



**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Sampling and Analysis Plan
for the Gunite and Associated Tanks
Treatability Study,
Wall Coring and Scraping in Tanks W-3
and W-4 (North Tank Farm),
Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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W-3 and W-4 (North Tank Farm),
Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

(ORNL/ER-412)

August 1997

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PREFACE

This document, *Sampling and Analysis Plan for the Gunitite and Associated Tanks Treatability Study, Wall Coring and Scraping in Tanks W-3 and W-4 (North Tank Farm), Oak Ridge National Laboratory, Oak Ridge, Tennessee* (ORNL/ER-412), was developed under Work Breakdown Structure 1.4.12.6.1.01.41.12.04.03.06 (U.S. Department of Energy-Headquarters Activity Data Sheet OR3300W) for the Gunitite and Associated Tanks (GAAT) Remediation Project. This document provides the GAAT Project with a guide for performing sampling and analysis of tank wall corings and scrapings from Tanks W-3 and W-4 (North Tank Farm).

CONTENTS

PREFACE	ii
FIGURES	iv
TABLES	iv
EXECUTIVE SUMMARY	v
1. INTRODUCTION	1
2. SAMPLING RATIONALE, PRIORITY, AND ANALYSIS	2
3. WALL SCRAPING AND CORING SAMPLING ACTIVITIES	3
4. ANALYSIS PROCEDURES FOR SAMPLES	4
5. QUALITY CONTROL	8
6. DATA MANAGEMENT	9

FIGURES

1 Overall analysis scheme for GAAT W-3 and W-4 wall scraping samples	6
2 Overall analysis scheme for GAAT W-3 and W-4 wall core samples	7

TABLES

1 Data Quality Objectives for GAAT W-3 and W-4 sampling and analysis activities	2
2 Priority and rationale for GAAT W-3 and W-4 sampling and analysis activities	2
3 Summary of sampling activities for GAAT W-3 and W-4	3
4 Analytical methods for GAAT W-3 and W-4 samples	5
5 Analysis summary for GAAT W-3 and W-4 samples	8

EXECUTIVE SUMMARY

This Sampling and Analysis Plan documents the procedures for collecting and analyzing wall core and wall scraping samples from Tanks W-3 and W-4 in the North Tank Farm. These activities are being conducted to support the Comprehensive Environmental Response, Compensation, and Liability Act Treatability Study of the Gunite and Associated Tanks at Oak Ridge National Laboratory in Oak Ridge, Tennessee. The sampling and analysis activities will be performed in concert with sludge retrieval and sluicing of the tanks. Wall scraping and wall core samples will be collected from each quadrant in each tank by using a scraping sampler and a coring drill deployed by the Houdini robot vehicle. Each sample will be labeled, transported to the Radioactive Materials Analytical Laboratory, and analyzed for physical and radiological characteristics, including total activity, gross alpha, gross beta, radioactive strontium and cesium, and other alpha and gamma emitting radionuclides. The Data Quality Objectives process, based on U.S. Environmental Protection Agency (EPA) guidance (EPA QA/G-4, September 1994), was applied to identify the objectives of this sampling and analysis. The results of the analysis will be used to (1) validate predictions of a strontium concrete diffusion model, (2) estimate the amount of radioactivity remaining in the tank shells, (3) provide information to correlate with measurements taken by the Gunite Tank Isotope Mapping Probe and the Characterization End Effector, and (4) estimate the performance of the wall cleaning system.

1. INTRODUCTION

This Sampling and Analysis Plan documents the collection and analysis of wall core and wall scraping samples from North Tank Farm Tanks W-3 and W-4. These activities are being conducted to support the Comprehensive Environmental Response, Compensation, and Liability Act Treatability Study of the Gunite and Associated Tanks (GAAT) at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The sampling and analysis activities will be conducted in concert with sludge retrieval and sluicing of the tanks. Each sample will be labeled, transported to the Radioactive Materials Analytical Laboratory (RMAL), and analyzed for physical and radiological characteristics. The Data Quality Objectives process, based on U.S. Environmental Protection Agency (EPA) guidance (EPA QA/G-4, September 1994), was applied to identify the objectives of this sampling and analysis. The results of the analysis will be used to (1) confirm predictions of a strontium concrete diffusion model, (2) estimate the amount of radioactivity remaining in the tank shells, (3) provide information to correlate with measurements taken by the Gunite Tank Isotope Mapping Probe and Characterization End Effector, and (4) estimate the performance of the wall cleaning system. On the basis of experience gained from this effort, the approach for sampling and analysis for the South Tank Farm Tanks will be developed.

