FINAL

QUALITY ASSURANCE PROJECT PLAN
PAINESVILLE FUSRAP SITE
PAINESVILLE, OHIO

US Army Corps of Engineers®

Prepared for:

U.S. ARMY ENGINEER DISTRICT, BUFFALO
Buffalo, New York
Formerly Utilized Sites Remedial Action Program

Contract No. DACW49-03-D-00003/0002

Prepared by:

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East Hartford, CT

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for the
PAINESVILLE FUSRAP SITE
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Contract No. DACW49-03-D-0003 / Delivery Order No. 0002

QUALITY ASSURANCE PROJECT PLAN APPROVALS

By their specific signature, the undersigned certify that they reviewed and provided comments on this QAPP for use during activities at the Painesville FUSRAP Site, Painesville, Ohio.

APPROVED BY:

[redacted]

Kim Nelson, PG

9/30/05
Date

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AOC	Area Of Concern
CAR	Corrective Action Report
COC	Chain Of Custody
CV	Coefficient of Variation
DGPS	Differential Global Positioning System
DOE	US Department of Energy
DOT	Department Of Transportation
DQOs	Data Quality Objectives
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
eV	electron Volt
FSM	Field Site Manager
FSP	Field Sampling Plan
ft	foot (or feet)
FUSRAP	Formerly Utilized Sites Remedial Action Program
FWHM	Full Width at Half Maximum
GEL	General Engineering Laboratories
GIS	Geographical Information System
GWS	Gamma Walkover Surveys
HPGe	High Purity Germanium
IATA	International Air Transport Association
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LQAP	Laboratory Quality Assurance Plan
LQAC	Laboratory Quality Assurance Coordinator
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAD	North American Datum
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
OEPA	Ohio Environmental Protection Agency
OVA	Organic Vapor Analyzer
OVM	Organic Vapor Monitor

pCi/g	picoCuries per gram
PID	PhotoIonization Detector
PM	Project Manager
POC	Point Of Contact
PPE	Personal Protective Equipment
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
QL	Quantitation Limit
RCAs	Recommendations for Corrective Action
RCOC	Radiological Contaminant Of Concern
RE	Relative Error
RPD	Relative Percent Difference
RT	Retention Times
SOP	Standard Operating Procedure
SRM	Standard Reference Material
SRSM	Site Radiation Safety Manager
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers
USACE-Buffalo	U.S. Army Corps of Engineers, Buffalo District
USGS	U.S. Geological Survey
Z_{Rep}	Replicate Z-Score

1.0 INTRODUCTION

1.1 OVERVIEW

The primary focus of this *Quality Assurance Project Plan (QAPP)* is on the analytical methods and quality assurance (QA) /quality control (QC) procedures that will be used to analyze environmental samples and manage data at the Painesville Formerly Utilized Sites Remedial Action Program (FUSRAP) Site in Painesville, Ohio (hereafter referred to as the "Site"). This QAPP presents the project organization, objectives, procedures, functional activities, and specific QA/QC activities associated with the radiological survey, sampling, and analysis activities to be performed at the Site for the U.S. Army Corps of Engineers, Buffalo District (USACE-Buffalo) by Cabrera Services, Inc. (CABRERA) under Contract No. DACW49-03-D-0003, Delivery Order No. 0002 (hereafter referred to as the "Contract"). The requirements of this QAPP are applicable to CABRERA and subcontractor project personnel.

This QAPP establishes an overall project QA plan and provides the framework for more specific requirements described in the site-specific *Field Sampling Plan for the Painesville FUSRAP Site in Painesville, Ohio* (FSP, CABRERA, 2005b). Together, the FSP and QAPP provide the background, site description, study objectives, technical approaches, and QA/QC procedures for project activities at the Site. This document follows the recommended format for QAPPs described in USACE Engineering Manual EM-200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001).

1.2 PURPOSE AND SCOPE

The purpose of this QAPP is to describe the standards for execution of survey, sampling, and analysis activities within the scope of work at the Site. These standards include the data quality objectives (DQOs), the work to be performed to fulfill the objectives, and the methods used to obtain defensible, interpretable data.

The scope of this document is to provide the appropriate QA procedures and QC measures to be applied throughout the Painesville FUSRAP Site Project and to describe the following items:

- The organization and responsibilities of key individuals at the contract laboratory and on CABRERA'S project team.
    - QA objectives.
    - Sampling and analytical laboratory procedures.
    - Sample collection, handling, and preservation.
    - Field and laboratory custody procedures.
    - Calibration, maintenance, and field procedures and protocols.
    - Data reduction, validation, and reporting.
    - Internal QC checks.
    - QA performance and system audits.

- Preventive maintenance procedures and schedules.
- Data assessment and presentation.
- Corrective actions.
- QA reports to management.

The following paragraphs give a brief view of the primary staff and the responsibilities of the management, QA/QC, and primary task leadership for the field and laboratory tasks. Project activities will be performed within the framework of the organization and functions described in this section. The organization for the projects is designed to provide clear lines of responsibility and authority. This control structure provides for the following:

- Identifying lines of communication and coordination.
- Monitoring project schedules and performance.
- Managing key technical resources.
- Providing periodic progress reports.
- Coordinating support functions such as laboratory analysis and data management.
- Rectifying deficiencies.

Subcontractor and laboratory personnel providing services in support of this program will perform work in strict compliance with the appropriate contract specifications for the activity. In addition to project QA, contractor corporate-level QA personnel (independent of the project) will have the authority to review, audit, document compliance, identify deficiencies, and recommend corrective actions. QA personnel will have sufficient authority, organizational freedom, and ability to:

- Identify QA problems.
- Initiate, recommend, or provide solutions to QA problems through designated channels.
- Ensure that program activities, including processing of information, deliverables, and installation or use of equipment, are reviewed in accordance with QA objectives.
- Ensure that deficiencies and non-conformances are corrected.
- Ensure that further processing, delivery, or use of data is controlled until the proper disposition of a non-conformance, deficiency, or unsatisfactory condition.

2.0 PROJECT LABORATORY ORGANIZATION AND RESPONSIBILITIES

General Engineering Laboratories, LLC (GEL), of Charleston, South Carolina, has been selected by CABRERA to conduct radiochemistry analysis. The functional roles for GEL are described in this subsection. From the project perspective, the structure is designed to facilitate information exchange between the laboratory and the USACE and CABRERA project team members. Information exchanges include planning, technical requirements, schedules, sample identification; preservation procedures; sample container requirements; sample collection procedures; decontamination protocols; and sample labeling, packing, holding times, and shipping. A GEL organizational chart is presented in GEL's Laboratory Quality Assurance Plan (LQAP), which is presented in Appendix B.

2.1 RADIOCHEMISTRY LABORATORY MANAGER

The Radiochemistry Laboratory Manager, [redacted], will ensure that project needs are identified to laboratory management. The Radiochemistry Laboratory Manager will provide direction/support for administrative and technical project staff, interface with laboratory project staff on technical issues, and provide QA oversight for analytical data. The Radiochemistry Laboratory Manager will ensure that laboratory personnel understand and conform with elements of this QAPP as they relate to their activities.

2.2 LABORATORY PROJECT MANAGER

The Laboratory Project Manager, [redacted], will schedule project analytical requirements, monitor analytical status/deadlines, approve laboratory reports, and coordinate data revisions/corrections and resubmittal of packages to project staff. She will be the primary point of contact (POC) for CABRERA project personnel.

2.3 LABORATORY QA COORDINATOR

The Laboratory QA Coordinator (LQAC), [redacted], and the QA department staff will ensure conformance with authorized policies, procedures, and sound practices, and recommend improvements, as necessary. They will inform the Laboratory Project Manager of any non-conformances, ensure that control samples are introduced into the sampling train, and establish testing lots. In addition, the LQAC will also review results of internal QA audits and recommend corrective actions and schedules for their implementation.

The responsibilities of the LQAC and department staff include, but are not limited to, the following:

- Administering the laboratory QA/QC program.
- Implementing QC procedures for each test parameter.
- Documenting the laboratory's performance on precision and bias for each analytical method and ensuring that the laboratory's performance meets the project requirements.
- Reviewing the analytical methodology employed by laboratory personnel and modifying these protocols, as necessary.

- Coordinating performance auditing.
- Reviewing analytical results, including raw data, calculations, etc.
- Inspecting laboratory logbooks and the data retrieval system.
- Monitoring the proper documentation and maintaining records.
- Identifying and implementing training requirements for laboratory analytical personnel.
- Overseeing QA/QC implementation at the laboratory on a daily basis.
- Identifying QA/QC problems and recommending appropriate corrective action.
- Preparing status reports, including progress, problems, and recommended solutions.
- Preparing reports documenting completion of corrective actions.

2.4 DATA REPORTING MANAGER

The primary responsibility of the Data Reporting Manager, [redacted], is to review analytical data reports for conformance to electronic data deliverable criteria, data package completeness, and typographical errors. The Data Reporting Manager will also provide technical direction and instruction for the transfer of laboratory data.

2.5 LABORATORY ANALYSTS AND TECHNICIANS

The laboratory analysts and technicians have the following QA/QC responsibilities:

- Maintaining familiarity with, and conforming to, the procedures and policies contained in the LQAP.
- Conducting routine maintenance, standardization, and calibration of instruments and other analytical equipment.
- Reviewing analytical results with the Laboratory Project Manager.
- Reporting irregular results or practices to the Laboratory Project Manager.

2.6 SAMPLE CUSTODIAN

The Sample Custodian will receive samples from the field, sign and date chain-of-custody (COC) forms, record the date and time of sample receipt, and record the condition of both shipping containers and sample containers.

The Sample Custodian will verify and record agreement or non-agreement of information on sample documents. If there is non-agreement, the Sample Custodian will record the problems/inconsistencies for the samples and inform the Laboratory Project Manager. The Sample Custodian, in accordance with laboratory SOPs, will also label samples with laboratory sample numbers, and place samples and spent samples into appropriate storage and/or secure areas.

3.0 DATA ASSESSMENT ORGANIZATION AND RESPONSIBILITIES

Under the direction of USACE, CABRERA is responsible for the implementation of work assignments. CABRERA's primary responsibilities include technical plan development; sample collection; data processing, presentation, and reporting; and adherence to the QA procedures and QC measures associated with the activities. Project activities will be conducted in accordance with the CABRERA Radiation Safety Program (RSP) and applicable standard RSP QA procedures and QC measures associated with the work activities. A list of the procedures contained in CABRERA's RSP is presented in Appendix C. The following descriptions of project responsibilities for the functional roles presented below refer to positions contained within CABRERA's organizational structure. CABRERA's QC team is fundamental to the success of the project. The goal of the QC team is to provide a mechanism for the ongoing control and quality of the project activities at the Site. The professionals identified in the following subsections will ensure that the specified quality is achieved for each aspect of the work. The project-specific organization chart is provided in Figure 3-1, and a table of key project personnel with contact information is presented in Table 3-1.

3.1 USACE RESPONSIBILITIES

USACE personnel within the organizational structure hold overall management responsibility for the entire project. The USACE-Buffalo Project Manager will be the prime interface with the site property owners, the U.S. Environmental Protection Agency (USEPA), and the Ohio Environmental Protection Agency (OEPA). For purposes of QA, USACE personnel will be responsible for project direction and decisions concerning technical issues and strategies, and will set the basic policies in accordance with work assignments.

3.2 VICE PRESIDENT

The Vice President, [redacted], PhD, CHP, is the corporate officer responsible for the overall quality of CABRERA's work products. For the Painesville FUSRAP project, he will be responsible for ensuring that the project team implements the policies and procedures required under the USACE Contract and for ensuring that appropriate corrective actions are taken in the event that project performance is unacceptable to USACE. He will work closely with the CABRERA Quality Assurance Coordinator (QAC) and Project Manager (PM) to ensure established protocols and procedures are implemented.

3.3 QUALITY ASSURANCE COORDINATOR

The QAC, [redacted], P.G., will be responsible for planning, implementing, and tracking quality assurance activities and maintaining communication with QC and analytical task staff members. The QAC will work with the Vice President, PM, and Data Management Coordinator (DMC) to ensure that established QC procedures are implemented. She, or a designee, may conduct periodic site and project audits as part of this process. She may conduct periodic audits of onsite procedures, including safety procedures. The QAC's duties include QC task staffing; and ensuring that QC data evaluation, data verification, and reporting procedures are followed. The ultimate goal of these activities is to produce data that satisfy the project objectives.

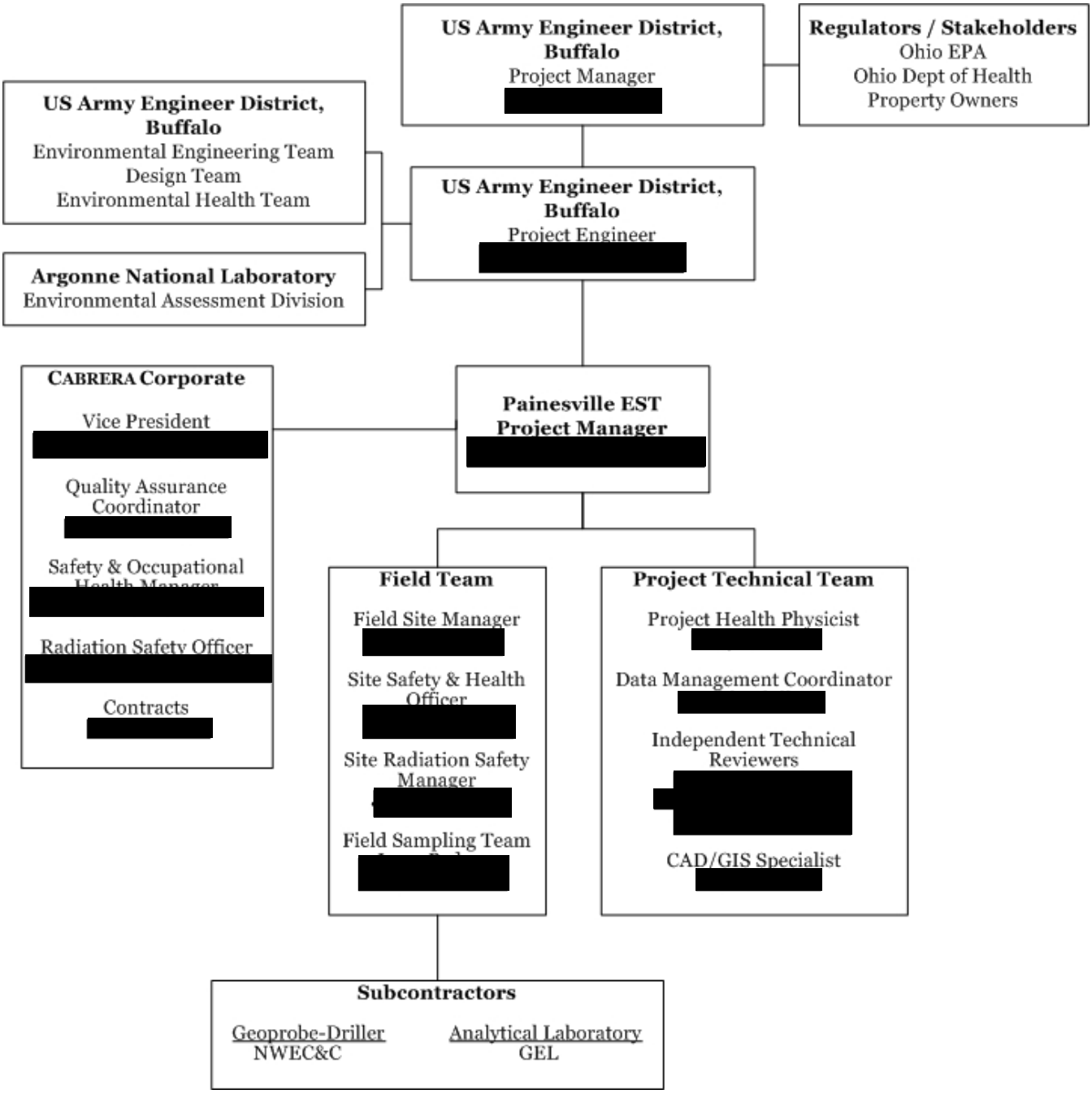

Figure 3-1: Project Organizational Chart

Table 3-1: Key Project Personnel

TITLE	NAME	TELEPHONE
US Army Corps of Engineers - Buffalo		
USACE Project Manager	[redacted]	[redacted]
USACE Project Engineer	[redacted]	[redacted]
USACE Industrial Hygienist	[redacted]	[redacted]
USACE Project Health Physicist	[redacted]	[redacted]
CABRERA		
Vice President	[redacted]	[redacted]
Project Manager	[redacted]	[redacted]5
Safety and Occupational Health Manager	[redacted]	[redacted]
Radiation Safety Officer	[redacted]	[redacted]
Contracts	[redacted]	[redacted]
Quality Control Coordinator	[redacted]	[redacted]
Data Management Coordinator	[redacted]	[redacted]
Project Health Physicist	[redacted]	[redacted]
Field Site Manager	[redacted]	[redacted]
Site Radiation Safety Manager	[redacted]	[redacted]
Site Safety & Health Officer	[redacted]	[redacted]
Subcontractors		
Radioanalysis - GEL	[redacted]	[redacted]
Geoprobe Contractor – NWEC&C	[redacted]	[redacted]

3.4 PROJECT MANAGER

The PM for this effort will be [redacted], CHP. He will be responsible for ensuring the appropriateness and adequacy of technical services provided for the project, and for developing the technical approaches and level-of-effort required to address each task. He will also be responsible for the day-to-day conduct of work, including integration of input from supporting disciplines, USACE, and subcontractors. He will work closely with the Field Site Manager (FSM) during implementation of the field program. Specific responsibilities of this role include:

- Initiating project activities;
- Directing project planning activities;
- Ensuring that qualified technical personnel, including subcontractors, are assigned to each task;
- Identifying and fulfilling equipment and other resource requirements;
- Monitoring project activities to ensure compliance with established scopes, schedules, and budgets;
- Ensuring overall technical quality and consistency of project activities and deliverables; and
- Serving as the Contractor POC with USACE.

The CABRERA Vice President and PM have overall responsibility for ensuring that project activities are performed in accordance with USACE and State of Ohio requirements, and consistent with the policies outlined in this QAPP.

3.5 DATA MANAGEMENT COORDINATOR

The Data Management Coordinator, [redacted], is responsible for management of project tasks associated with field data collection and laboratory analytical data. She will also be responsible for managing the project database and coordinating near-real time data transfers between USACE, ANL, and CABRERA project personnel. She reports to the PM and will work closely with the Field Site Manager for resolution of concerns during data collection.

3.6 PROJECT HEALTH PHYSICIST

The Project Health Physicist, [redacted], is responsible for radiological field activities and has authority to direct such activities, to stop and restart work if necessary, and to take appropriate actions, as required, to address radiological emergency situations. He will work directly with the FSM and Site Radiation Safety Manager (SRSM), and in concert with the Corporate Radiation Safety Officer (RSO), to ensure that the CABRERA FSP and QAPP are properly implemented.

3.7 SITE SAFETY AND HEALTH OFFICER

The Site Safety and Health Officer (SSHO), [redacted], will report directly to the PM and will be responsible for ensuring that the Site Safety and Health Plan (SSHP) is followed and that site personnel are appropriately trained in its provisions. This person will have the authority to issue stop-work orders for site activities that they believe to be unsafe. When so stopped, work shall not recommence until the Corporate Safety and Occupational Health Manager, Corporate RSO, and PM approve the restart.

3.8 FIELD SITE MANAGER

The FSM, [redacted] will report directly to the PM and will be responsible for managing the field activities described in the FSP. The responsibilities of the FSM include ensuring that the field team has the appropriate equipment and supplies for conducting the prescribed survey, sampling, and analysis activities; reviewing the calibration and analytical data generated in the field; and forwarding the field data to the PM on a regular basis. The FSM will serve as the task leader for field investigation activities conducted as part of the sampling and analysis program. (S)he will be responsible for specific field operations such as surface and subsurface soil sampling, gamma walkover surveys, downhole gamma field screening, operation of the onsite laboratory, waste handling and disposition, instrumentation calibration, field measurements, field QA/QC, and recordkeeping. (S)he will direct the day-to-day activities necessary to implement the sampling and analysis program, ensuring that field health and safety practices are in compliance with the SSHP. The FSM will oversee the field staff and subcontractors to ensure that procedures are executed in the proper manner, activities are properly documented, the prescribed scope of work is completed, and communication protocols are maintained.

3.9 FIELD TEAM

The CABRERA field team members will include Health Physics Technicians, as well as a specialty subcontractor able to perform the prescribed soil sampling. The team will be responsible for performing field activities as stipulated in the FSP and QAPP, and will report directly to the FSM. The responsibilities of the field team members will be as follows:

- Onsite Laboratory Coordinator – Operate the onsite laboratory in accordance with applicable requirements and procedures. Responsible for setup, calibration, maintenance, and operation of equipment and instrumentation used to conduct onsite gamma spectroscopy analysis. Maintain appropriate sample custody requirements. Generate and record analytical data, and provide data to the FSM on a regular basis.

- Health Physics Technicians - Perform periodic instrument checks, perform gamma walkover surveys and downhole screening, coordinate with the subcontractor to collect and prepare surface and subsurface soils samples from the soil cores, establish and maintain appropriate radiological zones and controls, perform radiation surveys of personnel and equipment, and maintain data records.

- Geoprobe® Soil Sampling Crew - Under the direction of the CABRERA FSM, access and setup sampling equipment at designated locations, remove soil core samples, assist in the containerization and stabilization of the cores for transfer to the soil preparation area, and assist in the cleaning/decontamination of the Geoprobe® sampling equipment. Maintain appropriate subsurface soil coring documentation and logs.

4.0 DATA QUALITY OBJECTIVES

The DQOs for the pre-remediation sampling activities to be conducted at the Site are provided below to establish a systematic procedure for defining the criteria that must be met for the data collection design to be satisfied. The DQO process includes a description of when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. The DQO process consists of the following seven steps (EPA 2000a and 2000c):

1. State the problem,
2. Identify the decision,
3. Identify inputs to the decision,
4. Define the study boundaries,
5. Develop the decision rule,
6. Specify tolerable limits on decision errors, and
7. Optimize the design.

The DQO process is described in the following sections as it applies to the pre-remediation sampling activities to be conducted at the Site.

4.1 STATE THE PROBLEM

This investigation will serve to determine whether residual radionuclide concentrations comply with cleanup criteria as defined in the Feasibility Study Addendum for the Site (USACE 2005). Where they do not comply, remediation will be required. In places where the horizontal and vertical boundaries of soil to be excavated will be refined, additional characterization will occur to ensure that subsurface lenses of contamination do not extend outside the planned excavation boundaries.

The first step in the DQO process is to provide a clear and concise problem statement so that the focus of the project is unambiguous. The problem statements for the Site pre-remediation sampling effort are as follows:

- **Boreholes in Class 1 SUs are needed to determine the depth profile of contamination in known areas of impact.**
- **Downhole gamma logging correlation factors are required to help focus remediation planning and removal volume estimates.**

- **Downhole gamma logging is needed at boreholes bounding Class 1 units to verify the appropriateness of the CSM and either adjust or improve the certainty of the boundaries of known contaminated areas specified in the existing CSM.**

- **Data on the residual concentrations and distributions of RCOCs in surface soils of Class 2 SUs are needed to demonstrate that residual radioactivity in soil meets all cleanup criteria.**

- **Waste profile samples are needed to characterize the radionuclide content for future disposal.**

4.2 IDENTIFY THE DECISION

The second step in the DQO process is to identify the decision that must be made using data on the concentrations and distributions of RCOCs. The objective of this step is to develop decision statements that require environmental data to address the problem statement. The fundamental decision that must be made using this data is whether the soil meets the cleanup requirements defined in the Feasibility Study for the Site. Exposures are limited to 25 mrem/yr consistent with the criterion established by the NRC decommissioning rule (10 CFR 20 Subpart E). The exposure scenario used to establish the soil concentration guidelines specified in this QAPP is the construction worker scenario.

4.2.1 Principal Study Questions and Alternative Actions

To determine if the site meets the cleanup requirements, specific decision statements are developed to address each MARSSIM-consistent requirement shown above. These specific decision statements consist of two key elements – three principal study questions (PSQ), and alternative actions (AA) for each PSQ. If a PSQ is not met, the AA defines what additional steps must be taken. For areas not expected to require excavation (Class 2 SUs), answering "yes" to both PSQs indicates that all requirements have been met and no further action is required. The PSQs and AAs for the Site FSS are shown in Table 4-1.

Table 4-1. Principal Study Questions and Alternative Actions for Painesville Soils

	Principal Study Question		AA No.	Alternative Action (AA)
	No.	**Question**		
Areas Where CSM Indicates Excavation is Likely to be Required (Class 1 SUs)	**1**	Does subsurface soil exceeding the $DCGL_w$ criterion (SOR > 1) extend into areas where existing data indicate that excavation is not required?	1	Yes - Reconfigure boundary such that the area(s) that fail to meet the criteria are classified as soil likely to require remediation and investigate likely reason for encountering buried contamination. Refine the CSM and evaluate the implications for the assumption that buried contamination (in the absence of surface contamination) is unlikely to occur at this site. This is a dynamic aspect of the investigation. New subsurface sample locations should be located away from the contaminated zone at a distance equal to the site's geostatistical correlation range with a goal of bounding the subsurface contamination. If any new borehole is observed to be contaminated, the process is repeated.
			2	No – Boundary between areas requiring excavation and not requiring excavation is defined.
	2	Based on existing data and data gathered at boundaries between areas requiring excavation and not requiring excavation, can depth of soil exceeding the $DCGL_w$ criterion (SOR > 1) be discerned within $\pm$ 1 ft vertically?	1	Yes – No additional data needed.
			2	No – Acquire data vertically from areas to be excavated using a biased sampling scheme until required resolution is met.

Table 4-1 (cont). Principal Study Questions and Alternative Actions for Painesville Soils

Areas Where CSM Indicates Excavation is Unlikely to be Required (Class 2 SUs)	**3**	Does soil within Class 2 SUs contain RCOCs at average concentrations less than or equal to the $DCGL_w$ criterion (SOR $\leq$ 1)?	1	Yes - If $DCGL_w$ criterion is met, then no further action (NFA) is required.
			2	No – Reconfigure boundary such that the area(s) that fail to meet the criteria are classified as soil likely to require remediation. New surface sample locations should be dynamically planned and located using an indicator geostatistical tool to determine optimal placement of the additional samples to most cost effectively reduce the uncertainty to acceptable levels.

Using the PSQs and AAs shown in Table 4-1, the following key DQO decision statements were developed for the Site pre-remediation field sampling project:

1. For each survey unit likely to require excavation, determine whether subsurface soil exceeding the $DCGL_w$ criterion (SOR > 1) extends into areas expected to be clean. If subsurface soil contamination is observed to extend into those areas, reconfigure the area boundaries to include locations that fail to meet the subsurface soil criterion. Refine the CSM and evaluate the implications for the assumption that buried contamination (in the absence of surface contamination) is unlikely to occur at this site. Otherwise, no further characterization is necessary.

2. For each survey unit likely to require excavation, determine whether the depth of soil exceeding the $DCGL_w$ criterion (SOR > 1) can be discerned within ± 1 foot (ft) vertically. If not, conduct an investigation targeting areas within the SUs where uncertainty remains. Otherwise, no further characterization is necessary.

3. For each survey unit where the CSM indicates that remediation is not necessary, determine whether surface soil contains RCOCs at concentrations less than or equal to the $DCGL_w$ criteria (SOR $\leq$ 1). This will require a gross gamma count rate equivalent as a surrogate for an SOR score based on laboratory results. If the soil scan survey of the survey unit results in count rates greater than the surrogate greater than or equal to the $DCGL_W$ criteria, a biased soil sample shall be collected for analysis. Otherwise, no further sampling is required.

4. For each survey unit where the CSM indicates that remediation is not expected to be necessary, determine whether the average SOR value (based on concentrations of RCOCs in surface soil across the survey unit) is less than or equal to the $DCGL_w$ criterion ($SOR_w \leq 1$),

and thus no further action is required. Otherwise reconfigure boundary such that the area(s) that fail to meet the criteria are classified as soil likely to require remediation (SOR_w >1).

To demonstrate that a survey unit meets all of the cleanup criteria requirements, decision statement Nos. 3 and 4 must indicate that no further action is required.

For the waste profile sampling, the field decision will center on determining whether surface and subsurface samples obtained through borehole sampling are in fact representative of contaminated soil. These samples will be screened in the onsite lab, then sent to the offsite lab for radiological and chemical quantification.

Decisions regarding downhole scanning at Class 1 boreholes for the purpose of determining the depth of contamination will rely on downhole core scanning results. Correlation between downhole gamma counts and laboratory analysis, as described later in this document, will be performed using data from the initial depth-bounding boreholes. Field decisions will focus on determining at what depth the subsurface materials transition from contaminated material to non-contaminated native soil or fill.

In cases where the areal-bounding boreholes indicate the presence of subsurface contamination, additional boreholes will be drilled to the outside of the contaminated zone. These boreholes will have downhole gamma logging performed to test for the presence of contamination at the new boundary location. These locations will be spaced at a distance within the Site's geostatistical correlation range. If any of these new bounding boreholes are observed to be contaminated, the process will be repeated until the known contamination is sufficiently bounded. The Class 1/Class 2 boundary will then be reconfigured, along with the sampling locations of the triangular grid within the Class 2 SUs.

4.2.2 Proposed Cleanup Guidelines

Proposed derived concentration guideline levels (DCGLs) for residual radioactivity in soil (i.e., cleanup guidelines) were developed for the Site using the Residual Radioactivity (RESRAD) computer code, version 6.22. (ANL 2003) These cleanup guidelines were based on limiting future doses to the 25 mrem/yr criterion established by the NRC decommissioning rule (10 CFR 20 Subpart E), for the critical group as defined in the Feasibility Study Addendum (USACE 2005). The exposure scenario that was used was for a construction worker.

The initial list of radionuclides of concern included the primary radionuclides in the thorium decay series and uranium decay series (Th-232, Ra-228, Th-228, U-234, U-235, U-238, Th-230, Ra-226, and Pb-210). The thorium decay series was included because low levels of Th-232 and its decay products have been detected at the site, are not unexpected in uranium ore residuals. The primary radionuclides present in uranium ore material are U-234, U-235, U-238, Th-230, and Ra-226 (and their decay products).

Because many of these radionuclides are present as decay products associated with a long-lived (long half-life) "parent" radionuclide, the list of RCOCs was simplified by combining the decay products with their respective parent radionuclides where appropriate. Grouping decay series

radionuclides in this manner simplifies the site survey and verification processes, without eliminating consideration of the health effects associated with exposures to the decay products. Grouping simply means that the health effects impacts (radiological dose or risk) associated with decay products have been added to the overall parent radionuclide impact.

For example, the cleanup guideline for Th-232+D (thorium 232 plus decay products) includes consideration of the Th-232 progeny Ra-228 and Th-228 (as well as their short-lived decay products). Inherent in this approach is the conservative assumption that all decay products associated with a long-lived parent are in secular equilibrium (or present at the same activity concentration as the parent). The individual guidelines for the uranium isotopes were also simplified into a combined "U-total" value. The U-total guideline assumes the uranium isotopes are present in their natural activity ratios of 1:1:0.046 for U-238, U-234, and U-235, respectively. A complete description of the derivation of the DCGLs for the Site, including a detailed listing of assumptions used in the modeling process is provided in the Feasibility Study Addendum [FSA, (USACE 2005)].

DCGLs were developed for two specific areas: 100 m^2 and 10,000 m^2. The primary DCGL values for each RCOC at the Site are based on an area of 10,000 m^2 and depth of 2 m. These guidelines (DCGLw) apply to the average concentration over an entire survey unit. The other DCGL value will be used as potential guidelines for localized areas of elevated activity (elevated measurement criteria or DCGLemc value). The DCGLemc ensures that while localized areas of elevated activity may significantly exceed the DCGLw at specific locations, the overall impact of these smaller areas will not cause the average concentration for the survey unit to exceed the DCGLw.

Table 4-2 shows the proposed DCGL values for the Site. The proposed DCGLs are incremental to background. Soil containing radioactivity at the DCGL level (for a single radionuclide) would result in an annual dose to a construction worker of 25 mrem/yr. Since it is possible for more than one radionuclide to be present in soil, the DCGLs will be applied using a sum-of-ratios (SOR) approach. The residual concentration in soil for each radionuclide (after background subtraction) will be divided by its respective DCGL, and these ratios will be added together. As long as this sum-of-ratios is less than or equal to 1.0, the dose criterion of 25 mrem/yr will be met.

Table 4-2. Derived Concentration Guideline Levels for the Painesville Site[1]

Radionuclide	Average Background Levels (pCi/g)	Construction Worker Scenario $DCGL_w$ (pCi/g)	Construction Worker Scenario 100 m^2 $DCGL_{emc}$ (pCi/g)
U-total	2.64	482	810
Ra-226+D	0.95	9	12
Th-230	1.45	25	34
Th-232+D	1.07	6	8

[1] DCGLs represent soil concentrations that would result in a dose rate of 25 mrem/yr to an individual representative of the modeled exposure conditions. Note that DCGLs are incremental to background.

The general SOR formula for use with the DCGLs in Table 4-2 is shown below. The concentration terms used in the numerators of the SOR equation are the net concentrations after subtraction of the average background concentrations for each radionuclide.

$$SOR_{DCGLw} = \frac{Ra-226}{Ra-226\_DCGL} + \frac{Th-230}{Th-230\_DCGL} + \frac{Th-232}{Th-232\_DCGL} + \frac{U-total}{U-total\_DCGL}$$

4.3 IDENTIFY INPUTS TO THE DECISION

Information on RCOCs must be collected from four key components in the field: (1) Subsurface soil samples in and around the existing Class1 SUs; (2) Downhole gamma measurements within each borehole location to direct biased subsurface soil sampling; (3) surface soil samples in existing Class 2 SUs; and (4) Surface gamma walkover survey scans. A more detailed discussion of specific field activities is included in Section 5 of the FSP.

Three techniques will be used in the field to generate information pertinent to the principal study questions. These include surface gamma walkover surveys, downhole gamma logging, and surface/subsurface soil sampling combined with an appropriate laboratory analytical techniques (e.g., gamma and alpha spectrometry).

For subsurface soil, downhole gamma logging will primarily be used to determine whether RCOCs exceed DCGLs at depth. Soil sampling within known Class 1 SUs will be used to develop relationships between the gross measurements collected using the downhole gamma instruments and soil activity concentrations. The goal of this investigation is to develop reliable field screening indicators that will correlate increased count rates to the presence of RCOCs that approach SOR > 1. These indicators will be developed using the onsite gamma spectroscopy lab in concert with the downhole gamma counts performed at the same intervals. Details of this approach are provided in Section 4.3.4.

4.3.1 Surface Gamma Scans

Surficial scans, where possible, are particularly effective at identifying spatial trends in surficial contamination and potential DCGL concerns. Surficial gamma scans will be collected through systematic walkovers and through stationary readings at selected locations by using either a two-inch by two-inch (2x2) or a three-inch by three-inch (3x3) sodium iodide (NaI) scintillation detector. Locations for both mobile and stationary scans will be logged by using a global positioning system (GPS) unit.

Site-specific detection sensitivities have been calculated for a 3x3 NaI scintillation detector by following the approach detailed in NUREG-1507 (NRC 1998), which is presented in Appendix C of the FSP. (Cabrera 2005) Ra-226, Th-232 (and progeny), and U-238 (and progeny) are readily detectable by these NaI GWSs. Th-230 alone is not, but the co-located presence of the other three RCOCs will aid in the ability to identify Th-230. A review of the existing site data (Section 2.3 of the FSP) indicates that Th-230 is usually found at concentrations equal to or less than Ra-226. In addition, the DCGLs for Th-230 are much higher than for Ra-226, so the use of

gamma detection technologies should be adequate for identifying areas where Th-230 is present in significant amounts (and co-located with Ra-226). Trigger levels for surficial soils will be developed by determining background count rates for a set of locations across the area of concern, determining an average background response and its variability, developing a detection limit estimate based on MARSSIM's recommended process, and using this gross activity detection limit as the trigger level for further investigation/biased sampling.

The use of direct scanning technologies for screening potential surface contamination above DCGL requirements is most likely to be successful and implementable when both surface moisture and surface vegetation are at a minimum over soil surfaces. This fact should be taken into consideration when scanning activities are being scheduled.

For areas covered with either asphalt (i.e., roadways) or concrete pads (i.e. slabs of former buildings), surface GWS may prove to be ineffective due to reduced sensitivity. Scan MDC calculations will be performed for overburden layers of each to determine the minimum concentrations of RCOCs that could be expected to be detected. If shown to be ineffective, high density GWS will be supplanted with strategically placed biased and random soil samples in these areas. The goal of these additional samples is to investigate the potential for contamination located under various overburden layers. To assess this potential contamination, cores will be bored through the asphalt or concrete to allow access to the underlying soil. The number of samples required and actual placement will be determined while in the field, based on the results of the GWS and field crew observations.

4.3.2 Downhole Gamma Logging

Gross gamma count rates will be collected at each internal and bounding Class 1 SU borehole in 6-inch increments starting from the bottom and working upwards. A 1 in. by 1 in. (1 x 1) NaI detector suspended from a nylon cord will be used to obtain these measurements. Results will be compared to Action Levels (ALs) developed using activity correlation factors developed from analysis of sectioned soil cores taken in the Class 1 SU's. Analysis will performed both in the onsite lab and at the offsite lab (See Section 4.3.4).

Application of these correlation factors will be used during downhole gamma counting in all borehole locations bounding the Class 1 SUs. Subsurface soil from intervals exceeding established ALs will be selected for biased soil sampling and analysis in the onsite and offsite labs.

4.3.3 Soil Samples

Physical samples will be collected from surface and subsurface soils to support the MARSSIM survey process. Surface soil samples will be representative of the top 15 cm (6 in.) of soil. Subsurface soil samples will be extracted from segmented borings into representative subsurface intervals of 30-cm (12-in.) each that may pose SOR concerns. Physical soil samples will be screened in the onsite gamma spectroscopy lab and sent to the off-site analysis for Ra-226 by Lucas Cell, and isotopic Th, and isotopic U by alpha spectroscopy.

4.3.4 Development of Activity Correlation Factors

In order to improve characterization performance and reduce costs, it is proposed to use near real-time measurement technologies where appropriate. Near real-time measurement technologies can potentially serve two roles by: (1) providing information about the contamination status of surficial soils, and (2) providing information about the contamination status of subsurface soil cores and/or samples.

After instrument detection levels have been established, a set of approximately 30 to 40 surface soil samples and gamma count rate measurements, and 30 to 40 subsurface soil samples and downhole gamma count rate measurements will be collected at specific locations representing a range of contamination levels across the site. If possible, the majority of the correlation samples will be collected from locations where the gamma count range spans across and on either side of the range from the $DCGL_w$ (i.e., lowest) to the $DCGL_{emc}$ (highest). Soil samples will be screened with the onsite gamma spectroscopy lab for Ra-226, Th-230, Th-232, and U-238 before being sent to the offsite lab for confirmatory analysis. Table 6-4 provides a summary of expected analytical methods and capabilities associated with soil sampling. While quick-count gamma spectroscopy may be used for samples comprising part of the initial correlation data analysis, the analytical data used to support the correlation for surface scans used to demonstrate compliance with the $DCGL_{emc}$ will be from an approved qualified offsite laboratory.

These sets of paired, co-located, soil concentration and count rate data points will be used to construct statistically based relationships between gamma count rate and surface soil or subsurface soil concentrations of the RCOCs. These two relationships (i.e., one for surface soil and one for subsurface soil) will involve the use of a non-parametric statistical approach that will categorize the data into three separate groups or "bins." One bin will represent a range of count rates for which there is a very small probability of surface soil results equaling or exceeding an SOR of 1 (i.e., 'uncontaminated'). Another bin will represent a range of count rates for which there is a high probability of surface soil sample results exceeding an SOR of 1 (i.e., 'contaminated'). A third (mid-range) bin will represent a range of count rates where there is a moderate probability that soil samples will either equal or exceed an SOR of 1 ("too close to tell"). This mid range group represents a range of count rates where sampling is highly recommended to achieve definitive results. The low range group will be used to establish a count rate trigger value that will provide high confidence that a survey unit will pass (i.e., be released) if all gamma scan measurements are at or below this trigger value. Similarly, the high range group provides a count rate threshold indicative of a high probability of the cleanup criteria being exceeded.

For Th-230, which is not easily detected by gamma scanning, the relationship between site concentrations of Th-230 and Ra-226 will be used to support the correlations of activity and gamma count rate described above. As discussed previously, historical site data indicates that Th-230 is usually found at concentrations equal to or less than Ra-226. In addition, the DCGLs for Th-230 are higher than for Ra-226. Sample results from the characterization efforts conducted prior to the FSS will be evaluated to verify that Th-230 is not expected to be present at any location where gamma emitters such as Ra-226 are not also present. As long as there is a reasonably consistent relationship between Th-230 and other gamma emitters, the correlation approach described above will be

sufficient to ensure that areas with concentrations approaching an SOR of 1 are not missed by gamma scan surveys.

4.4 DEFINE THE STUDY BOUNDARY

The fourth step in the DQO process is to define the spatial and temporal boundaries that the data must represent to support the decision statements. The study area boundary consists of surface and subsurface soil within the FUSRAP boundary of the Site. Figure 2-1 of the FSP provides the boundary for the Site as defined under FUSRAP.

The study area will be divided into Class 1 and Class 2 SUs consistent with MARSSIM guidance. (Note: Class 3 SUs are not anticipated at this site). Class 1 units have been defined as areas where remediation has taken place or where data indicate the presence of contamination above DCGL requirements. However, the CSM may need to be refined as the Class1/Class2 boundary samples are collected to determine if subsurface contamination indeed extends across the boundaries. It is expected that Class 1 units will include areas where contaminated scrap steel was stored or moved about the Site, or was used as part of the chlorine scrubbing process. The initial layout of the FSS SUs for the Site is provided in Figure 4-1. Figure 4-2 provides an overview of the initial sampling effort as described in Section 4.3, *Inputs to the Decision.* The sampling locations shown in Figure 4-2 were chosen to best test the current assumptions of the CSM.

Figure 4-1. Layout of Preliminary Final Status Survey Units. Site configuration portrayed circa 1998.

Figure 4-2. Locations of all systematically placed sampling locations. Site configuration portrayed circa 1998.

Class 2 SUs will be defined as areas where there may be evidence of the potential presence of elevated levels of residual radionuclides, but where concentrations of the RCOCs are not expected to exceed DCGL requirements. Class 2 SUs may be as large as 10,000 m^2, and will likely surround the Class 1 units.

While not anticipated, Class 3 SUs may be designated if needed. Class 3 SUs will be defined as areas that have a low probability of containing RCOCs associated with site activities. There is no size limit for Class 3 units.

The general survey unit boundaries described above are for planning purposes only. The actual layout of units and individual unit boundaries may be redefined at the discretion of the project technical team with the approval of USACE, as dictated by field conditions and sample data. The discovery of unexpected contamination during FSS work in Class 2 or Class 3 areas may require remediation and reclassification of areas as Class 1 SUs.

4.5 DEVELOP THE DECISION RULE

The decision rules for this investigation flow from the principal study questions and the decision logic is structured to promote an efficient and cost-effective investigation. The order and basic structure of the decision logic can be expressed in the following four steps.

1. Refine the Class 1/Class 2 boundaries through surface and downhole scanning,
2. Determine the depth of contamination in Class 1 areas,
3. Conduct FSS in Class 2 SUs, and
4. Investigate and resolve any anomalies.

Sampling and analysis for waste classification will be performed in conjunction with determining the depth of contamination in Class 1 areas.

4.5.1 Decision Rules for Class 1 Units

Figure 4-3 illustrates the decision rules for Class 1 units. The decision logic follows two parallel branches:

The left branch provides the logic applied to surface scanning. Note that the initial activity on the left branch calls for performing gamma walkover scans over all accessible soil (Class 1 and Class 2) at the site. Soil samples will need to be acquired to establish the relationship between the concentration of the COCs in soil and the gamma scan readings. Based on the walkover surveys and the existing CSM, sampling locations are selected for those samples. Prior to collecting each sample, a direct gross gamma reading is obtained at each sample location. After the scan/soil concentration relationship is established, the scans made in the Class 1 areas are evaluated to determine whether there are any exceedances of the DCGLs near the common boundaries with Class 2 areas as initially estimated. If so, the boundary between the two classes is adjusted. If not, the boundaries are deemed to be acceptable, and it is appropriate to proceed to the Class 2 decision logic.

The right branch provides the logic applied to downhole scans. Like the left branch, the right branch establishes the relationship between scan readings and the concentrations of COCs in soil.

Since soil will be extracted in a core from each borehole, samples will be carefully acquired from each core to ensure that they correspond with the targeted depths of the downhole scan readings.

The scans will then be used to determine the depth of contamination in each borehole. The location of the each depth-bounding borehole will be determined by evaluating the existing CSM and the use of indicator geostatistics.

After the downhole scan/soil concentration relationship is established, the area-bounding downhole work can proceed simultaneously with the depth-bounding downhole work. However, results from downhole scans completed along the estimated Class 1/Class 2 boundaries will be compared to the $DCGL_w$ to determine whether the boundary is appropriately located. If the scan results are greater than the $DCGL_w$, the boundary between the two classes is adjusted. If not, the boundaries are deemed to be acceptable, and it is appropriate to proceed to the Class 2 decision logic.

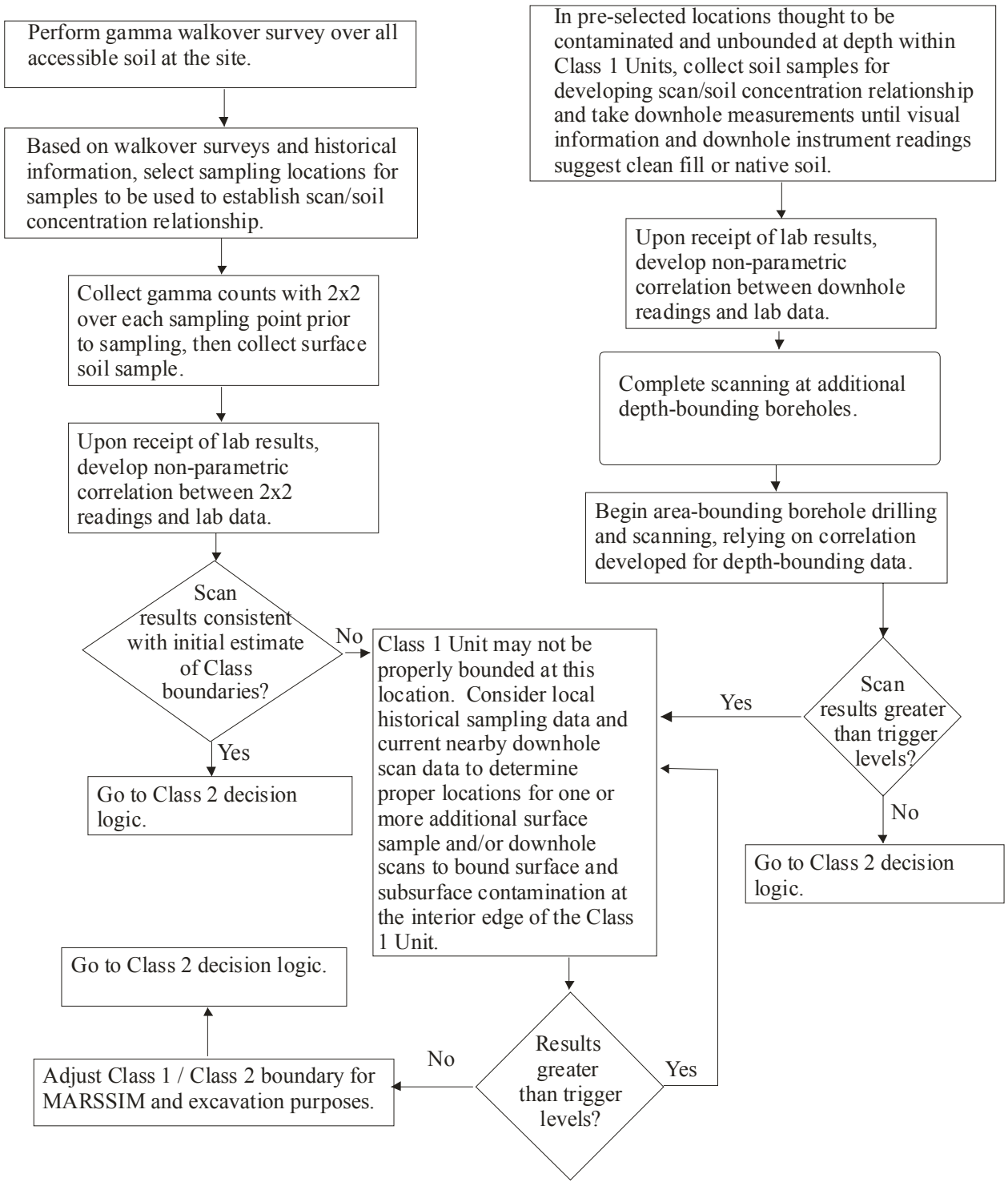

Figure 4-3. Decision Flow Diagram for Class 1 SUs

4.5.2 Decision Rules for Class 2 Units

Figure 4-2 illustrates the decision logic for FSS data collection and decision making applied to Class 2 units. The following text describes the decision logic presented in the flowchart.

1. Technically defensible gross count rate trigger levels will have been developed for gamma walkover survey instrumentation. These trigger levels will include gross count rate thresholds that reliably identify soil concentrations representative of an SOR value of 1.0 based on the $DCGL_w$ values. This will require development of a relationship for gamma count rate to surface soil activity concentrations using data collected during the planned characterization effort prior to site remediation. The relationships developed using historical site data can be a starting point for this, but these relationships should be refined with surface gamma scan and sample data collected specifically for that purpose, at exactly the same locations.

2. Class 2 FSS unit numbers and layout will be determined on the basis of sampling results to date, excavation footprints, and prior civil surveys. Class 2 units should encompass all areas in the study area not included as Class 1 units. Figure 4-2 includes an initial layout of Class 2 SUs based on historical data. This figure can be used as a starting point for establishing the final survey unit classification scheme based on the most recent characterization data.

3. Surface scans will have been performed over 100% of accessible areas using standard walkover gamma scan survey techniques and NaI detectors. Gamma scan data from walkover surveys over Class 2 SUs will be obtained by walking the areas in parallel paths using a traverse spacing of 1 meter (orthogonal walkovers will not be required). The goal is to have a data density of approximately one measurement per square meter. Surface gamma scan results will be compared to the trigger levels discussed above, and locations with results greater than the applicable trigger level will be flagged as anomalies requiring further investigation. If scanning is not possible, biased sampling will be conducted at these locations to confirm DCGL compliance. Additional remediation and reclassification of the affected area of the survey unit to Class 1 may be required.

4. The number of systematic surface sampling locations will be determined for each unit. The minimum number of locations will be determined by MARSSIM Sign test design requirements (details provided in Appendix D). Based on historical data and Type I (alpha) and Type II (beta) error tolerances of 0.025 and 0.05, respectively, the minimum number of samples per survey unit is 17. Sampling locations will be laid out on triangular grids, where possible.

