Quality Assurance Project Plan Requirements for Sampling and Analysis

Environmental Restoration Project

March 1996

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1.0 DOCUMENT PURPOSE AND CONTEXT

This Environmental Restoration (ER) Quality Assurance Project Plan (QAPP) requirements document supersedes the Generic Quality Assurance Project Plan prepared by the Los Alamos National Laboratory (LANL) ER Project in 1991 (LANL 1991, 0412). This document is tiered to the US Environmental Protection Agency's (EPA's) Region VI "Interim Draft Requirements for Quality Assurance Project Plans" (EPA QA/R-5, 1994, 52288).

This document is part of the ER Project Quality Assurance (QA) Program hierarchy of documents (Figure P-1). This document details quality requirements that must be addressed in ER Project sampling and analysis plans (SAPs). Use of this document in conjunction with the ER "Sampling and Analysis Plan Outline and Crosswalk" (Lewis et al., 1996, 52242) will facilitate the development of SAPs. It is intended that compliance with this document will allow for site-specific flexibility in planning and implementing environmental activities and will cause quality and consistency to be designed into ER Project environmental data collection activities.

The requirements presented in this document apply to all ER SAPs whether they are stand alone documents or part of other documents. Those other documents include Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) plans and reports, expedited cleanup (EC) plans, voluntary corrective action (VCA) plans, closure plans, etc.

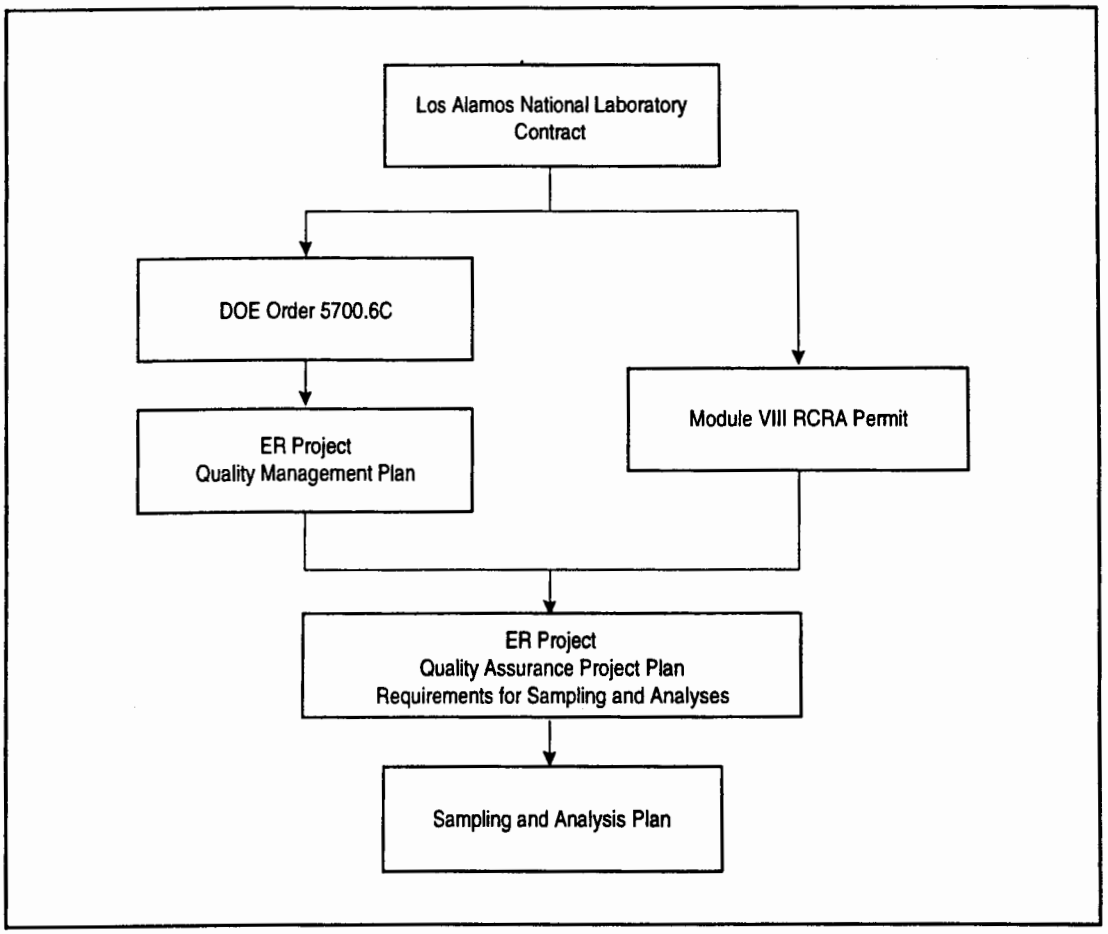

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Figure P-1. Document hierarchy.

2.0 DOCUMENT STRUCTURE

In accordance with the EPA Region VI QAPP guidance (EPA 1994, 52288), this document is divided into four major sections: Section A-Project Management, Section B-Measurement/Data Acquisition, Section C-Assessment/Oversight and Section D-Validation and Usability. Its contents have been bulletized to aid in identifying site-specific requirements.

Section A introduces requirements for defining the environmental problem to be solved, developing the general approach to solving the problem and documenting the related activities. Section B expands on section A by defining more detailed requirements concerning problem definition, problem solution and documentation. Section C presents requirements for evaluating the planning, problem resolution and documentation processes. Section D presents requirements for data review and evaluation. Appendix I through Appendix V provide supporting information to facilitate compliance with Section A through Section D.

A1 APPROVALS

1. NAME: J. Jansen

TITLE: Environmental Restoration Project Manager

SIGNATURE: _____ DATE 2-26-96

2. NAME: L. Souza

TITLE: Environmental Restoration Quality Assurance Officer

SIGNATURE: _____ DATE 2/26/96

3. NAME: B. Garcia

TITLE: New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, Bureau Chief

SIGNATURE: _____ DATE _____

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A1.1 Concurrence

1. NAME: G. Allen

TITLE: Field Unit One Project Leader

SIGNATURE: GR Allen DATE 26 Feb 96

2. NAME: T. Glatzmaier

TITLE: Project Consistency Team Manager

SIGNATURE: M Mann for T.G. DATE 2-27-96

3. NAME: G. Gould

TITLE: Field Unit Two Project Leader

SIGNATURE: Billie M Wheat for TEG DATE 2/26/96

4. NAME: B. Martin

TITLE: Field Unit Three Project Leader

SIGNATURE: B. Martin DATE 2/26/96

5. NAME: D. McInroy

TITLE: Regulatory Compliance Manager

SIGNATURE: DM DATE 2/26/96

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6. NAME: A. Pratt

TITLE: Field Unit Four Project Leader

SIGNATURE: _____ DATE 2/26/96

7. NAME: C. Rofer

TITLE: Field Unit Five Project Leader

SIGNATURE: _____ DATE 2/26/96

8. NAME: M. Salazar

TITLE: Decommissioning Project Leader

SIGNATURE: _____ DATE 2/26/96

9. NAME: S. Bolivar

TITLE: Field Support Facility Leader

SIGNATURE: _____ DATE 2/26/96

10. NAME: T. Taylor

TITLE: Department of Energy, Los Alamos Area Office, ER Program Manager

SIGNATURE: _____ DATE 3/1/96

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A3 DISTRIBUTION LIST

No.	Name	Title
1.	J. Jansen	Environmental Restoration Project Manager
2.	L. Souza	Quality Assurance Officer
3.	T. Taylor	Department of Energy, Los Alamos Area Office, ER Program Manager
4.	G. Allen	Field Unit One Project Leader
5.	T. Glatzmaier	Project Consistency Manager
6.	G. Gould	Field Unit Two Project Leader
7.	B. Martin	Field Unit Three Project Leader
8.	D. McInroy	Regulatory Compliance Manager
9.	A. Pratt	Field Unit Four Project Leader
10.	C. Rofer	Field Unit Five Project Leader
11.	M. Salazar	Decommissioning Project Leader
12.	S. Bolivar	Field Support Facility Leader
13.	B. Garcia	New Mexico Environment Department, Hazardous and Radioactive Material Bureau, Bureau Chief
14.	R. Kern	New Mexico Environment Department, Hazardous and Radioactive Material Bureau, Program Manager
15.	B. Hoditschek	New Mexico Environment Department, Hazardous and Radioactive Material Bureau, Program Manager
16.	B. Driscoll	Environmental Protection Agency, Region VI

A4 PROJECT/TASK ORGANIZATION

SAPs must specify the functional roles and responsibilities for the task or tasks for which they are developed. Names and telephone numbers for the identified roles and responsibilities should be provided during the readiness review.

In addition to the functional roles and responsibilities, a concise SAP organizational chart showing relationships and lines of communication among project participants must be provided. It is important to include the principal data users and decision-makers as part of the SAP. If the SAP is written to address multiple tasks or potential release sites (PRSs), including having multiple field organizations with common support groups, then the functional roles and responsibilities and organizational chart must reflect this situation.

Appendix I of this document provides the functional roles and responsibilities and an organizational chart for the ER Project to the field project leader/decommissioning project leader (FPL/DPL) level. If necessary, Appendix I can be referenced as part of the SAP organization.

A5 PROBLEM DEFINITION

The ER Project undertakes many environmental data collection activities, including

- investigations described by the RFI Work Plans prepared by the ER Project, as well as supplementary RFI sampling and analysis for which the need is identified after the initial work plan has been carried out;
- field observations to support intermediate field decisions, such as biasing selection of samples for laboratory analysis by field radiation measurements;
- data collection prior to and during corrective actions, such as ECs, VCAs, and corrective measures implementation (CMIs), to delineate the extent of areas requiring remediation;
- verification sampling to demonstrate that corrective actions are complete; and
- monitoring required as part of interim actions or final remedies.

As the first step toward ensuring environmental data quality, clear problem descriptions must be established for all environmental data collection activities. A systematic planning process must be used to develop specific, problem-related questions to be answered, and an expression of the associated environmental decisions to be made.

For regulatory decisions, the ultimate decision-makers for the ER Project include the EPA and New Mexico state regulators. However, it is the responsibility of the ER Project to provide plans, reports, and other documentation needed to support the decision-making process. In those plans and reports the ER Project will propose and defend the decisions that it believes are appropriate.

Key planning participants responsible for defining the problems and developing the problem-solving approach should be identified early in the planning process. This core planning team typically includes

- FPLs or their designees;
- field team leaders (FTLs) and selected field personnel;
- Earth Sciences Council (ESC) personnel (geologists, hydrologists, geochemists); and
- Decision Support Council (DSC) personnel (chemists, ecological and human health risk assessment specialists, statisticians).

The core team will contact others, as necessary, to provide historical, technical and regulatory information.

The results of the planning process shall be documented in a SAP. SAPs may be prepared as stand-alone documents or as addenda to existing work plans, or they may be incorporated into corrective action plans or RFI reports. Problem definitions will be documented in the SAP by providing

- a clear statement of the question or questions to be answered by the data to be collected; and
- a clear statement of the decision or decisions for which these answers are required, including anticipated alternative courses of action.

The scope of activities and documentation that address the requirements of this document will be commensurate with the importance of the decisions to be based on the data supporting those decisions. The SAP or the document to which it is attached must provide enough information so that a technically trained reader can understand the activity's historical and regulatory context as well as its objectives. In all cases, the SAP must present either explicitly or by reference the following:

- a physical/historical description of the site and the problem including, as appropriate, a summary of existing information such as
  - engineering drawings and site process histories;
  - a site conceptual model describing known and potential releases and existing or potential exposure scenarios;
  - a list of potential or known contaminants; and
  - a list or summary of existing data.
- identification of practical constraints, such as physical limitations on sample collection, scheduling constraints imposed by the need to coordinate with corrective actions, limitations of available measurement technology, and budgetary constraints; and

- applicable technical, regulatory or program-specific drivers that will impact the problem-solving approach, including the approach (or reference thereto) used to calculate risk-based contaminant thresholds.

Additional guidance for generating appropriate problem descriptions and decision statements for each phase of a study is provided in the EPA data quality objective (DQO) guidance (EPA 1994, 50288). More detailed requirements concerning SAP development are presented in Section B1 of this document.

A6 PROJECT/TASK DESCRIPTION

The SAP must summarize the approach that is selected to address problem-related questions and decisions that are identified. This project/task description will describe:

- measurements expected during the project, which will provide the data inputs necessary to answer the question(s);
- a general schedule for project completion, which must also identify other activities with which these measurements need to be coordinated;
- special personnel and equipment requirements, such as field screening methods that require trained operators;
- specific reporting requirements, including field observations, results of field audits, data validation reports, and electronic deliverables;
- quality assurance (QA) activities, including technical reviews, surveillances, and audits to be implemented during the course of the work; and
- schedule for the work to be performed.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Potential data quality concerns will be identified by the planning team for each type of measurement to be made, based on the proposed use of the data and the foreseeable consequences of errors resulting from incorrect interpretation of the measurements. Potential data quality concerns include, but are not limited to

- collecting a number of samples adequate to support the decision (the number of samples could be inadequate, for example, if measurement or sampling variability exceeds expectations);
- choosing measurement techniques and methods that are selective, sensitive, and precise enough to allow target analyte concentrations to be distinguished from prespecified threshold levels;

- limiting contamination of samples to insignificant levels; and
- maintaining the desired degree of data comparability to allow for statistically valid evaluation or pooling of the data.

The planning process will result in a list of criteria that are expected to increase the likelihood that data of the right type, quantity, and quality are collected to support the decision(s). In addition to the items listed in Section A5 of this document, such a list should include the following types of descriptors:

- identification of a focused list of environmental variables that must be measured or collected (e.g., analytes, concentrations/ radioactivities, physicochemical parameters, risk exposure model parameters;
- specification of the data reporting units;
- specification of decision or action levels, e.g., screening action levels (SALs) or bases for deriving them (e.g., risk-based criteria);
- geographical boundaries of each PRS or PRS aggregate;
- subpopulations (e.g., geologic strata or risk-based exposure units);
- temporal considerations that affect the time during which data can be collected; and
- sample matrices of interest.

The SAP must document in detail the ways in which the collected data will be summarized and used to make the decisions. Possible uses of measurements include, but are not limited to

- comparison of individual observations with prespecified thresholds, such as background upper tolerance level (UTLs), SALs, or PRGs; and
- calculation of 95% upper confidence bounds for the mean of a measured parameter within a prespecified area or volume, for comparison with thresholds such as PRGs.

The consequences of making an incorrect decision should also be considered. When appropriate, quantitative limits on acceptable decision errors should be specified. The scientific and statistical assumptions that form the basis of the SAP may include contaminant transport models, exposure models, and statistical models to support hypothesis testing or estimation (based on components of variance from sampling and measurement). The planning process will ultimately result in selection of a cost-effective sampling and analysis plan that meets the applicable quality criteria. See Section B1 of this document for more specifics on SAP design and selection.

A8 PROJECT NARRATIVE

A project narrative is not required for ER Project data collection efforts as stated in Interim Draft EPA Requirements for (QAPP) (EPA 1994, 52288). Project narratives are intended for EPA Category IV projects, whereas all anticipated efforts at LANL are EPA Category I (EPA 1994, 52288).

A9 TRAINING/CERTIFICATION

A9.1 Training

The FPL is responsible for determining specific training and certification needs and to document required training in accordance with LANL-ER-AP-O5.2. The review of worker training and qualifications shall be conducted before workers are assigned to ER Project activities. Individuals developing and implementing SAPs for the ER Project must receive, at a minimum, orientation to familiarize them with the purpose, scope, methods of implementation, and applicability of the following documents as they relate to the individual's work:

- LANL ER quality management plan (QMP);
- this document;
- applicable SAP; and
- standard operating procedure (SOPs), administrative procedures, site-specific health and safety plans, and work plans.

Training consists of a reading list, classroom and video presentations, and other methods of instruction. In addition to the above, the responsible FPL shall determine any special training needs such as for use of special sample collection devices, cleanup systems, or other training not described in LANL-ER-AP-5.2. The FPL shall also define the associated training needs in the site SAP.

A9.2 Certification

Certification of training in such areas as radiation worker and hazardous waste operator and emergency response (HAZWOPER) is required for many ER Project activities. In addition, certification might be needed for special techniques used in sampling and analysis. These certifications shall be documented in the site-specific SAPs or health and safety plans as applicable. The FPL is responsible for identifying worker certification needs for the field unit and site.

A10 DOCUMENTATION AND RECORDS

The ER Project-wide requirements for documentation and records are described in Chapter 5 of the ER Project Installation Work Plan (IWP) (LANL 1995, 52009). These requirements are detailed further in the ER Project Administrative and Quality Procedures (LANL 1995, 49708) and the SOPs for the ER Project (LANL 1991, 21556). Additional data management requirements needed to meet project-specific goals must be specified in the SAP.

Figure A-1 illustrates the flow of data generated for the ER Project as defined by the data management and records requirements for the ER Project. Following this flow,

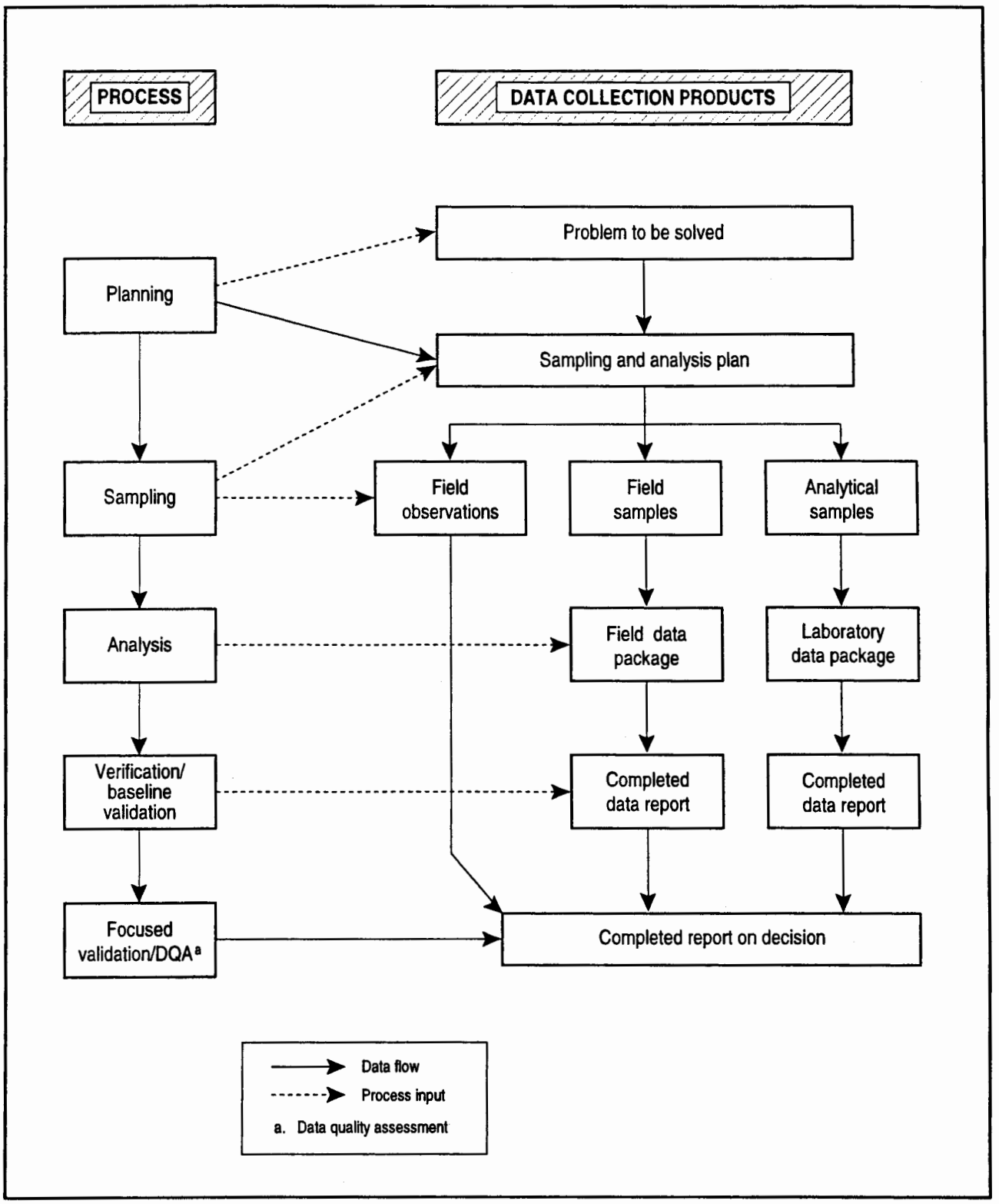

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Figure A-1. Project data flow for the Environmental Restoration Project.

results obtained from field instruments, field measurements, and field laboratories are verified and validated in the field to support rapid decision-making. Section D of this document provides the criteria and process for these reviews. Any nonroutine data gathering techniques must have the data management and records requirements documented in the SAP, either through direct insertion (mainly for one-time use of a technology) or by citation of an SOP.

Results of radiological screening conducted in the field or mobile radiological van (e.g., for sample shipping purposes) must be documented and sent with the samples to the Sample Management Office (SMO). All logs, field data reports, instrument calibration records, check sample analyses, and raw data must be submitted to the Records-Processing Facility (RPF) and all final results and electronic data needed to support decision-making must be submitted to the Facility for Information Management, Analysis, and Display (FIMAD).