As part of the sampling and analysis activities, a scraping device will be used to obtain samples of material adhering to the wall surface, and a drilling tool deployed by the Houdini robot vehicle will be used to obtain core samples of the gunite walls. Analysis of the samples will include the following:

1. a record of visual observations (color, texture, etc.), including video recording and a digital color photograph;
2. total activity by liquid scintillation;
3. gross alpha and gross beta;
4. total radioactive strontium; and
5. other alpha- and gamma-emitting radionuclides, including ^{137}Cs .

This plan documents those areas in which standard EPA procedures and protocols cannot be followed because of the nature of the tanks and their contents. Contamination and exposure control considerations (personnel exposure and tank configuration limitations) are the same as those discussed in the Radiation Work Permit, North Tank Farm Operations Plan, and Hazardous Waste Operations and Emergency Response plans; therefore, they are not addressed in this plan. Details of the sampling procedure for collecting and containerizing wall core samples is described in the Core Drill Operations Procedure (GAAT-TS/P-195). The Sample Chain of Custody Procedure (ESP-501 Rev. 2, 10/9/95) will be used by the field team for sample identification, chain of custody, sample tracking, data review, and sample security. A report of results will be issued after the sampling and analyses activities have been completed.

2. SAMPLING RATIONALE, PRIORITY, AND ANALYSIS

The Data Quality Objectives pertinent to this plan are presented in Table 1; specific sampling parameters identified for each functional area are presented in Table 2.

Table 1. Data Quality Objectives for GAAT W-3 and W-4 sampling and analysis activities

Question	Data application	Requirement
1. What is the wall surface radioactive contamination before the walls of Tanks W-3 and W-4 are cleaned (sluiced/scarified)?	Estimate radioactivity present on tank wall surface (in material sorbed onto the wall surface that is readily removable)	Collect wall surface scrapings from identified undisturbed areas and analyze for radioactivity
2. What is the profile of radioactive contamination in the walls of Tanks W-3 and W-4 before they are cleaned?	Estimate radioactivity at consistent depth intervals in tank walls	Collect wall core samples from identified undisturbed areas and analyze for radioactivity
3. What is the wall surface radioactive contamination after the walls of Tanks W-3 and W-4 are cleaned?	Estimate radioactivity present on tank wall surface (in material sorbed onto the wall surface that is readily removable)	Collect wall surface scrapings from identified cleaned areas and analyze for radioactivity
4. What is the profile of radioactive contamination in the walls Tanks W-3 and W-4 after they are cleaned?	Estimate radioactivity at consistent depth intervals in tank walls	Collect wall core samples from identified cleaned areas and analyze for radioactivity

Table 2. Priority and rationale for GAAT W-3 and W-4 sampling and analysis activities

Item	Priority and functional area	Basis for sampling
1	Risk Management	Determine what the levels and distribution of radioactive strontium are on the surface or within the first few centimeters of the interior wall of the tank shell to compare with the prediction of the concrete diffusion model for strontium (<i>Risk Assessment Pathway/Transport Modeling for the Gunite and Associated Tanks, Oak Ridge National Laboratory, Oak Ridge, Tennessee, DOE/OR/02-1454&D1, March 1996</i>)
2	Remediation	Estimate the amount of radioactivity in the tank shells after wall cleaning (sluiced/scarified) to provide a basis for final tank shell disposition decisions or further study
3	Remediation Device Design and Operation	Compare the estimated total radioactivity in the tank shells before and after wall cleaning to determine the effectiveness of the wall cleaning operation in removing wall surface contamination
4	Measurement Device Design and Operation	Determine the correlation between wall scraping/coring results and the data provided by the Gunite Tank Isotope Mapping Probe and Characterization End Effector measurements to assess the reliability of using the Gunite Tank Isotope Mapping Probe or Characterization End Effector to measure wall contamination

3. WALL SCRAPING AND CORING SAMPLING ACTIVITIES

Table 3 is a listing of the wall scraping and coring sampling activities to be conducted in Tanks W-3 and W-4. The wall scraping device will be used to collect at least 4 to 8 scraping samples from each of Tanks W-3 and W-4, for a total of at least 8 to 16 scraping samples. Wall core samples will be collected, through the use of a coring drill deployed by the Houdini robot vehicle, from each location where a wall scraping is collected, for a total of at least 8 to 16 core samples. The total number of samples collected will depend on the technical limitations of deploying the sampling equipment and collecting the samples.