5. A surface gamma scan measurement will be taken, and one surface sample representative of the top 15 cm (6-in.) of soil will be collected at each surface sample location within a survey unit**.** These samples will be analyzed by Lucas Cell for Ra-226 and by alpha spectrometry for total uranium, Th-230, and Th-232. The results from these analyses will be used to compute the average SOR score for each survey unit. If the average SOR score exceeds the $DCGL_w$ requirement (survey unit average SOR > 1), remediation and reclassification of the affected area of the survey unit to Class 1 may be required. If the average meets the $DCGL_w$ requirement, the Sign test will also be applied to surface sample results. If the unit fails the

Sign test, additional investigation may be undertaken to determine the cause, and additional remediation may be required. Ultimately each survey unit must pass the Sign test (at specified error tolerances) in order to be in compliance with the cleanup criteria.

6. If a survey unit satisfies all DCGL requirements, the unit will be considered to be in compliance with cleanup criteria and ready for release. If a survey unit fails one or more of the DCGL requirements and requires additional remediation, the affected areas of the FSS unit may be reclassified as a Class 1 unit dependent upon the cleanup criteria that are used in the Record of Decision.

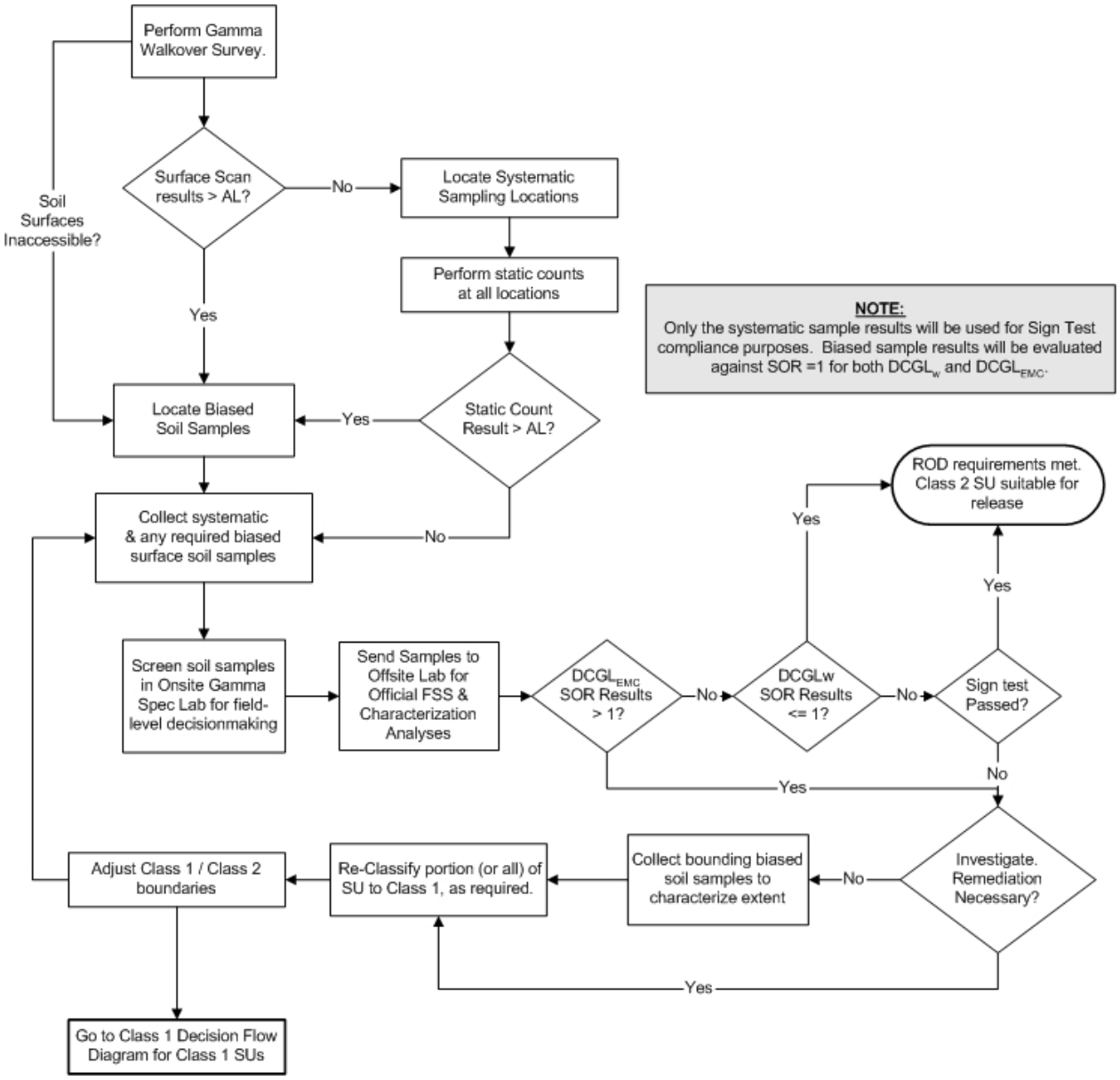

Figure 4-4. Decision Flow Diagram for Class 2 SUs

4.6 SPECIFY TOLERABLE LIMITS ON DECISION ERROR

As part of the DQO process, the null hypothesis for demonstrating compliance of data with cleanup goals must be stated. The null hypothesis (H_0) tested is that residual contamination exceeds the acceptance criterion (cleanup goal). If the null hypothesis is rejected, the alternative hypothesis must be accepted, and the finding of the evaluation is that the site satisfies the guideline. The Sign test will be used, as described in MARSSIM, to test the null hypothesis for $DCGL_w$ compliance. For the $DCGL_{emc}$ requirements, scan results will be compared against scanning/screening triggers derived for that purpose, and sample results will be compared directly to $DCGL_{emc}$ requirements.

To enable testing of data relative to cleanup goals, the USACE has established acceptable decision errors for the project. There are two types of fundamental errors. The Type I (alpha) decision error is that the survey unit will be found to have met the release criteria when, in fact, it does not. The probability of a Type I error is set at 0.025. This provides a confidence level of 97.5% that the statistical tests will not determine that a surveyed area satisfies criteria when, in fact, it does not. The Type II (beta) decision error is that the survey unit will be found not to have met the release criteria when, in fact, it does. The probability of a Type II error used to determine sample quantity per survey unit is set at 0.25. This provides a confidence level of 75% that the statistical tests will not determine that a surveyed area does not satisfy criteria when, in fact, it does. Type II errors affect disposal costs and do not adversely affect public safety and health.

The following laboratory data quality indicators for precision, accuracy, representativeness, completeness, and comparability have been established for this survey effort. Details and formulae are provided in Section 7.0.

- Precision will be determined by comparison of replicate values from field measurements and sample analysis; the objective will be either a relative percent difference (RPD) of 30% or less at 50% of the criterion value for non-radiological analyses, and a Replicate Z-Score (Z_{Rep}) of ≤ 2 for radiological analyses, corresponding to agreement at the 95% confidence level.

- Accuracy is the degree of agreement with the true or known; the objective for this parameter will be ± 30% at 50% of the criterion value.

- Representativeness and comparability are assured through the selection and proper implementation of systematic sampling and measurement techniques.

- Completeness refers to the portion of the data that meets acceptance criteria and is therefore usable for statistical testing. The objective is 90% for this project.

Note that characterization survey data often include radionuclide concentrations in the range of background, making data quality indicators difficult to evaluate. For example, there may be few data at concentrations near 50% of the criterion value. Data analysts should consider these limitations during the data quality assessment.

4.7 OPTIMIZE THE DESIGN

Field survey and screening techniques, soil sampling methods, instrument selection and detection capabilities, survey/sampling frequency, and the DQO process will be used, as appropriate, throughout data collection to focus efforts and minimize cost. As data is collected and analyzed, the assumptions in this plan should be reviewed for accuracy. That is, the sampling and analysis process detailed in the next section should be revisited if initial data indicate that conditions are significantly different than the initial assumptions.

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5.0 SAMPLING PROCEDURES, SAMPLE RECEIPT, HANDLING, CUSTODY AND HOLDING TIME REQUIREMENTS

5.1 SAMPLING PROTOCOLS

This section describes the components of the sampling procedures that will be performed to meet the quality assurance objectives for the project activities to be performed at the Site.

5.1.1 Generic Sampling Protocols

This section includes brief descriptions of field procedures used to conduct pre-remedial surveys. Criteria or guidelines for choosing among alternatives are also included when more than one procedure can be used. Detailed equipment and sampling protocols are provided and discussed in the Painesville FUSRAP Site FSP. The detailed equipment and sampling procedures present the QC specifications, documentation requirements, field forms, stepwise descriptions of the procedure, and any special conditions or precautions that must be considered in the field. The rationale and procedures are selected for use during the DQO development process and are documented in the FSP. These site-specific designs include the sampling locations and specific sample collection criteria.

Prior to beginning each sampling event, the FSM will ensure that the field personnel understand the purpose and objectives of the event. Topics of review and discussion with the team may include schedules, responsibilities, sampling locations, types of samples to be collected (both field samples and QC samples), number of samples collected, sample identification numbering schemes, preservation requirements, parameter(s) to be analyzed, sampling procedures, equipment decontamination procedures, and COC requirements. Field personnel shall read and be cognizant of applicable sections of this QAPP before planning or performing the fieldwork. The PM and FSM will ensure that field personnel also have copies of the *Quality Control Plan for the Painesville FUSRAP Site* (QCP, Cabrera 2005), SSHP, FSP, and CABRERA RSP radiological SOPs while in the field.

Proper site sampling location selection is critical to generating representative data. Locations selected for subsurface and surface sampling during the DQO process must represent the site, zone, and/or matrix under investigation. Sampling locations for subsurface and surface soils are pre-determined using a statistical sampling approach and are biased based on field gamma walkover and downhole gamma logging results. Specific sample collection criteria developed to guide decision-making in the field are documented in the FSP. (Cabrera 2005b)

General criteria used to select sampling locations are:

- Known or suspected contaminant release area.
- Results of previous survey and sampling efforts to detect radiological contaminants in surface and subsurface soils in the AOC.
- Classification of survey units as MARSSIM Class 1 or Class 2.
- Calculation of the appropriate number of samples required for the specific Class survey unit.

- Geometry and spacing of the systematic grid established within the survey units.
- Designated number of samples to be collected per boring.
- Results of dynamic geostatistical modeling to minimize uncertainty in survey unit boundaries.
- Presence of overhead, underground, or surface obstructions to the operation of equipment and the performance of subsurface coring (e.g., power lines, sewer or water piping, standing water, etc.).

5.1.2 Sampling Equipment Decontamination

Equipment decontamination is an integral part of the data collection and QA process. The implementation of proper decontamination practices and procedures will begin in the field prior to use of sample collection equipment. If non-dedicated field sampling equipment is used, it will be decontaminated prior to use and after sample collection at each location in accordance with CABRERA RSP SOP OP-018, *Decontamination of Equipment and Tools*. Equipment to be decontaminated may include direct-push soil sampling tubes, stainless steel scoops, bowls, spoons, or hand augers. Other equipment that may not directly contact sample materials (such as down-hole rods, shovels, etc.) will be cleaned to remove visible soil residues using dry or wet manual wiping.

If more aggressive decontamination methods such as pressure washing or steam cleaning become necessary, a field decontamination station will be established. The location of this field station will require the approval of the USACE and the construction contractor. The decontamination station will be designed to properly contain and collect any solid or liquid wastes generated from the cleaning process. Disposition of cleaning wastes will be in accordance with the discussion of investigation-derived wastes in the Site FSP.

Decontaminated equipment will be swiped for radiological contamination to determine the potential for cross-contamination. Large-area swipe samples (or smears) will be collected from decontaminated sampling equipment and field counted for gross alpha and beta contamination with a portable detector prior to use at a subsequent sampling location or final release from the Site.

5.1.3 Sample Custody

Sample possession during sampling efforts must be traceable from the time of collection until the results are verified and reported. The sample custody procedures provide a mechanism for documentation of information related to sample collection and handling to achieve this objective. The sample handling procedures are discussed in Section 5.3. This section contains a general discussion of sampling custody practices, which are intended to address potential problems with labeling errors, transcription errors, preservation errors, etc. Overall, the QC checks discussed in this section are the mechanism that detects and corrects errors.

To ensure that important information pertaining to each sample is recorded, documentation procedures have been standardized. Sample custody procedures for this program are based on EPA-recommended protocols that emphasize careful documentation of sample collection and transfer data. These protocols are detailed in the EPA *Technical Enforcement Guidance Document (Section*

4.4, OSWER-9950.1). The FSM will be responsible for field team adherence to proper custody and documentation procedures for sampling operations.

Custody, which refers to the physical possession of a sample and the storage of that sample in a secure area, is typically considered in three parts: sample collection, laboratory, and final (evidence) files. Sample custody forms will be used to document the relevant information for each sample collected. A master sample logbook will be maintained onsite to provide additional documentation for sample collection. CABRERA will retain site-specific field logbooks for a minimum of 5 years. The analytical laboratory will retain raw data and other supporting records related to sample analysis for a minimum of 5 years.

5.1.4 Field Operations

Each sample collected will be assigned a unique field sample number, which will be indicated on the sample label attached to the container. Sample labels serve to identify the sample by documenting the client name, project name, sample identification, sample type, who collected it, when it was collected, analyses required, and the preservation method(s) used. Both the sample label and Chain of Custody (COC) form will contain the sample identification numbers in order to track and enter sample information using the geographical information system (GIS) database for the Site. These labels will be completed with an indelible ink pen or generated by a computer, and will be affixed securely to the sample container immediately upon collection. The QA/QC samples (e.g., blanks and duplicates) will be numbered in the same manner and will not be distinguishable by the laboratory from the rest of the samples.

COC records will be sequentially numbered to facilitate tracking of the shipment of individual samples. After the sample identification information is entered in the field logbook, it will be entered on the COC form and shipped with the samples. The COC form will then be filed in a document control file.

Prior to shipping, two custody seals will be affixed to each of the sample coolers on opposite corners. The custody seals will serve as an indicator of tampering and must remain intact until the cooler is opened at the laboratory.

5.1.5 Field Records

Documentation of field sampling will be performed to ensure data validity and facilitate analysis and evaluation. Field personnel are responsible for recording field activities on the appropriate field documentation form in sufficient detail to allow the significant aspects of the event to be reconstructed without relying on memory. It is the responsibility of the FSM to ensure that documents are complete and legible. At the end of each day, documents completed that day will be reviewed by the FSM for accuracy, completeness, and legibility. Field documents pertaining to sample collection will contain the sample identification numbers to be used for entering and tracking the data in the GIS database for the Site.

The field documentation forms or equivalent records that will be maintained during this investigation are listed below:

- Soil sampling and borehole log forms,

- Field logbooks,
- Daily quality control reports,
- Annotation of maps, and
- Equipment calibration logs.

Each completed form (a copy or original, depending on the type of form) will be maintained onsite with other completed forms of the same type until the completion of the field activity. Specific documentation requirements for each form are identified in the following subsections.

5.1.5.1 Soil Sampling and Borehole Log Forms

Certain descriptive and sample information will be recorded during the completion of each subsurface borehole and the removal/logging of soil samples. The information will be recorded on a soil description form, core log form, or other appropriate form, as described in the appropriate SOPs presented in the FSP.

5.1.5.2 Field Logbooks

After sample collection and before proceeding to the next sampling location, the samplers will complete the following procedures:

- Enter the sample into the COC record in accordance with Section 5.3.6.
- Apply signed custody seals on the container lid.
- Complete appropriate forms or logbook entries.

A master project field logbook will be maintained by the FSM or another designated field team member at the site to record information pertinent to daily activities, the field sampling program, and the equipment preparation efforts. Field logbooks will be bound, with pages numbered and entries made in permanent, waterproof ink. The FSM will review field log entries daily and sign or initial the final page for each day. Upon completion of the field activities, logbooks will become part of the final project file. Entries in the master project field logbook will include the following information:

- Author, date, and times of arrival at and departure from the work site;
- Weather conditions (e.g., temperature, humidity, wind speed, precipitation);
- Identification of subcontractors working on the site;
- Description of field activities and summary of daily tasks;
- Names of field crew members;
- Sample information and identification or references to appropriate logs/forms;
- Information regarding sampling changes and scheduling modifications;
- Field observations;

- Any problems or non-conformances associated corrective actions, notifications made as a result, and a summary of the content of discussions;
- The impact of the day's activities on the project schedule; and
- Site visitors or communications with non-project personnel, organizations, or agencies (e.g., regulators, property owners, press, other USACE personnel).

Individual field notebooks will be maintained by the onsite laboratory coordinator and, if necessary (based on site dimensions and layout), by members of the field survey and sampling team. These notebooks will be all-weather type with numbered pages, and entries will be made in permanent waterproof ink. At the end of each workday, or more frequently as situations change, field notebooks will be presented to, and reviewed by, the FSM. Entries in the field notebooks will include the following information:

- Author, date, and times of field survey or sampling activities;
- Description of the field activity;
- Names of field crew members;
- Sample collection method;
- Number and volume of sample(s) collected;
- Information regarding sampling changes and scheduling modifications;
- Details of the sampling location (including a sketch maps, if necessary);
- Field observations;
- Types of field instruments used and purpose of use;
- Field measurements made (e.g., radiological, chemical);
- Sample identification number(s) and sample documentation information; and
- Log photographs taken.

5.1.5.3 Daily Quality Control Report

A Daily Quality Control Report (DQCR) will be used as a record of daily field activities showing the sequence of events. A copy of this report is included in Appendix D. The FSM will be responsible for ensuring that activities are documented in the field DQCR. At a minimum, the field DQCR will include the following information for the specific day:

- Site/project identification;
- Weather conditions (e.g., temperature, humidity, wind speed, precipitation);
- Identification of subcontractors working on the site;
- Tasks/activities performed;
- References to appropriate field logs for each activity performed, if details are necessary;

- Any problems or non-conformances associated corrective actions, notifications made as a result, and a summary of the content of discussions;
- The impact of the day's activities on the project schedule; and
- Site visitors or communications with non-project personnel, organizations, or agencies (e.g., regulators, property owners, press, other USACE personnel).

CABRERA will submit to the designated USACE representative a DQCR for each day that field activities are conducted. The DQCR will be signed and dated by the CABRERA FSM and will be submitted to the designated USACE representative on a weekly basis. Any deviation that may affect the project DQOs will be immediately communicated to the designated USACE representative.

5.1.5.4 Annotation of Maps

Copies of site base maps or sketches will be used by the field teams to record key site conditions and to show approximate locations of soil cores, field structures, field staging or decontamination areas, radiologically controlled areas, utilities, or other appropriate site location information. If a sample location is moved, this will be documented on the site map. Field measurements using a differential global positioning system (DGPS) will be recorded to relate the new sample location to samples on the existing map. The maps or sketches will be maintained by the FSM during field activities and transferred to the project files for a record of sampling locations.

5.1.5.5 Equipment Calibration Log

Equipment calibration logs will be recorded in field logbooks and transferred to, and maintained in, electronic calibration logs to document the calibration measurements and frequencies of site equipment.

5.1.5.6 Corrections to Documentation

Measurements performed and samples collected will be documented in field logs. Field personnel will initial each page as it is completed. Corrections will be made by drawing a line through the incorrect entry and writing in the correct entry. The person making the correction will date and initial the correction. There will be no erasures or deletions from the field logs.

5.1.6 Locational Surveys and Sampling

5.1.6.1 Subsurface Soil Cores

Subsurface soil core samples will be collected at pre-determined locations in accordance with the coordinates supplied in the FSP, and at biased locations based on the results of ground surface gamma walkover surveys. Further rationale for selecting these locations and maps showing the sample locations are contained in the FSP. Table 5-1 provides a summary of the minimum number of analyses anticipated for the pre-remediation investigation.

5.1.6.2 Surface Soil Samples

Surface soil samples will be collected from the Class 2 SUs as shown in Figure 4-2. Further rationale for selecting these sample locations is presented in the FSP. Table 5-1 provides a summary of the minimum number of analyses anticipated for the pre-remediation investigation.

Table 5-1. Estimated Minimum Number of Analyses for Soil Samples

Parameter	Number of Analyses[1]			
	Field Samples	Field Duplicates (5% rate)	USACE QA Split Samples (5% rate)	Total Number of Analyses
Onsite Lab Gamma Spectroscopy Screening	375	18	18	411
Offsite Lab - Isotopic Uranium by alpha spectroscopy	375	18	18	411
Offsite Lab - Isotopic Thorium by alpha spectroscopy	375	18	18	411
Offsite Lab - Radium-226 by Lucas Cell	375	18	18	411

[1] Number of field samples is approximate. Actual numbers will reflect screening results and biased sampling needs. Initial estimate is based on 17 compliance samples per Class 2 SU.

5.1.6.3 Sample Location Surveys

Core sample locations will be determined in the field using DGPS and the grid coordinates provided in the FSP. If sample locations are moved due to utilities, obstructions, surface water, or results of field monitoring, the revised locations will be determined using DGPS. Reproducibility of locations for additional radiological survey or remediation work will be accomplished through the use of DGPS, using existing USGS benchmarks referenced to Ohio State Plane Coordinate System. Each core/sample location will be flagged by inserting a wire flag or wooden stake at the sample location to facilitate identification at a later date, if necessary. Final sample location survey accuracy will be second order, and data will be provided in a Computer Aided Design (CAD) format compatible with *ArcView* GIS file format.

5.2 SAMPLING METHOD REQUIREMENTS

Several elements of field and sampling activities are comprehensive and apply to all types of procedures. The standard approach for each element is addressed in the FSP. During implementation of the fieldwork, the PM, Project HP, FSM, and sampling team members will ensure that measurement and field procedures are followed as specified in the FSP, and that measurements meet the prescribed acceptance criteria. If a problem arises, prompt action will be

taken to correct the problem. Corrective action procedures are described in Section 6.8 of this QAPP.

5.3 SAMPLE HANDLING

The FSM is responsible for ensuring that samples are collected with properly decontaminated equipment and containerized in properly cleaned sample bottles. Sample bottles and containers will be certified as clean according to EPA Level I requirements, as appropriate.

Sampling and preservation procedures will be as mandated by each respective test method. In order to preserve the integrity of the sample before it is analyzed, proper sample containment, preservation methods, holding times, and shipping and COC procedures will be followed. A summary of the recommended sample containers, sample volume, preservation, and holding times for each analytical method and sample matrix is provided in Table 5-2.

The sample handling requirements discussed below are applicable to samples prepared for off-site analysis and, where appropriate, for samples prepared for onsite analysis.

5.3.1 Sample Containers

Samples for radiological analyses will be stored and shipped in high-density polyethylene (HDPE) containers in accordance with laboratory protocols for the specific analysis method (see Table 5-2) and client requirements. Sample containers will be packed in coolers for shipping to minimize the potential for breakage. The use of ice or coolant packs is not necessary for coolers containing radiological samples, as they may be stored and shipped at ambient temperatures.

Personal monitoring samples, if collected, will be sealed and shipped in resealable plastic bags and padded coolers to ensure that samples are not exposed to elevated temperatures.

Table 5-2. Sample Analytical Methods, Matrices, and Requirements

Analysis	Matrix	Method	Minimum Sample Quantity[1]	Standard Sample Quantity	Container	Normal Lab TAT[2]	Preservative	Holding Times
Onsite Gamma Spectroscopy	Soil	EPA 901.1	1000 g	1000 g	HDPE	N/A	N/A	N/A
Offsite Ra-226 via Lucas Cell	Soil	EPA 903.1M	200 g	1000 g	HDPE	30 days	N/A	N/A
Isotopic Uranium by Alpha Spectroscopy (U-233/234, -235, -238)	Soil	DOE EML HASL 300 U-02-RC mod	20 g	1000 g	HDPE	30 days	N/A	N/A
Isotopic Thorium by Alpha Spectroscopy (Th-228, -230, -232)	Soil	DOE EML HASL 300 Th-01-RC mod	20 g	1000 g	HDPE	30 days	N/A	N/A

[1] Lab usually requests 3 to 5 times the minimum quantities for re-runs, matrix spikes,, matrix spike duplicates, etc.
[2] TAT = Turn-around time, in calendar days. Shorter TAT are available at additional cost.

5.3.2 Sample Preservation and Holding Times

Sample preservation and holding time requirements will not be applicable for the intended radiological analyses and matrices. Samples for radiological analyses will not be subject to laboratory/analytical QA limitations based on hold times (see Table 5-2). Soils containing Site RCOCs may be stored indefinitely without an adverse impact on the quality of radiological data from alpha spectroscopy. However, timely handling and delivery of samples to the offsite laboratory is desirable from the perspective of project efficiency, scheduling, and performance of field activities.

5.3.3 Sample Receipt

The offsite laboratory will follow laboratory SOPs for handling, identifying, and controlling samples, and COC procedures to maintain the validity of the samples. These SOPs are based on the use of a laboratory information management system (LIMS) for tracking samples from receipt through reporting of the analytical results.

Upon receipt, the sample custodian will inspect sample containers for integrity. The presence of leaking or broken containers or custody seals will be noted on the COC form. The sample custodian will sign the COC form (with date and time of receipt), thus assuming custody of the samples.

The information on the COC form will be compared with that on the sample labels to verify sample identity. Any inconsistencies will be resolved with the CABRERA PM or FSM before sample analysis proceeds.

5.3.4 Sample Labels

Labels will be affixed to sample containers during sampling activities. Sample labels are waterproof and will be completed with an indelible ink pen or computer generated label and affixed to the sample container.

Information will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels will be as follows:

- Sample identification number;
- Sample type (discrete or composite);
- Site name and location number;
- Analysis to be performed;
- Type of chemical preservative present in container;
- Date and time of sample collection; and
- Sampler's name and initials.

5.3.5 Sample Identification

A sample numbering scheme will be used to identify each sample designated for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Each sample generated will be assigned a unique, sequential number to ensure that there is no duplication. Subsequent sequential numbers for each unique location will be assigned to ensure that the next sequential number will be used, even when returning to a unique location that has been sampled previously.

Sample identification numbers will be used on sample labels or tags, field data sheets and/or logbooks, COC records, and other applicable documentation used during the project. Field Sample Identifiers for a given site will be stored in a temporary database until the samples are being prepared for shipment to the laboratory at the end of the sampling event. At that time, the COC will be prepared by selecting the Field Sample Identifiers from the list, thereby providing a double-check that the Field Sample Identifier on the sample bottle is consistent with the COC.

The sample numbering scheme used for field samples will be used for duplicate samples so that these types of samples will not be discernible by the laboratory. Other field QC samples, however, will be numbered so that they can be readily identified. A summary of the sample-numbering scheme to be used for the project is presented in Table 5-3.

Table 5-3. Sample ID Numbering Scheme

Sample Type	Sample ID
Surface Sample	PV-SSXXX-Y-Z.Z-Z.Z
Subsurface Sample	PV-SBXXX-Y-Z.Z-Z.Z

SAMPLE ID NOTES:

PV	Painesville Site identifier.
SS	Surface Sample
SB	Subsurface Soil Sample
XXX	Location ID. Unique for each boring/sample location.
Y	Sample Type ID: 0 = Routine (systematic) samples, 1 = Field Duplicate Samples, 2 = USACE QA split samples, 3 = Biased Samples, and 4 = Onsite Lab Duplicate.
Z.Z-Z.Z	Depth interval of sample in feet below ground surface (e.g., 0.0-0.5)

5.3.6 Chain-of-Custody

An overriding consideration for environmental data is the ability to demonstrate that samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until sample disposition will be documented to accomplish this goal. Documentation will be accomplished through a COC

record that indicates each sample and the individuals responsible for sample collection, shipment, and receipt.

Samples that are collected will be accompanied by a COC record. The following information will be recorded to complete the COC record:

- Project name and number;
- Initials of sampler;
- The sample number, date and time collected, and sample type;
- Analyses requested;
- Any special instructions and/or sample hazards; and
- Date and time that the sample is relinquished with the signature and name of company of the individual that is relinquishing.

The purpose of sample custody procedures is to document the history of sample containers and samples from the time of preparation through sample collection, shipment, and analysis. An item is considered to be in one's custody if one or more of the following conditions apply:

- It is in a person's actual possession;
- It is in view after being in physical possession; and/or
- It is locked up so that no one can tamper with it after the sample is in physical custody.

The following COC procedures will be followed for samples submitted to the laboratory for chemical, radiological, or physical properties analysis:

- Each individual field sampler is responsible for the care and custody of samples they collect until the samples are properly transferred to temporary storage or for shipping.
- The individual responsible for shipping the samples from the field to the laboratory will be responsible for the completion and accuracy of the COC form.
- The original copy of the COC form will be inserted in a sealable plastic bag and placed inside the cooler/container used for sample transport after the field copy of the form has been detached, or a copy has been produced.
- Each time the samples are transferred, the signatures of the persons relinquishing and receiving the samples, as well as the date and time, will be documented.
- A copy of the carrier air bill or bill of lading will be used as custody documentation during times when samples are being shipped and will be retained as part of the permanent COC documentation.
- The laboratory will record the condition of the sample containers upon receipt.
- The COC form will be delivered by facsimile or electronically to CABRERA from the laboratory upon receipt of the samples.

- Changes or corrections to the information documented by the COC form (including, but not limited to, field sample ID or requested analyses) must be changed and initialed by the person requesting the change. In situations where the request comes from CABRERA, a copy of the COC form will be altered, initialed, and forwarded to the laboratory, where it will supersede the original COC form.
- A copy of the COC form and any documented changes to the original will be returned from the laboratory as part of the final analytical report to the PM. This record will be used to document sample custody transfer from the sampler to the laboratory and will become a permanent part of the project file.

5.3.7 Sample Packaging and Shipping

The objective of sample handling procedures is to ensure that samples arrive at the laboratory intact and free of external contamination. Samples will be packed and shipped in accordance with applicable U.S. Department of Transportation (DOT) regulations, U.S. Nuclear Regulatory Commission (NRC) regulations, and International Air Transport Association (IATA) standards (as detailed in the most current edition of *IATA Dangerous Goods Regulations* for hazardous materials shipments), as applicable.

5.3.7.1 Sample Packaging

Sample containers will be packaged in thermally insulated, rigid-body coolers. Samples will be packaged, classified, labeled, shipped, and tracked in accordance with CABRERA SOPs. During the time period between collection and shipment, samples will be stored in a secure area. Samples will be shipped for radiological analysis when a batch/cooler has been collected. It is not anticipated that samples will be collected/analyzed for chemical (i.e., non-radiological) constituents during this field effort.

Two custody seals will be placed on each cooler used for sample transport to ensure that no sample tampering occurs between the time that the samples are placed in the coolers and the time the coolers are opened for analysis at the laboratory. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the shipping coolers. Custody seals will be signed and dated by the individual responsible for completing the COC form and packaging the samples in the cooler.

5.3.7.2 Additional Requirements for Samples Classified as Radioactive Materials

Transportation of radioactive materials is regulated by the DOT under 49 CFR 173.401. Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements. In addition to the packaging and shipping requirements cited in this section, the following will be performed for radioactive materials:

- The cooler will have the shipper and receiver addresses affixed to it in case the Federal Express air bill is lost during shipping.
- Samples will be screened prior to packing to determine if they meet the definition of a DOT class 7 (radioactive) material.

- For samples that meet DOT requirements for radioactive materials:
- The cooler will be surveyed for radiation to ensure that the package meets the requirements for limited quantity, as specified in 49 CFR.
- A notice will be enclosed on the inside of the cooler that includes the name of the consignor and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package – limited quantity of material, UN2910." The outside of the inner packaging or, if there is no inner packaging, the outside of the package itself will be labeled "Radioactive."
- Appropriate hazard class label and "Cargo Aircraft Only," if applicable, will be placed on the cooler.
- The air bill for shipment will be completed and attached to the top of the shipping box/cooler, which will then be transferred to the courier for delivery to the lab.

5.3.7.3 Sample Shipping

Samples for radiological analyses will be shipped to the offsite lab no later than one week after the time of collection. All sample shipments will be prepared as overnight express deliveries using a commercial carrier service, i.e. FedEx. The lab's sample receiving department will be notified if any special arrangements for sample receipt are required, such as a Saturday delivery.

5.4 VERIFICATION/DOCUMENTATION OF COOLER RECEIPT CONDITION

The analytical services laboratory will follow its standard operating procedures (SOPs) for handling, identification, control, and COC procedures and to maintain the validity of the samples. These SOPs are based on the use of a laboratory information management system (LIMS) for tracking samples from receipt through reporting of the analytical results. Project-specific laboratory sample custody protocols are discussed below.

5.5 CORRECTIVE ACTION FOR INCOMING SAMPLES

A designated sample custodian will be responsible for samples received at the laboratory. The sample custodian will be familiar with custody requirements and the potential hazards of dealing with environmental samples. In addition to receiving samples, the sample custodian will also be responsible for documenting sample receipt, storage before and after sample analysis, and the proper disposal of samples. Upon sample receipt, the sample custodian will:

- Inspect the sample container for integrity and ensure that custody seals are in place. The relative temperature of the temperature blank packed with the samples upon receipt and presence of leaking or broken containers will be noted on the COC/sample analysis request forms. It should be noted that radiological samples do not require temperature documentation at receipt, cooling, or shipping with temperature blanks.
- Sign (with date and time of receipt) the COC/sample analysis request forms, thus assuming custody of the samples, and assign the laboratory sample identification numbers.

- Compare the information on the COC/sample analysis request forms with the sample tags and labels to verify sample identity. Inconsistencies will be resolved with a field sampling representative before sample analysis proceeds.
- Store samples in accordance with Section 5.5.1.
- Alert appropriate laboratory managers and analysts of any analysis requiring immediate attention because of short holding times specified in analytical protocols.

5.5.1 Sample Storage

Samples for radiological analysis do not require field temperature controls or time constraints on delivery to the analytical laboratory. In the field or at the analytical laboratory, samples will be stored in controlled-access areas, accountability will be maintained, and provisions will be in place to address handling and potential contamination control issues.

5.5.2 Sample Tracking

Each sample will receive a unique laboratory sample identification number at the laboratory when it is logged into the laboratory computer. Each person handling a sample batch will note the location change, time, and date, and will sign the custody record.

For samples that require extraction or digestion prior to analysis, a sample extraction or digestion record will be prepared. Laboratory data will be entered on the sample extraction form by computer and permanently recorded in a bound laboratory logbook.

The laboratory will maintain a sample tracking system that documents the following activities:

- Organization/individual who performed sample analyses;
- Date of sample receipt, extraction, if applicable, and analysis;
- Sample holding times;
- Names of analysts;
- Sample preparation procedures;
- Analytical methods used to analyze the samples;
- Calibration and maintenance of instruments;
- Deviations from established analytical procedures, if applicable;
- QC procedures used to ensure that analyses were in control while data were being generated (instrument calibration, precision checks, method standards, method blanks, etc.);
- Procedures used for the calculation of precision and accuracy for the reported data; and
- Statement of quality of analytical results.

5.5.3 Recordkeeping

Data related to sample preparation and analysis, as well as observations by laboratory analysts, will be permanently recorded in bound laboratory notebooks. Laboratory notebook pages will be signed and dated daily by laboratory analysts. Corrections to notebook entries will be made by drawing a single line through the erroneous entry and writing the correct entry next to the one that was crossed out. Corrections will be initialed and dated by the analyst.

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6.0 ANALYTICAL PROCEDURES

For this project, soil samples will be analyzed for RCOCs by alpha spectroscopy and the Lucas Cell methods at an off-site contract laboratory. Field screening for radioactivity will be conducted by gamma walkover surveys, downhole gamma surveys, and gamma spectroscopy screening in the onsite laboratory. Details of the procedures to be used are discussed below.

6.1 IDENTIFICATION OF RADIOLOGICAL ANALYTICAL METHODS

The off-site analytical methods will be carried out in accordance with the laboratory's approved SOPs, QA procedures, and QA program. The laboratory's procedures will be based on the Lucas Cell method, EPA 903.1 (modified) for Ra-226, Department of Energy (DOE) Environmental Measurements Laboratory (EML) HASL-300-U02 (modified) for alpha spectroscopy for isotopic U, and DOE EML HASL-300-Th-01 (modified) for isotopic Th.

To ensure that adequate detection sensitivity is achieved in the laboratory radiological analyses, site-specific soil DCGL values were compared to the required laboratory MDCs for the specified radioanalytical methods. This comparison, which is presented in Table 6-1 indicates that sensitivities of the particular laboratory analytical methods proposed for this project are considered sufficient to satisfy project analytical goals.

Table 6-1. Site-Specific DCGLs and Required Laboratory MDCs

RCOC	Analytical Method	Required MDC (pCi/g)	$DCGL_w$ (pCi/g)	$DCGL_{EMC}$ (pCi/g)
U-total	DOE EML HASL 300 U-02-RC mod	0.1	482	810
Ra-226	EPA 903.1 mod (Lucas Cell)	0.5	9	12
Th-230	DOE EML HASL 300 Th-01-RC mod	0.1	25	34
Th-232+D	DOE EML HASL 300 Th-01-RC mod	0.1	6	8

Laboratory radiological methods will follow procedures outlined in the laboratory QAP (LQAP), Appendix B to this Plan. These SOPs for systems operations and performance of processes include the following:

- Digestion for Alpha Isotopic Separation,
- Alpha Isotopic Analyses,
- Operation of the Alpha Spectroscopy System, and
- Evaluation of Quality Control Samples.

6.2 FIELD SCREENING FOR RADIONUCLIDES

Site soils and materials will be field-screened for radioactive content for two reasons:

- To select samples for laboratory radioanalysis, and
- To direct biased soil samples to site areas that may have levels of residual radioactivity in excess of the DCGLs.

Field screening for radionuclides will be performed by three methods, as described below.

6.2.1 Gross Gamma Walkover Surveys

Gross gamma walkover surveys (GWSs) will be performed to map relative levels of surface and near surface radioactive materials. GWSs at the Site will be performed using 3 x 3 NaI detector(s), coupled with ratemeter/scaler(s) and equipped with DGPS receiver/dataloggers, to collect geospatially correlated gamma count rate data. The GWS/data logging protocol will provide a minimum data density of one logged measurement per square meter of ground surface. The results of these measurements will provide data regarding elevated surface activities of detectable RCOCs. Gross gamma measurements provide readings, in units of counts per minute, which are proportional to the gamma fluence rate at the measurement locations. Although these measurements are quantitative in nature, detector readings are influenced by any gamma-emitting radionuclides and do not provide radionuclide-specific activity concentrations.

6.2.2 Downhole Gross Gamma Measurements

Downhole gross gamma surveys will be performed to map gamma count rate as a function of depth below ground surface (bgs). These screening surveys will be performed inside subsurface boring holes using a 1 x 1 NaI detector coupled to an appropriate ratemeter/scaler. The results of these measurements provide data regarding the potential for elevated subsurface activity concentrations. Gross gamma measurements provide readings, in units of counts per minute, which are proportional to the gamma fluence rate at the measurement locations. Although these measurements are quantitative in nature, detector readings are influenced by all gamma-emitting radionuclides that may be present and do not provide radionuclide-specific activity concentrations.

6.2.3 Onsite Gamma Spectroscopy Laboratory

Surface and subsurface soil samples will be analyzed at the Onsite Gamma Spectroscopy Laboratory, which will employ a high purity germanium (HPGe) coaxial detector, or equivalent. The HPGe gamma spectroscopy system will be used to provide field screening of volumetric samples. The system will include a HPGe detector with a ≥ 30% relative efficiency and lead shielding. System efficiency calibration will be either based on detector response to a NIST traceable standard or based on a mathematical calibration derived from instrument response to a NIST traceable standard. If a mathematical calibration is utilized, it will be verified in the field using a NIST traceable standard. System energy calibrations will be performed using a designated standard with known gamma energies.

Soil samples will be collected at selected locations in the Site survey units. Personnel collecting samples will ensure each sample is placed into a clean, unused container. Each sample will be labeled and annotated with the appropriate sample number, the sampler's name, the sampling date and time, the sample location and any applicable comments. For each single sample or related batch of samples, a sample chain-of-custody form will be filled out. The samples will be either individually listed or batch listed (by chain of custody form number) in the Project Logbook. Samples awaiting shipment to the contract off-site laboratory will be stored in a designated, secure location. Original chain-of-custody forms will remain with the samples to which they apply throughout their life cycle and will be annotated with the shipper's tracking number during times when they are in transit.

Following collection, these samples will be prepared for analysis in accordance with approved procedures by being heated in an oven for moisture removal, ground, and sieved, and subsequently transferred into one-liter marinelli containers prior to gamma spectroscopy analysis. The gamma spectroscopy system will be operated by a trained operator in accordance with standard operating procedures. The operator will perform spectral analysis during each measurement, which will encompass the evaluation of spectra for problems such as peak shift, high dead-time and other potential inconsistencies in spectral structure. A qualified Radiological Engineer will review the integrity of the sample analysis results for each sample. This review will encompass the analysis of sample results for spectral energy shift, agreement between progeny activities assumed to be in secular equilibrium, the presence of potentially unidentified radionuclides, potential source model inconsistencies, as well as other potential inconsistencies.

Count times will be long enough to achieve sufficient MDCs for each radionuclide to meet applicable Site action levels.

6.2.4 Spectroscopic Energy Lines

Site ROPCs may be quantified for activity concentrations directly via gamma decays, or inferred via gamma-emitting progeny, assuming a secular equilibrium state. Table 6-2 provides a list of gamma and x-ray emissions from the Site RCOCs that may be used for determining soil activity concentrations. The list is broken down into direct emissions from the RCOC itself or from its decay progeny which can be used to infer the parent's activity.

Table 6-2. Spectroscopic Gamma Energy Lines for Site RCOCs

RCOC	Direct / Inferred	Inferred Nuclide	Photon Emission (keV), *primary	Yield (%)	Sample HPGe MDA (pCi/g)[1]
Th-232	Inferred	Pb-212	238.6	43.3	0.04
		Ac-228	*911.2	25.8	0.1
Th-230	Direct	N/A	*12.3 (x-ray)	8.6	3.85
			67.6 (x-ray)	0.38	
Ra-226	Direct	N/A	*186.2	3.59	0.4
	Inferred	Bi-214	609.3	46.3,	0.05
		Pb-214	1764.5	15.8	0.04
			295.2, 351.9	19.2, 37.2	
U-238	Inferred	Th-234	*63.3	4.8	0.35
		Pa-234m	1001.0	0.84	2.70

1. The nuclide MDA values stated in the table are from a 1500g sugar background sample in a marinelli beaker counted for 20 minutes on CABRERA's 60% ReGE detector inside a lead cave. Actual Site MDAs will vary depending upon detector characteristics, count time, geometry, and activity content of samples.

Ra-226 may be measured directly by detection of its 186.2 keV energy line. However, it should be noted that the presence of U-235 can cause interference with direct Ra-226 detection since it has a gamma line of similar energy (185.7 keV). Should Ra-226 be encountered, the short-lived equilibrium daughters of radium may be used to determine radium-226 concentrations in the soil. Unfortunately, once the soil is disturbed, these short-lived daughters must be allowed to grow back in. The parent of these daughters, Rn-222, has a moderate half life of 3.8 days, therefore requiring at least two to three weeks of progeny ingrowth to reestablish equilibrium. Since the purpose of establishing the onsite laboratory is to obtain real time sample results to control excavation activities and enhance remediation decision making, this delay is not practical. The presence of U-235 will be determined via offsite analyses by alpha spectroscopy during the technology verification phase of the project. Uranium is not expected to be detected in significant quantities on this project. Thus, the only result from this issue may be minor over-reporting of Ra-226 during field screening.

Gamma spectroscopy will also identify other gamma emitting radionuclides that may be present in soils. CABRERA's Onsite Laboratory will use a gamma library compiled with data from the National Nuclear Data Center, which lists gamma energy yields for a full range of gamma emitting radionuclides. The data used to compile the library is updated through March 2002.

6.2.5 Onsite Laboratory Quality Assurance

Initial and daily calibrations of the Onsite Laboratory gamma spectroscopy system will be performed using a mixed-gamma NIST traceable source. System quality assurance will be ensured by tracking peak energy, peak resolution, and net peak area for a high and low energy peak, based on daily source counts. These quality assurance checks will be performed in accordance with applicable CABRERA quality control procedures. The procedures in question are included in

CABRERA's Nuclear Materials License and, as such, have been reviewed and found adequate by the NRC. Copies are available for inspection upon request. Instrument control charts will be generated and evaluated and will be included as part of the Final Report.

Gamma spectroscopy system quality assurance will be ensured by tracking peak energy, peak resolution, and net peak area for a high and low energy peak, based on daily counts of a designated source. This source will consist of Co-60 (for the high-energy peak at 1,332.5 keV) and a low energy gamma emitter (e.g., Am-241 at 59.54 keV, Cd-109 at 88.01 keV, etc.). These quality assurance checks will be performed in accordance with the instrument's standard operating procedure. Instrument control charts will be generated and evaluated in accordance with this procedure. QC data and each spectral data report will be reviewed by a qualified radiological engineer.

6.3 FIELD SCREENING FOR NON-RADIOLOGICAL CONSTITUENTS

As specified in the project SSHP (Cabrera 2005a), initial or continuous screening will be conducted for volatile organic vapors or other non-radiological constituents in the breathing zone as the field team engages in intrusive activities or any activities in areas where there is historical evidence of the presence of chemical contaminants. Instruments to be used for field screening during intrusive activities may be an organic vapor analyzer (OVA) or photoionization detector (PID). Daily calibration of these instruments according to the manufacturers' specifications will provide for sufficient accuracy in evaluating the potential health risks.

Because VOC levels can fluctuate considerably over the course of a day, ambient background measurements for VOCs will be recorded in the morning, mid-day, and afternoon, at a minimum. Background measurements will also be recorded if the weather or wind direction changes, or if there are significant changes in work activities near the background measurement location. More frequent background monitoring may be required if there is the potential for non-site organic contaminants nearby that could impact the evaluation of ambient background concentrations of site organic contaminants. Daily background measurements will be logged in the project/field logbook. Monitoring frequency and action levels are presented in the project SSHP.

6.4 PREVENTIVE MAINTENANCE

The primary objective of a preventive maintenance program is to promote the timely and effective completion of a measurement effort. The preventive maintenance is designed to minimize the downtime of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas.

- Establishment of maintenance responsibilities;
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus; and
- Establishment of an adequate inventory of critical spare parts and equipment.

The Contractor's inventory and primary calibration facility maintain sufficient radiological instrumentation redundancy that precludes the requirement for a repair and maintenance capability.

Maintenance and/or repair of equipment are performed by the equipment manufacturer or authorized representative under contract or purchase order.

6.4.1 Responsibilities and Procedures

Equipment and apparatus used in the Contractor's environmental measurement programs fall into two general categories:

- Equipment permanently assigned to a specific laboratory (e.g., alpha spectroscopy), and
- Field sampling equipment available for use on an as-needed basis (e.g., field meters).

Maintenance of laboratory instruments is the responsibility of the offsite laboratory. Generally, the laboratory manager or supervisor of a laboratory is responsible for the instruments and equipment in his or her work area. The laboratory manager will establish maintenance procedures and schedules for each major equipment item. This responsibility may be delegated to laboratory personnel, although the managers retain responsibility for ensuring adherence to prescribed protocol. Laboratories are bound by analytical contractual agreements to maintain the ability to produce data that meet the project objectives and to follow method specifications. This ensures that adequate spare parts, maintenance, schedules, and emergency repair services are available.

Maintenance responsibilities for field equipment and the Onsite Laboratory are assigned to the FSM. However, the field team using the equipment is responsible for checking the status of the equipment prior to use, and reporting any problems encountered. The field team is also responsible for ensuring that critical spare parts are included as part of the field equipment checklist and that non-operational field equipment is removed from service and a replacement obtained.

6.4.2 Field Equipment

As discussed in Section 6.5 of this QAPP, the field equipment will be properly calibrated, charged, and in good general working condition prior to the beginning of each working day. Maintenance and calibration of equipment prior to field use will be a prerequisite. As appropriate, field instruments will be maintained in accordance with manufacturers' specifications. When used, field test kits will be inspected and associated monitoring equipment will be maintained in accordance with manufacturers' specifications.

Field instruments and field test kits will be properly protected against inclement weather conditions during the field investigation. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative of the ranges that will be encountered during cold-weather working conditions. At the end of each working day, field equipment will be taken out of the field and placed in a cool, dry room for overnight storage. Field instrumentation and equipment maintenance, repair, and calibration procedures will be in accordance with the manufacturers' specifications.

Subcontractor equipment (e.g., drill rigs, water trucks, etc.) will arrive at the site each day in proper working condition. Lubrication, hydraulic, and motor oils will be checked by the subcontractor prior to the start of each working day to ensure that fluid reservoirs are full and that there are no leaks.

Prior to the start of each working day, the field task leads will also inspect equipment for fluid leaks.

6.4.3 Laboratory Equipment

6.4.3.1 Maintenance Schedules

The ability to generate valid analytical data requires that analytical instrumentation be properly maintained. The effectiveness of any maintenance program depends largely on adherence to specific maintenance schedules for each major equipment item. Other maintenance activities are conducted on an as-needed basis. Each laboratory will be responsible for maintaining service contracts or in-house service personnel for major instruments. These service contracts will not only provide for routine preventive maintenance, but also for emergency repair service. Manufacturers' recommendations will provide the primary basis for the established maintenance schedules, and manufacturers' service contracts will provide the primary maintenance for many major instruments (e.g., GC instruments and analytical balances). The elements of an effective maintenance program include the following, which are discussed in the ensuing subsections:

- Instrument maintenance logbooks,
- Instrument calibration and maintenance, and
- Available spare parts.

A guide of preventive maintenance procedures to be followed by the offsite laboratory is provided in the LQAP, Appendix B to this plan.

Preventive maintenance procedures will be developed for use where instructions are not provided in the manufacturer-supplied operator's manual. As applicable, each department will maintain a major equipment and measurement standards list. A record of instrument maintenance, calibration and repair, if applicable, will also be maintained. The supervisor and operating personnel are responsible for complying with department maintenance schedules.

6.4.3.2 Instrument Maintenance Logbooks

Each analytical instrument will be assigned an instrument logbook. Maintenance activities are to be recorded in the instrument logbook, and the information entered will include:

- Date of service,
- Person performing service,
- Type of service performed and reason for service,
- Replacement parts installed (if appropriate), and
- Miscellaneous information.

If service is performed by the manufacturer, a copy of the service record will be taped into the page facing the notebook page or filed separately where the above information is entered.

6.4.4 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. The inventory includes those parts (and supplies) that:

- Are subject to frequent failure,
- Have limited useful lifetimes, or
- Cannot be obtained in a timely manner should failure occur.

The CABRERA FSM and the GEL managers will be responsible for maintaining adequate field and laboratory inventories of instrumentation, equipment, and appropriate spare parts. The instrument operators have the responsibility, with the appropriate laboratory or field leader, to ensure that an acceptable inventory of spare parts is maintained.

6.5 CALIBRATION PROCEDURES AND FREQUENCY

This section contains brief descriptions of the analytical methods and calibration procedures for the field measurements that may be collected during the site activities. In cases where instruments not listed in this section are to be used, specific information on calibration and frequency for that instrument will be provided. Calibration procedures for field instrumentation are performed to ensure that the instruments are operating properly and produce data that can satisfy the objectives of the sampling program. These screening level data are used to monitor worker health and safety and to assist sample collection. Field instruments used for this program include:

- Instruments for measuring surface and subsurface radioactivity:
  - NaI detector(s) and ratemeter/scaler(s) for gamma walkover surveys (GWSs),
  - NaI detector(s) and ratemeter/scaler(s) for downhole gamma logging,
  - Two channel alpha/beta counting system (for performing gross alpha and beta counting of swipes and air samples), and
  - Geiger-Mueller (GM) detector and ratemeter for screening personnel and equipment for radiological contamination.
- DGPS receivers/data loggers for logging gamma walkover measurements and locating scan measurements.
- Real-time organic vapor monitoring instruments:
  - Photoionization detectors (PIDs), such as HNU®, organic vapor monitor (OVM), and Micro TIP®; and
  - Combustible gas meter.