Data generated from internal or contract analytical laboratories shall be submitted to the SMO following the requirements of the statement of work (SOW) (LANL 1995, 49738) for the analytical laboratories. The SOW provides the data-reporting requirements for all routine analytical services, analytical cost (Section II.B of the SOW), and a minimum list of the data reporting requirements for nonroutine analyses in Section V of the SOW. Any nonroutine analyses must have the actual site-specific data reporting requirements included in the SAP. This might include field logs, raw data, results of calibration and quality control (QC) checks and other data generated by the measurement system such as "case narratives." Nonroutine data turnaround time requirements and record retention requirements must also be specified in the SAP.

Once baseline data validation efforts are completed as described in Section D1 of this document, data become accessible through FIMAD to the field unit personnel (for data analyses such as comparisons to site contaminant background levels, SALs, and risk assessment), and other potential data users including regulators and the public. Field data and other hardcopy data packets, as appropriate, shall be sent to the RPF by appropriate field unit or SMO personnel following the procedures specified in Chapter 5 of the IWP (LANL 1995, 52009). Once data packages are delivered to the RPF, they will be available to data users to follow the procedures for accessing data in the RPF.

FPLs shall direct the field unit technical team data evaluation activities that follow verification and baseline validation. Those activities may include data quality assessment (DQA) and focused validation efforts as described in Section D of this document. All of the outputs of the DQA and focused validation efforts must be documented following the ER Project requirements or site-specific requirements included in the approved SAP.

As necessary, corrections identified in data verification or validation shall be incorporated into FIMAD. Only those data qualifiers based on the baseline validation criteria as described in Section D1 of this document will be used. Typically, the responsible data generator (e.g., laboratory) will be required to correct identified measurement problems and submit a revised report with the necessary corrections. Any changes resulting from the focused validation efforts must be sent to the RPF in addition to FIMAD, so that all records are current and consistent.

B1 SAMPLING PROCESS DESIGN

Alternative sampling and analysis options will be evaluated during planning and the most cost-effective design that is expected to meet the planning specifications will be selected. Cost-effectiveness may be determined through professional judgment or through a cost-benefit analysis. By selecting a particular sampling design, the type and number of samples, and the means of allocating samples, is defined. Specific sampling locations (and/or frequency of sample collection) are selected along with sample acquisition methods, measurement methods, and other procedures that will be used to collect and analyze the samples. The type and number of quality assessment/quality control samples to be collected in the field must also be determined, and the frequency and/or location for these samples documented.

SAP documentation requirements are specified in the following sections. The SAP design must be recorded in the appropriate document (i.e., RFI work plan, RFI report, accelerated cleanup plan, etc.). The SAP outline (LANL1996, 52242), which details additional SAP requirements, is to be followed in developing the SAP.

B1.1 Environmental Sampling Plan Design

All of the information listed below, as appropriate to the design, must be documented in enough detail to make the SAP third-party implementable.

- the number, or frequency of collection, for each type of sample (e.g., composite, grab, integrated) to be collected;
- the sampling network design (e.g., rectangular or triangular grid, stratification) and the assumptions underlying the design;
- the locations of the sampling points (preferably marked on a map);
- when field measurement methods are used, the techniques and/or guidelines to be followed in selecting sampling points, a description of or reference to the measurement technique/method to be used, and a description of how field screening results are to be used;
- if sample point selection will be made during field activities, the method(s) to be used to locate sampling points in the field, including specifics on how locational data are to be collected, stored, and transmitted;
- a description of the portion of each medium that will be collected for analysis;
- specification of nonmeasurement data required as inputs to solving the problem;
- references to all administrative procedures and SOPs used to carry out the work under the SAP;

- specific criteria, process, and schedule used to determine if methods with unknown performance characteristics will meet project goals; and
- design for well installation, as needed.

B1.2 Assessment and QC Sampling Plan

In addition to specifying the type, frequencies, and number of field samples and/or measurements to be made, SAPs must include

- a description of the selected number and type of assessment/ quality control samples required to support the SAP; and
- a reference to, or description of, the process used to arrive at the number and type of assessment/quality control samples.

LANL-ER-SOP-1.05 describes types of assessment and QC samples and their uses in estimating sampling and measurements quality on a site-wide basis, and it provides instructions for selecting the appropriate samples to support data collection efforts. The primary goal is to obtain estimates of variance and bias associated with measurement of each of the major analyte classes in each medium that will be sampled. By compiling and analyzing those data, statistical estimates will be available for designing subsequent phases of data collection and in analyzing the probability of making decision errors. When used for SAP design, LANL-ER-SOP 1.05 may be referenced rather than including in the SAP a description of the assessment/quality control sample selection process.

B2 SAMPLING METHODS REQUIREMENTS

Selecting methods appropriate for collecting samples of each environmental medium of interest is an important part of the planning process used to prepare the SAP. The sample collection methods must preserve sample integrity to ensure that the samples adequately represent the environmental media from which they are taken.

Technical issues considered in selecting sampling methods must be documented in the SAP. Therefore, the SAP must document the following:

- environmental medium to be sampled (e.g., air, sludge, soil, sediment, rock, water, etc.);
- type of samples needed by the SAP design (e.g., grab, composite, core, etc.);
- portion of the environmental medium (i.e., the target population) the data user wishes to represent (e.g., 0" to 12" depth of entire PRS or PRS aggregate) with the samples;
- types of analyses to be performed on the samples (e.g., volatiles, semivolatiles, metals) and any special sampling tool or method demanded by the analytical methods (e.g., SUMMA canisters);
- volume of each sample necessary to satisfy all analysis requirements (e.g., there are special considerations for using

hydro-punch sampling or for collecting samples for volatile organics in the different media, because each medium could require different volumes and containers);

- size and type of sampling equipment appropriate for collecting the desired samples. This is especially important for analytical methods that require special containers such as air sampling, certain volatile organics analytical methods, and certain on-site measurements;

- decontamination (see LANL-ER-SOP-1.08) that must be performed on nondisposable sampling equipment prior to and between uses. Wash water and other wastes generated during the sampling operation must be managed and disposed of in accordance with LANL-ER-AP-05.3;

- waste minimization (including the minimization of decontamination wastes); and

- constraints on the sampling events that might significantly affect the projected time or costs (e.g., inclement weather or threats to endangered species).

These requirements should be summarized to include references to the procedures that will be used to conduct the sampling. Where existing SOPs or other official guidance provide adequate documentation of any of these required criteria, those documents shall be cited in the SAP. For example, LANL-ER-SOP-1.02 addresses the requirements for sample containers, preservatives, sample volumes, and holding times; routine sampling procedures are documented in the ER Project SOPs, Chapter 6, "Sampling Techniques." Additional guidance is presented in Appendix II for selecting sampling methods and equipment.

If all site-specific requirements are not adequately addressed by reference, then the requirements shall be documented in the SAP by developing and referencing new SOPs or revised SOPs. Otherwise the requirements must be included in the SAP by incorporating the equivalent SOP requirements. For example, implementation requirements and support facilities needed to ensure safety and work of adequate quality should be specified in the SAP. Where site-specific performance requirements are necessary for sampling operations, those requirements should be written into the SAP. For those tasks that might be useful to more than one field unit, developing new SOPs is encouraged in lieu of writing instructions into the SAP.

Ultimate authority and responsibility for field operations lies with the responsible FPL. However, responsibility for corrective actions in the field that address deviations from SAPs and other field-work-related contingencies may rest with the cognizant field team leaders who report to the FPL. When possible, corrective actions should be anticipated and delineated in the SAP.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

All personnel must follow the SOPs addressing sample handling and custody (ER Project SOPs, Chapter 1, "General Instructions"). Those SOPs must be referenced in the SAP. In cases where deviations from an SOP are planned, the deviations must be

fully described in the SAP. In addition, the requirements in the following paragraphs must be met for all SAPs.

All samples must be identified in accordance with LANL-ER-SOP-01.04, which establishes the requirements for identifying each boring location, monitoring well, and sample collected during surface water, groundwater, sediment, waste stream, soil, and air sampling programs. The numbering system, which satisfies EPA requirements for sample identification (EPA 1987, 11654), provides a tracking capability to facilitate data retrieval. It ensures that all information required to identify and track samples is readily accessible and unique to a particular sample.

Chain-of-custody requirements satisfying EPA guidance (EPA 1991, 52287) must be implemented as delineated in LANL-ER-SOP-01.04 to provide legal and technical defensibility of ER Project sample data. Chain-of-custody records must be initiated at the time of sample collection and remain active until final disposition of the sample.

B3.1 Sample Management Office

The SMO must be alerted by the field units as to the types and quantities of environmental and QA/QC sample containers, as well as preservatives, needed for a particular sampling operation. This alert should come at least four weeks prior to any sampling that requires SMO services. All special considerations, such as availability of analytical laboratory services or return of unused sample materials, must be coordinated with the SMO.

If archiving of samples or sample derivatives (e.g., extracts, digestates) is required, arrangements must be made with the SMO before sampling. These arrangements must be documented in the SAP.

B3.2 Field Packaging and On-Site Measurements

All analytical services, including field laboratory services (radiological van, chemistry van, etc.), must be coordinated through the Field Support Facilities Group. However, if a field unit elects to package samples in the field or to use a field laboratory, the instructions for doing so must be written into the SAP or in SOPs referenced by the SAP. In those cases, at a minimum, the following sample collection and analysis activities must be addressed in the SAP:

- provision of sample containers, preservatives, coolers, labels, etc.;
- chain of custody and sample tracking (beginning when the samples are collected and sent to the analytical laboratory and ending with returned results);
- sample packaging and shipment to analytical laboratories;
- identification of available laboratory services (includes radiological van, chemistry van, and other on-site measurements) by reference to the applicable SOW for analytical services as designated by the SMO; and
- final disposition of sample materials.

Responsibilities for the above activities as well as schedules for completing the activities (when appropriate) must be delineated in the SAP. Additional guidance for using

on-site measurement methods is included in the Department of Energy (DOE) document "Guidance for Planning On-Site Measurements" (DOE 1995, 52240).

In addition to the above requirements, all ER Project samples must be classified prior to shipment as hazardous or nonhazardous pursuant to International Air Transportation Association, Department of Transportation regulations (see 49 CFR 171-173) and EPA guidance (EPA 1987, 11654). LANL-ER-SOP-1.03 addresses the issues of determining the hazard status, packaging, and shipping of ER Project samples and provides more specific direction on sample packaging and transport.

B3.3 Sample Volumes, Containers, Holding Times, And Preservatives

Requirements for selecting sample volumes, containers, holding times, and preservatives for samples subjected to routine analyses are presented in LANL-ER-SOP-1.02. Routine analyses are addressed in detail in Section B4 of this document. Sample preservation and holding time requirements for nonroutine analytical measurements must be specified directly in the SAP.

B4 ANALYTICAL METHODS REQUIREMENTS

The SAP must include the following information:

- analytical and other measurement methods to be used. This includes sample preparation techniques (e.g., extraction, cleanup, digestion, etc.) and special equipment (e.g., instrument sample preparation equipment critical to the analyses);
- any decontamination procedures needed to prevent compromising the representativeness of the sample and analyses; and
- specific performance criteria for the above bulleted items.

The analytical services contracts, which include SOWs (LANL 1995, 49738) for analytical services, were developed for the ER Project to meet most users' needs in a cost-effective manner. Those SOWs can be especially appropriate for screening assessments and other types of investigations requiring broad-scan methods or very rigorous QC. They include lists of the analytes grouped into standard ER Project analyte suites such as volatile organics and metals (see also Appendix III). It is unnecessary to specify in a SAP any routine analytical requirements that are addressed in the analytical laboratory SOWs (LANL 1995, 49738). The preferred method of specifying which analytical methods will be used is by summarizing them in a table by analytical method number or, when SOW-related analytical services are used, by reference to the analytical laboratory SOWs (LANL 1995, 49738).

Analytical method selection must be based on the requirements of the decision to be made. These decisions are established during the planning process (see Sections A5–A7 of this document). The SAP requirements for analytical methods must reflect the following considerations:

- required analytical information (e.g., analyte list, including whether determinations will be made for total, soluble, extractable, isotopic, volatile species, etc., and how the data will be used);
- sensitivity;

- selectivity;
- precision and bias;
- sample preparation;
- sample holding times;
- turnaround time;
- waste minimization;
- cost; and
- data comparability.

Consideration of the above elements, along with historical performance information on the available methods, is used to determine which of the following options provides the most cost-effective and timely approach to meet needs:

- routine analytical methods provided by the analytical services contracts;
- methods optimized for site-specific use (e.g., *in-situ* methods);
- nonroutine, off-site analytical services; or
- any combination of the above that provides the most cost-effective and timely approach to meet site-specific needs.

Detailed information and guidance for analytical method selection is included in Appendix IV. To facilitate the selection of sample preparation and chemical analysis methods, experienced analytical chemists are available from the DSC Chemistry Team.

When nonroutine analytical services are selected for a project, it is necessary to identify the critical aspects of the analytical methods. Those critical aspects are

- target analytes or variables and associated quantitation limit requirements;
- descriptions of, or citations of, sample preparation and analysis methods;
- standardization/calibration procedures that are related to individual sample analytical data and equipment;
- analytical raw data required, such as mass spectra, chromatograms, and graphite furnace atomic absorption outputs;
- all manual calculations used to generate results;
- analytical QC raw data including, for example
  - blanks

  - spikes (matrix, surrogate, tracers/carriers, etc.)
  - QC samples (laboratory control sample, site-specific performance evaluation materials, etc.); and
- special analytical conditions that require different sample handling, preparation, or analytical procedures.

If standard analytical methods are to be followed, the methods may be cited in the SAP; otherwise the specifications in the SAP must be detailed enough to allow any qualified analyst to repeat the specified work using similar equipment.

Each FPL is ultimately responsible for data quality in his/her respective field unit. Additional information defining the options that need to be considered when selecting nonroutine analytical methods is available in the guidance for analytical method selection in Appendix IV. These options are specific to the type of analytical method needed. The selected options must be specified in the SAP.

B5 QUALITY CONTROL REQUIREMENTS

This section provides the quality control requirements for sampling, analyses, and other measurements (e.g., land surveys and biological assessments that must be performed routinely). The approach at LANL is to tailor QC activities to site-specific needs through planning and eliminating unnecessary QC checks.

SAPs should be designed to assess the major components of total study error to enable the final evaluation of whether environmental data are of sufficient quality to support the related decisions. The QC requirements must be designed to provide measurement error information that can be used to initiate corrective actions that limit the total measurement error. Consequently, SAPs must

- describe the QC samples and procedures associated with sampling and measurement,
- list specific QC checks that are required for each type of sampling and measurement data to be collected. The list must include
  - the frequencies of the control checks, and
  - the required acceptance criteria for each QC check.

The SAP must also provide

- as necessary, procedures for calculating QC statistics; a reference to this document's glossary (see Precision and Bias) might suffice,
- an explanation delineating how contingencies such as missing data, nondetects and out-of-range data will be addressed (see also Section D3 of this document), and
- anticipated corrective actions associated with failure of sampling or measurement systems to meet acceptance criteria.

If established SOPs or standard methods are used for sampling and measurement, and those documents specify the applicable QC checks, frequencies, acceptance criteria, and corrective actions, those documents may be cited. Otherwise, the appropriate QC activities must be described explicitly in the SAP.

For sample collection activities, the QC procedures specified in LANL-ER-SOP-1.05 must be followed or specific QC procedures must be provided in the SAP or in the SOP used for the sampling.

B5.1 Sampling

QC for sampling must be part of a comprehensive QA approach that includes quality oversight of field groups and analytical laboratories. The approach to selecting QC samples for field activities is presented in LANL-ER-SOP-1.05.

For the routine analytical services provided through the analytical services contracts, a default set of QC procedures and criteria are specified in the analytical laboratory SOW (LANL 1995, 49738). Provided that these defaults are adequate and routine analyses are selected, additional QC procedures for the sample analyses need not be spelled out in the SAP.

For nonroutine analyses (such as on-site measurements, specialized analyses, or land surveys), the project-specific QC procedures and limits must be specified in the SAP or in SOPs. Many on-site measurements are capable of providing data adequate for decision-making in the field if the QC activities are designed to support a quantitative assessment of the measurement performance. For nonroutine services that are conducted in the field or are unique to the field situation, the QC procedures must be specified in the SAP or an SOP that provides for adequate QC review in the field.

B6 INSTRUMENT/EQUIPMENT PURCHASING, TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

Items and services procured by the ER Project shall be approved by the responsible FPL or shall be acquired under the FPL's direction. As necessary, an FPL or designee will develop the purchase specifications for goods and services that are designed to satisfy the needs of the field unit. Once the FPL or designee has approved the specifications, the goods or services will be purchased through the field unit's contractors or the LANL purchasing group (e.g., BUS-5).

Goods and services received that do not meet purchase or performance specifications shall be identified. The FPL or designee shall control nonconforming items or services to prevent use until compliance with the original or modified specifications has been demonstrated, or until the item is retired from potential use.

Only equipment that is maintained and calibrated in accordance with the manufacturer's recommendations or in accordance with equal or more stringent standards shall be used for data collection. Support organizations must maintain equipment as specified in SOPs and SAPs. The ER Project will monitor support organizations' performance through periodic audits and use of performance evaluation samples.

When equipment maintenance, inspection, and calibration requirements are delineated in SOPs, it is sufficient to cite the applicable SOP. When requirements are not

delineated in SOPs, the SAP must define the requirements or cite manufacturers' maintenance and calibration schedules. When maintenance and calibration requirements that exceed those recommended by the manufacturer are deemed appropriate, and such requirements are not delineated in an SOP, they must be stated explicitly in the SAP.

Service contracts may provide a vehicle for routine preventive maintenance and emergency repair service. In such cases, actions taken by an instrument service representative shall be documented in the records for that instrument.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

Equipment designated for use in ER Project work plans shall be specified to meet site-specific planning specifications. Measuring and testing equipment used in the field or an analytical laboratory must be controlled by formal calibration procedures, which are required for proper operation of equipment and instruments. If available and applicable, instrument manufacturer directions for calibration may be cited instead of repeating them in ER Project documents. All calibration standards shall be traceable to nationally recognized standards such as those from the National Institute of Standards and Technology, unless such traceability is inappropriate or not possible. If traceability is inappropriate or not possible, the manner in which the suitability of calibration standards is determined must be stated in the SAP.

B7.1 Field Equipment

Field equipment must be properly calibrated and charged, as appropriate, and must be in good general working condition before the beginning of each day of use. ER Project SOPs and SAPs specify the required checks and calibration for each type of field equipment. These requirements include the frequencies of checks and calibrations necessary to ensure that operability is acceptable. Field equipment that does not meet calibration requirements shall be taken out of service until acceptable performance can be verified. Nonoperational field equipment shall also be removed from service and may be returned to the supplier for replacement. Maintenance records must be maintained for each field instrument according to a unique number affixed to the instrument used to facilitate tracking of instrument records. The unique serial number for each instrument shall be used on all related documentation concerning that instrument. These records should be reviewed before equipment use to ensure that maintenance and calibration are current.

All instruments used for environmental investigations must be properly protected against inclement weather as needed.

Logbooks specific to individual equipment items shall be used to record the

- equipment identifier;
- inspection, maintenance, and calibration action(s) performed;
- trigger(s) for the maintenance, calibration, or inspection action(s);
- identity of each person performing the work;

- date on which the work was performed; and
- condition of the equipment upon completion of the action(s).

Use of tabulated maintenance, inspection, and calibration requirements and actions is recommended for convenience.

B7.2 Laboratory Equipment

For the services provided through the analytical services contracts (LANL 1995, 49738), all laboratories are expected to meet or exceed manufacturers' recommendations for maintaining and calibrating equipment. Contracts may be used to require implementation of certain calibration and maintenance procedures.

Before enlisting analytical services outside of the analytical services contracts, ER Project QA personnel or designees shall review the laboratory's operations to ensure that an adequate equipment maintenance and calibration program is in place.

Oversight of analytical laboratories is addressed in Section C1.2 of this document.

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Supplies and consumables will be inspected and accepted for use in the ER Project by the appropriate FPL or designee. Supplies and consumables are those items necessary to support the sampling and analysis operations. Field supplies will normally be inspected and accepted by the field team leader. Laboratory supplies will normally be inspected and accepted by the laboratory manager. Acceptance criteria for specific supplies and consumables will be listed in the SAP or field-unit-specific SOP.

To the extent practicable, spare parts for field and laboratory equipment must be kept readily available to minimize downtime. However, to control costs, the responsible supervisor shall determine the numbers and types of spare parts to be stocked for each type of equipment. The FPL or designee shall identify those pieces of equipment for which a record of spare parts availability must be maintained.

After a defective part has been replaced, it shall be returned to the manufacturer for repair, stored for future inspection, or discarded. If a defective part is stored temporarily, it shall be labeled as defective and the label shall indicate when the part was taken out of service and the nature of the deficiency. If a defective part or equipment item was used to collect data and such use may have compromised the integrity of the data, a note in the data record shall be made. The SAP must

- identify individuals who will inspect and accept supplies and consumables for the task, and
- list acceptance criteria for critical supplies and consumables in order to satisfy the technical and quality objectives of the task.

B9 DATA ACQUISITION REQUIREMENTS (NONDIRECT MEASUREMENTS; REQUIREMENTS FOR USING ARCHIVED DATA AND NONMEASUREMENT DATA)

If archived data or nonmeasurement data (e.g., interviews, maps, spreadsheets, computer data bases, calculations) are to be used in decision-making, the acceptability of the data shall be assessed on a case-by-case basis. The data acceptability may be confirmed by comparing data from more than one source or by corroborating the data through additional data collection. Information received through interviews shall be documented with written concurrence by the interviewee. For numerical data, prior validations shall be reviewed to assess the technical validity of the data as well as their suitability for use in making decision(s).

The responsible FPL shall determine the level of effort to be used in the data review. The effort will be commensurate with the amount of information available and the importance of the data relative to decision(s).

