i)perylene
8270 C	✓	✓	Benzo(k)fluoranthene
8270 C	✓	✓	Benzoic Acid
8270 C	✓	✓	Benzyl alcohol
8270 C	✓	✓	bis(2-chloroethoxy)methane
8270 C	✓	✓	bis(2-Chloroethyl)ether
8270 C	✓	✓	bis(2-chloroisopropyl)ether
8270 C	✓	✓	bis(2-Ethylhexyl) phthalate (DEHP)
8270 C	✓	✓	Butyl Benzyl Phthalate
8270 C	✓	✓	Chrysene
8270 C	✓	✓	Di-n-butyl phthalate
8270 C	✓	✓	Di-n-octyl Phthalate
8270 C	✓	✓	Dibenzo(a,h)anthracene
8270 C	✓	✓	Dibenzofuran
8270 C	✓	✓	Diethyl Phthalate
8270 C	✓	✓	Dimethyl Phthalate
8270 C	✓	✓	Fluoranthene
8270 C	✓	✓	Fluorene
8270 C	✓	✓	Hexachlorobenzene
8270 C	✓	✓	Hexachlorobutadiene

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.



46 North Medical Drive • Salt Lake City, UT 84113-1105 • phone (801) 584-8469 • fax (801) 584-8501
www.health.utah.gov/eis/labimp/



ACZ Laboratories, Inc.
Resource Conservation and Recovery Act
Page 6 of 6

<u>Organic Instrumentation</u>			
	Solid	Non-Potable Water	
8270 C	✓	✓	Hexachlorocyclopentadiene
8270 C	✓	✓	Hexachloroethane
8270 C	✓	✓	Indeno(1,2,3-cd)pyrene
8270 C	✓	✓	Isophorone
8270 C	✓	✓	n-Nitroso-di-n-Propylamine
8270 C	✓	✓	n-Nitrosodimethylamine
8270 C	✓	✓	n-Nitrosodiphenylamine
8270 C	✓	✓	Naphthalene
8270 C	✓	✓	Nitrobenzene
8270 C	✓	✓	Pentachlorophenol
8270 C	✓	✓	Phenanthrene
8270 C	✓	✓	Phenol
8270 C	✓	✓	Pyrene
8270 C	✓	✓	Semivolatile Organic Compounds

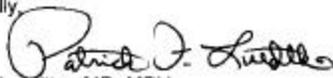
<u>Radiochemistry</u>			
	Solid	Non-Potable Water	
9310	✓	✓	Gross Alpha and Gross Beta
9315	✓	✓	Alpha Emit Radium Isotope
9320	✓	✓	Radium 226

<u>Volatile Organic Preparation</u>			
	Solid	Non-Potable Water	
5030 B		✓	Purge-and-Trap for Aqueous Samples

The effective date of this certificate letter is: 5/1/2007.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.

Respectfully,



Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services

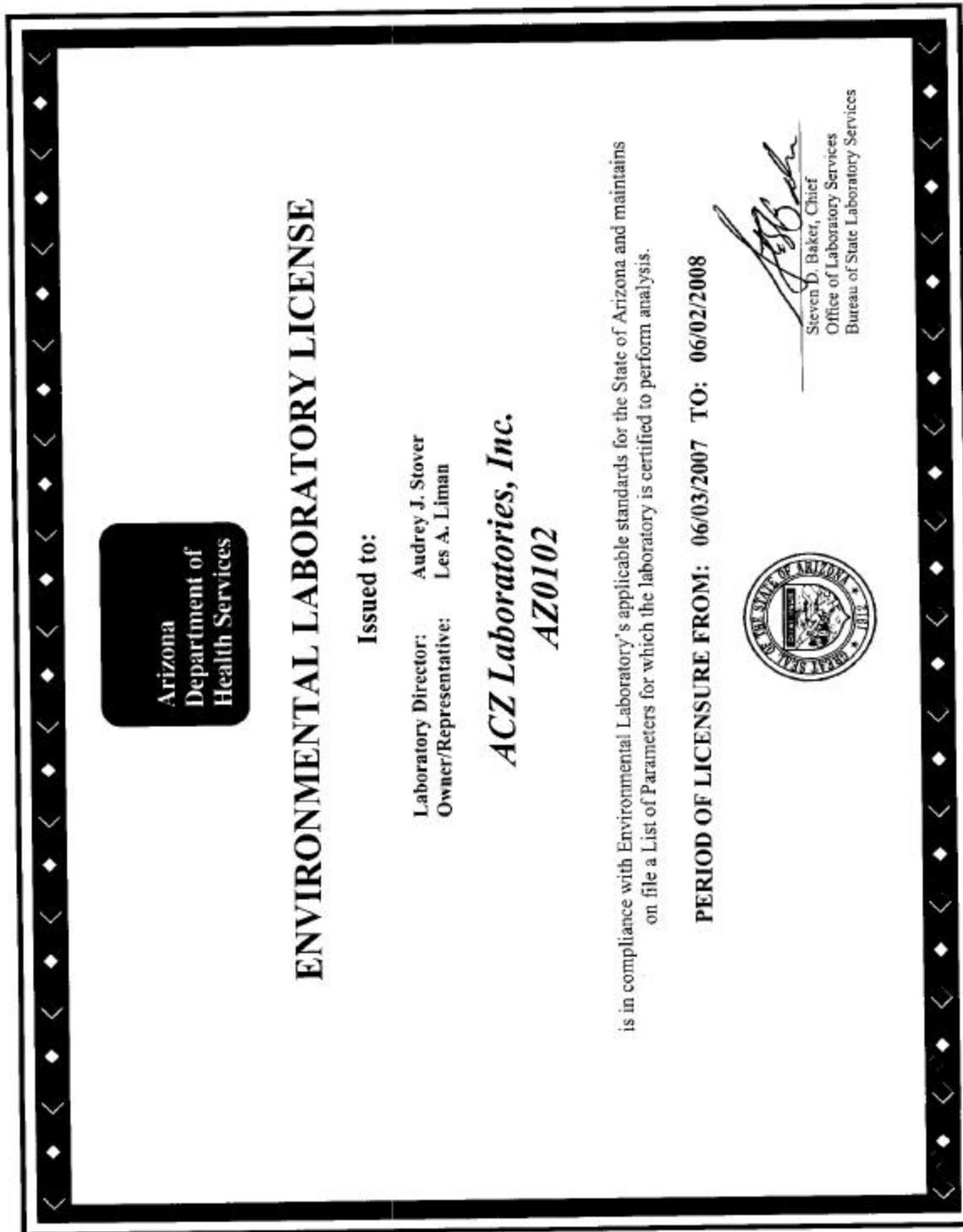
The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.



