

Quality Assurance Program Plan

Prepared by:
Environment, Health and Safety Division
Environmental Services Group
Environmental Restoration Program

September 2009

Revision 5



Ernest Orlando Lawrence Berkeley National Laboratory
Berkeley, CA 94720

This work was supported by the Director, Office of Science, U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Review and Approval

Prepared By: David Baskin Date: 9/8/09
David Baskin
Environmental Restoration Program Leader
Environmental Services Group

Reviewed By: Ned Borglin Date: 09/08/2009
Ned Borglin
Quality Assurance Manager
Environmental Services Group

Suying Xu Date: 9/8/09
Suying Xu
Environmental Restoration Program Data Manager
Environmental Services Group

Approved By Ron Pauer Date: 9/9/09
Ron Pauer
Environmental Protection Group Leader
Environmental Services Group

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1.0

Introduction

1.1 Purpose and Scope

This Quality Assurance Program Plan (QAPP) establishes the requirements for collecting data required as part of the Resource Conservation and Recovery Act (RCRA) Corrective Action Program (CAP) at the Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab). The purpose of the QAPP is to provide guidance on how quality assurance (QA) and quality control (QC) procedures are applied in order to produce data that are:

- Scientifically valid.
- Of documented quality.
- Legally defensible.

The format and elements of this QAPP are in accordance with United States Environmental Protection Agency (EPA) guidance, including EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations EPA QA/R-5 (March 2001) and EPA Guidance for Quality Assurance Project Plans EPA QA/G-5 (December 2002). Specific elements required in a QAPP include: project management, measurement data acquisition, assessment and oversight, data review and verification, and usability. These elements are discussed in the following four sections.

1.2 Background

Berkeley Lab is a multipurpose research facility operated by the University of California (UC) as part of the United States Department of Energy (DOE) national laboratory system. Berkeley Lab is located in the Berkeley/Oakland hills in Alameda County, California, and encompasses approximately 200 acres on the northeast side of the UC Berkeley campus (Figure 1.1 and Figure 1.2). The western three-quarters of the Berkeley Lab site are in the City of Berkeley and the eastern quarter is in the City of Oakland.

As a result of Berkeley Lab's mission as a research facility, many types of chemicals have been used or produced as wastes. Some of these chemicals were released to the environment over the more than 60 years of Berkeley Lab's operation. These include primarily volatile organic compounds (VOCs) used as cleaning solvents, polychlorinated biphenyls (PCBs), petroleum hydrocarbons, metals, and tritium.

Berkeley Lab hazardous waste activities operate under a RCRA Hazardous Waste Facility Permit, which was issued by the California Environmental Protection Agency - Department of Toxic Substances Control (DTSC). The Permit requires that Berkeley Lab investigate and address historic releases of hazardous waste or hazardous constituents that may have occurred at the facility, in accordance with RCRA CAP requirements. Investigation of potentially contaminated groundwater, soil, and surface water are

conducted by the Berkeley Lab Environmental Restoration Program (ERP). The ERP is a section of the Environmental Services Group (ESG) of Berkeley Lab's Environment, Health, and Safety Division (EH&S).

The objectives of the CAP are to evaluate the nature and extent of releases of hazardous waste or hazardous waste constituents; to evaluate facility characteristics; and to identify, develop, and implement appropriate corrective measures to protect human health and the environment. The primary components of the CAP are:

- RCRA Facility Investigation (RFI) - to evaluate the nature and extent of the releases of hazardous waste and hazardous constituents, and to gather other data to support the Corrective Measures Study (CMS) and/or the need to implement Interim Corrective Measures (ICMs).
- Interim Corrective Measures (ICMs) - to control or abate imminent threats to human health and/or the environment from releases, or to prevent or control the further spread of contamination while long-term remedies are pursued.
- Corrective Measures Study (CMS) - to develop and evaluate corrective measure alternative(s) and recommend the final corrective measures.
- Corrective Measures Implementation (CMI) - to design, construct, operate and maintain the corrective measures selected and monitor their performance.

Berkeley Lab is currently in the operation, maintenance and monitoring phase of the CMI. The corrective measures required for soil contamination have been completed (Berkeley Lab, 2007a). The corrective measures required for groundwater contamination have been implemented and are operational (Berkeley Lab, 2007a).