While radiation detection instruments are not calibrated in the field, to ensure that some instruments are operating properly and are producing accurate and reliable data, routine operational QC checks will be performed prior to use and verified during use. Factory calibrations will be performed at a

frequency recommended by the manufacturer. At a minimum, factory calibrations of radiation detection instruments will be performed annually and after factory repair.

In cases where instrument calibration is performed in the field, calibration procedures will be provided to the field crew with the instrument. Prior to shipping the instruments, the PM or designee will confirm that these procedures are shipped with the instruments included with the equipment. Field calibrations will be performed/checked at the beginning of the day and at the end of the day, at a minimum. If field calibration reveals that the instrument is outside established accuracy limits, the instrument should be serviced in the field. If necessary, the instrument will be returned to the manufacturer for immediate repair and servicing. A backup instrument will be available for each of the critical real-time instruments used in the field. Calibration records will contain the following information:

- Instrument name and identification number,
- Name of person performing the calibration,
- Date of calibration,
- Calibration points,
- Results of the calibration,
- Manufacturer's lot number of the calibration standards, and
- Expiration dates for the field standards, where applicable.

The FSM or designee will inspect equipment to ensure its proper working condition prior to the beginning of each working day. Field equipment and instruments will be properly protected against inclement weather conditions during the field investigation. At the end of each working day, field equipment and instruments will be properly decontaminated, taken out of the field, and placed in a cool, dry room for overnight storage and charging, as appropriate to the instrument.

6.5.1 Radiation Detection Instrument Calibration and Field Checks

Instruments used during the survey will have current calibration/maintenance records kept on-site for review and inspection. The records will include, at a minimum, the following:

- Name of the equipment,
- Equipment identification (model and serial number),
- Manufacturer,
- Date of calibration, and
- Calibration due date.

Instrumentation shall be maintained and calibrated to manufacturers' specifications to ensure the instruments have the required traceability, sensitivity, accuracy, and precision. Instruments will be calibrated at a facility possessing appropriate NRC or Agreement State licenses for performing calibrations using National Institute of Standards and Technology (NIST) traceable sources. Instruments will be checked daily in order to ensure that the calibration is current (i.e., not expired).

Instruments will be operationally checked daily (i.e., QC or source checks) to ensure they respond in a consistent manner when exposed to known radiation sources. Records of daily source checks will be maintained and filed in the project file, along with control charts associated with each instrument. The following subsections describe initial setup and daily QC checks performed on each type of radiation detection instrument listed above.

6.5.1.1 NaI Detectors

NaI detectors will be used to measure gross gamma radiation levels during surface walkover surveys. These detectors will be used in conjunction with a ratemeter/scaler that reads out in counts per unit time. Prior to initial NaI detector use, ten source measurements will be made on a source representative of the gamma energy expected from radiological contaminants of potential concern. From the initial 10 source measurements, the mean of the observed count rate will be calculated. Thereafter, NaI detectors will be source-checked daily, with an acceptance criterion of ± 20% of the mean of the initial 10 source counts. Instrument response will be recorded and evaluated against that criterion. Instruments with response rates outside the ± 20% acceptance criterion will be removed from service.

6.5.1.2 GM Detectors

GM detectors will be used for routine gross beta/gamma contamination monitoring, These detectors will be used in conjunction with a ratemeter that reads out in counts per unit time. Prior to initial GM detector use, 10 source measurements will be made on a source representative of the gamma energy expected from radiological contaminants of potential concern. From the initial 10 source measurements, the mean of the observed count rate will be calculated. Thereafter, GM detectors will be source-checked daily, with an acceptance criterion of ± 20% of the mean of the initial 10 source counts. Instrument response will be recorded and evaluated against that criterion. Instruments with response rates outside the ± 20% acceptance criterion will be removed from service.

6.5.1.3 Alpha Beta Sample Counter

The alpha beta sample counter will be used to perform gross alpha and gross beta analyses on swipe samples and air samples as appropriate. The alpha beta counter will use either a solid scintillation or gas flow proportional detector, coupled to an appropriate dual-channel scaler instrument. Prior to initial alpha beta counter use, ten alpha background counts, ten beta background counts, ten alpha source counts, and ten beta source counts will be performed. The background counts will be used to calculate minimum detectable activity for the counter at various count times. The initial source checks will be used to calculate acceptance criteria for subsequent daily source checks. This calculation involves calculating the mean and standard deviation of both the alpha and beta initial source counts. The acceptance criteria for each channel will then be set at ± 2σ or 3σ from the mean, as described below.

Daily alpha and beta source checks will be performed and evaluated against these acceptance criteria. If an alpha beta counting system channel falls outside 2σ of the mean but is within 3σ of the mean, the source check may be repeated a single time. If the result is still outside 2σ, the

instrument will be removed from service. If a single source check falls outside 3σ, the channel will be removed from service. Results of both alpha and beta daily checks will be plotted on individual instrument control charts, which will be reviewed by a qualified radiological engineer.

6.5.2 DGPS System

By design, the DGPS unit does not require calibration, using data received from the satellite constellation to determine the precision and accuracy of its readings. To ensure the accuracy of DGPS measurements, daily satellite availability checks will be performed. Measurements will only be recorded when a minimum of five satellites are in view and the positional dependence of precision (PDOP) is less than four.

To provide additional QC for this system, the unit will be checked daily against a known calibration point. The calibration point will be selected upon commencement of fieldwork and will consist of a benchmark or monument of known location, if available. If no monument or benchmark is available, a stable site feature unlikely to move during the project (e.g., fencepost, pavement intersection, etc.) will be chosen. Prior to initial DGPS use, ten static positional readings will be obtained at the calibration point. From these positional readings, a mean position will be determined. This position will be expressed in units of northing/easting, latitude/longitude, or other equivalent unit. The position will also be referenced to a horizontal North American Datum (NAD). Thereafter, the DGPS unit will be checked against the calibration point at least daily. The acceptance criterion for DGPS daily checks will be within one meter of the calibration point. DGPS units exhibiting positional error in excess of one meter will be removed from service. Results of the daily checks will be recorded and posted to a DGPS control chart, which will be reviewed by a qualified engineer.

6.5.3 Real-Time Organic Vapor Monitoring Instrument Calibration

Real-time OVMs are routinely used to monitor total airborne organic vapors during field operations; measurements are used to evaluate worker health and safety. PPE requirements and site control decisions are based upon the results of real-time measurements. Real-time instruments also provide screening level data for VOC concentrations in drill cuttings, soil boring samples, and groundwater wells. It is anticipated that a photoionization detector (PID) will be utilized in the field for this project. The calibration frequency for a PID is presented in the following subsection. Due to the rigors of field use, backup instruments will be available for the duration of the project. Detailed procedures for calibration and operation of these instruments are available from the distributors.

6.5.4 Photoionization Detector

PIDs can measure total organic vapors and are highly sensitive to aromatic compounds, moderately sensitive to unsaturated chlorinated compounds, and less sensitive to aliphatic hydrocarbons. The instrument can respond to organic compounds with ionization potentials (IPs) less than the rated electron voltage (eV) of the ultraviolet (UV) bulb in the unit. Due to its longevity and range of detectable contaminants, the most frequently used UV bulb is a 10.2 eV. Other bulbs are available from the manufacturer (e.g., 9.5 eV, and 11.7 eV). Field personnel will know which bulb is installed in the unit to ensure that the instrument is capable of detecting the particular contaminant of interest.

Several manufacturers produce instruments with PIDs for field monitoring of airborne VOCs. The more common PIDs are HNU® Systems (PI-101), Thermo Environmental OVM (580 B), and Photovac MicroTIP® (Total Ionizables Present). The manufacturer's calibration requirements for the specific instrument in use will be followed. General guidelines for PID calibration include:

- Factory service and calibration once per year.
- For the HNU Systems PI-101, three-point calibration on a quarterly basis using UHP air and two representative concentrations of isobutylene-in-air standards.
- For any PID instrument, a two-point calibration prior to daily use (UHP air and a representative concentration of isobutylene in air standard).
- Single-point calibration at the end of each day of use.

6.5.5 Laboratory Equipment and Calibration

This subsection provides the general requirements for calibration of measuring and test equipment and instruments used in laboratory analysis. This program is designed to ensure that instruments are calibrated to operate within manufacturers' specifications and that the required traceability, sensitivity, and precision of the equipment/instruments are maintained. Measurements that affect the quality of an item or activity will be taken only with instruments, tools, gauges, or other measuring devices that are accurate, controlled, calibrated, adjusted, and maintained at predetermined intervals to ensure the specified level of precision and accuracy.

Before any instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. Sample measurements will be performed within the calibrated range of the instrument. Preparation of reference materials used for calibration will be documented in a laboratory notebook.

Laboratory instrument calibration typically consists of two types: initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. The instrument response over that range is expressed as a correlation coefficient.

Continuing calibration usually includes measurement of the instrument response to fewer calibration standards and requires instrument response to compare certain limits (e.g., 10%) of the initial measured instrument response. Continuing calibration may be used within an analytical sequence to verify stable calibration throughout the sequence and/or to demonstrate that instrument response did not drift during a period of nonuse.

The following subsections present calibration procedures for the following instruments:

- HPGe gamma spectrometer,
- Alpha spectrometer,
- Balances, and

- Thermometers.

Note: Alternative procedures used as specified in the instrument calibration procedures for various instruments used in the laboratory, which are not in this QAPP, will be provided in the laboratory's LQAP.

6.5.5.1 HPGe Gamma Spectrometer

Prior to counting samples, the detector and associated electronics must be energy- and efficiency-calibrated. Energy calibration is performed by counting a radioactive source containing known gamma ray emitting radionuclides, at a fixed amplifier gain. An energy calibration factor is then generated by determining the channel numbers corresponding to full energy peak centroids from gamma rays emitted over the full energy range of interest from multi-peaked and/or multi-nuclide radioactivity sources. Efficiency calibration is accomplished by counting a calibrated source of a particular geometry at a reproducible source-to-detector orientation. The measured emission rate of the calibration standard is then compared to the actual disintegration rate to determine the detector counting efficiency. The values for energy and efficiency calibration are maintained in configuration files, which are referenced when analyzing samples.

6.5.5.2 Alpha Spectrometer

Alpha spectrometers are calibrated per the laboratory's applicable SOPs. Alpha spectrometer calibrations consist of a weekly energy and efficiency calibration and daily pulser checks. Alpha calibration standards are counted once each calendar week while in use to update the detector energy and efficiency calibrations. Pulser checks are performed daily prior to counting samples to verify the proper operation of the detectors. Peak centroid, peak energy pulser count rate, and peak full width at half maximum (FWHM) are monitored and stored in quality assurance files.

6.5.5.3 Balances

Laboratory balances will be calibrated and serviced annually by a qualified service technician. Calibration of the balances will be verified daily against three NIST traceable Class S-certified weights. The Class S weights used by the analysts for the daily balance checks will be calibrated annually by a qualified service technician. The calibration of the balances will be verified at the masses that bracket the measurements performed on the balances. Acceptance criteria will be clearly identified in the balance log. A maximum performance criterion of ±1% will be applied to top-loading balances, and ±0.1% to analytical balances.

6.5.5.4 Thermometers

Oven and refrigerator thermometers will be calibrated annually against a NIST-certified thermometer in the range of interest. Annual calibrations will be recorded in a calibration notebook. Daily readings will be recorded from the respective oven or refrigerator.

6.5.5.5 Records

Records will be maintained as evidence of required calibration frequencies, and equipment will be marked suitably to indicate calibration status. If marking on the equipment is not possible, records traceable to the equipment will be readily available for reference.

6.6 LABORATORY/FIELD QC PROCEDURES

Internal quality control is achieved by collecting and/or analyzing a series of QC samples including duplicate, replicate, blank, spike, and spike duplicate samples to ensure that the analytical results are within quality control limits specified by the program. QC samples will be used to assess laboratory performance and gauge the likelihood of cross-contamination associated with both field and laboratory activities. QC samples will be collected and analyzed only in conjunction with samples designated for laboratory analysis. QC samples will not be collected for samples to be analyzed by field test kits since these results will be verified using off-site laboratory analysis. The QC sample results are used to quantify precision and accuracy and identify any problems or limitations associated with sample results.

Standard analytical QC checks to be instituted by field and laboratory personnel include, but are not limited to, the following:

- Swipe samples,
- Field duplicate samples,
- Matrix spike/matrix spike duplicates (MS/MSDs),
- Method blanks,
- Laboratory control samples (LCS), and
- Laboratory duplicates.

These types of samples are discussed in the following subsections. QC samples will be submitted to the laboratory using the same information as routine samples but identified in a way that does not readily identify them to the laboratory as QC samples.

6.6.1 Field Quality Control

Field QC samples will be documented in field logbooks and submitted "blind" to the laboratory, so that the laboratory cannot distinguish between natural and QC samples during analysis. These components of the sampling program will ensure that data of known quality are produced throughout the sampling and analysis component of field programs.

The QA goals for the program are to eliminate or minimize the potential for inconsistencies in protocols, including the field protocols themselves, which can introduce error into the data collection process. To achieve this goal, SOPs have been developed and will be followed by field personnel as consistently as possible given the variability of natural conditions encountered in the field. The FSM will monitor the field implementation of the SOPs. Any deviation from SOPs

necessitated by unanticipated field conditions will be fully documented as they occur and reported to the PM.

Field QC checks have been introduced into the sample collection procedures to identify and minimize the potential for interference or introduction of non-environmental contaminants during sample collection, storage, transport, and/or equipment decontamination. These checks are provided through the collection of field QC samples.

6.6.2 Analytical Sequence QC

Laboratory QC is necessary to control the analytical process, to assess the accuracy and precision of analytical results, and to identify likely causes for atypical analytical results. The QC checks in the laboratory are specific to the analytical method and generally include the use of the following QC samples as appropriate for the method.

Details of the off-site analytical laboratory QC are described in GEL's LQAP (see Appendix B). In general, internal laboratory QC checks will consist of the following:

- Instrument performance checks,
- Instrument calibration,
- Retrieval of documentation pertaining to instrument standards, samples, and data,
- Documentation of sample preservation and transport and analytical methodology, and
- Analysis of QC samples.

6.6.3 Batch/Matrix-Specific/Performance-Based QC

Quality control samples will be collected and analyzed as stated below. The frequency of sample collection will be as specified below and in Table 5-1, or as otherwise stated in the Site FSP.

6.6.3.1 Field Quality Control Samples

6.6.3.1.1 Swipe Samples

Swipe samples will be substituted for reagent water for radiological assessment on sampling equipment. Swipe samples will be obtained on the same frequency stated above, and will be analyzed for gross alpha and gross beta radiation in the field swipe counter.

6.6.3.1.2 Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. Field duplicates are handled as co-located individual samples with no mixing or homogenization prior to analysis. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Duplicate samples will be collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. One field duplicate

will be collected at a frequency of no less than 5%, or one per a maximum of 20 investigative samples.

6.6.3.1.3 USACE QA Split Samples

USACE QA split samples will also be collected for radiological QA purposes and sent to Severn Trent Laboratories (STL) in St. Louis, Missouri in accordance with the *USACE Radiological Quality Assurance for the Painesville FUSRAP Site* (see Appendix E). The sample material contained in the sampling device will be homogenized and split between the appropriate containers for each sample analysis parameter. The USACE QA splits will be collected at a frequency of 5%, or one per 20 investigative samples, but with the total number of duplicate samples not to exceed 20. Duplicates will be analyzed for the same sample parameters specified for the investigative sample.

6.6.3.2 Laboratory Quality Control Samples

6.6.3.2.1 Matrix Spike/Matrix Spike Duplicates (MS/MSDs)

MS/MSDs are samples in which known amounts of compounds are added in the laboratory before extraction and analysis. Two aliquots of the sample are spiked for the duplicate analysis. The results of the duplicate spiked samples are used to measure the percent recovery of each spiked compound and compare the recovery between samples, which provides estimates of the accuracy and precision of the method. The solution of target analytes in matrix spikes for organic analyses is based on SW-846 methods and does not include target analytes, but is rather a representative subset. When reviewed in conjunction with other QC data, MS/MSD data may indicate the need for reanalysis using a more appropriate method. MS/MSD analyses will be performed using project matrices. For each matrix type, at least one spiked set of MS/MSDs will be analyzed for each batch of samples for every 20 (or less) samples received. The MS/MSD portion of the sample will be collected in a separate container from the routine sample to provide sufficient sample volume and to allow for the assessment of unspiked results for field precision.

6.6.3.2.2 Laboratory Method Blanks

Method blank results indicate laboratory control of interferences from the analytical system, reagents, and glassware on sample results. The likelihood of radiological contamination being attributable to laboratory sources is minimal. However, method blanks for radiological analyses will be performed at a frequency of one per sample extraction/analytical batch to detect or account for instrument responses to other types of interference.

6.6.3.2.3 Laboratory Control Samples

Laboratory control/check samples are laboratory certified samples that are fortified (spiked) with the analyte of interest and analyzed with the associated sample batch. It is spiked usually in the mid-calibration range and is selected based on the sample matrix (solid or liquid). These samples are used to demonstrate that the instrument and the method are operating within acceptable accuracy limits and that the analytical system is in control. LCS are required for analytical methods performed in the laboratory, and their preparation and the required frequency of analysis is

described in each analytical SOP. For each matrix type, at least one set of LCSs will be analyzed for each batch of samples for every 20 (or less) samples received.

6.6.3.2.4 Laboratory Duplicate Samples

Laboratory duplicates are repeated but independent determinations of the same sample, by the same analyst, at essentially the same time, and under the same conditions. Duplicate samples are obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. The analysis of laboratory duplicate samples monitors precision; however, it may be affected by sample inhomogeneity, particularly in the case of nonaqueous samples. A laboratory duplicate will be run at a frequency of no more than one for every 20 field samples.

6.6.3.3 Calibration Standards

Initial calibration is performed as required for each analytical method, usually using a range of calibration standards with the low standard near the detection limit for the compound. These standards are used to determine the linear dynamic range for the initial instrument calibration. EPA, NIST, or other approved standards will be used when possible. Calibration is discussed in more detail in Section 6.5 of this QAPP.

6.6.4 Control Limits

The radiological control limits and acceptance criteria are presented in Table 6-3 and Table 6-4. The corrective action activities listed in the tables are to be used as guidelines and are not necessarily followed in the order listed. The primary intent of these guidelines is to identify any problems and correct the problem before proceeding. The offsite laboratory may follow alternative corrective action in accordance with their LQAP (see Appendix B).

6.6.5 Reporting Checks

After validated laboratory data have been made available, the data will be compiled into tables for the report to facilitate the assessment of results. An independent check of the data entered into these tables will be performed for accuracy and completeness, and corrections will be made as necessary as discussed in Sections 6.8 and 9.1 of this QAPP.

6.7 PERFORMANCE AND SYSTEM AUDITS

A QA audit is an independent appraisal of a measurement system. It typically includes a performance evaluation using apparatus and/or standards that are different from those used in the measurement system. It also may include an evaluation of the potential of the system to produce data of adequate quality to satisfy the objectives of the measurement efforts. The independent, objective nature of the audit requires that the auditor be functionally independent of the sampling/analytical team.

QA audits play an important role in an overall QA/QC program. Audits may consist of two types: system audits and performance audits. The purpose of a system audit is to determine whether appropriate program systems are in place. A performance audit is used to indicate whether those

systems are properly functioning. This section describes the role of the Corporate QAC, who conducts the audits, and the nature of both system and performance audits.

6.7.1 Quality Assurance Coordinator

The QAC is the person who designs and/or performs QA systems and performance audits. Since QA audits represent, by definition, independent assessments of a measurement system and associated data quality, the auditor must be functionally independent of the measurement effort to ensure objectivity. However, the auditor is experienced with the objectives, principles, and procedures of the measurement efforts to perform a thorough and effective evaluation of the measurement system. The auditor's technical background and experience provide a basis for appropriate audit standard selection, audit design, and data interpretation. Especially important is the ability to identify components of the system that are critical to overall data quality, so that the audit focuses heavily upon these elements. The auditor also has writing skills sufficient to clearly document the findings and recommendations of the audit. The function of the QA auditor is to:

- Observe procedures and techniques in use in the various measurement efforts, including field sampling and analysis;
- Check and verify instrument calibration records;
- Assess the effectiveness of and adherence to the prescribed QC procedures;
- Review document control and COC procedures;
- Submit audit samples of comparable composition as those being tested for analysis;
- Review the malfunction reporting procedures;
- Identify and correct any weaknesses in the sampling/analytical approach and techniques;
- Assess the overall data quality of the various sampling/analytical systems; and
- Challenge the various measurement systems with certified audit standards.

6.7.2 Project System Audits

The QA auditor may, on an announced or unannounced basis, call for a corporate project audit (system audit). The PM will respond by submitting this project QAPP and the project QCP. The auditor will determine if the QAPP and QCP are in place functionally and whether the required reviews have been and are being conducted. Certain projects may be identified for a more formal audit. These audits will involve an in-depth evaluation of the implementation of the QAPP for the project as they apply to field and data analysis and reduction procedures.

6.7.3 Technical Performance Audits

Technical performance audits will be performed on an ongoing basis during the project as field data are generated, reduced, and analyzed. Numerical analyses, including manual calculations, mapping, and computer modeling, will be documented and will be the subject of performance audits in the form of QC review, numerical analysis, and peer review. Records of numerical analyses will be

legible, reproduction quality, and complete enough to permit logical reconstruction by a qualified individual other than the originator.

6.7.4 Field Audits

In accordance with CABRERA radiological SOP AP-004, *Radiological Compliance Audits*, periodic in-field performance audits may be conducted by the QA auditor, or designee, for the particular discipline of field activities. The purpose of field audits is to ensure that the methods and protocols detailed in this QAPP and the SOPs are being consistently adhered to in the field. Prior to an audit, the QA auditor will prepare checklists to ensure completeness of the review and to document the results of the audit. Items to be examined may include, as appropriate:

- The availability and implementation of approved work procedures;
- Calibration and operation of equipment;
- Packaging, storage, and shipping of samples obtained; and
- Documentation procedures.

The records of field operations will be reviewed to verify that field-related activities were performed in accordance with appropriate project procedures. Items reviewed would include, but not be limited to:

- The calibration records of field equipment,
- Daily field activity logs,
- COC documentation, and
- Field logs.

During an audit and upon its completion, the auditors will discuss the findings with the individuals audited and cite any corrective actions to be initiated. Findings will be noted on the audit checklist and the results provided to the CABRERA PM and the USACE Project Engineer. The CABRERA PM will ensure that the corrective actions are implemented.

6.7.5 Laboratory Audits

The laboratory internal audit protocols are described in the laboratory QAPP. The LQAC will audit the performance of the laboratory on this project as part of internal laboratory audits. The audit will consist of a review of systems, procedures, and documentation. Any deficiencies/deviations will be documented, and a summary report prepared.

The laboratory will participate in external performance audits, if initiated by USACE. These performance audits may be in the form of laboratory tours and procedure or recordkeeping reviews, or in the form of blind performance samples submitted by the field crews. Details of the external performance audits will be specified by USACE.

In addition, the EPA may conduct announced or unannounced audits of the laboratory. Written reports on the results of these audits will be distributed to the USACE Project Engineer and the CABRERA PM.

6.8 NON-CONFORMANCE/CORRECTIVE ACTIONS

During the course of the Site project, it is the responsibility of the CABRERA PM, QAC, FSM, and the sampling team members to see that measurement procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event that a problem arises, it is imperative that prompt action be taken to correct the problem(s).

Problems or questions about field or analytical data quality that may require corrective action are documented by the FSM and reported to the QAC. Corrective actions may be required if QC results exceed method or project criteria, reporting or flagging errors are identified, or requested information has not been reported. Laboratory response usually involves a written explanation of the problem or reissuing laboratory reports and/or electronic data files. If significant data quality problems have occurred and the data are critical to decision making, samples may be reanalyzed or recollected and reanalyzed. That determination must be made by the CABRERA PM in association with the QAC, Project Health Physicist, and through discussions with the USACE project staff.

6.8.1 Field Activities

The initial responsibility for monitoring the quality of field measurements and observations lies with the field personnel. The FSM is responsible for verifying that QC procedures are followed. This requires that the FSM assess the correctness of field methods and the ability to meet QA objectives. Any non-conformance with established procedures presented in the project plans will be identified and corrected. The CABRERA PM will be notified and will be responsible for issuing a non-conformance report for each non-conforming condition. In addition, corrective actions will be implemented and documented in the appropriate field logbook. Non-conforming conditions include:

- Improper instrument calibrations or operational checks,
- Improper survey or sampling procedures, and
- Physical or documentation discrepancies with samples upon receipt at the laboratory.

The CABRERA PM shall be notified in the event discrepancies are discovered by field personnel, during a desk or field audit, by the independent QA laboratory, or during data assessment. The CABRERA PM will immediately suspend applicable survey operations until the extent of the discrepancy and its impact on the accuracy and the validity of the survey data can be assessed. The cause of the discrepancy will be identified and corrective actions, such as procedure revisions or personnel retraining, will be instituted to prevent a reoccurrence. If necessary, re-surveys or re-sampling will be performed to correct the discrepancy. The CABRERA PM will notify the USACE PE of the identified problem, corrective action(s), and the impact on the overall project.

6.8.2 Laboratory Analyses

The responsibility to monitor the quality of the analytical system lies with the offsite laboratory. The laboratory will verify that QC procedures are followed and that the results of analysis of QC samples are within the acceptance criteria. This requires that the laboratory assess the correctness of the following items, as appropriate:

- Sample preparation procedures,
- Initial calibrations and calibration verifications,
- Method blank results,
- Laboratory control standards,
- Laboratory duplicate analyses, and
- MS/MSD results.

If the assessment reveals that any of the QC acceptance criteria are not met, the laboratory must immediately assess the analytical system to correct the problem. The analyst will notify the Laboratory Section Manager and LQAC of the problem and, if possible, will identify potential causes and corrective action.

The nature of the corrective action obviously depends on the nature of the problem. For example, if continuing calibration verification is determined to be out of control, the corrective action may require recalibration of the analytical system and reanalysis of all samples since the last acceptable continuing calibration standard.

When the appropriate corrective action measures have been defined and the analytical system is determined to be "in control," the analyst documents the problem, the corrective action, and the data demonstrating that the analytical system is in control. Copies of the documentation are provided to the Lab Section Manager for inclusion in the narrative.

Data generated concurrently with an out-of-control system will be evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results, data will be reported and the deficiency noted in the case narrative. Where sample results are impaired, the Laboratory Project Manager or Group Leader will be notified and appropriate corrective action (e.g., reanalysis) will be taken.

The approach to corrective action procedures for individual analyses will be based on the recommendations included in the specific analytical protocol and the offsite laboratory's LQAP/SOPs.

6.8.3 Corrective Action Report

The CABRERA PM, QAC, or other project team members will initiate a corrective action request in the event that QC results exceed acceptability limits, or upon identification of some other problem or potential problem. Method-specified responses are presented in Section 6.6. Problems such as these will be followed up by the PM and QAC. Corrective action may also be initiated by the QAC

based on QC data or audit results. Corrective actions may include the use of data qualifier flags, reanalysis of the sample or samples affected, resampling and reanalysis, and recommending a change in procedures, depending on the severity of the problem. Problems that require corrective action are documented by the use of a Corrective Action Report (CAR).

6.8.4 Recommendations for Corrective Action

A system for issuing formal Recommendations for Corrective Action (RCAs) will be established to address significant and systematic deficiencies identified during audits or other independent QA reviews of field and laboratory procedures. The specific procedures and structure of corrective action systems vary among suppliers, but the system will provide structure and formats for:

- Recommendations issued by the QAC or Project Health Physicist;
- Requests to address specific problems or deficiencies identified during QA audits of laboratory or field operations;
- A specific, recommended time frame for response and implementation of corrective actions; and
- If satisfactory resolution is not obtained, requests to higher levels of management until a corrective action is agreed upon, or until another response is deemed sufficient.

RCAs will be issued only by a member of the QA Group, or by their designee in a specific role. Each RCA will address a specific problem or deficiency, usually identified during QA audits of laboratory or project operation (Section 6.7). Although the RCA system (and form) provides for distinguishing among problems of different urgency, RCAs are typically issued only to address significant, systematic deficiencies. Each of these formal written recommendations requires a written response from the responsible party (i.e., to whom the RCA was issued). A system exists to track these RCAs and their corresponding responses. On a monthly basis, a summary of the "unresolved" RCAs is prepared by the QA Group and issued to management. These reports list RCAs that have been issued to the work areas that each manager is responsible for and the current status of each. Each RCA response requires verification by the QA Group that the corrective action has been implemented before the status is changed in the monthly report. In the event that there is no response to the RCA within 30 days, or if the corrective action is disputed, the recommendation and/or conflict is pursued to successively higher management levels until the issue is resolved.

Table 6-3. Quality Control Acceptance Criteria

Parameter	MS/MSD		LCS/LCSD	
	Accuracy (% Recovery)	Precision[1] (RPD)	Accuracy (% Recovery)	Precision[1] (RPD)
Isotopic Uranium	70-130	30	70-130	30
Isotopic Thorium	70-130	30	70-130	30
Radium-226	70-130	30	70-130	30

[1] at 50% of the criterion value.
RPD = Relative percent difference
MS/MSD = Matrix Spike/Matrix Spike Duplicate
LCS/LCSD = Laboratory Control Sample/Laboratory Control Sample Duplicate
NA = Not applicable

Table 6-4. Summary of Laboratory Calibration and Internal Quality Control Procedures

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
Offsite Laboratory					
DOE HASL-300 U-02-RC (modified) / DOE HASL-300 Th-01-RC (modified)	Isotopic Uranium & Isotopic Thorium	Efficiency/ Background Check	Daily	Investigation Level: average response ± 2 sigma. Action Level: average response ± 3 sigma.	1. Repeat check if failure is greater than investigation level but less than action level. If second check exceeds investigation level, remove from service and contact the lab PM. 2. If check exceeds action level, remove from service and contact Lab PM.
		LCS	One per batch of ≤ 20 samples, per day, not to exceed 20 samples	Recovery within QC Acceptance Criteria in Table 6-3.	1. Accuracy: a. If recoveries are out in both the LCS and LCSD, stop and correct problem. Contact the LAB PM for instructions on reanalysis or repreparation. b. If the result is out in either the LCS or LCSD, check the calibration. If the recoveries for the calibration are acceptable, proceed with analyses. If results are still out, stop and correct instrument problem. Contact the Lab PM for instructions on reanalysis or repreparation. 2. Precision: Demonstrate acceptable RPDs for analyses that failed by analyzing a 3rd LCS. If RPDs between the 3rd and either LCS or LCSD are acceptable, proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem. Contact the Lab PM for approval to proceed, write CAR.
		MS/MS Duplicate (if required)	One per batch of ≤ 20 samples, per day, not to exceed 20 samples	QC Acceptance Criteria in Table 6-3.	1. If either MS or MSD is outside of either accuracy or precision tolerances and LCS/ LCSD results are acceptable, then flag MS/ MSD results and write CAR 2. Contact Lab PM to determine if special measures should be performed in an attempt to resolve matrix interferences.

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
DOE HASL-300 U-02-RC (modified) / DOE HASL-300 Th-01-RC (modified), (cont'd)	Isotopic Uranium & Isotopic Thorium (cont'd.)	Method Blanks	1 per extraction batch and analytical batch	1. <MDC 2. Must meet surrogate criteria	1. If sample concentration is <MDC or if sample concentration is >10 times the concentration in the method blank, then report results and write CAR; 2. Otherwise, reextract/reanalyze if still within HT and enough sample volume; if not within HT or enough sample, contact Lab PM for decision.
		Laboratory Duplicate	One per batch of ≤ 20 samples, per day, not to exceed 20 samples.	Zrep ≤ 2	Flag data. Discuss in Case Narrative.
EPA 903.1M	Ra-226 via Lucas Cell	Efficiency Check	Daily	Investigation Level: average ± 2 sigma. Action Level: average ± 3 sigma.	1. Repeat check if failure is greater than investigation level but less than action level. If second check exceeds investigation level, remove from service and contact Lab PM. 2. If check exceeds action level, remove from service and contact Lab PM.
		Background Assessment	Weekly	Bounds test established internally at laboratory	1. Perform decontamination on detector, shielding, and associated equipment. 2. Re-perform check. If check exceeds action level, remove from service and contact Lab PM

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
EPA 903.1M (cont'd)	Ra-226 via Lucas Cell (cont'd)	LCS	One per batch of ≤ 20 samples, per day, not to exceed 20 samples.	Recovery within QC Acceptance Criteria in Table 6-3.	1.Accuracy: a. If recoveries are out in both the LCS and LCSD, stop and correct problem. Contact the Lab PM for instructions on reanalysis or repreparation. b. If the result is out in either the LCS or LCSD, check the calibration. If the recoveries for the calibration are acceptable, proceed with analyses. If results are still out, stop and correct instrument problem. Contact the Lab PM for instructions on reanalysis or repreparation. 2. Precision: Demonstrate acceptable RPDs for analyses that failed by analyzing a 3rd LCS. If RPDs between the 3rd and either LCS or LCSD are acceptable, proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem. Contact the Lab PM for approval to proceed, write CAR.
		Method Blanks	1 per extraction batch and analytical batch	1. <MDC 2. Must meet surrogate criteria	1. If sample concentration is <MDC or if sample concentration is >10 times the concentration in the method blank, then report results and write CAR; 2. Otherwise, reextract/reanalyze if still within HT and enough sample volume; if not within HT or enough sample, contact Lab PM for decision.
		Laboratory Duplicate	One per batch of ≤ 20 samples, per day, not to exceed 20 samples.	Investigation Level: Zrep ≤ 2	Flag data. Discuss in Case Narrative.
Onsite Laboratory					
EPA 901.1	Gamma Spectroscopy	Efficiency/ Resolution Check	Daily	Investigation Level: Avg ±2 sigma Action Level: Avg ±3 sigma	1. Repeat check if measurement is greater than Investigation Level (IL) but less than Action Level (AL). If second check > IL, remove from service and contact Cabrera PM or FSM. 2. If check exceeds AL, remove from service and contact Cabrera PM or FSM.

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
		Energy Calibration Check	Daily	Peak Centroid ≤ 1 keV from actual energy	Remove from service and contact Cabrera PM or FSM.
		Background Assessment	Weekly	Bounds test established internally at laboratory	1. Perform decontamination on detector, shielding, and associated equipment 2. Re-perform check. If check exceeds AL, remove from service and contact Cabrera PM or FSM.
		Laboratory Duplicate	One per batch of ≤ 20 samples, not to exceed a total of 20.	Investigation Level: Zrep ≤ 2 Action Level: Zrep ≤ 3	1. If Zrep ≥ 2, flag data (see Table 9-1) and note in sample documentation. 2. If Zrep ≥ 3, contact Cabrera PM or FSM to investigate.

[a] Corrective actions associated with project work shall be documented and the records maintained by the laboratory.

CAR = Corrective Action Report
HT = Holding Time
LAB PM = Laboratory Project Manager
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
MSD = Matrix Spike Duplicate
QC = Quality Control
QL = Quantitation Limit
RPD = Relative Percent Difference
RF = Response Factor
Zrep = Replicate Z-Score
RT = Retention Time

Note: Analyses of field and laboratory duplicates will be compared to the initial analytical results by calculating a Z-score value for each data set by the following equation:

$$Z_{Rep} = \frac{|Sample - Duplicate|}{\sqrt{\sigma^2_{Sample} + \sigma^2_{Duplicate}}}$$

Where: Sample = first sample value (original),
Duplicate = second sample value (duplicate),
σ_{Sample} = 2 sigma TPU of the sample, and
$\sigma_{Duplicate}$ = 2 sigma TPU of the duplicate.

The calculated Zrep results will be compared to a performance criteria of less than or equal to 2. Calculated Zrep values less than 2 will be considered acceptable and values greater than 2 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- The sample measurement and duplicate or replicate measurement are of the same normally distributed population.
- The standard deviations, σ_{Sample} and $\sigma_{Duplicate}$, represent the true standard deviation of the measured population.

7.0 DATA REDUCTION/CALCULATION OF DATA QUALITY INDICATORS

The evaluation/assessment of measurement data is required to ensure that the QA objectives for the program are met and that quantitative measures of data quality are provided. The data evaluation procedures, calculations and applications used for this project are based on the *Guidance for Data Quality Assessment Process: Practical Methods for Data Analysis (QA/G-9),* (EPA, 2000b).

There is a distinction between routine quality control and data assessment that are conducted as a part of laboratory operations, and the project-related data assessment process conducted after the data have been reported. It is assumed that the planning, standard procedures, and monitoring activities conducted during the sampling and analysis process serve to control the process as much as possible to produce data of sufficient quality for project needs. After the data are reported, any part of the process that could not be controlled, and to what extent that may affect the quality of the reported data, will be identified.

The routine quality control procedures conducted in the laboratory are established in the published methods, this document, and the analytical SOPs. The laboratory is responsible for following those procedures and operating the analytical systems within statistical control limits. These procedures include proper instrument maintenance, calibration and continuing calibration checks, and internal quality control sample analyses at the required frequencies (i.e., method blanks, MS/MSDS, laboratory duplicates). One of the additional ongoing data assessment processes is maintaining control charts for representative QC sample analyses to monitor system performance. This provides verification that the system is in statistical control, and indicates when performance problems occur, so the problems can be corrected as soon as possible. When reporting the sample data, the laboratory will provide the results of associated QC sample analyses so the project staff can evaluate the performance of the analytical process.

Problems with analytical data often occur in spite of precautions taken in planning and execution of the sampling and analysis task. In these cases, the data assessment conducted by the project QA staff after the data have been reported will identify the problem, determine which data are affected, state how these data may be limited for use in the intended applications, and make recommendations for corrective actions as necessary.

The discussion of data assessment presented in this section pertains to the project-related assessment of data that is performed after data have been reported and laboratory analyses have been completed. Data assessment procedures that will be performed for the Painesville FUSRAP Site project include:

- Initial review of analytical and field data for complete and accurate documentation, holding time compliance, and required frequency of QC samples;
- Evaluation of blank results to identify systematic contamination;
- Statistical calculations for accuracy and precision using the appropriate quality control sample results;
- Estimates of completeness, in terms of the percent of valid unqualified data; and

- Assigning data qualifier flags to the data as necessary to reflect limitations identified by the process.

Qualified data will be discussed in the task reports, and data flags can be transmitted to users via data tables from the database and in analytical data reports.

7.1 FORMULAS

Several of the data validation acceptance criteria involve specific calculations. The appropriate formulas are presented below.

7.1.1 Instrument Response Linearity (Calibration)

Acceptance criteria for certain non-radiological instrument response linearity checks are based upon the correlation coefficient, r, of the best-fit line for the calibration data points. The correlation coefficient reflects the linearity of response to the calibration standards and is calculated as:

$$r = \frac{n\sum(xy) - \left(\sum x\right)\left(\sum y\right)}{\sqrt{\left[n\left(\sum x^2\right) - \left(\sum x\right)^2\right]\left[n\left(\sum y^2\right) - \left(\sum y\right)^2\right]}}$$

where:

x	=	Calibration concentrations;
y	=	Instrument response (peak area); and
n	=	Number of calibration points (x, y data pairs)

7.1.2 Precision

The degree of agreement between the numerical values of a set of duplicate samples performed in an identical fashion constitutes the precision of the measurement. During the collection of data using field methods and/or instruments, precision is checked by reporting measurements at one location and comparing results. The measurements are considered sufficiently precise only if the values are within a specified percentage of each other. Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified for calibration and internal QC checks are based upon precision.

Analyses of field and laboratory duplicates for radiological sample analyses will be compared to the initial radioanalytical results by determining a Replicate Z-score (Z_{Rep}) value for each data set by the following equation taken from Chapter 18 of the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP, EPA 2004):

$$Z_{\mathrm{Re}\,p} = \frac{\left|(Sample - Duplicate)\right|}{\sqrt{\sigma^2{}_{Sample} + \sigma^2{}_{Duplicate}}}$$

Where:

Sample	=	first sample value (original)
Duplicate	=	second sample value (duplicate)
σ_{sample}	=	TPU of the sample
$\sigma_{duplicate}$	=	TPU of the duplicate

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified for calibration and internal QC checks for non-radiological analyses are based upon precision in terms of the coefficient of variation (CV) or the relative percent difference (RPD). The standard deviation (S) of a sample set is calculated as:

$$S = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$$

where:

x	=	Individual measurement result;
$\bar{x}$	=	Mean value of individual measurement results; and
n	=	Number of measurements.

The CV as a percentage is then calculated as:

$$CV = \left(\frac{S}{\bar{x}}\right) \times 100$$

The RPD calculation allows for the comparison of two analysis values in terms of precision with no estimate of accuracy. Relative percent difference is calculated as:

$$RPD = \frac{|M - m|}{\left(\frac{M + m}{2}\right)} \times 100$$

where:

M	=	First measurement value; and
m	=	Second measurement value.

For duplicate measurements, CV is related to RPD by the following:

$$CV = \frac{RPD}{\sqrt{2}}$$

7.1.3 Accuracy

Accuracy is the degree of agreement of a measurement, X, with an accepted reference or true value, T. Accuracy is usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100(X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system and is assessed by means of reference samples and percent recoveries. Error may arise from personnel, instrument, or method factors.

The accuracy of data collected using field instruments is difficult to quantify. However, it can be qualitatively maximized by strict adherence to standard protocols and, where applicable, to manufacturers' operating and calibration procedures. This will ensure that the data are accurate and within the manufacturer's reported accuracy limits.

Two types of analytical check samples are used: laboratory control samples (blank spike) and the matrix spike. Analytical accuracy is expressed as the percent recovery of an analyte that has been added to the control samples or a standard matrix (e.g., blank soil, analyte-free water, etc.) at a known concentration prior to analysis.

The accuracy of data is typically summarized in terms of relative error (RE). This calculation reflects the degree to which the measured value agrees with the actual value, in terms of percent of the actual value. Relative error is calculated as:

$$\% RE = \frac{\text{Measured Value - Actual Value}}{\text{Actual Value}} \times 100$$

This way of expressing accuracy allows for a comparison of accuracy at different levels (e.g., different concentrations) and for different parameters of the same type (e.g., different compounds analyzed by the same method). Control sample analyses are typically evaluated using this calculation.

In this program, another calculation is frequently used to assess the accuracy of a procedure. Percent recovery is a calculation used to determine the performance of many of the quality control checks, where:

$$\% \text{ Recovery} = \frac{\text{Measured Value}}{\text{Actual Value}} \times 100$$

Another similar calculation used to determine the performance of a method for recovery of a spike concentration added to a sample is the percent spike recovery calculation. The percent spike recovery is determined as:

$$\%\,\text{Spike Recovery} = \frac{[(\textit{Measured Sample Value Plus Spike}) - (\textit{Measured Sample Value})]}{(\textit{Value of Spike Added})}\, x\, 100$$

7.2 CONTROL LIMITS

Control limits for central tendency and variability are generated by the laboratory to statistically monitor system performance. These limits are within method specified tolerances. Since control limits may change as the analytical system is improved and matrices change, these limits are not provided in this plan.

7.3 DOCUMENTATION

Data reviewed to perform each of the above procedures and the implications to sample results are discussed in each of the following subsections.

7.3.1 Blank Data Assessment

As noted in Section 6.0, the likelihood of radiological contamination being attributable to laboratory sources is minimal. However, method blanks are analyzed to account for other sources of interference specific to radiological analyses. If interference is indicated in method blanks, the samples associated with the blank may be qualified to indicate that some or all of the detected analytes may be from laboratory sources. If the concentrations reported in the samples are similar to the blank concentrations, it is likely that all of the contamination was introduced, and this assessment is made in the QA/QC report for the sampling task.

7.3.2 Accuracy

As previously defined, accuracy is associated with correctness, and is a comparison between a measured value and a known, or "true" value. Accuracy is calculated from matrix spike or LCS results.

Spike results are reported by the laboratory as percent recovery and are compared to the accuracy objectives stated in Section 6.0. Results that do not satisfy the objectives are assigned a data qualifier flag to indicate uncertainty associated with inaccuracy.

Matrix spikes are spikes of a known concentration of an analyte into a matrix representative of the actual samples. If recovery is outside the established limits, samples from the same extraction batch may be qualified. Matrix spike results are generally more sample specific. If matrix spike recovery is outside the established limits, results for samples collected from similar conditions and/or handled in the same batch will be examined. If any results appear atypical and can be related, those results may also be qualified. The flagged data will be discussed in the QA/QC report for the sampling task, and specific limitations such as poor or enhanced recovery for specific compounds will be stated. Further investigation or corrective action may be taken to find methods to reduce the interferences.

Confidence intervals can be calculated for an analytical method if performance audit samples are submitted or a series of matrix spikes are analyzed. The results are used to define confidence intervals for the recovery of each compound analyzed.

7.3.3 Precision

7.3.3.1 Onsite Laboratory Precision of Field Duplicates

Field duplicate samples will be collected at a rate of 5% of samples collected as per Table 5-1. When duplicate analysis is required, the original sample counted by the onsite laboratory will be sent to the offsite laboratory for confirmation. Duplicate analyses performed by the laboratory will be compared to the initial analytical results by determining a Z_{Rep} value for each data set using the equation provided in Section 7.1.2.

The calculated Z_{Rep} will be compared to performance criteria of ≤ 2 as a warning limit and ≤ 3 as a control limit. Calculated Z_{Rep} values less than 2 will be considered acceptable, and values greater than 2 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- The sample measurement and duplicate or replicate measurement are of the same normally distributed population; and
- The standard deviations represent the true standard deviation of the measured population

7.3.3.2 Offsite Laboratory Precision

Precision is a measure of variability between duplicate or replicate analyses, and is calculated for field and laboratory replicates. By definition, field or total precision incorporates laboratory precision. Precision is calculated as the RPD between duplicate samples or analyses, or matrix spike/matrix spike duplicates as appropriate. The calculated RPDs for laboratory QC samples are compared to the objectives stated in Section 6.6.4. The calculated RPDs for field duplicates will be compared to a project goal of 30% for soil samples. Results that do not satisfy the objectives are assigned a data qualifier flag indicating uncertainty associated with imprecision.

An average RPD may be calculated and reported as a measure of overall analytical precision for compounds with multiple measurements. The specific samples collected or analyzed in duplicate are flagged if they do not satisfy the QA objectives. In addition, associated samples may be flagged to indicate variability due to poor precision. For poor field duplicate precision, samples collected by the same sampling team, from the same equipment, or on the same day may be affected; close evaluation of those results should indicate the most likely source of variability, and the corresponding samples will be qualified as warranted. For poor laboratory precision, samples processed and analyzed in the same batch will be more closely evaluated, and any anomalous results will be qualified.

The LQAC is responsible for ensuring that data qualifier flags are assigned to the data as required by the established QC criteria, and that they are reported and understood by project staff using the data for specific applications. The LQAC is also responsible for initiating corrective actions for

analytical problems identified during the QC data assessment process. These corrective actions range from verifying that the method was in statistical control during the analytical runs, to reanalysis or resampling.

7.4 SAMPLE QUANTITATION/REPORTING LIMITS (LIMIT OF DETECTION)

This section presents and defines limits to be used in describing detectable concentrations. The Critical Value (L_c) is defined as the response threshold used to decide whether the analyte concentration of a sample is above that of the blank. The Minimum Detectable Concentration (MDC) describes the sensitivity of an analysis to measure a specific radionuclide or radiation. Laboratory detection limits are primarily a function of instrument sensitivity, sample geometry, target analyte, and count time. MDC is an *a priori* value that describes the smallest radionuclide concentration that a given detection system can detect a specified percentage (confidence level) of the time. The GEL required MDC values are presented in Table 6-1.

7.4.1 Procedures

The performing laboratory will determine a) L_c in order to properly qualify each result prior to reporting; and b) MDC to demonstrate that it can meet or exceed the required MDC or quantitation limits. For the alpha spectroscopy that will be utilized for the sample analyses, the MDC value associated with each measurement is reported along with the analytical result.

7.4.2 Radionuclide Method Detection and Quantification Limits

The generic form of the L_c equation is provided below. (EPA 2004) This generic form allows the use of non-uniform count times between the background and sample counts and varying confidence factors:

$$L_c = z_{1-\alpha}\sqrt{R_B t_B\left(1+\frac{t_s}{t_b}\right)}$$

Where:

$Z_{1-\alpha}$	=	Confidence Factor (generic)
R_B	=	Background count rate
t_B	=	Background count time
t_S	=	Sample count time

The more common application of the Lc equation is the "Currie equation," (Currie 1968) which is a simplification of the above equation where the background and sample count times are the same and a 95% confidence interval is used, i.e. $\alpha = 0.05$ or $_{z1-\alpha} = 1.645$:

$$L_c = 2.33\sqrt{C_B}$$

Where:

2.33	=	statistical factor
C_B	=	Background counts

The MDC values required of the contractor laboratory, along with the site-specific DCGLs, are presented in Table 6-1 for the specific analytical methods for this project. The definitions for these reporting and quantitation limits are presented in this subsection.

In order to determine MDC values for the alpha spectroscopy performed by the laboratory, a minimum detectable activity (MDA) value is generated during each analysis. The MDC is derived by adjusting the MDA value for the mass of the sampled media. The equation by which MDA is calculated for alpha spectroscopy is:

$$MDA = \frac{4.65\sqrt{C_B} + 2.71}{2.22 * Y * V * Eff * A * T_S}$$

Where:

2.71	=	Statistical Factor (95% Confidence Level)
4.65	=	Confidence Factor (95% Confidence Level)
C_B	=	Background counts
2.22	=	dpm to picoCuries conversion factor
Eff	=	Detector efficiency
Y	=	Chemical yield
V	=	Sample volume/weight
A	=	Abundance
T_S	=	Sample count time

The chemical yield is calculated as:

$$Y = \frac{C_T}{T * Eff * D_T}$$

Where:

C_T	=	Total Counts in the Tracer Peak.
T	=	Count Time (in minutes).
Eff	=	Detector Efficiency.
D_T	=	Dpm of Tracer added to each sample.

7.4.3 Minimum Detectable Activity Determination for Field Instrumentation

MDA values for field instrumentation are determined *a proiri* using characteristic detector values and anticipated sample and background count times. The equation by which MDA is calculated is:

$$MDA\left(\frac{dpm}{100cm^2}\right) = \frac{3 + 3.29\sqrt{R_B * T_{S+B}\left(1 + \frac{T_{S+B}}{T_B}\right)}}{Eff * T_{S+B} * \frac{PA}{100cm^2}}$$

Where:

3	=	Statistical Factor (95% Confidence Level)
3.29	=	Confidence Factor (95% Confidence Level)
R_B	=	Background count rate (cpm)
Eff	=	Detector efficiency
T_B	=	Background count time (min)
T_{S+B}	=	Sample count time (min)
PA	=	Probe active area (cm^2), if applicable

7.5 TOTAL PROPAGATED UNCERTAINTY

Total Propagated Uncertainty (TPU) is an estimate of the overall uncertainty in a radiometric measurement. The components of the TPU are classified as either random or systematic.

The random uncertainties, also called counting uncertainties, derive from the statistically random (normally distributed) nature of radioactive decay and are estimated as the square root of the total number of counts acquired during an analysis. Counting uncertainty (CU) always applies to the measurement of the analyte of interest in a nuclear measurement. In cases where the chemical yield is determined by the analysis of a radioactive tracer, that yield uncertainty (YU) is also a random uncertainty and is estimated as the square root of the total number of tracer counts acquired. CU and YU are calculated in activity units to afford comparability to the sample result.