Table 3. Summary of sampling activities for GAAT W-3 and W-4

Activity	Tanks W-3 and W-4
Wall scrape samples	<ol style="list-style-type: none"> 1. Divide tank into quadrants. These same quadrants will be used for all wall scraping and coring sampling. 2. Within each quadrant, identify <i>undisturbed and cleaned</i> ("cleaned with sluicer/scarifier") <i>areas</i> of the tank wall that are appropriate for sampling 3. Collect a wall scraping sample from an identified <i>undisturbed area</i> within each quadrant, for a total of four individual samples 4. Collect a wall scraping sample from an identified <i>cleaned area</i> within each quadrant, for a total of four individual samples 5. Place each scraping blade with one adhered wall sample into an individual container, label, and send container to RMAL
Wall core samples	<ol style="list-style-type: none"> 1. Collect a wall core sample, up to 4 in. in length each, using a 0.75-in. inner diameter coring bit, from an identified <i>undisturbed area</i> within each quadrant (as close as possible to the locations in Step 3 for wall scrape samples), for a total of four individual core samples 2. Collect a wall core sample, up to 4-in. in length each, using a 0.75-in. inner diameter coring bit, from an identified <i>cleaned area</i> within each quadrant (as close as possible to the locations in Step 4 for wall scrape samples), for a total of four individual core samples 3. For each core sample, remove coring bit from drilling device while retaining core sample in coring bit or remove core sample from bit (as appropriate), place bit or core sample (as appropriate) into container, label, and send container to RMAL (see Core Drill Operations Procedure, GAAT-TS/P-195)

Before sampling and analysis begins, the tanks will be divided into quadrants. If feasible, samples will be collected from two locations (one in a cleaned area and one in an undisturbed area) within each of the quadrants. The scraping and core samples will be collected from areas located up to 5 to 6 ft above the tank floor. The distance above the floor is limited by the maximum extension of the drilling tool deployed by the Houdini robot vehicle. The exact locations of where the wall samples are taken will be determined by the GAAT Project Manager based on review of the wall videos and other existing data. Video inspection will be performed to guide the sampling devices and to evaluate the structural integrity of the walls at the scraping and coring locations. The location of

the sample retrieval will be noted in the field logbooks with cross reference to the sample identity record submitted to the RMAL. Any unusual observations will be noted in the shift supervisor's log.

If a wall scraping sample is to be collected from the same location or near enough to the location of a core sample such that the drilling operation has the potential to dislodge readily removable surface contamination, then that scraping sample will be collected *before* the wall core sample is collected. This is to ensure the removable material is captured by the scraper and not already dislodged from the wall by the drilling.

A 1-in. outer diameter coring bit with a 0.75-in. inner diameter will be used to obtain 0.75-in.-diam cores. Initial wall cores will be taken to a depth into the wall of up to 1.5 in. If the radioanalytical results on the cores show that radioactivity does not penetrate to the full depth of these cores, then cores taken subsequently will also be up to 1.5 in. in depth. If radioanalytical results of the initial 1.5-in. cores show radioactivity does penetrate to the full depth of the cores, then taking additional, deeper (e.g., up to 4 in. long) cores will be considered and determined by the GAAT Project Manager. In no instance will the tank walls be penetrated entirely through.

Initial core samples will be taken as one core per coring bit to compare with subsequent core samples taken as more than one core per coring bit. Examination of the core integrity and comparison of the effects of the two sampling methods on the core integrity will be used by the GAAT Project Manager to determine whether to sample later cores as one per bit or multiple cores per bit.

Each sample will be transported to the RMAL after it is retrieved and placed in an appropriate container. Each wall scraping sample will be retained on the scraper blade for transfer to the lab. Each core sample may be retained within the coring bit for transfer to the lab or the core sample may be removed from the bit before transfer to the lab, depending on how intact the core sample remains if removed from the bit before transport to the lab. If a core sample is retained in the coring bit for transfer to the lab, then the lab will remove the core sample from the bit, decontaminate the bit, and return it to the GAAT team for taking more samples.

At the RMAL, samples will be transferred to a high-radiation level hot cell if gamma radiation levels exceed 500 mrem/hour; otherwise, samples will be transferred to a radiochemical hood. Sample transfers will be coordinated with Waste Management, as required.