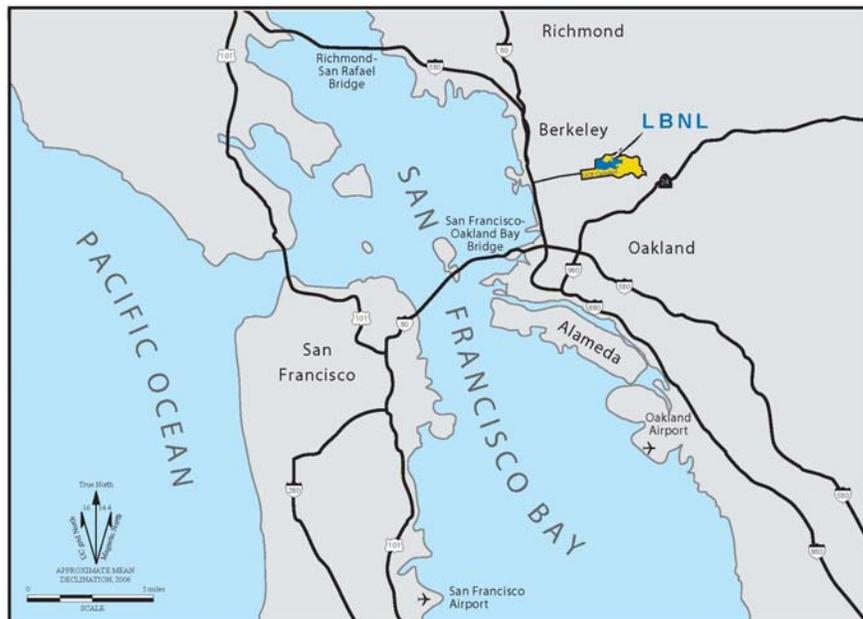


Figure 1.1 Regional Setting of the Lawrence Berkeley National Laboratory

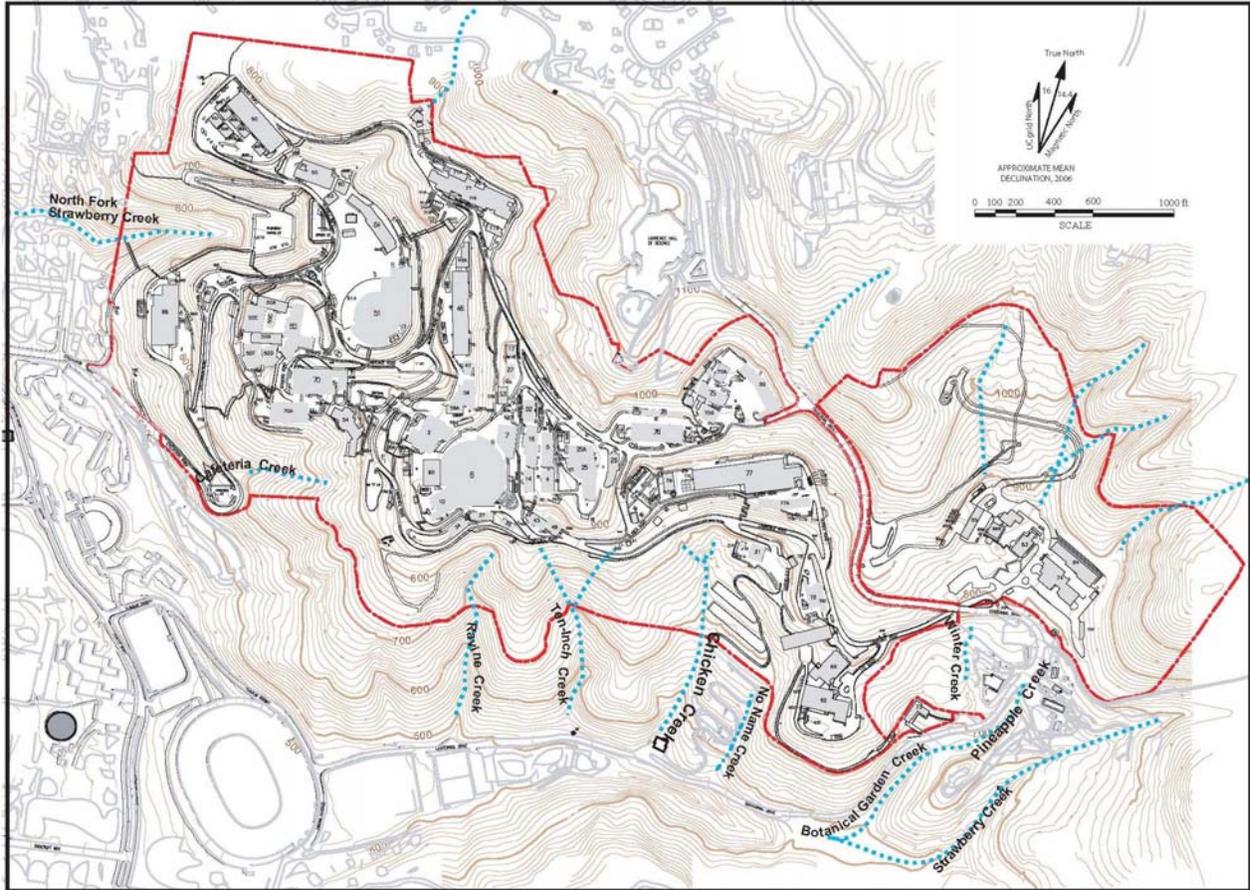


Figure 1.2 Site Location Map Lawrence Berkeley National Laboratory

2.0

Project Management

2.1 Project Organization

The ERP and the laboratories that analyze the samples collected under this QAPP are the data generators. The users of the data are the ERP technical personnel responsible for managing CAP requirements, the regulatory agencies overseeing the CAP, and other interested stakeholders (e.g., the general public and the DOE site managers). The relationship between the data generators and data users is shown in Figure 2.1.

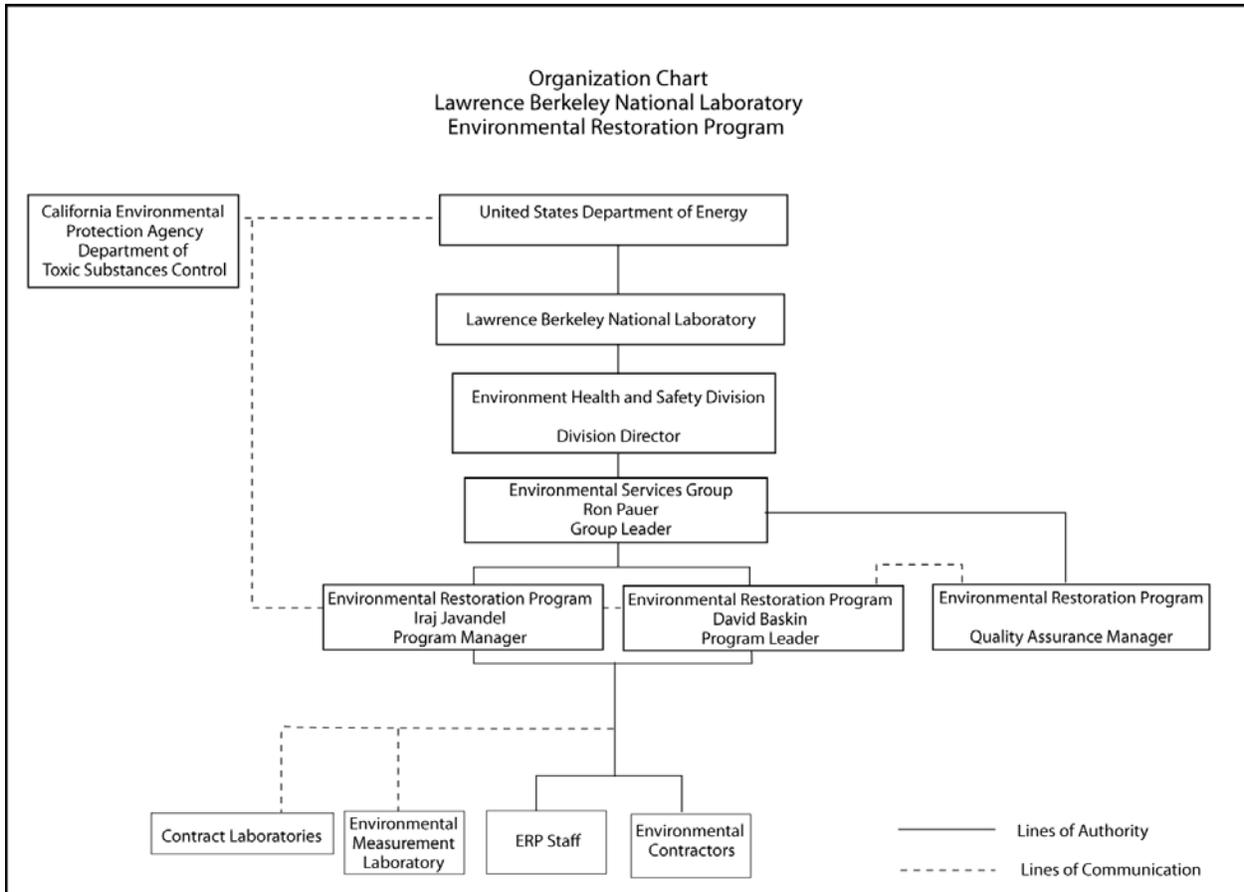


Figure 2.1 Project Organization

2.1.1 Data Generators

Environmental Services Group (ESG) Leader

The ESG Leader has overall responsibility for ensuring that appropriate QA measures are implemented for site surveillance and monitoring activities, site characterization, and corrective actions associated with Federal, State, and local environmental regulations pertinent to Berkeley Lab. The Group Leader is also responsible for ensuring that sufficient resources (personnel, supplies, and equipment) are available for compliance with the requirements of this QAPP and the associated EH&S Procedures.

Environmental Restoration Program (ERP) Leader

The ERP Leader is responsible for ensuring that ERP site personnel are provided access to the current QAPP and the EH&S Procedures relevant to their required activities, and that they are trained to perform fieldwork in accordance with QAPP and Procedure requirements. The Program Leader is also responsible for ensuring that ERP activities are carried out in accordance with QAPP and Procedure requirements, ensuring that laboratory reporting meets the requirements of this QAPP, and initiating corrective actions when conditions adverse to data quality are identified.

Quality Assurance (QA) Manager

The QA Manager is responsible for reviewing the requirements of the QAPP and for overseeing the implementation of the Environmental Compliance Audits and Assessment Program for ERP. The QA Manager documents any corrective action requirements that ensue from the review findings, and conducts and documents follow-up of such corrective action requirements.

Analytical Laboratories

Environmental samples are analyzed by the Berkeley Lab Environmental Measurement Laboratory (EML) and outside contract laboratories. All laboratories used for environmental sample analysis must be certified by the California Department of Public Health (CDPH) under the California Environmental Laboratory Accreditation Program (ELAP) for all requested analytical methods. The primary contract laboratories currently used by ERP include:

Chemical and Physical Analyses:

- BC Laboratories, Inc. (Bakersfield, California)
- Curtis & Tompkins, Ltd. (Berkeley, California)

Radionuclide Analyses:

- Eberline Services (Richmond, California)

The specific contract laboratories utilized could change over the course of the program due to contracting changes.

2.1.2 Data Users

Regulatory Agencies

The DTSC will use the data generated under this QAPP to support decisions of CMI completion, or determinations of Technical Impracticability (TI) should achieving the required cleanup levels be determined to be technically impracticable. The East Bay Municipal District (EBMUD) will use data generated under this QAPP to monitor compliance with requirements of Berkeley Lab's Wastewater Discharge Permit.

Environmental Restoration Program (ERP)

The ERP primarily uses the data collected under this QAPP to monitor the effectiveness of the groundwater remedial systems that have been constructed and other corrective measures that have been implemented for groundwater remediation. The ERP submits quarterly progress reports to the DTSC that contain all the data collected during the quarterly reporting period. The ERP also uses data collected under this QAPP to assure compliance with Berkeley Lab's Wastewater Discharge Permit, and to determine soil management and disposal requirements for waste soils generated during ERP activities.