Systematic uncertainties are attributable to actual errors in the measurement of a physical quantity. For example, if a balance has an accuracy of ± 0.1%, the results of those gravimetric measurements are not normally distributed, but rather are assumed to be biased by that amount. Estimates of systematic uncertainties in the lab are somewhat subjective, but should be supported by empirical data whenever possible. Systematic uncertainties associated with the preparation of a sample are called preparation uncertainties (PU) and are defined based on the number of volumetric and gravimetric measurements, quantitative transfers, etc. In the case of chemical yield determinations made by the measurement of a stable carrier, or by gravimetric measurement of a final precipitate or reside, the PU also includes an estimate of the uncertainty introduced by that technique. Systematic uncertainties associated with the analysis, called instrument uncertainties (IU) include biases associated with sample positioning, standard values, calibration coefficients, etc. PU and IU are typically provided as a percentage of the final result. To afford comparability to the sample results, PU and IU are expressed in activity units by multiplying the percentage by the sample activity (A).

All contributions to TPU are considered to be independent of each other. Consequently, the individual contributions are combined as the square root of the sum of the squares. The final TPU result is expressed in activity units, such a pCi/g or pCi/L.

$$TPU = \sqrt{CU^2 + YU^2 + (A * PU)^2 + (A * IU)^2}$$

TPU is expressed as a value at a specific confidence interval. The default convention at GEL is to provide the TPU at the 2-sigma confidence interval. This asserts approximately a 95% confidence level that the actual sample value is within the reported uncertainty range of the calculated result.

7.6 COMPLETENESS

Completeness is a measure of the degree to which the amount of sample data collected meets the scope and a measure of the relative number of analytical data points that meet the acceptance criteria, including accuracy, precision, and any other criteria required by the specific analytical method used. Completeness is defined as a comparison of the actual numbers of valid data points and expected numbers of points expressed as a percentage.

The QA objectives for completeness will be based upon a project goal of 90%. The ability to meet or exceed this completeness objective depends on the nature of samples submitted for analysis. If data cannot be reported without qualifications, project completion goals may still be met if the qualified data, i.e., data of known quality even if not perfect, are suitable for the specified project goals.

Difficulties encountered while handling samples in the laboratory, as well as unforeseen complications regarding analytical methods, may affect completeness during sample analysis. Access to various areas and/or media along with unanticipated difficulties with sample collection affect field data completeness. For example, poor sample recovery in a split-spoon sample may reduce the number of soil samples that can be collected, and therefore affects the completeness.

Completeness is calculated after the QC data have been evaluated, and the results applied to the measurement data. In addition to results identified as being outside of the QC limits established for the method, broken or spilled samples, or samples that could not be analyzed for any other reason are included in the assessment of completeness. The percentage of valid results is reported as completeness. The completeness will be calculated as follows:

$$Completeness\ (\%) = \frac{T - (I + NC)}{T} \times 100$$

where:

T	=	Total number of expected measurements for a method and matrix;
I	=	Number of invalidated results for a method and matrix; and
NC	=	Number of results not collected (e.g., bottles broken etc.) for a method and a matrix.

7.7 REPRESENTATIVENESS

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper

design of the sampling program. The representativeness criterion is best satisfied by making certain that sampling locations are properly selected and a sufficient number of samples are collected. Representativeness is addressed by describing sampling techniques and rationale used to select sampling locations. EPA approved and standardized sampling procedures will be used where practical, and considered as guidance in other cases, in conjunction with the survey and sampling design developed in the FSP to ensure the representativeness of sample data.

7.8 COMPARABILITY

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The comparability of the data, a relative measure, is influenced by sampling and analytical procedures. By providing specific protocols to be used for obtaining and analyzing samples, data sets should be comparable regardless of who obtains the sample or performs the analysis.

The analytical laboratory will be responsible for enhancing comparability using the following controls:

- Use of current, standard EPA-approved methodology for sample preservation, holding, and analysis;
- Consistent reporting units for each parameter in similar matrices;
- EPA- or NIST-traceable standards, when available;
- Analysis of EPA QC samples, when available; and
- Participation in inter-laboratory performance evaluation studies.

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8.0 FIELD AND LABORATORY OPERATIONS DOCUMENTATION

The data reduction, review, and reporting procedures described in this section will ensure that complete documentation is maintained, that transcription and data reduction errors are minimized, the quality of the data is reviewed and documented, and the reported results are properly qualified. Laboratory data production and management will be described in the GEL LQAP (Appendix B). CABRERA will be responsible for maintaining adequate documentation and records to support information provided to the USACE regarding the Painesville FUSRAP project. These records will be forwarded to the USACE, if requested. Original copies of field data, field records, analytical data, training records, and other project-specific documentation will be retained by CABRERA in a manner and for durations required in CABRERA SOP, AP-001, *Record Retention*.

8.1 FIELD AND TECHNICAL DATA

The field and technical (non-laboratory) data that will be collected during a field effort can generally be characterized as either "objective" or "subjective" data. Objective data (e.g., radiological field screening results) include direct measurements of field data such as field screening/analytical parameters and water level measurements. Subjective data include descriptions and observations such as descriptions of sampling locations and conditions, and physical descriptions of soil samples.

8.1.1 Data Reduction

Field data will be exported from its data collection devices, as appropriate, and imported to appropriate data base management systems. Original field forms will be filed as hard copies for later review and verification of electronic copies of such data. Field data may also be imported into selected geospatial modeling software to allow for the preparation of radionuclide distribution documents as required.

Subjective data will be filed as hard copies for later review and incorporation into technical reports, as appropriate. The subjective data will be formatted into a usable medium, such as a computer database program. The database will allow for the generation of summary tables, graphs, and figures while maintaining the integrity and accountability of the original data.

8.1.2 Electronic Data

Electronic data collected during the day will be backed-up at the end of the same day in the field (e.g. to CD, zip drive, or 'memory stick') and before processing or editing. This is an archive of the raw data and, once created, shall not be altered. More than one day's data may go on a single back-up media. Field computer(s) used to store GPS data will be backed up weekly. Raw archived data will be stored in a different location from weekly backups. Electronic GPS data will be provided daily to off-site data processing specialists. The time and date that data files are transmitted will be recorded in the data logbook. File names will be verified by comparison with field notes and corrected if necessary, following approval by the CABRERA PM.

8.1.3 Photographs

Photographs taken during the project will be noted in the field logbook. If photographs are taken to document sampling points or to facilitate relocating the point at a later date, they will attempt to include two or more permanent reference points within the photograph. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required.

8.1.4 Post-Processing

Post-processing specialists will convert daily GWS/GPS data to state plane coordinates, as necessary, and review the data for errors to fluctuations/interferences in the GPS signal. Post-processing specialists will be able to determine qualitatively, by density of recorded GPS positions, rapid or increased velocity of the surveyor performing the GWS, which could have an adverse effect on the predicted scan MDC. Post-processing specialists will inform the PM of any identified deficiencies and will make corrections as directed. Conversions, errors, corrections, and/or adjustments to project data shall be documented in the data logbook.

8.1.5 Data QA Review

The QA review for usability of objective field and technical data will be performed at two different levels. In the first level, data will be reviewed at the time of collection by following standard procedures and QC checks. In the second level, after data reduction into tables or arrays, the data will be reviewed for anomalous values. Any inconsistencies or anomalies discovered by this review will be immediately resolved, if possible, by seeking clarification from the field personnel responsible for collecting the data. Inconsistencies and anomalies will be documented during the review process.

Subjective field and technical data will be approved for use by review of field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made to check recorded data at that time to confirm the recorded observations. Whenever possible, peer review also will be incorporated into the data QA review process, particularly for subjective data, in order to maximize consistency among field personnel. For example, during drilling activities, scheduled periodic reviews of archived soil samples will be performed to ensure field personnel consistently use the appropriate soil-texture descriptions and codes.

8.2 SAMPLE MANAGEMENT RECORDS

Environmental and radiological samples will be handled under strict COC procedures beginning in the field. The CABRERA FSM will be the field sample custodian and will be responsible for ensuring that the procedures outlined in the QAPP are followed. Sample custody for field activities will include the use of COC forms, sample labels, custody seals, and field logbooks. Dedicated field logbooks will be used throughout the project to document field activities. Supplies and reagents (source and lot numbers, if appropriate) used for field measurements will be recorded in the field logbooks.

Once samples are transported to the laboratory, custodial responsibility is transferred to the Laboratory Sample Manager to assure that the appropriate procedures and methods are followed. GEL's LQAP will detail the laboratory COC and sample storage procedures. The laboratory shall fax a copy of the fully executed COC forms to the Contractor Field Lab Manager each day samples are received. This fax will also be used to confirm that the cooler(s) were received by the laboratory. Field contact information may be found in the Site FSP. The laboratory will keep final evidence files containing relevant and appropriate project sample information. This sample information includes, but is not limited to the following items:

- Chain-of-custody records;
- Sample log-in receipt forms;
- Copies of laboratory sheets;
- Copies of bench sheets;
- Instrument raw data printouts;
- Chromatograms;
- Pertinent correspondence memoranda; and
- Final report file.

If agreed upon by all parties, the laboratory can email scanned copies of the COC.

8.3 DATA REDUCTION

Data reduction is performed by the individual analysts and consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. The complexity of the data reduction will depend on the specific analytical method and the number of discrete operations (extractions, dilutions, and levels/concentrations) involved in obtaining a sample that can be measured.

For those methods using a calibration curve, sample response will be applied to the linear regression line to obtain an initial raw result, which is then factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained to minimize rounding errors, and results generally will not be expressed in more than two significant figures.

Copies of raw data and calculations used to generate the final results will be retained on file to allow for reconstruction of the data reduction process at a later date.

8.4 LABORATORY DATA REVIEW

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, QC sample results, and performance evaluation samples. These reviews are performed prior to submission of the data to the Laboratory Project Manager.

Criteria for analytical data review/verification include checks for internal consistency, transmittal errors, laboratory protocol, and laboratory QC. QC sample results and information documented in field notes will be used to interpret and evaluate laboratory data. The QA Section independently conducts a review of the data package to eliminate technical errors that might affect the quality of the data.

The laboratory will complete standard review procedures, including:

- Proofing analyses requested with analyses performed;
- Preliminary data proofing for anomalies—investigation and corrections, where possible;
- Proofing of laboratory data sheets for reporting limits, holding times, surrogate recovery performance, and spike recovery performance; and
- Double-checking computerized data entry, if required.

The Laboratory Project Manager or Group Leader will review data for consistency and reasonableness with other generated data and determine whether program requirements have been satisfied. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analyses should be repeated.

Prior to final review/signoff by the Laboratory Project Manager or Group Leader, the Data Reporting Section will verify that the report deliverable is complete and in proper format, and screen the report for compliance with laboratory and client QA/QC requirements. The Laboratory Project Manager or Group Leader will be the final laboratory review prior to reporting the results to the CABRERA PM. The laboratory Project Manager will also do a final completeness check before submitting the data report to CABRERA.

The QA Section will independently conduct a complete review of selected projects to determine whether laboratory and client QA/QC requirements have been met. Discrepancies will be reported to the Laboratory Project Manager or Group Leader for resolution.

8.5 DATA REPORTING PROCEDURES

8.5.1 Data Package Format and Contents

Data resulting from the investigation will be presented in written reports. The reports will consist of a presentation of the raw analytical data, summaries of the review and verification effort, as appropriate, as well as interpretative findings relative to the data. This information will allow new data review to be performed.

Reports will contain final results (uncorrected for blanks and recoveries), analytical methods, detection limits, surrogate recovery data, method blank data, and results of QC samples (where applicable). In addition, special analytical problems and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Data are generally reported in units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of activity or mass per

unit volume (e.g., pCi/L or µg/L). Concentrations in solid or semisolid matrices are expressed in terms of activity or mass per unit mass of sample (e.g., pCi/g or mg/kg).

The final data report provided by the laboratories will be a Level IV report and will include:

- Cover page/laboratory chronicle;
- Chain-of-custody sample request form;
- Sample data (including QC sample) results;
- Laboratory instrument calibration data; and
- Case narrative describing data qualifiers, sample collection, sample preparation and analysis dates, and a description of any technical problems encountered with the analysis.

QC results include MS/MSDs, method blanks, and the results of the field QA samples, in addition to laboratory control samples (LCSs). Sample data results, including QC sample results, will also be delivered in an electronic format for input into the program data management system. Laboratories are responsible for reviewing the electronic deliverable to ensure that the electronic data matches the hard copy reports.

8.5.2 Electronic Deliverables

This project relies heavily on field data collected and stored electronically. Electronic data is subject to damage and/or loss if not properly protected. As such, project electronic data shall be downloaded from its collection device (e.g., laptop computers, data loggers, DGPS data collectors, etc.) on at least a daily basis. At the conclusion of each day's survey activities, electronic data collected that day will be backed up to appropriate removable media (e.g., CD, zip disk, or equivalent.

Electronic submittals to the USACE-Buffalo shall be in Adobe Acrobat Portable Document Format (PDF). Also, original files including, but not limited to, documents and databases shall be provided to the USACE-Buffalo, if requested. Original files to be submitted shall include working copies of any documents/data in the appropriate MS format (e.g., Word, Excel, Access, etc.). Documents shall be screened for potential violation of the 1974 Privacy Act prior to submittal. Data collected and generated shall be submitted to the USACE-Buffalo in Microsoft Access format. A complete, comprehensive laboratory analytical package, able to be validated, shall also be submitted in searchable PDF format on CD-ROM.

Table 8-1 presents the approximate number of copies of the Data Report that will be required for the Site survey and sampling activities.

8.6 DATA MANAGEMENT PROCEDURES

The results for samples analyzed in support of this project will be entered into an electronic data report as described in Section 8.5.2.

8.6.1 Laboratory Turnaround Time

The laboratory turnaround time varies by analyte and analytical method and is specified in the GEL contract. Normal turnaround times for GEL radioanalyses for the Site analytes/methods are indicated in Table 5-2.

8.6.2 Data Archival/Retention Requirements

Field, laboratory, and cartographic data within the laboratories' database system collected from the site during sampling will be archived on durable electronic media. Backup media containing databases and programs or software utilities will be maintained in a secure location. CABRERA will retain relevant and appropriate project information in project files. The information contained in these files may include, but not necessarily limited to, the following items:

- Field notes and information;
- Correspondence, meeting notes, and telephone memoranda;
- Chain-of-custody records, laboratory information; sample receipt forms;
- Data evaluation, reference, and audit information; and
- Copies of reports.

Hard copy data and data storage media will be archived in a manner and for durations required in CABRERA SOP, AP-001, *Record Retention*.

8.6.3 Standard Plans and Reports

Project reports will include a section (or appendix) on QA review. This review will summarize field documentation, field audits, field screening, sample collection and method analysis, duplicate samples, field blanks, sample holding times, MS recoveries, surrogate recoveries, MSD results, and laboratory method blank results. Any corrective actions taken will also be discussed.

Table 8-1. Submittals to the USACE-Buffalo

Deliverable	Electronic Compact Disc - Read Only Memory (copies)	Paper (copies)
Memos and Status Reports	0	6
Draft Reports	2	10
Final Reports	2	10

9.0 DATA ASSESSMENT PROCEDURES

9.1 DATA QC REVIEW

The purpose of analytical data review is to eliminate unacceptable data and to qualify data for any data quality limitations identified during review. In addition to the laboratory QA review, data deliverables will be evaluated, at a minimum, for the following:

- Compliance with requested testing,
- Completeness of analytical report, and
- Confirmation of receipt of requested deliverables.

At a minimum, data will be reviewed by the QAC, or other QA staff, to evaluate the sampling and analytical performance. Using the following procedure, this primarily is applicable to data for which final data review will not be performed:

- Review chain-of-custody documents to verify sample identities.
- Review sample log-in documents to verify any potential problems with custody seals, container integrity, sample preservation, labeling, etc.
- Review the matrix spike data to evaluate the potential for matrix effects and as a measure of analytical accuracy. MS recoveries will be compared against the acceptance criteria in Section 6 to determine if they are within warning and control limits for percent recoveries.
- Review MS/MSD data to evaluate sample homogeneity and as a measure of analytical precision. MS/MSD data will be compared to the acceptance criteria in Section 6 for the maximum RPD.
- Review LCS data as a measure of analytical accuracy. LCS data will be compared to the certified acceptable ranges of analytical values.
- Review of sample and sample duplicate data as a measure of sample homogeneity and as a measure of analytical precision. Sample and sample duplicate data will be compared against the acceptance criteria in Section 6 for the maximum RPD or Z_{Rep}.
- Identify and report any potential problems, such as MS or RPD values outside of acceptance criteria.

This process will identify analytical methods and compounds for which the QA objectives are not satisfied, and corresponding sample data will be qualified with a "flag" indicating the problem. Samples collected on the same day, or analyzed in the same run or batch, or individual samples may be flagged, depending on the type of problem that has been identified. Reanalysis or re-sampling may be recommended as a corrective action at this time if data are determined to be unacceptable for the intended application.

Data qualifiers or 'flags' used shall be in accordance with standard notation provided in Chapter 8 of the MARLAP manual, shown in Table 9-1.

Table 9-1. Data Qualifiers

Qualifier	Description
U	A normal, not detected ($<C_L$) result.
Q	A reported TPU that exceeds the project's required uncertainty limit.
J	An unusually uncertain or estimated result.
R	A rejected result: the problems (quantitative or qualitative) are so sever that the data can not be used.
S	A result with a related spike result (LCS, MS, or MSD) that is outside the control limit for recovery.
P	A result with an associated replicate result that exceeds the control limit.
B	A result with associated blank result, which is outside the control limit used to indicate high or low results.

QC results will be reported by sample matrix and analytical method in tabular form. The measurement data will be discussed and qualified as appropriate based on the QC results. For example, matrix spike interference will influence specific samples or matrices, while laboratory blank contamination will influence samples extracted or analyzed on a specific day or during a specific analytical run.

In cases where there are a large number of QC analyses of one type, a second level, or summary, table may be constructed. The summary tables will typically report mean or pooled statistics to describe the overall performance of the method. For example, the summary table of duplicate sample results might report the average RPD for duplicates measured for the compound, and indicate the number of individual RPDs that did not meet the acceptance criteria. This type of table can serve as an indication of the overall QC results. However, these applications will often have to be developed or modified from existing programs for individual investigations. A summary assessment of the data presented in these tables will be prepared for each phase of sampling, as appropriate.

Custom table formats will be used as an aid to interpretation of the investigative data. The particular format will depend on how the QC results are expected to influence the investigative data and will be developed by data management staff through discussion with the users. For example, QC results may be grouped with analytical batches, field collection batches, or summarized for the entire project.

The data review report (for samples subject to full data review) will include a narrative explanation of what samples the report applies to, a reference to the criteria or procedures used to qualify the data, and a description of which results were qualified and why. This report will accompany the QC data summary.

9.2 DATA VERIFICATION/VALIDATION

Data validation will be performed by USACE Buffalo District staff. Independent, third party review of the laboratory radiological data may be utilized on an as-needed basis as indicated by data-quality conditions. If implemented, the USACE-Buffalo shall be notified for concurrence prior to utilization.

9.3 DQO RECONCILIATION

The CABRERA PM will direct the project team in the final verification and reconciliation of the data results and the data review process with the project DQOs in regard to:

- The perspective of the end data user;
- Concentrations of the RCOCs;
- The final number of samples, sampling locations, and site media;
- Lateral and vertical study boundaries; and
- Performance and appropriateness of the field survey techniques and laboratory analyses and methods that were utilized.

9.3.1 Field QA Reports

The FSM will provide the CABRERA PM with daily field progress reports at weekly intervals. The CABRERA PM will be immediately notified of field QA situations requiring corrective action. In addition, the CABRERA QAC will be copied for all corrective action documentation.

9.3.2 Laboratory QA Reports

The Laboratory QA Coordinator will provide project reports specific to the delivery order to the CABRERA PM, as requested. These reports summarize QA activities for the reporting period, including results of performance audits (external and internal), results of system audits (external and internal), summaries of corrective action to remedy out-of-control situations, and recommendations for revisions of laboratory procedures to improve the analytical systems. The CABRERA PM will be immediately notified of laboratory QA situations requiring immediate corrective action.

9.3.3 Data Submittals

Analytical reports will summarize the departures from approved protocols in the case narratives. Important data findings will be incorporated into the case narratives, where appropriate. Analytical reports in their entirety will be submitted to USACE as a separate document and/or transmitted in an electronic format at the request of the USACE-Buffalo.

9.4 PROJECT COMPLETENESS ASSESSMENT

Project completeness assessment is the measure of the volume of qualified data compared to the planned data volume and whether that data is sufficient to meet project objectives. The QA

objectives for completeness will be based upon a project goal of 90%. Data completeness is addressed in detail in Section 7.6 of this plan.

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APPENDIX B: GEL LQAP

Note: The Laboratory Quality Assurance Plan (LQAP) for GEL is provided in electronic file format submitted with hard copies of this QAPP. Printed copies of the LQAP will be provided upon request.

GENERAL ENGINEERING LABORATORIES, LLC

QUALITY ASSURANCE PLAN

(GL-QS-B-001 REVISION 18)

Quality Assurance Plan Approval Signatures:

Prepared by:
General Engineering Laboratories, LLC

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SECTION 1
INTRODUCTION

Section 1 - Introduction

General Engineering Laboratories, LLC (GEL) is a privately owned environmental laboratory dedicated to providing personalized client services of the highest quality. Our mission is to be the "Analytical Firm of First Choice."

GEL was established as an analytical testing laboratory in 1981. Now a full service lab, our analytical divisions use state of the art equipment and methods to provide a comprehensive array of organic, inorganic, radiochemical and bioassay analyses and related support services to meet the needs of our clients.

This Quality Assurance Plan provides an overview of our quality assurance program for analytical services. Outlined in this plan are the responsibilities, policies and processes essential to maintaining client satisfaction and our high quality of performance.

Everyone on our staff is expected to understand the policies, objectives and procedures that are described in this plan and to fully appreciate our commitment to quality and their respective roles and responsibilities with regard to quality. We also expect any analytical subcontractors we employ to perform in accordance with the quality assurance requirements delineated in this plan. All GEL employees are required to participate in Annual Quality Systems training.

This Quality Assurance Plan (QAP) has been prepared according to the standards and requirements of the US Environmental Protection Agency (EPA) and the National Environmental Laboratory Accreditation Program (NELAP) Quality Systems Standards June 2001 effective July 2003.

1.1 Quality Policy

GEL's policy is "to provide high quality, personalized analytical services that enable our clients to meet their environmental needs cost effectively."

We define quality as "…consistently meeting the needs and exceeding the expectations of our clients." As such, we consistently strive to:

- meet or exceed client and regulatory requirements
- be technically correct and accurate
- be defensible within contract specifications
- provide services in a cost-effective, timely and efficient manner

At GEL, quality is emphasized at every level—from the Chairman, CEO, CFO and COO to the newest of employees. Management's ongoing commitment to quality is demonstrated by their dedication of personnel and resources to develop, implement, assess, and improve our technical and management operations.

Our quality assurance program is designed to comply with the guidelines and specifications outlined in the following:

- NELAC 2002
- ASME/NQA-1
- ISO/IEC Guide 17025
- QAPPs, U.S. EPA QA/R5
- Department of Energy Order 414.1a
- Current U.S. EPA CLP statements of work for inorganic and organic analyses
- ANSI N42.23 Quality Assurance for Bioassay Laboratories 1995
- Appendix B to Part 50 –Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.

1.2 Quality Goals

GEL's primary goals are to:

- Ensure that all measurement data generated is scientifically and legally defensible, of known and acceptable quality per the data quality objectives (DQOs), and thoroughly documented to provide sound support for environmental decisions
- Ensure compliance with all contractual requirements, environmental standards, and regulations established by local, state and federal authorities.

Additional goals include:

- A comprehensive quality assurance program to ensure the timely and effective completion of each measurement effort.
- A commitment to excellence at all levels of the organization.
- Early detection of deficiencies that might adversely affect data quality.
- Adequate document control.

- Effective quality assurance objectives for measurement systems and for quality data in terms of accuracy, precision, completeness, and comparability through the use of proven methods.
- The establishment of procedures that demonstrate that the analytical systems are in a state of statistical control.
- The implementation of corrective actions to ensure the integrity of data.
- Reduction of data entry errors through comprehensive automated data handling procedures.
- The development and implementation of good laboratory and standard operating procedures (SOPs).
- Ability to customize quality assurance procedures to meet a client's specific requirements for data quality.
- Good control of instruments, services, and chemical procurement.
- A continuously evolving laboratory information management system (ALPHALIMS).
- Validated and documented computer hardware and software.

1.3 Key Quality Elements

A sound quality assurance program is essential to our ability to provide data and services that consistently meet our high standards of integrity. The key features of our program are:

- An independent quality assurance (QA) validation and Quality Systems Department.
- A formal quality policy and QAP.
- Management Review
- Stated data quality objectives.
- A comprehensive employee training program.
- Ethics policy and education program.
- Internal audits and self-evaluations.
- A closed-loop corrective action program.
- State-of-the-art facilities and instruments.
- Adherence to standard operating procedures.
- EPA/NIST traceable reference materials.
- Electronically based document control.
- Chain of custody and electronic sample tracking.
- Inter-laboratory comparison programs.
- Formal laboratory accreditations.
- The evaluation of subcontractor laboratories.
- Statistical controls for analytical precision and accuracy.
- Replicate, method blank, matrix spike, tracer yield, internal standards, and surrogate measurements.
- The preventive maintenance of instrumentation and equipment.
- Independently prepared blind standard reference materials.
- Multi-level review processes.
- Focus on client satisfaction.
- Electronic tracking of client commitments, nonconformances and corrective actions.
- Trend analysis of nonconforming items.

1.4 Management Reviews

The effectiveness of the Quality System is reviewed at least annually by Senior Management. These reviews address issues that impact quality, and the results of the reviews are used to develop and implement improvements to the system. Records of the review meetings are maintained as quality documents.

1.5 Disposition of Client Records

In the event that the laboratory should change ownership, the responsibility for the maintenance and disposition of client records shall transfer to the new owners. In the unlikely event that the laboratory ceases to conduct business, clients shall be notified and asked to provide instructions as to how their records should be returned or disposed. If a client does not provide instructions, those records will be maintained and disposed in a manner consistent with regulations and good laboratory practices for quality records.

1.5 Supporting Documents

Our laboratory operations and the quality of our analytical data comply with the specifications described in the documents listed in Appendix A.

1.6 Definitions

Applicable definitions are listed in Appendix B.

SECTION 2
ORGANIZATION, MANAGEMENT, AND PERSONNEL

Section 2 - Organization, Management, and Personnel

The chart found in Appendix C depicts our corporate organization, chain of command and flow of responsibility. The illustration in this appendix is designed to ensure the overall quality and cost efficiency of our company's analytical products and services.

Our structure is based on customer-focused divisions that follow a project from the point of initial contact to the final invoicing of work. These divisions include expertise in project management, sample receipt and custody, sample preparation and analysis, data review and data packaging. An independent Quality Systems Management Department monitors the adherence of these divisions to the Quality Assurance Program.

The general responsibilities associated with the following position levels are discussed in this section:

- Chairman
- Chief Executive Officer (CEO) and President
- Chief Financial Officer (CFO)
- Chief Operating Officer (COO)
- Quality Systems Director
- Laboratory Directors
- Project Managers
- Group Leaders
- Laboratory and Technical Staff
- Information Systems Manager
- Environmental Manager

An overview of GEL's employee training protocol is also provided at Section 2.11.

2.1 Chairman, CEO/President, Chief Financial Officer and Chief Operating Officer

Operational responsibility rests with GEL's three owners and COO. [redacted] occupies the position of COO. As the highest level executives, their philosophical approach to quality, technology and customer service keeps GEL unique.

[redacted] comprise our Executive Committee. They are also part of a Leadership Team that works to create a workplace environment that attracts and retains highly qualified professionals.

As Chairman, [redacted] oversees the Executive Committee and leads management in implementing total quality initiatives that ensure quality services that meet stringent criteria of excellence. She has responsibility for public relations efforts and community affairs. [redacted] holds a Bachelor of Arts in Education from the University of South Carolina.

As CEO and President, [redacted] has overall operational responsibility for GEL. He operates the laboratory according to corporate policies and applicable licenses and regulations.

[redacted] also has primary responsibility for the development and administration of our analytical testing and environmental consulting services. He holds a Bachelor of Science in Commerce from the University of Virginia.

[redacted] is GEL's Chief Financial Officer and oversees our financial management. He is responsible for contracts administration, invoicing, purchasing, payroll, accounts payable and receivable, inventory control, property control, and financial forecasting. [redacted] holds a Bachelor of Science in Business Administration from the Citadel.

The Chief Operating Officer is [redacted]. Ms. [redacted] is responsible for the daily operations of the laboratories and client services.

Together, the Chairman, CEO/President, CFO and COO form GEL's Executive Committee. Their responsibilities include the following:

- Ensuring that the individuals who staff our technical and quality positions have the necessary education, training and experience to competently perform their jobs.
- Ensuring that all staff members receive ancillary training, as needed, to enhance performance in assigned positions.
- Budgeting, staffing, managing and equipping the laboratory to meet current and future analytical program requirements.

- Overseeing the implementation and overall effectiveness of our Quality Assurance Plan, health and safety initiatives, and environmental programs.
- Managing production and cost control activities.
- Ensuring development of capabilities in response to new or revised regulations, instrumentation and procedures, and quality assurance initiatives.

2.2 Technical Laboratory Co-Directors

To enhance our responsiveness to clients through dedicated expertise and teamwork, our laboratory is divided into two major divisions, Chemistry and Radiochemistry, each with its own Technical Laboratory Director.

The Technical Directors report to the Executive Committee and are ultimately responsible for the technical content and quality of work performed within each division. They are also responsible for strategic planning, profitability and growth, personnel management and business development. Other responsibilities include:

- Monitoring and meeting profitability and growth objectives of the division.
- Establishing and implementing short and long range objectives and policies that support GEL's goals.
- Defining the minimum level of qualification, experience, and skills necessary for positions in their divisions.
- Establishing and implementing policies and procedures that support our quality standards.
- Ensuring that technical laboratory staff demonstrate initial and continuing proficiency in the activities for which they are responsible.
- Documenting all analytical and operational activities of the laboratory.
- Supervising all personnel employed in the division.
- Ensuring that all sample acceptance criteria is verified and that samples are logged into the sample tracking system, properly labeled and stored.
- Documenting the quality of all data reported by the division.
- Developing internal mechanisms and measurements to improve efficiency.
- Overseeing activities designed to ensure compliance with laboratory health and safety requirements.
- Allocating the resources necessary to support an effective and ongoing quality assurance program.
- Representing the company to the public and to clients.
- Ensuring the appropriate delegation of authorities during periods of absence.

Due to high volume and variety of analytical tests performed in the Chemistry Laboratory, the Technical Director for the Chemistry Laboratory has the daily assistance of a Production Manager.

2.3 Quality Systems Director

Our Quality Systems Director (QSD) reports directly to the CEO. The QSD manages the design, implementation and maintenance of our quality systems in a timely, accurate, and consistent manner.

In addition to having responsibility for the initiation and recommendation of corrective and preventative actions, the QSD is responsible for:

- Establishing, documenting and maintaining comprehensive and effective quality systems.
- Developing and evaluating quality assurance policies and procedures pertinent to our laboratory functions, and communicating these with the division directors and managers.
- Ensuring that the operations of the lab are in conformance with the Quality Assurance Plan and meet the quality requirements specific to each analytical method.
- Ensuring that laboratory activities are in compliance with local, state and federal environmental laws and regulations.
- Reviewing project-specific quality assurance plans.
- Ensuring that quality control limits are established and followed for critical points in all measurement processes.
- Initiating internal performance evaluation studies using commercially purchased certified, high-purity standard reference materials.
- Performing independent quality reviews of randomly selected data reports.
- Conducting periodic audits to ensure method compliance.

- Conducting or arranging periodic technical system evaluations of facilities, instruments and operations.
- Overseeing and monitoring the progress of nonconformances and corrective actions.
- Communicating system deficiencies, recommending corrective action to improve the system, and defining the validity of data generated during out of control situations.
- Preparing and updating quality assurance documents and reports to management.
- Coordinating inter-laboratory reviews and comparison studies.
- Overseeing Stop Work Orders in out of control situations.
- Administering accreditation and licensing.
- Administering our document control system.
- Providing guidance and training to laboratory staff as requested.
- Evaluating subcontractors and vendors that provide analytical and calibration services.
- Designating quality systems authorities in times of absence to one or more appropriately knowledgeable individuals.

2.4 Quality Systems Review

The effectiveness of the Quality System is reviewed on a regular basis during meetings of the Leadership Team, which may be as often as weekly, but not less than quarterly. These meetings address issues that impact quality and the subsequent discussions are used to design and implement improvements to the system. At least annually, a management assessment of GEL's Quality System is conducted and reported. The QSD maintains records of these assessments.

2.5 Manager of Client and Support Services

Project Managers (PMs) serve as primary liaisons to our clients. PMs, under the guidance of the Manager of Client and Support Services, manage the company's interaction with clients. They are the client's fist point of contact and have responsibility for client satisfaction and for communicating project specifications and changes to the appropriate laboratory areas.

Additional responsibilities include:

- Retaining clients and soliciting new work.
- Managing multiple sample delivery orders and preparing quotes.
- Working with clients to define analytical methodologies, quality assurance requirements, reports, deliverables, and pricing.
- Overseeing sample management and informing laboratory staff of the anticipated arrival of samples for analysis.
- Conducting a final technical review of all client documents (quotes, hard copy deliverables, invoices, routine and specialized reports).
- Working with the accounting team on invoicing and collection issues.
- Working with the Laboratory Directors and Production Manager to project workloads and determine schedules.

2.6 Production Manager and Group Leaders

Group Leaders are a critical link between project management, lab personnel and support staff. They report to the Technical Directors and have the following responsibilities:

- Planning and coordinating the operations of their groups to meet client expectations.
- Scheduling sample preparation and analyses according to holding times, quality criteria, and client due dates.
- Ensuring a multi-level review of 100% of data generated by their groups.
- Coordinating nonconformances and corrective actions in conjunction with the Quality Systems Management team.
- Serving as technical resources to their groups, including data review.
- Managing special projects, reviewing new work proposals, and overseeing the successful implementation of new methods.
- Monitoring and controlling expenses incurred within their groups such as overtime and consumables.
- Providing performance and career development feedback to their group members.

2.7 Laboratory and Technical Staff - General Requirements

At GEL, every effort is made to ensure that the laboratory is sufficiently staffed with personnel who have the training, education and skills to perform their assigned jobs competently.

Depending upon the specific position, laboratory personnel are responsible for:

- Complying with quality assurance and quality control requirements that pertain to their group and/or technical function.
- Demonstrating a specific knowledge of their particular function and a general knowledge of laboratory operations.
- Understanding analytical test methods and standard operating procedures that are applicable to their job function.
- Documenting their activities and sample interactions in accordance with analytical methods and standard operating procedures.
- Implementing the quality assurance program as it pertains to their respective job functions.
- Identifying potential sources of error and reporting any observed substandard conditions or practices.
- Identifying and correcting any problems affecting the quality of analytical data.

2.8 Information Systems Manager

The Information Systems Manager reports directly to the COO. The responsibilities of this position include management of the Computer Services Team and ALPHALIMS, our laboratory information management system.

The combined responsibilities of the Information Systems Team, performing under the leadership of the Information Systems Manager, include the:

- Development and maintenance of all software and hardware.
- Translation and interpretation of routines for special projects.
- Interpretation of general data and quality control routines
- Optimization of processes through better software and hardware utilization.
- Customization, testing and modification of data base applications.
- Maintenance and modification of our computer modeling, bar coding, CAD, statistical process control, project management, and data packaging systems.
- Development and maintenance of client and internal electronic data deliverables.
- Validation and documentation of software used in processing analytical data.

2.9 Environmental Manager

The Environmental Manager oversees our physical facility, laboratory and radiation safety programs, and instrumentation. This position reports to the COO, and manages and supervises the functions and staff assigned to these areas.

Responsibilities of the Environmental Manager include:

- Planning, evaluating and making recommendations for facility maintenance, additions and renovations.
- Overseeing building renovations and new construction activities.
- Implementation of the Chemical Hygiene and Radiation Safety programs.
- Installing, maintaining, repairing and modifying analytical instrumentation.
- Providing technical expertise and training in instrumentation operation, calibration and maintenance.
- Monitoring and ensuring regulatory compliance for waste management operations and off-site disposal.

2.10 Director of Human Resources

The Director of Human Resources reports directly to the CEO. The DHR manages the design, implementation, and ongoing development of our Human Resources. Responsibilities of the DHR include:

- Administration, orientation and indoctrination of all new employees
- Administration and compliance with Federal, State, and Local employment regulations
- Sourcing candidates for all functional positions to maintain and strengthen the technical services provided by GEL
- Management of occupational health and safety as it relates to Federal, State, and OSHA regulations

2.11 Employee Training

To ensure that our clients receive the highest quality services possible, we train our employees in the general policies and practices of the company, as well as the specific operating procedures relative to their positions. We conduct and document this training according to GL-

HR-E-002 for Employee Training and GL-HR-E-003 for Maintaining Training Documentation.

New employees participate in a company orientation shortly after they are hired. During orientation they receive information on quality systems, ethics/data integrity, laboratory safety, and employment practices. Each new employee is also provided a manual that reiterates our policies on equal opportunity, benefits, leave, conflicts of interest, employee performance and disciplinary action. Employees can access standard operating procedures, the Quality Assurance Plan, Safety, Health and Chemical Hygiene Plan, and the Laboratory Waste Management Plan on GEL's Intranet.

Other training provided on an ongoing basis may include:

- Demonstration of initial proficiency in analytical methods and training to SOPs conducted by a trainer who has been documented as qualified and proficient in the process for which training is being provided.
- Demonstration of continued analyst proficiency is updated annually, usually during the first quarter of each year. Proficiency is demonstrated by acceptable LCS data, which is readily available for query and review through the ALPHALIMS system.
- Company-wide, onsite training.
- Courses or workshops on specific equipment and analytical techniques.
- University courses.
- Professional and trade association conferences, seminars, and courses.

Documentation of employee training is the joint responsibility of the employee and the applicable Group Leader. If an SOP is revised during the course of the year, training to the revised SOP must be documented.

2.12 Ethics and Data Integrity

As our corporate vision statement explains, "We are a company that values: Excellence as a way of life, Quality Service, A Can-Do attitude, and a fundamental commitment to Ethical Standards." Employees attend Ethics education programs that focus on the high standards of data integrity and ethical behavior mandated by our company and expected by our clients.

The annual ethics training includes:

- Specific examples of unethical behaviors for the industry and for the laboratory
- Explanation of Internal Auditing for unethical behaviors and practices
- GEL use of electronic audit functions using instrument and AlphaLIMs software
- Explanation of GEL's Ombudsman policy for reporting inappropriate activities
- Examples of consequences of inappropriate or unethical behaviors/practices

All employees sign an Ethics and Data Integrity Agreement that reflects their commitment to always perform their duties with these high standards. (See Appendix G.)

SECTION 3
QUALITY SYSTEMS

Section 3 - Quality Systems

Our Quality Systems include all quality assurance (QA) policies and quality control procedures (QC) necessary to plan, implement, and assess the work we perform. GEL's QA Program establishes a quality management system (QMS) that governs all of the activities of our organization.

GEL's quality management system is designed to conform to the requirements specified in the standards referenced in Appendix A. Essential elements of our quality management system are described in this section.

3.1 Quality Systems Team

The quality systems team is responsible for managing GEL's QA Program. This team functions independently of the systems it monitors and is comprised of the Quality Systems Director, Lead Auditor, QA Officers and/or Specialists.

Following is a summary of the responsibilities of each position.

3.1.1 Quality Systems Director

- Reports to the CEO
- Demonstrates strict adherence to and support of the company ethics policy.
- Serves as management's representative for quality
- Responsible for the implementation and maintenance of the QMS
- Supervises the Quality Systems Team and their functions
- Initiates and recommends preventive action and solutions to quality problems
- Implements appropriate action to control quality problems until solutions are implemented and verified to be effective
- Verifies that effective solutions are implemented
- Demonstrates knowledge of the Quality System as defined by NELAC, DOECAP, and AND DOELAP.

3.1.2 Quality Systems Lead Auditor

- Reports to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Demonstrates knowledge of the Quality System defined under NELAC, DOECAP, and DOELAP and other quality standards such as ISO 9001:2000.
- Plans, schedules and participates in GEL's client audits, internal audits and subcontractor audits
- Conducts conformance audits as necessary to verify implementation and closure of audit action items
- Serves as liaison to client and third party auditors
- Coordinates laboratory responses to audit reports and prepares final response
- Monitors progress of corrective actions
- Prepares and monitors progress of internal and subcontractor audit reports

3.1.3 Quality Assurance Officers

- Report to the Quality Systems Director
- Demonstrate strict adherence to and support of the company ethics policy.
- Demonstrate the ability to evaluate data objectively without outside influence
- Have documented training and/or experience in QA/QC procedures and knowledge of the Quality system as defined under NELAC
- Have knowledge of analytical methods
- Assist in the conduct of internal and supplier audits
- Administer corrective actions and nonconformances
- Monitor and respond to client -identified nonconformances and technical inquiries
- Implement and maintain statistical process control (SPC) system
- Ensure the monitoring of balances, weights, and temperature regulation of ovens, waterbaths, and refrigerators
- Coordinate the monitoring of DI water system and volatile coolers
- Write or review Quality documents and standard operating procedures under the direction of the QS Director
- Provide training in quality systems and good laboratory practices.
- Manage Laboratory Certification processes

- Coordinate the receipt and disposition of external and internal performance evaluation samples.

NOTE: Once PE samples have been prepared in accordance with the instructions provided by the PE vendor, they are managed and analyzed in the same manner as environmental samples from clients. The analytical and reporting processes for PE samples are not specially handled.

3.1.4 Quality Systems Specialists

- Report to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Assist the team as directed with respect to Records Management, Document Control, Laboratory Certification, temperature and weight calibrations, logbook review, training documentation and nonconformances, etc.

3.2 Quality Documents

Our Quality Systems policies and procedures are documented in the QA Plan (GL-QS-B-001) and other supporting documents. GEL's management approves all company quality documents. Pre-approval is secured for any departures from such documents that may affect quality.

In addition, to the QA Plan, Quality Systems allows for QA Project plans (QAPjP) and includes standard operating procedures and any other quality assurance program requirements defined by individual contracts. The QA Plan describes the quality standards that we apply to our laboratory operations. We use Quality Assurance Project Plans to specify individual project requirements. The QA Plan and supporting documents are verified to be understood and are implemented throughout the laboratory fractions to which they apply.

Finally, our Standards Operating Procedures (SOPs) are used to describe in detail those activities that affect quality. SOP's are prepared, authorized, changed and released in accordance with GL-ADM-E-001. SOPs are accessible electronically via GEL's Intranet.

3.3 Document Control

The control of quality documents is critical to the effective implementation of our Quality Program. We define and control this process in accordance with GL-DC-E-001 for Document Control. Responsibilities for document control are divided between the Group Leaders and the Document Control Officer (DCO).

Group Leaders are responsible for:

- Supporting the development and maintenance of controlled documents that apply to their respective departments
- Reviewing all quality documents annually for continued validity
- Ensuring documentation that the affected employees are aware of revisions to documents or manuals.

The Computer Services Team is responsible for:

- Electronic maintenance of all records required for control, re-creation and maintenance of analytical documentation
- Maintenance of electronic copies of archived data and the electronic log of how they were determined

The DCO is responsible for:

- Demonstrating strict adherence to and support of the company ethics policy.
- Managing the system for the preparation, authorization, change and release of the Quality Manual, QAP, project plans and standard operating procedures
- Ensuring that current controlled documents are accessible via GEL's Intranet.
- Managing a system to document current revision numbers and revision dates for all distributed documents and manuals
- Managing a system to identify the nature of document revisions.
- Maintaining hard or electronic copies of obsolete documents
- Maintaining electronic or hard copy originals of all controlled documents

Revisions to controlled quality documents are made by replacing individual sections or the entire document, as determined by the DCO.

3.4 Controlled Document Review

Internally generated controlled documents undergo a multi-level review and approval process before they are issued. These levels include a procedural review, technical and/ or quality review and the final authorization of the appropriate manager or director. To ensure that new or revised standard operating procedures are not implemented prematurely, SOPs are effective upon the date of the final approval signature.

3.5 Quality Records

Quality records provide evidence that specified quality requirements have been met and documented. We generate them in accordance with applicable procedures, programs and contracts. Quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- Audit records
- Run logs, instrument data and analytical logbooks
- Instrument, equipment and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports and corrective actions
- Method development and start-up procedures including method detection limit studies
- Technical training records
- Waste management records
- Standard logs
- Software validation documentation
- Standard Operating Procedures (SOPs)
- Sample collection and field data

Our Quality Records are:

- Documented in a legible manner
- Indexed and filed in a manner conducive to ready retrieval
- Stored in a manner that protects them from loss, damage, and unauthorized alterations
- Accessible to the client for whom the record was generated
- Retained and disposed in the identified time period

The generation, validation, indexing, storage, retrieval, and disposition of our quality records are detailed in GL-QS-E-008 for Quality Record Management and Disposition. The Quality Records of subcontracted services are also required to meet the conditions established in this SOP.

3.6 Internal and Supplier Quality Audits

We conduct internal audits annually to verify that our operations comply with the requirements of our QA program and those of our clients. We perform supplier audits as necessary to ensure that they too meet the requirements of these programs. Both internal and supplier audits are conducted in accordance with GL-QS-E-001 for the Conduct of Quality Audits.

3.6.1 Audit Frequency

Internal audits are conducted at least annually in accordance with a schedule approved by the Quality Systems Director. Supplier audits are contingent upon the categorization of the supplier, and may or may not be conducted prior to the use of a supplier or subcontractor (see GL-QS-E-001). Type I suppliers and subcontractors, regardless of how they were initially qualified, are re-evaluated at least once every three years.

Additional internal and supplier audits may be scheduled if deemed necessary.

3.6.2 Audit Team Responsibilities

Internal and supplier audits are conducted by qualified staff under the direction of the Lead Auditor or Quality Systems Director. A qualified audit team member shall have the technical expertise to examine the assigned activities.

We do not allow staff to audit activities for which they are responsible or in which they are directly involved. It is the responsibility of the Lead Auditor to ensure that such conflicts of interest are avoided when the audit team is assembled.

The Leadership Team has a significant role in the internal audit process, including:

- Provision of audit personnel
- Empowerment of the audit team with authority to make the audit effective
- Development and implementation of timely corrective action plans

3.6.3 Identification and verification of OFIs

Opportunities for Improvement are identified conditions that adversely affect the quality of products or services. Several examples of objective evidence are used to support an OFI, which might be classified as a finding, concern, observation, and/or recommendation.

The Lead Auditor may initiate a Nonconformance (NCR) or Corrective Action Request and Report (CARR) referencing the OFI. The NCR or CARR is then entered

into the NCR system per GL-QS-E-012 for NCR Database Operation.

Implementation of a corrective action is later verified by a re-audit of the deficient area, review of new or revised documents, or, if the OFI does not warrant immediate action, the corrective action may be verified during the next scheduled audit.

3.7 Managerial and Audit Review

Our Leadership Team reviews the audit process at least yearly. This ensures the effectiveness of the corrective action plan and provides the opportunity to introduce changes and improvements.

We document all review findings and corrective actions. Implementation plans and schedules are monitored by the QS Team.

3.8 Nonconformances

Processes, materials, and services that do not meet specifications or requirements are defined as nonconforming. Such non-conformances can include items developed in-house or purchased from vendors, samples received from clients, work in progress, and client reports.

At GEL, we have a nonconformance reporting system (NCR) that helps us prevent the entry of defective goods and services into our processes and the release of non-conforming goods and services to our clients. Our NCR system provides a means for documenting the disposition of nonconforming items and for communicating these to the persons involved in the process affected by the adverse condition(s).

Nonconformances are documented according to GL-QS-E-004 for the Documentation of Nonconformance Reporting and Disposition and Control of Nonconforming Items. We regularly review SOPs, client complaints, and quality records, including completed NCRs, to promptly identify conditions that might result in situations or services that do not conform to specified quality requirements.

Our Quality Assurance Officers process, categorize and trend nonconformances. Trending information is provided to the Leadership Team and Group Leaders of the affected areas.

3.9 Corrective Action

There are two categories of corrective action at GEL. One is corrective action implemented at the analytical and data review level in accordance with the analytical SOP. The other is formal corrective action documented by the Quality Systems Team in accordance with GL-QS-E-002. Formal corrective action is initiated when a nonconformance reoccurs or is so significant that permanent elimination of the problem is required.

We include quality requirements in most analytical SOPs to ensure that data is reported only if the quality control criteria is met or the quality control measures that did not meet the acceptance criteria are documented.

Formal corrective action is implemented according to GL-QS-E-002 for Conducting Corrective Action and documented according to GL-QS-E-012 for NCR Database Operations.

Any employee at GEL can identify and report a nonconformance and request that corrective action be taken. Any GEL employee can participate on a corrective action team as requested by the QS team or Group Leaders. The steps for conducting corrective action are detailed in GL-QS-E-002.

3.10 Performance Audits

In addition to internal and client audits, our laboratory participates in annual performance evaluation studies conducted by independent providers. We routinely participate in the following types of performance audits:

- Proficiency testing and other inter-laboratory comparisons.
- Performance requirements necessary to retain certifications (Appendix D).
- Evaluation of recoveries of certified reference and in-house secondary reference materials using statistical process control data.
- Evaluation of relative percent difference between measurements through SPC data.

We also participate in a number of proficiency testing programs for federal and state agencies and as required by contracts. It is our policy that no proficiency evaluation samples be analyzed in any special manner.

Our annual performance evaluation participation generally includes a combination of studies that support the following:

- US Environmental Protection Agency Discharge Monitoring Report, Quality Assurance Program (DMR-QA). Annual national program sponsored by EPA for laboratories engaged in the analysis of samples associated with the NPDES monitoring

program. Participation is mandatory for all holders of NPDES permits. The permit holder must analyze for all of the parameters listed on the discharge permit. Parameters include general chemistry, metals, BOD/COD, oil and grease, ammonia, nitrates, etc.

- Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP). A semiannual program developed by DOE in support of DOE contractors performing waste analyses. Participation is required for all laboratories that perform environmental analytical measurements in support of environmental management activities.
- Environmental Measurements Laboratory (EML). Semiannual DOE radionuclide program for analysis of low-level radionuclides in environmental samples. Participation is required for DOE contractor per DOE order 5400.1, Chapter IV, Part 10C. Participation is also required for laboratories performing work in support of DOE/Environmental Management (EM). Matrices evaluated are from actual materials obtained from the environment at DOE facilities.
- The PAT program is utilized for metals and organics in air monitoring. It is a quarterly industrial hygiene laboratory proficiency program administered by AIHA for the analysis of metals, organics and asbestos. Successful participation is mandatory in order to obtain and maintain AIHA accreditation.
- ERA's InterLab RadCheM Proficiency Testing Program for radiological analyses. This program completes the process of replacing the USEPA EMSL-LV Nuclear Radiation Assessment Division program discontinued in 1998. Laboratories seeking certification for radionuclide analysis in drinking water also use the study. This program is conducted in strict compliance with the USEPA National Standards for Water Proficiency Testing Studies.
- Water Pollution (WP). Biannual program for waste methodologies. Parameters include both organic and inorganic analytes.
- Water Supply (WS): Biannual program for drinking water methodologies. Both organic and inorganic parameters are included.

At GEL, we also evaluate our analytical performance on a regular basis through statistical process control acceptance criteria. Where feasible, this criteria is applied to both measures of precision and accuracy and is specific to sample matrix.

We establish environmental process control limits at least annually. In Radiochemistry, quality control evaluation is based on static limits rather than those that are statistically derived. Our current process control limits are maintained in AlphaLIMS.