4. ANALYSIS PROCEDURES FOR SAMPLES

The RMAL, Building 2026 at ORNL, will receive the samples for physical observation and radiochemical analysis. Analyses conducted will follow standard EPA SW-846 or ORNL analytical chemistry procedures (Table 4). Standard procedure "Sample Management in the Radioactive Materials Analytical Laboratory, Building 2026 - CASD-OP-RML-AD02, Rev 1" will be followed (i.e., standard procedure for sample receipt, log in and identity, chain of custody, sample tracking, data review, sample security). The radiation level of the incoming sample will determine whether the sample is handled and prepared in a hood or hot cell. The appropriate methods used will be described in the laboratory's report of results to the GAAT Program. In all cases, any deviations from written procedures during the sampling or analysis will be documented. Samples will be retained according to the laboratory's standard operating procedure (CASD-OP-RML-AD02), with

the exception that no sample will be disposed of without written approval by the GAAT Project Manager.

Table 4. Analytical methods for GAAT W-3 and W-4 samples

Methods	Analysis
<i>Sample Management in the Radioactive Materials Analytical Laboratory, Building 2026 (CASD-OP-RML-AD02, Rev 1)</i>	Sample and data management
<i>RMAL-ORNL Quality Assurance Project Plan QAPjP for the Characterization of Radioactive Waste (QAP-X-96-CASD/RML-001)</i>	Quality assurance plan for laboratory analysis
Gross Alpha and Gross Beta Radioactivity in Drinking Water (CASD-AM-EPA-900.0)	Gross alpha and beta radioactivity sample preparation
Gamma-emitting Radionuclides in Drinking Water (CASD-AM-EPA-901.1)	Gamma-emitting radionuclides sample preparation
<i>Operation of Packard MO 2500TR Liquid Scintillation Counter (CASD-AM-RML-RA12)</i>	1. Total activity by liquid scintillation 2. Sum of alpha- and beta-emitting radionuclides analysis
<i>Operation and Calibration of the Tennelec LB4000 (CASD-AM-RML-RA02)</i>	Gross alpha and gross beta analysis
<i>Determination of ⁸⁹Sr/ ⁹⁰Sr in High Level Samples Using Extraction Chromatography (CASD-AM-RML-RA13)</i>	Radioactive strontium sample preparation
<i>Operation and Calibration of the Canberra, Nuclear Data Genie - ESP Data Acquisition and Processing (CASD-AM-RML-RA04)</i>	Alpha and gamma spectroscopy data acquisition and processing system

Figures 1 and 2 show the anticipated analysis schemes to characterize the wall scraping and core samples, respectively. As soon as the samples are transported to the RMAL, this process will begin. The scraping sample submitted to the laboratory is assumed to be mixed with sludge that has adhered to the wall surface. All samples will be removed from the sample transport container and transferred to a hot cell or radiochemical hood, as appropriate. Before any sample treatment, the samples will be photographed with a color digital camera and video camera, and a physical description of the sample (color and consistency) will be documented.

The scraping sample will be removed from the scraper blade by appropriate means, such as scraping or gently rinsing the sample off the blade with distilled, deionized water. If there is a sufficient amount of sample material on the scraper blade such that it is visible and can be weighed (e.g., not just a smear on the blade), then the sample will be weighed. Otherwise, the sample will be leached from the blade without weighing. If there is more than enough sample material than is necessary for the analyses, then the material will be well-mixed and a "representative aliquot" will be collected, weighed, and dissolved into solution. After completion of the analyses, the remaining sample material will be archived for possible future characterization.

The intact core will be gently washed by dipping into distilled, deionized water to remove surface contamination that may be caused by drag-down of material along the core surface from drilling into the wall. Core samples will then be sliced with a 1-mm-diam blade jewelry saw at consistent intervals: 0.25-in. intervals for the first 1 in. of the core starting from the interior wall

surface end, and 0.5-in. intervals for the remainder of the core. To document where along the core each slice is taken, the photograph of the intact core will be marked showing the location of each core slice cut, and each core slice will be identified and labeled to refer to its position in the original intact core. Each core slice will be gently rinsed in distilled, deionized water and digitally photographed showing the cross sectional area. The slices will be dissolved into solution individually.