It could be important to prepare a pedigree for data of interest that describes the procedures used to collect the data and the qualifications of personnel who collected the data. The FPL or designee shall determine the need for, and method of, documenting a data pedigree.

B10 DATA MANAGEMENT

Chapter 5 of the IWP (LANL 1995, 52009) presents LANL's approach to data and records management. Following this approach, electronic data are stored in FIMAD and all other records are stored in the RPF. Data and records management requirements not specified in Chapter 5 of the IWP, applicable SOPs, or applicable SOWs must be specified in the SAP. See also Section A10 of this document.

Figure A-1 illustrates the flow of data generated for the ER Project. Results obtained from field instruments, field measurements, and field laboratories are verified and validated in the field to permit decisions to be made rapidly. The criteria and process for these reviews are discussed in Section D of this document. The results of radiological screening conducted in the field or in a mobile radiological van should be documented and sent along with the samples to the SMO.

Manually recorded data are recorded in accordance with LANL-ER-SOPs-1.04 and 3.12. They are reviewed by the field team as required by LANL-ER-SOPs 1.01, 1.04, and 3.12. Data that are transferred electronically are not subject to this review. However, the portion of the data that will be manually entered into the database (e.g., some nonroutine and field analytical methods, field notes, and other data recorded on forms in the field and then entered into FIMAD) must be reviewed for data entry errors. Field records, even if rendered illegible, must be kept as permanent records and may not be discarded.

Data generated as a result of analytical services by internal or contract laboratories must be submitted to the SMO, which is responsible for routine data verification and baseline validation as defined in Section D1 of this document. Nonroutine data verification/validation is the responsibility of the field unit team. Upon completion of the data verification/baseline validation process (see Section D1 of this document), the data must be transferred to accessible FIMAD files. Data entries include any qualifying flags assigned during baseline validation.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following sections provide a summary of the assessment activities required by the ER Project. The FPLs/DPLs and quality assurance officer (QAO) are responsible for tracking the results of assessments and response actions to ensure that deficiencies are corrected in a timely manner. The QAO is responsible for identifying the personnel who participate in planned assessments, surveillances, etc., and ensuring that they are qualified to implement those evaluations.

Assessments planning includes delineation of responsibilities and reporting authorities. The manner in which evaluation results will be reported, and to whom they will be reported, are determined during planning for the evaluation. Schedules for preliminary and follow-up interviews, meetings, etc., are decided in advance of the evaluation and designed to adversely affect work schedules as little as possible.

C1.1 Internal Assessment

The process by which the ER Project assesses systems (programmatic assessments) and performance is described in LANL-ER-QP-01.5Q. System assessments provide an effectiveness evaluation of systems established to ensure the quality of project activities. Performance assessments provide feedback on the effectiveness of activities in meeting ER Project objectives.

C1.1.1 Field Unit Assessments

The ER Project uses self-assessments and formal, independent field assessments to assess compliance with the SOPs identified in work plans, RFI reports, site characterization analyses (SCAs), ECs, closure plans, SAPs, etc., and associated QA documents (including this document). The FPLs/DPLs are responsible for determining the number and types of assessments to be conducted and for arranging for their implementation. The number, frequency, and purpose of each assessment must be specified in the SAP. At a minimum, assessments should review the processes used in the field to record information about each sample taken, control the chain of custody, determine the locations of sampling points, implement the specified sample collection methods, and implement the specified procedures for sample handling.

C1.1.2 Corrective Action

Deficiencies identified during assessments are documented in accordance with LANL-ER-QP-1.04Q. Corrective action requests are issued to the FPL/DPL to identify, document, and implement the necessary corrective actions.

C1.2 Oversight of Analytical Laboratories

C1.2.1 Laboratory Assessments

The performance of LANL's analytical chemistry and contract laboratories, including mobile analytical laboratories are assessed prior to acceptance for use and annually. These assessments are typically performed under the Albuquerque DOE FSMP Program, by LANL representatives, or through audits by other organizations (DOE, EPA, and other DOE management and operations contractors).

Checklists developed by (or equivalent to) the Albuquerque DOE FSMP checklists are used in these assessments. When assessments by other organizations are used, they are compared to the Albuquerque FSMP checklists and accepted, either partially or completely, depending on how they match the FSMP criteria.

C1.2.2 Analytical Laboratories Performance Measurement

The ER Project implements a program to evaluate and track the performance of its analytical laboratories. Results from blind performance evaluation samples obtained by the ER Project and/or quality assessment/quality control samples included in individual SAPs are used, as necessary, to assess matrix- and analyte-specific precision and bias across the ER Project. These assessments are performed on a continuing basis to provide the ER Project with laboratory and site performance data. Other approaches are also used, as needed, to assess performance, including approaches to track the performance of laboratories generating data within a field season or field unit. This information is used to design future SAPs and to assign acceptance criteria to QC data parameters.

C1.2.3 Data Package Assessment

In addition to the baseline and focused validation processes described in Section D2 of this document, a percentage of each laboratory's data packages is assessed to monitor performance of individual laboratories. These assessments include a review of raw data and the calculations that support the reported results. A statistical and performance-based frequency for conducting these assessments is developed for each laboratory. The required data package assessment of laboratory frequencies are reported as they are developed.

C1.2.4 Monitoring and Tracking Administrative Indicators

Indicators that include turnaround times, holding times, and responses to problems (problem resolution) are used to identify trends in performance-related and administrative functions. This information is made available throughout the ER Project for planning purposes.

C1.2.5 Problem Resolution

The problem resolution process includes the following:

- problem identification,
- problem analysis,
- corrective action, and
- resolution tracking system.

The problem resolution information is forwarded to the responsible FPL/DPL and QAO.

C1.3 ER Project Peer Reviews

ER Project plans and reports are peer-reviewed in accordance with LANL-ER-AP-01.3. This procedure provides for selecting appropriate personnel to conduct reviews and for formal comment resolution.

C1.4 Readiness Reviews

Before performing selected field activities, a readiness review is conducted in accordance with LANL-ER-AP-5.1. Implementing this procedure ensures that field work complies with applicable directives, guidance, SOPs, administrative requirements, and applicable regulations.

C2 REPORTS TO MANAGEMENT

C2.1 Project Status

Periodic reports are generated to describe ER Project status and to satisfy the requirements of Hazardous and Solid Waste Amendments (HSWA) Module VIII of the RCRA permit. The FPL or DPL is responsible for identifying the types of reports and frequencies in their respective SAPs or project plans. More detailed descriptions of RFI, corrective measures study/corrective measures implementation (CMS/CMI), voluntary corrective action (VCA) and EC plans and reports are provided in Chapter 3 of the IWP (LANL 1995, 52009).

C2.2 Quality Assurance Reports

The results of QA assessment activities identified in Sections C1.1 and C1.2 of this document are assembled, summarized, and distributed to the ER Project management team on a quarterly basis. These reports describe significant quality problems, recommend solutions, and identify personnel responsible for resolving the problems.

D1 DATA REVIEW: VERIFICATION AND BASELINE VALIDATION

All data generated by ER Project data collection activities will undergo a data review process that accomplishes two goals. First, "data verification" assures that needed data are available for further evaluation, assures that contract, or other, specifications have been met (or noted where not met), and provides the information needed for prompt and appropriate payment for analytical services. Second, "baseline validation" attaches qualifiers to data that do not meet specifications and provides information on potential deficiencies of that data. Reason codes for the qualifiers are also assigned to data to help users understand why a qualifier was added and the potential impacts of the data deficiency. The product of this first process is a report in FIMAD that can be used, as is, for data quality assessment (DQA) (see Section D3 of this document) and, as necessary, to focus further validation efforts. See Figure D-1 for a portrayal of the data verification/baseline validation process and Figure D-2 for a flow diagram that shows where the process fits into the entire data collection process.

For routine analytical services (RAS), the verification and baseline validation processes are carried out simultaneously. Those processes make use of a checklist for data completeness and compliance that is based on the routine analytical contracts, and that use standard validation qualifiers based on the commonly accepted contract laboratory program (CLP), "CLP Functional Guidelines" for review of analytical data. During this process, missing items are obtained from the laboratory that generated the data and any required corrections to erroneous data are made. These error corrections include both problems with compliance and problems with data entry into FIMAD.

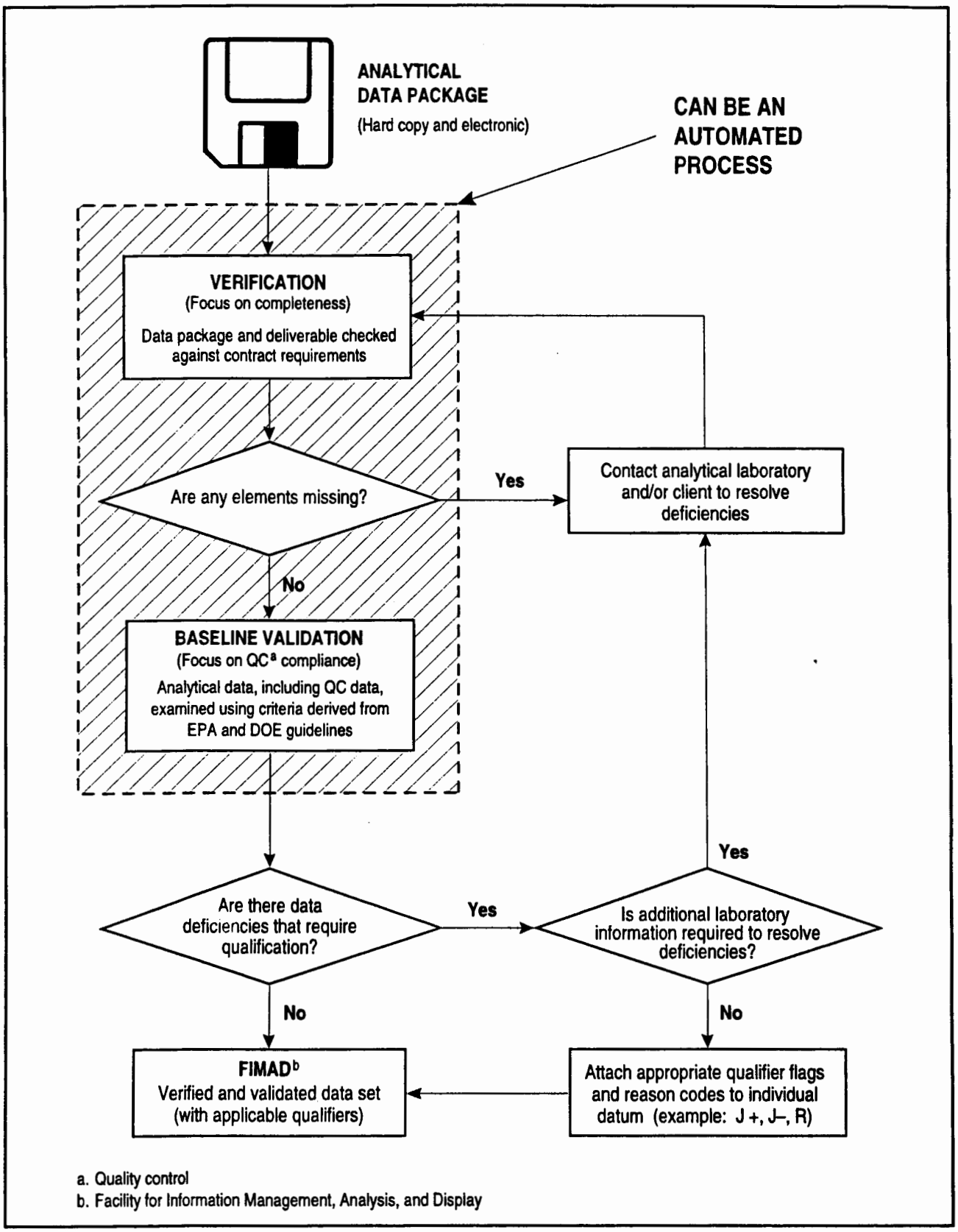
For routine analytical services, the SAP must state that the "LANL ER Checklist and Criteria for Verification and Baseline Validation" (LANL 1995, 52241), including data qualifiers and reason codes, will be used for verification and baseline validation. Forms and checklists may be provided for clarification, based on the analytical services used, e.g., organics, inorganics, high explosive (HE), radiochemistry, or commonly used mobile laboratory SOWs.

If known, the SAP should identify anticipated needs for focused validation (see Section D2 of this document). For example, when petroleum hydrocarbons are anticipated to be an interference in semivolatile analyses, the SAP should specify that the chromatograms will be reviewed to assess the effect or potential effect of interferences on the reported data.

For nonroutine analytical services (NRAS), which include off-site analytical services, field analyses, and field measurements, verification criteria must be stated in the SAP or SOP. These verification, or acceptance, criteria are most efficiently used when they are provided as a checklist or data review SOP. The qualifiers that have been stipulated for the routine analytical services should be used to provide consistent data qualifiers within FIMAD. The SOP must also provide reason codes that are appropriate for the specific analyses. In the case of NRAS, the verification and baseline validation criteria should be combined. This will create a single set of requirements that must be met. Data failing these requirements will be qualified and reason codes will be attached.

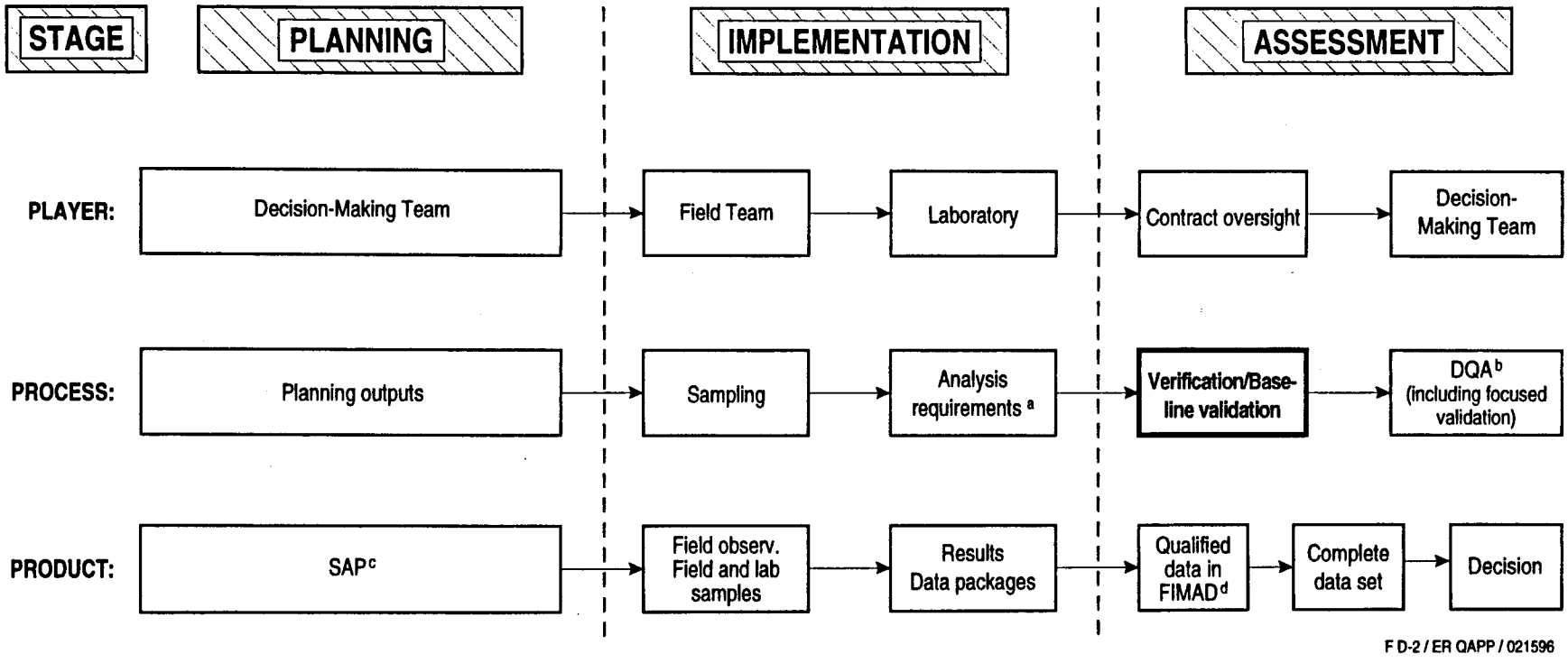
For NRAS, the SAP must provide the following:

- the problem-specific verification and baseline validation criteria (the analytical data generator must be made aware of these criteria). Note that if the nonroutine service closely resembles



F D-1 / ER QAPP / 021596

Figure D-1. The data verification/baseline validation process.



a. Analysis requirements are specified in a formal statement of work or contract.
b. Data quality assessment
c. Sampling and analysis plan
d. Facility for Information Management, Analysis, and Display

Figure D-2. Data flow diagram for the Environmental Restoration Project.

a routine service, the routine verification/baseline validation procedures may be cited, with appropriate deviations identified;

- the payment implications if measurement criteria are not met;
- the process for corrective action (e.g., completion and correction of data package); and
- if known, any need for additional focused validation (see Section D2 of this document).

These items can be provided by reference to appropriate SOPs and SOWs or by incorporating the requirements into the SAP.

The baseline validation process focuses on the measurement data. The variability associated with the measurement process often represents only a minor component of the overall variability in the environmental data collection process. Other components of variability in a data set include, but are not limited to, spatial variability of environmental contaminants, variability in the sampling processes, and uncertainty in all other processes that occur during planning, sample collection, field data recording, and reporting. Consequently, data validation should not be overemphasized at the expense of other elements of the data collection process. To better match the cost of data validation with its comparable value, the ER Project requires only this streamlined verification/baseline validation process.

D2 FOCUSED DATA VALIDATION

The purpose of focused data validation is to determine the technical adequacy of measurement data when

- the data are qualified as deficient during the verification/baseline validation process. For example, when holding times are exceeded, interferences are present, artifacts are detected in the laboratory blank, poor sample recovery is indicated, or multiple deficiencies are noted, a focused validation may be required to assist in the determination of data adequacy for the intended use;
- the DQA process requires additional information about the variability or uncertainty of the reported data; or
- the DQA process requires additional information about the data quality prior to making a data use decision because of anomalies detected in a data set.

Figure D-3 depicts where focused validation usually occurs in the DQA process. Focused data validation usually occurs as a result of specific data use questions that arise during the DQA process, which is described in Section D3 of this document. However, unusual, excessive, or potentially fatal deficiencies noted in the report for data verification/baseline validation may trigger focused validation as an initial step in the DQA process. If this appears to be the case, the field unit technical team is notified through appropriate qualifiers and reason codes in FIMAD and must make a decision as to whether the focused validation should be initiated during DQA.

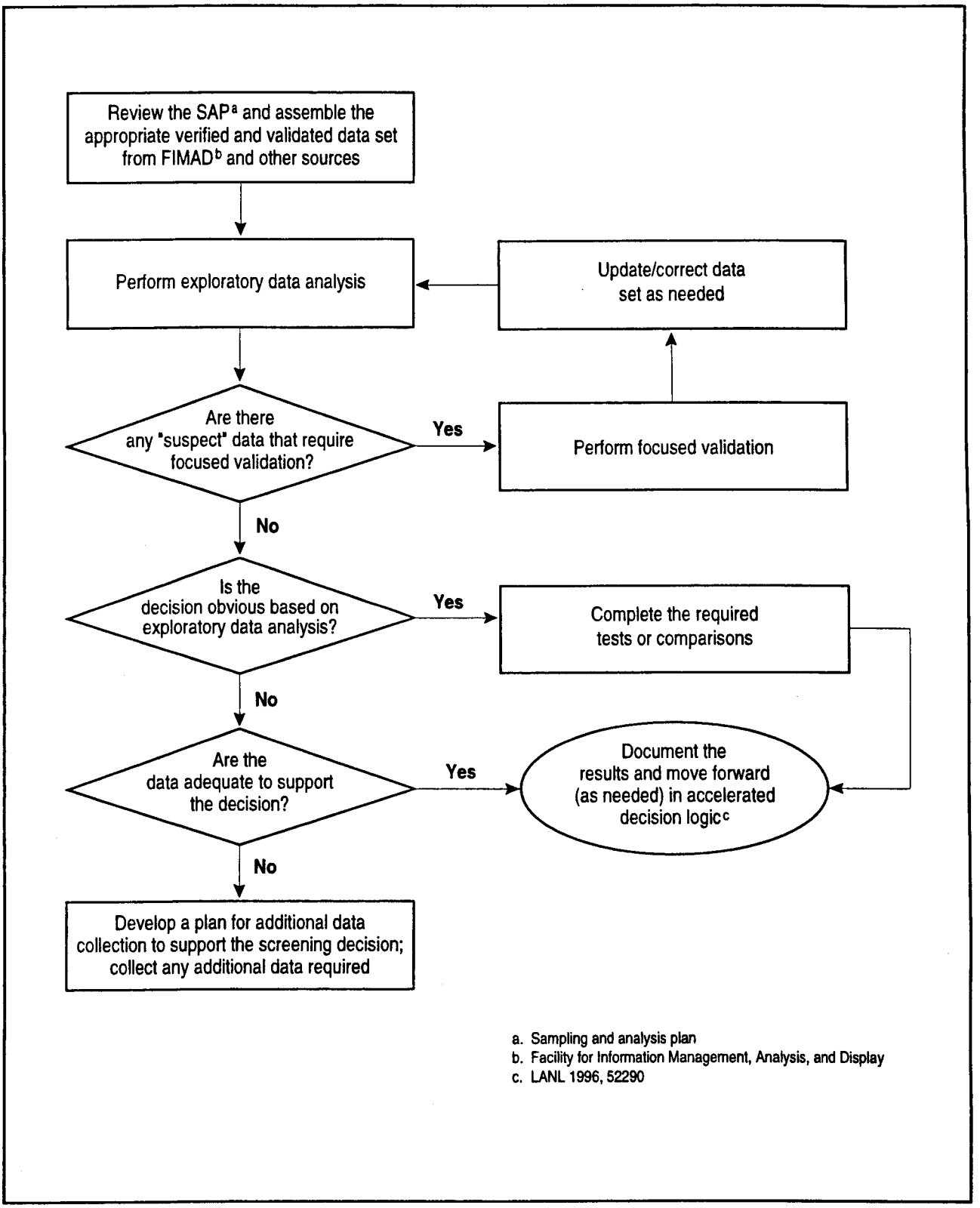


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Figure D-3. The data quality assessment process.