2.2 Problem Definition Background

Berkeley Lab's cleanup activities are currently in the operation, monitoring and maintenance stage of the CMI phase of the CAP. During this phase, Berkeley Lab is collecting data to document the progress of the implemented corrective measures toward achieving the required groundwater cleanup levels (Media Cleanup Standards [MCSs]), and to document that site groundwater plumes are stable or attenuating and that contamination is not migrating offsite in groundwater or surface water. Berkeley Lab will use the data to determine when the required groundwater cleanup levels have been achieved or to complete a TI evaluation should achieving the required cleanup levels be determined to be technically impracticable. A determination of TI requires approval of the DTSC.

2.3 Project Task Description and Schedule

Details of the activities that are covered under provisions of this QAPP are provided in the *RCRA Corrective Measures Implementation (CMI) Workplan* (Berkeley Lab, 2005a), the *Groundwater Monitoring and Management Plan* (Berkeley Lab, 2006a), the *Soil Management Plan* (Berkeley Lab, 2006b) and the *RCRA Corrective Measures Implementation (CMI) Report* (Berkeley Lab, 2007a). These project tasks are summarized below.

2.3.1 Groundwater Sampling

The corrective measures approved by DTSC for remediating contaminated groundwater include soil flushing and groundwater capture systems, enhanced bioremediation through subsurface injection of Hydrogen Release Compound[®] (HRC), and Monitored Natural Attenuation (MNA). These measures have been implemented and are operational. Completion of corrective measures will be documented by

comparing residual concentrations of chemicals of concern in groundwater to the required cleanup levels (MCSs) (Berkeley Lab, 2005b). In addition, continued assessment of the effectiveness of MNA and enhanced bioremediation using HRC-injection is documented by comparing concentrations of key hydrochemical parameters (including nitrates, sulfates, and dissolved oxygen) to guideline parameter values listed in *Monitoring Protocols for Monitored Natural Attenuation and Enhanced Bioremediation* (Berkeley Lab, 2005c). Monitoring wells (compliance wells) for demonstrating compliance with MCSs are located throughout the area of groundwater contamination and are downgradient from those areas to monitor for downgradient plume migration. Locations for assessing effectiveness of MNA and enhanced bioremediation using HRC-injection consist of key wells within the contaminant plumes designated in the *CMI Report* (Berkeley Lab, 2007a).

2.3.2 Surface Water Sampling

Surface water samples are collected to document that chemicals of concern are not migrating offsite in surface water.

2.3.3 Soil Sampling

Soil samples are collected to determine appropriate management and disposal requirements for waste soils generated during ERP activities.

2.3.4 Treatment System Sampling

Water discharge samples are collected from groundwater treatment systems to document that the treatment systems are in compliance with the discharge permit issued by EBMUD for wastewater discharges into the sanitary sewer, and to determine when the carbon used for treatment needs to be changed out.

2.3.5 Laboratory Analyses

Analytical data that are generated under provisions of this QAPP consist primarily of concentrations of VOCs, metals, and tritium in groundwater, surface water, and soil. Soil and groundwater samples may also be analyzed for other potential contaminants such as PCBs, semi-volatile organic compounds (SVOCs), and petroleum hydrocarbons. Analyses for non-contaminant hydrochemical indicator parameters (including nitrates, sulfates, and dissolved oxygen) are also required to support the continued evaluation of the potential effectiveness of MNA and HRC.

2.3.6 Technical Report Preparation

Quarterly groundwater progress reports and annual status summary reports are submitted to DTSC. Additional technical reports are produced on an as-needed basis. Semiannual reports are also produced to comply with requirements of Berkeley Lab's wastewater discharge permit.

2.3.7 Schedule

After the required cleanup levels (MCSs) have been achieved at a specific groundwater unit, Berkeley Lab will submit documentation requesting that DTSC certify corrective measures for that unit are complete. When MCSs might be attained at a groundwater unit is not known at this time and will not be known until sufficient data have been collected to determine contaminant reduction rates resulting from the implemented corrective measures, and how these rates change over the long term. The effectiveness of the implemented remedial technologies in achieving the required MCSs will be evaluated at five-year intervals beginning in 2011, as part of the DTSC-required Five Year Reviews. In the event that a review determines a remedy is not effective, either an alternative remedy will be proposed and, if approved by DTSC, implemented; or Berkeley Lab will request a Determination of Technical Impracticability (TI) from the DTSC. If TI is approved, active corrective measures would be terminated at a unit; however, continued long-term groundwater monitoring would be required.

2.4 Quality Objectives and Criteria for Measurement Data

Data quality objectives (DQOs) are the qualitative and quantitative statements that clarify a study's technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used to establish the quality and quantity of data needed to support decisions. The following discusses the DQO process that will be utilized on this program.

Step 1 - State the Problem

Contaminated groundwater at Berkeley Lab poses a potential threat to human health and the environment. To mitigate this potential threat, corrective measures have been implemented in accordance with the requirements specified in the *RCRA Corrective Measures Implementation (CMI) Report* (Berkeley Lab, 2007a). These measures have been designed to reduce residual concentrations of chemicals of concern to levels at or below the DTSC-required MCSs.

To address both risk-based and regulatory-based requirements, two sets of MCSs were developed. Cleanup to risk-based MCSs is the short-term goal for areas of Berkeley Lab where groundwater is not considered to be a potential drinking water source (i.e., does not meet State Water Resources Control Board (SWRCB) well yield criteria of at least 200 gallons per day). Cleanup to more stringent regulatory-based MCSs is the short-term goal for all areas where groundwater meets the SWRCB well yield criteria and is therefore considered to be a potential drinking water source. The regulatory-based MCSs for groundwater were set at the drinking water standards (Maximum Contaminant Levels [MCLs] for drinking water). Although groundwater is not used for drinking water or other beneficial uses at Berkeley Lab, the overall long-term goal for all groundwater at Berkeley Lab is the reduction of contaminant concentrations to MCLs.

Step 2 - Identification of the Decision

The data collected under provisions of this QAPP are primarily used to assess the technical success and practicability of the implemented corrective measures for attaining the required MCSs. The principal issues that will be decided include:

Has the implemented corrective measure attained the MCSs?

Is attaining the MCSs technically practicable?

Should alternative corrective measures be considered?

The required decisions for this process and the sequence with which the decisions need to be resolved are shown on Figure 2.2.