Liquid scintillation counting will be performed on each prepared wall scraping sample and each separate core slice sample. Before further radiochemical analyses of the prepared core slice samples, the RMAL will report the total activity measured by liquid scintillation in each slice to the GAAT Project Manager who will decide, in conjunction with RMAL staff, whether to composite the slices based on the level of total activity. The slices, taken in the order starting from the interior surface of the wall, that account for 90% of the total activity in the entire core will be retained as separate pieces. Those slices accounting for the remaining 10% of the total activity in the entire core will be composited.

Aliquots of the (individual or composited) digested sample will be taken for radionuclide analysis. Concentrations of radionuclides will be determined on an aliquot of sample sized according to the level of radioactivity. Samples will be analyzed for total activity, gross alpha/beta, radioactive Sr, ^{137}Cs , and other radionuclides (^{134}Cs , ^{60}Co , ^{152}Eu , ^{154}Eu , ^{155}Eu , $^{239}\text{Pu}/^{240}\text{Pu}$, $^{238}\text{Pu}/^{241}\text{Am}$, ^{241}Am , and ^{244}Cm) (Table 5).

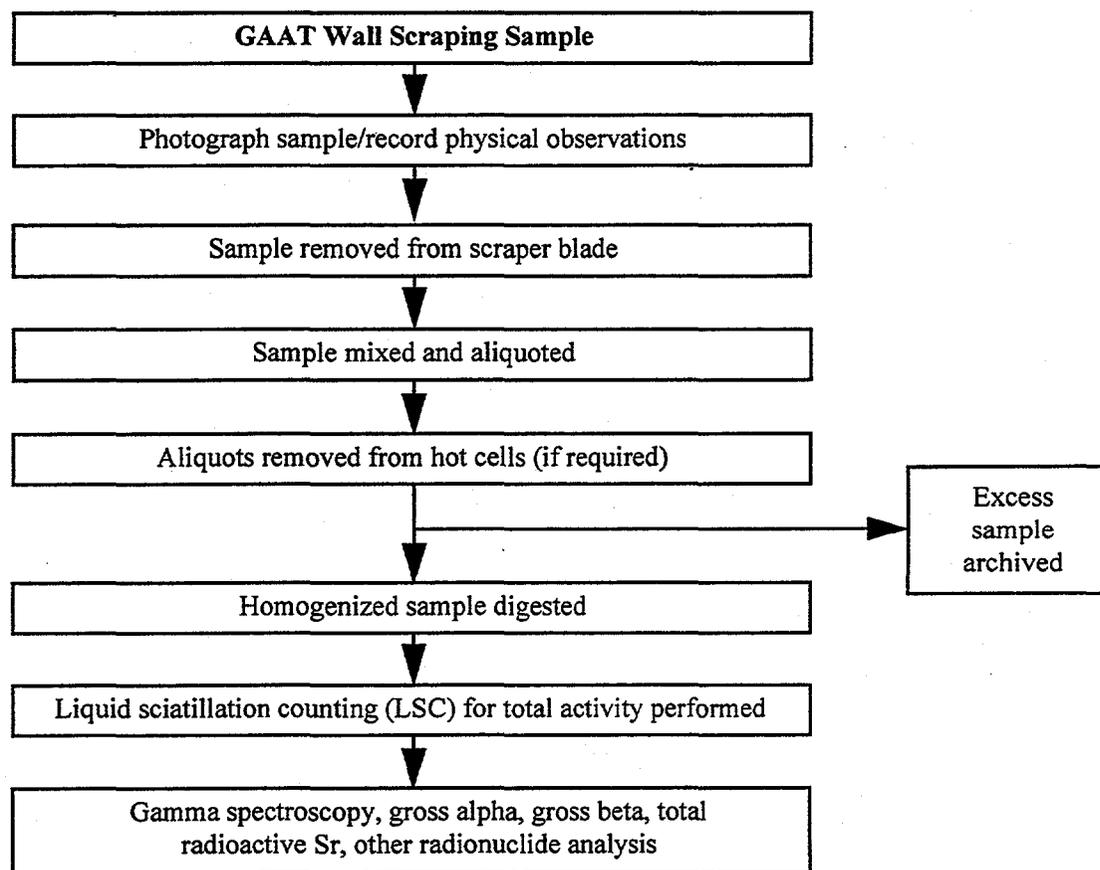


Fig. 1. Overall analysis scheme for GAAT W-3 and W-4 wall scraping samples.