Focused validation for the LANL ER Project does not result in any adjustment of data (e.g., for bias), because PRS-specific data will usually be insufficient for such a purpose. However, it might be possible, based on historical ER Project-wide QA/QC data, used in conjunction with the site-specific data, to support a conclusion of a bias that can be quantitated and taken into consideration in a decision. Bias considerations must be addressed on a case-by-case basis by the DSC.

Factors which may be used to focus validation are

- qualitative QC measures,
- quantitative QC measures,
- degree of importance of the detection/quantitation limit,
- concern with detectable concentrations,
- analytical false negatives,
- analytical false positives,
- potential use of data not meeting defined performance criteria, or
- analytical uncertainly/variability, especially when results are close to action thresholds and/or detection/quantitation limits.

D3 DATA QUALITY ASSESSMENT: RECONCILIATION WITH PLANNING (SAP) OBJECTIVES

Data quality assessment (DQA) is a data analysis and interpretation process involving scientific and statistical evaluation of data sets to determine if they are sufficient to support specific decisions. To implement the DQA process, the data analyst will work closely with a multidisciplinary team, potentially including the field team leader, data manager, chemist, statistician, risk assessor, and earth scientists. Figure D-3 provides an overview of the approach the ER project uses to implement the DQA process to determine adequacy to support a decision.

The DQA process includes a review of the SAP objectives, data quality requirements, sampling design, and exploratory and confirmatory statistical analyses of the data. Initially the data analyst will assemble the data set, including field information such as sample coordinates and descriptions and associated field measurements, and review any additional reports (e.g., a data validation report).

DQA usually begins with exploratory data analysis, including a significant graphical component. An interactive statistical graphics computer program is very useful for this purpose. Because this process evaluates individual data points within the context of entire data sets, it can quickly identify both "suspect" data and critical observations that could affect decisions based on these data. If necessary, "suspect" data can be submitted for focused validation (see Section D2 of this document) to determine whether they resulted from errors in the data generation process. "Suspect" and other unusual observations may also be reviewed by experts on the natural environment and the measurement process to determine if they have scientific explanations. A third possibility is that such observations simply represent the true variability inherent in the measurement process or the environment.

Following exploratory data analyses and any required focused validation, the DQA process will determine the validity of

- removing questionable results from the data set,
- correcting incorrect data, or
- leaving the data set unaltered.

Any changes made to the data set must be fully documented.

The remainder of the DQA process is intended to reconcile the data with the requirements specified in the SAP, and to assess the adequacy of the data to support the SAP objectives. The DQA process addresses the questions "Did we get what we asked for?" and "Did we ask for what we need?" How this is done depends in part on how quantitatively the original requirements were formulated.

To assess the adequacy of the sampling design to support a decision (e.g. "Did we ask for what we need?"), the data analyst must work with other members of the DQA team to determine if the number and types of samples, as specified in the SAP and as actually collected, were appropriate. This includes

- determining if the number and location of samples required by the SAP were taken;
- determining if the appropriate media were sampled;
- judging the adequacy of the sample number and locations, given the updated understanding of the problem; and
- determining if the understanding of the problem changed since the SAP was prepared because of observations made by the field team.

While problems on one or more of the above do not automatically rule out using the data as planned, they can suggest that supplemental data must be collected before proceeding.

In some cases, the correct decision will be obvious by inspection of the data set; for example, when reported values are far above or are uniformly below SALs. Provided that the sampling design was adequate to support this obvious decision, the evaluation of data adequacy for that decision may terminate after the initial exploratory analysis and the site moves forward in the accelerated decision logic (LANL, 1996, 52290).

If the decision is not obvious, either because the data do not all point in the same direction, or because of some minor problem with the design, or if the SAP specifies that the decision will be based on the results of certain statistical tests or calculations (e.g., on upper confidence bounds for certain population parameters), further examination of the analytical data is required. Qualitative evaluation of the analytical and field data will determine if

- analytical measurements for all variables specified in the SAP were generated;
- the appropriate suite(s) of analytes were requested, given the updated understanding of the problem;

- the analytical methods used were appropriate for the analytes of interest (e.g., inductively coupled plasma atomic emission spectrometry (ICPAES) is typically considered inappropriate for measuring thallium concentrations in soil);

- the detection or quantitation limits reported for "nondetects" were less than or equal to the decision levels specified in the SAP;

- measurement performance requirements (precision and bias) specified in the SAP were met; and

- data collected at different times are consistent between sampling events and between sample request/report numbers.

Beyond these qualitative evaluations, the ER Project will use the DQA process defined by EPA (EPA 1995, 52289), or its equivalent, to assess data adequacy to support a statistically based decision. This process focuses on the adequacy of the data set for decision-making, rather than the integrity of individual measurements. The EPA DQA process assumes that a statistical approach to sampling and analysis was taken, and that the basis for this design (such as the outputs of EPA's DQO process (EPA 1994, 50288) was either recorded in the SAP or can be developed retrospectively. The first two steps of this formal DQA process, review of the sampling design and preliminary data review, are as described above. The remaining three steps are summarized below.

- The data analyst will work with the DQA team to ensure that the most appropriate statistical test will be used. (If the DQO process was followed, then a statistical test was specified in the SAP. However, additional or alternate tests may be considered at this time, particularly if the understanding of the problem has been updated.) Then the underlying assumptions that must hold for the proposed statistical procedures will be evaluated for this data set. In addition, the data analyst will consult with the appropriate scientists and site experts to make sure that the comparisons implied by the statistical test are appropriate from a scientific standpoint.

- In general, the data analyst will use the site data to generate estimates of total study error and to perform the appropriate statistical tests at a significance level consistent with the decision-makers' desire to control decision errors. (Again, if the DQO process was followed, then these limits on decision errors were among its outputs.) In cases where the data set will be used to support a no further action (NFA) proposal or some other specified decision outcome, the data analyst should evaluate the confidence associated with this decision outcome and determine if the data are sufficient to support the decision in that case.

- If an adequate level of confidence was achieved at the contaminant concentrations actually observed, this observation supports the case that data are sufficient to support the proposed decision.

Results of DQA will be documented in adequate detail for the decision-maker and peer reviewers to evaluate the effect of these results on decision-making. If a decision can be made based on the data, the documentation will include both the decision outcome and also the level of confidence that can be ascribed to the decision. The data analyst and other members of the DQA team will develop recommendations in cases where the data are not deemed sufficient to support a decision, which may be included in the documentation or presented to the decision-makers in a less formal manner. If further investigations appear to be required, the data analyst will summarize information contained in the existing data as it applies to the design of subsequent SAPs for this site. As appropriate, the DQA team may recommend that limitations be placed on current or future uses of the data.

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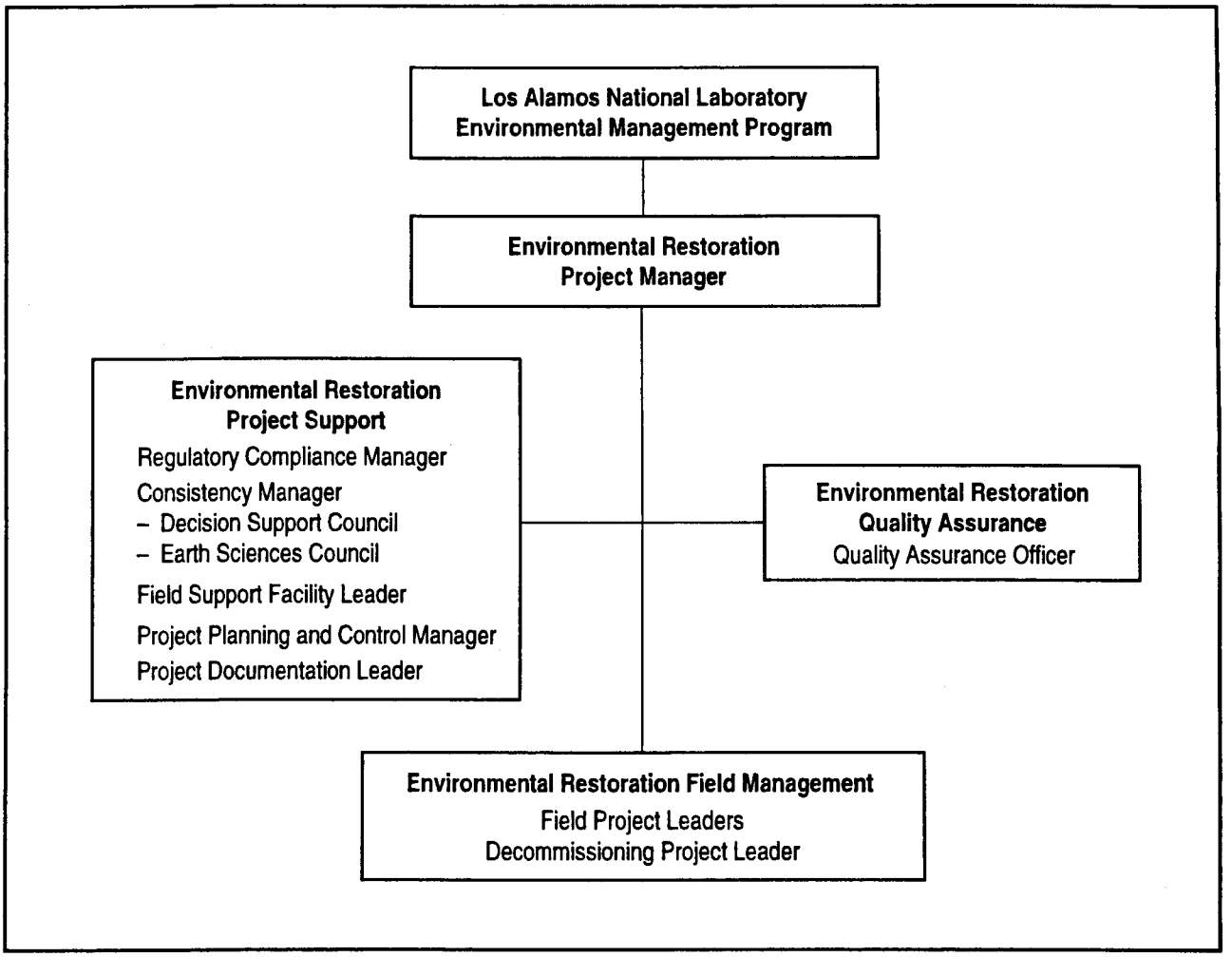
ACRONYMS AND ABBREVIATIONS

AAS	atomic absorption spectroscopy
ADS	activity data sheets
AEC	Army Environmental Center
ASTM	American Society for Testing and Materials
CLP	Contract Laboratory Program
CMS/CMI	corrective measures study/corrective measures implementation
COC	chemical of concern
COPC	chemical of potential concern
CRDL	contract-required detection limit
DOE	US Department of Energy
DPL	Decommissioning Project Leader
DQA	data quality assessment
DQO	data quality objective
DSC	Decision Support Council
EC	expedited cleanup
EDL	estimated detection limit
EPA	US Environmental Protection Agency
EQL	estimated quantitation limit
ER	Environmental Restoration
FIMAD	Facility for Information Management, Analysis, and Display
FPL	Field Project Leader
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
HAZWOPER	hazardous waste operator and emergency response
HE	high explosive
HSWA	Hazardous and Solid Waste Amendments
ICP(ICPAES)	inductively coupled plasma
IWP	Installation Work Plan
LANL	Los Alamos National Laboratory
NFA	no further action
NRAS	nonroutine analytical services
OM	on-site measurements
PE	performance evaluation
PPC	Project Planning and Control
PRS	potential release site
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QMP	Quality Management Plan
RAS	routine analytical services
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RPF	Records-Processing Facility
SAL	screening action level
SAP	sampling and analysis plan
SCA	site characterization analyses
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
TCLP	Toxicity characteristic leaching procedure
TIC	tentatively identified compound
USATHAMA	US Army Toxic and Hazardous Materials Agency
UTL	upper tolerance level
VCA	voluntary corrective action
VOC	volatile organic contaminant/compound
VOST	volatile organic sampling train

1.0 OVERVIEW

The ER Project is part of the LANL Environmental Management Program. The ER Project is led by a project management team consisting of the ER Project Manager, a Regulatory Compliance Manager, a Consistency Manager, five FPLs, a DPL, a Field Support Facility Leader, a Project Planning and Control (PPC) Manager, Project Documentation Leader, and a QAO (Figure I-1). Project-wide responsibilities, lines of communication, and the organizational structure are divided into functional areas as described below.



F A-1 / ER QAPP / 022096

Figure I-1. Project organizational structure for the Environmental Restoration Project.

1.1 ER Project Manager

The ER Project Manager has overall responsibility for organizing, controlling, coordinating, and directing all ER Project operations. He is the final authority for

- identifying overall project objectives such as identifying which sites require investigation/remediation and decommissioning,
- ensuring that all operations are conducted in a safe manner and in accordance with applicable requirements as set forth in the LANL ER QMP,
- reviewing and approving site investigation reports, and
- allocating funding for ER Project operations.

1.2 ER Project Field Management

The five FPLs, the DPL, and their teams make up the ER Project field management functional area. The project leaders report directly to the ER Project Manager. They are responsible for

- identifying ER Project team members for their respective field units;
- identifying and defining site-specific ER Project objectives and project quality objectives, e.g., data quality objectives (DQOs);
- scheduling project activities;
- coordinating with ER Project and contractor personnel to ensure availability of resources;
- developing and implementing site-specific planning documents such as SAPs, RFI work plans, EC plans, VCA plans, CMS/CMI plans, and decommissioning plans to achieve project objectives, developing RFI reports, develop decommissioning reports, responding to any notices of deficiency; and preparing and reviewing reports on the implementation of the above activities;
- communicating with regulators on SAP issues to gain acceptance of the regulator regarding the approach to problem solving and the outcome of the problem solving process;
- organizing, coordinating, controlling, and directing contractors and ER Project team members to meet ER Project objectives;
- defining/specifying quality requirements for materials and services purchased for field unit operations;
- implementing corrective actions to reconcile identified deficiencies with ER Project and regulatory requirements;

- identifying training opportunities and requirements for ER Project and contractor personnel; and
- implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

Each of these project leaders have teams (contractor and LANL employees) that assist them in developing appropriate work plans, implementing the work plans, reviewing data, making decisions, and reporting on the results of their activities.

1.3 ER Project Support

The ER Project Compliance Manager, Consistency Manager, Field Support Facility Leader, PPC Manager, Project Documentation Leader, and their teams make up the ER Project support functional area. These managers and leaders report directly to the ER Project Manager. They are responsible for providing technical and administrative support to the ER Project leaders and each other, and for implementing the LANL ER QMP and this document.

1.3.1 Regulatory Compliance Manager

This manager is the primary interface with the State of New Mexico, the EPA and regulatory agencies, as appropriate. The Compliance Manager

- provides technical support to the FPLs and the DPL on regulatory issues;
- is responsible for initiating permit modifications based on results of ER Project activities;
- provides technical support to the Field Support Facility, FPLs, and the DPL concerning waste management issues;
- is responsible for managing site closure activities for the ER Project; and
- is responsible for implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.2 Consistency Manager

The Consistency Manager

- has primary responsibility for promoting consistency throughout ER Project activities;
- is responsible for the development and revisions of ER Project procedures, policies, etc.;
- is assisted in the above task by the DSC, ESC, and the resources available to the ER Project through LANL, DOE, and contractor personnel; and

- is responsible for implementing this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.3 Field Support Facility Leader

The Field Support Facility Leader

- is responsible for operating the ER Field Support Facility and supporting ER Project activities;
- manages the packaging, shipping, and tracking of samples to analytical laboratories;
- establishes and administrates contracts with analytical laboratories for performing analysis of ER Project samples;
- manages the ER Project's electronic data management system;
- manages contracts drilling and coring activities;
- manages the mobile analytical facilities (radiological and chemistry vans);
- identifies the costs of these field support functions for use by the FPLs in their budgeting and planning functions; and
- implements this document and other applicable documents, policies, orders, etc., as set forth in the LANL ER QMP.

1.3.4 Project Planning and Control Manager

The PPC Manager

- provides planning and control system support to the ER Project;
- integrates information from the field units on an ER Project-wide basis to support the development of the ER Project baseline schedule and budget activity data sheets (ADSs), and reports to the ER Project Manager and DOE;
- provides critical path analyses, what-if scenarios and operational load leveling to ER Project management; and
- maintains a master index of records generated by the ER Project.

Each field unit team includes a PPC specialist. These specialists coordinate through the PPC Manager to ensure consistency in level of detail, unit costs, etc.

1.3.5 ER Project Documentation Leader

The ER Project Documentation Leader (PDL) supports the ER Project by managing the RPF and functions. This task includes

- processing hardcopy records of ER Project activities to the LANL central records facility,
- making records available to the public as part of the ER Project administrative record,
- distributing documents (including controlled documents), and
- preparing documents and retrieving documents in support of ER Project activities.

1.4 ER Project Quality Assurance Officer

The ER Project QAO reports to the ER Project Manager and provides support to the ER Project management team. The QAO is responsible for

- identifying ER Project QA requirements;
- advising ER Project management on QA matters;
- developing, reviewing, and approving the ER Project QMP and other applicable quality assurance/control/assessment documents; and
- assessing the effectiveness of the ER Project's implementation of applicable governing documents and regulations such as the HSWA Permit, the LANL ER QMP, and the LANL ER QAPP, by
  - performing assessment and oversight of ER Project activities,
  - implementing the analytical laboratory oversight functions (including laboratory qualification and performance monitoring),
  - reporting quality problems to the appropriate level manager and requesting the implementation of corrective actions, and
  - tracking corrective actions to completion.

1.0 INTRODUCTION

The objective of environmental sampling is to obtain samples of material that represent a particular population about which information is needed. The population could be a geographical area, the collection of waste material in one or more containers, a stream of fluid, etc. Decisions concerning the possibility of taking NFA or of having to remediate a site will be based on the data derived from analysis of the collected samples. If the samples do not reflect the true contaminant distribution of the site, environmental problems could go unaddressed or a great deal of effort might be expended in unnecessary site remediation.

Contaminants of potential concern (COPCs) must be identified, and sampling locations and depths must be identified, prior to selecting the devices or methods for collecting the samples. The sample collection methods and tools are then selected to satisfy the investigation's quality objectives.

2.0 FACTORS AFFECTING SAMPLING TOOL SELECTION AND SAMPLE HANDLING

Most of the environmental samples collected at LANL are soils. However, liquids are sampled occasionally, and when it is necessary to establish the presence or distribution of permeable layers, or to establish stratigraphic control, continuous coring may be necessary. Those items that must be identified before sampling methodology can be selected are addressed below.

1. *The Intended Use of the Data, i.e., Objectives of the SAP.* These might include

    - providing input such as contaminant location, variability, and site contaminant concentration profiles for future SAP design;
    - determining whether contaminants are present above predetermined action levels such as SALs;
    - providing information for selecting remediation alternatives;
    - determining the volume and location of media that must be removed or treated to achieve cleanup levels; and
    - verifying attainment of cleanup levels.

    Involving the correct personnel to develop SAPs is essential to success of the investigation. This selection will usually mean that at least one statistician will be involved at the outset of planning. Where soils are to be collected and analyzed, subject matter experts representing the disciplines of soil science, geology, geochemistry, hydrology, risk assessment, and analytical chemistry should also be involved, as necessary. The responsible FPL should be involved; the public and the regulators should be included as necessary.

    When evaluating the problem to be resolved and identifying associated contaminants, not only should the primary LANL process at the site be considered but also those processes that are related. For example, HE casting and milling operations would leave a potential legacy of HE contaminants. However, the milling machines must have been lubricated periodically, and spilled lubricants might have

been cleaned up with degreasing (i.e., chlorinated organic) solvents, thus creating a potential legacy of petroleum hydrocarbons and chlorinated organics as well as the HE. Outputs of the planning process should include estimates of the tolerable decision errors. Factoring into the decision error are limits that should be established for tolerable sampling and measurement error.

2. *The Types of Samples to be Collected.* Grab samples are discrete samples taken at a single location and depth or single point in time. Grab samples may be collected to establish the distribution of contaminants over a site. They are also useful for monitoring changes in contaminant concentrations over time and pinpointing single spots of high contaminant concentration (i.e., hot spots).

   Composite samples, which are mixtures of individual grab samples or portions of samples, are useful for obtaining an estimate of average contaminant concentrations over a given space and time at relatively low cost. However, compositing has a tendency to effect dilution of contaminants by mixing samples of higher concentration with samples of lower concentration. As a result, composite sampling is not appropriate for identifying hot spots or when concentrations approach the detection limit of the analytical method.

   Integrated samples are collected by accumulating, either continuously or discretely, portions of the medium being sampled. They provide average concentration values over a discrete time interval and the sampling devices can often be programmed for automatic sample acquisition. Integrated samples are typically collected from liquid and air media only.

3. *The Geographical Locations (Flat Area, Hillside, Stream Bed, etc.) of the sampling points.* These will be affected by the intent of the SAP and the ability to collect samples in the desired locations.