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www.health.utah.gov/els/labimp/



APPENDIX C ADHS Certificate and List of Certified Parameters



Arizona
Department of
Health Services

ENVIRONMENTAL LABORATORY LICENSE

Issued to:

Laboratory Director: Audrey J. Stover
Owner/Representative: Brad Craig

ACZ Laboratories, Inc.
AZ0102

is in compliance with Environmental Laboratory's applicable standards for the State of Arizona and maintains on file a List of Parameters for which the laboratory is certified to perform analysis.

PERIOD OF LICENSURE FROM: 06/03/2008 TO: 06/02/2009



A handwritten signature in black ink, appearing to read "Steven D. Baker".

Steven D. Baker, Chief
Office of Laboratory Services
Bureau of State Laboratory Services

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Lab Director: Ms. Audrey J. Stover

Phone: (970) 879-6175

Fax: 815 301-3857

Program	HW	Parameter	EPA Method	Billing Code	Cert Date
		Alkline Digestion For Hexavalent Chromium	EPA 3060A	PREP2	05/09/07
		Alpha-Emitting Radium Isotopes	EPA 9315	RADIO	09/23/97
		Aluminum	EPA 6010B	MTL3	06/03/98
		Aluminum	EPA 6020	MTL7	04/12/04
		Antimony	EPA 6010B	MTL3	05/09/02
		Antimony	EPA 6020	MTL7	02/24/97
		Aromatic & Halogenated Vocs	EPA 8021B	VOC1	01/15/03
		Arsenic	EPA 6010B	MTL3	05/09/02
		Arsenic	EPA 6020	MTL7	02/24/97
		Barium	EPA 6010B	MTL3	06/03/98
		Barium	EPA 6020	MTL7	02/24/97
		Beryllium	EPA 6010B	MTL3	05/01/92
		Beryllium	EPA 6020	MTL7	02/24/97
		Boron	EPA 6010B	MTL3	04/04/06
		Cadmium	EPA 6010B	MTL3	06/03/98
		Cadmium	EPA 6020	MTL7	02/24/97
		Calcium	EPA 6010B	MTL3	06/03/98
		Chromium Total	EPA 6010B	MTL3	06/03/98
		Chromium Total	EPA 6020	MTL7	02/24/97
		Chromium, Hexavalent	EPA 7196A	MTL4	04/12/04
		Closed System Purge And Trap Extract. Vocs	EPA 5035A	PREP2	12/05/06
		Cobalt	EPA 6010B	MTL3	06/03/98
		Cobalt	EPA 6020	MTL7	02/24/97
		Continious Liquid-Liquid Extraction	EPA 3520C	PREP2	05/09/02
		Copper	EPA 6010B	MTL3	06/03/98
		Copper	EPA 6020	MTL7	02/24/97
		Corrosivity Ph Determination	EPA 9040C	HAZ1	12/05/06
		Cyanide	EPA 9012B	MISC7	12/05/06
		Cyanide Extractions For Solids And Oils	EPA 9013A	PREP3	12/05/06
		Dissolved In Water	EPA 3005A	PREP1	05/09/02
		Gross Alpha And Beta	EPA 9310	RADIO	09/23/97
		Hem For Aqueous Samples	EPA 9070A	MISC6	05/09/07
		Hydrogen Ion (Ph)	EPA 9045D	NIA6	12/05/06
		Ignitability (Flash Point)	EPA 1010A	HAZ2	12/05/06
		Iron	EPA 6010B	MTL3	06/03/98
		Lead	EPA 6010B	MTL3	06/03/98
		Lead	EPA 6020	MTL7	02/24/97
		Lithium	EPA 6010B	MTL3	06/26/02
		Magnesium	EPA 6010B	MTL3	06/03/98

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Program	HW			
Parameter	EPA Method	Billing Code	Cert Date	
Manganese	EPA 6010B	MTL3	06/03/98	
Manganese	EPA 6020	MTL7	02/24/97	
Mercury	EPA 7470A	MTL5	06/02/97	
Mercury	EPA 7471A	MTL5	05/01/92	
Microwave Assisted Digestions	EPA 3051	PREP1	06/12/03	
Molybdenum	EPA 6010B	MTL3	06/03/98	
Nickel	EPA 6010B	MTL3	05/01/92	
Nickel	EPA 6020	MTL7	02/24/97	
Nonhalogenated Organics Using Gc/Fid	EPA 8015D	VOC4	12/05/06	
Paint Filter Liquids Test	EPA 9095B	MISC17	12/05/06	
Potassium	EPA 6010B	MTL3	06/03/98	
Purge And Trap For Aqueous Samples	EPA 5030C	PREP2	12/05/06	
Radium 228	EPA 9320	RADIO	06/26/02	
Sediments, Sludges And Soils	EPA 3050B	PREP1	05/09/02	
Selenium	EPA 6010B	MTL3	06/24/08	
Semivolatile Compounds By Gc/Ms	EPA 8270C	SOC16	06/03/98	
Separatory Funnel Liquid-Liquid Extraction	EPA 3510C	PREP2	05/09/02	
Silica	EPA 6010B	MTL3	04/04/06	
Silver	EPA 6010B	MTL3	06/03/98	
Silver	EPA 6020	MTL7	02/24/97	
Sodium	EPA 6010B	MTL3	06/03/98	
Soxhlet Extraction	EPA 3540C	PREP2	05/09/02	
Splp	EPA 1312	HAZ6	02/15/96	
Strontium	EPA 6010B	MTL3	05/09/02	
Tclp	EPA 1311	HAZ5	05/01/92	
Thallium	EPA 6010B	MTL3	06/26/02	
Thallium	EPA 6020	MTL7	02/24/97	
Tin	EPA 6010B	MTL3	06/03/98	
Titanium	EPA 6010B	MTL3	04/04/06	
Total Metals	EPA 3010A	PREP1	05/09/02	
Total Recoverable In Water	EPA 3005A	PREP1	05/09/02	
Ultrasonic Extraction	EPA 3550B	PREP2	05/09/02	
Vanadium	EPA 6010B	MTL3	06/24/08	
Vocs By Gc/Ms	EPA 8260B	VOC8	06/03/98	
Waste Dilution	EPA 3580A	PREP2	05/12/03	
Zinc	EPA 6010B	MTL3	06/03/98	
Zinc	EPA 6020	MTL7	02/24/97	
Total Licensed Parameters in this Program:		76		
Program	SDW			
Parameter	EPA Method	Billing Code	Cert Date	