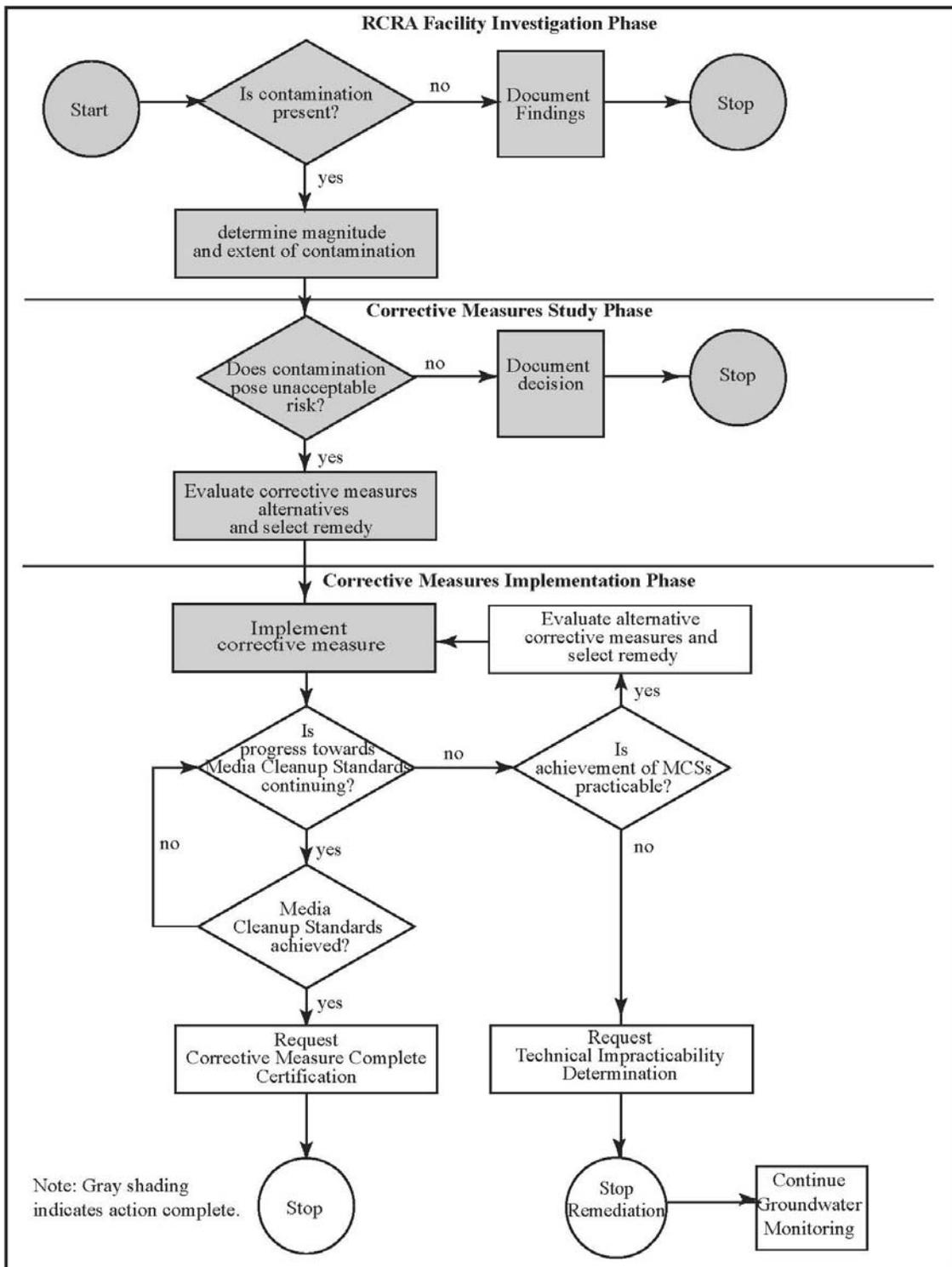


Figure 2.2 Flowchart of Decision Process

Step 3 - Identify the Inputs to the Decision

The required decision inputs are primarily the contaminant concentration data obtained from groundwater samples. The groundwater data are used to assess the magnitude and extent of groundwater contamination, with an emphasis on changes that may be occurring over time due to remedial activities. Supplemental input to support the decision consists of surface water sampling results, used to document that chemicals of concern are not migrating offsite in surface water.

Secondary decision inputs also include results of post treatment water samples to document compliance with the wastewater discharge permit, and soil samples to characterize waste soil for disposal purposes.

Step 4 - Define the Boundaries of the Site

Groundwater samples are collected at locations within the current boundaries of Berkeley Lab, primarily from existing groundwater monitoring wells and temporary groundwater sampling points. Soil samples are collected from within the site boundaries. Surface water samples are collected from site creeks either within the site boundaries or downstream from the site boundaries.

Step 5 - Develop a Decision Rule

Attainment of cleanup is evaluated by comparing sample concentrations to the DTSC-required MCSs. When the concentrations of chemicals of concern in all wells at a groundwater unit are less than MCSs for four consecutive quarters of monitoring, and chemicals of concern are not detected in surface water migrating offsite, Berkeley Lab may request corrective measures completion approval from the DTSC. Approval of the request will indicate that operation of the corrective measure can be terminated.

The continued effectiveness of MNA and enhanced bioremediation using HRC-injection is assessed based on annual review of the results of monitoring of VOC concentrations and hydrochemical parameters in the groundwater. These data are used to assess whether conditions indicative of natural attenuation or bioremediation are present and whether these remedies are likely to result in reductions in VOC concentrations to MCSs. In the event that a review indicates that these remedies are not effective, either an alternative remedy will be proposed or a Technical Impracticability (TI) evaluation will be prepared.

Compliance with permit requirements for wastewater discharges associated with remedial activities is addressed by conducting sampling and reporting as specified in the Wastewater Discharge Permit. Compliance with soil disposal requirements is addressed by conducting sampling and reporting as specified by the facility where disposal of waste soil is planned.

Step 6 and 7 - Specify Tolerable Limits on Decision Errors

When evaluating site cleanup, two types of decision errors are possible: a decision that remediation is complete may be made when contaminant concentrations exceed the MCSs (Type I error), or,

alternatively, a decision that further remediation is necessary when contaminant concentrations do not exceed the MCSs (Type II error).

Generally, decisions based on sampling are made by comparing the MCSs to Exposure Point Concentrations (EPCs) that are either maximum concentration values or 95% upper confidence limits (UCLs) on the mean of site sampling data. Since the 95% UCL is the least conservative of these two measures of site concentrations, there is up to a 5% chance of making a Type I error, which is considered to be a tolerable limit on decision errors. The potential consequences (threat to human health or the environment) of making a Type I error was minimized by setting MCSs at levels where the theoretical Incremental Lifetime Cancer Risks (ILCRs) are less than or at the lowest reasonably achievable level within the EPA target range for risk managers, and Hazard Indices (HIs) are less than 1. Although an Incremental Lifetime Cancer risk (ILCR) anywhere within the target range for risk managers (between 10^{-4} and 10^{-6}) is considered by the EPA to be safe and protective of public health, the lowest reasonably achievable level within the target range was selected as the risk-based MCS.

Due to the conservative nature of the EPCs used to compare site sampling data to MCSs, there is a relatively high probability of making a Type II error especially when maximum values are used to identify areas requiring remediation. The probability of making such errors varies significantly and is generally not documented, since regulatory requirements include use of maximum values and UCLs rather than use of lower confidence limits (LCLs), which are therefore not calculated. For soil remediation, the cost of remediating larger soil areas than needed to meet MCSs is generally weighed against the cost of additional sampling and assessment to better define appropriate EPCs and delineate areas exceeding MCSs. For groundwater samples, the possibility of making such errors is minimized by using long term monitoring records to make site decisions, so that anomalous data points can be identified and mitigated (e.g. through resampling if decisions may be based on the anomalous data). Due to the degree of public and regulatory scrutiny, the higher probability of making a Type II error than making a Type I error is considered to be tolerable.

Wastewater samples are collected to determine compliance with the wastewater discharge permit. Exceedence of the permit requirements is a possible Type I decision error. The tolerance for making a Type I decision error is based on permit requirements for sampling, so is not controlled by Berkeley Lab. This error will be minimized by regular monitoring and maintenance of the remedial systems and following the analytical requirements set forth by the regulatory agencies that issues the permit. Type II decision errors are not relevant to such compliance sampling.

Characterization samples for soil disposal are collected to determine compliance with landfill acceptance criteria. Exceedence of the requirements is a possible Type I decision error. The tolerance for making a Type I decision error is based on landfill requirements for sampling, so is not controlled by Berkeley Lab. This error will be minimized by following EH&S Procedures for soil sampling, processing, handling and shipping. Type II decision errors are not relevant to such compliance sampling.

2.5 Special Training Requirements

Project field personnel are required to read pertinent work plans before engaging in specific field activities. Equipment manuals are maintained in files available to all field personnel. In addition, each staff member must have the education, training, technical knowledge, and experience to perform assigned functions in the collection of field samples and data. Before personnel engage in fieldwork, training will be provided, if needed, to achieve initial proficiency. During the course of work, training is provided, if needed, to maintain proficiency and adapt to changes in technology, methods or job responsibilities.

Project field personnel must have completed 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training in compliance with Federal regulations (29 CFR 1910.120). In addition, field personnel must have completed an 8-hour refresher course within the previous 12 months if the 40-hour training course was completed more than one year before. All personnel must receive three days of field training by a trained supervisor before conducting fieldwork without direct supervision. Supervisory personnel must have completed an 8-hour supervisor training course in addition to having the equivalent training of the field personnel they are supervising. Additional task-specific training requirements are specified in the EH&S Procedure applicable to the work activity being performed.

2.6 Documentation and Records

Documentation and records are generated for the following general project activities: field operations, laboratory analyses, treatment systems, technical reports, and technical system audits.

2.6.1 Field Operations Records

Documentation requirements for field activities are specified in EH&S Procedures, which specify the information required and the protocol for completing the required documentation and records, such as:

- Field notebook
- Groundwater Sampling Data Sheet
- Soil Sampling Data Sheet
- Surface Water Sampling Data Sheet
- Treatment system forms
- Sample labels
- Chain-of-custody (COC) records.