We also measure precision through the use of matrix duplicates and/or matrix spike duplicates. The upper and lower control limits (UCL and LCL respectively) for precision are plus or minus three times the standard deviation from the mean of a series of relative percent differences. The static precision criteria for radiochemical analyses is 0 - 20% for activity levels exceeding the contract reporting detection limit (CRDL).

Accuracy is measured through laboratory control samples and/or matrix spikes, as well as surrogates and internal standards. The UCLs and LCLs for accuracy are plus or minus three times the standard derivation from the mean of a series of recoveries. The static limit for radiochemical analyses is 75 - 125%. Specific Instructions for out-of control situations are provided in the applicable analytical SOP.

3.11 Essential Quality Control Measures

Some quality control measures are method-specific. There are, however, general quality control measures that are essential to our quality system. These quality measures are described in Appendix F and include:

- Monitoring of negative and positive controls
- Defining variability and reproducibility through duplicates
- Ensuring the accuracy of test data including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, etc.
- Evaluating test performance using method detection limits and quantitation limits or range of applicability such as linearity
- Selecting the appropriate method of data reduction

SECTION 4

FACILITIES

Section 4 - Facilities

Our laboratory is designed with a full-service approach to handling environmental needs. The layout provides dedicated space for radiochemical analyses, bioassay analysis, organic extractions, semi-volatile organic analyses, volatile organic analyses, metals analyses, general chemistry analyses, and air analyses.

The laboratory and support offices occupy approximately 85,000 square feet engineered to meet the stringent quality control and utility requirements of the modern environmental laboratory. Records are temporarily stored on-site then warehoused in a climate-controlled building off-site. The diagram in Appendix I depicts the layout of the laboratories.

Discussed in this section are:

- Facility security
- Utility services and deionized water
- Prevention of contamination
- Assessment of contamination

4. Facility Security

Our facility features secured laboratory and storage areas. Restricted entry assures sample integrity and client confidentiality, which satisfies clients and potential national security interests.

Visitors cannot gain entry without being escorted through the laboratory by authorized personnel. A designated sample custodian and a bar-coded chain-of-custody provide a second level of security.

4.2 Utility Services

Each defined laboratory area is equipped with the following utilities:

- Cold Water
- Hot Water
- Deionized Water
- Compressed Air
- Natural Gas
- Vacuum
- 110 Volt AC
- 208 Volt AC (at selected stations)
- Specialty gases (as required)

4.2.1 Deionized Water

We have two independent deionized water (DI) systems. One serves radiochemistry while the other serves the remaining laboratories. DI water is made from city water flowing through a deionization system capable of producing 5 gallons per minute of Type II laboratory water. Tables 1 and 2 list the minimum requirements for Type I and Type II DI water.

Table 1: ASTM Type I DI Water

Quality Parameter	Limits
Bacteria, CFU/mL	<10
pH	not specified
Resistivity, min. MΩ-cm at 25C	>16.67
Conductivity, max. μmho/cm at 25C	≤ 0.06
Trace Metals, Single (Cd,Cr,Cu,Ni,Pb, Zn)	< 0.05 mg/L
Trace Metals, Total	< 0.1 mg/L
Free Chlorine	not specified
Ammonia/Organic Nitrogen	not specified
TOC	not specified
Organic Contaminants	Activated carbon

Table 2: ASTM Type II DI Water

Quality Parameter	Limits
Bacteria, CFU/mL	< 1000
pH	not specified
Resistivity, min. MΩ-cm at 25C	> 1.0
Conductivity, max. μmho/cm at 25C	≤ 1.0
Trace Metals, Single (Cd,Cr,Cu,Ni,Pb, Zn)	< 0.1 mg/L
Trace Metals, Total	not specified
Free Chlorine	< 0.1 mg/L
Ammonia/Organic Nitrogen	< 0.1 mg/L
TOC	< 1.0 mg/L
Organic Contaminants	not specified

We monitor compliance with the above limits according to GL-LB-E-016 for Collection and Monitoring the DI Water Systems. Our monitoring activities and frequencies can be found in Table 1 of the SOP.

4.3 Prevention of Contamination

Work areas that are free of sample contaminants, constituents and measurement interferences are important to the generation of quality data. With this in mind, we designed our laboratories to prevent contamination and reinforce this design with good laboratory practices.

In addition to keeping our work areas free of dust and dirt accumulations, policies and features that prevent or minimize contamination include:

- An air conditioning system that controls the environment of individual laboratories for optimum performance of sensitive instruments and to eliminate potential cross contamination
- Segregation of volatile and semi-volatile laboratories to minimize potential contamination associated with the use of commonly required solvents
- Negative and positive pressure air locks to isolate selected laboratories to prevent the entry of airborne contaminants
- Fume hoods to remove fumes and reduce the risk of aerosol and airborne contaminants and personnel safety hazards are monitored in accordance with GL-FC-E-003 for Fume Hood Face Velocity Performance Checks.
- Restricted access to the volatiles laboratory (authorized personnel only)
- Designated area for glassware preparation wherein all glassware used in sample prep and analysis is cleaned according to GL-LB-E-003 for Glassware Preparation
- Segregated storage areas for volatiles and radioactive samples
- Production, use and monitoring of Type I and Type II DI water

4.4 Assessment of Contamination Levels

We evaluate contamination resulting from the following sources on the basis of quality assurance and quality control data derived from the analytical method and method blanks.

- Sample containers
- Reagent water
- Reagents and solvents
- Sample storage
- Chemical and physical interference
- Constituent carryover during analysis

Contamination in each of the volatile storage coolers is monitored by the weekly analysis of water blanks. Four DI water blanks are placed in the cooler at the beginning of each month with one being analyzed each week. If the concentration of any target analyte exceeds the PQL, corrective action is implemented to eliminate the source of contamination, evaluate the effect of samples stored in the cooler, and to notify clients.

SECTION 5

EQUIPMENT and REFERENCE MATERIALS

Section 5 - Equipment and Reference Materials

GEL's ability to efficiently generate data that is reproducible, accurate, and legally defensible is attributable to our use of high-quality instruments, equipment, and reference materials.

Provided in this section are:

- GEL's policies governing instruments, equipment, and reference materials
- Identification of instrumentation and support equipment
- Procurement protocol

5.1 General Policies

It is our policy to purchase instrumentation, equipment and high-quality reference materials that meet or exceed the method and regulatory requirements for the analyses for which we are accredited. If we need to use instruments or equipment not under our permanent control, we ensure that it also meets these standards.

Instrumentation and equipment is placed into service on the basis of its ability to meet method or regulatory specified operating conditions such as range and accuracy. All laboratory instrumentation and testing equipment is maintained in accordance with standard operating procedures (SOPs).

Instrumentation and equipment is used in a manner that assures, where possible, that measurement uncertainty is known and consistent with specified quality requirements. Instruments and equipment are taken out of service and segregated or labeled as such under the following conditions:

- Mishandling and/or overloading
- Results produced are suspect
- Demonstrated defect or malfunction

Tagged or segregated instruments and equipment remain out of service until repaired and shown by test, calibration, or verification to perform satisfactorily. Instruments that are in service and normally calibrated prior to and during use are not tagged.

Each item of equipment, including reference materials is, if appropriate, labeled, marked or otherwise identified to indicate its calibration status. We maintain records for each major item of equipment, instrumentation, and all reference materials significant to quality performance. These records are often in the form of maintenance logs, which are kept in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other record Keeping Devices.

Documentation included in these records includes but is not limited to:

- Equipment name
- Manufacturer's name
- Type identification
- Serial number or other unique identification
- Date received and date placed in service (if available)
- Current location
- Condition when received (if known)
- Manufacturer's instruction, where available
- Dates and results of calibrations and or verifications
- Date of next calibration and/or verification, where written procedures do not specify frequency
- Details of maintenance carried out to date and planned for the future
- History of any damage, malfunction, modification or repair

5.2 Instrumentation and Support Equipment

Appendix H lists the instruments we use for the analysis of environmental, radiochemical and bioassay samples. Where feasible, our instruments are equipped with autosamplers that improve efficiency and facilitate consistent sample introduction to the sample detector. They are also connected to an area network to facilitate data transfer.

Devices that may not be the actual test instrument but are necessary to support laboratory operations are referred to as support equipment. We also maintain this equipment in proper working order. Support equipment utilized at GEL includes:

- balances
- ovens
- refrigerators
- freezers
- incubators
- water baths
- temperature measuring devices
- volumetric dispensing devices

- muffle furnaces
- distillation apparatus
- grinders and homogenizers
- hot plates and heating mantles
- ultraviolet sterilizers.

Guidelines for the required calibration and evaluation of this equipment are discussed in Section 7.

We perform radiochemical and bioassay analytical services in accordance with the instrumentation and reference methods approved by the Department of Energy (DOE), the Environmental Measurements Lab (EML), the Environmental Protection Agency (EPA), ASTM, and Los Alamos Health and Environmental Chemistry (LAHEC). Modifications to these methods may be appropriate as a result of Performance Based Measurement Systems (PBMS).

SOPs are used to describe our procedures for all routine analyses performed by our labs. These procedures include step-by-step instructions for sample collection, storage, preparation, analysis, instrument calibration, quality control, disposal, and data reporting.

5.3 Procurement and Control of Purchased Items

Materials and services that affect the quality of our products are designated as Quality Materials and Services and are only purchased from approved suppliers. We approve and document suppliers according to GL-QS-E-001 for the Conduct of Quality Audits.

At GEL, we maintain documentation of specific quality requirements for Quality Materials and Services. Records that document the quality of a product or service may include:

- certificates of analysis and traceability
- verifications of chemical quality
- inspections of equipment or materials
- verifications or inspections of vendor product specifications

Our procedure for requisitioning supplies, instruments, equipment and other common use material is described in GL-RC-E-002 for Material Requisition. These requests typically include:

- The date and name of person(s) requesting materials
- Account, department, project number to which the material is to be billed
- Recommended supplier or vendor
- Additional information necessary to expedite the purchase request
- Specifications that could affect the quality of products and services
- Vendor's material part number
- Amount of material needed
- Description of material
- Cost per unit
- Person(s) authorizing the purchase
- Time frame in which the material is needed

The equipment, instruments and reference materials we purchase are inspected upon receipt in accordance with GL-RC-E-001 for the Receipt and Inspection of Material and Services. This inspection is to verify that procured items meet the acceptance criteria defined in the procurement documentation. Staff performing initial inspection routinely:

- Open and inspect all items for damage
- Compare the items with the issued purchase order or contract for catalog or part number, description or procurement specification, quality requirement, and acceptance criteria
- Label items with a limited shelf life with the date received
- Determine if the items conform to the specifications agreed to by the vendor.

The individual responsible for the technical acceptance of the item provides procurement and receiving staff with the proper acceptance documentation. Items found not to conform to quality standards are returned to the supplier, identified as nonconforming or disposed according to the established procedures in GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning, and Control of Nonconforming Items.

SECTION 6
HEALTH and SAFETY

Section 6 - Health and Safety

GEL maintains a safe work environment and promotes healthy work practices. Our corporate Safety, Health and Chemical Hygiene Plan was developed by a resident certified industrial hygienist. Procedures outlined in the plan are consistent with Occupational Safety and Health Administration, CERCLA, the Environmental Protection Agency, and SCDHEC.

All employees are trained in the safety practices applicable to their job functions. This training is conducted in accordance with GL-HR-E-002 for Employee Training.

Discussed in the section are:

- Fire safety and safety equipment
- Safety equipment and procedures related to handling radioactive samples

6.1 Fire Safety

Our facility is equipped with a fire alarm system designed to detect smoke in all areas of the facility. Certain high-risk areas, such as, the cold and ambient storage areas, organic sample preparation lab, hazardous waste lab, and solvent storage are additionally equipped with automatic halon systems. Fire blankets and dry chemical extinguishers are located at strategic points throughout the lab. We routinely inspect these extinguishers in accordance with GL-FC-E-004. Lab personnel are trained in the proper use and selection of fire extinguishers.

In order to decrease the risk of fire, bulk solvents are stored in a halon protected storage room.

6.2 Evacuation

In the unlikely event of a fire (or other emergency), we have defined evacuation routes depicted in Appendix I. This diagram is posted in pertinent areas of the facility and designated staff serve as evacuation leaders for the work groups.

6.3 Safety Equipment

Safety equipment, including safety glassed, lab coats, safety goggles, protective gloves, hard hats, and coveralls, is available to all employees as needed. We also provide respirators when needed to those who have completed training in the use of this specialized equipment.

Eyewashes and overhead showers are located throughout the laboratory. We routinely inspect these as directed in GL-FC-E-002 for Testing of Emergency Eyewash and Shower Equipment.

6.4 Radiation Safety

Since GEL specializes in the handling of radioactive material, we have health physics procedures to ensure its safe handling. While lab personnel do not encounter significant levels of radiation requiring personnel monitoring, a Dosimetry Program is in effect utilizing personal dosimeters for designated personnel. These dosimeters are exchanged quarterly and records of exposure are maintained. Instructions for the proper use of dosimeters are addressed in GL-RAD-S-009 for Dosimetry Procedures.

We take special precautions to ensure that samples are safely processed. Upon receipt, trained personnel use a survey meter to screen all samples for the presence of radioactivity. Protocols for the receipt of radioactive samples and for surveying suspected or known radioactive samples are detailed in GL-RAD-S-007 for Receiving Radioactive Samples and GL-RAD-S-001 for Radiation Survey Procedures. This process is described in Section 9.

Upon leaving a radiologically controlled area, personnel check their hands and feet for potential contamination. This is done utilizing detection instrumentation that employs Geiger-Mueller or scintillation technologies. In addition, stations with portable detection instruments are set up for personnel frisking and in-process contamination surveys.

Key areas throughout the facility are surveyed:

- Laboratory analytical areas (Monthly smears)
- Radioactive Sample Storage Areas (Monthly smears and exposure rate)
- Sample Receipt and Waste Handling Areas (Monthly smears and exposure rate)
- Unrestricted and Radioactive Material Prohibited Areas (Quarterly smears)

SECTION 7

MEASUREMENT, TRACEABILITY, AND CALIBRATION

Section 7 - Traceability and Calibration

Traceability of measurements and the calibration of testing equipment are imperative to our ability to produce accurate and legally defensible data. As such, we have implemented procedures to ensure that equipment calibration and measurement verification are traceable to nationally recognized standards.

Where possible, calibration certificates provide traceability to national standards of measurement. Calibration certificates provide measurement results and any associated uncertainty of measurement, and/or a statement of compliance with the identified specification. Calibration certifications are maintained as quality records.

When traceability to a national standard is not applicable, verification of measurement is achieved through in inter-laboratory comparisons, proficiency tests, or independent analyses.

The following measurement and traceability practices are described in this section:

- Calibration criteria for support equipment
- General requirements
- Balances
- Temperature sensitive devices and temperature monitoring
- Air displacement pipets
- Calibration criteria for instruments
- Calibration verification
- Initial calibration verification
- Continuing calibration verification

7.1 Calibration Criteria for Support Equipment

This section addresses calibration protocols for support equipment, including balances, temperature - sensitive equipment, and air displacement pipets. The general criteria applicable to the calibration of support equipment is as follows:

- Equipment is maintained in proper working order. Records of all maintenance activities including service calls are kept.
- Calibrations or verifications over the entire range of use, using NIST traceable references when available, are conducted annually.
- If results of calibration and verification are not within the specifications for the equipment's application, then:
  1. The equipment is removed from service until repaired
  2. Under certain conditions, a deviation curve may be prepared. All measurements are corrected for the deviation, recorded and maintained.
- Prior to use each day, balances, ovens, freezers, refrigerators, incubators and water baths are checked with NIST traceable references (where possible) in the expected use range.
- If prescribed by the test method, additional monitoring is performed for a device used in a critical test (such as an incubator or water bath).
- Support equipment is used only if the reference standard specifications (provided by the supplier or described in the analytical method) are met.
- Reference standards of measurement such as Class S or equivalent weights or traceable thermometers may be used for calibration when demonstrated that their performance as reference standards will not be invalidated.
- Reference standards of measurement are calibrated by a body that can provide, where possible, traceability to a national standard.
- Reference standards and measuring and testing equipment are, where relevant, subject to in-service checks between calibrations and verifications.
- Reference materials, where possible, are traceable to national or international standards of measurement, or to national or international standard reference materials.
- Mechanical volumetric dispensing devices, except Class A glassware, are checked monthly for accuracy.

7.1.1 Balances

Our balances are under a service contract for annual calibration, maintenance and cleaning. Each balance is labeled with a serial number, service date, date of next service, and signature of the service technician.

Balances are setup, calibrated, and operated in the range required by the analytical method in accordance with GL-LB-E-002 for Balances. Prior to using a balance, the analyst is responsible for checking its calibration.

Calibration and calibration verification are performed using weights that are or have been calibrated against Class S or equivalent weights. These weights are traceable to NIST and calibrated annually by the South Carolina Department of Agriculture (or other independent agency).

Calibration and calibration verification is recorded in the balance calibration logbook If the calibration or calibration verification does not meet the specified acceptance criteria, the balance is recalibrated. If the calibration criteria is still not met, the balance is removed from service and tagged as such.

7.1.2 Refrigerators, Freezers, Incubators, Ovens, Water Baths and Similar Devices

Careful control of temperature is often central to the production of acceptable data. Temperature excursions beyond the established limits may invalidate a procedure and the associated data. Constant monitoring in accordance with GL-LB-004 for Temperature Monitoring assures us that regulatory and/or method temperature requirements are being met.

We measure temperatures with thermometers that are calibrated annually against a NIST traceable thermometer. The NIST traceable thermometers are independently calibrated at least once per year. The protocol for thermometer calibration is described in GL-QS-E-007. We monitor the temperature of the following equipment according to GL-LB-004:

- Refrigerators and freezers used to store samples, standards, and other temperature sensitive materials
- Incubators
- Ovens
- Water Baths
- Autoclaves

We monitor the temperatures of refrigerators and freezers prior to use on each working day. The temperatures of ovens, water baths, and other devices used as part of an analytical process must be monitored prior to, during, and immediately after use. Incubators and other devices used for microbiological or other specialized analytical methods may require more frequent monitoring as specified in the corresponding SOP.

Temperature measurements are documented on logs specific to each piece of equipment. The logs are posted on or near each refrigerator, freezer, waterbath, oven or other temperature control device. Each log includes the following information:

- Date and time of each measurement

Initials of person taking measurement

- Acceptance limits for device being monitored
- Whether device conforms with specifications at time of measurement
- Name, location and number of device being monitored
- Name and telephone number of person to contact in event of device failure
- Notation of any out of control condition

The sterilization pressure of each autoclave run must be documented in addition to the sterilization temperature. When the process to maintain and document temperatures within acceptance limits does not conform to specifications, a nonconformance report (NCR) is issued. Appropriate action is then taken to disposition the nonconformance according to GL-QS-E-004 for Nonconformance Identification, Control, Documentation, Reporting, and Dispositioning.

Examples of nonconformances are:

- Failure to maintain process temperature within acceptance limits
- Failure of device to achieve calibration
- Total failure of temperature control device
- Failure to monitor the temperature as required

7.1.3 Air Displacement Pipets

Air displacement pipets offer a level of precision and accuracy exceeded only by Class A transfer pipets. Due to disposable tips, these pipets eliminate the possibility of cross-contamination.

We calibrate air displacement pipets monthly using five replicate measurements of a frequently used volume setting in accordance with GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets. As specified in the SOP, the calibration of an air displacement pipet is verified daily prior to use, based on a single point measurement.

The acceptance criteria for each measurement is based on the standard deviation of the five calibration measurements. Tolerance limits for commonly used

verification volumes and accuracy and precision checks are included in the pipet calibration logbook. Calibrations and daily calibration verifications are traceable to each pipet using the unique identification found on its label.

If a pipet does not meet the calibration tolerance limits, its is removed from service until it again demonstrates compliance after being cleaned and/or repaired. Analysts whose jobs may require the use of air displacement pipets are trained in their proper use and calibration.

7.2 Instrument Calibrations

To ensure that the data generated by an instrument is accurate, we calibrate the instrument using standards containing known concentrations of target analytes. We verify the accuracy of calibration standards by analyzing an additional standard containing the target analytes. This initial calibration verification standard (ICV) originates from a second source. The stability of the instrument over the calibration range is verified by the analysis of a continuing calibration verification standard (CCV).

Traceability of calibration, calibration verification, and other quality control standards to the recognized standard is documented per GL-LB-E-007 for Laboratory Standards Documentation. Individual identification numbers are assigned to each source standard and each subsequent intermediate and working standard prepared.

The identification number makes it possible to trace a standard to a parent standard and ultimately to the source standard. The date each standard is prepared, the recipe used in the preparation, the person preparing the standard, and the standard's expiration date are documented in the appropriate standards log. The information is accessible via the standard ID number.

We record the ID numbers on instrument run logs, analytical logbooks, sample preparation logs, and instrument raw data. Calibration standards that are used in the analysis of a particular sample or group of samples can be traced to NIST, US EPA, or other nationally recognized standard.

Calibration procedures for specific instruments, and the frequencies of performance for defined methods, are described in the applicable operating or analytical SOP. General guidelines include:

- Verification of initial calibrations with a standard obtained from a second source (unless one is not available).
- Analysis of verification standards (ICV and CCV) with each initial calibration within 15% of the true value unless historical data has demonstrated that wider limits are applicable.
- Preparation of calibration curves as specified in the reference method.
- If a test method does not specify the number of calibration standards, the minimum number is two not including blanks with one at the lowest quantitation limit. The reference SOP must establish the initial calibration requirements.

7.3 Calibration Verification

Unless otherwise specified by the method or demonstrated through historical data, the recovery of target analyte(s) in calibration verification standards shall be between 85 - 115%. We discuss additional requirements below.

7.3.1 Initial Calibration Verification (ICV)

- If an initial calibration curve is not established on the day of analysis, the integrity of the curve should be verified each day of use or every 24-hour period. Verification requires the initial analysis of a blank and standard from a second source. The standard concentration should be at the method-defined level. If not specified, a standard at a mid-level concentration may be used.
- If the initial calibration verification does not meet acceptance criteria, the analytical procedure is stopped and evaluated, and appropriate corrective measures are taken. Initial calibration verification must be acceptable before any samples are analyzed.

7.3.2 Continuing Calibration Verification

Additional standards called CCVs are analyzed after the initial calibration curve or the integrity of the initial calibration curve is accepted. CCVs are analyzed at a frequency of 5% or every 12 hours, whichever is more frequent. If instrument consistently drifts outside acceptance criteria before the next calibration, the frequency is increased.

CCVs may be from the same source as the calibration standards or a second source. The concentration is determined by the anticipated or known concentration of the samples and/or method-specified levels. At least one CCV shall be at a low-level concentration.

To the extent possible, we bracket the samples in each interval (every 20 samples or every 12 hours) with CCV concentrations closely representing the lower and upper range of reported sample concentrations. If this is not possible, the standard calibration checks should vary in concentration throughout the range of the data being acquired.

If the recovery of a CCV does not meet the acceptance criteria and routine corrective actions fail to produce a second consecutive check within acceptance criteria, a new initial calibration curve should be constructed. Analytes of interest found in corresponding environmental samples may be reported, however, if all of these criteria are met:

1. CCV recovery for target analyte exceeds the acceptance criteria (biased high)
2. Target analyte in the environmental sample is not detected at a concentration exceeding the level required by client contract (i.e., MDL, PQL).

Non-detects that meet this criteria are also referred to as "passable non-detects."

If samples are found to contain target analytes that exceed the associated quantitation limits and the CCV recovery does not meet the acceptance criteria, the affected samples are analyzed. This occurs only after a new calibration curve has been established, evaluated and accepted.

7.4 Bioassay Instrument Calibration and Frequency

Our Bioassay instruments are calibrated at the frequency of the instrument's use, stability, and method requirements. The calibration procedure for each instrument is described in the corresponding analytical SOP. A summary, however, is presented below. Client specified calibration frequencies are used when more stringent than our own requirements.

Gamma Spectrometer: daily source check; weekly background check; and annual calibration.

Alpha Spectrometer: daily pulser check; monthly background check; and monthly calibration.

Ra-226 Lucas Cells: daily source and background checks before use; annual calibration.

LSC: daily source and background checks before use; and calibration every 6 months.

Kinetic Phosphorimeter: daily source and background checks, high and low range, before use; and daily calibration, before use.

GFPC: daily source and weekly background checks, and annual calibration.

SECTION 8
ANALYTICAL METHODS AND STANDARD OPERATING PROCEDURES

Section 8 - Analytical Methods and Standard Operating Procedures (SOPs)

We provide a wide array of parameters including volatile organics, extractable organics, metals, general inorganic/wet chemistry, radiochemistry, radiobioassay and limited microbiology. The procedures we use to determine these parameters are consistently executed due to our extensive system of SOPs and our training requirements for analytical staff.

A list of our SOPs and the analytical methods they represent (if applicable) is provided in Appendix J. Discussed here are:

- Selection of analytical methods
- Standard operating procedures
- Method validation and initial demonstration of capability
- Sample aliquots
- Data verifications
- Standard and reagent documentation and labeling (Refer to Section 10.1)
- Computers and data requirements

8.1 Selection of Analytical Method

Project Managers are ultimately responsible for selecting the test codes and methods assigned to a client based on client requirements and sample collection techniques. In selecting methods, our goal is to meet the specific needs and requirements of the client while providing data that is scientifically valid.

When the use of a specific test method is mandated, only that method is used. If the analysis cannot be performed by the client-requested method, we notify the client. We do not perform method substitutions without the client's consent. We recommend that clients who submit data to regulatory agencies also obtain the agency's approval of method modifications.

A Project Management ALPHA LIMS User Manual (GL-CS-M-001) is available to assist PMs and PMAs in selecting test codes and methods and communicating the client's analytical and data reporting specifications.

8.2 Standard Operating Procedures (SOPs)

We determine each parameter by the protocol detailed in the corresponding SOP. The defined protocol originates from the analytical method or methods referenced in the SOP and may incorporate regulatory and client requirements. Descriptions of the methods we employ can be found in:

- EPA SW846 3rd Edition, Revision III
- EPA/600/479/020
- Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC)
- American Society for Testing and Materials (ASTM)
- Standard Methods for the Examination of Water and Wastewater (SM)
- South Carolina Department of Health and Environmental Control (SCDHEC)
- Code of Federal Regulations (CFR) Titles 40 and 49
- Department of Energy Environmental Measurements Laboratory (EML)
- Los Alamos Health and Environmental Chemistry (LAHEC)
- DOE
- HASL
- EPA CLP

In addition to these references, a number of our radiochemistry procedures were developed in conjunction with Florida Sate University (FSU) under the guidance of Dr. Bill Burnett.

Laboratory sections have access to GEL's SOPs to ensure that each operational system and analytical procedure is performed in a uniform manner. SOPs are controlled according to GL-DC-E-001 for Document Control and are posted on the Intranet by the Document Control Officer.

We write and issue SOPs in accordance with GL-ADM-E-001 for the Preparation, Authorization, Change and Release of Standard Operating Procedures. A technical and/or quality review is made of each new or revised SOP prior to its implementation.

Technical reviews ensure that procedures are technically sound and method-compliant, and are conducted by a senior analyst, group leader, or data reviewer. The quality review is an independent review by a member of the Quality Systems team and ensures that the quality requirements of the method, regulatory

agencies, and GEL are adequately and accurately identified.

SOPs are modified when:

- Instruments or equipment change
- An error is identified
- Improvements in technology and/or reagents need to be incorporated
- Reference methods are revised or discontinued

Proposed revisions are submitted for review on Documentation Initiation and Revision Request (DIRR) forms. Changes are not implemented without a technical and quality review.

We review our SOPs annually and revise them as necessary. Analytical SOPs either contain or reference other SOPs that contain:

- reference method
- applicable matrix or matrices
- method detection limit
- scope and application including parameters to be analyzed
- method summary
- definitions
- interferences and limitations
- specific safety requirements
- required equipment and supplies
- reagents and standards
- sample collection, preservation, shipment, and storage
- quality control
- calibration and standardization
- procedure
- calculations
- method performance
- pollution prevention
- data assessment and acceptance criteria for quality control measures
- corrective actions for out of control or unacceptable data
- waste management
- references
- tables, diagrams, flowcharts, validation data
- identification of any modifications we have made to the published procedure

8.3 Method Validation and Initial Demonstration of Capability

An initial demonstration of method performance is required before a new analytical method is implemented and any time that there is a significant change in instrumentation or methodology. Exempted from this requirement are microbiological analyses and any tests for which spiking solutions are not available. Analyses that are exempt include those for determining:

- total dissolved, total suspended, total volatile, and total solids
- pH
- odor
- color
- free liquids
- temperature
- dissolved oxygen
- turbidity

We conduct the initial demonstration as described in 8.3.1. Records of initial demonstration are maintained in accordance with GL-QS-E-008 for Quality Records Management and Disposition. These records are available upon request.

After we demonstrate our ability to perform a specific analysis, we continue to demonstrate method performance through the analysis of laboratory control samples and performance evaluation samples.

If spiking solutions or quality control samples are not available, an analyst is trained by a qualified trainer to conduct the analysis. Analyst capability and proficiency is evaluated by the appropriate Group Leader before the analyst is qualified to perform the analysis on client samples. The evaluation is documented and maintained according to GL-HR-E-003 for Maintaining Technical Training Records.

8.3.1 Procedure for Initial Demonstration of Capability

We conduct initial demonstrations of capability for mandated analytical or EPA reference test methods following the procedure outlined below. This procedure is adapted from the EPA test method published in 40CFR part 136, Appendix A.

Step 1: A quality control sample is obtained from an outside source (if possible). If one is not available, the sample may be prepared internally using stock standards that are prepared independently from those used in instrument calibration.

Step 2: The QC sample is diluted in a volume of clean matrix to a concentration approximately 10 times the method-stated or method detection limit determined in accordance with GL-LB-E-001 for the Determination of Method Detection Limits. Sufficient volume of the diluted

QC sample is prepared so that at least four aliquots of the required method are analyzed

Step 3: Four aliquots of the diluted quality control sample are prepared and analyzed according to the analytical test method. This may occur concurrently or over a period of days.

Step 4: With the results obtained from the analysis of the diluted QC sample, the average recovery (x) in the appropriate reporting units (such as ug/L) and the standard deviation of the population sample (n-1) (in the same units) is calculated for each parameter of interest.

Step 5: For each parameter, the standard deviation (s) and the average recovery (x) are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if a non-standard method). If "s" and "x" for all parameters meet the acceptance criteria, analysis of samples may begin. If any one parameter exceeds the acceptance range, the performance is unacceptable for that parameter.

Step 6: When one or more tested parameters fail one or more of the acceptance criteria we:

1. Locate and correct the source of the problem and repeat the test for every parameter of interest.
2. Repeat the test for all parameters that failed to meet criteria. Repeated failure will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem. Repeat the test for all compounds of interest.

8.4 Sample Aliquots

When obtaining aliquots from a sample, it is imperative that the subsamples be representative of the parent sample. This ensures that the results obtained from the analysis of the aliquots are representative of the entire parent sample, not just the subsample. We employ different techniques to obtain subsamples.

We can obtain representative aliquots of soil samples for the determination of metals through quartering. This involves the repeated quartering of the sample until the resulting quarter is equivalent to the amount of sample needed for analysis. Quartering may not be appropriate for obtaining subsamples for volatiles or other analyses where potential contamination or loss of target analytes is a concern.

Water samples are inverted several times prior to the collection of a subsample. This ensures a thorough mix and is absolutely required for the accurate determination of analytes like total and total suspended solids.

The appropriate techniques for obtaining sample aliquots for designated analyses are discussed in the applicable SOPs.

8.5 Data Verification

All of the data we include in final reports to our clients undergoes extensive data verification. At GEL, we have a multi-level review process that takes place in all areas of the laboratory beginning with sample login. This process and the responsibilities of each level of review are delineated in a number of procedures, including GL-OA-E-044 for Organics Data Validation, GL-GC-E-092 for General Chemistry Data Validation and Packaging, GL-MA-E-017 for Metals Data Validation, and GL-RAD-D-003 for Data Review, Validation, and Package Assembly.

8.5.1 Sample Login:

Samples are analyzed by the methods and for the target analytes identified when samples are logged into our database. If there is an error in this entry that is not promptly identified, the incorrect analytical method may be used or certain analytes may not be determined.

To prevent this, the person who enters the information into the database is generally the client's assigned Project Manager or PM Assistant. This entered information is reviewed against the client confirmation letter and/or chain of custody. If errors are identified, they are immediately corrected.

8.5.2 Data Validation in the Laboratory

The multi-level review process in our laboratory includes initial review by the analyst, a second review by a peer, and a final review by a group leader or data reviewer. Where appropriate based on personnel and client needs, the industrial division institutes two levels of review.

Our analytical data reviews ensure that:

- The analytical procedures comply with current SOPs.
- Quality control samples are analyzed at the frequency specified in the SOP or client specifications.
- The acceptance criteria for quality control samples is met, including recoveries of matrix spikes and laboratory control samples, the relative

percent difference for matrix duplicates, matrix spike duplicates, laboratory control sample duplicates, and concentrations of target analytes in the method blank.

- Instrument data, run logs, and logbooks are reviewed to ensure that all method quality control criteria were met (e.g., calibration, initial calibration verifications, and continuing calibration verifications).
- Documentation is sufficient to reconstruct the analytical procedure.
- Data is maintained according to GL-LB-E-008, "Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, and Other Record Keeping Devices."
- Raw data is in agreement with the computer generated batch sheets and data reports.
- The calculations, dilution factors, concentration reported, and nominal concentrations are verified.
- Comments, qualifiers, or nonconformances for noncompliant or questionable data are documented.
- Data generated when the analytical process appears to be out of statistical control is not reported.

8.5.3 Validation of Data Reports and Packages

Before we report data to the client, we review the requested data report for package accuracy, completeness, and client-specifications. Responsibilities for review are dependent upon the type of report or package being generated. (Refer to Section 11 for Data Report Formats.)

When a client is receiving a certificate of analysis or certificate of analysis and Quality Control Summary Report, the Project Manager (PM) or Project Manager Assistant (PMA) reviews the information for accuracy, completeness and the addition of pertinent comments made by the laboratory about the analysis or sample. The PM or PMA also reviews data for consistency as described in the Project Management ALPHALIMS Manual, GL-CS-M-001.

If a client requests a case narrative, our data validators review the analyst-prepared case narrative for accuracy and to assure its consistency with the information included on the certificate of analysis and Quality Control Summary Report. If a client requests a more detailed level of data package up to and including a CLP-like package, every laboratory fraction of data is reviewed by that fraction's data validator. The data is then compiled into a final data package again reviewed by the PM or PMA.

8.6 Standard and Reagent Documentation and Labeling

The documentation and labeling of standards and reagents is addressed in GL-LB-E-007 for Laboratory Standards Documentation, and in Section 10.1 of the QAP, Record Keeping System and Design.

8.7 Computer and Electronic Data Related Requirements

Our Information Management System SOPs (IMS) describe the way in which we manage our software programs and hardware systems. Control of software development and modification activities is described in GL-IMS-E-001. All development and revision activities are validated, verified, and controlled with revision software or other procedures prior to production use.

Analytical software that is purchased from a vendor is validated and verified in accordance with GL-IMS-E-004 for the "Verification and Validation of Software." Documentation requirements are also described in this SOP.

SECTION 9
SAMPLE HANDLING, ACCEPTANCE, RECEIPT & INTERNAL CHAIN OF CUSTODY

Section 9 - Sample Handling, Acceptance, Receipt, and Internal Chain of Custody

The way we receive and handle samples is critical to providing our clients with data that is of the highest quality and legally defensible. We have strict policies that govern the acceptance and receipt of a sample, sample handling and integrity, maintenance of the internal chain of custody, and storage of the sample upon completion of the required analytical processes. This section describes the policies and practices that we employ, including the following:

- Agreements to perform analysis
- Proper labeling of submitted samples
- Chains of custody
- Sample receipt procedures
- Sample receipt procedures for radioactive samples
- Sample tracking
- Sample storage
- Sample disposal

9.1 Agreement to Perform Analysis

Before we accept samples, we should have an agreement with the client that specifies the analytical methods, the number of samples to be analyzed, the price for the analysis, the date by which the client must receive results, and the reporting format. Any special requirements the client may have, such as non-routine methods and reporting limits, should be part of that agreement.

An agreement to perform analysis should be in one of three forms, further detailed in our Analytical Services Reference Manual and the SOPs for Delegated Authorization to Commit the Company and Request for Proposal (RFP)/Contract Review (GL-CO-E-002 and GL-CO-E-003):

- Client confirmation letter (CCL) between the client and project manager for a specific group of samples. This letter includes the cost, turn-around time, requested analysis, sample matrix, number of samples, and type of client report.
- Sample acceptance by the Project Manager from an established client based on previously agreed to conditions and confirmed by the client's submission of the sample(s).
- Contractual agreement for analytical services over a designated time period or project that delineates the specifications agreed upon.

9.2 Sample Labels and Chain of Custody Forms

Once an agreement is established, we assume joint responsibility with the client to ensure that the samples submitted are properly labeled and accompanied by full and complete documentation that includes chain of custody and, where possible, material safety data sheets. Samples that are submitted without proper documentation may be refused.

Sample labels should include the:

- client's sample identification
- location, date, and time of collection
- collector's name
- chemical preservatives used
- constituents of interest (if space permits)

When requested, we ship labeled sample containers with appropriate preservatives and a chain of custody to the client for use during sample collection. We prepare and ship these containers according to GL-RC-E-003 for Sample Bottle Preparation and Shipment. There are several advantages to using these containers, including:

- Dedication of appropriate type sample container for the intended analyte or analytical method.
- Proper sample preservation for analytical test
- Traceability of bottle lot number to the manufacturer's certification that the containers are clean and show no signs of contamination.

Chain of custody forms include the following information and are initiated at the time of sample collection:

- name and address of client
- client sample identification
- date and time of sample collection
- sample matrix
- description of sampling site location
- number of containers
- methods, chemical and physical constituents for which the analyses are to be conducted
- preservatives

- date and signature of person who collected the sample
- date of transfer and signature of person relinquishing sample to the laboratory.

When our Field Services personnel collect samples, our standard chain of custody form and certified containers are automatically used. Our standard chain of custody forms are also available to our clients and are included with each shipment of pre-labeled and preserved containers. GEL chain of custody forms should always be used unless otherwise agreed to by contract.

9.3 Sample Conditions

In addition to properly documenting sample container labels and the chain of custody form, we need to make sure that samples meet the established requirements for analytical testing. This is particularly critical for samples that are being analyzed to meet regulatory requirements.

Samples should be collected in the appropriate type of container, preserved as directed, and stored in the conditions specified in the analytical method or established regulatory guidelines. In addition, samples should be submitted with sufficient time to conduct the specified analysis within the regulatory or method holding time. Aliquots should be of sufficient volume to perform the requested analyses. A summary of these conditions and holding times for routine analyses can be found in Appendix K.

9.4 Sample Receipt

Samples submitted to us are received in a central sample receiving area by our sample custodian or login clerk. Every sample is subject to the protocols established in GL-SR-E-001 for Sample Receipt, Login, and Storage.

Our sample custodian acknowledges receipt of a sample by signing the chain of custody and recording the date and time custody was transferred from the client to the laboratory. The date, time, and person receiving the sample are also recorded on a standard or client-specific Sample Receipt and Review form.

The sample custodian is also responsible for noting the condition of a sample upon its arrival. This information is recorded on both the sample chain of custody and the Sample Review and Receipt form. As detailed in GL-SR-E-001, the sample custodian should:

- Inspect all sample containers for integrity.
- Document any unusual physical damage or signs of tampering with custody seals.
- Place any samples that appear to be leaking or have unusual odor under the fume hood while notifying the responsible project manager.
- Review the chain of custody submitted by the client for completeness.
- Compare descriptions and other information on the sample container labels to that listed on the chain of custody.
- Verify the sample is within the regulatory holding time for the analyses.
- Measure and record the temperature of sample aliquots that are to be used for analyses requiring thermal preservation.
- Measure and record the pH of all sample aliquots submitted for analyses that require chemical preservation to a specific pH.
- Verify that there are adequate sample aliquots for the requested analyses.
- Verify that appropriate sample containers were used for requested analyses.

If the sample custodian discovers any abnormalities or departures from standard conditions, the PM is informed immediately. The PM will then notify the client as quickly as possible so that a decision can be made to proceed with the analysis or submit another sample or additional sample aliquots.

Common abnormalities or departures from standard conditions include:

- Sample containers with signs of damage, leaking, or tampering.
- Incomplete/missing chain of custody.

NOTE: If a nonradioactive sample has no chain of custody, the sample custodian should initiate one. "INITIATED ON RECEIPT" should be documented on the chain of custody.

- Discrepancies between the information on the chain of custody and the sample container labels.
- Method or regulatory holding time is exceeded.
- Sample is not preserved to the method or regulatory-required pH.
- The sample container does not meet method or regulatory criteria.

- The sample temperature exceeds or falls below the thermal preservation regulation or method requirement by more than 2°C.

NOTE: If a sample is hand delivered to the laboratory immediately after collection with evidence that the chilling process has begun (arrival on ice), the sample shall be deemed acceptable.

- Radioactivity that exceeds that allowed by our radioactive license. (The handling of radioactive samples is discussed in 9.5.)

Samples that are not appropriate for the requested analyses or have no full test specifications require:

- Retention of all correspondence and records of conversations concerning the final disposition of the sample.
- Full documentation on the chain of custody and Sample Receipt and Review form of the nonconforming condition and a decision to proceed with analysis.
- Documentation that the analysis is qualified appropriately on the final report.

9.5 Receipt of Radioactive Samples

The radioactive samples we receive are subject to the same monitoring identified in 9.4 when radioactivity levels do not exceed the level permitted by our license. Special procedures governing the receipt of radioactive samples are described in the GL-RAD-S-007 for the Receiving of Radioactive Samples. These procedures prevent the inadvertent spread of radioactive contamination.

Because we cannot exceed the limits of our radioactive license, it is imperative that our clients notify us of impending shipments of radioactive samples. We reserve the right to refuse and return any radioactive sample where the radioactivity:

- Exceeds our permitted level by itself or in combination with other samples already on site; or
- Exceeds our administrative level of 25mR/hr.

The following special requirements for receiving radioactive samples are applicable:

- Only designated staff trained in the proper handling of radioactive materials handle radioactive samples.
- If a sample is labeled as “Radioactive II”, the custodian will not open the sample but will immediately inform the Radiation Safety Officer (RSO).
- The radioactivity of the sample will be measured by scanning the exterior surface of the cooler using a survey meter calibrated in mR/hr. See GL-RAD-S-001 for our Radiation Survey Procedures.
- If the radioactive level of the exterior of the cooler exceeds 0.5 mr/hr, the RSO will be notified before the cooler is opened.
- If the radioactivity level of a sample or group of samples is found to exceed 25mR/hr, the RSO will be notified immediately. The client will be contacted and arrangements will be made to return the sample(s) or reduce the per sample exposure.
- If a chain of custody is not submitted with a sample, it will be placed on hold until a chain of custody is submitted.
- The inside of the cooler will be surveyed to ensure that no leakage or contamination has occurred.
- Each sample container will be surveyed and the highest reading will be documented on the Radioactive Shipment Inventory.

9.6 Sample Tracking

We track the samples we receive by a unique laboratory identification number that is automatically assigned when information pertaining to the sample is first entered into our database. Pursuant to GL-SR-E-001, the following information is entered for each sample received:

- client and/or project code
- client sample ID
- sample matrix
- equivalent laboratory sample matrix
- type of report format specified by client
- date and time of collection
- date received
- initials of person making entries
- number of containers submitted for the sample
- requested analyses
- pertinent observations or comments affecting the sample analysis or rejection

As soon as this information is entered, ALPHA LIMS automatically assigns a unique number to the sample and its containers. We use the number to track the location of a sample container and to link to any subsamples and subsequent digestates and extracts.

The unique laboratory identification number is printed on a durable barcode label that contains the client identification, sample date and time. Once labeled, the sample container's identification number is uploaded into the database by scanning the barcode. Information included in the database at the time of sample scanning is the container's storage location, bottle type and volume, physical characteristics of the bottle, preservative, and the initials of the person entering this information. Entering of this information into the database is an important part of initiating our electronic internal chain of custody.

9.7 Internal Chain of Custody

Chain of custody procedures ensure traceability and sample integrity. Our legal and evidentiary chain of custody protocol establishes a continuous record of the physical possession, storage, and disposal of sample containers, collected samples and aliquots, and sample digestates or extracts.

The internal chain of custody starts with the scanning of a container's barcode label into an electronic database while identifying the location of the sample and the person having custody, or placing the sample in a secured storage area. If we supply the containers, the chain of custody may begin when the containers are provided to the client.

With regard to the internal chain of custody, a sample is defined as being in someone's custody if:

- It is in one's actual physical possession
- It is in one's view after being in one's physical possession
- It is in one's possession and then is locked up so that no tampering may occur
- It is kept in a secured area restricted to authorized personnel only

The protocol for ensuring sample integrity using the internal chain of custody is detailed in GL-LB-E-012 for Verifying the Maintenance of Sample Integrity. The electronic internal chain of custody works in conjunction with the chain of custody submitted by the client with a sample to:

- Account for all time associated with a sample, its subsamples, and extracts or digestates from the time the sample is received at GEL to its disposal.
- Identify all individuals who physically handled the sample
- Provide evidence that the sample was stored in accordance with method and regulatory protocols

The electronic internal chain of custody is stored in ALPHA LIMS so that information demonstrating the proper maintenance of custody can be provided to the client on the data reports or electronic data deliverables.

9.8 Sample Storage

In order to ensure the maintenance of sample integrity, all aliquots are stored in secured areas designated for sample storage. The storage location of each sample aliquot can be tracked using the internal chain of custody. Areas designated for sample storage include:

- Main cooler where most samples requiring maintenance at a temperature range of 2° - 6° C are stored.
- Volatile coolers for samples to be analyzed for volatile contaminants.
- Radioactive cooler for segregation of radioactive sample aliquots requiring refrigeration.
- Ambient storage for non-radioactive samples not requiring refrigeration.
- Ambient storage for radioactive samples.
- Refrigerators for the storage of samples requiring bacteriological analysis and temporary storage for those requiring the determination of biochemical oxygen demand.

The temperature of each refrigerated storage unit is monitored at least twice a workday and documented per "Temperature Monitoring and Documentation Requirements for Refrigerators Freezers, Ovens Incubators, and Other Similar Devices," (GL-LB-E-004). In addition, the main and radioactive coolers are monitored twenty-four hours a day by temperature sensors that are connected to our main security system. If the temperatures exceed the required range, an alarm is sounded and the security system notified the facilities manager or his designee immediately. This allows corrective actions to be initiated promptly.

Prior to and immediately after analysis, samples and their digestates and extracts are stored in compliance with the requirements of the requested analytical methods and GL-SR-E-001 for Sample Receipt, Login, and Storage. If a single aliquot is supplied for analyses by several methods, the most stringent analytical storage requirements are applied to the sample.

If samples are to be analyzed for volatile organic compounds, they are stored in designated volatile coolers that are maintained at a temperature range of 2° - 6° C. No sample aliquots are stored in these refrigerators unless they are to be analyzed for volatiles. These storage units are monitored on a weekly basis for contamination by the analysis of volatile cooler storage blanks.

At the beginning of each month, eight 40-mL vials are filled with treated deionized water, which is used for volatile method blanks and placed in each volatiles cooler. Each week, one or two vials are analyzed by EPA 8260B and the data is reported to the Quality Department. If the analysis reveals evidence of potential contamination, appropriate corrective actions are immediately implemented.

Sample aliquots for non-volatile analysis, which also should be maintained between 2° - 6° C, are stored in the main cooler unless they are radioactive. In order to reduce the chance of contamination, radioactive samples are stored in a designated cooler.

Sample aliquots designated for the determination of total coliform bacteria, fecal coliform bacteria, or total plate count are delivered to the bacteriology laboratory and stored in the designated refrigerator at a temperature range of 2-6° C. This allows easy access for the analyst ensuring that the short regulatory holding times are met. After analysis is complete, the remaining sample aliquot is disposed of in accordance with the Laboratory Waste Management Plan.

Sample aliquots to be analyzed for biochemical oxygen demand (BOD) are also delivered to the bacteriology laboratory and stored in the designated BOD cooler. This cooler is also maintained at 2° - 6° C. After initiation of this analysis, the sample aliquots are returned to the main cooler.

After all analyses are complete and results are submitted to the client, sample aliquots are transferred to the sample archive area. They are stored in this area until they are disposed.

Radioactive and non-radioactive samples remain segregated in archive to reduce the risk of contamination.

9.9 Sample Disposal

Our policies concerning sample disposal are described in the Laboratory Waste Management Plan (GL-LB-G-001) and can be divided into two categories: those governing the disposal of sample laboratory waste, and those directing the disposal of remaining sample aliquots after the completion of all analyses.

9.9.1 Sample laboratory waste

Unless otherwise requested by contract, laboratory sample waste is collected throughout the laboratory in designated satellite containers found in sample collection and accumulation areas. Sample wastes are segregated based on the type of analysis by which they were generated, by matrix, and radioactivity. This contains certain process contaminants thus decreasing the amount of waste material that may be labeled hazardous. It also ensures that solid and aqueous wastes are not mixed.

The satellite collection containers are regularly emptied by the Laboratory Waste Manager (or designee) into labeled 55-gallon drums in the waste staging areas. The following information is recorded in a log located in the staging area: container identification, satellite station source, date transferred to 55-gallon drum, volume transferred, and initials of the person transferring the material.

We have separate radioactive and non-radioactive staging areas. The composited sample wastes then undergo hazardous waste characterization. The analyses requested differ depending upon sample matrix. Aqueous sample waste composites are typically analyzed for metals, base neutrals and acids, pesticides, PCBs, pH, cyanide, and volatile compounds. Solid sample waste composites are analyzed for the TCLP parameters, BTEX, TPH, total lead, and water content.

Sample waste is disposed in accordance with the Laboratory Waste Management Plan (GL-LB-G-001).

9.9.2 Remaining Sample Aliquots

Sample not consumed during the sample preparation or analytical procedures is either returned to the client in accordance with GL-SR-E-002 for Return of Samples or disposed pursuant to the Laboratory Waste Management Plan. All radioactive samples are returned to the client unless otherwise specified by contract. Non-radioactive samples are returned to a client under the conditions and terms agreed to by contract. A chain of custody listing the laboratory waste technician as the relinquishing party is enclosed with each set of samples being returned to a client. Unless otherwise specified by the client, all non-radioactive samples are shipped by UPS. If the samples

are radioactive, the procedure for shipment is delineated in GL-RAD-S-008 for the Shipment of Radioactive Samples.

It is our policy to hold samples for a minimum of thirty days after invoicing and before disposal, unless otherwise specified by contract or if the sample is part of litigation. If the sample is part of litigation, disposal of the physical sample shall occur only with concurrence of the affected legal authority, sample data user, and/or client.

When sample analyses are complete and regulatory and/or contractual holding times have expired, samples are moved from their storage locations to the radioactive or non-radioactive archives. Samples that are to be returned to the client or held for an extended time period are segregated from the other samples. Radioactive and non-radioactive samples remain segregated.

When internal or client-specified storage time expires, samples with like matrices are composited into 55-gallon drums. The composites are then subject to the same treatment and disposal protocol as described in 9.9.1. In addition to the log documenting which samples are composted in which drum, the barcode labels for each disposed sample are scanned into our data base and assigned the status of disposed.

SECTION 10
RECORDS

Section 10 - Records

Our quality records provide the documentation we need to support analytical results and conclusions. Documented evidence that quality assurance and quality control requirements have been met is critical to providing data that fulfills the specifications of applicable procedures, programs and contracts.