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Program	SDW	Parameter	EPA Method	Billing Code	Cert Date
		Alkalinity	SM 2320B	NIA1	04/10/03
		Aluminum	EPA 200.7	MTL3	04/10/03
		Antimony	EPA 200.8	MTL7	04/10/03
		Arsenic	EPA 200.8	MTL7	04/10/03
		Barium	EPA 200.8	MTL7	04/10/03
		Beryllium	EPA 200.8	MTL7	04/10/03
		Bromide	EPA 300.0	NIIIA1	04/10/03
		Cadmium	EPA 200.8	MTL7	04/10/03
		Calcium	EPA 200.7	MTL3	04/10/03
		Carbon, Total Organic	SM 5310B	MISC1	04/10/03
		Chloride	EPA 300.0	NIIIA1	04/10/03
		Chromium Total	EPA 200.8	MTL7	04/10/03
		Copper	EPA 200.8	MTL7	04/10/03
		Cyanide	EPA 335.4	MISC7	06/26/02
		Cyanide	SM 4500 CN F	MISC7	04/10/03
		Fluoride	EPA 300.0	NIIIA1	04/10/03
		Fluoride	SM 4500-F C	NIB9	04/10/03
		Gamma Emitting Isotopes	EPA 901.1	RADIO	06/24/08
		Gross Alpha	EPA 900	RADIO	05/12/03
		Gross Beta	EPA 900	RADIO	04/10/03
		Hardness	SM 2340B	MTL3	05/09/02
		Hydrogen Ion (Ph)	SM 4500-H B	NIA6	05/09/07
		Iron	EPA 200.7	MTL3	04/10/03
		Lead	EPA 200.8	MTL7	04/10/03
		Magnesium	EPA 200.7	MTL3	04/10/03
		Manganese	EPA 200.7	MTL3	04/10/03
		Mercury	EPA 245.1	MTL5	04/10/03
		Nickel	EPA 200.8	MTL7	04/10/03
		Nitrate	EPA 353.2	NIB1	04/10/03
		Nitric Acid/Hydrochloric Acid	SM 3030F	PREP1	06/24/08
		Nitrite	EPA 353.2	NIIB4	06/26/02
		Orthophosphate	EPA 365.1	NIIB5	04/10/03
		Preliminary Filtration	SM 3030B	PREP1	12/24/03
		Radium 226	EPA 903.1	RADIO	04/10/03
		Radium 228	EPA 904	RADIO	04/10/03
		Residue, Filterable (Tds)	SM 2540C	NIIA8	04/10/03
		Selenium	EPA 200.8	MTL7	04/10/03
		Silica	EPA 200.7	MTL3	04/10/03
		Silver	EPA 200.8	MTL7	04/10/03
		Sodium	EPA 200.7	MTL3	04/10/03
		Specific Conductance	SM 2510B	NIA7	04/10/03

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Program		SDW		
Parameter	EPA Method	Billing Code	Cert Date	
Strontium	EPA 200.7	MTL3	04/10/03	
Sulfate	EPA 300.0	NIIIA1	04/10/03	
Thallium	EPA 200.8	MTL7	04/10/03	
Turbidity, Ntu: Nephelometric	EPA 180.1	NIA9	04/10/03	
Uranium	EPA 200.8	MTL7	04/13/05	
Zinc	EPA 200.7	MTL3	04/10/03	
Total Licensed Parameters in this Program:		47		

Program		WW		
Parameter	EPA Method	Billing Code	Cert Date	
Acidity	SM 2310B	NIIA1	06/26/02	
Alkalinity, Total	SM 2320B	NIA1	06/26/02	
Aluminum	EPA 200.7	MTL3	10/16/95	
Aluminum	EPA 200.8	MTL7	04/12/04	
Ammonia	EPA 350.1	NIIB1	05/01/92	
Antimony	EPA 200.7	MTL3	05/09/02	
Antimony	EPA 200.8	MTL7	02/24/97	
Arsenic	EPA 200.7	MTL3	05/09/02	
Arsenic	EPA 200.8	MTL7	02/24/97	
Barium	EPA 200.7	MTL3	10/16/95	
Barium	EPA 200.8	MTL7	02/24/97	
Base/Neutrals And Acids Excluding Pesticides	EPA 625	SOC16	05/12/03	
Beryllium	EPA 200.7	MTL3	10/16/95	
Beryllium	EPA 200.8	MTL7	02/24/97	
Biochemical Oxygen Demand	SM 5210B	DEM1	05/09/07	
Boron	EPA 200.7	MTL3	05/01/92	
Bromide	EPA 300.0	NIIIA1	09/27/01	
Cadmium	EPA 200.7	MTL3	10/16/95	
Cadmium	EPA 200.8	MTL7	02/24/97	
Calcium	EPA 200.7	MTL3	05/25/94	
Chemical Oxygen Demand	EPA 410.4	DEM3	05/01/92	
Chloride	EPA 300.0	NIIIA1	05/25/94	
Chloride	SM 4500-CL E	NIA2	05/09/07	
Chromium Total	EPA 200.7	MTL3	10/16/95	
Chromium Total	EPA 200.8	MTL7	02/24/97	
Chromium, Hexavalent	SM 3500-CR D	MTL8	05/09/02	
Cobalt	EPA 200.7	MTL3	10/16/95	
Cobalt	EPA 200.8	MTL7	02/24/97	
Copper	EPA 200.7	MTL3	10/16/95	
Copper	EPA 200.8	MTL7	02/24/97	
Cyanide, Total	EPA 335.4	MISC7	05/08/07	