2.6.2 Laboratory Records

The analytical laboratories are responsible for preparing reports summarizing the results of analysis, and for preparing detailed data packages that include all information necessary to perform data validation. The reports are in both paper copy and Electronic Data Deliverable (EDD) format and include the following elements:

- COC record
- Analyte list for each sample
- Reporting limits for each analyte
- Holding time chronology
- Quality control summary
- Analytical results
- Identification of analytical methods used.

The following quality control information is also included on the EDD:

- Laboratory blank results
- Laboratory control sample (LCS) results with percent recoveries and control limits
- Surrogate recoveries and control limits
- Matrix spike/matrix spike duplicate (MS/MSD) results with calculation of percent recoveries and relative percent difference and control limits.

In addition, every paper report discusses:

- Results outside control limits
- Corrective action/comments on variations such as poor detection limits, missing data, etc.,
- A statement from the responsible laboratory personnel that results do or do not meet quality acceptance criteria.

Copies of the laboratory reports are maintained in the files of the ERP data manager. The EDDs are entered into the ESG Microsoft Access database.

2.6.3 Treatment System Records

Soil flushing treatment systems are inspected daily. During the inspection, the condition of the systems and associated components including valves, pressure gauges, and totalizers are observed and evaluated. Water leaks from pipes or overflows from holding tanks, etc., are also noted. Any components that are not operating properly are repaired. If necessary, flow volumes are adjusted to prevent overflows. All pressure gauges are read and filters replaced as necessary (i.e. pressure drop greater than 2 pounds per square inch [psi] for a two-filter system and/or at the judgment of the technician). The inspection details are entered into an Excel spreadsheet.

The soil vapor extraction treatment system is currently monitored daily; however, the system may be monitored less frequently if a reduced schedule is approved by the Bay Area Air Quality Management District (BAAQMD). Data and observations are recorded either in the field logbook or on an Excel spreadsheet form. Information recorded includes system influent and effluent vapor concentrations as

measured with a photoionization detector (PID), system airflow, and date and time of system operation. While monitoring, the condition of the systems and associated components, including valves, pressure gauges, and fittings, are observed and evaluated. Air leaks from pipes or fittings are noted. Any component that is not operating properly is repaired and documented on the field log sheet.

2.6.4 Technical Reports

Data generated are documented in quarterly progress reports and annual status summary reports. Additional technical reports are produced on an as-needed basis. Technical submittals are also produced to comply with Berkeley Lab's wastewater discharge permit.

2.6.5 Technical Systems Audit (TSA)

A Technical Systems Audit (TSA) is performed under the direction of the Quality Assurance Manager to evaluate overall compliance with this QAPP. The results of the review, including summaries of problems and corrective action requests and closeouts, are documented in a report that is submitted to the Program Leader.

2.6.6 Records Management

Records generated by ERP activities are managed in accordance with the requirements of the *ERP Records Management Plan* (Berkeley Lab, 2007b). The Plan sets forth the procedures and requirements for the following general elements of records management:

- Types of records subject to the Plan requirements
- Responsibilities
- Record indexing, managing electronic documents, using and returning records and records inventory and annual review
- Official program file location and storage
- Archiving and retention of records

3.0

Measurement Data Acquisition

3.1 Sampling Process Design

3.1.1 Groundwater Sampling

Groundwater samples are collected and analyzed for VOCs, inorganic elements (metals) and/or tritium in accordance with a schedule that is reviewed and approved by the San Francisco Bay Regional Water Quality Control Board (Water Board). The current schedule for groundwater sampling (Berkeley Lab, 2005d) is based on requirements of the CMI phase of the CAP and was approved by the Water Board in August 2005. In addition, groundwater samples are analyzed for hydrochemical parameters to assess the effectiveness of MNA or enhanced bioremediation. The primary objectives of groundwater monitoring during the CMI phase are: (1) to evaluate the effectiveness of the corrective measures that have been implemented for cleanup of groundwater contamination; (2) to ensure that groundwater plumes are not migrating offsite; and (3) to monitor progress towards the long-term goal of cleanup to MCLs in those areas where CAP-required MCSs have been achieved but concentrations still exceed MCLs.

VOCs

To accomplish these objectives, wells are monitored for VOCs in the following areas:

- Where Media Cleanup Standards (MCSs) (cleanup levels) for groundwater are exceeded.
- Downgradient from areas of groundwater contamination.
- Near the downgradient site perimeter.
- In areas where VOC concentrations exceed MCLs.

Inorganics

Groundwater samples are collected from selected monitoring wells and analyzed for inorganic elements (metals) of potential concern. The wells that are sampled and the specific analytes monitored were selected based on a comparison of historical concentrations of metals detected in site monitoring wells to Berkeley Lab groundwater background levels (Berkeley Lab, 2002) and to MCLs for drinking water.

Radionuclides

Radionuclides, including tritium, are not regulated under RCRA, but are addressed under the oversight of the DOE. Although not regulated under RCRA, groundwater-monitoring recommendations for tritium have been included in the revised groundwater monitoring requests submitted to the Water Board.

Other Analytes and Parameters

In addition to the requirements noted above, selected groundwater samples are analyzed for other site related contaminants, such as PCBs and petroleum hydrocarbons.

Groundwater samples are analyzed for hydrochemical parameters indicative of natural attenuation or enhanced bioremediation in specific areas where MNA or enhanced bioremediation are being implemented, as specified in the CMI Report.

3.1.2 Surface Water Sampling

Surface water sampling requirements are specified in the *Groundwater Monitoring and Management Plan* (Berkeley Lab, 2006a). Surface water samples are collected from all site creeks during the rainy season and from all flowing creeks during the dry season and analyzed for VOCs and metals. Surface water samples are also collected for tritium analysis from Chicken Creek and North Fork Strawberry Creek.

3.1.3 Soil Vapor Sampling

Sampling and offsite analysis of soil vapor associated with soil vapor extraction treatment systems is electively conducted (it is not required by the BAAQMD Permit to Operate). Sampling is conducted to quantify potential contaminant concentrations below the sensitivity of the PID used for permit-required system monitoring. The frequency of soil vapor sampling is determined by the Program Leader.

3.1.4 Other Sampling

The types, locations and analytical methods for the collection of other environmental samples (i.e. soil vapor, soil, and sediment) are specified in location- and activity-specific work plans prepared prior to the start of work activities. Work plans are reviewed by the ERP Manager and by the DOE. In addition, the work plans may be submitted to appropriate regulatory agencies for review and approval.

3.2 Sampling Methods Requirements

Requirements for collecting samples are specified in EH&S Procedures, posted on the web at <https://www.lbl.gov/ehs/esg/ControlledProcedures/controlledprocindex.shtml>. Quality assurance during field operations is implemented by conducting all operations in accordance with EH&S Procedures, including:

- No. 230, Groundwater and Soil Vapor Extraction Treatment System Monitoring & Maintenance.
- No. 231, Drilling, Logging, Sampling and Destroying Borings.
- No. 233, Sampling Groundwater.
- No. 234, Soil Sampling – Manual Methods.
- No. 235, Processing, Handling and Shipping of ERP Samples.

- No. 236, Containerization and Disposal of Investigation-Derived Waste.
- No. 237, Equipment Decontamination.

Project field personnel are responsible for documenting any deviations from Procedure protocols in the field notebook(s), and for reporting the deviations to the Program Leader. Permanent changes and modifications to Procedure protocols may only be made by filing a written modification memo as a supplement to the specific Procedure. Modifications must be reviewed and signed by both the ERP Leader and the ESG Leader and be included as a supplement to the modified Procedure, until such time that the Procedure is revised to reflect the new protocol.

Whenever data are generated, the following items are documented along with the data:

- Item, system or sample that is being described.
- Date and location of generation.
- Identification of measuring and test equipment used.
- Signature or initials of persons generating the data.
- A unique identifier, if the above are insufficient to identify the data.

Errors are corrected by drawing a single line through the error, writing the date and corrector's initials in ink, and writing the correction as near to the error as possible.

3.3 Sample Handling and Custody Requirements

Custody of samples collected during the field investigation must be traceable at all times to legally responsible parties. Written tracking of each sample is initiated during collection, by entries in the following, as appropriate: field notebook, Sampling Data Sheet, COC records and/or sample label. The COC records document possession of the samples from the time of collection until disposal of the sample. Copies of field forms are included in the EH&S Procedures. Sample handling and custody requirements are specified in the following EH&S Procedures:

- No. 235, Processing, Handling and Shipping of ERP Samples.
- No. 268, Environmental Sample Tracking & Data Management.