As described in Section 3 of this Quality Assurance Plan (QAP), quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- External, supplier, and internal audits
- Run logs
- Instrument data and analytical logbooks
- Instrument, equipment and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports
- Corrective actions
- Method development and start-up procedures including MDL studies
- Training records
- Waste management records
- Standard logs
- Software validation
- Standard operating procedures (SOPs)
- Sample collection and field data

Our procedures provide a legal and evidentiary chain of custody are described in Section 9 of this QAP. Described in this section are:

- Record keeping system and design
- Records management and storage
- Sample handling records
- Records of support activities
- Analytical records
- Administrative records

10.1 Record Keeping System and Design

We manage, maintain and store our quality records according to GL-QS-E-008 for Quality Records Management and Disposal. The protocols established in this document work in conjunction with those for specific types of records addressed in other SOPs to govern our record keeping system. Our record keeping system allows the historical reconstruction of all laboratory activities that produced analytical data.

We facilitate historical reconstruction by maintaining the following records and information, from the time a sample is received until it is disposed.

- A master list of all employee signatures and initials is maintained in Human Resources. This allows the identification of any GEL personnel who accept, handle, analyze, prepare, review, store, or dispose of a sample, its subsamples, associated data and reports, and other related documentation.
- If we provide bottles and containers to a client or sampling personnel, these records are kept in accordance with GL-RC-E-003 for Sample Bottle Preparation and Shipment. These electronic and paper records include:
  - Supplier and lot numbers of containers and/or bottles provided
  - Certifications that the containers are free of contaminates that may bias the analyses
  - Addition of preservatives and identity of person responsible for this preservation.
  - Barcode of containers supplied to a particular client or for a specific field-sampling event.

The person or agency responsible for collecting a sample is documented on the chain of custody and entered into ALPHA LIMS. Other records supporting the acceptance of a sample include:

- Date and time of sample receipt
- Person accepting sample
- Condition of sample upon receipt
- Client-confirmation letter and/or sample quote
- Client chain of custody
- Electronically generated sample ID numbers specific to each sample aliquot and linked to the client's

sample description, sample collection and receipt information, and analyses to be performed.

- Identification of each person who has custody of a sample, its subsamples, extracts, or digestates. (This is provided through the internal chain of custody procedures described in Section 9.)

Documentation that materials purchased for use in the analysis or preparation of samples meet specifications is maintained in accordance with GL-RC-E-001 for Receipt and Inspection of Material and Services.

Records of equipment calibrations are maintained and traceable by date and ID number to a specific analysis. These records include certifications of calibration and service that have been initialed or signed.

Our thermometers are calibrated against the NIST traceable thermometer and records of this calibration are maintained as described in GL-QS-E-007 for Thermometer Calibration. Records of the daily and monthly calibration verifications of our analytical balances are kept in accordance with GL-LB-E-002 for Balances. The calibration records for our air-displacement pipets are maintained in pipet calibration logs specific to each pipet according to GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets.

When methods and/or regulations specify that samples, subsamples, extracts, and/or digestates be stored at designated temperatures, or when the method, itself, has temperature sensitive steps, we document those temperatures on monitoring logs at the frequency defined in the corresponding SOPs. We can trace the specific storage location of a sample through the internal chain of custody.

We require that the initials of all personnel responsible for monitoring temperatures be recorded in the temperature monitoring logs pursuant to GL-LB-E-004, "Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators, and Other Similar Devices." The logs are reviewed for completeness in accordance with GL-QS-E-005 for the Review of Monitoring Devices.

Documentation on the instruments and equipment used for the analysis of samples is recorded in run logs, laboratory logbooks, instrument data and/or sample preparation logs. Routine or corrective maintenance that is performed on equipment or instruments is recorded in the maintenance log specific to the instrument. We document these records in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Forms and Other Record Keeping Devices.

The standards containing known quantities of target analytes that we use in instrument calibration, calibration verification, and as quality control samples, such as matrix spikes and laboratory control samples, are documented according to GL-LB-E-007 for Standards Documentation. These records contain the following information.

- Recipe by which each standard was prepared
- Traceability of each child standard to its parent
- Date each standard was prepared
- Initials of person preparing the standard
- Expiration dates
- Concentration of each standard

This information allows us to document that the standards used were prepared in accordance with the established protocol, produced using source standards that meet the method and regulatory criteria, and used prior to their expiration date.

If required, reagents used in the preparation, dilution, and analysis of samples are verified to be free of interferences or target analytes. We record these verifications in the reagent logs in accordance with GL-LB-E-008.

Analytical and sample preparation methods applied to each sample aliquot are documented via the internal chain of custody, method information, and information recorded in lab notebooks, sample preparation logs, run logs, and instrument data. The laboratory protocol we employ during analysis is dictated by the SOP in effect at the time the sample was analyzed or prepared by a specific method.

Run logs, laboratory notebooks, instrument data and sample preparation logs are used to document the preparation and analysis of samples and the associated instrument calibrations. These logs and notebooks are governed by GL-LB-E-009 for Run Logs and GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Record Keeping Devices. As stated in these SOPs, sample preparation and analytical records that are not electronically generated should be:

- Legible
- Recorded in permanent ink

- Corrected using one line marked through the error, initialed and dated
- Initialed by the responsible party

We maintain electronic records for each analytical batch. These records include the ID numbers of each client and quality control sample prepared and/or analyzed together, the method of preparation and analysis, and the matrix of the samples included in the batch.

Through our electronic statistical process control system (SPC), the acceptance criteria applied for all quality control (QC) samples is stored and maintained. The acceptance limits for target analytes are method, matrix, and time-period specific, which allows us to regenerate the criteria applied to QC samples associated with identified client samples.

Our Quality Systems Team maintains the records of nonconformances and corrective actions associated with specific samples, batches, and processes. We maintain these records according to GL-QS-E-004 for the Documentation of Non- conformance Reporting and Dispositioning, and Control of Nonconforming Items; and GL-QS-E-002 for Conducting a Corrective Action.

Electronic data records are maintained in a secured database designed to protect the integrity of the data. Data that is uploaded directly from instruments and that manually entered is backed up by a second system.

Permanent records of electronic data deliverables are maintained along with the corresponding sample preparation and analytical data review records. This documentation includes the initials of the reviewer and date of the review.

Records of the data we report to our clients are maintained in a manner that protects client confidentiality, as well as any potential national security concerns. These records include copies of certificates of analysis, quality control summary reports, case narratives, CLP forms, and other information we provided to the client. The copies may be paper or electronic. The majority of the data packages submitted to Federal clients are stored electronically prior to being submitted to the client.

Records of samples being disposed or returned to the client are documented in accordance with GL-SR-E-002 for Return of Samples and the Laboratory Waste Management Plan. Such records include the date samples are returned or disposed, the destination of the samples, and name of the person transferring the samples.

10.2 Record Storage

We store quality records in compliance with GL-QS-E-008 for Quality Records Management and Disposition. The records are:

- Stored in a secured area to maintain data integrity and protect client confidentiality, including any national security concerns.
- Kept in areas where they are protected from fire loss, environmental deterioration, and, in the case of electronic records, electronic or magnetic sources.
- Indexed and filed in a manner allowing for ready retrieval.
- Accessible to the client for whom the record was generated.
- Retained for an identified period of time that equals or exceeds five years as determined by applicable law and client contract requirements.

Electronic data records are stored on compact disks.

All of the hardware and software we need to reconstruct data is maintained according to GL-IMS-E-002 for Computer Software Development and Maintenance. Records that are stored or generated by network or personal computers have either hard copy or write-protected backup.

10.3 Sample Handling Policy

Records of all procedures applicable to samples are maintained in our possession. These records include documents that pertain to:

- Preservation, including sample container and holding time
- Sample identification, receipt, acceptance or rejection, and login
- Sample storage and tracking including shipping receipts, transmittal forms, routing and assignment records
- Sample preparation (ID codes, cleanup and separation protocols, volumes, weights, instrument printouts, meter readings, calculations, reagents)
- Sample analysis
- Standard and reagent origin, receipt, preparation, and use

- Equipment receipt, use, specification, operating conditions and preventative maintenance
- Instrument calibration frequency and acceptance criteria
- Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions
- Method performance criteria including expected quality control requirements
- Quality control protocols
- Electronic data security, software documentation and verification, software and hardware audits, backups and records of any changes to automated data entries
- Automated sample handling systems
- Disposal of hazardous samples

10.4 Records of Laboratory Support Activities

In addition to sample handling records, we maintain the following:

- Original raw data for calibrations, samples and quality control measures, including worksheets and data output records (chromatograms, strip charts, and other instrument readout records)
- A written description of or reference to the specific method used, including the computational steps used to translate parameter observations into a reportable analytical value
- Copies of final reports
- Archived standard operating procedures
- Correspondence relating to project-specific laboratory activities
- Corrective action reports, audits and audit responses
- Proficiency test results

10.5 Analytical Records

We document and maintain analytical records, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs according to GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Record Keeping Devices, and GL-LB-E-009 for Run Logs. The information that is documented in analytical records includes:

- Laboratory sample ID code
- Date and time of analysis
- Instrument ID and operating conditions/parameter (or reference to such data)
- Method of analysis
- All calculations
- Dilutions
- Initials of analyst or operator
- Units of measurement

Our policy is to produce and maintain analytical records that are:

- Accurate
- Reviewed and verified
- Legible and understandable
- Traceable and authentic to their source
- Grouped in a contemporary manner with data entered and information recorded as it is obtained

10.6 Administrative Records

A number of pertinent records are maintained by Human Resources or Quality Systems, including:

- Staff qualifications and experience.
- Training records, including initial demonstrations of proficiency. (See procedure GL-HR-E-002 for Employee Training.)
- A log of names, initials and signatures for individuals having responsibility for initialing laboratory records.

We monitor continuing demonstrations of proficiency through ALPHALIMS per GL-HR-E-002 for Employee Training.

SECTION 11
LABORATORY REPORT FORMAT and CONTENTS

Section 11 - Laboratory Report Format and Contents

Accurate data is of little benefit to a client unless it is reported in a format that is easy to interpret and provides all pertinent information relating to the analysis of a sample. At GEL, we have developed certificate of analysis report formats that meet the different needs of our clients yet provide all of the information necessary to satisfy regulatory requirements while allowing for the interpretation of the data. Each format provides accurate, clear, unambiguous and objective data.

In addition to a certificate of analysis, a client can request and receive an extended data package. This package may include any of the following: certificates of analysis; summaries of quality control; case narratives; instrument data; sample preparation data; measurement traceability and calibration information; and electronic data deliverables. If clients require the reporting of data following the established contract laboratory protocol (CLP), we can provide a CLP-like data package that will meet their needs.

It is important that the certificate of analysis format and data package requirements be discussed with the client prior to our acceptance of the samples. Project Managers and contract staff are responsible for establishing an agreement with the client concerning data reporting and the potential cost to the client for data packages and/or specialized reporting. Our analytical data is reported to three significant figures, unless otherwise required by client contract.

Laboratory reports and data packages are store and transmitted in a manner that protects client confidentiality and potential matters of national security. No reports or data packages are released to persons or organizations outside GEL without the expressed consent of the client. If directed by a regulatory agency or subpoenaed to submit documents to a court of law, we will notify the client of the demand and the records being released.

The following elements of report formats and data packages are described in this section:

- Certificates of analysis (C of A)
- Quality control summary reports (QCSR)
- Analytical case narratives
- Electronic data deliverables (EDDs)
- Types of data packages and reporting formats
- Review of data packages and reports

11.1 Certificates of Analysis

We have two primary C of A report formats, Level 1 and Level 2. Both contain the following information when applicable:

- Title
- GEL address and phone number
- Name of PM or person serving as the primary client contact
- Barcode identification of the C of A
- Number of page and total number of pages
- Name and address of client, where appropriate
- Project name or code if applicable
- Client-provided sample description
- Unique laboratory ID number for the sample
- Sample matrix
- Characterization and condition of the sample where relevant
- Date of receipt of sample
- Date and time of sample collection, if provided
- Date and time of sample analysis, reanalysis, and/or sample preparation
- Initials of analyst and person responsible for sample prep
- Analytical batch number
- Sample analysis and preparation methods (or unambiguous description of any non-standard method used)
- Reference to sampling procedure
- Additions to or deviations or exclusions from the test method, and other information relevant to a specific test, such as environmental conditions and the use and meaning of data qualifiers
- Nonconformances that affect the data
- Whether data is calculated on a dry weight or wet weight basis
- Identification of the reporting units, such as ug/1 or mg/kg
- Statement of the estimated uncertainty of the test result, if applicable
- Signature and title of the person(s) accepting responsibility for the content of the C of A

- Date C of A was issued
- Clear identification of data provided by outside sources, such as air temperature or ambient water temperature
- Identification of the reporting detection limit (RDL) or practical quantitation limit (PQL) for each analyte, if applicable.

If a portion of the sample analysis is subcontracted, the C of A will identify the subcontractor or applicable accreditation number, and the data that was determined by the subcontracting laboratory

.Level 2 Certificates of analysis contain the following additional information:

- Dilution factors
- Method detection limits
- Surrogate recoveries and the acceptance criteria for all organic analyses
- Estimated concentrations determined for nondetects and appropriate "U" and "J" qualifiers for nondetects and concentrations that fall between the MDL and PQL respectively.

Once issued, a C of A is not altered unless a subsequent C of A is identified as a revised report.

11.2 Quality Control Summary Report (QCSR)

We prepare and analyze samples in groups of twenty or less. The quality control data that demonstrates the sample preparation and/or analytical efficiency of the batch is summarized on a QCSR. The data reported on the QCSR may be limited to a sample delivery group contained in the batch or may include all quality control for the batch. Information reported on QCSR includes:

- Quality control sample ID number
- Type of quality control sample
- Concentrations determined, where applicable, for method blanks, matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, serial dilutions, and laboratory control sample duplicates
- Acceptance criteria for matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, and laboratory control sample duplicates
- Nominal concentrations of matrix spikes, matrix spike duplicates, LCSs, and LCS duplicates
- Concentration of parent sample for the matrix spikes, matrix spike duplicates, or sample duplicates
- Percent recoveries for LCS and matrix spikes
- Relative percent differences for the matrix spike duplicates, matrix duplicates, and LCS duplicates
- Analytical batch number with which the quality control data is associated
- Parent sample numbers for matrix spikes, matrix duplicates, and matrix spike duplicates
- Sample or sample delivery group ID
- Project code
- Date issued, page numbers/total number of pages
- Identification of recoveries or relative percent differences that do not meet the acceptance criteria

11.3 Analytical Case Narratives

Analytical case narratives are written by an analyst or data validator to describe the overall conditions affecting the analysis of a batch or a specific sample in the batch. Case narratives usually include:

- Sample delivery group ID number
- Analytical batch number
- Methods of preparation and analysis
- Sample matrix
- Initial of person preparing and/or reviewing the narrative
- Specific sample ID numbers
- Identification and description of batch quality control samples including parent sample identification
- Affirmation that all sample preparation conditions specified by the method or regulatory agencies were met or identification of specific deviations
- Affirmation that all analysis criteria specified by the method or regulatory agencies were met or identification of specific deviations
- Instrumentation employed if applicable and verification of its calibration
- Summary of batch quality control as compared to acceptance criteria
- Identification of nonconformances
- Pertinent comments and observations of factors that affect sample data quality

11.4 Electronic Data Deliverables (EDDs)

Electronic data deliverables are generated according to client specifications. EDDs use programs supplied by the client or created internally by our EDD team. Internally generated EDDs are usually written in Pearl or Microsoft Excel.

11.5 Types of Data Packages and Reports

We offer three levels of data reports and the ability to design packages to meet the needs of our clients. The levels of data reports are summarized in Table 1.

Table 1: Data Report Formats

Level	Contents
1	Level 1 C of A
2	Level 2 C of A
3	Level 2 C of A plus QCSR

If a client so requests, the above reports can be accompanied by EDDs, case narratives, copies of associated nonconformance reports, and other support documentation. The client's specific requirements are communicated to the laboratory and data reviewers through ALPHA LIMS.

If a client requests a CLP-like data package, and we agree to provide one, it is compiled in accordance with GL-LB-E-013 for the Generation and Assembly of CLP Data Packages. If a client does not request a full CLP-like data package but asks for data to be provided on CLP forms generated from software, we follow the applicable procedures in GL-LB-E-013.

11.6 Review of Data Reports, EDDs, and Data Packages

Level 1, Level 2, and Level 3 data reports are reviewed for accuracy and completeness by the PM or PMA according to GL-ADM-E-002 for Process, Review, and Distribution of Certificates of Analysis and COA packages. CLP-like data packages are reviewed in the laboratory by a data reviewer, who is responsible for reviewing specific fractions of the data package for accuracy, consistency, and completeness in accordance with the SOP for that lab area.

No data package fraction is to be provided to the data packaging team without the approval of the appropriate data reviewer. Data reviewers oversee the review of associated EDDs and ensure that the EDD is in agreement with the package.

Project managers are responsible for reviewing the complete data package to ensure that all of the client's needs are met and to be able to notify the client of any nonconformances or failures to provide requested information prior to the submission of the package.

CLP-like data packages are reviewed in compliance with the basic protocol. Specific requirements are described in GL-LB-013 for the Generation and Review of CLP Data Packages.

SECTION 12
SUBCONTRACTING ANALYTICAL SAMPLES & OUTSIDE SUPPORT SERVICES

Section 12 - Subcontracting Analytical Samples and Outside Support Services

We provide a full array of organic, inorganic, and radiochemical analyses. The subcontracting of samples to other facilities, while infrequent, may occur when:

- The client has requested analytical services for which we are not certified or do not offer as a routine product.
- The regulatory or method holding times and/or client due dates are in danger of not being met as the result of instrument malfunction or the unexpected influx of a large group of samples.

No samples are subcontracted without the client's consent. The laboratories selected to receive subcontracted samples are expected to meet the following criteria:

- Demonstrated technical capability to provide data that meets and conforms to our quality standards.
- Established certification, if available, for the requested analyses.
- Successful proficiency evaluation results, if available.
- Commitment to meet time requirements for delivery of results to the client.
- Agreement to provide all documentation requested in conjunction with the analysis.
- NELAP accreditation for the analysis if it is covered or mandated under the NELAP Program.

We audit potential subcontractors for technical and administrative compliance as directed in GL-QS-E-001 for Conduct of Quality Audits. An audit may be in the form of a book audit instead of an on-site review.

If there is evidence of a technical, administrative, or quality deterioration, the laboratory is removed from our list of approved subcontractor laboratories pending further evaluation, which may include on on-site audit. Once the laboratory again demonstrates compliance with GEL's standards, it can be reclassified as an approved subcontractor laboratory.

At GEL, we have a multi-faceted and trained staff. There are occasions, however, when it may be necessary to obtain the services of professionals outside of GEL. This may be due to such things as sample workload, introduction of a new instrument or method requiring special knowledge, or employee leaves of absence.

Any outside support services or service personnel are subject to the same scrutiny as a subcontract laboratory. If a service fails to meet our standards for excellence, the appropriate parties are promptly notified. If immediate corrections are not implemented and services are not of adequate quality to maintain confidence, the contract is canceled.

SECTION 13
CLIENT SATISFACTION

Section 13 - Client Satisfaction

Meeting the needs and expectations of our clients is essential to meeting our commitment to be the environmental laboratory of first choice. An important part of meeting this commitment involves receiving and resolving client concerns and complaints.

Client complaints that question the quality of laboratory data or data deliverables are directed to Quality Systems. These concerns are responded to with input from the laboratory, EDD team or data packaging group as may be needed.

The types of complaints, area(s) affected, and any impacts on quality are trended on a quarterly basis. This information is available to members of the Leadership Team and other managers and group leaders.

We use ALPHA LIMS to monitor client complaints, nonconformances and corrective actions. Every complaint is entered into the system upon receipt and assigned an internal and external due date. The external due date is often established by client contract. The internal due date allows time for the Quality Systems Team to review the response and transmit it to the client on or before the due date.

If we notice a trend that significantly affects the quality of our data, a corrective action is initiated following GL-QS-E-002 for Conducting Corrective Action. The implementation and verification of the corrective action affirms an effective and permanent solution.

The Quality Systems Team promptly audits those areas of activity or responsibility for which a complaint or concern has been stated.

APPENDIX A: REFERENCES

- National Environmental Laboratory Accreditation Program, NELAP, 2002.
- 10 CFR 50, Appendix B, US Code of Federal Regulations.
- 40 CFR Part 136, October 1984, Part VII, EPA 600 Series Methodologies for the Analysis of Organic Contaminants.
- DOE Order 414.1b, Quality Assurance, U.S. Department of Energy.
- EPA Requirements for Quality Assurance Project Plans (QAPPs), US EPA QA/R5.
- Model Statement of Work for Analytical Laboratories, Prepared for Department of Energy Albuquerque Operations Office by AGRA Earth and Environmental, Rev 4, February 2002.
- Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American National Standard ANSI/ASQC E4-1994.
- Measurement Associated Instrument Quality Assurance for Radiobioassay Laboratories ANSI N42.23-1995.
- US Department of Defense Quality Systems Manual for Environmental Laboratories, June 2002.
- US Department of Defense Quality Systems Manual for Environmental Laboratories, Version 3 Draft
- US Department of Energy Quality Systems Manual for Analytical Services, Draft Revision B, July 2002.

APPENDIX B: DEFINITIONS

The following definitions are used throughout the text of our Quality Systems Plan. These definitions were reprinted from "Definitions for Quality Systems," NELAC, July 2, 1998. The original source of each definition is provided.

ALPHA LIMS: GEL's laboratory information management system.

Acceptance Criteria: specified limits placed on characteristics of an item, process, or service defined in the requirement documents. (ASQC)

Accreditation: the process by which an agency or organization evaluates and recognizes a program of study or an institution as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (Glossary of Quality Assurance Terms, QMAS, 8/31/92)

Analytical Detection Limit: the smallest amount of an analyte that can be distinguished in a sample by a given measurement procedure throughout a given (e.g., 0.95) confidence interval. (Applicable only to radiochemistry)

Analytical Reagent (AR) Grade: designation for the high purity of certain chemical reagents and solvents given by the American Chemical Society. (Quality Systems)

Batch: environmental samples, which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (Quality Systems)

Blank: a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subject to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC, Definitions of environmental Quality Assurance Terms, 1996)

Blind Sample: a subsample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Calibrate: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.

Calibration: the set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measurement. (VIM - 6.13)

Calibration Curve: the graphical relationship between the known values, such as concentrations, of a series of calibration standards and their analytical response.

Calibration Standard: a solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The calibration solutions are used to calibrate the instrument response with respect to analyte concentration. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Certified Reference Material (CRM): a reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody: an unbroken trail of accountability that documents the physical security of samples, data and records.

Confirmation: verification of the presence of a component through the use of an analytical technique that differs from the original test method. These may include:

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional cleanup procedures

Corrective Action: action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useful form.

Detection Limit: the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence. See Method Detection Limit.

Document Control: the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC, Definitions of Environmental Quality Assurance Terms, 1996)

Duplicate Analyses: the analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

Environmental Detection Limit (EDL): the smallest level at which a radionuclide in an environmental medium can be unambiguously distinguished for a given confidence interval using a particular combination of sampling and measurement procedures, sample size, analytical detection limit, and processing procedure. The EDL shall be specified for the 0.95 or greater confidence interval. The EDL shall be established initially and verified annually for each test method and sample matrix. (NELAC, Radioanalysis Subcommittee)

Holding Times (Maximum Allowable Holding Times): the maximum times that samples may be held prior to analysis and still be considered valid. (40 CFR Part 136)

Initial Demonstration of Capability: procedure to establish the ability of the laboratory to generate acceptable accuracy and precision which is included in many of the EPA's analytical test methods. In general, the procedure includes the addition of a specified concentration of each analyte (using a QC check sample) in each of four separate aliquots of laboratory pure water. These are carried through the entire analytical procedure and the percentage recovery and the standard deviation are determined and compared to specified limits. (40 CFR Part 136)

Internal Standard: a known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method.

Laboratory: body that calibrates and/or tests.

NOTES:

1. In cases where a laboratory forms part of an organization that carries out other activities besides calibration and testing, the term "laboratory" refers only to those parts of that organization that are involved in the calibration and testing process.

2. As used herein, the term "laboratory" refers to a body that carries out calibration or testing
   - ◊ at or from a permanent location
   - ◊ at or from a temporary facility, or
   - ◊ in or from a mobile laboratory. (ISO 25)

Laboratory Control Sample: a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias to assess the performance of all or a portion of the measurement system. (NELAC)

Laboratory Duplicate: aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.

Legal Chain of Custody (COC): an unbroken trail of accountability that ensures the physical security of samples, data and records. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Limit of Detection (LOD): the lowest concentration level that can be determined by a single analysis and with a defined level of confidence to be statistically different from a blank. (Analytical Chemistry, 55, p.2217, Dec. 1983, modified)(See also Method Detection Limit.)

Limit of Quantitation (LOQ): **)**: the lowest concentration level of the initial calibration curve used to quantitate an analyte. The LOQ is usually 3X to 10 X the LOD.

Matrix: the component or substrate that contains the analyte of interest. For purposes of batch determination, the following matrix types shall be used:

- ◊ Aqueous: any aqueous sample excluded from the definition of a drinking water matrix or saline/estuarine source. Includes surface water, groundwater and effluents.
- ◊ Drinking Water: any aqueous sample that has been designated a potable or potential potable water source.
- ◊ Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt-water source.
- ◊ Non-aqueous liquid: any organic liquid with <15% settleable solids.
- ◊ Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- ◊ Solids: includes soils, sediments, sludges and other matrices with >15% settleable solids.
- ◊ Chemical Waste: a product or by-product of an industrial process.
- ◊ Air Samples: media used to retain the analyte of interest from an air sample such as sorbent tubes or summa canisters. Each medium shall be considered as a distinct matrix. (Quality Systems)

Matrix Spike: prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Matrix Spike Duplicate (spiked sample/fortified sample duplicate): a second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

May: permitted, but not required. (TRADE)

Method Blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples containing an analyte of interest through all steps of the analytical procedures. (NELAC)

Method Detection Limit: the minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater that zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

Must: denotes a requirement that must be met. (Random House College Dictionary)

Negative Control: measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

NELAC: National Environmental Laboratory Accreditation Conference. A voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of National Environmental Laboratory Accreditation Program.

Performance Audit: the routine comparison of independently obtained quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Performance Based Measurement System (PBMS): a set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.

Positive Control: measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation: refrigeration and or reagents added at the time of sample collection to maintain the chemical and or biological integrity of the sample.

Proficiency Test Sample (PT): a sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Proficiency Testing: determination of the laboratory calibration or testing performance by means of inter-laboratory comparisons. (ISO/IEC Guide 2 - 12.6, amended)

Proficiency Testing Program: the aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results in comparison to peer laboratories and the collective demographics and results summary of all participating laboratories.

Protocol: a detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.

Pure Reagent Water: shall be water in which no target analytes or interferences are present at a concentration which would impact the results when using a particular analytical test method.

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality within a stated level of confidence. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the need of users. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Manual: a document stating the quality policy, quality system and quality practices of an organization. This may also be called a Quality Assurance Plan or a Quality Plan. NOTE: the quality manual may call up other documentation relating to the laboratory's quality arrangements.

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. (ANSI/ASQC E-41994)

Quantitation Limits: the maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user. For organic and general chemistry

Range: the difference between the minimum and the maximum set of values.

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes, which have been transcribed verbatim, dated and verified accurate by signature), the exact copy or exact transcript may be submitted.

Reagent Blank (method reagent blank): a sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Reference Material: a material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30 -2.1)

Reference Standard: a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM - 6.08)

Requirement: a translation of the needs into a set of individual quantified or descriptive specifications for the characteristics of an entity in order to enable its realization and examination.

Selectivity: (Analytical chemistry) the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances.

Sensitivity: the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

Shall: denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there will be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (*Style Manual for Preparation of Proposed American National Standards*, American National Standards Institute, eighth edition, March 1991P)

Should: denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (*Style Manual for Preparation of Proposed American National Standards*, American National Standards Institute, eighth edition, March 1991P)

Standard Operating Procedures (SOPs): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Spike: a known mass of target analyte added to a blank sample or subsample; used to determine recovery efficiency or for other quality control purposes.

Standard Reference Material (SRM): a certified reference material produced by the U.S. National Institute of Standards and Technology and characterized for absolute content, independent of analytical test method.

Surrogate: a substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Test: a technical operation that consists of the determination of one or more characteristics or performance of a given product, material equipment, organism, physical phenomenon, process or service according to a specified procedure.

NOTE: the result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2 - 12.4)

Test Method: defined technical procedure for performing a test.

Tolerance Chart: a chart in which the plotted quality control data is assessed via a tolerance level (e.g. +/- 10% of a mean) based on the precision level judged acceptable to meet overall quality/data use requirements instead of a

statistical acceptance criteria (e.g. +/-3 sigma). (ANSI N42.23-1995, Measurement and Associated Instrument Quality Assurance for Radiochemistry Laboratories)

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

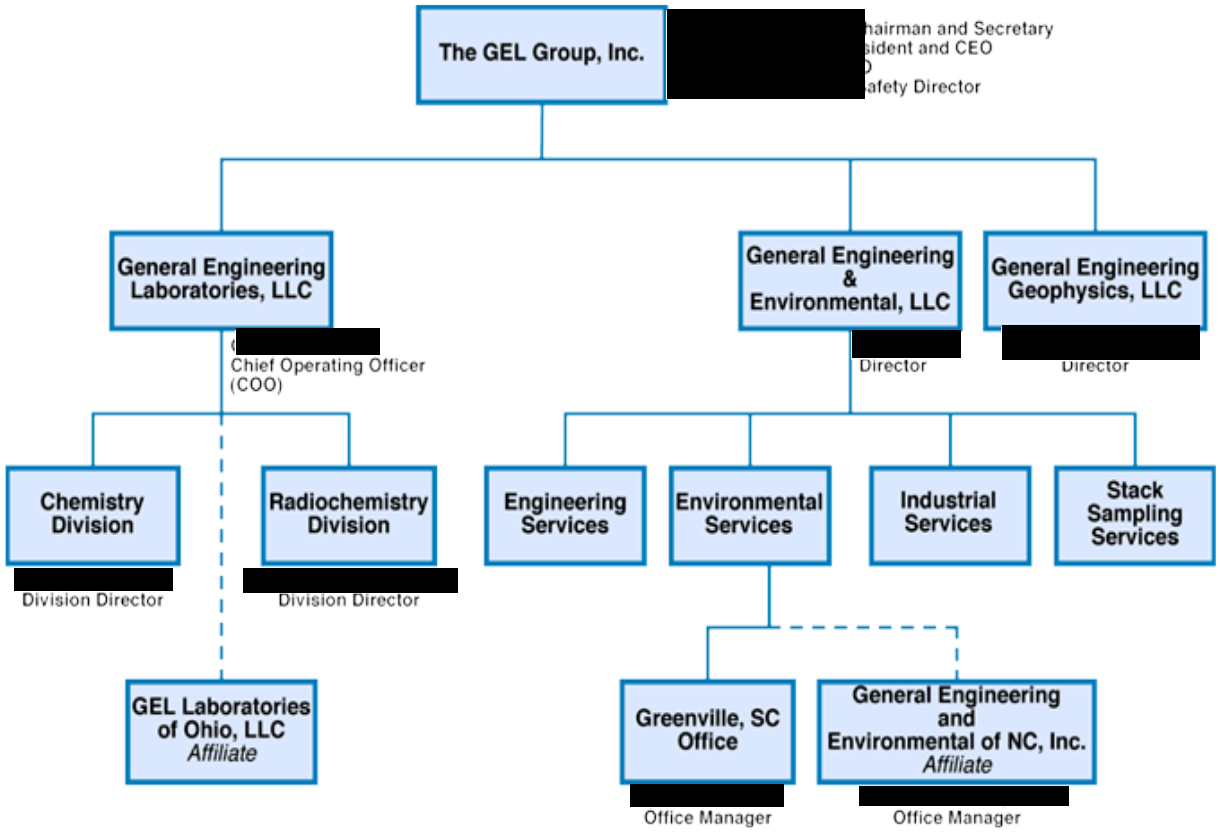
Verification: confirmation by examination and provision of evidence that specified requirements have been met.

NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustments, or to repair, or to downgrade, or to declare obsolete. In all cases it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Validation: the process of substantiating specified performance criteria

APPENDIX C: CORPORATE ORGANIZATION CHART



APPENDIX D: CERTIFICATIONS

General Engineering Labs, LLC (GEL) maintains environmental laboratory certification in many states, including primary NELAP in Florida and secondary in Utah, New York, California and New Jersey. We expand our list of certification as needed. Original Scope of Accreditations are maintained in the Quality Assurance work area. Electronic copies are available in pdf form on the GEL intranet. *Please call to confirm the status of any certification of interest to you.*

- **U.S. Department of Agriculture** - Foreign soil importation permit # S-52597
- **U.S. Army Corps of Engineers** (USACE) - Validation by the Hazardous, Toxic and Radioactive Waste (HTRW) Center of Expertise
- **U.S. Department of Energy** (DOE) - Established Basic Ordering Agreement (BOA) in support of ICPT, for use by DOE and its eligible subcontractors. Audited by DOE's Office of Environmental Management under the Environmental Management Consolidated Audit Program (EMCAP)
- **U.S. Navy** - approval for Naval Facilities Command Southern Division Remedial Action Contract
- **National Environmental Laboratory Accreditation Program (NELAP) -** Primary issued through the State of Florida - Department of Health – Bureau of Laboratories; Secondary issued through the States of California, New York, New Jersey and Utah
- **Clinical Laboratory Improvement Amendments (CLIA)** U.S. Department of Health and Human Services Certificate of Compliance for Acceptance of Human Specimens (GEL ID: 42D0904046)
- **USEPA** Office of Ground Water and Drinking Water, Perchlorate under UCMR
- **USEPA Region 5** Radiochemical Parameters for the Safe Drinking Water Act (SDWA)

- **Alaska** Department of Environmental Conservation, Contaminated Sites Program (UST-062)
- **Arizona** Department of Health Services, Division of Public Health Services License (GEL ID AZ0668)
- **Arkansas** Department of Environmental Quality Laboratory Certification Program for Wastewater, Groundwater, Solid Waste
  Reciprocal Certification to SC DHEC
- **California** Environmental Laboratory Accreditation Program Certification (GEL ID: 01151CA)
- **Colorado** Department of Public Health and Environment, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water Chemistry and Radiochemistry

- **Connecticut** - Department of Public Health - Potable Water, Waste Water and/or Trade Waste, Sewage and/or Effluent, Soil and Radiochemistry Reciprocal Certification (GEL ID: PH-0169)

- **Florida** Department of Health - Office of Laboratory Services, Safe Drinking Water, Clean Water Act and RCRA Certification (Lab ID: 87156)

- **Georgia** Department of Natural Resources, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water (inorganics) (GEL ID: 938)

- **Hawaii** State of Hawaii, Department of Health, State Laboratories Division, Safe Drinking Water Parameters

- **Idaho** Department of Health and Welfare, Bureau of Laboratories, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water - Inorganics and Radiologicals

- **Illinois** EPA Environmental Laboratory Accreditation for Drinking Water, Waste Water and Hazardous & Solid Waste (GEL ID: 200029)

- **Indiana** Indiana State Department of Health, Chemistry Laboratory (GEL ID: C-SC-01)

- **Kansas** Department of Health and Environmental Laboratory (GEL ID: E-10332)

- **Kentucky** Department of Environmental Protection for Drinking Water (GEL ID: 90129)

- **Maryland** Department of Health and Mental Hygiene, Laboratories Administration, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water -Radiochemistry (GEL ID: 270)

- **Massachusetts** Department of Environmental Protection, Division of Environmental Analysis – Potable Water (Radiochemistry)

- **Michigan** Department of Environmental Quality, Reciprocal Certification to SC DHEC. Drinking Water & Radiological Protection Division Certification for Inorganic Chemistry (GEL ID: 9903)

- **Nevada** Department of Human Resources, Health Division, Bureau of Licensure and Certification, Radiologicals and Non-Radiologicals (GEL ID: SC-12-2002-57)

- **New Jersey** Department of Environmental Protection, Safe Drinking Water, Solid and Hazardous Waste, and Water Pollution Certification (GEL ID: SC002)
- **New Mexico** State of New Mexico, Environment Department, Drinking Water Bureau

- **New York** Department of Health, Environmental Laboratory Approval Program Certification, Potable Water, Non-potable Waters and Solids/Hazardous Wastes (GEL ID: 11501)

- **North Carolina** Department of the Environment and Natural Resources, Waste Waters/Ground Waters (GEL ID: 233) and North Carolina Department of Health and Human Services, Division of Public Health, Drinking Water Certification Office (GEL Lab No. 45709)

- **North Dakota** State Department of Health for Drinking Water, Waste Water and Hazardous & Solid Waste (GEL ID: R-158) (Reciprocal certification with South Carolina)

- **Oklahoma** Department of Environmental Quality, General Water Quality/Sludge Testing Laboratory Dual Certification (GEL ID: 9904)

- **Pennsylvania** Department of Environmental Protection - Bureau of Laboratories, Safe Drinking Water Certification (GEL ID: 68-485)

- **South Carolina** Department of Health and Environmental Control - Environmental Laboratory Certification Program, Clean Water, Safe Drinking Water and Solid/Hazardous Wastes (GEL ID: 10120)

- **South Carolina** Department of Health and Environmental Control (DHEC) Radioactive Material License (License #362)

- **Tennessee** Department of Health - Division of Laboratory Services, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program, Safe Drinking Water-Radiochemistry and Non-radiochemistry (GEL ID: 02934)

- **Texas** Department of Health - Bureau of Laboratories, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program, Safe Drinking Water, including radiochemistry (GEL ID: TX 213)

- **Utah** Department of Health, Division of Epidemiology and Laboratory Services, Services, Safe Drinking Water, Clean Water and Resource and Conservation and Recovery Act Certifications (Customer ID: GEL)

- **Vermont** Department of Environmental Conservation, Water Supply Division (Reciprocal Certification with South Carolina)

- **Virginia** Department of General Services - Division of Consolidated Laboratory Services, Safe Drinking Water Reciprocal Certification (Radiologicals and Non-Radiologicals) (GEL ID: 00151)
- **Washington** State of Washington, Department of Ecology, Environmental Laboratory Certification Program (GEL ID C223)
- **Wisconsin** Department of Natural Resources Reciprocal Certification with South Carolina (GEL ID: 999887790)

APPENDIX E: ESSENTIAL QUALITY CONTROL REQUIREMENTS

At GEL, we enforce strict adherence to quality control measures. Quality control measures for each type of analysis are delineated in the associated standard operating procedure and include those specified in the identified analytical method. Client requests for additional quality control agreed to by us will be communicated to the laboratory by the project manager and performed accordingly.

All quality control measures are assessed and evaluated on an on-going basis. We use these measures to establish statistically derived quality control acceptance criteria. The acceptance criterion is used to evaluate whether the analytical process is in control, and to assist us in establishing the validity of the data. Our procedures for handling out of control situations are written in the analytical standard operating procedure.

Method-specific quality measures are described in the appropriate standard operating procedure. Essential but general quality control requirements are summarized in the sections below for chemical testing, including inorganic and organic analyses, microbiological analyses, and radiochemical testing.

E1 Chemical Testing

This section includes our quality control requirements for inorganic and organic analyses, and discusses:

- Negative controls
- Positive controls
- Analytical variability and reproducibility
- Method evaluation
- Method detection limits
- Data reduction
- Quality of standards and reagents
- Selectivity
- Constant and consistent test condition

E1.1 Negative controls

We implement a negative control at least once per analytical batch of samples having the same matrix, and where, if applicable, the same extraction or preparation method is employed. The negative control is a method blank that we use to determine the presence of contamination. If discovered, we must investigate the source of contamination and take measures to correct, minimize or eliminate the source if:

1. The concentration of target analyte exceeds the established practical quantitation limit and exceeds a concentration greater than 1/10 of the measured concentration of any sample in the analytical batch;
2. The concentration of a target analyte in the method blank exceeds that present in the samples and is greater than 1/10 of the specified regulatory limit.

If a method blank is indicative of contamination, we must assess each sample in that batch against the above criteria to determine if the data is acceptable. Any sample associated with a contaminated method blank shall be reprocessed for analysis, or we will report the results with appropriate data qualifiers.

E1.2 Positive Control -Method Performance

E1.2.1 Laboratory Control Sample (LCS)

Purpose: The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside of these criteria, indicates that the analytical system is “out of control”. Any affected samples associated with an out of control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes.

Frequency: The LCS is analyzed at a minimum of 1 per preparation batch. Exceptions would be for those analytes for which no spiking solutions are available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Composition: The LCS is a controlled matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes. NOTE: the matrix spike may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. Alternatively the LCS may consist of a media containing known and verified concentrations of analytes or as Certified Reference Material (CRM). All analyte concentrations shall be within the calibration range of the methods. The following shall be used in choosing components for the spike mixtures:

The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected should be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked.

a) For methods that include 1-10 targets, spike all components;
b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;
c) For methods with more than 20 targets, spike at least 16 components .

Note: Unless otherwise noted in project quality assurance plans or if components interfere with an accurate assessment, all Dept. of Defense projects will have LCS, MS, and MSD that contain all target analytes.

Evaluation Criteria and Corrective Action: The results of the individual batch LCS are calculated in percent recovery. The laboratory shall document the calculation for percent recovery. The individual LCS is compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory determines internal criteria or utilizes client specified assessment criteria.

A LCS that is determined to be within the criteria effectively establishes that the analytical system is in control and validates system performance for the samples in the associated batch. Samples analyzed along with a LCS determined to be “out of control” should be considered suspect and the samples reprocessed and re-analyzed or the data reported with appropriate data qualifying codes.

E1.2.2 Sample Specific Controls

The laboratory must document procedures for determining the effect of the sample matrix on method performance. These procedures relate to the analyses of matrix specific Quality Control (QC) samples and are designed as data quality indicators for a specific sample using the designated test method. These controls alone are not used to judge laboratory performance. Examples of matrix specific QC include: Matrix Spike (MS); Matrix Spike Duplicate (MSD); sample duplicates; and surrogate spikes.

E1.2.3 Matrix Spike; Matrix Spike Duplicates:

Purpose: Matrix specific QC samples indicate the effect of the sample matrix on the precision and accuracy

of the results generated using the selected method. The information from these controls is sample/matrix specific and would not normally be used to determine the validity of the entire batch.

Frequency: The frequency of the analysis of matrix specific samples shall be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the required mandated test method.

Composition: The components to be spiked shall be as specified by the mandated test method. Any permit specified analytes, as specified by regulation or client requested analytes shall also be included. If there are no specified components, the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen using the following criteria for choosing the number of analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a 2 year period.

a) For methods that include 1-10 targets, spike all components;
b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;
c) For methods with more than 20 targets, spike at least 16 components.

Evaluation Criteria and Corrective Action: The results from matrix spike/matrix spike duplicate are primarily designed to assess the precision and accuracy of analytical results in a given matrix and are expressed as percent recovery (% R) and relative percent difference (RPD).

Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory should determine internal criteria and document the method used to establish the limits. For matrix spike results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.4 Matrix Duplicates:

Purpose: Matrix duplicates are defined as replicate aliquots of the same sample taken through the entire analytical procedure. The results from this analysis indicate the precision of the results for the specific sample using the selected method. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.

Frequency: The frequency of the analysis of matrix duplicates may be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the mandated test method.

Composition: Matrix duplicates are performed on replicate aliquots of actual samples. The composition is usually not known.

Evaluation Criteria and Corrective Action The results from matrix duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD) or another statistical treatment (e. g., absolute differences). The laboratory shall document the calculation for relative percent difference or other statistical treatments.

Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits. For matrix duplicates results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.5 Surrogate Spikes:

Purpose Surrogates are used most often in organic chromatography test methods and are chosen to reflect

	the chemistries of the targeted components of the method. Added prior to sample preparation/extraction, they provide a measure of recovery for every sample matrix.
Frequency	Except where the matrix precludes its use or when not available, or is not a method requirement, surrogate compounds are added to all samples, standards, and blanks for all appropriate test methods.
Composition:	Surrogate compounds are chosen to represent the various chemistries of the target analytes in the method. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.
Evaluation Criteria and Corrective Action:	The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory determines internal criteria and documents the method used to establish the limits.
	Surrogates outside the acceptance criteria must be evaluated for the effect indicated for the individual sample results. The appropriate corrective action may be guided by the data quality objectives or other site specific requirements. Results reported from analyses with surrogate recoveries outside the acceptance criteria include appropriate data qualifiers.

E1.3 Method Evaluation

The following procedures, as described in the other sections of the QAP, are in place in order to ensure the accuracy of the reported result:

- Procedure for initial demonstration of analytical capability performed initially (prior to the analysis of any samples) and if there is a significant change in instrument type, personnel, matrix or test method. Refer to Section 8.
- Procedures for initial and continuing calibration protocols as specified in Section 7.
- Procedures for utilizing proficiency test samples to evaluate the ability of a procedure and/or analyst laboratory to produce accurate data as specified in Section 3.

E1.4 Method Detection Limits

Method detection limits (MDLs) are determined as descried in GL-LB-E-001 for the Determination of Method Detection Limits. This procedure is based on that established in 40 CFR Part 136, Appendix B.

Where possible, MDL studies are conducted for both aqueous and solid matrices using a clean matrix appropriate to the test method (such as laboratory pure reagent water or Ottawa sand.) MDL studies for the majority of routine parameters are conducted by:

- analyzing seven replicates of the lowest calibration standard
- determining the standard deviation of the seven replicates
- multiplying the standard deviation by 3.143 (based on six degrees of freedom and representing a 99% confidence level) to obtain the calculated MDL.

If the MDL study is being conducted for a new method or target analyte, the following steps are taken:

- the MDL is estimated based on information provided in the method or analytical experience
- a standard with a concentration three to five times the estimated MDL is prepared and analyzed seven times
- the MDL is calculated as above based on the standard deviation and degreases of freedom
- the MDL is evaluated for reasonableness by verification through analysis of a prepared standard solution two to three times the calculated MDL.

MDL studies are not performed for any target analyte for which spiking solutions are not available such total volatile solids, pH, color, odor, temperature dissolved oxygen or turbidity.

Practical quantitation limits (PQLs) are determined by either multiplying the MDL by 5 TO 10 or are equal to that of the lowest calibration standard. Concentrations of a target analyte determined to be greater that its PQL are defined as quantitative results. All quantitative reported results are bracketed by calibration or calibration verification standards.

All MDL studies conducted by the laboratory are submitted to the Quality team for an independent review. Upon acceptance of the MDL study, the MDLs reported to clients via our computer system are updated unless otherwise specified by contract. PQLs are also updated as directed by the new MDLs or changes to procedures.

All data pertaining to the study and the calculation of the MD(s) is stored on compact discs. The compact discs are maintained as quality records in the Quality department.

E1.5 Data Reduction

The procedures for data reduction, such as use of linear regression, are documented in the individual analytical standard operating procedures. GEL's policy governing the manual integration of chromatographic data is detailed in GL-LB-E-017 for Procedure and Policy for Manual Integration. Understanding of the procedures used for data reduction is an important part of an analyst demonstrating proficiency in an analytical procedure. All analysts who may potentially perform manual integrations of chromatographic data are also trained to GL-LB-E-017.

Manual integrations of chromatographic peaks can only be performed in accordance with this GL-LB-E-017. This ensures that the integrations are done in a consistent and technically justifiable manner while meeting the requirements set forth under the Good Automated Laboratory Practices.

E1.6 Quality of Standards and Reagents

The quality of standards used in instrument calibration or quality control samples and reagents used in sample preparation and/or analysis must meet the criteria described in Section 7. In methods where the purity is not specified, analytical grade reagents are used. Reagents of lesser purity than those specified by the test method are never used. Upon receipt and prior to use the labels on the container are checked to verify that the purity of the reagents meets the documented requirements of the particular test method.

The quality of water sources is monitored and documented as described Section 4. The quality of water used in sample preparation or analysis meets the method-specified requirements. The type of water available in the laboratory is described in Section 4.

E1.7 Selectivity

Absolute and relative retention times aid in the identification of components in chromatographic analyses and to evaluate the effectiveness of a column in separating constituents. The procedures governing retention time widows are documented in the applicable analytical SOP and meet all regulatory and method requirements.

In addition to retention time windows, the acceptance criterion for mass spectral training is also documented in the appropriate analytical SOP. In all cases, the acceptance criteria meet or exceed those specified in the analytical methods.

Unless stipulated in writing by the client, confirmations are performed to verify the compound identification of positive results detected on a sample from a location that has not been previously tested by our laboratory. Such confirmations are performed on a second column for organic tests such as pesticides, herbicides, or acid extractable or when recommended by the analytical test method except when the analysis involves the use of a mass spectrometer. All conformation is documented.

E1.8 Constant and Consistent Test Conditions

GEL's implementation of standard operating procedures that specify quality criteria including initial and continuing calibrations assures that our test instruments consistently operate within the specifications required of the application for which the equipment is used.

In addition to the specifications applied to instrumentation, glassware used for sample preparation or analyses is cleaned in a manner that reduced the potential for positive or negative interferences. Glassware is prepared in accordance with GL-LB-E-003 for Glassware Preparation.

This SOP details the procedures used to clean the following groups of glassware:

- That used for the determination of metals with a special section for bottles to be used for the determination of mercury by either EPA 7470 or 7471A.
- Reusable bottles and plasticware
- Bottles sued for the determination of biochemical oxygen demand
- Glassware used in the determination of organic compounds
- That used for the determination of methylene blue active substances
- Glassware used in the determination of total organic halides
- Glassware used in the analyses of samples for total kjeldahl nitrogen and total phosphorous
- Generic glassware used in all other analyses

If the method specifies that the glassware be stored in a particular manner, this requirement is documented in the appropriate analytical SOP.

Section E2 Microbiology

The quality control elements included in this section apply to microbiological analyses performed at GEL. The analyses include the determination of both total and fecal coliforms and standard plate counts.

Discussed in this section are:

- Negative controls
- Positive controls
- Test variability and reproducibility
- Method evaluation
- Test performance
- Data reduction
- Quality of standards, reagents, and media
- Selectivity
- Test conditions

E2.1 Negative Controls

We demonstrate that the cultured samples have not been contaminated during sampling handling and analysis or environmental exposure by the use of negative controls. These negative controls include both sterility checks of media and method blanks.

All blanks and non-inoculated controls specified by the test methods are prepared and analyzed at the frequency stated in the method and in the corresponding standard operating procedure.

A minimum of one non-inoculated control is prepared and analyzed is analyzed with analytical batches containing only one sample. If the analytical batch contains multiple samples, a series of method blanks is prepared. This series includes least one beginning and ending negative control with additional controls inserted after every 10 samples.

If the method blanks show evidence of contamination, the data obtained for the associated samples is not reported and the client is advised that resampling will be necessary.

Prior to initial use, each lot of media is subjected to a sterility check by analyzing an aliquot of sterile buffer water. If there is any evidence of contamination, the media is not utilized for the analysis of samples and is either returned to the supplier or disposed of in accordance with the Laboratory Waste Management Plan.

E2.2 Positive Controls

Positive controls are used to demonstrate that the medium can support the growth of the target organism and that it produces the specified or expected reaction to that organism. Prior to the initial and then on a monthly basis each lot of media is tested using least one pure culture of with a known positive reaction. If the positive reaction does not occur, the media is not used for sample analysis and is either returned to the supplier or disposed of according to the Laboratory Waste Management Plan.

E2.3 Test Variability and Reproducibility

We demonstrate reproducibility of our data by analyzing sample duplicates for least 5% of the suspected positive samples. Each analyst performing microbiological analyses makes parallel analyses on at least one positive sample per month.