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Program	WW	Parameter	EPA Method	Billing Code	Cert Date
		Cyanide, Total By Quickchem	QUIKCHEM 10-204-00-1	MISC7	06/24/08
		Fluoride	EPA 300.0	NIIIA1	05/09/02
		Fluoride	SM 4500-F C	NIB3	05/09/02
		Gross Alpha	EPA 900	RADIO	04/10/03
		Gross Beta	EPA 900.0	RADIO	04/10/03
		Hardness	SM 2340B	NIA5	01/12/06
		Hydrogen Ion (Ph)	SM 4500-H B	NIA6	05/09/07
		Iron	EPA 200.7	MTL3	10/16/95
		Kjeldahl Nitrogen	EPA 351.2	NIIB3	05/09/02
		Lead	EPA 200.7	MTL3	10/16/95
		Lead	EPA 200.8	MTL7	02/24/97
		Lithium	EPA 200.7	MTL3	04/10/03
		Magnesium	EPA 200.7	MTL3	05/25/94
		Manganese	EPA 200.7	MTL3	10/16/95
		Manganese	EPA 200.8	MTL7	02/24/97
		Mercury	EPA 1631E	MTL10	04/10/03
		Mercury	EPA 245.1	MTL5	10/16/95
		Molybdenum	EPA 200.7	MTL3	10/16/95
		Molybdenum	EPA 200.8	MTL7	02/24/97
		Nickel	EPA 200.7	MTL3	10/16/95
		Nickel	EPA 200.8	MTL7	02/24/97
		Nitrate-Nitrite (As N)	EPA 353.2	NIB1	05/01/92
		Nitric Acid/Hydrochloric Acid	SM 3030F	PREP1	06/24/08
		Nitrite	EPA 353.2	NIIB4	05/09/07
		Oil And Grease, Tph	EPA 1664A	MISC6	12/05/06
		Orthophosphate	EPA 365.1	NIIB5	05/01/92
		Phenols	EPA 420.4	MISC8	05/09/07
		Phosphorus Total	EPA 365.1	NIIB6	05/01/92
		Potassium	EPA 200.7	MTL3	05/25/94
		Preliminary Filtration	SM 3030B	PREP1	06/24/08
		Purgeables	EPA 624	VOC8	05/12/03
		Radium 226	EPA 903.1	RADIO	04/10/03
		Residue Filterable	SM 2540C	NIA8	12/05/06
		Residue Nonfilterable	SM 2540D	NIIA5	12/05/06
		Residue Total	SM 2540B	NIIA4	12/05/06
		Residue Volatile	EPA 160.4	NIIA7	05/01/92
		Residue, Settleable Solids	SM 2540F	NIIA6	05/01/92
		Selenium	EPA 200.7	MTL3	05/09/02
		Selenium	EPA 200.8	MTL7	02/24/97
		Selenium	SM 3114B	MTL6	05/09/02

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

Program	WW	Parameter	EPA Method	Billing Code	Cert Date
		Silica, Dissolved	EPA 200.7	MTL3	05/01/92
		Silver	EPA 200.7	MTL3	10/16/95
		Silver	EPA 200.8	MTL7	02/24/97
		Sodium	EPA 200.7	MTL3	05/25/94
		Specific Conductance	SM 2510B	NIA7	05/24/07
		Strontium	EPA 200.7	MTL3	05/09/02
		Sulfate	EPA 300.0	NIIIA1	05/25/94
		Sulfate	SM 4500-SO4 D	NIB3	05/18/05
		Thallium	EPA 200.8	MTL7	02/24/97
		Tin	EPA 200.7	MTL3	05/09/02
		Total Organic Carbon	SM 5310B	MISC1	05/09/07
		Total Radium	EPA 903.0	RADIO	
		Turbidity	EPA 180.1	NIA9	05/01/92
		Uranium	EPA 200.8	MTL7	02/24/97
		Vanadium	EPA 200.7	MTL3	10/16/95
		Vanadium	EPA 200.8	MTL7	02/24/97
		Zinc	EPA 200.7	MTL3	10/16/95
		Zinc	EPA 200.8	MTL7	02/24/97

Total Licensed Parameters in this Program: 89

Instruments	Quantity	Date
RADIATION COUNTING INSTRUMENT	4	07/11/01
GAS CHROMATOGRAPH	3	05/29/08
GAS CHROMATOGRAPH/MASS SPECTROMETER	3	05/29/08
INDUCTIVELY COUPLED PLASMA SPECTROMETER	3	05/29/08
INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETER	3	05/29/08
AUTOMATED AUTOANALYZER	3	05/29/08
ION CHROMATOGRAPH	1	05/29/08
ATOMIC ABSORPTION SPECTROPHOTOMETER	1	05/09/07
MERCURY ANALYZER	1	05/29/08

Softwares
ENVIROQUANT - GCMS
AGILENT - ICP/MS
LEEMAN MERCURY ANALYZER
TJA TRACE-ICP
ENVIROQUANT - HPLC
BERTHOLD LB770 - COUNTER FOR RADIOACTIVITY
TENNELEC LB 5100 - COUNTER FOR RADIOACTIVITY

Wednesday, July 2 2008

AZ License: AZ0102

Lab Name: ACZ Laboratories, Inc.

CANBERRA XLB - COUNTER FOR RADIOACTIVITY

APPENDIX D

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

DEPARTMENT REPORT FOR MANAGEMENT REVIEW OF THE QUALITY SYSTEM

Department: _____

Quarter Ending: _____

OPERATIONS: EVALUATE ALL OPERATIONS (FROM LOG-IN –REPORTING) AS IT PERTAINS TO THE DEPARTMENT

What operations-related issues within the company, including client feedback, have the department encountered during the last quarter? Were any of the issues reoccurring? What actions were taken to resolve the issues? What actions can be taken to reduce/eliminate these issues in the future?

RESOURCES & PERSONNEL: EVALUATE RESOURCES & PERSONNEL AS THEY PERTAIN TO THE DEPARTMENT

Did the department have adequate resources (supplies, instrumentation, facilities, etc.) and properly trained staff for the volume of work? What resources must be available for the work expected next quarter? What obstacles do employees within the department routinely experience that hinder efficiency/productivity?