3.4 Analytical Methods Requirements

Maximum allowable Quantitation Limit (QL) requirements for organic and metal analyses and Minimum Detectable Activity (MDA) for the principal radionuclide analyses are listed in the Tables 3-1 and 3-2. When it is not possible to achieve the required quantitation limits, the maximum allowable quantitation limit is adopted from Practical Quantitation Limit (PQL) guidelines detailed in California Code of Regulations (CCR) Title 22, Section 66264.801, for water samples, and EPA Publication SW-846 for soil and sediment samples. When concentrations of analytes are high enough to require dilution, the

quantification limits are modified according to the required dilution factor. The MDAs shown on Table 3-1 were calculated using typical aliquots and efficiencies.

Table 3-1. Target Analytes and Maximum Allowable Quantitation Limit Requirements

Analyte	Analytical Method	Maximum Allowable QL		
		Soil	Groundwater	Surface Water
VOCs	8260	residential ESLs	MCLs	WQC
SVOCs	8270	residential ESLs	MCLs	WQC
PCBs	8080	residential ESLs	MCLs	WQC
Metals	6000/7000	residential ESLs	MCLs	WQC hardness=250 mg/L
Minimum Detectable Activity (MDA)				
Tritium	906	0.2 pCi/g	300 pCi/L	300 pCi/L

ESL: Regional Water Quality Control Board Environmental Screening Levels (ESLs) for residential soil.

MCLs: Title 22, California Code of Regulations (CCR) Maximum Contaminant Levels (MCLs) for drinking water.

WQC: EPA National Ambient Water Quality Criteria for freshwater aquatic life lowest observed effect level (chronic).

Target analytes and maximum allowable quantitation limits for sample analyses performed for investigation of fuel contamination and specific fuel constituent analytes are summarized in Table 3-2.

Table 3-2. Target Analytes and Maximum Allowable Quantitation Limits for Petroleum Hydrocarbon Sites

Analyte	Analytical Method	Maximum Allowable QL	
		Soil	Water
TPH-Diesel	8015M	10 mg/kg	50 µg/L
TPH-Gasoline	8015M*	1 mg/kg	50 µg/L
Motor Oil	8015M*	50 mg/kg	100 µg/L
Benzene	8020 or 8260	0.005 mg/kg	0.5 µg/L
Toluene	8020 or 8260	0.005 mg/kg	0.5 µg/L
Ethylbenzene	8020 or 8260	0.005 mg/kg	0.5 µg/L
Total xylenes	8020 or 8260	0.005 mg/kg	1 µg/L

*Alternative method is acceptable if it achieves the required QL and it is approved by Program Leader.

Field measurement parameters include conductivity, turbidity, pH, temperature, organic vapor concentrations, and groundwater levels. These measurements are made using calibrated commercially manufactured instruments.

3.5 Quality Control Requirements

Required laboratory quality control samples, acceptance criteria, and corrective actions if control limits are exceeded are discussed below.

3.5.1 Laboratory Quality Control Samples

Primary laboratory quality control samples consist of method blanks and spiked samples (laboratory control samples, matrix spike/matrix spike duplicate [MS/MSD] and surrogate spikes). Method blanks, laboratory control samples and MS/MSD samples are run for all chemical analyses, usually in batch groups of ten samples. Surrogate spike samples are run for all organic analyses. Method blanks, laboratory control samples and MS/MSD samples are run for all radionuclide analyses. Table 3.3 summarizes laboratory quality control samples.

Method Blanks

A method blank is a clean sample or a sample of matrix prepared by the laboratory that is analyzed under identical conditions with field samples. Method blanks are used to detect cross contamination during analysis and indicate bias introduced by the analytical procedure.

Spiked Samples

Laboratory Control Samples (LCSs) consist of interference-free matrix that is spiked with known concentrations of target analytes. The LCS is used to document laboratory performance by checking the precision and accuracy of the analytical procedure, free of any matrix effects. LCSs are prepared by the analytical laboratory prior to sample analyses and consist of the same type of matrix as the batch samples. LCSs are run as needed for radionuclides and organic analyses (according to specific SW-846 methods and when matrix spike recoveries are out-of-range).

A *matrix spike/matrix spike duplicate* (MS/MSD) pair consist of two separate aliquots of a field sample submitted for organic analysis, both spiked with equal known concentrations of one or more contaminant analytes. The MS/MSD samples are then analyzed using the same protocols as that used for the unspiked sample aliquot. Matrix spiked samples are used to determine the effect of the matrix on a method's recovery efficiency.

A *surrogate spike* is a known quantity of a non-contaminant organic compound added to samples for organic analysis. The percent recovery of the surrogate is used to assess the accuracy of the method.

The frequency of analysis, representative acceptance criteria (control limits) and corrective action for results outside control limits for the principal laboratory QC samples are shown in Table 3-3. Acceptance criteria are method-dependent and analyte-specific and may vary from those shown. For method blanks, any detection is outside control limits. For spiked samples, the percent recovery (%R) is calculated and compared to control limits.

Table 3-3. Summary of Laboratory Quality Control Samples

QC Check	Frequency*	Acceptance Criteria**	Corrective Action if Out of Acceptance Criteria
Method Blank	One for each sample batch of up to twenty samples	<QL or MDA	Laboratory to evaluate and correct source of contamination. Assess impact on sample results and request reanalysis of associated samples if necessary.
LCS	As needed according to method procedure.	%R=75% to 125%	Laboratory to evaluate and correct source of error. Assess impact on sample results and request reanalysis of associated samples.
MS/MSD	One matrix spike/matrix spike duplicate sample pair for every twenty samples.	%R=75% to 125% RPD<20% (water) RPD<30% (soil)	Laboratory to flag MS recoveries as attributable to matrix effects.
Surrogate Spike	One surrogate recovery analysis for each sample analyzed.	%R=75% to 125%	Assess impact on sample results and request reanalysis of associated samples if necessary.

* Frequency of analysis is method specific and may vary from those shown.

**Acceptance criteria are method dependent and analyte specific and may vary from those shown.

RPD: Relative Percent Difference

For MS/MSD samples, the Relative Percent Difference (RPD) between the concentration of the matrix spike and matrix spike duplicate is calculated and compared to the laboratory control limits.

RPD is calculated as follows:

$$RPD = \frac{(X_1 - X_2)}{0.5(X_1 + X_2)} \times 100\%$$

where:

X_1 = MS result

X_2 = MSD result

Percent Recovery (%R) is calculated as follows:

$$\% R = \frac{SSR - SR}{SA} \times 100\%$$

where:

SSR = analyte concentration of spiked sample

SR = analyte concentration of unspiked sample

SA = actual concentration of analyte added to the sample

Additional laboratory QC samples may include performance evaluation samples and duplicate samples. A *performance evaluation* (PE) sample is a known amount of an analyte in a convenient matrix prepared by an outside organization. This check sample provides information on the accuracy of the analytical method. The acceptance criteria are method-dependent and analyte-specific. A *laboratory duplicate* consists of two separate aliquots of a field sample. The duplicate sample results are used to assess the precision of the analytical method. Acceptance criteria are the same as those listed for duplicate soil or split water field QC samples listed below. In addition, the laboratory runs initial and continuing calibration blanks, initial and continuing calibration verifications, and interference check samples, as required for equipment calibration

3.5.2 Field Quality Control Samples

Field quality control samples include trip blanks, equipment/field blanks, and field duplicates and splits, and are summarized in Table 3-4.

Trip Blank

A *trip blank* is a clean sample of matrix that is carried to the sampling site and maintained with the collected samples while in transit to the laboratory, where it is analyzed along with the sample batch. Trip blanks provide a measure of the positive interferences introduced by the sample preservation, transportation, storage, and analysis, or contamination derived from sample transport containers (i.e., ice chest).

Equipment / Field Blank

An *equipment/field blank* is collected by pouring organic-free (deionized or distilled) water into the sample collection equipment and from there into a sample bottle. The equipment blank should be collected immediately after decontaminating the equipment. Equipment/field blanks are used to verify the effectiveness of cleaning procedures and determine the type of contaminants introduced through contact with sampling equipment.