For analysis requiring sample volumes of less than 100mL or where the clients submit duplicate sample aliquots, a sample duplicates is analyzed with each analytical batch.

E2.4 Method Evaluation

Our ability to perform a specified analysis successfully for its intended purpose is demonstrated and documented in meeting at a minimum the acceptance criteria specified by the method, by the EPA, and by state programs under which we are certified. The acceptance criteria demonstrate that the test method as performed at GEL provides correct and expected results with respect to specified detection capabilities, selectivity, and reproducibility.

Proficiency of the analysis is demonstrated prior to the test method through the use of positive and negative controls. The validation of microbiological test methods is conducted under the same conditions as those for routine analysis.

All validation data is recorded in a logbook specified by the appropriate SOP. We maintain the data as long as the analysis is being conducted and for a minimum of five years after the retirement of an analytical method.

E2.5 Test Performance

Test performance is demonstrated for all growth and recovery media used by the appropriate growth and reaction of target organisms to the test media through the use of positive controls as discussed in E2.2.

E2.6 Data Reduction

All data is calculated and subjected to data reduction and statistical interpretations as specified by the method's SOP. These specifications incorporate those found in the associated analytical method.

For test methods specifying colony counts, such as membrane filter or colony counting, then the ability of individual analysts to count colonies is verified at least once per month. This verification includes having two or more analysts count colonies from the same plate.

E2.7 Quality of Standards, Reagents and Media

In addition to the performance of positive and negative controls, we ensure that the quality of the reagents and media meets or exceeds the requirements specified in the analytical methods. The commercially dehydrated powders used to prepare certain culture media as well as the media that is purchased ready for use are both subjected to positive and negative controls. In addition, all reagents, commercial dehydrated powders and media are used within the shelf life of the product as documented in Section 8.

We retain all manufacturer supplied "quality specification statements" which may contain such information as shelf life of the product, storage conditions, sampling regimen/rate, sterility check including acceptability criteria, performance checks including the organism used, their culture collection reference and acceptability criteria, date of issue of specification, or statements assuring that the relevant product batch meets the product specifications.

All media and buffers are prepared using deionized water that has been demonstrated to be free from bacterial contamination. The deionized water used for microbiological analyses and the monitoring of the deionized water is discussed in Section 4.

Media, solutions and reagents are prepared, used and stored in accordance with appropriate SOP. As described in 2.2, all laboratory media are be evaluated at least monthly to ensure they support the growth of specific microbial cultures. In addition, selective media are checked to ensure they suppress the growth of non-target organisms.

The laboratory detergent is be checked by use of the inhibitory residue test to ensure that its residues do not inhibit or promote growth of microorganisms.

E2.8 Selectivity

We perform all confirmation and verifications tests specified by the test method according to the procedures outlined in our SOPs.

In order to demonstrate traceability and selectivity, we use reference cultures of microorganisms obtained from a recognized national collection. We do not subculture bacterial working stocks. The storage and maintenance of all working and reference stocks are specified in the applicable analytical SOP.

E2.9 Test Conditions

We monitor background levels by the use of method blanks and other negative controls. The acceptable background counts for each analysis and how to deal with situations in which these levels are exceeded are specified in the applicable SOP.

Walls, floors, ceilings and work surfaces of our microbiological laboratory are non-absorbent and easy to clean and disinfect. Measures are taken to avoid accumulation of dust by the provision of sufficient storage space and daily cleaning of exposed surfaces.

The temperature measuring devices such as liquid-in-glass thermometers used in incubators, autoclaves and other equipment are of the appropriate quality to achieve the specification in the test method.

The graduation of the temperature measuring devices is appropriate for the required accuracy of measurement. Each device is calibrated at least annually to national or international standards for temperature in accordance with GL-QS-E-007 for Thermometer Calibration.

The temperatures of incubators, refrigerators, autoclaves, and waterbaths are monitored and documented in accordance with GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators, and Other Similar Devices. While in use, each piece of equipment is maintained in the temperature range specified by the applicable SOP and test method.

Records of autoclave operations including temperature and time are maintained for every cycle.

Volumetric equipment such as automatic dispensers, air displacement pipets and disposal pipets are all used in the microbiology laboratory. This equipment is routinely checked for accuracy as discussed in Section 7.

Conductivity meters, pH meters, and other similar measurement instruments are calibrated according to the methods specified requirements detailed in the SOP.

Mechanical timers are checked regularly against electronic timing devices to ensure accuracy.

Section E3 Radiochemical Analysis

This section describes the general quality control applied to radiochemical analysis. The specific quality control criteria applied to each analysis are delineated in the corresponding SOP.

Discussed in this section are:

- Negative controls
- Positive controls
- Test variability/reproducibility
- Tracers and carriers
- Method evaluation
- Radiation measurement system calibration
- Data reduction
- Quality of standards and Reagents
- Test Conditions

E3.1 Negative Controls

Method blanks serve as the primary negative controls providing a means of assessing the existence and magnitude of contamination introduced via the analytical scheme. A method blank is analyzed at a frequency of one per preparation or analytical batch and is one of the quality control measures to be used to assess batch acceptance.

The activity level determined for each target in the method blank is assessed against the specific acceptance criteria specified in the applicable SOP. These criteria are based on a designated sample aliquot size and include appropriate calculations to compare the blank to activity levels determined for different sizes of sample aliquots.

The activity level of any target analyte in the method blank should be less than or equal to the contract required detection limit. The method blank may exceed this limit if the activity is less than 5% that of the lowest sample activity in the batch.

If the method blank acceptance criteria is not met, the specified corrective action and contingencies delineated in the SOPs are followed. Any failures of method blanks to meet the acceptance criteria are documented in the laboratory report and through GEL's nonconformance reporting system specified in GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

The activity levels determined for method blanks are not subtracted from those obtained for the samples in the associated preparation or analytical batch. Correction factors such as instrument background and analyte presence in the tracer may, however, be applied to all analyzed samples including both client samples and internal quality control samples.

E3.2 Positive Controls

Positive controls routinely employed in radiochemical analyses include both laboratory control samples (LCS) and matrix spikes (MS.)

The laboratory standards used to prepare LCS and MS are from a different source than those used in instrument calibration, except when the calibration has been verified with a different source. This requirement may be superseded by client specific contract requirements. The activity levels of target analytes in the LCS and MS exceed ten times the prior detection limit and are less than one hundred times this detection limit. If a radiochemical method, however, has more than one reportable analyte isotope, the LCS and MS need to only include one of the analyte isotopes.

Gamma spectroscopy is the exception to this guideline requiring the LCS and MS to contain isotopes representing the low, medium, and high-energy range of the analyzed gamma spectra.

E3.2.1 Laboratory Control Sample (LCS)

Laboratory control samples are analyzed at a minimum of once per preparation or analytical batch containing twenty or less samples.

The recovery of target analytes in the LCS is compared to the acceptance criteria (75% - 125%) specified in the applicable analytical SOP. If the recovery of the LCS does not fall within the acceptance range, the corrective actions and contingency steps specified in the SOP are implemented. These steps include the completion of an internal nonconformance report in accordance with GL-QS-E-004 and noting the failure on the laboratory report.

E3.2.2 Matrix Spike (MS)

Matrix spikes are analyzed at a minimum of once per preparation or analytical batch containing twenty samples or less under the following conditions:

- The analytical method does not utilize an internal standard or carrier
- There is a physical or chemical separation process
- There is sufficient sample volume provided for the analysis.

The target analyte recoveries are one of the quality control measures used to assess batch acceptance. The recovery of target analytes in the MS is compared to the acceptance criteria (75% - 125%) specified in the applicable analytical SOP. If the recovery of the MS does not fall within the acceptance range, the data associated with that matrix spike is qualified accordingly.

E3.3 Test Variability/Reproducibility

The reproducibility of measurements is evaluated by the use of matrix duplicates. Matrix duplicates are analyzed once per preparation or analytical batch of twenty samples. The relative percent difference (RPD) obtained between the activity levels obtained for the sample and its duplicate are evaluated against the range in the SOP. This range is 0%- 20% for activities greater than the contract reporting limit. If the RPD exceeds these criteria, the corrective actions addressed in the SOP are implemented.

E3.4 Tracers and Carriers

Two additional quality control measures specific to radiochemical analysis are tracers and carriers. If the analytical method requires a tracer or carrier, each sample result will be associated with a tracer recovery that is calculated and reported. For radiochemistry procedures requiring gravimetric or radiometric recovery (tracer yields), the acceptable limits are 15% - 125%. These limits may vary for specific clients and/or projects. If the applicable limits are not met, the corrective actions delineated in the SOP are implemented.

E3.5 Method Evaluation

GEL evaluates the radiochemical preparation and analytical methods to ensure the accuracy of the reported result. This evaluation includes initial demonstrations of capability as described in Section 8 and the analysis of proficiency test samples as described in Section 3. The suppliers of proficiency test samples conform to the requirements of ANSI N42.22.

E3.6 Radiation Measurement System Calibration

It is not generally necessary or practical to calibrate radiochemical instrumentation each day of use due to its stability and the time-consuming nature of some of the measurements. There are, therefore, significant differences in the calibration requirements for radiochemical instrumentation from that used for chemical analyses.

Calibration differences include but are not limited to the following:

- The requirement in Section 7 for the determination of the appropriate number of standards for initial calibration is not applicable to radiochemical methods. If the radiochemical method requires multiple standards for initial calibration, the number of standards is included in the applicable SOP.
- If linear regression or non-linear regression is used to fit standard response or calibration standard results to a calibration curve, the correlation coefficient is determined. This differs from Section 7.
- The requirement identified in Section 7 for the bracketing of quantitative results by calibration or calibration verification standards is not applicable to radiochemical analyses due to the non-correlated event nature of decay counting instrumentation.
- As indicated in Section 7, the LCS may fill the requirements for the performance of an initial calibration and continuing calibration verification standard. The calibration verification acceptance criteria are same as specified for the LCS (75 -125%)
- Background calibration measurements are made on a regular basis and monitored using control charts. These values are subtracted from the total measured activity in the determination of the sample activity. The frequency of these measurements is indicated in the table below.

Instrument type	Minimum Frequency
Gamma spectroscopy	Monthly
Alpha spectroscopy	Monthly
Gas-proportional	Day of use
Scintillation counters	Day of use

- Instrument calibration shall be performed with reference standards as defined in Section E3.8.
- The frequency of calibration shall be addressed in the governing SOPs

E3.7 Data Reduction

All sources of method uncertainties and their propagation must be traceable to reported results. This is performed under the guidance of the ISO “Guide to the Expression of Uncertainty in Measurement” and the NIST Technical Note 1297 on “Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results”.

E3.8 Quality of Standards and Reagents

The reference standards we use are obtained from the National Institute of Standards and Technology (NIST), EPA, or suppliers providing NIST standards. Reference standards should be accompanied by a certificate of calibration

whose content is described in ANSI N42.22 - 1995, Section 8, Certificates. All reagents used shall be analytical reagent grade or better.

E3.9 Test Conditions

GEL adheres to written procedures that minimize the possibility of cross contamination between samples. This prevents incorrect analysis results from the cross contamination. Procedures are in place, for example, to separate known radioactive and nonradioactive samples from the time of sample receipt to analysis and sample disposal.

Instrument performance checks are performed on a regular basis and monitored with control charts. This ensures that the instrument is operating properly and that the calibration has not changed. The same check source used in the preparation of the control chart at the time of calibration is used in the performance checks of the instrument. The sources must provide adequate counting statistics for a relatively short count time and should be sealed or encapsulated to provide loss of activity and contamination of the instrument and laboratory personnel.

Instrument performance checks include checks on the counting efficiency and the relationship between channel number and alpha or gamma ray energy. These checks are performed at the frequency indicated in the table below.

Instrument	Frequency of Counting Efficiency	Frequency of Channel # and Alpha and Gamma Ray Energy
Gamma Spectroscopy	Day of use	Day of use
Alpha Spectroscopy	Monthly	Day of use
Gas proportional	Day of use	Day of use
Scintillation Counters	Day of use	Day of use

THE GEL GROUP INC.

ETHICS and DATA INTEGRITY AGREEMENT

I. I, _____, state that I understand the high standards of integrity required of me with regard to the duties I perform and the data I report in connection with my employment at The GEL Group Inc.

II. I agree that in the performance of my duties at The GEL Group Inc.:

A. I shall not intentionally report data values that are not the actual values obtained;

B. I shall not intentionally report dates and times of data analyses that are not the actual dates and time of data analyses; and

C. I shall not intentionally represent another individual's work as my own.

III. I agree to inform The GEL Group Inc. of any accidental or intentional reporting of non-authentic data by myself in a timely manner.

IV. I agree to inform The GEL Group Inc. of any accidental or intentional reporting of non-authentic data by other employees.

_____ _____

(Signature) (Date)

APPENDIX G: EQUIPMENT LIST

ORGANIC EXTRACTIONS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Dionex Solvent Extraction	ACE 200	Jan-97	97070827
3	Tekmar Sonic Distribution	600		22461D
2	Analytical Bio-Chemistry Laboratories GPPC System	AP-1000	Feb-93	9436-SI 1 (23) 9437-SI 9231 SI
8	Zymark Turbovap	Turbovap II	May-96	TV9612N6726 TV9631N6975 TV9628N6939 TV9809R7994 TV0146N10597 TV0146N10596 TV0146N10598 TV0146N10595
4	Soxtherms	SOX416/SE416	Jan-05	4041427 4040014 4040019 4040018
3	N-Evaps Organomation	115 1205	Jun-93 Jun-95	2812 6184 2038

SEMIVOLATILE ORGANIC ANALYSES

#	Equipment	Model #	Purchase Date	ID/Serial #
2	LC/MS/MS - Water HPLC MicroMass Mass Spectrometer	2795	May-02 May-02	D02SM9212M (LC) QAA212 (MS) D99SM9012R (LC) QAA125 (MS)
1	Hewlett Packard HPLC with Diode Array Detector	1100	Oct-99	DE91605558
1	Hewlett Packard HPLC with Diode Array Detector and Fluoresence Detector	1100	Nov-99	DE91608274

6	Hewlett Packard 5973 Gas Chromatograph/ Mass Spectrometer	5973	May-97	US70810371(US0 0026073) US72010604(US0 0009213) US82311233(US0 003050) US82311481(US0 0028102) US82311417(US0 0007297) US82311610
4	Hewlett Packard Gas Chromatograph-FID	5890	Feb-91 Aug-98	3033A33351 (CTC-H5500) 3203A41418(CTC A2005) 3203A41419(CTA 2005) 2950A28331 (7673)
1	Head Space Autosampler	CTC-HS500	Jun-94	30362
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5972	May-93	3310A47337
7	Hewlett Packard Gas Chromatograph-ECD	6890	Aug-97 Nov-97 Mar-98 Jul-98	US00010134 US00009591 US00023402 US00023068 US10133016 US00028911 US00023343

VOLATILE ORGANIC ANALYSES

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer with OI 4560 Purge and Arcon Autosampler	5973	Oct-99	US91911845
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer with 4560/Arcon Autosampler	5973	Nov-98	US82311236

1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5972	May-93	3341A00976
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5972	Jun-93	3251A00145
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Jan-98	US72010562
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Mar-99	US82311536
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Jul-05	US82311616
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
1	Tracor Gas Chromatograph with a Photoionization Detector and a Flame Ionization Detector and Tekmar LCS 2000 with Arcon Autosampler	540	Nov-90	891691
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with 014560/Arcon Autosampler	5972	Feb-94	3418A01517
1	Hewlett Packard Apollo 9000 Series 735 Platforms running: Ingress 6.3, Target 3.12 HPUX 9.05, and Envision 3.20		Feb-94	6239A02398
1	PE Nelson 2600 Series Gas Chromatography Software System Operating on 386 PC Computers	NEC 386 SX/2	Nov-90	2022574419

METALS ANALYSES

#	Equipment	Model #	Purchase Date	ID/Serial #
2	Perkin Elmer Mercury Analyzer	Fims 400 Fims 100	Nov-97 Jul-01	4179 1538

1	PS Analytical Atomic Fluorescence Mercury Analyzer	10.035	Aug-02	024
2	Perkin Elmer Inductively Coupled Plasma Mass Spectrometer	ELAN 6100 ELAN 9000	Dec-01 Apr-02	187000 P1160304
2	Optima 4300DV Spectrometer	4300DV	Apr-02 Apr-02	077N1030502 077N2061001
1	Thermo-Jarrell Ash Simultaneous Inductively Coupled Plasma Trace Analyzer with Autosampler and Ultrasonic Nebulizer	61E Trace	Jan-95	489890

GENERAL CHEMISTRY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	KONELAB	Aquakem 200		
1	Dohrman Total Organic Carbon Analyzer	DC190	May-93	9302211
1	OI Analytical, TOC 1010	1010	Jul-99	18935710267
2	Horizon Speed Vap II	9000 9000	Oct-01 April-02	01-337 01-340
4	Environmental Express Midi Still	N/A	Mar-02 Mar-02	2022 2023 2017 0102 MC-100
2	Lachat QuikChem 8000	8000	Jul-01 Jul-02	A83000-1910 A83000-2077
1	ThermoSpectronic	20D+	Nov-03	3DUD255001
2	Mitsubishi Total Organic Halogen Analyzers	TOX-10-C TOX-10-C	Jul-84 Jan-90	43R00334 43R31429
1	Dionex Ion Chromatograph	DX 500	Oct-99	99050260
2	Dionex Ion Chromatograph	Series 4500I	Jun-89 Mar-93	873450 930613
1	Bran & Luebbe/Technicon Automated Chemistry Segmented Flow Autoanalyzer	TRACCS 800	Mar-90	165-A011-02
1	Turbidimeter	Micro100	Jun-03	205205
1	Dohrman DX 2000 TOX/EOX	DX2000	Feb-94	9309876
1	EM Science Karl Fischer Moisture Analyzer	EV-5	Jan-86	83109-01

1	Tecator Kjeltec System with Distiller and Block Digestor	1026 1015	Jan-93 Jan-93	10002767
2	Bran & Luebbe Block Digestor	BD-20/40	Mar-90	GG0869033 GG0619005
1	Midi Vap Cyan-Ten Midi Cyanide Distillation	MC-100	Jul-93	MCVA1390797
#	**Equipment**	**Model #**	**Purchase Date**	**ID/Serial #**
1	NH3/TKN Distillation Unit	100		9215306
2	Lab-Line Pyro Multi-Magnestire	59380		0300-0171 0300-0170
1	YSI Dissolved Oxygen Meter	59		93601908
1	Metrohm Peak IC Detector	732	Jun-03	11173
2	IEC Clinical Centrifuge			428189 42831885
1	Pensky Martin Flashpoint Tester	HFP 380		23800146
1	Radpid Tester Setaflash	PetroLab		22012
2	Baxter TDS Ovens	DN63		DN63
1	VWR TSS Oven	1370FM		101399
1	Muffle Furnace			
1	Sartorius Balance	LP8200P	Jul-03	14908834
2	Precision Water Baths		Nov-03	R7U-1 602101333
1	Sartorius Analytical Balance	GEL# Bac745		90606745
1	Sartorius Analytical Balance	GEL# B003		39100015
1	Sartorius Analytical Balance	GEL# B006		39010019
1	Sequoia Turner Spectrophotometer	340	Oct-93	007611TF
2	HACH COD Reactor	COD Reactor	Jan-94	911005731C 9807000017919
1	Orion Conductivity Meter	160	Jan-94	32241041
1	Expandable Ionanalyzer	EA940	Jan-90	2060
1	Setaflash Flashpoint Analyzer	01SF	Dec-93	2779
1	Parr 1261 Calorimeter	Parr 1261	Jan-89	289

1	Sartorius Balance	GEL #B005		3410156
2	Sartorius Analytical Balance	GEL #B-010 GEL #B-012		30505030 40245216

AIR ANALYSES

#	Equipment	Model #	Purchase Date	ID/Serial #
3	Nutech Modular Isokinetic Stack Sampling System	N/A	Jan-92	80491
1	Nutech Modified Method 5 Stack Sampling System	N/A	N/A	N/A
2	Nutech Midget Impinger Stack Sampling System	N/A	N/A	N/A
1	Nutech Volatile Organic Sampling Train	N/A	Jan-92	8250
1	JUM Total Hydrocarbon Analyzer	N/A	Feb-92	10620192
1	Shimadzu Gas Chromatograph with two Flame Ionization Detectors and one Flame Photometric Detector	N/A	Jan-92	C10552911986
2	Western Research SO2 Analyzer	N/A	Jan-92	91-721AT2-7857
2	ThermoEnvironmental Instruments NOX Analyzer	N/A	Jan-92	10S-35093-251
1	20 Foot Mobile Laboratory Mounted on Diesel Truck Bed	N/A	Jan-92	VX16084096M31798
3	Olympus Phase Contract Microscopes (PCM#1, #2 and #3) Green Filter and Walton-BeckettGraticule	N/A	N/A	9F00629F0010307222
1	Tekmar Head Space Autosampler	N/A	N/A	91168002
1	Olympus Stereo Zoom Microscope	N/A	Jan-92	SZ4045

RADIOCHEMISTRY/BIOASSAY

#	Equipment	Model #	Purchase Date	ID/Serial #

2	Tennelec LB-4100 Proportional Counter with 32 Detectors	LB4100	Mar-93 Jun-93 Dec-98	18483 21938
4	Beckman Liquid Scintillation Counters	LS600/LL LS6500 LS6500 LS6066 LS6500LL	Jun-93 Jun-93 Apr-94 Mar-03 Sep-05	7065155 7067083 7067404 7060655 7070506
1	Canberra Scintillation Detector (NaI)	G0470 Relative Efficiency 100%	Mar-99	
3	Wallac Liquid Scintillation Counters	Guardian/ Quantallus	Mar-97 Dec-98 Dec-99	4040127 2200082 4140299
2	Canberra Germanium Detectors for Gamma Spectroscopy System	NIGC3019 Relative Efficiency 40%	OCT-01 OCT-01	10017452 100017444
4	Canberra Germanium Detectors for Gamma Spectroscopy System	GC3019 Relative Efficiency 40%	Nov-97 Nov-97 May-97 May-97	1922864 2461 2605 9912854
7	Canberra Germanium Detectors for Gamma Spectroscopy System	GC3519 Relative Efficiency 100%	Dec-91 Dec-91 Jan-94 Nov-97 May-97 May-97	5933088 11912863 12922955 1943199 1943234 7933154 11912876
2	Canberra & Ortec High Efficiency Germanium Detectors for Gamma Spectroscopy System	GC4018 Relative Efficiency 40-45%	May-97 Nov-98 Nov-98	30-TN10348 37-TN11260A
2	Canberra & Ortec High Efficiency Germanium Detectors for Gamma Spectroscopy System	GC8021 90210P Relative Efficiency 80-90%	Aug-94 Nov-98	8943324 30-TP30546A
1	Canberra GX 3519 Extended Range High Efficiency Germanium Detector for Gamma Spectroscopy System	GR3520 Relative Efficiency 40%	Aug-93	8932581
1	Canberra GCW 3522 Germanium Well Detector for Gamma Spectroscopy System	GCW3523 Relative Efficiency 40%	Apr-94	3941466
3	Canberra Low Energy Germanium Detector for X-Ray Spectroscopy System	GL2020/S Relative Efficiency 30%	Feb-95 Jan-95 Mar-98	129 22782 195 4119 3984452

1	Digital Vax Station 4000/90 Computer System for Alpha/Gamma Data Management System	VS49-K-AA	Dec-94	AB43500 OWN
2	DEC Alpha Work Stations for Alpha/Gamma Data Management System	600 AV 600 AV	Nov-98 Nov-98	N183806280 N188806229
112	Canberra Alpha Spectrometers for Alpha Spectroscopy System (Environmental)	7401	1992 to 1995	Varied
6	Ludlum Scalers for Radium 226 Analysis/ Lucas Cells	2000	Dec-00 May-92 Jun-93 Oct-93 Dec-98 Dec-00	101846 86493 104617 140731 078964 125015
2	Protean Automatic Proportional Counter	WPC 9550	3/1/2002 7-04	0021910 924233
4	Protean Multi-Detector (16) Proportional Counter	MDS-16	Apr-02	10751-4
2	Laser Kinetic Phosphorimeter	KPA-11 KPA-11	Mar-94	91-45050014 9445050064
1	Wallac Wizard 3 in Automatic Gamma counter	1480	Nov-05	4800440
12	Sartorius Balance	BP310P TE313S A200S EB6DCE-I EB6DCE-L I12000S R300S HD2000D I5D LC4200S BP310S BP210S LC3201D CP2202S A200S BP3100S LC6200S TE2101 B610 LC4800P I8100P BP221S U6100 U6100+	Pre-2001	38040037 16107662 38080204 15804126 15701734 4019033 38110047 39020004 39039003 40309539 50410272 70104421 60108592 14509268 40020046 51204863 30503785 16750207 39100015 410010032 21100147 90606745 36040216 39010019

	Sartorius Balance (Continued)	2200S 1872 CP232S AT261 AE240 AE160		38110007 3410156 15750050 M64061 L62858 C31514
3	Mettler Balance	AE240 AT261 AE160		L28658 M64061 B28926
1	Precisa Balance	3100C		28488
6	Beckman Centrifuges	TJ-6	1997	
1	Allegra 6 Centrifuge			
1	Industrial Centrifuge			
5	Thermo IEC Centrifuge	Centra CL3		37501230 37500869 37501045 37501117
10	Lindberg Blue Muffle Furnace	Box Furnace	 Pre-2001 Pre-2001 Pre-2001 Pre-2001	#5 X05K-5D0171-XK T23J-441455-UJ NO8L-51994-NL BF51841C #9 #12 #10
3	Vulcan Oven	A-500		
120	Canberra Alpha Analyst Spectrometer with PIRS Detectors	7200	1988-2002	Varied

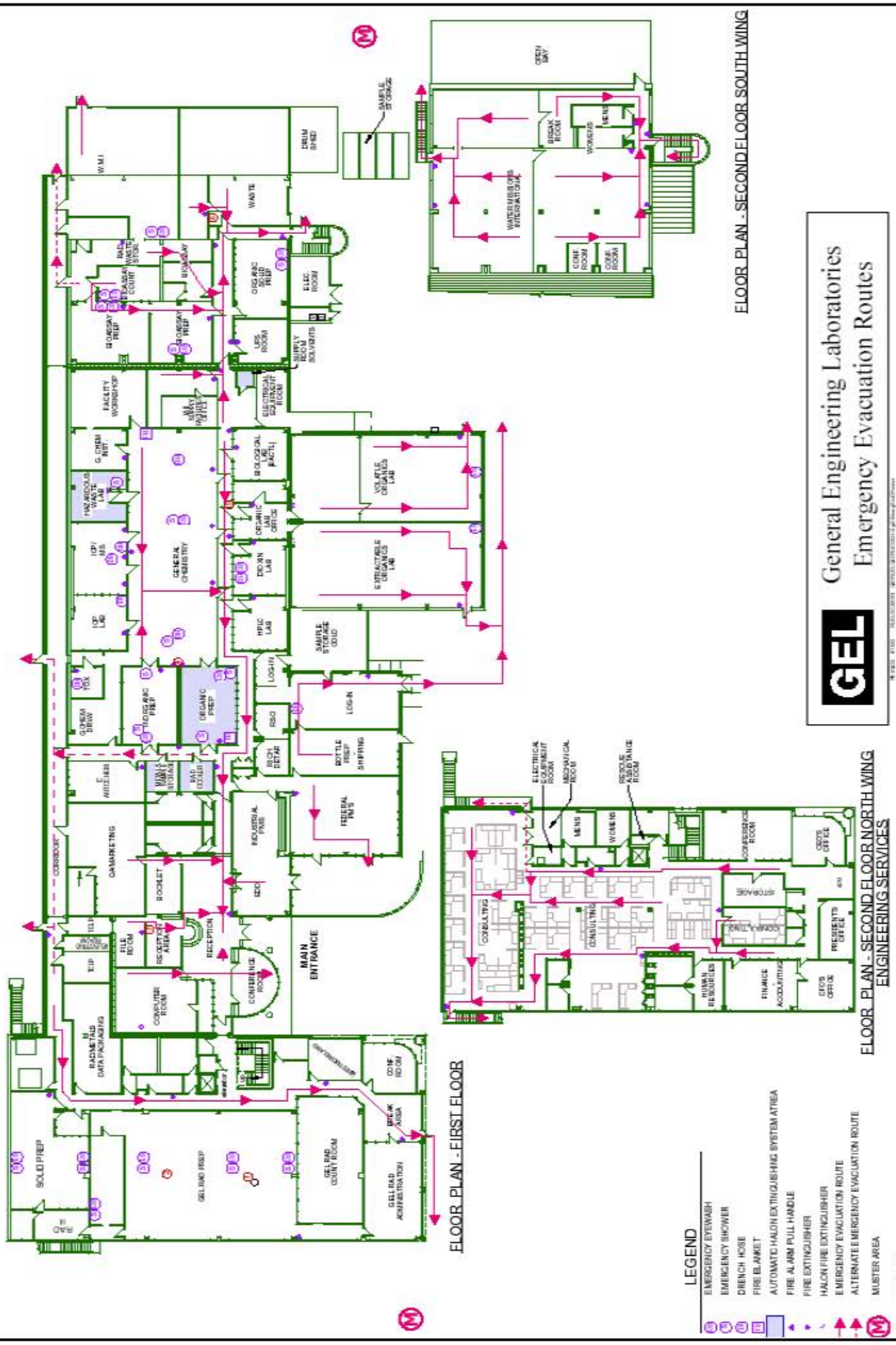
LABORATORY INFORMATION MANAGEMENT SYSTEMS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	SUN Ultra Enterprise 3000, Solaris 2.5.1, 6 CPUs, (new carlos) 512 MB RAM, 50 GB Disk (mirrored, 100 Mbps Eth card, Oracle 7)	N/A	Apr-98	SUN-E3-167
1	SUN Ultra Enterprise 3000, Solaris 2.6, 6 CPUs, (prodsvr01) 512 MB RAM, 25 GB Disk (mirrored, 100 Mbps Eth card, Oracle 8I, Rad Tower)	N/A	Apr-98	SUN-E3-167
1	Windows NT Server, NT4, 2 CPU 256 MB RAM 10 GB Disk (rad_server), 100 Mbps Eth card, ORACLE 7	N/A	Aug-98	PC Server Class
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (hpclp1) 50GB Disk (mirrored and RAID%), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (kilroy) 50GB Disk (mirrored and RAID5), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	SUN Ultra Enterprise 4500, Salaris 9 20 CMUs, 6 GB RAM, 720 GB Disk (mirrored RAID 5), Oracle 9, 100 Mbps Ethernet card	E4500	Feb-03	941H35EF
1	Rave - Ultra AX-MP 2 CPU's, 1024 MB RAM, 60 GB Disk (mirrored)	E450	Oct-99	257703
1	Rave - Ultra AX-MP 2 CPU's, 1024 MB RAM, 60 GB Disk (mirrored)	E250	Mar-00	302971
1	SUN Sparc-5 225 MB, 5 GB	N/A		521F00XX
1	SUN Sparc-5 225 MB, 10 GB	N/A		434F2457

UNIVERSAL POWER SUPPLY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	International Power Machines Durable Power 300	FE-Series	May-99	BP-FE-81

APPENDIX H: FACILITIES WITH EVACUATION ROUTES



APPENDIX I: STANDARD OPERATING PROCEDURES & ANALYTICAL METHODS

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-ADM-E-001	Preparation, Authorization, Change, and Release of SOPs	N/A
GL-ADM-E-002	Process, Review, and Distribution of COAs and COA Packages	N/A
GL-AP-E-001	Invoicing Analytical Lab Numbers	N/A
GL-CO-E-001	Revising General Engineering Laboratories Catalog of Analytical Services	N/A
GL-CO-E-002	Delegated Authority to Commit the Company	N/A
GL-CO-E-003	Request for Proposal (RFP)/Contract Review	N/A
GL-CS-E-002	Internal Review of Contractually Required Quality Criteria for Client Package Delivery	N/A
GL-CS-E-005	Electronic Data Deliverables	N/A
GL-CS-E-006	Subcontracting Analytical Services	N/A
GL-CS-M-001	Project Management AlphaLIMS Manual	N/A
GL-DC-E-001	Document Control	N/A
GL-FC-E-001	Facility Security	N/A
GL-FC-E-002	Testing Emergency Eyewash and Shower Equipment	N/A
GL-FC-E-003	Fume Hood Face Velocity Performance Checks	N/A
GL-FC-E-004	Inspection of Fire Extinguishers	N/A
GL-FS-E-001	Field pH	N/A
GL-FS-E-002	Field Specific Conductance	N/A
GL-FS-E-003	Field Dissolved Oxygen	N/A
GL-FS-E-004	Field Total and Free Residual Chlorine	N/A
GL-FS-E-005	CME-45 B Drilling Rig	N/A
GL-FS-E-006	Hydrolab Datasonde 4a Operation	N/A
GL-FS-E-007	Low Level Mercury Sampling By EPA Method 1669	EPA 1669
GL-GC-E-001	Total Dissolved Solids	160.1, 2540C
GL-GC-E-002	Fluoride Determination by Ion Selective Electrode	340.2, SM 4500F-B, SM 4500F-C
GL-GC-E-004	General Chemistry Standards Definitions and Preparation	N/A
GL-GC-E-007	Total Organic Halogen (TOX) on Liquid Samples Using the Mitsubishi TOX-10 Analyzer	1650C, 9020B
GL-GC-E-008	pH	150.1, 9040B, 9041A, 9045C, 4500 H
GL-GC-E-009	Conductivity and Salinity	120.1, 9050, SM 2510B
GL-GC-E-010	Paint Filter Test	9095A
GL-GC-E-011	Total Solids	160.3, 2540B, 2540G

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-GC-E-012	Total Suspended Solids	160.2
GL-GC-E-017	Oil and Grease and Gravimetric Total Petroleum Hydro Carbons (TPH) Aqueous Samples	9070A(Mod), SM 5520F
GL-GC-E-018	Oil and Grease and Total Recoverable Petroleum Hydrocarbons (TPH) in Solids	9071A, SM 5520E, SM 5520F
GL-GC-E-019	Ammonia Determination by TRAACS 800 Methodology	350.1
GL-GC-E-026	Total Phosphorus	365.4
GL-GC-E-027	Pensky-Martens Closed Cup Flashpoint	1010
GL-GC-E-028	Carbonaceous Biochemical Oxygen Demand (CBOD)	405.1, SM 5210
GL-GC-E-029	Corrosivity Toward Steel	1110(Mod)
GL-GC-E-031	Fecal Coliform by Membrane Filter	9222D
GL-GC-E-032	Carbon Dioxide (Total and Free) by Calculation	310.1, SM 4500-CO2-D
GL-GC-E-033	Alkalinity - Total, Bicarbonate Carbonate, Hydroxide, and Phenolphthalein	310.1(Mod), 2320B
GL-GC-E-034	Fecal Coliform Most Probable Number (5 Tube Dilution)	SM 9221-E1, SM 9221-E2
GL-GC-E-035	Volatile Suspended Solids	160.2, 160.4, SM 2540E
GL-GC-E-036	Color by Visual Comparison	110.2, SM 2120B
GL-GC-E-037	Turbidity	2310B, 180.1
GL-GC-E-040	Pretreatment of Cyanide Amenable to Chlorination	335.1(Mod), 335.3 (Mod), 9010B, 9012A
GL-GC-E-041	Nitrate/Nitrite Sample Preparation and Analysis Using the TRAACS 800 Autoanalyzer	353.1
GL-GC-E-044	Colorimetric Determination of Chromium, Hexavalent	7196A
GL-GC-E-045	Biochemical Oxygen Demand (BOD)	405.1, SM 5210
GL-GC-E-046	Orthophosphate	365.2, SM 4500-PE
GL-GC-E-047	Methylene Blue Active Substance	425.1, 5540C
GL-GC-E-048	Heating Value Determination by Bomb Calorimeter	ASTM D 240-00, 4809-00 (M), E711-87 (M)
GL-GC-E-050	Threshold Odor, Consistent Series EPA 140.1	140.1
GL-GC-E-052	Sulfide (Methylene Blue Method)	376.2(M), HACH 8131
GL-GC-E-053	Heterotrophic Plate Count (Standard Plate Count)	SM 9215
GL-GC-E-054	Total Coliform by Membrane Filter	SM 9222B(M)
GL-GC-E-055	Total Kjeldahl Nitrogen (TKN) Analysis Using the Traacs 800 Autoanalyzer	351.2
GL-GC-E-056	Sulfite	SM 4500-SO3 2-B
GL-GC-E-057	Volatile Solids and % Ash-550-Procedure for Water Samples	160.4, SM 2540E
GL-GC-E-058	Volatile Solids and % Ash-550-Procedure for Solid and Semi-Solid Samples	SM 2540G

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-GC-E-059	Dissolved Oxygen Analysis by Membrane Electrode Method	4500-O-G
GL-GC-E-061	Chemical Oxygen Demand (COD) - Digestion Reactor Method	410.4, HACH 8000
GL-GC-E-062	Total Carbon and Total Organic Carbon Analysis Using the Dohrmann DC-190 Boat Sampler	9060(M)
GL-GC-E-063	Total Coliform by Most Probable Number (5 Tube Dilution)	SM 9221B(M)
GL-GC-E-064	Density	ASTM D5057
GL-GC-E-065	Specific Gravity	ASTM D5057
GL-GC-E-066	Flashpoint by Setaflash	1020A
GL-GC-E-067	Cyanide Sample Preparation	9012A, 9010B, 335.1, 335.3, 335.4, 335.2 CLP-M
GL-GC-E-068	Viscosity	Manufacturer's Method
GL-GC-E-069	Reactive Cyanide and Sulfide	SW-846
GL-GC-E-071	Total Phosphorous Sample Preparation	365.4
GL-GC-E-072	Ammonia Sample Preparation	350.1, 350.2
GL-GC-E-073	Free Cyanide Analysis by Microdiffusion	ASTM D 4282
GL-GC-E-074	Extractable Organic Halides (EOX) Using the Dohrmann DX-2000 Analyzer	SW846 9023
GL-GC-E-076	Total Residue Chlorine	SM 4500 CIG, 330.5
GL-GC-E-077	Cyanide Weak Acid Dissociable Sample Preparation and Analysis	335.4, 4500-CN-1
GL-GC-E-079	Bomb Preparation Method for Solid Waste	5050
GL-GC-E-082	Acid-Soluble Sulfides	9030B, 9034
GL-GC-E-086	Ion Chromatography	300.0, SM 4110B, 9056
GL-GC-E-087	Percent Water by Karl Fischer Titration	ASTM E203-96
GL-GC-E-090	Acidity	305.1, 305.2, 2310B
GL-GC-E-091	Wavelength Verification of Sequoia-Turner Spectrophotometers	N/A
GL-GC-E-092	General Chemistry Data Packaging and Validation	N/A
GL-GC-E-093	Total, Total Inorganic and Total Organic Carbon (TOC) using the O-I-Analytical Model 1010 TOC Analyzer	415.1, SW846 9060
GL-GC-E-094	N-Hexane Extractable Material (HEM, Oil and Grease) and Silica GEL Treated N-Hexane Extractable Material (SGT-HEM Non Polar material)	1664, SW846 9070A
GL-GC-E-095	Cyanide Analysis by Lachat QuikChem 8000 FIA	335.2 CLP-M, 335.1, 335.3. 335.4, 9010B, 9012A
GL-GC-E-096	Perchlorate by Ion Chromatography (IC)	314.0
GL-GC-E-097	Boiling Point	ASTM D 1120 (M)
GL-GC-E-098	Total Halogens	ASTM D 808-00

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-GC-E-099	Ferrous Iron	SM 3500-Fe-D
GL-GC-E-100	Total Hardness by Titration	130.2
GL-GC-E-101	Hydrazine	ASTM D 1385-01
GL-GC-E-102	Total Recoverable Phenol Determination by the Lachat QuickC hem FIA+ 8000 Series	420.2, 9066
GL-GC-E-103	Total Phosphorus by the Lachat QuickChem FIA+ 8000 Series	365.4
GL-GC-E-104	Total Kjeldahl Nitrogen (TKN) using the Lachat QuickChem FIA+8000	351.2
GL-GC-E-105	The Volumetric Determination of Settleable Solids	160.5, SM 2540F
GL-GC-E-106	Ammonia Determination by the Lachat Quickchem FIA + 8000 Series	350.1 Rev2
GL-GC-E-107	Inorganic Calculations	N/A
GL-GC-E-108	Nitrate/Nitrite by KONELAB	353.1
GL-HR-E-002	Employee Training	N/A
GL-HR-E-003	Maintenance of Training Records	N/A
GL-IMS-E-001	Software Modification	N/A
GL-IMS-E-002	Computer Software Development and Maintenance	N/A
GL-IMS-E-004	The Verification and Validation of Software	N/A
GL-IMS-E-005	Computer Services	N/A
GL-IMS-E-006	Method Backup for Computer Controlled Instrumentation	N/A
GL-IMS-E-007	Creating Standard Products	N/A
GL-LB-E-001	Determination of Method Detection Limits	N/A
GL-LB-E-002	Balances	N/A
GL-LB-E-003	Glassware Preparation	N/A
GL-LB-E-004	Temperature Monitoring and Documentation Requirements for Refrigerators, Ovens, Incubators, and Other Similar Devices	N/A
GL-LB-E-005	Data Review/Validation	N/A
GL-LB-E-006	Toxicity Characteristic Leaching Procedure Preparation	1311
GL-LB-E-007	Laboratory Standards Documentation	N/A
GL-LB-E-008	Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbook, Forms and Other Record Keeping Devices	N/A
GL-LB-E-009	Run Logs	N/A
GL-LB-E-010	Maintenance and Use of Air Displacement Pipets	N/A
GL-LB-E-012	Verifying the Maintenance of Sample Integrity	N/A
GL-LB-E-013	CLP/CLP-Like Data Package Assembly, Revision and Archiving	N/A
GL-LB-E-015	Control of Laboratory Standards	N/A
GL-LB-E-016	Collection and Monitoring of DI Water Systems	N/A

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-LB-E-017	Procedure and Policy for Manual Integration	N/A
GL-LB-E-018	Instrument Clock Verification	N/A
GL-LB-E-020	Tuning of High Intensity Ultra-Sonic Processor	N/A
GL-LB-E-022	Generation of Swipe Data	N/A
GL-LB-E-023	Waste Extraction Test (Wet)	N/A
GL-LB-E-024	Synthetic Precipitation Leaching Procedure	1312
GL-LB-E-025	Modified Elutriate Test	N/A
GL-LB-E-026	Container Suitability Testing	N/A
GL-LB-G-001	Laboratory Waste Management Plan	N/A
GL-LB-N-001	Safety, Health and Chemical Hygiene Plan	N/A
GL-MA-E-006	Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS	3005A, 200 Series
GL-MA-E-008	Acid Digestion of Total Metals in Aqueous Samples and Extracts for Analysis by ICP or ICP-MS	3010A, 200 Series
GL-MA-E-009	Acid Digestion of Sediments, Sludges, and Soils	3050B
GL-MA-E-010	Mercury Analysis Using the Perkin Elmer Automated Mercury Analyzer	245.1, 245.2, 245.5, 245.5 CLP-M, 7470A, 7471A, SM 3112B
GL-MA-E-012	Inorganic CLP Sample Digestions	ILMO 4.0, CLP
GL-MA-E-013	Determination of Metals by ICP	EPA 200.7, SW-846 6010B, and 200.7 CLP-M
GL-MA-E-014	Determination of Metals by ICP-MS	6020, 200.8
GL-MA-E-016	Sample Preparation for Total Recoverable Elements by EPA 200.2	EPA 200 series 200.7, 200.8
GL-MA-E-017	Metals Data Validation	N/A
GL-MA-E-018	Mercury Analysis using the PS Analytical Millennium Automated Mercury Analyzer	EPA 1631
GL-MA-E-019	NIOSH 7300 Filter Digestion	7300
GL-MA-E-021	Total Digestion of Sediment Samples for Analysis by ICP or ICP-MS	N/A
GL-OA-E-001	Establishing Retention Time Windows for Gas Chromatographic Analysis	8000
GL-OA-E-002	Organic Standards Preparation and Traceability	N/A
GL-OA-E-003	Non-Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	8000B, 3510B, 8015B, 3550B, CA Method
GL-OA-E-004	Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	5030B, 8000B, 8015B, CA Method
GL-OA-E-007	Dioxins and Furans	8280
GL-OA-E-009	Semivolatile Analysis by Gas Chromatograph/Mass Spectrometer	8270C, EPA 625
GL-OA-E-010	Extraction of Semivolatile and Nonvolatile Organic Compounds from Soil, Sludge, and Other Miscellaneous Samples	8270C, 8081, 8081A, 8082, 8015A, 8310, FL-PRO, CT-ETPH

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-OA-E-011	Analysis of Chlorophenoxy Acid Herbicides by ECD	8151A
GL-OA-E-013	Extraction of Semivolatile and Nonvolatile Organic Compounds from Groundwater, Wastewater, and Other Aqueous Samples	608, 625, 8270B, 8081, 8081A, 8082, 8015A, 8015B, 8310
GL-OA-E-015	Extraction of Herbicides from Groundwater, Wastewater, and Other Aqueous Samples	8151A
GL-OA-E-020	Percent Moisture	3550
GL-OA-E-022	Volatile Organic Compounds by Gas Chromatograph/Mass Spectrometer Applicable to EPA Method 524.2	524.2
GL-OA-E-026	Volatile Organic Compounds (VOC) by Gas Chromatograph/Mass Spectrometer	624
GL-OA-E-027	Extraction of Herbicides from Soil and Sludge Samples	8151A
GL-OA-E-030	Polynuclear Aromatic Hydrocarbons	8000B, 8310
GL-OA-E-033	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)	8330, 8000B
GL-OA-E-036	Florisil Cleanup of Organochlorine Pesticide Solvent Extracts	3510C, 3550B
GL-OA-E-037	Sulfuric Acid/Permanganate Cleanup of PCB Solvent Extract	3550B, 3610C, 8082
GL-OA-E-038	Volatile Organic Compounds (VOC) by Gas Chromatography/Mass Spectrometer	8260A, 8260B, 5030A, 5030B, 5035
GL-OA-E-039	Closed -System Purge-and-Trap Collection and Extraction Volatile Organics and Soil and Waste Samples	5035
GL-OA-E-040	Polychlorinated Biphenyls	8000B, 8082, 608
GL-OA-E-041	Organochlorine Pesticides and Chlorinated Hydrocarbons	8000B, 8080, 8081, 8081A, 8121, 608
GL-OA-E-044	Organics Data Validation	N/A
GL-OA-E-045	Sulfur Clean-up	3660B
GL-OA-E-046	Common Industrial Solvents, Glycols and Various Organic Compounds by Flame Ionization Detector	8000A, 3510B, 8015A, 3550A, CA Method
GL-OA-E-047	Gel Permeation Cleanup of Solvent Extracts	3640A, 3510C, 3550B
GL-OA-E-048	Determination of Petroleum Range Organics by GC-FID (FL-PRO and CT-ETPH)	3510C, 3550B, 8000B, 8015B, FL-PRO
GL-OA-E-049	Silica Gel Cleanup Using Solid Phase Silica Gel Extraction Cartridges	3550B, 3510C
GL-OA-E-050	Extraction of Semivolatile and Nonvolatile Organic Compound from Oil	N/A
GL-OA-E-051	Dioxins and Furans	8280A
GL-OA-E-052	The Determination of Petroleum Range Organics by GC-FID (TNRCC-Method 1005)	TNRCC Method 1005
GL-OA-E-053	Analysis of 1,4-Dioxane by Gas	SW 846 8260B

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
	Chromatograph/Mass Spectrometer	
GL-OA-E-054	The Determination of Gasoline Range Organics Using Flame Ionization Detection Per Alaska Method- AK101	AK101
GL-OA-E-055	The Determination of Diesel Range Organics Using Flame Ionization Detection Per Alaska Methods AK102 and AK103	AK102, 103
GL-OA-E-056	Definitive Low Level Analysis Using Liquid Chromatography/Mass Spectrometer/Mass Spectrometry (LC/MS/MS) by SW 846 Method 8321 Modified (8321M)	8321 (M)
GL-OA-E-057	Sample Preparation for Perchlorate Analysis Using Liquid Chromatography/Mass Spectrometry/Mass Spectrometry	314.0, 8321A (M)
GL-OA-E-058	Volatile Storage Blanks	N/A
GL-OA-E-059	Analysis of 1,2-Dibromomethane EDB and 1,2-Dibromo-3-Chloroproane (DBCP) in Water by ECD by 504 or 8011	504, 8011
GL-OA-E-060	Extraction and Screening of Organic Compounds	N/A
GL-OA-E-061	Haloacetic Acids in Water	552.2
GL-QS-B-001	Quality Assurance Plan	N/A
GL-QS-E-001	Conduct of Quality Audits	N/A
GL-QS-E-002	Conducting Corrective Action	N/A
GL-QS-E-003	Training and Qualifying Quality Assurance Audit Personnel	N/A
GL-QS-E-004	Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items	N/A
GL-QS-E-005	Review of Monitoring Device Logs	N/A
GL-QS-E-007	Thermometer Calibration	N/A
GL-QS-E-008	Quality Records Management and Disposition	N/A
GL-QS-E-011	Method Validation and Initial Demonstration of Capability	N/A
GL-QS-E-012	NCR Database Operation	N/A
GL-QS-E-013	Handling of Proficiency Evaluation Samples	N/A
GL-RAD-A-001	Determination of Gross Alpha And Gross Non-Volatile Beta in Water	900.0, 9310
GL-RAD-A-001B	Determination of Gross Alpha And Gross Non-Volatile Beta in Soil	900.0 (M), 9310
GL-RAD-A-001C	Determination of Gross Alpha in Water by Coprecipation	520/5-84-006 Method 00-02
GL-RAD-A-002	Determination of Tritium	906.0
GL-RAD-A-003	Determination of Carbon-14 in Water, Soil, Vegetation and Other Solid Matrices	N/A
GL-RAD-A-004	Determination of Strontium 89/90 in Water, Soil, Milk, Filters, Vegetation and Tissues	905.0 (M), DOE RP501 (M), HASL-300 (M)

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-RAD-A-005	Determination of Technitium-99	HASL-300(M), DOE RP550 (M)
GL-RAD-A-006	Determination of Iodine	901.1(M), HASL-300(M)
GL-RAD-A-007	Determination of Radon-222 in Water	SM 7500 Rn-B (M)
GL-RAD-A-008	Determination of Radium-226	903.1 (M)
GL-RAD-A-009	Determination of Radium-228 in Water	904.0 (M), Ra-05 (M)
GL-RAD-A-009B	Determination of Total Alpha Emitting Radium and Radium-228 in Soil	HASL-300 (M)
GL-RAD-A-010	Total Alpha Radium Isotopes in Water	900.1 (M)
GL-RAD-A-011	Isotopic Determination of Americium, Curium, Plutonium, and Uranium	DOE RP800 (M), HASL-300 (M)
GL-RAD-A-013	Determination of Gamma Isotopes in Water and Soil	900.1 (M), HASL-300 (M)
GL-RAD-A-014	Determination of Total Radioactivity in Contact Waste	N/A
GL-RAD-A-015	Digestion for Soils	N/A
GL-RAD-A-016	Determination of Radiometric Polonium	N/A
GL-RAD-A-017	Determination of Iodine-131 in Water	902.0, SM 7500-IB
GL-RAD-A-018	Determination of Lead-210 in Liquid and Solid Matrices	N/A
GL-RAD-A-019	Determination of Phosphorus-32 in Soil and Water	N/A
GL-RAD-A-020	Determination of Promethium-147 in Soil and Water	N/A
GL-RAD-A-021	Soil Sample Preparation for the Determination of Radionuclides	N/A
GL-RAD-A-021B	Soil Sample Ashing for the Determination of Radionuclides	N/A
GL-RAD-A-022	Determination of NI-59 and NI-63	N/A
GL-RAD-A-023	Total Uranium in Environmental Samples by Kinetic Phosphorescence	ASTM D 5174
GL-RAD-A-026	Preparation of Special Matrices for the Determination of Radionuclides	N/A
GL-RAD-A-028	Radium-226 in Drinking Water by EPA Method 903.1	903.1
GL-RAD-A-029	Determination of Strontium-89/90 in Drinking Water by EPA Method 905.0	905.0
GL-RAD-A-030	Determination of Radium-228 in Aqueous Samples	904.0, 9320
GL-RAD-A-031	Determination of Selenium and Tellurium	N/A
GL-RAD-A-032	Isotopic Determination of Neptunium	N/A
GL-RAD-A-033	Determination of Chlorine-36 in Soil and Water Samples	N/A
GL-RAD-A-035	Isotopic Determination of Plutonium-241	DOE RP800 (M), HASL-300 (M)
GL-RAD-A-036	Isotopic Determination of Americium, Curium, and	DOE RP800 (M), HASL-