4. *The Sampling Point Coordinates.* Each sample collected must be linked to four coordinates: the three spatial coordinates (*x*, *y* and *z*), and the time of collection.

5. *The Nature of the Material to be Sampled (Tuff, Soil, Sediment, Sludge, Water, Air, Stack Gases, etc.).* The material to be sampled will be determined by expectations associated with contaminant deposition and transport mechanisms and will influence the choice of sample collection tools and methods. For example, collection of sandy (i.e., noncohesive) soils requires methodology that prevents sample losses from the collection tool between the point of collection until it is safely containerized. Guidance on the selection of sample collection tools for various types of samples and types/conditions of media to be sampled are presented in Section 3.0 of this appendix. An experienced field team member should be consulted when selecting sampling tools and a thorough inspection of the site should be made before or during SAP development so the nature of the media being sampled can be appropriately identified. This might require the input of a geologist, hydrologist, etc., to accurately characterize the media to be sampled.

6. *The Analyses to be Performed on the Collected Samples (Determined by SAP Objective(s)).* Sample handling, storage, and transport can significantly affect the integrity of the samples. Collection of samples for volatile analyses requires that the sample be agitated as little as possible and the sample containers be filled as much as possible to minimize the headspace volume. Grab samples are the preferred sample type when determining volatile analytes or radionuclides, because volatiles can be lost through compositing or integration, and radionuclides (e.g., Pu) are often distributed as particulates. Semivolatiles, pesticides,

polychlorinated biphenyl (PCBs), TPH, metals, and radionuclides are generally not subject to loss through volatilization, and therefore are not subject to the gentle handling constraints associated with the volatiles.

Enough sample must be collected to provide sufficient material for completing all of the required analyses. This amount can be determined easily by consulting the chosen analytical methods, reviewing past experiences, consulting the appropriate LANL ER SOP, or consulting a member of the SMO or DSC Chemistry Team. Coordination with the SMO can be especially important if a particular sample type is being collected for the first time or a particular suite of analytes is to be determined for the first time. It is usually best to collect more sample than necessary for the required analyses in the event that an analysis of the sample must be repeated.

If a sample requires special handling, it is advisable to record on the chain-of-custody form accompanying the sample, and on the analytical order, all special handling requirements. For example, if stones, vegetable matter, other debris, etc., should be excluded from the analyses, a note to that effect should accompany the sample.

7. *The Preservatives and Containers Used to Store the Samples (Dictated by the Analytes to be Determined and the Analytical Protocol).* Many analytes tend to adsorb to the inside walls of their containers. This causes an apparent loss of analyte because the adsorbed analytes may not be transferred during sample preparation with the rest of the sample. Even worse, the loss of analyte may not be apparent at all. Conversely, contaminants can leach into the sample from the containers, especially if liquid is present in the sample. Thus, the choice of container can be critical to obtaining accurate analytical results. Chemical preservatives can retard or prevent the plating of contaminants onto container walls. The choice of container closure (i.e., lid, cap, etc.) is also important, as the glues used to fasten liners into the closures can release contaminants into the sample. When standard analytical protocols are used, containers and preservatives are generally dictated by the analytical protocols. In cases where sample preservation conditions are not specified for a particular analysis, an experienced chemist should be consulted for advice. LANL-ER-SOP-01.02 also provides guidance for the preservation and containerization of samples.

8. *Sample Holding Times, Storage, and Shipping.* Because loss of analytes from sample degradation is a common problem, it is important not to store a sample for too long a period before it is analyzed. The acceptable storage period (i.e., holding time) is a function of the analytes of interest, the sample matrix, and the storage conditions. Most degradation rates are greatest soon after sample collection and decrease over time. However, biodegradation rates can increase with time as microorganisms increase in number.

   If a sacrifice in sensitivity is acceptable for volatile organic contaminants/compounds (VOCs), the methanol extraction (NMED circa 1994, ER ID number 52243) may be used to extract the analytes from the sample matrix on-site. The advantage of this on-site extraction technique is that the extract submitted for analysis is more stable than the original sample with regard to analyte loss. Water samples to be submitted for VOC analyses must be preserved with acid (e.g., sodium bisulfate or hydrochloric acid) upon collection.

   Light-sensitive analytes must be stored in dark-colored containers or in the dark to prevent photodegradation. Volatile organic compounds are easily lost through

agitation or mixing of samples and can be lost readily when the seal between the sample container and its closure is not air-tight. It is therefore extremely important to ensure that the screw threads on sample containers and corresponding caps are free of debris before the samples are sealed in the containers. All soil samples collected for HE analyses should be frozen to prevent degradation. Freezing can be effected by adding dry ice to the sample cooler. Chemical oxidation/reduction of analytes in a sample can be minimized by protection from atmospheric oxygen and by adding chemical preservatives. While sample preservation protocols typically require adding a predetermined amount of preservative to a sample, it is not the *amount* of added preservative that is important so much as the *condition* that the added preservative is expected to create and sustain within the sample until the sample is analyzed. If insufficient preservative is added, the preservative might be consumed before the sample is analyzed.

Standard analytical methods typically specify sample preservation and storage conditions and will serve as guidance for sample preservation and storage for other analytical methods. If using analytical methods that do not specify sample preservation and storage conditions, it is important to ensure that the selected preservatives do not interfere with the analysis. Consult LANL-ER-SOP-1.02 for specific holding times related to various analyses. Where storage conditions are not specified, the DSC Chemistry Team should be consulted.

9. *Sample Collection Costs and Time.* Estimates of sampling costs will be affected by the time projected for sampling, the number of personnel involved in the sampling effort, the number of samples to be collected, the costs of training the sampling personnel, costs for equipment rental/purchase (e.g., drill rigs), and costs devoted to packaging and shipping samples. Time schedules can be affected significantly by the availability of equipment and weather. Equipment availability may be a more significant issue for large items such as drill rigs, for which availability could be limited during peak sampling season. Failure to achieve quality standards or to satisfy DQOs is not an acceptable consequence of reducing costs.

10. *Waste Minimization.* Sampling plan implementation results in the generation of sampling waste such as discarded environmental materials, decontamination fluids, and used disposable sampling equipment. These and other wastes generated during sampling must be managed in accordance with LANL-ER-AP-5.3, and minimized in accordance with LANL-AR-10-8.

3.0 THE SAMPLE COLLECTION METHOD SELECTION PROCESS

After considering the above aspects of sample collection/storage and shipping, the sampling equipment and sampling methodology may be selected, consistent with SAP objectives, etc. This selection requires that the collected samples are representative of the medium being sampled and that they be collected and handled in a manner that preserves their integrity. The sample collection methods must be chosen to obtain those samples that best represent the media of interest.

The selection of sample collection methods and sampling apparatus will depend primarily on the nature of the medium to be sampled, the analyses to be performed on the sample, the type of sample to be collected (i.e., grab or composite), the sampling depth, the sampling costs, and availability of sampling equipment. LANL-ER-SOPs 01.01 through 01.04 present requirements and guidance for sample collection, preservation, packaging, transportation, and storage. The discussions below provide a summary of the conditions for which selected sampling tools are most appropriate.

1. *Soil and Sediment Sampling.* Table II-1 presents those sampling tools most useful for collecting environmental soil and sediment samples. For ephemeral streams these methods are suitable for sampling stream beds in the absence of water; when the stream bed is under water, refer to Table II-2 or II-3.

   Augers are especially suited to collecting composite samples because the augering action homogenizes the soil, whereas they are not useful for collecting samples for volatile analyses because the augering action causes loss of volatiles. Augers are not recommended for collecting cohesionless soil samples as the sample may not be retained when the auger is removed from the ground. The open tube sampler is recommended for collecting samples that are to be characterized lithologically. Scoops are useful only for collecting surface grab samples, which may then be composited either at the sampling site or in a laboratory. They are not recommended for collecting volatiles because the act of scooping and pouring the samples into a container can cause loss of volatiles. Thin-walled tube samplers can be used with or without sample liners to collect core samples. When used with a stainless steel or brass liner, the liner can be easily sealed with end caps after sample collection and submitted for volatiles analyses. If a clear plastic liner is used, lithologic descriptions of the core can be obtained. The thin walled tube sampler, because it is pushed into the ground hydraulically rather than being tamped or hammered into the ground, does not compact the soil. It is thus well suited to the determination of geotechnical parameters such as porosity, hydraulic conductivity, grain size distributions, and Atterberg limits. For soil sampling at depths greater than 5 ft., mechanical drivers such as auger drill rigs are typically used to push the sampling tool into the ground.

   Table II-2 presents sampling tools useful for sampling drainage sediment from flowing rivers, streams, and surface water drainage. If the flowing water source is dry at the time of sampling, the sampler should refer to Table I-1 for soil sampling methods.

   Sediment sampling may be used to determine if contaminants are migrating downstream of the potential contaminant source. Samples should be taken from those areas such as ponds and low-lying ponding areas in which contaminants can accumulate during periods of flow. If background samples are needed, they should generally be taken from upstream of the potential contaminant source.

   Use of dippers and scoops should be confined to shallow waters of low flow rates. The dipper may be more effective than the scoop at retrieving fine grained sediments, but due to the lack of a good cutting edge its use is generally limited to soft sediment.

   The methods most appropriate for sampling sediments in standing water include the scoop, dipper, and box and dredge samplers. All of these except the dredge sampler are most useful in shallow water. The box and dredge samplers used with a wire line can be used in deep water. Table II-3 is a tabulation of likely applications of these sampling tools.

2. *Water Sampling.* Table II-4 presents sampling methods useful for collecting samples from streams, rivers, and drainage flows. The bottle submersion approach is the simplest, requiring that a bottle attached to an extendible arm be submerged below the water surface until it is full. The subsurface filling of the bottle prevents the loss of volatiles. If samples are to be composited after collection, volatiles analyses should not be performed on the composited sample because of the great

TABLE II-1

RECOMMENDED USES FOR SOIL SAMPLING TOOLS

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Hand Auger	No	All except geotechnical	AC,VC	0 to 5.0 ft.	06.10 06.18
Open Tube (Trier)	No	No	Lithology	0 to 5.0 ft.	06.17
Ring Sampler	Yes[3]	Yes	Gra, AC	0 to 0.7 ft.	06.11
Scoop (Spade and Scoop)	Yes[3]	All except geotechnical	Grab, AC	0 to 0.5 ft.	06.09
Split Spoon	Yes	Yes	Grab, AC, VC,	0 to 2 ft.	06.24
Split Tube (Core Barrel)	No	All except geotechnical	Grab, VC, Lithology	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.26
Split Tube with SS[4] liner (Core Barrel)	Yes	All except geotechnical	Grab, VC,	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.26
Thin-Walled Tube[5]	Yes	All	Grab	0.5 to 5.0 ft.; >5 ft. with mechanical driver	06.10

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for volatiles analyses, but is not recommended for this use.
4 SS = stainless steel
5 SS sampler recommended for collecting samples to be analyzed for chemical or radiological contaminants.

TABLE II-2

SOIL SAMPLING TOOLS USEFUL FOR SAMPLING IN FLOWING WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Dredge Sampler (Ponar Grab)	Yes[3]	All except geotechnical	Grab, AC, Lithology	0 to 0.5 ft.	06.14
Gravity Corer	Yes	Yes	Grab, AC, VC, Lithology	0 to 3 ft.	06.14
Hand Corer	Yes	Yes	Grab, AC, VC, Lithology	0 to 3 ft.	06.14
Scoop/Trowel	Yes[3]	Yes[3]	Grab, AC	0 to 0.5 ft.	06.14

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for these analyses, but is not recommended for this use.

TABLE II-3

SOIL SAMPLING TOOLS USEFUL FOR SAMPLING IN STANDING WATER

	Analyses				
Sampling Tool	Volatiles	Non-volatiles[1]	Sample Type[2]	Approximate Sampling Depth	Applicable ER SOP
Dredge Sampler (Ponar Grab)	Yes[3]	All except geotechnical	Grab; AC; Lithology	0 to 0.5 ft.	06.14
Gravity Corer	Yes	Yes	Grab; AC; VC; Lithology	0 to 3 ft.	06.14
Hand Corer	Yes	Yes	Grab; AC; VC; Lithology	0 to 3 ft.	06.14
Scoop/Trowel	Yes[3]	Yes[3]	Grab; AC	0 to 0.5 ft.	06.14

1 Includes geotechnical parameters, herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; VC = vertical composite sample; Lithology = lithology description
3 Can be used to collect samples for these analyses, but is not recommended for this use.

potential for loss of analytes during compositing. All but the dipper method are useful for collecting composite samples. The dipper method should only be used for collecting samples that will not have volatile organic analyses performed on them.

Sampling of standing surface water (see Table II-5) should be conducted based on the SAP requirements which should include a consideration of suspected contaminant concentrations and natures of the COPCs. For example, if dense organics that are immiscible with water are to be sampled, those contaminants are most likely to be found at the bottom of the body of water. However, water-immiscible COPCs that are less dense than water are most likely to be found at the surface.

TABLE II-4

TOOLS USEFUL FOR SAMPLING FLOWING SURFACE WATER

	Analyses				
Sampling Tool	Volatiles	Non-volatiles[1]	Sample Type[2]	Approximate Sampling Depth	Applicable ER SOP
Bottle Submersion	Yes	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Dipper	No	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Extendible Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Extendible Tube Sampler	Yes[3]	Yes	Grab, AC; I; VC	0.5 to 5.0 ft.	06.13
Single Stage Sampler	No	Yes	Grab	Surface	06.29
Peristaltic Pump	Yes	Yes	Grab, AC; I; V	0.5 to 5.0 ft.	06.13

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.

Groundwater might be sampled using a pump to bring the water to the surface and into a sample collection container or it might be sampled using a container that is lowered into a groundwater monitoring well. In the case of vacuum lysimeters which are useful for collecting soil water in the vadose zone, a porous cup is buried beneath the ground surface and the surrounding water is pushed into the cup under a pressure differential. Table II-6 presents various sampling tools used at LANL that are appropriate for groundwater.

3. *Container Sampling.* This section addresses sample collection from drums, tanks, and bags. Sampling of closed drums can be dangerous, depending on the drum contents. When the contents are unknown, remote mechanical devices made of "nonsparking" materials can be used to pierce the top of the drum prior to sampling to allow combustible vapors to escape safely. See Table II-7.

TABLE II-5

SAMPLING TOOLS USEFUL FOR SAMPLING STANDING SURFACE WATER

	Analyses				
Sampling Tool	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Approximate Sampling Depth**	**Applicable ER SOP**
Bottle Submersion	Yes	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Dipper	No	Yes	Grab, AC, I	0 to 0.5 ft.	06.13
Extendible Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Extendible Tube Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to 5.0 ft.	06.13
Kemmerer Bottle Sampler	Yes[3]	Yes	Grab, AC, I, VC	0.5 to >5 ft.[4]	06.13
Peristaltic Pump	Yes[3]	Yes	Grab, AC, I, V	0.5 to 5.0 ft.	06.13

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.
4 Most appropriate at depths greater than 5 ft.

TABLE II-6

TOOLS USEFUL FOR SAMPLING GROUNDWATER AND SOIL WATER

	Analyses				
Sampling Tool	Volatiles	Non-volatiles[1]	Sample Type[2]	Approximate Sampling Depth	Applicable ER SOP
Bailer	Yes[3]	Yes	Grab, I[4]	0 to 30 ft.[5]	06.03
Bladder Pump	Yes	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Vacuum Lysimeter[6]	Yes	Yes	Grab, I	0 to 6 ft.	06.05
Pressure-Vacuum[6] Lysimeter	Yes	Yes	Grab, I	0 to 50 ft.	06.05
High Pressure-Vacuum Lysimeter[6]	Yes	Yes	Grab, I	0 to >50 ft.	06.05
Piston Pump	Yes[3]	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Submersible Pump	Yes[3]	Yes	Grab, I, VC[4]	0 to >30 ft.	06.03
Syringe Sampler	Yes	Yes	Grab	0 to >30 ft.	06.03

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample
3 Can be used to collect samples for these analyses, but is not recommended for this use.
4 Acceptable, but not the preferred application.
5 Can be used at depths greater than 30 ft., though the preferred depth is less than 30 ft.
6 Not recommended for clay soils.

The hand auger is recommended for sampling soils from drums when toxicity characteristic leaching procedures (TCLP) or radionuclide testing will be performed. Compositing is also recommended except when collecting samples for volatile organic analytes. The auger is especially effective for collecting composite samples because the augering action tends to homogenize the samples.

4. *Air Sampling.* Air canisters such as SUMMA canisters can be used to collect relatively large volumes of gases for subsequent analyses. Air and exhaust gases can be trapped on a sorbent and later released from the sorbent material for analysis. The volatile organic sampling train (VOST) can be used to collect volatile organic contaminants with boiling points less than 100 °C. See Table II-8.

TABLE II-7

TOOLS USEFUL FOR SAMPLING CONTAINER CONTENTS

		Analyses			
Sampling Tool	**Nature of Sample**	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Applicable ER SOP**
Coliwasa Sampler	Sludges, Liquids, Slurries	Yes[3]	Yes	Grab, I[4]	06.15
Hand Auger	Soils	No	Yes	AC, VC	06.18
Open Tube (Trier)	No	No	Lithology	0 to 5.0 ft.	06.17
Thin-walled Tube Sampler with SS[5] liner	Soils	Yes	Yes	Grab	06.10
Thief Sampler	Dry Powders or Granules	No	Yes	Grab	06.16
Weighted Bottle	Liquids and Slurries in Tanks	Yes[3]	Yes	Grab, VC	06.19

1 Includes herbicides metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; AC = areal composite sample; I = integrated sample; VC = vertical composite sample.
3 Contents of sampler should be transferred carefully to sample container to minimize loss of volatiles.
4 Acceptable, but not the preferred application.
5 SS = stainless steel.

TABLE II-8

TOOLS USEFUL FOR SAMPLING AMBIENT AIR AND EXHAUST STACKS

		Analyses			
Sampling Tool	**Nature of Sample**	**Volatiles**	**Non-volatiles[1]**	**Sample Type[2]**	**Applicable ER SOP**
Canister	Air or exhaust	Yes[3]	No	Grab, I	06.22
Filter	Air or Exhaust	No	Yes	I	06.25
Volatile Organic Sampling Train	Air or Exhaust	Yes	No	I	06.21

1 Includes herbicides, metals, PCBs, pesticides, radionuclides, semivolatile organics, and total petroleum hydrocarbons.
2 Grab = grab sample; I = integrated sample
3 Not recommended for polar, highly water-soluble compounds such as alcohols, ketones, and acetonitrile.

1.0 INTRODUCTION

Tabulated in this appendix are the analyses and related information provided through the LANL analytical laboratory contracts Statement of Work (LANL 1995, 49738). Section 2 lists, for RAS, estimated detection limits (EDLs) for inorganic analytes, and estimated quantitation limits (EQLs) for organic, HE and radiochemical analytes. Section 3 lists data for NRAS.

EDLs are based on the Contract Laboratory Program "Contract Required Detection Limits (CRDLs)," which are not necessarily achievable in real world samples. EQLs listed for soil/sediment are based on wet sample weight but, normally, data are reported on a dry weight basis, thus causing EQLs higher than those cited for dry weight.

In parts of this appendix, references are made to analytical methods that are approved for quantifying specific analytes or analyte suites, by citing the associated method numbers. Method numbers in this appendix that are preceded by "SW" indicate methods belonging to the SW-846 analytical methods compendium (EPA 1986, 31732).

2.0 ROUTINE ANALYTICAL SERVICES

2.1 Inorganics (Metals and Inorganic Compounds)

2.1.1 Sample Preparation

Following are the sample preparation procedures that are appropriate for use in determining metals. Methods from the most recent version of SW-846 should be used, although CLP sample preparation procedures (from Statement of Work ILM03.0 or more recent) may be used, if appropriate for the matrix.

- SW-3005 Acid digestion of waters for total recoverable or dissolved metals for analysis by flame AAS or ICP;
- SW-3010 Acid digestion of aqueous samples and extracts for total metals for analysis by flame AAS or ICP;
- SW-3020 Acid digestion of aqueous samples and extracts for total metals for analysis by furnace AAS, with the exception of As and Se, which are to be prepared according to methods 7060 and 7740;
- SW-3040 Dissolution procedure for oils, greases or waxes (microwave digestion of these samples is preferred);
- SW-3050 Acid digestion of sediments, sludges, and soils.
- SW-1311 TCLP (note that changes made in the Federal Register, Volume 57, No. 227, p. 55114, must be incorporated); and
- SW-3015 and SW-3051 Microwave digestion procedures.

2.1.2 Target Analyte List and Detection Limits

EDLs are presented in Table III-1. For water samples, the EDLs are based on CLP CRDLs.

Mercury should be determined by the cold vapor technique with the EDL for water = 0.2 µg/L and the EDL for soils = 0.1 mg/Kg. The cold vapor technique soil EDL is based upon a 1-gram sample taken to a final volume of 100 mL. This is a TCLP metal and may be requested as a separate determination.

In cases where the EDL for a metal cannot be met using ICPAES, or false positives are suspected to be a problem at a laboratory, the subcontractor must use the GFAA technique (e.g., method SW7841 for thallium and method SW7421 for lead) or ICP-MS technique (e.g. method SW6020).