Field Duplicate

Field duplicate samples consist of two samples collected independently at a sampling location during a single sampling event. Field duplicates are collected to evaluate the precision of the sample collection method; however, variability in duplicate sample results can be an indicator of matrix variability and inhomogeneity.

Field Split

A *field split* sample is two or more representative portions taken from a sample or subsample and analyzed by different laboratories. Results are used to check interlaboratory comparability and variability of results.

The frequency of analysis, representative acceptance criteria (control limits), and corrective action for results outside control limits for the field QC samples are shown in the following table. Acceptance criteria are method-dependent and analyte-specific and may vary from those shown. For blanks, any detection (above the reporting limit) is outside control limits. For duplicate and splits, the RPD is calculated and compared to control limits.

Table 3-4. Summary of Field Quality Control Procedures

QC Check	Frequency	Acceptance Criteria	Corrective Action if Out of Acceptance Criteria
Trip Blank (water)	Approximately one out of every 10 samples for VOC analysis.	<QL or MDA	Determine and correct source of contamination. Flag affected sample results.
Equipment Blank (water)	One per each analytical method. Approximately one out of every 10 samples.	<QL or MDA	Determine and correct source of contamination. Flag affected sample results.
Field Duplicate or Split (water)	One per each analytical method. Approximately one out of every 20 samples. In addition, the initial post development samples from new groundwater monitoring wells are split.	RPD<35% at concentrations greater than 5 times the QL or MDA	Investigate differences in results.

3.5.3 Quality Assurance Objectives

Performance and acceptance criteria are expressed in terms of data quality indicators (DQIs). The principal indicators of data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS), and are defined below.

Comparability

Comparability expresses the degree of confidence with which one data set can be compared with another. The comparability of all data is assured by adherence to standard sample collection and field measurement procedures, use of standard methodology and standard reference materials, and by reporting data in consistent units. To avoid errors in comparing data, data are reported in the following standard units:

- Water chemistry analytical results for organics in micrograms per liter ($\mu\text{g/L}$).
- Soil/sediment chemistry analytical results in milligrams per kilogram (mg/kg).
- Soil vapor chemistry results in parts per billion per volume air (ppbv).
- Field vapor screening results in parts per million (ppm).
- Time in hours and minutes on 24-hour clock.

- Temperature in degrees Celsius (°C).
- Conductivity in micromhos per centimeter($\mu\text{mhos/cm}$).
- Water radiological analysis results in picocuries per liter (pci/L).
- Soil and sediment radiological analysis results in picocuries per gram (pci/g).
- Turbidity in nephelometric turbidity units (ntus).
- pH in pH units.
- Flow rates in gallons per minute (gpm).
- Groundwater elevations in feet (ft).
- Dimensions in feet (ft) or inches (in).
- Distances in feet (ft).

Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population. To ensure that analytical results are representative of the actual sample composition, EH&S Procedures for sample collection, sample control, sample handling, documentation, and equipment decontamination are followed.

Precision, Accuracy and Completeness

Precision is a measure of mutual agreement among individual measurements of the same property. *Accuracy* is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. *Completeness* is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected to be obtained under correct, normal conditions.

Laboratory Measurements

The QA/QC criteria are:

- *Precision* - determined by duplicate analyses. Analyses shall meet the criteria described for specific methods in EPA Publication SW-846;
- *Accuracy* - determined by surrogate spike and matrix spike analyses. Accuracy will be reported as a percent recovery of the test compound and shall meet the criteria described for specific methods in EPA Publication SW-846; and
- *Completeness* - expressed as the percentage of valid data obtained compared to the amount of data generated.

Field Measurement

The precision and accuracy objectives for measurement data are summarized in Table 3-5. The QC objective for completeness for the measurement parameters is 100 percent.

Table 3-5. Data Quality Objectives for Selected Groundwater Measurement Data

Measurement Parameter	Accuracy	Precision
Casing diameter	±0.1 in	±0.1 in
Well depth	±0.1 ft	±0.1 ft
Depth to water	±0.01 ft	±0.01 ft

Field measurement instruments that are utilized include: flame ionization detector (FID), photoionization detector (PID), pH and temperature meter, electrical conductivity (EC) meter, turbidity meter, water level indicator, and flow meter. Accuracy of field measurements is ensured by calibrating instruments on an appropriate schedule according to manufacturer specifications. Field measurements are recorded to at least the following accuracy using the specified units:

- pH to 0.01 pH units.
- Conductivity to two significant figures for values below 100 µmhos/cm, and to three significant figures for those above 100 µmhos/cm.
- Temperature to 0.1° c or 0.1° f.
- Ionizable vapor concentrations to 1 part per million per volume air (ppmv).
- Flow meter readings to the nearest 0.1 gpm.
- Turbidity to 0.1 NTUs.

Sensitivity

Sensitivity is the measure of a concentration at which an analytical method can positively identify and report analytical results. The sensitivity of an analytical method is indicated by the quantitation limits (QLs) and method detection limits (MDLs). The MDL is the lowest measured concentration above which one can confidently assert that the analyte has been detected. The QL is the lowest concentration in which there is some confidence that the measured concentration is relatively close to the true concentration.

3.6 Preventive Maintenance

ERP field personnel are responsible for the routine preventive maintenance of equipment and instruments and arranging for equipment replacement or factory repair when required. Repairs to equipment are documented in field logbooks.

3.7 Instrument Calibration and Frequency

Laboratory

All analytical instruments are calibrated according to laboratory-specific QA criteria. The laboratory's calibration program verifies that equipment is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. Frequency of calibration is based on the type of equipment, inherent stability, manufacturer's recommendations, values provided in recognized standards, intended data use, specified analytical methods, effect of error upon the measurement process, and prior experience.

Records are prepared and maintained for each piece of equipment subject to calibration. Records demonstrating accuracy of preparation, stability, and proof of continuity of reference standards are also maintained.

For radionuclide analysis, recognized procedures such as American National Standards Institute (ANSI) N42.15-1990, *Performance Verification of Liquid Scintillation Counting Systems* and Draft ANSI Standard N13.30 *Performance Criteria for Radiobioassay* are adopted. Instrument performance assessment of the liquid scintillation counter is done by the internal software of the manufacturer using National Institute of Standards and Technology (NIST) standards.

The laboratory runs and documents calibration standards as specified by EPA protocol SW-846. The accuracy of calibration standards is determined from quality control check samples available from EPA or NIST traceable vendors.

Field

Equipment and instruments are maintained and calibrated to operate according to the manufacturer's specifications. ERP equipment operations manuals and calibration/maintenance logbooks are maintained in files in the ERP field office. The manuals include operating, maintenance and calibration instructions. Calibrations are recorded in the field sampling data sheets.

Field personnel verify (by checking the instrument label and prior calibration data, or by performing calibration checks) that equipment/instruments are properly calibrated prior to use. A list of the principal field instruments utilized by the ERP and a summary of calibration requirements are presented in Table 3-6.

Table 3-6. Calibration Criteria for Field Instruments

Instrument	Measurement	Quality Control Check	Minimum Frequency
YSI 3000	temperature, water level and conductivity	check against factory-supplied standard	daily, before use
YSI33	salinity, conductivity and temperature	check against factory-supplied standard	daily, before use
HACH HQ40D	pH, temperature, conductivity, dissolved oxygen	Check against factory-supplied standard	daily, before use
Oakton	pH, conductivity, temperature, total dissolved solids (TDS)	Check against factory-supplied standard	daily, before use
LaMotte 2008	turbidity	check against factory-supplied standard	daily, before use
Orion 130	conductivity, temperature and salinity	check against factory-supplied standard	daily, before use
Orion 260	pH	check against factory -supplied standard buffers	daily, before use
Sensidyne (FID)	organic vapor	check against 200 ppmv methane or 100 ppmv isobutylene	every 3 months
Hnu P101 (PID)	organic vapor	check against ambient air and span gas	daily, before use
Solinst 101	water level	reference to steel tape	not required
Keck Kir-89	oil-water interface	reference to steel tape	not required

3.8 Inspection / Acceptance Criteria for Supplies and Consumables

All materials are visually inspected upon receipt to assure that they are undamaged, in clean condition, and conform to what is listed on the packing invoice. The materials/equipment are also compared to the type/model listed on the purchase order. If possible, equipment is tested prior to installation to assure that it runs properly.