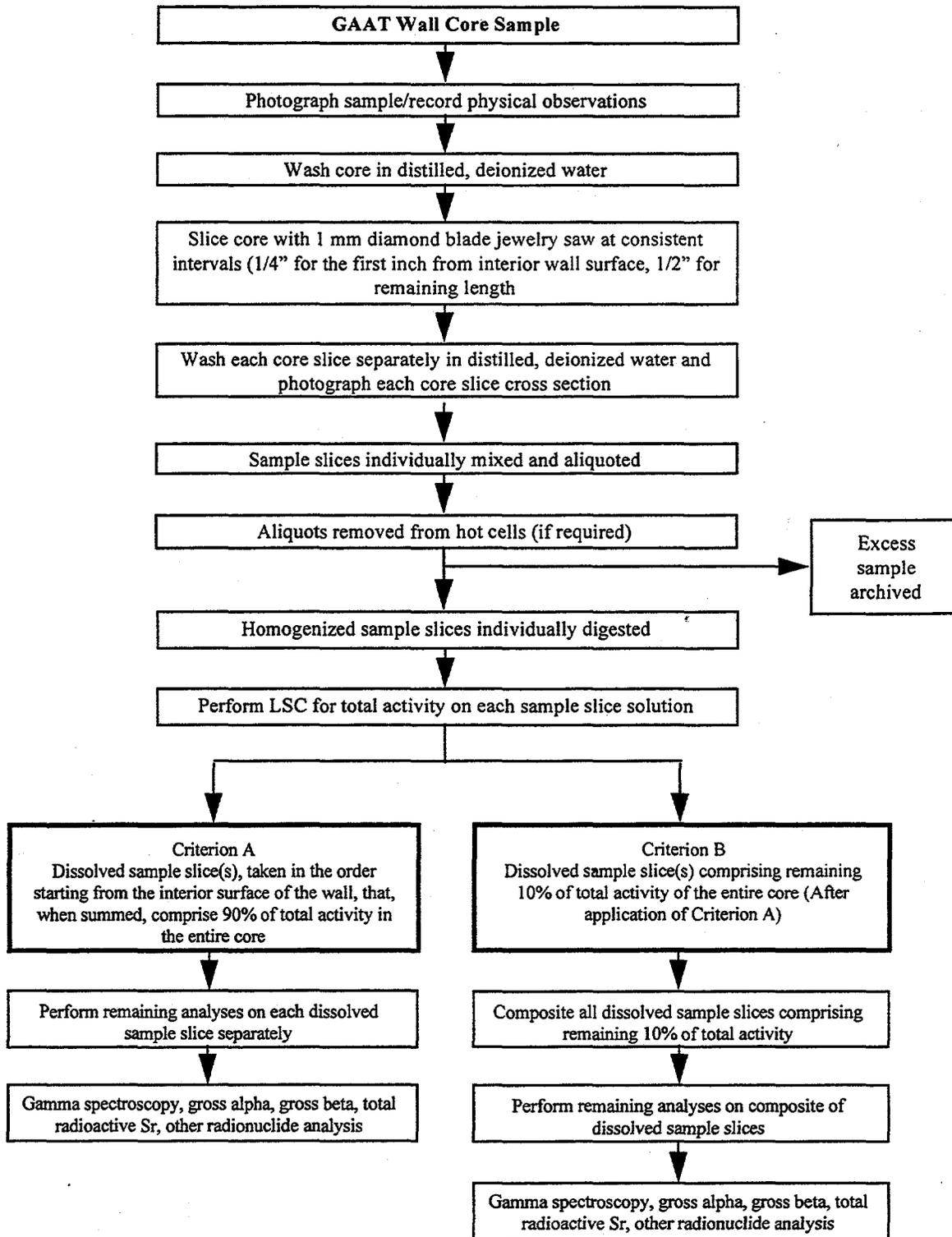


Fig. 2. Overall analysis scheme for GAAT W-3 and W-4 wall core samples.