TABLE III-1

DETERMINATION OF METALS

	ICPAES[1]		GFAA or ICP-MS	
Analyte	**Water, mg/L**	**Soils, mg/Kg[2]**	**Water, mg/L**	**Soils, mg/Kg[2]**
Aluminum	200	40		
Antimony	60	12		
Arsenic[3]	NR[4]	NR[4]	10	2
Barium	200	40		
Beryllium	5	1		
Cadmium[3,5]	5	1		
Calcium	5000	1000		
Chromium[3,5]	10	2		
Cobalt	50	10		
Copper	25	5		
Iron	100	20		
Lead[3,5]	3	0.6	1	0.2
Magnesium	5000	1000		
Manganese	15	3		
Nickel	40	8		
Potassium	5000	1000		
Selenium[3]	NR[4]	NR[4]	5	1
Silver[3,5]	10	2		
Sodium	5000	1000		
Thallium	NR[4]	NR[4]	10	2
Vanadium	50	10		
Zinc	20	4		

1 Recommended method for ICPAES analysis is SW6010A.
2 Soil EDLs for ICPAES, GFAA, and ICP-MS analytes are based upon a 1-gram sample taken to a final volume of 200 mL.
3 This is a Toxicity Characteristic Leaching Procedure (TCLP) metal and may be requested as a separate determination. The TCLP regulatory limits are the EDLs for these analytes. Method SW-1311 (7/92) is the method to be used for TCLP.
4 NR = not recommended; analyte should not be determined using this method.
5 Atomic absorption (AA) methods or ICP-MS may also be used for these analytes.

TCLP metals (identified as footnote 3 in Table III-1) may be requested as a separate determination. Laboratories should consider EDLs for TCLP metals using the TCLP to be the regulatory limits. Method SW-1311 (7/92) is the method to be used for TCLP.

Cyanide may be determined using methods SW9010, SW9010A, SW9012, or EPA 335.2. The EDLs for cyanide are 10 µg/L (water) and 0.05 mg/kg (soils). The soil EDL for CLP ILM03.0 method 335.2 is based upon a 5-gram sample taken to a final volume of 250 mL.

The contractor may vary weights and final volumes for metals and cyanide analyses; however, any allowable variance must still meet the EDL.

2.2 Volatiles

Table III-2 identifies the volatile target analytes and associated EQLs. The US EPA methods that are options for use are method SW8260 (11/90 or more recent) or the CLP method for volatiles (OLM02.0 or more recent, using capillary column). These methods are based on purge and trap sample extraction/concentration followed by gas chromatography/mass spectrometry analysis.

Tentatively identified compounds (TICs) may be requested. If requested, they should be identified and quantitated per the CLP method for volatiles, OLM02.0 (or more recent).

TABLE III-2

VOLATILE TARGET ANALYTES AND EQLS

Target Analyte	Water, mg/L	Soil/Solids, mg/kg
Chloromethane	10	10
Vinyl Chloride	10	10
Bromomethane	10	10
Chloroethane	10	10
Acetone	20	20
Dichlorodifluoromethane	10	10
Iodomethane	5	5
Trichlorotrifluoroethane	5	5
Trichlorofluoromethane	5	5
Methylene Chloride	5	5
1,1-Dichloroethene	5	5
Carbon Disulfide	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (total)	10	10
Bromochloromethane	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
1,1-Dichloropropene	5	5
2-Butanone	20	20
2,2-Dichloropropane	5	5

TABLE III-2

VOLATILE TARGET ANALYTES AND EQLS (Continued)

1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Benzene	5	5
1,2-Dichloropropane	5	5
Trichloroethene	5	5
Dibromomethane	5	5
Bromodichloromethane	5	5
t-1,3-Dichloropropene	5	5
c-1,3-Dichloropropene	5	5
1,1,2-Trichloroethane	5	5
1,3-Dichloropropane	5	5
Chlorodibromomethane	5	5
4-Methyl-2-Pentanone	20	20
Toluene	5	5
2-Hexanone	20	20
1,2-Dibromoethane	5	5
Tetrachloroethene	5	5
Chlorobenzene	5	5
1,1,1,2-Tetrachloroethane	5	5
Ethylbenzene	5	5
o,m,p-Xylene (mixed)	5	5
Styrene	5	5
Bromoform	5	5
1,1,2,2,-Tetrachloroethane	5	5
1,2,3-Trichloropropane	5	5
Isopropylbenzene	5	5
Bromobenzene	5	5
n-Propylbenzene	5	5
2-Chlorotoluene	5	5
4-Chlorotoluene	5	5
1,3,5-Trimethylbenzene	5	5
tert-Butylbenzene	5	5
1,2,4-Trimethylbenzene	5	5
sec-Butylbenzene	5	5
1,3-Dichlorobenzene	5	5
1,4-Dichlorobenzene	5	5
p-Isopropyltoluene	5	5
1,2-Dichlorobenzene	5	5
n-Butylbenzene	5	5
1,2-Dibromo-3-Chloropropane	10	10

2.3 Semivolatiles

Table III-3 identifies the semivolatile target analytes and associated EQLs. The US EPA methods that are options for use are method SW-8270 (11/90 or more recent) or the CLP method for semivolatiles (OLM02.0 or more recent). These methods are based on solvent extraction, concentration, and GC/MS detection and quantitation.

TICs may be requested. If requested, they should be identified and quantitated per the CLP method for semivolatiles, OLM02.0 (or more recent).

2.4 Pesticides and Aroclors

Table III-4a identifies the pesticide and aroclor target analytes and associated EQLs. The US EPA methods that are options for use are methods SW-8081, *dual column option*, (11/92 or more recent) or the CLP method for pesticides/aroclors (OLM01.8 or more recent). These methods are based on solvent extraction, concentration, and GC/EC detection and quantitation.

Since the EQLs are sensitive to the nature of the sample matrix, Table III-4b presents factors by which the EQLs in Table III-4a are to be multiplied, depending on the matrix.

2.5 High Explosives

Table III-5a presents the HE target analytes for method SW8330 and associated EQLs. For water samples these analytes may be determined using either of the following methods:

- SW8330, or
- US Army Toxic & Hazardous Materials Agency (USATHAMA), 1990, "Improved Salting-Out Solvent Extraction Method for Determination of Low Levels of Nitroaromatics and Nitramines in Groundwater" coupled with the USATHAMA 6/30/88 "Determination of Explosives in Water by High Pressure Liquid Chromatography" (method no. UW14).

For soil samples, the analytes in Table III-5a may be determined using either of the following methods:

- SW8330, or
- USATHAMA, August 1989, "Reversed-Phase Method for the Determination of Explosive Residues in Soil."

Table III-5b lists additional HE analytes that may be determined using USATHAMA analytical methods.

TABLE III-3

SEMIVOLATILE TARGET ANALYTES AND ASSOCIATED EQLS

Target Analyte	Water, mg/L	Soil/Solid, mg/kg[1]
Acenaphthene	10	330
Acenaphthylene	10	330
Aniline	20	660
Anthracene	10	330
Azobenzene	20	660
Benzo(a)anthracene	10	330
Benzoic acid	50	3300
Benzo(b)flouranthene	10	330
Benzo(K)flouranthene	10	330
Benzo(g,h,i)perylene	10	330
Benzo(a)pyrene	10	330
Benzyl alcohol	20	1300
Bis(2-chloroethoxy)methane	10	330
Bis(2-chloroethyl)ether	10	330
4-Bromophenyl phenylether	10	330
Butylbenzylphthalate	10	330
4-Chloroaniline	20	1300
4-Chloro-3-methylphenol	20	660
2-Chloronaphthalene	10	330
2-Chlorophenol	10	330
4-Chlorophenyl phenylether	10	330
Chrysene	10	330
Dibenz(a,h)anthracene	10	330
Dibenzofuran	10	330
1,2-Dichlorobenzene	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
3,3'-Dichlorobenzidine	20	660
2,4-Dichlorophenol	10	330
Diethylphthalate	10	330
Dimethyl phthalate	10	330
2,4-Dimethylphenol	10	330
2,4-Dinitrophenol	50	1600
Di-n-butylphthalate	10	330
4,6-Dinitro-2-methylphenol	50	1600
2,4-Dinitrotoluene	10	330
2,6-Dinitrotoluene	10	330
Di-n-octyl phthalate	10	330
Bis(2-ethylhexyl)phthalate	10	330

TABLE III-3 (Continued)

SEMIVOLATILE TARGET ANALYTES AND ASSOCIATED EQLS

Target Analyte	Water, mg/L	Soil/Solid, mg/kg[1]
Fluoranthene	10	330
Fluorene	10	330
Hexachlorobenzene	10	330
Hexachlorobutadiene	10	330
Hexachlorocyclopentadiene	10	330
Hexachloroethane	10	330
Indeno(1,2,3-cd)pyrene	10	330
Isophorone	10	330
2-Methylnaphthalene	10	330
2-Methylphenol	10	330
4-Methylphenol	10	330
Naphthalene	10	330
2-Nitroaniline	50	1600
3-Nitroaniline	50	1600
4-Nitroaniline	20	660
Nitrobenzene	10	330
2-Nitrophenol	10	330
4-Nitrophenol	50	1600
N-Nitrosodimethylamine	10	330
N-Nitrosodiphenylamine	10	330
N-Nitroso-di-n-propylamine	10	330
2,2'-oxybis(1-Chloropropane)	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Phenol	10	330
Pyrene	10	330
1,2,4-Trichlorobenzene	10	330
2,4,5-Trichlorophenol	50	1600
2,4,6-Trichlorophenol	10	330

1 EQLs for soil are based on no Gel Permeation Chromatography (GPC) clean-up being performed. The laboratories' GPC equipment will determine what the EQL is, based on the volume of extract the GPC equipment uses. However, if possible, the laboratories should concentrate the GPC extract to a volume that makes the EQL for a sample that underwent GPC clean-up no more than twice the listed EQL.

TABLE III-4a

PESTICIDE/AROCLOR TARGET ANALYTES AND EQLS

Analyte	Waters, mg/L (See also Table III-4b)
Aldrin	0.05
α-BHC	0.05
β-BHC	0.05
δ-BHC	0.05
γ-BHC (Lindane)	0.05
α-Chlordane	0.05
γ-Chlordane	0.05
4,4'-DDD	0.10
4,4'-DDE	0.10
4,4'-DDT	0.10
Dieldrin	0.10
Endosulfan I	0.05
Endosulfan II	0.10
Endosulfan sulfate	0.10
Endrin	0.10
Endrin Ketone	0.10
Endrin Aldehyde	0.10
Heptachlor	0.05
Heptachlor epoxide	0.05
Methoxychlor	0.50
Toxaphene	5.00
Aroclor-1016	1.00
Aroclor-1221	2.00
Aroclor-1232	1.00
Aroclor-1242	1.00
Aroclor-1248	1.00
Aroclor-1254	1.00
Aroclor-1260	1.00

TABLE III-4b

EQL ADJUSTMENT FACTORS FOR VARIOUS SAMPLE MATRICES

Matrix	Factor[1]
Ground Water	1
Low-concentration soil by sonication[2]	33
High-concentration soil and sludges by sonication[2]	1000
Non-water miscible waste	10,000

1 To obtain the matrix-dependent EQL, multiply the EQL in Table III-4a by this factor.
2 This factor is based on no GPC clean-up. The factor will vary for soil samples that undergo GPC, based on the GPC equipment used (volume of extract put through GPC). The laboratories should adjust the final volume of the GPC extract to keep make this factor no greater than 66, if possible.

TABLE III-5a

NITROAROMATIC AND NITRAMINE HE TARGET ANALYTES AND EQLS

		EQL[1]		
		Waters, µg/L		Soils, mg/Kg
Target Analyte	Abbreviation	Low Level	High Level	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	(HMX)	ND	13.0	2.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine	(RDX)	0.84	14.0	1.0
1,3,5-Trinitrobenzene	(1,3,5-TNB)	0.26	7.3	0.25
1,3-Dinitrobenzene	(1,3-DNB)	0.11	4.0	0.25
Methyl-2,4,6-trinitrophenylnitramine	(Tetryl)	ND	20.0	0.65
Nitrobenzene	(NB)	ND	6.4	0.26
2,4,6-Trinitrotoluene	(2,4,6-TNT)	0.11	6.9	0.25
4-Amino-2,6-dinitrotoluene	(4-Am-DNT)	0.06	ND	ND
2-Amino -4,6-dinitrotoluene	(2-Am-DNT)	0.035	ND	0.26
2,4-Dinitrotoluene	(2,4-DNT)	0.02	5.7	0.25
2,6-Dinitrotoluene	(2,6-DNT)	0.31	9.4	0.26
2-Nitrotoluene	(2-NT)	ND	12.0	0.25
3-Nitrotoluene	(3-NT)	ND	7.9	0.25
4-Nitrotoluene	(4-NT)	ND	8.5	0.25

1 These EQLs apply only to the SW-846 and USATHAMA methods listed above. If "ND" appears in a cell, the EQL has not been determined. In those cases, assume an EQL of 1.0 mg/L for the low level waters and an EQL of 10 mg/L for the high waters where values are missing.

TABLE III-5b

ADDITIONAL HE TARGET ANALYTES AND EQLS

Analyte	Water, µg/L[1]	Soil, mg/Kg[1]	Analytical Method
Nitroglycerine	25	0.50	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of NG and PETN in Water (or Soil, as applicable)
Pentaerythritol Tetranitrate	25	0.50	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of NG and PETN in Water (or Soil, as applicable)
Nitroguanidine	5.0	0.51	USATHAMA Aug., 1989, Reversed Phase HPLC Method for the Determination of Nitroguanidine in Water (or Soil, as applicable)
Tetrazene	6.11	1.3	USATHAMA Reversed Phase HPLC Method for the Determination of Tetrazene in Water (or Soil, as applicable)
Nitrocellulose	70.0	ND	USATHAMA Reversed Phase HPLC Method for the Determination of Tetrazene in Water

1 These are assumed EQLs based on the USATHAMA lower limit of the linear concentration range.

2.6 Radiochemical Analytes

Table III-6a presents EQLs for commonly determined individual radiochemical analytes as well as analyte suites. The gamma spectroscopy analyte suite (see "Multiple isotopes" in Table III-6a) is defined by Table III-6b.

TABLE III-6a

TARGET ANALYTE EQL BY MATRIX; PCI/G OR PCI/L UNLESS OTHERWISE INDICATED

Analyte	Soil	Water	Technique[1]
Gross alpha/beta	10.0	3.0	gas-proportional
Gross alpha/beta	10.0	NA	liquid scintillation
Strontium-90[2]	2.0	5.0	gas-proportional
Americium-241	0.1	0.1	alpha spectroscopy
Plutonium-238, -239	0.1	0.1	alpha spectroscopy
Thorium-228, -230, -232	0.1	0.1	alpha spectroscopy
Thorium-230, -232	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Uranium-234, -235, -238	0.1	0.1	alpha spectroscopy
Uranium-234, -235, -238	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Tritium	300 pCi/L	300	liquid scintillation
Multiple isotopes (Table III-6b)	Am-241: 1 Cs-137: 1	Am-241: 20 Cs-137: 20	gamma spectroscopy
Gross gamma	2.0	100	NaI(Tl) or HPGE detection
Total uranium	0.5 µg/g	1 µg/L	KPA[3] (commonly requested nonroutine analysis)
Total uranium	0.5 µg/g	1 µg/L	ICP-MS (commonly requested nonroutine analysis)
Radium-226	1.0	1.0	assorted
Radium-228	0.5	0.5	assorted
Thorium-234	1.0	20	assorted
Lead-210	2.0	5.0	assorted

1 The Los Alamos National Laboratory methods for these analytes are contained in LA-10300-M, "Health and Environmental Chemistry: Analytical Techniques, Data Management, and Quality Assurance."
2 It may be presumed that strontium-89 is not present.
3 Kinetic Phosphorescence analysis, also referred to as pulsed-laser phosphorimetry (ASTM method D5174-91) or kinetic laser phosphorescence.

TABLE III-6b

GAMMA SPECTROSCOPY SUITE DEFINITION

Nuclide symbol	Nuclide name	Nuclide symbol	Nuclide Name
Ac-228	actinium-228	Pa-231	protactinium-231
Am-241	americium-241	Pa-233	protactinium-233
Ann Rad	annihilation radiation	Pa-234m	protactinium-234m
Ba-140	barium-140	Pb-210	lead-210
Bi-211	bismuth-211	Pb-211	lead-211
Bi-212	bismuth-212	Pb-212	lead-212
Bi-214	bismuth-214	Pb-214	lead-214
Cd-109	cadmium-109	Ra-223	radium-223
Ce-139	cerium-139	Ra-224	radium-224
Ce-144	cerium-144	Ra-226	radium-226
Co-57	cobalt-57	Ru-106	ruthenium-106
Co-60	cobalt-60	Rn-219	radon-219
Cs-134	cesium-134	Se-75	selenium-75
Cs-137	cesium-137	Sn-113	tin-113
Eu-152	europium-152	Sr-85	strontium-85
Hg-203	mercury-203	Th-227	thorium-227
I-129	iodine-129	Th-234	thorium-234
K-40	potassium-40	Tl-208	thallium-208
La-140	lanthanum-140	U-235	uranium-235
Mn-54	manganese-54	Y-88	yttrium-88
Na-22	sodium-22	Zn-65	zinc-65
Np-237	neptunium-237		

3.0 NONROUTINE ANALYTICAL SERVICES

Table III-7 presents individual analytes and analyte suites that comprise the NRAS included by the laboratory contracts SOW (LANL 1995, 49738). In some cases, references are made to the analytical methods that are approved or recommended for quantifying the listed parameter. Where analyte suites are listed but the analytes within the suite are not defined, the field unit is responsible for identifying which analytes are to be quantified, and for selecting the analytical method appropriate for quantifying the selected analytes at the desired concentration levels in the applicable sample matrices.

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION (Continued)

ACROLEIN AND ACRYLONITRILE (soil and water)
Method SW8240
Method SW8030
Method SW8260 or Method EPA 524
AGENT BYPRODUCTS (soil and water)
Thioglycol
Organosulfurs
GB/VX Breakdown Products
DIMP/DMMP
IMPA, MPA, Fluoracetic acid
ANIONS (soil and water)
Fluoride
Nitrites/Nitrates
Sulfates
HERBICIDES
Method EPA 515
Method 1658
Method EPA 531
Method EPA 632
Method EPA 632
Method SW8150
LOW DETECTION LEVEL FOR INORGANICS
SOW 10/91(CLP metals)
LOW DETECTION LEVEL FOR ORGANICS
Volatile Organic Analysis (VOA), Method EPA 524.2
Volatile Organic Analysis (VOA), Method 1624
Volatile Organic Analysis (VOA), SOW 6/91 (CLP VOA)
Semivolatiles (SV), Method 1625
Organochlorine Pesticides
ORGANIC ANALYSES
Method 8015M/ CADHS TPH
Total Recoverable Petroleum Hydrocarbons, Method EPA 418.1
GC VOAs, Method SW8010/8020
Organophosphorus Pesticides
Polyaromatic hydrocarbons, Method SW8310
Picric Acid
Total PCBs - water and soil
PCBs by Congener
Alcohol-F lists
Phenols
VOA-F lists
Appendix IX
Volatile Organic Analyses (VOA)
Semivolatiles (SV)
Pesticides/PCB's

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION (Continued)

Chlorophenoxy Herbicides
Organophosphorus Pesticides
Dioxins/Furans
Metals
TCLP (extractions and associated analyses)
Zero Headspace Extraction
Tumbler Extraction
Volatiles
Semivolatiles
Herbicides
Pesticides
Metals
Reactive CN/Sulfide
Density
Flash Point
Ignitability
Free Liquids
RADIOCHEMISTRY
Uranium by KPA
Carbon-14 (C-14)
Technetium-99 (Tc-99)
Air Analyses
Method TO-1
Method TO-2
Method TO-5 PAHs
Method TO-13 PAHs
Method TO-14
Volatile Organic Sampling Train (VOST)
Fixed Gases
Benzene, Ethylbenzene, Toluene, Xylene (BTEX)
Method EPA 504.1
Halogenated Volatiles, Method SW8010
Aromatic Volatiles, Method SW8020
Organophosphorus Pesticides, Method SW8140
Volatile Organics by GC/MS, Method SW8240
Total Petroleum Hydrocarbon, TPH-G
GFAA Metals Al, Se, Pb, Tl, Cd, Sb, Ag
UNUSUAL MATRICES
Tissue/Vegetation:
Organochlorine Pesticides and PCBs, Method SW8080
Metals by ICPAES, Method SW6010 (Each Metal for Kemron)
Mercury, Method SW7470
Non-soil solids:
Volatiles
Semivolatiles

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION (Continued)

Target Analyte List (TAL) Metals and CN
Pesticides/PCGs
BIOLOGICAL TESTS
Arsenic in Biota
Mercury in Biota
Selected Explosives in Biota
Selected Metals in Biota
Selected Pesticides in Biota
WATER QUALITY PARAMETERS
Anion(s) First Analyte
Acidity
Alkalinity
Ammonia
Anions 300.0 First Analyte
Bicarbonate/carbonate
Bromide
Biochemical Oxygen Demand (BOD)
Carbon - Total Organic Carbon (TOC)
Carbonate
Chloride
Chlorine - residual
Chlorophyll A
Chemical Oxygen Demand (COD)
Color
Corrosivity, Langelier
Cyanide - free (no distillation)
Cyanide - reactive
Cyanide - total
Cyanide-Amenable to Chlorination
Dissolved Inorganic Carbon (DX)
Flash point, Setaflash
Fluoride (distilled)
Fluoride (non-distilled)
Formaldehyde
Hardness (as CaCO3)
Hexavalent Chromium (Hex Chrome, Chromium-VI, Cr(VI))
Ion Chromatography (IC) Scan (Cl, NO2, NO3, PO4, SO4, Br)
Iodide
Infrared (IR) Scan
Langlier Index
Metals, Safe Drinking Water Act (SDWA)
Nitrate/Nitrite (NO3/NO2)
Nitrogen, Total Kjeldahl
Nitrogen, Total Organic
Oil and Grease

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION (Continued)

Oil and Grease-Gravimetric
Petroleum Hydrocarbons
pH
Phenolics, Total
Phosphate-Ortho
Phosphate
Phosphate-Total
Phosphorus
SOC (soluble organic carbon)
Solids - Percent Ash
Solids-Percent Moisture
Solids-Percent Solids
Solids-Settleable
Solids-Total
Solids-Total Dissolved (TDS)
Solids-Total Suspended (TSS)
Solids-Total Volatile (TVS)
Specific Conductivity
Specific Gravity
Sulfate
Sulfide
Sulfite
Surfactants, Methylene Blue Active Substances (MBAS)
Temperature
TOX (total organic halides)
Turbidity
GEOTECHNICAL
1-Dimensional Consolidation
Atterburg Limits
Bulk Density
Cation Exchange
CU Triazial (3pt.) (Shelby Tube) -Triazial Shear
Dimensional Swell
Grain Size - Hydrometer
Grain Size - Sieve Analysis
Grain Size, Method ASTM 0422
Hydraulic Conductivity
Hydraulic Extrusion/visual classification
Modified Proctor (4 inch diameter. mold)
Modified Proctor (6 inch diameter mold)
Moisture Ash & Organic Matter
Moisture Content
Particle Size (%passing N 200 sieve)
Particle Size (combined)
Paste pH (rock)

TABLE III-7

NONROUTINE ANALYTES, ANALYTE SUITES AND RELATED INFORMATION (Concluded)

Permeability (after 2 weeks)
Permeability (constant head)
Permeability (sample remolding)
pH
Proctor Penetrometer
Soil Classification
Specific Gravity
Standard Proctor (4 inch diameter mold)
Standard Proctor (6 inch diameter mold)
Unconfined Compressive Strength
Unit Weight (density)
UU Triazial (3 pt)
Visual Classification
Void Ratio (porosity)

1.0 INTRODUCTION

Selection of analytical methods is complicated by the diversity of methods available and the tendency of individuals making method selections to use those with which they are familiar. Method selection may be further complicated by the belief that certain standard analytical protocols such as SW-846 are applicable beyond their intended purposes. The scientist sometimes feels forced to use standard methods because they are widely accepted as being robust, accurate, precise, etc., even though a more accurate, more precise, more robust, cheaper, or less time consuming method is available or can be readily developed. It is also frequently easier and more cost-effective for commercial laboratories to standardize their operations by selecting a few robust methods that are applicable to most routine samples.