3.9 Data Acquisition Requirements (Non-Direct Measurements)

Non-direct measurements are generally not anticipated. When a numerical model is required, the code is first verified against available analytical solutions to check the accuracy of the mathematical calculation. The selected model is also calibrated against site data. Sensitivity analyses are then conducted to obtain information about how these model parameters will affect the results.

3.10 Data Management

As discussed in detail in Section 2.6, data and other records are managed in accordance with requirements of the *ERP Records Management Plan* (Berkeley Lab, 2007b). All data must be recorded in permanent ink, with mistakes crossed out with a single line, initialed and dated rather than erased. All data include the date, initials of the sampler/analyst, identification of method used, item, system, sample and/or

location description, and any other relevant information. Field data recording requirements are included in the EH&S Procedures.

Historically, the data generated by the ERP has been entered into 4th Dimension, a relational database program. The data are stored and managed by the ERP Database Manager in accordance with the requirements described in the *Data Management Plan* (Berkeley Lab, 1992). Since October 1, 2007, the data has also been entered into a Microsoft Access database directly from the analytical laboratory EDDs. The data in the Access database are managed in accordance with requirements of EH&S Procedure 255: *Maintenance of ESG Sampling Databases*. Some historical groundwater data are maintained in a 4th Dimension database.

4.0

Assessment / Oversight

4.1 Assessment and Response Actions

The Program Leader monitors the status of the project and reviews records to assure that project requirements are being fulfilled. The Program Leader may conduct a Performance Evaluation of a laboratory when the validity of laboratory results is questionable. The Performance Evaluation consists of blind sample(s) whose identity is unknown to those operating the measurement system. If a problem is discovered that materially affects quality, the Program Leader initiates the Nonconformance and Corrective Action Report (NCAR) process in accordance with EH&S Procedure 208: *Nonconformance and Corrective Action Reporting*.

The Quality Assurance Manager performs an Annual Technical Systems Audit (TSA) of field activities. The TSA is a thorough and systematic onsite assessment, where facilities, equipment, personnel, training, procedures, and record keeping are examined for conformance with the QAPP.

4.2 Reports to Management

Quality assurance/quality control results are reported in the Quarterly Progress Reports submitted to DTSC, and in other task-specific reports where the data quality may be compromised. Quality Assurance records are maintained in the Program Leader's office for a minimum of three years.

5.0

Data Validation and Usability

5.1 Data Review and Verification Requirements

Data validation per EPA guidance is not required for data generated in the CMI phase of the CAP. This section discusses the requirements for data review and verification.

Review and verification of field data are performed under the direction of the Program Leader by checking field procedures, conducting periodic surveillance of data acquisition procedures, and comparing data to previous measurements. Field measurements that depart from historical trends are rechecked at the time of measurement, when possible. Analytical data that depart from historical trends are rechecked at the direction of the Program Leader. The laboratory may be requested to reanalyze the sample if sufficient sample volume remains, or confirmation sampling may be conducted if sample reanalysis is not feasible.

The Program Leader or representative reviews all laboratory analytical reports to assess the validity of the data. Data review and verification procedures are discussed below.

Field Data

After field sampling activities are completed, the Program Leader or representative reviews all field reports and COC records to assess compliance with requirements specified in this plan, including:

- Required sampling procedures were followed.
- All specified samples were collected.
- Samples were collected at the appropriate locations and depths.
- The required number of QC samples was collected.

The Program Leader or representative reviews field documentation to verify that sample collection and handling procedures were in accordance with requirements of this QAPP and applicable EH&S Procedures.

Laboratory Data

The analytical laboratories are responsible for preparing a paper report summarizing the results of analysis and for preparing an EDD that includes all information necessary to perform data review and verification. Data reports from the laboratory include the following elements:

- COC record.
- Analyte list for each sample.
- Reporting limits for each analyte.

- Sample preservation.
- Holding time chronology.
- Quality control summary.
- Analytical results.
- Identification of analytical methods used.

In addition, every data report contains:

- Results outside control limits for surrogate recoveries, laboratory control samples and duplicate reproducibility.
- Corrective action/comments on variations such as inadequate detection limits, missing data, etc.

The Program Leader or representative reviews the records of field data collection and laboratory reports to determine if the laboratory reporting is accurate and complete, and to assess compliance with DQO requirements specified in this plan. The Program Leader or representative verifies that QC criteria were met by checking the following, as applicable:

- Samples were extracted and analyzed within required holding times.
- No analytes were detected in method blank.
- No analytes were detected in trip blank or equipment blank.
- Laboratory control samples were within control limits.
- Surrogate and ms/msd recoveries were within control limits.
- Duplicate and split sample precision was within control limits.
- Preservation requirements were met.
- Initial and continuing calibrations were met.

5.2 Review and Verification Methods

The Program Leader or representative reviews the results of the investigation to ensure compliance with the DQOs specified in this plan. Analytical results are deemed usable if the following conditions are met:

- Sample integrity has not been compromised by missed holding times or inappropriate storage or handling.
- Laboratory calibration criteria have been met, and laboratory and field QC samples (blanks and LCS) have met the acceptance criteria listed in Section 3.5.

If the laboratory reports are incomplete, in error, or inconsistent with the DQOs of this plan, the Program Leader or representative requests that the laboratory review and/or re-evaluate results and/or reporting procedures, and submit revised reports; or re-analyze samples if possible. When laboratory procedures are

suspected to be the cause of anomalous results, the Program Leader or representative notifies the laboratory, which initiates the appropriate corrective actions.

During data review and verification, unacceptable or suspect data must be evaluated to determine the cause. If the evaluation indicated that the cause was noncompliance with an established procedure or requirement that materially affects data quality, the Program Leader initiates the NCAR process. If the suspect data have been included in the database, the data are identified by data qualifier “flags” in the database and in all applicable data tables.

5.3 Reconciliation with Data Quality Objectives

The assessment of measurement data is required to ensure that the DQOs for the ERP are met and that quantitative measures of data quality are provided. Precision, accuracy, completeness, and limitations are determined from quality control sample results and then applied to the results for environmental samples. If results of duplicate samples are above the acceptance criteria specified in this plan, the results are reviewed and evaluated. Duplicate sample results above the acceptance criteria may not indicate invalid data, but may be the effect of matrix variability and inhomogeneity. If the variability can be attributed to matrix variability or inhomogeneity, results are considered valid, with a note that matrix interference may be present.

6.0

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Appendix A

Acronyms

Berkeley Lab	E. O. Lawrence Berkeley National Laboratory
CAP	RCRA Corrective Action Program
CMI	Corrective Measures Implementation
CMS	Corrective Measures Studies
COC	chain-of-custody
DOE	U.S. Department of Energy
DQOs	data quality objectives
DTSC	Department of Toxic Substances Control
EDD	electronic data deliverable
EH&S	Environment, Health and Safety Division
EPA	U. S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERP	Environmental Restoration Program
ESG	Environmental Services Group
FID	flame ionization detector
gpm	gallons per minute
HRC	Hydrogen Release Compound [®]
LCS	laboratory control sample
MCL	Maximum Contaminant Level
MCSs	Media Cleanup Standards
µmhos/cm	micro mhos per centimeter
MDA	Minimum Detectable Activity
mg/kg	milligrams per kilogram
µg/L	micrograms per Liter
MNA	Monitored Natural Attenuation
MS/MSD	matrix spike/matrix spike duplicate
NCAR	Nonconformance and Corrective Action Report
NIST	National Institute of Standards and Technology
NTU	nephelometric turbidity units
%R	percent recovery
PCBs	polychlorinated biphenyls
pCi/g	picocuries per gram (10 ⁻¹² Curies per gram)
pCi/L	picocuries per Liter (10 ⁻¹² Curies per liter)
PID	photoionization detector
ppmv	parts per million per volume air

PQL	practical quantitation limit
PRG	Preliminary Remediation Goal
QA	quality assurance
QAPP	Quality Assurance Program Plan
QC	quality control
QL	quantitation limit
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
TI	Technical Impracticability
UC	University of California
UCL	upper confidence limit
VOC	volatile organic compound
Water Board	Regional Water Quality Control Board
WQC	Water Quality Criteria