QUALITY ASSURANCE & QUALITY CONTROL: EVALUATE QA/QC AS THEY PERTAIN TO THE DEPARTMENT

Are any failed QC indicators reoccurring? If so, describe. Were any changes to policies/procedures implemented during the past quarter as a result of corrective and/or preventive actions? If yes, were they effective? If no, what changes would be effective?

MISC: PROVIDE ADDITIONAL FEEDBACK

FRMQA041.08.06.02

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

DATE OF REVIEW : _____

Attendees:

SUITABILITY OF POLICIES & PROCEDURES :

Do ACZ's policies and procedures accurately reflect management's Quality Policy Statement? Are ACZ's policies and procedures effective? If no, what changes are necessary?

REVIEW OF STAFF RESOURCES & TRAINING:

Did ACZ have appropriate staff to handle the volume of work received during the past quarter? Was all staff properly trained and was training documented before a new analyze independently analyzed client samples?

REVIEW OF INSTRUMENTATION / EQUIPMENT, SUPPLIES & CONSUMABLES :

Did ACZ have necessary and properly functioning instrumentation and equipment to perform the volume of work received last quarter? Did ACZ have adequate supplies and consumables on hand to perform the volume of work?

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF RECENT INTERNAL AUDITS:

Did the QA/QC department adhere to its internal audit schedule? Did any department(s) have significant issues? Were corrective actions completed properly and within the agreed time frame? Was follow-up completed for all corrective actions?

REVIEW OF RECENT EXTERNAL AUDITS:

Did the audit report(s) cite any repeat deficiencies? Did any department(s) have significant issues? Were all corrective actions completed properly and within the agreed time frame? Was follow-up completed for all corrective actions?

REVIEW OF RECENT PROFICIENCY TESTING STUDIES:

A) Were all analyte values reported for each study?

WP	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
WS	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
RAD	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Soil/UST	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>

B) Did ACZ passed 2 out of the 3 most recent PT studies for each analyte?

WP	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
WS	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
RAD	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Soil/UST	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>

C) Were corrective actions completed within the agreed time frame for all studies?

WP	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
WS	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
RAD	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Soil/UST	NA <input type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>

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Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF RECENT CORRECTIVE / PREVENTATIVE ACTIONS:

What corrective / preventive actions were implemented during the past quarter? What trends are apparent? Were corrective actions completed within the agreed time frame? Have changes resulting from corrective / preventive actions been implemented? Are they effective?

REVIEW OF CLIENT COMPLAINTS/FEEDBACK:

Did ACZ receive client feedback (positive or negative) during the past quarter? For complaints received, did ACZ adhere to its client complaint policy? Were complaints handled in a manner satisfactory to the client? Were all complaints resolved? What quality indicators are repeated?

REVIEW OF CHANGES IN VOLUME / TYPE OF WORK:

Did ACZ experience a significant change in volume and/or type of work last quarter? How did we do? What improvements can be made? Is ACZ prepared for volume and/or type of work expected next quarter?

REVIEW OF ETHICS PROGRAM:

Were all Ombudsman issues addressed in a timely manner? Were any data integrity issues/concerns brought to the attention of the Ombudsman issues or dilemmas? Were all employees trained on ACZ's Ethics and Proactive Prevention Program (SOPAD039)? Was follow-up training conducted within the time frame stated in SOPAD039?

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Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF DEPARTMENTS:

Geochemistry

Clean Room / Prep

Inorganic Inst / Prep

Wet Chemistry Instrument

Wet Chemistry Manual

Organics

Radiochemistry

Log-In

Client Services (Sales / PMs)

Document Control

Information Systems

APPENDIX E REFERENCES UTILIZED BY ACZ

- "NELAC Standards," National Environmental Laboratory Accreditation Conference, (current version).
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," USEPA, Federal Register Vol. 67, No. 205, October 23, 2002.
- "Manual for the Certification of Laboratories Analyzing Drinking Water," USEPA, (current version).
- "Methods for the Chemical Analysis of Water and Wastes," USEPA, EPA-600/4-79-020, March 1983.
- "Test Methods for Evaluating Solid Waste," USEPA, SW-846 Third Edition, Update III, December 1996.
- "Guidelines in Establishing Test Procedures for the Analysis of Wastewater Pollutants," Code of Federal Regulations 40, Parts 136, 141, 143.
- "Quality Assurance of Chemical Measurements," Taylor, J., Lewis Publishers, Michigan, 1987
- "Annual Book of Standards, Water Analysis," ASTM, 1989.
- "Quality Control in Analytical Chemistry," Kateman, G., Vol. 60, 1985.
- "Principles of Environmental Analysis, Analytical Chemistry," Keith, L.H., et al., Vol. 55, 1983.
- "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," USEPA, 1979.
- "Guidance for the Data Quality Assessment: Practical Methods for Data Analysis," USEPA, EPA 600/R-96-084, July 2000.
- "Methods for the Determination of Metals in Environmental Samples," USEPA, EPA 600/4-91-010, June 1991.
- "Methods for the Determination of Metals in Environmental Samples," Supplement I [to EPA 600/4-91-010], USEPA, EPA 600/R-94-111, May 1994.
- "Methods for the Determination of Inorganic Substances in Environmental Samples," USEPA, EPA 600/R-93-100, August 1993.
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, EPA 821/B-96-005, December 1996.
- "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," USEPA, EPA 600/4-80-032. August 1980.
- "Determination of Lead-210, Thorium, Plutonium and Polonium-210 in Drinking Water: Methods 909, 910, 911, 912," 01A0004860 (Region 1 Library), March 1982.
- "Good Automated Laboratory Practices - Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations" USEPA, 2185, 1995.

APPENDIX F DEFINITIONS OF TERMS

Acceptance Criteria: specified limits places on characteristics of an item, process, or service defined in requirement documents.

Accreditation: verification by a competent, disinterested, third party that a laboratory possesses the capability to produce accurate test data, and that it can be relied upon in its day-to-day operations to maintain high standards of performance.

Accuracy: 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; a data quality indicator.

Analytical Spike (AS): an aliquot of client sample to which a known amount of target analyte is added and that demonstrates the absence or presence of interference in the matrix. The AS is prepared exactly the same way as the LFB, only spiking into sample instead of reagent blank, and is not prepped (digested) prior to analysis. The AS may also be referred to as a post-digestion spike.