Overshadowing all other considerations, the use of certain analytical methods might be governed by Federal, state, or other regulations, or ER Project representatives may enter into agreements with regulators to use specific analytical methods. For example, the RCRA mandates the use of solid waste methods, SW-846, in the following circumstances:

- determination of hazardous waste characteristics (SW-846 method 1311) followed by appropriate analytical method,
- determination of free liquid (SW-846 method 9095),
- analyses associated with submission of delisting petitions,
- analyses associated with a hazardous waste incinerator trial burn, or
- determination of air emissions from process equipment.

While the first two determinations listed above may occasionally be relevant for the LANL ER Project, the others are not likely to apply at all. It is imperative to notify the SMO when one of these five circumstances dictates strict use of an SW-846 method so that the laboratory can be informed.

2.0 CONSIDERATIONS IN SELECTING ANALYTICAL METHODS AND QC

Analytical method performance criteria derive from the site-specific planning requirements. Communicating with regulators in the early stages of planning is good practice and is an integral part of a thorough planning process, as it espouses full participation of *all* stakeholders. Since it is not always possible to have regulators actually present during scoping meetings, it is important to gain acceptance from them of the approach taken to identify the important performance criteria. The approach used could lead to selecting other-than-traditional (e.g., SW-846/CLP) methods. Negotiation of method selection with regulators is possible and is encouraged. The DSC Chemistry Team will be helpful in these negotiations.

Large-volume RAS contracts have been developed for the ER Project, including the laboratory-required QC procedures and criteria. In addition, these contracts include the ready capacity to allow for many NRAS. The list of RAS and allowed methods, with detection or quantitation limits identified for each analyte, is presented in the analytical laboratory Statement of Work (SOW for RAS [LANL 1995, 49738]) and Appendix III of this document. The services under NRAS are listed in that same appendix. Note that

many of the NRAS have "standard" or commonly used and accepted methods available, and others may be more specialized. The analytical services contracts do identify required deliverables; however, more technical expertise is needed when selecting a more specialized or emerging method to determine what kinds of QC procedures are appropriate for the method and what criteria are appropriate for the specific data quality need. The DSC Chemistry Team is the best source of assistance for selecting NRAS and QC procedures and criteria.

Method selection must include consideration of the following factors:

Desired analytical information. The COPCs, chemicals of concern (COC), or other parameters of interest must be identified. If particular forms of the analytes (e.g., dissolved, extractable, suspended, leachable, isotopic, total, etc.) are of interest, those forms must be identified. The use of the analytical information in the context of the study should be identified and recorded. The role the analytical information will play in the decision-making process should be identified. For example, risk assessment decisions, screening decisions, waste characterization decisions, etc., may be required. How the data will be used to compute statistical parameters — i.e., how it will be compared to numerical limits such as SALs, etc., to support these decisions — should be included in the SAP.

Sensitivity. The needed measurement ranges must also be identified. The measurement ranges will be influenced by the expected contaminant concentrations and the decision levels such as SALs, risk-based cleanup levels, background levels used in place of SALs, and waste characterization regulatory limits. SALs and background levels for contaminants important at LANL can be found on-line in FIMAD. If contaminants are expected to be present at concentrations near the decision level, the selected method should be able to distinguish concentrations both less than and greater than the decision level. The relationship between the decision level and the lowest reasonably quantifiable concentration is frequently a limiting factor for method selection. The quantitation limit of the method must be low enough to support determination of the COPC and COC concentrations with the desired confidence. However, the ability of a particular method to achieve the reported quantitation limit depends on the concentrations of chemical and physical interferences in the sample matrix. There are some instances when the commonly used methods cannot detect or quantitate certain analytes at or below the SAL (e.g., vinyl chloride, benzo(a)pyrene). In these cases, it may not be possible to meet the SAL using any reasonable approach. If there is no reason to believe that any of these analytes could be a LANL ER problem, it is not likely an issue. However, if there is cause for concern, the DSC Chemistry Team can be consulted to identify potential analytical procedures that may be satisfactorily employed.

Selectivity. The degree to which an analytical method is adversely impacted by the presence of interferences is a function of its selectivity. If the method responds to more than one analyte, the presence of one analyte may affect the accuracy or precision with which another can be determined. Often, interferences arise from chemical analytes that are not target analytes, or by physical effects — the net effect being to lower the confidence in the quality of the result reported for the target analyte by increasing the dispersion of analytical results or by introducing a bias. Potential interferences should be identified during selection of analytical methods, and if a problem is possible, sample preparation/cleanup procedures to remove interferences or alternative methods can be identified by the DSC Chemistry Team.

Precision. Method selection should take into account the allowable precision error associated with the analytical measurement as determined through the DQO planning process. Ideally, the precision error is known prior to analytical method selection. However, method selection can be made without knowing the precision error and precision error may be determined later. In those cases, the project may be at risk of having selected inadequate methods.

Confidence in estimating certain statistical parameters, such as the arithmetic mean, can be increased by averaging many measurements. This may be especially useful when using on-site measurements (OM) or abbreviated routine measurements that cost less and require less time to implement than fixed laboratory methods. A good example is the use of OM, optimized, or focused methods for a known contaminant problem.

Stability and Robustness. Instrument stability is a function of precision and drift, which influences the measurement system stability. Stable instruments require relatively fewer recalibrations whereas unstable methods may require frequent recalibrations and may require averaging the results of several repeat analyses on the same sample to increase the confidence in the results. It is important to understand the stability of a measurement system on both short (hourly or daily) and long (weekly or monthly) time scales. Frequently, the stability of a system is not stated explicitly in a particular analytical protocol but can be inferred from the required calibration frequency. If a measurement system is robust, it will be stable and will yield results that are comparable, even when used by different operators, on different instruments, in different laboratories, and on samples of varying matrix compositions.

Bias. The impact of bias on data quality should be evaluated in the SAP planning process. In some cases, use of the data without a consideration of the bias may be acceptable if the bias consideration does not change the decision (e.g., high bias on sample results less than the action limit or low bias on sample results greater than the action limit). This decision needs to be made during the evaluation of the data during DQA. When bias needs to be addressed, the data reviewers must be consulted to determine the direction and magnitude of the suspected bias as well as the significance of the bias. Without sufficient information to assure that the bias is real and significant, corrections for bias cannot be justified. Selection of methods with no bias (or a well characterized bias) relative to the methods used previously, generally facilitates planning, but it is not necessary as long as the degree of bias and its significance can be determined before making the required decision.

Sample Preparation. Prior to chemical analysis, a sample is usually treated chemically or physically to yield a derivative of the sample. It is the derivative of the sample (extract, digestate, electroplate, pulverized sample, etc.) that is actually analyzed. The sample preparation method must be compatable with the sample matrix and is usually specified as part of the analytical procedure, either explicitly or as a reference to another procedure. The sample preparation procedure may be followed with a sample cleanup procedure designed to remove the majority of the interferences, either without affecting the analytes of interest or by affecting them in a quantifiable manner. If interferences are known to exist at a particular site, methods should be selected that allow for mitigation of the interferences and this information should be conveyed to the analytical laboratory. Advice on method selection for mitigating interferences can be obtained from members of the DSC Chemistry Team. When special interferences and methods for mitigating them are known in advance, the analytical laboratory should be alerted to the situation. The conveyance of special instructions to analytical laboratories should be coordinated through the SMO.

Sample Holding Times. Because changes in analyte concentrations caused by sample degradation is a potential problem, it is important to not store a sample for too long a period before it is analyzed. The acceptable storage period, or holding time, for a given sample container is a function of the analytes of interest, the sample matrix and the storage conditions. The holding time clock begins upon sample collection and terminates upon initiation of sample preparation or analysis (either of original sample, such as a purge of the sample for volatiles analysis or the analysis of an extract or digestate). Thus, both the field unit and the analytical laboratory share responsibility for ensuring that holding time requirements are satisfied, since the ability of the analytical laboratory to meet regulatory holding times depends on the samples being shipped with adequate time remaining for timely analyses.

Both regulatory and technical issues can influence, or determine, acceptable holding times. The regulatory issue can often complicate the process, despite the fact that there is limited scientific basis[1] for regulatory holding times. Holding time effects can become significant long before a regulatory holding time is reached. Conversely, exceeding a holding time might have no detrimental effects on the sample, especially if the sample is preserved properly. For example, despite regulatory requirements, studies[1] have shown that most volatile target compounds are stable for at least 12 weeks. Significant losses were not seen until after 90 days and were noted for carbon disulfide, 2-hexanone, 2-butanone, 4-methyl-2-pentanone, carbon tetrachloride, styrene, and cis-1,3 -dichloropropene.[2]

If samples are not analyzed within the applicable holding time, it might be necessary to collect additional samples, especially if regulations require adherence to the holding times. However, there are instances when resampling should not be required—even if holding times are mandated by regulation or regulators. For example, if an analyte of concern is found at a level above a SAL even after the holding time was exceeded, it could be that the analyte had an initially higher concentration than the determined value and the missed holding time would have no adverse impact on the ability to make a sound decision. In that case, resampling would be wasteful. When there is a concern related to holding time exigencies, the DSC Chemistry Team should be consulted for guidance. Regulators should also be informed of the situation prior to a decision to resample or prior to accepting results associated with missed holding times. The possible effects of the missed holding times on the integrity of the data and the impact on the decision to be made should be discussed, and the conclusions should be based on sound scientific knowledge and judgment. LANL-ER SOP-01.02 and standard analytical methods typically specify sample preservation and storage conditions and will serve as guidance for sample preservation and storage when applicable.

Holding times are not always mandated or specified in analytical procedures. In addition, there may be instances when a true determination of the holding time effects is warranted (e.g., when there is public concern or potential litigation and results are negative in a situation where holding times were exceeded). A determination can be made through the use of ASTM method D4515-85, which provides an analytical and statistical tool to model sample degradation on a site-specific basis. If using analytical methods that do not specify sample preservation, holding times, or storage conditions, it is important to ensure that the selected preservative does not interfere with the analysis.

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1 "Holding Times of Volatile Organics in Water," Bottrell, D., Fisk, J., Robertson, G., Petty, J., Dempsey, C., and Bartling, ML, Fifth Annual Waste Testing and Quality Assurance Symposium, July 1989.

2 Ibid.

When regulatory holding times are exceeded, and the context for the sampling is not regulatory, there may be more room for flexibility in dealing with the potential problem of changes in the sample. However, for water samples this should never be the case as *all water samples for volatiles analyses must be acidified* (preferably as described below).

If adherence to holding time requirements is critical, it may be appropriate to analyze the samples in the field or to take direct field measurements at the sampling point. An example would be the determination of VOCs using GC or GC/MS analytical methods based on fixed laboratory methods. Holding times can sometimes be extended by limited sample preparation in the field. For example, water samples to be analyzed for VOCs can be, and *should be*, acidified to prevent microbial degradation (250 mg of sodium bisulfate per 40 ml sample has proved to be very effective). Methanol extraction of soils in the field (NMED 1994, 52243) is another way to extend holding times for volatile organics, although this will raise the detection limits. Immediate freezing of samples (using dry ice in the field) is a possibility for HE, and is recommended for soil samples to be analyzed for HE components.

Turnaround Time. The selected sample preparation and analysis methods must allow for the sample results to be generated in a timely manner. The required turnaround time could play a major role in the method selection and is often a primary factor in selecting field analyses over fixed laboratory analyses. Some of the reasons for requiring measurements on-site are

- a decision must be made in, for example, less than 24 hours to continue work efficiently, such as during a remediation;
- to direct work in real time, such as during an Expedited Site Characterization (a DOE-HQ initiative) and when there is a potential for a change in direction from the original design, and new knowledge gained from on-site measurements will allow for a speedy change;
- when there are constraints such as sample degradation (addressed under "holding times") or temporal constraints that require instant analysis; and
- for gaining important health and safety information to protect the workers and the public.[4]

When time is a factor, it is important to assure that data quality needs can be met, even if abbreviated methods are used, because of the time constraints. An example of when it is important to make sure that "fast" analyses will not compromise data use is when counting times for radioisotopes will be inadequate to meet sensitivity needs if the time is constrained.

Cost. While cost is not a technical issue, it will factor into the selection of analytical methods. As budgets are reduced, the ability to generate sufficient data with adequate quality becomes more difficult. If the EPA- and DOE- mandated DQO process is used,

3 Standard Practice for Estimation of Holding Time for Water Samples Containing Organic Constituents," ASTMD4515-85.

4 "Planning Guidance for Using Onsite Measurements," Fisk, J, Bath, R, and Klevano, C, draft, December 1995 - for DOE-EM26.

the last step of the process, "Optimization of Design," will identify a reasonably cost-effective solution to sampling and analysis that is adequate for supporting the decision. Assistance from a statistician on the DSC Statistics Team, as well as the DSC Chemistry Team, should be solicited for this.

Data Comparability. Data collected in various phases of a project often must be compared or pooled into a single data set, or subgroup of data sets, before a decision can be made. To do this, the comparability of the data and the data quality must be acceptable. If the data from more than one phase of the project are directly comparable, pooling is easy. If the data are not directly comparable but the data quality (e.g., precision and bias) from each phase is known, it could be possible to combine them in a useful manner. If the data quality of a particular data set is unknown, the ability to compare data, or to pool the data with other data sets, to make decisions is hampered. Even worse, the ability to make a decision with the desired degree of confidence may be rendered impossible if the data qualities are indeterminate. For example, use of hydrofluoric acid digestion prior to determination of metals will yield analytical results that are incomparable to analyses based on nitric acid/hydrochloric acid digestions. Attempts to compare results from the two different approaches could be futile. When strict comparability of data is required, all samples must be prepared and analyzed using the same methods over the duration of the study.

Availability of Adequate Analytical Methods. The primary consideration in selecting analytical methods/services should be the analytical method performance criteria derived from the data quality objectives developed for the site. However, because the use of RAS often provides the most cost-effective approach to chemical analyses, serious consideration should be given to using these services even when the resulting data quality may exceed the needs of the decision-makers.

When RAS methods are inadequate or there is a better way to meet analytical needs (e.g., faster and/or cheaper), other methods can be found through the same analytical contracts as NRAS which can make capacity for many additional methods immediately available. There may be other instances when the already-procured analytical methods do not meet needs, in which case special contracts/arrangements need to be made. Further discussion of RAS and NRAS will follow in Sections 3.0 and 4.0 of this Appendix.

Immunoassay test kits are an example of methods that might be non-SW-486 or non-CLP methods. These test kits can be used effectively if due consideration is given to their limitations. For example, some test kits provide actual concentration values while others only provide an indication of whether the analyte is present at a concentration above a certain cutoff value (i.e., "go/no go" tests). Because their utility is becoming more recognized, some immunoassay test kits have been approved as SW-846 methods with qualifications on their use.

3.0 ROUTINE ANALYTICAL SERVICES (RAS) CAN BE PROVIDED THROUGH ANALYTICAL CONTRACTS DEVELOPED FOR THE ER PROJECT

The SOW for RAS (LANL 1995, 49738) is the source for the list in Appendix III of analytical services available through the RAS contracts, including target analytes, estimated quantitation limits EQLs, estimated detection limits EDLs, and methods that are acceptable. The following section (3.1) describes an approach one might use to arrive at needed analytical methods and to determine if the RAS methods are adequate.

3.1 Selection of SW-846, CLP, and AEC (formerly USATHAMA) Methods

When using CLP or Army Environmental Center (AEC) methods (CLP and SW-846 are comparable in performance, the differences being transparent to the data user), the appropriate SW-846 method should be identified, then the CLP or USATHAMA method equivalent to the selected SW-846 method substituted. The first step is to identify those methods that appear to serve the intended purpose (Table IV-1 can be helpful here). Table IV-1 shows the relationship among the analytical methods allowed by the analytical support subcontracts for routine services. In most cases, an SW-846 method is allowed and use of SW-846 methods will support most needs. However, especially with regard to radionuclides (techniques allowed are cited) and selected high explosives, laboratory-specific methods are allowed or specific USATHAMA methods are required. The user must then verify the applicability of the method by referring to the particular protocol and

- verify that the method is applicable to supporting the decision to be made based on results generated from the method either alone or in conjunction with other data;
- verify that the sensitivity, comparability to other analytical methods, detection limits, selectivity, stability bias, and precision of the protocol meet the needs of the SAP;
- verify that the protocol is not subject to interferences that are anticipated to be present in the sample at concentrations that will render the analyses invalid; and
- balance factors such as turnaround times, holding times, and analytical costs.

Selected AEC methods are available for high explosives analyses for which no equivalent CLP or SW-864 methods exist. Refer to Table IV-1 when selecting these high explosives routine analytical serves. Because radiochemistry methods are not as standardized as other chemistry methods, the allowed techniques are cited, but the method numbers (nonexistent) are not.

4.0 NONROUTINE ANALYTICAL SERVICES

A large number of NRAS can be provided through the contract mentioned above. Appendix III provides the list of NRAS available through the RAS contracts. Many of the NRAS services involve use of standard or commonly accepted methods (though not routinely provided through these contracts). In addition, many of the NRAS methods are simple modifications of the RAS methods, in which case the deliverables are alike, the QC procedures can be cited, and criteria can be modified to meet needs (e.g., a lower detection limit may need to be demonstrated). However, for specialized or emerging methods some prescriptive narrative in the SAP is needed to make sure that project goals are met. The following information is required as a set of deliverables from the contractors when NRAS is requested;

- target analytes/measurement parameters and associated analytical results and quantitation or measurement limits,
- citation of sample preparation and analysis method used (when a "standard" method is used) or a description of the technology used when a standard method cannot be cited,

TABLE IV-1

RELATIONSHIPS AMONG SW-846, CLP AND AEC ANALYSIS METHODS[1]

SW-846 Method Allowed by Analytical Contracts[2]	Comparable CLP Method	Comparable AEC Method
6010, Metals by ICP-AES	SOW ILM03.0	None
6020, Metals by ICP-MS	SW-6020	None
7000 Series, Metals by AA/GFAA	EPA200 Series	None
9010, Total Cyanide	EPA335.2	None
9012, Total Cyanide	EPA335.2	None
8081, Organochlorine pesticides/PCBs by capillary GC	None	None
8151, Chlorinated herbicides by capillary GC	None	None
8260, VOCs by capillary GC/MS	OLM03.0 (capillary column)	None
8270, SVOCs by capillary GC/MS	OLM03.0 (capillary column)	None
8330, Nitroaromatics and nitramines by reversed phase HPLC with UV detection	None	1. Reversed Phase HPLC Method for Determination of Explosives Residues in Soil 2. UW14, Determination of Explosives in Water by HPLC 3. Improved Salting-Out Solvent Extraction Method for Determination of Low Levels of Nitroaromatics and Nitramines in Ground Water
8331, Tetrazene by reversed phase HPLC with UV detection	None	1. Reversed Phase HPLC Method for Determination of Tetrazene Water 2. Reversed Phase HPLC Method for Determination of Tetrazene Water in Soil
None	None	1. 1989 Reversed-Phase HPLC Method for the determination of NG and PETN in Water 2. 1989 Reversed-Phase HPLC Method for the determination of NG and PETN in Water
None	None	1. 1989 Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water 2. 1989 Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water
None	None	Reversed-Phase HPLC Method for the determination of Nitroguanidine in Water

1 The applicability of sample preparation methods should be verified by consulting the chosen analytical method. Radionuclide determination techniques are provided in Table III.B.1.