Table 5. Analysis summary for GAAT W-3 and W-4 samples

Issues to be addressed	Type of sample	Types of analyses to be performed on each sample	Detection limit ^e
1. Risk Management	Wall scraping sample ^{a,b}	Visual observations (log description and digital photo and video)	NA
2. Remediation		Liquid scintillation count (total activity)	1 Bq/L
3. Remediation Device Design and Operation		Gamma spectroscopy for all significant gamma emitters (¹³⁷ Cs in particular, ¹³⁴ Cs, ⁶⁰ Co, ¹⁵² Eu, ¹⁵⁴ Eu, ¹⁵⁵ Eu)	0.374 Bq/L ^d
4. Measurement Device Design and Operation		Gross alpha by dry plate counting	0.11 Bq/L ^d
		Gross beta using liquid scintillation counting	0.15 /Bq/L ^d
		Standard strontium separation	0.074 Bq/L ^d
		Alpha spectroscopy (²³⁹ Pu/ ²⁴⁰ Pu, ²³⁸ Pu/ ²⁴¹ Am, ²⁴⁴ Cm, ²⁴¹ Am)	1 Bq/L
1. Risk Management	Wall core sample ^{a,b}	Visual observations (log description and digital photo and video)	NA
2. Remediation		Liquid scintillation count (total activity)	1 Bq/L
3. Remediation Device Design and Operation		Gamma spectroscopy for all significant gamma emitters (¹³⁷ Cs in particular, ¹³⁴ Cs, ⁶⁰ Co, ¹⁵² Eu, ¹⁵⁴ Eu, ¹⁵⁵ Eu)	0.374 Bq/L ^d
4. Measurement Device Design and Operation		Gross alpha by dry plate counting	0.11 Bq/L ^d
		Gross beta using liquid scintillation counting	0.15 /Bq/L ^d
		Standard strontium separation	0.074 Bq/L ^d
		Alpha spectroscopy (²³⁹ Pu/ ²⁴⁰ Pu, ²³⁸ Pu/ ²⁴¹ Am, ²⁴⁴ Cm, ²⁴¹ Am)	1 Bq/L

^aSample size may vary depending on sample tool effectiveness and collection method.

^bAnalysis protocols per RMAL ORNL Quality Assurance Project Plan for the Characterization of Radioactive Waste (QAP-X-96-CASD/RML-001).

^cThe detection limit for highly radioactive samples will vary and is dependent on factors, such as dilutions, counting time, and background levels used during the measurements.

^dThese detection limits are based on the National Primary Interim Drinking Water Regulations.

5. QUALITY CONTROL

All information generated during laboratory analysis will be filed in request folders, which will be retained by the laboratory. Copies will be made available for the tank project files. Documentation filed in the request folder for each analysis will include the following:

1. sample identity;
2. number and title of the standard procedures;

3. detailed, step-by-step description of any deviation from the standard procedures;
4. rationale for any procedural deviation;
5. results of any analysis, including results of percentage recovery of each spike and percentage difference of each set of duplicates; and
6. observations and sample description, including photos.

Review of data packages will be conducted by using the laboratory's sample management standard operating procedures (CASD-OP-RML-AD02, Rev 1). This procedure includes security measures and the initiation and use of chain-of-custody forms.

Instrument logbooks will be maintained to record periodic balance and instrument maintenance. Daily instrument and balance checks will be recorded in these logbooks. Calibration data associated with specific analyses for this project will be filed in the analytical request folder.

Information pertaining to calibration standards, spiking standards, and reagents used will be retained in the logbooks. This information will include manufacturer, lot number, and expiration dates (if any) of stocks; dates prepared; and names of persons who prepared dilutions or dissolutions. At the completion of the project, all results and information of deviation from EPA SW-846 or ORNL analytical chemistry procedures will be compiled into a report. A discussion of the probable error for the analytical results will also be included in the report.

The quality control acceptance criteria for EPA methods from SW-846 may not always be applicable or practicable for highly radioactive samples. Modifying the procedures may be necessary for as low as reasonably achievable considerations. All deviations and dilutions, and the reason for the deviations and dilutions, will be documented and reported by RMAL. Error propagation will be documented and reported.

Ordinarily, trip blanks are submitted with each shipment of samples to the laboratory. However, because so few samples per tank will be collected over an extended period of time and submitted to the laboratory, no trip blanks will be submitted to the laboratory.

6. DATA MANAGEMENT

Sampling data will be managed and validated in accordance with the GAAT Quality Assurance Project Plan (ORNL/ER-225/R1, Appendix A-1, Rev. 1 (001-225/007-0895)). The data will be compiled into a report and issued to team members. Data used to confirm the strontium diffusion model and used to select the limit of technology parameters (e.g., water pressure) for wall cleaning will be placed in the Oak Ridge Environmental Information System.

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