Analytical System: the combination of events, techniques, and procedures used to generate analytical results.

Audit: a systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.

Batch: environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same matrix, meeting the above criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of 20 or less prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group.

All required QC samples must be prepared and/or analyzed with each batch at the frequency required by the method, even if there are less than 20 client samples in the batch. If the workgroup has more than 20 samples, then sufficient batch QC must be analyzed for additional samples. Every batch of environmental samples is assigned a unique (i.e. traceable) six-digit numerical identifier called the LIMS Workgroup number.

Blank: a sample that has not been exposed to the analyzed sample stream utilized to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. See also Equipment Blank, Field Blank, Instrument Blank, Method Blank, Reagent Blank. Refer to section 11.3 for types of blanks.

Blind Sample: a sub-sample for analysis with a composition known to the submitter. The analyst or laboratory may know the identity of the sample but not its composition. It is used to test the analyst or laboratory's proficiency in the execution of the measurement process.

Calibration: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of applied calibration standard should bracket the range of planned or expected sample measurements.

Calibration Curve: the graphical relationship between the known values, such as concentrations, or a series of calibration standards and their instrument responses.

Case Narrative: Additional documentation provided in the client report that describes any abnormalities and deviations that may affect the analytical results and summarizes any issues in the data package that need to be highlighted for the data user to help them assess the usability of the data.

Chain of Custody Form: a legal record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses.

Continuing Calibration Blank (CCB): the same solution as the calibration blank, it detects baseline drift in the calibration of the instrument. When specified by the method, analyze a CCB immediately after each CCV, including the final CCV.

Continuing Calibration Verification (CCV): a solution of method analytes of known concentrations used to confirm the continued calibration of the instrument. The CCV is analyzed at the frequency indicated in the test SOP.

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

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e. the data meet specified acceptance criteria)

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

Demonstration of Capability (DOC): a procedure to establish the ability of the analyst to generate acceptable accuracy [and precision, if applicable].

Detection Limit: the lowest concentration or amount of target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value (see Method Detection Limit).

Document Control: the act of ensuring that 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.

Equipment Blank: a sample of analyte-free media that has been used to rinse common sampling equipment to check the effectiveness of decontamination procedures.

False Positive (Type I or alpha error): concluding that a substance is present when it truly is not.

False Negative (Type II or beta error): concluding that a substance is not present when it truly is.

Field Blank: a blank prepared in the field by filling a clean container with Type I water and appropriate preservative, if any, for the specific sampling activity being undertaken.

Holding Time (Maximum Allowable Holding Time): the maximum time that samples may be held prior to analysis and still be considered valid or not compromised.

Initial Calibration Blank (ICB): a solution identical to the calibration blank and confirms the absence of background contamination in the calibration blank. When specified by the method, an ICB is analyzed immediately after the ICV.

Initial Calibration Verification (ICV): a solution of method analytes of known concentrations intended to determine the validity of the instrument calibration. The ICV must be analyzed immediately after each calibration and must be prepared from a source independent of the calibration standards, preferably purchased from a different manufacturer.

Instrument Blank: an aliquot of Type I water or solvent processed through the instrument steps of the measurement process; used to determine presence of instrument contamination.

Internal Standard (IS): a known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Laboratory Fortified Blank (LFB): a reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample and determines whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Legal Chain of Custody Protocols: procedures employed to record the possession of samples from the time of sampling until analysis and are performed at the special request of the client. These protocols include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Linear Dynamic Range (LDR): concentration range over which the instrument response to analyte is linear.

Matrix Duplicate (DUP): a second aliquot of a client sample that is prepared and analyzed in the same manner as all other samples in the same workgroup. The DUP demonstrates the precision of the method.

Matrix Spike (spiked sample or fortified sample): a sample prepared by adding a known amount of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes (MS or LFM) are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate: a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Maximum Contamination Limit (MCL): the numerical value expressing the maximum permissible level of contaminant in water that is delivered to any user of a public water system.

May: denotes permitted action, but not required action.

Method Blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as client samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for the sample analyses.

Method Detection Limit: the minimum concentration of an analyte, in a given fortified matrix, that can be measured and reported with 99% confidence that the concentration is greater than zero.

Must: denotes a requirement.

The NELAC Institute (TNI): a voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories.

Outlier (Statistical): an observation or data point that deviates markedly from other members of the population.

Performance Audit: the routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

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.

Protocol: a detailed written procedure [SOP] for laboratory operation that must be strictly followed.

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality.

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Manual [QAP]: a document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products, and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control.

Quantitation Limit [Reporting Limit, Practical Quantitation Limit]: level, concentration, or quantity of a target variable (i.e. target analyte) below which data is reported as estimated. The quantitation limit may or may not be statistically determined, or may be an estimate that is based upon analyst experience or judgment.

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for reconstructing and evaluating the report of the activity or study.

Reagent Blank (method reagent blank): a sample consisting only of Type I water and reagent(s) without the target analyte(s) or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

Reference Method: a method of known and documented accuracy and precision issued by an organization recognized as competent to do so (EPA, etc.). The reference method is included on the client report.

Sample Tracking: procedures employed to record the possession of the samples from the time of sampling until analysis, reporting, and archiving. These procedures include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.

Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels (i.e. concentrations) of a variable of interest.

Shall: denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there is no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Should: denotes a guideline of recommendation whenever noncompliance with the specification is permissible.

Signal to Noise Ratio (S/N): a dimensionless measure of the relative strength of an analytical signal (S) to the average strength of the background instrumental noise (N) for a particular sample.

Spike: a known amount of target analyte added to a blank sample or client sub-sample; used to determine the recovery efficiency or for other quality control purposes.

Standard Deviation: the measure of the degree of agreement (precision) among replicate analyses of a sample. The population standard deviation (n degrees of freedom) should only be used for more than 25 data points; otherwise, when referenced, standard deviation implies sample standard deviation (n-1 degrees of freedom).

Standard Operating Procedure (SOP): a written document which details the manner in which an operation, analysis, or action is performed. The techniques and procedures are thoroughly prescribed in the SOP and are the accepted process for performing certain routine or repetitive tasks.