2 Refers to the most recent version of SW-846 methods, e.g., 8081A, 9010A, etc.

TABLE IV-2

TARGET ANALYTE EQL[1] BY MATRIX; pCi/g OR pCi/L UNLESS INDICATED

Analyte	Soil	Water	Technique[2]
Gross alpha/beta	10.0	3.0	gas-proportional
Gross alpha/beta	10.0	NA	liquid scintillation
Strontium-90[3]	2.0	5.0	gas-proportional
Americium-241	0.1	0.1	alpha spectroscopy
Plutonium-238, -239	0.1	0.1	alpha spectroscopy
Thorium-228, -230, -232	0.1	0.1	alpha spectroscopy
Thorium-230, -232	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Uranium-234, -235, -238	0.1	0.1	alpha spectroscopy
Uranium-234, -235, -238	0.1	0.1	ICP-MS-FIA (commonly requested nonroutine analysis)
Tritium	300 pCi/L	300	liquid scintillation
multiple isotopes (Table III.F.4)	Am-241: 1 Cs-137: 1	Am-241: 20 Cs-137: 20	gamma spectroscopy
Gross gamma	2.0	100	NaI(Tl) or HPGE detection
Total uranium	0.5 mg/g	1 mg/L	KPA[4] (commonly requested nonroutine analysis)
Total uranium	0.5 mg/g	1 mg/L	ICP-MS (commonly requested nonroutine analysis)
Radium-226	1.0	1.0	assorted
Radium-228	0.5	0.5	assorted
Thorium-234	1.0	20	assorted
Lead-210	2.0	5.0	assorted

1 EQL
2 The Los Alamos National Laboratory methods for these analytes are contained in LA-10300-M, "Health and Environmental Chemistry: Analytical Techniques, Data Management, and Quality Assurance."
3 It may be presumed that strontium-89 is not present.
4 Kinetic phosphorescence analysis, also referred to as pulsed-laser phosphorimetry (ASTM D 5174-91) or kinetic laser phosphorescence.

- calibration data,
- raw analytical data (instrument outputs),
- manual calculations used for generating results (unless specified in cited method), and
- all QC documentation.

4.1 Selection of NRAS Methods

Whether choosing the NRAS method from the list available through the analytical contracts or citing alternate (including new, emerging, and innovative) technologies, there are performance criteria to be considered, just as in selecting "standard" methods.

A process similar to the RAS method selection process described in Section 3.0 of this appendix should be undertaken when choosing nonroutine analytical methods. However, that process cannot be flow charted in a detailed manner, as the number of possible method selections is so large. Instead, the user is required to evaluate the possible analytical methods with respect to the following performance criteria and additional features, as appropriate, to ensure that the selected method meets the needs of the SAP. These performance criteria and additional features are directly linked to the method selection factors listed in Section 2.0 of this appendix.

4.1.1 Nonroutine Analytical Performance Criteria

- Method Quantitation Limit
- Selectivity (degree to which method is free from interferences)
- Comparability to Existing Methods
- Linearity (determination of useful linear calibration range)
- Precision
- Short-Term/Long-Term Stability (analytical system stability/ precision)
- Robustness (minimal adverse impact to data quality from changing analysts, laboratories, and other operational conditions)
- Bias (accuracy)

4.1.2 Nonroutine Additional Information

- Required Competency Level of Analyst (on-site measurements only)
- Training Requirements (on-site measurements only)
- Sample Preparation Requirements
- Method SOP (method number and title; method applicability and limitations; safety concerns; sample preservation, storage and preparation; calibration procedures; analysis procedure; data reporting requirements; QC requirements; routine equipment care and maintenance; references)
- QA requirements
- Quality Assessment requirements
- Cost per Analysis
- Turnaround Time

In some cases, a particular performance criterion or additional information item may not be readily quantifiable. For example, selectivity is inherently difficult to quantify, even for standard methods such as the CLP and SW-846 methods. In such cases, the applicability of the method should still be demonstrated through the analysis of reference materials or spiked samples, etc., before it is used for analysis of environmental samples under the SAP. If the method is used prior to this verification, the field unit is at risk and will be required to demonstrate applicability at a later date. At times the best professional judgment of a competent analyst, such as a DSC Chemistry Team member, may be involved in the assessment of the items above. This is especially true in the case of difficult-to-measure parameters such as data comparability. In all cases, the evaluation of the nonroutine analytical method, including the bases for conclusion regarding the method's applicability to the intended data use, should be documented. This documentation may be included in the SAP either directly or by reference.

When making the decision to use a method that is new, emerging, innovative, or not demonstrated for the site-specific matrix, it is critical that method be tested first as to its applicability. This testing is best done by using site-specific performance evaluation (PE) materials that have been well characterized for the analytes of interest. During the ongoing period of sampling and analyses, performance information should be gathered, documented, and evaluated so that another potential user of the method may benefit from the precedent.

5.0 ON-SITE MEASUREMENTS

This special case of using on-site analytical methods needs special attention. Complete guidance for planning for the use of OM is provided in (DOE 1995, 52240). There are many benefits to be derived from using OM, such as

- abbreviated methods that are focused for the analytes of interest, and that may provide better data and be less costly for those parameters than the standard survey-type analyses;
- faster analyses—this is especially important when a decision must be made on-site and data must be collected in "real-time";
- the ability to make changes in the SAP based on new knowledge that may be gained from the OM data; and
- the opportunity for decreasing total error by maximizing the number of samples using the abbreviated methods.

When making a decision to use OM there are several critical elements that must be considered and criteria that should be met to justify the use. There are times that the same benefits can be derived from using fixed laboratories (either close-support such as the LANL laboratories or contractor laboratories) to perform the abbreviated, or even "screening" methods with a rapid turnaround time, if time is a factor. Unless there is a large number of analyses to be performed, it is not often cost-effective to set up in the field (other than for hand-held or "back of the pick-up" methodology). The critical elements are outlined in Chapter 2 of the cited draft OM guidance (DOE 1995 52240).

GLOSSARY

Abbreviated method A shortened form of a method. Usually refers to analytical methods that have been modified to require less rigorous sample preparation, analysis conditions or quality control.

Aliquot A portion of a sample or sample derivative taken for analysis.

Analysis A process used to measure one or more attributes of a sample in a clearly defined, controlled, systematic manner. Often requires treating a sample chemically or physically before the measurement step to render the sample or a derivative thereof (e.g., a digestate or extract) ready for measuring the selected attribute.

Analyte The particular chemical or radiochemical species to be identified and/or quantified in a sample of interest.

Assessment The evaluation process used to measure the performance or effectiveness of a system and its elements. In this document, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management system review, peer review, inspection, and surveillance.

Audit (quality) A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements, whether these arrangements are implemented effectively, and whether they are suitable to achieve objectives.

Baseline data validation Data validation directed toward determining whether the data in question satisfy clearly defined quality control checks. This validation is used to assign a consistent set of qualifiers to data that draw attention to potential data deficiencies.

Bias (1) The degree to which the value obtained for a measured parameter deviates from the value accepted as the true, or reference, value. (2) A systematic deviation from the true value that remains constant over replicated measurements within the statistical precision of the measurement process. Synonymous with *deterministic error, fixed error,* and *systematic error.* Sometimes referred to as *accuracy*, though the mathematical equation for computing accuracy differs from that for bias. Typically expressed as a percentage deviation, bias is computed as follows:

$$Bias = \frac{1}{T}(\bar{x} - T) \times 100\%,$$

where

$\bar{x}$ is the average of several determinations and T is the true value.

The true value may be the value established for a spiked sample or a certified standard reference material such as a performance evaluation sample.

Blank sample A sample expected to have negligible or unmeasurable amounts of the analytes of interest. Results of blank sample analyses indicate whether or not field samples might have been contaminated during one or more steps of the sample collection, transport, storage, preparation and analysis process.

Blind sample See *Single Blind Sample* and *Double Blind Sample.*

Calibration A process used to identify the relationship between the true, or reference, analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement system. The response of the measurement system is typically established for a series of calibration standards and the relationship is represented graphically and/or mathematically.

Calibration blank A calibration standard prepared to contain negligible or unmeasurable amounts of the analytes of interest. Used to establish the zero concentration point for analytical measurement calibration.

Calibration Standard A sample prepared to contain known amounts of the analytes of interest and of other constituents required for the analysis. Ideally, the calibration standard matrices emulate the matrices of the environmental samples.

Chain of custody An unbroken, documented trail of accountability designed to ensure that the physical integrity of samples, data, and records remains uncompromised.

Collocated sample (collocated field sample) One of two or more samples collected as close together in time and space as the sampling equipment allows so that each sample is expected to be equally representative for a given analyte within the common space and time interval.

Comparability A qualitative measure of the degree to which one item or data set can be compared with another.

Corrective Actions Measures taken to rectify conditions adverse to quality and, where necessary, to preclude their recurrence.

Data quality assessment That process, based on data obtained by implementing a sampling and analysis plan, by which the design in the sampling and analysis plan is evaluated to assess the validity of the SAP approach and the assumptions upon which the SAP design was based. The process, which focuses on determining whether the data are sufficient for a specific use, should be applied whenever the outcome of a study is not obvious and before the results are delivered to the decision makers.

Data quality objectives (DQOs) The qualitative and quantitative statements that specify the quality of data required to support decisions.

Data Quality Objectives Process A Total Quality Management (TQM) tool, based on the Scientific Method and developed by the U.S. Environmental Protection Agency, to facilitate the planning of environmental data collection activities. The products of the DQO process are the DQOs.

Data validation A systematic process performed externally from the data generator which applies a defined set of performance-based criteria to a body of data that may result in qualification of the data. This process occurs prior to drawing a conclusion from the body of data. It may comprise a standardized review (baseline validation) and/or a problem-specific review (focused validation) of the data.

Data verification A process of evaluating the completeness, correctness, consistency, and compliance of a laboratory data package against a standard or contract.

"Completeness" means all required information is present—both hard copy and electronic. "Correctness" means the reported results are based on properly documented and correctly applied algorithms. "Consistency" means that values are the same when they are reported in different reports or are transcribed from one report to another. "Compliance" means that the data pass numerical QC tests based on parameters or limits specified in a contract or in an auxiliary document. The primary purposes of verification are to determine appropriate payment to those providing services and to point out areas of noncompliance with QC specifications that may affect data use and that can be made a focus of further data validation or data quality assessment activities.

Double blind sample A sample whose analyte concentration and sample identity are unknown to the analyst. Double blind samples are usually submitted to an analytical laboratory without the laboratory's knowledge so that the ER Project can evaluate the laboratory's performance.

Duplicate analysis An analysis (includes sample preparation and analysis) performed on one of a pair of identically prepared subsamples of the same sample. Not to be confused with a duplicate measurement.

Duplicate measurement One of a pair of measurements performed on a prepared sample (e.g., digestate or extract) under identical conditions.

Environmental sample See *field sample.*

Error The inevitable uncertainty associated with scientific measurements or decisions. Measurement error comprises three types of errors: (1) systematic error (or bias), which is always of the same algebraic sign, (2) random error which varies in algebraic sign and is unpredictable, and (3) blunders which are unpredictable human errors such as transcription errors. Decision error comprises (1) false positive error which is quantified as the probability of rejecting a null hypothesis when the hypothesis is actually true and (2) false negative error which is quantified as the probability of not rejecting a null hypothesis when the hypothesis is false.

Estimated quantitation limit The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine analytical laboratory operating conditions. The estimated quantitation limit is generally 5 to 10 times the method detection limit. However, a nominal value may be chosen for the estimated quantitation limit within these guidelines to simplify data reporting. For many analytes, the estimated quantitation limit is selected as the lowest non-zero standard in the calibration curve. Sample estimated quantitation limits are highly matrix-dependent, and the specified estimated quantitation limits might not always be achievable.

Equipment blank (equipment rinsate blank) A blank sample that is used to rinse the sample collection equipment and is then transferred to a sampling container. The equipment blank is collected after equipment decontamination is completed but prior to collection of another field sample.

Error The difference between an observed or computed value and the value accepted as the true value.

Field blank A blank sample either prepared in the field or carried to the sampling site, exposed to sampling conditions (e.g., bottle caps removed, preservatives added), and returned to a laboratory for analysis in the same manner in which environmental samples are analyzed. Used to identify the presence of contamination potentially added during the sampling and analysis process.

Field matrix spike A known amount of a field sample to which a known amount of target analyte has been added. Used to compute the proportion of added analyte that is recovered upon analysis.

Field reagent blank Same as *field blank.*

Field sample See *sample.*

Field split A field sample that has been divided in the field into equally representative portions (See *split sample*).

Focused data validation A technically based analyte-, sample-, and potentially data use-specific process that extends the qualification of data beyond method or contractual compliance and provides a level of confidence that an analyte is present or absent. If the analyte is present, the quality of the quantitation may be obtained through focused validation. This validation process may focus on the data needed for a given decision, which can include review of raw analytical data such as chromatograms or mass spectra.

Hazardous waste Any waste material that satisfies the definition of "hazardous waste" as given in 40 CFR Part 261, "Identification and Listing of Hazardous Waste."

Hypothesis A tentative assumption made to draw out and test its logical or empirical consequences. In hypothesis testing, the hypothesis is labeled as either "null" or "alternative," depending on the decision maker concern for making a decision error.

Interference A chemical or physical entity whose influence results in a decrease or increase in the response of an analytical method or other measurement system relative to the response obtained in the absence of the entity. Interferences in chemical analyses may often be mitigated by changing sample preparation methods or conditions, or by changing analysis methods or conditions.

Inspection examination or measurement of an item or activity to verify conformance to specific requirements

Laboratory split samples Portions of sample taken from the same sample container, prepared for analysis and analyzed independently but under identical conditions. Each split sample is expected to be equally representative of the original material.

Management systems review The qualitative assessment of a data collection operation and/or organization(s) to establish that the prevailing quality management structure, policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained.

Matrix See *sample matrix.*

Matrix spike An aliquot of sample spiked with a known concentration of target analyte(s). The spiking typically occurs before sample preparation and analysis.

Matrix spike duplicate An intralaboratory split sample spiked with a known amount of target analyte (s). Spiking occurs prior to sample preparation and analysis.

May Denotes permission but not a requirement.

Method A body of procedures and techniques for systematically performing an activity.

Method blank An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing and which is prepared and analyzed in the same manner as samples.

Method detection limit (MDL) The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is determined from analysis of samples of a given matrix type containing the analyte after subjecting the sample to the usual preparation and analyses.

Mixed waste Hazardous waste material as defined by 40 CFR part 261 (RCRA), mixed with radioactive contaminants.

Must Denotes a requirement that has to be met.

Nonroutine analysis Those analytical requests not defined as routine analyses. The LANL ER statement of work for analytical services provides more details concerning the nature of nonroutine analyses.

Out of control A condition for which the quality of outputs of a process are suspect based on a statistical interpretation of QC sample data.

Performance criteria Measurable criteria used to assess all or part of a process.

Performance evaluation A type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory.

Population (statistical) The total aggregate of observations that conceptually might occur as the result of performing a particular operation in a particular way. For example, the soil comprising a PRS or PRS aggregate.

Population unit The smallest subunit of the population that is of interest for a particular study.

Population variability The degree to which a particular characteristic of the population varies.

Precision A concept used to describe dispersion of measurements with respect to a measure of location or central tendency. Precision may be represented by the standard deviation of a set of measurements. The standard deviation is computed as follows (assuming each measured value, x_i, is statistically independent of the others and the measured values are normally distributed about an average value:

$$s_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{(n-1)}}$$

where

s_x is an estimate of the standard deviation of a sample of values taken from the population of x values,

x_i is the value of a single measurement,

$\bar{x}$ is the arithmetic mean of the measured values, and

n is the number of x values used in the computation.

Prepared sample A sample treated in such a manner as to render it amenable to analysis. May include: digestate, distillate, electroplate, extract, filter retentate, filtrate, homogenate, precipitate, pulverized/sieved portion of sample, residue, etc. See also *sample derivative.*

Quality assessment sample A sample submitted for analysis, the data from which are used to assess the quality of performance of a sampling or analysis process. May include performance evaluation samples, field duplicates, field blanks, etc.

Quality assessment The overall system of activities whose purpose is to provide assurance that the overall quality control job is being executed effectively. It involves a continuing evaluation of the products and of the performance of the production system.

Quality assurance (QA) An integrated system of management activities involving planning, implementation, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Assurance Project Plan A formal document describing in comprehensive detail the necessary QA, QC, and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria.

Quality control The overall system of activities whose purpose is to control the quality of a product or service while work is in progress so that the product or service meets the needs of users.

Quality control (QC) sample A sample which, upon analysis, provides information useful for adjusting, controlling, or verifying continuing acceptability of sampling or and analysis activities that are in progress.

Quality indicators Quantitative statistics and qualitative descriptors used to interpret the degree of acceptability or utility of data to the user. Indicators of quality include precision, bias, representativeness, reproducibility, comparability, and statistical confidence.

Quality management That aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning implementation, and assessment) pertaining to the quality system.

Quality Management Plan (QMP) A formal document that describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing all activities.

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 (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

Radioactive tracer A radioactive material added to, or induced in, a sample for the purpose of monitoring chemical or physical losses of the target analytes. The tracer is assumed to behave in the same manner as that of the target analytes.

Radioactive waste Waste material containing radionuclides, or contaminated by radionuclides.

Random Being or relating to a member of a set (1) whose members have equal probability of occurring or (2) from which each member has equal probability of being selected. Frequently applied to selection of sampling points. Should not be confused with haphazard.

Relative precision (See also *Precision*) The precision measured relative to a particular value. Relative precision expressed as the relative standard deviation (RSD) may be calculated as follows:

$$RSD = \frac{s_x}{\bar{x}} \times 100\%,$$

where

s_x is the standard deviation, and

$\bar{x}$ is the arithmetic mean of all the measurements used to compute the standard deviation.

Remediation The process of reducing the concentration of a contaminant)or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health.

Replicate measurement A re-analysis (remeasurement) of a prepared sample.

Replicate sample One of multiple samples taken from and expected to be representative of the same population and carried through all steps of the sampling and analysis procedures in an identical manner. One type of replicate sample is a duplicate sample.

Representativeness A measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Rinsate Blank See *Equipment blank.*

Routine analysis The analysis categories of inorganics, metals, organics, radiochemistry and high explosives as defined in the current contract laboratory statement of work.

Sample A portion of a material (e.g., rock, soil, water, air), which, alone or in combination with other samples, is expected to be representative of the material or area from which it is taken. Samples are typically sent to a laboratory for analysis or inspection or are analyzed in the field, either with a portable apparatus or in a mobile laboratory. When referring to samples of environmental media, the term *field sample* may be used.

Sample derivative The material to be analyzed that results from subjecting a sample to a sample preparation process. May include: digestate, distillate, electroplate, extract, filter retentate, filtrate, homogenate, precipitate, pulverized/sieved portion of sample, residue, etc. See also *prepared sample.*

Sample matrix In chemical analysis, that portion of a sample which is exclusive of the analytes of interest. Together, the matrix and analytes of interest form the sample.

Screening Action Level (SAL) Medium-specific concentration level for a chemical derived using conservative criteria. The derivation of a SAL is most often based on low risk under a very restrictive exposure scenario, but if a regulatory standard exists and is less than the value derived by this risk-based computation, it will be used for the SAL.

Selectivity The ability of a chemical analysis method or physical measurement system to discriminate among the responses for individual variables of interest when a mixture of the variables is being measured. Selectivity for chemical analyses may be enhanced by changing sample preparation methods or by changing analysis methods or conditions.

Self-assessment Assessments of work that does not produce manufactured items. In environmental data operations or engineering projects, such as activities include design, inspection, laboratory and/or field analysis, repair, and installation.

Sensitivity An indication of the lowest analyte concentration that can be measured with a specified degree of confidence.

Service The category of economic activity that does not produce manufactured items. In environmental data operations or engineering projects, such activities include design, inspection, laboratory and/or field analysis, repair, and installation.

Shall Denotes a requirement that is mandatory and has to be met.

Should Denotes a guideline or recommendation.

Single blind sample A sample submitted for analysis whose composition is known to the submitter but not to the analyst, although the analyst might be aware that the sample is not a routine environmental sample.

Site-specific performance evaluation sample A sample of known composition with respect to selected analytes which, upon analysis, is expected to yield results that fall within a prescribed range. Performance evaluation samples are selected to mimic as

closely as possible those matrices representative of environmental samples from a particular location. They may be naturally occurring materials or manufactured materials that have been characterized exhaustively, at least with respect to selected analytes and with respect to interferences associated with quantifying those analytes by selected analysis methods.

Split sample A sample that has been subdivided into two or more portions expected to be of the same composition. Used to characterize within-sample heterogeneity, sample handling, and measurement variability.

Standard operating procedure (SOP) A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

Surrogate compound An organic compound used in the analyses of organic analytes that is similar to the target analytes in chemical composition and behavior in the analytical process but is not normally found in the field samples.

Third Party Implementable Enough information is provided at a level of detail that enables any qualified party to execute the plan as intended.

Total measurement error The sum of all errors that occur from sampling through reporting of results; the difference between the reported result and the true value of the population that was to have been sampled.

Total Quality Management (TQM) The process of applying quality management to all activities of the organization, including technical and administrative operations. See *Quality Management* and *Quality System*.

Trip blank A sample of analyte-free media taken to the sampling site and returned to the analytical laboratory unopened along with samples taken in the field. It is stored with the samples until the samples have been analyzed. Used to monitor cross contamination of samples during handling and storage both in the field and in the analytical laboratory.

Variance (statistical) The square of the standard deviation (See *Precision*). A concept used to describe the dispersion of measurements with respect to a measure of location or central tendency.