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
	Plutonium in Large Soil Samples	300 (M)
GL-RAD-A-037	Radium-226 and Radium-228 in Drinking Water by Sulfate Precipitation and Gamma-Ray Spectrometry	N/A
GL-RAD-A-038	Determination of Thorium/Uranium	DOE RP800 (M), HASL-300 (M)
GL-RAD-A-040	Determination of Fe-55 in Liquid and Solid Matrices by Liquid Scintillation Counter	N/A
GL-RAD-A-041	Determination of Total Activity in Solids and Liquids	N/A
GL-RAD-A-042	The Isotopic Determination of Americium, Curium, Plutonium and Uranium in Liquid Samples by Vacuum Box Method	N/A
GL-RAD-A-043	Determination of Plutonium, Uranium and Thorium	N/A
GL-RAD-A-044	Total Alpha Radium in Isotopes	903.0, 9315
GL-RAD-A-045	Isotopic Determination of Plutonium, Uranium, Americium, Curium and Thorium	HASL-300 (M)
GL-RAD-A-046	Isotopic Determination of Ra-224 and Ra-226 by Alpha Spectrometry	N/A
GL-RAD-A-047	48 Hour Rapid Gross Alpha Test	N.J.A.C. 7:18, EPA 600/4-80-032 Method 900.0 Modified
GL-RAD-A-048	Determination of Calcium 45 in Soils and Waters	N/A
GL-RAD-A-049	The Determination of Sulfur-35 in Liquid Matrices	N/A
GL-RAD-B-001	Sequential Determination of Isotopic Americium, Curium, Californium, Plutonium, Strontium and Uranium in Urine	N/A
GL-RAD-B-002	Determination of Polonium-210, Radium-226, and Radium-228 in Urine	N/A
GL-RAD-B-003	Determination of Isotopic Thorium and Uranium in Urine Samples	N/A
GL-RAD-B-004	Determination of Lead-210 in Bioassay Samples	N/A
GL-RAD-B-005	Management of Blank Populations	N/A
GL-RAD-B-008	Determination of Gross Alpha Activity in Nasal Swipes	N/A
GL-RAD-B-009	Bioassay Countroom Alpha Spectroscopy System	N/A
GL-RAD-B-010	Sequential Determination of Thorium, Plutonium and Uranium in Fecal Samples	N/A
GL-RAD-B-011	Determination of Tritium in Urine	906.0
GL-RAD-B-012	Ashing of Fecal Samples	N/A
GL-RAD-B-013	Sequential Determination of Americium and Plutonium in Fecal Samples	N/A
GL-RAD-B-014	Preparation of Synthetic Urine and Fecal Material	N/A
GL-RAD-B-015	Determination of Protactinium in Urine	N/A
GL-RAD-B-016	Determination of Technetium-99 in Urine	N/A

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-RAD-B-017	Determination of Neptunium in Urine	N/A
GL-RAD-B-018	Operation of the Chemcheck Automatic KPA	N/A
GL-RAD-B-019	Total Uranium in Bioassay Samples by Kinetic Phosphorescence	N/A
GL-RAD-B-020	The Determination of NI-59 and NI-63 in Urine	N/A
GL-RAD-B-022	The Determination of Gross Alpha Beta and Gross Nonvolatile Beta	N/A
GL-RAD-B-023	The Determination of Carbon 14 in Urine	N/A
GL-RAD-B-024	Managing Statistical Data in the Bioassay Lab	N/A
GL-RAD-B-025	The Combination and Preservation of Urine Samples	N/A
GL-RAD-B-026	Bioassay Data Review, Validation and Data Assembly	N/A
GL-RAD-B-027	Specific Gravity in Urine	ASTM D5057
GL-RAD-D-002	Analytical Methods Validation for Radiochemistry	N/A
GL-RAD-D-003	Data Review, Validation, and Data Package Assembly	N/A
GL-RAD-I-001	Gamma Spectroscopy System Operations	N/A
GL-RAD-I-004	Beckman LS-6000/6500 Operating Procedure	N/A
GL-RAD-I-006	LB4100 Gross Alpha/Beta Counter Operating Instructions	N/A
GL-RAD-I-007	Ludlum Model 2000 Lucas Cell Counter Operating Instructions	N/A
GL-RAD-I-008	VAX/VMS Quality Control Software Program	N/A
GL-RAD-I-009	The Alpha Spectroscopy System	N/A
GL-RAD-I-010	Counting Room Instrumentation Maintenance and Performance Checks	N/A
GL-RAD-I-011	Operation of the Chemchek Kinetic Laser Phosphorimeter	N/A
GL-RAD-I-012	Managing Statistical Data in the Radiochemistry Laboratory	N/A
GL-RAD-I-013	Column Preparation	N/A
GL-RAD-I-014	WALLAC Guardian Model 1414-003	N/A
GL-RAD-I-015	WPC 9550 Gross Alpha/Beta Counter	N/A
GL-RAD-I-016	Multi-Detector Counter	N/A
GL-RAD-I-017	Wallac 1220 Quantalus Liquid Scintillation Counter	N/A
GL-RAD-I-018	Operation of Wallac 1480 Gamma Wizard	N/A
GL-RAD-M-001	Preparation of Radioactive Standards	N/A
GL-RAD-M-003	Magnetic Backup of Hard Drives for Alpha and Gamma Spectroscopy	N/A
GL-RAD-S-001	Radiation Survey Procedures	N/A
GL-RAD-S-002	Radiation Related Emergency Procedures	N/A
GL-RAD-S-003	Inventory and Tracking of Radioactive Material	N/A

Standard Operating Procedures		
SOP #	**SOP Title**	**Methods**
GL-RAD-S-004	Radioactive Material Handling Procedure	N/A
GL-RAD-S-006	Radiation Worker Training	N/A
GL-RAD-S-007	Receiving of Radioactive Samples	N/A
GL-RAD-S-009	Dosimetry Procedures	N/A
GL-RAD-S-010	Handling of Biological Materials	N/A
GL-RAD-S-013	Air Sampling for Radioactivity	Guide 825
GL-RC-E-001	Receipt and Inspection of Material and Services	N/A
GL-RC-E-002	Material Requisition Form Procedure	N/A
GL-SR-E-001	Sample Receipt, Login, and Storage	N/A
GL-SR-E-002	Return of Samples	N/A
GL-SR-E-003	Inspection, Cleaning and Screening of Sample Coolers	N/A

APPENDIX J: SAMPLE STORAGE AND PRESERVATION REQUIREMENTS

Parameter	Container[1]	Preservation	Holding Time[2]
Inorganics			
Acidity	P,G	4°C	14 days
Alkalinity	P,G	4°C	14 days
Demand (BOD)	P,G	4°C	48 hours
Bromide	P,G	None	28 days
Chemical Oxygen Demand (COD)	P,G	4°C, H_2SO_4 to pH<2	28 days
Chlorine by Bomb	P,G	None	None
Chloride	P,G	None	28 days
Color	P,G	4°C	48 hours
Conductivity	P,G	4°C	28 days
Corrosivity by pH	P	None	Immediate
Corrosivity to Steel	P	None	None
Cyanide amenable to chlorination	P,G	4°C, NaOH to pH>12, 0.6g ascorbic acid [3]	14 days [4]
Cyanide, total	P,G	4°C, NaOH to ph>12, 0.6g ascorbic acid [3]	14 days [4]
Dissolved Oxygen	G (bottle and tap)	None	Immediate
Fixed and Volatile Solids	P,G	4°C	7 days
Flashpoint	P,G	None	None
Fluoride	P	None	28 days
Hardness	P,G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months
Heating Value	P	None	None
Hydrazine	G	HC1 to pH<2	Immediate
Percent (%) Moisture	P	4°C	None
Ammonia Nitrogen	P,G	4°C, H_2SO_4 to pH<2	28 days
Nitrate	P,G	4°C	48 hours
Nitrite	P,G	4°C	48 hours
Nitrate/Nitrite	P,G	4°C, H_2SO_4 to pH<2	28 days
Total Kjeldahl and Organic Nitrogen	P,G	4°C, H_2SO_4 to pH<2	28 days
Odor	G	4°C, Zero headspace	Immediate
Oil and Grease	G	4°C, HC1 or H_2SO_4 to pH<2	28 days
Orthophosphate	P,G	Filter immediately, 4°C	48 hours
Total Phenols	G	4°C, H_2SO_4 to pH<2	28 days
pH	P,G	None	Immediate
Total Phosphorus	P,G	4°C, H_2SO_4 to pH<2	28 days
Residual Chlorine	P,G	None	Immediate
Salinity	P	None	28 days
Specific Gravity	P	4°C	7 days
Sulfate	P,G	4°C	28 days
Sulfide	P,G	4°C, add ZNAce and NaOH to pH>9	7 days
Sulfite	P,G	None	Immediate
Sulfur by Bomb	G	None	None
Surfactants	P,G	4°C	48 hours
Settleable Solid	P,G	4°C	48 hours
Total Dissolved Solid	P,G	4°C	7 days
Total Solid	P,G	4°C	7 days
Total Suspended Solid	P,G	4°C	7 days
Volatile Solid	P,G	4°C	7 days
Total Organic Carbon	P,G	4°C,HCl or H_2SO_4 to pH<2	28 days
Total Organic Halides	G	4°C, H_2SO_4 to pH<2	28 days

Parameter	Container[1]	Preservation	Holding Time[2]
Total Petroleum Hydrocarbons	G	4°C, H_2SO_4 to pH<2	28 days
Turbidity	P,G	4°C	48 hours
Metals (except chromium VI and mercury)	P	4°C,HNO_3 to pH<2	6 months
Chromium VI - Aqueous	P	4°C	24 hours
Chromium VI - Solids	P	4°C	7 days for extraction
Mercury - Wastewater and Drinking water	P,G	4°C,HNO_3 to pH<2	28 days
Mercury - Others	G	4°C,HNO_3 to pH<2	28 days
Bacteriology			
Coliform, fecal	P,G	4, 0.008% $Na_2S_2O_3$ [3]	6 hours
Standard Plate Count	P,G	4°C, 0.008% $Na_2S_2O_3$	24 hours
Coliform, total - Wastewater	P,G	4°C, 0.008% $Na_2S_2O_3$	6 hours
Coliform, total - Groundwater	P,G	4°C, 0.008% $Na_2S_2O_3$	24 hours
Organics			
Base/Neutral and Acid Extractables - Water	Amber G, teflon-lined cap	4°C 0.008% sodium thiosulfate solution	7 days for extraction 40 days after extraction for analysis
Base/Neutral and Acid Extractables - Solid and Waste	G, teflon-lined cap	4°C	14 days for extraction 40 days after extraction for analysis
Base/Neutral and Acid Extractables - Concentrated Waste	G, teflon-lined cap	None	7 days for extraction 40 days after extraction for analysis
BTEX - Solid and sludge	G, teflon-lined septum	4°C	14 days
BTEX - Water	G, teflon-lined septum	4°C, 0.008% $Na_2S_2O_3$, zero headspace	14 days
TPH-GRO	G, teflon-lined cap	4°C, HCl to pH s, zero headspace	14 days
TPH-DRO	G, teflon-lined cap	4°C	14 days
Volatiles - Groundwater	G, teflon-lined cap	4°C, HCl to pH s, zero headspace	14 days
Chlorinated Herbicides - Water	Amber G, teflon-lined cap	4°C 0.008% sodium thiosulfate solution	7 days for extraction 40 days after extraction for analysis
Chlorinated Herbicides - Solid and Waste	G, teflon-lined cap	4°C	14 days for extraction 40 days after extraction
Volatiles - Drinking Water	G, teflon-lined cap	4°C, 0.008% $Na_2S_2O_3$[3], zero headspace	14 days
Volatiles (excluding 2 chloroethylvinylether) - Wastewater	Encore Sampler	4°C, zero head-space, HC1 to pH 2	14 days

Parameter	Container[1]	Preservation	Holding Time[2]
Volatiles - Wastewater	G, teflon-lined cap	4°C, 0.008% $Na_2S_2O_3$[3], zero headspace	7 days
Volatiles - Solid and Sludge -	Encore Sampler	4°C	14 days
Volatiles - Concentrated Waste	G, teflon-lined septum	None	14 days
Industrial Solvents	G, teflon-lined septum	4°C	None
Organochlorine Pesticides and PCBs	Amber G, teflon-lined cap	4°C 0.008% sodium thiosulfate solution	7 days for extraction 40 days after extraction for analysis
PCBs in Oil	G, teflon-lined cap	None	7 days for extraction 40 days after extraction for analysis
Dioxin	G, teflon-lined cap	4°C	7 days for extraction 40 days after extraction for analysis
Total Petroleum Hydrocarbon	G, teflon-lined septum	4°C	14 days
Coliform, total - Drinking water	P,G	4°C, 0.008% $Na_2S_2O_3$	30 hours
Radiochemistry			
Carbon-14 - Water and Soil	P	4°C	6 months
Gamma Isotopes - Water	P	HNO_3 to pH-2	6 months
Gamma Isotopes - Soil	P	None	6 months
Gross Alpha and Beta - Water	P	HNO_3 to pH-2	6 months
Gross Alpha and Beta - Soil	P	None	6 months
Iodine-129 - Water and Soil	P	None	6 months
Iodine -131 - Water	P	None	6 months
Neptunium - Water	P	HNO_3 to pH-2	6 months
Neptunium - Soil, Vegetation, and Air Filters	P	None	6 months
Plutonium - Water	P	HNO_3 to pH-2	6 months
Plutonium - Soil, Vegetation, and Air Filters	P	None	6 months
Thorium - Water	P	HNO_3 to pH-2	6 months
Thorium - Soil, Vegetation, and Air Filters	P	None	6 months
Uranium - Water	P	HNO_3 to pH-2	6 months
Uranium - Soil, Vegetation, and Air Filters	P	None	6 months
Americium - Water	P	HNO_3 to pH-2	6 months
Americium - Soil, Vegetation, and Air Filters	P	None	6 months
Curium - Water	P	HNO_3 to pH-2	6 months
Curium - Soil, Vegetation, and Air Filters	P	None	6 months
Lead-210 - Water	P	HNO_3 to pH-2	6 months
Nickel-59 - Water and Soil	P	None	6 months
Nickel-63 - Water and Soil	P	None	6 months
Phosphorus-32 -Water	P	HNO_3 to pH-2	6 months

Parameter	Container[1]	Preservation	Holding Time[2]
Phosphorus-32 -Soil	P	None	6 months
Polonium -Water	P	HNO_3 to pH-2	6 months
Polonium -Soil	P	None	6 months
Promethium-147 -Water	P	HNO_3 to pH-2	6 months
Promethium-147 -Soil	P	None	6 months
Radium-223 - Water	P	None	6 months
Radium-224 - Water	P	None	6 months
Radium-226 - Water	P	HNO_3 to pH-2	6 months
Radium-228 - Water	P	HNO_3 to pH-2	6 months
Radon-222 - Water	40ml volatile bottle	4^oC, Zero headspace	7 days
Radon-222 - Soil	P	4^oC	6 months
Strontium-89/90 -Water	P	HNO_3 to pH-2	6 months
Strontium-89/90 -Soil	P	None	6 months
Technetium-99 -Water	P	HNO_3 to pH-2	6 months
Technetium-99 -Soil	P	None	6 months
Total Alpha Radium -Water	P	HNO_3 to pH-2	6 months
Total Alpha Radium -Soil	P	None	6 months
Total Uranium -Water	P	HNO_3 to pH-2	6 months
Tritium - Water, Soil, Vegetation, and Air Filters	P	4^oC	6 months
Iron 55 -Water	P	HNO_3 to pH-2	6 months
Iron 55 -Soil	P	None	6 months
Total Uranium -Soil	P	None	6 months

[1] P = Polyethylene; G = Glass

[2] Samples should be analyzed as soon as possible after collection. The holding times listed are maximum times that samples may be held before analysis and be considered valid.

[3] Used only in the presence of residual chlorine.

[4] Maximum holding time is 24 hours when sulfide is present. All samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If present, remove by adding cadmium nitrate powder until a negative spot test is obtained. Filter sample and add NaOH to pH12.

APPENDIX C: CABRERA RADIATION SAFETY PROGRAM - LIST OF RADIATION SAFETY PROCEDURES

Cabrera Radiation Safety Program

Note: The CABRERA Radiation Safety Program (RSP) is provided in electronic file format submitted with hard copies of this QAPP. Printed copies of the RSP will be provided upon request. The following is a list of Radiation Safety Procedures contained in the RSP.

AP-001 Record Retention

AP-002 [Reserved]

AP-003 Radiological Conditions Awareness Report

AP-004 Radiological Compliance Audit

AP-005 ALARA

AP-006 Respiratory Protection Program

AP-007 Bioassay Program

AP-008 Dosimetry Program

AP-009 Training

AP-010 Personnel Protective Equipment

AP-011 Emergency Response

AP-012 Radiation Work Permits

AP-013 Packaging Radioactive Waste

AP-014 Classifying Radioactive Waste

AP-015 [Reserved]

AP-016 Radioactive Material Tracking

OP-001 Radiological Surveys

OP-002 Air Sampling and Analysis

OP-003 [Reserved]

OP-004 Unconditional Release of Material from Radiological Control

OP-005 Volumetric and Material Sampling

OP-006 [Reserved]

OP-007	[Reserved]
OP-008	Chain of Custody
OP-009	Use and Control of Radioactive Check Sources
OP-010	[Reserved]
OP-011	Procurement and Receipt of Radioactive Material
OP-012	Opening Radioactive Material Containers
OP-013	[Reserved]
OP-014	Contamination Containment Devices
OP-015	Step-Off Pads
OP-016	Portable HEPA Systems and Vacuum Cleaners
OP-017	Empty Transport Vehicle Radiological Surveys
OP-018	Decontamination of Equipment and Tools
OP-019	Radiological Posting
OP-020	Operation of Contamination Survey Meters
OP-021	Alpha-Beta Counting Instrumentation
OP-022	Operation of Ionization Chambers
OP-023	Operation of Micro-R Meters
OP-024	Direct Reading Dosimeters

APPENDIX D: STANDARD FORMS AND CHECKLISTS

Daily Quality Control Report

Boring Log

Field Documentation Checklist

Health and Safety Checklist

Instrument Calibration Checklist

Sample Collection Checklist

Sample Handling/Shipment Checklist

Decontamination Checklist

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

DAILY QUALITY CONTROL REPORT

Painesville FUSRAP Site – Project No. 04-3200.02

This field report shall be completed each day that field activities are performed at the Painesville Site. Attach an additional sheet of paper, if necessary, to adequately complete each required entry.

USACE PE/PM: _____ **Precipitation:** _____
DATE/Day: _____ **Wind:** _____
Temperature: _____

SUBCONTRACTORS ON SITE (Identify subcontractors onsite by company name): _____

WORK PERFORMED (Briefly describe project tasks that were performed. Reference appropriate logs if details necessary): _____

PROJECT SCHEDULE (Describe impact of day's work, if any, on overall project schedule):

PROBLEMS, NON-CONFORMANCES, CORRECTIVE ACTIONS, NOTIFICATIONS (Describe any hazards, injuries, regulatory or procedural issues, items of non-compliance, etc. Identify individuals contacted as a result of these items. Include name/title/organization/time contacted/and a summary of content of discussion):

SITE VISITORS, CONTACTS (Identify any non-project personnel that visited the site or made contact with project personnel. Include names/titles/organizations/time of contact/ and any other pertinent details of the conversation): _____

DQCR prepared by:

Print Name	Signature	Title	Date

CABRERA SERVICES

PROJECT NAME:
LOCATION:
CLIENT:

FIELD BORING LOG
Boring No.:
Page No.:

Contractor:	Driller:	Date Started:	Rock Refusal Depth:
Method:	Water Elevation:	Date Finished:	Rock Cored (FT):
Elevation:	Soil Drilled:	Total Depth:	Casing Size:
			Core Size:
Logged By:	Checked By:		

Sample Information										
Elevation	Depth (feet)	Casing Blows/Foot	Downhole Gamma (1-min)	Sample No. & Penetration/Recovery (feet)	Sample Type	Sample Description and Classification	Group Designation	Remarks	Equipment Installed	Lab Tests Performed

Notes

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

FIELD DOCUMENTATION CHECKLIST

Painesville FUSRAP Site – Project No. 04-3200.02

Date:_____

Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, please provide an explanation on the form.

Field Documentation	Yes	No	N/A
1. Was all original field data recorded in black indelible ink?	☐	☐	☐
2. Were log books filled out properly; accurately recounting the days events?	☐	☐	☐
3. Were all field forms completed and information accurately recorded:			
• Field Sampling Forms	☐	☐	☐
• Downhole Gamma Log Sheets • Chain of Custody Forms	☐	☐	☐
• Field Logbooks	☐	☐	☐

List additional field forms completed:_____

_____

_____

4. Was field documentation forwarded to office for peer review and QC if requested?	☐	☐	☐
5. Were deficiencies reported to QC Manager/Project Team Manager?	☐	☐	☐

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature:_____

Date:_____

HEALTH AND SAFETY CHECKLIST

Painesville FUSRAP Site – Project No. 04-3200.02

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, provide an explanation on the form.

Documentation	Yes	No	N/A
1. Is the Site Health and Safety Plan (SSHP) at the Site?	☐	☐	☐
2. Has the SSHP and/or supplement been reviewed, dated, and signed within the last year?	☐	☐	☐
3. Have all employees undergone the Painesville site briefing?	☐	☐	☐
4. Is there a written acknowledgement that all employees have been briefed on and read the SSHP (signature sheet)?	☐	☐	☐
5. Are the following training records current and available:			
• 40-Hour HAZWOPER for ALL employees?	☐	☐	☐
• 24 Hours Supervised Field Experience?	☐	☐	☐
• 8-Hour HAZWOPER Annual Refresher?	☐	☐	☐
• CPR/First Aid (minimum two persons on site)?	☐	☐	☐
• 8-Hour Hazardous Waste Site Supervisor, and refresher?	☐	☐	☐
• Initial Site Health and Safety Briefing?	☐	☐	☐
• Site Health and Safety Briefing for each location or site (record in field log notebook)?	☐	☐	☐
6. Are emergency maps and phone numbers posted at the site and maintained in vehicles?	☐	☐	☐
7. Were fire extinguishers checked on the first day?	☐	☐	☐
8. Were all applicable Material Safety Data Sheets at the Site?	☐	☐	☐
9. Are documents current and available that indicate personnel are medically fit to work and wear the required personal protective equipment (if required)?	☐	☐	☐

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

HEALTH AND SAFETY CHECKLIST (continued)

Painesville FUSRAP Site – Project No. 04-3200.02

	Yes	No	N/A
Observations			
10. Are work zones adequately designated?	☐	☐	☐
11. Is required personal protective equipment available and correctly used, maintained, and stored?	☐	☐	☐
12. Is the following emergency equipment located at each site:	☐	☐	☐
• Fire extinguisher?	☐	☐	☐
• Eye wash (minimal)?	☐	☐	☐
• Communications (walkie talkie or phone)?	☐	☐	☐
• First aid kit?	☐	☐	☐
13. Is the buddy system in use?	☐	☐	☐
14. Are personnel refraining from drinking, chewing, smoking, taking medications, or other hand-to-mouth contact while working in the contaminated zone?	☐	☐	☐
15. Is the site organized to allow the use of lifting equipment, and avoid tripping hazards and spreading contamination?	☐	☐	☐
16. Was a random employee asked if he/she knew site hazard and emergency procedures?	☐	☐	☐

Personnel Observed and Locations: _____

_____

_____

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature: _____

Date: _____

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

INSTRUMENT CALIBRATION CHECKLIST

Painesville FUSRAP Site – Project No. 04-3200.02

Date: _____

Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, provide an explanation on the form.

Instrument Calibration	**Yes**	**No**	**N/A**
1. Were all field instruments shown to be in current calibration?	☐	☐	☐
2. Were all field instruments calibrated properly according to manufacturer's instructions?	☐	☐	☐
3. Were all calibration standards within expiration date?	☐	☐	☐
4. Did the calibration log form(s) list all calibration events	☐	☐	☐

List instruments used at the Site:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature: _____

Date: _____

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

SAMPLE COLLECTION CHECKLIST

Painesville FUSRAP Site – Project No. 04-3200.02

Boring Location Number(s):_____

Sampling Date:_____

Complete for each boring location inspected.. Answer each question by checking the appropriate column (yes, no, not observed (N/O) or N/A). If "no" is checked, provide an explanation on the form.

General	Yes	No	N/O	N/A
1. Were new protective gloves worn between sampling locations and/or intervals?	☐	☐	☐	☐
2. Were samples collected using methods described in the FSP?	☐	☐	☐	☐
3. Were sample containers filled in the correct order, (if applicable)?	☐	☐	☐	☐
4. Was sampling equipment appropriate for the purpose and site conditions?	☐	☐	☐	☐
5. Was sampling equipment decontaminated or disposable/dedicated equipment used between each sample?	☐	☐	☐	☐
6. Were procedures for collecting QA/QC samples followed as per the FSP and QAPP?	☐	☐	☐	☐
7. Were sampling locations properly identified by GPS?	☐	☐	☐	☐
8. Were containers adequately protected from contamination prior to sample collection?	☐	☐	☐	☐
Soil Sampling				
9. Were soil samples collected in dedicated liners according to the procedures listed in the FSP?	☐	☐	☐	☐
10 Was each core scanned with a GM detector and PID (if applicable)?	☐	☐	☐	☐
11 Was downhole gamma logging performed and counts logged on form?	☐	☐	☐	☐
12 Was core lithology described and documented in a boring log?	☐	☐	☐	☐
13 Were samples collected according to the procedures listed in the FSP?	☐	☐	☐	☐

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature: _____

Date: _____

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

SAMPLE HANDLING/SHIPMENT CHECKLIST

Painesville FUSRAP Site Site – Project No. 04-3200.02

Boring Location Number(s): _____

Sampling Date: _____

Answer each question by checking the appropriate column (yes, no, not observed (N/O) or N/A). If "no" is checked, provide an explanation on the form.

Packing, Storing, and Shipment of Samples	Yes	No	N/O	N/A
1. Were the samples handled according to the SAP?	☐	☐	☐	☐
2. Did the samples remain on ice or refrigerated (except for sample transfer from coolers or refrigerators) from collection until cooler was taped for shipment?	☐	☐	☐	☐
3. Were COC forms filled out accurately and completely including project name and number, sampling date, sampling time, analytical parameters, preservatives, size and number of containers for each analytical parameter, and media sampled?	☐	☐	☐	☐
4. Were COC forms signed and dated by the preparer and the form taped to the inside of the cooler lid?	☐	☐	☐	☐
5. Were signed and dated custody seals properly placed on the cooler and the cooler sealed with strapping tape?	☐	☐	☐	☐
6. Was a shipping label attached to the cooler?	☐	☐	☐	☐
7. Was a radiological survey performed on the coolers prior to shipment?	☐	☐	☐	☐
8. Was the survey documented?	☐	☐	☐	☐

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature: _____

Date: _____

CABRERA SERVICES
RADIOLOGICAL ENVIRONMENTAL REMEDIATION

DECONTAMINATION CHECKLIST

Painesville FUSRAP Site – Project No. 04-3200.02

Boring Location Number(s):_____

Date:_____

Answer each question by checking the appropriate column (yes, no, not observed (N/O) or N/A). If "no" is checked, provide an explanation on the form.

Equipment	Yes	No	N/O	N/A
1. Was all sampling equipment decontaminated properly prior to use and between sample intervals?	☐	☐	☐	☐
2. Was each decontamination event recorded in the log book?	☐	☐	☐	☐
3. Was IDW (decontamination water) properly handled?	☐	☐	☐	☐
4. Was equipment exiting the contamination Zone properly surveyed for verification of radiological decontamination?	☐	☐	☐	☐
5. Were appropriate decontamination blanks (wipe samples) collected from decontaminated sampling equipment?	☐	☐	☐	☐
6. Did personnel accompany the drilling rig to the decontamination pad by walking behind the rig to check for possible removable debris?	☐	☐	☐	☐
7. Were wipes collected from work areas (on-site lab, trailer, etc.) as specified in the SAP to evaluate possible spread of radiological contaminants?	☐	☐	☐	☐

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature:_____

Date:_____

APPENDIX E: USACE RADIOLOGICAL QUALITY ASSURANCE FOR THE PAINESVILLE FUSRAP SITE

US Army Corps
of Engineers ®
Buffalo District

Radiological Quality Assurance for the Painesville Pre-Remedial Sampling

720 Fairport Nursery Road
Painesville, Ohio 44077

Radiological Quality Assurance Split Samples for USACE -Buffalo District

11.AUGUST.2005

This document is derived from:

USACE Engineer Regulation:

ER 1110-1-263, *Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities,* Final (USACE, 1998).

USACE Engineering Manuals:

EM 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans***,** Final (USACE, 1994)

EM 200-1-6, *Chemical Quality Assurance for HTRW Projects*, Final (USACE, 1997).

ACRONYMS

ANSI	American National Standards Institute
AR	Army Regulation
ASQ	American Society for Quality (formerly American Society for Quality Control (ASQC)) CEMP-RT Corps of Engineers, Environmental Division, Policy and Technology Branch
CDQAR	Chemical Data Quality Assessment Report
CDQM	Chemical Data Quality Management
CQAB	Chemistry Quality Assurance Branch (formerly the Missouri River Laboratory, Omaha, NE)
CQAR	Chemical Quality Assurance Report
CX	Center of Expertise
DACS	Department of the Army, Chief of Staff
DMC-PQ	Director of the Army, Management Directorate, Management Practices Branch, Total Army Quality
DOD	Department of Defense
DQO	Data Quality Objectives
EM	Engineer Manual
ER	Engineer Regulation
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HQDA	Headquarters, Department of the Army
HTRW	Hazardous, Toxic, and Radioactive Waste
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MFR	Memorandum for Record
MSC	Major Subordinate Command
OCSA	Office Chief of Staff, Army
OE	Ordnance and Explosives (formerly Ordnance and Explosive Waste (OEW))
OM	Office Memorandum
PM	Project Manager
QA	Quality Assurance
QC	Quality Control
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

I - *USACE Engineering Manual and Regulation Outline*

CHEMICAL DATA QUALITY MANAGEMENT FOR HAZARDOUS, TOXIC, RADIOACTIVE WASTE REMEDIAL ACTIVITITES

1. Purpose. The purpose is to assure that the analytical data meet project data quality objectives (DQOs). Chemical QA is required to ensure that analytical data generated for all projects meets the criteria prescribed by the technical project planning (TPP) team.

2. Applicability. Applies to the above-mentioned project.

3. References. References are provided in Appendix A.

4. Acronyms. A list of acronyms is provided (see page 2).

5. Definitions. A list of definitions is provided in Appendix B

6. Policy. The policy of the USACE is to produce products and services which fully meet customers' expectations of quality, timeliness and cost effectiveness, within the bounds of legal responsibility. An acceptable level of quality does not imply perfection; however, there should be no compromise of functional, health, or safety requirements. Adherence to the Quality Management principles outlined in Engineer Regulation (ER) 1110-1-12 will contribute to achieving this goal. CDQM procedures must be formulated to ensure harmony with the USACE Strategic Vision and should be executed in concert with activities presented in other USACE guidance.

7. Discussion.

a. The intent this document is to ensure the production of high quality chemical data that satisfy the project-specific data quality objectives (DQOs). This document is an attempt to ensure that data are of known and appropriate quality. Detailed technical guidance on CDQM is provided in EM 200-1-6.

b. The analytical service providers shall have verifiable quality systems compliant with the principles of the Department of Defense Quality Systems Manual.

c. The goal is to generate data of known quality for the intended usage on the first attempt. Most important is the application of guidance contained in EM 200-1-2 on technical project planning, EM 200-1-3 on preparation of sampling and analysis plans, and EM 200-1-6 on chemical quality assurance.

d. A district project chemist must be involved in project CDQM support. However, execution of the USACE CDQM program may involve a variety of staff, including center or region chemists, Chemistry Quality Assurance Branch (CQAB) chemists, HTRW Center of Expertise (CX) chemists, HQUSACE chemist, and geographic district engineering and construction personnel.

e. This document describes the Quality Assurance (QA) program to monitor compliance. These procedures may also apply to in-house projects. The district

project chemist, in conjunction with the technical team, shall determine the appropriate level of compliance monitoring. This determination shall be based upon the intended use of the results and the degree of confidence needed in the quality of the results. The required level of compliance monitoring shall be included in the project DQOs. Compliance monitoring may consist of a combination of activities, which are fully described in EM 200-1-6.

Compliance monitoring activities can include the following:

(1) validation of primary and QA laboratories;
(2) technical document review;
(3) sample handling quality assurance;
(4) quality assurance sample collection and analysis;
(5) data review in the form of a Chemical Quality Assurance Report (CQAR);
(6) assessment of data usability in the form of a Chemical Quality Data Assessment Report (CDQAR);
(7) single-or double-blind performance evaluation sample analysis;
(8) review of primary laboratory data;
(9) validation of data;
(10) field audits;
(11) laboratory audits;
(12) tape audits.

While all twelve of these CDQM activities may be used, six of the twelve should be used on most projects. The six primary CDQM activities for USACE HTRW projects are:

a. validation of primary and QA laboratories;
b. technical document review;
c. sample handling quality assurance;
d. QA sample collection and analysis;
e. preparation of CQARs;
f. preparation of CDQARs.

These compliance monitoring procedures should routinely be considered as candidates for inclusion in each project's set of CDQM activities. Any of these six primary CDQM activities may be waived for a specific project by the district PM in concurrence with the technical team as defined in EM 200-1-2. Waiver of any element must be fully justified and documented in a memorandum for record (MFR). The MFR must describe how chemical data quality is preserved in the absence of the waived elements. The completed MFR must have the concurrence of the technical project team, including the district project chemist.

8. Responsibilities.

The districts are responsible for:

(1) determining requirements for sampling and analysis;
(2) project planning to ensure data quality;
(3) obtaining data of known quality through the use of validated laboratories;
(4) developing project specific DQOs and providing a DQO summary to all project laboratories;
(5) performing data review to determine data quality;
(6) assessing data usability in the form of a CDQAR or equivalent;
(7) performing contractor oversight;

The CQAB is responsible to provide support at the request of the districts, the HTRW CX, and HQUSACE. Project services which are available include:

(1) technical assistance in development of DQOs, Sampling and Analysis Plans, and commercial laboratory standard operating procedures;
(2) inspecting QA sample shipments and reporting deficiencies;
(3) analyzing QA samples, or providing for the analysis of QA samples; and
(4) providing an independent assessment of the inter-laboratory analytical data in the form of a CQAR or equivalent, including resolution of discrepancies with the primary laboratory.

II – USACE Buffalo District Quality Assurance Procedures

The following will be applied to the stated project in an effort to produce and support data of known quality as it applies to chemical quality assurance.

1.0 Quality Assurance Laboratory

The laboratory selected for quality assurance analysis:

STL – St. Louis
Attn: [redacted]
13715 Rider Trail North
Earth City, MO 63045

[redacted]
Project Manager
STL – St. Louis
314-298-8566

Buffalo District's contracting mechanism for analytical work will be conducted through Cabrera Services.

2.0 CDQM Activities

At a minimum the following CDQM activities will be accomplished for the Painesville pre-remedial sampling:

a. assessment of primary and QA laboratories;
In general, laboratories need to be approved prior to field studies or sample analysis. All laboratories must be in compliance with the most current version of the Department Of Defense Quality Systems Manual. Compliance will be demonstrated by filling out the self-declaration form. Any laboratory which has a current, unexpired USACE laboratory validation will be considered to be in compliance with this policy until the former validation expires. A NELAP accreditation for the parameters of interest (where available) is also strongly recommended.

b. technical document review;
The HTRW design district is responsible for a QC review of the prime contractor's QC Plan and all project-specific deliverables.

c. sample handling quality assurance;
The QA laboratory provides quick feedback regarding problems with sample shipments. The QA laboratory is responsible for checking the sample shipment for temperature, proper preservatives, correct containers etc.

d. QA sample collection and analysis;
QA sample collection and analysis is the main tool to determine that the data generated by primary laboratories is technically valid and of adequate quality for the intended data usage.

e. preparation of Chemical Quality Assurance Reports (CQARs);
The CQAR document reviews the QA laboratory data and the corresponding primary laboratory data. Data for project samples, QC and QA samples are compared and the impact of the primary laboratories data is documented.

f. preparation of Chemical Data Quality Assessment Reports (CDQARs);
The CDQAR documents usability, DQO attainment, and contract compliance.

3.0 DQOs

The goal in taking QA samples is to support stated project specific DQOs by determining the quality of the analytical data. This assessment of the above CDQM activities will be determined by the assigned USACE district chemist:

[redacted]
USACE -Buffalo District
716-879-4158
[redacted]@usace.army.mil

4.0 Sampling, Sample Receipt, Handling, Custody and Holding Time Requirements

a. Responsible party for taking of QA split samples will be the assigned contractor on the project site.
b. The contractor will take a split of the primary sample for analysis listed in

section 5.0 QA Analytical Procedures.

c. QA sample handling will be identical to the primary field sample.
d. The contractor shall provide containers, labels, coolers and chain of custodies for QA samples.
e. **Appendix C** contains a point of contact sheet with instructions for QA field handling and contacts.

5.0 QA Analytical Procedures

QA analytical procedures to be performed will be the following:

Analyte:	**Matrix:**	**Method**
Thorium-228, -230, -232	Soil	Alpha Spec – DOE EML HASL-300
Uranium-234, -235, -238	Soil	Alpha Spec – DOE EML HASL-300
Radium-226	Soil	EPA 903.1 modified (Lucas Cell)

See project QAPP (for primary samples) for analytical PQLs.
See Appendix C – POC for contact and sample information for number of QA samples to be taken.

6.0 Data Assessment Procedures

Any time chemical data are generated, their quality must be assessed prior to use.

The following will be performed for the stated project:

a. Data Verification. Data verification is the most basic assessment of data. Data verification is a process for evaluating the completeness, correctness, consistency, and compliance of a data package against a standard or contract. In this context, "completeness" means all required hardcopy and electronic deliverables are present. Data verification should be performed by the government or independent entity for QA laboratory deliverables, and by the laboratory contract holder for primary laboratory deliverables.

b. Data Review. Data review is the next step in the data assessment hierarchy. Data review is the process of data assessment performed to produce the CQAR. Data review includes an assessment of summary QC data provided by the laboratory. Data review may include examination of primary and QA laboratory data and the internal QC and QA sample results to ascertain the effects on the primary laboratory's data.

CQAR will contain the following as it applies:
-a review of QA sample inspection results;
-a comparison of QA sample data with project sample data;
-a review of primary and QA laboratory QC data; and
-a review of field QC data (*i.e.*, TB and EB results).

c. Data Evaluation. Data evaluation is the process of data assessment done by district project chemists to produce a CDQAR. Data evaluation is performed to determine whether the data meet project-specific DQOs and contract requirements. To prepare a CDQAR, the district project chemist relies upon the DQO summary from the SAP, the CQAR, field oversight findings, laboratory audits, PE sample results, and any other data quality indicators available.

CDQAR will contain the following as it applies:
- a memorandum for record
- a separate report to the data users
- a memorandum to data user and/or PM and/or TM and/or customer
- an integral section of project report (prepared by or reviewed and approved by district project chemist)
- an appendix to the project report (prepared by or reviewed and approved by district project chemist).

APPENDIX A
REFERENCES

ER 1110-1-263, *Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities,* Final (USACE, 1998). This ER prescribes Chemical Data Quality Management (CDQM) responsibilities and procedures for projects involving hazardous, toxic and/or radioactive waste (HTRW) materials. Its purpose is to assure that the analytical data meet project data quality objectives (DQOs). This is the umbrella regulation that defines CDQM activities and integrates all of the other USACE guidance on environmental data quality management. This regulation applies to all USACE commands having responsibility for HTRW projects, within the 50 United States of America and its territories.

EM 200-1-2, *Technical Project Planning (TPP) Process*, Final (USACE, 1998). This engineer manual promotes the identification of the type, quantity, and quality of data needed for HTRW site investigations/remediations for the customers of USACE, progressing from site investigation and evaluation through remedial design (RD) to site closeout. It identifies the key persons and their roles/responsibilities in the Technical Planning Teams in the data quality design process. This process consists of four phases: Phase I - Identify Current Project; Phase II - Determine Data Needs; Phase III - Develop Data Collection Options; and Phase IV - Finalize Data Collection Program. The process includes development of detailed project objectives, Data Quality Objectives (DQOs), Measurement Quality Indicators (MQIs), Statement/Scope of Work (SOW), the technical basis for Sampling and Analysis Plans (SAPs), Quality Assurance Project Plans (QAPPs), and Work Plans. A "cross-walk" to the EPA's seven-step process is also included.

EM 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans***,** Final (USACE, 1994) and currently in revision. This EM provides guidance for the preparation of a project-specific Sampling and Analysis Plan (SAP) for the collection of environmental data. In addition, default sampling and analytical protocols are included which may be used verbatim or modified based upon project-specific DQOs. The goal of this document is to promote consistency in the generation and execution of SAPs and thus to help generate chemical data of known quality for its intended purpose. The revision of this document will include the "Shell " requirements (i.e., USACE clarifications and supplementary requirements to SW-846 methods) which currently exist as interim guidance.

EM 200-1-6, *Chemical Quality Assurance for HTRW Projects*, Final (USACE, 1997). This EM provides specific guidance, procedures, criteria, and tools for chemical implementation of the USACE Environmental Quality Assurance (QA) Program. Chemical QA is required to ensure analytical data generated for all projects meet the criteria prescribed by the technical project planning team. This EM is intended for use by USACE personnel as a critical companion document to ER 1110-1-263.

Additional References:

AR 5-1, Army Management Philosophy
AR 11-2, Management Control
AR 200-1, Environmental Protection and Enhancement
AR 200-2, Environmental Effects of Army Actions
AR 200-3, Natural Resources-Land, Forest and Wildlife Management
AR 600-100, Army Leadership
DA PAM 200-1, Handbook for Environmental Impact Analysis
ER 5-1-10, Corps-wide Areas of Work Responsibility
ER 5-1-11, Program and Project Management
ER 10-1-2, U.S. Army Corps of Engineers Division and District Offices
ER 385-1-92, Safety and Occupational Health Document Requirements for HTRW and OEW Activities
ER 1110-1-12, Quality Management
ER 1110-1-8158, Corps-Wide Centers of Expertise Program
ER 1180-1-6, Construction Quality Management
ER 1110-1-263, 30 Apr 98
EM 1110-1-502, Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities
OM 10-1-2, Organization Titles
"Leadership for Total Army Quality" Concept Plan, February 1993, OCSA, HQDA (DACS-DMC-PQ)
"Environmental Cleanup and Protection Management Plan for Military Programs", January 1996, CEMP-RT
“Changes in HTRW Technical Roles and Responsibilities due to Division Laboratory Closures”, September 1997, CEMP-RT
EPA Implementation Guide for the Code of Environmental Management Principles for Federal Agencies (CEMP), EPA-315-B-97-001
ANSI Specification and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E4.

APPENDIX B
DEFINITIONS

Activity. An all-inclusive term describing a specific set of operations or related tasks to be performed, either serially or in parallel, that in total result in the completion of a product or service.

Assessment. The evaluation process used to measure the performance or effectiveness of a system and its elements.

Audit. An independent, systematic examination to determine whether activities comply with planned arrangements, whether the arrangements are implemented effectively, and whether the results are suitable to achieve objectives.

Center. A command and control entity similar in function to an MSC, with responsibility for a more narrowly defined scope of activities. Centers usually have programmatic and functional boundaries instead of geographical boundaries like divisions.

Characteristic. Any property or attribute of a datum, item, process, or service that is distinct, describable and/or measurable.

Comparability. A quantitative characteristic that defines the extent to which a chemical parameter measurement is consistent with, and may be compared to, values from other sampling events.

Completeness. A quantitative evaluation of what percentage of the chemical measurements met the project data quality objectives.

Conformance. An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation.

Corrective action. Measures taken to rectify conditions adverse to quality and, where possible, to preclude their recurrence.

Data of known quality. Data that have the qualitative and quantitative components associated with their derivation documented appropriately for their intended use, and such documentation is verifiable and defensible.

Data quality assessment. A statistical and scientific evaluation of the data set to determine the validity and performance of the data collection design and statistical test, and the adequacy of the data set for its intended use.

Data quality objectives. Qualitative and quantitative statements that clarify technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed for support decisions.

Data usability review. The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

Deficiency. An unauthorized deviation from approved procedures or practices, or a defect in an item.

District project chemist. Chemist that provides project support at the district level. This should be a district chemist, or if requested by a district with insufficient resources, may be a chemist from another design district, the CQAB, or the HTRW CX.

Document. Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

Entity. Something which can be individually described and considered, such as a process, product, item, organization, or combination thereof.

Feedback. Communication of data quality performance to sources which can take appropriate action.

Finding. An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive or negative, and is normally accompanied by specific examples of the observed condition.

HTRW activities. Activities undertaken for the U.S. EPA's Superfund Program, the Defense Environmental Restoration Program, including Formerly Used Defense Sites and Installation Restoration Program sites at active DOD facilities, HTRW actions associated with Civil Works projects, and any other mission or non-mission work performed for others at HTRW sites. Such activities include, but are not limited to, Preliminary Assessments/Site Inspections, Remedial Investigations, Feasibility Studies, Engineering Evaluation/Cost Analyses, Resource Conservation and Recovery Act Facility Investigations/Corrective Measures Studies/Corrective Measures Implementation/Closure Plans/Part B Permits, or any other investigations, design activities, or remedial construction at known, suspected, or potential HTRW sites. HTRW activities also include those conducted at petroleum tank sites and construction sites containing HTRW.

Independent assessment. An assessment performed by a qualified individual, group, or organization that is not a part of the organization directly performing and accountable for the work being assessed.

Inspection. Examination or measurement of an item or activity to verify conformance to specific requirements.
Item. An all-inclusive term used in place of the following: appurtenance, facility, sample, assembly, component, equipment, material, module, part, product, structure, subassembly, subsystem, system, unit, documented concepts, or data.

Manager. Individual directly responsible and accountable for planning, implementing, and assessing work.

Management system. A structured non-technical system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for conducting work and for producing items and services.

Method. A body of procedures and techniques for performing an activity systematically presented in the order in which they are to be executed.

Nonconformance. A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate; nonfulfillment of a specified requirement.

Primary laboratory. Laboratory that analyzes the majority of the project samples.

Procedure. A specified way to perform an activity.

Process. A set of interrelated resources and activities which transforms inputs into outputs.

Program. A group of projects, services or other activities that may be categorized by funding source, customer requirements or other common criteria for which resources are allocated and collectively managed.

Project. Any work (products, services, *etc.*) intended to produce a specific outcome or solution to a customer problem or need.

Project manager. The leader of the project team, responsible for managing the project parameters (budget, cost, safety, schedule, scope and quality), as well as interfacing with those involved in the project process (customers, functional elements, government, and non-government entities).

Quality. The totality of features and characteristics of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user.

Quality assurance. An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement that measures the degree of excellence of environmental data and communicates this information to a data generator or data user in a convincing manner.

Quality assurance laboratory. The CQAB or other laboratory that analyzes the project QA samples.

Quality assurance sample. A sample collected to monitor the quality of sampling operations. This type of sample is analyzed by the quality assurance laboratory and typically includes split samples, duplicate samples, and various types of blank samples.

Quality control. The overall system of technical activities that monitors the degree of excellence of environmental data so that the stated requirements of defined standards are achieved.

Quality control sample. A sample collected to monitor and control the quality of sampling operations. This type of sample is analyzed by the primary laboratory and typically includes split samples, duplicate samples, and various types of blank samples.

Quality improvement. A management program for improving the quality of operations.

Quality management. The 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 systemic activities pertaining to the quality system.

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.

Standard operating procedure. A written document that details the process 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.

Technical review. A documented critical review of work that has been performed within the state-of-the-art. The review is accomplished by one or more qualified reviewers who are independent of those who performed the work, but are collectively equivalent in technical expertise to those who performed the original work. The review is an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance that established requirements are satisfied.

Technical systems audit. A thorough, systematic, on-site, qualitative audit of facilities, equipment, personnel, training, procedures, record keeping, data verification/validation, data management, and reporting aspects of a system.

Validation. Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

APPENDIX C
QA SPLIT SAMPLE NOTIFICATIONS*

1. **Primary contractor (Cabrera Services)** to notify USACE BUFFALO DISTRICT Chemist within 24 hours of QA sample shipment ([redacted]).

2. **Primary contractor (Cabrera Services)** to provide on-site USACE BUFFALO DISTRICT representative a signed copy of the USACE BUFFALO DISTRICT QA split COC. If a USACE representative is not available fax ([redacted] to USACE project chemist or email.

3. **Primary contractor** (**Cabrera Services**) to notify USACE BUFFALO DISTRICT Chemist of QA sample receipt at lab and report any anomalies.

4. **Primary contractor** (**Cabrera Services**) to provide corresponding QA split sample analytical results to USACE BUFFALO DISTRICT Chemist.

5. **Primary contractor** (**Cabrera Services**) shall track and provide preliminary analytical results to USACE BUFFALO DISTRICT Chemist.

6. USACE BUFFALO DISTRICT Chemist to perform evaluation and comparison of the analytical results.

* Note: All notifications and submittals shall be provided and documented via email.

QA Sample POC Fact Sheet

Project: Painesville FUSRAP
Phase: Pre-remedial sampling

TITLE	NAME	PHONE:
USACE Project PM	[redacted]	[redacted]
USACE Project PE	[redacted]	[redacted]
USACE Project Chemist	[redacted]	[redacted]
Responsible Contractor	Cabrera Services	
Contractor PM	[redacted]	Office: 845-956-0095 [redacted] [redacted]
Contractor Field POC	[redacted]	Trailer: TBD Cell: [redacted]
		Laboratory Address:
QA Laboratory	STL St. Louis	13715 Rider Trail North Earth City, MO 63045
QA Laboratory POC	[redacted] – PM	Fax: [redacted]
Sampling Dates:	Start Date: September 2005	End Date: October 2005
Estimated Number of QA Samples:		
Analytical Parameter (s)	Soil:	
Thorium-228, -230, -232	18	
Uranium-234, -235, -238	18	
Radium-226	18	

Comments:
The contractor shall contact Peter Lorey - USACE via email or phone [redacted] when QA samples are to be shipped to the QA laboratory. Electronic copies of the COC for QA samples shall be sent to via email or Fax: [redacted]