Supervisor [however named]: the individual designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training, and experience to perform the required analyses.

Surrogate (SURR): a substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.

Test Method: adoptions of a scientific technique for a specific measurement problem, as documented in a laboratory SOP or published by a recognized authority.

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.

APPENDIX G TECHNICAL DIRECTORS

Name	Department	Degree
James Rhudy	Organics	BA, Molecular Biology; BA, Biochemistry
Matt Sowards	Radiochemistry, Wet Chemistry Manual	BS, Neurophysiology
Steve Pulford	Metals, Clean Room	BS, Chemical Engineering
Billy Grimes	Metals, Inorganic Inst	BA, Biology
Carol Poirot	Wet Chemistry Instrument	BS, Physics; MS, Material Sciences
Lee Thompson	Geochemistry	BS, Microbiology

APPENDIX E
ARIZONA LABORATORY DATA QUALIFIERS

Arizona Data Qualifiers
Revision 3.0
9/20/2007

Developed by the Sub-committee of the Arizona Environmental Laboratory Advisory Committee

This is an updated list of the Rev. 2.0 Arizona Data Qualifiers dated 11/26/2003, with some new qualifiers added, some obsolete ones deleted and some modified.

Using the following Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency. Arizona Department of Environmental Quality expects that data reported utilizing the following qualifiers, unless stated otherwise, is useable, scientifically valid and defensible. In the laboratory's judgment if the data should not be used for compliance, the T6 qualifier must be used. Other general guidelines for use and application of the following data qualifiers can be found as an attachment to this document (ATTACHMENT A).

Note: For drinking water samples, please use the [AZ Drinking Water Data Qualifiers 10/23/2001 \[PDF 23K\]](#)

Microbiology:

- A1 = Too numerous to count.
- A2 = Sample incubation period exceeded method requirement.
- A3 = Sample incubation period was shorter than method requirement.
- A4 = Target organism detected in associated method blank.
- A5 = Incubator/water bath temperature was outside method requirements.
- A6 = Target organism not detected in associated positive control.
- A7 = Micro sample received without adequate headspace.
- A8 = Plate count was outside the method's reporting range. Reported value is estimated.

Method/calibration blank:

- B1 = Target analyte detected in method blank at or above the method reporting limit.
- B2 = Non-target analyte detected in method blank and sample, producing interference.
- B3 = Target analyte detected in calibration blank at or above the method reporting limit.
- B4 = Target analyte detected in blank at or above method acceptance criteria.
- B5 = Target analyte detected in method blank at or above the method reporting limit, but below trigger level or MCL.
- B6 = Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.
- B7 = Target analyte detected in method blank at or above method reporting limit.

Concentration found in the sample was 10 times above the concentration found in the method blank.

Confirmation:

C1 = Confirmatory analysis not performed as required by the method.
C2 = deleted
C3 = Qualitative confirmation performed.
C4 = Confirmatory analysis was past holding time.
C5 = Confirmatory analysis was past holding time. Original result not confirmed.
C6 = deleted
C7 = deleted
C8 = Sample RPD between the primary and confirmatory analysis exceeded 40%.
Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.

Dilution:

D1 = Sample required dilution due to matrix.
D2 = Sample required dilution due to high concentration of target analyte.
D3 = deleted.
D4 = Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
D5 = Minimum Reporting Limit (MRL) adjusted due to sample dilution; analyte was non-detect in the sample.
D6 = Minimum Reporting Limit (MRL) adjusted due to an automatic 10X dilution performed on this sample for the purpose of reporting traditional drinking water analytes for wastewater requirements.

Estimated concentration:

E1 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not possible due to insufficient sample.
E2 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
E3 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.
E4 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL).
E5 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.
E6 = Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.
E7 = Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.

E8 = Analyte reported to MDL per project specification. Target analyte was not detected in the sample.

Hold time:

H1 = Sample analysis performed past holding time.

H2 = Initial analysis within holding time. Reanalysis for the required dilution was past holding time.

H3 = Sample was received and analyzed past holding time.

H4 = Sample was extracted past required extraction holding time, but analyzed within analysis holding time.

H5 = This test is specified to be performed in the field within 15 minutes of sampling; sample was received and analyzed past the regulatory holding time.

BOD/CBOD:

K1 = The sample dilutions set-up for the BOD/CBOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.

K2 = The sample dilutions set up for the BOD/CBOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. Any reported result is an estimated value.

K3 = deleted.

K4 = deleted.

K5 = The dilution water D.O. depletion was > 0.2 mg/L.

K6 = Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.

K7 = A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.

K8 = Glucose/glutamic acid BOD/CBOD was above method acceptance levels.

Laboratory fortified blank/blank spike:

L1 = The associated blank spike recovery was above laboratory acceptance limits

L2 = The associated blank spike recovery was below laboratory acceptance limits.

L3 = The associated blank spike recovery was above method acceptance limits.

L4 = The associated blank spike recovery was below method acceptance limits.

Matrix spike:

M1 = Matrix spike recovery was high; the associated blank spike recovery was acceptable.

M2 = Matrix spike recovery was low; the associated blank spike recovery was acceptable.

M3 = The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The associated blank spike recovery was acceptable.

M4 = The analysis of the spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.

M5 = Analyte concentration was determined by the method of standard addition (MSA).

M6 = Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.

M7 = Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.

General:

N1 = See case narrative.

N2 = See corrective action report.

N3 = deleted.

N4 = The Minimum Reporting Limit (MRL) verification check did not meet the laboratory acceptance limit.

N5 = The Minimum Reporting Limit (MRL) verification check did not meet the method acceptance limit.

N6 = Data suspect due to quality control failure, reported per data user's request.

Sample quality:

Q1 = Sample integrity was not maintained. See case narrative.

Q2 = Sample received with head space.

Q3 = Sample received with improper chemical preservation.

Q4 = Sample received and analyzed without chemical preservation.

Q5 = Sample received with inadequate chemical preservation, but preserved by the laboratory.

Q6 = Sample was received above recommended temperature.

Q7 = Sample inadequately dechlorinated.

Q8 = Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policies 0154.000 and 0155.000.

Q9 = Insufficient sample received to meet method QC requirements.

Q10 = Sample received in inappropriate sample container.

Q11 = Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.

Duplicates:

R1 = RPD/RSD exceeded the method acceptance limit.

R2 = RPD/RSD exceeded the laboratory acceptance limit.

R3 = deleted.

R4 = MS/MSD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.

R5 = MS/MSD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.

R6 = LFB/LFBD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.
R7 = LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
R8 = Sample RPD exceeded the method acceptance limit.
R9 = Sample RPD exceeded the laboratory acceptance limit.
R10 = deleted.
R11 = The RPD calculation for MS/MSD does not provide useful information due to the varying sample weights when Encore samplers/methanol field preserved samples are used.

Surrogate:

S1 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits.
S2 = deleted.
S3 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits. No target analytes were detected in the sample.
S4 = Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
S5 = Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.
S6 = Surrogate recovery was below laboratory and method acceptance limits. Reextraction and/or reanalysis confirms low recovery caused by matrix effect.
S7 = Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.
S8 = The analysis of the sample required a dilution such that the surrogate recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
S9 = deleted.
S10 = Surrogate recovery was above laboratory and method acceptance limits. See case narrative.
S11 = Surrogate recovery was high. Data reported per ADEQ policy 0154.000.
S12 = Surrogate recovery was low. Data reported per ADEQ policy 0154.000.

Method/analyte discrepancies:

T1 = Method approved by EPA, but not yet licensed by ADHS.
T2 = Cited ADHS licensed method does not contain this analyte as part of method compound list.
T3 = Method not promulgated either by EPA or ADHS.
T4 = Tentatively identified compound. Concentration is estimated and based on the closest internal standard.
T5 = Laboratory not licensed for this parameter.
T6 = The reported result cannot be used for compliance purposes.

T7 = Incubator/Oven temperatures were not monitored as required during all days of use.

Calibration verification:

V1 = CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.

V2 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.

V3 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed. See case narrative.

V4 = deleted.

V5 = CCV recovery after a group of samples was above acceptance limits. This target analyte was not detected in the sample; acceptable per EPA Method 8000C.

V6 = Data reported from one-point calibration criteria per ADEQ policy 0155.000.

V7 = deleted.

V8 = deleted.

V9 = CCV recovery was below method acceptance limits.

Calibration:

W1= deleted.

W2= deleted.

ATTACHMENT A

“Guidance on the Usage of Data Qualifiers”

These standardized data qualifiers are for use in qualifying analytical results for compliance samples in Arizona to represent events that occurred during analysis. The technical subcommittee has endeavored to develop qualifiers that are succinct and narrow in scope to eliminate broad or multiple interpretations when assessing the impact on data. It must also be noted that due to the specialized nature of the individual qualifiers, it is likely that more than one qualifier may be needed in order to accurately represent the data.

- Note:
1. Using the Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency.
 2. As specified in the Arizona Adopted Rules, R9-14-615.C.9, *for each parameter tested at the laboratory for which quality control acceptance criteria are not specified in the approved method or by EPA or ADEQ,:*
 - a. Use default limits provided in Exhibit II; or
 - b. Statistically develop limits from historical data

The laboratory has an option of using ADHS Default Limits which can be accessed at <http://www.azdhs.gov/lab/license/tech/altdefaultlimit.pdf>

Microbiology:

None.

Method/calibration blank:

Apply appropriate qualifier to affected analyte in the blank if target analyte is not detected at \geq RL in the samples. If analytes are detected, then all corresponding analytes for the associated samples should also be qualified.

Confirmation:

For methods that require qualitative confirmation. C3 applies to methods that require quantitative confirmation.

Dilution:

If all analytes are reported from the diluted sample, apply qualifier to the entire sample. Otherwise apply qualifier to each analyte that required dilution.

Estimated concentration:

Appropriate qualifier must be used for any analyte result reported outside the calibration range. Affects data reported outside the calibration range or down to the MDL. E8 is only required if additional clarification is necessary.

Hold time:

Qualify samples appropriately when method extraction and/ or analysis holding time have been exceeded.

BOD/CBOD:

Qualifiers K5, K6, & K8 indicate situations that may impact all results in an analytical run and should be used to qualify all affected samples as well as any affected quality control samples when reported.

Laboratory fortified blank/blank spike:

Appropriate qualifier must be applied to the affected analytes in the Laboratory fortified blank/blank spike and to all corresponding analytes in the associated samples.

Matrix spike:

Appropriate qualifier must be applied to the affected analytes in the matrix spike and should also be added to all corresponding analytes in the associated spiked sample. If a batch spike recovery is outside of the acceptable range, it is permissible to only flag the sample that was spiked and not the other samples in the batch. As required in the Arizona Adopted Rules A.A.C. R9-14-617.8.d, clients must always be informed if the batch QC result is unacceptable whether one of their samples was spiked or not. The laboratory can choose how the unacceptable QC is reported to the client (e.g., cover letter or flag).

The ADEQ policy 0154.000 can be accessed at
<http://www.azdeq.gov/function/business/download/spike8.pdf>

General:

None.

Sample quality:

Flag samples with appropriate qualifier when sample quality may be potentially impacted or when method requirements were not met.

The ADEQ policy 0154.000 can be accessed at

<http://www.azdeq.gov/function/business/download/spike8.pdf>

The ADEQ policy 0155.000 can be accessed at

http://www.azdeq.gov/function/business/download/one_pt3.pdf

Duplicates:

For use with sample, matrix spike, LFB and LFB/blank spike duplicates. Qualify all affected analytes. For MS/MSD or sample duplicates qualify only the original source sample.

Surrogate:

Qualify surrogates appropriately when they do not meet criteria. Surrogate failures in quality control samples will most likely require additional narration. S11 & S12 are used to qualify sample surrogates and only in cases where the Laboratory Fortified Blank/ blank spike has acceptable surrogate recoveries.

Method/analyte discrepancies:

For use with methods or analytes that are not currently approved under the Environmental Laboratory Licensure Rules or for which the lab is not licensed.

Calibration verification:

Appropriate qualifier must be applied to all affected analytes in any samples associated with the calibration verification.

The ADEQ policy 0155.000 can be accessed at

http://www.azdeq.gov/function/business/download/one_pt3.pdf

Calibration:

None.